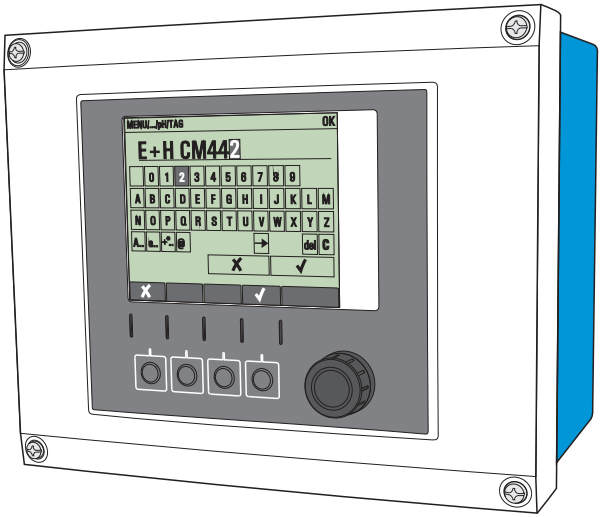
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Liquiline CM442

Universal four-wire multichannel controller

Operation & settings



BA450C/07/EN/03.10
71099471
Valid as of:
Software version 01.00.00

Endress+Hauser

People for Process Automation

Operation concept

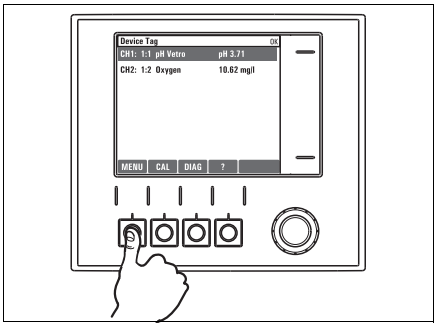


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Fig. 1: Pressing the soft key: selecting the menu directly

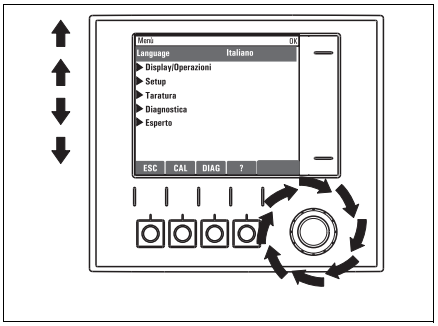

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Fig. 2: Turning the navigator: moving the cursor in the menu

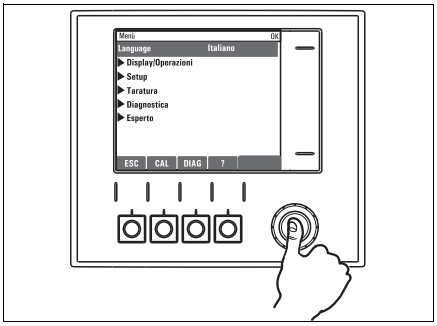

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Fig. 3: Pressing the navigator: launching a function

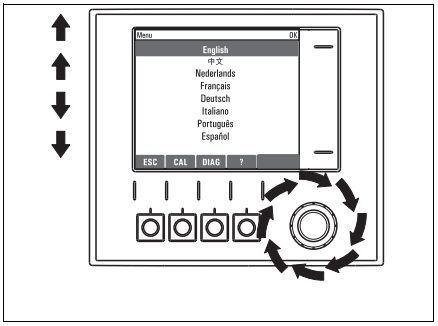

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Fig. 4: Turning the navigator: selecting a value (e.g. from a list)

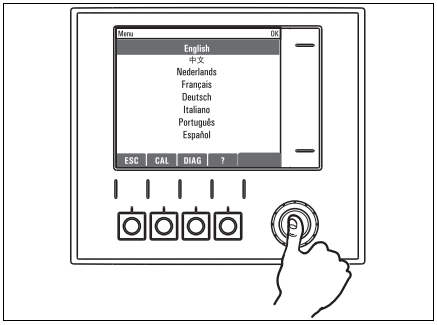

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Fig. 5: Pressing the navigator: accepting the new value

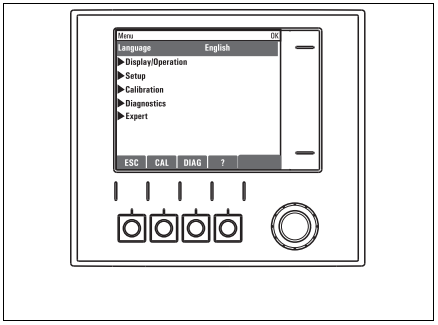

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Fig. 6: Result: new setting is accepted

Table of contents

1 About this manual

This manual gives a detailed account of all the configuration options **in the "Setup" menu**.

A description of the following menus is provided here:
- Inputs
  - Input configuration
  - Split into separate sections based on the different types of sensor that can be connected

  Some submenus are identical for all sensor types.
  These submenus are repeated in each input-specific section to make sure you can find the information you need quickly and easily.
- Outputs
  - Output configuration
  - Split into separate sections based on the different output types
- Additional functions
  - Settings for alarm sensors and controllers
  - Cleaning program configuration
- Data management
  - Firmware updates
  - Saving and loading configurations

This manual does not include the following:
- Setup/General settings
  —> Operating Instructions BA444C "Commissioning"
- Display/Operation
  —> Operating Instructions BA444C "Commissioning"
- Calibration
  —> Operating Instructions BA451C "Calibration"
- Diagnostics
  —> Operating Instructions BA445C "Maintenance & Diagnostics"
- Expert
  —> Internal Service Manual

2 Information on sensors with the Memosens protocol

Sensors with the Memosens protocol have integrated electronics that save calibration data and other information. The sensor data are automatically communicated to the transmitter when the sensor is connected and are used to calculate the measured value.

Data digital sensors save include:
- Manufacturer data
  - Serial number
  - Order code
  - Date of manufacture
- Calibration data
  - Date of calibration
  - Calibration values
  - Number of calibrations
  - Serial number of the transmitter used to perform the last calibration
- Operating data
  - Date of initial commissioning
  - Hours of operation under extreme operating conditions
  - Sensor monitoring data

The specific data that are recorded and communicated to the transmitter depend on the sensor used. Differences can also occur within a sensor type.
In the case of the CM44x controller, this causes different menu items to be displayed or hidden depending on the sensor connected.
Pay attention to specific information in this manual.

Example:
The amperometric oxygen sensor COS51D cannot be sterilized. For this reason, you will not be able to define limit values for sterilization in the diagnostics settings for this sensor. On the other hand, these menu items are displayed for a sterilizable amperometric sensor, such as COS22D.

3 Inputs: pH/ORP

3.1 Sensor identification and damping

The following functions are available for every input. The description below is always the same. However, any settings you make always individually affect the input selected.

Path: Menu/Setup/Inputs

Function	Options	Info
Sensor type	Options ■ None ■ Oxygen (amp.) ■ Oxygen (opt.) ■ pH Glass ■ pH ISFET ■ Cond c ■ Cond i ■ ORP ■ Turbidity ■ Nitrate **Factory setting** None	The function is only available if you have not connected a sensor to the input in question. You can select a sensor from the list and configure the settings for the sensor type without connecting the sensor.
<Parameter> depending on which sensor has been selected		**If no sensor is connected:** The selected sensor type is displayed **If a sensor is connected:** The user enters the menu directly
If you are configuring the settings for an input without a sensor being connected, all the subsequent functions move down one hierarchical level.		
Channel	Options ■ On ■ Off **Factory setting** On	**On** The channel display is switched on in the measuring mode **Off** The channel is not displayed in the measuring mode, regardless of whether a sensor is connected or not.
Sensor type	Read only (Only available if a sensor is connected)	Connected sensor type
Order code		Order code of the connected sensor

Path: Menu/Setup/Inputs

Function	Options	Info
Main value	Options ■ pH (only pH sensor) ■ mV ■ % (only ORP sensor) **Factory setting** pH (pH sensor) mV (ORP sensor)	Select the unit for the main measured value.
Depending on the input: Damping pH or Damping ORP or Damping Cond or Damping turbidity or Damping nitrate or Damping DO	0 to 60 s **Factory setting** 0 s	The damping causes a floating average curve of the measured values over the time specified.
Damping temp.	0 to 60 s **Factory setting** 0 s	

3.2 Temperature and medium compensation (only pH)

Path: Menu/Setup/Inputs/pH

Function	Options	Info
Temp. compensation	Options ■ Off ■ Automatic ■ Manual **Factory setting** Automatic	Decide how you want to compensate the medium temperature: ■ Automatically using the temperature sensor of your sensor (ATC) ■ Manually by entering the medium temperature ■ Not at all
This setting only refers to compensation during measurement. You enter the compensation for calibration in the calibration settings.		
Internal buffer *(only pH glass)*	pH 0 to 14 **Factory setting** pH 7.00	Only change the value if you are using a sensor with an internal buffer other than pH 7.
Medium comp.	Options ■ Off ■ 2-point ■ Table **Factory setting** Off	Take a sample from the medium and determine its pH value at different temperatures in the lab. Decide whether you want to compensate using two points or several points in a table.
The dissociation of water changes with increasing temperature. The balance shifts towards the protons; the pH value drops. You can balance out this effect with the "Medium compensation" function.		

3.3 Main value and temperature format

Path: Menu/Setup/Inputs/pH or ORP

Function	Options	Info
Main value format *(only pH)*	Options ■ #.# ■ #.## **Factory setting** #.#	Specify the number of decimal places for displaying the main measured value.
Temperature format	Options ■ #.# ■ #.## **Factory setting** #.#	Select how many decimal places should be used to display the temperature.

3.4 Cleaning

Path: Menu/Setup/Inputs/<Parameter> (depends on input)

Function	Options	Info
Cleaning	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Select a cleaning program. This program is executed if: ■ A diagnostics message is present at the channel **and** ■ A cleaning process has been specified for this message (—> "Inputs/Diag. settings/Diag. behavior").

You define the cleaning programs in the "Setup/Additional functions/Cleaning" menu.

3.5 Calibration settings

3.5.1 Stability criteria

You define the permitted measured value fluctuation which must not be exceeded in a certain timeframe during calibration.
If the permitted difference is exceeded, calibration is not permitted and is aborted automatically.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
▶ Stability criteria		
Delta mV	1 to 10 mV **Factory setting** 1 mV	Permitted measured value fluctuation during calibration
Duration	10 to 60 s **Factory setting** 20 s	Timeframe within which the permitted range for measured value fluctuation should not be exceeded

3.5.2 Buffer recognition (only pH)

Automatic buffer recognition

To ensure a buffer is detected correctly, the measuring signal may deviate by a maximum of 30 mV from the value stored in the buffer table. This is approx. 0.5 pH at a temperature of 25°C. If both buffers - 9.00 and 9.20 - were used, this would cause the signal intervals to overlap and buffer recognition would not work. For this reason, the controller would recognize a buffer with a pH of 9.00 as a pH of 9.20. —> Do not use the buffer with a pH of 9.00 for automatic buffer recognition.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Temp. compensation	Options ■ Off ■ Automatic ■ Manual **Factory setting** Automatic	Decide how you want to compensate the buffer temperature: ■ Automatically using the temperature sensor of your sensor (ATC) ■ Manually by entering the buffer temperature ■ Not at all
Temperature *Temp. compensation="Manual"*	-50 to 250 °C (-58 to 482 °F) **Factory setting** 25 °C (77 °F)	Specify the buffer temperature.
This setting only refers to compensation during calibration, not in measuring mode. You perform the compensation in the measuring mode further down in the menu.		

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Buffer recognition	Options ■ fixed ■ Automatic *(only pH glass)* ■ Manual **Factory setting** fixed	**fixed** You choose values from a list. This list depends on the setting for "Buffer manufacturer". **Automatic***(only pH glass)* The controller recognizes the buffer automatically. The recognition depends on the setting for "Buffer manufacturer". **Manual** You enter any two buffer values. These must differ in terms of their pH value.
Buffer manufacturer	Options ■ Endress+Hauser ■ Ingold/Mettler ■ DIN 19266 ■ DIN 19267 ■ Merck/Riedel ■ Hamilton ■ Special buffer **Factory setting** Endress+Hauser	Temperature tables are stored internally in the unit for the following pH values: ■ Endress+Hauser 2.00 / 4.00 / 7.00 / *(9.00)* / 9.20 / 10.00 / 12.00 ■ Ingold/Mettler 2.00 / 4.01 / 7.00 / 9.21 ■ DIN 19266 1.68 / 4.01 / 6.86 / 9.18 ■ DIN 19267 1.09 / 4.65 / 6.79 / 9.23 / 12.75 ■ Merck/Riedel 2.00 / 4.01 / 6.98 / 8.95 / 12.00 ■ Hamilton 1.09 / 1.68 / 2.00 / 3.06 / 4.01 / 5.00 / 6.00 7.00 / 8.00 / 9.21 / 10.01 / 11.00 / 12.00
ℹ You have the possibility of defining two buffers of your own with the "Special buffer" option. For this purpose, two tables are displayed in which you can enter value pH value/temperature value pairs.		
Isotherm pnt.	pH 0 to 14 **Factory setting** pH 7.00	Isotherm intersection pH glass: Value is identical to the internal buffer. Do not change the value. pH-ISFET: The controller automatically accepts the value saved at the factory.

3.5.3 Calibration timer and calibration expiration date

You can specify the calibration interval for the sensor here.
Once the time configured elapses, the "Calibration timer" diagnostics message appears on the display.

The timer is reset automatically if you recalibrate the sensor.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Calibration timer	Options ■ Off ■ On **Factory setting** Off	Switches the function on or off
Calibration timer *Calibration timer="On"*	1 to 10000 h **Factory setting** 1000 h	Specify the time after which the timer should have timed out. Once this time has elapsed, the "Sensor check" diagnostics message, along with the code 102, appears on the display.
Calib. expiration date	Options ■ Off ■ On **Factory setting** Off	The function checks whether the calibration of a sensor is still valid. Example: You install a precalibrated sensor. The function checks how much time has elapsed since the sensor was last calibrated. A diagnostics message is displayed if the time since the last calibration is longer than the predefined warning and alarm limit.
▶ Calib. expiration date		
Warning limit	1 to 12 months **Factory setting** 11 months	Diagnostics message: 105 "Sensor check" Warning and alarm limits mutually affect each other's possible ranges for adjustment.
Alarm limit	1 to 12 months **Factory setting** 12 months	Diagnostics message: 104 "Sensor check" General rule: Alarm limit > warning limit

3.6 Diagnostics settings

This menu branch is used for specifying alarm and warning limits, and for defining whether and how diagnostics tools should be used.
The associated diagnostics code is displayed for every setting.

3.6.1 Sensor check system (only pH glass)

The sensor check system (SCS) monitors the high impedance of the pH glass.
An alarm is issued if a minimum impedance value is undershot or a maximum impedance is exceeded.

- Glass breakage is the main reason for a drop in high impedance values.
- The reasons for increasing impedance values include:
  - Dry sensor
  - Worn pH glass membrane

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Glass impedance (SCS)	0 to 10000 MΩ	Specify your limit values for monitoring the impedance of the pH glass.
Function	Options ■ On ■ Off **Factory setting** On	**On** SCS operates with the following settings for the warning and alarm limits. **Off** SCS is switched off.
Upper alarm limit	**Factory setting** 2000 MΩ	Diagnostics code and associated message text: 124 "Sensor glass"
Upper warning limit	**Factory setting** 1600 MΩ	Diagnostics code and associated message text: 125 "Sensor glass"
Lower warning limit	**Factory setting** 1 MΩ	Diagnostics code and associated message text: 123 "Sensor glass"
Lower alarm limit	**Factory setting** 0 MΩ	Diagnostics code and associated message text: 122 "Sensor glass"

3.6.2 Slope (only pH)

The slope characterizes the sensor condition. The bigger the deviation from the ideal value (59 mV/pH) the poorer the condition of the sensor.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Slope	5.00 to 99.00 mV/pH	Specify your limit values for slope monitoring.
Warning limit	**Factory setting** 55.00 mV/pH	Associated diagnostics code and message text: 509 "Sensor calib."
Alarm limit	**Factory setting** 53.00 mV/pH	Associated diagnostics code and message text: 508 "Sensor calib."

3.6.3 Zero point (only pH glass) or Operating point (only pH-ISFET)

pH glass sensors

The zero point characterizes the condition of the sensor reference. The bigger the deviation from the ideal value (pH 7.00) the poorer the condition. This can be caused by KCl leaking or reference contamination.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Zero point *(pH glass)* Operating point *(pH ISFET)*	**pH glass** -2.00 to 16.00 **pH ISFET** -950 mV to 950 mV	Specify your limit values for zero point or operating point monitoring.
Upper alarm limit	**Factory setting** pH 9.00 / 400 mV	Associated diagnostics code and message text: 504 "Sensor calib." (pH glass) 514 "Sensor calib." (pH ISFET)
Upper warning limit	**Factory setting** pH 8.00 / 300 mV	Associated diagnostics code and message text: 505 "Sensor calib." (pH glass) 515 "Sensor calib." (pH ISFET)
Lower warning limit	**Factory setting** pH 6.00 / -300 mV	Associated diagnostics code and message text: 507 "Sensor calib." (pH glass) 517 "Sensor calib." (pH ISFET)
Lower alarm limit	**Factory setting** pH 5.00 / -400 mV	Associated diagnostics code and message text: 506 "Sensor calib." (pH glass) 516 "Sensor calib." (pH ISFET)

3.6.4 Sensor condition check (only pH glass)

Sensor condition check (SCC) monitors the electrode status and the degree of electrode aging. The electrode status is updated after every calibration.

The main reasons for a deteriorating electrode status are:
- Glass membrane blocked or dry
- Diaphragm (reference) blocked

Remedial action
1. Clean or regenerate the sensor.
2. Replace the sensor if this does not have the desired effect.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Sensor Condition Check		The function can only be switched on or off. It uses internal limit values
Function	Options ■ On ■ Off **Factory setting** On	Diagnostics code and associated message text: 127 "SCC sufficient" 126 "SCC bad"

3.6.5 ORP-Meas value (only ORP)

You can specify limit values in order to monitor your process. A diagnostics message is displayed if the limits are exceeded or undershot.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ ORP-Meas value		Specify your limit values for monitoring the measured value.
Upper alarm limit	**Factory setting** 1000 mV	Diagnostics code and associated message text: 842 "Process value"
Upper warning limit	**Factory setting** 900 mV	Diagnostics code and associated message text: 942 "Process value"
Lower warning limit	**Factory setting** -900 mV	Diagnostics code and associated message text: 943 "Process value"
Lower alarm limit	**Factory setting** -1000 mV	Diagnostics code and associated message text: 843 "Process value"

3.6.6 Process check system

The process check system (PCS) checks the measuring signal for stagnation. An alarm is triggered if the measuring signal does not change over a certain period (several measured values).

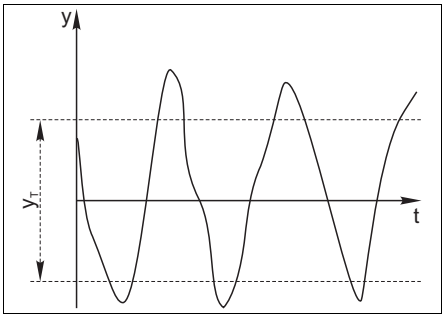


Fig. 7: Normal measuring signal, no alarm

y Measuring signal
y_T Set value for "Tolerancewidth"

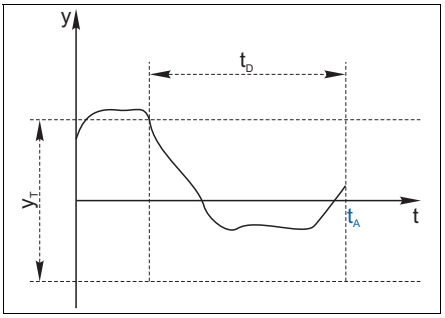


Fig. 8: Stagnating signal, alarm is triggered

t_D Set value for "Duration"
t_A Time when the alarm is triggered

The main causes of stagnating measured values are:
- Contaminated sensor, or sensor in air
- Sensor failure
- Process error (e.g. through control system)

Remedial action

1. Clean the sensor.
2. Check the measuring chain.
3. Switch off the controller and switch it back on again.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Process Check System		Diagnostics code and associated message text: 904 "Process check"
Function	Options ■ On ■ Off **Factory setting** On	
Duration	1 to 240 min **Factory setting** 60 min	The measured value must change during this time. Otherwise the error message is triggered.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
Tolerancewidth *not available with pH/*Redox	0.01 to 20 % **Factory setting** 0.05 %	Interval around the measuring signal (raw value) for detecting stagnation. Measured values within the set interval are regarded as stagnating.

3.6.7 Limits operating hours

The total operating time of the sensor and its use under extreme conditions is monitored. If the operating time exceeds the defined threshold values, the device issues a corresponding warning or alarm.

Each sensor has a limited life expectancy which heavily depends on the operating conditions. If you specify warning and alarm limits for operating times under extreme conditions, you can guarantee the operation of your measuring point without any downtime by performing maintenance tasks in time.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Limits operating hours		Specify your limit values for monitoring the number of operating hours under extreme conditions.
The range of adjustment for the operating hours alarm and warning limits is generally 1 to 50000 h.		
Function	Options ■ On ■ Off **Factory setting** On	**On** The operation of the sensor under extreme conditions is monitored, recorded in the sensor and diagnostics messages are displayed on the controller. **Off** No diagnostics messages. However, the time the sensor operates under extreme conditions is recorded in the sensor and can be read in the sensor information in the diagnostics menu.
▶ Operating time		Total operating time of the sensor
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 199 "Operating time"
▶ Operation > 80°C		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 193 "Operating time"
▶ Operation > 100°C		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 194 "Operating time"

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Operation < -300 mV		*only pH*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 180 "Operating time"
▶ Operation > 300 mV		*only pH*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 179 "Operating time"

3.6.8 Delta slope (only pH)

The device determines the difference in slope between the last calibration and the penultimate calibration, and issues a warning or an alarm depending on the setting configured. The difference is an indicator for the condition of the sensor. The greater the change, the greater the wear experienced by the pH-sensitive glass membrane as a result of chemical corrosion or abrasion.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Delta slope	0.10 to 10.00	Specify your limit values for monitoring the slope differential.
Function	Options ■ On ■ Off **Factory setting** Off	
Warning limit	**Factory setting** 5.00 mV/pH	Diagnostics code and associated message text: 518 "Sensor calib."
Alarm limit	**Factory setting** 6.00 mV/pH	Diagnostics code and associated message text: 145 "Delta slope al"

3.6.9 Delta zeropoint (only pH glass) or Delta operating point (only pH ISFET)

The device determines the difference between the last calibration and the penultimate calibration, and issues a warning or an alarm depending on the setting configured. The difference is an indicator for the condition of the sensor. The following applies to pH glass electrodes: The greater the change, the greater the wear experienced by the reference as a result of contaminating ions or KCl leaks.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Delta zeropoint *(pH glass)* Delta operating point *(pH ISFET)*	**pH glass** pH 0.00 to 2.00 **pH ISFET** 0 to 950 mV	Specify your limit values for monitoring the zero point or operating point differential.
Function	Options ■ On ■ Off **Factory setting** Off	
Warning limit	**Factory setting** pH 0.50 / 25 mV	Diagnostics code and associated message text: 520 "Sensor calib." (pH glass) 522 "Sensor calib." (pH ISFET)
Alarm limit	**Factory setting** pH 1.00 / 50 mV	Diagnostics code and associated message text: 519 "Sensor calib." (pH glass) 521 "Sensor calib." (pH ISFET)

3.6.10 Sterilizations

The system counts the number of operating hours in which the sensor is exposed to a temperature that is typical for a sterilization. This temperature depends on the sensor.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Sterilizations	0 to 99	Specify the limit values for the number of sensor sterilizations.
Function	Options ■ On ■ Off **Factory setting** Off	
Warning limit	**Factory setting** 30	Diagnostics code and associated message text: 108 "Sensor check"

3.6.11 Diagnostic behavior

This branch, along with the same functions, can be found in various parts of the menu. The list of diagnostic messages displayed depends on the path selected. There are device-specific messages, and messages that depend on what sensor is connected.

Paths: Menu/Setup/General settings/Diagnostics or
Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
List of diagnostic messages		Select the message to be changed.
Diagnostic message	Options ■ On ■ Off **Factory setting** Depends on the message	You can deactivate or reactivate a diagnostic message here. Deactivating means: ■ No error message in the measuring mode ■ No error current at the current output
Error class	Options ■ Maintenance (M) ■ Out of specification (S) ■ Function check (C) ■ Failure (F) **Factory setting** Depends on the message	The messages are divided into different error classes in accordance with NAMUR NE 107. —> BA445C "Maintenance&diagnostics"
Error current	Options ■ On ■ Off **Factory setting** Depends on the message	Decide whether an error current should be output at the current output if the diagnostic message display is activated.
Diag. output	Options ■ None ■ Alarm relay ■ Relay 1 to n (depends on the device version) **Factory setting** None	You can use this function to select an output to which the diagnostic message should be assigned. You first have to configure a relay output before being able to assign the message to an output (Menu/Setup/Outputs, assign "Diagnostics" function and set Operating mode to "Normal"). —> BA450C "Operation&configuration"
One alarm relay is always available, regardless of the device version. Other relays are optional.		
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Decide whether the diagnostic message should trigger a cleaning program. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.
Info	Read only	Here you can find more information on the diagnostic message and instructions on how to resolve the problem.

3.7 Tag control

"Tag" stands for the name of a measuring point, and is used in many areas of process measuring technology.

Path: Menu/Setup/Inputs

Function	Options	Info
▶ Tag control		Additional information on the display: tag control currently used
Operating mode	Options ■ Off ■ Tag ■ Tag group **Factory setting** Off	**Off** No tag control, all sensors are accepted. **Tag** Only sensors with the same tag are accepted. **Tag group** Only sensors in the same tag group are accepted.
Tag group	Customized text **Factory setting** EH_CM44_	Enter the tag name. The controller checks every sensor to be connected as to whether this sensor belongs to the measuring point, and only accepts the sensors that have the same tag.

3.8 Sensor input factory setting

Here you can restore the factory settings for the sensor input. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for this particular input are restored. All other settings remain unchanged.

4 Inputs: Conductivity

Enter the "Inputs" menu

1. Select: Menu/Setup/Inputs.
2. Navigate to an input channel to which a conductivity sensor is connected.
3. Press the navigator button to configure the input.

4.1 Temperature format, sensor identification and damping

The following functions are available for every input. The description below is always the same. However, any settings you make always individually affect the input selected.

Path: Menu/Setup/Inputs

Function	Options	Info
Sensor type	Options ■ None ■ Oxygen (amp.) ■ Oxygen (opt.) ■ pH Glass ■ pH ISFET ■ Cond c ■ Cond i ■ ORP ■ Turbidity ■ Nitrate **Factory setting** None	The function is only available if you have not connected a sensor to the input in question. You can select a sensor from the list and configure the settings for the sensor type without connecting the sensor.
<Parameter> depending on which sensor has been selected		**If no sensor is connected:** The selected sensor type is displayed **If a sensor is connected:** The user enters the menu directly
If you are configuring the settings for an input without a sensor being connected, all the subsequent functions move down one hierarchical level.		
Channel	Options ■ On ■ Off **Factory setting** On	**On** The channel display is switched on in the measuring mode **Off** The channel is not displayed in the measuring mode, regardless of whether a sensor is connected or not.
Temperature format	Options ■ #.# ■ #.## **Factory setting** #.#	Select how many decimal places should be used to display the temperature.
Sensor type	Read only (Only available if a sensor is connected)	Connected sensor type
Order code		Order code of the connected sensor

Path: Menu/Setup/Inputs

Function	Options	Info
Depending on the input: Damping pH or Damping ORP or Damping Cond or Damping turbidity or Damping nitrate or Damping DO	0 to 60 s **Factory setting** 0 s	The damping causes a floating average curve of the measured values over the time specified.
Damping temp.	0 to 60 s **Factory setting** 0 s	

4.2 Operating mode and cell constant

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Operating mode	Options ■ Conductivity ■ Resistance *(only Cond c)* ■ Concentration *(only Cond i)* **Factory setting** Conductivity	Alternatively to the conductivity, you can also measure the resistivity with a **conductive conductivity sensor**. Alternatively to the conductivity, you can determine the concentration of the medium with an **inductive conductivity sensor**.
Cell constant	Read only (Only available if a sensor is connected)	The cell constant of the connected sensor is displayed (—> sensor certificate)

4.3 Installation factor (only inductive sensors)

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Inst. factor	Read only (Only available if a sensor is connected)	Displays the current value. Only changes with a calibration.

In confined installation conditions, the wall affects conductivity measurement in the liquid. The installation factor compensates for this effect. The transmitter corrects the cell constant by multiplying by the installation factor.
The size of the installation factor depends on the diameter and the conductivity of the pipe nozzle, as well as the distance between the sensor and the wall.
If there is a sufficient distance between the wall and the sensor (a > 15 mm (0.59"), from DN 80), the installation factor f does not have to be taken into consideration (f = 1.00).
If distances from the wall are smaller, the installation factor is bigger for electrically insulating pipes (f >1), and smaller for electrically conductive pipes (f < 1).
It can be measured using calibration solutions, or a close approximation determined from the following diagram.

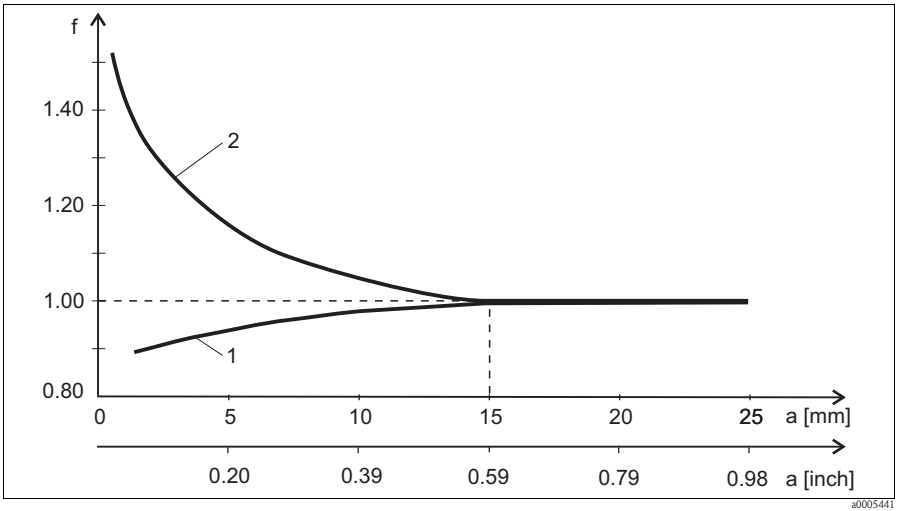


Fig. 9: Relation between the installation factor f and the wall distance

1 Electrically conductive pipe wall
2 Electrically insulating pipe wall

4.4 Concentration table (only inductive sensors)

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Conc. Table *(Operating mode=Concentration)*	Options ■ NaOH 0..15% ■ NaOH 18..50% ■ HCl ■ HNO3 ■ H2SO4 0..30% ■ H2SO4 32..84% ■ H3PO4 ■ User table 1 ■ User table 2 ■ User table 3 ■ User table 4 **Factory setting** NaOH 0..15%	Concentration tables saved at the factory: NaOH: 0 to 15%, 0 to 100 °C NaOH: 18 to 50%, 0 to 100 °C HCl: 0 to 20%, 0 to 80 °C HNO_3: 0 to 25%, 0 to 90 °C H_2SO_4: 0 to 30%, 0 to 100 °C H_2SO_4: 32 to 84%, 0 to 100 °C H_3PO_4: 0 to 15%, 0 to 90 °C
Temp. comp. mode *(Operating mode=Concentration)*	Options ■ with temp. comp ■ without temp. comp **Factory setting** with temp. comp	Only select "without temp. comp" in very small temperature ranges. In all other cases, select "with temp. comp".
Table name *(Conc. Table=one of the user tables)*	Customized text, 16 characters	Assign a meaningful name to the selected table.
▶ Edit table *(Conc. Table=one of the user tables)*	3-column table	Assign conductivity and concentration value pairs for a specific temperature.
Conc. unit *(Operating mode=Concentration)*	**Read only** %	This is for information purposes only. No options are available.

Example of a concentration table:

Conductivity (uncompensated)	Concentration	Temperature
1.000 mS/cm	0.000 mg/l	0.00 °C
2.000 mS/cm	0.000 mg/l	100.00 °C
100.0 mS/cm	3.000 mg/l	0.00 °C
300.0 mS/cm	3.000 mg/l	100.00 °C

4.5 Main measured value and unit

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Cond. unit *(Operating mode=Conductivity)* Unit *(Operating mode=Resistance)*	Options Conductivity/resistance ■ Auto / Auto ■ µS/cm / MΩm ■ mS/cm / MΩcm ■ S/cm / kΩcm ■ µS/m / kΩm ■ mS/m / Ωm ■ S/m / Ωcm **Factory setting** Auto / Auto	The picklist depends on the operating mode. You can either choose from units for conductivity or units for resistivity. Since there are no options for concentration measurement, this function is not displayed for such measurements.
Main value format	Options ■ Auto ■ # ■ #.# ■ #.## ■ #.### **Factory setting** #.###	Specify the number of decimal places. "Auto" means: the number of digits is automatically set in dependence of the measured value.
Alpha ref. temp.	-5.0 to 100.0 °C (23.0 to 212.0 °F) **Factory setting** 25.0 °C (77.0 °F)	Reference temperature for calculating the temperature-compensated conductivity The alpha coefficients and alpha reference temperatures of Endress+Hauser calibration solutions can be found in the documentation enclosed.
Temp. source	Options ■ Sensor ■ Manual **Factory setting** Sensor	Decide how you want to compensate the medium temperature: ■ Automatically using the temperature sensor of your sensor ■ Manually by entering the medium temperature
Medium temperature *(Temp. source=Manual)*	-50.0 to 250.0 °C (-58.0 to 482.0 °F) **Factory setting** 25.0 °C (77 °F)	Enter the temperature of your medium.

4.6 Temperature compensation

Temperature coefficient α = change in the conductivity per degree of temperature change:
$\kappa(T) = \kappa(T_0)(1 + \alpha(T - T_0))$
$\kappa(T)$ ... conductivity at process temperature T
$\kappa(T_0)$ ... conductivity at reference temperature T_0

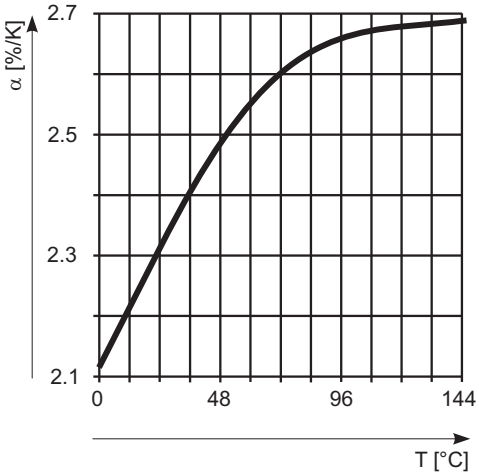
The temperature coefficient depends both on the chemical composition of the solution and the temperature itself.

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Compensation *(Operating mode=Conductivity)*	Options ■ None ■ Linear ■ NaCl (IEC 746-3) ■ Water ISO7888 ■ UPW NaCl ■ UPW HCl ■ User table 1 ■ User table 2 ■ User table 3 ■ User table 4 **Factory setting** Linear	Various methods are available to compensate for the temperature dependency. Depending on your process, decide which type of compensation you want to use. Alternatively, you can also select "None" and thus measure uncompensated conductivity.

Linear temperature compensation
The change between two temperature points is taken to be constant, i.e. α = const. The value for alpha is stored in the sensor and is recalculated for each calibration. You already specified the related reference temperature in this menu.

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
NaCl compensation In the case of NaCl compensation (as per IEC 60746), a fixed non-linear curve specifying the relationship between the temperature coefficient and temperature is saved in the device. This curve applies to low concentrations of up to approx. 5 % NaCl.  **Compensation for natural water** A non-linear in accordance with ISO 7888 is saved in the device for temperature compensation in natural water. **Ultrapure water compensation (for conductive sensors)** Algorithms for pure and ultrapure water are stored in the device. These algorithms take the dissociation of the water and its temperature dependency into account. They are used for conductivity values up to approx. 100 µS/cm. ■ UPW NaCl: Optimized for pH-neutral contamination. ■ UPW HCl: Optimized for measuring the acid conductivity downstream of a cation exchanger. Also suitable for ammonia (NH_3) and caustic soda (NaOH).		
User-defined tables You can save a function that takes the properties of your specific process into account. To do so, determine the value pairs made up of the temperature T and conductivity κ with: ■ $\kappa(T_0)$ for the reference temperature T_0 ■ $\kappa(T)$ for the temperatures that occur in the process Use the following formula to calculate the α values for the temperatures that are relevant in your process: $\alpha = \frac{100\%}{\kappa(T_0)} \cdot \frac{\kappa(T) - \kappa(T_0)}{T - T_0}$; $T \neq T_0$		
Temp. comp. mode *(Operating mode=Conductivity)*	Options ■ Conductivity ■ Coeff. Alpha **Factory setting** Conductivity	**Conductivity** You specify the temperature, conductivity and uncompensated conductivity. Recommended for large measuring ranges and small measured values. **Coeff. Alpha** As the value pairs, you specify an alpha value and the related temperature.

Path: Menu/Setup/Inputs/Conductivity

Function	Options	Info
Table name *(Compensation=one of the user tables)*	Customized text, 16 characters	Assign a meaningful name to the selected table.
▶ Edit table *(Compensation=one of the user tables)*	■ Temperature ■ Conductivity ■ Temperature comp. cond. or ■ Temperature ■ Coefficient alpha	Maximum number of rows: 25 The type of table depends on the option under "Temp. comp. mode".

4.7 Cleaning

Path: Menu/Setup/Inputs/<Parameter> (depends on input)

Function	Options	Info
Cleaning	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Select a cleaning program. This program is executed if: ■ A diagnostics message is present at the channel **and** ■ A cleaning process has been specified for this message (—> "Inputs/Diag. settings/Diag. behavior").

You define the cleaning programs in the "Setup/Additional functions/Cleaning" menu.

4.8 Diagnostics settings

This menu branch is used for specifying alarm and warning limits, and for defining whether and how diagnostics tools should be used.
The associated diagnostics code is displayed for every setting.

4.8.1 Process check system

The process check system (PCS) checks the measuring signal for stagnation. An alarm is triggered if the measuring signal does not change over a certain period (several measured values).

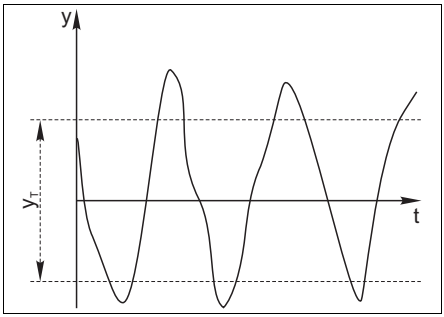


Fig. 10: Normal measuring signal, no alarm

y *Measuring signal*
y_T *Set value for "Tolerancewidth"*

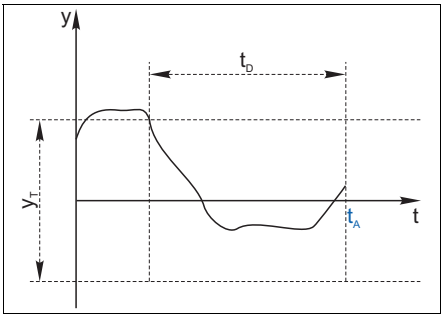


Fig. 11: Stagnating signal, alarm is triggered

t_D *Set value for "Duration"*
t_A *Time when the alarm is triggered*

The main causes of stagnating measured values are:
- Contaminated sensor, or sensor in air
- Sensor failure
- Process error (e.g. through control system)

Remedial action
1. Clean the sensor.
2. Check the measuring chain.
3. Switch off the controller and switch it back on again.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Process Check System		Diagnostics code and associated message text: 904 "Process check"
Function	Options ■ On ■ Off **Factory setting** On	

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
Duration	1 to 240 min **Factory setting** 60 min	The measured value must change during this time. Otherwise the error message is triggered.
Tolerancewidth *not available with pH/*Redox	0.01 to 20 % **Factory setting** 0.05 %	Interval around the measuring signal (raw value) for detecting stagnation. Measured values within the set interval are regarded as stagnating.

4.8.2 Limits operating hours

The total operating time of the sensor and its use under extreme conditions is monitored. If the operating time exceeds the defined threshold values, the device issues a corresponding warning or alarm.

Each sensor has a limited life expectancy which heavily depends on the operating conditions. If you specify warning and alarm limits for operating times under extreme conditions, you can guarantee the operation of your measuring point without any downtime by performing maintenance tasks in time.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Limits operating hours		
The range of adjustment for the operating hours alarm and warning limits is generally 1 to 50000 h.		
Function	Options ■ On ■ Off **Factory setting** Off	**On** The operation of the sensor under extreme conditions is monitored, recorded in the sensor and diagnostics messages are displayed on the controller. **Off** No diagnostics messages. However, the time the sensor operates under extreme conditions is recorded in the sensor and can be read in the sensor information in the diagnostics menu.
▶ Operating time		Total operating time of the sensor
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 199 "Operating time"
▶ Operation > 80°C		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 193 "Operating time"

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Operation > 120°C		*Only conductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 195 "Operating time"
▶ Operation > 125°C		*Only inductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 196 "Operating time"
▶ Operation > 140°C		*Only conductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 197 "Operating time"
▶ Operation > 150°C		*Only inductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 198 "Operating time"
▶ Operation > 80°C < 100nS/cm		*Only conductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 187 "Operating time"
▶ Operation < 5°C		*Only inductive sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 188 "Operating time"

4.8.3 Sterilizations

The system counts the number of operating hours in which the sensor is exposed to a temperature that is typical for a sterilization. This temperature depends on the sensor.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Sterilizations	0 to 99	Specify the limit values for the number of sensor sterilizations.
Function	Options ■ On ■ Off **Factory setting** Off	
Warning limit	**Factory setting** 30	Diagnostics code and associated message text: 108 "Sensor check"

4.8.4 Diagnostic behavior

This branch, along with the same functions, can be found in various parts of the menu. The list of diagnostic messages displayed depends on the path selected. There are device-specific messages, and messages that depend on what sensor is connected.

Paths: Menu/Setup/General settings/Diagnostics or
Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
List of diagnostic messages		Select the message to be changed.
Diagnostic message	Options ■ On ■ Off **Factory setting** Depends on the message	You can deactivate or reactivate a diagnostic message here. Deactivating means: ■ No error message in the measuring mode ■ No error current at the current output
Error class	Options ■ Maintenance (M) ■ Out of specification (S) ■ Function check (C) ■ Failure (F) **Factory setting** Depends on the message	The messages are divided into different error classes in accordance with NAMUR NE 107. —> BA445C "Maintenance&diagnostics"
Error current	Options ■ On ■ Off **Factory setting** Depends on the message	Decide whether an error current should be output at the current output if the diagnostic message display is activated.
Diag. output	Options ■ None ■ Alarm relay ■ Relay 1 to n (depends on the device version) **Factory setting** None	You can use this function to select an output to which the diagnostic message should be assigned. You first have to configure a relay output before being able to assign the message to an output (Menu/Setup/Outputs, assign "Diagnostics" function and set Operating mode to "Normal"). —> BA450C "Operation&configuration"
One alarm relay is always available, regardless of the device version. Other relays are optional.		
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Decide whether the diagnostic message should trigger a cleaning program. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.
Info	Read only	Here you can find more information on the diagnostic message and instructions on how to resolve the problem.

4.8.5 Polarization detection (only conductive sensors)

As a result of flow through the electrolyte/electrode interface, reactions take place here which result in additional voltage. These polarization effects limit the measuring range of conductive sensors. Sensor-specific compensation increases the level of accuracy at the measuring range limits.

The controller recognizes the Memosens sensor and automatically uses suitable compensation. You can view the measuring range limits of the sensor under Diagnostics/Sensor information/Sensor specifications.

Path: Menu/Setup/Inputs/Conductivity/Polarisation

Function	Options	Info
Polarisation	Options ■ On ■ Off **Factory setting** Off	Diagnostics code and associated message text: 168 "Sensor check"

4.9 Tag control

"Tag" stands for the name of a measuring point, and is used in many areas of process measuring technology.

Path: Menu/Setup/Inputs

Function	Options	Info
▶ Tag control		Additional information on the display: tag control currently used
Operating mode	Options ■ Off ■ Tag ■ Tag group **Factory setting** Off	**Off** No tag control, all sensors are accepted. **Tag** Only sensors with the same tag are accepted. **Tag group** Only sensors in the same tag group are accepted.
Tag group	Customized text **Factory setting** EH_CM44_	Enter the tag name. The controller checks every sensor to be connected as to whether this sensor belongs to the measuring point, and only accepts the sensors that have the same tag.

4.10 Sensor input factory setting

Here you can restore the factory settings for the sensor input. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for this particular input are restored. All other settings remain unchanged.

4.11 Sensor factory setting (CLS50D only)

Here you can restore the sensor factory settings. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for the sensor are restored. The settings for the input remain unchanged.

5 Inputs: Oxygen

Enter the "Inputs" menu

1. Select: Menu/Setup/Inputs.
2. Navigate to an input channel to which an oxygen sensor is connected.
3. Press the navigator button to configure the input.

5.1 Temperature format, sensor identification and damping

The following functions are available for every input. The description below is always the same. However, any settings you make always individually affect the input selected.

Path: Menu/Setup/Inputs

Function	Options	Info
Sensor type	Options ■ None ■ Oxygen (amp.) ■ Oxygen (opt.) ■ pH Glass ■ pH ISFET ■ Cond c ■ Cond i ■ ORP ■ Turbidity ■ Nitrate **Factory setting** None	The function is only available if you have not connected a sensor to the input in question. You can select a sensor from the list and configure the settings for the sensor type without connecting the sensor.
<Parameter> depending on which sensor has been selected		**If no sensor is connected:** The selected sensor type is displayed **If a sensor is connected:** The user enters the menu directly
If you are configuring the settings for an input without a sensor being connected, all the subsequent functions move down one hierarchical level.		
Channel	Options ■ On ■ Off **Factory setting** On	**On** The channel display is switched on in the measuring mode **Off** The channel is not displayed in the measuring mode, regardless of whether a sensor is connected or not.
Temperature format	Options ■ #.# ■ #.## **Factory setting** #.#	Select how many decimal places should be used to display the temperature.
Sensor type	Read only (Only available if a sensor is connected)	Connected sensor type
Order code		Order code of the connected sensor

Path: Menu/Setup/Inputs

Function	Options	Info
Depending on the input: Damping pH or Damping ORP or Damping Cond or Damping turbidity or Damping nitrateor Damping DO	0 to 60 s **Factory setting** 0 s	The damping causes a floating average curve of the measured values over the time specified.
Damping temp.	0 to 60 s **Factory setting** 0 s	

5.2 Main value

Path: Menu/Setup/Inputs/DO

Function	Options	Info
Main value	Options ■ Concentration liquid ■ Concentration gaseous ■ Saturation ■ Partial pressure ■ Raw value nA **Factory setting** Concentration liquid	
Unit *Main value="Concentration liquid" or "Concentration gaseous"*	Options *(Main value="Concentration liquid")* ■ mg/l ■ µg/l ■ ppm ■ ppb Options *(Main value="Concentration gaseous")* ■ %Vol ■ ppmVol *(Main value="Concentration gaseous"* **Factory setting** mg/l %Vol	

5.3 Medium compensation (in the process)

Path: Menu/Setup/Inputs/DO

Function	Options	Info
Medium pressure	Options ■ Process pressure ■ Air pressure **Factory setting** Air pressure	
Altitude *Medium pressure="Air pressure"*	-300 to 4000 m **Factory setting** 0 m	Enter the altitude **or** the average air pressure (mutually dependent values). If you specify the altitude, the average air pressure is calculated from the barometric altitude formula and vice versa. If you are compensating using the process pressure, enter the pressure in your process here. The pressure is then independent of the altitude.
Air pressure or Medium pressure	*Medium pressure="Air pressure"* 500 to 1200 hPa *Medium pressure="Process pressure"* 500 to 9999 hPa **Factory setting** 1013 hPa	
Salinity	0 to 100 g/kg **Factory setting** 0 g/kg	The influence of salt content on oxygen measurement is compensated with this function. Example: sea water measurement as per Copenhagen Standard (30 g/kg).

5.4 Polarization voltage (only amperometric sensors)

A polarization voltage between the anode and the cathode is applied at the cathode of the amperometric sensor. This causes the oxygen dissolved in the electrolyte to be reduced selectively at the cathode. Given a constant polarization voltage, the electrical current resulting from the cathode and anode reaction is proportional to the concentration of oxygen.

You can configure the polarization voltage depending on the process.
If the polarization voltage is switched off, you can achieve a longer sensor service life under extreme conditions.

Path: Menu/Setup/Inputs/DO

Function	Options	Info
▶ Sensor pol.voltage		Polarization voltage of the sensor (standard: 650 mV)
Mode	Options ■ Off ■ Internal sensor value ■ Setting up ■ Off at def. temperature **Factory setting** Internal sensor value	■ Off No polarization, e.g. if temperatures are at a constantly high level ■ Internal sensor value Polarization voltage saved in the sensor ■ Setting up Other polarization voltage ■ Off at def. temperature No polarization above this temperature
Sensor pol.voltage *Mode="Setting up"*	0 to 750 mV **Factory setting** 650 mV	Enter the desired polarization voltage.
Temperature *Mode="Off at def. temperature"*	50.0 to 140.0 °C 122.0 to 284.0 °F **Factory setting** 80 °C 176 °F	Specify the temperature as of which the sensor should no longer be polarized (extreme operating conditions). The polarization voltage saved in the sensor is used up to this temperature.

5.5 Cleaning

Path: Menu/Setup/Inputs/<Parameter> (depends on input)

Function	Options	Info
Cleaning	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Select a cleaning program. This program is executed if: ■ A diagnostics message is present at the channel **and** ■ A cleaning process has been specified for this message (—> "Inputs/Diag. settings/Diag. behavior").

You define the cleaning programs in the "Setup/Additional functions/Cleaning" menu.

5.6 Calibration settings

5.6.1 Stability criteria

You define the permitted measured value fluctuation which must not be exceeded in a certain timeframe during calibration.
If the permitted difference is exceeded, calibration is not permitted and is aborted automatically.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
▶ Stability criteria		
Delta signal	0.1 to 2.0 % **Factory setting** 0.2 %	Permitted measured value fluctuation during calibration. Referenced to the raw value in nA in the case of amperometric sensors, and referenced to the partial pressure in the case of optical sensors.
Delta temperature	0.10 to 2.00 °C 0.18 to 3.60 °F **Factory setting** 0.50 °C 0.90 °F	Permitted temperature fluctuation during calibration
Duration	10 to 60 s **Factory setting** 20 s	Timeframe within which the permitted range for measured value fluctuation should not be exceeded

5.6.2 Medium compensation (during calibration)

Path: Menu/Setup/Inputs/DO/Calib. settings

Function	Options	Info
Medium pressure	Options ▪ Process pressure ▪ Air pressure **Factory setting** Air pressure	
Altitude *Medium pressure="Air pressure"*	-300 to 4000 m **Factory setting** 0 m	Enter the altitude **or** the average air pressure (mutually dependent values). If you specify the altitude, the average air pressure is calculated from the barometric altitude formula and vice versa. If you are compensating using the process pressure, enter the pressure in your process here. The pressure is then independent of the altitude.
Air pressure or Medium pressure	*Medium pressure="Air pressure"* 500 to 1200 hPa *Medium pressure="Process pressure"* 500 to 9999 hPa **Factory setting** 1013 hPa	

Path: Menu/Setup/Inputs/DO/Calib. settings

Function	Options	Info
Rel. hum. (air variable)	0 to 100 % **Factory setting** 100 %	

5.6.3 Calibration timer and calibration expiration date

You can specify the calibration interval for the sensor here.
Once the time configured elapses, the "Calibration timer" diagnostics message appears on the display.

The timer is reset automatically if you recalibrate the sensor.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Calibration timer	Options ■ Off ■ On **Factory setting** Off	Switches the function on or off
Calibration timer *Calibration timer="On"*	1 to 10000 h **Factory setting** 1000 h	Specify the time after which the timer should have timed out. Once this time has elapsed, the "Sensor check" diagnostics message, along with the code 102, appears on the display.
Calib. expiration date	Options ■ Off ■ On **Factory setting** Off	The function checks whether the calibration of a sensor is still valid. Example: You install a precalibrated sensor. The function checks how much time has elapsed since the sensor was last calibrated. A diagnostics message is displayed if the time since the last calibration is longer than the prespecified warning and alarm limit.
▶ Calib. expiration date		
Warning limit	1 to 12 months **Factory setting** 11 months	Diagnostics message: 105 "Sensor check" Warning and alarm limits mutually affect each other's possible ranges for adjustment.
Alarm limit	1 to 12 months **Factory setting** 12 months	Diagnostics message: 104 "Sensor check" General rule: Alarm limit > warning limit

5.7 Diagnostics settings

This menu branch is used for specifying alarm and warning limits, and for defining whether and how diagnostics tools should be used.
The associated diagnostics code is displayed for every setting.

5.7.1 Slope

The (relative) slope characterizes the sensor condition. Decreasing values indicate electrolyte exhaustion. You can control when the electrolyte should be replaced by specifying limit values and the diagnostics messages these limit values trigger.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Slope	0.0 to 200.0 %	Specify the limit values for slope monitoring in your sensor.
Upper alarm limit	**Factory setting** 150.0 %	Diagnostics code and associated message text: 510 "Sensor calib."
Upper warning limit	**Factory setting** 140.0 %	Diagnostics code and associated message text: 511 "Sensor calib."
Lower warning limit	**Factory setting** 60.0 %	Diagnostics code and associated message text: 509 "Sensor calib."
Lower alarm limit	**Factory setting** 50.0 %	Diagnostics code and associated message text: 508 "Sensor calib."

5.7.2 Zero point (only amperometric sensors)

The zero point corresponds to the sensor signal that is measured in a medium in the absence of oxygen. You can calibrate the zero point in water that is free from oxygen or in high-purity nitrogen. This improves accuracy in the trace range.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Zero point	0.0 to 10.0 nA	Specify the limit values for zero point monitoring in your sensor.
Warning limit	**Factory setting** 3.0 nA	Diagnostics code and associated message text: 513 "Zero Warn"
Alarm limit	**Factory setting** 4.0 nA	Diagnostics code and associated message text: 512 "Sensor calib."

5.7.3 Process check system

The process check system (PCS) checks the measuring signal for stagnation. An alarm is triggered if the measuring signal does not change over a certain period (several measured values).

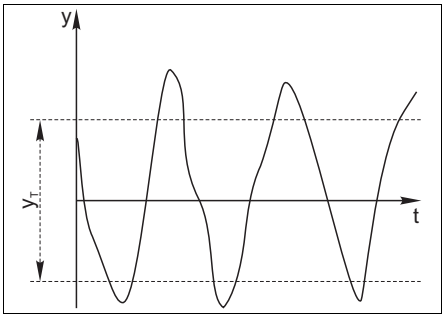


Fig. 12: Normal measuring signal, no alarm

y *Measuring signal*
y_T *Set value for "Tolerancewidth"*

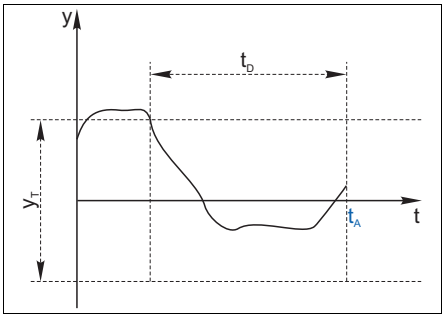


Fig. 13: Stagnating signal, alarm is triggered

t_D *Set value for "Duration"*
t_A *Time when the alarm is triggered*

The main causes of stagnating measured values are:
- Contaminated sensor, or sensor in air
- Sensor failure
- Process error (e.g. through control system)

Remedial action

1. Clean the sensor.
2. Check the measuring chain.
3. Switch off the controller and switch it back on again.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Process Check System		Diagnostics code and associated message text: 904 "Process check"
Function	Options ■ On ■ Off **Factory setting** On	
Duration	1 to 240 min **Factory setting** 60 min	The measured value must change during this time. Otherwise the error message is triggered.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
Tolerancewidth *not available with pH/*Redox	0.01 to 20 % **Factory setting** 0.05 %	Interval around the measuring signal (raw value) for detecting stagnation. Measured values within the set interval are regarded as stagnating.

5.7.4 Limits operating hours

The total operating time of the sensor and its use under extreme conditions is monitored. If the operating time exceeds the defined threshold values, the device issues a corresponding warning or alarm.

Each sensor has a limited life expectancy which heavily depends on the operating conditions. If you specify warning and alarm limits for operating times under extreme conditions, you can guarantee the operation of your measuring point without any downtime by performing maintenance tasks in time.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Limits operating hours		
The range of adjustment for the operating hours alarm and warning limits is generally 1 to 50000 h.		
Function	Options ■ On ■ Off **Factory setting** On	**On** The operation of the sensor under extreme conditions is monitored, recorded in the sensor and diagnostics messages are displayed on the controller. **Off** No diagnostics messages. However, the time the sensor operates under extreme conditions is recorded in the sensor and can be read in the sensor information in the diagnostics menu.
▶ Operating time		Total operating time of the sensor
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 199 "Operating time"
▶ Operation < 5°C		*Only optical sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 188 "Operating time"
▶ Operation > 25°C		*Only optical sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 190 "Operating time"

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Operation > 40°C		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 192 "Operating time"
▶ Operation > 80°C		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 193 "Operating time"
▶ (Operation above first specified nA value)		*Only amperometric sensors, sensor-specific limit*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 183 "Operating time" (COS51D) 184 "Operating time" (COS22D)
▶ (Operation above second specified nA value)		*Only amperometric sensors, sensor-specific limit*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 185 "Operating time" (COS51D) 186 "Operating time" (COS22D)
▶ Operation < 25µs		*Only optical sensors (µS = fluorescence decay time, raw value of optical measurement)*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 181 "Operating time"
▶ Operation > 40 µs		*Only optical sensors*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 182 "Operating time"

5.7.5 Delta slope (only amperometric sensors)

The device determines the difference in slope between the last calibration and the penultimate calibration, and issues a warning or an alarm depending on the setting configured. The difference is an indicator for the condition of the sensor. An increasing change indicates the formation of buildup on the sensor diaphragm or electrolyte contamination. Replace the diaphragm and electrolyte as specified in the instructions in the sensor operating manual.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Delta slope	0.0 to 50.0 %	Specify the limit values for monitoring the slope differential.
Function	Options ■ On ■ Off **Factory setting** On	
Warning limit	**Factory setting** 5.0 %	Diagnostics code and associated message text: 518 "Sensor calib."
Alarm limit	**Factory setting** 10.0 %	Diagnostics code and associated message text: 145 "Delta slope al"

5.7.6 Delta zero point (only amperometric sensors)

The device determines the difference between the last calibration and the penultimate calibration, and issues a warning or an alarm depending on the setting configured. The difference is an indicator for the condition of the sensor. Increasing differences indicate the formation of buildup on the cathode. Clean the cathode as specified in the instructions in the sensor operating manual.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Delta zeropoint	0.0 to 10 nA	Specify your limit values for monitoring the zero point differential.
Function	Options ■ On ■ Off **Factory setting** On	
Warning limit	**Factory setting** 2.0 nA	Diagnostics code and associated message text: 520 "Sensor calib."
Alarm limit	**Factory setting** 1.0 nA	Diagnostics code and associated message text: 519 "Sensor calib."

5.7.7 Sterilizations (only sterilizable sensors)

The system counts the number of operating hours in which the sensor is exposed to a temperature that is typical for a sterilization. This temperature depends on the sensor.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Sterilizations	0 to 99	Specify the limit values for the number of sensor sterilizations.
Function	Options ■ On ■ Off **Factory setting** Off	
Warning limit	**Factory setting** 30	Diagnostics code and associated message text: 108 "Sensor check"

5.7.8 Calibrations, cap (only sterilizable, amperometric sensors)

The calibration counters in the sensor make a distinction between sensor calibrations and calibrations with the membrane cap currently used. If this cap is replaced, only the (cap) counter is reset.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Cap calibrations		Specify how many calibrations may be performed with a membrane cap before the cap has to be replaced. The number depends heavily on the process and must be determined individually.
Function	Options ■ On ■ Off **Factory setting** On	
Warning limit	**Factory setting** 6	Diagnostics code and associated message text: 529 "Sensor calib."

5.7.9 Sterilizations, cap (only amperometric sensors)

The sterilization counters in the sensor make a distinction between the sensor and the membrane cap currently used. If this cap is replaced, only the (cap) counter is reset.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Cap sterilisations		Specify how many sterilizations may be performed with a membrane cap before the cap has to be replaced. The number depends heavily on the process and must be determined individually.
Function	Options ■ On ■ Off **Factory setting** On	
Warning limit	**Factory setting** 6	Diagnostics code and associated message text: 109 "Sensor check"

5.7.10 Diagnostic behavior

This branch, along with the same functions, can be found in various parts of the menu. The list of diagnostic messages displayed depends on the path selected. There are device-specific messages, and messages that depend on what sensor is connected.

Paths: Menu/Setup/General settings/Diagnostics or
Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
List of diagnostic messages		Select the message to be changed.
Diagnostic message	Options ■ On ■ Off **Factory setting** Depends on the message	You can deactivate or reactivate a diagnostic message here. Deactivating means: ■ No error message in the measuring mode ■ No error current at the current output
Error class	Options ■ Maintenance (M) ■ Out of specification (S) ■ Function check (C) ■ Failure (F) **Factory setting** Depends on the message	The messages are divided into different error classes in accordance with NAMUR NE 107. –> BA445C "Maintenance&diagnostics"
Error current	Options ■ On ■ Off **Factory setting** Depends on the message	Decide whether an error current should be output at the current output if the diagnostic message display is activated.

Paths: Menu/Setup/General settings/Diagnostics or Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
Diag. output	Options ■ None ■ Alarm relay ■ Relay 1 to n (depends on the device version) **Factory setting** None	You can use this function to select an output to which the diagnostic message should be assigned. You first have to configure a relay output before being able to assign the message to an output (Menu/Setup/Outputs, assign "Diagnostics" function and set Operating mode to "Normal"). —> BA450C "Operation&configuration"
One alarm relay is always available, regardless of the device version. Other relays are optional.		
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Decide whether the diagnostic message should trigger a cleaning program. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.
Info	Read only	Here you can find more information on the diagnostic message and instructions on how to resolve the problem.

5.8 Tag control

"Tag" stands for the name of a measuring point, and is used in many areas of process measuring technology.

Path: Menu/Setup/Inputs

Function	Options	Info
▶ Tag control		Additional information on the display: tag control currently used
Operating mode	Options ■ Off ■ Tag ■ Tag group **Factory setting** Off	**Off** No tag control, all sensors are accepted. **Tag** Only sensors with the same tag are accepted. **Tag group** Only sensors in the same tag group are accepted.
Tag group	Customized text **Factory setting** EH_CM44_	Enter the tag name. The controller checks every sensor to be connected as to whether this sensor belongs to the measuring point, and only accepts the sensors that have the same tag.

5.9 Sensor input factory setting

Here you can restore the factory settings for the sensor input. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for this particular input are restored. All other settings remain unchanged.

5.10 Sensor factory setting (COS61D)

Here you can restore the sensor factory settings. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for the sensor are restored. The settings for the input remain unchanged.

6 Inputs: Turbidity and solids

Enter the "Inputs" menu

1. Select: Menu/Setup/Inputs.
2. Navigate to an input channel where a turbidity sensor is connected.
   You cannot make some settings if the sensor is not connected.
3. Press the navigator button to configure the input.

6.1 Temperature format, sensor identification and damping

The following functions are available for every input. The description below is always the same. However, any settings you make always individually affect the input selected.

Path: Menu/Setup/Inputs

Function	Options	Info
Sensor type	Options ■ None ■ Oxygen (amp.) ■ Oxygen (opt.) ■ pH Glass ■ pH ISFET ■ Cond c ■ Cond i ■ ORP ■ Turbidity ■ Nitrate **Factory setting** None	The function is only available if you have not connected a sensor to the input in question. You can select a sensor from the list and configure the settings for the sensor type without connecting the sensor.
<Parameter> depending on which sensor has been selected		**If no sensor is connected:** The selected sensor type is displayed **If a sensor is connected:** The user enters the menu directly
If you are configuring the settings for an input without a sensor being connected, all the subsequent functions move down one hierarchical level.		
Channel	Options ■ On ■ Off **Factory setting** On	**On** The channel display is switched on in the measuring mode **Off** The channel is not displayed in the measuring mode, regardless of whether a sensor is connected or not.
Temperature format	Options ■ #.# ■ #.## **Factory setting** #.#	Select how many decimal places should be used to display the temperature.
Sensor type	Read only (Only available if a sensor is connected)	Connected sensor type
Order code		Order code of the connected sensor

Path: Menu/Setup/Inputs

Function	Options	Info
Depending on the input: Damping pH or Damping ORP or Damping Cond or Damping turbidity or Damping nitrate or Damping DO	0 to 60 s **Factory setting** 0 s	The damping causes a floating average curve of the measured values over the time specified.
Damping temp.	0 to 60 s **Factory setting** 0 s	

6.2 Application and main measured value

Calibration data records are saved under an individual name in the turbidity sensor. A new sensor is calibrated at the factory and thus already has appropriate data records. You can add your own data records during each calibration. These are then available for selection under "Application".

Path: Menu/Setup/Inputs/Turbidity

Function	Options	Info
Application type	Options ■ Clear water ■ Solid **Factory setting** Clear water	Preselection for saved calibration data records
Application	Options ■ Formacin ■ Kaolin ■ SiO2 ■ TiO2 ■ Primary sludge ■ Digest. sludge ■ Activ. sludge **Factory setting** Formacin or Primary sludge	Select a saved calibration data record The options and the factory setting depend on the setting in "Application type".

Path: Menu/Setup/Inputs/Turbidity

Function	Options	Info
Unit	Options Application="Formacin" ■ FNU ■ NTU Options All apart from "Formacin" ■ g/l ■ ppm **Factory setting** FNU g/l	Select the unit for the main measured value.
Main value format	Options ■ #.# ■ #.## ■ #.### ■ # **Factory setting** #.#	Specify the number of decimal places.

6.3 Cleaning

Path: Menu/Setup/Inputs/<Parameter> (depends on input)

Function	Options	Info
Cleaning	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Select a cleaning program. This program is executed if: ■ A diagnostics message is present at the channel **and** ■ A cleaning process has been specified for this message (—> "Inputs/Diag. settings/Diag. behavior").

You define the cleaning programs in the "Setup/Additional functions/Cleaning" menu.

6.4 Calibration settings

6.4.1 Calibration timer and calibration expiration date

You can specify the calibration interval for the sensor here.
Once the time configured elapses, the "Calibration timer" diagnostics message appears on the display.

The timer is reset automatically if you recalibrate the sensor.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Calibration timer	Options ■ Off ■ On **Factory setting** Off	Switches the function on or off
Calibration timer *Calibration timer*="*On*"	1 to 10000 h **Factory setting** 1000 h	Specify the time after which the timer should have timed out. Once this time has elapsed, the "Sensor check" diagnostics message, along with the code 102, appears on the display.
Calib. expiration date	Options ■ Off ■ On **Factory setting** Off	The function checks whether the calibration of a sensor is still valid. Example: You install a precalibrated sensor. The function checks how much time has elapsed since the sensor was last calibrated. A diagnostics message is displayed if the time since the last calibration is longer than the prespecified warning and alarm limit.
▶ Calib. expiration date		
Warning limit	1 to 12 months **Factory setting** 11 months	Diagnostics message: 105 "Sensor check" Warning and alarm limits mutually affect each other's possible ranges for adjustment.
Alarm limit	1 to 12 months **Factory setting** 12 months	Diagnostics message: 104 "Sensor check" General rule: Alarm limit > warning limit

6.4.2 Stability criteria

You define the permitted measured value fluctuation which must not be exceeded in a certain timeframe during calibration.
If the permitted difference is exceeded, calibration is not permitted and is aborted automatically.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
▶ Stability criteria		
Delta turbidity	0.1 to 5.0 % **Factory setting** 2.0 %	Permitted measured value fluctuation during calibration
Delta temperature	0.10 to 2.00 °C 0.18 to 3.60 °F **Factory setting** 0.50 °C 0.90 °F	Permitted temperature fluctuation during calibration
Duration	0 to 100 s **Factory setting** 10 s	Timeframe within which the permitted range for measured value fluctuation should not be exceeded

6.5 Diagnostics settings

This menu branch is used for specifying alarm and warning limits, and for defining whether and how diagnostics tools should be used.
The associated diagnostics code is displayed for every setting.

6.5.1 Limits operating hours

The total operating time of the sensor and its use under extreme conditions is monitored. If the operating time exceeds the defined threshold values, the device issues a corresponding warning or alarm.

Each sensor has a limited life expectancy which heavily depends on the operating conditions. If you specify warning and alarm limits for operating times under extreme conditions, you can guarantee the operation of your measuring point without any downtime by performing maintenance tasks in time.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Limits operating hours		Specify your limit values for monitoring the number of operating hours under extreme conditions.
The range of adjustment for the operating hours alarm and warning limits is generally 1 to 50000 h.		
Function	Options ■ On ■ Off **Factory setting** Off	**On** The operation of the sensor under extreme conditions is monitored, recorded in the sensor and diagnostics messages are displayed on the controller. **Off** No diagnostics messages. However, the time the sensor operates under extreme conditions is recorded in the sensor and can be read in the sensor information in the diagnostics menu.
▶ Operating time		Total operating time of the sensor
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 199 "Operating time"
▶ (Operation below specified temperature limit)		
The names of the menu functions in brackets depend on the sensor specification. For this reason, they cannot be specified here.		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 935 "Process temp."
▶ (Operation above specified temperature limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 934 "Process temp."
▶ (Operation below specified turbidity limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 943 "Process value"
▶ (Operation above specified turbidity limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 942 "Process value"
▶ Filter change		*Only for nitrate sensor!*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 157 "Filter change"

6.5.2 Process check system

The process check system (PCS) checks the measuring signal for stagnation. An alarm is triggered if the measuring signal does not change over a certain period (several measured values).

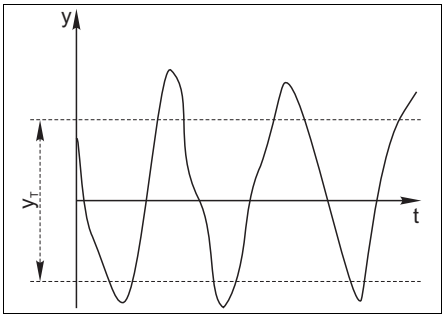


Fig. 14: Normal measuring signal, no alarm

y *Measuring signal*
y_T *Set value for "Tolerancewidth"*

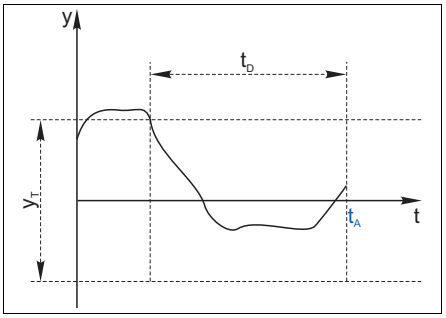


Fig. 15: Stagnating signal, alarm is triggered

t_D *Set value for "Duration"*
t_A *Time when the alarm is triggered*

The main causes of stagnating measured values are:
- Contaminated sensor, or sensor in air
- Sensor failure
- Process error (e.g. through control system)

Remedial action

1. Clean the sensor.
2. Check the measuring chain.
3. Switch off the controller and switch it back on again.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Process Check System		Diagnostics code and associated message text: 904 "Process check"
Function	Options ■ On ■ Off **Factory setting** On	
Duration	1 to 240 min **Factory setting** 60 min	The measured value must change during this time. Otherwise the error message is triggered.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
Tolerancewidth *not available with pH/*Redox	0.01 to 20 % **Factory setting** 0.05 %	Interval around the measuring signal (raw value) for detecting stagnation. Measured values within the set interval are regarded as stagnating.

6.5.3 Diagnostic behavior

This branch, along with the same functions, can be found in various parts of the menu. The list of diagnostic messages displayed depends on the path selected. There are device-specific messages, and messages that depend on what sensor is connected.

Paths: Menu/Setup/General settings/Diagnostics or
Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
List of diagnostic messages		Select the message to be changed.
Diagnostic message	Options ■ On ■ Off **Factory setting** Depends on the message	You can deactivate or reactivate a diagnostic message here. Deactivating means: ■ No error message in the measuring mode ■ No error current at the current output
Error class	Options ■ Maintenance (M) ■ Out of specification (S) ■ Function check (C) ■ Failure (F) **Factory setting** Depends on the message	The messages are divided into different error classes in accordance with NAMUR NE 107. —> BA445C "Maintenance&diagnostics"
Error current	Options ■ On ■ Off **Factory setting** Depends on the message	Decide whether an error current should be output at the current output if the diagnostic message display is activated.
Diag. output	Options ■ None ■ Alarm relay ■ Relay 1 to n (depends on the device version) **Factory setting** None	You can use this function to select an output to which the diagnostic message should be assigned. You first have to configure a relay output before being able to assign the message to an output (Menu/Setup/Outputs, assign "Diagnostics" function and set Operating mode to "Normal"). —> BA450C "Operation&configuration"
One alarm relay is always available, regardless of the device version. Other relays are optional.		

Paths: Menu/Setup/General settings/Diagnostics or Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Decide whether the diagnostic message should trigger a cleaning program. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.
Info	Read only	Here you can find more information on the diagnostic message and instructions on how to resolve the problem.

6.6 Tag control

"Tag" stands for the name of a measuring point, and is used in many areas of process measuring technology.

Path: Menu/Setup/Inputs

Function	Options	Info
▶ Tag control		Additional information on the display: tag control currently used
Operating mode	Options ■ Off ■ Tag ■ Tag group **Factory setting** Off	**Off** No tag control, all sensors are accepted. **Tag** Only sensors with the same tag are accepted. **Tag group** Only sensors in the same tag group are accepted.
Tag group	Customized text **Factory setting** EH_CM44_	Enter the tag name. The controller checks every sensor to be connected as to whether this sensor belongs to the measuring point, and only accepts the sensors that have the same tag.

6.7 Sensor input factory setting

Here you can restore the factory settings for the sensor input. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for this particular input are restored. All other settings remain unchanged.

6.8 Sensor factory setting

Here you can restore the sensor factory settings. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for the sensor are restored. The settings for the input remain unchanged.

7 Inputs: Nitrate

Enter the "Inputs" menu

1. Select: Menu/Setup/Inputs.
2. Navigate to an input channel where a nitrate sensor is connected.
   You cannot make some settings if the sensor is not connected.
3. Press the navigator button to configure the input.

7.1 Temperature format, sensor identification and damping

The following functions are available for every input. The description below is always the same. However, any settings you make always individually affect the input selected.

Path: Menu/Setup/Inputs

Function	Options	Info
Sensor type	Options ■ None ■ Oxygen (amp.) ■ Oxygen (opt.) ■ pH Glass ■ pH ISFET ■ Cond c ■ Cond i ■ ORP ■ Turbidity ■ Nitrate **Factory setting** None	The function is only available if you have not connected a sensor to the input in question. You can select a sensor from the list and configure the settings for the sensor type without connecting the sensor.
<Parameter> depending on which sensor has been selected		**If no sensor is connected:** The selected sensor type is displayed **If a sensor is connected:** The user enters the menu directly
If you are configuring the settings for an input without a sensor being connected, all the subsequent functions move down one hierarchical level.		
Channel	Options ■ On ■ Off **Factory setting** On	**On** The channel display is switched on in the measuring mode **Off** The channel is not displayed in the measuring mode, regardless of whether a sensor is connected or not.
Temperature format	Options ■ #.# ■ #.## **Factory setting** #.#	Select how many decimal places should be used to display the temperature.
Sensor type	Read only (Only available if a sensor is connected)	Connected sensor type
Order code		Order code of the connected sensor

Path: Menu/Setup/Inputs

Function	Options	Info
Depending on the input: Damping pH or Damping ORP or Damping Cond or Damping turbidity or Damping nitrate or Damping DO	0 to 60 s **Factory setting** 0 s	The damping causes a floating average curve of the measured values over the time specified.
Damping temp.	0 to 60 s **Factory setting** 0 s	

7.2 Application and main measured value

Calibration data records are saved under an individual name in the nitrate sensor. A new sensor is calibrated at the factory and always has a corresponding data record. You can add additional data records during each calibration. These are then available for selection under "Application".

Path: Menu/Setup/Inputs/Nitrate

Function	Options	Info
Application	Depends on the sensor	Select a saved calibration data record
Unit	Options ■ mg/l NO3-N ■ mg/l NO3 ■ ppm NO3-N ■ ppm NO3 **Factory setting** mg/l NO3-N	Select the unit for the main measured value.
Main value format	Options ■ #.# ■ #.## ■ #.### ■ # **Factory setting** #.#	Specify the number of decimal places.

7.3 Cleaning

Path: Menu/Setup/Inputs/<Parameter> (depends on input)

Function	Options	Info
Cleaning	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Select a cleaning program. This program is executed if: ■ A diagnostics message is present at the channel **and** ■ A cleaning process has been specified for this message (—> "Inputs/Diag. settings/Diag. behavior").

You define the cleaning programs in the "Setup/Additional functions/Cleaning" menu.

7.4 Calibration settings

7.4.1 Calibration timer and calibration expiration date

You can specify the calibration interval for the sensor here.
Once the time configured elapses, the "Calibration timer" diagnostics message appears on the display.

The timer is reset automatically if you recalibrate the sensor.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Calibration timer	Options ■ Off ■ On **Factory setting** Off	Switches the function on or off
Calibration timer *Calibration timer="On"*	1 to 10000 h **Factory setting** 1000 h	Specify the time after which the timer should have timed out. Once this time has elapsed, the "Sensor check" diagnostics message, along with the code 102, appears on the display.
Calib. expiration date	Options ■ Off ■ On **Factory setting** Off	The function checks whether the calibration of a sensor is still valid. Example: You install a precalibrated sensor. The function checks how much time has elapsed since the sensor was last calibrated. A diagnostics message is displayed if the time since the last calibration is longer than the prespecified warning and alarm limit.
▶ Calib. expiration date		

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
Warning limit	**Factory setting** 11 months	Diagnostics message: 105 "Sensor check" Warning and alarm limits mutually affect each other's possible ranges for adjustment.
Alarm limit	**Factory setting** 12 months	Diagnostics message: 104 "Sensor check" General rule: Alarm limit > warning limit

7.4.2 Stability criteria

You define the permitted measured value fluctuation which must not be exceeded in a certain timeframe during calibration.
If the permitted difference is exceeded, calibration is not permitted and is aborted automatically.

Path: Menu/Setup/Inputs/Calib. settings

Function	Options	Info
▶ Stability criteria		
Delta nitrate	0.1 to 5.0 % **Factory setting** 2.0 %	Permitted measured value fluctuation during calibration
Delta temperature	0.10 to 2.00 °C 0.18 to 3.60 °F **Factory setting** 0.50 °C 0.90 °F	Permitted temperature fluctuation during calibration
Duration	0 to 100 s **Factory setting** 10 s	Timeframe within which the permitted range for measured value fluctuation should not be exceeded

7.5 Diagnostics settings

This menu branch is used for specifying alarm and warning limits, and for defining whether and how diagnostics tools should be used.
The associated diagnostics code is displayed for every setting.

7.5.1 Limits operating hours

The total operating time of the sensor and its use under extreme conditions is monitored. If the operating time exceeds the defined threshold values, the device issues a corresponding warning or alarm.

Each sensor has a limited life expectancy which heavily depends on the operating conditions. If you specify warning and alarm limits for operating times under extreme conditions, you can guarantee the operation of your measuring point without any downtime by performing maintenance tasks in time.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Limits operating hours		Specify your limit values for monitoring the number of operating hours under extreme conditions.
The range of adjustment for the operating hours alarm and warning limits is generally 1 to 50000 h.		
Function	Options ■ On ■ Off **Factory setting** Off	**On** The operation of the sensor under extreme conditions is monitored, recorded in the sensor and diagnostics messages are displayed on the controller. **Off** No diagnostics messages. However, the time the sensor operates under extreme conditions is recorded in the sensor and can be read in the sensor information in the diagnostics menu.
▶ Operating time		Total operating time of the sensor
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 199 "Operating time"
▶ (Operation below specified temperature limit)		
The names of the menu functions in brackets depend on the sensor specification. For this reason, they cannot be specified here.		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 935 "Process temp."
▶ (Operation above specified temperature limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 934 "Process temp."
▶ (Operation below specified turbidity limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 943 "Process value"
▶ (Operation above specified turbidity limit)		
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 942 "Process value"

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Filter change		*Only for nitrate sensor!*
Warning limit	**Factory setting** 10000 h	Diagnostics code and associated message text: 157 "Filter change"

7.5.2 Process check system

The process check system (PCS) checks the measuring signal for stagnation. An alarm is triggered if the measuring signal does not change over a certain period (several measured values).

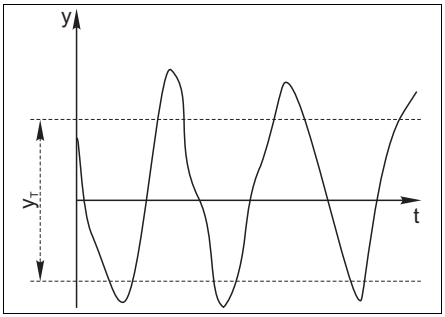


Fig. 16: Normal measuring signal, no alarm

y *Measuring signal*
y_T *Set value for "Tolerancewidth"*

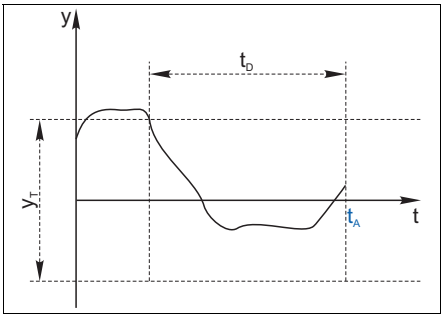


Fig. 17: Stagnating signal, alarm is triggered

t_D *Set value for "Duration"*
t_A *Time when the alarm is triggered*

The main causes of stagnating measured values are:
- Contaminated sensor, or sensor in air
- Sensor failure
- Process error (e.g. through control system)

Remedial action
1. Clean the sensor.
2. Check the measuring chain.
3. Switch off the controller and switch it back on again.

Path: Menu/Setup/Inputs/Diag. settings

Function	Options	Info
▶ Process Check System		Diagnostics code and associated message text: 904 "Process check"
Function	Options ■ On ■ Off **Factory setting** On	
Duration	1 to 240 min **Factory setting** 60 min	The measured value must change during this time. Otherwise the error message is triggered.
Tolerancewidth *not available with pH/*Redox	0.01 to 20 % **Factory setting** 0.05 %	Interval around the measuring signal (raw value) for detecting stagnation. Measured values within the set interval are regarded as stagnating.

7.5.3 Diagnostic behavior

This branch, along with the same functions, can be found in various parts of the menu. The list of diagnostic messages displayed depends on the path selected. There are device-specific messages, and messages that depend on what sensor is connected.

Paths: Menu/Setup/General settings/Diagnostics or
Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
List of diagnostic messages		Select the message to be changed.
Diagnostic message	Options ■ On ■ Off **Factory setting** Depends on the message	You can deactivate or reactivate a diagnostic message here. Deactivating means: ■ No error message in the measuring mode ■ No error current at the current output
Error class	Options ■ Maintenance (M) ■ Out of specification (S) ■ Function check (C) ■ Failure (F) **Factory setting** Depends on the message	The messages are divided into different error classes in accordance with NAMUR NE 107. —> BA445C "Maintenance&diagnostics"
Error current	Options ■ On ■ Off **Factory setting** Depends on the message	Decide whether an error current should be output at the current output if the diagnostic message display is activated.

Paths: Menu/Setup/General settings/Diagnostics or Menu/Setup/Inputs/Diag. settings/Diag. behavior

Function	Options	Info
Diag. output	Options ■ None ■ Alarm relay ■ Relay 1 to n (depends on the device version) **Factory setting** None	You can use this function to select an output to which the diagnostic message should be assigned. You first have to configure a relay output before being able to assign the message to an output (Menu/Setup/Outputs, assign "Diagnostics" function and set Operating mode to "Normal"). —> BA450C "Operation&configuration"
One alarm relay is always available, regardless of the device version. Other relays are optional.		
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Decide whether the diagnostic message should trigger a cleaning program. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.
Info	Read only	Here you can find more information on the diagnostic message and instructions on how to resolve the problem.

7.6 Tag control

"Tag" stands for the name of a measuring point, and is used in many areas of process measuring technology.

Path: Menu/Setup/Inputs

Function	Options	Info
▶ Tag control		Additional information on the display: tag control currently used
Operating mode	Options ■ Off ■ Tag ■ Tag group **Factory setting** Off	**Off** No tag control, all sensors are accepted. **Tag** Only sensors with the same tag are accepted. **Tag group** Only sensors in the same tag group are accepted.
Tag group	Customized text **Factory setting** EH_CM44_	Enter the tag name. The controller checks every sensor to be connected as to whether this sensor belongs to the measuring point, and only accepts the sensors that have the same tag.

7.7 Sensor input factory setting

Here you can restore the factory settings for the sensor input. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for this particular input are restored. All other settings remain unchanged.

7.8 Sensor factory setting

Here you can restore the sensor factory settings. For this purpose, simply press the navigator button and select "OK" when the prompt for the device software appears.
Only the factory settings for the sensor are restored. The settings for the input remain unchanged.

8 Outputs

8.1 Current outputs

The basic version of the device always has two current outputs.
You can configure additional current outputs with extension modules.

Possible applications
- For outputting a measured value to a process control system or an external recorder
- For outputting a manipulated variable to connected actuators

The current output curve is always linear.

Path: Menu/Setup/Outputs

Function	Options	Info
▶ Current output		In addition, the slot and output numbers are displayed Example: 1:2 = slot 1, current output 2.
Current output	Options ■ On ■ Off **Factory setting** Off	
Source of data	Options ■ None ■ Connected inputs ■ Controller **Factory setting** None	The sources of data on offer depend on your device version. All the sensors and controllers connected to inputs are available for selection.
Measured value	Options ■ None ■ Depends on the Source of data **Factory setting** None	The measured value you can select depends on the option selected under "Source of data".

The table on the next page lists the measured values available depending on the data source.
Apart from measured values from connected sensors, you can also select a controller as the data source. The best way to do so is by using the "Additional functions" menu. Here, you can also select and configure the current output for outputting the controlled variable.

Path: Menu/Setup/Outputs

Function	Options	Info
Hold behavior	Options ■ Freeze ■ Fixed value ■ None **Factory setting** Depends on the channel:output	**Freeze** The device freezes the last current value. **Fixed value** You define a fixed current value that is output at the output. **None** A hold does not affect this current output.
Hold current *Hold behavior="Fixed value"*	0.0 to 23.0 mA **Factory setting** 22.0 mA	Specify which current should be output at this current output in the event of a hold.

Measured value depending on the Source of data

Source of data	Measured value
pH Glass pH ISFET	Options ■ Raw value mV ■ pH ■ Temperature
ORP	Options ■ Temperature ■ ORP mV ■ ORP %
Oxygen (amp.) Oxygen (opt.)	Options ■ Temperature ■ Partial pressure ■ Concentration liquid ■ Saturation ■ Raw value nA (only Oxygen (amp.)) ■ Raw value µs (only Oxygen (opt.))
Cond i Cond c	Options ■ Temperature ■ Conductivity ■ Resistance
Turbidity	Options ■ Temperature ■ Turbidity g/l ■ Turbidity FNU
Nitrate	Options ■ Temperature ■ NO3 ■ NO3-N

Measured value depending on the Source of data

Source of data	Measured value
Controller 1	Options ■ Bipolar (only current outputs) ■ Unipolar+ ■ Unipolar-
Controller 2	

Outputting the controller manipulated variable via the current output

Assign "Unipolar+" to the output to which an actuator that can increase the measured value is connected. Assign "Unipolar-" to the output to which an actuator that can decrease the measured value is connected.

To output the manipulated variable of a two-sided controller, positive manipulated variables and negative manipulated variables generally have to be output to different actuators, as most actuators are able to influence the process in one direction only (not in both). For this purpose, Liquiline splits the bipolar manipulated variable y into two unipolar manipulated variables y+ and y-.

Only the two unipolar manipulated variable parts are available for selection for outputting to modulated relays. If outputting the values via a current output, you also have the possibility of outputting the bipolar manipulated variable y to one current output only (split range).

8.2 Alarm relay and optional relays

The basic version of the device always has one alarm relay.
Additional relays are also available depending on the version of the device.

The following functions can be output via a relay

- Limit switch status
- Controller manipulated variable for controlling an actuator
- Diagnostics messages
- Status of a cleaning function in order to control a pump or a valve

You can assign a relay to multiple inputs in order to clean several sensors with just one cleaning unit, for example.

Path: Menu/Setup/Outputs

Function	Options	Info
▶ Alarm relay or relay at channel No.		
Function	Options ■ Off ■ LimitSwitch ■ Controller ■ Diagnostics ■ Cleaning **Factory setting** Off	The following functions depend on the option selected. These versions are illustrated individually in the following section to provide a clearer understanding of the options. Function="Off" switches off the relay function and means no further settings are required.

8.2.1 Outputting the status of a limit switch

Function="LimitSwitch"

Function	Options	Info
Source of data	Options ■ None ■ Limit switch 1 ■ Limit switch 2 ■ Limit switch 3 ■ Limit switch 4 ■ Limit switch 5 ■ Limit switch 6 ■ Limit switch 7 ■ Limit switch 8 **Factory setting** None	Select the limit switch via which the status of the relay is to be output. The limit switches are configured in the "Setup/Additional functions/Limit switches" menu.

8.2.2 Outputting the manipulated variable of a controller

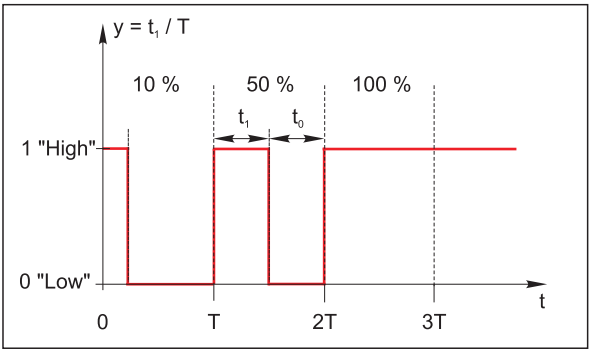
To output a controller manipulated variable via a relay, the relay is modulated. The relay is energized (pulse, t_1) and is then de-energized (interval, t_0).

Function="Controller"

Function	Options	Info
Source of data	Options ■ None ■ Controller 1 ■ Controller 2 **Factory setting** None	Select the controller that should act as the data source.
Operating mode	Options ■ PWM ■ PFM **Factory setting** PWM	PWM=pulse width modulation PFM=pulse frequency modulation

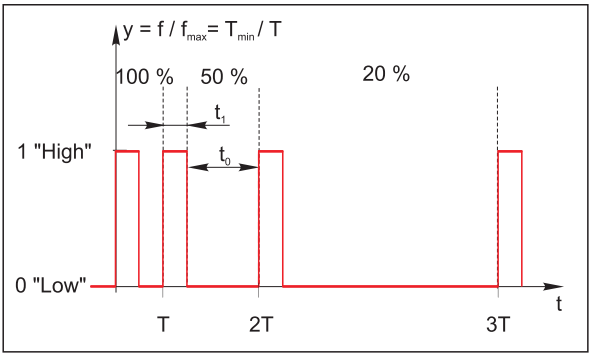
Types of modulation:

1. **PWM** (pulse width modulation):
   The duty cycle is varied within a period **T** ($T=t_1+t_0$). The cycle duration remains constant.



Typical application: solenoid valve

2. **PFM** (pulse frequency modulation):Here, pulses of a constant length (t_1) are output and the interval between the pulses varies (t_0). At a maximum frequency, $t_1 = t_0$.



Typical application: dosing pump

Function="Controller"

Function	Options	Info
Actuator type	Options ■ None ■ Unipolar- ■ Unipolar+ **Factory setting** None	Here you specify what part of the controller should power the relay. "Unipolar+" is the part of the manipulated variable which the controller uses to increase the process value (e.g. for heating purposes). On the other hand, select "Unipolar-" if you want to connect an actuator to the relay that causes the controlled variable to drop (e.g. for cooling purposes).

Function="Controller"

Function	Options	Info
Cycle duration *Operating mode="PWM"*	(Shortest turn-on time) ... 999.0 s **Factory setting** 10.0 s	Specify the cycle duration within which the duty cycle should be varied (only PWM).
The settings for Cycle duration and Shortest turn-on time mutually affect one another. The following applies: Cycle duration ≥ Shortest turn-on time.		
Shortest turn-on time *Operating mode="PWM"*	0.3 s ... (Cycle duration) **Factory setting** 0.3 s	Pulses that are shorter than this limit value are not output in order to conserve the actuator.
Maximumfrequency *Operating mode="PFM"*	1 to 180 min^{-1} **Factory setting** 60 min^{-1}	Maximum number of pulses per minute The controller calculates the pulse duration based on this setting.

8.2.3 Outputting diagnostics messages via the relay

You can output two categories of diagnostics messages via the relay:
1. Diagnostics messages from one of the 4 Namur classes
   (—> BA445C "Maintenance&Diagnostics" for more information on the Namur classes)
2. Diagnostics messages which you have individually assigned to the relay output

A message is individually assigned to the relay output at 2 specific points in the menu:
- Menu/Setup/General settings/Diagnostics/Device behavior
  (device-specific messages)
- Menu/Setup/Inputs/../Diag. settings/Diag. behavior
  (sensor-specific messages)

Function="Diagnostics"

Function	Options	Info
Operating mode	Options ■ Normal ■ Namur M ■ Namur S ■ Namur C ■ Namur F **Factory setting** Normal	**Normal** If this option is selected, the diagnostics messages which you have individually assigned to the relay are output via the relay. **Namur M ... F** If you decided to use one of the Namur classes, all the messages that are assigned to the individual class are output via the relay. You can also change the Namur class assignment for every diagnostics message. (Menu/Setup/General settings/Diagnostics/Device behavior or Menu/Setup/Inputs/../Diag. settings/Diag. behavior)
Attributed diagnostic messages *Operating mode="Normal"*	Read only List of diagnostic messages	All the messages assigned to the relay output appear on the display. You do not have the option of editing the information here.

8.2.4 Outputting the status of a cleaning function

Function="Cleaning"

Function	Options	Info
Assignment	Options ■ None ■ Cleaning 1 - Water ■ Cleaning 2 - Water ■ Cleaning 3 - Water ■ Cleaning 4 - Water **Factory setting** None	Here you can specify how a cleaning function should be displayed for the alarm relay. You can define the cleaning programs under: Menu/Setup/Additional functions/Cleaning.

9 Additional functions

9.1 Limit switch

There are different ways of configuring a limit switch:
- Assigning a switch-on and switch-off point
- Assigning a switch-on and switch-off delay for a relay
- Setting an alarm threshold and also outputting an error message
- Starting a cleaning function

Path: Menu/Setup/Additional functions/Limit switches

Function	Options	Info
▶ Limit switches 1 to 8		Select the limit switch to be configured. The submenus are then identical for every switch.
Source of data	Options ■ Connected sensors ■ Controllers available **Factory setting** None	Specify the input or output which should be the source of data for the limit switch.
Measured value	Options ■ None ■ Depends on the Source of data **Factory setting** None	The measured value you can select depends on the option selected under "Source of data".

Measured value depending on the Source of data

Source of data	Measured value
pH Glass pH ISFET	Options ■ Raw value mV ■ pH ■ Temperature
ORP	Options ■ Temperature ■ ORP mV ■ ORP %
Oxygen (amp.) Oxygen (opt.)	Options ■ Temperature ■ Partial pressure ■ Concentration liquid ■ Saturation ■ Raw value nA (only Oxygen (amp.)) ■ Raw value µs (only Oxygen (opt.))

Measured value depending on the Source of data

Source of data	Measured value
Cond i Cond c	Options ■ Temperature ■ Conductivity ■ Resistance
Turbidity	Options ■ Temperature ■ Turbidity g/l ■ Turbidity FNU
Nitrate	Options ■ Temperature ■ NO3 ■ NO3-N
Controller 1 Controller 2	Options ■ Bipolar (only current outputs) ■ Unipolar+ ■ Unipolar-

Controller manipulated variable as the source for the limit switch

You can monitor the manipulated variable by assigning the controller manipulated variable to a limit switch (e.g. configure a dosing time alarm).

Path: Menu/Setup/Additional functions/Limit switches

Function	Options	Info
Cleaning program	Options ■ None ■ Cleaning 1 ■ Cleaning 2 ■ Cleaning 3 ■ Cleaning 4 **Factory setting** None	Use this function to choose the cleaning instance which should be started when the limit switch is active.
Function	Options ■ On ■ Off **Factory setting** Off	Activating/deactivating the limit switch
Operating mode	Options ■ Above limit check ■ Below limit check ■ In range check ■ Out of range check ■ Change rate **Factory setting** Above limit check	Type of limit value monitoring: ■ Limit value overshoot or undershoot ■ Measured value within or outside a range ■ Change rate

Path: Menu/Setup/Additional functions/Limit switches

Function	Options	Info
Limit value	**Range of adjustment and factory setting** Depends on the measured value	*Operating mode="Above limit check" or "Below limit check"*
■ If the measured values are increasing, the relay contact is closed when the on-value is exceeded ("Limit value" + ½ "Hysteresis") and the start delay has elapsed ("Start delay"). ■ If the measured values are decreasing, the relay contact is reset when the off-value is undershot ("Limit value" - ½ "Hysteresis") and following the release delay ("Release delay").		
Range lower value Range upper value	**Range of adjustment and factory setting** Depends on the measured value	*Operating mode="In range check" or "Out of range check"*
■ If the measured values are increasing, the relay contact is closed when the on-value is exceeded ("Range lower value" + ½ "Hysteresis") and the start delay has elapsed ("Start delay"). ■ If the measured values are decreasing, the relay contact is reset when the off-value is undershot ("Range upper value" - ½ "Hysteresis") and following the release delay ("Release delay").		
Hysteresis	**Range of adjustment and factory setting** Depends on the measured value	The hysteresis is the difference between the switch-on point and the switch-off point if values, which cause the limit switch to pick up, become closer or move further apart. It is needed to ensure a stable switching behavior.
Start delay Release delay	0 to 9999 s **Factory setting** 0 s	Synonyms: pick-up and drop-out delay
Delta value	**Range of adjustment and factory setting** Depends on the measured value	*Operating mode="Change rate"*
Delta time	00:01 to 23:59 **Factory setting** 01:00	
Auto Confirm	00:01 to 23:59 **Factory setting** 00:01	

9.2 Controller

Additional information on the fundamentals of control engineering is provided in a special document on the CD.

Make the following decisions when configuring a controller:

1. What type of process can your process be assigned to?
   –> Process type
2. Should it be possible to influence the measured variable (controlled variable) in one direction or in both directions?
   One-sided or two-sided controller, –> Controller type
3. What should be the controlled variable (sensor, measured value)? –> Controlled variable
4. Define the parameters for the controller:
   – Setpoint, –> Setpoint
   – Neutral zone, –> Xn
   – Gain (P-value), –> Kp
   – Integral action time (I-value), –> Tn
   – Derivative action time (D-value), –> Tv
5. What should the controller do in the event of a hold (measured error, sensor replacement, cleaning etc.)?
   – Pause or continue with dosing?
   – At the end of a hold, continue or restart the control loop (affects I-value)?
6. How should the actuator be triggered?
   – Assign "Unipolar+" to the output for an actuator which can increase the measured value.
   – Assign "Unipolar-" to the output for an actuator which can decrease the measured value.
   – Select "Bipolar" if you want to output the manipulated variable via one current output only (split range).
7. Configure the outputs and switch on the controller.

Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

Function	Options	Info
Control	Options ■ On ■ Off **Factory setting** Off	First configure the controller and leave the switch at "Off" during this time. Once you have made all the settings, you can assign the controller to an output and switch it on.
Name	Customized text	Give the controller a name so you can identify it later on.
Process type	Options ■ Inline ■ Batch **Factory setting** Inline	Decide what type of process best describes your particular process.

Batch process

The medium is in a closed system.
The task of the control system is to dose in such a way that the measured value (controlled variable) changes from its start value to its target value. No more dosing is needed once the setpoint has been reached and the system is stable. If the target value is overshot, a two-sided control system can compensate for this.
In the case of 2-sided batch control systems, a neutral zone is used/configured to suppress oscillations around the setpoint.

In-line process

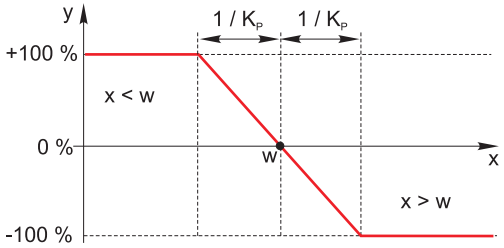
In an in-line process, the control system works with the medium flowing by in the process. Here, the controller has the task of using the manipulated variable to set a mixture ratio between the medium and dosing agent such that the resulting measured variable corresponds to the setpoint. The properties and volume of the medium flow can change at any time and the controller has to react to these changes on a continuous basis. If the flow rate and medium remain constant, the manipulated variable can also assume a fixed value once the process has settled. Since the control process is never "finished" here, this type of control is also referred to as continuous control.

A mixture of both process types can often be found in practice: the semi-batch process. Depending on the ratio between the flow and the container volume, this arrangement behaves either like a batch process or an in-line process.

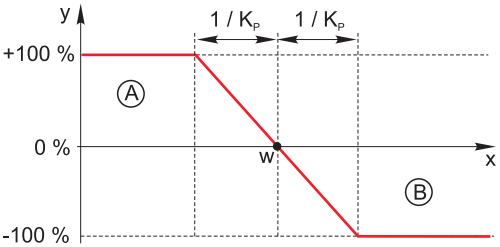
Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

Function	Options	Info
Controller type	Options ▪ PID ▪ PID 2-sided **Factory setting** PID 2-sided	PID = 1-sided PID 2-sided = 2-sided Depending on the actuator connected, you influence the process in just one direction (e.g. heating) or in both directions (e.g. heating and cooling).

A 2-sided controller can output a manipulated variable in the range from -100% to +100%, i.e. the manipulated variable is bipolar. The manipulated variable is positive if the controller should increase the process value. In the case of a pure P-controller, this means that the value of the controlled variable x is smaller than the setpoint w. On the other hand, the manipulated variable is negative if the process value should be decreased. The value for x is greater than the setpoint w. The following graphic illustrates the relationship $y = K_p * (w-x)$:



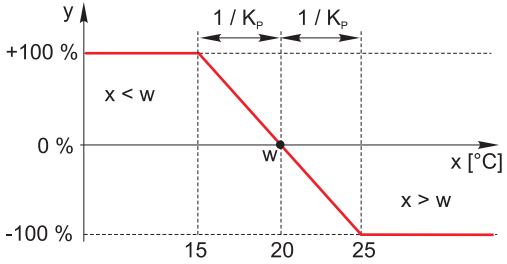
Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

Function	Options	Info
Effective direction *Controller type="PID"*	Options ■ Direct ■ Reverse **Factory setting** Reverse	In what direction should the controller influence the measured value? ■ The measured value should increase as a result of dosing (e.g. heating) —> "Reverse" ■ The measured value should decrease as a result of dosing (e.g. cooling) —> "Direct"
A 1-sided controller has a unipolar manipulated variable, i.e. it can only influence the process in one direction. If the controller should increase the process value, set "Reverse" as the effective direction. The controller then becomes active when the process value is too small (range A). With the "Direct" effective direction, the controller acts as a "downwards controller". It becomes active when the process value (e.g. the temperature) is too high (range B).  The red curve shows overlap between the curves of the two 1-sided controllers.		
▶ Controlled variable		
Source of data	Options ■ Connected sensors **Factory setting** None	Specify the input or output which should be the source of data for the controlled variable.
Measured value	Options ■ None ■ Depends on the Source of data **Factory setting** None	Specify the measured value that should be your controlled variable. The measured value you can select depends on the option selected under "Source of data".
▶ Setpoint		
Setpoint	**Range of adjustment and factory setting** Depends on the Source of data	Specify the setpoint for the controlled variable.
▶ Parameters		
The Liquiline PID controller has been implemented in the serial structural form, i.e. it has the following parameters: ■ Gain K_p ■ Integral action time T_n ■ Derivative action time T_v		

Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

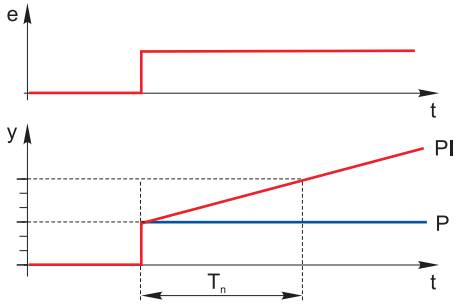
Function	Options	Info
Kp	0.000 to 9999.000	The gain specifies the effect of the P-value **It is always indicated in basic units (reciprocal value of the measuring unit, depending on the sensor)!**

If T_n and T_v are set to zero, the controller acts completely as a P controller, i.e. the manipulated variable y is proportional to the control deviation e. If used as a temperature controller with the setpoint w = 20°C, a gain of K_p = 0.2 would cause the controller to cool entirely at 25°C, and to heat entirely at 15°C.



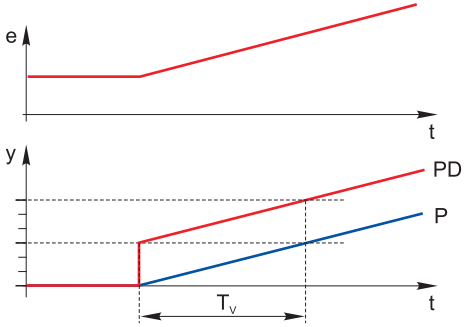
Tn	0.0 to 9999.0 s	The integral action time specifies the effect of the I-value

The integral action time is the time needed in a step-function response to achieve a change in the manipulated variable - as a result of the I effect - which has the same magnitude as the P-value.



e = control deviation, e=w-x (setpoint controlled variable)

Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

Function	Options	Info
Tv	0.0 to 9999.0 s	The derivative action time specifies the effect of the D-value
The derivative action time is the time by which the ramp response of a PD controller reaches a specific value of the manipulated variable at an earlier stage than it would solely as a result of its P-value.  		
Xn *Controller type="PID 2-sided"*	**Range of adjustment and factory setting** Depends on the Source of data	Tolerance range about the setpoint that prevents minor oscillations about the setpoint if using two-sided control loops.
Clock	0.333 to 100.000 s	**Expert setting!** Only change this value if you know exactly what you are doing!
▶ Hold behavior		Hold=measured value is no longer reliable
Manipulated Variable	Options ■ Freeze ■ Set to zero **Factory setting** Freeze	How should the controller react to a measured value that is no longer reliable? **Freeze** The manipulated variable is frozen at the current value **Set to zero** Manipulated variable is set to 0 (no dosing)
State	Options ■ Freeze ■ Reset **Factory setting** Freeze	Internal controller status **Freeze** No change **Reset** After a hold, the control system starts from scratch, and settling time takes place again.

Path: Menu/Setup/Additional functions/Controller 1 or Controller 2

Function	Options	Info
▶ Manual mode		
Simulation	Options ■ On ■ Off **Factory setting** Off	**On** Makes it possible to manually output the manipulated variable, i.e. the value configured for Y is output as a manipulated variable (manual mode). **Off** The manipulated variable calculated by the controller is output.
Y	-100 to 100 % **Factory setting** 0 %	Editable manipulated variable, which is output in the manual mode.
Y Actual output	Read only	Manipulated variable actually output: Input manually for "Simulation" = "Off", calculated by the controller for Simulation" = "On"
Setpoint	Read only	Configured setpoint
X		Current measured value
▶ Output selection		Goes to the "Outputs" menu —> "Outputs" section

9.3 Cleaning programs

Path: Menu/Setup/Additional functions/Cleaning

Function	Options	Info
▶ Cleaning 1 ... 4		You can create 4 different cleaning programs
Cleaning time	5 to 600 s **Factory setting** 10 s	Cleaning time ... Cleaning duration The cleaning duration and interval depend on the process and sensor. Determine the variables empirically or based on experience. The interval value can be between 1 minute and 7 days. Example: You have set the value "01-00:00". Each day, the cleaning cycle starts at the same time you started the first cleaning cycle.
Cleaning interval	00-00:01 to 07-00:00 (DD-hh:mm) **Factory setting** 01-00:00	

Path: Menu/Setup/Additional functions/Cleaning

Function	Options	Info
Hold behavior	Options ■ On ■ Off **Factory setting** Off	Decide whether there should be a hold for the assigned sensor during the cleaning process.
▶ Output selection		Goes to the "Outputs" menu You can assign the cleaning program directly to one or more outputs. —> "Outputs" section
▷ Start cyclic	Action	Start the cyclical cleaning process with the settings above
▷ Start manually	Action	Start an individual cleaning process If cyclical cleaning is enabled, there are times in which it is not possible to manually start the process.
▷ Stop	Action	End the cleaning process (cyclically or manually)
State of cleaning	Read only	Indicates whether cleaning is currently taking place or not
Time to next clean	Read only	Countdown to the next cleaning process (only if cyclical cleaning has been started)

10 Data administration

10.1 Firmware update

Please contact your local sales office for information on firmware updates available for your controller and its compatibility with earlier versions.
Your **current firmware version** can be found at: Menu/Diagnostics/System information/Software version.

First save your current setup on an SD card since a firmware update overwrites your settings with the factory settings. After updating the firmware, you can restore your setup by uploading it from the SD card.

To install a firmware update, you must have the update available on an SD card.
1. Insert the SD card into the controller card reader.
2. Go to: Menu/Setup/Data management/Firmware update.
   –> The update files on the SD card are displayed.
3. Select the desired update and select yes when the following question is displayed: The current firmware will be overwritten. After this the device will reboot. Do you want to proceed?
   –> The firmware is loaded and the device is then started with the new firmware.

10.2 Saving the setup

Saving the setup gives you the following advantages:
- Quick and easy to restore a setup following a firmware update
- Copying settings for other devices
- Quick and easy switching between various setups, e.g. for different user groups or for recurring sensor type change
- Restoring a tried-and-tested setup, e.g. if you have changed a lot of settings and no longer know what the original settings were

1. Insert the SD card into the controller card reader.
2. Go to: Menu/Setup/Data management/Save setup.
3. Assign a file name (Name).
4. Then select "Save".
5. If you have already assigned the file name, you will be asked whether you want to overwrite the existing setup.
   Select "OK" to confirm, or cancel the action and give the file a new name.

–> Your setup is stored on the SD card and you can upload it quickly to the device at a later date.

10.3 Loading the setup

You can load a setup you have saved quickly and easily:

1. Insert the SD card into the controller card reader.
2. Go to: Menu/Setup/Data management/Load setup.
   —> A list of all the setups on the SD card is displayed.
3. Select the desired setup.
   The device then displays the following message: The current parameters will be overwritten and the device will reboot. Do you want to proceed?
4. Select "OK" to confirm or cancel the action.

—> The desired setup is restored after restarting the device.

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