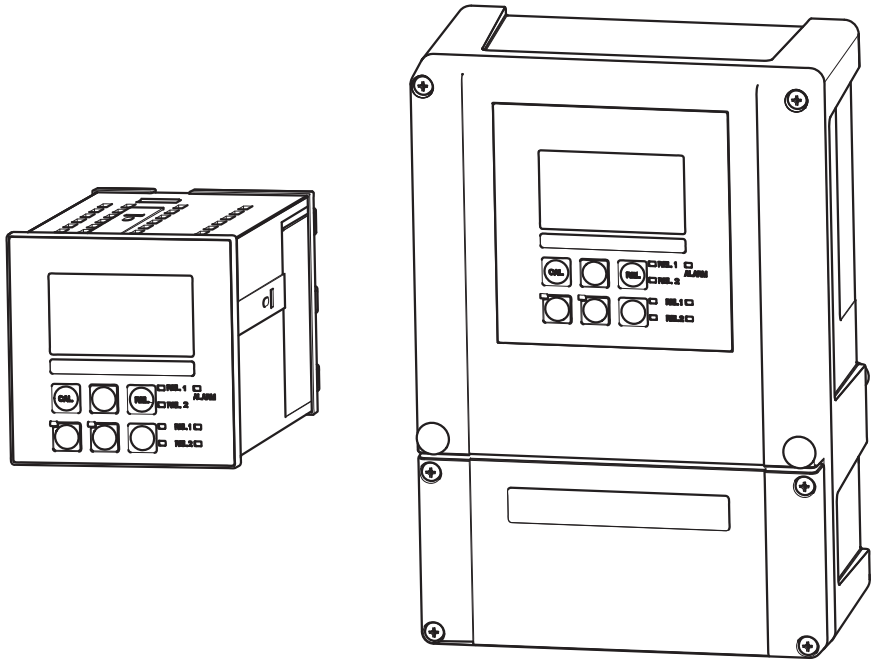
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Liquisys M CUM223/253

Transmitter for turbidity and suspended solids



BA200C/07/EN/13.11
71130243

valid as of:
software version 2.42

Endress+Hauser
People for Process Automation

Brief operating instructions

This explains how to use these Operating Instructions to commission your transmitter quickly and safely:

	Safety instructions
Page 5 ff.	General safety instructions
Page 6 ff.	Explanation of the warning symbols You can find special instructions at the appropriate position in the chapter in question. The positions are indicated with the icons Warning ⚠, Caution ☝ and Note ✎

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	Installation
Page 10 ff.	Here you can find information on installation conditions and the dimensions of the transmitter.
Page 11 ff.	You can find information on how to install the transmitter on these pages.

t

	Wiring
Page 15 ff.	Here you can find out how to connect sensors to the transmitter.

t

	Operation
Page 20 ff.	The display and operating elements are described here.
Page 23 ff.	The operating concept is explained here.
Page 32 ff.	The system configuration is explained here.
Page 57 ff.	You can find information on how to calibrate the sensor on these pages.

t

	Maintenance
Page 67 ff.	Here you can find information on the maintenance of the entire measuring point.
Page 69 ff.	The accessories which can be delivered for the transmitter are listed on the pages indicated.
Page 73 ff.	Here you can find information on trouble-shooting.
Page 80 ff.	Here you can find an overview of the spare parts which can be delivered as well as an overview of the system.

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	Technical data
Page 10 ff.	Dimensions
Page 87 ff.	Ambient and process conditions, weight, materials etc.

t

	Appendix
Page 92 ff.	Here you can find the operating matrix

Table of contents

1 Safety instructions

1.1 Designated use

Liquisys M is a transmitter for determining the turbidity and the solids content of a liquid medium.

The transmitter is particularly suited for use in the following areas:
- Drinking water treatment
- Water treatment
- Condensate treatment
- Sewage treatment plant
- Chemical industry
- Pharmaceutical industry

Any other use than the one described here compromises the safety of persons and the entire measuring system and is, therefore, not permitted.
The manufacturer is not liable for damage caused by improper or non-designated use.

1.2 Installation, commissioning and operation

Please note the following items:
- Installation, commissioning, operation and maintenance of the measuring system must only be carried out by trained technical personnel.
  Trained personnel must be authorized for the specified activities by the system operator.
- Electrical connection must only be carried out by a certified electrician.
- Technical personnel must have read and understood these Operating Instructions and must adhere to them.
- Before commissioning the entire measuring point, check all the connections. Ensure that electrical cables and hose connections are not damaged.
- Do not operate damaged products and secure them against unintentional commissioning. Mark the damaged product as being defective.
- Measuring point faults may only be rectified by authorized and specially trained personnel.
- If faults can not be rectified, the products must be taken out of service and secured against unintentional commissioning.
- Repairs not described in these Operating Instructions may only be carried out at the manufacturer's or by the service organization.

1.3 Operational safety

The transmitter has been designed and tested according to the state of the art and left the factory in perfect functioning order.
Relevant regulations and European standards have been met.

As the user, you are responsible for complying with the following safety conditions:
- Explosion protection regulations
- Installation instructions
- Local prevailing standards and regulations.

Ex systems have an additional Ex documentation which is part of the Operating Instructions (see also chapter "Scope of delivery").

Electromagnetic compatibility
With regard to electromagnetic compatibility, this device has been tested in accordance with the applicable European standards for industrial applications.
The electromagnetic compatibility indicated only applies to a device that has been connected in accordance with the instructions in these Operating Instructions.

1.4 Notes on safety icons and symbols

Safety icons

Warning!
This symbol alerts you to hazards that can cause serious damage to the instrument or to persons if ignored.

Caution!
This symbol alerts you to possible faults which could arise from incorrect operation. They could cause damage to the instrument if ignored.

Note!
This symbol indicates important items of information.

Electrical symbols

Direct Current (DC)
A terminal at which DC is applied or through which DC flows.

Alternating Current (AC)
A terminal at which (sine-form) AC is applied or through which AC flows.

Ground connecting
A terminal which, from the user's point of view, is already grounded using a grounding system.

Protective ground terminal
A terminal which must be grounded before other connections may be set up.

Alarm relay

Input

Output

DC voltage source

Temperature sensor

2 Identification

2.1 Device designation

2.1.1 Nameplate

Compare the order code on the nameplate (on the transmitter) with the product structure (s.b.) and your order.
The device version can be identified from the order code.

Note!
The release codes for retrofitting the software for Chemoclean (left of the slash) or the Plus package (right of the slash) are listed under "Codes".

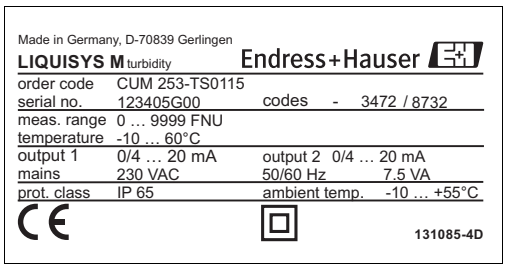


Fig. 1: CUM253 nameplate (example)

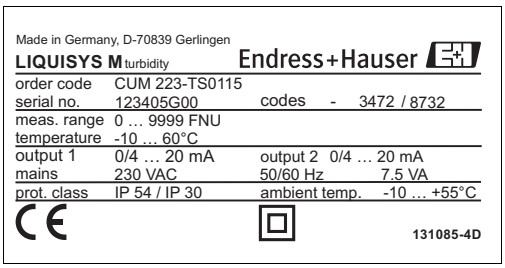


Fig. 2: CUM223 nameplate (example)

2.1.2 Product structure

	Input, software version
TB	Suspended solids with factory setup > residual concrete water
TU	Turbidity and suspended solids measurement
TS	Turbidity and suspended solids measurement, with additional functions (Plus package)

	Power supply; approval
0	230 V AC
1	115 V AC
2	230 V AC; CSA Gen. Purp.
3	115 V AC; CSA Gen. Purp.
5	100 V AC
7	24 V AC/DC; CSA Gen. Purp.
8	24 V AC/DC

	Output
0	1 x 20 mA, primary value
1	2 x 20 mA, primary value + secondary value
3	PROFIBUS PA
4	PROFIBUS DP
5	1 x 20 mA, primary value, HART
6	2 x 20 mA, primary value, HART + secondary value

	Additional contacts
05	not selected
10	2 relays (limit/P(ID)/timer)
15	4 relays (limit/P(ID)/Chemoclean) **(not with PROFIBUS DP)**
16	4 relays (limit/P(ID)/timer) **(not with PROFIBUS DP)**
20	1 x 4 ... 20 mA input + 2 relays (limit/P(ID)/timer)
25	1 x 4 ... 20 mA input + 4 relays (limit/P(ID)/Chemoclean) **(not with PROFIBUS DP)**
26	1 x 4 ... 20 mA input + 4 relays (limit/P(ID)/timer) **(not with PROFIBUS DP)**

	Marking
1	Tagging (Tag), see additional spec.

CUM253-	complete order code
CUM223-	

2.1.3 Additional functions of the Plus Package

- Current output table to cover wide ranges with varying resolution, fields O33x
- Process Check System (PCS): live check of the sensor, function group P
- Concentration measurement, function group K
- Automatic cleaning function start, field F8

2.2 Scope of delivery

The delivery of the field instrument includes:
- 1 transmitter CUM253
- 1 plug-in screw terminal
- 1 cable gland Pg 7
- 1 cable gland Pg 16 reduced
- 2 cable glands Pg 13.5
- 1 Operating Instructions BA200C/07/EN
- versions with HART communication:
  1 Operating Instructions Field Communication with HART, BA208C/07/EN
- versions with PROFIBUS communication:
  1 Operating Instructions Field Communication with PROFIBUS PA/DP, BA209C/07/EN

The delivery of the panel-mounted instrument includes:
- 1 transmitter CUM223
- 1 set of plug-in screw terminals
- 2 tensioning screws
- 1 Operating Instructions BA200C/07/EN
- versions with HART communication:
  1 Operating Instructions Field Communication with HART, BA208C/07/EN
- versions with PROFIBUS communication:
  1 Operating Instructions Field Communication with PROFIBUS PA/DP, BA209C/07/EN

If you have any questions, please contact your supplier or your local sales center.

2.3 Certificates and approvals

2.3.1 CE mark

Declaration of conformity
The product meets the requirements of the harmonized European standards. It thus complies with the legal requirements of the EC directives.
The manufacturer confirms successful testing of the product by affixing the CE symbol.

2.3.2 CSA general purpose

C.M2.3-..2...
C.M2.3-..3...
C.M2.3-..7...

3 Installation

3.1 Quick installation guide

Warning!
If the measuring point or parts of the measuring point are in explosion-hazardous areas you have to follow the "Safety instructions for electrical apparatus for explosion-hazardous areas". These instructions (XA194C/07/a3) are part of the scope of delivery.

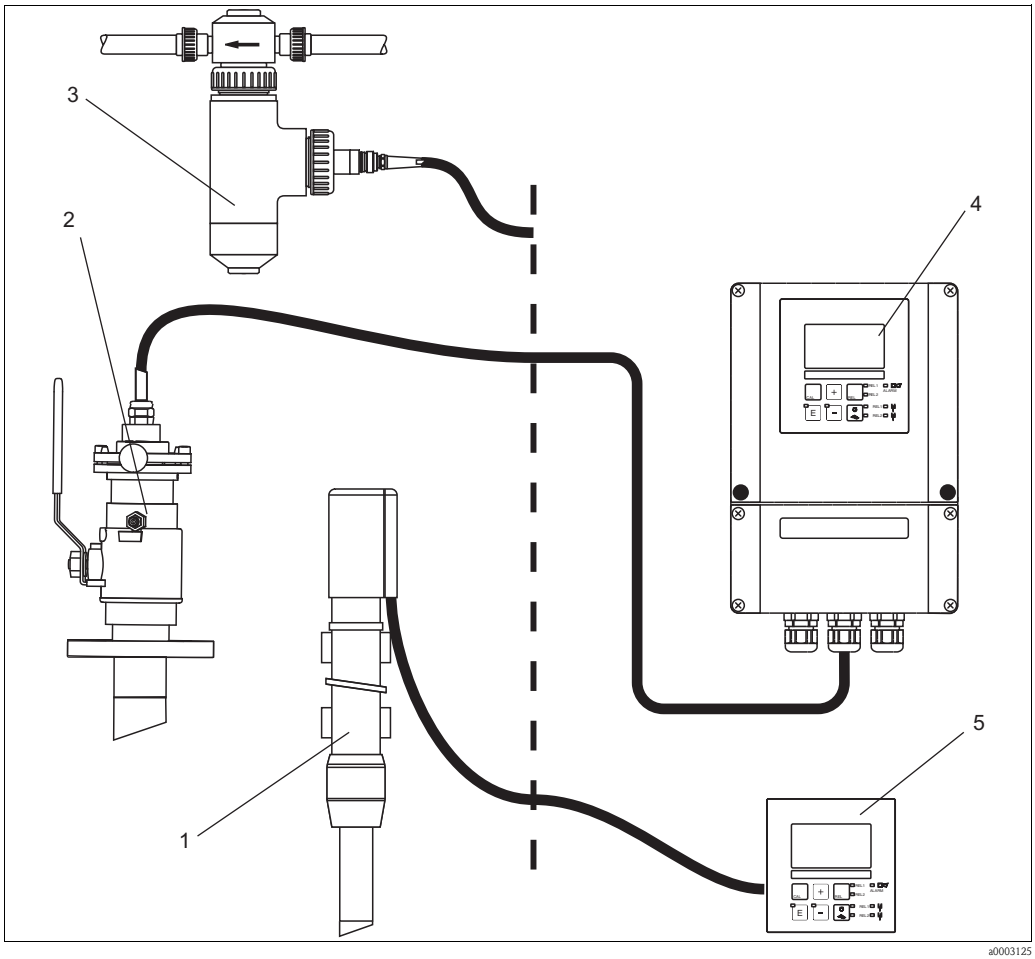
Proceed as follows to completely install the measuring point:

- Install the transmitter (see "Installation instructions" section).
- If the sensor is not yet installed in the measuring point, install it (see Technical Information of the sensor).
- Connect the sensor to the transmitter as illustrated in the "Electrical connection" section.
- Connect the transmitter as illustrated in the "Electrical connection" section.
- Commission the transmitter as explained in the "Commissioning" section.

3.1.1 Measuring system

A complete measuring systems comprises:
- The transmitter Liquisys M CUM223 or CUM253
- A sensor with or without an integrated temperature sensor
- An immersion, flow or retractable assembly

Options: extension cable CYK81, junction box VBM or RM



1 Immersion assembly CYA611
2 Retractable assembly CUA451
3 Assembly with gas bubble trap
4 Liquisys CUM253
5 Liquisys CUM223

3.2 Incoming acceptance, transport, storage

- Make sure the packaging is undamaged!
  Inform the supplier about any damage to the packaging.
  Keep the damaged packaging until the matter has been settled.
- Make sure the contents are undamaged!
  Inform the supplier about damage to the contents. Keep the damaged products until the matter has been settled.
- Check that the order is complete and agrees with your shipping documents.
- The packaging material used to store or to transport the product must provide shock protection and humidity protection. The original packaging offers the best protection. Also, keep to the approved ambient conditions (see "Technical data").
- If you have any questions, please contact your supplier or your local sales center.

3.3 Installation conditions

3.3.1 Field instrument

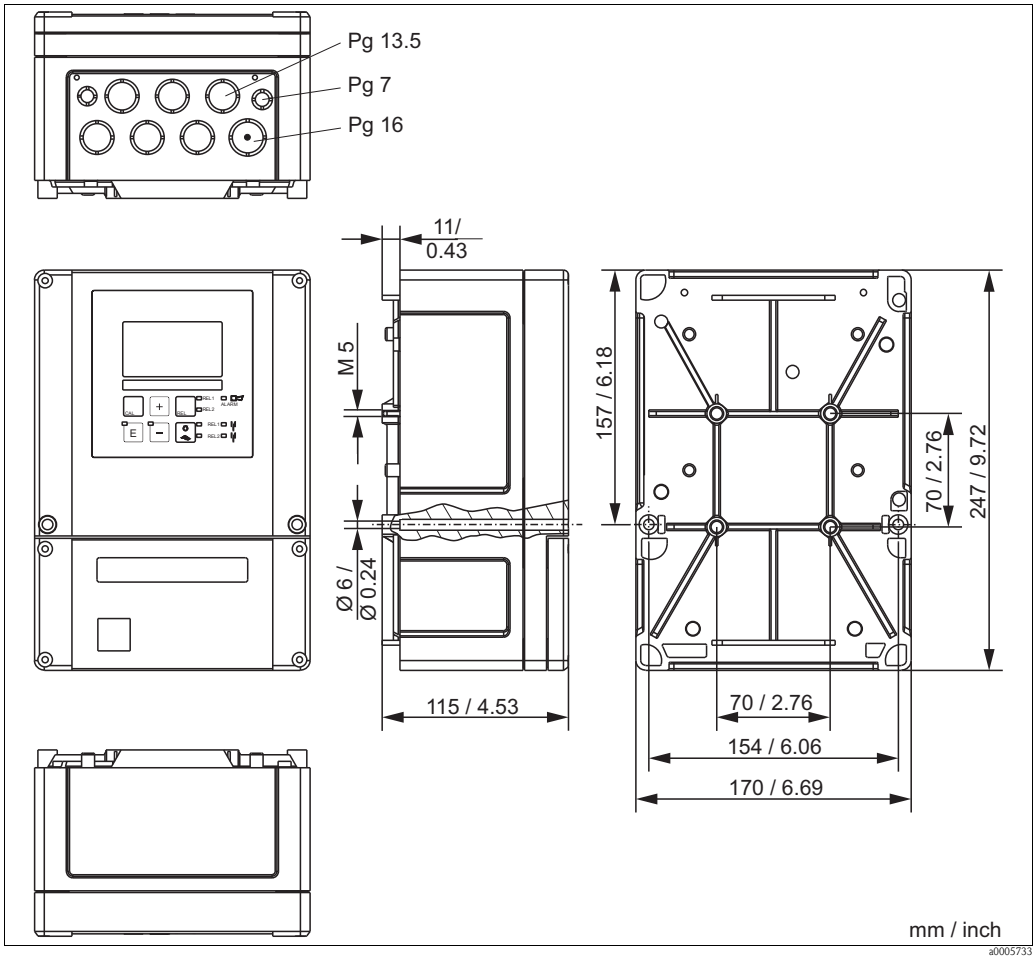
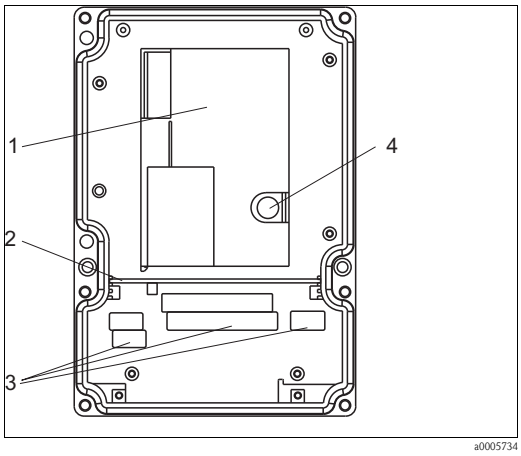


Fig. 3: Field instrument

Note!
There is a hole in the punching for the cable entry (connection of supply voltage). It serves as a pressure balance during air freight dispatching. Make sure no moisture penetrates the inside of the housing before the cable installation. The housing is completely air-tight after the cable installation.



1 Removable electronics box
2 Partition plate
3 Terminals
4 Fuse

Fig. 4: View into the field housing

3.3.2 Panel-mounted instrument

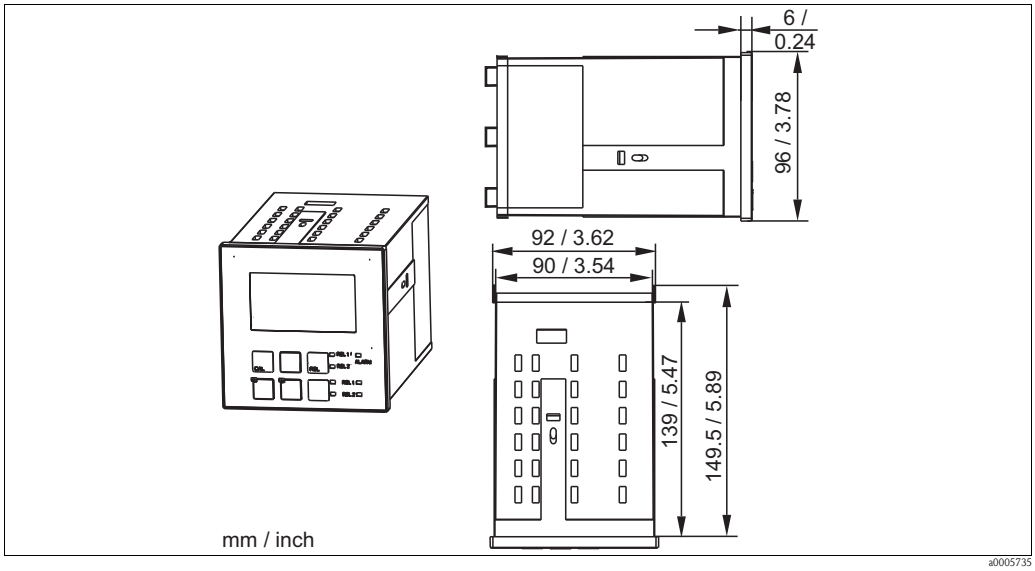


Fig. 5: Panel-mounted instrument

3.4 Installation instructions

3.4.1 Field instrument

There are several ways of securing the field housing:

- Wall mounting with fixing screws
- Post mounting to cylindrical pipes
- Post mounting to square securing masts

Note!
When mounting in the open air with unprotected exposure to weather conditions, a weather protection cover (see Accessories) is required.

Transmitter wall mounting

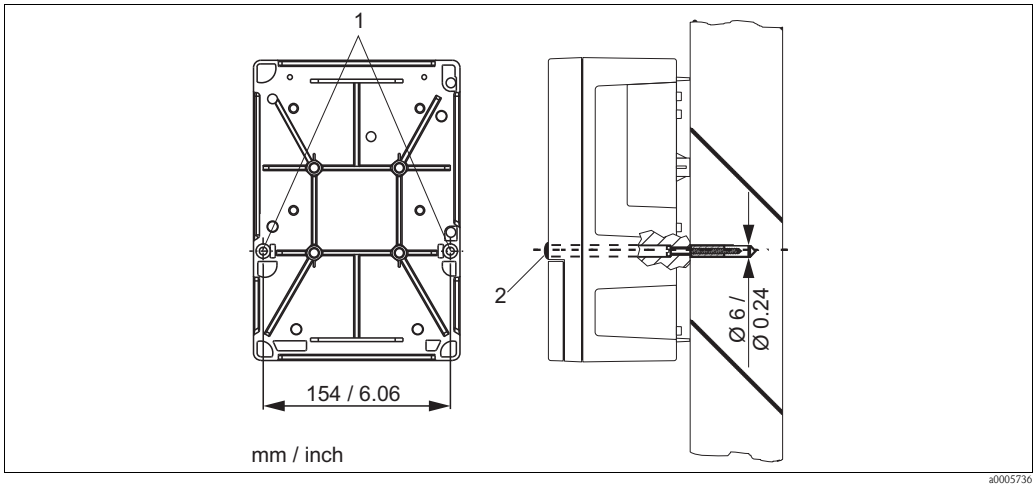


Fig. 6: Wall mounting field device

For wall mounting the transmitter, proceed as follows:

1. Drill the bores as shown in Fig. 6.
2. Drive the two fixing screws through the securing bores (1) from the front.
3. Mount the transmitter on the wall as shown.
4. Cover the bores with plastic caps (2).

Transmitter post mounting

Note!
You require a post mounting kit to secure the field device to horizontal and vertical posts or pipes (max. Ø 60 mm (2.36")). The kit can be acquired as an accessory (see "Accessories" section).

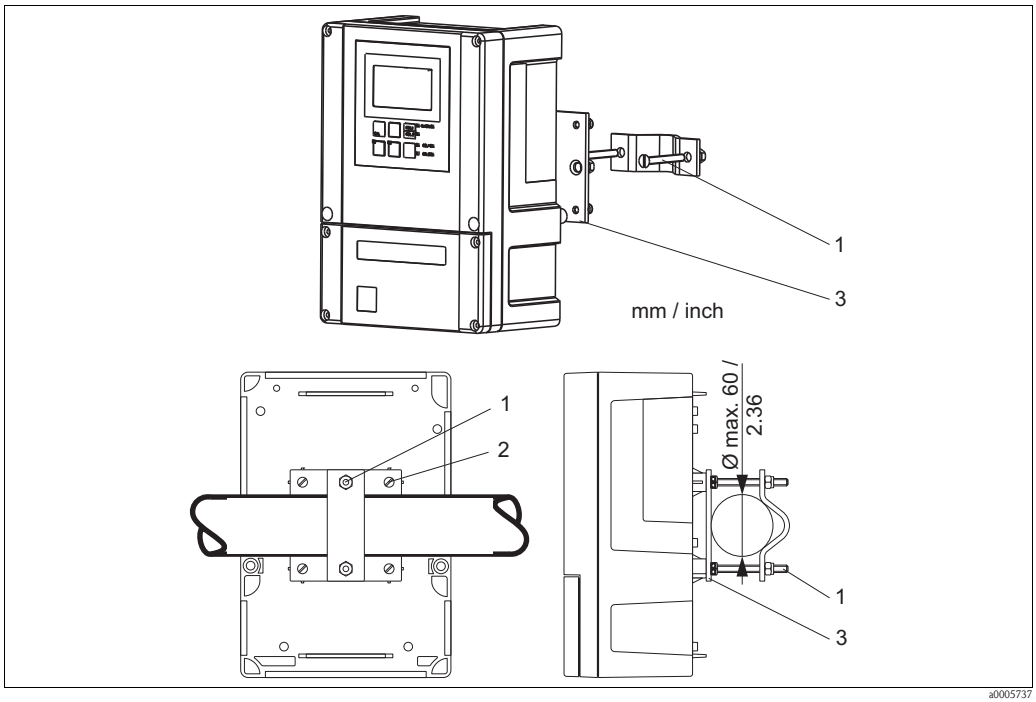


Fig. 7: Post mounting field device to cylindrical pipes

For post mounting the transmitter, proceed as follows:

1. Guide the two securing screws (1) of the mounting kit through the openings of the securing plate (3).
2. Screw the securing plate onto the transmitter using the four fixing screws (2).
3. Secure the retainer with the field device on the post or pipe using the clip.

You can also secure the field device to a square universal post in conjunction with the weather protection cover. These can be acquired as accessories, see "Accessories" section.

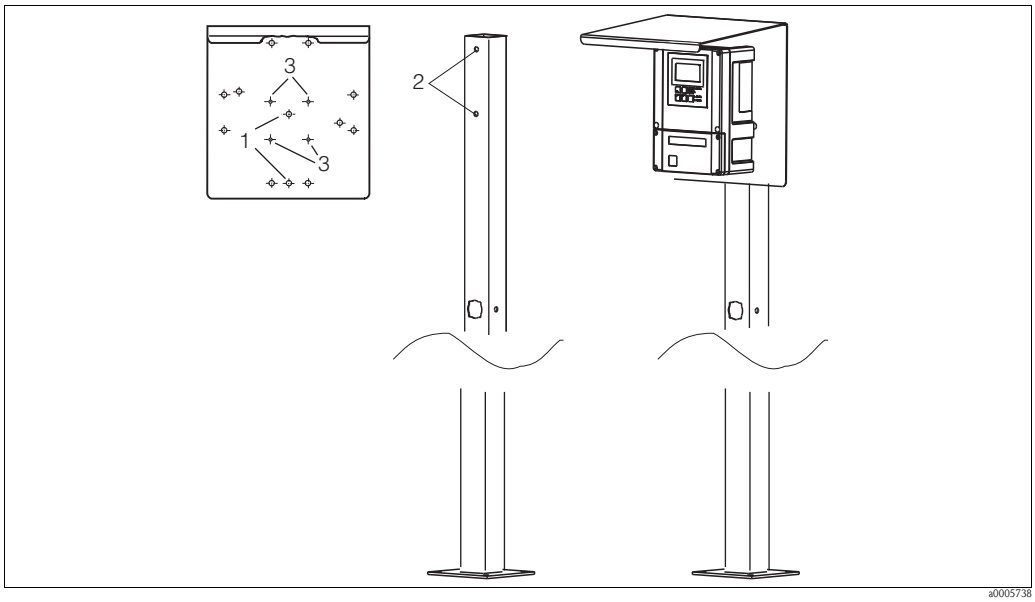


Fig. 8: Mounting field device with universal posts and weather protection cover

For mounting the weather protection cover, proceed as follows:

1. Screw the weather protection cover with 2 screws (bores 1) to the upright post (bores 2).
2. Secure the field device to the weather protection cover. To do so, use the bores (3).

3.4.2 Panel-mounted instrument

The panel-mounted instrument is secured with the clamping screws supplied (see Fig. 9).
The necessary installation depth is approx. 165 mm (6.50").

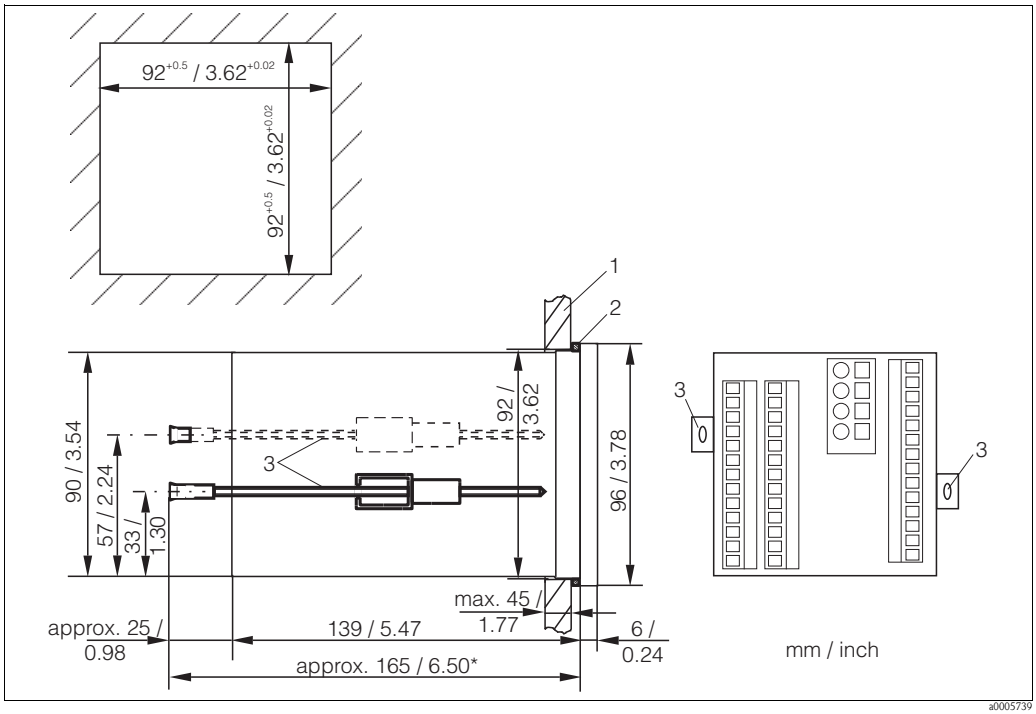


Fig. 9: Securing the panel-mounted instrument

1 Wall of the cabinet
2 Seal
3 Clamping screws
** Required installation depth*

3.5 Post-installation check

- After installation, check the transmitter for damage.
- Check whether the transmitter is protected against moisture and direct sunlight (e.g. by the weather protection cover).

4 Wiring

4.1 Electrical connection

Warning!
- The electrical connection must only be carried out by a certified electrician.
- Technical personnel must have read and understood the instructions in this manual and must adhere to them.
- Ensure that there is no voltage at the power cable before beginning the connection work.

4.1.1 Electrical connection

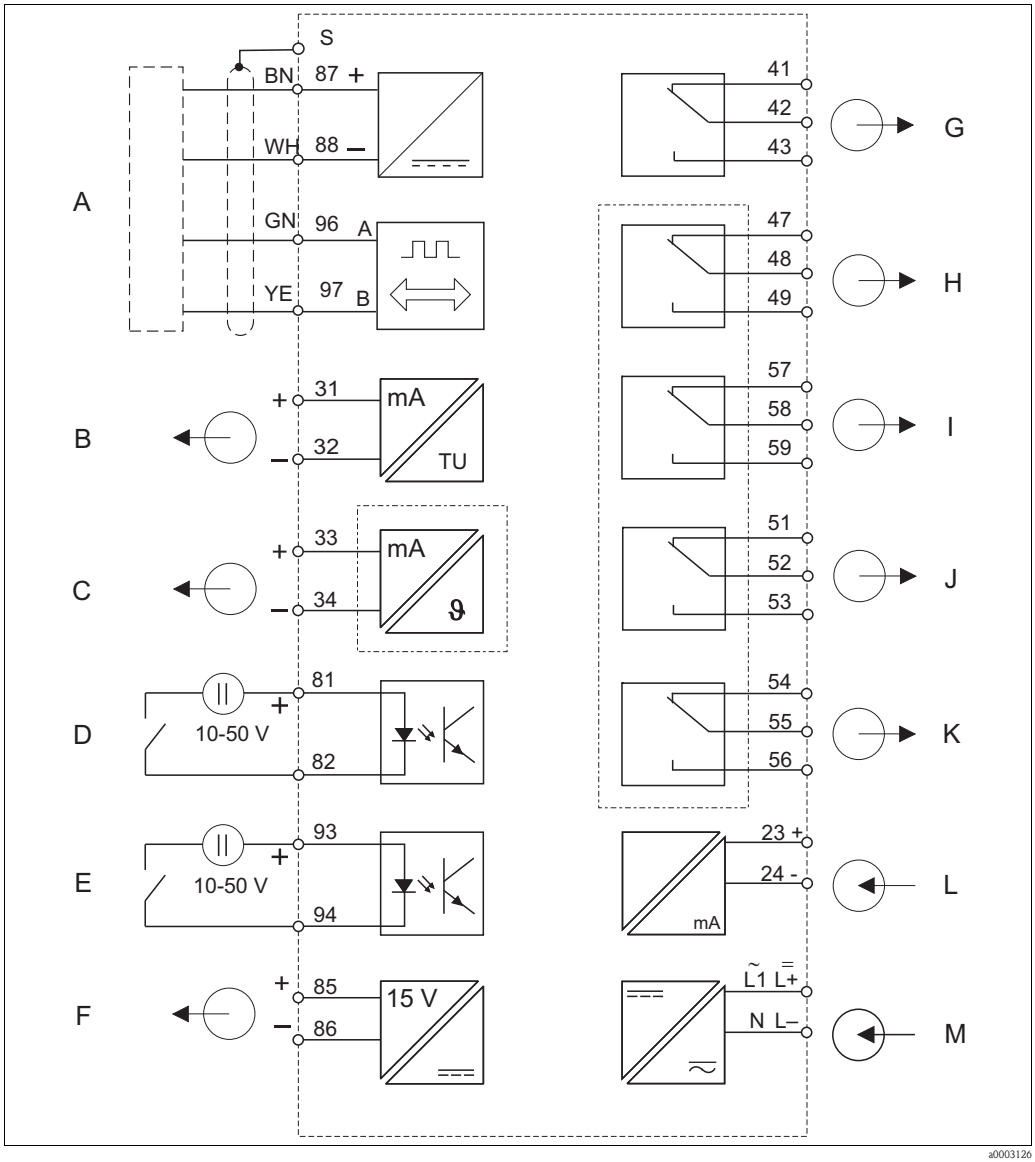


Fig. 10: Electrical connection of the transmitter

A	*Sensor*	*H*	*Relay 1 (current-free contact position)*
B	*Signal output 1 turbidity/solids content*	*I*	*Relay 2 (current-free contact position)*
C	*Signal output 2 temperature*	*J*	*Relay 3 (current-free contact position)*
D	*Binary input 1 (Hold)*	*K*	*Relay 4 (current-free contact position)*
E	*Binary input 2 (Chemoclean)*	*L*	*Current input 4 to 20 mA*
F	*Aux. voltage output*	*M*	*Power supply*
G	*Alarm (current-free contact position)*		

Note!
The device is approved for protection class II and is generally operated without a protective ground connection.
The circuits "C" and "F" are not galvanically isolated from each other.

Field instrument connection
To connect the field instrument proceed as follows:

1. Open the front cover to get access to the terminals.
2. Cut the punching for the Pg gland out of the housing. Mount a Pg gland and guide the measuring cable through the Pg gland into the housing.
3. Connect the measuring cable in accordance with the connection diagram.
4. Fix the Pg gland.

Caution!
- Always protect plugs, terminals and cables against humidity.
- Terminals marked NC may not be wired.
- Unmarked terminals may not be wired.

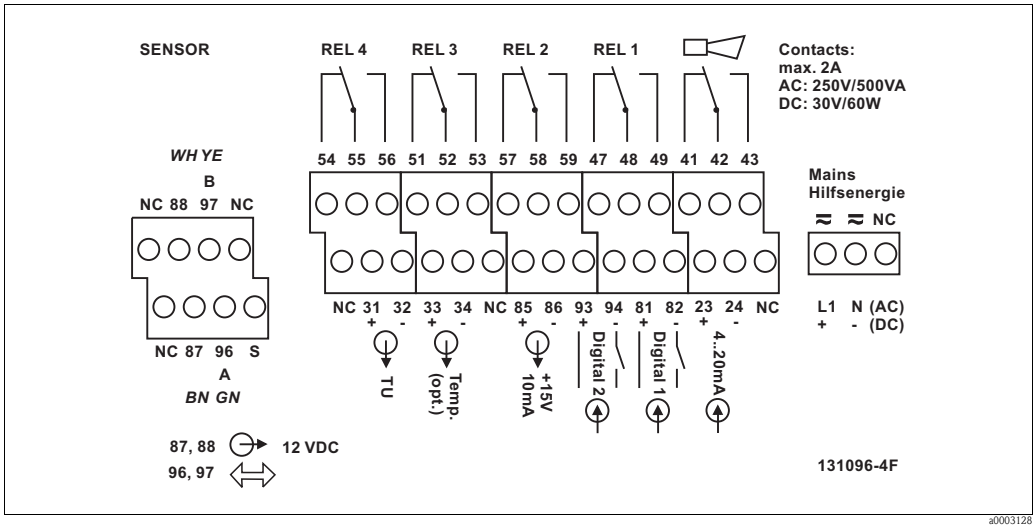


Fig. 11: Field instrument connection compartment sticker

Note!
Please label the sensor terminal block with the sticker provided.

Panel-mounted instrument connection
Connect the cables in accordance with the connection diagram.

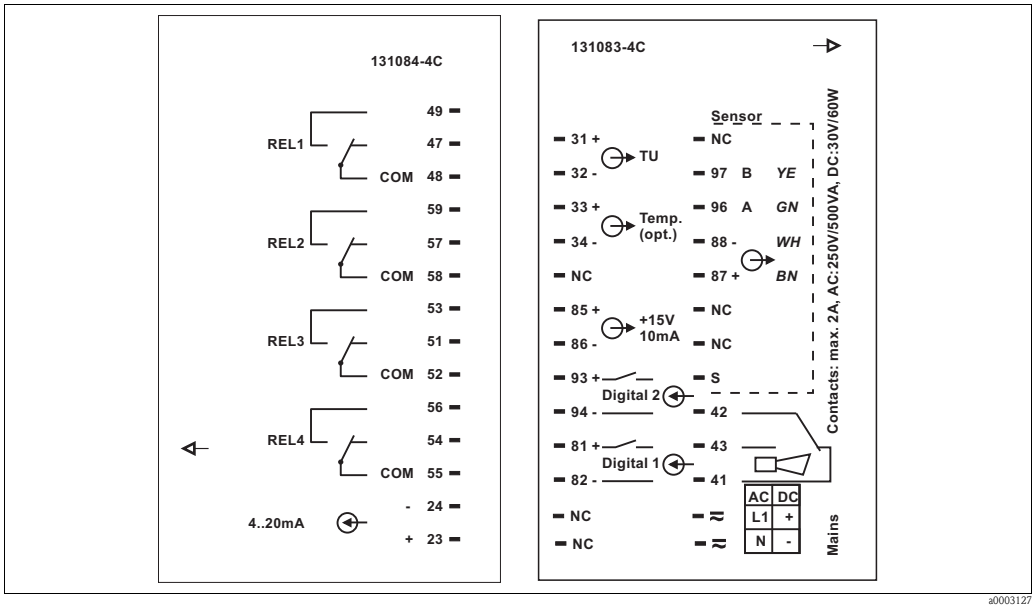


Fig. 12: Panel mounted instrument connection sticker

Caution!
- Terminals marked NC may not be wired.
- Unmarked terminals may not be wired.

4.1.2 Measuring cable and sensor connection

The sensor is connected via a screened fixed cable. To extend the measuring cable, use a junction box and an extension cable:

Sensor	Sensor cable	Extension
Turbidity sensor CUS31/CUS41	Fixed cable	VBM junction box + CYK81 cable

You can also use the measuring cable CMK.

Maximum cable length	
Turbidity sensor CUS31/CUS41	max. 200 m (656 ft.) with CYK81

Structure of the measuring cable

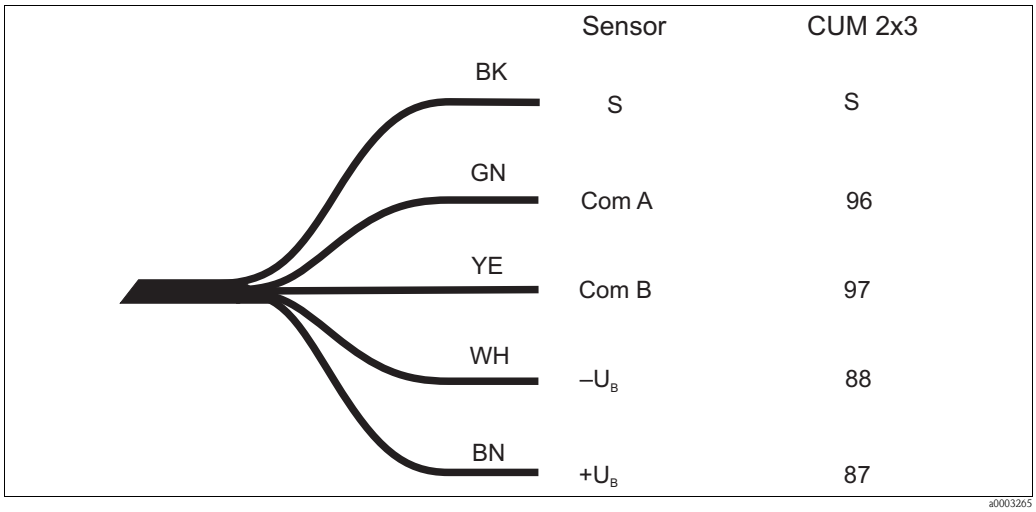


Fig. 13: Structure of measuring cable CYK8 and CYK81 (extension cable)

Note!
For further information on cables and junction boxes refer to the chapter "Accessories".

Connection of the sensor

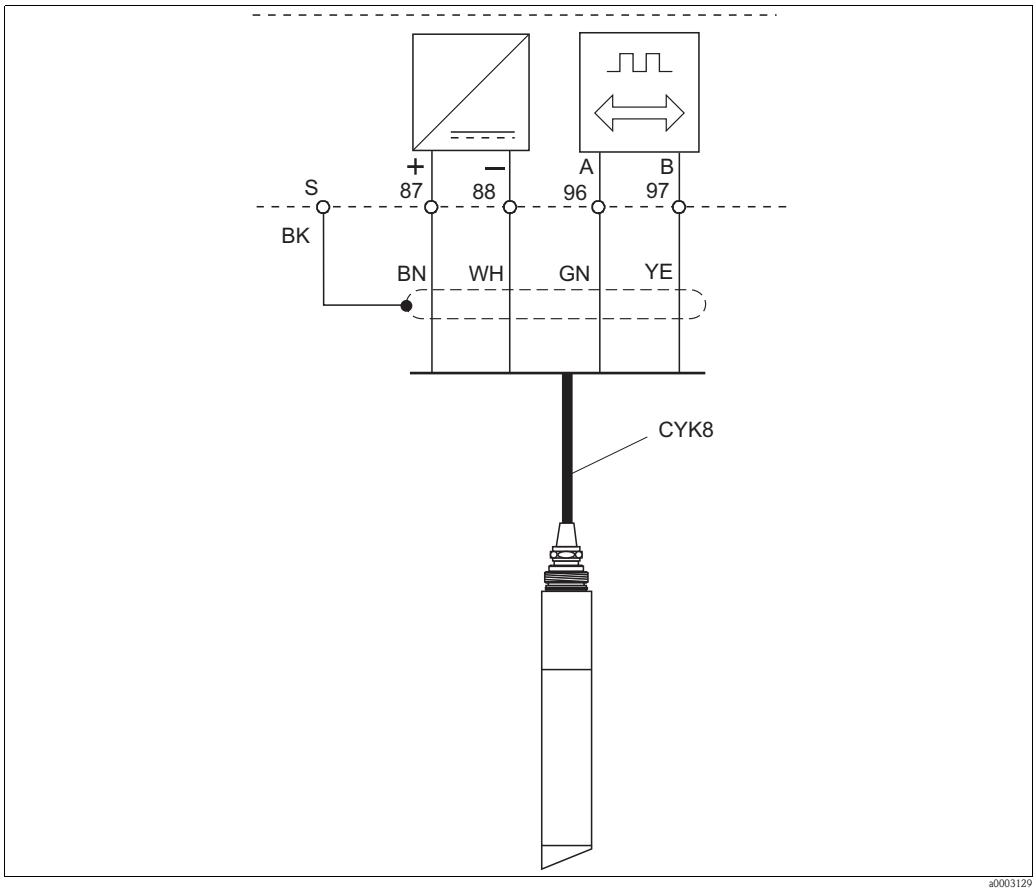


Fig. 14: Connection of the turbidity sensors CUS31 and CUS41

4.1.3 Alarm contact

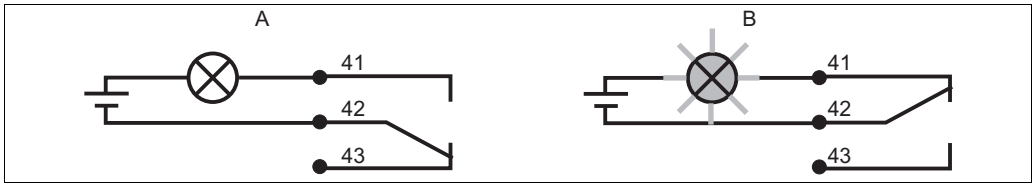


Fig. 15: Recommended fail-safe switching for the alarm contact
A Normal operating status *B Alarm condition*

Normal operating status:
Device in operation and no error message present (alarm LED off)

- Relay energized
- Contact 42/43 closed

Alarm condition
Error message present (alarm LED red) or device defective or voltage-free (alarm LED off)

- Relay de-energized
- Contact 41/42 closed

4.2 Post-connection check

After the electrical connection, carry out the following checks:

Device condition and specifications	Notes
Are the transmitter and cables damaged on the outside?	Visual inspection

Electrical connection	Notes
Are the mounted cables strain relieved?	
Cable run without loops and cross-overs?	
Are the signal lines correctly connected in accordance with the wiring diagram?	
Are all screw terminals tightened?	
Are all cable entries installed, tightened and sealed?	

5 Operation

5.1 Quick operation guide

You have the following ways of operating the transmitter:
- On site via the key field
- Via the HART interface (optional, with corresponding order version) per:
  – HART handheld terminal or
  – PC with HART modem and the FieldCare software package
- Via PROFIBUS PA/DP (optional, with corresponding order version) with:
  PC with corresponding interface and the FieldCare software package (see Accessories) or via a programmable logic controller (PLC)

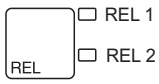
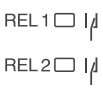
Note!
For operation via HART or PROFIBUS PA/DP, please read the relevant sections in the additional Operating Instructions:
- PROFIBUS PA/DP, field communication for Liquisys M CXM223/253, BA209C/07/EN
- HART, field communication for Liquisys M CXM223/253, BA208C/07/EN

The following section only explains operation via the keys.

5.2 Display and operating elements

5.2.1 Display

LED display

	Indicates the current operating mode, "Auto" (green LED) or "Manual" (yellow LED)
	Indicates the activated relay in the "Manual" mode (red LED)
	Indicates the working status of relay 1 and 2 LED green: measured value within the permitted limit, relay inactive LED red: measured value outside the permitted limit, relay active
	Alarm display, e.g. for continuous limit value overshoot, temperature sensor failure or system error (see error list)

LC display

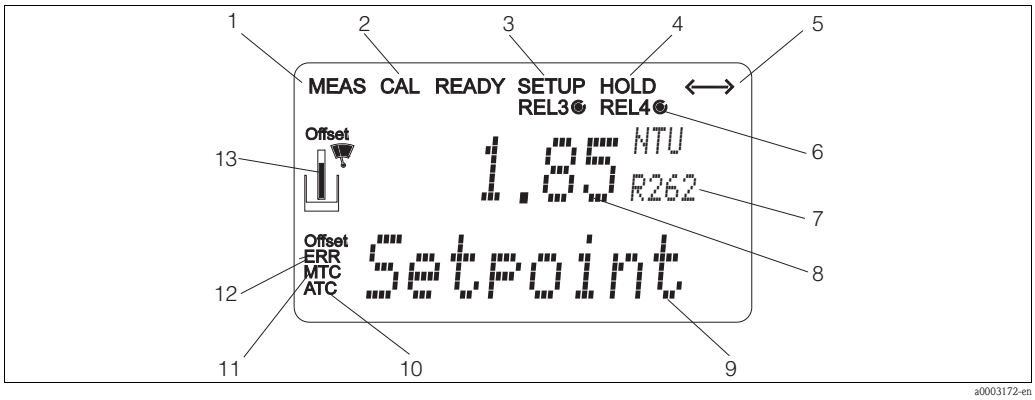


Fig. 16: LC display transmitter

1 *Indicator for measuring mode (normal operation)*
2 *Indicator for calibration mode*
3 *Indicator for setup mode (configuration)*
4 *Indicator for "Hold" mode (current outputs remain at last current state)*
5 *Indicator for receipt of a message for devices with communication*
6 *Indicator of working status of relays 3/4: inactive, active*
7 *Function code display*
8 *In measuring mode: measured variable*
In setup mode: configured variable
9 *In measuring mode: secondary measured value*
In setup/calibr. mode: e.g. setting value
10 *"Error": error display*
11 *Temperature offset*
12 *Sensor symbol*

5.2.2 Operating elements

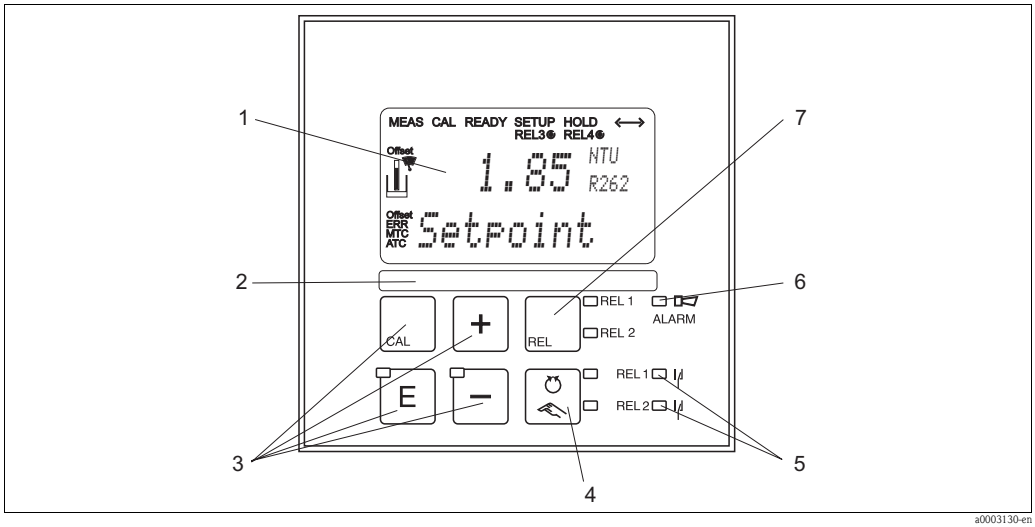
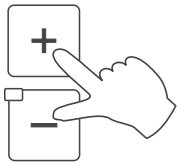
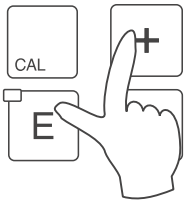
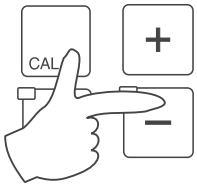


Fig. 17: Operating elements

1 *LC display for displaying the measured values and configuration data*
2 *Field for user labelling*
3 *4 main operating keys for calibration and device configuration*
4 *Changeover switch for automatic/manual mode of the relays*
5 *LEDs for limit contactor relay (switch status)*
6 *LED for alarm function*
7 *Display of the active contact and key for relay changeover in manual mode*

5.2.3 Key assignment

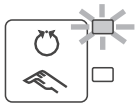
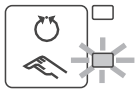
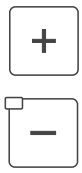
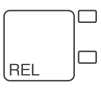
CAL	**CAL key** When you press the CAL key, the device first prompts you for the calibration access code: ■ Code 22 for calibration ■ Code 0 or any other code for reading the last calibration data Use the CAL key to accept the calibration data or to switch from field to field within the calibration menu.
E	**ENTER key** When you press the ENTER key, the device first prompts you for the setup mode access code: ■ Code 22 for setup and configuration ■ Code 0 or any other code for reading all configuration data. The ENTER key has several functions: ■ Calls up the Setup menu from the measuring mode. ■ Saves (confirms) data entered in the setup mode. ■ Moves on within function groups.
+ −	**PLUS key and MINUS key** In the setup mode, the PLUS and MINUS keys have the following functions: ■ Selection of function groups. ✎ Note! Press the MINUS key to select the function groups in the order given in the "System configuration" section. ■ Configuration of parameters and numerical values ■ Operation of the relay in manual mode In the measuring mode, you get the following sequence of functions by **repeatedly pressing the PLUS key**: 1. Temperature display in F 2. Temperature display hidden 3. Current input signal in % 4. Current input signal in mA 5. Measured value display in FNU or NTU (uncompensated value without reflection compensation offset and slope, refered to data set 1) In the measuring mode, the following is displayed in sequence by **repeatedly pressing the MINUS key:** 1. Current errors are displayed in rotation (max. 10). 2. Once all the errors have been displayed, the standard measurement display appears. In the function group F, an alarm can be defined separately for each error code.
REL 1 REL 2 REL	**REL key** In the manual mode, you can use the REL key to switch between the relay and the manual start of cleaning. In the automatic mode, you can use the REL key to read out the switch-on points (for limit contactor) or set points (for PID controller) assigned to the relay in question. Press the PLUS key to jump to the settings of the next relay. Use the REL key to get back to the display mode (automatic return after 30 s).

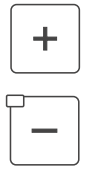
	**AUTO key** You can use the AUTO key to switch between automatic mode and manual mode.
	**Escape function** If you press the PLUS and MINUS key simultaneously, you return to the main menu or are taken to the end of calibration if calibrating. If you press the PLUS and MINUS key again, you return to the measuring mode.
	**Locking the keyboard** Press the PLUS and ENTER key for at least 3 s to lock the keyboard against any unauthorized data entry. All the settings can continue to be read. The code prompt displays the code 9999.
	**Unlocking the keyboard** Press the CAL and MINUS key for at least 3 s to unlock the keyboard. The code prompt displays the code 0.

5.3 Local Operation

5.3.1 Automatic/manual mode

The transmitter normally operates in automatic mode. Here, the relays are triggered by the transmitter. In the manual mode, you can trigger the relays using the REL key or start the cleaning function.
How to change the operating mode:

	1. The transmitter is in **Automatic mode**. The top LED beside the AUTO key is lit.
	2. Press the AUTO key.
	3. To enable the manual mode, enter the code **22** via the PLUS and MINUS keys. The bottom LED beside the AUTO key lights up.
	4. Select the relay or the function. You can use the REL key to switch between the relays. The relay selected and the switch status (ON/OFF) is displayed on the second line of the display. In the manual mode, the measured value is displayed continuously (e.g. for measured value monitoring for dosing functions).

	5. Switch the relay. It is switched on with PLUS and switched off with MINUS. The relay remains in its switched state until it is switched over again.
	6. Press the AUTO key to return to the measuring mode, i.e. to the automatic mode. All the relays are triggered again by the transmitter.

Note!
- The selected operating mode remains in effect even after a power failure.
- The manual mode has priority over all automatic functions (Hold).
- Hardware locking is not possible in the manual mode.
- The manual settings are kept until they are actively reset.
- Error code E102 is signalled in the manual mode.

5.3.2 Operating concept

Operating modes

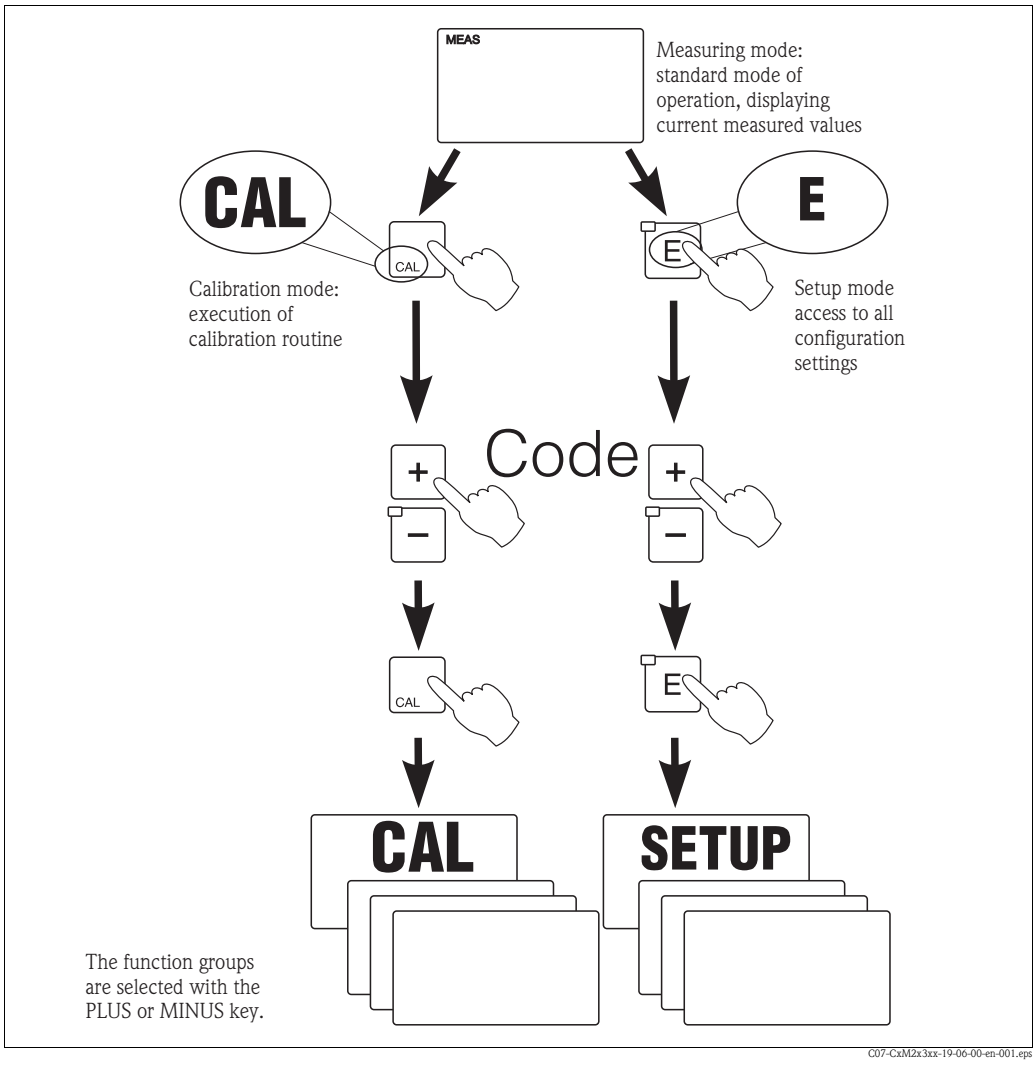


Fig. 18: Description of the possible operating modes

Note!
If no key is pressed in the setup mode for approx. 15 min, the device automatically returns to the measuring mode. Any active Hold (Hold during setup) is reset.

Access codes

All device access codes are fixed and cannot be altered. When the device requests the access code, it distinguishes between different codes.

- **Key CAL + Code 22:** access to Calibration and Offset menu
- **Key ENTER + Code 22:** access to the setup menus
- **Keys PLUS + ENTER:** locks the keyboard
- **Keys CAL + MINUS:** unlocks the keyboard
- **Key CAL or ENTER + any code:** access to read mode, i.e. all the settings can be read but not modified.
  The device continues measuring in the read mode. It does not shift to the Hold status. The current output and the controllers remain active.

Menu structure

The configuration and calibration functions are arranged in function groups.

- In setup mode, select a function group with the PLUS and MINUS keys.
- In the function group itself, switch from function to function with the ENTER key.
- Within the function, select the desired option with the PLUS and MINUS keys or edit the settings with these keys. Then confirm with the ENTER key and continue.
- Press the PLUS and MINUS keys simultaneously (Escape function) to exit programming (return to the main menu).
- Press the PLUS and MINUS simultaneously keys again to switch to the measuring mode.

Note!
- If a modified setting is not confirmed with ENTER, the old setting is retained.
- An overview of the menu structure is provided in the Appendix to these Operating Instructions.

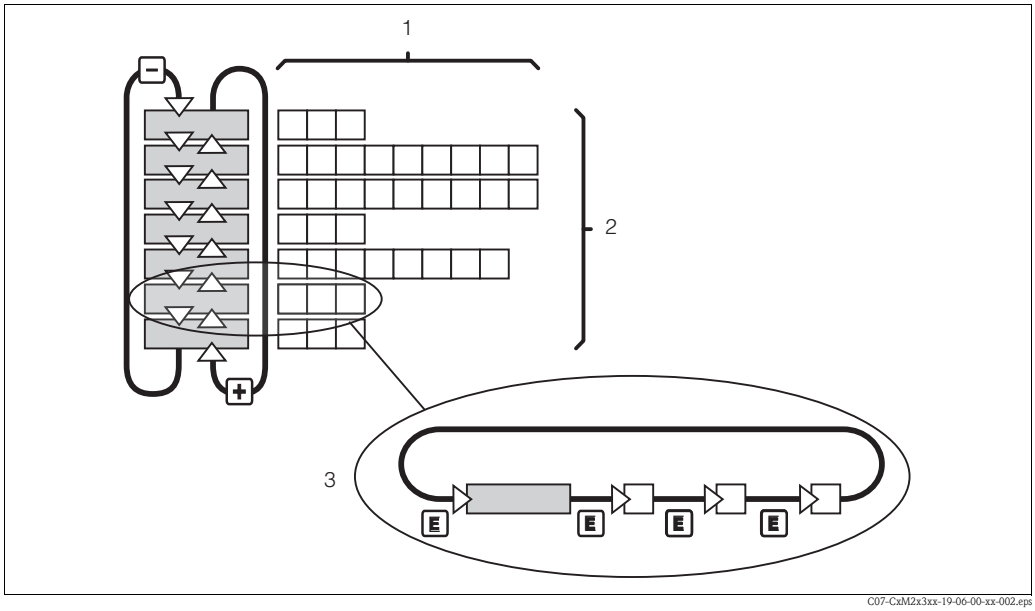


Fig. 19: Diagram of the menu structure

1 Functions (parameters selected, numbers entered)
2 Function groups, scroll backwards and forwards with the PLUS and MINUS keys
3 Switch from function to function with the ENTER key

Hold function: "freezing" of the outputs

During setup and calibration, the current output can be "frozen". It constantly retains its current status. "HOLD" appears on the display. If the controller actuating variable (steady control 4 to 20 mA) is output via current output 2, it is set to 0/4 mA in Hold.

Note!
- Hold settings can be found in the "Service" section.
- During Hold, all contacts will go to their normal positions.
- An active Hold has priority over all other functions.
- With every Hold, the I-component of the controller is set to zero.
- Any alarm delay is reset to "0".
- This function can also be activated externally via the Hold input (see Wiring diagram; binary input 1).
- The manual Hold (field S3) remains active even after a power failure.

6 Commissioning

6.1 Function check

Warning!
- Check all connections for correctness.
- Make sure that the supply voltage is identical to the voltage written on the nameplate!

6.2 Switching on

Familiarize yourself with the operation of the transmitter before it is first switched on. Please refer in particular to the "Safety instructions" and "Operation" sections.
After power-up, the device performs a self-test and then goes to the measuring mode.
Now calibrate the sensor in accordance with the instructions in the "Calibration" section.
Then perform the first configuration in accordance with the instructions in the "Quick start-up" section. The values set by the user are kept even in the event of a power failure.
The following function groups are available in the transmitter (the groups only available in the Plus Package are marked accordingly in the functional description):

Setup mode
- SETUP 1 (A)
- SETUP 2 (B)
- CURRENT INPUT (Z)
- CURRENT OUTPUT (O)
- ALARM (F)
- CHECK (P)
- RELAY (R)
- CONCENTRATION MEASUREMENT (K)
- SERVICE (S)
- E+H SERVICE (E)
- INTERFACE (I)

Calibration and offset mode
- CALIBRATION (C)
- OFFSET (V)
- SLOPE (N)

Note!
A detailed explanation of the function groups available in the transmitter can be found in the "System configuration" section.

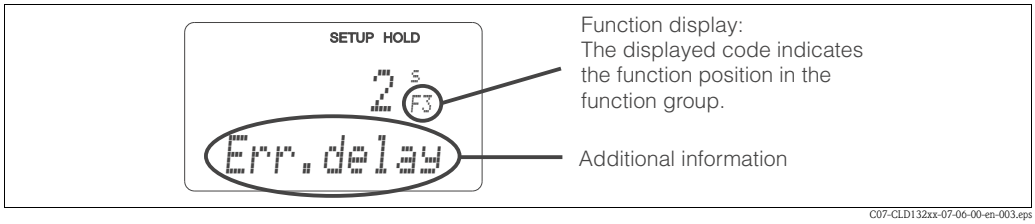


Fig. 20: Example for display in setup mode

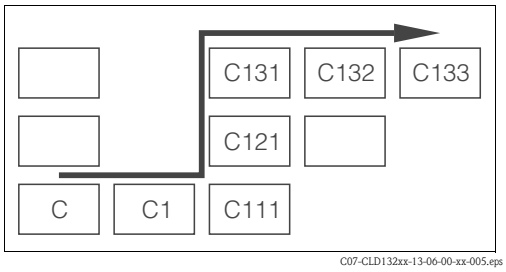


Fig. 21: Function coding

Selecting and locating functions is facilitated by a code displayed for each function in a special display field Fig. 20.
The structure of this coding is given in Fig. 21. The first column indicates the function group as a letter (see group designations). The functions in the individual groups are counted from the top to the bottom and from the left to the right.

Factory settings

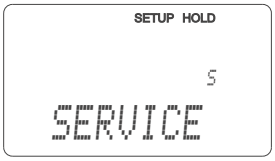
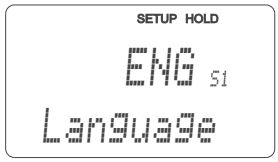
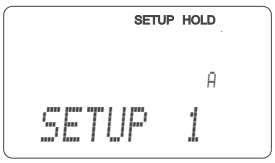
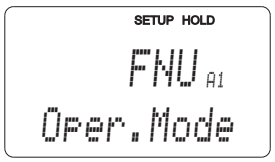
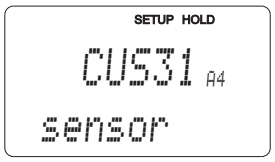
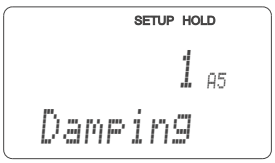
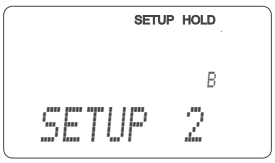
The first time it is switched on, the device has the factory setting for all functions. The table below provides an overview of the most important settings.
All other factory settings can be found in the description of the individual function groups in the "System configuration" section (the factory setting is highlighted in **bold**).

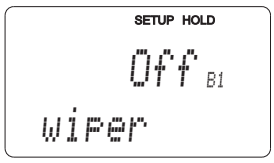
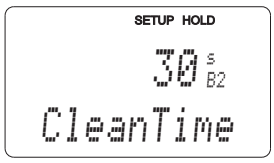
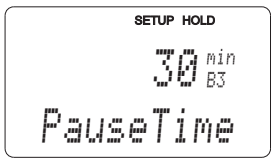
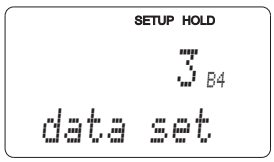
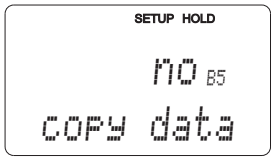
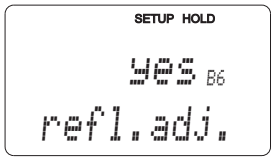
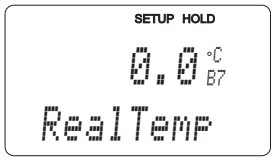
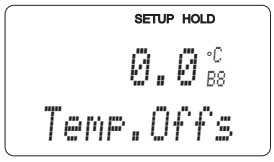
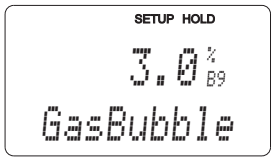
Function	Factory setting
Type of measurement	Turbidity in FNU Temperature in °C
Temperature offset / turbidity offset	0 °C / 0 FNU
Limit value for controller 1	9999 FNU
Contact function limit contactor 1	MAX contact without delay
Limit value for controller 2	100 °C
Contact function limit contactor 2	MAX contact without delay
Current outputs 1 and 2*	4 to 20 mA
Current output 1: measured value for 4 mA signal current	0 FNU
Current output 1: measured value for 20 mA signal current	10.0 FNU
Current output 2: temperature value for 4 mA signal current*	-5.0 °C (23 °F)
Current output 2: temperature value for 20 mA signal current*	100.0 °C (212 °F)
Measured value damping	10
Calibration data set	No. 3
Wiper controller	Off

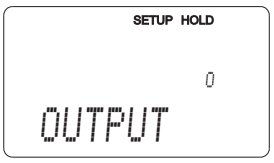
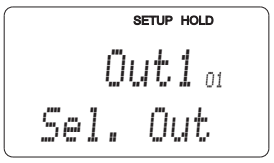
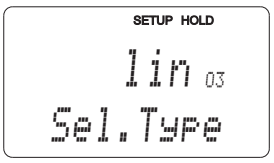
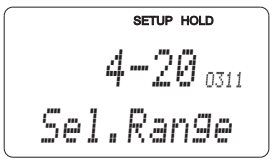
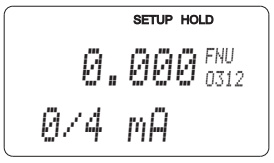
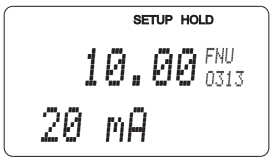
* For corresponding version

6.3 Quick start-up

After power-up, you must make some settings to configure the most important functions of the transmitter which are required for correct measurement. The following section gives an example of this.

User input	Setting range (Factory settings, bold)	Display
1. Press the ENTER key. 2. Enter the code 22 to edit the setup. Press ENTER.		
3. Press MINUS until you get to the "Service" function group. 4. Press ENTER to be able to make your settings.		
5. In S1, select your language, e.g. "ENG" for English. Press ENTER to confirm.	**ENG = English** GER = German FRA = French ITA = Italian NEL = Dutch ESP = Spanish	
6. Press PLUS and MINUS simultaneously to exit the "Service" function group.		
7. Press MINUS until you get to the "Setup 1" function group. 8. Press ENTER to be able to make your settings for "Setup 1".		
9. In A1, select the desired mode of operation, e.g. "FNU". Press ENTER to confirm.	**FNU** NTU ppm mg/l g/l % spec.	
10. A4 displays the sensor type. Press ENTER.	CUS31 CUS41	
11. In A5, enter measured value damping. Measured value damping causes averaging over the specified number of individual measured values. This is used for example, to stabilize the display if the measurement is unstable. Enter "1" if no damping is required. Press ENTER to confirm. The display returns to "Setup 1"	**10** 1 to 60	
12. Press MINUS to go to the "Setup 2" function group. 13. Press ENTER to edit "Setup 2".		

User input	Setting range (Factory settings, bold)	Display
14. In B1, switch wiper controller on or off. Press ENTER to confirm.	**off** on auto	
15. In B2, enter operation period of wiper. Press ENTER to confirm.	**30 s** 3 to 999 s	
16. In B3, enter pause time between two wiping cycles. Press ENTER to confirm.	**30 min** 1 to 7200 min	
17. In B4, select the calibration data set to be used. Press ENTER to confirm.	**3** 1 to 3	
18. In B5, select the data set to be copied. Press ENTER to confirm.	**no** 1 ➔ 2 1 ➔ 3 2 ➔ 3 3 ➔ 2	
19. In B6, select if the measured value shall be displayed with reflection adjustment (for solutions ≤ 2 FNU / 5 ppm). Press ENTER to confirm.	**yes** no	
20. In B7, enter the corrected temperature of the temperature sensor (for adjustment to external measurement). Press ENTER to confirm.	**Current measured value** -5.0 to 100.0 °C	
21. In B8, the current offset is displayed. Press ENTER to confirm.	**Current offset** -5.0 to 5.0 °C	
22. In B9, enter gas bubble barrier. For clear media with measured values <1000 NTU the gas bubble barrier has to be set to 100 %. Press ENTER to confirm.	**3.0 %** 0.1 to 100 %	

User input	Setting range (Factory settings, bold)	Display
23. Press MINUS to go to the "Current output" function group 24. Press ENTER to edit "Current output".		
25. In O1, select current output. Press ENTER to confirm.	**Out1** Out2	
26. In O3, select the linear characteristic. Press ENTER to confirm.	**lin = linear** sim = simulation Tab = table	
27. In O311, select the current range. Press ENTER to confirm.	**4 to 20 mA** 0 to 20 mA	
28. In O312, enter turbidity or temperature value corresponding to 0/4 mA. Press ENTER to confirm.	**0.0 NTU** **0.0 FNU** **0.0 ppm** **0.0 mg/l** **0.0 g/l** **0.0 kg/l** **0.0 t/m** **0.0 %** **0.0 °C**	
29. In O313, enter turbidity or temperature value corresponding to 20 mA. Press ENTER to confirm.	**10.00 NTU** **10.00 FNU** **10.00 ppm** **10.00 mg/l** **300.0 g/l / 3.00 g/l** **99.99 kg/l** **99.99 t/m** **10.0 %** **100.0 °C**	
30. Press PLUS and MINUS simultaneously to switch to the measuring mode.		

Note!
The integrated calibration data sets are based on standard measurements. For turbidity values >1000 NTU or suspended solids recalibrate the sensor with the medium to be measured (see chapter "Calibration").

6.4 System configuration

6.4.1 Setup 1 (Turbidity)

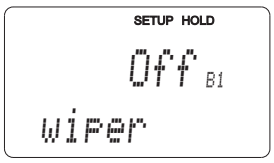
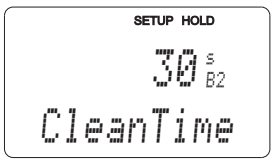
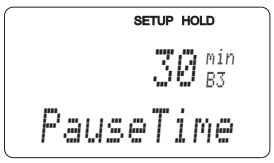
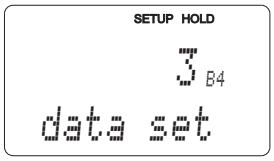
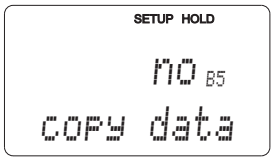
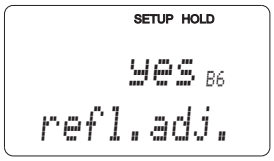
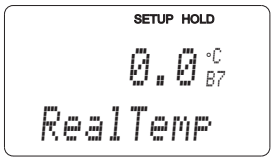
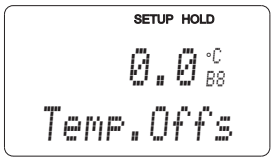
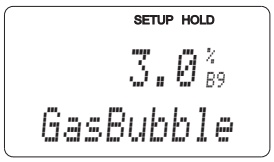
In the SETUP 1 function group, you can change the operating mode and the sensor settings.

Coding		Field	Selection or range (factory settings bold)	Display	Info
A		**Function group SETUP 1**		SETUP HOLD A SETUP 1	Basic settings.
	A1	Select operating mode	FNU NTU ppm mg/l % spec.	SETUP HOLD FNU A1 Oper.Mode	Any change in operating mode causes an automatic reset of user defined settings. The offsets for turbidity and temperature are reset to zero.
	A2	Select display unit	**kg/l** % t/m	SETUP HOLD kg/l A2 Conc.Unit	A2 is only accessible, if A1 = spec.
	A3	Select display format	**XX.xx** X.xxx XXX.x XXXX	SETUP HOLD XX.xx A3 Format	A3 is only accessible, if A1 = spec.
	A4	Connected sensor is displayed	CUS31 CUS41	SETUP HOLD CUS31 A4 sensor	The transmitter automatically detects which sensor is connected.
	A5	Enter measured value damping	**10** 1 to 60	SETUP HOLD 10 A5 Damping	Measured value damping causes averaging over the specified number of individual measured values. It is used, for example, to stabilize the display with applications that fluctuate a great deal. There is no damping if “1” is entered.

6.4.2 Setup 2 (Temperature)

In the SETUP 2 function group, you can change the temperature and wiper settings.

Coding	Field	Selection of range (factory settings bold)	Display	Info
B	**Function group SETUP 2**		SETUP HOLD B SETUP 2	Initial display in function group SETUP 2.

Coding		Field	Selection of range (factory settings bold)	Display	Info
	B1	Switch wiper controller on or off	**off** on auto		If “auto”is selected, the wiper is operated in combination with a cleaning function via timer/Chemoclean (“wipe and clean”). In this case B2 and B3 are not applicable.
	B2	Enter operating period of wiper	**30 s** 3 to 999 s		
	B3	Enter pause time between two wiping cycles	**30 min** 1 to 7200 min		
	B4	Select calibration data set to be used	**3** 1 to 3		There are 3 calibration data sets stored in every operation mode (A1). Data set 1 cannot be changed. A hold is active during the load of a new selected data set (independent of the settings in S2).
	B5	Copy data sets	no 1 ➔ 2 1 ➔ 3 2 ➔ 3 3 ➔ 2		Data set 1 cannot be changed (factory setting). However, it can be used as a basis for a customer calibration data set. To work with the copy of a data set, select the data set in field B4.
	B6	Display measured value with reflection compensation?	yes no		With CUS31 / CUS41: Displays the measured value with or without reflection compensation. Only effective in NTU, FNU, ppm, mg/l.
	B7	Enter corrected temperature of the temperature sensor	Current measured value -5.0 to 100.0 °C		This entry can be used to calibrate the temperature sensor to an external measurement.
	B8	Displays the temperature difference (offset)	Current offset -5.0 to 5.0 °C		The difference between the temperatures measured and entered is displayed.
	B9	Enter gas bubble barrier	3.0 % 0.1 to 100 °C		Compensates gas bubble formation, which may arise from small amounts of dissolved gas in the medium. 0.1 % = no formation of gas bubbles. 100 % = strong gas bubble formation. For clear media (measured value below 1000 NTU) always set the gas bubble barrier to 100 %.

6.4.3 Current input

To use the "Current input" function group, you need a relay board with current input which is not part of the basic version. With this function group you can monitor process parameters and use these for feedforward control. For this purpose, you must connect the current output of an external measured variable (e.g. flowmeter) to the 4 to 20 mA input of the transmitter. The following assignment applies:

Flow in main stream	Current signal in mA	Current input signal in %
Flowmeter start of measuring range	4	0
Flowmeter end of measuring range	20	100

Monitoring of flow in main stream
This arrangement is particularly practical if the sample flow through a flow assembly in an open outlet is completely independent of the flow in the main stream.
This permits signalling of an alarm condition in the main stream (flow too low or has completely stopped) and triggers dosing switch-off even if the medium flow is retained due to the method of installation.

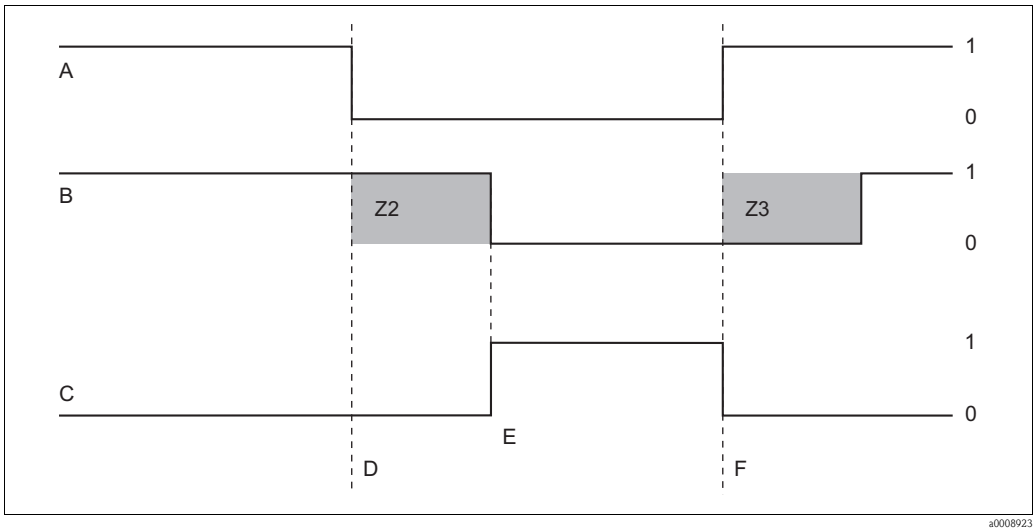


Fig. 22: Alarm signalling and dosing switch-off by the main stream

A Flow in main stream
B Relay contacts of PID controller
C Alarm relay
D Flow below switch-off limit Z4 or flow failure
E Flow alarm
F Flow restoration
Z2 Delay for controller switch-off, see field Z2
Z3 Delay for controller switch-on, see field Z3
0 Off
1 On

Feedforward control to PID controller

For control systems with very short reaction times, you can optimize the control. Additionally you measure the flow rate of the medium. You apply this flow rate value (0/4 to 20 mA) as feedforward control to the PID controller.

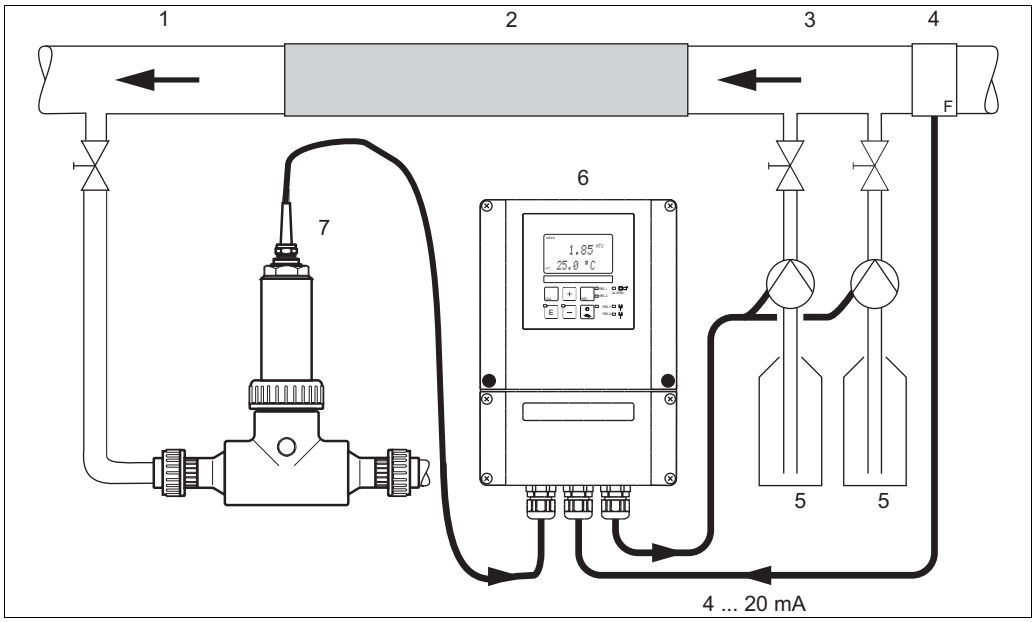


Fig. 23: Arrangement example for feedforward control of the flow rate in the main stream to the PID controller(s)

1 Measuring water extraction point
2 Static mixer
3 Injection points
4 Flowmeter
5 Reagents
6 Liquisys M CUM253
7 CUA250 with CUS31

Feedforward control is a multiplying function as illustrated in the figure below (example with factory setting):

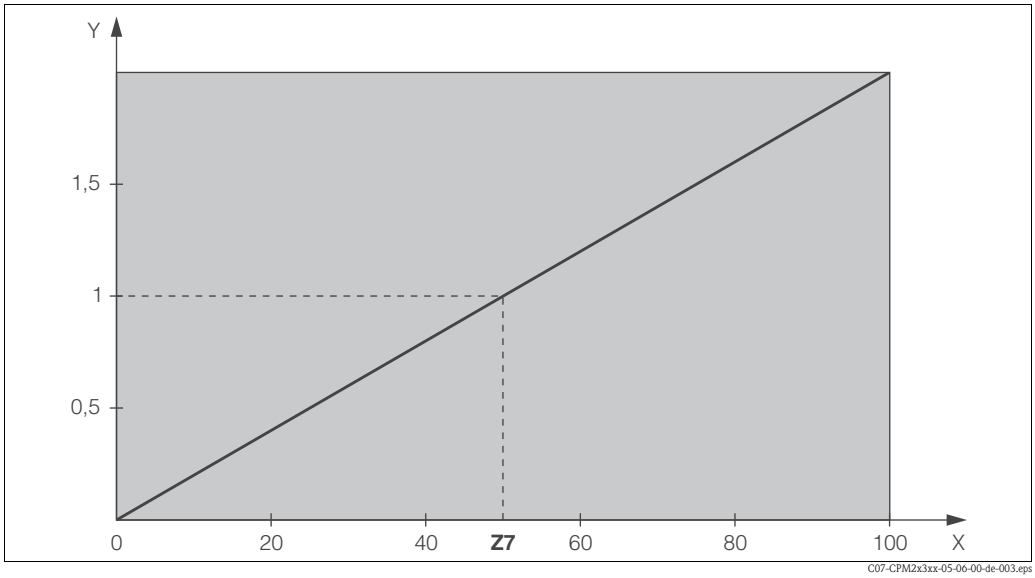
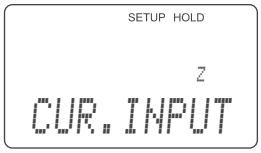
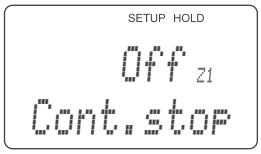
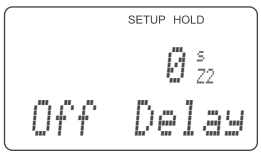
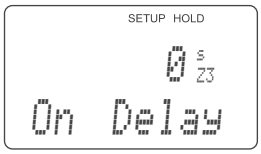
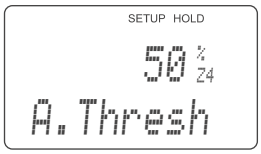
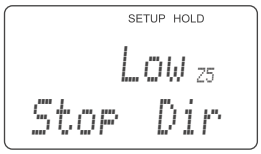
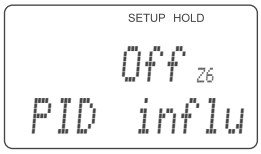
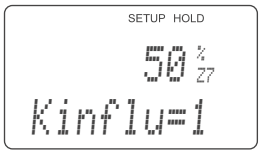


Fig. 24: Multiplying feedforward control

Y Gain K_{infl}
X Current input signal [%]
Z7 Input value, when gain K_{infl} = 1

The basic version does not include functions in *italic*.

Coding		Field	Setting range (Factory settings, bold)	Display	Info
Z		**CURRENT INPUT function group**			Current input settings.
	Z1	*Select flow monitoring of main stream (with controller switch-off)*	**Off** *On*		Flow monitoring may only be switched on if the flowmeter is connected in the main stream. If Z1 = off, fields Z2 to Z5 are not available.
	Z2	*Enter the delay for controller switch-off through current input*	**0 s** *0 to 2000 s*		Brief flow shortfalls can be suppressed by a delay and do not result in controller switch-off.
	Z3	*Enter the delay for controller switch-on through current input*	**0 s** *0 to 2000 s*		In the case of a controller, a delay until a representative measured value is received is useful if the flow fails for an extended period.
	Z4	*Enter the switch-off limit value for the current input*	**50%** *0 to 100%*		0 to 100% corresponds to 4 to 20 mA at the current input. Observe measured value assignment to the current output of the flowmeter.
	Z5	*Enter the switch-off direction for the current input*	**Low** *High*		The controller is switched off if the value entered in Z4 is undershot or overshot.
	Z6	*Select feedforward control to PID controller*	**Off** *Lin = linear* *Basic*		If Z6 = off, the field Z7 is not available. Z6 = basic: disturbance variable only affects the basic load (alternatively dosing in proportion to quantity can be used if usual PID controlling is not possible, due to a defective sensor, for example).
	Z7	*Enter value for feedforward control at which gain = 1 applies*	**50%** *0 to 100%*		When the value is set, the controller actuating variable is the same size when feedforward control is switched on as when feedforward control is switched off.

6.4.4 Current outputs

Use the "Current output" function group to configure the individual outputs. You can enter either a linear characteristic (O3 (1)) or a user-defined current output characteristic in conjunction with the Plus Package (O3 (3)). Exception: if you have chosen a "continuous controller" for current output 2, you cannot enter a user-defined current output characteristic for this current output. In addition, you can simulate a current output value (O3 (2)) to check the current outputs.
If a second current output is present, you can output the controller actuating variable in accordance with field R 237 via the current output.

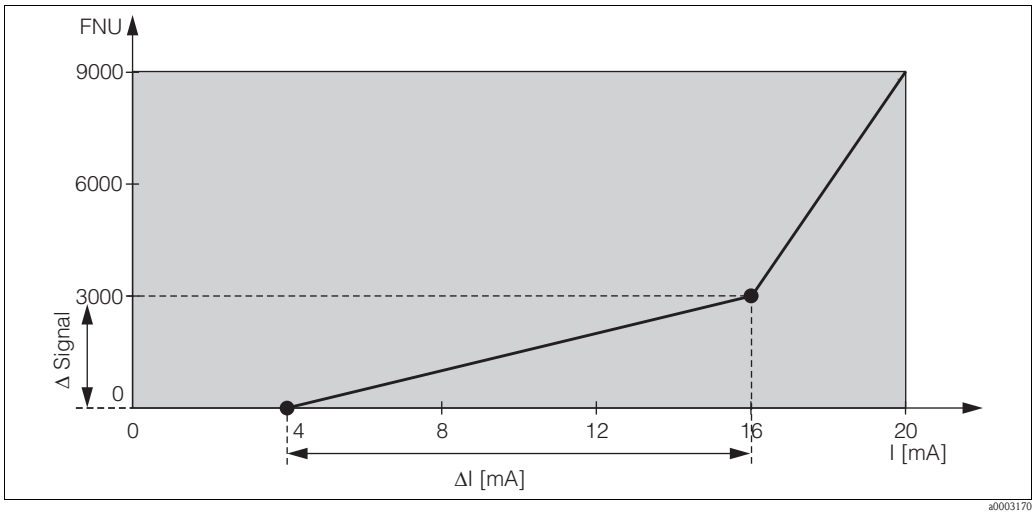


Fig. 25: User defined current output characteristic

The current output characteristic must be strictly monotonously increasing or strictly monotonously decreasing.
The distance per mA between two table value pairs must be greater than:

- 0.005 FNU / NTU / ppm mg/l / %
- 0.05 g/l
- Temperature: 0.25 °C

The values for the sample characteristic (Fig. 25) are entered in the following table. The distance per mA can be calculated from Δ signal / Δ mA.

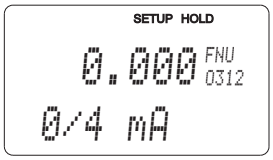
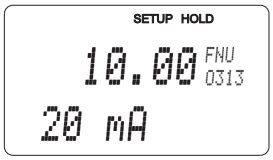
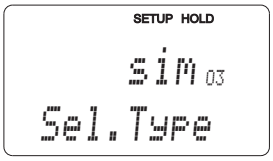
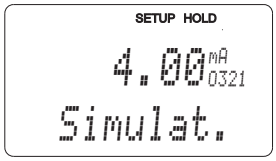
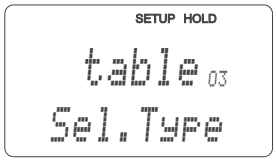
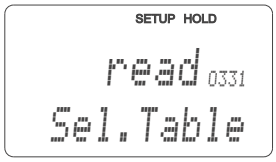
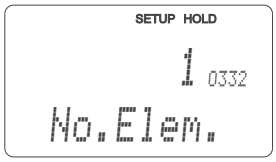
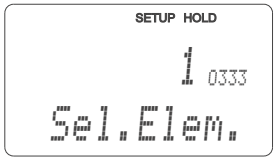
	Current output 1			Current output 2		
Value pair	**Tu / °C**	**Current [mA]**	**Distance per mA**	**Tu / °C**	**Current [mA]**	**Distance per mA**
1	0	4				
2	3000	16	250			
3	9000	20	1500			

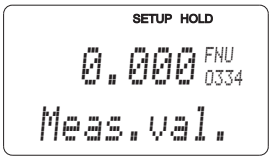
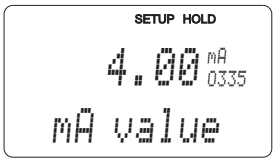
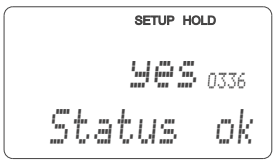
First enter the desired current output configuration into the following blank table with a pencil. Calculate the resulting signal distance per mA to observe the necessary minimum slope. Then enter the values in the device.

	Current output 1			Current output 2		
Value pair	**Tu / °C**	**Current [mA]**	**Distance per mA**	**Tu / °C**	**Current [mA]**	**Distance per mA**
1						
2						
3						
4						
5						
6						
7						
8						
9						

Basic version does not include functions in *italic*.

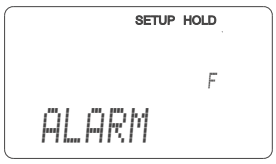
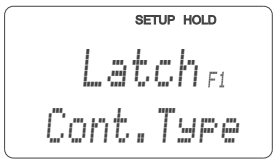
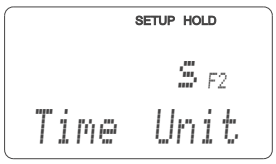
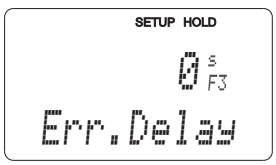
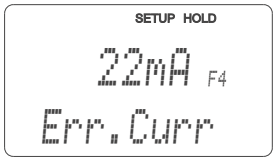
Coding	Field	Setting range (Factory settings, bold)	Display	Info
O	**CURRENT OUTPUT function group**		SETUP HOLD 0 OUTPUT	Configuration of the current output (does not apply for PROFIBUS).
O1	Select current output	**Out1** *Out 2*	SETUP HOLD Out1 01 Sel. Out	Output 2 not available for all versions. A characteristic can be selected for every output.
O2	Select measured variable for 2nd current output	**°C** mg/l *Contr*	SETUP HOLD °C 02 Sel. Out2	R237 = curr (current output 2) can only be selected if O2 = Contr is selected (relay board required).
O3 (1)	Enter or output linear characteristic	**lin = linear** (1) sim = simulation (2) *tab = table (3)*	SETUP HOLD lin 03 Sel.Type	The characteristic can have a positive or negative slope for the measured value output. In the case of actuating variable output (O2 = Contr), an increasing current corresponds to an increasing actuating variable.
O311	Select current range	**4 to 20 mA** 0 to 20 mA	SETUP HOLD 4-20 0311 Sel.Range	

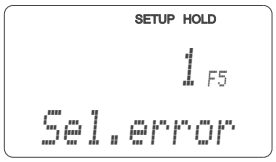
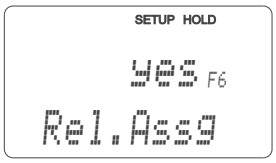
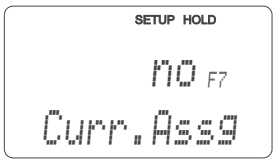
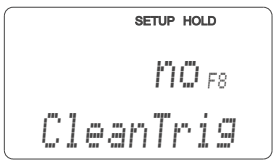
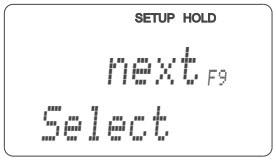
Coding			Field	Setting range (Factory settings, bold)	Display	Info
		O312	0/4 mA value: Enter corresponding turbidity or temperature value	**0.000 FNU** **0.000 NTU** **0.000 ppm** **0.000 mg/l** **0.000 g/l** **0.000 kg/l** **0.000 t/m** **0.000 %** **0.000 °C**		Here you can enter the turbidity or temperature value at which the min. current value (0/4 mA) is applied at the transmitter output. Minimum distance between 0/4 mA and 20 mA value: see field O313 Display format from A3
		O313	20 mA value: Enter corresponding turbidity or temperature value	**10.00 FNU** **10.00 NTU** **10.00 ppm** **10.00 mg/l** **300 g/l / 3.00 g/l** **99.99 kg/l** **99.99 t/m** **10.0 %** **100 °C**		Here you can enter the turbidity or temperature value at which the max. current value (20 mA) is applied at the transmitter output. Display format from A3 If two factory settings are displayed the one on the left side stands for CUS41 the one on the right side stands for CUS31.
	O3 (2)		Simulate current output	Lin = linear (1) **Sim = simulation** (2) *Tab = table (3)*		Simulation is not ended until (1) or (3) is selected.
		O321	Enter simulation value	**Current value** 0.00 to 22.00 mA		Entering a current value results in this value being directly output at the current output.
	O3 (3)		*Enter current output table (only for Plus Package*)	lin = linear (1) sim = simulation (2) *tab = table* (3)		Versions TB and TS only. Values can also be added or altered at a later stage. The values entered are automatically sorted by increasing current value. For further characteristics, see O3 (1), O3 (2).
		O331	*Select table options*	**read** *edit*		
		O332	*Enter number of table value pairs*	**1** *1 to 10*		Enter the number of pairs from the x and y value (measured value and current value) here.
		O333	*Select table value pair*	**1** *1 to No. elem.* *Assign*		The function chain O333 ... O335 will run through as many times as correspond to the value in O332. "Assign" appears as the last step. After confirmation the system jumps to O336.

Coding			Field	Setting range (Factory settings, bold)	Display	Info
		O334	*Enter x value*	**0.000 FNU** **0.000 NTU** **0.000 ppm** **0.000 mg/l** **0.000 g/l** **0.000 kg/l** **0.000 t/m** **0.000 %** **0.000 °C**		x value = measured value specified by user.
		O335	*Enter y value*	**4.00 mA** *0.00 to 20.00 mA*		y value = current value belonging to O334 specified by user. Return to O333 until all values are entered.
		O336	*Message as to whether table status is OK*	**yes** *no*		Back to O3. If status = no, correct table (all settings made up until now are retained) or back to measuring mode (table is deleted).

6.4.5 Monitoring functions

The monitoring functions are used to define various alarms and configure output contacts. Each individual error can be defined to be effective or not (at the contact or as an error current). An alarm condition can be defined to activate a cleaning function (F8)

Coding		Field	Setting range (Factory settings, bold)	Display	Info
F		**ALARM function group**			Alarm function settings.
	F1	Select contact type	**Latch = latching contact** Momen = momentary contact		The contact type selected only applies to the alarm contact.
	F2	Select time unit	**s** min		
	F3	Enter alarm delay	**0 s (min)** 0 to 2000 s (min)		Depending on the option selected in F2, the alarm delay is entered in s or min.
	F4	Select error current	**22 mA** 2.4 mA		This selection must be made even if all error reporting is switched off in F5. ☝ Caution! If "0-20 mA" was selected in O311, "2.4 mA" may not be used.

Coding		Field	Setting range (Factory settings, bold)	Display	Info
	F5	Select error	**1** 1 to 255		Here you can select all the errors which should trigger an alarm. The errors are selected via the error numbers. Please refer to the table in section 9.2 "System error messages" for the meaning of the individual error numbers. The factory settings remain in effect for all errors not edited.
	F6	Set alarm contact to be effective for the selected error	**yes** no		If “no” is selected, all the other alarm settings are deactivated (e.g. alarm delay). The settings themselves are retained. This setting **only** applies to the error selected in F5.
	F7	Set error current to be effective for the selected error	**no** yes		The option selected in F4 is effective or ineffective in the event of an error. This setting **only** applies to the error selected in F5.
	F8	*Automatic cleaning function start*	**no** *yes*		This field is not available for certain errors, see "Trouble-shooting and fault elimination" section.
	F9	Select return to menu or next error	**next** = next error ←R		If ←R is selected, you return to F, if next is selected, you go to F5.

Check

The CHECK function group is only available for devices with a Plus Package.
In the CHECK function group, you can select different monitoring functions for the measurement. All monitoring functions are off by default. To adapt the Sensor Check System to the current application conditions, add and set the suitable functions.

Alarm threshold monitoring (fields P1 to P4)
You can use this function to monitor the measured value for permissible upper and lower limits and trigger an alarm (E154, E155).

PCS alarm (Process Check System), (fields P5 to P8)
AC (Alternating Check): The function AC (field P5) is used to check measuring signals for deviations. If the measuring signal does not change within an hour an alarm (E152) is triggered. The reason for such sensor behavior can be contamination, cable rupture or similar.
CC (Controller Check): You can monitor the controller activity with the function CC. This function is mainly used for batch processes and single-sided limit switches. A malfunction of the controller is detected and reported thanks to freely adjustable monitoring times (E156 – E157).

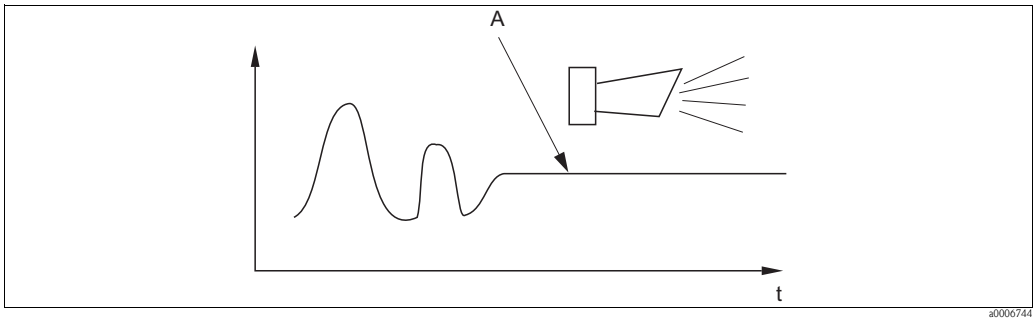


Fig. 26: PCS alarm (live check)

A Constant measuring signal = alarm triggered after PCS alarm time has elapsed

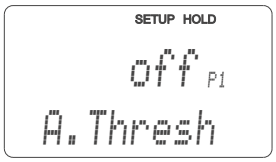
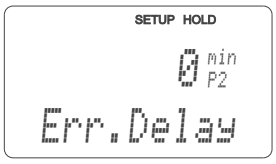
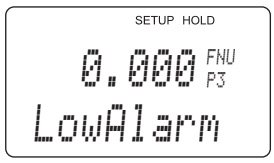
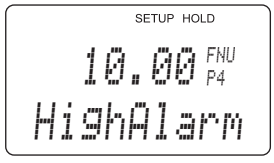
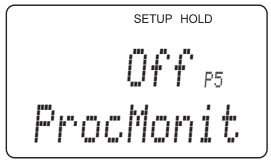
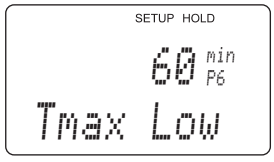
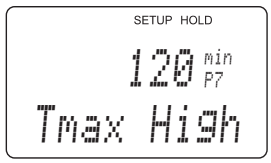
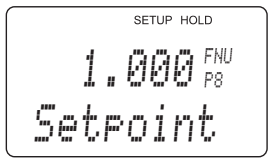
Note!
Any PCS alarm pending is automatically deleted as soon as the sensor signal changes.

Monitoring functions at a glance

	Functional description	Possible settings	Alarm event	Application
Alarm threshold monitoring (P1 ... P4)	– Freely adjustable lower alarm threshold (AT) – Freely adjustable upper alarm threshold (AT)	off	—	Applications **with** or **without** dosage control of chemicals
		only lower AT	Lower AT reached or dropped below	
		only upper AT	Upper AT reached or exceeded	
		lower and upper AT	Lower AT reached or dropped below or upper AT reached or exceeded	
Controller monitoring (CC: Controller Check, P5 ... P8)	– Switch-on period monitoring – Switch-off period monitoring	off	—	Applications **with** dosage control of chemicals
		on	Set maximum period for permanent switch-on or switch-off exceeded	
Sensor activity monitoring (AC: Alternation Check, P5 ... P8)	Monitoring for signal change	off	—	Applications **with** or **without** dosage control of chemicals
		on	No change within 1 hour	

The function group "Check" is used to monitor the lower und upper limits of the measured value and to initiate alarms.
Basic version does not include functions in *italic*.

Coding	Field	Setting range (Factory settings, bold)	Display	Info
P	**CHECK function group**		SETUP HOLD P CHECK	Settings for sensor and process monitoring

Coding		Field	Setting range (Factory settings, bold)	Display	Info
	P1	*Select alarm threshold monitoring*	**Off** *Low* *High* *Lo+Hi* *Low!* *High!* *Lo+Hi!*		Alarm signalling optionally with or without simultaneous controller switch-off. XXXX = without controller switch-off XXXX! = with controller switch-off (Errors: E154, E155)
	P2	*Enter alarm delay*	**0 s (min)** *0 to 2000 s (min)*		Depending on your selection in F2, you can enter the error delay in min or s. Only after this delay, a high or low limit violation causes an alarm as per field P3/P4.
	P3	*Enter lower alarm threshold*	**0.000 FNU** *0 to 9999 FNU*		
	P4	*Enter upper alarm threshold*	**10.00 FNU** *0 to 9999 FNU*		
	P5	*Select process monitoring (PCS alarm)*	**Off** *AC* *CC* *AC+CC* *AC!* *CC!* *AC+CC!*		AC = sensor activity check (E152) CC = controller check (E156, E157) XXXX = without controller switch-off XXXX! = with controller switch-off
	P6	*Enter maximum permissible duration for lower CC setpoint limit violation* (field P8)	**60 min** *0 to 2000 min*		Only when P5 = CC or AC+CC
	P7	*Enter maximum permissible duration for upper CC setpoint limit violation* (field P8)	**120 min** *0 to 2000 min*		Only when P5 = CC or AC+CC
	P8	*Enter CC setpoint (for P6/P7)*	**1.000 FNU** *0 to 9999 FNU*		Selected value is an absolute value. This function is mainly used for batch processes and single-sided limit switches.

6.4.6 Relay contact configuration

To use the RELAY function group, you need a relay board which is not part of the basic version.

The following relay contacts can be selected and configured as desired (max. four contacts, depending on options installed):
- Limit contactor for measured turbidity value: R2 (1)
- Limit contactor for temperature: R2 (2)
- PID controller: R2 (3)
- Timer for cleaning function: R2 (4)
- Chemoclean function: R2 (5)

Limit contactor for measured turbidity value and temperature

The transmitter has different ways of assigning a relay contact.
Switch-on and switch-off points and pick-up and drop-out delays can be assigned to the limit contactor. In addition, you can configure an alarm threshold to output an error message and to start a cleaning function in conjunction with this.
These functions can be used both for turbidity measurement and for temperature measurement.

Please refer to Fig. 27 for a clear illustration of the relay contact states.
- When the measured values increase (maximum function), the relay contact is closed as of t_2 after the switch-on point (t_1) has been overshot and the pick-up delay has elapsed ($t_2 - t_1$).
  The alarm contact switches if the alarm threshold (t_3) is reached and the alarm delay ($t_4 - t_3$) has also elapsed.
- When the measured values decrease, the alarm contact is reset when the alarm threshold (t_5) is undershot as is the relay contact (t_7) after the drop-out delay ($t_7 - t_6$).
- If the pick-up and drop-out delays are set to 0 s, the switch-on and switch-off points are also switch points of the contacts.

Settings can also be made for a minimum function in the same way as for a maximum function.

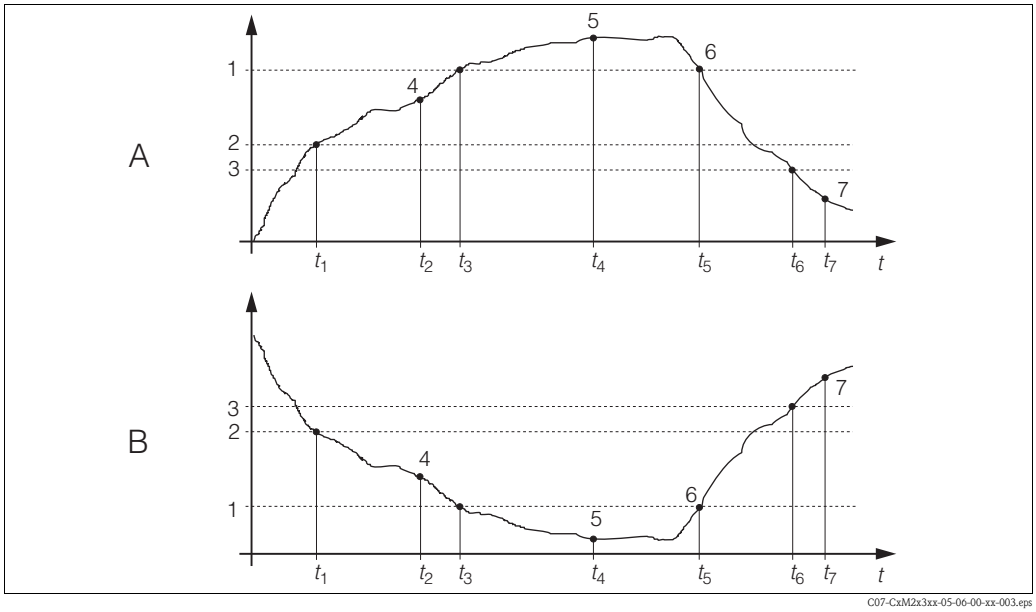


Fig. 27: Illustration of the alarm and limit value functions

A Switch-on point > switch-off point: Max. function
B Switch-on point < switch-off point: Min. function

1 Alarm threshold
2 Switch-on point
3 Switch-off point
4 Contact ON
5 Alarm ON
6 Alarm OFF
7 Contact OFF

P(ID) controller

You can define various controller functions for the transmitter. On the basis of the PID controller, P, PI, PD and PID controllers can be implemented. For an optimum control system, use the controller that best suits your application. Depending on the option selected in the R 237/R 266 field, the actuating signal can be output via relays or via current output 2 (if available).

- **P controller**
  Used for simple linear control purposes with small system deviations. Where major changes are to be controlled, overshooting may occur. In addition, a lasting control deviation is to be expected.
- **PI controller**
  Is used for control systems where overshooting is to be avoided and no lasting control deviation should occur.
- **PD controller**
  Is used for processes that require quick changes and where peaks are to be corrected.
- **PID controller**
  Is used for processes where a P, PI or PD controller does not control sufficiently.

Configuration options of the PID controller
The following configuration options are available for a PID controller:

- Change control gain K_p (P influence)
- Set integral action time T_n (I influence)
- Set derivative action time T_v (D influence)

Basic load dosing (Basic)
The basic load dosing (field R231) is used to set a constant dosage (field R2311)

PID controlling plus basic load dosing
If you select this function (PID + Basic) in field R231 the PID controlled dosage will not be lower than the basic load value entered in field R2311.

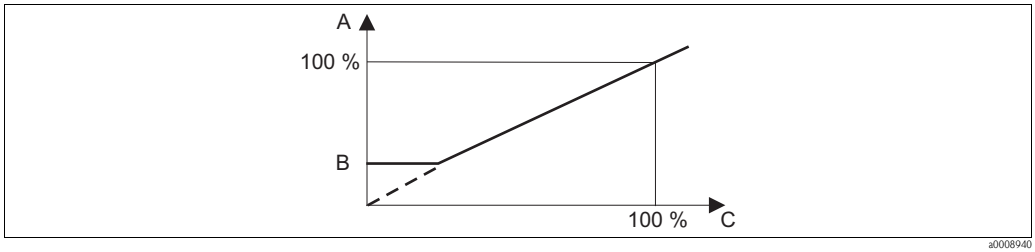


Fig. 28: Control characteristic PID controller with basic load dosing

A PID with basic load
B Basic load
C PID

Commissioning
If you do not yet have any experience for setting the control parameters, set the values that yield the greatest possible stability in the control circuit. Proceed as follows to optimize the control circuit further:

- Increase the control gain K_p until the controlled variable just starts to overshoot.
- Reduce K_p slightly and then reduce the integral action time T_n so that the shortest possible correction time without overshooting is achieved.
- To reduce the response time of the controller, also set the derivative action time T_v.

Control and fine optimization of the set parameters with a recorder

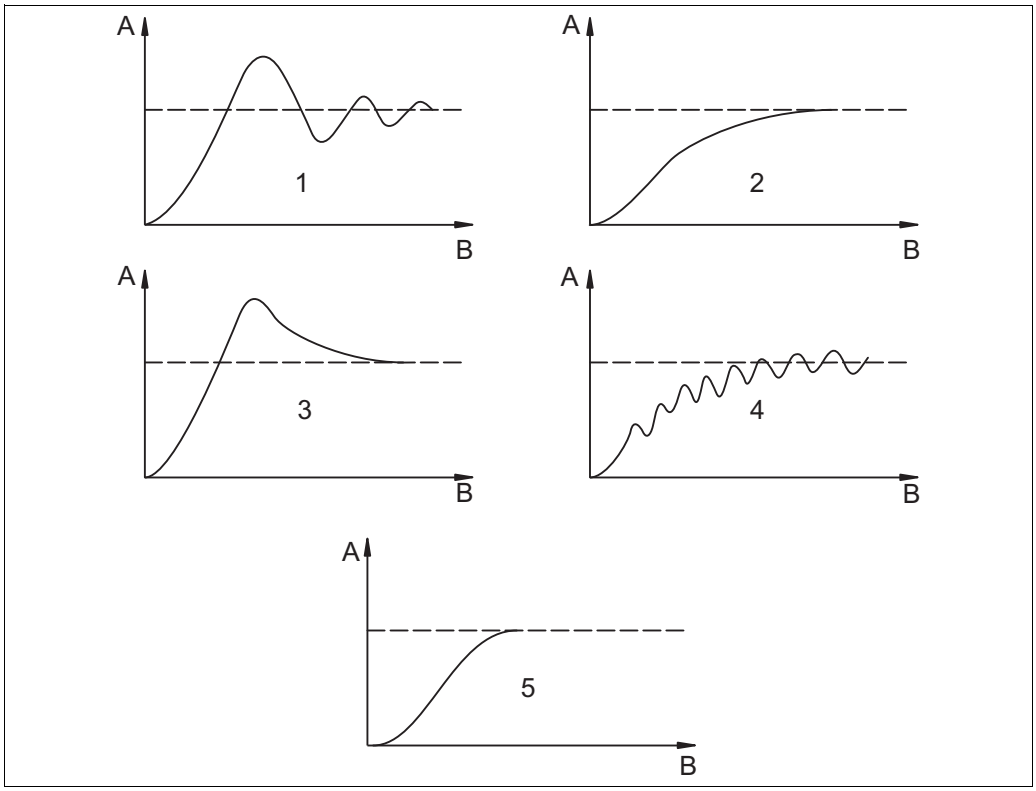


Fig. 29: Optimization of settings T_n and K_p

A Actual value
B Time

1 *T_n too small*
2 *T_n too large*
3 *K_p too large*
4 K_p too small
5 Optimum setting

Actuating signal outputs (R237 ... R2310)

Each control contact outputs a cyclical signal whose intensity corresponds to the controller's manipulated variable. A distinction is made according to the type of signal cycle:

- Pulse length modulation
  The bigger the calculated manipulated variable is, the longer the contact affected remains picked up. The period T can be adjusted between 0.5 and 99 s (field R238). Outputs with pulse length modulation are used to activate solenoid valves.
- Pulse frequency modulation
  The bigger the calculated manipulated variable is, the higher the switching frequency of the contact affected. The maximum switching frequency 1/T can be set between 60 and 180 min^{-1}. The on-time t_{ON} is constant. It depends on the set maximum frequency and is approx. 0.5 s for 60 min^{-1} and approx. 170 ms for 180 min^{-1}. Outputs with pulse frequency modulation are used to activate directly controlled solenoid dosing pumps.

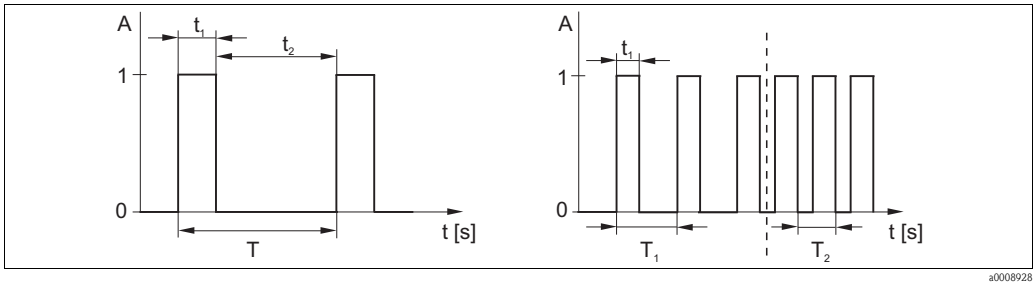


Fig. 30: Signal of a pulse-length modulated controller contact (left) and of a pulse-frequency modulated controller contact (right)

A Contact 1 = on, 0 = off
B Time [s] $t_1 = t_{on}$ $t_2 = t_{off}$
T Period length
T_1 T_2 Impulse period length (impulse freq. $1/T_1$ and $1/T_2$)

Constant controller
Via the current output 2, the minimum actuating variable (0 %) of the controller is output with 0/4 mA and the maximum actuating variable (100%) of the controller is output with 20 mA.

Control characteristic for direct and inverse control action
You can choose between two control characteristics in the R236 field:

- Direct control action = maximum function
- Inverse control action = minimum function

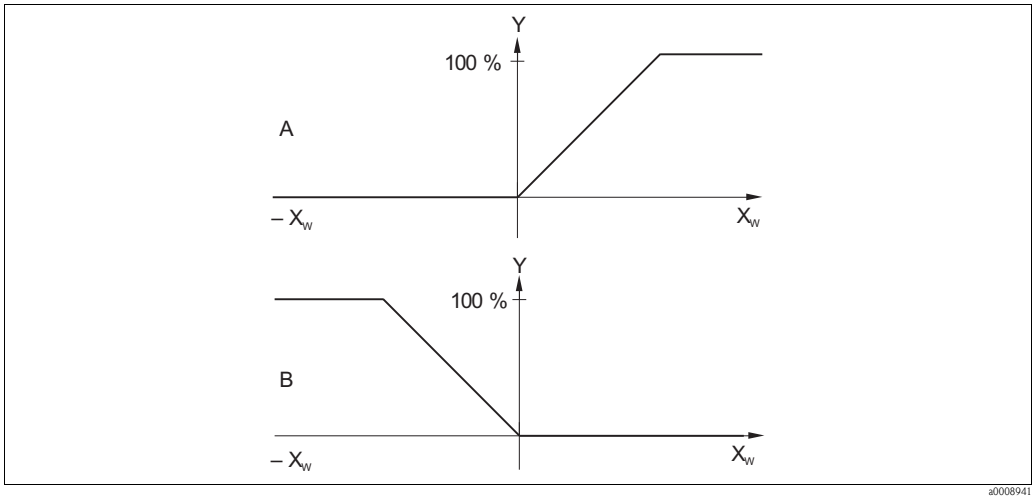


Fig. 31: Control characteristic of a proportional controller with direct and inverse control action

A Direct = max. function
B Inverse = min. function

Timer for cleaning function

This function includes a simple cleaning option. You can set the time interval after which cleaning should start. So you can only select a constant interval sequence.
Other cleaning functions are available for selection in conjunction with the Chemoclean function (version with four contacts, see "Chemoclean function" section).

Note!
Timer and Chemoclean do not work independently of one another. While one of the two functions is active, the other cannot be started.

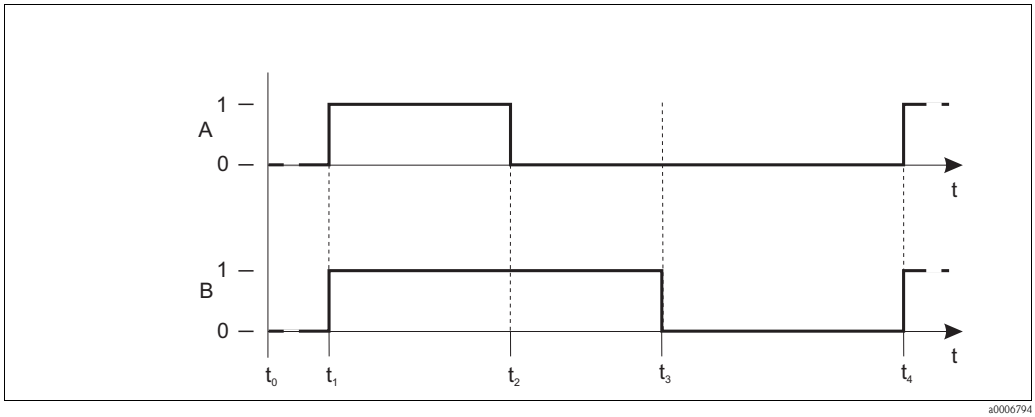


Fig. 32: Correlation of cleaning time, pause time and hold dwell period

A Wiper and/or spray cleaning system
B Hold function
0 Inactive
1 Active

t_0 *Normal mode*
t_1 *Cleaning start*
t_2-t_1 *Cleaning time*
t_3-t_2 *Clean hold dwell period (0 to 999 s)*
t_4-t_3 *Pause time between two cleaning intervals (1 to 7200 min)*

Chemoclean function

Just like the timer function, Chemoclean can also be used to start a cleaning cycle. However, Chemoclean also gives you the added option of defining different cleaning and rinsing intervals. As a result, it is possible to clean irregularly with different repeat cycles and to separately set the cleaning times with post rinse times.

Note!
- To use the Chemoclean function the transmitter has to be equipped with a designated relay board (see product structure or chapter "accessories").
- Timer and Chemoclean do not work independently of one another. While one of the two functions is active, the other cannot be started.
- For the Chemoclean function, the relays 3 (water) and 4 (cleaner) are used.
- If cleaning is prematurely aborted, a post rinse time always follows.
- If the setting is "Economy", cleaning only takes place with water.

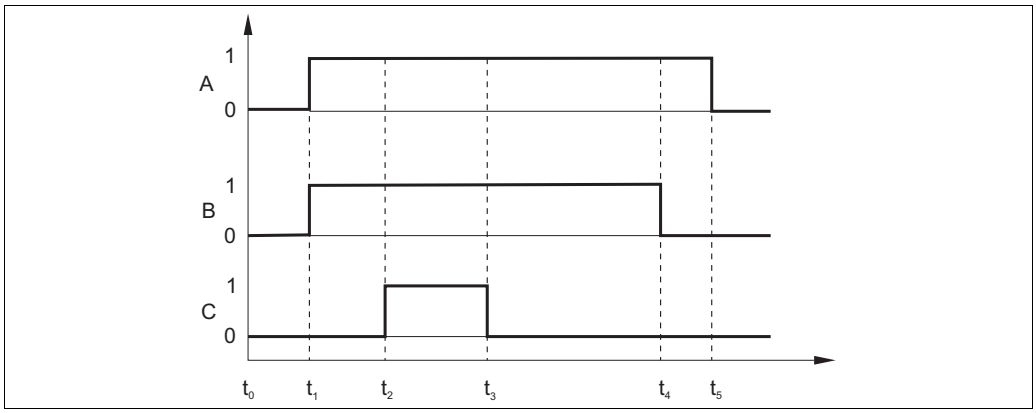


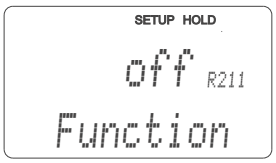
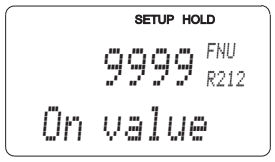
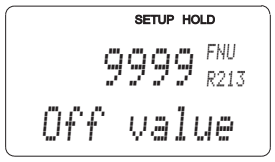
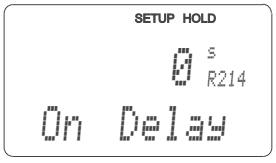
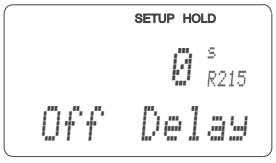
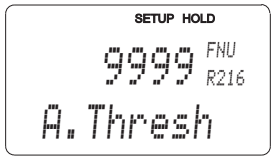
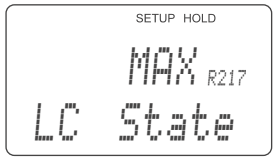
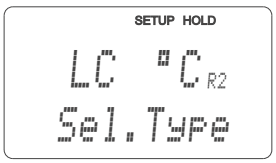
Fig. 33: Sequence of a cleaning cycle

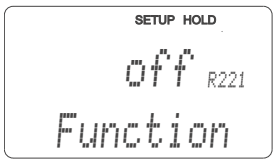
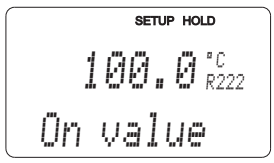
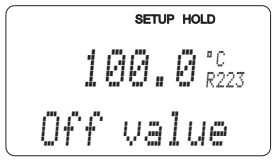
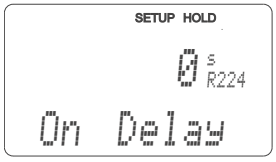
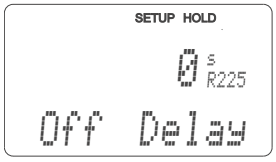
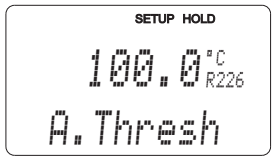
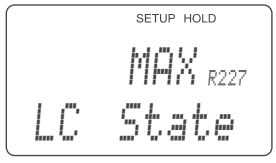
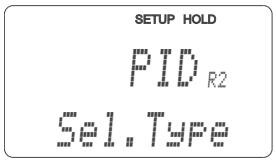
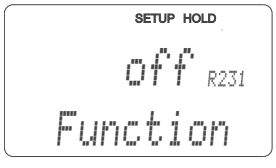
A Hold
B Water
C Cleaner
0 Contact on
1 Contact off

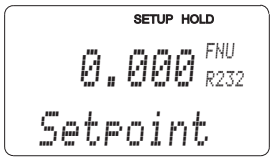
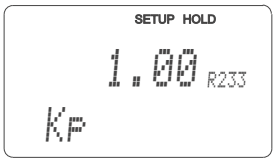
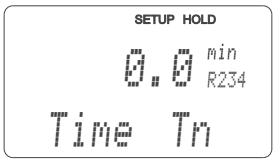
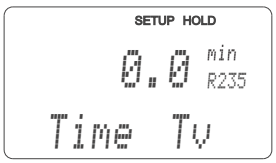
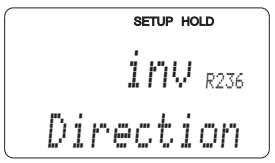
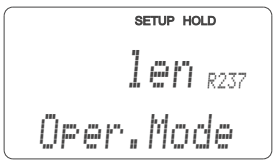
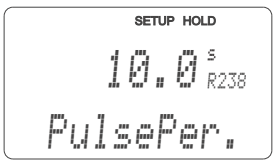
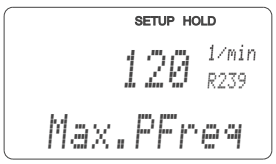
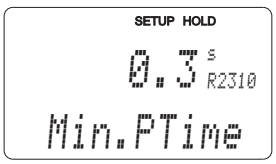
t_0 *Normal mode*
t_1 *Cleaning start*
$t_2 - t_1$ *Pre-rinse time*
$t_3 - t_2$ *Cleaning time*
$t_4 - t_3$ *Post rinse time*
$t_5 - t_4$ *Hold dwell period*

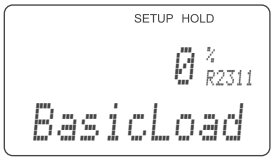
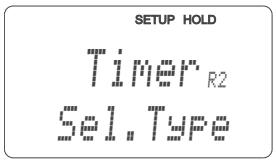
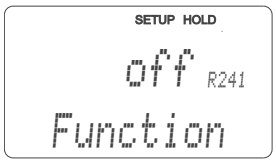
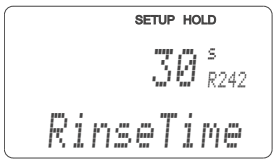
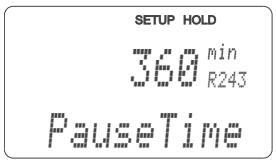
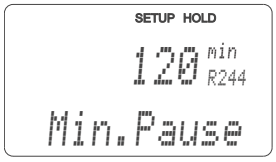
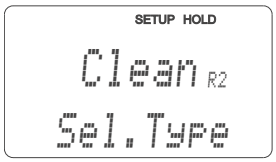
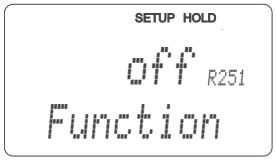
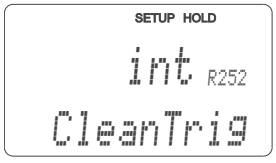
Basic version does not include functions in *italic*.

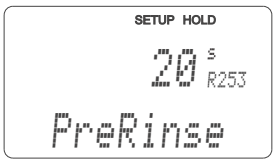
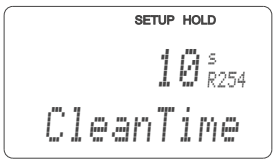
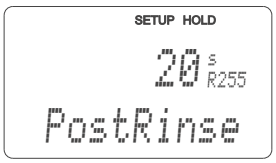
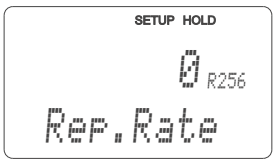
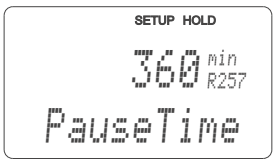
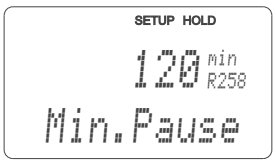
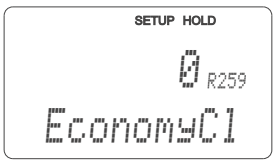
Coding		Field	Setting range (Factory settings, bold)	Display	Info
R		**RELAY function group**		SETUP HOLD R ATC RELAIS	Relay contact settings.
	R1	*Select contact to be configured*	**Rel1** *Rel2* *Rel3* *Rel4*	SETUP HOLD Rel1 R1 Sel.Relay	Rel3 (water) and Rel4 (cleaner) are only available with the relevant version of the transmitter. If Chemoclean is used as the cleaning method, Rel4 is not available.
	R2 (1)	Configure limit contactor for turbidity measurement	**LC PV = limit contactor TU** (1) LC °C = limit contactor T (2) PID controller (3) Timer (4) *Clean = Chemoclean (5)*	SETUP HOLD LC PV R2 Sel.Type	PV = process value If Rel4 is selected in the R1 field, Clean = Chemoclean cannot be selected. By confirming with ENTER, another relay function already switched on is switched off and its settings are reset to the factory settings.

Coding		Field	Setting range (Factory settings, bold)	Display	Info
R211	Switch function of R2 (1) off or on	**Off** On		All the settings are retained.
R212	Enter the switch-on point of the contact	**9999 FNU** **9999 NTU** **9999 ppm / 3000 ppm** **9999 mg/l / 3000 mg/l** **300.0 g/l / 3 g/l** **99.99 kg/l** **99.99 t/m** **200.0 %**		Never set the switch-on point and the switch-off point to the same value! (Only the operating mode selected in A1 is displayed.) If two factory settings are displayed the one on the left side stands for CUS41 the one on the right side stands for CUS31.
R213	Enter the switch-off point of the contact	**9999 FNU** **9999 NTU** **9999 ppm / 3000 ppm** **9999 mg/l / 3000 mg/l** **300.0 g/l / 3 g/l** **99.99 kg/l** **99.99 t/m** **200.0 %**		Entering a switch-off point selects either a Max contact (switch-off point < switch-on point) or a Min contact (switch-off point > switch-on point), thereby implementing a hysteresis that is constantly required (see "Illustration of the alarm and limit functions" figure). If two factory settings are displayed the one on the left side stands for CUS41 the one on the right side stands for CUS31.
R214	Enter pick-up delay	**0 s** 0 to 2000 s		
R215	Enter drop-out delay	**0 s** 0 to 2000 s		
R216	Enter alarm threshold	**9999 FNU** **9999 NTU** **9999 ppm / 3000 ppm** **9999 mg/l / 3000 mg/l** **300.0 g/l / 3 g/l** **99.99 kg/l** **99.99 t/m** **200.0 %**		If the alarm threshold is undershot/overshot, this triggers an alarm with the error message and error current at the transmitter (note alarm delay in field F3). If defined as a Min contact, the alarm threshold must be < switch-off point. If two factory settings are displayed the one on the left side stands for CUS41 the one on the right side stands for CUS31.
R217	Display status for limit contactor	**MAX** MIN		Display only.
R2 (2)	Configure limit contactor for temperature measurement	LC PV = limit contactor TU (1) **LC °C = limit contactor T (2)** PID controller (3) Timer (4) *Clean = Chemoclean (5)*		By confirming with ENTER, another relay function already switched on is switched off and its settings are reset to the factory settings.

Coding	Field	Setting range (Factory settings, bold)	Display	Info
R221	Switch function of R2 (2) off or on	**Off** On		Settings made for the limit contactor are not deleted by switching the function off.
R222	Enter switch-on temperature	**100.0 °C (212 °F)** -5.0 to 100.0 °C (23 to 212 °F)		Never set the switch-on point and the switch-off point to the same value!
R223	Enter switch-off temperature	**100.0 °C (212 °F)** -5.0 to 100.0 °C (23 to 212 °F)		Entering a switch-off point selects either a Max contact (switch-off point < switch-on point) or a Min contact (switch-off point > switch-on point), thereby implementing a hysteresis that is constantly required (see "Illustration of the alarm and limit functions" figure).
R224	Enter pick-up delay	**0 s** 0 to 2000 s		
R225	Enter drop-out delay	**0 s** 0 to 2000 s		
R226	Enter alarm threshold (as absolute value)	**100.0 °C (212 °F)** -5.0 to 100.0 °C (23 to 212 °F)		If the alarm threshold is undershot/overshot, this triggers an alarm with the error message and error current at the transmitter (note alarm delay in field F3). If defined as a Min contact, the alarm threshold must be < switch-off point.
R227	Display status for limit contactor	**MAX** MIN		Display only.
R2 (3)	Configure P(ID) controller	LC PV = limit contactor TU (1) LC °C = limit contactor T (2) **PID controller (3)** Timer (4) *Clean = Chemoclean (5)*		By confirming with ENTER, another relay function already switched on is switched off and its settings are reset to the factory settings.
R231	Switch function of R2 (3) off or on	**Off** On Basic PID+B		On = PID controller Basic = basic load dosing PID+B = PID controller + basic load dosing

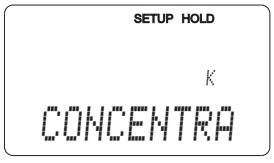
Coding	Field	Setting range (Factory settings, bold)	Display	Info
R232	Enter set point	**0.000 FNU** **0.000 NTU** **0.000 ppm** **0.000 mg/l** **0.000 g/l** **0.000 kg/l** **0.000 t/m** **0.000 %**		The set point is the value to be maintained by the control system. Using this control process, this value is restored upwards or downwards when a deviation occurs.
R233	Enter control gain K_p	**1.00** 0.01 to 20.00		See "P(ID) controller" section.
R234	Enter integral action time T_n (0.0 = no I-component)	**0.0 min** 0.0 to 999.9 min		See "P(ID) controller" section. With every Hold, the I-component is set to zero. Although Hold can be deactivated in field S2, this does not apply for Chemoclean and timer!
R235	Enter derivative action time T_v (0.0 = no D-component)	**0.0 min** 0.0 to 999.9 min		See "P(ID) controller" section.
R236	Select controller characteristic	**inv = inverse** dir = direct		dir = Max. function inv = Min. function The setting is required depending on the control deviation (upward or downward deviation, see "P(ID) controller" section).
R237	Select pulse length or pulse frequency	**len = pulse length** freq = pulse frequency *curr = current output 2*		Pulse length e.g. for solenoid valve, pulse frequency e.g. for solenoid dosing pump, see "Actuating signal outputs" section. Curr = current output 2 can only be selected if O2 = Contr.
R238	Enter pulse interval	**10.0 s** 0.5 to 999.9 s		This field only appears if pulse length is selected in R237. If pulse frequency is selected, R238 is skipped and entries continue with R239.
R239	Enter maximum pulse frequency of the adjuster	**120 min^{-1}** 60 to 180 min^{-1}		This field only appears if pulse frequency is selected in R237. If pulse length is selected, R239 is skipped and entries continue with R2310.
R2310	Enter minimum switch-on time t_{ON}	**0.3 s** 0.1 to 5.0 s		This field only appears if pulse length is selected in R237.

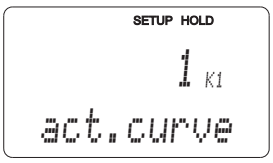
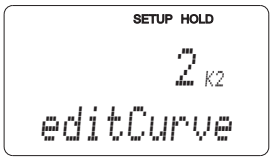
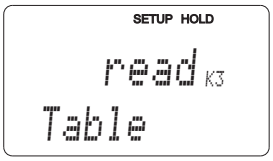
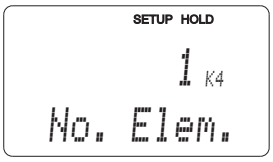
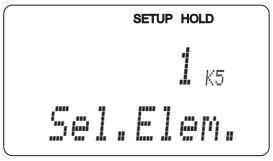
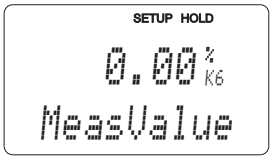
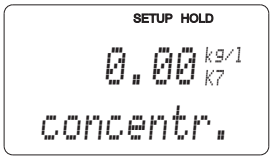
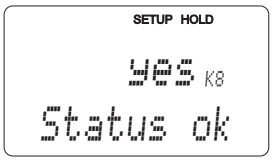
Coding		Field	Setting range (Factory settings, bold)	Display	Info
R2311	Enter basic load	**0 %** 0 to 40 %		When you select the basic load, you enter the desired dosing quantity. 100% basic load would correspond to: – Constantly on for R237 = len – Fmax at R237 = freq (field R239) – 20 mA at R237 = curr
R2 (4)	Configure cleaning function (timer)	LC PV = limit contactor TU (1) LC °C = limit contactor T (2) PID controller (3) **Timer (4)** *Clean = Chemoclean (5)*		Cleaning only takes place with one cleaning agent (usually water). By confirming with ENTER, another relay function already switched on is switched off and its settings are reset to the factory settings.
R241	Switch function of R2 (4) off or on	**Off** On		Settings made for the timer are not deleted by switching the function off.
R242	Enter rinsing/cleaning time	**30 s** 0 to 999 s		Settings for Hold and relay are active for this time.
R243	Enter pause time	**360 min** 1 to 7200 min		The pause time is the time between two cleaning cycles (see "Timer for cleaning function" section).
R244	Enter minimum pause time	**120 min** 1 to R243 min		The minimum pause time prevents constant cleaning if a cleaning trigger is present.
R2 (5)	*Configure cleaning with Chemoclean (for version with four contacts , Chemoclean option and contacts 3 and 4 assigned)*	*LC PV = limit contactor TU(1)* *LC °C = limit contactor T (2)* *PID controller (3)* *Timer (4)* **Clean = Chemoclean (5)**		See "Chemoclean function" section. By confirming with ENTER, another relay function already switched on is switched off and its settings are reset to the factory settings.
R251	*Switch function of R2 (5) off or on*	**Off** *On*		
R252	*Select type of start pulse*	**Int = internal (time-controlled)** *Ext = external (digital input 2)* *I+ext = internal + external* *I+stp = internal, suppressed by external*		The cycle for the "int" function is started by the end of the pause time (R257). No real time clock is available. External suppression is required for irregular time intervals (e.g. weekends).

Coding			Field	Setting range (Factory settings, bold)	Display	Info
		R253	*Enter pre-rinse time*	**20 s** *0 to 999 s*		Rinsing with water takes place.
		R254	*Enter cleaning time*	**10 s** *0 to 999 s*		Cleaning with cleaning agent and water takes place.
		R255	*Enter post rinse time*	**20 s** *0 to 999 s*		Rinsing with water takes place.
		R256	*Enter number of repeat cycles*	**0** *0 to 5*		R253 to R255 is repeated.
		R257	*Enter pause time*	**360 min** *1 to 7200 min*		The pause time is the time between two cleaning cycles (see "Timer function" section).
		R258	*Enter minimum pause time*	**120 min** *1 to R257 min*		The minimum pause time prevents constant cleaning if an external cleaning start is present.
		R259	*Enter number of cleaning cycles without cleaning agent (economy function)*	**0** *0 to 9*		After cleaning with cleaner, up to 9 cleaning sessions can be carried out with water only until the next cleaning session with cleaner takes place.

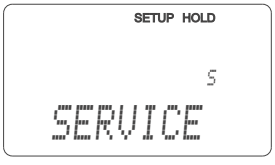
6.4.7 Concentration measurement

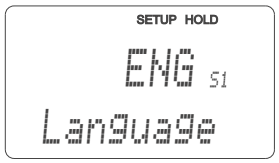
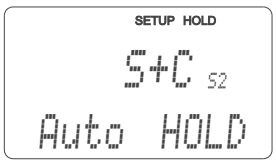
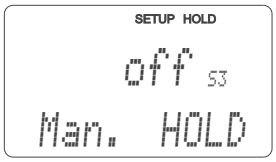
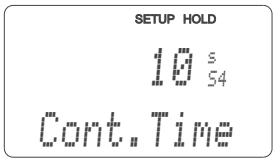
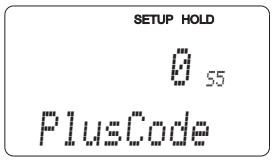
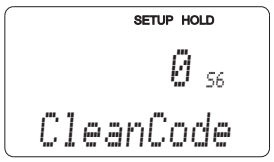
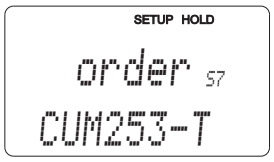
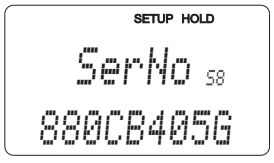
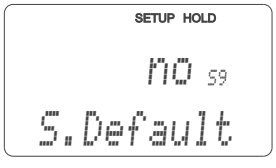
The basic version does not include functions in *italic*.

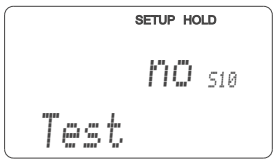
Coding	Field	Selection or range (factory settings bold)	Display	Info
K	**Function group CONCENTRATION**			Four different concentration curves can be entered in this function group.

Coding		Field	Selection or range (factory settings bold)	Display	Info
	K1	*Selection of concentration curve, to be used to calculate the display value*	**1** *1 to 4*		The curves are independent of each other. Therefore, four different curves can be defined.
	K2	*Selection of table to be edited*	**2** *1 to 4*		The modification of a table (curve) is independent from the selected curve in K1. The selected table (curve) will not be overwritten until the input of all table values is complete.
	K3	*Select table option*	**read** *edit*		This selection applies to the concentration curve selected in K2.
	K4	*Enter number of reference elements*	**1** *1 to 10*		Each element consists of two numeric values.
	K5	*Select element*	**1** *1 to number of element in K4 assign*		Any element can be edited.
	K6	*Enter turbidity value*	**0.00 %** *entire measuring range*		The function chain K5 ... K7 will be repeated automatically as many times as corresponds to the value in K4. Then the system jumps to K8.
	K7	*Enter concentration value*	*entire measuring range*		Measuring unit as selected in A2.
	K8	*Message whether or not the table status is ok*	**yes** *no*		Only display If not, then set table correctly (all previous settings are kept) or back to measurement mode (this makes the table invalid).

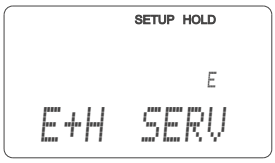
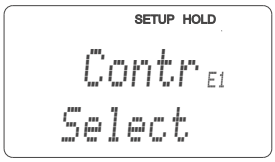
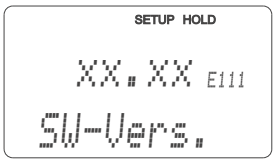
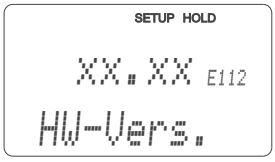
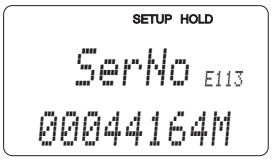
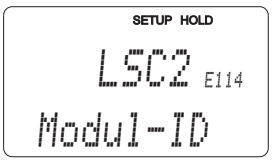
6.4.8 Service

Coding	Field	Setting range (Factory settings, bold)	Display	Info
S	**SERVICE function group**			Service function settings.

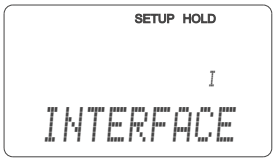
Coding	Field	Setting range (Factory settings, bold)	Display	Info
S1	Select language	**ENG = English** GER = German FRA = French ITA = Italian NL = Dutch ESP = Spanish		
S2	Configure Hold	**S+C = Hold during configuration and calibration** Cal = Hold during calibration Setup = Hold during configuration None = no Hold		S = setup C = calibration
S3	Manual Hold	**off** on		The setting is retained even in the event of a power failure.
S4	Enter Hold dwell period	**10 s** 0 to 999 s		
S5	Enter SW upgrade release code (Plus Package)	**0** 0000 to 9999		You can find the code on the nameplate. If an incorrect code is entered, you are taken back to the measurement menu. The number is edited with the PLUS or MINUS key and confirmed with the ENTER key. "1" is displayed if the code is active.
S6	Enter SW upgrade release code Chemoclean	**0** 0000 to 9999		You can find the code on the nameplate. If an incorrect code is entered, you are taken back to the measurement menu. The number is edited with the PLUS or MINUS key and confirmed with the ENTER key. "1" is displayed if the code is active.
S7	Order number is displayed	CUM253-T		If the device is upgraded, the order code is **not** automatically adjusted.
S8	Serial number is displayed	880CB405G		
S9	Reset the device to the basic settings ⚠	**no** Sens = sensor data Facty = factory settings		Sens = last calibration is deleted and is reset to factory setting. Facty = all data (apart from A1 a. S1) are deleted and reset to the factory setting!

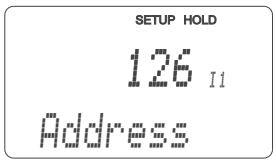
Coding		Field	Setting range (Factory settings, bold)	Display	Info
	S10	Perform device test	**no** Displ = display test		

6.4.9 E+H Service

Coding			Field	Setting range (Factory settings, bold)	Display	Note
E			**E+H SERVICE function group**			Information on the device version
	E1		Select module	**Contr = controller** (1) Trans = transmitter (2) Main = power unit (3) Rel = relay module (4)		
		E111 E121 E131 E141	Software version is displayed			If E1 = contr: instrument software If E1 = trans, main, rel: module firmware
		E112 E122 E132 E142	Hardware version is displayed			Only display function
		E113 E123 E133 E143	Serial number is displayed			Only display function
		E114 E124 E134 E144	Module ID is displayed			Only display function

6.4.10 Interfaces

Coding	Field	Setting range (Factory settings, bold)	Display	Info
I	**INTERFACE function group**			Communication settings (only for device version HART or PROFIBUS).

Coding		Field	Setting range (Factory settings, bold)	Display	Info
	I1	Enter bus address	Address HART: **0** to 15 or PROFIBUS: 0 to **126**		Each address may only be used once in a network. If a device address ≠ 0 is selected, the current output is automatically set to 4 mA and the device is set to multi-drop operation.
	I2	Display of measuring point			

6.5 Communication

For devices with a communication interface, please also refer to the separate Operating Instructions BA208C/07/en (HART®) or BA209C/07/en (PROFIBUS®).

6.6 Calibration

Measuring chain calibration is performed in this function group.
The calibration data are saved in an EEPROM directly in the sensor. For this reason:

- Recalibration is not required in the event of a power failure
- Recalibration is not required when the transmitter is replaced
- Customer-specific recalibration is required, however, when the sensor is replaced

Three calibration data records are saved in the sensor for each of the four main operating modes.

	FNU/NTU	ppm or mg/l	g/l	%
Factory data record no. 1 **not** changeable	Formazine	SiO_2	Activated sludge	Residual concrete water
User data record no. 2 changeable	Formazine	Kaolin	Activated sludge	Residual concrete water
User data record no. 3 changeable	Formazine	SiO_2	Activated sludge	Residual concrete water

Select the desired data record in the SETUP 2 function group in the B4 field.

- In the FNU operating mode, the sensor is factory calibrated with formazine traceable to ISO 7027.
- In the ppm operating mode, the calibration data records for Kaolin and SiO_2 are derived from the FNU data records.
- In the % operating mode, the calibration data records are set to the average of various residual concrete waters. They are preset in such a way that correct values are displayed for average clarity. However the settings do not follow a standard currently applicable.
- In the g/l operating mode also, the sensor is not calibrated to a fixed value as no standard is directly applicable. You must carry out a calibration because the media of the various applications differ too greatly here.

Three-point sensor calibration is the standard calibration. It is absolutely **essential**:
- When commissioning the sensor in sludge applications
- When changing to another sludge type

Three-point sensor calibration is **not** necessary:
- When commissioning the sensor in the drinking water area (sensor has been calibrated for drinking water applications in the factory).
- For residual concrete water. Density measurement for determining the concentration of residual concrete water is based on %–data records. They are preset in such a way that correct values are displayed for average clarity. One-point calibration is often sufficient to adjust the system in the event of deviating values.
- When recalibrating with the same sludge type. One-point calibration suffices here if the degrees of lightness and clarity, for example, do not differ too greatly.

Note!
- Sludge samples tend sediment. Mix the sample well, even during the calibration process, but not to the extent that gas bubbles are formed.
- The sensor has to be far enough away from the floor and the wall of the calibration vessel during calibration. The immersion depth must be at least 40 mm.
- The characteristic determined during the calibration is stored in the selected data record (Setup 2, B4 field).
- Calibration is not possible if data record 1 is selected with the factory setting.
- If the calibration data deviate from the standard values by a factor of two or more, a warning (E084) is output. The calibration results are accepted.
- If the calibration results are outside the permitted range, a calibration error (E045) is indicated. The calibration results are not accepted.
- For every type of calibration, the installation adjustment and the offset are reset to zero and the slope to 1.0.

Calibration menu

The calibration menu offers the following options:

3–Pt	Three-point calibration
Corr	Three-point correction
Edit	Edit calibration
Refl	Installation adjustment
1–Pt	One-point calibration
Data	Calibration data

Three-point calibration (3–Pt)

You should perform the calibration in the turbidity/solids concentration range in which you plan to measure. The overall calibration characteristic of the measuring chain is determined using three samples of known turbidity or known solids content.
Calibration with a very dark, high-absorption medium returns small slopes while light, clear media return big slopes.
You can create the requisite probes by diluting a medium sample. In general, very good calibration results are achieved with a concentration gradation of 10 %, 33 % and 100 %. The following condition must be met for the calibration:

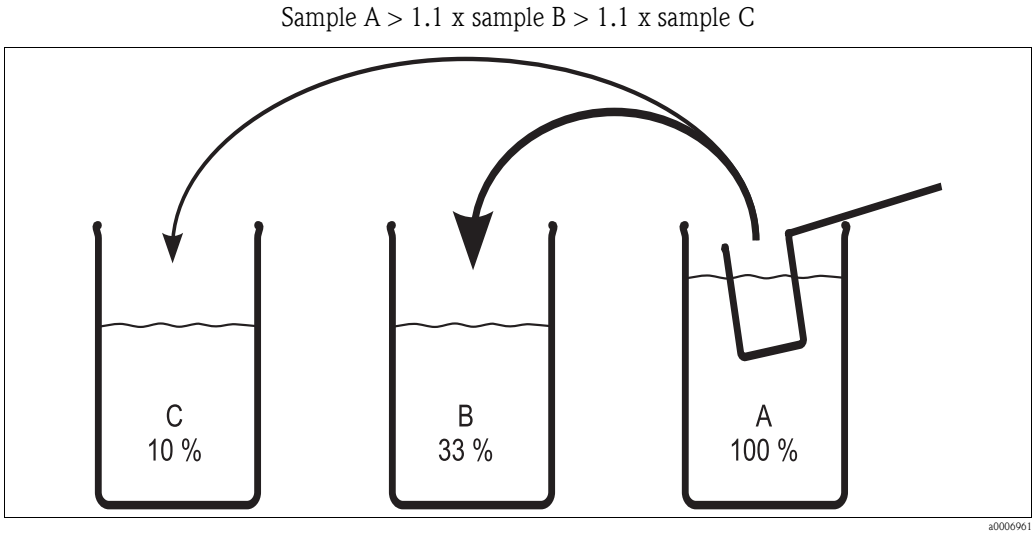


Fig. 34: Making the samples for a three-point calibration

A Original sample
B 1 part sample A + 2 parts water
C 1 part sample A + 9 parts water

A different dilution ratio should be selected for very high-absorption media to achieve accurate calibration results. Instead of 100 % – 33 % – 10 %, you can use dilution ratios of 100 % – 20 % – 5 % or 100% – 10 % – 3.3 %.
If the scattered light of a light sample hits a sensor that is calibrated for a dark medium, it can happen that the signal value is so high that it is above the calibration curve.

Three-point correction (Corr)
If the calibration was performed with an unknown sample concentration but with a defined dilution, the correct value determined afterwards in the laboratory is entered here.

Edit calibration (Edit)
If each of the samples has been determined afterwards in the laboratory, the correction for the calibration is entered here.

Installation adjustment (Refl)
In installation adjustment, backscatter from the immediate sensor environment is compensated. Installation adjustment must be performed with a medium whose turbidity is lower than 2 FNU or 5 ppm.

One-point calibration (1–Pt)
In the area of TS/concentration measurement, one-point calibration is used to change the conversion factor (field C166). The slopes are not changed.
In the FNU range, the two slope values are adjusted by a one-point calibration. This is possible because the conversion factor in the FNU range is always 1 and the editing range is limited to 4000 FNU. In this way, the two curves are always increasing and the calibration remains clear.
In the ppm range, the slope values are adjusted up to 500 ppm. For higher values, the conversion factor is changed.

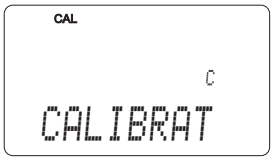
Calibration data (Data)
Here, you can display the calibration points 1 to 3, slope 1 and 2 and the conversion factor.
With three-point calibration, the curves used in the algorithm are adjusted as precisely as possible using the data points acquired. The difference between the ideal curve of the algorithm and the three actual calibration points can be found as a correction factor in the C161, C162 and C163 fields of the data function. The correction values are indicated in %. The values should be as close to 100 % as possible. Values from 70 to 80 % are acceptable. 50 % in one or two calibration points clearly indicates a problematic calibration. A warning (E084) is output here for this reason. This can

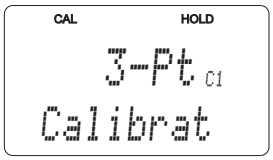
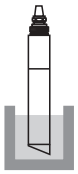
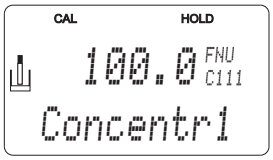
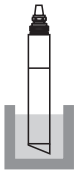
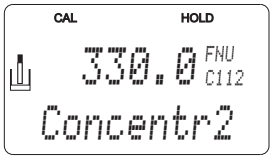
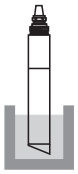
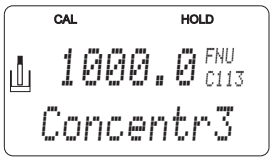
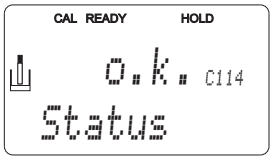
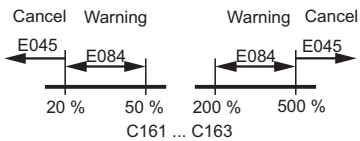
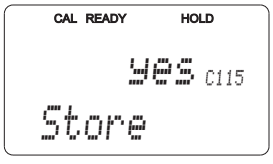
mean that significant deviations can occur between the calibration points. The calibration points themselves are always retrieved correctly.

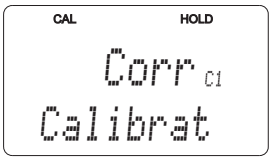
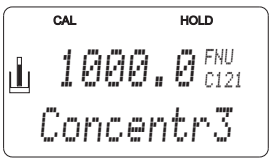
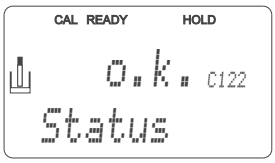
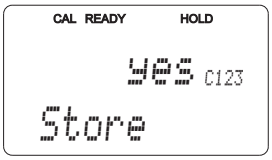
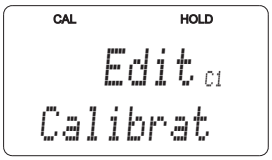
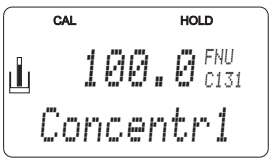
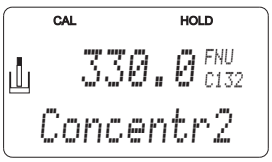
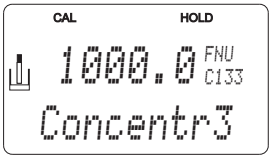
Version TB: Initial settings for residual concrete water
The version TB contains the Plus-package with additional setting options. The default values set in individual fields of the menus differ from the standard version to make commissioning as simple as possible.
These values are so selected that no additional settings need to be made for applications in **residual concrete water**. If you ever reset the device to the original factory settings (set default), you can find valid values for residual concrete water in the table below.

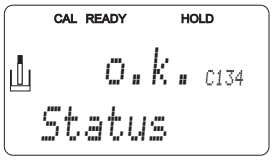
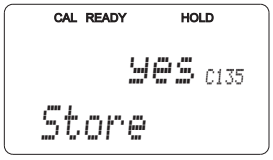
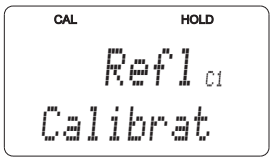
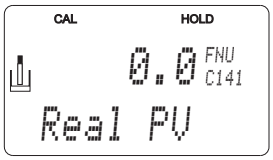
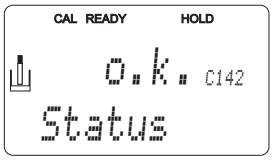
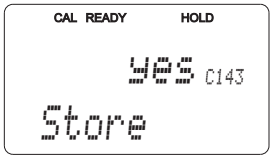
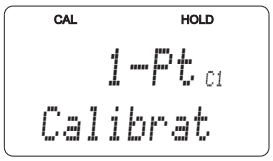
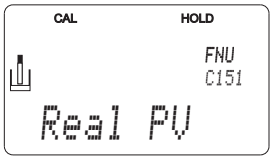
	Menu field	Setting
Mode of operation	A1	spec.
Unit	A2	kg/l
Display format	A3	XX.xx
Measured value damping	A5	10
Calibration data record	B4	3
Current output	O1	Out1
Characteristic	O2	lin
Current range	O211	0 to 20 mA
Measured value 0 mA	O212	1.00
Measured value 20 mA	O213	1.30
Active characteristic	K1	1
Edited characteristic	K2	1
Table option	K3	edit
Number of value pairs	K4	2
Support point	K5	1 to 2
Measured value / display value	K6 / K7	1: 0%/1.00 2: 50%/1.50
Language version	S1	GER

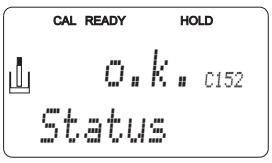
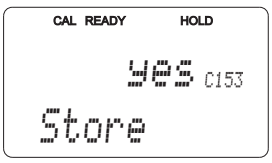
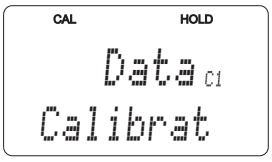
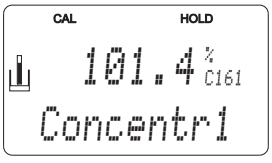
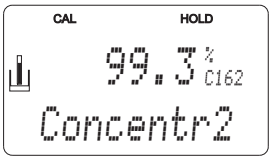
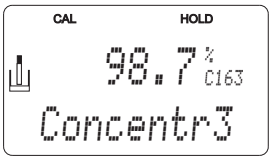
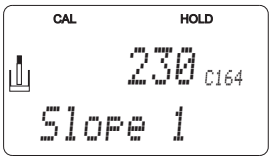
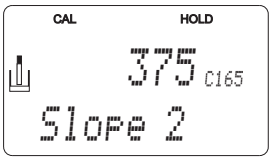
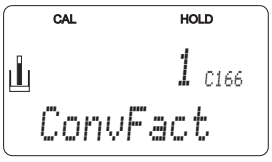
Note!
Calibration is carried out in the % measuring range (the transmitter switches automatically). With the above setting, a density of e.g. 1.12 kg/l = 12 % must be selected. In some cases, it may be necessary to adapt the calibration to a real sample. To do so, perform a single-point calibration.

Coding	Field	Selection or range (factory settings bold)	Display	Info
C	**Function group CALIBRATION**			Calibration settings.

Coding			Field	Selection or range (factory settings bold)	Display	Info
	C1 (1)		Select calibration	**3-Pt = Three-point calibration** (1) Corr = Three-point correction (2) Edit = Edit calibration (3) Refl = Fitting with reflection compensation (4) 1-Pt = Single-point calibration (5) Data = Calibration data (6)		For data set 1 (B4), only the "Data" function is accessible. The offset is reset with 3 Pt and Edit.
Immerse sensor in the calibration solution (sample 1).						Immerse the sensor so that there is sufficient distance to the tank wall (no reflection).
		C111	Enter concentration of the first calibration solution	Value from last calibration		
Immerse sensor in the calibration solution (sample 2).						Immerse the sensor so that there is sufficient distance to the tank wall (no reflection).
		C112	Enter concentration of the second calibration solution	Value from last calibration		**C112** ≥ **1.1 x C111**
Immerse sensor in the calibration solution (sample 3).						Immerse the sensor so that there is sufficient distance to the tank wall (no reflection).
		C113	Enter concentration of the third calibration solution	Value from last calibration		**C113** ≥ **1.1 x C112**
		C114	Calibration status is displayed	o. k. E. xxx		
		C115	Store calibration results	**yes** no new		If C114 = E xxx, then only no or **new** (Exception: calibration warning E84). If new, return to C. If yes / no, return to "Measurement".

Coding		Field	Selection or range (factory settings bold)	Display	Info
C1 (2)		Select calibration	3-Pt = Three-point calibration (1) **Corr = Three-point correction (2)** Edit = Edit calibration (3) Refl = Fitting with reflection compensation (4) 1-Pt = Single-point calibration (5) Data = Calibration data (6)		
	C121	Enter correct concentration of the third calibration solution	**Current value from C113** entire measuring range		If the calibration is performed with an unknown sample concentration, but with a definite dilution (1/10; 1/3;1), the laboratory value is to be entered.
	C122	Calibration status is displayed	**o. k.** Exxx		
	C123	Store calibration results	**yes** no new		If C122 = E xxx, then only no or **new** (Exception: calibration warning E84). If new, return to C. If yes / no, return to "Measurement".
C1 (3)		Select calibration	3-Pt = Three-point calibration (1) Corr = Three-point correction (2) **Edit = Edit calibration (3)** Refl = Fitting with reflection compensation (4) 1-Pt = Single-point calibration (5) Data = Calibration data (6)		
	C131	Enter concentration of the first calibration solution	**Current value from C111** entire measuring range		
	C132	Enter concentration of the second calibration solution	**Current value from C112** C132 ≥ 1.1 x C131		
	C133	Enter concentration of the third calibration solution	**Current value from C113** C133 ≥ 1.1 x C132		

Coding			Field	Selection or range (factory settings bold)	Display	Info
		C134	Calibration status is displayed	o.k. Exxx		
		C135	Store calibration results?	**yes** no new		If C134 = E xxx, then only no or **new** (Exception: calibration warning E84). If new, return to C. If yes / no, return to "Measurement".
	C1 (4)		Select calibration	3-Pt = Three-point calibration (1) Corr = Three-point correction (2) Edit = Edit calibration (3) **Refl = Fitting with reflection compensation (4)** 1-Pt = Single-point calibration (5) Data = Calibration data (6)		**Only for solutions = 2 FNU / 5 ppm!** Backscatter from the immediate sensor environment is compensated for clear media.
		C141	Enter correct measured value	**0.0 NTU** 0.0 to 2.0 NTU **0.0 FNU** 0.0 to 2.0 FNU **0.0 ppm** 0.0 to 5.0 ppm **0.0 mg/l** 0.0 to 5.0 mg/l		Only for the ranges NTU, FNU, ppm, mg/l
		C142	Calibration status is displayed	o.k. Exxx		
		C143	Store calibration results?	**yes** no new		If C142 = E xxx, then only no or **new** (Exception: calibration warning E84). If new, return to C. If yes / no, return to "Measurement".
	C1 (5)		Select calibration	3-Pt = Three-point calibration (1) Corr = Three-point correction (2) Edit = Edit calibration (3) Refl = Fitting with reflection compensation (4) **1-Pt = Single-point calibration (5)** Data = Calibration data (6)		For FNU: Adaption C164, C165 For ppm, mg/l: up to 500 - adaption C164, C165 above 500 - adaption C166 For g/l, %: Adaption C166. An existing basic calibration (three-point) is corrected by the single-point calibration.
		C151	Enter current calibration value	**Current measured value** Entire measuring range		

Coding			Field	Selection or range (factory settings bold)	Display	Info
		C152	Calibration status is displayed	o.k. Exxx		
		C153	Store calibration results?	**yes** no new		If C152 = E xxx, then only no or **new** (Exception: calibration warning E84). If new, return to C. If yes / no, return to "Measurement".
	C1 (6)		Select calibration	3-Pt = Three-point calibration (1) Corr = Three-point correction (2) Edit = Edit calibration (3) Refl = Fitting with reflection compensation (4) 1-Pt = Single-point calibration (5) **Data = Calibration data (6)**		
		C161	Calibration point 1 is displayed	Comparison value		Deviation relative to standard sensor (= 100 %)
		C162	Calibration point 2 is displayed	Comparison value		Deviation relative to standard sensor (= 100 %)
		C163	Calibration point 3 is displayed	Comparison value		Deviation relative to standard sensor (= 100 %)
		C164	Slope 1 is displayed	Current value		Slope of characteristic 1 of the sensor
		C165	Slope 2 is displayed	Current value		Slope of characteristic 2 of the sensor
		C166	Conversion factor is displayed	Current value		Conversion factor of internal turbidity units into displayed unit

6.7 Offset

The settings in the OFFSET function group can be used to calibrate the measurement to a reference measurement. This requires a linear shift of all the measured values, i.e. the adjustment is determined for one measured value, and all others are calculated using the same adjustment.

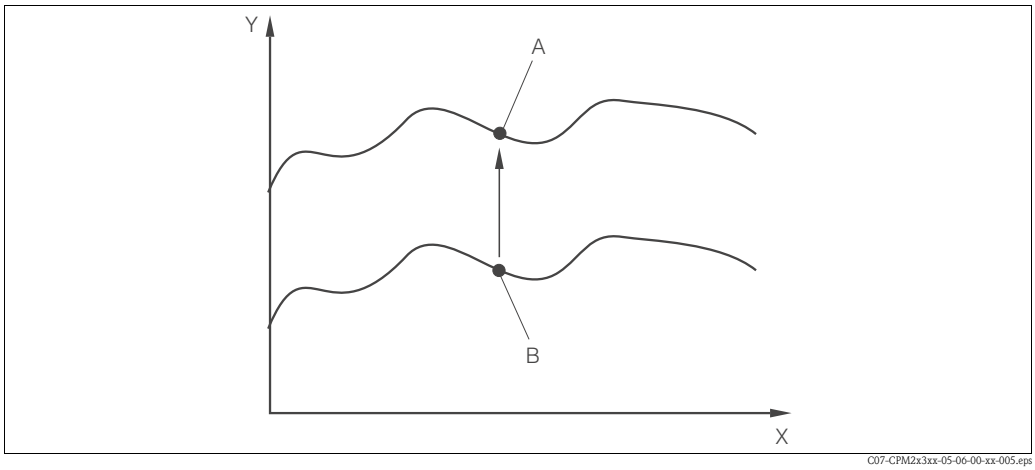
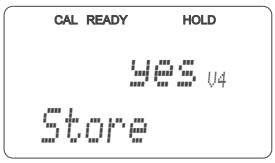


Fig. 35: Offset

X Time
Y Measured value
A Calibrated value
B Current measured value

Note!
Following a calibration, the offset is automatically set to zero.

Coding		Field	Setting range (Factory settings, bold)	Display	Info
V		**Function group OFFSET**		CAL V OFFSET	
	V1	Enter absolute value	**Current measured value**	CAL HOLD 0.0 FNU V1 Real PV	
	V2	Enter offset	**Current offset**	CAL HOLD 0.0 FNU V2 PV Offset	
	V3	Calibration status is displayed	o.k. E xxx	CAL READY HOLD o.k. V3 Status	

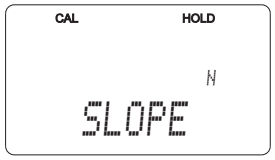
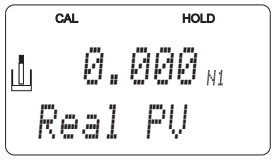
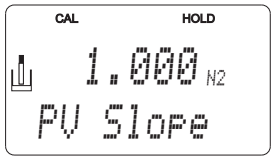
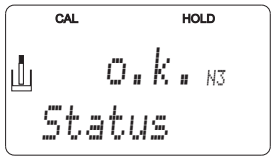
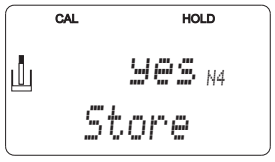
Coding		Field	Setting range (Factory settings, bold)	Display	Info
	V4	Store calibration result?	**yes** no new		If V3 = E xxx, then only no or **new**. If new, return to V. If yes/no, return to "Measurement".

6.8 Slope

With the settings in the function group SLOPE, a measured value can be adapted to a reference value. All measured values are proportionally adapted over the entire measuring range according to this change.

Example:
The displayed measured value is 2.5 g/l. It is adapted to the reference value of 2.0 g/l by means of the slope function. The change is 20 %, i.e. all measured values are reduced by 20 % over the entire measuring range.

Note!
An OFFSET having been edited before is reset to the factory setting. In contrast to the one-point calibration, the edited slope can be reset by setting the slope factor to 1.0.

Coding		Field	Setting range (Factory settings, bold)	Display	Info
N		**Function group SLOPE**			
	N1	Enter absolute value	**Current measured value**		
	N2	Enter slope	**Current slope**		Slope is displayed, can be edited.
	N3	Status is displayed	o.k. E xxx		
	N4	Store slope?	**yes** no new		

7 Maintenance

Take all the necessary measures in time to guarantee the operational safety and reliability of the entire measuring system.

Maintenance work at the transmitter comprises:
- Calibration (see "Calibration" section)
- Cleaning of assembly and sensor
- Cable and connection check

Warning!
- When carrying out all work on the device, please observe any possible effects on the process control or the process itself.
- When removing the sensor during maintenance or calibration, please consider potential hazards due to pressure, high temperatures and contamination.
- Make sure the device is de-energized before you open it.
  If work must be carried out when the device is live, this may only be performed by an electrical technician!
- Switching contacts can be fed by separate circuits. These circuits must also be de-energized before work on the terminals is performed.

Caution ESD!
- Electronic components are sensitive to electrostatic discharge. Personal protective measures such as discharging at the PE beforehand or permanent grounding with a wrist strap are required.
- For your own safety, use only genuine spare parts. With genuine spare parts, the function, accuracy and reliability are also guaranteed after repair.

Note!
If you have any queries, please contact your E+H sales center responsible.

7.1 Maintenance of the entire measuring point

7.1.1 Cleaning the transmitter

Clean the front of the housing with usual commercial cleaning agents.

In accordance with DIN 42 115, the front is resistant to:
- Isopropanol
- Diluted acids (max. 3%)
- Diluted alkalis (max. 5%)
- Esters
- Hydrocarbons
- Ketones
- Household cleaners

Caution!
For cleaning purposes, never use:
- Concentrated mineral acids or alkalis
- Benzyl alcohol
- Methylene chloride
- High-pressure steam

7.1.2 Checking the measuring point

The sensors CUS31 and CUS41 cannot be simulated as they contain the complete data processing and all the measured values are transmitted to CUM223/253 using the digital interface RS 485. Therefore a functional sensor is required for the measuring point test.

Method for testing a measuring point:

- Check that device is operable and that the display reacts appropriately, e.g. by pressing the PLUS key.
- Check the current outputs by carrying out a current simulation (Field O3(2)).
- Measure the sensor operating voltage: approx. 10 to 16 V at terminals 87 (+) and 88 (–).
- The cause for an incorrect voltage may be present either at the device or at the sensor.
  – Replace the sensor.
  – If the sensor operating voltage is still too low replace the power supply module LSGA/LSGD (Pos. 10/20, make sure to use the appropriate version – see spare parts).
- Sensor operating voltage is o.k. but no measured turbidity value even with a new sensor. Replace the transmitter module MKT1.

7.1.3 Replacing the sensor

The sensors CUS31/CUS41 contain their own digital signal processor and communicate with the turbidity measuring instrument via an interface RS 485. All sensor data (factory calibration data and customer calibration data) are permanently saved in the sensor.

You can find detailed information on these sensors in the:

- Operating Instructions Turbimax W CUS31 BA176C/07/en.
- Technical Information Turbimax W CUS41 TI177C/07/en.

When replacing a sensor pay attention to the following:

- Replacing the sensor CUS31-xxA or CUS41
  All calibration data are saved in the sensor. When using the original data records (“read only”), no calibration is necessary after sensor replacement. Medium-specific calibrations must be repeated.
- Replacing the sensor CUS31-xxE or CUS31-xxS
  All factory calibration data are saved in the sensor. The sensor and the assembly are calibrated together. No additional calibration is required for applications with pure or ultrapure water, if the sensor **and** the assembly are replaced together. The calibration data of the sensor are automatically transferred to the measuring instrument.

7.1.4 Maintenance assembly

Please refer to the corresponding assembly Operating Instructions for information on maintaining and trouble-shooting the assembly. Here you can find a description for assembling and disassembling, sensor replacement, seal replacement, as well as information on stability and spare parts and accessories.

7.2 "Optoscope" service tool

The Optoscope together with the “Scopeware” software offers the following possibilities, without having to remove or open the transmitter and without galvanic connection to the instrument:

- Documentation of the instrument settings in conjunction with Commuwin II
- Software update by the service technician
- Upload/download a hex dump to duplicate configurations.

The Optoscope serves as an interface between the transmitter and PC / laptop. The information exchange takes place via the optical interface on the transmitter and via an RS 232 interface on the PC / laptop (see "Accessories").

8 Accessories

8.1 Sensors

Turbimax W CUS31
- Turbidity sensor for drinking water and wastewater applications, 90 ° scattered light method
- Ordering acc. to product structure, see Technical Information (TI176C/07/en)

Turbimax W CUS41
- Turbidity sensor for wastewater and solid content measurements, 90 ° scattered light method
- Ordering acc. to product structure, see Technical Information (TI177C/07/en)

8.2 Connection accessories

CYK81 measuring cable
- Non-terminated measuring cable for extension of sensor cables of e.g. Memosens sensors, CUS31/CUS41
- 2 wires, twisted pair with shield and PVC-sheath (2 x 2 x 0.5 mm^2 + shield)
- Sold by the meter, order no.: 51502543

Junction box VBM
- For cable extension
- 10 terminals
- Cable entries: 2 x Pg 13.5 or 2 x NPT ½"
- Material: aluminum
- Ingress protection: IP 65 (≙ NEMA 4X)
- Order numbers:
  - cable entries Pg 13.5: 50003987
  - cable entries NPT ½": 51500177

Junction box RM
- For cable extension (e.g. for Memosens sensors)
- 5 terminals
- Cable entries: 2 x Pg 13.5
- Material: PC
- Ingress protection: IP 65
- Order no.: 51500832

8.3 Mounting accessories

CYY101 weather protection cover for field devices, absolutely essential if operating the unit outdoors

- Material: stainless steel 1.4031 (AISI 304)
- Order No. CYY101-A

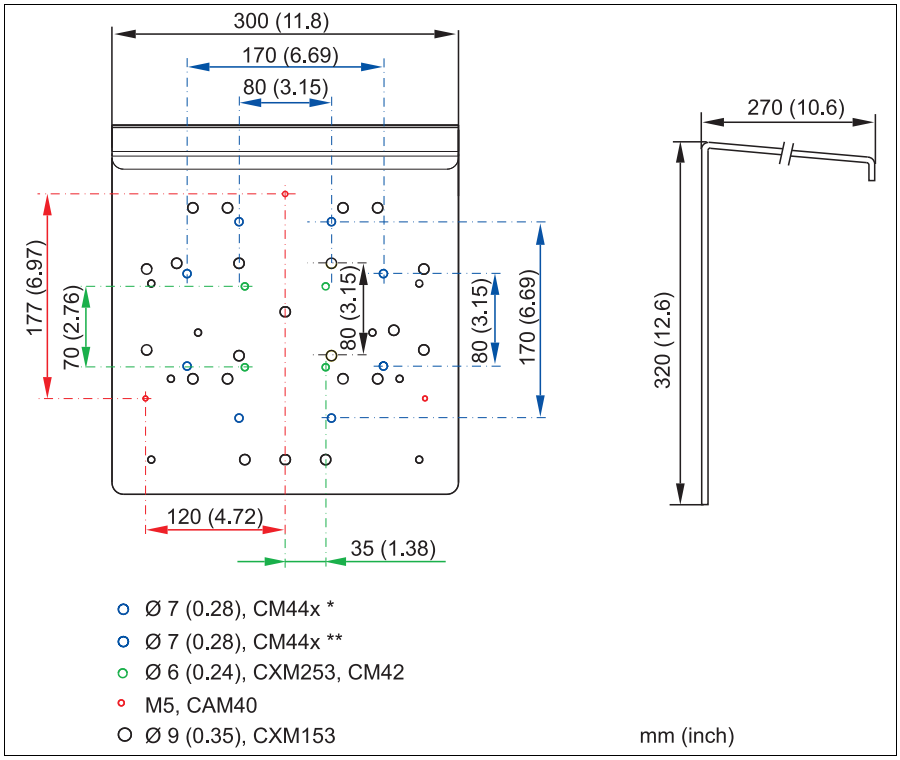


Fig. 36: Weather protection cover for field devices

* *Wall and post mounting*
** *Rail mounting*

CYY102 universal post

- Square pipe for mounting transmitters
- Material: stainless steel 1.4301 (AISI 304)
- Order No. CYY102-A

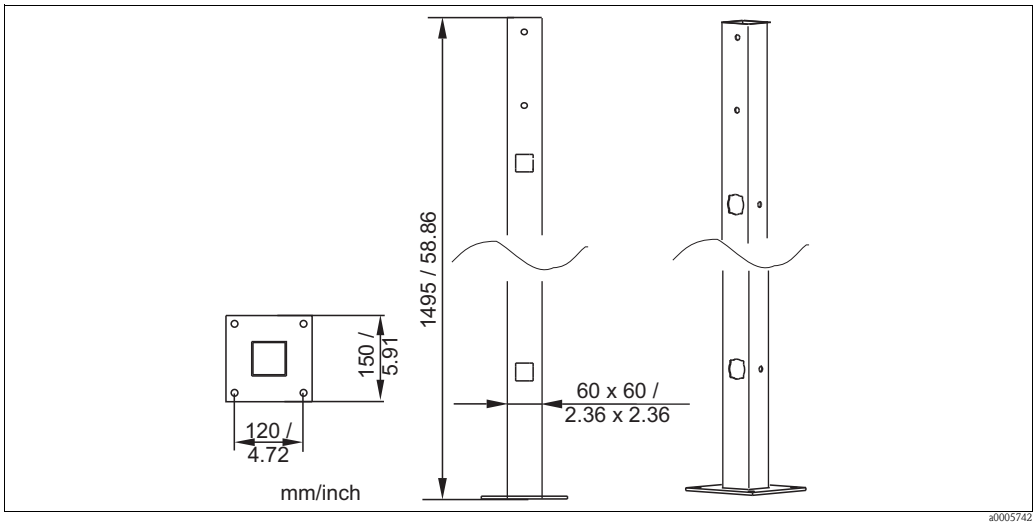


Fig. 37: Universal post

Post mounting kit
- For mounting of field housing on horizontal or vertical pipes (Ø max. 60 mm (2.36"))
- Material: stainless steel 1.4301
- order no. 50086842

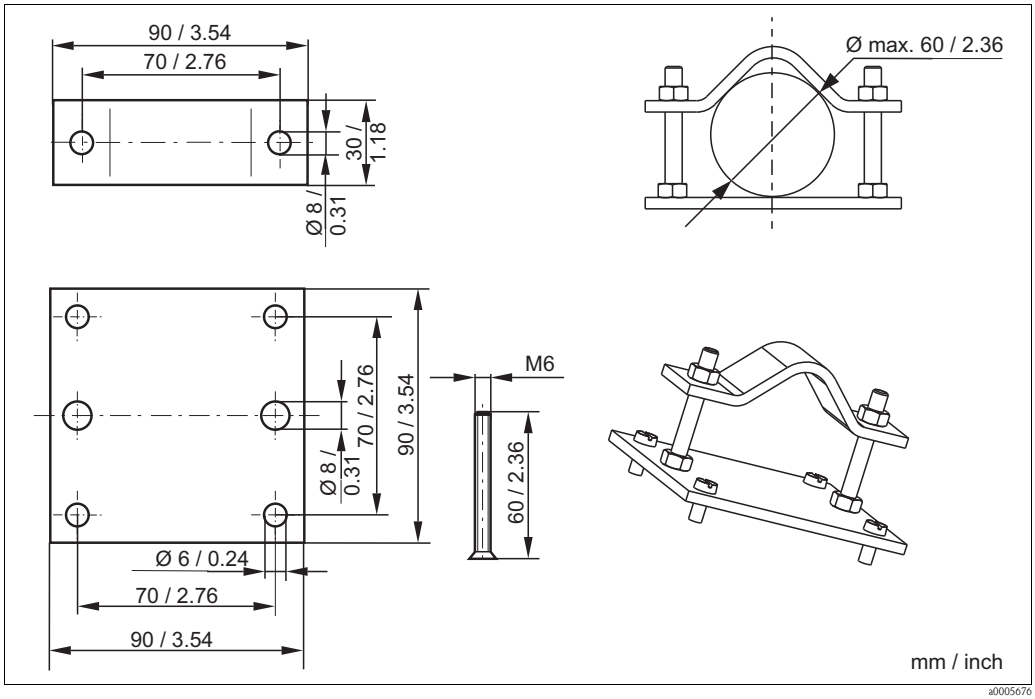


Fig. 38: Post mounting kit

8.4 Measuring system

- Compact turbidity measuring station CUE31
  Mounted panel ready for connection for measuring fine turbidity in drinking water and other waters with turbidity levels < 1 FNU.
  Ordering acc. to product structure (Technical Information TI393C/07/en)

8.5 Software and hardware add-ons

The add-ons can only be ordered by quoting the serial number of the device in question.

- Plus Package
  Order no. 51500385
- Chemoclean
  Order no. 51500963
- Two-relay card
  Order no. 51500320
- Four-relay card
  Order no. 51500321
- Two-relay card with current input
  Order no. 51504304
- Four-relay card with current input
  Order no. 51504305

8.6 Optoscope

Optoscope
- Interface between transmitter and PC / laptop for service purposes.
- The Windows software "Scopeware" required for the PC or laptop is supplied with the Optoscope. The Optoscope is supplied in a sturdy plastic case with all the accessories required.
- Order no. 51500650

9 Trouble-shooting

9.1 Trouble-shooting instructions

The transmitter constantly monitors its functions itself. If an error occurs which the device recognizes, this is indicated on the display. The error number is shown below the display of the main measured value. If more than one error occurs, you can call these up with the MINUS key.
Refer to the "System error messages" table for the possible error numbers and remedial measures. Should a malfunction occur without any transmitter error message, please refer to the "Process-specific errors" or the "Device-specific errors" tables to localize and rectify the error. These tables provide you with additional information on any spare parts required.

9.2 System error messages

The system error messages can be called up and selected with the MINUS key.

Error no.	Display	Tests and/or remedial measures	Alarm contact		Error current		Autom. cleaning start		PROFIBUS status	
			Facty	User	Facty	User	Facty	User	PV[1)]	Temp
E001	EEPROM memory error	1. Switch device off and then on again.	Yes		No		—	—[2)]	0C	0C
E002	Instrument not calibrated, calibration data invalid, no user data, user data invalid (EEPROM error), instrument software not suitable to hardware (controller)	2. Load device software compatible with the hardware (with optoscope, see "Optoscope service tool" section). 3. Load measurement-parameter specific device software. 4. If the error persists, send in the device for repair to your local service organization or replace the device.	Yes		No		—	—[2]	0C	0C
E003	Download error	Invalid configuration. Repeat download, check optoscope.	Yes		No		No		0C	0C
E004	Instrument software version not compatible with module hardware version	Load software compatible with hardware. Load measurement-parameter specific device software.	Yes		No		No		0C	0C
E007	Transmitter malfunction, instrument software not compatible with transmitter version	Contact E+H Service.	Yes		No		—	—[2]	0C	0C
E008	Sensor or sensor connection faulty	Check sensor and sensor connection (Service). Check initialization of wiper.	Yes		Yes		No		0C	0C
E026	Wiper error	Check wiper and test function using manual control if necessary.	Yes		No		No		44	80
E045	Calibration aborted	Repeat calibration	No		No		—	—[2]	80	80
E055	Below main parameter measuring range	Check measurement and connections; check device and measuring cable.	Yes		No		No		44	80
E057	Main parameter measuring range exceeded		Yes		No		No		44	80
E059	Below temperature measuring range		Yes		No		No		80	44
E061	Temperature measuring range exceeded		Yes		No		No		80	44

Error no.	Display	Tests and/or remedial measures	Alarm contact		Error current		Autom. cleaning start		PROFIBUS status	
			Facty	User	Facty	User	Facty	User	PV[1]	Temp
E063	Below current output range 1	Check measured value and current assignment.	Yes		No		No		80	80
E064	Current output range 1 exceeded		Yes		No		No		80	80
E065	Below current output range 2		Yes		No		No		80	80
E066	Current output range 2 exceeded		Yes		No		No		80	80
E067	Set point exceeded limit contactor 1	Check configuration.	Yes		No		No		80	80
E068	Set point exceeded limit contactor 2		Yes		No		No		80	80
E069	Set point exceeded limit contactor 3		Yes		No		No		80	80
E070	Set point exceeded limit contactor 4		Yes		No		No		80	80
E079	Measuring value outside concentration table	Clean sensor, check table.	Yes		No		No		44	80
E080	Current output 1 range too small	Decrease current output spreading	Yes		No		—	—[2]	80	80
E081	Current output 2 range too small		Yes		No		—	—[2]	80	80
E084	Calibration warning	Calibration data are within limits but deviate from standard values by a factor of more than two.	No		No		No		80	80
E085	Incorrect setting for error current	If the current range "0 to 20 mA" was selected in field O311, the error current "2.4 mA" may not be set.	No		No		—	—[2]	80	80
E100	Current simulation active		No		No		—	—[2]	80	80
E101	Service function active	Switch off service function or switch device off and then on again.	No		No		—	—[2]	80	80
E102	Manual mode active		No		No		—	—[2]	80	80
E106	Download yes	Wait for download to finish.	No		No		—	—[2]	80	80
E116	Download error	Repeat download.	Yes		No		—	—[2]	0C	0C
E152	PCS alarm	Check sensor and connection.	Yes		No		No		44	44
E153	Offset	Adjustment range exceeded	No		No		No		80	80
E154	Below lower alarm threshold for period exceeding alarm delay	Perform manual comparison measurement if necessary. Service sensor and recalibrate.	Yes		No		No		–[3]	–
E155	Above upper alarm threshold for period exceeding alarm delay		Yes		No		No		–	–
E156	Current value undershoots alarm threshold (CC setpoint) for longer than the set permissible maximum period		Yes		No		No		–	–
E157	Current value exceeds alarm threshold (CC setpoint) for longer than the set permissible maximum period		Yes		No		No		–	–

Error no.	Display	Tests and/or remedial measures	Alarm contact		Error current		Autom. cleaning start		PROFIBUS status	
			Facty	User	Facty	User	Facty	User	PV[1)]	Temp
E162	Dosage stop	Check settings in the CURRENT INPUT and CHECK function groups.	Yes		No		No		-	-
E171	Flow in main stream too low or zero	Restore flow.	Yes		No		No		-	-
E172	Switch-off limit for current input exceeded	Check process variables at sending measuring instrument. Change range assignment if necessary.	Yes		No		No		-	-
E173	Current input < 4 mA	Check process variables at sending measuring instrument.	Yes		No		No		-	-
E174	Current input > 20 mA	Check process variables at sending measuring instrument. Change range assignment if necessary.	Yes		No		No		-	-

1) PV = Process variable

2) If this error occurs, there is no possibility of starting a cleaning session (field F8 not applicable with this error).

3) Current error messages not applicable via PROFIBUS

9.3 Process-specific errors

Use the following table to locate and correct errors.

Error	Possible cause	Tests and / or remedial measures	Equipment, spare parts, personnel
Value indicated 0.0	Sensor / sensor cable defective	Test with new or with different functional sensor.	CUS31 or CUS41 (either type is suitable for rough function test)
	Sensor extension line interrupted	Check junction boxes and line.	Sensor simulation see chapter "Maintenance of the entire measuring point".
	Incorrect sensor connection	Check connection.	See chapter "Wiring".
	Instrument input defective	Replace module MKT1 for testing.	See spare parts list.
	Data transfer errror	Replace module LSGA (AC power supply unit) or LSGD (DC power supply unit) for testing.	See spare parts list.
	Wiper blocked	Switch instrument off and back on, wiper has to wipe once.	Repair at manufacturer only.
Display value 0.0	Sensor completely blocked	Clean optics	Use spray cleaning or wiper.
Fixed incorrect measured value	Impermissible instrument operating state (no response to key actuation)	Switch instrument off and back on	EMC problem: check line routing if problem persists, check for possible sources of interference.
Measured value fluctuates	Measuring cable interference	Connect cable screen acc. to connection diagram (do not ground)	See chapter "Wiring".
	Signal output line interference	Check line routing Try separate line routing, grounding screen to PLC/PCS.	Separate signal output, meas. input and supply lines.
	Irregular flow rate / turbulence / air bubbles / big solids particles	Choose better place of installation or eliminate turbulences. Possibly use large measured value damping factor. Set gas bubble barrier to 100 %.	Measured value damping see field A5.

Error	Possible cause	Tests and / or remedial measures	Equipment, spare parts, personnel
Display value implausible / no or creeping change of display	No or incorrect sensor calibration	Calibration with original sample required for concentration or solids concentration	See chapter "Calibration".
	Sensor soiled	Clean sensor.	Remove coarse coats with brush. Remove carbonates and similar coats with 3 % hydrochlorid acid. Remove organic coats and grease with oxidation agents and / or grease solvents.
		Use spray cleaning.	See instructions of assembly used for spray cleaning.
		Use wiper version.	Wiper upgrade at factory.
	Wiper rubber defective	Replace wiper arm.	Wiper arm service kit 50089252
	Sensor installed in “dead” zone or air cushion in assembly or flange	Check installation conditions, move sensor to area with optimum flow conditions. Caution if installed in horizontal lines!	
	Incorrect sensor orientation	Orient sensor: ■ Measuring surface should face flow in normal media. ■ Orient meas. surface at 90° to flow in media with high solids concentration	Frontal “bombardment” of measuring surface with highly viscous solids may result in an adhering coating.
Incorrect temperature value	Temperature sensor defective	If temperature display is required: replace sensor.	Turbidity measurement itself does not require temperature measurement.
Controller or timer cannot be activated	No relay module installed	Install LSR1-2 or LSR1-4 module.	See spare parts list in chapter "Spare parts".
Controller/limit contact does not work	Controller switched off	Activate controller.	See fields R2xx.
	Controller in "Manual/Off" mode	Choose "Auto" or "Manual/On" mode.	Keyboard, REL-key
	Pickup delay setting too long	Disable or shorten pickup delay.	See fields R2xx.
	"Hold" function active	“Automatic Hold” during calibration, “Hold” input activated; “Hold” via keyboard active.	See fields S2 to S4.
Controller/limit contact works continuously	Controller in "Manual/On" mode	Set controller to "Manual/Off" or "Auto".	Keyboard, REL and AUTO keys
	Dropout delay setting too long	Shorten dropout delay.	See field R2xx.
	Control loop interruption	Check measured value, current output, actuators, chemical supply.	
No turbidity current output signal	Line open or short-circuited	Disconnect line and measure directly on instrument.	mA meter 0–20 mA
	Total load in current loop excessive (>500Ω)	Disconnect line and measure line.	Ohmmeter
	Instrument with PROFIBUS PA/DP	PA/DP instruments have no current output.	
Fixed current output signal	Current simulation active	Switch off simulation.	See field O3 (2).
	Impermissible operating state of processor system	Switch instrument off and back on.	EMC problem: check installation, screen, grounding if problem persists.
Incorrect current output signal	Incorrect current assignment	Check current assignment: 0–20 mA or 4–20 mA?	Field O311
	Total load in current loop excessive (> 500 Ω.)	Disconnect line and measure line.	Ohmmeter
Current output table not accepted	Value interval too small	Select practical intervals.	

Error	Possible cause	Tests and / or remedial measures	Equipment, spare parts, personnel
No HART communication	No central HART module	Verify by looking at nameplate: HART = -xxx5xx and -xxx6xx.	Upgrade to LSCH-H1 / -H2.
	No or wrong DD (device description)	For further information see BA208C/07/en, "HART® - Field communication with Liquisys M CxM223/253".	
	HART interface missing		
	Instrument not registered with HART server		
	Load too low (load > 230 Ω required)		
	HART receiver (e.g. FXA 191) not connected via load but via power supply		
	Incorrect device address (addr. = 0 for single operation, addr. > 0 for multi-drop operation)		
	Line capacitance too high		
	Line interferences		
	Several devices set to same address	Set addresses correctly.	Communication not possible with several devices set to same address.
No PROFIBUS® communication	No central PA/DP module	Verify by looking at nameplate: PA = -xxx3xx /DP = xxx4xx.	Upgrade to LSCP module, see chapter "Spare parts".
	Incorrect instrument software version (without PROFIBUS)	For further information, see BA209C/07/en "PROFIBUS PA/DP - Field communication with Liquisys M CxM223/253".	
	Commuwin (CW) II: Incompatible CW II and instrument software versions		
	No or incorrect DD/DLL		
	Incorrect baud rate setting for segment coupler in DPV-1 server		
	Incorrect station (master) addressed or duplicate address		
	Incorrect station (slaves) address		
	Bus line not terminated		
	Line problems (too long, cross section too small; not shielded, screen not grounded, wires not twisted)		
	Bus voltage too low (bus supply voltage typ. 24 V DC for non-Ex)	Voltage at instrument's PA/DP connector must be at least 9 V.	

9.4 Instrument-specific errors

The following table helps you during the diagnosis and points to any spare parts required.

Depending on the degree of difficulty and the measuring equipment present, diagnosis is carried out by:
- Trained operator personnel
- The user's trained electrical technicians
- Company responsible for system installation/operation
- Endress+Hauser Service

Information on the exact spare part designations and on how to install these parts can be found in the "Spare parts" section.

Error	Possible cause	Tests and/or remedial measures	Execution, tools, spare parts
Device cannot be operated, display value 9999	Operation locked	Press CAL and MINUS keys simultaneously.	See "Function of keys" section.
Display dark, no light-emitting diode active	No line voltage	Check whether line voltage is present.	Electrical technician/e.g. multimeter
	Supply voltage wrong/too low	Compare actual line voltage and nameplate data.	User (data for energy supply company or multimeter)
	Connection faulty	Terminal not tightened; insulation jammed; wrong terminals used.	Electrical technician
	Device fuse defective	Compare line voltage and the nameplate data and replace fuse.	Electrical technician/suitable fuse; see drawing in "Spare parts" section.
	Power unit defective	Replace power unit, note variant.	On-site diagnosis by Endress+Hauser Service, test module necessary
	Central module defective	Replace central module, note variant.	On-site diagnosis by Endress+Hauser Service, test module necessary
	CUM253: ribbon cable, item 310 loose or defective	Check ribbon cable, renew if necessary.	See "Spare parts" section.
Display dark, light-emitting diode active	Central module defective (module: LSCH/LSCP)	Renew central module, note variant.	On-site diagnosis by Endress+Hauser Service, test module necessary
Display is on but – No change in display and/or – Device cannot be operated – Missing pixels in display	Device or module in device not correctly mounted	CUM223: reinstall module. CUM253: reinstall display module.	Perform with the aid of the installation drawings in the "Spare parts" section.
	Operating system in unpermitted mode	Switch device off and then on again.	Poss. EMC problem: if this persists, check the installation.
Device gets hot	Voltage wrong/too high	Compare line voltage and nameplate data.	User, electrical technician
	Power unit defective	Replace power unit.	Diagnosis only by Endress+Hauser Service
Incorrect meas. turbidity and/or temperature	Transmitter module defective (module: MKT1), please first carry out tests and take measures as per the "Process errors without messages" section to make sure that the error is not in the cabling or in the sensor	Measuring input test: Simulation of the sensor is not possible. Test the input with new or different sensor.	If test negative: replace module (note variant). Perform with the aid of the exploded view drawings in the "Spare parts" section. If test positive: check peripherals once more.
	Erroneous data transfer	Replace module LSGA (AC) or LSGD (DC)	See "Spare parts" section.
	Data transfer disturbed (EMC)	Check cable routing. Separate sensor cable from supply cables.	Connect sensor cable screen to "S" terminal , do not ground.
	Wrong sensor cable / cable too long	Max. line length with extension is 200 m (656 ft.); use only cable type CYK81	
Current output, current value incorrect	Adjustment not correct	Check with installed current simulation, connect mA meter directly to current output.	If simulation value incorrect: adjustment in factory or new module LSCxx required. If simulation value correct: check current loop for load and shunts.
	Load too big		
	Shunt/short to ground in current loop		
	Incorrect mode of operation	Check whether 0–20 mA or 4–20 mA is selected.	
No current output signal	Current output stage defective (module LSCH/LSCP)	For safety reasons, first completely disconnect the auxiliary power output. Check with installed current simulation, connect mA meter directly to current output.	If test negative: Renew central module LSCH/LSCP (note variant).
No function of additional relay	CUM253: ribbon cable item 320 loose or defective	Check ribbon cable seating, renew cable if required.	See "Spare parts" section.
Only 2 additional relays can be triggered	Relay module LSR1-2 installed with 2 relays	Upgrade to LSR1-4 with 4 relays.	User or Endress+Hauser Service

Error	Possible cause	Tests and/or remedial measures	Execution, tools, spare parts
Additional functions (Plus package) missing	No or incorrect release code used	If retrofitting: check whether the correct serial number was quoted when ordering the Plus package.	Handled by Endress+Hauser Sales
	Incorrect device serial number saved in LSCH/LSCP module	Check whether serial number on the nameplate matches SNR in LSCH/ LSCP (field S 8).	The serial number of the device is definitive for the Plus package.
Additional functions (Plus package and/or Chemoclean) missing after LSCH/LSCP module replaced	Replacement modules LSCH or LSCP have the **device** serial number 0000 when they leave the factory. The Plus package or Chemoclean are not enabled on leaving the factory.	In the case of LSCH/LSCP with SNR 0000, a **device** serial number can be entered once in fields E115 to E117. Then enter the release code for the Plus package and/or Chemoclean.	For a detailed description, see "Replacing central module" section.
No HART or PROFIBUS PA/ DP interface function	Incorrect central module	HART: LSCH-H1 or H2 module, PROFIBUS PA: LSCP-PA module, PROFIBUS DP: LSCP-DP module, see field E112.	Replace central module; user or Endress+Hauser Service.
	Wrong software	SW version see field E111.	SW can be modified with optoscope.
	Bus problem	Remove some devices and repeat the test.	Contact Endress+Hauser Service.
No temperature output signal	Instrument does not have 2nd current output	Refer to nameplate for variant; change LSCH-x1 module if necessary.	Module LSCH-x2, see chapter "Spare parts".
	Instrument with PROFIBUS PA	PA instrument has no current output!	
Chemoclean function not available	No relay module (LSR1-x) installed or only LSR1-2 available Additional function not enabled	Install LSR1-4 module. Chemoclean is enabled using the release code supplied by E+H in the Chemoclean retrofit kit.	Module LSR1-4, see chapter "Spare parts".
Plus package functions not available	Plus package not enabled (enable with code that depends on serial number and is received from E+H with order of extension package)	– When upgrading instrument with Plus package: code received from E+H ⇒ enter. – After replacing defective LSCH/LSCP module: first enter instrument serial number (s. nameplate) manually, then enter code.	For a detailed description, see chapter "Replacing the central module".

9.5 Spare parts

Spare parts are to be ordered from your sales center responsible. Specify the order numbers listed in the chapter "Spare parts kits".

To be on the safe side, you should **always** specify the following data with your spare part orders:
- Instrument order code (order code)
- Serial number (serial no.)
- Software version where available

Refer to the nameplate for the order code and serial number.
The software version is displayed in the instrument sofware (see chapter "Instrument configuration") if the instrument processor system is functional.

9.5.1 Dismantling the panel-mounted instrument

Caution!
Please note the effects on the process if the device is taken out of service!

Note!
Please refer to the following diagram for the item numbers.

1. Disconnect the terminal block (item 426 b) from the rear of the device to de-energize the device.
2. Then remove the terminal blocks (item 426 a and item 430) from the rear of the device. Now you can disassemble the device.
3. Press in the latches of the end frame (item 340) and remove the frame from the rear.
4. Release the special screw (item 400) by turning it counter-clockwise.
5. Remove the entire electronics block from the housing. The modules are only mechanically connected and can be easily separated:
   – Simply remove the processor/display module from the front.
   – Pull out the brackets of the rear plate (item 320) slightly.
   – Now you can remove the side modules.
6. Remove the turbidity transmitter (item 270) as follows:
   – Using fine side-cutting pliers, nip off the heads of the plastic distance holders.
   – Then remove the module from above.

Assembly is the reverse of the disassembly sequence. Tighten the special screw hand-tight without a tool.

9.5.2 Panel-mounted instrument

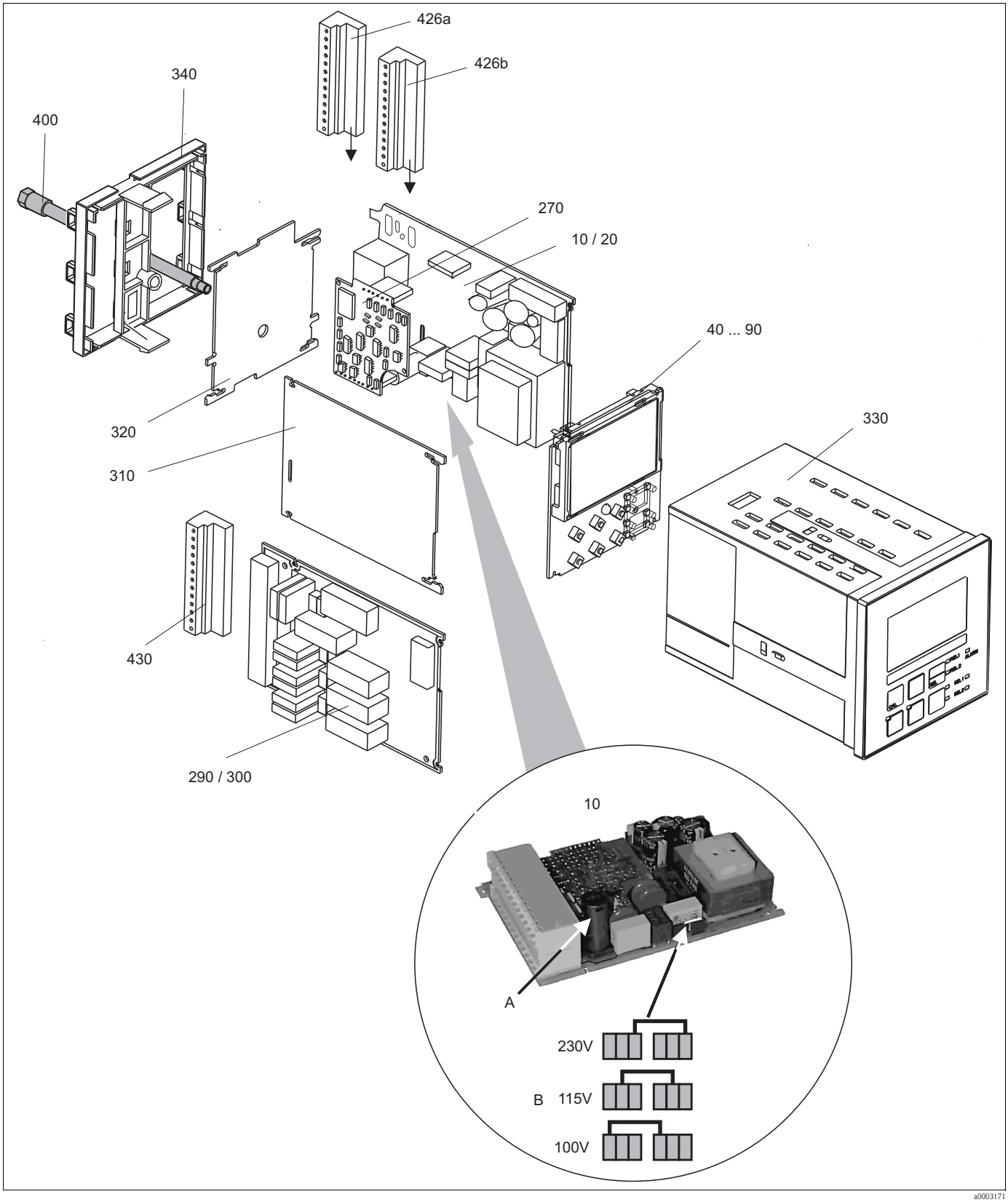


Fig. 39: Exploded view drawing of panel-mounted instrument

The exploded view drawing contains the components and spare parts of the panel-mounted instrument. You can take the spare parts and the corresponding order number from the following section using the item numbers.

Item	Kit description	Name	Function/contents	Order number
10	Power unit (main module)	LSGA	100 / 115 / 230 V AC	51500317
20	Power unit (main module)	LSGD	24 V AC + DC	51500318
40	Central module (controller)	LSCH-S1	1 current output	51501228
50	Central module (controller)	LSCH-S2	2 current outputs	51501229
60	Central module (controller)	LSCH-H1	1 current output + HART	51501230
70	Central module (controller)	LSCH-H2	2 current outputs + HART	51501231
80	Central module (controller)	LSCP	PROFIBUS PA/no current output	51501232
90	Central module (controller)	LSCP-DP	PROFIBUS DP/no current output	51502499
90	Kit CUM2x3 Central module PROFIBUS DP	LSCP-DP	Central module PROFIBUS DP Relay module + 2 relays Current input and terminals valid of: hardware version 3.0	71134728
270	Turbidity transmitter	MKT1	Turbidity + temperature	51501209
290	Relay module	LSR1-2	2 relays	51500320
290	Relay module	LSR2-2i	2 relays + current input 4 to 20 mA	51504304
290	Kit CxM2x3 Relay module PROFIBUS DP		Relay module + 2 relays Current input and terminals DP valid of: hardware version 3.0	71134732
300	Relay module	LSR1-4	4 relays	51500321
300	Relay module	LSR2-4i	4 relays + current input 4 to 20 mA	51504305
310	Side panel		Kit with 10 parts	51502124
310, 320, 340, 400	Housing mechanical parts		Rear plate, side panel, end frame, special screw	51501076
330, 400	Housing module		Housing with front membrane, sensory tappets, gasket, special screw, tensioning dogs, connection plates and nameplates	51501075
340	End frame PROFIBUS DP		Rear frame for PROFIBUS DP, with D-submin plug connector	51502513
426a, 426b	Terminal strip set Standard + HART		Complete terminal strip set, standard + HART	51501205
426a, 426b	Terminal strip set PROFIBUS PA		Complete terminal strip set, PROFIBUS PA	51502128
426a, 426b	Terminal strip set PROFIBUS DP		Complete terminal strip set, PROFIBUS DP	51502491
430	Terminal strip		Terminal strip for relay module	51501078
A	Fuse		Part of power unit, item 10	
B	Choice of line voltage		Position of jumper on power unit, item 10 depending on line voltage	

9.5.3 Dismantling the field instrument

Caution!
Please note the effects on the process if the device is taken out of service!

Note!
Please refer to the following diagram for the item numbers.

To dismantle the field instrument you need the following tools:
- Standard set of screwdrivers
- Torx-screwdriver size TX 20

Proceed as follows:

1. Open and remove the cover of the connection compartment (item 420).
2. Disconnect the mains terminal (item 470) to de-energize the device.
3. Open the display cover (item 410) and loosen the ribbon cables (item 310/320) on the side of the central module (item 40 to 90).
4. To remove the central module (item 40), loosen the screw in the display cover (item 450 b).
5. Proceed as follows to remove the electronics box (item 330):
   – Release the screws in the housing base (item 450 a) with two revolutions.
   – Then push the entire box backwards and remove it from above.
   – Make sure that module locks do not open!
   – Loosen the ribbon cables (item 310/320).
   – Bend the module locks out and remove the modules.
6. To remove the docking module (item 340), remove the screws in the housing base (item 450 c) and remove the entire module from above.
7. Proceed as follows to remove the turbidity transmitter (item 270):
   – Using fine side-cutting pliers, nip off the heads of the plastic distance holders.
   – Then remove the module from above.

To assemble, carefully push the modules into the trolley tracks of the electronics box and let them engage in the side box noses.

Note!
- Incorrect mounting is not possible. Modules inserted in the electronics box incorrectly are not operable since the ribbon cables cannot be connected.
- Make sure the cover seals are intact to guarantee IP 65 ingress protection.

9.5.4 Field instrument

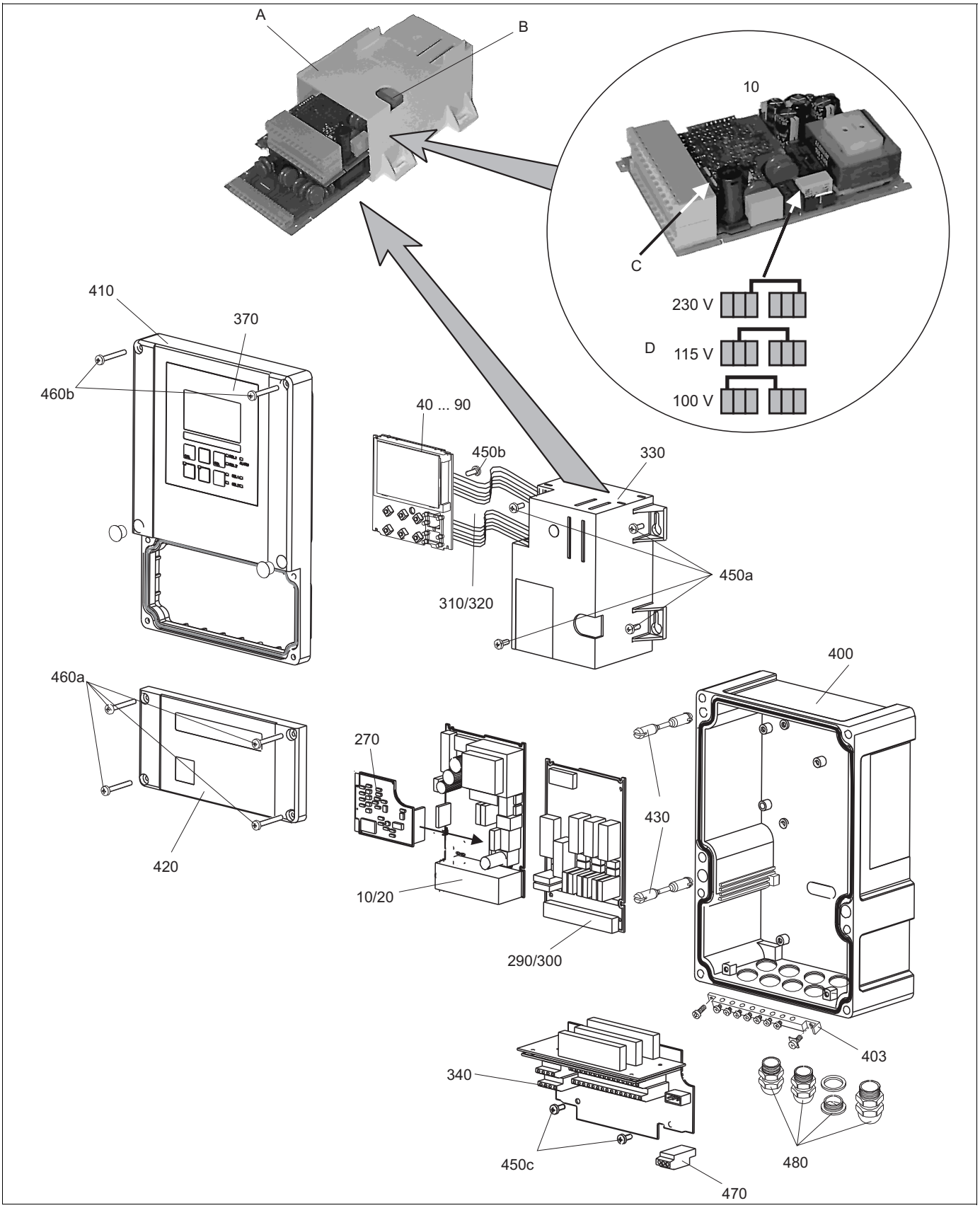


Fig. 40: Exploded view drawing of field instrument

The exploded view drawing contains the components and spare parts of the field device. You can take the spare parts and the corresponding order number from the following section using the item numbers.

Item	Kit description	Name	Function/contents	Order number
10	Power unit (main module)	LSGA	100 / 115 / 230 V AC	51500317
20	Power unit (main module)	LSGD	24 V AC + DC	51500318
40	Central module (controller)	LSCH-S1	1 current output	51501228
50	Central module (controller)	LSCH-S2	2 current outputs	51501229
60	Central module (controller)	LSCH-H1	1 current output + HART	51501230
70	Central module (controller)	LSCH-H2	2 current outputs + HART	51501231
80	Central module (controller)	LSCP	PROFIBUS PA/no current output	51501232
90	Central module (controller)	LSCP-DP	PROFIBUS DP/no current output	51502499
90	Kit CUM2x3 Central module PROFIBUS DP	LSCP-DP	Central module PROFIBUS DP Relay module + 2 relays Current input and terminals valid of: hardware version 3.0	71134728
270	Turbidity transmitter	MKT1	Turbidity + temperature	51501209
290	Relay module	LSR1-2	2 relays	51500320
290	Relay module	LSR2-2i	2 relays + current input 4 to 20 mA	51504304
290	Kit CxM2x3 Relay module PROFIBUS DP		Relay module + 2 relays Current input and terminals DP valid of: hardware version 3.0	71134732
300	Relay module	LSR1-4	4 relays	51500321
300	Relay module	LSR2-4i	4 relays + current input 4 to 20 mA	51504305
310, 320	Ribbon cable lines		2 ribbon cable lines	51501074
330, 340, 450	Internal housing parts		Docking assembly, empty electronics box, small parts	51501073
450a, 450c	Torx screws K4x10		Internal housing parts	
450b	Torx screw for central module		Internal housing parts	
370, 410, 420, 430, 460	Housing cover		Display cover, connection compartment cover, front membrane, hinges, cover screws, small parts	51501068
460a, 460b	Screws for housing cover		Parts of housing cover	
400, 480	Housing base		Base, threaded joints	51501072
430	Hinges		2 pairs of hinges	51501069
470	Terminal strip		Terminal strip for connection to mains	51501079
A	Electronics box with relay module LSR1-x (bottom) and power unit LSGA/LSGD (top)			
B	Fuse also accessible if electronics box installed			
C	Fuse		Part of power unit, item 10	
D	Choice of line voltage		Position of jumper on power unit, item 10 depending on desired line voltage	

9.5.5 Replacing the central module

Note!
Generally, when a central module has been replaced, all data which can be changed are set to the factory setting.

Proceed as described below if a central module is replaced:

1. If possible, note the customized settings of the device, such as:
   – Calibration data
   – Current assignment, main parameter and temperature
   – Relay function selections
   – Limit value/controller settings
   – Cleaning settings
   – Monitoring functions
   – Interface parameters
2. Disassemble the device as explained in the "Dismantling the panel-mounted instrument" or "Dismantling the field instrument" section.
3. Use the part number on the central module to check whether the new module has the same part number as the previous module.
4. Assemble the device with the new module.
5. Start up the device again and check the basic functions (e.g. measured value and temperature display, operation via keyboard).
6. Enter the serial number:
   – Read the serial number (“ser-no.”) on the nameplate of the device.
   – Enter this number in the fields E115 (year, one-digit), E116 (month, one-digit), E117 (consecutive number, four-digit).
   – In the field E118, the complete number is displayed again so you can check it is correct.

   Caution!
   You can only enter the serial number for new modules with the serial number 0000. This can only be done **once**! For this reason, make sure the number entered is correct before you confirm with ENTER!
   Entry of an incorrect code will prevent the additional functions from being enabled. An incorrect serial number can only be corrected at the factory!

   Press ENTER to confirm the serial number or cancel the entry to enter the number again.
7. If available, enter the release codes for the Plus Package and/or Chemoclean in the "Service" menu.
8. Check the Plus Package release (e.g. by opening the function group CHECK / Code P) or the Chemoclean function.
9. Make the customer device settings again.

9.6 Return

If the transmitter has to be repaired, please return it *cleaned* to the sales center responsible. Please add a detailed failure description. If the failure diagnosis is not clear please send also the cable and the sensor.
Please use the original packaging, if possible.

9.7 Disposal

The device contains electronic components and must therefore be disposed of in accordance with regulations on the disposal of electronic waste.
Please observe local regulations.

10 Technical data

10.1 Input

Measured variables

Turbidity, suspended solids, temperature

Measuring range

CUS31:	0.000 to 9999 FNU/NTU 0.00 to 3000 ppm 0.0 to 3.0 g/l 0.0 to 200.0 %
CUS41:	0.00 to 9999 FNU/NTU 0.00 to 9999 ppm 0.0 to 300.0 g/l 0.0 to 200.0 %
Temperature:	-5.0 to +70.0 °C (+23 to +158 °F)

Cable specification

Cable length: max. 200 m (656 ft.)

Signal input

Digital communication

Temperature measurement

NTC 30 kΩ at 25 °C (77 °F)

Binary inputs

Voltage: 10 to 50 V
Power consumption: max. 10 mA

Current input

4 to 20 mA, galvanically separated

Load: 260 Ω at 20 mA (voltage drop 5.2 V)

10.2 Output

Output signal

0/4 to 20 mA, galvanically separated, active

HART	
Signal coding	Frequency Shift Keying (FSK) + 0.5 mA via current output signal
Data transfer rate	1200 Baud
Galvanic isolation	yes

PROFIBUS PA	
Signal coding	Manchester Bus Powered (MBP)
Data transfer rate	31.25 kBit/s, voltage mode
Galvanic isolation	yes (IO-Module)

PROFIBUS DP	
Signal coding	RS485
Data transfer rate	9.6 kBd, 19.2 kBd, 93.75 kBd, 187.5 kBd, 500 kBd, 1.5 MBd
Galvanic isolation	yes (IO-Module)

Signal on alarm	2.4 or 22 mA in case of an error	
Load	maximum 500 Ω	
Transmission range	CUS31/CUS41: Temperature:	adjustable, min. Δ 0.1 FNU, Δ 0.1 ppm, Δ 0.1 g/l, Δ 0.1 % adjustable, Δ 10 to Δ 100 % of measuring range
Resolution	max. 700 digits/mA	
Isolation voltage	max. 350 V_{RMS}/500 V DC	
Overvoltage protection	according to EN 61000-4-5	
Auxiliary voltage output	Output voltage: Output current:	15 V ± 0.6 max. 10 mA
Contact outputs	Switching current with ohmic load (cos φ = 1): Switching current with inductive load (cos φ = 0.4): Switching voltage: Switching power with ohmic load (cos φ = 1): Switching power with inductive load (cos φ = 0.4):	max. 2 A max. 2 A max. 250 V AC, 30 V DC max. 500 VA AC, 60 W DC max. 500 VA AC, 60 W DC
Limit contactor	Pickup/dropout delay:	0 to 2000 s
Controller	Function (adjustable): Controller response: Control gain K_p: Integral action time T_n: Derivative action time T_v: Period for pulse length controller: Frequency for pulse frequency controller: Basic load:	pulse length/pulse frequency controller PID 0.01 to 20.00 0.0 to 999.9 min 0.0 to 999.9 min 0.5 to 999.9 s 60 to 180 min^{-1} 0 to 40% of max. set value
Alarm	Function (selectable): Alarm threshold adjustment range: Alarm delay:	Latching / momentary contact Turbidity / suspended solids / temperature: complete measuring range 0 to 2000 s 0 to 2000 min

Protocol specific data

HART	
Manufacturer ID	11_h
Device type code	0095_h
Transmitter specific revision	0001_h
HART specification	5.0
DD files	www.products.endress.com/profibus
Load HART	250 Ω
Device variables	None (dynamic variables PV, SV, only)
Features supported	-

PROFIBUS PA	
Manufacturer ID	11_h
Ident number	1517_h
Device revision	11_h
Profile version	2.0
GSD files	www.products.endress.com/profibus
GSD file version	
Output values	Main value, temperature value
Input values	Display value of PLC
Features supported	Device locking: The device can be locked by hardware or software.

PROFIBUS DP	
Manufacturer ID	11_h
Ident number	$151F_h$
Profile version	2.0
GSD files	www.products.endress.com/profibus
GSD file version	
Output values	Main value, temperature value
Input values	Display value of PLC
Features supported	Device locking: The device can be locked by hardware or software.

10.3 Power supply

Supply voltage

Depending on ordered version:
100/115/230 V AC +10/-15 %, 48 to 62 Hz
24 V AC/DC +20/-15 %

Fieldbus connection

HART	
Supply voltage	n/a, active current outputs
Integrated reverse voltage protection	n/a, active current outputs

PROFIBUS PA	
Supply voltage	9 V to 32 V, max. 35 V
Polarity sensitive	no
FISCO/FNICO compliant acc. to IEC 60079-27	no

PROFIBUS DP	
Supply voltage	9 V to 32 V, max. 35 V
Polarity sensitive	n/a
FISCO/FNICO compliant acc. to IEC 60079-27	no

Power consumption

max. 7.5 VA

Mains protection

Fine-wire fuse, medium-slow blow 250 V/3.15 A

10.4 Performance characteristics

Measured value resolution

CUS31:	0.001 FNU/NTU, 0.01 ppm, 0.01 g/l, 0.01 %
CUS41:	0.01 FNU/NTU, 0.01 ppm, 0.01 g/l, 0.01 %
Temperature:	0.1 °C

Maximum measured error[1)]

Display	
CUS31/CUS41:	± 2 % of measured value (min. 0.02 FNU)
Temperature:	max. 1.0 % of measuring range
Signal output	
CUS31/CUS41:	1 % of current output range (min. 0.02 FNU)
Temperature:	max. 1.25 % of current output range

Repeatability[2)]

± 1 % of measured value (min. 0.01 FNU)

1) acc. to IEC 746-1, for nominal operating conditions
2) acc. to IEC 746-1, for nominal operating conditions

10.5 Environment

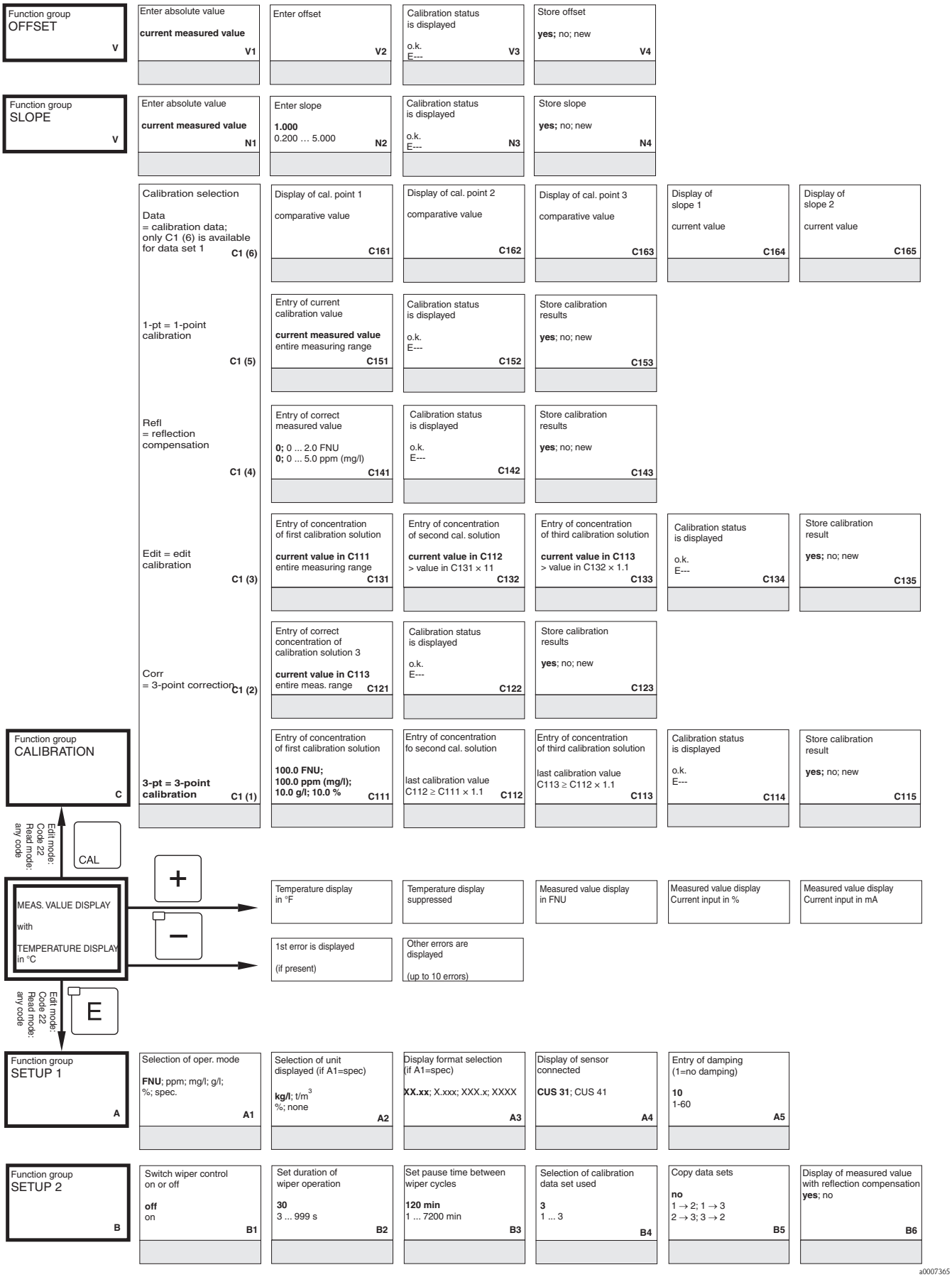
Ambient temperature	–10 to +55 °C (+14 to +131 °F)	
Storage temperature	–25 to +65 °C (-13 to +149 °F)	
Electromagnetic compatibility	Interference emission and interference immunity as per EN 61326-1:2006, EN 61326-2-3:2006	
Ingress protection	Panel mounted instrument: Field instrument:	IP 54 (front), IP 30 (housing) IP 65 / tightness acc. to NEMA 4X
Electrical safety	according EN/IEC 61010-1:2001, Installation Category II, for use up to 2000 m above sea level	
CSA	Apparatus with CSA General Purpose Approval are certified for indoor use.	
Relative humidity	10 to 95%, non-condensing	
Pollution degree	The product is suitable for pollution degree 2.	

10.6 Mechanical construction

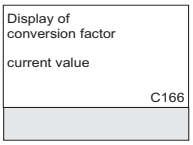
Dimensions	Panel-mounted instrument: Field instrument:	96 x 96 x 145 mm (3.78 x 3.78 x 5.71 inches) Installation depth: approx. 165 mm (6.50") 247 x 170 x 115 mm (9.72 x 6.69 x 4.53 inches)
Weight	Panel-mounted instrument: Field instrument:	max. 0.7 kg (1.5 lb) max. 2.3 kg (5.1 lb)
Material	Housing of panel-mounted instrument: Field housing: Front membrane:	Polycarbonate ABS PC Fr Polyester, UV-resistant
Terminals	Cross section	max. 2.5 mm^2 (14 AWG)

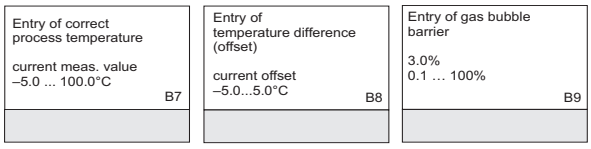
11 Appendix

Operating matrix

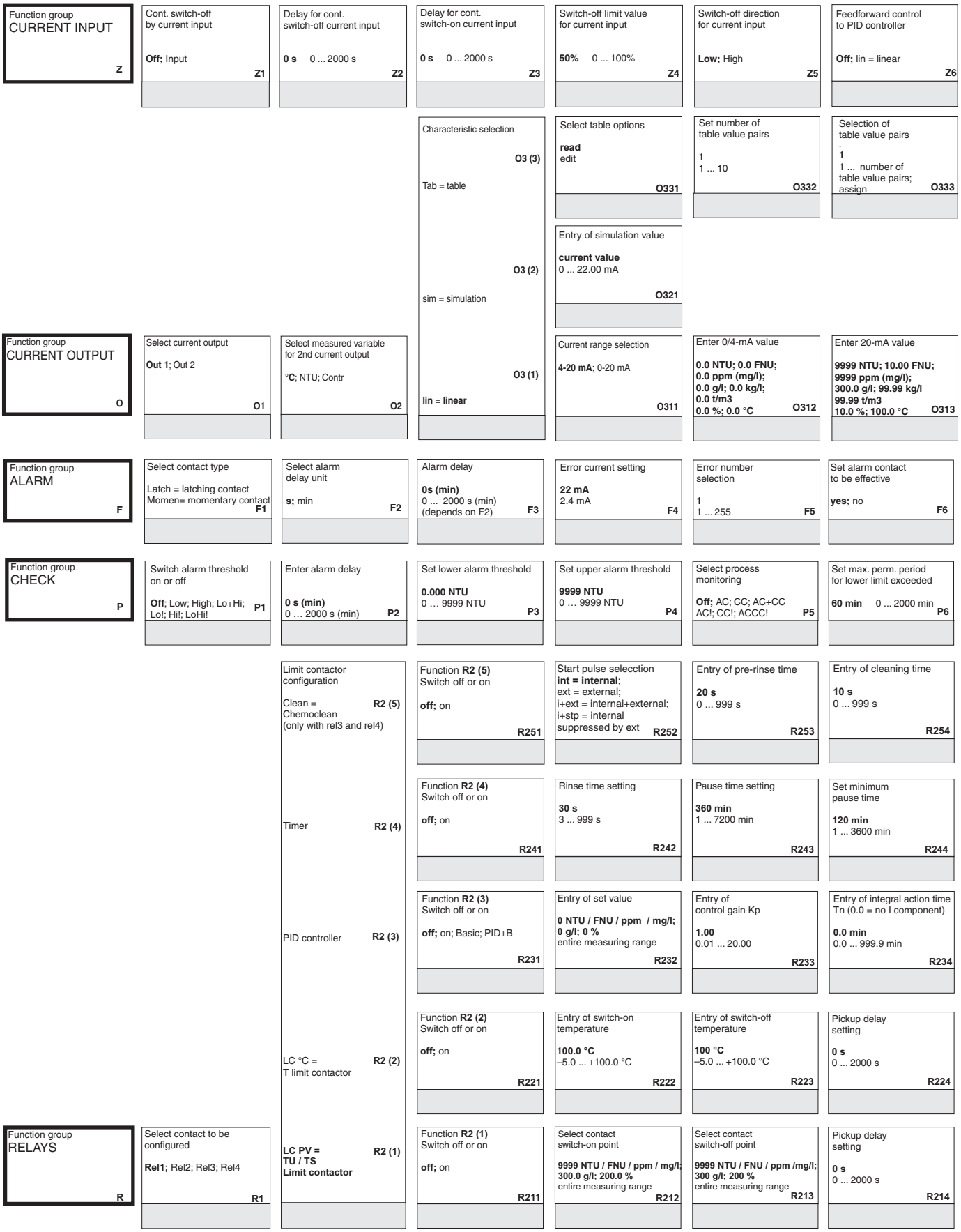


a0007365


Display of
conversion factor
current value
C166


Entry of correct
process temperature
current meas. value
–5.0 ... 100.0°C
B7
Entry of
temperature difference
(offset)
current offset
–5.0...5.0°C
B8
Entry of gas bubble
barrier
3.0%
0.1 … 100%
B9

a0007366


Function group CURRENT INPUT Z
Cont. switch-off by current input
Off; Input
Z1
Delay for cont. switch-off current input
0 s 0 ... 2000 s
Z2
Delay for cont. switch-on current input
0 s 0 ... 2000 s
Z3
Switch-off limit value for current input
50% 0 ... 100%
Z4
Switch-off direction for current input
Low; High
Z5
Feedforward control to PID controller
Off; lin = linear
Z6
Characteristic selection
O3 (3)
Tab = table
O3 (2)
sim = simulation
O3 (1)
lin = linear
Select table options
read
edit
O331
Set number of table value pairs
1
1 ... 10
O332
Selection of table value pairs
1
1 ... number of table value pairs; assign
O333
Entry of simulation value
current value
0 ... 22.00 mA
O321
Function group CURRENT OUTPUT O
Select current output
Out 1; Out 2
O1
Select measured variable for 2nd current output
°C; NTU; Contr
O2
Current range selection
4-20 mA; 0-20 mA
O311
Enter 0/4-mA value
0.0 NTU; 0.0 FNU;
0.0 ppm (mg/l);
0.0 g/l; 0.0 kg/l;
0.0 t/m3
0.0 %; 0.0 °C
O312
Enter 20-mA value
9999 NTU; 10.00 FNU;
9999 ppm (mg/l);
300.0 g/l; 99.99 kg/l
99.99 t/m3
10.0 %; 100.0 °C
O313
Function group ALARM F
Select contact type
Latch = latching contact
Momen= momentary contact
F1
Select alarm delay unit
s; min
F2
Alarm delay
0s (min)
0 ... 2000 s (min)
(depends on F2)
F3
Error current setting
22 mA
2.4 mA
F4
Error number selection
1
1 ... 255
F5
Set alarm contact to be effective
yes; no
F6
Function group CHECK P
Switch alarm threshold on or off
Off; Low; High; Lo+Hi; Lo!; Hi!; LoHi!
P1
Enter alarm delay
0 s (min)
0 ... 2000 s (min)
P2
Set lower alarm threshold
0.000 NTU
0 ... 9999 NTU
P3
Set upper alarm threshold
9999 NTU
0 ... 9999 NTU
P4
Select process monitoring
Off; AC; CC; AC+CC
AC!; CC!; ACCC!
P5
Set max. perm. period for lower limit exceeded
60 min 0 ... 2000 min
P6
Limit contactor configuration
Clean = Chemoclean
(only with rel3 and rel4)
R2 (5)
Function R2 (5)
Switch off or on
off; on
R251
Start pulse selecction
int = internal;
ext = external;
i+ext = internal+external;
i+stp = internal suppressed by ext
R252
Entry of pre-rinse time
20 s
0 ... 999 s
R253
Entry of cleaning time
10 s
0 ... 999 s
R254
Timer
R2 (4)
Function R2 (4)
Switch off or on
off; on
R241
Rinse time setting
30 s
3 ... 999 s
R242
Pause time setting
360 min
1 ... 7200 min
R243
Set minimum pause time
120 min
1 ... 3600 min
R244
PID controller
R2 (3)
Function R2 (3)
Switch off or on
off; on; Basic; PID+B
R231
Entry of set value
0 NTU / FNU / ppm / mg/l;
0 g/l; 0 %
entire measuring range
R232
Entry of control gain Kp
1.00
0.01 ... 20.00
R233
Entry of integral action time Tn (0.0 = no I component)
0.0 min
0.0 ... 999.9 min
R234
LC °C =
T limit contactor
R2 (2)
Function R2 (2)
Switch off or on
off; on
R221
Entry of switch-on temperature
100.0 °C
–5.0 ... +100.0 °C
R222
Entry of switch-off temperature
100 °C
–5.0 ... +100.0 °C
R223
Pickup delay setting
0 s
0 ... 2000 s
R224
Function group RELAYS R
Select contact to be configured
Rel1; Rel2; Rel3; Rel4
R1
LC PV =
TU / TS
Limit contactor
R2 (1)
Function R2 (1)
Switch off or on
off; on
R211
Select contact switch-on point
9999 NTU / FNU / ppm / mg/l;
300.0 g/l; 200.0 %
entire measuring range
R212
Select contact switch-off point
9999 NTU / FNU / ppm /mg/l;
300 g/l; 200 %
entire measuring range
R213
Pickup delay setting
0 s
0 ... 2000 s
R214

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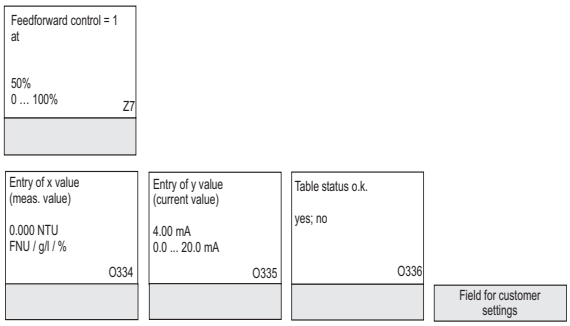
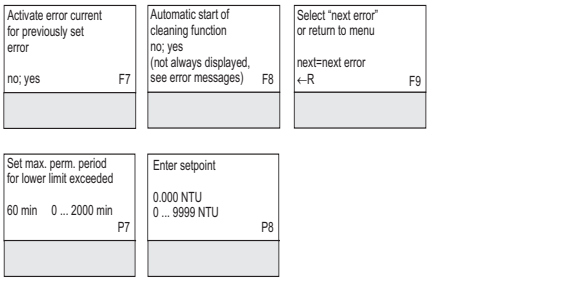
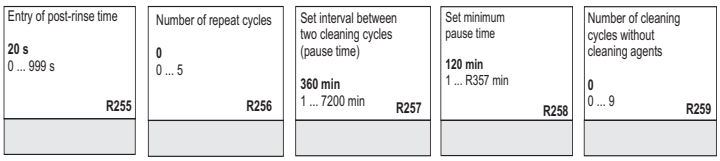
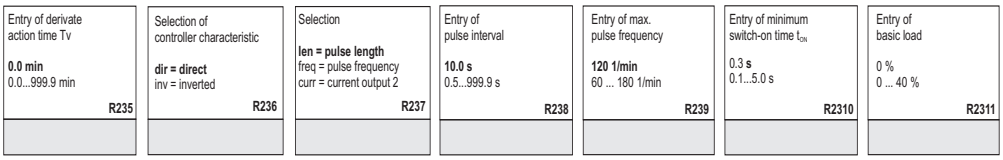
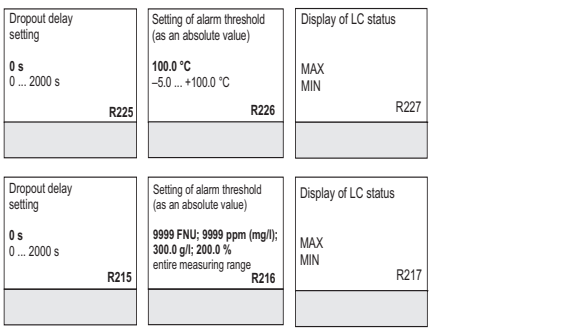

Feedforward control = 1
at
50%
0 ... 100%
Z7
Entry of x value
(meas. value)
0.000 NTU
FNU / g/l / %
O334
Entry of y value
(current value)
4.00 mA
0.0 ... 20.0 mA
O335
Table status o.k.
yes; no
O336
Field for customer settings

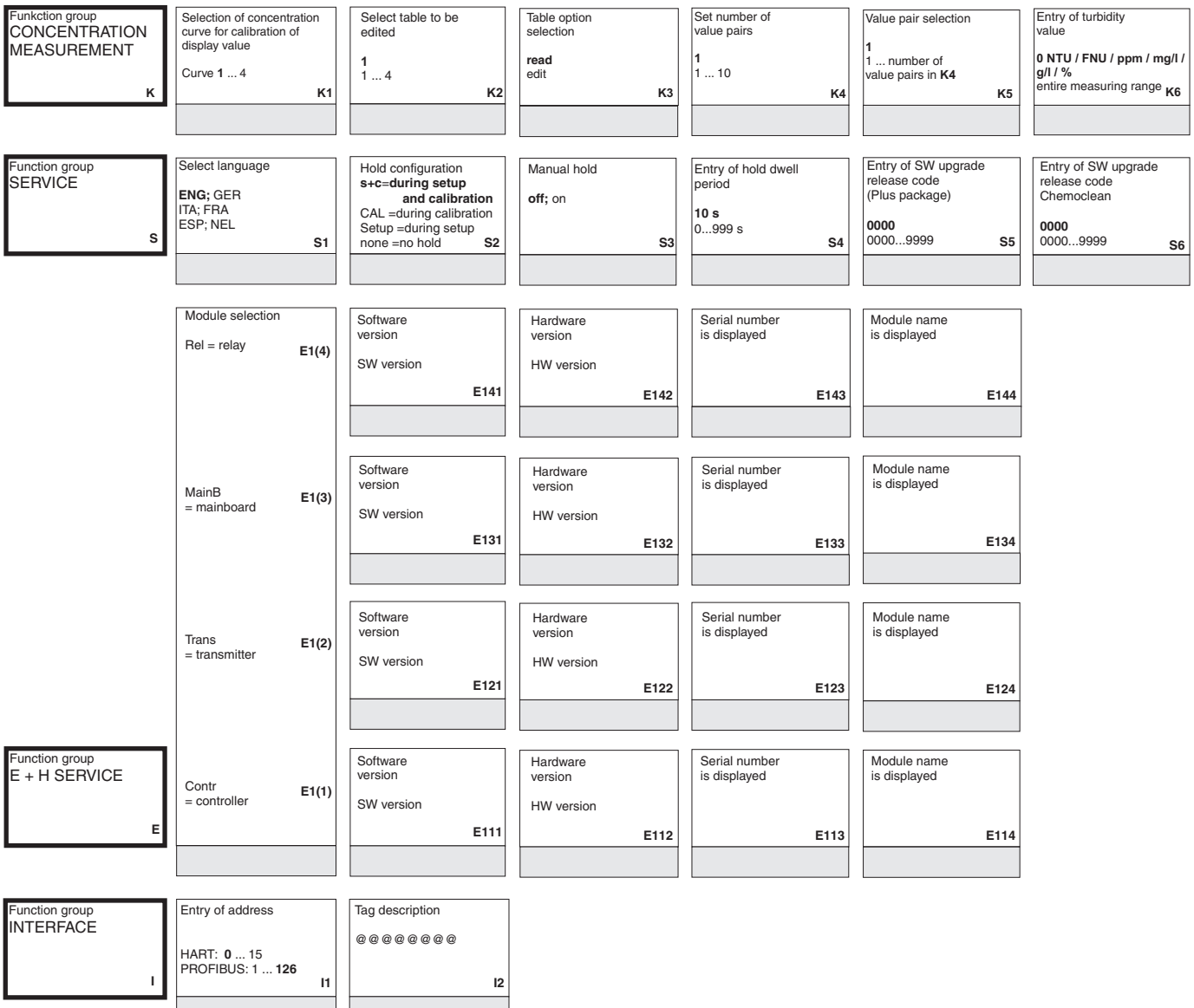

Activate error current
for previously set
error
no; yes
F7
Automatic start of
cleaning function
no; yes
(not always displayed,
see error messages)
F8
Select "next error"
or return to menu
next=next error
←R
F9
Set max. perm. period
for lower limit exceeded
60 min 0 ... 2000 min
P7
Enter setpoint
0.000 NTU
0 ... 9999 NTU
P8


Entry of post-rinse time
20 s
0 ... 999 s
R255
Number of repeat cycles
0
0 ... 5
R256
Set interval between
two cleaning cycles
(pause time)
360 min
1 ... 7200 min
R257
Set minimum
pause time
120 min
1 ... R357 min
R258
Number of cleaning
cycles without
cleaning agents
0
0 ... 9
R259

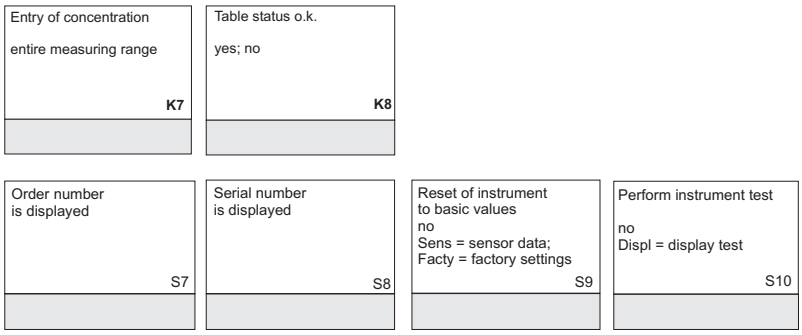

Entry of derivate
action time Tv
0.0 min
0.0...999.9 min
R235
Selection of
controller characteristic
dir = direct
inv = inverted
R236
Selection
len = pulse length
freq = pulse frequency
curr = current output 2
R237
Entry of
pulse interval
10.0 s
0.5...999.9 s
R238
Entry of max.
pulse frequency
120 1/min
60 ... 180 1/min
R239
Entry of minimum
switch-on time t_{ON}
0.3 s
0.1...5.0 s
R2310
Entry of
basic load
0 %
0 ... 40 %
R2311


Dropout delay
setting
0 s
0 ... 2000 s
R225
Setting of alarm threshold
(as an absolute value)
100.0 °C
–5.0 ... +100.0 °C
R226
Display of LC status
MAX
MIN
R227
Dropout delay
setting
0 s
0 ... 2000 s
R215
Setting of alarm threshold
(as an absolute value)
9999 FNU; 9999 ppm (mg/l);
300.0 g/l; 200.0 %
entire measuring range
R216
Display of LC status
MAX
MIN
R217

a0007368


Funktion group
CONCENTRATION MEASUREMENT
K
Selection of concentration curve for calibration of display value
Curve **1** ... 4
K1
Select table to be edited
1
1 ... 4
K2
Table option selection
read
edit
K3
Set number of value pairs
1
1 ... 10
K4
Value pair selection
1
1 ... number of value pairs in **K4**
K5
Entry of turbidity value
0 NTU / FNU / ppm / mg/l / g/l / %
entire measuring range
K6
Function group
SERVICE
S
Select language
ENG; GER
ITA; FRA
ESP; NEL
S1
Hold configuration
s+c=during setup and calibration
CAL =during calibration
Setup =during setup
none =no hold
S2
Manual hold
off; on
S3
Entry of hold dwell period
10 s
0...999 s
S4
Entry of SW upgrade release code (Plus package)
0000
0000...9999
S5
Entry of SW upgrade release code Chemoclean
0000
0000...9999
S6
Module selection
Rel = relay
E1(4)
Software version
SW version
E141
Hardware version
HW version
E142
Serial number is displayed
E143
Module name is displayed
E144
MainB = mainboard
E1(3)
Software version
SW version
E131
Hardware version
HW version
E132
Serial number is displayed
E133
Module name is displayed
E134
Trans = transmitter
E1(2)
Software version
SW version
E121
Hardware version
HW version
E122
Serial number is displayed
E123
Module name is displayed
E124
Function group
E + H SERVICE
E
Contr = controller
E1(1)
Software version
SW version
E111
Hardware version
HW version
E112
Serial number is displayed
E113
Module name is displayed
E114
Function group
INTERFACE
I
Entry of address
HART: **0** ... 15
PROFIBUS: 1 ... **126**
I1
Tag description
@@@@@@@@
I2

a0007369


Entry of concentration
entire measuring range
K7
Table status o.k.
yes; no
K8
Order number
is displayed
S7
Serial number
is displayed
S8
Reset of instrument
to basic values
no
Sens = sensor data;
Facty = factory settings
S9
Perform instrument test
no
Displ = display test
S10

a0007370

Index

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People for Process Automation

BA200C/07/EN/13.11
FM+SGML 6.0

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