Series 298

ANALOG MEASURING TRANSMITTERS PH 298, LF 298, OXI 298, CL 298
FOR pH/ORP, CONDUCTIVITY, OXYGEN AND CHLORINE

a **xylem** brand

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1   Overview

The analog measuring transmitters of the series 298 (pH 298, LF 298, Oxi 298, Cl 298) are an economical and technically flexible solution for measuring and (feedback) control tasks in field operation.

Due to the galvanically insulated outputs, the robust measuring transmitters (aluminum enclosure, protective class IP 65) feature a high operational safety.

Sensors   Each measuring transmitter of the series 298 processes the signal of a connected electrochemical sensor.

If the connected sensor does not have an integrated temperature sensor, an external temperature probe can be connected for temperature compensation and temperature measurement.
Depending on the model of the measuring transmitter, a type NTC, Pt100 or Pt1000 temperature probe is suitable.

Relay and current outputs   Measuring transmitters of the series 298 have two potential free relay outputs and two separate current outputs.

A relay output can be programmed as:

● Limiting value signal

● Timer

● PID controller (pulse duration controller)

One current output can be programmed as:

● Analog output

● PID controller (analog controller)

The states of all relay and current outputs are shown on the display.

Output of measurement data   The measurement data are displayed on the high-contrast OLED display and automatically stored in the internal data logger.

For further processing (e.g. by a process control system), the measurement data can be output with the serial communication interface RS485/Modbus.

2 Safety

2.1 Safety information

2.1.1 Safety information in the operating manual

This operating manual provides important information on the safe operation of the product. Read this operating manual thoroughly and make yourself familiar with the product before putting it into operation or working with it. The operating manual must be kept in the vicinity of the product so you can always find the information you need.

Important safety instructions are highlighted in this operating manual. They are indicated by the warning symbol (triangle) in the left column. The signal word (e.g. "CAUTION") indicates the level of danger:

WARNING
indicates a possibly dangerous situation that can lead to serious (irreversible) injury or death if the safety instruction is not followed.

CAUTION
indicates a possibly dangerous situation that can lead to slight (reversible) injury if the safety instruction is not followed.

NOTE
indicates a situation where goods might be damaged if the actions mentioned are not taken.

2.1.2 Safety signs on the product

Note all labels, information signs and safety symbols on the product. A warning symbol (triangle) without text refers to safety information in this operating manual.

2.1.3 Further documents providing safety information

The following documents provide additional information, which you should observe for your safety when working with the measuring system:

● Operating manuals of other components (e.g. sensors)

● Safety datasheets of calibration and maintenance equipment (e.g. cleaning solutions).

2.2   Safe operation

2.2.1   Authorized use

The authorized use of the measuring transmitter consists of its use in online analysis. Only the operation and running of the sensor according to the instructions and technical specifications given in this operating manual is authorized (see chapter 9 TECHNICAL DATA). Any other use is considered unauthorized.

2.2.2   Requirements for safe operation

Note the following points for safe operation:

● The product may only be operated according to the authorized use specified above.

● The product may only be supplied with power by the energy sources mentioned in this operating manual.

● The product may only be operated under the environmental conditions mentioned in this operating manual.

● The product must not be opened.

2.2.3   Unauthorized use

The product must not be put into operation if:

● it is visibly damaged (e.g. after being transported)

● it was stored under adverse conditions for a lengthy period of time (storing conditions, see chapter 9 TECHNICAL DATA).

2.3   User qualification

Target group   The measuring transmitter has been developed for online analysis. Some maintenance activities, e.g. changing the membrane caps in D.O. sensors, require the safe handling of chemicals. Thus, we assume that the maintenance personnel is familiar with the necessary precautions to take when dealing with chemicals as a result of their professional training and experience.

Special user qualifications   The following installation activities may only be performed by a qualified electrician:

● Connection to power supply.

● Connecting external, line voltage-carrying circuits to relay contacts.

3   Installation

3.1   Scope of delivery

The following parts are included in the scope of delivery:

● a measuring transmitter of the series 298 (e.g. pH 298, LF 298, Oxi 298, Cl 298)

● Option:
  Mounting plate with preassembled measuring transmitter

● Operating manual.

3.2   Basic principles of installation

3.2.1   Requirements of the measurement location

The measurement location must meet the environmental conditions specified in section 9 TECHNICAL DATA.

The measuring transmitter is designed for operation in an environment protected against moisture.

3.3   Safety requirements of the electrical installation

Electrical equipment (such as motors, contactors, cables, lines, relays, switches, instruments) must meet the following requirements:

● Compliance with national regulations (e.g. NEC, VDE and IEC)

● Suitability for the electrical conditions at the place of installation

  – Maximum operational voltage

  – Maximum operating current

● Suitability for the ambient conditions at the place of installation

  – Temperature resistance (minimum and maximum temperature)

  – Protection against water and dust (Nema or IP type of protection).

● Suitable fuse protection of the electrical circuit

  – Overcurrent protection devices
    (according to the technical data of the instrument input or output)

  – Overvoltage limitations of overvoltage category II

● Suitable external separator (e.g. switch or circuit-breaker) for the power supply of permanently installed instruments with separate power connection

  – compliant with the following regulations
    - IEC 60947-1
    - IEC 60947-3

–   in the vicinity of the instrument (recommendation)

● Fire resistant (cables and lines),
   compliant with the following regulations

–   UL 2556 VW-1 (for USA, Canada)

–   IEC 60332-1-2 (outside the USA, Canada)

3.4   Wall mounting of the measuring transmitter

For wall mounting there are bore holes in the enclosure bottom of the measuring transmitter.

The bore hole spacings are given in the dimensional drawing in the chapter technical data.

For wall mounting use the material (screws, screw anchors, etc.) suitable for the condition of the wall.

> Wall mounting must be done according to DIN standard, i.e. the mounting must be able to hold the 4-fold weight of the instrument (see chapter 9 TECHNICAL DATA).

3.5   Mounting the mounting plate (optional)

Only for scopes of delivery with mounting plate.

The base plate has four bore holes at the corners so it can be fixed to a wall. Make sure that the wall is stable enough to hold the weight of the drinking water plate. Only use mounting material suitable for the wall material (screws, screw anchors, etc.). The bore hole spacings are shown in the following figure:

20 mm   ←— 310 mm —→   20 mm

20 mm   20 mm

Diameter of the bore
holes 8.5 mm

Rear distance to the
wall 20 mm. Use the
enclosed distance
bolts

1060 mm

20 mm   20 mm

20 mm   20 mm
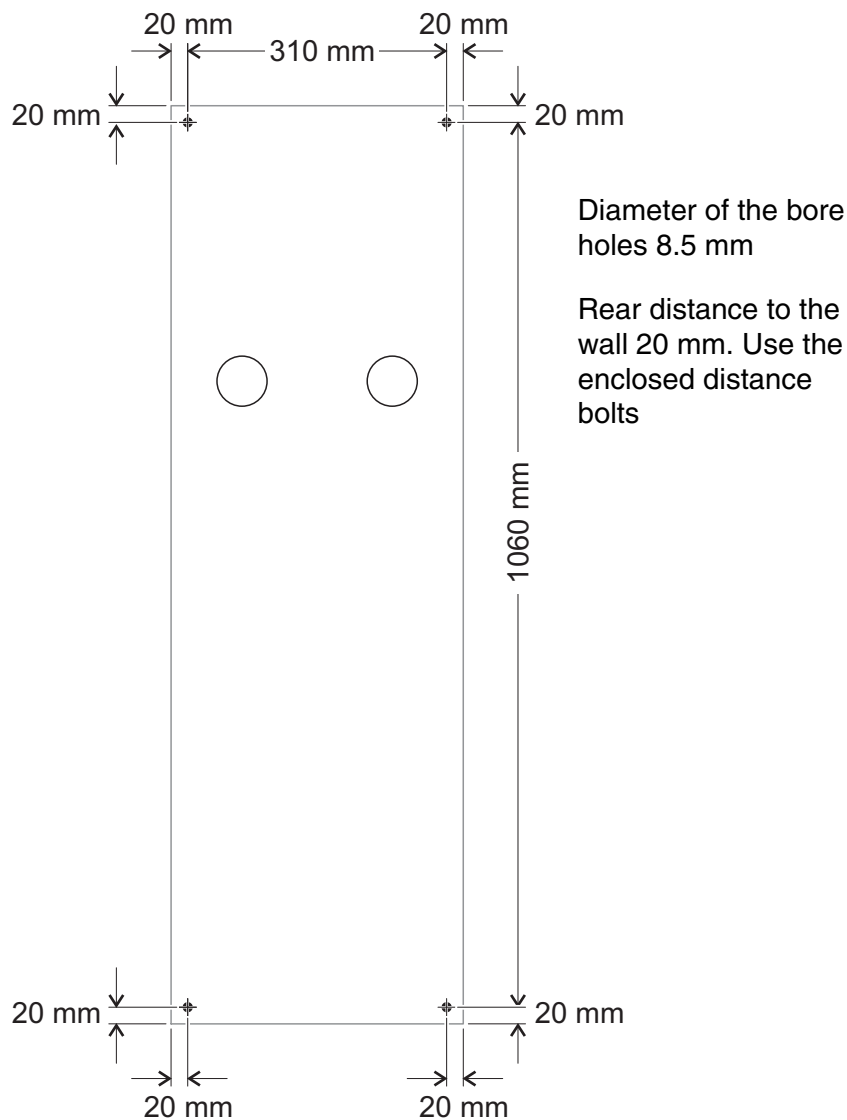
figure 3-1 Bore hole spacings for the drinking water plate (dimensions in mm)

Make sure that there is enough room under the drinking water plate
so the sample inlet and outlet can be connected, and that the display
of the measuring transmitter is easily accessible and clearly legible.

3.6   Connecting the sensor

The sensor is connected to the sensor connectors (X4.8 ... X4.11) of the
measuring transmitter.
An additional external temperature probe is connected to the connectors X4.3
to X4.6.

Suitable sensors	**Measuring transmitter type**	**Requirements**
	pH 298	Combination electrodes or separated electrodes
	LF 298 Oxi 298	Integrated temperature sensor
	Cl 298	Sensor with current output

Maximum cable length (sensor cable)	**Sensor type**	**max. cable length**
	Potentiometric sensors (pH/ORP)	10 m (without impedance converter)
	Conductometric measuring cells (conductivity)	20 m
	Amperometric sensors (chlorine)	

More detailed information is given in the datasheets and technical notes of the sensors.

General installation instructions

Always install the wires with a minimum distance of 20 cm from any other wires carrying a voltage of more than 60 V.

The free end of the sensor cable is stripped of insulation and all wires are equipped with wire end sleeves in the factory.

Tools
- Phillips screwdriver
- Small screwdriver.

NOTE
The sensor cable may only be connected to the sensor connectors (X4.8 ... X4.11). No wire of the cable may be connected with an external electrical potential. Otherwise, malfunctions could occur.

1   Remove the cover on the left and right-hand side of the measuring transmitter.

2   Remove two cross-head screws each on the left and right-hand side of the measuring transmitter.

3   Tilt down the front of the enclosure.

figure 3-2 Terminal assignment of the measuring transmitter (front, tilted downward)

1 Power supply,
   connection to the power supply in the enclosure bottom (**X1**.1-3)

2 Relay (**X2**.1-6)

3 Output (**X3**.1-3)
   Modbus (**X3**.4-6)

4 Temperature sensor (**X4**.3-6)
   Sensor (**X4**.8-11)
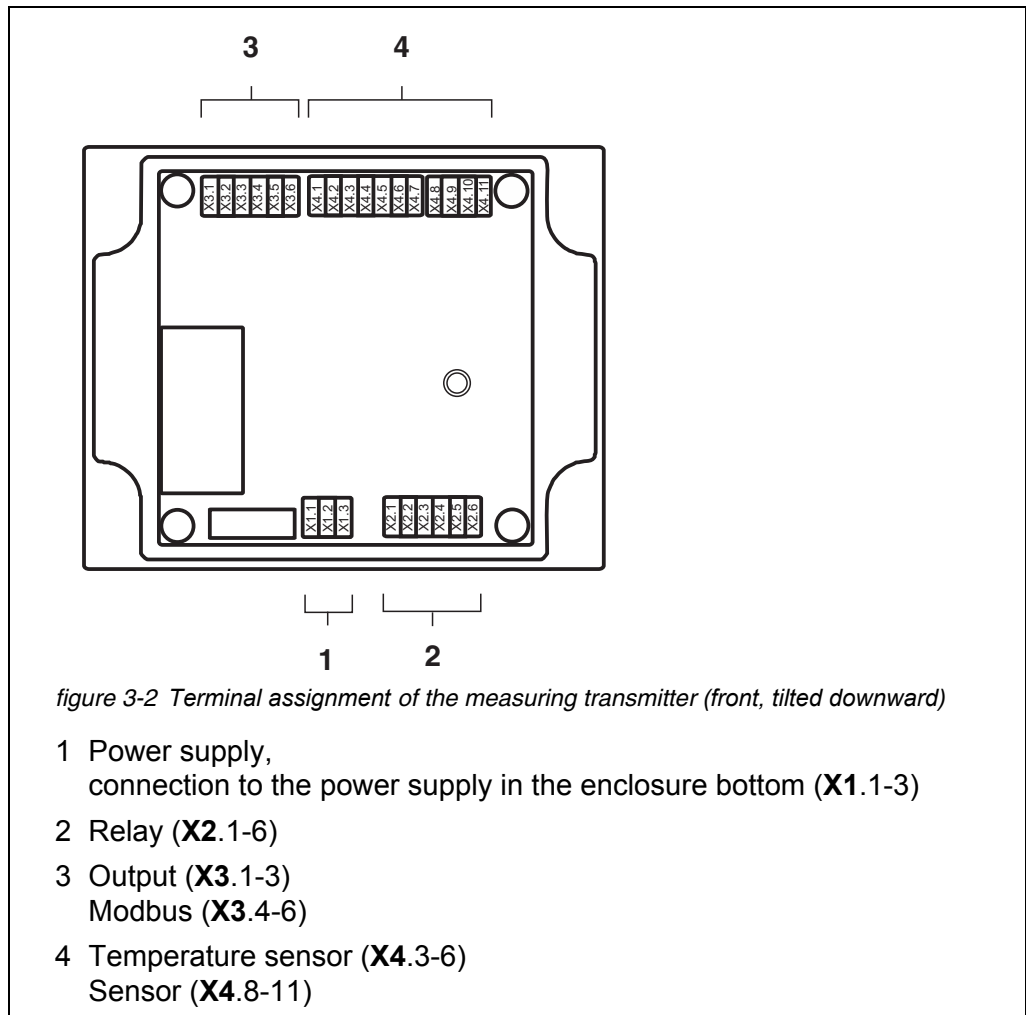
4   Loosen the coupling ring of the cable gland at the position for the sensor
     connector (X4.8 ... 12) on the enclosure.

5   If an external temperature probe is connected:
     Loosen the coupling ring of the cable gland at the position for the
     temperature probe (X4.3 ... 6) on the enclosure.

6   Through the cable gland, insert into the enclosure the sensor cable and/
     or the cable for the temperature probe.

7   Connect the cable ends to the terminal strip. When doing so, follow the
     designations of the terminals.

The assignment of the sensor cables to the terminals is listed in
detail for the different sensor types (see section 3.7).

8   Tighten the coupling rings for sensor and temperature probe.

9   Close the enclosure.

10   Reinstall the cover on the left and right-hand side of the measuring
        transmitter.

For instructions on how to mount the sensor at the site of operation
(e.g. depth of immersion etc..) please refer to the relevant sensor
operating manual.

3.7   Connection diagram for sensors

3.7.1   Connection diagram for WTW sensors

pH/ORP electrodes or armatures	Adapter required	Wire colors	Terminal designation
SensoLyt® 650-7	no	White	X4.3
		Brown	X4.5
		Yellow + green	X4.8
		Transparent	X4.10
L9090 SE DW EC Pt	AS 9_HI-xx	Yellow (shield)	X4.8
		Transparent (inner conductors)	X4.10
PL 80-120pH PL 80-225pH PL 89-225Pt	AS 9_HI-xx	Yellow (shield)	X4.8
		Transparent (inner conductors)	X4.10
PL 81-225pHT VP	VP 6-19/xx	White	X4.3
		Green	X4.5
		gray/brown	X4.7
		Blue or yellow	
		Copper + yellow/green	X4.8
		Transparent/white	X4.10

pH/ORP electrodes or arma-tures	Adapter required	Wire colors	Terminal designation
PL 82-225pHT VP	VP 6-19/xx	White	X4.3
		gray/brown	X4.4
		Green	X4.5
PL 82-120pHT VP		Blue or yellow	X4.7
		Copper + yellow/green	X4.8
		Transparent/white	X4.10

Conductivity measuring cell	Adapter required	Wire colors	Terminal designation
LRD 01	ADA/AMPH-LF	White	X4.3
		Brown	X4.5
		Black	X4.7
LRD 325		Yellow	X4.8
		Green	X4.9
		Pink	X4.10
		Gray	X4.11
LR 325/01 and 001	ADA/LAB-LF	White	X4.3
		Brown	X4.5
		Black	X4.7
TetraCon® 325(/C)		Yellow	X4.8
		Green	X4.9
		Pink	X4.10
		Gray	X4.11
TetraCon® DU/T(H)	ADA/LAB-LF with KKDU 325	White	X4.3
		Brown	X4.5
		Black	X4.7
		Yellow	X4.8
		Green	X4.9
		Pink	X4.10
		Gray	X4.11

Oxygen sensors	Adapter required	Wire colors	Terminal designation
TriOxmatic® 690/701/702	ADA/AMPH	Pink	X4.3
		black/gray	X4.5
		blue	X4.7
		Yellow	X4.8
		Brown	X4.9
		White	X4.10
		Green	X4.11

Chlorine sensors	Adapter required	Wire colors	Terminal designation
FCML 68/412 (N) and TCML (N)	AK-Cl 298	Black (+)	X4.10
		Brown (-)	X4.11

3.7.2   Connection diagram for temperature probe

figure 3-3 Three-wire circuit / two-wire circuit
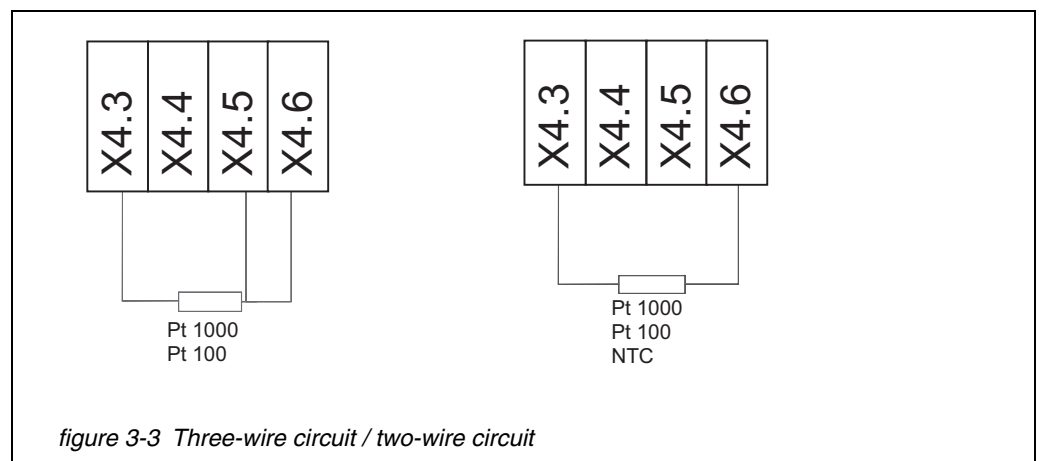
3.7.3   Connection diagram for other sensors

pH/ORP electrode
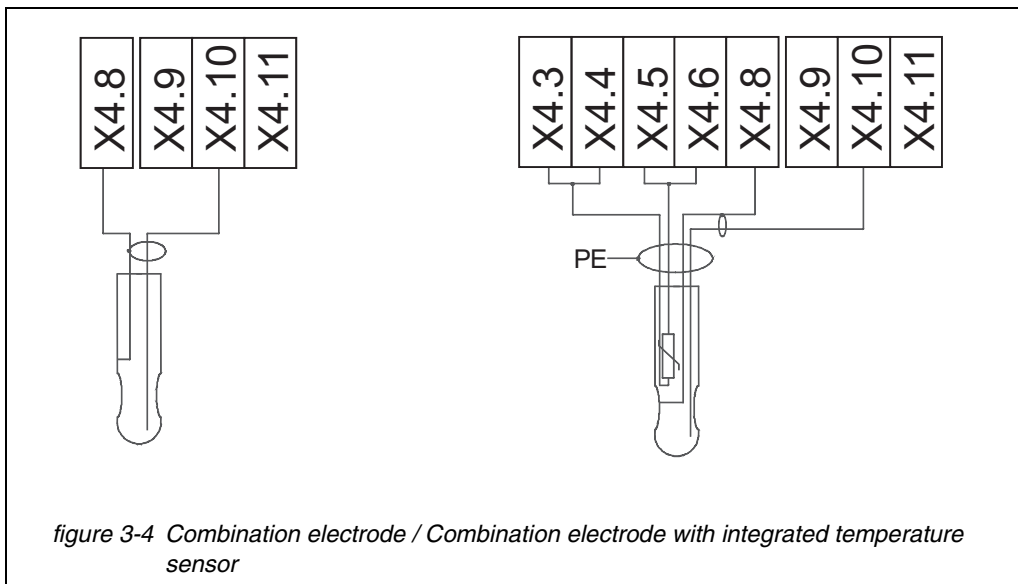
figure 3-4 Combination electrode / Combination electrode with integrated temperature sensor

Conductivity measuring cell

figure 3-5 2-electrode measuring cell / 4-electrode measuring cell

1 Measuring electrode

2 Feed electrode

3 Feed electrode

4 Measuring electrode

Oxygen sensor

figure 3-6 Membrane-covered amperometric oxygen sensor

1 Cathode

2 Anode

Chlorine measuring cell

figure 3-7 Measuring cell for disinfectant (chlorine)
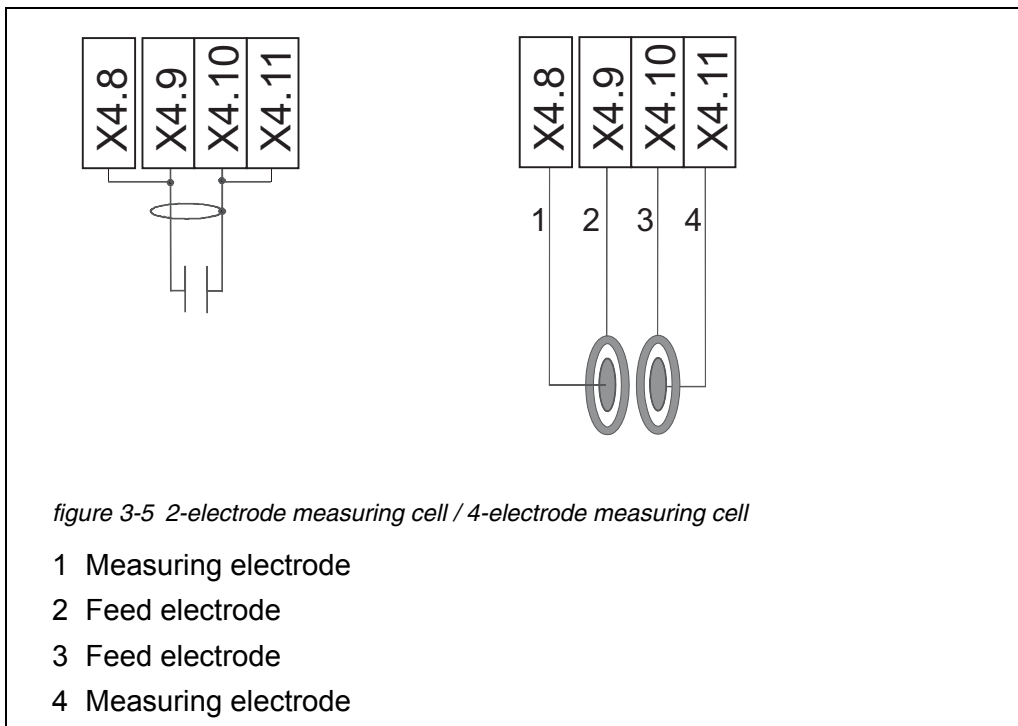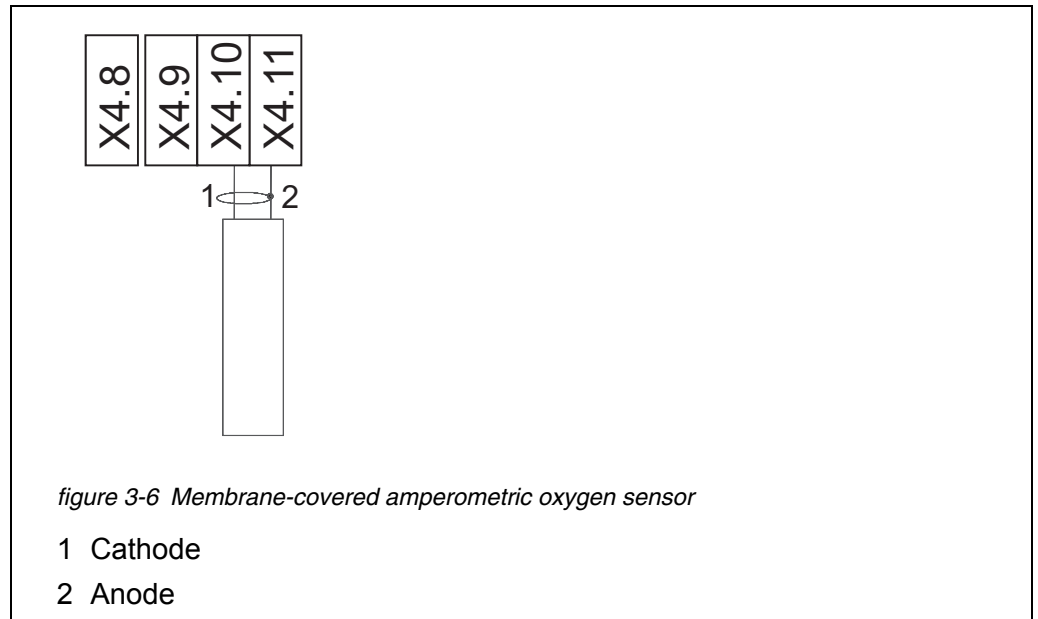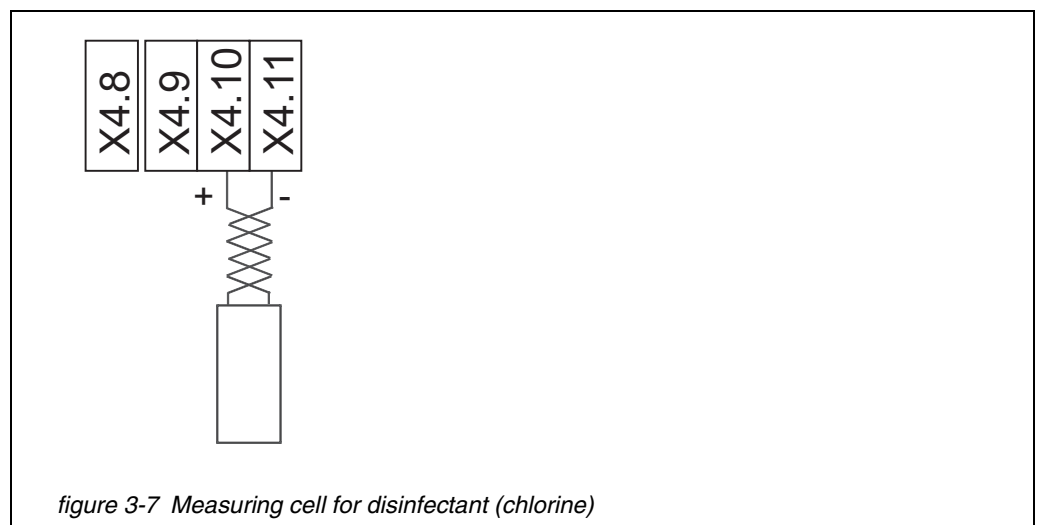
3.8   Connections (relays, current outputs, Modbus)

3.8.1   General installation instructions

WARNING

If external electrical circuits that are subject to the danger of physical contact are incorrectly connected to the relay contacts, there may be a danger of life threatening electric shock. Electrical circuits are regarded to be subject to the danger of physical contact when there are voltages higher than the Safety Extra Low Voltage (SELV).

Pay attention to the following points during installation:

● **Electrical circuits subject to the danger of physical contact must only**

be connected by a qualified electrician.

● **Electrical circuits subject to the danger of physical contact must only be connected when they are voltage-free.**

● **If electrical circuits subject to the danger of physical contact are switched with a relay, no circuit that is not subject to this danger may be operated on the further relays.**

● **Switching voltages and switching currents on the relay contacts must not exceed the values specified in chapter 9 TECHNICAL DATA. Protect electrical circuits against currents that are too high with an electrical fuse.**

● **Only single-phase loads may be switched with the relays. By no means may multi-phase loads be switched with the aid of several relays (example: three-phase current-driven pump). Always use a protective relay to switch multi-phase loads.**

● **After the measuring transmitter has been installed, it may only be opened if all external voltages have been switched off beforehand.**

Materials required   ● Wire end sleeves, suitable for the wires, with suitable crimping tool

Tools   ● Cable stripping knife

● Wire stripper

● Phillips screwdriver

● Small screwdriver

Connecting the wires to the terminal strip

1   Remove the cover on the left and right-hand side of the measuring transmitter.

2   Remove the two screws on the left and right-hand side of the enclosure of the measuring transmitter.

3   Tilt down the front of the enclosure.

4   Loosen the coupling ring of the cable gland at the position for the relay connection (X2.1 ... 6) on the enclosure.

*figure 3-8 Terminal assignment: Connection for relays, current outputs and Modbus
            (enclosure lid, rear side)*

1 **X2**.1: Relay 2: Normally closed
   X2.2: Relay 2: Changeover contact (max. 250 V AC / 5 A)
   X2.3: Relay 2: Normally open
   X2.4: Relay 1: Normally closed
   X2.5: Relay 1: Changeover contact (max. 250 V AC / 5 A)
   X2.6: Relay 1: Normally open

2 **X3**.1: Output: GND
   X3.2: Output 1: 0/4 ... 20 mA in relation to GND
   X3.3: Output 2: 0/4 ... 20 mA in relation to GND

3 **X3**.4: RS485 / Modbus: A (+)
   X3.5: RS485 / Modbus: B (-)
   X3.6: RS485 / Modbus: GND

5   Feed the line into the enclosure through the cable gland.

6   Connect the wires to the terminal strip. When doing so, note the
       specifications on the label under the terminal strip.

7   Tighten the coupling ring of the cable gland for the power line on the
       enclosure.

WARNING
**No free wires are allowed to project into the housing. Otherwise, there is a
danger that areas safe to contact could come into contact with dangerous
voltages. This could result in life threatening electric shock when working
with the measuring transmitter. Always cut off any wires that are not in use
as closely as possible to the cable gland.**

8   Close the enclosure.

9   Reinstall the cover on the left and right-hand side of the measuring
        transmitter.

3.9   Electrical connections: General instructions

Cable glands   All electric cables are fed from below via prepared openings in the enclosure of
the measuring transmitter. Cable glands are premounted for tightening pur-
poses between the cable and enclosure and for strain relief.

General instal-   Observe the following points when attaching connecting wires to the terminal
lation instructions   strip:

● Shorten all wires to be used to the length required for the installation

● Always fit all the ends of the wires with wire end sleeves before connecting
  them to the terminal strip

● Any wires that are not used and project into the enclosure must be cut off as
  closely as possible to the cable gland.

● Screw a small cable gland with sealing ring into each remaining free opening
  and close it with a blind plug.

WARNING
**No free wires are allowed to project into the housing. Otherwise, there is a
danger that areas safe to contact could come into contact with dangerous
voltages. This could result in life threatening electric shock when working
with the measuring transmitter. Always cut off any wires that are not in use
as closely as possible to the cable gland.**

3.10   Connecting the voltage supply

The measuring transmitters are supplied without power connection cable. A
module in the lower instrument part preinstalled by the manufacturer enables
the cabling! The requirements of the power cable to be used for permanent
installation are given in the chapter Technical data. For permanent installation,
a power disconnecter / circuit fuse protection is additionally required. This fuse
protection should be no more than 10A (slow). The external circuit breaker must
be suitable according to IEC 60947-1 and EN 60947-3 and labeled for the instru-
ment.

The plugs may only be plugged into grounded power sockets. The ground
protection must not be eliminated by using extensions without protective earth
conductor. Any interruption of the protective earth conductor within or outside
the measuring transmitter can lead to the risk of fire or electric shock if another
error occurs. Check the power cable regularly. The power cable must be
replaced if it is damaged.

WARNING

If the power supply is connected incorrectly, it may represent a danger to life from electric shock. Pay attention to the following points during installation:

● **The measuring transmitter must only be connected by an electrician.**

● **The measuring transmitter must only be connected in a voltage-free condition.**

● **The power supply must fulfill the specifications given on the nameplate and in chapter 9 TECHNICAL DATA.**

● **A switch or circuit breaker must be provided in the building installation as an interrupt facility for the measuring transmitter.**
  The interrupt facility must be

  – installed close to the measuring transmitter and easy to reach by the user and

  – marked as an interrupt facility for the measuring transmitter.

● **The measuring transmitter must only be opened after the installation if the mains voltage has been switched off beforehand.**

Materials required ● Wire end sleeves, suitable for the power cable, with suitable crimping tool

Tools ● Cable stripping knife

● Wire stripper

● Phillips screwdriver

● Small screwdriver.

NOTE
The protective earth conductor must not protrude into the enclosure. Otherwise, malfunctions could occur.

Connecting the power line

1   Remove the cover on the left and right-hand side of the measuring transmitter.

2   Remove the two screws on the left and right-hand side of the enclosure of the measuring transmitter.

3   Tilt down the front of the enclosure.

4   Loosen the coupling ring of the cable gland at the position for the power connection (X6.1 ... 3) on the enclosure.
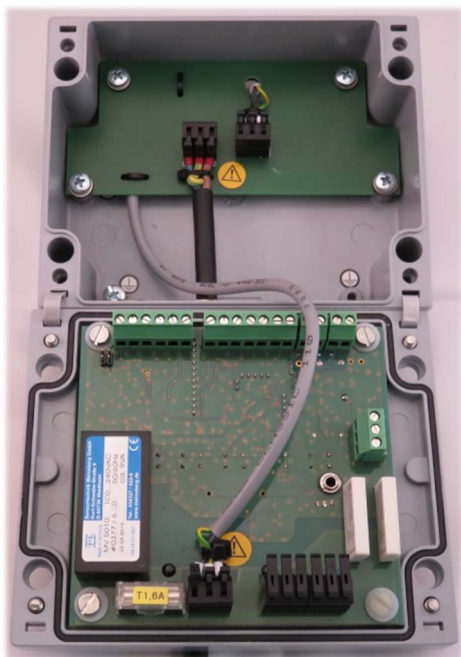
figure 3-9 Inserting the power line.

5   Feed the power line into the enclosure through the cable gland.
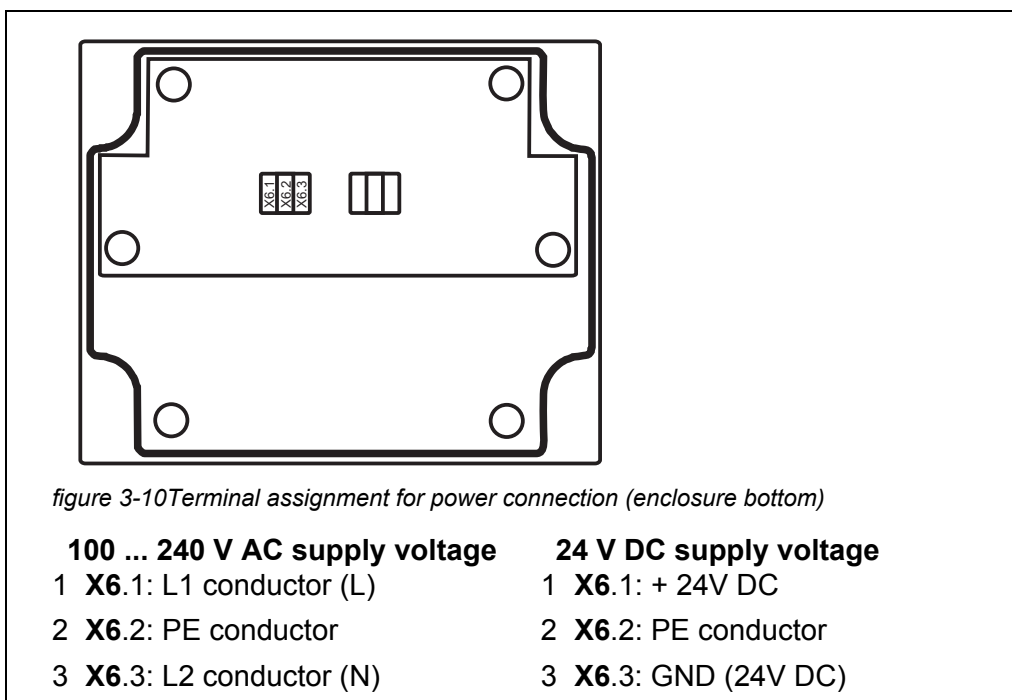
figure 3-10 Terminal assignment for power connection (enclosure bottom)

100 ... 240 V AC supply voltage	**24 V DC supply voltage**
1 **X6**.1: L1 conductor (L)	1 **X6**.1: + 24V DC
2 **X6**.2: PE conductor	2 **X6**.2: PE conductor
3 **X6**.3: L2 conductor (N)	3 **X6**.3: GND (24V DC)

6   Connect the wires to the terminal strip. Make sure that the cable assignment agrees with the specification on the terminal label under the terminal strip.

7   Fix the cable using the preinstalled cable tie.

8   Tighten the coupling ring of the cable gland for the power line on the enclosure.

The earth bolt in the bottom part of the transmitter is not used.

WARNING
No free wires are allowed to project into the housing. Otherwise, there is a danger that areas safe to contact could come into contact with dangerous voltages. Always cut off any wires that are not in use as closely as possible to the cable gland.

9   Close the enclosure.

10   Reinstall the cover on the left and right-hand side of the measuring transmitter.

3.11   Commissioning

Start checklist   Before starting the measuring transmitter, carry out the system check using the following checklist.
Always carry out the check before each commissioning.

Start checklist:

1   Are all components correctly connected with one another (see section 3.6 to section 3.8)?

2   Is the measuring transmitter correctly connected to the power supply (see section 3.10)?

3   Do the line voltage and line frequency agree with the data on the name plate of the measuring transmitter?

4   Is the sensor ready to measure, e.g. oxygen sensor filled with electrolyte solution?

Putting the measuring transmitter into operation

Switch on the power supply of the measuring transmitter.
As soon as the instrument is successfully initialized, the measured value display appears.

4   Operation

4.1   Operating elements
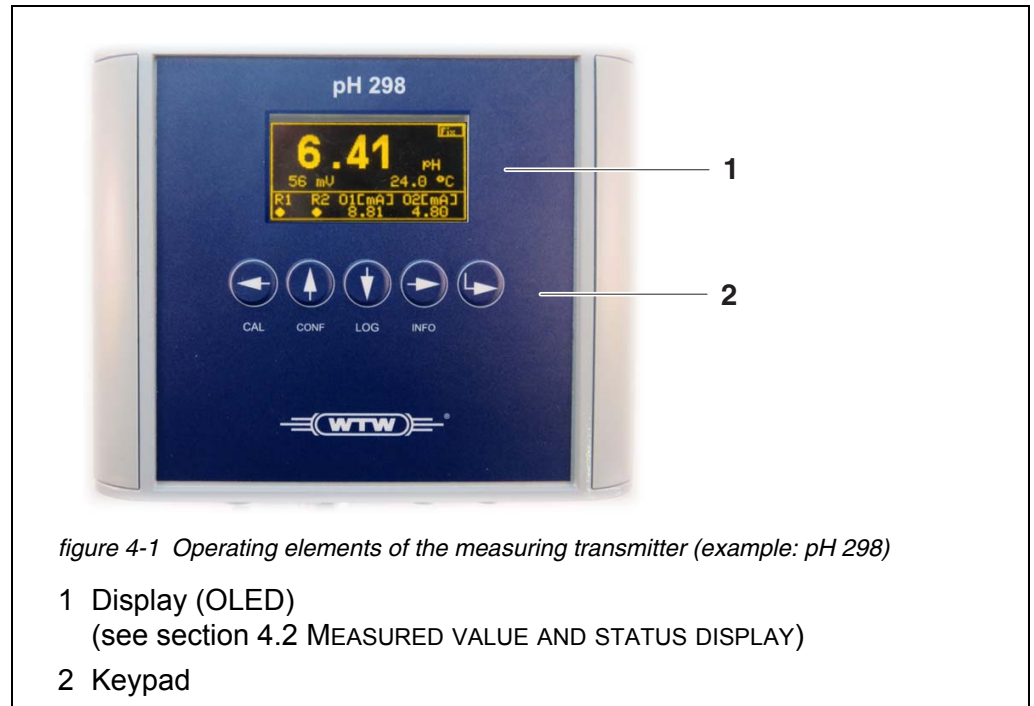
figure 4-1 Operating elements of the measuring transmitter (example: pH 298)

1 Display (OLED)
   (see section 4.2 MEASURED VALUE AND STATUS DISPLAY)

2 Keypad

Keys	Key	Symbol	Function
		<◄> **<CAL>**	Move the cursor/highlighting to the left In the measured value display: Open the *calibration* menu
		<▲> **<CONF>**	Move the cursor/highlighting upwards Open the *configuration* menu
		<▼> **<LOG>**	Move the cursor/highlighting downwards Display recorded data
		<►> **<INFO>**	Move the cursor/highlighting to the right Display system and sensor information
		<ENTER>	Select a menu item / confirm an entry

4.2   Measured value and status display

figure 4-2 Measured value and status display (example: pH)

1 Status display HOL (Hold):
   The measured value is frozen
   (also for relays, current outputs and Modbus)

2 *measured value*

3 *2nd value*

4 Status *relay 1* (in the example: closed)

5 Status *relay 2* (in the example: open)

6 Status *output 1* (actual value, in the example 4.90 mA)

7 Status *output 2* (actual value, in the example 5.00 mA)

8 *temperature*

9 Status display CAL:
   Calibration values outside the allowed limits

10 Status display Fix:
   fixed temp. active

Measured parameters   In addition to the main measured parameter (e.g. pH value, conductivity etc.), the measuring transmitter has secondary parameters, which are derived or calculated from the main measured parameter, and the temperature of the test sample.

The measured parameters can be used for feedback control via the relay and current outputs.

	Main measured value	Secondary measured value	Temperature
pH 298 (pH)	pH value	Electrode voltage in mV	*temperature* in °C

	Main measured value	**Secondary measured value**	**Temperature**
pH 298 (ORP)	ORP as absolute voltage in mV	ORP as voltage in mV in relation to the hydrogen electrode	*temperature* in °C
LF 298	Conductivity (and cell constant) in µS/cm or mS/cm	Salinity in g/kg or Resistance in Ohm or TDS in mg/ll	*temperature* in °C
Oxi 298	Oxygen saturation in % or Oxygen concentration in mg/l	Oxygen concentration in mg/l or Oxygen saturation in %	*temperature* in °C
Cl 298	Concentration in mg/l	Sensor output current in mA	*temperature* in °C

4.3   General operating principles

The keys of the instrument have the following functions, depending on the operating situation.

4.3.1   Opening the menu

In the measured value display, open a menu with settings or functions with the 4 labeled menu keys (**<CAL>**, **<CONF>**, **<LOG>**, **<INFO>**).

4.3.2   Navigation in menus

In a menu,

● select a sub-menu (settings or functions) with the 4 arrow keys (**<◄>**, **<▲>**, **<▼>**, **<►>**)

● open a setting or sub-menu with the ENTER key (**<ENTER>**)

4.3.3   Entering numerals

In input fields for numerals

● select the numeral to be edited with the left or right arrow key (**<◄>**, **<►>**)

- select a number in the range 0 ... 9 with the up or down arrow key (**<▲>**, **<▼ >**)

- cancel the input by simultaneously pressing the left and right arrow keys (**<◄>**, **<►>**). The values are not stored.

- confirm the numeral with the ENTER key (**<ENTER>**)

4.3.4 Terminating inputs and returning to the measured value display

- In an input field:
  Cancel the current input by simultaneously pressing the left and right arrow keys (**<◄>**, **<►>**).

- In a menu:
  Leave the current menu by simultaneously pressing the left and right arrow keys (**<◄>**, **<►>**).
  As an alternative, you can also select the menu item *back*.

4.3.5 Operating example: Setting the language

Proceeding: Selecting the language

1   Open the *configuration* menu with **<CONF>**.

2   Press **<◄►▲▼>** and **<ENTER>** to select and confirm the menu item *general*.

3   Using **<◄►▲▼>** and **<ENTER>**, select and confirm the menu item*laguage*.
     The list with available system languages pops up.

4   Select a language from the list with **<◄►▲▼>** .

5   Confirm the language with **<ENTER>**.
     The selection takes effect immediately. The display switches to the superordinate menu level.

6   Using **<◄> + <►>** or *back*, switch to the measured value display.

4.4   System settings (menu *configuration*)

All system settings for the measuring transmitter are in the menu *configuration*.

By pressing **<CONF>** after entering the password, you switch from the mea-

sured value display to the *configuration* menu (main menu).

```
  configuration
relay                      general
outputs                    PID controller
data logg..                modbus
temperature                simulation
meas. Range (LF 298)       back
sensor type (pH 298)
main value (Oxi 298 / Cl 298)
```

Details on the individual settings are given in the relevant chapters of the functions.

4.5   Setting the date and time

The date and time are used for the documentation of calibration data or measured value recording (data logger). Please set the date and time on commissioning.

1   Open the *configuration* menu with **<CONF>**.

2   Using **<◄►▲▼>** and **<ENTER>**, select and confirm the menu item*general*.

3   Using **<◄►▲▼>** and **<ENTER>**, select and confirm the menu item*clock*.
     The input field for the date pops up.

4   Using **<◄►▲▼>** and **<ENTER>**, enter and confirm the date.
     The input field for the time pops up.

5   Using **<◄►▲▼>** and **<ENTER>**, enter and confirm the time.
     The input is completed.

6   Using **<◄> + <►>** or *back*, switch to the measured value display.

4.6   Temperature compensation

To calculate the measured values for pH and oxygen, temperature compensation is obligatory.

The conductivity value can be displayed as real or temperature-corrected (referring to 25 °C).

For this the temperature of the measurement and calibration media has to be measured or stored as a fixed temperature. If the fixed temperature is enabled it is used for temperature compensation. The Fix message appears in the upper right-hand corner of the display.

Setting the fixed temperature

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄ ► >**, highlight the *temperature* menu item and confirm with **<ENTER>**.

Submenu	Selection/Values	Explanation
fixed temp.	*on* *off*	Enabling / disabling the fixed temperature
temp. Value		Input field for the fixed temperature value

3   Select the setting *fixed temp./on*.

4   Set the *temp. Value* in the input field.

5   Quit the menu *configuration*.

4.7 Calibrating (CAL menu)

4.7.1 General proceeding

The sensor is protected by a password against unauthorized calibration. For more information on password protection, refer to section 4.11.

General proceeding

1   Switch to the measured value display as necessary.

2   Open the *calibration* menu with **<CAL>**.
 The *password* input field pops up.

3   Enter the password.
 The *calibration* menu is open.

The *calibration* menu lists the calibration procedures suitable for the instrument type.
Details on calibration for your type of instrument are given in the following sections (see section 4.7.3 ... section 4.7.6).

Please note the instructions on calibration in the operating manual of your sensor in addition to the calibration procedure on the instrument.

Menu item	Explanation
input	The calibration values last determined are displayed. If a valid calibration by means of a calibration procedure is not possible, the calibration values can be manually entered here.
temp. offs.	Opens an input field for a constant offset of the displayed temperature value (positive or negative). If the temperature value measured by the temperature sensor of the probe deviates from the actual temperature, a constant value to increase or reduce the displayed temperature values can be entered here. Deviations can occur if, for example, long cables are used with a temperature probe of the Pt100 type.
one point	Starts the procedure for the single-point calibration with manual input of the calibration solution
two point	Starts the procedure for the two-point calibration with manual input of the calibration solution(s) (pH 298 only)
automatic	Starts the procedure for the automatic calibration. The measuring transmitter automatically recognizes the calibration solution used (only pH, Oxi, LF 298).
back	Return to the measured value display.

4   If the measured temperature value deviates from the actual temperature:
Using **<▲▼◄►>**, highlight the *temp. offs.* menu item and confirm with **<ENTER>**.
Enter the temperature offset.

5   Using **<▲▼◄►>**, select a calibration method (manual calibration, e.g. *one point* or *two point* or automatic calibration *automatic*) and confirm with **<ENTER>**.
The calibration procedure starts.
The status indicator HOL appears in the measured value display.
The linked relays and outputs are frozen.

6   Follow the user guide.
After completion of the calibration the calibration data are displayed.

| | If the displayed calibration values are not plausible, you can cancel the calibration and thus the taking over of the displayed calibration values with **<◄> + <►>**. The measuring transmitter continues measuring with the old calibration values. |

7   Confirm the calibration data with **<ENTER>**.
     Calibration is completed.

Recommissioning the sensor after calibrating

8   Confirm with **<ENTER>**. The display returns to the measured value display.

9   After calibrating, immerse the sensor in the test sample again.

10   Wait for a stable measured value.

4.7.2   Calibration evaluation

The measuring transmitter has a simple calibration evaluation.
Critical calibration values are displayed in the measured value display with the status indicator CAL.

Evaluation	Cal INFORMATION	Measured value display	Explanation
Successful calibration	Calibration values determined	Measured value No status display indicator	The calibration values determined are used.
Calibration successful with restriction	• Calibration values determined • Error message *Out of limit!*	Measured value Status display CAL:	The calibration values determined are used but they are outside the limits of a good calibration.[a]
Unsuccessful calibration	• Calibration values of the last valid calibration • Error message *!Calibration error!*	Current measured value Status indicator of the last valid calibration	The calibration values determined are outside the allowed limits for a valid calibration. They are neither stored nor used.[b]

a.   If your requirements of the measurement accuracy are high, we recommend that you check the calibration (also refer to the operating manual of your sensor).
b.   The measuring transmitter continues measuring with the old calibration values.
     To obtain a new calibration with valid calibration values:
     Recalibrate or exchange the sensor (wear part!) (also refer to the operating manual of your sensor).

4.7.3 Calibrating a pH / ORP electrode

Please note the special instructions on calibration in the operating manual of your sensor in addition to the calibration procedure on the instrument.

Menu item	Explanation
input	Input field for calibration values (*asymmetrie*, *slope*)
temp. offs.	Input field for offsetting the temperature value (positive or negative)
two point	Starts the procedure for the two-point calibration with manual input of the calibration solution(s) Any calibration solutions are allowed.
automatic	Starts the procedure for the automatic two-point calibration. The measuring transmitter automatically recognizes the calibration solution used. The target values do not have to be entered manually. The automatic recognition works for DIN/NIST and Technical buffers (TEC).
back	Return to the measured value display.

The automatic two-point calibration recognizes the following buffer sets:

Buffer set	pH values at 25 °C
NBS standard DIN 19266 (DIN/NIST)	1,68 4,01 6,86 9,18 12,45
Technical buffers (TEC)	2,00 4,01 6,98 10,01

4.7.4 Calibrating the conductivity measuring cell

Please note the special instructions on calibration in the operating manual of your sensor in addition to the calibration procedure on the instrument.

Menu item	Explanation
input	Input field for calibration values (*cell constant*, *temp. coeff.*, *cable offset*, *TDS factor*).
temp. offs.	Input field for offsetting the temperature value (positive or negative)
one point	Starts the procedure for the single-point calibration with manual input of the standard solution, Any standard solutions are allowed.
automatic	Starts the procedure for the automatic calibration. The measuring transmitter automatically recognizes the standard solution used. The automatic recognition works for the following standard solutions: – 0.01 mol/l KCl (1.41 mS/cm) – 0.1 mol/l KCl (12.9 mS/cm).
back	Return to the measured value display.

4.7.5 Calibrating an oxygen sensor

Please note the special instructions on calibration in the operating manual of your sensor in addition to the calibration procedure on the instrument.

Menu item	Explanation
input	Input field for calibration values (*slope*, *sensor type*, *air pressure*, *salinity*). If a TriOxmatic® 690 is used: Select the type *701* in the *sensor type* menu.
temp. offs.	Input field for offsetting the temperature value (positive or negative)
one point	Starts the procedure for the single-point calibration with manual input of the standard solution, Any standard solutions are allowed.
automatic	Starts the procedure for the automatic calibration. The measuring transmitter automatically recognizes the standard solution used. The automatic recognition works for calibration in water vapor-saturated air.
back	Return to the measured value display.

4.7.6   Calibrating a chlorine sensor

> Please note the special instructions on calibration in the operating manual of your sensor in addition to the calibration procedure on the instrument.

Calibration of the measuring transmitter Cl 298 (to measure free or total chlorine) in conjunction with the relevant measuring cells is done with single-point calibration in comparison with photometrically determined laboratory data.

Chlorine measuring cells have automatic temperature compensation integrated in the measuring cells. No fixed temperature is used for the calibration (fixed temperature, see section 4.6 TEMPERATURE COMPENSATION).

Menu item	Explanation
input	Input field for calibration values (slope)
temp. offs.	Input field for offsetting the temperature value (positive or negative)
one point	Starts the procedure for the single-point calibration with manual input of the standard solution, Any standard solutions are allowed.
back	Return to the measured value display.

4.8   Measured value recording (data logger)

The measuring transmitter has an integrated data logger with real time clock for 4000 datasets (date, time, main measured value, secondary measured value, temperature). The data logger automatically saves measured values according to the specified save interval.

The save interval is defined the submenu *configuration* / *data logg.*

Defining the save interval

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄ ►>**, highlight the *data logg.* menu item and confirm with **<ENTER>**.

3   Select the setting *interval*.

4   Enter the save interval in the input field *interval*.

5   Quit the menu *configuration*.

Displaying stored data

1   Switch to the measured value display as necessary.

2   Using **<LOG>**, show the recorded data on the display.
     The graphic display of the recorded data pops up.

figure 4-3 Data logger (graphic display)

<◄> or<►>	Move the displayed section along the time axis (t)
<ENTER>	Switch to the numerical display of the data. In the numerical display:
	<◄> or <►>: Switch to the next or last dataset.
	<ENTER>: Switch to the graphic display of the data.
<LOG>	Return to the measured value display.
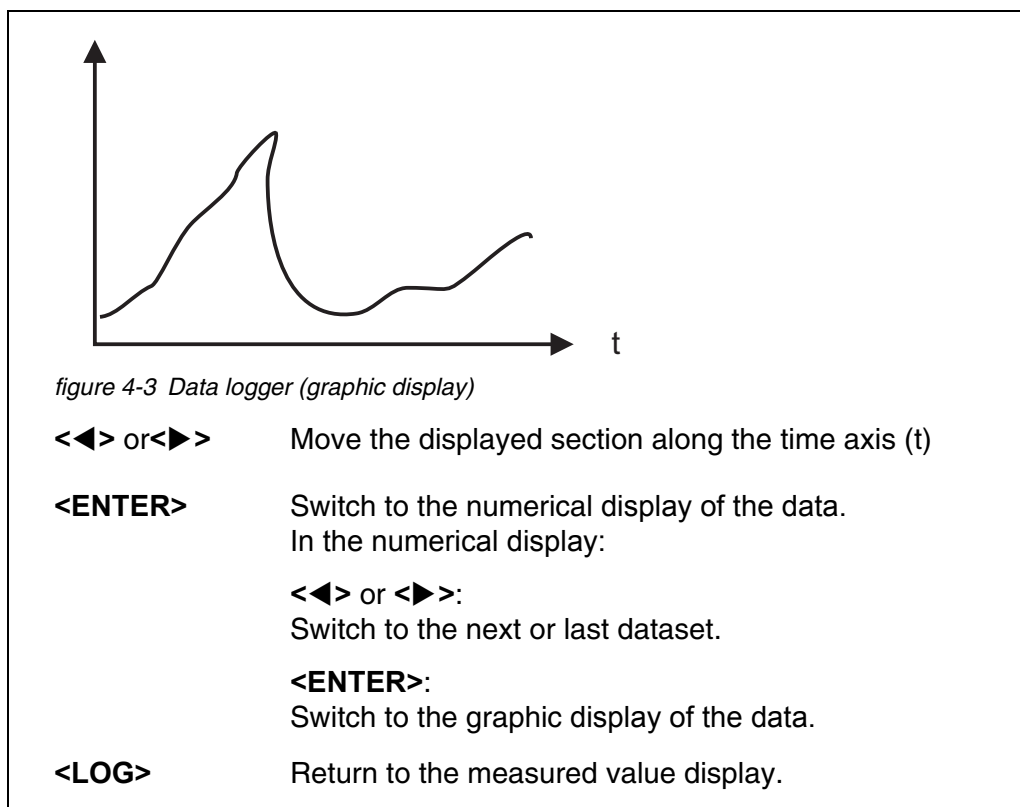
4.9   INFO menu

4.9.1   Overview

Pressing **<INFO>** switches from the measured value display to the *INFO* menu.

In the *INFO* menu, you can call up calibration data and instrument information.

4.10   Low power mode (*screensaver*)

Enabling the low power mode

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄►>**, highlight the *general* menu item and confirm with
     <ENTER>.

3   Select the setting *screensaver on*.

4   The low power mode is switched on.
        The screen saver is automatically enabled after 20 min.

Disabling the low   Activating any key switches the screen saver off again for 20 min.
power mode

4.11   Password protection

The settings in the menus *calibration* (CAL) and *configuration* (CONF) are password-protected.

To go to these menus you have to enter the password and confirm with ENTER.

The password is set to 1 in the delivery state.

Changing the   You can change the password in the menu item *configuration* / *general* / *pass-*
password   *word*.

Note down the new password and keep it in a safe place.

5   Outputs

The measuring transmitter has two relay outputs and two current outputs.

Functioning of the outputs

● Relay outputs work as normally closed or normally open contacts.

● Current outputs provide a current dependent on the measured value.

Functions

Relay	Current output
Limit indicator	*Analog output*
Timer	
PID controller as pulse width controller	*PID controller* as analog controller

5.1   Basic information on control functions

In this chapter you will find general information on the following relay functions:

● Limit indicator (see section 5.1.1)

● PID controller as pulse width controller (see section 5.1.3)

5.1.1   Limit indicator

With a limit indicator, a relay switches when a specified limiting value is exceeded or undercut.

Limit indicators can be used in the following way:

● Monitoring a limiting value using a relay:
  When a limiting value (upper or lower limiting value) is exceeded or undercut, a relay switches.The following relay actions are possible: *Open* or *Close* (see page 41)

● Monitoring two limiting values using two relays:
  If the upper limiting value is exceeded or undercut, a relay switches, and if the lower limiting value is exceeded or undercut, another relay switches. The following relay actions are possible: *Open* or *Close* (see page 41)

> If the simple monitoring (*Open*, *Close*) with one or two relay is not sufficient, use the PID controller (pulse width controller, see section 5.1.3).

Monitoring limiting values using one or two relays
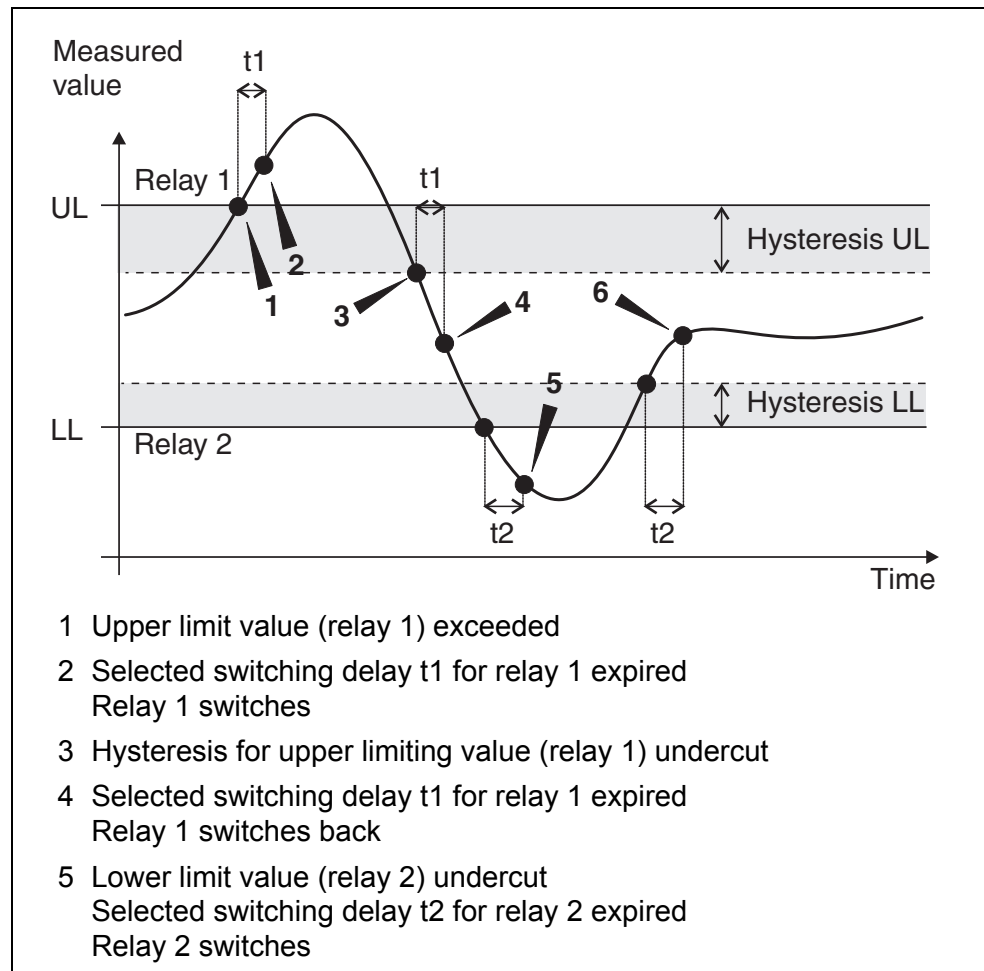
figure 5-1 Switching points for relays with the function of a limit indicator

A switching delay (t) can be set up for each relay for switching processes. This is the time period for which a limiting value must be exceeded before the relay switches. This prevents frequent switching if the measured values are close to the limiting value.

5.1.2   PID controller (relay and current output)

With the function, *PID controller*, a relay or output can be used as a regulator. The regulator can be configured as a **P**roportional regulator with switchable **I**ntegral and **D**ifferential regulator parts (**PID** Controller).

By activating or deactivating the **I**ntegral (*ti*) and **D**ifferential (*td*) regulator part, the following regulator types can be configured:

Regulator type	*td* [s] (reset time)	*ti* [s] (hold-back time)
P controller	0	0

Regulator type	**td [s] (**reset time)	**ti [s] (**hold-back time)
PI controller	0	1 to 9999
PD controller	1 to 9999	0
PID controller	1 to 9999	1 to 9999

Proportional output

With proportional output, a relay switches on and off cyclically within a defined measured value range (proportional band). When doing so, the relay switches with a turn-on duration corresponding to the measured value.

With proportional output, a current output outputs a current proportional to the measured value within a defined measured value range (proportional band).

Proportional outputs can be used in the following ways:

● Output with one relay or current output:
An output range is determined, with *Start value* and *End value*.
Above and below the output range, no output is effected.

● Output with two relays or current outputs:
For every relay or every current output an output range is determined, with *Start value* and *End value*. One relay or current output outputs in the upper output range and another relay or current output outputs in the lower output range.

Output with one relay

figure 5-2 Output with one relay

Output with two relays

Switching frequency f or
Pulse width v

Proportional bands
Relay 1 and 2

100
90

10
0

Measured value

2   1   1   2
Relay 1   Relay 2

1 *Start value*
  Measured value with minimum pulse width or switching frequency
2 *End value*
  Measured value with maximum pulse width or switching frequency
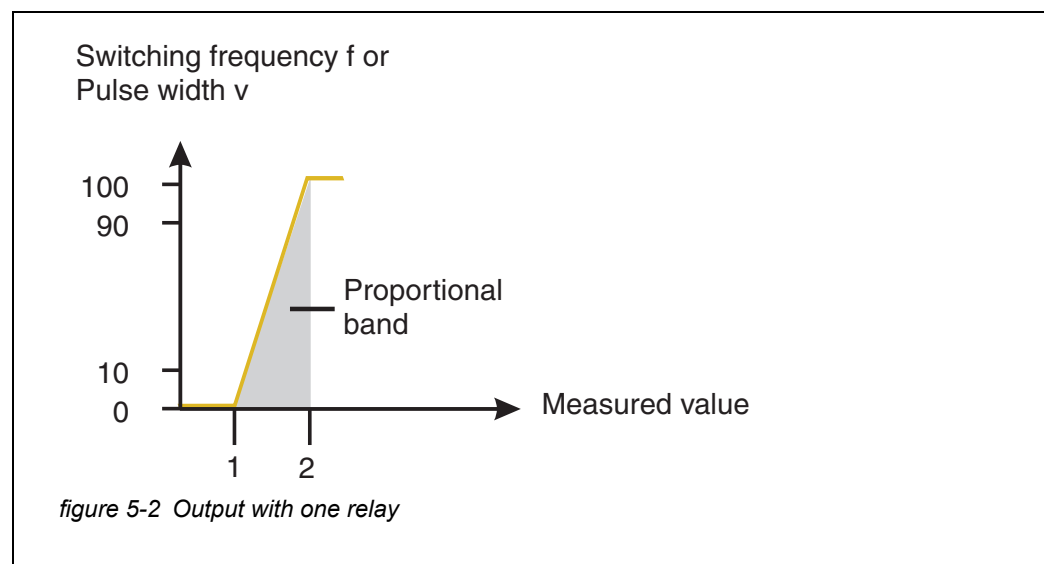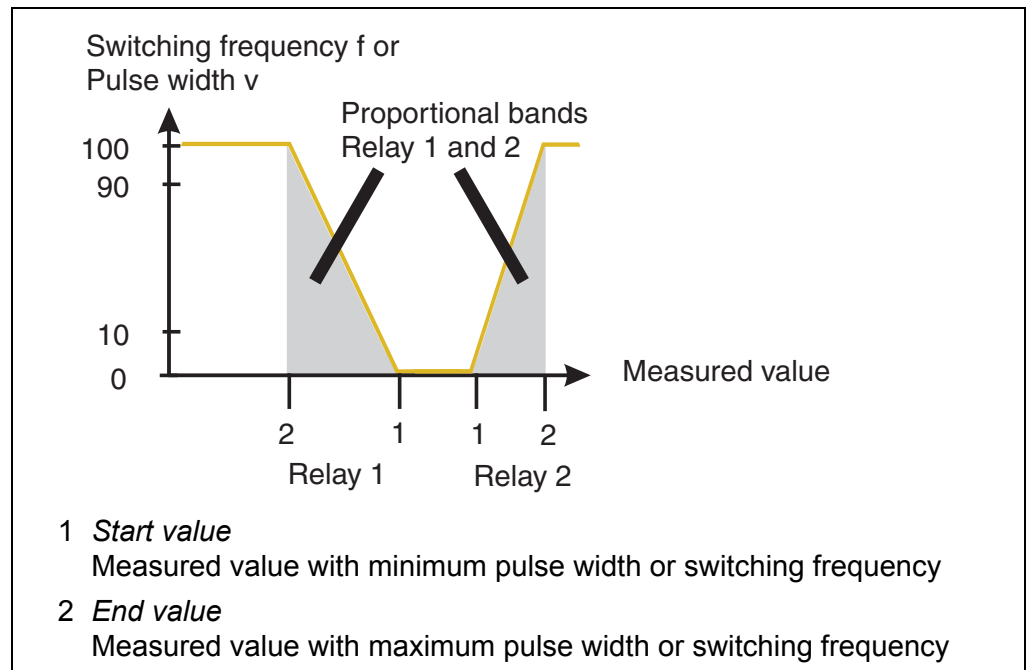
figure 5-3 Output with two relays

Proportional output with break point

Control with a simple proportional range is not suitable for all control types.

ℹ️ Processes to control the pH value are nonlinear. Frequently, the transmission constant in the range of the target value is considerably greater than at the limits of the control range. The use of the controller with fixed setting values will result either in an instability of the control cycle near the target value or in extremely long settling times (for batch processes) or high deviations (for continuous processes with greater disturbance variations).

The controller integrated in the measuring transmitter can be adapted to meet the special requirements of the process. The general static characteristic curve

of the controller is shown below. Thus it is possible to realize different transmission behavior for different parts of the control range.
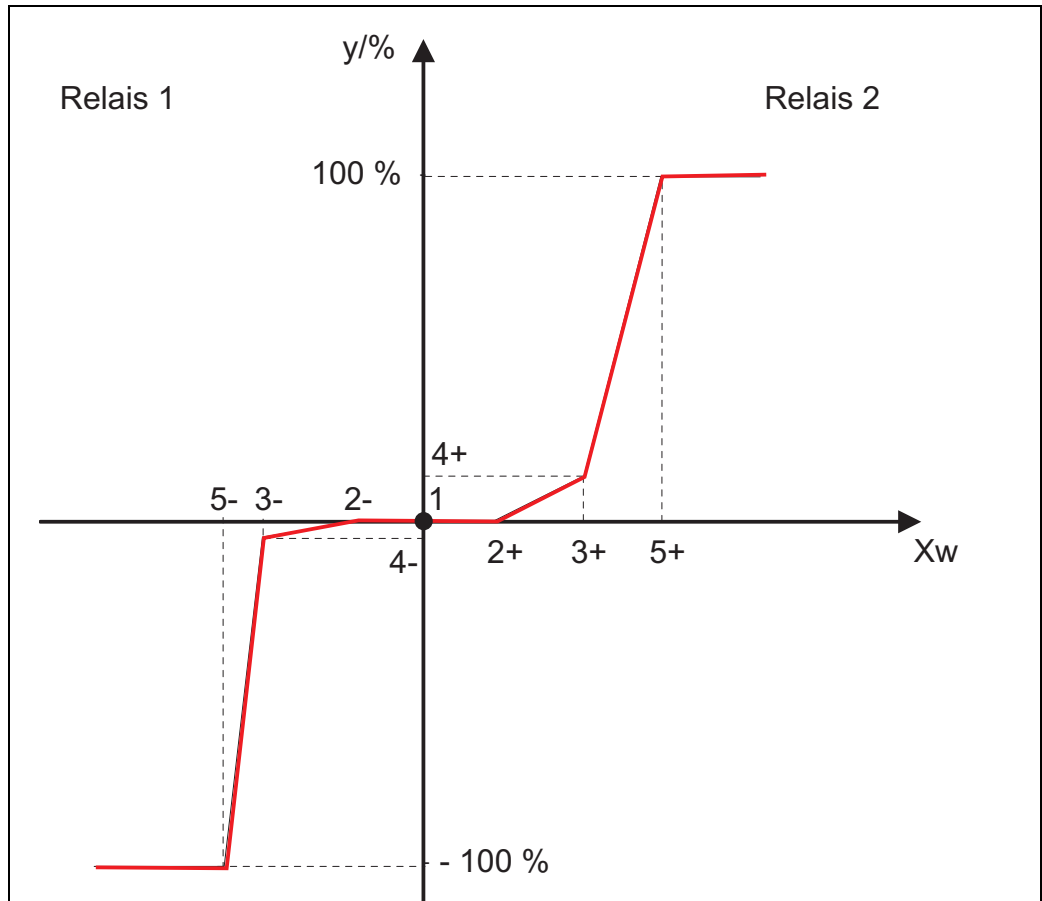
figure 5-4 Characteristic curve PID controller (example: pulse width output)

1 *target value*
   Measured value that should be achieved by the control

2 *dead band +*, *dead band -*
   Range around the target value. No regulation takes place within this range.

3 *break point x+*, *break point x-*
   The break points divide the control ranges for each relay into a range where the differential ratio (*derivative t.*) and integral ratio (*integral time*) take effect, and into a range where only the differential ration takes effect.

4 *break point y+*, *break point y+*
   Output value assigned to the measured value at the break point (here: Pulse width in %)

5 *lower limit*, *upper limit*
   upper or lower limit of the control range

The minimum time can be set to adjust to different actuators. It it used to prevent switching processes that are too quick for the actuator.
If it is undercut and the control parameter is outside the dead band, the actuator is triggered with the minimum time.
If the switch-off duration is shorter than the minimum time, the relay remains switched on without interruptions.

5.1.3 PID controller as pulse width controller (*PWM*)

The pulse width controller is linked with the 2 relay outputs (see characteristic curve). Within the cycle time, a switching pulse is calculated depending on the desired value deviation. The intervention in the control process takes place with this switching pulse. The control value is recalculated with the start of every period duration.

Pulse width output   The output of the pulse width is, for example, used to trigger valves.

With pulse width output, the turn-on duration (t_{On}) of the output signal is changed. Depending on the position of the measured value in the proportional range, the relay is operated for a longer or shorter time period.
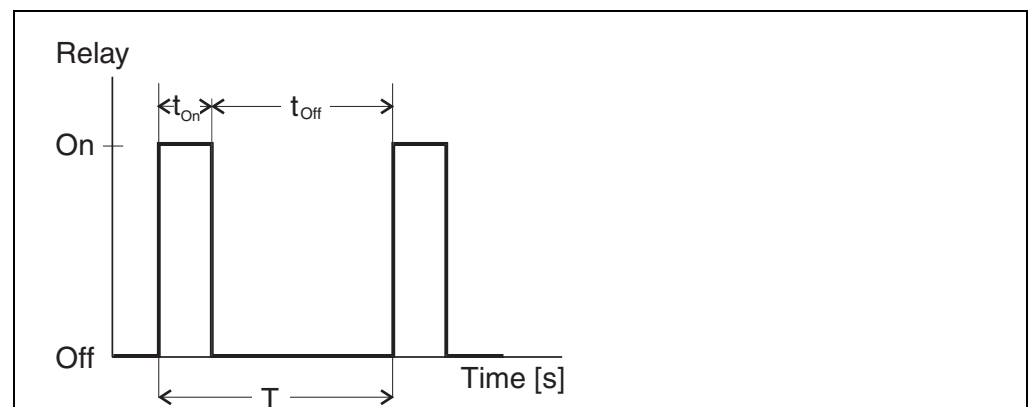
figure 5-5 Relay output of the pulse width output

The cycle time (T) consists of the turn-on duration and the turn-off duration (t_{On}, t_{Off}) of the relay. While the defined cycle time (T) remains constant, the turn-on duration (t_{On}), and thus the pulse width (v), changes depending on the measured value. The pulse width can be set in the range 0 % ... 100 %.

$$v = (t_{on} / T) * 100 \%$$

v = pulse width, T = cycle time, t_{On} = turn-on duration

● If the measured value is at the end of the proportional band (*End value*), the turn-on duration (t_{On}) is long, the turn-off duration is short. The relay is operated longer.

● If the measured value is at the beginning of the proportional band

(*Start value*), the turn-on duration (t_{On}) is short, i.e. the relay operated for a shorter period of time.

> If the duration of the close or open pulse is shorter than 0.1 s, the relay remains open or closed for the complete cycle time.

5.1.4   PID controller as analog controller (*current* 0/4 ... 20 mA)

The analog controller is linked with the 2 current outputs (see characteristic curve). After the sample rate has expired, the controller is recalculated and the resulting current is provided at the output. The current remains constant for the duration of the sample rate.

If the PID controller is configured as an analog controller, the analog outputs are automatically switched to current outputs by the software.

Observe the correct instrument coding (jumper)!

5.2   Configuring the relay outputs

5.2.1   Relay action

The relay action (opening or closing) is determined with the wiring on the terminal for each relay.

Settings	Explanations
Open	The relay should open with every event.
Close	The relay should close with every event.

Preferably set up the relay output for monitoring functions as normally closed.

Details on how to connect instruments to the relays (see section 3.8 CONNECTIONS (RELAYS, CURRENT OUTPUTS, MODBUS)).

5.2.2   Setting up the PID controller

A PID controller that is switched on has exclusive access to the relays or outputs, depending on the configuration. For relay functions (limiting value signal or timer) to be carried out, the *PID controller* has to be switched off (*release*/*off*) or configured as an analog controller (*type of the controller*/*current*).

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄ ► >**, highlight the *PID controller* menu item and confirm
     with **<ENTER>**.

3   Select the setting *release*/*off* or *type of the controller*/*current* .

4   Quit the menu *PID controller*.

5.2.3   Limiting value signal

The basics of the function are described in the introductory chapter (see
section 5.1.1).

1   Switch the *PID controller* off (*release*/*off***)** or configure it as an analog
     controller (*type of the controller*/*current*) (see section 5.2.2.).

2   Open the *configuration* menu with **<CONF>**.

3   Using **<▲ ▼ ◄ ► >**, highlight the *relay* menu item and confirm with
     <ENTER>.

Submenu	Selection/Values	Explanation
relay 1 *relay 2*	*select value*	*measured value*, *2nd value* *temperature*
	limits	Input field for the limiting value
	hysterese	Input field for the switching hysteresis
	min/*max*	Select the type of limiting value Min or Max
	release	Enable or disable the function

4   Configure the relay with **<▲ ▼ ◄ ► >** and **<ENTER>**.

5   Enable the function with *release*/*on*.

6   Quit the menu.

5.2.4   Time-controlled relay actions (*Timer*)

The *Timer* function determines for the relay 2 the time intervals during which the
relay is open or closed.

Relay 1 is always in the other condition during the specified intervals. During the *turn-on time* of relay 2 (relay closed), relay 1 is switched off.

When relay 2 is switched off (relay open), HOL is displayed. During this time, relay 1 is switched on (relay closed).

1   Switch the *PID controller* off (*release*/*off***)** or configure it as an analog controller (*type of the controller*/*current*) (see section 5.2.2.).

2   Open the *configuration* menu with **<CONF>**.

3   Using **<▲▼◄►>**, highlight the *relay* menu item and confirm with **<ENTER>**.

4   Using **<▲▼◄►>**, highlight the *Timer* menu item and confirm with **<ENTER>**.

Submenu	Selection/Values	Explanation
Timer	*turn-on time*	Input field for the turn-on duration (1…10000 min)
	turn-off time	Input field for the turn-off duration (1…10000 min)
	release	Enable or disable the function

5   Configure the relays with **<▲▼◄►>** and **<ENTER>** .

6   Enable the function with *release*/*on*.
     The *Timer* function is enabled.

7   Quit the menu.

5.3   Configuring the analog outputs

In the *Analog output* application, the measured values of the sensor linked at the current output are defined as strength of current.

5.3.1   Setting the PID controller

A PID controller that is switched on has exclusive access to the relays or outputs, depending on the configuration. For relay functions (limiting value signal or timer) to be carried out, the *PID controller* has to be switched off (*release*/*off***)** or configured as an analog controller (*type of the controller*/*current*).

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄ ► >**, highlight the *PID controller* menu item and confirm
     with **<ENTER>**.

3   Select the setting *release*/*off* or *type of the controller*/*PWM*.

4   Quit the menu *PID controller*.

5.3.2   Configuring the analog outputs

1   Switch off the *PID controller* (*release*/*off*) or configure it as a pulse width
     controller (*type of the controller*/*PWM*) (see section 5.2.2).

2   Open the *configuration* menu with **<CONF>**.

3   Using **<▲ ▼ ◄ ► >**, highlight the *outputs* menu item and confirm with
     <ENTER>.

Submenu	Selection/Values	Explanation
output 1 *output 2*	**current output**	
	output val.	measured value 2nd value temperature
	val. 0/4 mA	Input field for the 0/4 mA start value
	val. 20 mA	Input field for the 20 mA end value
	type	0...20 mA 4...20 mA
type u/i	*current* *voltage*	Select the analog output form *current* = 2 x 0/4…20 mA *voltage* = 2 x 0…5 V This configuration has to agree with the hardware coding (delivery setting: *current* = 2 x 0/4…20 mA). The output as voltage has to be coded by setting a jumper on the hardware.

4   Configure the outputs with **<▲ ▼ ◄ ► >** and **<ENTER>** .

5   Quit the menu.

5.3.3   Configuring the voltage outputs

1   Disconnect the instrument from the supply voltage

2   Remove all wires connected to the analog outputs

3   Open the instrument.

4   Carry out the instrument coding on the basic PCB inside the instrument
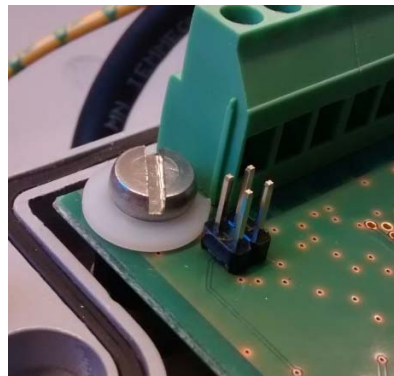
0/4 ... 20 mA (no jumpers)   0 ...5 V (jumper plugged in)

figure 5-6 Coding for the jumpers on the basic PCB

5   Close the instrument.
         Connect the analog outputs only after the software has been success-
         fully configured.

6   Open the *configuration* menu with **<CONF>**.

7   Using **<▲▼◄►>**, highlight the *outputs* menu item and confirm with
         <ENTER>.

8   Using **<▲▼◄►>**, highlight the *type u/i* menu item and confirm with
         <ENTER>.

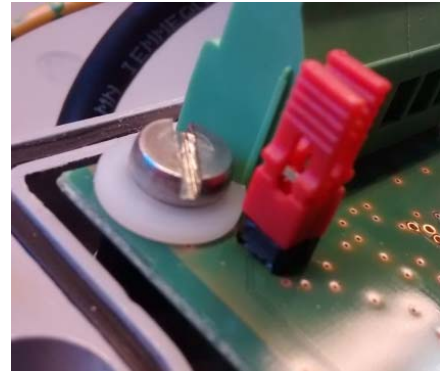| Submenu	Selection/Values	Explanation
output 1 *output 2*	**current output**	
	output val.	*measured value* *2nd value* *temperature*
	val. 0/4 mA	Input field for the 0/4 mA start value
	val. 20 mA	Input field for the 20 mA end value
	type	0...20 mA 4...20 mA
type u/i	*current* *voltage*	Select the analog output form *current* = 2 x 0/4…20 mA *voltage* = 2 x 0…5 V This configuration has to agree with the hardware coding (delivery setting: *current* = 2 x 0/4…20 mA). The output as voltage has to be coded by setting a jumper on the hardware.

9   Select the form of the analog output (*current*, *voltage*).

10   Configure the outputs with **<▲▼◄►>** and **<ENTER>** (see section 5.3 CONFIGURING THE ANALOG OUTPUTS).

11   Quit the menu.

5.4   Configuring the *PID controller*

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲▼◄►>**, highlight the *PID controller* menu item and confirm with **<ENTER>**.

Submenu	Selection/Values	Explanation
type of the controller	*PWM*	Pulse width controller
	current 0...20 *current* 4...20	Analog controller 0…20 mA Analog controller 4…20 mA
cont. Value	*measured value 1* *measured value 2* *temperature*	Select the target values *measured value* *2nd value* *temperature*
times	*cycle time* *derivative t.* *integral time* *minimal time*	Input fields for: Period Differential ratio Integral ratio (takes effect within the break points) For the configuration of the PID controller, the minimum time is the shortest duration of a switching intervention for a relay.
parameters	*upper limit* *lower limit* *target value* *dead band +* *dead band -* *break point x+* *break point x-* *break point y+* *break point y+*	Settings for control parameters: Lower limit of control range Upper limit of control range Target value Dead band, positive range Dead band, negative range Divides the proportional band for measured values > target value Break point x- (input value) Output value for measured value > target value Break point y+ (output value) Break point y- (output value)
release	*on* *off*	Enable / disable the function.

3 Select *type of the controller PWM* (relay) or *current* (output).

4 Configure the outputs with **<▲ ▼ ◄►>** and **<ENTER>** .

5 Select the setting *release*/*on*.
   The controller is active.

6 Quit the menu.

5.5   HOLD state

During maintenance activities such as calibrating or cleaning a sensor the measuring transmitter does not display a real measured value.

In these situations, the processing of the measured value for process control or regulation purposes is undesired.

To avoid the processing of the measured value, the current measured value is frozen at the measuring transmitter. The HOLD state is active.

In the HOLD state

● the system does not react to the current measured value or the state of the sensor

● linked outputs are frozen

● sensor errors do not cause the states of the linked outputs to change.

5.5.1   Activating/deactivating the HOLD state

Automatic   The HOLD status is automatically activated

● during calibration

● when the *Timer* function is active while for relay 2 the switch-off time is active (relay 2 is open).

● when a certain status is recognized at the signal input, e.g. due to operation of a flow monitor (see section 5.5.2 HOLD STATUS DURING OPERATION OF A FLOW MONITOR).

The HOLD status is automatically deactivated when the trigger for the automatic activation is terminated.

Manual   In situations where the sensor cannot provide any correct measured values, and the HOLD status is not triggered automatically, you can activate the HOLD status manually.

1   Press the key combination, **<INFO><INFO><CAL>**.
     The HOLD is switched on.
     The status indicator HOL is displayed.

2   Press the key combination, **<INFO><INFO><CAL>**.
     The HOLD is switched off.
     The status indicator HOL is no longer displayed.

5.5.2 HOLD status during operation of a flow monitor

By connecting an external voltage supply (e.g. a flow monitor) to the measuring transmitter (at the input for control signals) you can make sure that the measurement data are only evaluated at the signal input if a certain status is present.

A simple flow control (FlowControl) identifies two statuses

- Flow

- No flow.

If there is a flow, the flow monitor releases a control signal.

> If the measuring transmitter is part of a WTW drinking water platform for chlorine with flow monitoring, the default setting of the signal input causes the FLOW status to be triggered and shown on the display (FLO) if a signal is present (i.e. when a flow is recognized).
>
> For other sources of control signals the measuring transmitter provides the option of a manually configured signal input.

Manually configuring the signal input

To manually configure the signal input for a flow control, in the menu **<CONF>** / *general* / *Hold/Flow* select the menu item *Flow*.

If the signal input of the measuring transmitter is configured as *Flow*, it behaves as follows:

Signal at the signal input	Status triggered
Signal is present (input closed, e.g. flow recognized)	The measurement data from the sensors are evaluated. The status indicator FLO (FLOW) is displayed.
No signal (input open, e.g. no flow)	The measurement data from the sensors are not evaluated. The status indicator HOL (HOLD) is displayed additionally.

6   Communication with Modbus RTU

6.1   Connecting the Modbus interfaces

The Modbus is connected to the Modbus connectors (X3.4 ... X3.6) of the measuring transmitter.

General instal-lation instructions   Always install the wires with a minimum distance of 20 cm from any other wires carrying a voltage of more than 60 V.

Tools   ● Phillips screwdriver

● Small screwdriver.

NOTE
Modbus cables may only be connected to the Modbus connectors (X3.4 ... X3.6). No wire of the cable may be connected with an external electrical potential. Otherwise, malfunctions could occur.

1   Remove the cover on the left and right-hand side of the measuring transmitter.

2   Remove two cross-head screws each on the left and right-hand side of the measuring transmitter.

3   Tilt down the front of the enclosure.

4   Loosen the coupling ring of the cable gland at the position for the Modbus connection (X3.4 ... 6) on the enclosure.

5   Feed the Modbus cable into the enclosure through the cable gland.

figure 6-1 Terminal assignment Modbus (front, tilted downwards)

1 Modbus (**X3**.4-6)
   X3.4: A (+) RS485 / Modbus
   X3.5: B (-) RS485 / Modbus
   X3.6: GND / Modbus
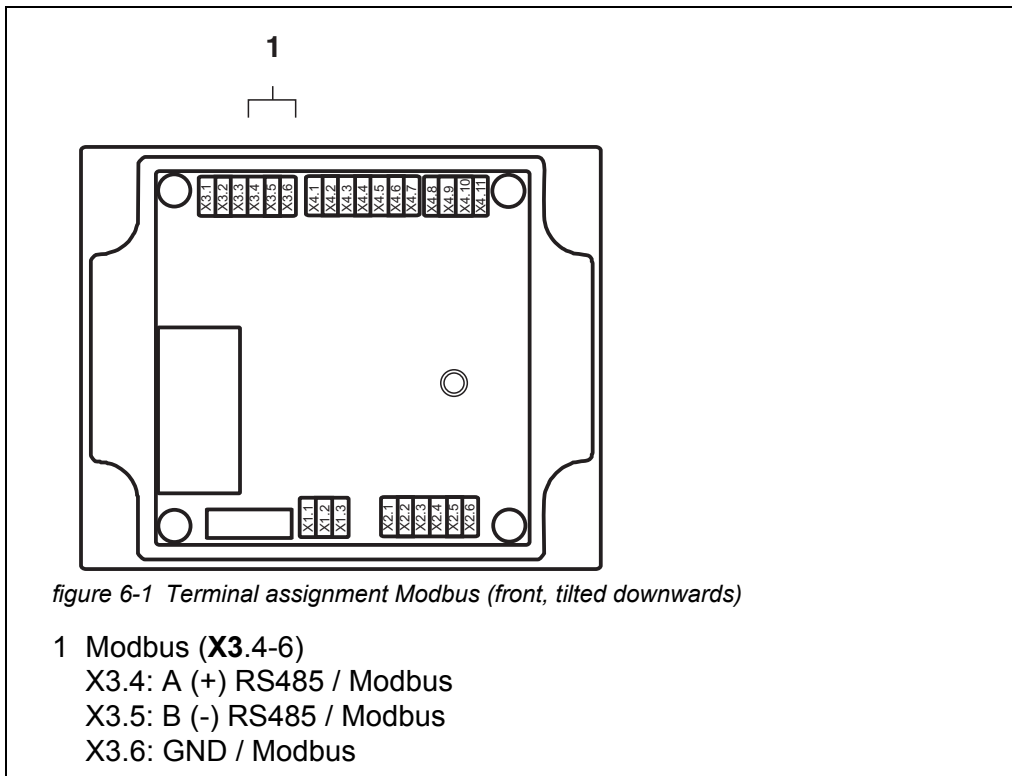
6   Connect the cable ends to the terminal strip. When doing so, follow the designations of the terminals.

7   Tighten the coupling rings for sensor and temperature probe.

8   Close the enclosure.

9   Reinstall the cover on the left and right-hand side of the measuring transmitter.

6.2   Setting the Modbus interface parameters

Opening the setting menu for Modbus RTU

1   Open the *configuration* menu with **<CONF>**.

2   Using **<▲ ▼ ◄ ►>** and **<ENTER>**, select and confirm the menu item-*modbus*.
     The menu with the Modbus setting pops up.

Settings

Submenu	Selection/Values	Explanation
device ID	*1 ... 247*	Instrument address of the 298 in the Modbus RTU

Submenu	Selection/Values	Explanation
baud rate	*9600* *19200* *38400*	Select the baud rate
parity	*none 1s* *none 2s* *even 1s* *even 2s* *odd 1s* *odd 2s*	None, 1 stop bit None, 2 stop bits Even, 1 stop bit Even, 2 stop bits Odd, 1 stop bit Odd, 2 stop bits

3   Edit the settings.

4   Quit the menu.

6.3   Data transmission

With each query of sensor data via the Modbus protocol, a block of consecutive registers is read.

Query and response telegram
The data transmission takes place via query and response telegrams. The form of the telegrams is determined by the Modbus RTU protocol.
The Modbus master sends a query telegram with a Modbus command to the Modbus slave (here, the pH 298, LF 298, Oxi 298, Cl 298). The Modbus slave sends a response telegram with the requested data or an error message.

6.3.1   Query format

Supported Modbus commands
The pH 298, LF 298, Oxi 298, Cl 298 provides the data block for read access only. Write Modbus commands are not carried out.

The following commands are available:

Modbus commands	Command code
Read Input Register	04h
Read Holding Register	03h

6.3.2   Data block of the sensor

The data of the sensor are stored in 8 registers.

Modbus		Information	Data format	
Register	Bit		Data type	Bit
0001	1-8	Sensor number (slave ID)	Int 8	7-0
0001	9-16	Sensor status	Int 8	15-8
0002	1-8	Sensor model	Int 8	7-0
0002	9-16	Instrument status	Int 8	15-8
0003	1-16	Measured temperature value	Float 32	31-16
0004	1-16			15-0
0005	1-16	Main measured value (IEEE-754 floating point, 32 bits)	Float 32	31-16
0006	1-16			15-0
0007	1-16	Secondary measured value (IEEE-754 floating point, 32 bits)	Float 32	31-16
0008	1-16			15-0

The counting of the Modbus registers and Modbus bits and the assignment of the MSB and LSB is different from that used with most programming languages.

	Modbus	Normally
Count start of the register	1	0
MSB* assignment of the register	Bit 1	Bit 15
LSB* assignment of the register	Bit 16	Bit 0

* MSB = Most significant bit, LSB = Least significant bit

6.3.3   Data traffic and timeout

A data query from the master is always followed by a response from the slave. Certain timeout periods have to be followed.

figure 6-2 Data traffic and timeout periods (T1 ... T3)

1 Data query master

2 Response slave

3 **T1**: Final recognition of query protocol (attention - depending on the baud rate, always 3 characters long)

4 **T2**: Working time of slave (max. 100mS), during this time no other data query may be in the bus.

5 **T3**: Switching time from send to receive max. 10 mS
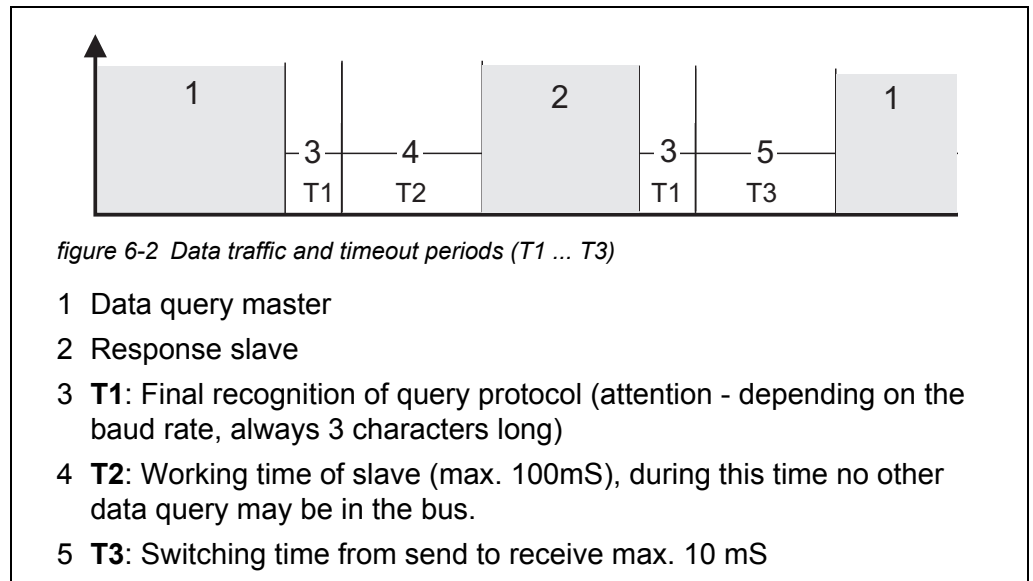
T1 for different baud rates

Baud rate	T1 in mS final recognition
9600	4,2
19200	2,18
38400	1,15

6.4   Coded data for fieldbus communication

6.4.1   Data formats of the sensor data block

Measured values (Float 32)   The data for temperature, main and secondary measured value are transmitted in IEE-754 Standard 32-Bit Floating Point format.

Address	Bit representation	
	MSB* LSB*	
Offset 0h bits 31-24	S E E E E E E	S = sign (bit 31)
Offset 1h bits 23-16	E M M M M M M M	E = exponent (bits 30-23)
Offset 2h bits 15-8	M M M M M M M M	M = mantissa (bits 22-0)
Offset 3h bits 7-0	M M M M M M M M	

* MSB = Most significant bit, LSB = Least significant bit

Other data (INT8)   All other data consist of only one byte each (Int8).

6.5   Instrument status

Code (hex)	Status indicator	Explanation
00h		Instrument runs without complaints
01h	HOL	HOLD manually triggered
02h	HOL	HOLD due to calibration mode
03h	HOL	HOLD due to *Timer* function
08h	Cal	CAL error

6.6   Measuring mode / sensor type

Code (hex)	Sensor type / measuring mode
01h	pH test amplifier
02h	ORP
03h	Cond 0…200 µS
04h	Cond 0…2 mS
05h	Cond 0…20 mS
06h	Cond 0…100 mS
07h	O2 oxygen
08h	Linear
09h	CL2 free chlorine
0Bh	aCond 0…200 µS
0Ch	aCond 0…2 mS
0Dh	aCond 0…20 mS
0Eh	aCond 0…100 mS
0Fh	Frequency counter
12h	CL2 free chlorine (direct sensor input)
13h	Cond 0…200 µS (4-pole)
14h	Cond 0…2 mS (4-pole)
15h	Cond 0…20 mS (4-pole)
16h	Cond 0…500 mS (4-pole)
17h	aCond 0…200 µS (4-pole)
18h	aCond 0…2 mS (4-pole)

Code (hex)	Sensor type / measuring mode
19h	aCond 0…20 mS (4-pole)
1Ah	aCond 0…500 mS (4-pole)
1Bh	Cond 0…20 µS ZK=0.1cm^{-1}
1Ch	Cond 0…2 µS ZK=0.01cm^{-1}
1Fh	Cond 0…200 µS ZK=0.1cm^{-1}
20h	Cond 0…20 µS ZK=0.01cm^{-1}

7   Maintenance and cleaning

7.1   Maintenance

Maintenance activities

Component	Maintenance
Measuring transmitter	No maintenance required
Sensor	Depending on the type of sensor (see operating manual of the sensor)

7.2   Cleaning

Measuring transmitter

Clean components mounted in the open of gross contamination as necessary. To prevent dirt from penetrating into the open enclosure, it is recommended that you roughly clean the component and its direct environment prior o each opening.

To clean the module, wipe the enclosure surfaces with a damp, lint-free cloth. If compressed air is available on site, blow off the worst of the dirt beforehand. Keep the enclosure closed while doing so.

NOTE
Do not use high-pressure water blasters for cleaning (danger of water penetration!). Also do not use aggressive **cleaning agents such as alcohol, organic solvents or chemical detergents.** *These types of cleaning agent can attack the surface of the housing.*
Do not use any hard brushes or metallic objects.

Sensor

The cleaning of the sensor depends greatly on the respective application. Instructions for this are given in the respective sensor operating manual.

8   What to do if ...

8.1   Information on errors

Information on possible errors of the sensor is given in chapter WHAT TO DO IF ... of the sensor operating manual.

8.2   Error causes and elimination

The measuring transmitter no longer reacts to entries

Cause	Remedy
– Error	– Switch off the power supply and switch it on again after 10 s

Implausible measured values

Cause	Remedy
– Communication with the sensor interrupted	– Check the cable connection

– Error in the sensor	– Switch off the power supply and switch it on again after 10 s
	– Further actions:
	See operating manual of your sensor, e.g.
	  – Clean the sensor
	  – Recalibrate the sensor
	  – Replace the sensor

8.3   Working on the open measuring transmitter

WARNING

If the measuring transmitter is opened during operation, there is a danger to life due to possible hazard of electric shock. Prior to opening the measuring transmitter, switch off the power supply and all relay circuits that present a hazard of electric shock and secure them against being switched on.

Only ever replace components when the measuring transmitter is switched off. Defective components are removed in the reverse order to the installation (see chapter 3 INSTALLATION).

8.4   Errors of the Modbus communication

Data transmission between the Modbus master and measuring transmitter interrupted

Cause	Remedy
– Wrong wiring	– Check / change the connections
– Wrong setting of the address, baud rate, parity	– Check / change the settings
– Incorrect protocol	– Adjust the protocol
– Measuring transmitter defective	– Contact the service department

The PLC does not receive any plausible input data

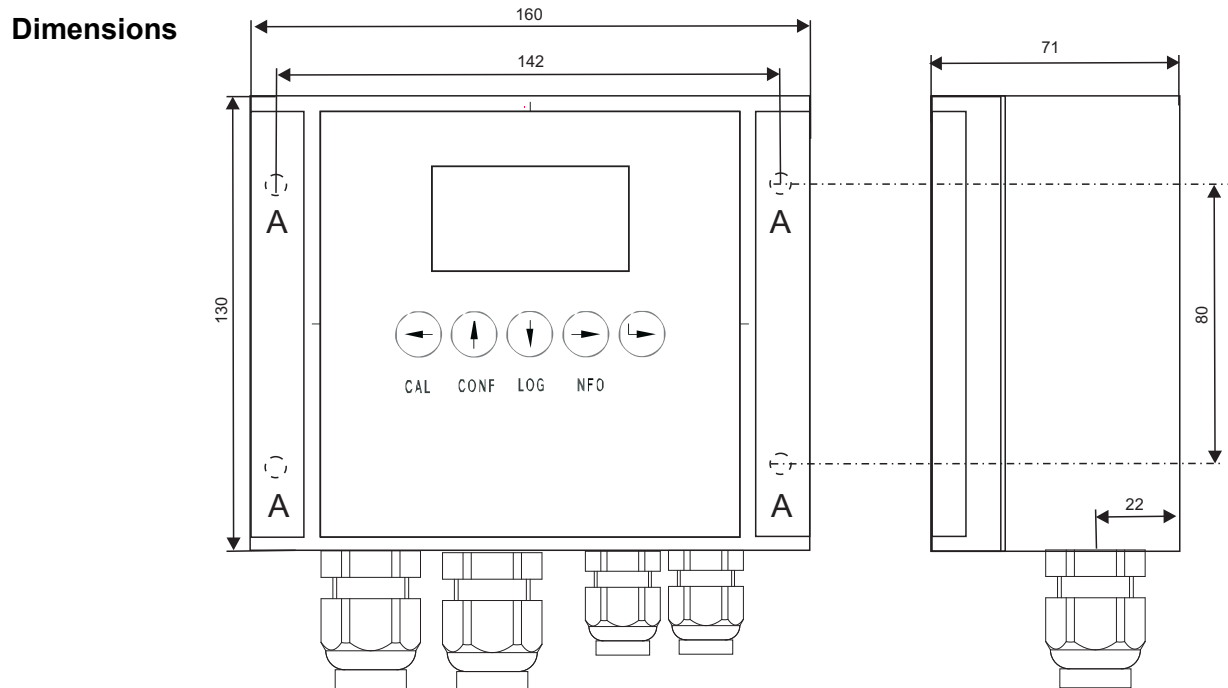| Cause	Remedy
– The data interpretation is incorrect	– Observe the data formats of the measuring transmitter
– The data interpretation of the PLC is incorrect	– Observe the data alignment of the PLC data representation. If necessary, exchange the most significant and least significant bytes word by word

9   Technical data

9.1   Measuring transmitter

Dimensions

figure 9-1 Dimension drawing with boreholes A (dimensions in mm)

Test certificates   CE

Mechanical structure

Enclosure material	Cast aluminum
Weight	Approx. 1.4 kg
Type of protection	IP 65

Ambient conditions   - 10 °C ... + 55 °C (-14 ... 131 °F)

Electrical data (line power version)	Power supply	Nominal voltage: 100 ... 240 VAC ± 10 %
		Frequency: 50/60 Hz according to DIN IEC 60038
		Line power connection: 2 poles, N and L
		Cable cross-section for the line power connection: Europe: 1.5 ... 4.0 mm^2 USA: AWG 14 ... 12
		Fuse on the operator side: 10 A maximum
	Protective class	II
	Overvoltage category	II
	Power consumption	Maximum approx. 9 W

Electrical data (24V version)	Power supply	Nominal voltage: 18 ... 36 VDC ± 10 %
		Line power connection: 2 poles, N and L (+PE)
		Cable cross-section for the line power connection: Europe: 1.5 ... 4.0 mm^2 USA: AWG 14 ... 12
		Fuse on the operator side: 10 A maximum
	Protective class	II
	Overvoltage category	II
	Power consumption	Maximum approx. 9 W

Relay (2 x)	Output	Galvanically separated
	Max. switching voltage	250 VAC
	Max. switching current	5 A
	Installation requirement	Fuse on the operator side: maximum 2 A

Relay functions	Programmable as:
	– Normally closed or normally open
	– Limiting value signal
	– Monitoring of the warning and error signals
	– Proportional frequency output
	– Proportional pulse width output

Current outputs (2 x)	Output	Galvanically insulated from the sensor
	Output current	Switchable between 0 - 20 mA and 4 - 20 mA
	Max. output voltage	5 V, with missing or erroneous load
	Accuracy	0.2 % of current value ± 50 µA, load max. 500 Ω
	Functions	Programmable:
		– Recorder attenuation adjustable 0 - 40 mA/s
		– Error behavior adjustable arbitrarily 0 ... 21 mA
		– Error behavior adjustable according to Namur NE43
		– Positive and negative characteristic curve

Terminals	Terminal type	Screw-type terminal strip, accessible by raising the lid
	Terminal ranges	0.2 ... 2.5 mm^2

Cable glands	Suitable for cable cross-sections	4.5 ... 10 mm
	M16x1.5	Clamping range 4.5 – 10 mm max. tightening torque 7 Nm
	M 20 x 1.5	Clamping range 7 – 13 mm max. tightening torque 12 Nm

EMC product and system character-istics	EN 61326	EMC requirements for electrical resources for control technology and laboratory use
		– Resources for industrial areas, intended for indispensable operation
		– Interference emission limits for resources of class B

Any combination of the measuring transmitter with accessory products in a user-specific system fulfills the listed EMC characteristics.

Meter safety	Applicable norms	– EN 61010-1

9.2   Mounting plate

Dimensions   1100 mm x 360 mm x 13 mm (H x W x D)

Ambient conditions   - 10 °C ... + 55 °C (-14 ... 131 °F)

Mechanical structure	Material plate	PVC rigid foam, spumed
	Material pipe	PVC
	Outlet	Rigid pipe connection (DN 10)

Allowed pressure	Outlet	pressureless
	Inlet (before pressure reducer)	0 ... 10 bar
	Inlet (after pressure reducer)	0 ... 6 bar, depending on the sensor

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11   Appendix: The *SETTINGS* menu

Setting	Submenu	Selection/Values	Explanation
relay	*relay 1* *relay 2*	*select value*	*measured value,* *2nd value* *temperature*
		limits	Input field for the limiting value
		hysterese	Input field for the switching hysteresis
		min/max	Select limiting value type Min or Max
		release	Enable or disable the function
	Timer	*turn-on time*	Input field for the turn-on duration (1…10000 min)
		turn-off time	Input field for the turn-off duration (1…10000 min)
		release	Enable or disable the function

Setting	Submenu	Selection/Values	Explanation
outputs	*output 1* *output 2*	*output val.*	*measured value,* *2nd value* *temperature*
		val. 0/4 mA	Input field for the 0/4 mA start value
		val. 20 mA	Input field for the 20 mA end value
		type	0...20 mA 4...20 mA
	type u/i	*current* *voltage*	Select the analog output form *current* 2 x 0/4…20 mA *voltage* 2 x 0…5 V

Setting	Submenu	Selection/Values	Explanation
data logg.	*interval*		Input field for the save interval
temperature	*fixed temp.*	*on* *off*	Enabling / disabling the fixed temperature
	temp. Value		Input field for the fixed temperature value
sensor type (pH 298)	*pH* *ORP*		pH / ORP electrodes can be connected to the pH 298 measuring transmitters. The sensor type used must therefore be specified in the instrument.
meas. Range (*cell constant*) (LF 298)	2-electrode measuring cells: 200 µS 2000 µS 20 mS 500 mS 4-electrode measuring cells: 20 µS (0.1) 2 µS (0.01) 200 µS (0.1) 20 µS (0.01)	20 µS ... 100 mS or 200 µS ... 500 mS	For the LF 298 measuring transmitter, you have to specify the conductivity measuring range in which it should measure.
		RES (resistance) SAL (salinity) TDS (total dissolved solids)	After selecting *meas. Range*: Selection of the secondary measured value.
main value (Oxi 298) and (Cl 298)	mg/l %	*concentration in mg/l* or *saturation in %*	With the Oxi 298 measuring transmitters, the main measured value and secondary measured value can be exchanged. In the factory condition, the oxygen concentration in mg/l is the main measured value and the oxygen saturation in % is the secondary measured value.

Setting	Submenu	Selection/Values	Explanation
general	*password*	Input field for the password	Change the password (in delivery condition: 1)
	clock	Input field for date / time	Setting of date and time
	reset		Restart
	laguage	*german* *english*	Selecting the language
	filter		Signal averaging
	screensaver	*on* *off*	Enabling / disabling the screen saver
	Hold/Flow	*Hold* *Flow*	Select the status *Hold* or *Flow*

Setting	Submenu	Selection/Values	Explanation
PID controller	*type of the controller*	*PWM*	Pulse duration controller
		current 0...20 *current* 4...20	Analog controller 0…20 mA Analog controller 4…20 mA
	cont. Value	*measured value 1* *measured value 2* *temperature*	Select the target values *measured value*, *2nd value* *temperature*
	times	*cycle time* *derivative t.* *integral time* *minimal time*	Input fields for: Period Differential ratio Integral ratio Shortest duration of a switching action

	parameters	*upper limit*
		lower limit
		Target value
		dead band +
		dead band -
		break point x+
		
		break point x-
		
		break point y+
		
		break point y+
			Settings for control parameters:
			Lower limit of control range
			Upper limit of control range
			Target value
			Dead band, positive range
			Dead band, negative range
			Break point x+
			   (input value) kpp_mw
			Break point x-
			   (input value) kpn_mw
			Break point y+
			   (output value) kpp_off
			Break point y-
			   (output value) kpn_off

	release	*on* *off*	Switching the controller on or off

Setting	Submenu	Selection/Values	Explanation
modbus	*device ID*	*1 ... 247*	Modbus interface parameters (see section 6.2)
	baud rate	*4800* *9600* *19200* *38400*	
	parity	*none 1s* *none 2s* *even 1s* *even 2s* *odd 1s* *odd 2s*	
simulation	*relay 1* *relay 2*	*on* *off*	The functioning of the relays and the correct mA output of the outputs can be checked.
	output 1 *output 2*	*4 mA* *12 mA* *20 mA*	
back			

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