Honeywell

APT4000 Series 4-Wire Toroidal Conductivity Analyzers User Manual

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Contents

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Intended use

The APT4000TC is used for measurement of electrical conductivity and temperature in liquids using electrodeless (toroidal) sensors.
Fields of application are: biotechnology, chemical industry, environment, food processing, water/waste-water treatment.
The sturdy molded enclosure can be fixed into a control panel or mounted on a wall or at a post. The protective hood provides additional protection against direct weather exposure and mechanical damage.
The device provides a second current output for temperature measurement, a PID controller (making use of the relay contacts), and a universal power supply for 24 ... 230 V AC/DC.
For CIP applications, you can switch between two parameter sets.

Trademarks

The following names are registered trademarks. For practical reasons they are shown without trademark symbol in this manual.
Sensocheck®
Sensoface®
VariPower®

Safety information

Be sure to read and observe the following instructions!

The device has been manufactured using state of the art technology and it complies with applicable safety regulations. When operating the device, certain conditions may nevertheless lead to danger for the operator or damage to the device.

⚠ CAUTION

Commissioning may only be carried out by trained experts. Whenever it is likely that protection has been impaired, the device shall be made inoperative and secured against unintended operation. The protection is likely to be impaired if, for example:

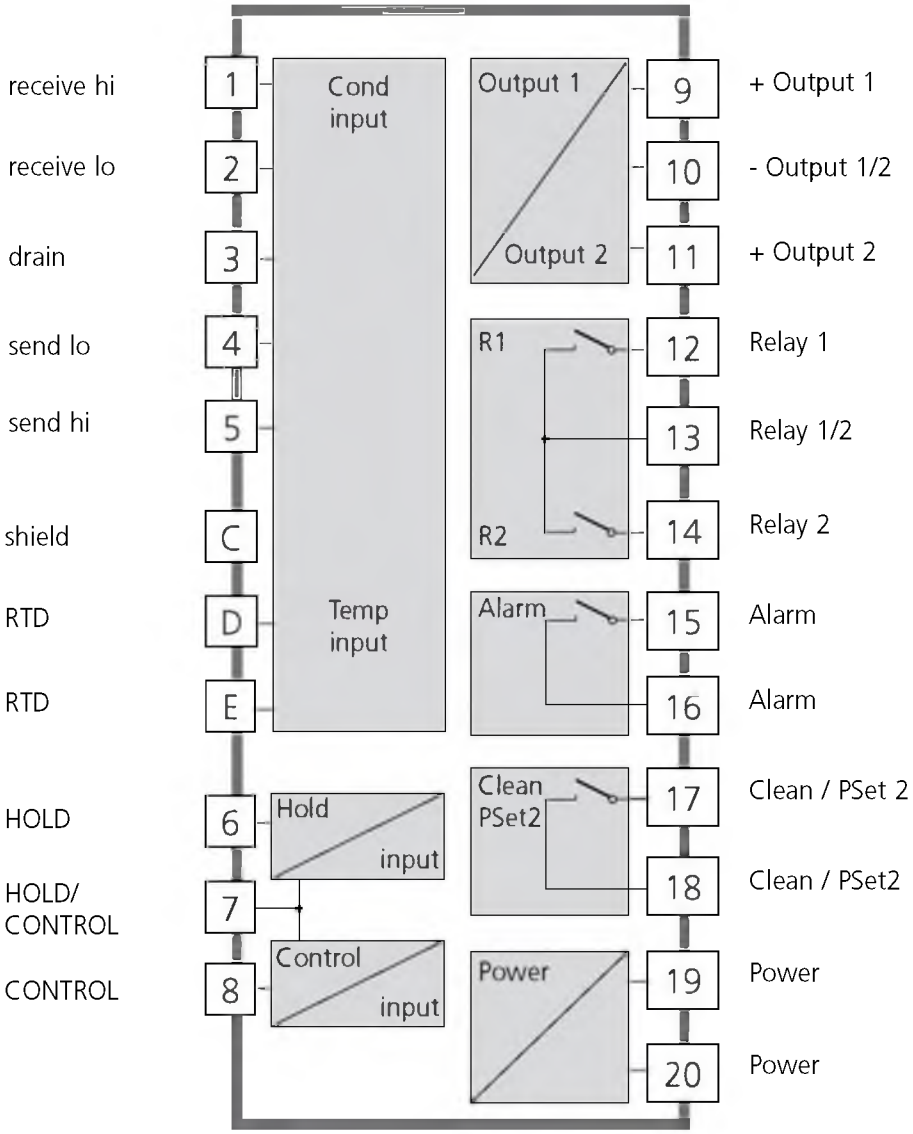
- the device shows visible damage
- the device fails to perform the intended measurements
- after prolonged storage at temperatures above 70 °C
- after severe transport stresses

Before recommissioning the device, a professional routine test in accordance with EN 61010-1 must be performed. This test should be carried out by the manufacturer.

CAUTION

Before commissioning it must be proved that the device may be connected with other equipment.

Overview of APT4000TC

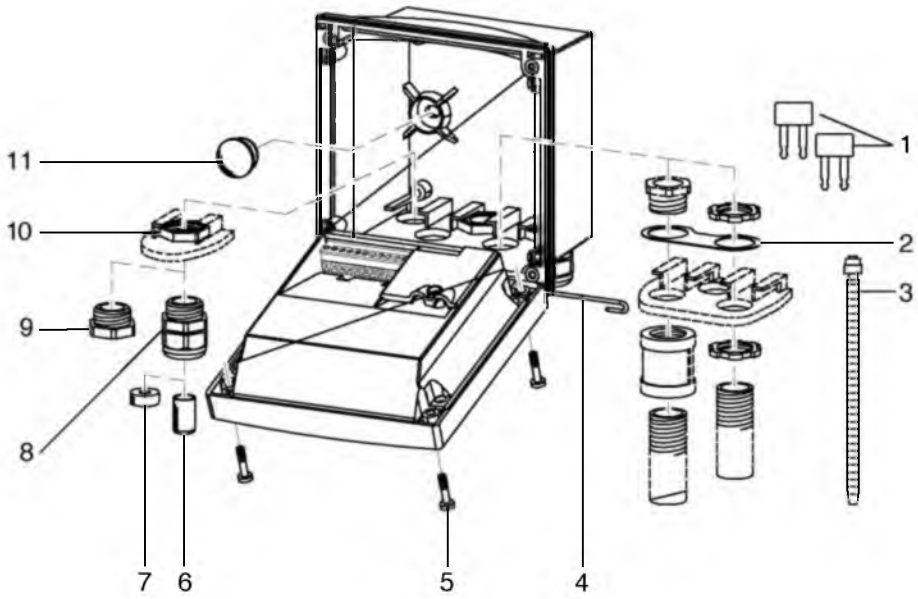


Assembly

Package contents

Check the shipment for transport damage and completeness. The package should contain:

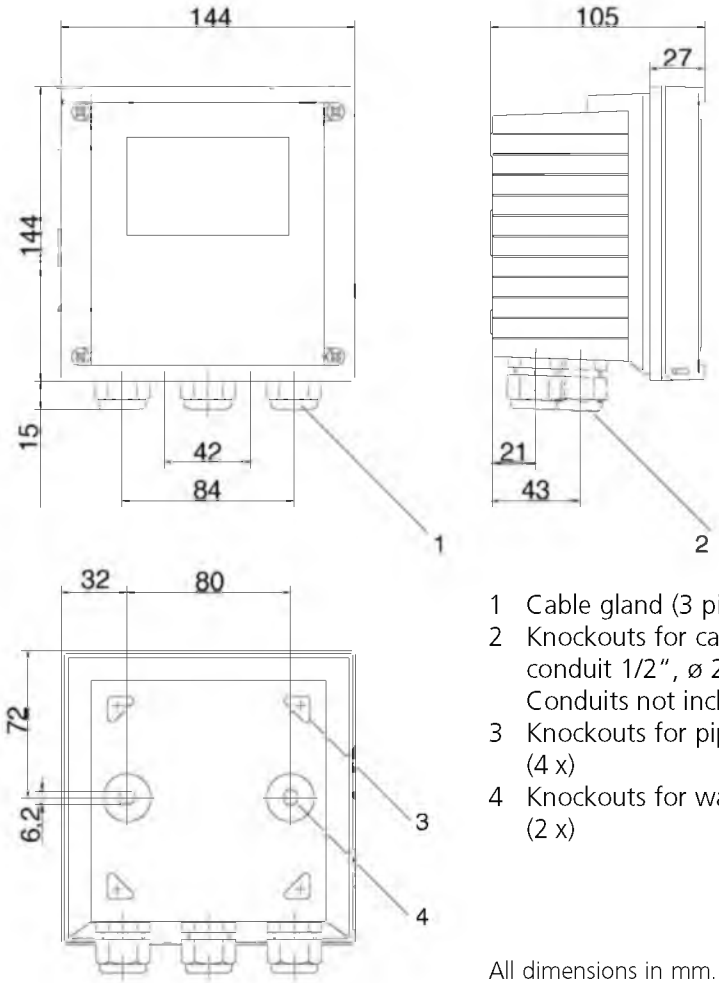
- Front unit of APT4000TC
- Rear unit
- Bag containing small parts
- This instruction manual
- Specific test report



1 Jumper (2 x)
2 Washer (1 x),
for conduit mounting: Place washer between enclosure and nut
3 Cable tie (3 x)
4 Hinge pin (1 x),
insertable from either side
5 Enclosure screw (4 x)
6 Sealing insert (1 x)
7 Rubber reducer (1 x)
8 Cable gland (3 x)
9 Filler plug (3 x)
10 Hexagon nut (5 x)
11 Sealing plug (2 x), for sealing in case of wall mounting

Fig.: Assembling the enclosure

Mounting plan

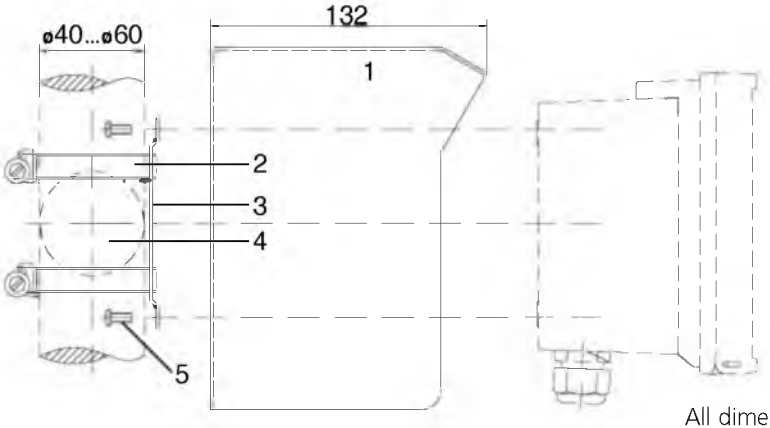


1 Cable gland (3 pieces)
2 Knockouts for cable gland or conduit 1/2", ø 21.5 mm (2 x) Conduits not included!
3 Knockouts for pipe mounting (4 x)
4 Knockouts for wall mounting (2 x)

All dimensions in mm.

Fig.: Mounting plan

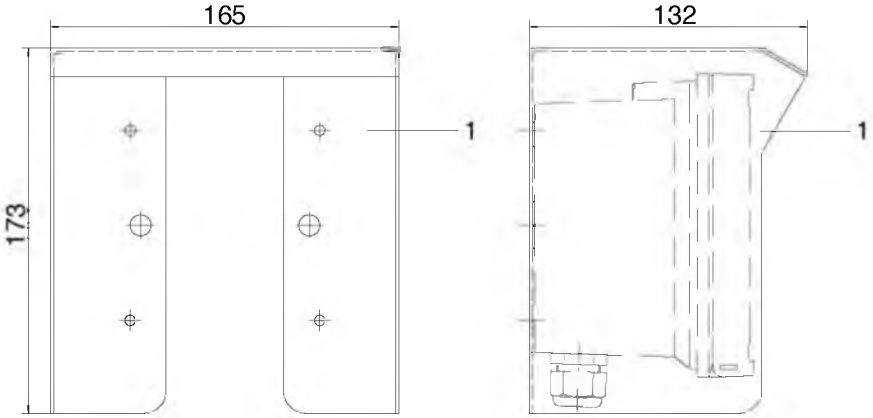
Pipe mounting, panel mounting



All dimensions in mm.

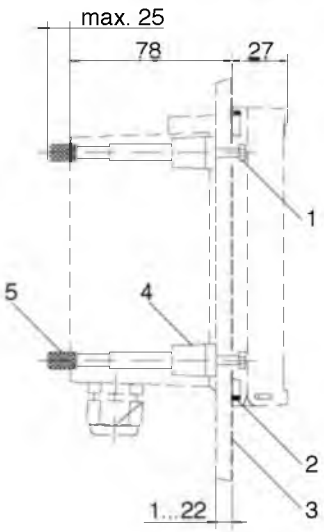
1 512005989-001 protective hood (if required)
2 Hose clamp with worm gear drive to DIN 3017 (2 x)
3 Pipe-mount plate (1 x)
4 For vertical or horizontal posts or pipes
5 Self-tapping screw (4 x)

Fig.: 51205988-001 pipe-mount kit



All dimensions in mm.

Fig.: 51205988-001 protective hood for wall and pipe mounting



1 Screw (4 x)
2 Gasket (1 x)
3 Panel
4 Span piece (4 x)
5 Threaded sleeve (4 x)

Panel cutout 138 x 138 mm
(DIN 43700)

All dimensions in mm.

Fig.: 51205990-001 panel-mount kit

Installation and connection

Installation instructions

- Installation may only be carried out by trained and qualified personnel in accordance with the instruction manual and as per applicable standards and regulations.
- Be sure to observe the technical specifications and input ratings during installation.
- Be sure not to notch the conductor when stripping the insulation.
- Before connecting the device to the power supply, make sure that its voltage lies within the range 20.5 to 253V AC/DC.
- All parameters must be set by a system administrator prior to commissioning.

The terminals are suitable for single wires and flexible leads up to 2.5 mm^2 (AWG 14).

CAUTION

Be sure to observe the additionally applicable national safety instructions!

Terminal assignments

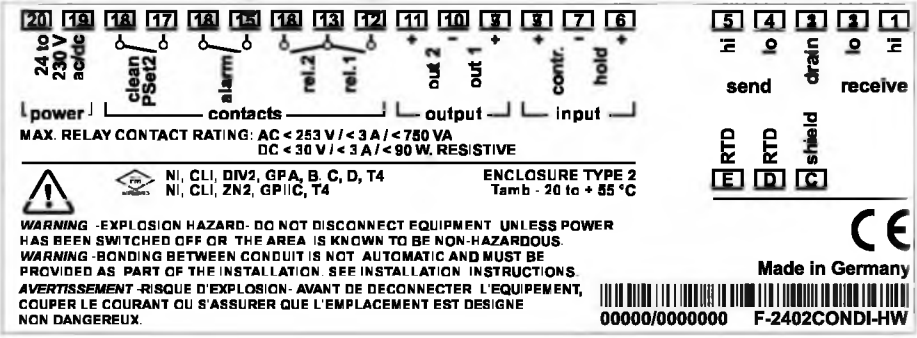
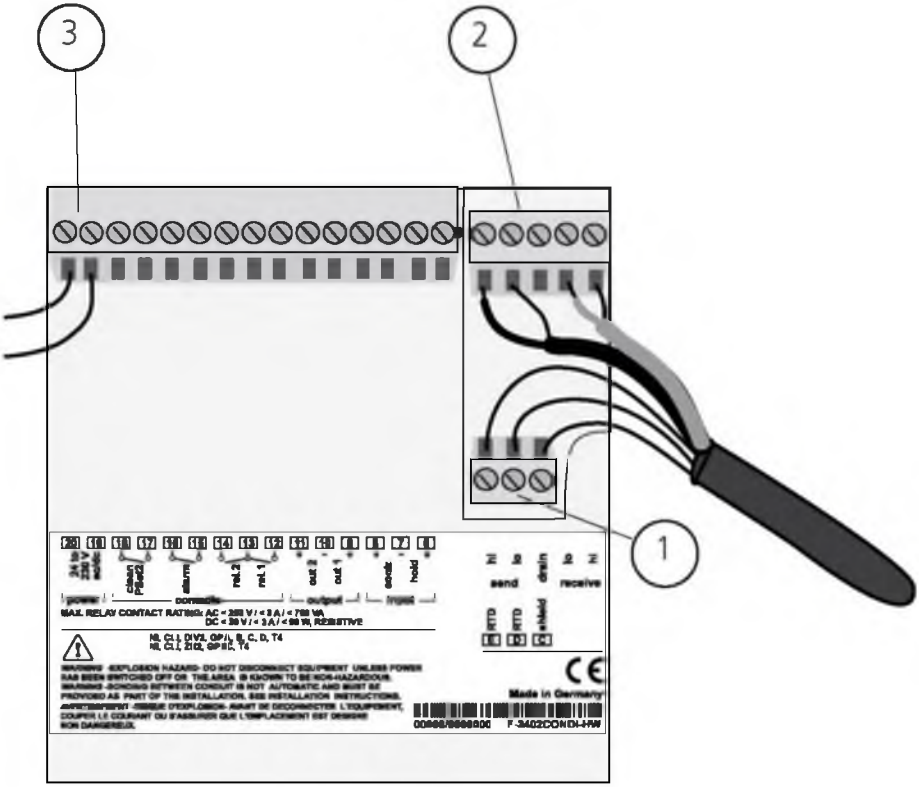


Fig.: APT4000TC terminal assignments



1) Terminals for temperature probe and outer shield
2) Terminals for toroidal conductivity sensor
3) Terminals for power supply

Fig.: Information on installation, rear side of device

Division 2 wiring

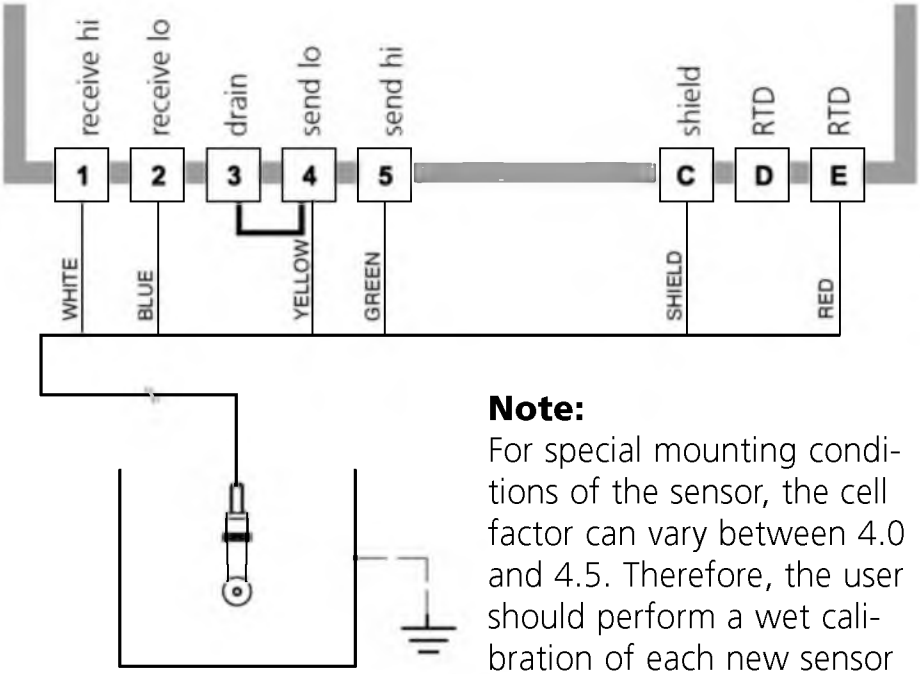
FM

The connections to the analyzer must be installed in accordance with the National Electric Code (ANSI-NFPA 70) Division 2 hazardous (classified) location non-incendive wiring techniques.

Conductivity measurement with Honeywell 5000TC toroidal conductivity sensor

The Honeywell 5000TC toroidal conductivity sensor is used to measure low to highest conductivity values. It can be used for measurements in safe areas.

APT4000TC



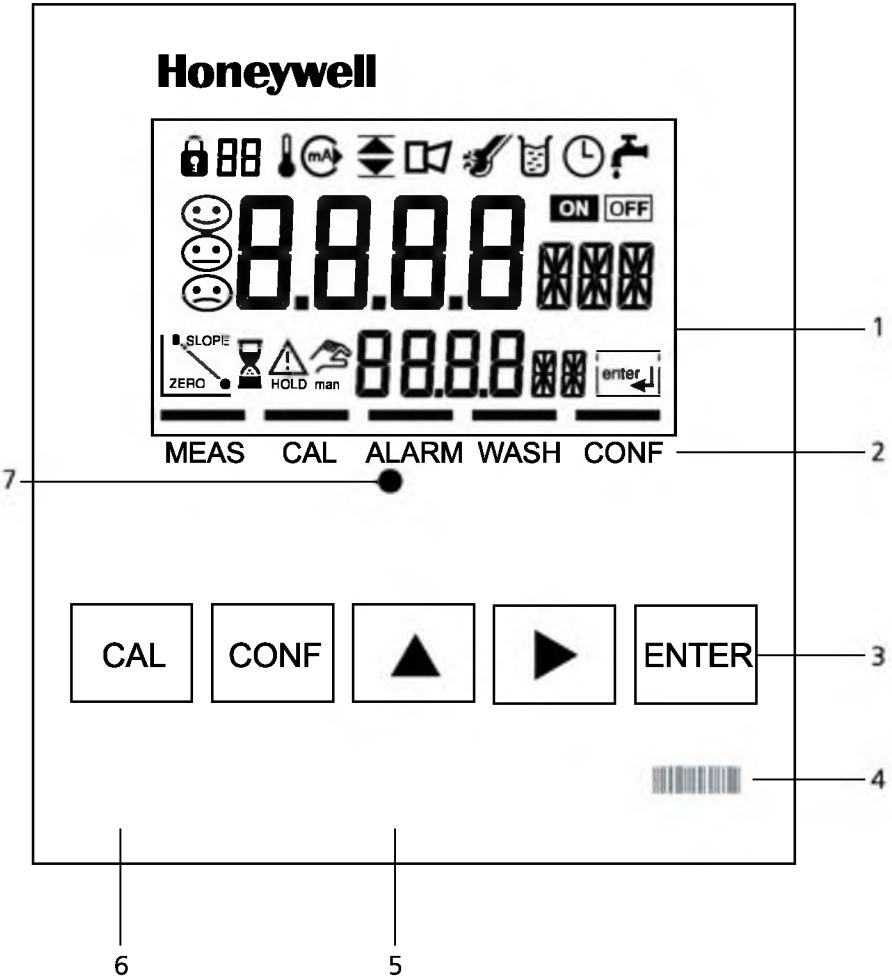
Note:
For special mounting conditions of the sensor, the cell factor can vary between 4.0 and 4.5. Therefore, the user should perform a wet calibration of each new sensor to determine the exact cell factor.

Settings for Honeywell 5000TC toroidal conductivity sensor

	Menu	Setting
Temp probe	CONF 1200	Pt 1000
Cell factor	CAL 1100	4.44

User interface and display

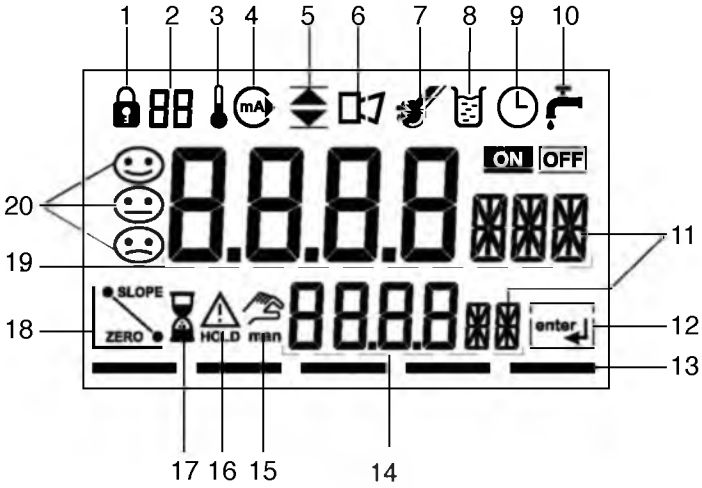
User interface



1 Display
2 Mode indicators (no keys), from left to right:
- Measuring mode
- Calibration mode
- Alarm
- Wash contact
- Configuration mode

3 Keypad
4 Coding
5 Rating plate
6 Model designation
7 Alarm LED

Display



1 Mode code entry
2 Parameter set 2 selected
3 Temperature
4 Current output
5 Limit values
6 Alarm
7 Sensocheck
8 Calibration
9 Interval/response time
10 Wash contact
11 Measurement symbol
12 Proceed with **ENTER**
13 Bar for identifying the device status, above mode indicators, from left to right:
- Measuring mode
- Calibration mode
- Alarm
- Wash contact
- Configuration mode

14 Lower display
15 Manual temp indicator
16 Hold mode active
17 Waiting time running
18 Sensor data
19 Main display
20 Sensoface

Operation: Keypad

CAL	Start, end calibration
CONF	Start, end configuration
▶	Select digit position (selected position flashes)
▲	Edit digit
ENTER	• Calibration: Continue in program flow • Configuration: Confirm entries, next configuration step • Measuring mode: Display output current

CAL → ENTER	Cal Info: Display of cell factor and zero point
CONF → ENTER	Error Info: Display of last error message
▶ + ▲	Start GainCheck device self-test

Safety functions

Sensocheck, Sensoface sensor monitoring

Sensocheck continuously monitors the sensor and its wiring. Sensocheck can be switched off (see Configuration of alarm settings).

Sensoface provides information on the conductivity sensor condition. The primary coil and its lines are continuously monitored for short circuits, the secondary coil and its lines are checked for open circuits.
The three Sensoface indicators inform of the sensor condition.

GainCheck device self-test

A display test is carried out, the software version is displayed and the memory and measured value transfer are checked.
Start GainCheck device self-test: ▶ + ▲

Automatic device self-test

The automatic device self-test checks the memory and measured-value transfer. It runs automatically in the background at fixed intervals.

Safety functions

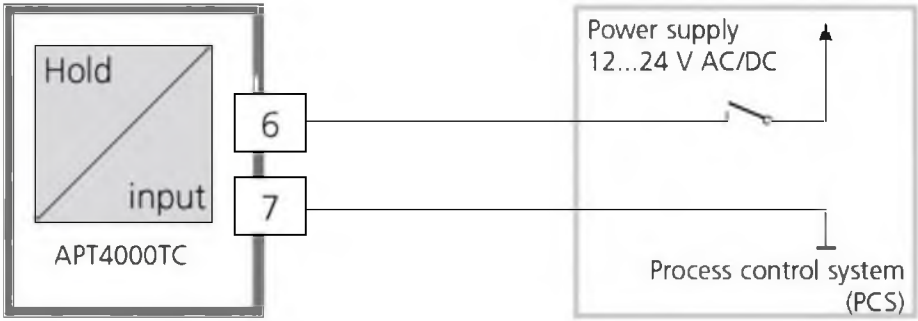
Hold mode

Display: ⚠ HOLD

The Hold mode is a safety state during configuration and calibration. Output current is frozen (Last) or set to a fixed value (Fix). Alarm and limit contacts are disabled.
If the calibration or configuration mode is exited, the device remains in the Hold mode for safety reasons. This prevents undesirable reactions of the connected peripherals due to incorrect configuration or calibration. The measured value and "HOLD" are displayed alternately. The device only returns to measuring mode after **ENTER** is pressed and 20 seconds have passed.

To activate the Hold mode from outside

The Hold mode can be activated from outside by sending a signal to the Hold input (e.g. from the process control system).



Hold active	Hold inactive
10 ... 30 V AC/DC	0 ... 2 V AC/DC

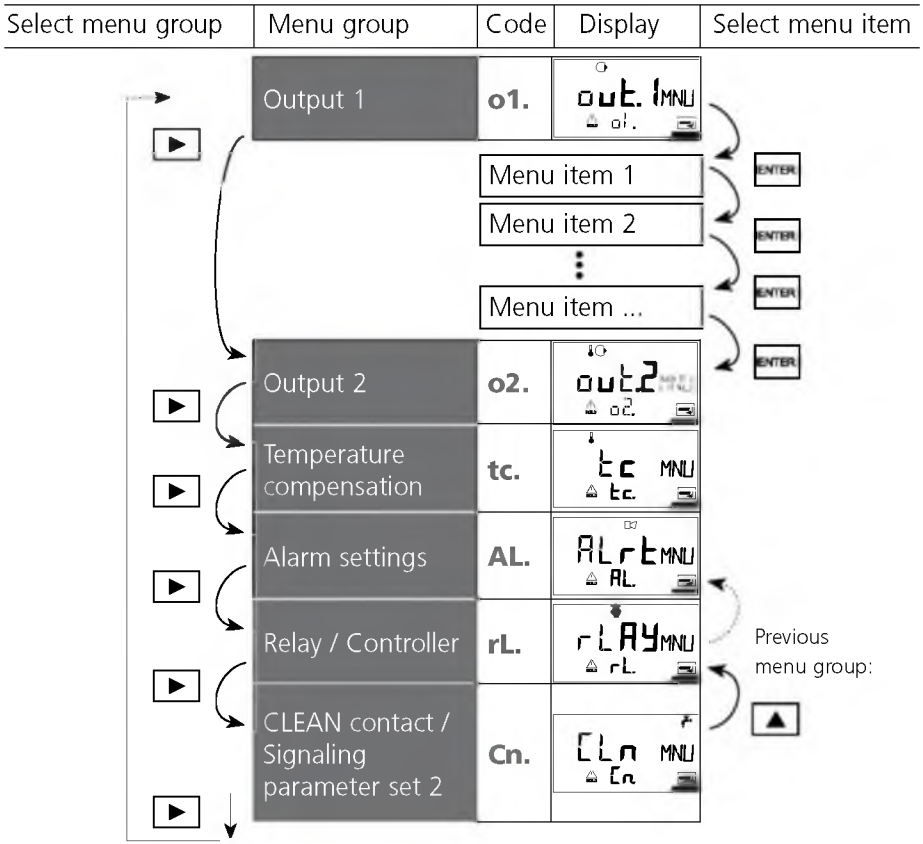
Configuration

In the Configuration mode you set the device parameters. The device can store two different parameter sets and switch between them. Sensor data and "Clean/Pset2" output are edited in parameter set 1 only. They are valid for both parameter sets.

Configuring	CONF	Press **CONF**.
Parameter set 1:	1200	Enter mode code "1200": **Edit parameter set 1** with ▶ and ▲, confirm/proceed with **ENTER.**
Parameter set 2: "88" appears in the display.	1288	Enter mode code "1288": **Edit parameter set 2** with ▶ and ▲, confirm/proceed with **ENTER**.
Hold During configuration the device remains in the Hold mode.	HOLD 0-20mA HOLD icon	The output current is frozen (at its last value or at a preset fixed value, depending on the configuration), limit and alarm contacts are inactive. The controller is in the configured state, Sensoface is off, "Configuration" mode indicator is on.
Input errors	Err	The configuration parameters are checked during the input. In the case of an incorrect input "Err" is displayed for approx. 3 sec. The incorrect parameters cannot be stored. Input must be repeated.
End	CONF ENTER	End with **CONF**. The measured value and Hold are displayed alternately, "ENTER" flashes. Press **ENTER** to end the Hold mode. The measured value is displayed. The output current remains frozen for another 20 sec (HOLD icon on, "hourglass" flashes).

Menu structure of configuration

The configuration steps are assigned to different menu groups.
With the arrow keys you can jump between the individual menu groups.
Each menu group contains menu items for setting the parameters.
Pressing **ENTER** opens a menu item. The values are edited using the arrow keys. Pressing **ENTER** confirms/stores the settings.
Return to measurement: Press **CONF**.



Overview of configuration steps

Code	Menu	Selection / Default
out1	**Output 1**	**(Factory setting bold print)**
o1.	Sensor selection *	**5000 TC** / other
	other*: Entry of cell factor	xx.xxx c
	Enter transfer ratio	xxx.xx
	Select measuring frequency	8 kHz / **12 kHz**
	Select temperature probe	Pt100 / **Pt1000** / NTC100
	Select measured variable	**mS/cm**, S/m, Conc, SAL
	Select solution (Conc)	**NaCl**, HCl, NaOH, H_2SO_4, HNO_3 (Code **01** ... 10) (see meas. ranges)
	Select current range	0-20 mA / **4-20 mA**
	Characteristic (not for SAL, Conc)	**Linear** / Logarithmic
	LIN: Enter current start	**000.0 mS** (xxx.x mS)
	Enter current end	**100.0 mS** (xxx.x mS)
	LOG: Enter current start	**0.1 mS** (in decades: 0.1...1000)
	Enter current end	**100 mS** (in decades: 0.1...1000)
	Time constant of output filter	**0 sec** (0 ... 120 sec)
	22 mA signal for error messages	ON / **OFF**
	Signal behavior during HOLD	**Last** / Fix
	Fix: Enter fixed value	**021.0 mA** (000.0 ... 21.0 mA)
out2	**Output 2**	
o2.	Select temperature unit	**°C** / °F
	Select current range	0 - 20 mA / **4 - 20 mA**
	Enter current start	**000.0 °C** (xxx.x °C)
	Enter current end	**100.0 °C** (xxx.x °C)
	Time constant of output filter	**0 sec** (0 ... 120 sec)
	22 mA signal for temp error	ON / **OFF**
	Signal behavior during HOLD	**LAST** / FIX
	Fix: Enter fixed value	**21.0 mA** (00.0 ... 21.0 mA)

Code	Menu		Selection / Default
tc	**Temperature compensation**		
tc.	Select temperature compensation		**OFF** / Lin / nLF
	Lin: Enter temperature coefficient		**02.00 %/K** (xx.xx %/K)
ALrt	**Alarm settings**		
AL.	Select Sensocheck		ON / **OFF**
	Enter alarm delay		**0010 s** (xxxx s)
	LED in HOLD mode		ON / **OFF**
rLAY	**Relay 1/2: Limit values, controller**		
rL.	Select limit function / controller		**LiMIT** / CtROL / USP
	L1.	Select contact function	**Lo** / Hi
		Select contact response	**N/O** / N/C
		Enter switching point	**000.0 mS** (xxxx)
		Enter hysteresis	**001.0 mS** (xxxx)
		Enter delay	**0010 sec** (0 ... 9999 sec)
	L2.	Select contact function	Lo / **Hi**
		Select contact response	**N/O** / N/C
		Enter switching point	**100.0 mS** (xxxx)
		Enter hysteresis	**001.0 mS** (xxxx)
		Enter delay	**0010 s** (xxxx SEC)
	Ct.	Enter neutral zone	**001.0 mS** (xxxx)
		(P) Controller gain K_P	**0100 %** xxxx %
		(I) Reset time T_R	**0000 sec** (xxxx sec)
		(D) Rate time T_D	**0000 sec** (xxxx sec)
		Controller type	**PLC** / PFC
		PLC: Pulse length	**0010 sec** (xxxx sec)
		PFC: Pulse frequency	**0060/min** (xxxx/min)
		Select HOLD behavior	**Y Last** / Y Off
Cln	**Contact CLEAN / PSet2**		
Cn.	(Select Cleaning / Parameter set signaling)*		**rinse** / PSet2
	rinse	Rinsing interval	**000.0 h** (xxx.x h)
		Rinse duration	**0060 sec** (xxxx sec)
		Contact response	**N/O** / N/C

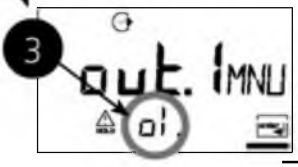
* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

Configuration

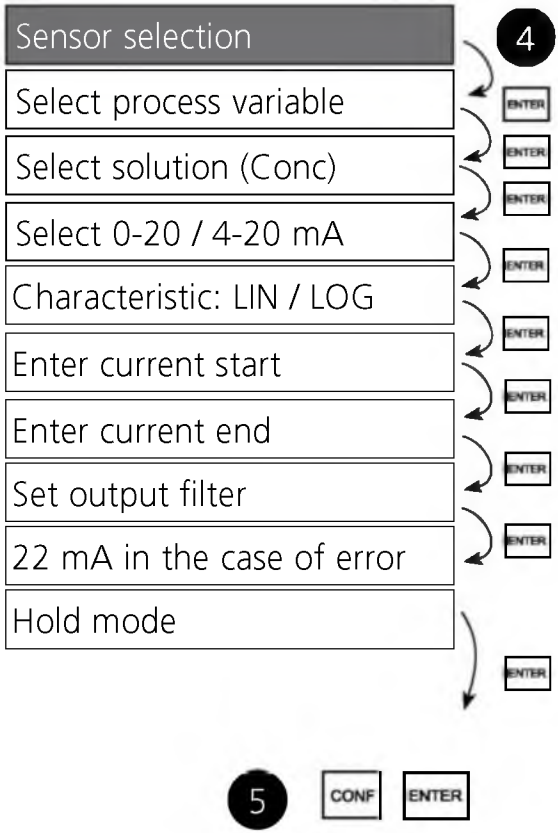
Output 1

Select sensor type

Output 1:



1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 27).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



Code	Display	Action	Choices
o1.		Select configuration (Press **CONF**.)	
	1200 After correct input a welcome text (CONF) is displayed for approx. 3 sec.	For parameter set 1: Enter mode code "1200" (Select position with ▶ arrow key and edit number with ▲ key. When the display reads "1200", press **ENTER** to confirm.)	
	1288 After correct input a welcome text (CONF) is displayed for approx. 3 sec.	For parameter set 2: Enter mode code "1288" (Select position with ▶ arrow key and edit number with ▲ key. When the display reads "1288", press **ENTER** to confirm.)	
	HOLD	Device is in the Hold mode (HOLD icon is on).	
	othr o1.Sn	Select sensor*: Select with arrow key ▶. Proceed with **ENTER**. **Note:** After each sensor selection the nominal cell factor of the sensor is stored. To adjust the cell factor to the device, calibrate the sensor afterwards!	**5000 TC** (5000 TC/ other)

Note: Characters represented in gray are flashing and can be edited.

* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

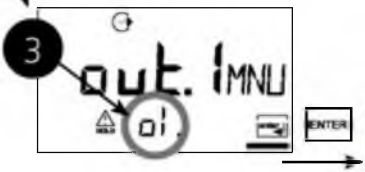
Configuration

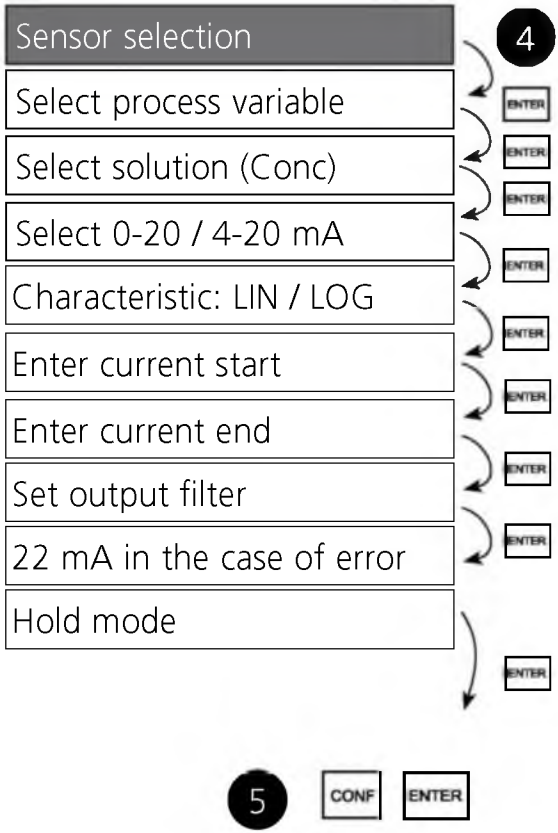
Output 1

Select sensor and temperature probe

1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 29).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

Output 1:





Code	Display	Action	Choices
o1.	  	With **other** selected, the sensor parameters are entered separately: • Enter cell factor: (Select position with ▶ key and edit number with ▲ key). Proceed with **ENTER** • Enter transfer ratio. Proceed with **ENTER.**	
	 	• Select measuring frequency: Select with arrow key ▶. Proceed with **ENTER**.	**12 KHZ** (8 KHZ 12 KHZ)
	  	• Select temperature probe: Select with arrow key ▶. Proceed with **ENTER.** **Note** When **other** is called once more, the last sensor parameters are displayed and can be edited.	**1000Pt** (100Pt 1000Pt 100NTC)

Note: Characters represented in gray are flashing and can be edited.

* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

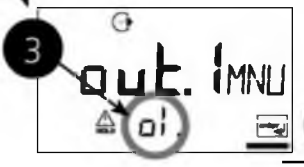
Configuration

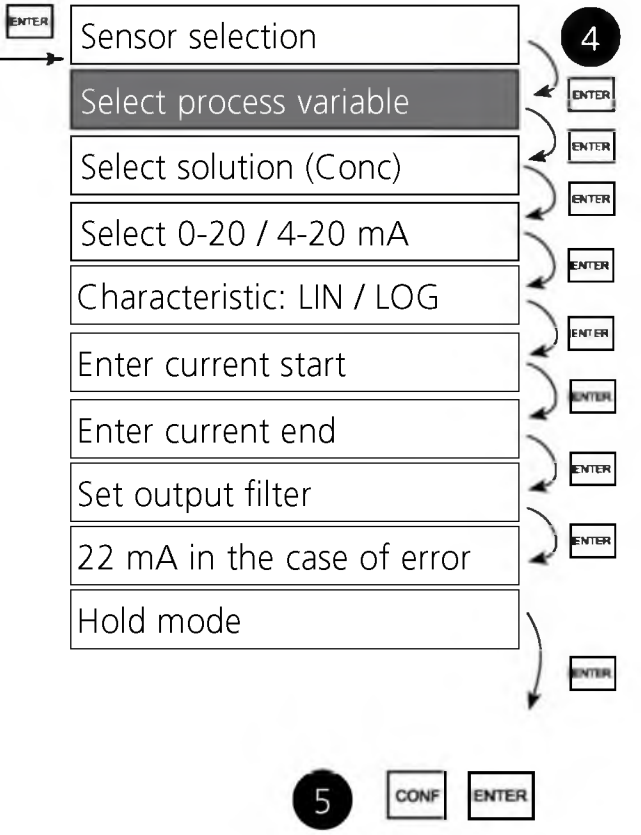
Output 1

Select process variable

1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 31).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

Output 1:





Code	Display	Action	Choices
o1.		Select process variable:	**000.0 mS**
		Select with ▸ arrow key Proceed with **ENTER**.	(0.000 mS 00.00 mS 000.0 mS 0000 mS 0.000 S/m 00.00 S/m 00.00 SAL 00.00 % (Conc))
	 	Conductivity: • 0.000 ... 9.999 mS/cm • 00.00 ... 99.99 mS/cm • 000.0 ... 999.9 mS/cm • 0000 ... 1999 mS/cm • 0.000 ... 9.999 S/m • 00.00 ... 99.99 S/m	
		Salinity (SAL): • 0.0 ... 45.0 ‰ (0 ... 35 °C)	
		Concentration (Conc): • 0.00 ... 9.99 % by wt	

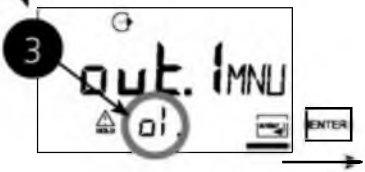
Note: Characters represented in gray are flashing and can be edited.

Configuration

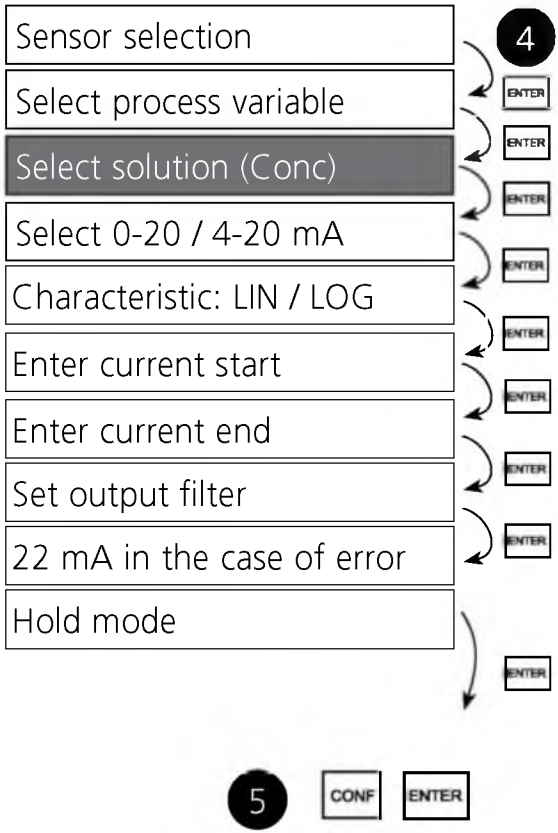
Output 1

Concentration measurement: Select solution

Output 1:

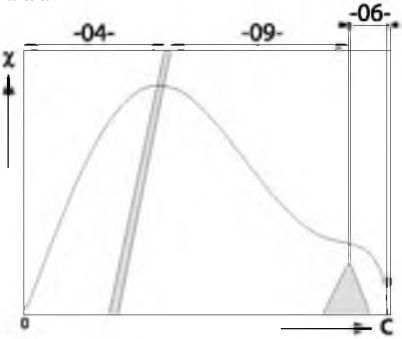


1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 33).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



Code	Display	Action	Choices
o1.	00.00 % / o1 Unit -01- SOL / o1 Conc -06- SOL / o1 Conc	Only with 00.00 % Conc can you select the process solution: Select with ▸ arrow key **-01-** NaCl (0 ... 26 % by wt) **-02-** HCl (0 ...18 % by wt) **-03-** NaOH (0 ... 14 % by wt) **-04-** H_2SO_4 (0 ... 30 % by wt) **-05-** HNO_3 (0 ... 30 % by wt) **-06-** H_2SO_4 (92 ... 99 % by wt) **-07-** HCl (22 ... 29 % by wt) **-08-** HNO_3 (35 ... 36 % by wt) **-09-** H_2SO_4 (32 ... 84 % by wt) **-10-** NaOH (18 ... 50 % by wt) Proceed with **ENTER**	**-01-SOL** (-01-SOL -02-SOL -03-SOL -04-SOL -05-SOL -06-SOL -07-SOL -08-SOL -09-SOL -10-SOL)

Example:
Measurement ranges for sulphuric acid



Concentration curves / ranges

(See Appendix: Concentration curves / ranges)

The concentration curves of many substances show a maximum. This means that if the substance concentration continues to increase and the temperature remains constant, the conductivity will drop. Therefore, a one-to-one correlation of values is only possible in defined ranges.

These partial ranges must be selected as measurement ranges in the configuration.

Configuration

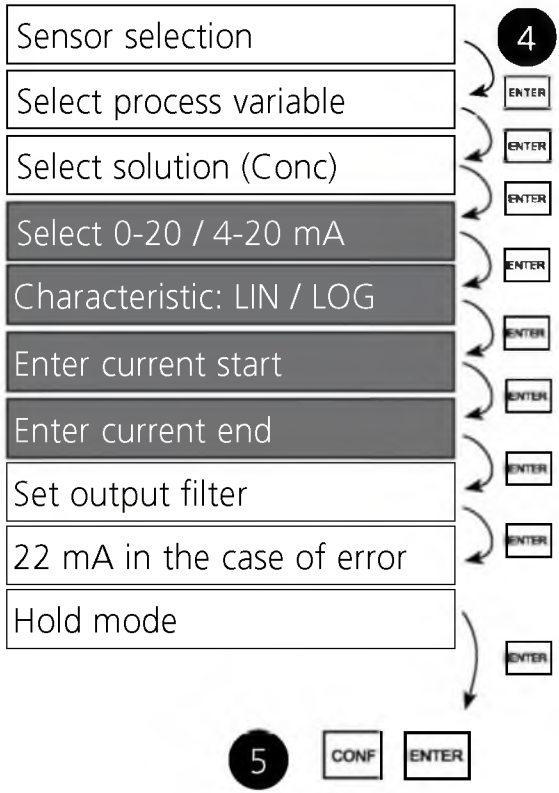
Output 1

Output current range. LIN/LOG characteristic

LIN characteristic: Current start / end

Output 1:

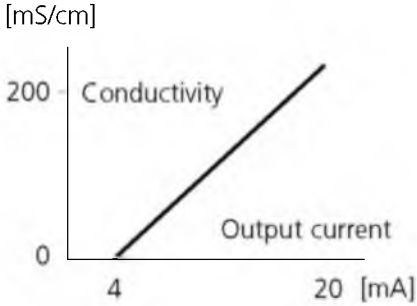
1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 35).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



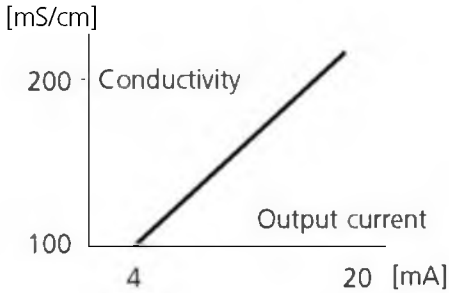
Code	Display	Action	Choices
o1.	4-20 mA o1. rNG	Set output current range Select with ▸ arrow key. Proceed with **ENTER**	**4-20 mA** (0 - 20 mA 4 - 20 mA)
	LIN o1.CH	Select output characteristic Select with ▸ arrow key. Proceed with **ENTER** (Step omitted for % (Conc) and SAL)	**LIN** (LIN / LOG)
	000.0 mS o1. 4mA 100.0 mS o1.20mA	With **LIN** selected: • Enter current start (lower end of scale). Select with ▸ key, edit number with ▲ key, proceed with **ENTER**. • Enter current end (upper end of scale). Proceed with **ENTER**	**000.0 mS** (xxx.x mS) **100.0 mS** (xxx.x mS)

Assignment of measured values:
Current start and current end

Example 1:
Range 0...200 mS/cm



Example 2: Range 100...200 mS/cm
Advantage: Higher resolution in range of interest



Configuration

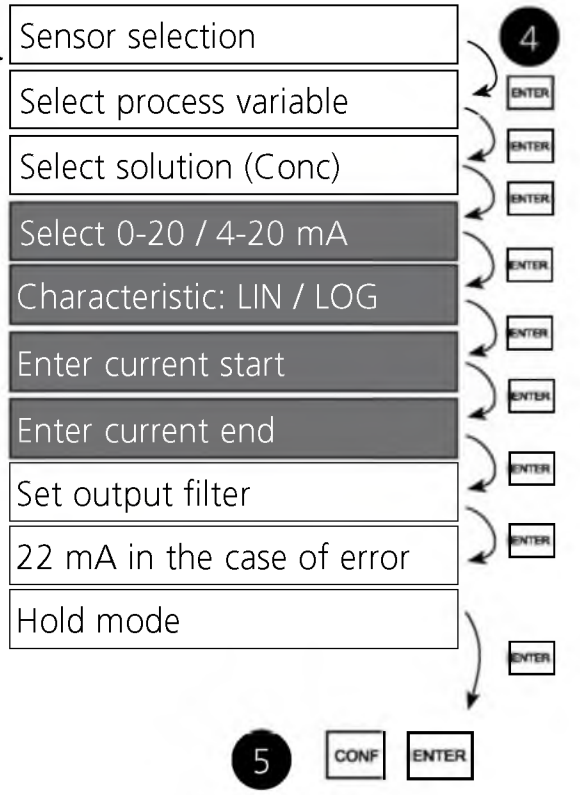
Output 1

Output current range. LIN/LOG characteristic

LOG characteristic: Current start / end

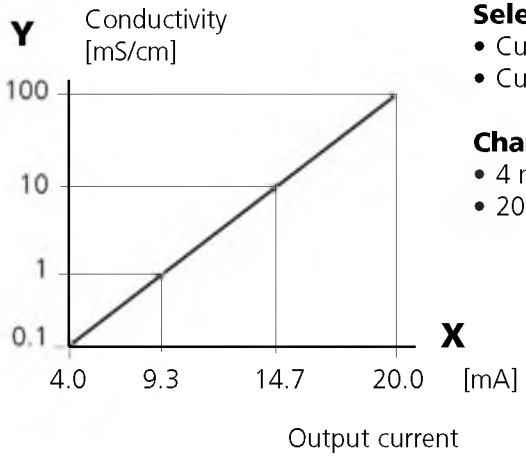
Output 1:

1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 37).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



Code	Display	Action	Choices
o1.	0.1 mS o1. 4 mA	With **LOG** selected: • Enter current start (lower end of scale). Select with ▸ key, edit number with ▲ key, proceed with **ENTER**.	**0.1 mS** (0.001 mS 0.01 mS 1.0 mS 10 mS 100 mS 1000 mS)
	100.0 mS o1.20 mA	• Enter current end (upper end of scale). Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**100 mS** (0.001 mS 0.01 mS 1.0 mS 10 mS 100 mS 1000 mS)

Example: Measurement range over 3 decades



Selection: 0-20/4-20mA
- Current start: 4 mA
- Current end: 20 mA

Characteristic: LOG
- 4 mA 0.1 mS/cm
- 20 mA 100 mS/cm

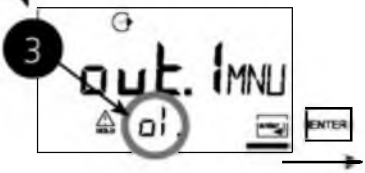
Configuration

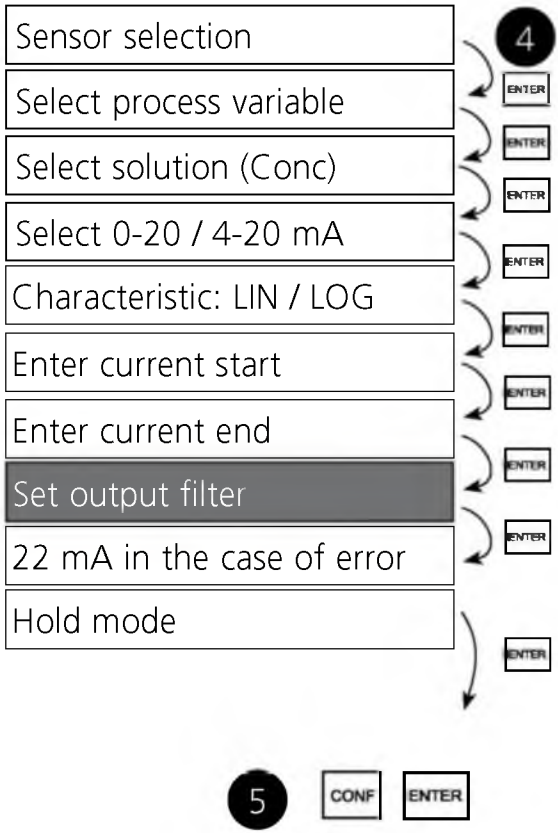
Output 1

Time constant of output filter

1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 39).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

Output 1:





Code	Display	Action	Choices
o1.	0000 SEC o1 FtME	Time constant of output filter Default setting: 0 s (inactive). To specify a time constant: Select with ▸ key, edit number with ▲ key, proceed with **ENTER**	**0 sec** 0 ... 120 sec

Time constant of output filter (attenuation)

To smoothen the current output, a low-pass filter with adjustable filter time constant can be switched on.
When there is a jump at the input (100 %), the output level is at 63 % after the time constant has been reached.
The time constant can be set from 0 to 120 sec.
If the time constant is set to 0 sec, the current output follows the input.

Note:
The filter only acts on the current output, not on the display, the limit values, or the controller!

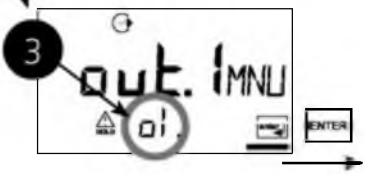
Time constant 0 to 120 sec

Configuration

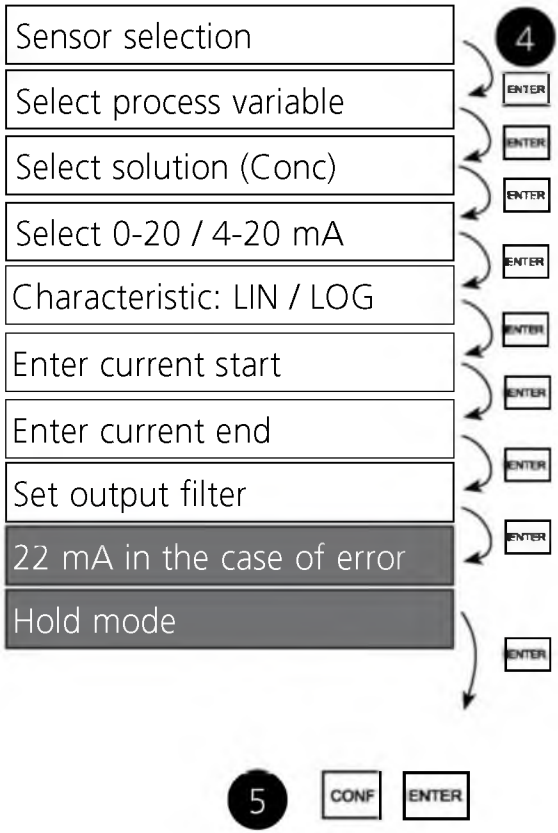
Output 1

Output current during Error and HOLD.

Output 1:

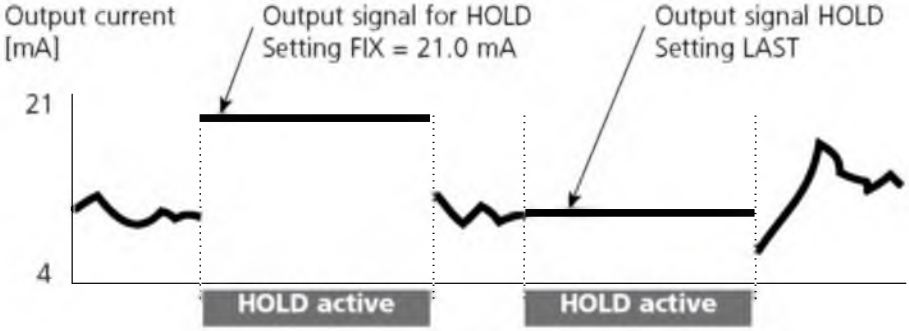


1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Output 1** menu group using arrow keys. All items of this menu group are indicated by the code "o1."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 41).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



Code	Display	Action	Choices
o1.	22 mA o1.FAIL	22 mA signal for error message Select with ▸ arrow key. Proceed with **ENTER**	**OFF** (OFF ON)
	LAST o1.HoLD	Output signal during HOLD LAST: During HOLD the last measured value is maintained at the output FIX: During HOLD a value (to be entered) is maintained at the output Select with ▸ arrow key. Proceed with **ENTER**	**LAST** (LAST FIX)
	FIX o1.HoLD 021.0 mA o1.Fix	Only with FIX selected: Enter current which is to flow at the output during HOLD. Select position with ▸ arrow key and edit number with ▲ key. Proceed with **ENTER**	**021.0 mA** (00.0 ... 21.0 mA)

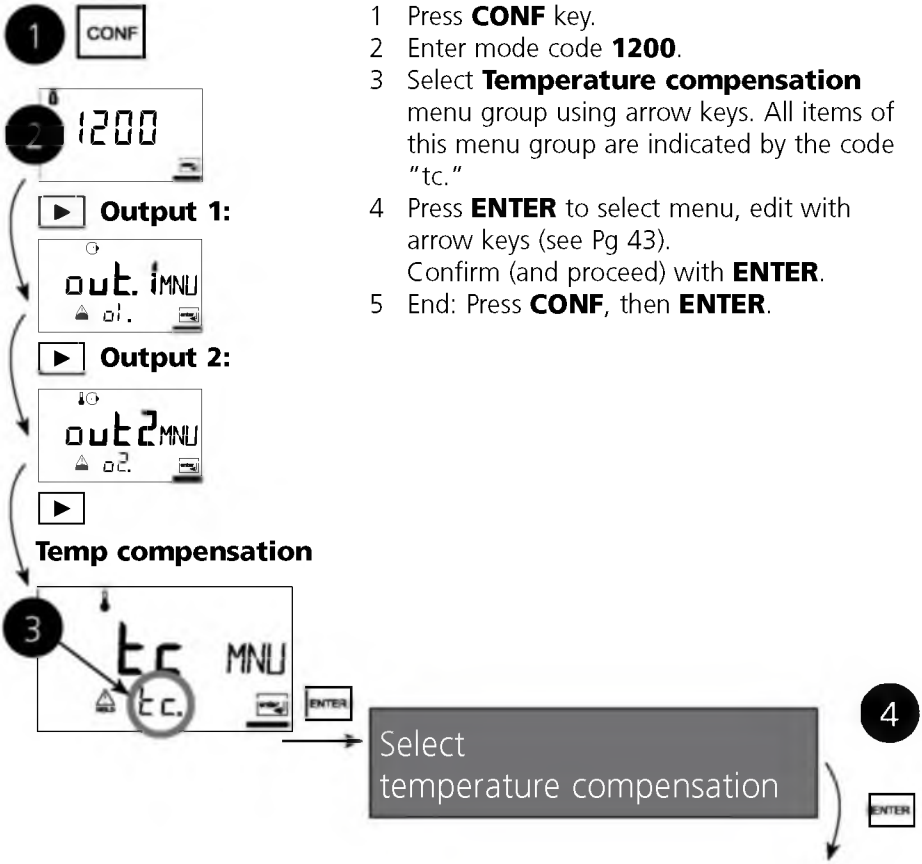
Output signal for HOLD:



Configuration

Temperature compensation

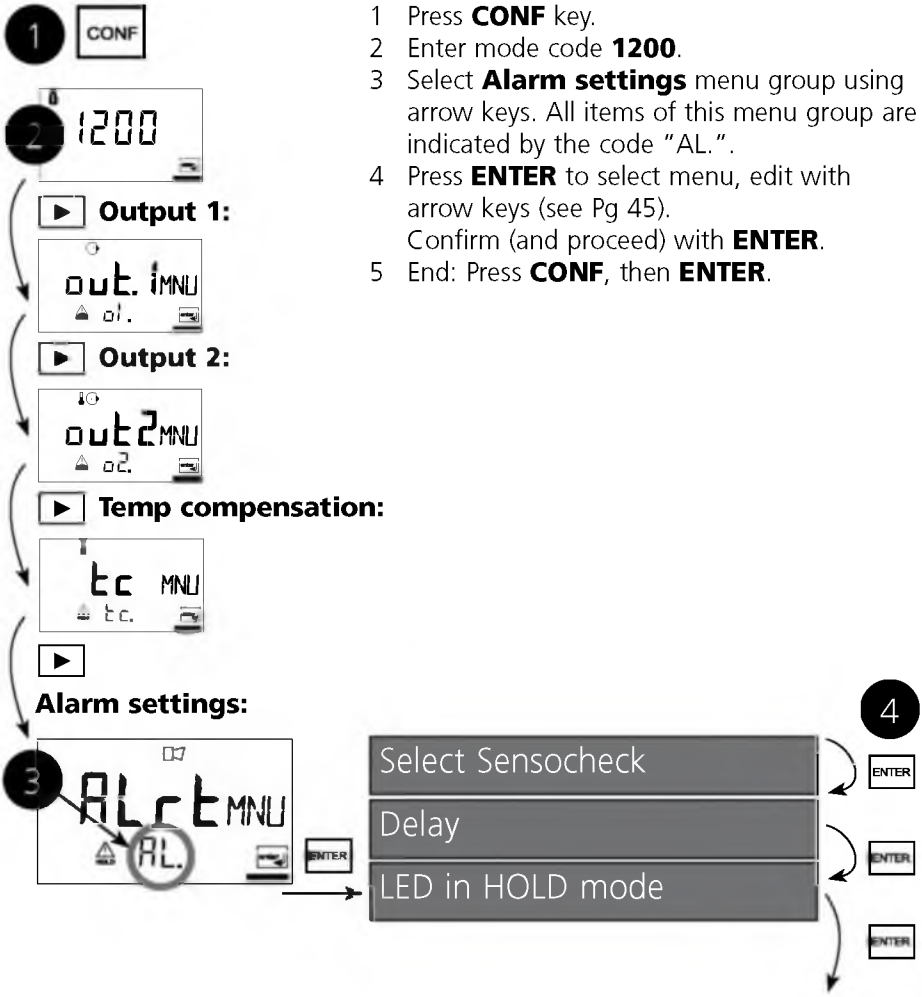
Select temperature compensation



1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Temperature compensation** menu group using arrow keys. All items of this menu group are indicated by the code "tc."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 43).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

Code	Display	Action	Choices
tc.	OFF tc. Lin tc. nLF tc.	Select temperature compensation (not for SAL, CONC) **OFF:** Temperature compensation switched off. Select with ▸ key, proceed with **ENTER**. **LIN:** Linear temperature compensation with entry of temperature coefficient and reference temperature. **NLF:** Temperature compensation for natural waters to EN 27888	**OFF** (OFF LIN nLF)
	00.0.0 %/K tc. LIN	Only with linear temperature compensation (LIN) selected: Enter temperature coefficient. Select position with ▸ key and edit number with ▲ key. Proceed with **ENTER**	**02.00%/K** (XX.XX%/K)

Configuration
Alarm settings

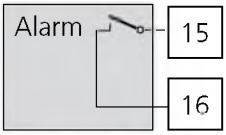


1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Alarm settings** menu group using arrow keys. All items of this menu group are indicated by the code "AL.".
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 45).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

Code	Display	Action	Choices
AL.	CHECK AL.Sn	Select Sensocheck (Continuous monitoring of sensor properties) Select with ▸ key. Proceed with **ENTER**	**OFF** (ON / OFF)
	0000 sec AL. dly	Alarm delay Select with ▸ key, edit number with ▲ key, proceed with **ENTER.**	**0010 sec** (xxxx sec)
	HoLd AL. LED	LED in HOLD mode Select with ▸, proceed with **ENTER**	**OFF** (ON / OFF)

LED state:

Setting	Alarm	HOLD
ON	on	flashes
OFF	flashes	off



Alarm contact
The alarm contact is closed during normal operation (N/C). It opens in the case of alarm or power outage. As a result, a failure message is provided even in the case of line breakage (fail-safe behavior). For contact ratings, see Specifications.

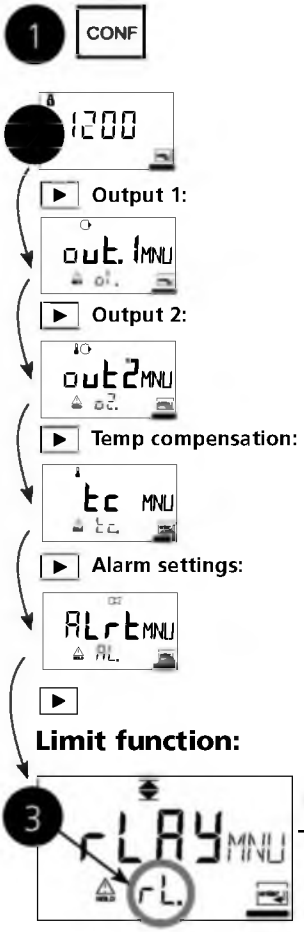
Error messages can also be signaled by a 22 mA output current (see Error messages and Configuration Output 1/Output 2).

The operating behavior of the alarm contact is shown in the Operating states table.

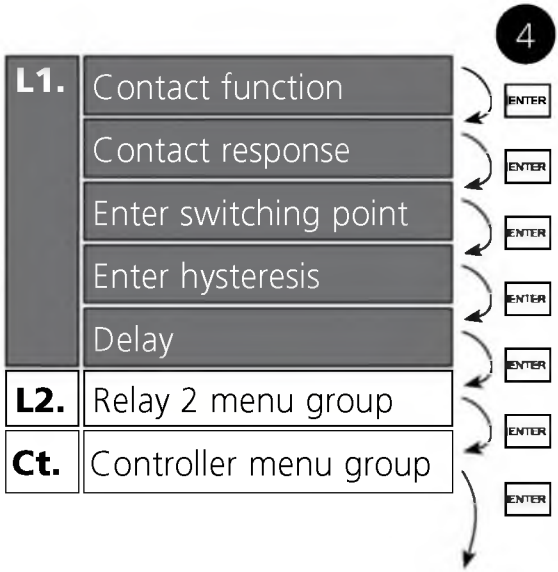
The **alarm delay** acts on the LED, the 22 mA signal, and the alarm contact.

Configuration

Limit function
Relay 1



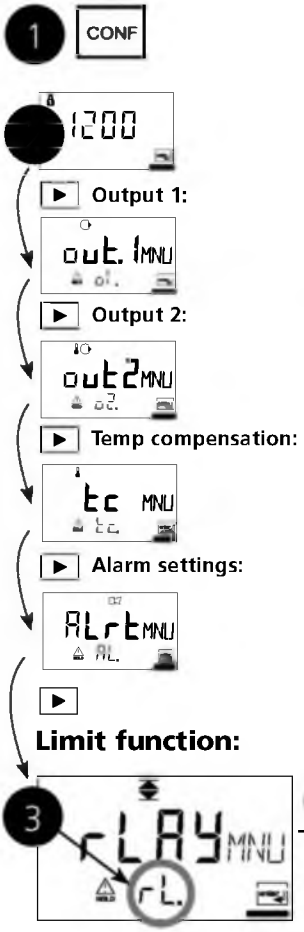
1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Limit function** menu group using arrow keys. All items of this menu group are indicated by the code "rL."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 47).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



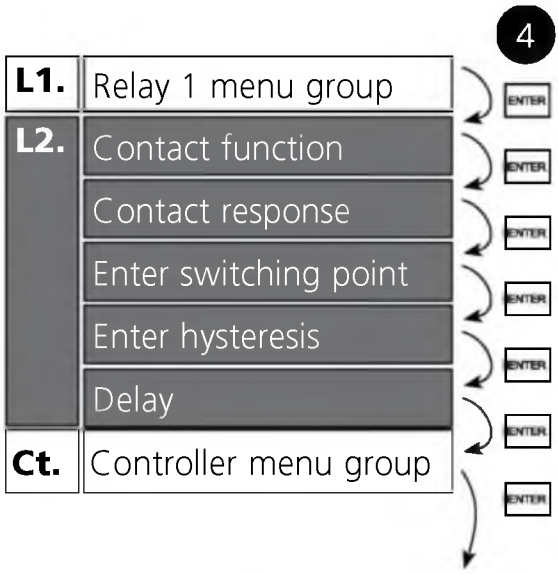
Code	Display	Action	Choices
rL.	LI MIT rL.SLCT CtROL rL.SLCT	Use of relays: Limit function (LiMIT) Controller (CtROL) Select with ▸ key, proceed with **ENTER** **Note:** Selecting **CtROL** leads to Controller menu group **Ct.**.	**LiMIT** (LiMit CtROL)
L1.	Lo LI. FCT	For limit 1 function, see Pg 49. Select with ▸ key, proceed with **ENTER.**	**Lo** (Hi)
	N/C LI. tYP	Limit 1 contact response N/O: normally open contact N/C: normally closed contact Select with ▸ key. Proceed with **ENTER**	**N/O** (NO N/C)
	000.0 mS LI LEVL	Limit 1 switching point Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**000.0 mS** (xxxx)
	001.0 mS LI. HYS	Limit 1 hysteresis Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**001.0 mS** (xxxx)
	0010 SEC LI. dLY	Limit 1 delay The contact is activated with delay (deactivated without delay) Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**.	**0010 sec** (0 ... 9999 sec)

Configuration

Limit function
Relay 2

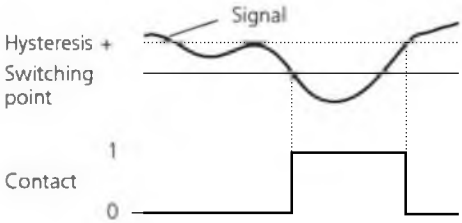


1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Limit function** menu group using arrow keys. All items of this menu group are indicated by the code "rL."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 49).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.

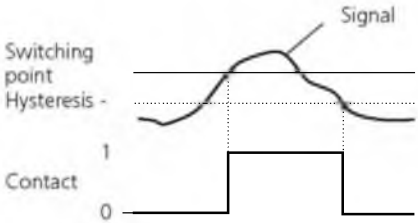


Code	Display	Action	Choices
L2.	Hi L2. FCT	For limit 2 function, see Fig. below. Select with ▸ key, proceed with **ENTER**	**Hi** (Lo)
	N/C L2. tYP	Limit 2 contact response N/O: normally open contact N/C: normally closed contact Select with ▸ key, proceed with **ENTER**	**N/O** (N/O N/C)
	100.0 mS L2LEVL	Limit 2 switching point Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**100.0 mS** (xxxx mS)
	001.0 mS L2. HYS	Limit 2 hysteresis Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**001.0 mS** (xxxx mS)
	0010 SEC L2. dLY	Limit 2 delay The contact is activated with delay (deactivated without delay) Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**0010 sec** (0 ... 9999 sec)

Limit Lo



Limit Hi



Controller functions

PID controller

P controller

Application in integrating systems
(e.g. closed tank, batch processes).

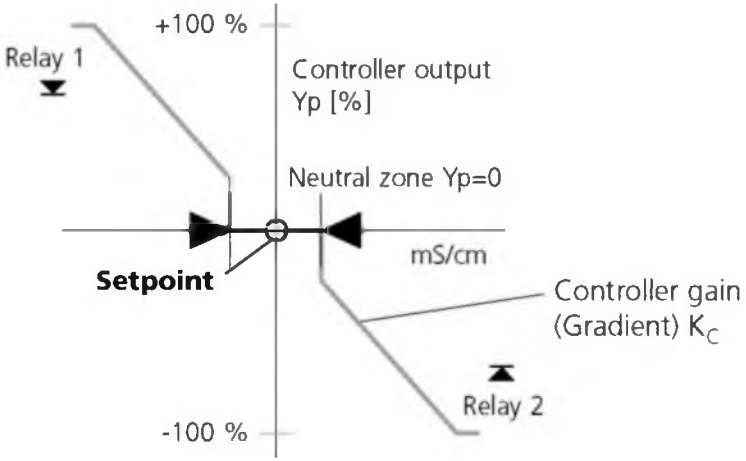
PI controller

Application in non-integrating systems
(e.g. drains).

PID controller

The additional derivative action compensates for measurement peaks.

Controller characteristic



Controller equations

$$\text{Controller output } Y = \underbrace{Y_P}_{\text{P-action}} + \underbrace{\frac{1}{T_R}\int Y_P dt}_{\text{I action}} + \underbrace{T_D \frac{dY_P}{dt}}_{\text{D action}}$$

Proportional action Y_P

$$Y_P = \frac{\text{Setpoint - Meas. value}}{\text{Meas. range}} * K_C$$

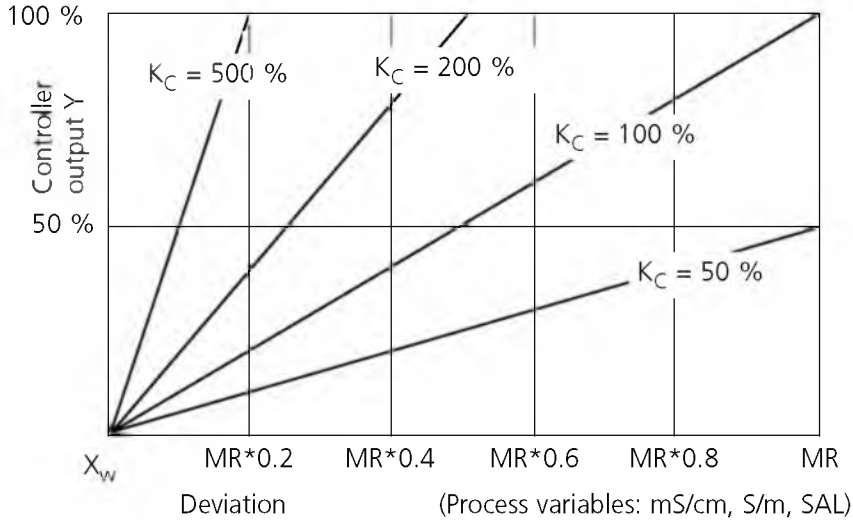
with:

Y_P	Proportional action
T_R	Reset time [s]
T_D	Rate time [s]
K_C	Controller gain [%]

Neutral zone (Y=0)

Tolerated deviation from desired value.
With the setting "1 mS/cm", for example, a deviation of ± 0.5 mS/cm from the desired value does not activate the controller.

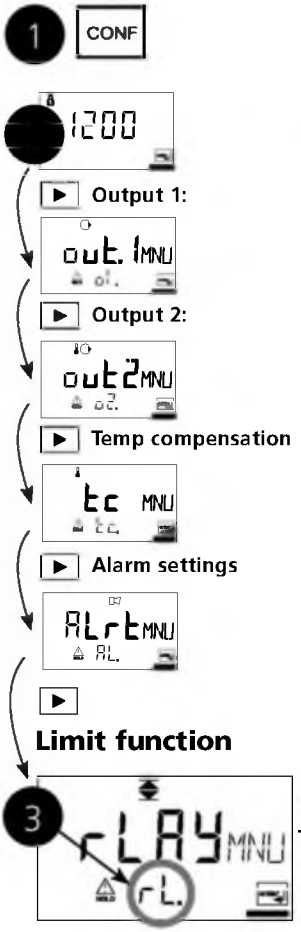
Proportional action (Gradient K_C [%])



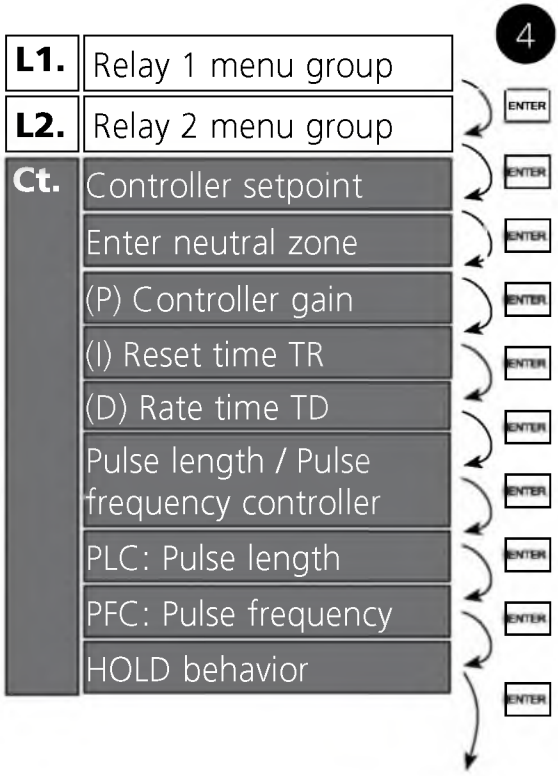
Configuration

Controller

Setpoint. Neutral zone



1 Press **CONF** key.
2 Enter mode code **1200**.
3 Select **Limit function** menu group using arrow keys. All items of this menu group are indicated by the code "rL."
4 Press **ENTER** to select menu, edit with arrow keys (see Pg 53).
Confirm (and proceed) with **ENTER**.
5 End: Press **CONF**, then **ENTER**.



Code	Display	Action	Choices
Ct.	050.0 mS Ct. SP	Setpoint Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**050.0 mS** (xxxx)
	001.0 mS Ct. dB	Neutral zone (dead band) Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**001.0 mS** (xxxx)
	0100 % Ct. PRP	Controller: P-action component Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**0100 %** (xxxx %)
	0000 SEC Ct. INT	Controller: I-action component (reset time) Select with ▸ key, edit number with ▲ key. Proceed with	**0000 sec** (xxxx sec)
	0000 SEC Ct. dIF	Controller: D-action component (rate time) Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**0000 sec** (xxxx sec)
	PLC Ct. tYP	Pulse length / Pulse frequency Select with ▸ key. Proceed with **ENTER**	**PLC** (PFC)
	0010 SEC CtPLEN	PLC: Pulse length Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**0010 sec** (xxxx sec)
	0060 /min CtPFRQ	PFC: Pulse frequency Select with ▸ key, edit number with ▲ key. Proceed with **ENTER**	**0060/min** (xxxx /min)
	Y LAST CtHOLD	Behavior during HOLD Select with ▸ key. Proceed with **ENTER.**	**Y Last** (Y Off/ Y Last)

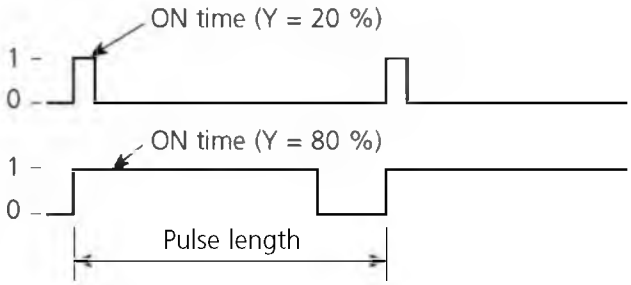
Controller functions

Pulse length / pulse frequency controller

Pulse length controller (PLC)

The pulse length controller is used to operate a valve as an actuator. It switches the contact on for a time that depends on the controller output. The period is constant. A minimum ON time of 0.5 sec is maintained even if the controller output takes corresponding values.

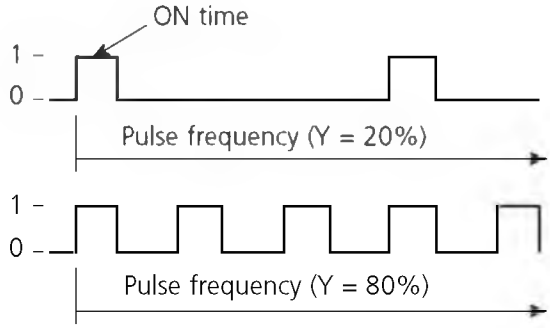
Output signal (switching contact) of pulse length controller



Pulse frequency controller (PFC)

The pulse frequency controller is used to operate a frequency-controlled actuator (metering pump). It varies the frequency with which the contacts are switched on.
The maximum pulse frequency [pulses/min] can be defined. It depends on the actuator.
The Contact ON time is constant. It is automatically calculated from the user-defined maximum pulse frequency.

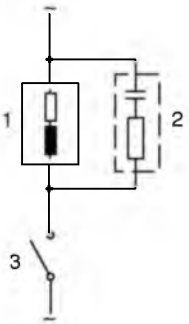
Output signal (switching contact) of pulse frequency controller

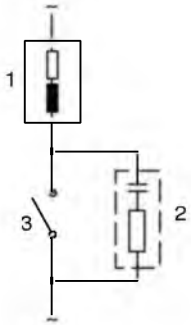


Protective wiring of relay outputs

Protective wiring of relay contacts

Relay contacts are subjected to electrical erosion. Especially with inductive and capacitive loads, the service life of the contacts will be reduced. For suppression of sparks and arcing, components such as RC combinations, nonlinear resistors, series resistors and diodes should be used.

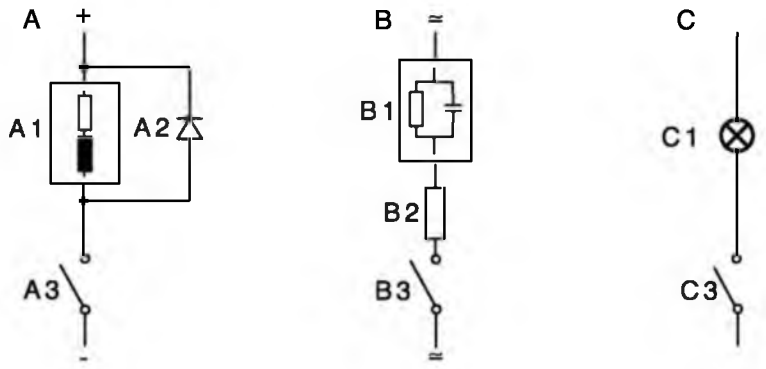




Typical AC applications with inductive load

1 Load
2 RC combination,
e.g. RIFA PMR 209
Typical RC combinations for 230 V AC:
Capacitor 0.1 µF / 630 V
Resistor 100 ohms / 1 W
3 Contact

Typical protective wiring measures



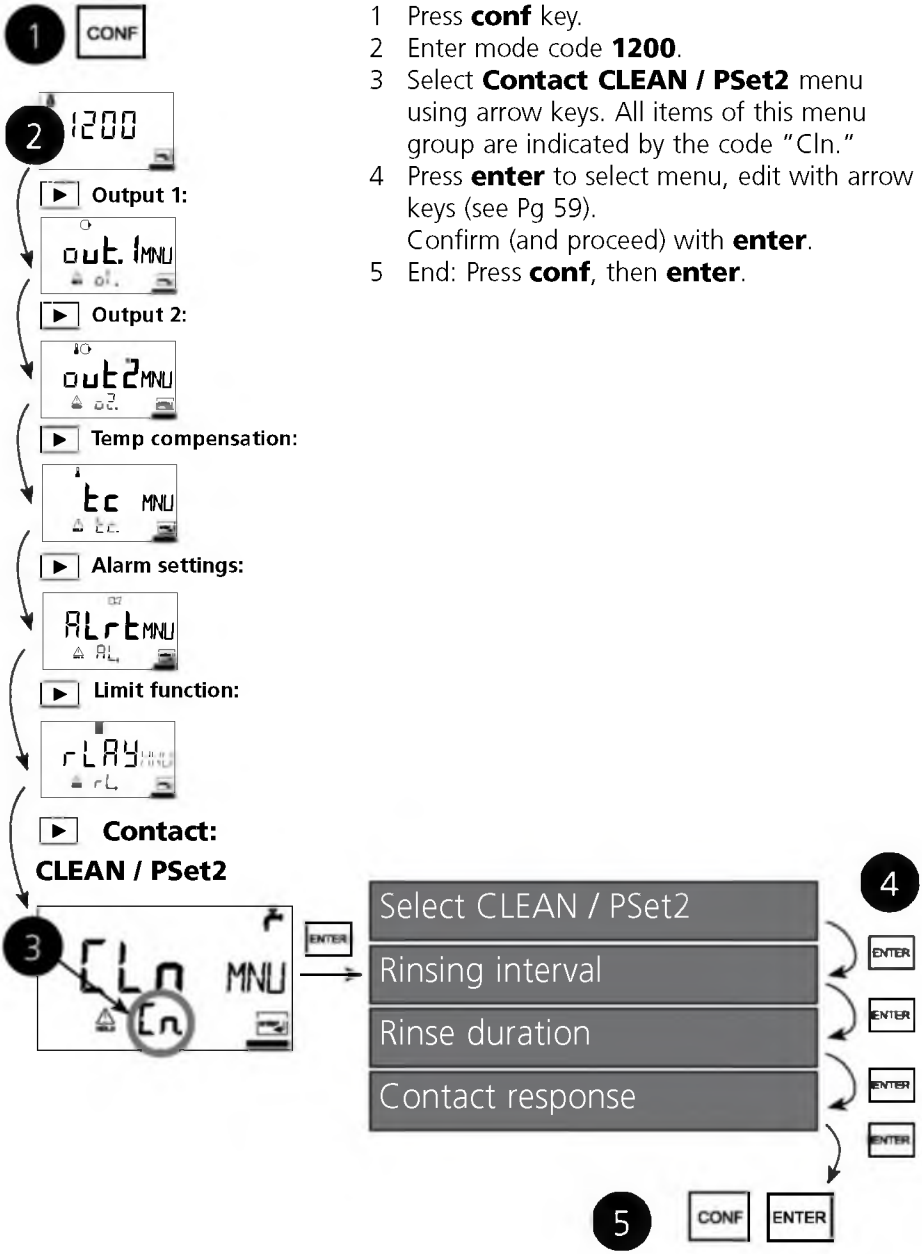
A: DC application with inductive load
B: AC/DC applications with capacitive load
C: Connection of incandescent lamps

A1 Inductive load
A2 Free-wheeling diode, e.g. 1N4007 (Observe polarity)
A3 Contact
B1 Capacitive load
B2 Resistor, e.g. 8 ohms/1 W at 24 V / 0.3 A
B3 Contact
C1 Incandescent lamp, max 60 W / 230 V, 30 W / 115 V
C3 Contact

Warning!
Make sure that the maximum ratings of the relay contacts are not exceeded even during switching!

Configuration

Controlling a rinsing probe or signaling parameter set 2



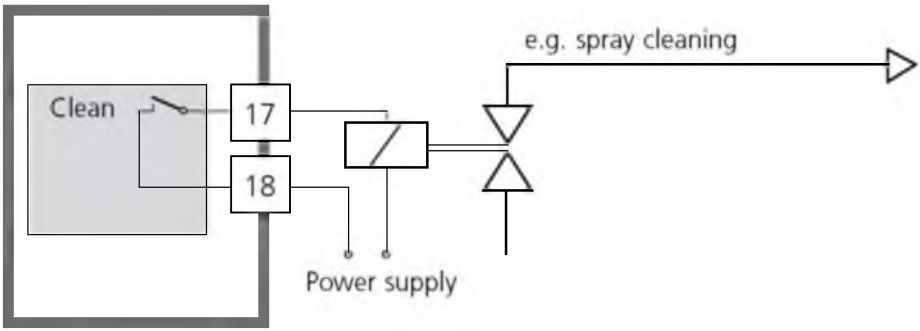
1 Press **conf** key.
2 Enter mode code **1200**.
3 Select **Contact CLEAN / PSet2** menu using arrow keys. All items of this menu group are indicated by the code "Cln."
4 Press **enter** to select menu, edit with arrow keys (see Pg 59).
Confirm (and proceed) with **enter**.
5 End: Press **conf**, then **enter**.

Code	Display	Action	Choices
Cn.	rinse CnSLCT ↓	Function selection*: Control of rinsing probe (rinse) Signaling selected parameter set 2 Select with ▸, proceed with **enter**	**rinse** (rinse / PSet2) For PSet2: see Pg 60
rinse	000.0h Cn.InTV	Rinsing interval * Select with ▸, edit number with ▲, proceed with **enter**	**000.0 h** (xxx.x h)
	0000SEC CnrINS	Rinse duration * Select with ▸, edit number with ▲, proceed with **enter**.	**0060 sec** (xxxx sec)
	N/C Cn.tYP	Contact response* N/O: normally open contact N/C: normally closed contact Select with ▸, proceed with **enter**	**N/O** (N/O NC)

* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

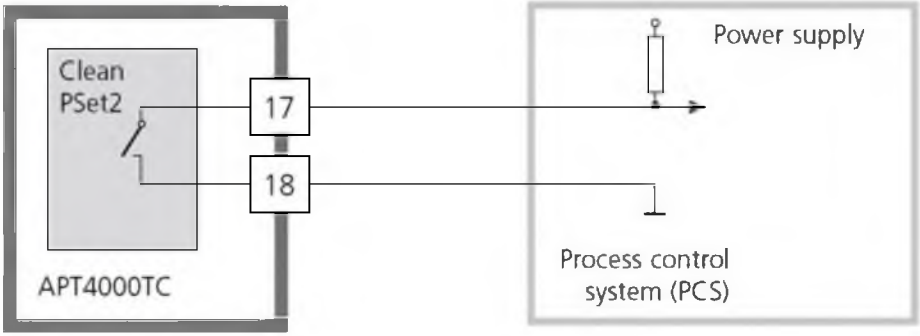
Controlling a rinsing probe

The "Clean" contact can be used to connect a simple rinsing probe. Rinse time and rinsing interval are defined during configuration. Contact response can be set as N/O, N/C.



Signaling parameter set 2

Depending on the selected parameter set, the relay is active or inactive. The signal can be used for superordinated process control systems.
Parameter set 2 is indicated by "88" in the upper left corner of the display.



	Parameter set 1 selected
	Parameter set 2 selected

Power supply:
AC< 250 V / < 3 A / < 750 VA
DC< 30 V / < 3 A / < 90 W

Selecting parameter set 1/2

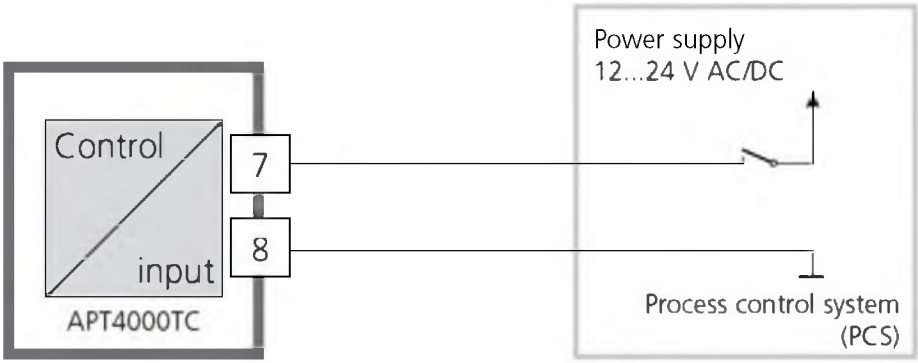
Manually or via a signal at the Control input

Display	Action	Choices
0000 After correct input a welcome text (CONF) is displayed for approx. 3 sec.	Select parameter set. Press **conf**, enter code 7654. Select with ▸ key, edit number with ▲ key, proceed with **enter**. Wrong settings change the measurement properties! If an invalid code is entered, the device returns to measuring mode.	
-1- MAN PAr -2- SET PAr Ctr EXT PAr	Select: • Parameter set 1 (MAN) • Parameter set 2 (MAN) • Automatic switchover via Control input (Ctr-EXT) Select with ▸, proceed with **enter**	**-1-** (-1- MAN -2-MAN Ctr-EXT) Ctr-EXT: see next page
-2- MAN YES -2- MAN NO	With **-1-** or **-2-** selected: Since the complete device configuration is changed in one step, there is a security prompt (No/Yes). **Note:** When pressing **enter** directly, the selection is not stored. Activation of parameter set 2 is indicated by "88" in the upper left corner of the display.	

Display	Action	Choices
Ctr EXT PAr	With Control input **Ctr-EXT** selected: You can switch between the parameter sets by applying an external signal to the Control input see below.	

External switchover of parameter sets

The parameter set can be selected from outside by sending a signal to the Control input (e.g. from the process control system). To do so, **Ctr-EXT** is set during configuration.



0 ... 2 V AC/DC	Parameter set 1 selected
10 ... 30 V AC/DC	Parameter set 2 selected

Note:
Parameter set 2 is indicated by "88" in the upper left corner of the display.

Default settings of parameter sets

Two complete parameter sets are stored in the EEPROM. As delivered, the two sets are identical but can be edited.

Note:
Fill in your configuration data on the following pages.

Code Parameter	Default setting
o1. Sensor selection *	5000 TC
o1. Process variable	000.0 mS
o1. Conc solution	-01-
o1. 0/4-20 mA	4-20 mA
o1. Characteristic	LIN
o1. Current start (LIN)	000.0 mS
o1. Current end (LIN)	100.0 mS
o1. Current start (LOG)	0.1 mS
o1. Current end (LOG)	100 mS
o1. Filter time	0 s
o1. 22mA signal	OFF
o1. Hold behavior	Last
o1. Fix current	021.0 mA
o2. Unit °C / °F	°C
o2. 0/4...20mA	4-20 mA
o2. Current start	000.0 °C
o2. Current end	100.0 °C
o2. Filter time	0 s
o2. 22mA signal	OFF
o2. Hold behavior	Last
o2. Fix current	021.0 mA
tc. Temp compensation	OFF
tc. Temp coefficient	02.00%/K
AL. Sensocheck	OFF
AL. Alarm delay	0010 s
AL. LED Hold	OFF

Code Parameter	Default setting
rL. Relay function	Limit
L1. Contact function	Lo
L1. Contact response	N/O
L1. Switching point	000.0 mS
L1. Hysteresis	001.0 mS
L1. Delay	0010 s
L2. Contact function	Hi
L2. Contact response	N/O
L2. Switching point	100.0 mS
L2. Hysteresis	001.0 mS
L2. Delay	0010 s
Ct. Setpoint	050.0 mS
Ct. Neutral zone	001.0 mS
Ct. P action	0100 %
Ct. I action	0000 s
Ct. D action	0000 s
Ct. PLC/PFC controller	PLC
Ct. Pulse length	0010 s
Ct. Pulse frequency	0060 /min
Ct. Hold behavior	Last
Cn. Rinse/ PSet2 *	rinse
Cn. Rinsing interval *	000.0 h
Cn. Rinse duration *	0060 s
Cn. Contact response*	N/O

* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

Parameter set - individual settings

Code Parameter	Setting P1 (conf 1200)	P2 (conf 1288)
o1. Sensor selection	_____	*
o1. Process variable	_____	_____
o1. Solution (Conc)	_____	_____
o1. 0/4-20 mA	_____	_____
o1. Characteristic (LIN/LOG)	_____	_____
o1. Current start	_____	_____
o1. Current end	_____	_____
o1. Filter time	_____	_____
o1. 22 mA signal	_____	_____
o1. Hold behavior	_____	_____
o1. Fix current	_____	_____
o2. Unit °C / °F	_____	_____
o2. 0/4 ...20 mA	_____	_____
o2. Current start	_____	_____
o2. Current end	_____	_____
o2. Filter time	_____	_____
o2. 22mA signal	_____	_____
o2. Hold behavior	_____	_____
o2. Fix current	_____	_____
tc. Temperature compensation	_____	_____
tc. Temperature coefficient	_____	_____
AL. Sensocheck	_____	_____
AL. Alarm delay	_____	_____
AL. LED Hold	_____	_____

Code Parameter	Setting P1 (conf 1200)	Setting P2 (conf 1288)
rL. Relay function	_____	_____
L1. Contact function	_____	_____
L1. Contact response	_____	_____
L1. Switching point	_____	_____
L1. Hysteresis	_____	_____
L1. Delay	_____	_____
L2. Contact function	_____	_____
L2. Contact response	_____	_____
L2. Switching point	_____	_____
L2. Hysteresis	_____	_____
L2. Delay	_____	_____
Ct. Setpoint	_____	_____
Ct. Neutral zone	_____	_____
Ct. P action	_____	_____
Ct. I action	_____	_____
Ct. D action	_____	_____
Ct. PLC/PFC controller	_____	_____
Ct. Pulse length	_____	_____
Ct. Pulse frequency	_____	_____
Ct. Hold behavior	_____	_____
Cn Rinse / PSet2*	_____	*
Cn Rinsing interval*	_____	*
Cn Rinse duration*	_____	*
Cn Contact response*	_____	*

* These parameters are only edited in parameter set 1. They are valid for both parameter sets.

Calibration

Calibration adjusts the device to the sensor.

Activate	CAL	Activate with **CAL**
	0000	Enter mode code: • Entry of cell factor 1100 • With calibration solution 0110 • Product calibration 1105 • Temp probe adjustment 1015 Select with ▸ key, edit number with ▲ key, proceed with **ENTER** key (End with **CAL ENTER**.)
Hold During calibration the device remains in the Hold mode.	HOLD CAL 1 250 °C HOLD icon	Output current is frozen (last value or preset fixed value, depending on configuration), limit and alarm contacts are inactive. The controller is in the configured state, Sensoface is off, "Calibration" mode indicator is on.
Input errors	Err	The calibration parameters are checked during the input. In the case of an incorrect input "Err" is displayed for approx. 3 sec. The incorrect parameters cannot be stored. Input must be repeated.
End	CAL ENTER	End with **CAL**. The measured value and Hold are displayed alternately, "enter" flashes. Press **ENTER** key to end the Hold mode. The measured value is displayed. The output current remains frozen for another 20 sec (HOLD icon on, "hourglass" flashes).

Information on calibration

Calibration can be performed by:

- Entry of cell factor
- Determining the cell factor with a known calibration solution taking account of the temperature
- Product calibration
- Zero calibration in air or with calibration solution
- Temperature probe adjustment

NOTICE

If measurements are taken in containers with A < 110 mm, be sure to choose a container with the same cross-section and the same material (metal/plastic) for calibration.

NOTICE

- All calibration procedures must be performed by trained personnel. Incorrectly set parameters may go unnoticed, but change the measuring properties.
- When another sensor is used, its sensor data (cell factor, transfer ratio, measuring frequency, temperature probe) must be entered in the configuration menu before calibration.
- Each time a new sensor is connected, the device must be calibrated.

Calibration by input of cell factor

Input of cell factor with simultaneous display of conductivity and temperature (without temperature compensation)

Display	Action	Remark
0000	Press **CAL** key, enter code 1100 Select with ▶ key, edit number with ▲ key, proceed with **ENTER.**	If an invalid code is entered, the device returns to measuring mode.
CAL CELL	Ready for calibration Remove and clean sensor	Display (3 sec) Device in Hold mode, measured value frozen. Sensoface inactive.
01.980 c 1033 µS 01.980 c 26.3°C	Enter cell factor: Select with ▶ key, edit number with ▲ key. Conductivity and temperature are alternately displayed during the input (lower display). Confirm entry with **ENTER**.	
01.980 c 0013 µS	The entered cell factor and zero point are displayed. Confirm with **ENTER**.	

Display	Action	Remark
	Conductivity and temperature are displayed. The measured value is shown in the main display alternately with "Hold"; "enter" flashes. Press **ENTER** to end calibration.	After end of calibration, the outputs remain in Hold mode for approx. 20 sec.

Calibration with calibration solution

Be sure to use known calibration solutions and the respective temperature-corrected conductivity values (see Appendix: Calibration solutions). During the calibration procedure the temperature should be kept constant.

Display	Action	Remark
0000	Press **CAL** key, enter code 0110 Select with ▸ key, edit number with ▲ key, proceed with **ENTER**.	If an invalid code is entered, the device returns to measuring mode.
CAL SoL	Ready for calibration Remove and clean sensor	Display (3 sec) Device in Hold mode, measured value frozen. Sensoface inactive.
10.83 mS 2.132	Immerse sensor in calibration solution. Enter the temperature-corrected conductivity value of the calibration solution: Select with ▸ key, edit number with ▲ key. Cell factor and temperature are alternately displayed in the lower display. Confirm entry with **ENTER**.	When there has not been an entry for 6 sec, the lower display alternately shows the conductivity and temperature value.

Display	Action	Remark
	The determined cell factor and zero point are displayed. Confirm cell factor with **ENTER**.	
	Conductivity and temperature are displayed. The measured value is shown in the main display alternately with "Hold"; "enter" flashes. Press **ENTER** to end calibration.	After end of calibration, the outputs remain in Hold mode for approx. 20 sec.

Product calibration

Calibration by sampling

The measurement process is only interrupted briefly. During product calibration the sensor remains in the process. Calibration is without TC correction!

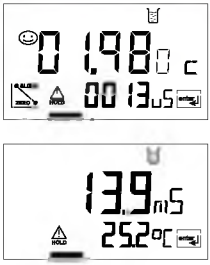
Procedure: During sampling the currently measured value is stored in the device. The device immediately returns to measuring mode. The calibration mode indicator flashes and reminds you that calibration has not been terminated. The sample is measured in the lab or directly on the site using a portable meter. The measured sample value is then entered in the device. The new cell factor is calculated from these two values.
If the sample is invalid, you can take over the value stored during sampling. In that case the old calibration values are stored. Afterwards, you can start a new product calibration.

Display	Action	Remark
0000	**Product calibration step 1:** Press **CAL** key, enter code 1105. (Press ▸ key to select position, enter number using ▲ key, confirm with **ENTER**.)	If an invalid code is entered, the device returns to measuring mode.
CAL PRD 1		Display (approx. 3 sec)
1.390 mS Store	Take sample and store value. Proceed with **ENTER**	Now the sample can be measured in the lab.

Display	Action	Remark
1.390 mS 28.38 °C	Measuring mode: From the flashing CAL mode indicator you see that sample calibration has not been terminated.	Until the sample value is determined and can be entered, the device is in measuring mode.
CAL PRD 2	**Product calibration step 2:** When the sample value has been determined, call up the product calibration once more (**CAL**, code 1105).	Display (approx. 3 sec)
1.285 mS CALC	Enter sample value. The new cell factor is calculated. Confirm with **ENTER**.	
0 1.980 c 0013 uS	The new cell factor and zero point are displayed. Confirm with **ENTER**.	New calibration: Press **CAL**.
	The measured value is shown in the main display alternately with "Hold". "enter" flashes. End with **ENTER**.	After end of calibration, the outputs remain in Hold mode for approx. 20 sec.

Zero calibration in air

Display	Action	Remark
0000	Press **CAL** key, enter code 1001. Select with ▸ key, edit number with ▲ key, proceed with **ENTER.**	The device is in the Hold mode. If an invalid code is entered, the device returns to measuring mode.
CAL ZRO	Ready for calibration Remove and clean sensor. (Sensor must be dry!)	Display (3 sec)
0000 µS 13 µS 0013 µS 00 µS	Modify the zero point until zero is displayed as conductivity value in the lower display. Select with ▸ key, edit number with ▲ key. If required, change the sign of the zero point. Press **ENTER** to confirm the zero point.	When there has not been an entry for 6 sec, the lower display alternately shows the conductivity and temperature value.

Display	Action	Remark
	The cell factor and zero point are displayed. Press **ENTER** to confirm the calibration data. Conductivity and temperature are displayed. Place sensor in process.	
	The measured value is shown in the main display alternately with "Hold"; "enter" flashes. End calibration with **ENTER**.	After end of calibration, the outputs remain in Hold mode for approx. 20 sec.

Zero calibration with calibration solution

Calibration solution with low conductivity

Display	Action	Remark
0000	Press **CAL** key, enter code 1001. Select with ▸ key, edit number with ▲ key, proceed with **ENTER**.	The device is in the Hold mode. If an invalid code is entered, the device returns to measuring mode.
CAL ZRO	Ready for calibration Remove and clean sensor	Display (3 sec)
1400 uS 1413 uS	Immerse sensor in calibration solution. Modify the value until the lower display shows the conductivity value of the calibration solution. Press **ENTER** to confirm calibration.	When there has not been an entry for 6 sec, the lower display alternately shows the conductivity and temperature value.
01.98 c 0013 uS	The cell factor and zero point are displayed. Press **ENTER** to confirm the calibration data.	

Display	Action	Remark
	Conductivity and temperature are displayed. Remove the sensor from the calibration solution and clean it. Place sensor in process.	
	The measured value is shown in the main display alternately with "Hold". "enter" flashes. End calibration with **ENTER**.	After end of calibration, the outputs remain in Hold mode for approx. 20 sec.

Temperature probe adjustment

Display	Action	Remark
0000	Activate calibration (Press **CAL**, enter 1015) Select with ▸ key, edit number with ▲ key, proceed with **ENTER**.	Wrong settings change the measurement properties! If an invalid code is entered, the device returns to measuring mode.
CAL TMP	Ready for calibration	Display (approx. 3 sec) The device is in the Hold mode.
025.1 °C 25.0 °C	Measure the temperature of the process medium using an external thermometer. Enter measured temperature value: Select with ▸ key, edit number with ▲ key, proceed with **ENTER**. End adjustment with **ENTER**. HOLD will be deactivated after 20 sec.	Default: Value of secondary display.

Measurement

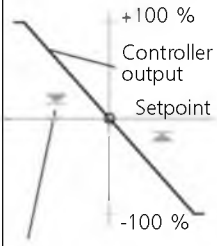
Display	Remark
1.390 mS 25.2 °C	In the measuring mode the main display shows the configured process variable (conductivity [mS/cm, S/m] or resistivity [MΩ·cm] or concentration [% by wt] or salinity [SAL]) and the lower display the temperature. During calibration you can return to measuring mode by pressing the **CAL** key, during configuration by pressing **CONF**, then **ENTER**.

Display	Remark
	**Display of output currents** Press **ENTER** while in measuring mode. The current at output 1 is shown in the main display, the current at output 2 in the secondary display. After 5 sec the device returns to measuring mode.
	**Display of calibration data** **(Cal Info)** Press **CAL** while in measuring mode and confirm code 0000. The current cell factor is shown in the main display, the zero point in the secondary display. After 20 sec the device returns to measuring mode. (Immediate return at pressing **ENTER**.)
 	**Sensor monitor for validation** of sensor and complete measured-value processing. Loop a defined sensing resistor (e.g. R = 100 Ω) through the sensor as shown in the figure. Press the **CONF** key and enter code 2222. The sensor monitor displays the directly measured resistance and the temperature. If there is a significant difference between resistor value and display, the sensor and its transmission behavior should be checked. Press **ENTER** to return to measurement. **Caution:** The device does not automatically go to Hold mode.
	**Display of last error message** **(Error Info)** Press **CONF** while in measuring mode and confirm code 0000. The last error message is displayed for approx. 20 sec. After that the message will be deleted (immediate return to measurement at pressing **ENTER**).

Diagnostics functions

These functions are used for testing the connected peripherals.

Display	Remark
out.1 12.2 mA 12.2	**Specify current at output 1 (current source 1)** • Press **CONF**, enter code 5555 The current indicated in the main display for output 1 can be edited. Select with ▸ key, edit number with ▲ key, proceed with **ENTER.** The actually measured current is shown in the secondary display. The device is in the Hold mode. Press **ENTER** to return to measurement (Hold remains active for another 20 sec).
out2 18.3 mA 15.4 mA	**Specify current at output 2 (current source 2)** • Press **CONF**, enter code 5556 The current indicated in the main display for output 2 can be edited. Select with ▸ key, edit number with ▲ key, proceed with **ENTER**. The actually measured current is shown in the secondary display. The device is in the Hold mode. Press **ENTER** to return to measurement.
tEST rELAIS 0.0. 1.0 R1 rELAIS ▶ Select a relay ▲ Test 0/1 ENTER Return to meas.	**Relay test (manual test of contacts)** • Press **CONF**, enter code 5557 The relays are frozen. This state is indicated in the display. The 4 digits in the display correspond to the 4 relays (as on terminal plate): 1st digit: R1 2nd digit: R2 3rd digit: AL 4th digit: CLN Function test using arrow keys – see left column. When exiting the function (**ENTER**), the relays are set corresponding to the measured value.

Display	Remark
CtrL	**Controller test (manual specification of controller output)** • Press **CONF**, enter code 5559. After function activation "Ctrl" is displayed for approx. 3 sec. With controller turned off, "OFF" is displayed in addition, then return to measuring mode. The function is used to start up control loops or check the actuators. For bumpless changeover to automatic operation (exiting this function), configure an I-action component (reset time).
CtrL OFF	
Controller characteristic  	Specify value: Select with ▸ key, edit number with ▲ key, proceed with **ENTER**.
The arrows indicate which relay (valve) is active:	The device is in Hold mode. Press **ENTER** to return to measurement (Hold remains active for another 20 sec).
▲ Relay 2 active (Meas. value < setpoint)	Controller output -100 to 0 %: Relay 2 active
▼ Relay 1 active (Meas. value < setpoint)	Controller output 0 to +100 %: Relay 1 active
-083 % 054	Momentary controller output (adjusted value has not been stored yet)

Operating states

Operating state	Out 1	Out 2	Rel. 1/2 Controller	Rel. 1/2 Limit value	Cleaning contact	Alarm contact	LED	Time out
Measurement								
Cal Info (CAL) 0000								20 sec
Error Info (CONF) 0000								20 sec
Zero point (CAL) 1001								
Calibration (CAL) 1100								
Calibration (CAL) 0110								
Temp adjustment (CAL) 1015								
Product cal 1 (CAL) 1105								
Product cal 2 (CAL) 1105								
Conf par set 1 (CONF) 1200								20 min
Conf par set 2 (CONF) 1288								20 min
Parameter set 1/2 (CONF) 7654								20 min

Operating state	Out 1	Out 2	Rel. 1/2 Controller	Rel. 1/2 Limit value	Cleaning contact	Alarm contact	LED	Time out
Sensor monitor (CONF) 2222	■	■	■	■	■	■	■	20 min
Current source 1 (CONF) 5555	■	●	●					20 min
Current source 2 (CONF) 5556	●	■	●					20 min
Relay test (CONF) 5557	●	●	■	■	■	■	■	20 min
Manual controller (CONF) 5559	●	●	■					20 min
Cleaning function	●	●	●		■			
HOLD input	●	●	●					

Explanation:

■ active

● as configured (Last/Fix or Last/Off)

Error messages (Error codes)

Error	Display	Problem Possible causes	Alarm contact	Red LED	Out 1 (22 mA)	out 2 (22 mA)
ERR 01	Measured value flashes	**Sensor** • Wrong cell factor • Measurement range violation • SAL > 45 ‰ • Sensor connection or cable defective	x	x	x	
ERR 02	Measured value flashes	**Unsuitable sensor** Conductance range > 3000 mS	x	x	x	
ERR 98	"Conf" flashes	**System error** Configuration or calibration data defective; completely reconfigure and recalibrate the device. Memory error in device program	x	x	x	x
ERR 99	"FAIL" flashes	**Factory settings** EEPROM or RAM defective This error message only occurs in the case of a total defect. The device must be repaired and recalibrated at the factory.	x	x	x	x
ERR 03	🌡	**Temperature probe** Open or short circuit Temperature range exceeded	x	x	x	x

Error	Display (flashes)	Problem Possible causes	Alarm contact	Red LED	Out 1 (22 mA)	Out 2 (22 mA)
ERR 11	mA	**Current output 1** Current below 0 (3.8) mA	x	x	x	
ERR 12	mA	**Current output 1** Current above 20.5 mA	x	x	x	
ERR 13	mA	**Current output 1** Span too small / too large	x	x	x	
ERR 21	mA	**Current output 2** Current below 0 (3.8) mA	x	x		x
ERR 22	mA	**Current output 2** Current above 20.5 mA	x	x		x
ERR 23	mA	**Current output 2** Span too small / too large	x	x		x
ERR 33		**Sensocheck**: Primary coil	x	x	x	
ERR 34		Secondary coil	Sensoface active			
		Temperature outside conversion tables (TC, conc, SAL)	Sensoface active			

Sensoface

The little smiley in the display (Sensoface) alerts to sensor problems (defective sensor, defective cable). The conditions for a friendly, neutral, or sad Sensoface are summarized in the following chart. Additional icons refer to the error cause.

Sensocheck

Continuously monitors the primary coil and its lines for short circuits and the secondary coil and its lines for open circuits. Critical values make the Sensoface "sad" and the corresponding icon flashes:

The Sensocheck message is also output as error message Err 33. The alarm contact is active, the red LED is lighted, output current 1 is set to 22 mA (when configured correspondingly). Sensocheck can be switched off during configuration (then Sensoface is also disabled). Exception: After a calibration a smiley is always displayed for confirmation.

Note

The worsening of a Sensoface criterion leads to the devaluation of the Sensoface indicator (Smiley becomes "sad").
To reset the Sensoface indicator, the defect must be remedied and the device be calibrated.

Display	Problem	Status
	Sensor defect	Short circuit in primary coil Open circuit in secondary coil (also see Error messages Err 33 and Err 34).
	Temperature error	Temperature outside range for TC, conc, SAL

Product line and accessories

Devices	Order No.
Toroidal Conductivity Analyzer	APT4000TC-E00
Mounting accessories	
Pipe-mount kit	51205988-001
Panel-mount kit	51205990-001
Protective hood	51205989-001

Specifications

Cond input	Input for toroidal conductivity sensor, e.g. 5000TC	
Display ranges	Conductivity	0.000 ... 1999 mS/cm
	Concentration	0.00 ... 100.0 % by wt
	Salinity	0.0 ... 45 ‰ (0 ... 35 °C)
Measurement ranges*	Conductivity	0.000 ... 9.999 mS/cm 00.00 ... 99.99 mS/cm 000.0 ... 999.9 mS/cm 0000 ... 1999 mS/cm 0.000 ... 9.999 S/m 00.00 ... 99.99 S/m
	Concentration	00.00 ... 99.99 % by wt
	Salinity	0.0 ... 45 ‰ (0 ... 35 °C)
Response time (T_{90})	Approx. 2 s	
Meas. error[1,2,3)]	< 1% meas. val. + 0.005 mS	

Temperature compensation *
(Reference temp 25 °C)

(OFF) Without
(Lin) Linear characteristic 00.00 ... 19.99 %/K
(NLF) Natural waters to EN 27888 (0 .. 35°C)

Concentration determination

Operating modes*	**-01-** NaCl	0.00 ... 9.99 % by wt	(0 ... 100 °C)
	-02- HCl	0.00 ... 9.99 % by wt	(0 ... 50 °C)
	-03- NaOH	0.00 ... 9.99 % by wt	(0 ... 100 °C)
	-04- H_2SO_4	0.00 ... 9.99 % by wt	(0 ... 110 °C)
	-05- HNO_3	0.00 ... 9.99 % by wt	(0 ... 50 °C)
	-06- H_2SO_4	92 ... 99 % by wt	(-17 ... 115 °C)
	-07- HCl	22 .. 39 % by wt	(-20 ... 50 °C)
	-08- HNO_3	35 ... 96 % by wt	(-20 ... 50 °C)
	-09- H_2SO_4	32 ... 84 % by wt	(-17 ... 115 °C)
	-10- NaOH	18 ... 50 % by wt	(0 ... 100 °C)

See Concentration curves in the Appendix.

Sensor standardization

Operating modes	• Input of cell factor with simultaneous display of conductivity and temperature • Entry of conductivity of calibration solution with simultaneous display of cell factor and temperature • Product calibration • Zero calibration • Temperature probe adjustment
Permitted cell factor	00.100 ... 19.999
Permitted transfer ratio	01.00 ... 199.99
Permitted zero offset	±0.5 mS/cm

Sensor monitoring

Sensocheck	• Monitoring of primary and lines for short circuit • Monitoring of secondary and lines for open circuit
Sensoface	Provides information on the sensor condition (evaluation of zero point, Sensocheck)
Sensor monitor	Sensor monitor for validation of sensor and complete measured-value processing (display: resistance / temperature)
Temperature input *	Pt100 / Pt1000 / NTC 100 kohms 2-wire connection, adjustable
Ranges	Pt100/Pt1000 -20 .. +200 °C (-4 ... +392 °F) NTC100 kohms -20 ... +130 °C (-4 ... 266 °F)
Resolution	0.1 °C / 1 °F
Meas. error[1,2,3)]	0.5 K (< 1K for Pt100; < 1K for NTC > 100°C)

Specifications

HOLD input	Galv. separated (OPTO coupler)	
Function	Switches device to HOLD mode	
Switching voltage	0 ... 2 V (AC/DC)	Hold inactive
	10 ... 30 V (AC/DC)	Hold active
CONTROL input	Galv. separated (OPTO coupler)	
Function	Switch-over to second parameter set	
Switching voltage	0 ... 2 V (AC/DC)	Parameter set 1
	10 ... 30 V (AC/DC)	Parameter set 2
Output 1	0/4 ... 20 mA, max. 10 V, floating (galv. connected to output 2)	
Measured variable*	Conductivity, concentration, or salinity	
Characteristic	Linear or logarithmic	
Overrange *	22 mA in the case of error messages	
Output filter * (attenuation)	Low-pass, filter time constant 0 ... 120 sec	
Measurement error [1)]	< 0.3% current value + 0.05 mA	
Start/end of scale	As desired within range	
Min. span	LIN: 5 % of selected range	
	LOG: 1 decade	
Output 2	0/4 ... 20 mA, max. 10 V, floating (galv. connected to output 1)	
Process variable	Temperature	
Overrange *	22 mA in case of temp error messages	
Output filter * (attenuation)	Low-pass, filter time constant 0 ... 120 sec	
Measurement error [1)]	< 0.3% current value + 0.05 mA	
Start/end of scale *	-20 ... 200 °C / -4 ... 392 °F	
Admissible span	20 ... 320 K (36 ... 608 °F)	
Alarm contact	Relay contact, floating	
Contact ratings	AC< 250 V / < 3 A / < 750 VA	
	DC< 30 V / < 3 A / < 90 W	
Contact response	N/C (fail-safe type)	
Alarm delay	0000 ... 0600 sec	

Limit values	Output via relay contacts R1, R2 Contacts R1, R2 floating but inter-connected
Contact ratings	AC< 250 V / < 3 A / < 750 VA DC< 30 V / < 3 A / < 90 W
Contact response*	N/O or N/C
Delay*	0000 ... 9999 sec
Switching points*	As desired within range
Hysteresis*	0 ... 50 % full scale
PID process controller	Output via relay contacts R1, R2 (see limit values)
Setpoint specification*	Within selected range
Neutral zone*	Max. 50 % of selected range
Proportional action*	Controller gain K_C: 0010 ... 9999 %
Integral action*	Reset time T_R: 0000 ... 9999 sec (0000 sec = no integral action)
Derivative action*	Rate time T_D: 0000 ... 9999 sec (0000 sec = no derivative action)
Controller type*	Pulse length or pulse frequency controller
Pulse period*	0001 ... 0600 sec, min. ON time 0.5 sec (pulse length controller)
Max. pulse frequency*	0001 ... 0180 min^{-1} (pulse frequency controller)

Cleaning function / Parameter set 2*

Clean / PSet2	Relay contact, floating, for controlling a rinsing probe or signaling parameter set 2
Contact ratings	AC< 250 V / < 3 A / < 750 VA DC< 30 V / < 3 A / < 90 W
Contact response	N/O when signaling parameter set 2 N/O or N/C when used as cleaning contact*
Rinsing interval*	000.0 ... 999.9 h (000.0 h = cleaning function switched off)
Rinse duration*	0000 ... 1999 sec

Specifications

Display	LC display, 7-segment with icons
Main display	Character height 17 mm, unit symbols 10 mm
Secondary display	Character height 10 mm, unit symbols 7 mm
Sensoface	3 status indicators (friendly, neutral, sad smiley)
Mode indicators	5 mode indicators "meas", "cal", "alarm", "cleaning", "config" 18 further icons for configuration and messages
Alarm indication	Red LED in case of alarm or HOLD, user defined
Keypad	5 keys: [CAL] [CONF] [▶] [▲] [ENTER]
Service functions	
Current source	Current specifiable for output 1 and 2 (00.00 to 22.00 mA)
Manual controller	Controller output entered directly (start of control process)
Device self-test	Automatic memory test (RAM, FLASH, EEPROM)
Display test	Display of all segments
Last Error	Display of last error occurred
Sensor monitor	Validation of sensor and complete measured-value processing (display: resistance / temperature)
Relay test	Manual control of the four switching contacts
Parameter sets*	Two selectable and configurable parameter sets for different process phases Switchover via CONTROL input or manually Signaling via relay contact PSet2
Data retention	Parameters and calibration data > 10 years (EEPROM)
Protection against electric shock	Safe electrical isolation of all extra-low-voltage circuits against mains by double insulation to EN 61010-1
Power supply	24 (-15%) ... 230 V AC/DC (+10%); approx. 5 VA; 2.5 W AC: 45 ... 65 Hz; Overvoltage category II, Class II

Nominal operating conditions

Ambient temp:	-20 ... +55 °C
Transport/Storage temp	-20 ... +70 °C
Relative humidity	10 ... 95% not condensing
Power supply	24 (-15%) ... 230 V AC/DC (+10%)
Frequency for AC	45 ... 65 Hz

EMC	EN 61326
Emitted interference	Class B (residential area) Class A for mains > 60 V DC
Immunity to interference	Industry

Explosion protection

FM:	NI Class I Div 2 Group A, B, C & D, T4 Ta = 55 °C; Type 2 NI Class I Zone 2-Group IIC, T4 Ta = 55°C; Type 2
CSA:	Class I Div 2 Groups A, B, C and D, T4 Ex nA IIC T4

Enclosure	Molded enclosure made of PBT (polybutylene terephtalate)
Color	Bluish gray RAL 7031
Mounting	• Wall mounting • Pipe mounting: Ø 40 ... 60 mm, □ 30 ... 45 mm • Panel mounting: cutout 138 x 138 mm (DIN 43700) • Sealed against panel
Dimensions	H 144 mm, W 144 mm, D 105 mm
Ingress protection	IP 65 / NEMA 4X
Cable glands	3 knockouts for cable glands M20x1.5 2 knockouts for NPT 1/2" or rigid metallic conduit
Weight	Approx. 1 kg

*) User-defined
1) To IEC 746 Part 1, at nominal operating conditions
2) ± 1 count
3) Plus sensor error

Calibration solutions

Potassium chloride solutions

(Conductivity in mS/cm)

Temperature	**Concentration**[1]		
[°C]	0.01 mol/l	0.1 mol/l	1 mol/l
0	0.776	7.15	65.41
5	0.896	8.22	74.14
10	1.020	9.33	83.19
15	1.147	10.48	92.52
16	1.173	10.72	94.41
17	1.199	10.95	96.31
18	1.225	11.19	98.22
19	1.251	11.43	100.14
20	1.278	11.67	102.07
21	1.305	11.91	104.00
22	1.332	12.15	105.94
23	1.359	12.39	107.89
24	1.386	12.64	109.84
25	1.413	12.88	111.80
26	1.441	13.13	113.77
27	1.468	13.37	115.74
28	1.496	13.62	
29	1.524	13.87	
30	1.552	14.12	
31	1.581	14.37	
32	1.609	14.62	
33	1.638	14.88	
34	1.667	15.13	
35	1.696	15.39	
36		15.64	

1 Data source: K. H. Hellwege (Editor), H. Landolt, R. Börnstein: Zahlenwerte und Funktionen ..., volume 2, part. volume 6

Sodium chloride solutions

(Conductivity in mS/cm)

Temperature	Concentration		
[°C]	0.01 mol/l [1]	0.1 mol/l [1]	Saturated [2]
0	0.631	5.786	134.5
1	0.651	5.965	138.6
2	0.671	6.145	142.7
3	0.692	6.327	146.9
4	0.712	6.510	151.2
5	0.733	6.695	155.5
6	0.754	6.881	159.9
7	0.775	7.068	164.3
8	0.796	7.257	168.8
9	0.818	7.447	173.4
10	0.839	7.638	177.9
11	0.861	7.831	182.6
12	0.883	8.025	187.2
13	0.905	8.221	191.9
14	0.927	8.418	196.7
15	0.950	8.617	201.5
16	0.972	8.816	206.3
17	0.995	9.018	211.2
18	1.018	9.221	216.1
19	1.041	9.425	221.0
20	1.064	9.631	226.0
21	1.087	9.838	231.0
22	1.111	10.047	236.1
23	1.135	10.258	241.1
24	1.159	10.469	246.2
25	1.183	10.683	251.3
26	1.207	10.898	256.5
27	1.232	11.114	261.6
28	1.256	11.332	266.9
29	1.281	11.552	272.1
30	1.306	11.773	277.4
31	1.331	11.995	282.7
32	1.357	12.220	288.0
33	1.382	12.445	293.3
34	1.408	12.673	298.7
35	1.434	12.902	304.1
36	1.460	13.132	309.5

1 Data source: Test solutions calculated according to DIN IEC 746-3

2 Data source: K. H. Hellwege (Editor), H. Landolt, R. Börnstein: Zahlenwerte und Funktionen ..., volume 2, part. volume 6

Concentration measurement

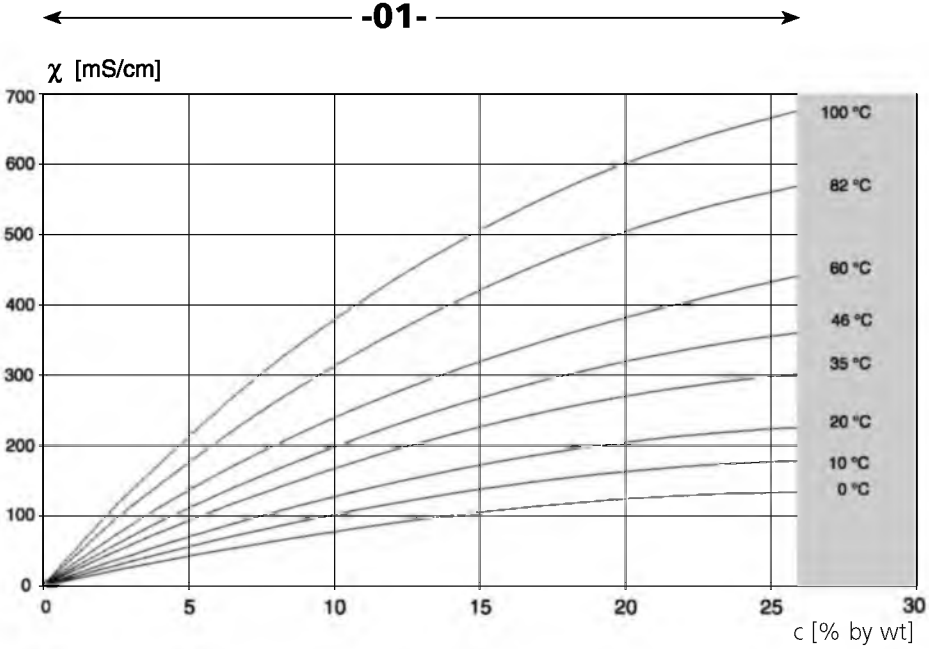
Concentration ranges

Substance	Concentration ranges		
NaCl Configuration	0-26 % by wt (0 °C) 0-28 % by wt (100 °C) **-01-**		
HCl Configuration	0-18 % by wt (-20 °C) 0-18 % by wt (50 °C) **-02-**	22-39 % by wt (-20 °C) 22-39 % by wt (50°C) **-07-**	
NaOH Configuration	0-13 % by wt (0 °C) 0-24 % by wt (100 °C) **-03-**	15-50 % by wt (0 °C) 35-50 % by wt (100 °C) **-10-**	
H_2SO_4 Configuration	0-26% by wt (-17°C) 0-37% by wt (110°C) **-04-**	28-88% by wt (-17°C) 39-88% by wt (115°C) **-09-**	94-99% by wt (-17°C) 89-99% by wt (115°C) **-06-**
HNO_3 Configuration	0-30 % by wt (-20 °C) 0-30 % by wt (50°C) **-05-**	35-96 % by wt (-20 °C) 35-96 % by wt (50°C) **-08-**	

For the solutions listed above, the device can determine the substance concentration from the measured conductivity and temperature values in % by wt. The measurement error is made up of the sum of measurements errors during conductivity and temperature measurement and the accuracy of the concentration curves stored in the device.
We recommend to calibrate the device together with the sensor. For exact temperature measurement, you should perform a temperature probe adjustment. For measuring processes with rapid temperature changes, a separate temperature probe with fast response should be used.
When measuring processes such as dilution or intensification of CIP solutions (Clean-In-Place), it is helpful to switch between the parameter sets for measuring the process medium and for measuring the CIP solution.

Honeywell

-01- Sodium chloride solution NaCl



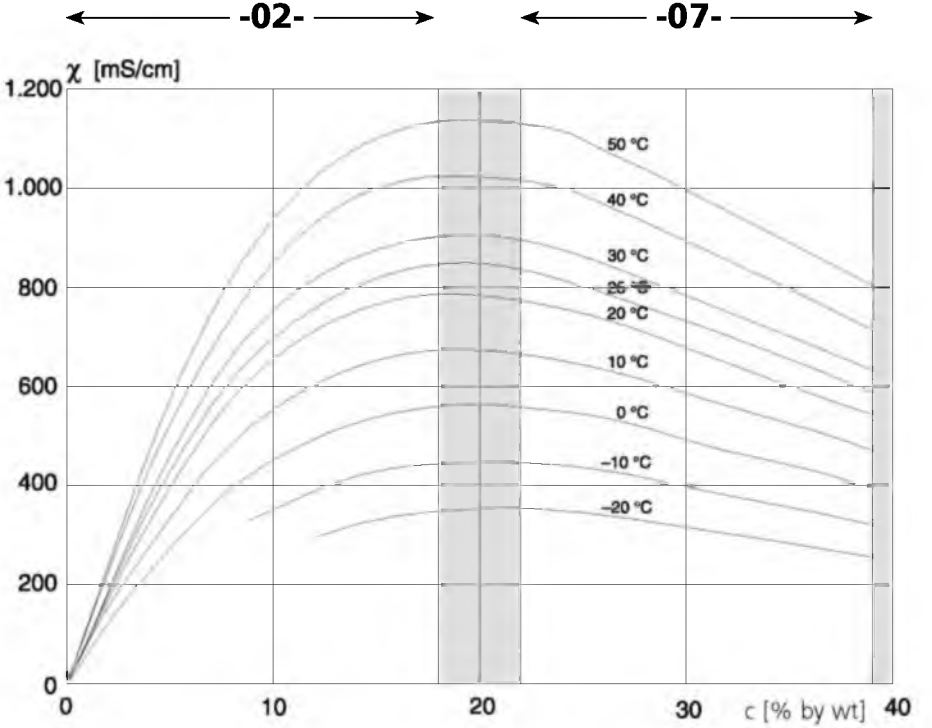
Concentration measurement not possible in this range.

Conductivity in dependence on substance concentration and process temperature for sodium chloride solution (NaCl)

Concentration curves

-02- Hydrochloric acid HCl

-07-

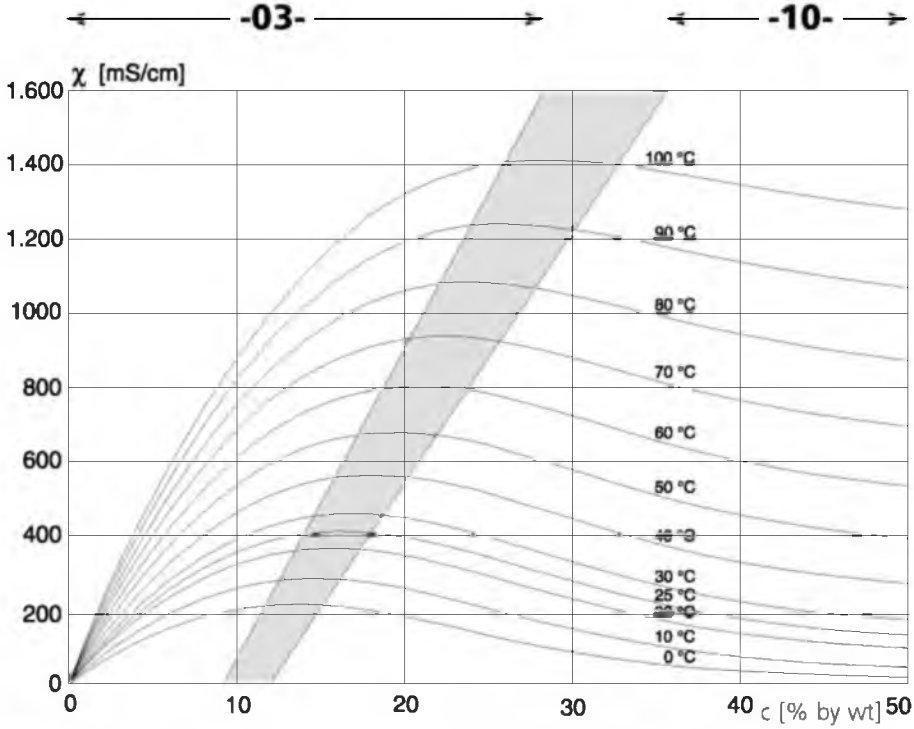


Concentration measurement not possible in this range.

Conductivity in dependence on substance concentration and process temperature for hydrochloric acid (HCl)
Source: Haase/Sauermann/Dücker; Z. phys. Chem. New Edition, Vol. 47 (1965)

-03- Sodium hydroxide solution NaOH

-10-



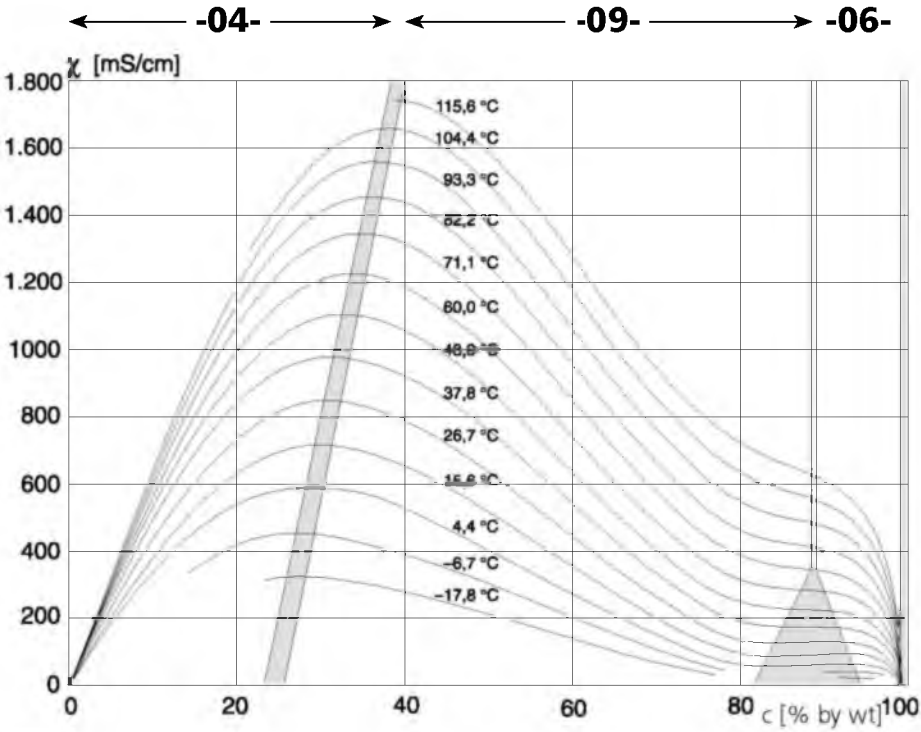
Conductivity in dependence on substance concentration and process temperature for sodium hydroxide solution (NaOH)

Concentration curves

-04- Sulphuric acid H_2SO_4

-06-

-09-

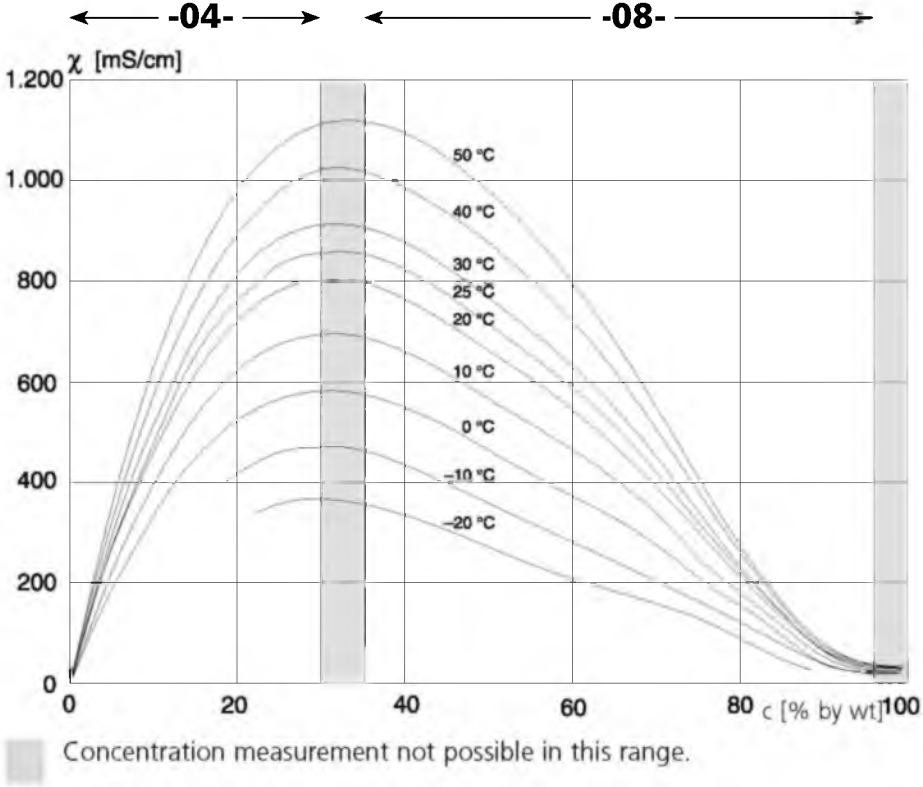


Concentration measurement not possible in this range.

Conductivity in dependence on substance concentration and process temperature for sulfuric acid (H_2SO_4)
Source: Darling; Journal of Chemical and Engineering Data; Vol.9 No.3, July 1964

-05- Nitric acid HNO_3

-08-



Conductivity in dependence on substance concentration and process temperature for nitric acid ($HN0_3$)
Source: Haase/Sauermann/Dücker; Z. phys. Chem. New Edition, Vol. 46 (1965)

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