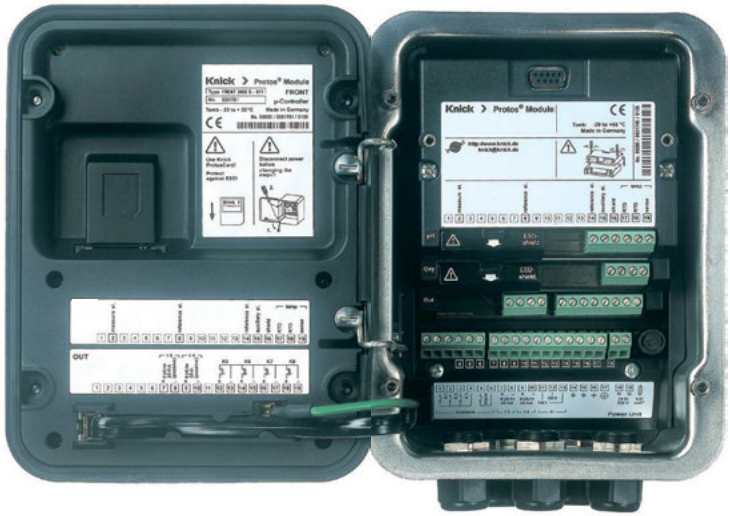
Knick

User Manual

Protos II 4400(X) / Protos 3400(X) Process Analysis System

Protos MS 4400(X)-160 / MS 3400(X)-160 Communication Module
For Memosens Sensors



MEMOSENS

Latest Product Information: www.knick.de

Returns

Clean and securely package the product before returning it to Knick Elektronische Messgeräte GmbH & Co. KG if required.
If there has been contact with hazardous substances, the product must be decontaminated or disinfected prior to shipment. The consignment must always be accompanied by a corresponding return form to prevent service employees being exposed to potential hazards.
Further information can be found at www.knick.de.

Disposal

The local codes and regulations must be observed when disposing of the product.

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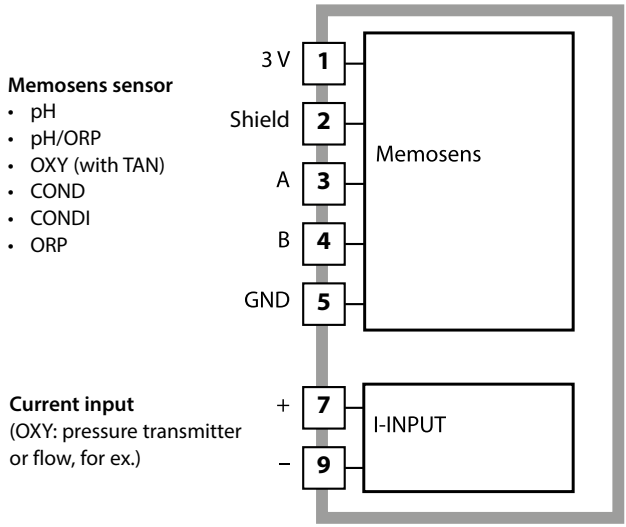
Intended Use

The module provides an RS-485 interface for the connection of Memosens sensors. It can be used to measure pH values, ORP, conductivity, and temperature. The TAN option also enables Memosens oxygen sensors to be connected. For pressure correction of oxygen sensors, there is an analog current input via which a pressure transmitter signal can be evaluated.

The MS 3400X-160 / MS 4400X-160 module is intended for operation in locations subject to explosion hazards which require equipment of Group II, device category 2(1), gas/dust.



Operation in Explosive Atmospheres
MS 3400X-160/ MS 4400X-160 Module

The module is approved for operation in explosive atmospheres.
When installing the product in a hazardous location, observe the information in the supplements to the certificates and, if applicable, the relevant control drawings.
Observe all applicable local and national codes and standards for the installation of electrical equipment in explosive atmospheres. For orientation, please refer to IEC 60079-14, EU directives 2014/34/EU and 1999/92/EC (ATEX), NFPA 70 (NEC), ANSI/ISA-RP12.06.01.

⚠ **WARNING!** Risk of impairment of explosion protection.

- Modules which have already been used shall be subjected to a professional routine test before they may be operated in another type of protection.
- Prior to commissioning, the operating company must verify the intrinsic safety in accordance with the installation regulations of IEC 60079-14 for the complete interconnection of all equipment involved, including the connecting cables.
- The interconnection of Ex and non-Ex modules (mixed assembly) is not permitted.
- In hazardous locations the device shall only be cleaned with a damp cloth to prevent electrostatic charging.

Maintenance

The Protos modules cannot be repaired by the user. For inquiries regarding module repair, please contact Knick Elektronische Messgeräte GmbH & Co. KG at www.knick.de.

Firmware Version

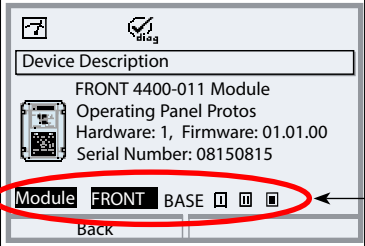
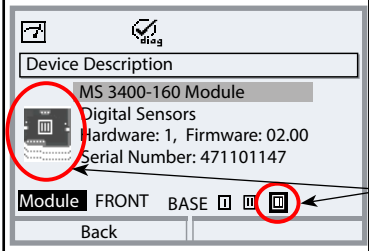
Module compatibility	Protos 3400	Protos 3400X	Protos II 4400	Protos II 4400X
	FRONT firmware version A.1 or higher		FRONT firmware version 01.00.00 or higher	
Protos MS 3400-160 module	x[1)]		x[3)]	
Protos MS 3400X-160 module		x[1)]		x[3)]
Protos MS 4400-160 module			x[2)]	
Protos MS 4400X-160 module				x[2)]

[1)] Module firmware version 02.xx.xx or higher
[2)] Module firmware version 01.xx.xx or higher
[3)] Module firmware version 03.01.00 or higher

Further information on the firmware version history can be found at www.knick.de.

Query Current Device Firmware/Module Firmware

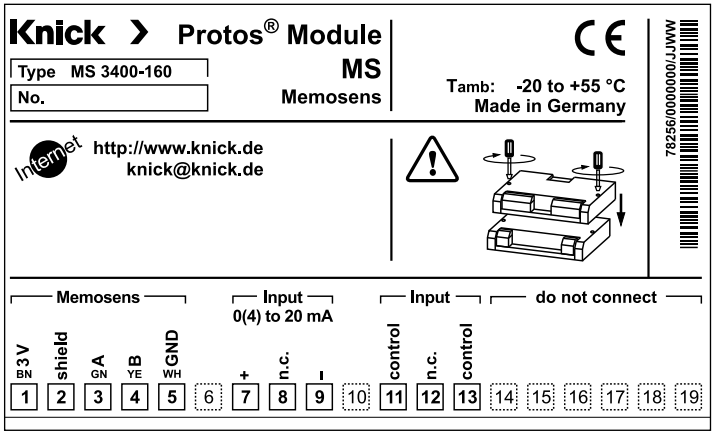
When the device is in measuring mode:
Press **menu** key, open Diagnostics menu: Device Description

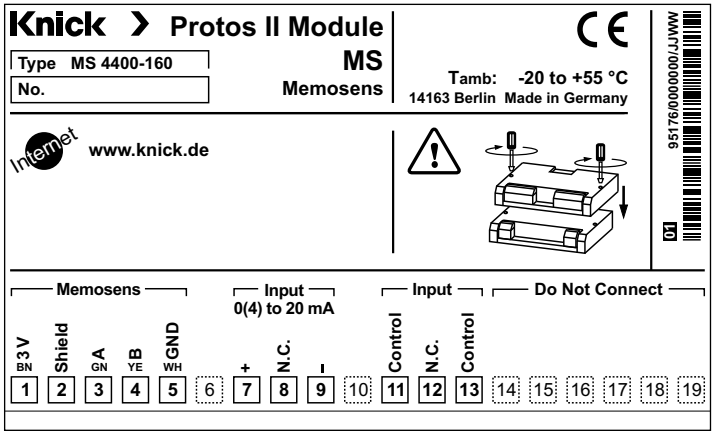
Menu	Display	Action
diag		**Device hardware and firmware version** Provides information on all modules installed: Module type and function, serial number, hardware and firmware version, and device options. Select the different modules (FRONT, BASE, slots 1 - 3) using the arrow keys.
		**Query module firmware** Here: MS 3400-160 module, "Digital Sensors", hardware and firmware version, serial number – here installed in slot 3.

Note: The display may vary depending on the device version.

Terminal Plate

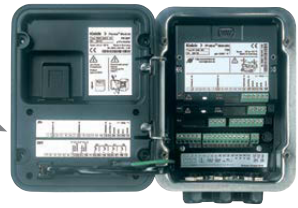
Terminal plate of MS 3400-160 / MS 4400-160 module:





Attaching the terminal plates

The terminal plates of the lower modules can be sticked to the inner side of the door. This facilitates maintenance and service.



Wiring with Memosens Cable

Terminal	Wire color	Wiring for Memosens or M12 cable
1	Brown (BN)	Power supply +
2	Transparent	Shield
3	Green (GN)	RS485 (A)
4	Yellow (YE)	RS485 (B)
5	White (WH)	Power supply – (GND)

See corresponding cable documentation.

Order Codes

Cable type	Cable length	Order code
Memosens® cable	3 m / 9.84 ft	CA/MS-003NAA
	5 m / 16.40 ft	CA/MS-005NAA
	10 m / 32.81 ft	CA/MS-010NAA
	20 m / 65.62 ft	CA/MS-020NAA
	Other lengths available on request.	
M12 cable	5 m / 16.40 ft	CA/M12-005NA
	10 m / 32.81 ft	CA/M12-010NA
	20 m / 65.62 ft	CA/M12-020NA

Installing the Module

⚠ **CAUTION!** Electrostatic discharge (ESD).
The modules' signal inputs are sensitive to electrostatic discharge.
Take measures to protect against ESD before inserting the module and wiring the inputs.

NOTICE! Strip the insulation from the wires using a suitable tool to prevent damage.

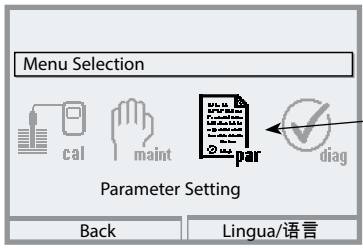
1) Switch off the power supply to the device.
2) Open the device (loosen the 4 screws on the front).
3) Plug the module into the slot (D-SUB connector), see figure.
4) Tighten the module's fastening screws.
5) Connect the sensor cable.
6) Check whether all connections are correctly wired.
7) Close the device by tightening the screws on the front.
8) Switch on the power supply.

⚠ **CAUTION!** Risk of losing the specified ingress protection.
Fasten the cable glands and screw together the housing correctly.
Observe the permissible cable diameters and tightening torques (see the specifications of the basic unit).
Insert blanking plugs or sealing inserts if necessary.

Parameter Setting

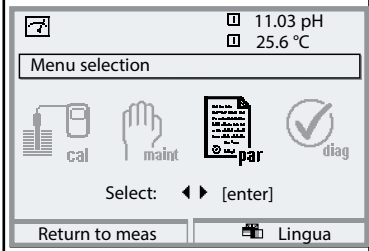
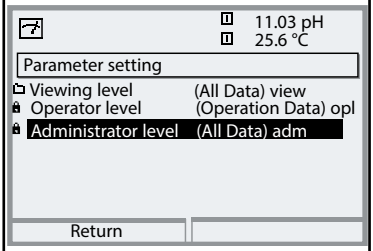
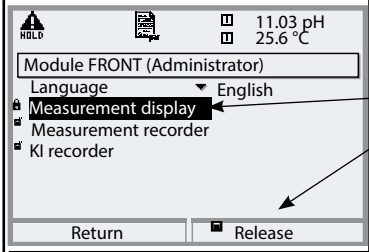
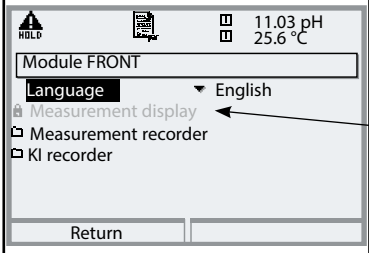
⚠ CAUTION! Incorrect parameter settings or adjustments can result in incorrect outputs.
The Protos II 4400(X) must therefore be commissioned by a system specialist, all its parameters must be set, and it must be fully adjusted.

NOTICE!
The "function check" (HOLD) mode is active during parameter setting.
The behavior of the current outputs depends on the parameter setting, i.e., they may be frozen at the last measurement or set to a fixed value. The red "Alarm" LED blinks.
Measurement operations must not be carried out while the Protos is in the function check (HOLD) mode, as this may put the user at risk due to unexpected system behavior.

Menu	Display	Action
		**Open the Parameter Setting menu** From the measuring mode: Press **menu** key to select menu. Select parameter setting using arrow keys, press **enter** to confirm

Parameter Setting: Operating Levels

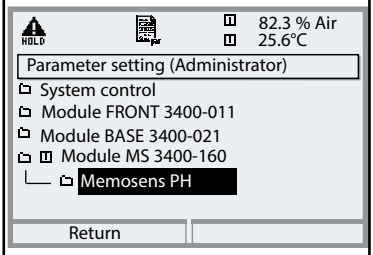
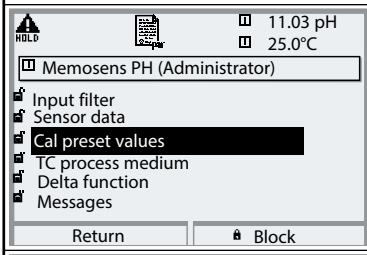
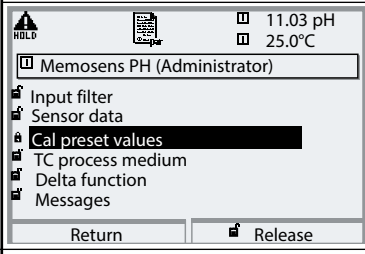
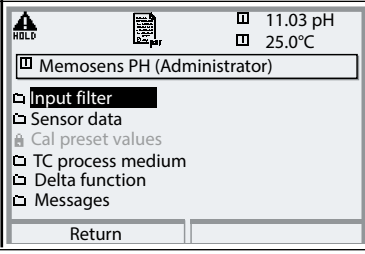
Viewing level, Operator level, Administrator level
Note: Function check (HOLD) mode active (Setting: BASE module)

Menu	Display	Action
par		**Open parameter setting** From the measuring mode: Press **menu** key to select menu. Select parameter setting using arrow keys, press **enter** to confirm.
		**Administrator level** Access to all functions, also passcode setting. Releasing or blocking functions for access from the Operator level.
		Functions which can be blocked for the Operator level are marked with the "lock" symbol. The functions are released or blocked using the softkey.
		**Operator level** Access to all functions which have been released at the Administrator level. Blocked functions are displayed in gray and cannot be edited (Fig.). **Viewing level** Display of all settings. No editing possible!

Note: The display may vary depending on the device version.

Parameter Setting: Locking a Function

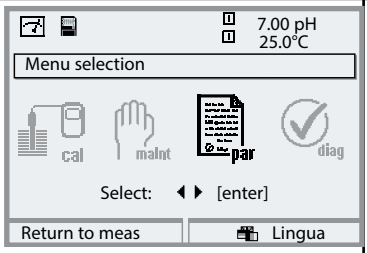
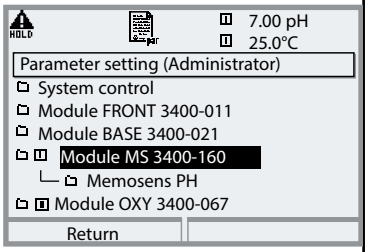
Administrator level: Enabling/locking functions for Operator level
Note: Function check (HOLD) mode active (Setting: BASE module)

Menu	Display	Action
par		**Example:** Blocking access to the calibration adjustments from the Operator level **Open parameter setting** Select Administrator level. Enter passcode (1989). Select "Memosens PH" (for example) using arrow keys, press **enter** to confirm.
		Select "Cal preset values" using arrow keys, "Block" with softkey.
		Now, the "Cal preset values" line is marked with the "lock" icon. This function cannot be accessed from the Operator level any more. The softkey function changes to "Release".
par		**Open parameter setting** Select Operator level, passcode (1246), select "Memosens PH", for ex. Now, the locked function is displayed in gray and marked with the "lock" icon.

Note: The display may vary depending on the device version.

Module Configuration: Operating Mode

Note: Function check (HOLD) mode active

Menu	Display	Action
par		**Open parameter setting** From the measuring mode: Press **menu** key to select menu. Select parameter setting using arrow keys, press **enter** to confirm. Passcode 1989 (To change passcode: Parameter setting > System control > Passcode entry)
		Select module. Press **enter** to confirm. **Operating mode** **See page:** pH 18 pH/ORP 43 ORP 45 O_2 (OXY) 63 COND 91 CONDI 125 If you want to use the SE670 digital sensor (inductive measurements), you must select operating mode ”digital”, see page 125.

Note: The display may vary depending on the device version.

Module Configuration: Operating Mode

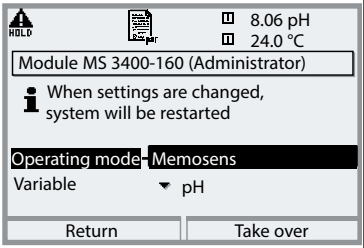
Note: Function check (HOLD) active

MS 4400-160(X) for Protos II 4400(X) from FW 01.00.00 MS 3400-160(X) for Protos II 4400(X) from FW 03.01.00		
Operating Mode: Memosens		
Variable	Auto	Automatic selection of process variables in the measurement display
	pH	Functionality: pH, ISFET, pH/ORP, ORP
	Conductivity	Functionality: 2-electrode / 4-electrode sensor
	Conductivity (ind.)	Functionality: CONDI, SE680M
	Oxygen	Functionality: Amperometric
Operating Mode: Others Digital		
Variable	Conductivity (ind.)	For application with SE 670

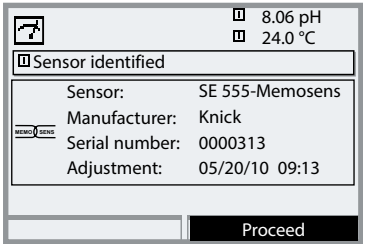
MS 3400-160(X) for Protos 3400(X) from SW 2.x		
Operating Mode: Memosens		
Variable	pH	For pH sensor, ISFET sensor
	ORP	For ORP sensor
	pH/ORP	For pH/ORP combination sensor
	pH (F 1.2)	Not used
	O_2	For amperometric oxygen sensor
	Cond	2-electrode or 4-electrode sensor
	CondI	For toroidal conductivity sensor
Operating Mode: Other Digital Sensors		
Variable	CONDI	For application with SE 670

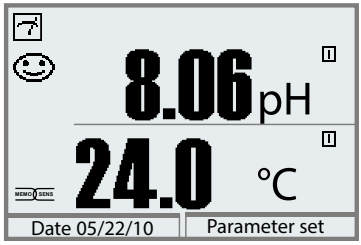
pH Parameter Setting

Selecting the mode and process variable (pH).
Note: Function check (HOLD) mode active

Menu	Display	Action
par		**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: pH Operating mode: Memosens Functionality: pH Protos 3400(X): Operating mode: Memosens Variable: pH

A connected Memosens sensor is displayed immediately:





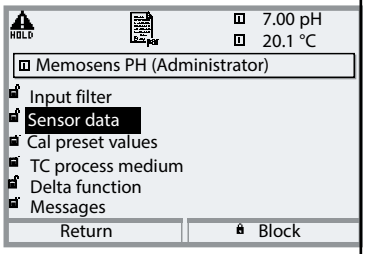
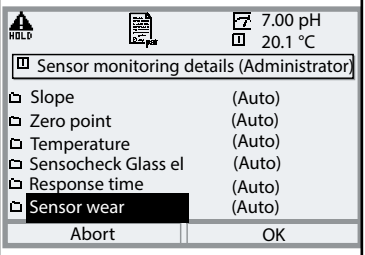
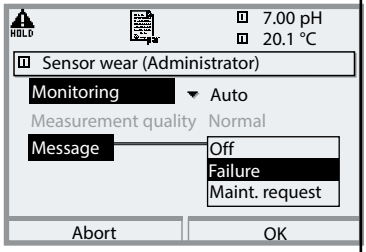
All sensor-typical parameters are automatically sent to the analyzer.
These are, for example, the measuring range, zero and slope of the sensor. Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected.
With "Plug&Measure", premeasured Memosens sensors can immediately be used for measurement without previous calibration.

With Protos 3400(X): The Memosens icon is displayed as long as a Memosens sensor is connected.

Note: The display may vary depending on the device version.

pH Parameter Setting

Note: Function check (HOLD) mode active

Menu	Display	Action
	  	**Sensor data** Memosens sensors provide most of the parameters automatically. **Sensoface** provides information on the sensor condition. In measuring mode a smiley face is displayed ☺ (friendly, neutral, sad) depending on the sensor data. Great deviations are signaled. To display the "Sensoface" icon, you must activate it in the Sensor Data menu. **Sensor monitoring details** For some parameters, you can choose between Auto and Individual. Auto: The parameters are read out directly form the sensor or are adjusted by the system. They are displayed in gray and cannot be edited. Individual: You must enter the parameters. **Messages** Limit violations can be signaled by a message (either "failure" or "maintenance request").

Note: The display may vary depending on the device version.

pH Parameter Setting

Parameter	Default	Selection / Range
Input filter		
Pulse suppression	Weak	Off, Weak, Medium, Strong
Input filter	010 sec	xxx sec (entry)
Sensor data		
Sensoface	On	On, Off
Sensor monitoring details		
Sensor parameters	Auto	- Slope - Zero point - Temperature - Sensocheck glass electrode - Response time - Sensor wear - SIP counter (default: Off) - Sensor operating time (default: Off)
Cal preset values		
Calimatic buffer	Knick CaliMat	Knick CaliMat, Mettler-Toledo, DIN 19267, NIST standard, NIST technical, Hamilton, Kraft, Hamilton A, Hamilton B, Hach, Ciba, Reagecon, Table
Drift control	Standard	Fine: 1.2 mV/min (Abort after 180 sec) Standard: 2.4 mV/min (Abort after 120 sec) Coarse: 3.75 mV/min (Abort after 90 sec)
Cal timer monitoring	Auto: 0168h	Auto, Off, Individual
Adaptive cal timer	Off	Off, On
Cal tolerance band check:	Off	Off, On
Cal tolerance zero	+00.20 pH	(entry)
Cal tolerance slope	+002.0 mV/pH	(entry)
TC process medium		
TC	Off	Off, Linear, Ultrapure water, Table Linear: enter temperature factor +XX.XX %/K Table: TC values adjustable in 5°C steps
Delta function		
Delta function	Off	Off, pH
Messages		
Messages pH value	Off	Off, Variable limits
Messages mV value	Off	Off, Variable limits

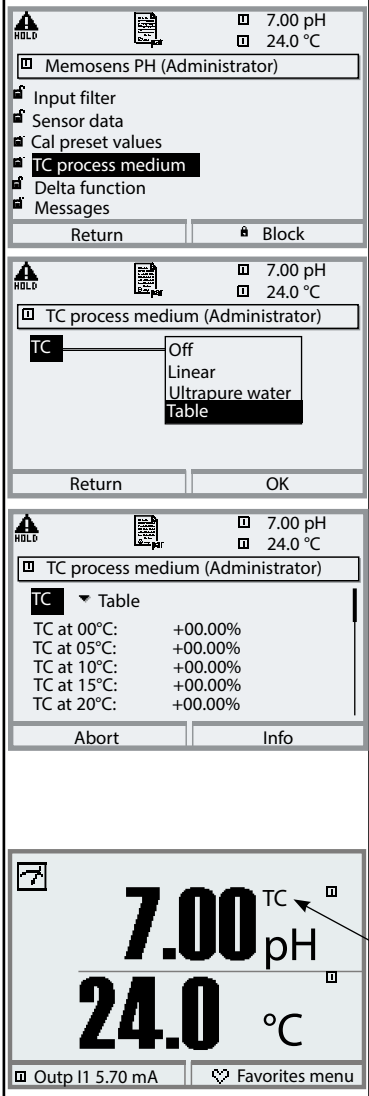
Note: The menus may vary depending on the device version.

Tolerance adjustment [1]: During calibration this function checks the zero and slope values and automatically performs an adjustment when the tolerance band is exceeded. The parameters are stored in the tolerance band recorder (Diagnostics menu).

1) Add-on function SW3400-005 with Protos 3400(X)

pH Parameter Setting

TC process medium
Note: Function check (HOLD) mode active

Menu	Display	Action
par		**TC process medium** You can choose from: • Linear (input of TC coefficient) • Ultrapure water • Table: When measuring media with a known temperature response, the output pH value can be corrected using a table. TC can be entered in 5°C steps for temperatures between 0 and 95°C. Then, the output pH value is corrected by the corresponding TC value depending on the measuring temperature. Intermediate values are linearly interpolated. In the case of lower or higher temperatures (< 0°C or > 95°C), the last table value is used for calculation. If the delta function has been activated (see next page) simultaneously with temperature compensation, the temperature is compensated first and then the delta value is subtracted. When the TC correction for process medium is switched on, "TC" appears in the display in measuring mode.

Note: The display may vary depending on the device version.

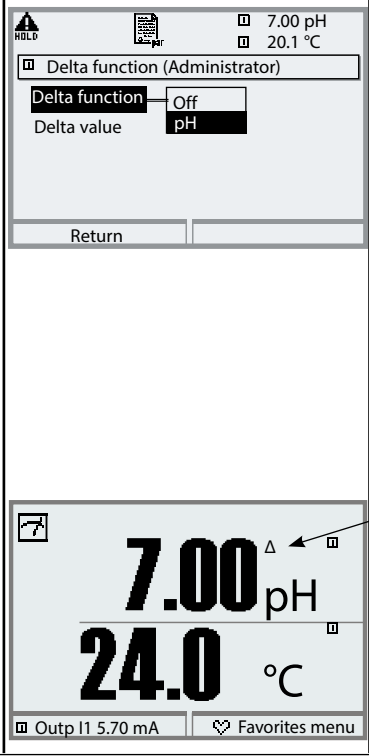
pH Parameter Setting

TC process medium, delta function
Note: Function check (HOLD) mode active

Temperature compensation of process medium

Linear temperature compensation, reference temp fixed at 25 °C / 77 °F

$pH_{(25\,°C\,/\,77\,°F)}$	=	pH_M + TC/100 % (25 °C / 77 °F - T_M)
$pH_{(25\,°C\,/\,77\,°F)}$	=	pH value compensated to 25 °C / 77 °F
pH_M	=	Measured pH value (temperature-corrected)
TC	=	Temperature factor [%/K]
T_M	=	Measured temperature [° C]

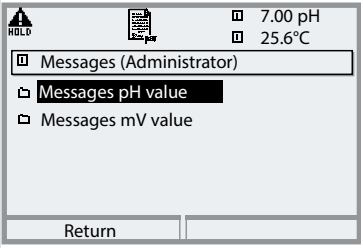
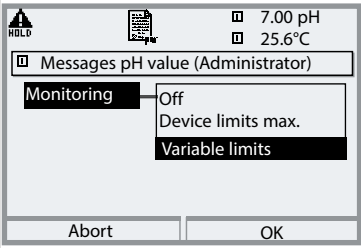
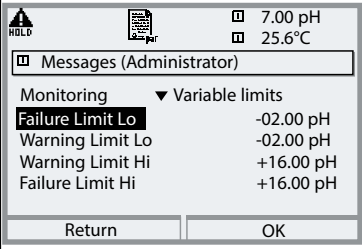
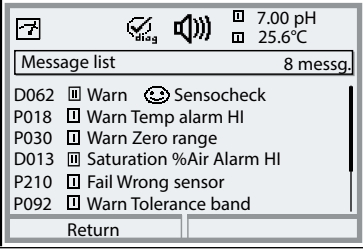
Menu	Display	Action
par		**Delta function** When a delta value is entered, the system calculates the difference Output value = measured value – delta value The output value controls all outputs and is shown on the display. When the delta function has been activated simultaneously with temperature compensation, the temperature is compensated first and then the delta value is subtracted. When delta function is switched on, "Δ" appears in the display in measuring mode.

Note: The display may vary depending on the device version.

pH Parameter Setting

Messages
Note: Function check (HOLD) mode active

Note: The display may vary depending on the device version.

Menu	Display	Action
par	  	**Messages** All parameters determined by the measuring module can generate messages. **Device limits max.:** Messages are generated when the process variable (e.g. pH) is outside the measuring range. The "Failure" icon is displayed, the NAMUR failure contact is activated (BASE module, factory setting: contact K4, N/C contact). The current outputs can signal a 22mA message (user defined). **Variable limits:** For the "failure" and "warning" messages, you can define upper and lower limits for message generation. **Message icons** Failure (Failure limit HiHi/LoLo) Maintenance (Warning limit Hi/Lo) Limit indication (here: lower range)
diag		**Diagnostics menu** When the "Maintenance" or "Failure" icons are blinking in the display, you should access the Diagnostics menu. The messages are displayed in the "Message list".

pH Calibration / Adjustment

Note: Function check (HOLD) mode active for the currently calibrated module
Current outputs and relay contacts behave as configured

The calibration/adjustment data are stored in the sensor. This allows calibrating, adjusting, regenerating or cleaning the sensors in a lab, far from the point of measurement. On the site, you simply replace the used sensors by calibrated/ adjusted sensors.

- **Calibration:** Detecting deviations without readjustment
- **Adjustment:** Detecting deviations with readjustment

NOTICE! Without adjustment every pH meter delivers an imprecise or wrong output value! Every pH electrode has its individual zero point and its individual slope. Both values are altered by aging and wear.
To determine the correct pH value, the pH meter must be adjusted to the electrode. The analyzer corrects the voltage delivered by the electrode with regard to electrode zero and slope and displays it as the pH value.
Be sure to perform an adjustment after having replaced the electrode!

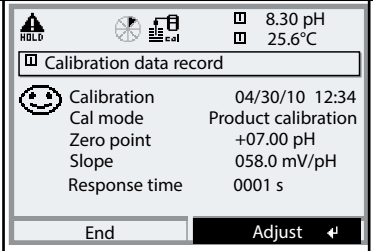
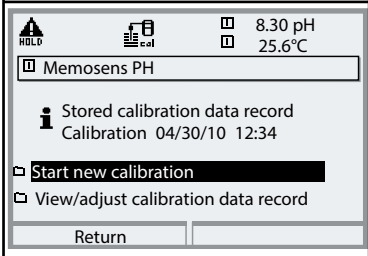
Procedure
First, a calibration is performed to detect the deviations of the electrode (zero, slope). To do so, the electrode is immersed in buffer solutions whose pH value is exactly known. The measuring module measures the electrode voltages and the buffer solution temperature and automatically calculates the electrode zero and slope. These data are stored in a calibration record. By "Adjustment" the determined calibration data can be used for correction (see following page).

Parameters determined by calibration

Zero point	is the pH value at which the pH electrode outputs the voltage 0 mV. It is different for each electrode and changes with age and wear.
Temperature	of the process solution must be detected since pH measurement is temperature-dependent. Many electrodes have an integrated temperature probe.
Slope	of an electrode is the voltage change per pH unit. For an ideal pH electrode, it lies at -59.2 mV/pH.

pH Calibration / Adjustment

Adjustment means that the values determined by a calibration are taken over. The values determined for zero and slope are entered in the calibration record. (Diagnostics > Module MS ... > Memosens PH > Cal record). These values are only effective for calculating the measured variables when the calibration has been terminated with an adjustment. A passcode ensures that an adjustment can only be performed by an authorized person (Administrator). The Operator can check the current sensor data by a calibration and inform the Administrator when there are deviations. You can use the add-on function SW3400-107[1)] for granting access rights (passcodes) and for AuditTrail (continuous data recording and backup according to FDA 21 CFR Part 11).

Menu	Display	Action
cal		**Administrator** With the corresponding access rights, the device can immediately be adjusted after calibration. The calibration values are taken over for calculating the measured variables.
		**Operator** (without administrator rights) After calibration, change to measuring mode. Inform Administrator. When opening the menu (Calibration, respective module), the Administrator sees all data of the last calibration and can take over the values or perform a new calibration.

Note: The display may vary depending on the device version.

1) With Protos 3400(X)

pH Calibration / Adjustment

Calibration methods

Note: With Memosens sensors, the calibration data are stored in the sensor. This allows using precalibrated sensors.
When the Protos is used for precalibrating sensors in the lab, you can use the calibration routines described below.

One-point calibration
The electrode is calibrated with one buffer solution only.
Here, only the electrode zero point is detected and taken into account by the Protos. One-point calibration is appropriate and permissible whenever the measured values lie near the electrode zero point so that slope changes do not have much of an impact.

Two-point calibration
The electrode is calibrated with two buffer solutions.
In that case, zero point and slope of the electrode can be detected and taken into account by the Protos. Two-point calibration is required if

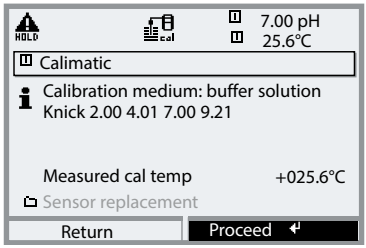
- the electrode has been replaced
- the measured pH values cover a wide range
- there is great difference between the measured pH value and the electrode zero
- the pH measurement must be very accurate
- the electrode is exposed to extreme wear.

Three-point calibration
The electrode is calibrated with three buffer solutions.
Zero and slope are calculated using a line of best fit according to DIN 19268.

Temperature compensation during calibration

There are two important reasons for determining the temperature of the buffer solution:
The slope of the pH electrode is temperature-dependent. Therefore the measured voltage must be corrected by the temperature influence.
The pH value of the buffer solution is temperature-dependent. For calibration, the buffer solution temperature must therefore be known in order to choose the actual pH value from the buffer table.

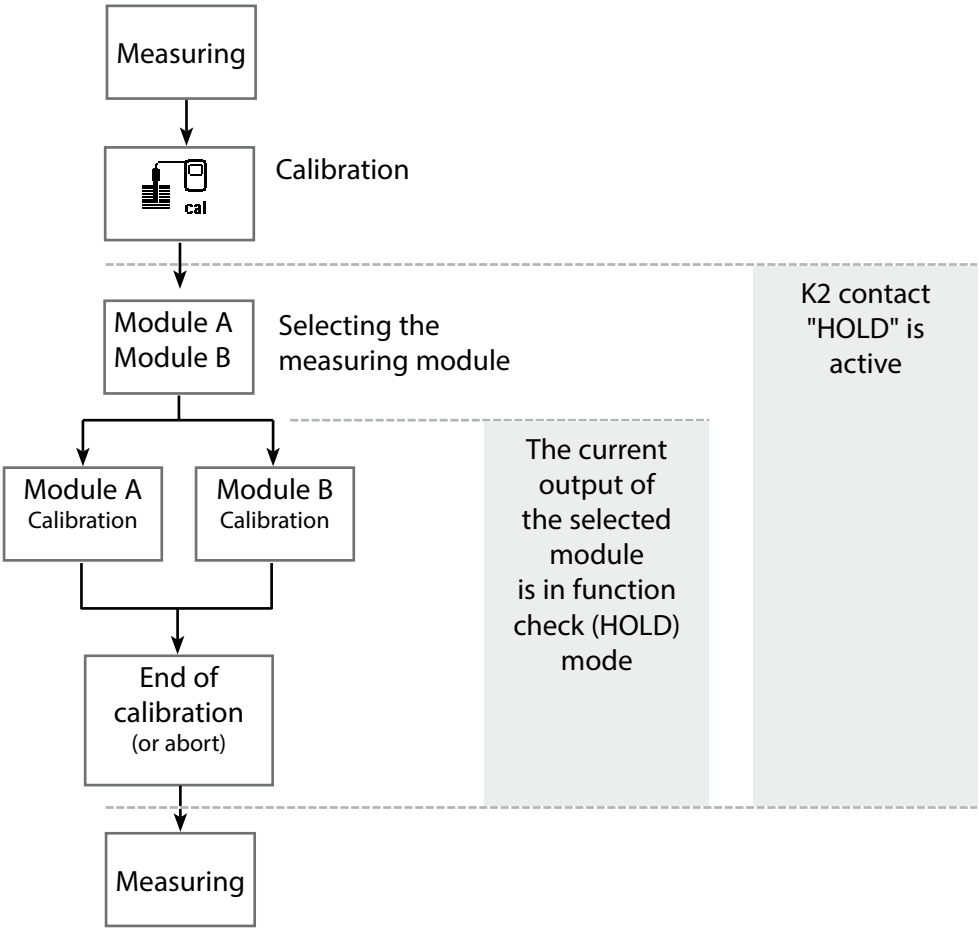
Automatic temperature compensation

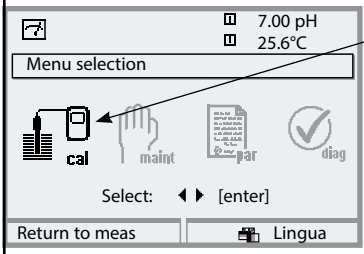
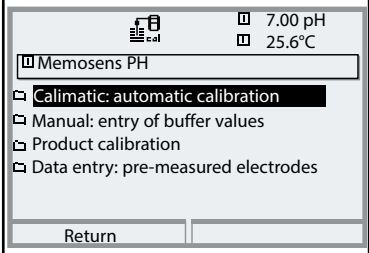


Protos measures the temperature of the buffer solution using the temperature detector integrated in the Memosens sensor.

HOLD Function During Calibration/Adjustment

Behavior of the signal and relay outputs during calibration/adjustment



Menu	Display	Action
		**Open calibration** Press **menu** key to select menu. Select calibration using arrow keys, press **enter** to confirm, passcode 1147 (To change passcode, select: Parameter setting > System control > Passcode entry). Calibration: Select "Memosens PH"
		Select calibration method: • Automatic buffer recognition (Calimatic) • Manual entry of buffer values • Product calibration (calibration with sampling) • Entry of previously measured electrode data • Temp probe adjustment (with Protos II 4400(X))
		During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE module).

Note: The display may vary depending on the device version.

pH Calibration / Adjustment

Calimatic automatic buffer recognition

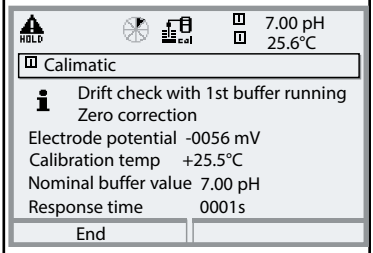
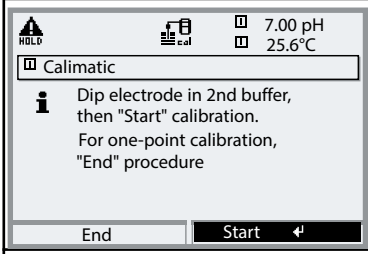
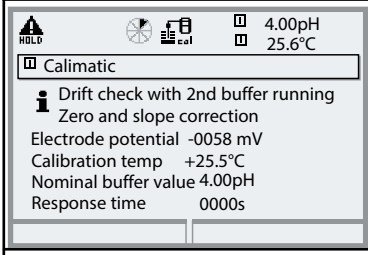
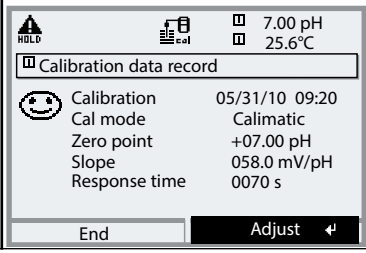
Automatic buffer recognition (Calimatic)
Automatic calibration using Knick Calimatic is performed with one, two or three buffer solutions. Protos automatically detects the nominal buffer value on the basis of the electrode potential and the measured temperature. Any sequence of buffer solutions is possible, but they must belong to the buffer set defined during parameter setting.
The Calimatic takes the temperature dependence of the buffer value into account. All calibration data is converted using a reference temperature of 25 °C / 77 °F.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
Only ever use fresh, undiluted buffer solutions which belong to the selected buffer set!

Menu	Display	Action
cal	HOLD 7.00 pH 25.6°C Calimatic Calibration medium: buffer solution Knick 2.00 4.01 7.00 9.21 Sensor replacement Return Proceed	**Select: Calimatic** Display of selected buffer set Proceed by pressing softkey or **enter**.
	HOLD 7.00 pH 25.6°C Calimatic Dip electrode in 1st buffer, then "Start" calibration. Return Start	Remove and rinse the electrode (**CAUTION:** Electrostatic hazard. Do not rub.), then immerse it in the first buffer solution. Start by pressing softkey or **enter**.

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Display of nominal buffer value. You can press "End" to reduce the waiting time before stabilization of the electrode potential (reduced accuracy of calibration values). From the response time, you see how much time the electrode needs for the potential to stabilize. If the electrode potential or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
		For a one-point calibration, press "End" softkey. For two-point calibration: Rinse electrode thoroughly! Immerse electrode in the second buffer solution. Start by pressing softkey or **enter**.
		Calibration is performed with the second buffer. Three-point calibration is performed correspondingly with the third buffer.
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables and to save them in the sensor.

Note: The display may vary depending on the device version.

pH Calibration / Adjustment

Calibration with manual entry of buffer values

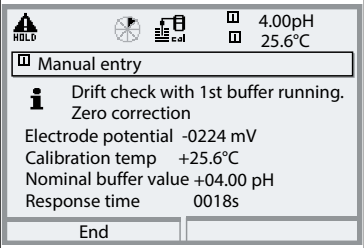
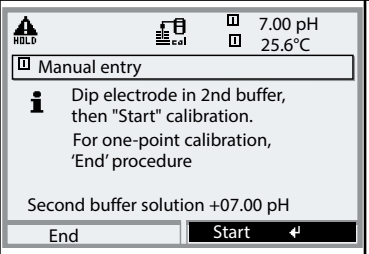
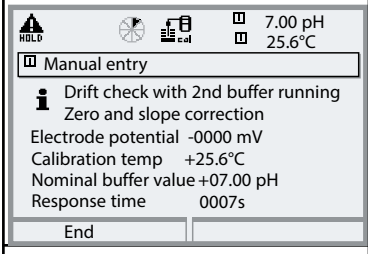
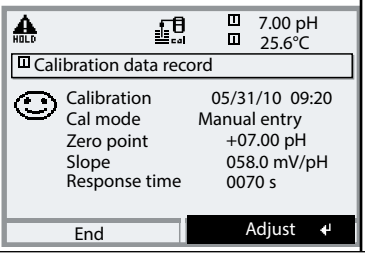
Calibration with manual entry of buffer values
Calibration with manual entry of buffer values is performed with one, two or three buffer solutions.
Protos displays the measured temperature.
You must then enter the temperature-corrected buffer values. To do so, refer to the buffer table (e.g. on the bottle) and enter the buffer value belonging to the displayed temperature.
Intermediate values must be interpolated.
All calibration data is converted using a reference temperature of 25 °C / 77 °F.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
Only ever use fresh, undiluted buffer solutions!

Menu	Display	Action
cal	HOLD cal 7.00 pH 25.6°C Manual entry Calibration medium: buffer solution Sensor replacement Cal temp +025.6°C First buffer solution +04.00 pH Return Proceed	**Select: Manual entry** Display: Cal temp Enter first buffer value Proceed by pressing softkey or **enter**
	HOLD cal 7.00 pH 25.6°C Manual entry Dip electrode in 1st buffer, then "Start" calibration. Return Start	Remove and rinse the electrode (**CAUTION:** Electrostatic hazard. Do not rub.), then immerse it in the first buffer solution. Start by pressing softkey or **enter**

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Calibration with first buffer solution. You can press "End" to reduce the waiting time before stabilization of the electrode potential (reduced accuracy of calibration values). From the response time, you see how much time the electrode needs for the potential to stabilize. If the electrode potential or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
		One-point calibration: "End". Two-point calibration: Rinse electrode thoroughly! Enter 2nd buffer value for correct temperature. Immerse electrode in the second buffer solution. Start by pressing softkey or **enter**
		Calibration is performed with the second buffer. Three-point calibration is performed correspondingly with the third buffer.
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables to save them in the sensor.

Note: The display may vary depending on the device version.

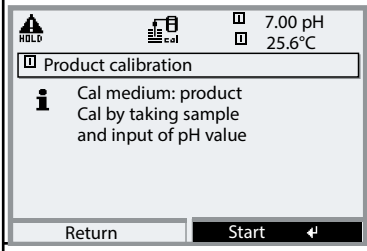
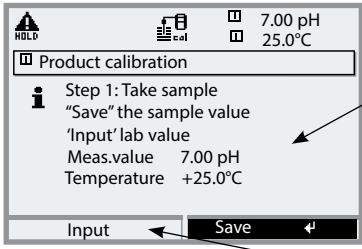
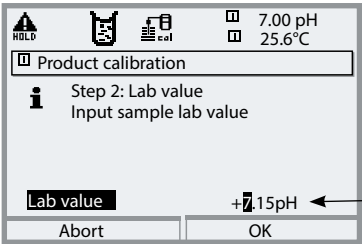
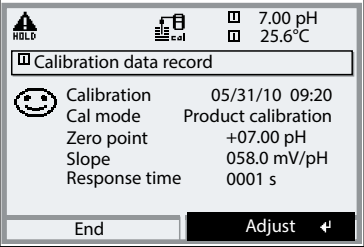
Product calibration (calibration with sampling)
When the electrode cannot be removed – e.g. for sterility reasons – its zero point can be determined with "sampling". To do so, the currently measured process value is stored by the Protos. Immediately afterwards, you take a sample from the process. The pH value of the sample is measured in the lab or directly on the site using a portable pH meter. The reference value is entered into the measuring system. From the difference between measured value and reference value, the Protos calculates the electrode zero point (this method only allows one-point calibration).

During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE).

NOTICE! The pH value of the sample is temperature-dependent. Therefore, the reference measurement should be performed at the sample temperature shown in the display. Transport the sample in an insulated container. The pH value may also be altered due to escaping of volatile substances.

Menu	Display	Action
cal	7.00 pH 25.6°C Calibration Memosens PH Return Info	**Memosens PH** The module is in function check (HOLD) mode. The assigned current outputs and relay contacts behave as configured (BASE). Press **enter** to confirm.
	7.00 pH 25.6°C Memosens PH Calimatic: automatic calibration Manual: entry of buffer values Product calibration Data entry: pre-measured electrodes Return	Select calibration mode "Product calibration" Press **enter** to confirm.

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		The module is in function check (HOLD) mode. **Product calibration** Product calibration is performed in 2 steps. Prepare sampling, start by pressing softkey or **enter**.
		**Step 1** Take sample. Save measured value and temperature at the moment of sampling ("Save" softkey or **enter**). Press **meas** to return to measurement. **Exception:** Sample value can be measured on the site and be entered immediately. To do so, press "Input" softkey.
		**Step 2** Lab value has been measured. When you open the Product calibration menu again, the display shown on the left appears: Enter reference value ("Lab value"). Confirm with OK or repeat calibration.
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables to save them in the sensor.

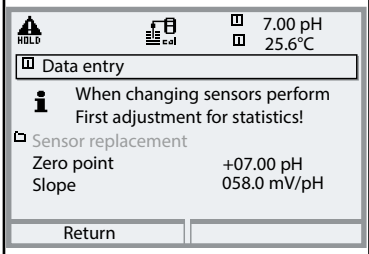
Note: The display may vary depending on the device version.

pH Calibration / Adjustment

Calibration by entering data from premeasured electrodes

Data entry of premeasured electrodes
Entry of values for zero point and slope of a pH electrode. The values must be known, e.g. determined beforehand in the laboratory.

During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE).

Menu	Display	Action
		**Select: Data entry of premeasured electrodes** Remove electrode and connect pre-measured electrode. Enter the values for • Zero point • Slope Return using softkey or press **meas** to return to measurement.

Note: The display may vary depending on the device version.

Temp Probe Adjustment

Note: With Protos II 4400(X) in the Calibration menu,
with Protos 3400(X) in the Maintenance menu.

This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. Make sure that the process temperature is precisely measured using a calibrated reference thermometer when performing an adjustment. The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display!

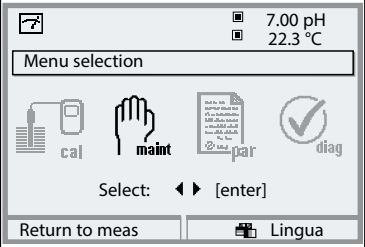
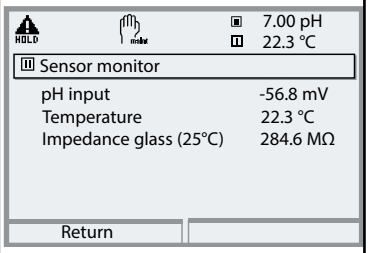
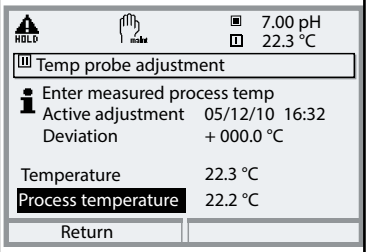
With Protos II 4400(X), the data from the last adjustment and the temperature offset can be called from the Diagnostics menu, see p. 40.

Monitoring functions for calibration
Protos provides comprehensive functions for monitoring proper calibration performance and the electrode condition. This allows documentation for quality management to ISO 9000 and GLP/GMP.

- Sensocheck monitors the electrode condition by measuring the glass electrode impedance.
- Regular calibration can be monitored by the cal timer.
- Adaptive cal timer - automatically reduces the calibration interval when the electrode is subjected to high stress
- The calibration record (GLP/GMP) provides all relevant data of the last calibration and adjustment.
- The logbook shows the time and date of a performed calibration.

pH Maintenance

Sensor monitor, temp probe adjustment
Note: Function check (HOLD) mode active

Menu	Display	Action
maint		**Opening the maintenance menu** From the measuring mode: Press **menu** key to select menu. Select maintenance using arrow keys, confirm by pressing **enter**. Passcode (as delivered): 2958 Then select Module MS 3400-160 and the corresponding Memosens PH sensor.
		**Sensor Monitor** For validation of sensor and complete signal processing.
		**Temp Probe Adjustment** [1)] This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. The adjustment value is stored in the sensor. Before performing an adjustment, you must precisely measure the process temperature using a calibrated reference thermometer. The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display!

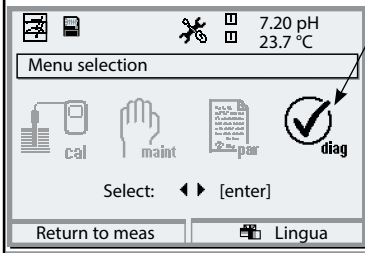
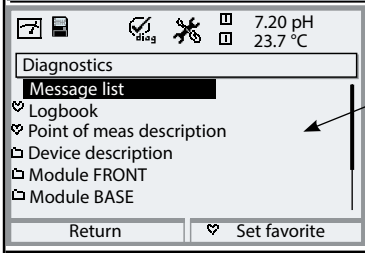
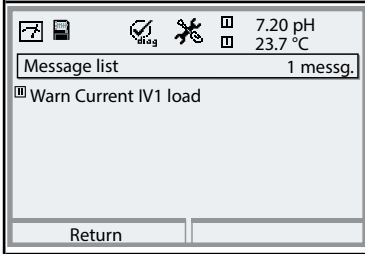
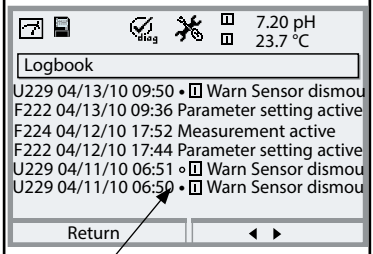
Note: The display may vary depending on the device version.

1) With Protos II 4400(X) in the Calibration menu

pH Diagnostic Functions

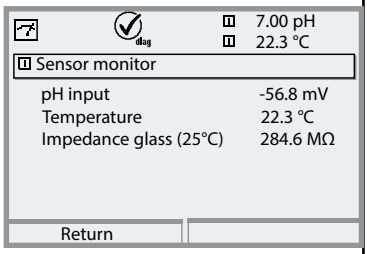
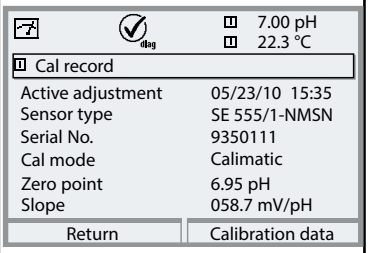
General status information of the measuring system
Select menu: Diagnostics

Note: The display may vary depending on the device version.

Menu	Display	Action
diag		**Opening the diagnostics menu** From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, confirm by pressing **enter**.
		The "Diagnostics" menu gives an overview of all functions available. Functions which have been set as "Favorite" can be directly accessed from the measuring mode.
		**Message List** Shows the currently activated warning or failure messages in plain text.
	 Module concerned: • Message activated ◦ Message deactivated	**Logbook** The logbook directly displays the last 50 events (Protos 3400) or 100 events (Protos II 4400) with date and time, e.g. calibrations, warning and failure messages, power failure etc. For parameter setting, see p. 154.

pH Diagnostic Functions

Menu selection: Diagnostics > Module MS ... > Memosens pH

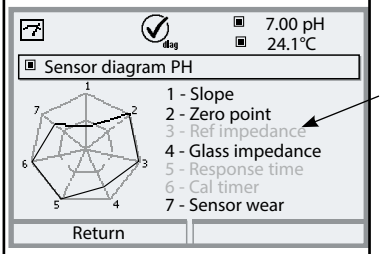
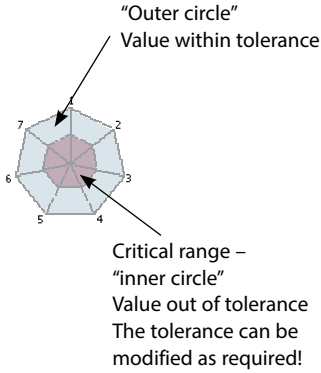
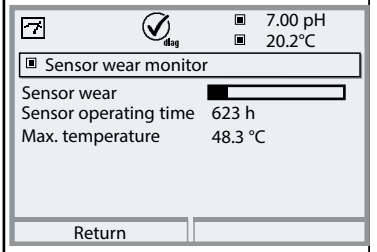
Menu	Display	Action
diag		**Sensor Monitor** Shows the values currently measured by the sensor. Important function for diagnostics and validation.
		**Calibration/Adjustment Record** Data of the last adjustment/calibration (Date, time, calibration method, zero and slope, isothermal potential, information concerning calibration buffers and response times) **Temp. Offset Log** Shows the data from the last temperature adjustment performed on the currently connected sensor.[1)]

Note: The display may vary depending on the device version.

1) With Protos II 4400(X)

pH Diagnostic Functions

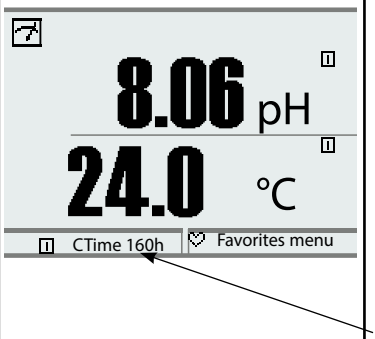
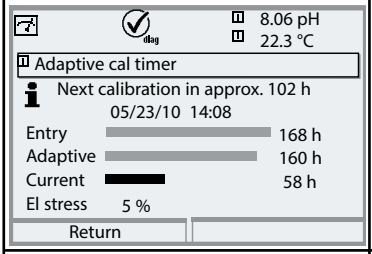
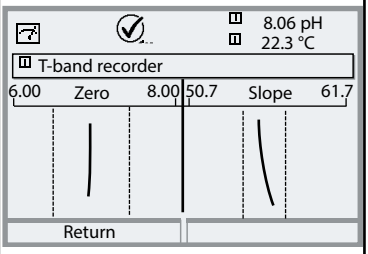
Menu selection: Diagnostics > Module MS ... > Memosens pH

Menu	Display	Action
diag		**Sensor Diagram** Graphical representation of the sensor parameters. Tolerance limit violations can be seen at a glance. Critical parameters are blinking. Parameters displayed in gray have been disabled during parameter setting or do not apply to the currently selected sensor. The tolerance limits (radius of "inner circle") can be modified as desired. See Parameter setting > Sensor data > Sensor monitoring details.
		
		**Sensor Wear** Display of sensor operating time and max. temperature during the operating time, graphical representation of sensor wear related to theoretical max. operating time.

Note: The display may vary depending on the device version.

pH Diagnostic Functions

Menu selection: Diagnostics > Module MS ... > Memosens pH

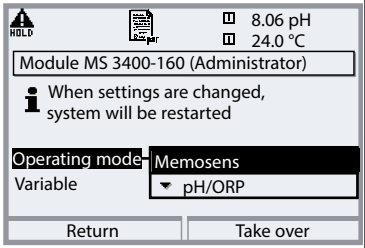
Menu	Display	Action
		**Calibration timer** After expiration of a presettable interval (Parameter setting, Memosens PH, Cal preset values), the calibration timer generates a warning message as a reminder that calibration is required. The remaining time can be indicated in the measuring mode by pressing a softkey (secondary display: "CTime").
diag		**Adaptive calibration timer** The time until the next due calibration is automatically reduced depending on the temperature and pH value, i.e. old electrode = timer expires sooner.
		**Tolerance adjustment** Add-on function SW3400-005 [1)] Records the tolerance ranges for zero and slope over the time. If the values determined by a calibration exceed the tolerance limits, the calibration is taken over as adjustment. Display can be graphical or as a listing. The tolerance band (zero, slope) is configured during parameter setting (Memosens PH, Cal preset values).

Note: The display may vary depending on the device version.

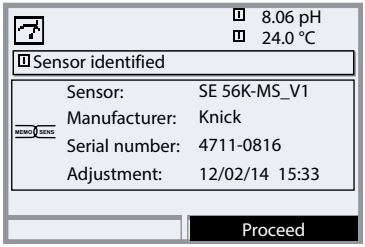
1) With Protos 3400(X)

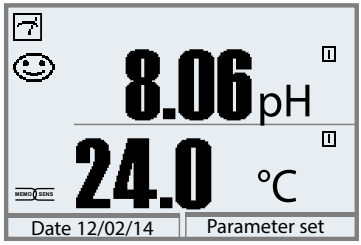
pH/ORP Parameter Setting

Selecting the mode and process variable (pH/ORP).
Note: Function check (HOLD) mode active

Menu	Display	Action
		**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: pH. Operating mode: Memosens Functionality: pH/ORP Protos 3400(X): Operating mode: Memosens Variable: pH/ORP

A connected Memosens sensor is displayed immediately:





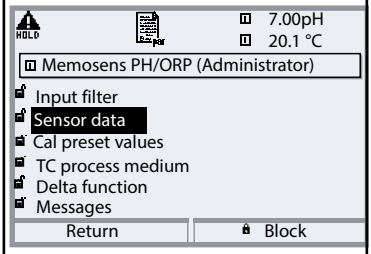
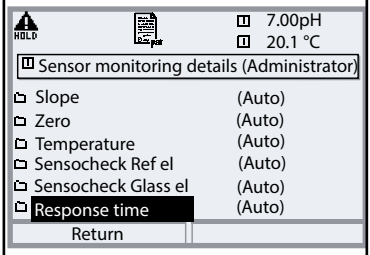
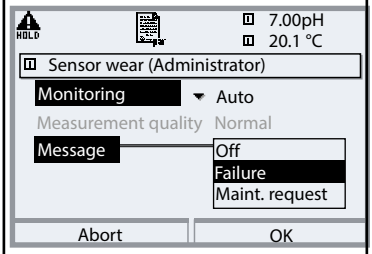
All sensor-typical parameters are automatically sent to the analyzer.
These are, for example, the measuring range, zero and slope of the sensor. Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected.
With "Plug&Measure", premeasured Memosens sensors can immediately be used for measurement without previous calibration.

With Protos 3400(X): The Memosens icon is displayed as long as a Memosens sensor is connected.

Note: The display may vary depending on the device version.

pH/ORP Parameter Setting

Note: Function check (HOLD) mode active

Menu	Display	Action
par		**Sensor data** Memosens sensors provide most of the parameters automatically. **Sensoface** provides information on the sensor condition (evaluating the sensor data). Great deviations are signaled. To display the "Sensoface" icon, you must activate it in the Sensor Data menu. **Sensor monitoring details** For some parameters, you can choose between Off/Auto/Individual. Off: No evaluation and no display in the sensor monitor. Auto: The parameters are read out directly from the sensor or are adjusted by the system. They are displayed in gray and cannot be edited. Individual: You must enter the parameters. **Messages** Limit violations can be signaled by a message (either "failure" or "maintenance request"). **Parameter setting** For pH, see page 19 and following. For ORP, see page 48 and following.
		
		

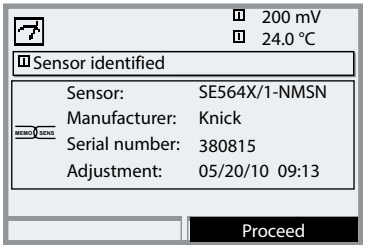
Note: The display may vary depending on the device version.

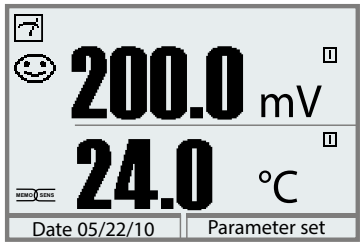
ORP Parameter Setting

Selecting the mode and process variable (ORP).
Note: Function check (HOLD) mode active

Menu	Display	Action
par	HOLD 200 mV 24.0 °C Module MS 3400-160 (Administrator) When settings are changed, system will be restarted Operating mode: Memosens Variable: ORP Return / Take over	**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: pH. Operating mode: Memosens Functionality: ORP Protos 3400(X): Operating mode: Memosens Variable: ORP

A connected Memosens sensor is displayed immediately:





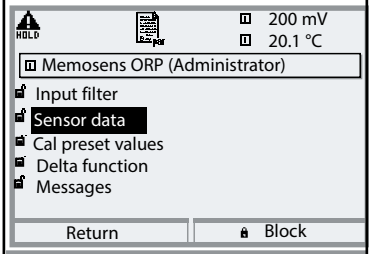
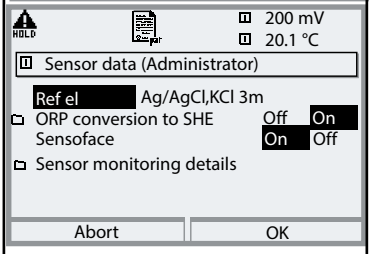
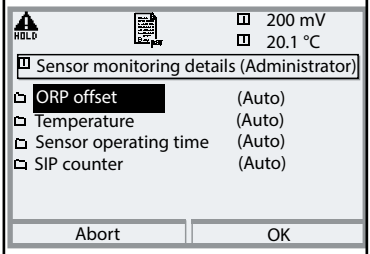
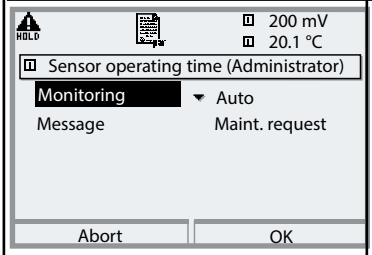
All sensor-typical parameters are automatically sent to the analyzer.
These are, for example, the measuring range, zero and slope of the sensor. Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected.
With "Plug&Measure", premeasured Memosens sensors can immediately be used for measurement without previous calibration.

With Protos 3400(X): The Memosens icon is displayed as long as a Memosens sensor is connected.

Note: The display may vary depending on the device version.

ORP Parameter Setting

Note: Function check (HOLD) mode active

Menu	Display	Action
par		**Sensor data** Memosens sensors provide most of the parameters automatically.
		**Sensoface** provides information on the sensor condition (evaluating the sensor data).
		**Sensor monitoring details** If the entries are displayed as "(Auto)" data, they can be displayed but not edited. The values are displayed in gray.
		**Messages** Limit violations can be signaled by a message (either "failure" or "maintenance request").

Note: The display may vary depending on the device version.

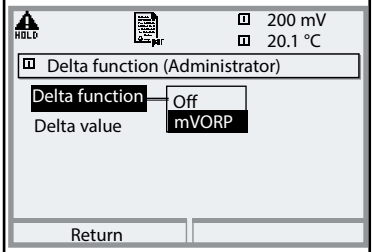
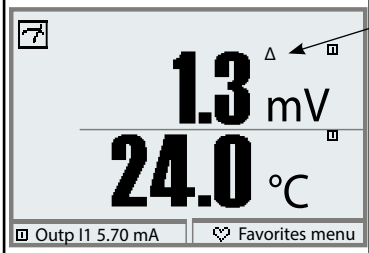
ORP Parameter Setting

Parameter	Default	Selection / Range
Input filter		
Pulse suppression	Off	On, Off
Sensor data		
Sensoface	On	On, Off
Sensor monitoring details		
Sensor parameters		SIP cycles and sensor operating time
Cal preset values		
Cal timer monitoring	Auto: 0168h	Auto, Off, Individual
ORP check	Test period 10 s Test difference 10 mV	Off, On
Delta function		
Delta function	Off	Off, ORP
Messages		
Messages ORP value	Off	Off, Variable limits

Note: The menus may vary depending on the device version.

ORP Parameter Setting

Delta function
Note: Function check (HOLD) mode active

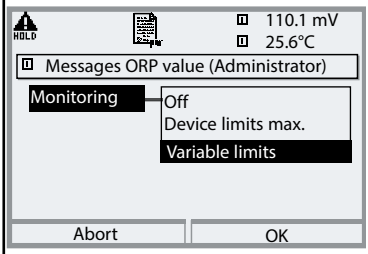
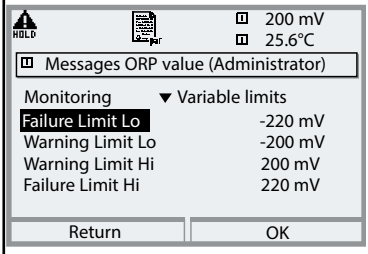
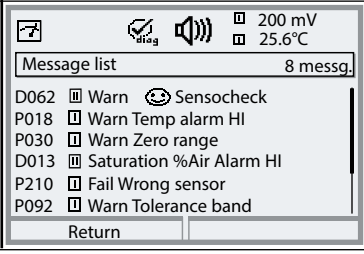
Menu	Display	Action
	 	**Delta function** When a delta value is entered, the system calculates the difference Output value = measured value – delta value The output value controls all outputs and is shown on the display. When delta function is switched on, "Δ" appears in the display in measuring mode.

Note: The display may vary depending on the device version.

ORP Parameter Setting

Messages
Note: Function check (HOLD) mode active

Note: The display may vary depending on the device version.

Menu	Display	Action
par	  	**Messages** All parameters determined by the measuring module can generate messages. **Device limits max.:** Messages are generated when the process variable (e.g. mV) is outside the measuring range. The "Failure" icon is displayed, the NAMUR failure contact is activated (BASE module, factory setting: contact K4, N/C contact). The current outputs can signal a 22mA message (user defined). **Variable limits:** For the "failure" and "warning" messages, you can define upper and lower limits for message generation. **Message icons** Failure (Failure limit HiHi/LoLo) Maintenance (Warning limit Hi/Lo) Limit indication (here: lower range)
diag		**Diagnostics menu** When the "Maintenance" or "Failure" icons are blinking in the display, you should access the Diagnostics menu. The messages are displayed in the "Message list".

ORP Calibration / Adjustment

Calibration/Adjustment Methods

- ORP data entry
- ORP adjustment
- ORP check
- Temperature (Temperature probe adjustment) [1)]

ORP calbration/adjustment

The potential of a redox electrode is calibrated using a redox (ORP) buffer solution. In the course of that, the difference between the measured potential and the potential of the calibration solution is determined. This potential difference is printed on the calibration solution bottle and is defined as the voltage across the redox electrode and a reference electrode. The determined difference is saved in the Memosens sensor.

Examples: 220 mV Pt against Ag/AgCl, KCl 3 mol/l
427 mV Pt against SHE

During measurement this difference is added to the measured potential.

$mV_{ORP} = mV_{meas} + \Delta mV$

mV_{ORP} = displayed oxidation-reduction potential (measured ORP)

mV_{meas} = direct electrode potential (ORP input, see Sensor monitor)

ΔmV = delta value, determined during calibration

ORP related to the standard hydrogen electrode (SHE)

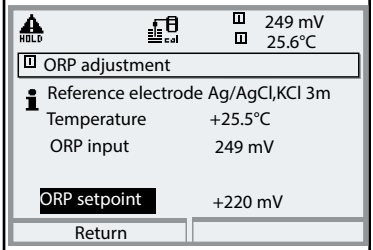
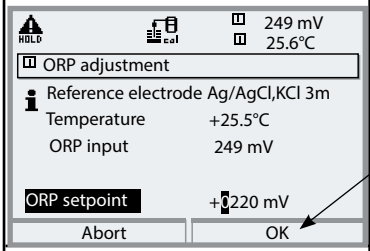
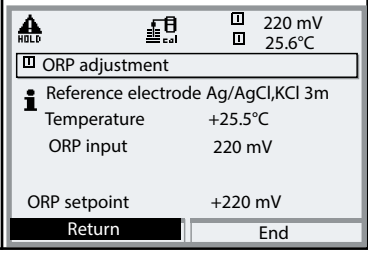
The oxidation-reduction potential can also be calibrated automatically with respect to the standard hydrogen electrode (SHE).
The temperature behavior of the reference electrode is automatically taken into account.

Reference electrode:

Ag/AgCl, KCl 3 mol/l (silver/silver chloride)

1) With Protos 3400(X) in the Maintenance menu see p. 52

Note: The display may vary depending on the device version.

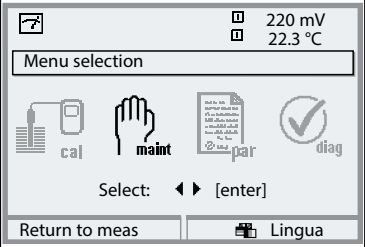
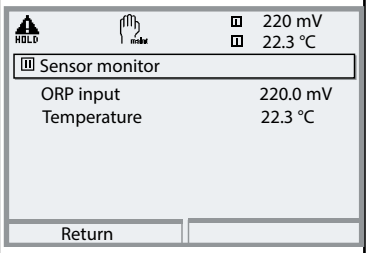
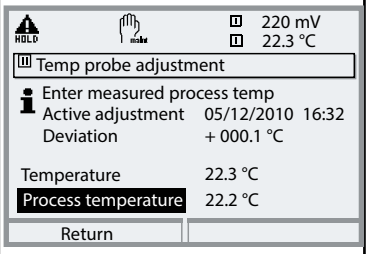
Menu	Display	Action
cal		The module is in function check (HOLD) mode! Immerse electrode in calibration medium and wait until the ORP value has stabilized. Enter the nominal ORP value of the temperature-corrected buffer value. **Be sure to observe the correct reference** (as configured) Press "**OK**" to confirm.
		
		End adjustment by pressing softkey or **enter**. The determined potential difference is saved in the Memosens sensor.

Temperature dependence measured against SHE (standard hydrogen electrode)

Temperature [°C]	Ag/AgCl/KCl 3 mol/l [ΔmV]
0	224
10	217
20	211
25	207
30	203
40	196
50	188
60	180
70	172
80	163

ORP Maintenance

Sensor monitor / Temp probe adjustment
Note: Function check (HOLD) mode active

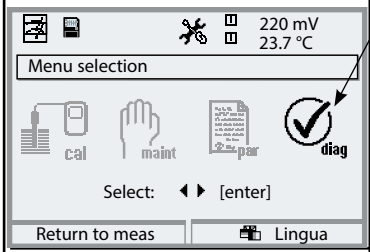
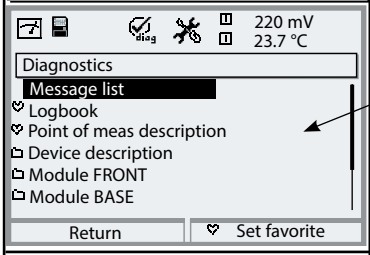
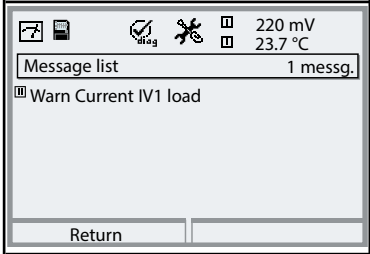
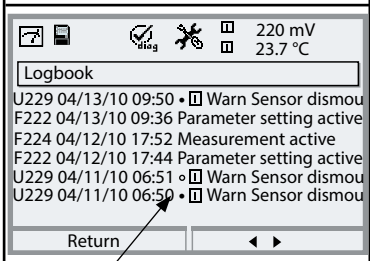
Menu	Display	Action
maint		**Opening the maintenance menu** From the measuring mode: Press **menu** key to select menu. Select maintenance using arrow keys, confirm by pressing **enter**. Passcode (as delivered): 2958 Then select Memosens ORP.
		**Sensor monitor** For validation of sensor and complete signal processing.
		**Temp probe adjustment** [1)] This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. Make sure that the process temperature is precisely measured using a calibrated reference thermometer when performing an adjustment! The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display! The adjustment value is saved in the Memosens.

Note: The display may vary depending on the device version.

1) With Protos II 4400(X) in the Calibration menu

ORP Diagnostic Functions

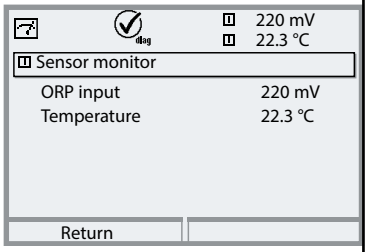
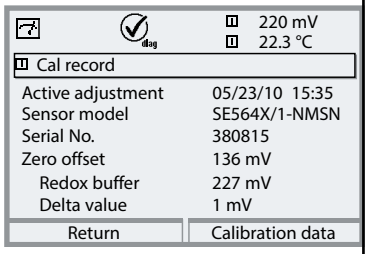
General status information of the measuring system
Select menu: Diagnostics

Menu	Display	Action
diag		**Opening the diagnostics menu** From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, confirm by pressing **enter**.
		The "Diagnostics" menu gives an overview of all functions available. Functions which have been set as "Favorite" can be directly accessed from the measuring mode.
		**Message list** Shows the currently activated warning or failure messages in plain text.
		**Logbook** The logbook directly displays the last 50 events (Protos 3400) or 100 events (Protos II 4400) with date and time, e.g. calibrations, warning and failure messages, power failure etc. For parameter setting, see p. 154.

Note: The display may vary depending on the device version.

ORP Diagnostic Functions

Menu selection: Diagnostics > Module MS ... > Memosens ORP

Menu	Display	Action
diag		**Sensor monitor** Shows the values currently measured by the sensor. Important function for diagnostics and validation.
		**Calibration/Adjustment Record** Data of last adjustment/calibration (Date, time, calibration method, zero, information concerning redox buffers, number of previous calibrations) **Temp. Offset Log** Shows the data from the last temperature adjustment performed on the currently connected sensor.[1)]

Note: The display may vary depending on the device version.

1) With Protos II 4400(X)

pH, ORP Messages

pH, ORP Messages with Protos 3400(X)

No.	pH, ORP message	Message type
P008	Meas. processing (factory settings)	FAIL
P009	Module failure (Firmware Flash check sum)	FAIL
P010	pH range	FAIL
P011	pH Alarm LO_LO	FAIL
P012	pH Alarm LO	WARN
P013	pH Alarm HI	WARN
P014	pH Alarm HI_HI	FAIL
P015	Temperature range	FAIL
P016	Temperature Alarm LO_LO	FAIL
P017	Temperature Alarm LO	WARN
P018	Temperature Alarm HI	WARN
P019	Temperature Alarm HI_HI	FAIL
P020	ORP range	FAIL
P021	ORP Alarm LO_LO	FAIL
P022	ORP Alarm LO	WARN
P023	ORP Alarm HI	WARN
P024	ORP Alarm HI_HI	FAIL
P025	rH range	WARN
P026	rH Alarm LO_LO	FAIL
P027	rH Alarm LO	WARN
P028	rH Alarm HI	WARN
P029	rH Alarm HI_HI	FAIL
P030	Zero range	WARN
P035	Slope range	WARN
P040	Isotherm potential Uis range	WARN
P045	mV range	WARN

No.	pH, ORP message	Message type
P046	mV Alarm LO_LO	FAIL
P047	mV Alarm LO	WARN
P048	mV Alarm HI	WARN
P049	mV Alarm HI_HI	FAIL
P050	Man. temperature range	FAIL
P060	SAD SENSOFACE: Slope	User-defined
P061	SAD SENSOFACE: Zero	User-defined
P062	SAD SENSOFACE: Ref impedance (Sensocheck)	User-defined
P063	SAD SENSOFACE: Glass impedance (Sensocheck)	User-defined
P064	SAD SENSOFACE: Response time	User-defined
P065	SAD SENSOFACE: Calibration timer	WARN
P069	SAD SENSOFACE: Calimatic (Zero/slope)	WARN
P070	SAD SENSOFACE: Sensor wear	User-defined
P071	SAD SENSOFACE: ISFET leakage current	User-defined
P090	Buffer offset (buffer table to be entered):	WARN
P091	Zero offset ORP	WARN
P092	Tolerance band	WARN
P110	CIP counter	User-defined
P111	SIP counter	User-defined
P112	Autoclaving counter	User-defined
P113	Sensor operating time (duration of use)	User-defined
P114	ISFET characteristic	User-defined
P115	Membrane body changes	User-defined
P120	Wrong sensor	FAIL
P121	Sensor (error in factory settings/characteristics)	FAIL
P122	Sensor memory (error in cal data records)	WARN
P123	New sensor, adjustment required	WARN
P130	SIP cycle counted	Text
P131	CIP cycle counted	Text

No.	pH, ORP message	Message type
P200	Noise level at pH input	FAIL
P201	Cal temp	WARN
P202	Cal: Buffer unknown	Text
P203	Cal: Identical buffers	Text
P204	Cal: Buf interchanged	Text
P205	Cal: Sensor unstable	Text
P206	Cal: Slope	WARN
P207	Cal: Zero	WARN
P208	Cal: Sensor failure (ORP check)	FAIL
P254	Module reset	Text

No.	Calculation Block PH / PH messages	Message type
A010	pH-Diff Range	FAIL
A011	pH-Diff Alarm LO_LO	FAIL
A012	pH-Diff Alarm LO	WARN
A013	pH-Diff Alarm HI	WARN
A014	pH-Diff Alarm HI_HI	FAIL
A015	Temperature-Diff Range	FAIL
A016	Temperature-Diff Alarm LO_LO	FAIL
A017	Temperature-Diff Alarm LO	WARN
A018	Temperature-Diff Alarm HI	WARN
A019	Temperature-Diff Alarm HI_HI	FAIL
A020	ORP-Diff Range	FAIL
A021	ORP-Diff Alarm LO_LO	FAIL
A022	ORP-Diff Alarm LO	WARN
A023	ORP-Diff Alarm HI	WARN
A024	ORP-Diff Alarm HI_HI	FAIL

pH, ORP Messages with Protos II 4400(X)

⊗ Failure ⚠ Out of Specification ◈ Maintenance Required

No.	Message Type	pH, ORP Message
P008	Failure	Meas. Processing (Factory Settings)
P009	Failure	Firmware Error
P010	Failure	pH Range
P011	Failure	pH Alarm LO_LO
P012	Out of Specification	pH Alarm LO
P013	Out of Specification	pH Alarm HI
P014	Failure	pH Alarm HI_HI
P015	Failure	Temperature Range
P016	Failure	Temperature Alarm LO_LO
P017	Out of Specification	Temperature Alarm LO
P018	Out of Specification	Temperature Alarm HI
P019	Failure	Temperature Alarm HI_HI
P020	Failure	ORP Range
P021	Failure	ORP Alarm LO_LO
P022	Out of Specification	ORP Alarm LO
P023	Out of Specification	ORP Alarm HI
P024	Failure	ORP Alarm HI_HI
P025	Out of Specification	rH range
P026	Failure	rH Alarm LO_LO
P027	Out of Specification	rH Alarm LO
P028	Out of Specification	rH Alarm HI
P029	Failure	rH Alarm HI_HI
P045	Failure	mV Range
P046	Failure	mV Alarm LO_LO
P047	Out of Specification	mV Alarm LO
P048	Out of Specification	mV Alarm HI
P049	Failure	mV Alarm HI_HI
P060	Failure/Maintenance Required	Sad Sensoface: Slope
P061	Failure/Maintenance Required	Sad Sensoface: Zero Point
P062	User-defined	Sad Sensoface: Reference Impedance
P063	User-defined	Sad Sensoface: Glass Impedance
P064	User-defined	Sad Sensoface: Response Time

No.	Message Type	pH, ORP Message
P065	Maintenance Required	Sad Sensoface: Calibration timer
P069	Maintenance Required	Sad Sensoface: Calimatic (Zero/Slope)
P070	User-defined	Sad Sensoface: Sensor Wear
P071	Maintenance Required	Sad Sensoface: ISFET Leakage Current
P072	Maintenance Required	Sad Sensoface: ISFET Operating Point
P074	Maintenance Required	Sad Sensoface: ORP Zero Offset
P090	Maintenance Required	Buffer Distance (User-Defined Buffer Table)
P092	Maintenance Required	Tolerance Band
P110	User-defined	CIP Counter
P111	User-defined	SIP Counter
P112	User-defined	Autoclaving Counter
P113	User-defined	Sensor Operating Time
P120	Failure	Wrong Sensor (Sensor Verification)
P121	Failure	Sensor Error (Factory/Characteristic Data)
P122	Maintenance Required	Sensor Memory Error (Cal Data)
P123	Maintenance Required	New Sensor, Adjustment Required
P124	Maintenance Required	Sensor Date
P130	Info	SIP Cycle Counted
P131	Info	CIP Cycle Counted
P200	Failure	Noise Level at pH Input
P201	Maintenance Required	Cal Temperature
P202	Info	Cal: Buffer Unknown
P203	Info	Cal: Identical Buffers
P204	Info	Cal: Buffers Interchanged
P205	Info	Cal: Sensor Unstable
P206	Maintenance Required	Cal: Slope
P207	Maintenance Required	Cal: Zero Point
P208	Failure	Cal: Sensor Failure (ORP Check)
P254	Info	Module Reset

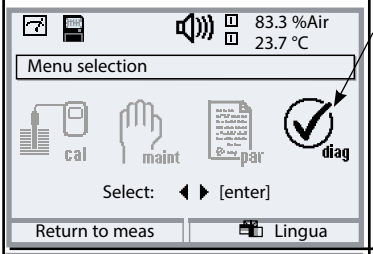
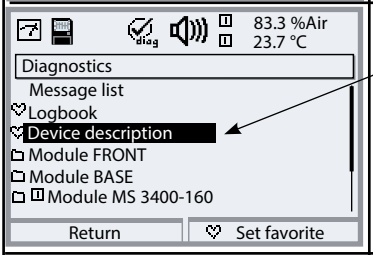
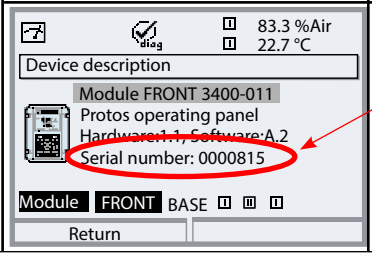
No.	Message Type	Calculation Block PH / PH Messages
A010	Failure	pH Diff Range
A011	Failure	pH Diff Alarm LO_LO
A012	Out of Specification	pH Diff Alarm LO
A013	Out of Specification	pH Diff Alarm HI
A014	Failure	pH Diff Alarm HI_HI
A015	Failure	Temperature Diff Range
A016	Failure	Temperature Diff Alarm LO_LO
A017	Out of Specification	Temperature Diff Alarm LO
A018	Out of Specification	Temperature Diff Alarm HI
A019	Failure	Temperature Diff Alarm HI_HI
A020	Failure	ORP Diff Range
A021	Failure	ORP Diff Alarm LO_LO
A022	Out of Specification	ORP Diff Alarm LO
A023	Out of Specification	ORP Diff Alarm HI
A024	Failure	ORP Diff Alarm HI_HI
A045	Failure	mV Diff Range
A046	Failure	mV Diff Alarm LO_LO
A047	Out of Specification	mV Diff Alarm LO
A048	Out of Specification	mV Diff Alarm HI
A049	Failure	mV Diff Alarm HI_HI
A200	Maintenance Required	Calculation Block Configuration

Oxygen Measurement (TAN required)

SW3400-015: Oxygen measurement
SW3400-016: Oxygen trace measurement
FW4400-015: Oxygen measurement in the saturation and ppb range

For connecting Memosens OXY sensors to the MS 3400(X)-160 / MS 4400(X)-160 module, you require an add-on function (see above).
The add-on functions are device-specific. When ordering an add-on function, you therefore have to specify the serial number of your FRONT module in addition to the respective order number.
(The FRONT module contains the Protos system control).
The manufacturer then supplies a TAN (transaction number) to activate the add-on function.

Serial number of FRONT module

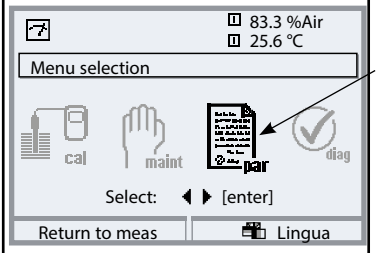
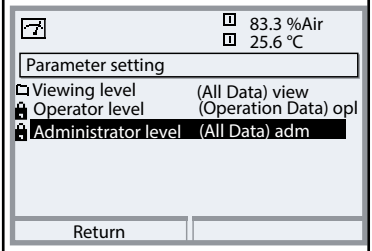
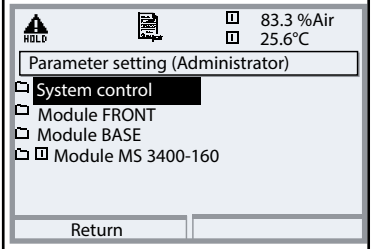
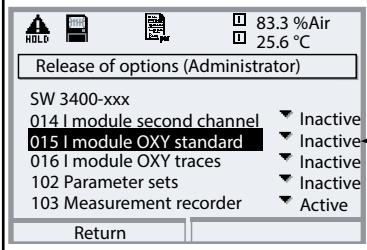
Menu	Display	Action
diag		**Menu selection** Open diagnostics. From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, confirm by pressing **enter**.
		**Diagnostics** Select "Device description" using arrow keys, confirm by pressing **enter**.
		**Device description** Specify this serial number when ordering an add-on function.

Note: The display may vary depending on the device version.

Activating an Add-On Function

Select menu: Parameter setting/System control/Release of options

Note: The TAN for releasing an add-on function is only valid for the device with the corresponding serial number (see previous page).

Menu	Display	Action
par		**Menu selection** Open parameter setting. From the measuring mode: Press **menu** key to select menu. Select parameter setting using arrow keys, confirm by pressing **enter**.
		**Parameter setting** Select Administrator level using arrow keys, press **enter** to confirm. Enter passcode and confirm (Passcode as delivered: 1989).
		Select system control using arrow keys, press **enter** to confirm. Then select Release of options using arrow keys, confirm with **enter**.
		**Release of options** Select the add-on function to be released. Set option to "active". Enter the TAN at the prompt. (Note: The TAN is only valid for the device with the corresponding serial number, see previous page.) The option is available after the TAN has been entered.

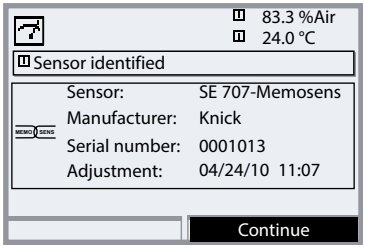
Note: The display may vary depending on the device version.

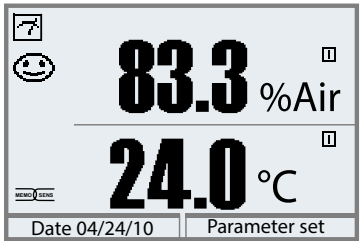
OXY Parameter Setting

Selecting the mode and process variable (OXY).
Note: You must activate the function by entering a TAN
Note: Function check (HOLD) mode active

Menu	Display	Action
par	HOLD 83.3 %Air 24.0 °C Module MS 3400-160 (Administrator) When settings are changed, system will be restarted Operating mode: Memosens Variable: Oxy Return / Take over	**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: Oxygen. Operating mode: Memosens Functionality: Amperometric Protos 3400(X): Operating mode: Memosens Variable: Oxy

A connected Memosens sensor is displayed immediately:



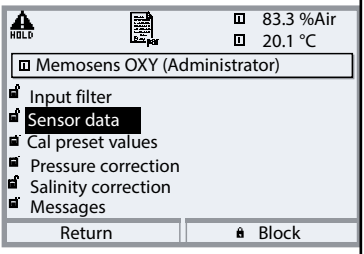
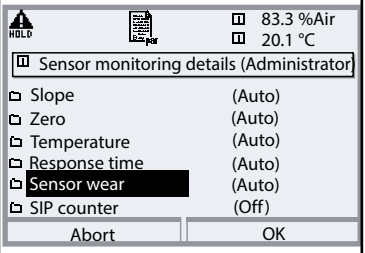


All sensor-typical parameters are automatically sent to the analyzer.
These are, for example, the measuring range, zero and slope of the sensor. Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected.
With "Plug&Measure", premeasured Memosens sensors can immediately be used for measurement without previous calibration.

With Protos 3400(X): The Memosens icon is displayed as long as a Memosens sensor is connected.

Note: The display may vary depending on the device version.

Note: Function check (HOLD) mode active.

Menu	Display	Action
		**Sensor data** Memosens sensors provide most of the parameters automatically.
		Sensoface provides information on the sensor condition. In measuring mode a smiley face is displayed ☺ (friendly, neutral, sad) depending on the sensor data. Great deviations are signaled. To display the "Sensoface" icon, you must activate it in the Sensor Data menu.
		**Sensor monitoring details** Auto: The parameters are read out directly from the sensor or are adjusted by the system. They are displayed in gray and cannot be edited. Individual: You must enter the parameters. In addition, you can specify values for SIP counter and sensor operating time which will trigger a message.

Note: The display may vary depending on the device version.

OXY Parameter Setting

Note: Function check (HOLD) mode active.

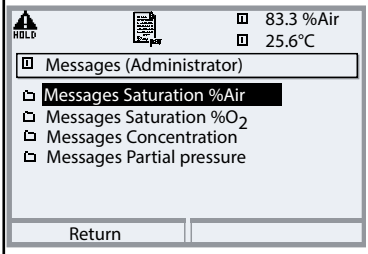
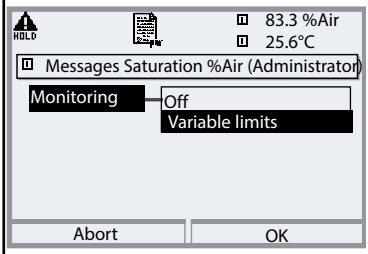
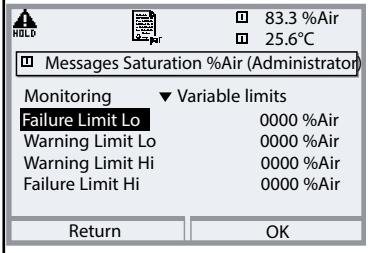
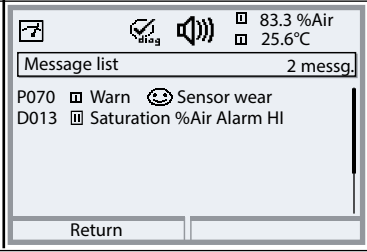
Parameter	Default	Selection / Range
Input filter		
Pulse suppression	Weak	Off, Weak, Medium, Strong
Input filter	010 sec	xxx sec (entry)
Sensor data		
Measure in	Liquids	Liquids, Gases
Sensoface	On	On, Off
Sensor monitoring details		
Sensor parameters		SIP cycles and sensor operating time
Cal preset values		
Product calibration	%Air	Sat (%Air), Conc (mg/l, µg/l, ppm, ppb),
		p´ (mmHg, mbar)
Calibration timer		
- Monitoring	Auto	Off, Auto, Individual
- Cal timer	0000 h	Auto: 720 h (or entry: xxxx h)
Pressure correction		
Pressure transmitter	Absolute	Absolute
I input	4 ... 20 mA	0 ... 20 mA / 4 ... 20 mA
Start 0(4) mA	0000 mbar	xxxx mbar
End (20 mA)	9999 mbar	xxxx mbar
Pressure during meas	Manual	Manual (default 1013 mbar), External
Pressure during cal	Manual	Manual (default 1013 mbar), External
Salinity correction		
Entry	Salinity	Salinity, Chlorinity, Conductivity (00.00 g/kg or 0.000 µS/cm, depending on selection)
Messages Liquid (gas messages marked with *)		
Messages Saturation %Air	Off	Off, Variable limits
Messages Saturation %O_2	Off	Off, Variable limits
Messages Concentration*	Off	Off, Variable limits
Messages Partial pressure*	Off	Off, Variable limits

Note: The menus may vary depending on the device version.

Messages

Note: Function check (HOLD) mode active

Note: The display may vary depending on the device version.

Menu	Display	Action
par		**Messages** All parameters determined by the measuring module can generate messages. **Device limits max.:** Messages are generated when the process variable (eg, saturation) is outside the measuring range. The "Failure" icon is displayed, the NAMUR failure contact is activated (BASE module, factory setting: contact K4, N/C contact). The current outputs can signal a 22-mA message (user defined). **Variable limits:** For the "failure" and "warning" messages you can define upper and lower limits for message generation. **Message icons** Failure (Failure limit HiHi/LoLo) Maintenance (Warning limit Hi/Lo) Limit indication (here: lower range)
		
		
diag		**Diagnostics menu** When the "Maintenance" or "Failure" icons are blinking in the display, you should access the Diagnostics menu. The messages are displayed in the "Message list".

OXY Calibration / Adjustment

Note: The function check (HOLD) mode is active for the currently calibrated module, the current outputs behave as configured.

Note: With Memosens sensors, the calibration data are stored in the sensor. This allows using precalibrated sensors.
When the Protos is used for precalibrating sensors in the lab, you can use the calibration routines described below.

Calibration/adjustment methods

- Automatic calibration in water/air
- Product calibration (saturation/concentration/partial pressure)
- Data entry
- Zero correction
- Temperature (Temperature probe adjustment) [1)]

- **Calibration:** Detecting deviations without readjustment
- **Adjustment:** Detecting deviations with readjustment

NOTICE! Without adjustment every dissolved oxygen meter delivers an imprecise or wrong output value! After replacing the sensor, the electrolyte, or the sensor membrane, you must perform a calibration.
The resulting values must be taken over by an adjustment for calculating the measured variables (measured-value display, output signals)!

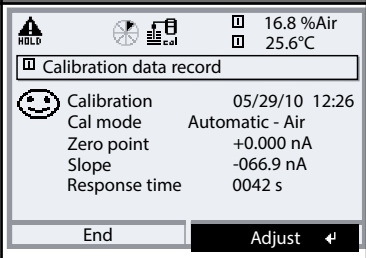
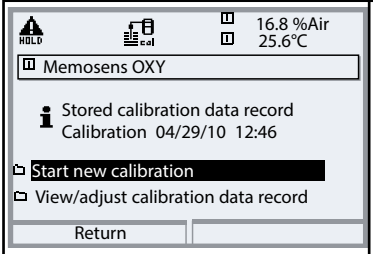
Procedure

Every oxygen sensor has its individual slope and zero point. Both values are altered, for example, by aging. For sufficiently high accuracy of oxygen measurement, the meter must be regularly adjusted for the sensor data (adjustment).

1) With Protos 3400(X) in the Maintenance menu see p. 81

OXY Calibration / Adjustment

Adjustment means that the values determined by a calibration are taken over. The values determined for zero and slope are entered in the calibration record. (Cal record can be called in the Diagnostics menu for Memosens OXY.)
These values are only effective for calculating the measured variables when the calibration has been terminated with an adjustment.
A passcode ensures that an adjustment can only be performed by an authorized person (Administrator).
The Operator can check the current sensor data by a calibration and inform the Administrator when there are deviations.
You can use the add-on function SW3400-107 [1)] for granting access rights (passcodes) and for AuditTrail (continuous data recording and backup according to FDA 21 CFR Part 11).

Menu	Display	Action
cal		**Administrator** With the corresponding access rights, the device can immediately be adjusted after calibration. The calibration values are saved in the sensor and taken over for calculating the measured variables.
		**Operator** (without administrator rights) After calibration, change to measuring mode. Inform Administrator. When opening the menu (Calibration, respective module), the Administrator sees all data of the last calibration and can take over the values or perform a new calibration.

Note: The display may vary depending on the device version.

1) With Protos 3400(X)

Recommendations for calibration
It is always recommended to calibrate in air. Compared to water, air is a calibration medium which is easy to handle, stable, and thus safe. In the most cases, however, the sensor must be removed for a calibration in air. In certain processes the sensor cannot be removed for calibration. Here, calibration must be performed directly in the process medium (e.g. with aeration).
For applications where concentration is measured, calibration in air has proved to be useful.

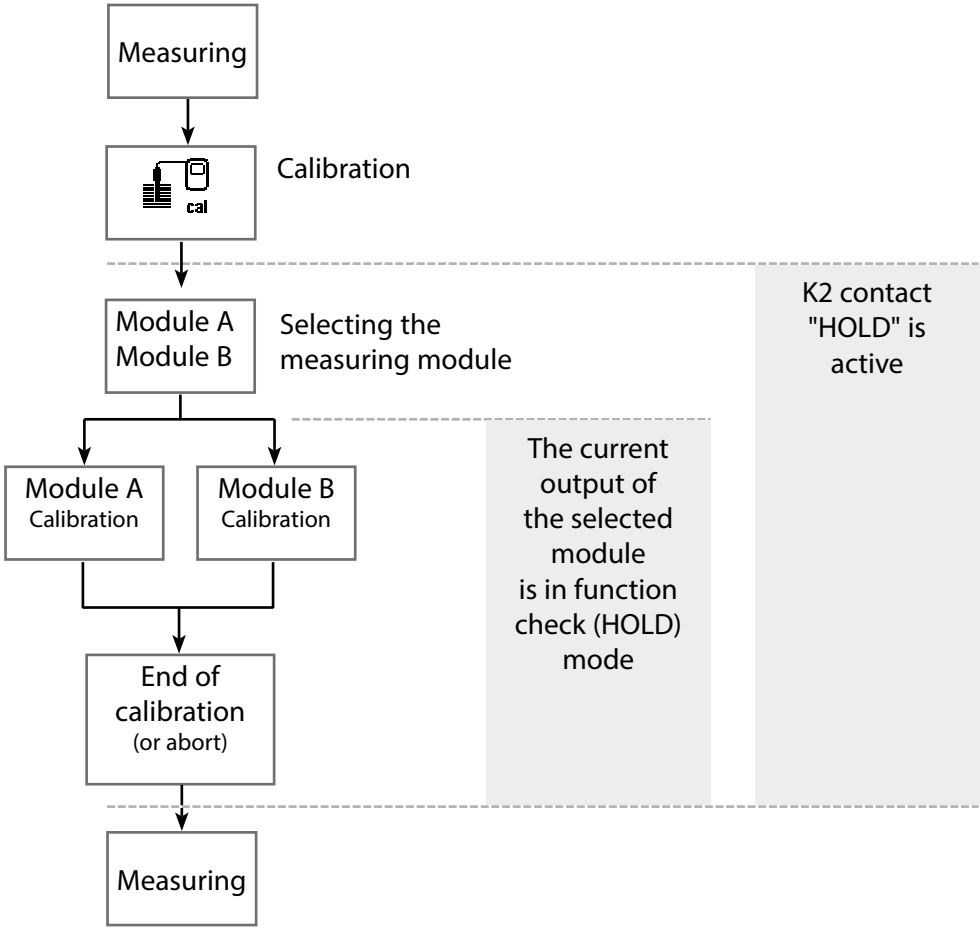
Common Combination: Process Variable / Calibration Mode

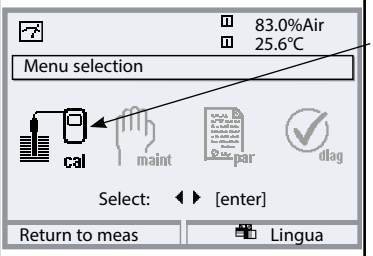
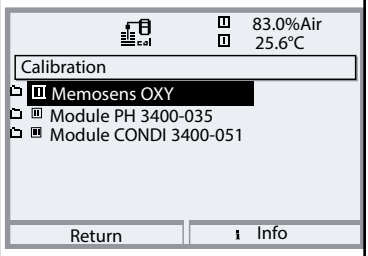
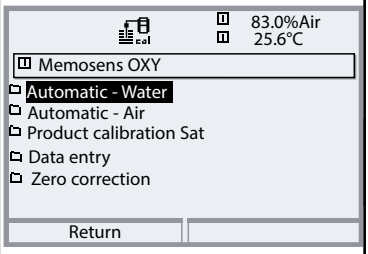
Measurement	Calibration
Saturation	Water
Concentration	Air

If there is a temperature difference between the calibration medium and the measured medium, the sensor must be kept in the respective medium for several minutes before and after calibration in order to deliver stable measured values. The type of calibration pressure detection is preset during parameter setting.

HOLD Function During Calibration/Adjustment

Behavior of the signal and relay outputs during calibration/adjustment



Menu	Display	Action
	  	**Opening the calibration menu** Press **menu** key to select menu. Select calibration using arrow keys, press **enter** to confirm, passcode 1147 (To change passcode, select: Parameter setting/System control/ Passcode entry). Calibration: Select "Memosens OXY" Select a calibration method: • Automatic - Water • Automatic - Air • Product calibration Saturation (concentration/partial pressure) • Data entry • Zero correction • Temp probe adjustment (with Protos II 4400(X)) When you access calibration, the analyzer automatically proposes the previous calibration method. If you do not want to calibrate, "Return" with the left softkey. **During calibration the module is in function check (HOLD) mode.** Current outputs and relay contacts of the module behave as configured (BASE module).

Note: The display may vary depending on the device version.

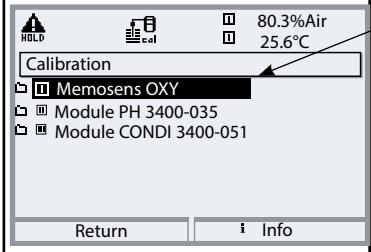
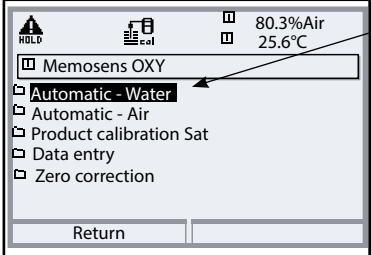
OXY Calibration / Adjustment

Automatic calibration in water

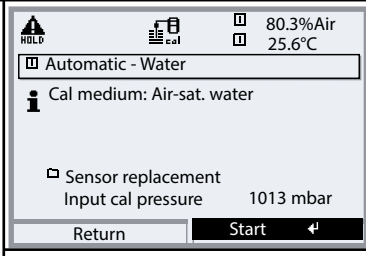
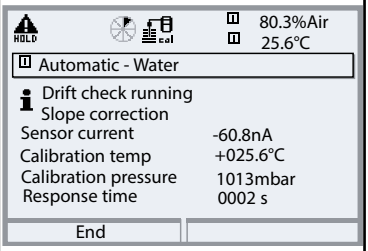
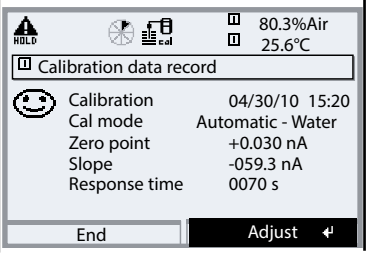
Automatic calibration in water
The slope is corrected using the saturation value (100 %) related to air saturation.

During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE module).

NOTICE!
Ensure sufficient incident flow to the sensor (see Specifications of oxygen sensors)! The calibration medium must be in equilibrium with air. Oxygen exchange between water and air is very slow. Therefore, it takes a relatively long time until water is saturated with atmospheric oxygen. If there is a temperature difference between calibration medium and measured medium, the sensor must be kept in the respective medium for several minutes before and after calibration.

Menu	Display	Action
cal		**Select:** Memosens OXY The module is in function check (HOLD) mode. The assigned current outputs and relay contacts behave as configured (BASE). Press **enter** to confirm.
		Select calibration method: "Automatic - Water" Remove sensor and immerse it in cal medium (air-saturated water), ensure sufficient incident flow to the sensor. Press **enter** to confirm.

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Display of selected calibration medium (Air-sat. water) Enter cal pressure if "manual" has been configured. Start with softkey or **enter**
		Drift check. Display during calibration • Sensor current • Calibration temperature • Calibration pressure • Response time Waiting time can be reduced by pressing **enter** (without drift check: reduced accuracy of calibration values!). From the response time, you see how long it takes the sensor to deliver a stable signal. If the signal or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min. You must re-start the calibration. If successful, place sensor in process, exit calibration using softkey or **enter**
		**Adjustment** Press "Adjust" to save the values determined during calibration in the sensor and use them for calculating the measured values.

Note: The display may vary depending on the device version.

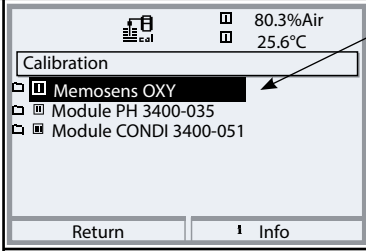
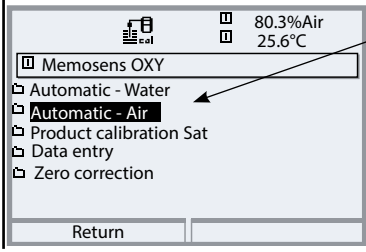
Automatic calibration in air

The slope is corrected using the saturation value (100 %), similar to air saturation of water. Since this analogy only applies to water-vapor saturated air (100 % relative humidity) and often the calibration air is less humid, the relative humidity of the calibration air must also be specified. If you do not know the exact value of the relative humidity of the calibration air, you can take the following reference values for a sufficiently precise calibration:

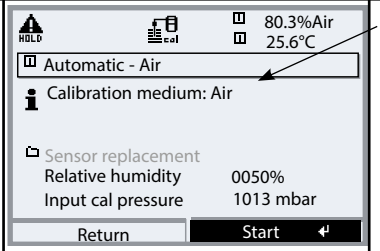
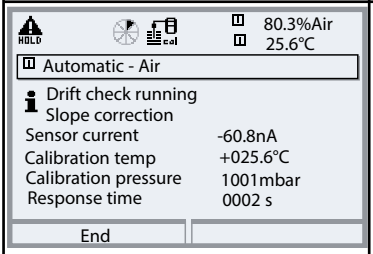
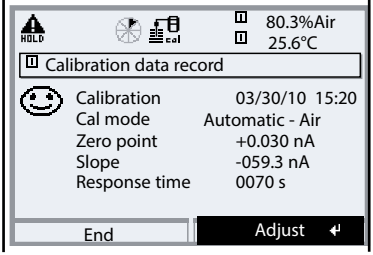
- Ambient air: 50 % rel. humidity (average)
- Bottled gas (synthetic air): 0 % rel. humidity

NOTICE!

The sensor membrane must be dry. Be sure to keep temperature and pressure constant during calibration. If there is a temperature difference between calibration medium and measured medium, the sensor must be kept in the respective medium for several minutes before and after calibration.

Menu	Display	Action
cal		**Select:** Memosens OXY The module is in function check (HOLD) mode. The assigned current outputs and relay contacts behave as configured (BASE). Press **enter** to confirm.
		Select calibration method: "Automatic - Air" Remove sensor and place it in air. Press **enter** to confirm.

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Calibration medium: Air Enter relative humidity, eg: • Ambient air: 50 % • Bottled gas: 0 % Enter cal pressure if "manual" has been configured. Start using softkey or **enter**
		Drift check. Display during calibration • Sensor current, calibration pressure and response time. Waiting time can be reduced by pressing "End" (without drift check: reduced accuracy of calibration values!). From the response time, you see how long it takes the sensor to deliver a stable signal. If the signal or the measured temperature fluctuate greatly, the calibration procedure is aborted after approx. 2 min. You must re-start the calibration. If successful, replace sensor in the process. Exit calibration using softkey or **enter**.
		**Adjustment** Press "Adjust" to save the values determined during calibration in the sensor and use them for calculating the measured values.

Note: The display may vary depending on the device version.

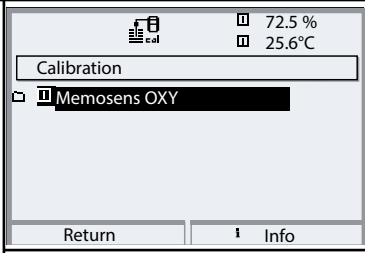
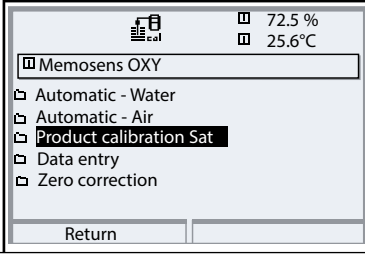
OXY Calibration / Adjustment

Product calibration (saturation/concentration/partial pressure [hPa, mmHg] – preset in: Parameter setting > Cal preset values)

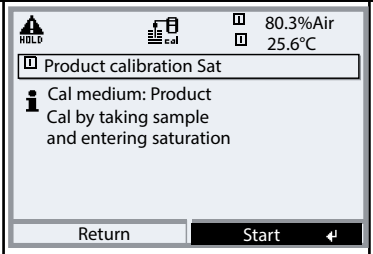
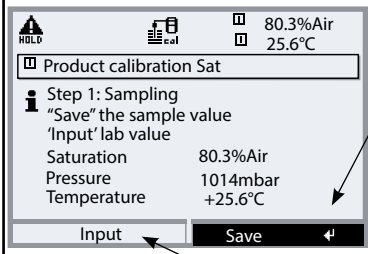
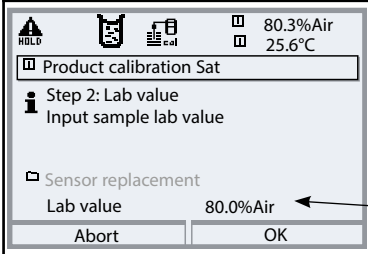
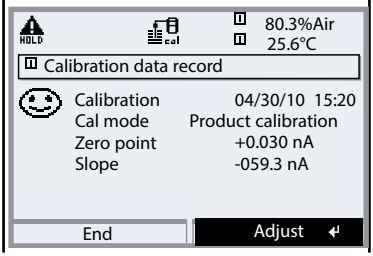
Product Calibration (Calibration with Sampling)
When the sensor cannot be removed – eg, for sterility reasons – its slope can be determined with "sampling". To do so, the currently measured saturation value of the process is saved by the Protos. Directly afterwards, a reference value is determined using a portable meter, for example. The reference value is entered into the measuring system. From the difference between measured value and reference value, the Protos calculates the correction values of the sensor. With low saturation values, the Protos corrects the zero point, with high values the slope.

During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE module).

NOTICE!
The reference value must be measured at temperature and pressure conditions similar to those of the process.

Menu	Display	Action
cal		**Select:** Memosens OXY The module is in function check (HOLD) mode. The assigned current outputs and relay contacts behave as configured (BASE). Press **enter** to confirm.
		Select calibration mode: "Product calibration". Sat (or Conc, p´) is preset in Parameter setting / Cal preset values. Press **enter** to confirm.

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		**Product calibration Sat** Product calibration is performed in 2 steps. Prepare reference measurement (eg, with portable meter), start by pressing softkey or **enter**
		**Step 1** Take sample. Save measured value and temperature at the moment of sampling ("Save" softkey or **enter**). Press **meas** to return to measurement. **Exception:** Sample value can be measured on the site and be entered immediately. To do so, press "Input" softkey.
		**Step 2** Lab value has been measured. When you open the Product calibration menu again, the display shown on the left appears: Enter reference value ("Lab value"). Press "OK" to confirm.
		**Adjustment** Press "Adjust" to save the values determined during calibration in the sensor and use them for calculating the measured values.

Note: The display may vary depending on the device version.

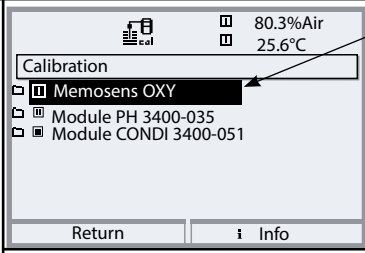
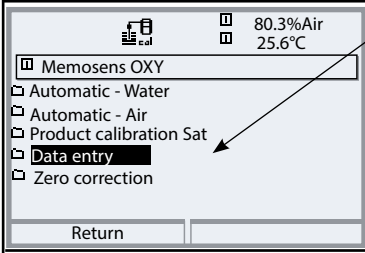
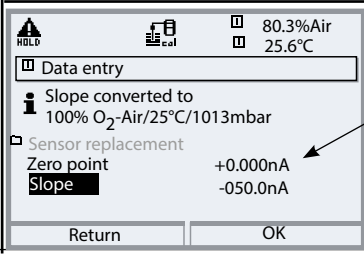
OXY Calibration / Adjustment

Data entry of premeasured sensors

Data entry of premeasured sensors
Entry of values for slope and zero point of a sensor, related to 25 °C/77 °F, 1013 mbar/14.69 psi.

During calibration the module is in function check (HOLD) mode. Current outputs and relay contacts of the module behave as configured (BASE module).

Slope = Sensor current at 100 % atmospheric oxygen, 25 °C/77 °F, 1013 mbar/14.69 psi

Menu	Display	Action
cal		**Select:** Memosens OXY Press **enter** to confirm.
		Select calibration method: "Data entry" Press **enter** to confirm.
		The module is in function check (HOLD) mode! Enter the values for slope, zero point. The data are saved in the sensor. Press "OK" to confirm.

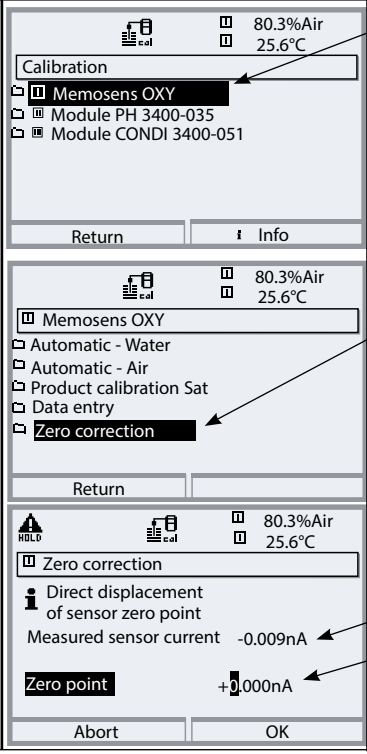
Note: The display may vary depending on the device version.

OXY Calibration / Adjustment

Zero correction

Zero correction

For trace measurements below 500 ppb, the zero point should be calibrated. If a zero correction is performed, the sensor should remain for at least 10 to 60 minutes in the calibration medium (media containing CO_2: at least 120 min) to obtain stable, non-drifting values. During zero correction, a drift check is not performed.

Menu	Display	Action
cal		**Select:** Memosens OXY The module is in function check (HOLD) mode. The assigned current outputs and relay contacts behave as configured (BASE). Press **enter** to confirm. Select calibration method: "Zero correction" Press **enter** to confirm. The module is in function check (HOLD) mode. Zero correction: Display of measured sensor current. Enter the input current for the zero point. The zero point is saved in the sensor. Press "OK" to confirm.

Note: The display may vary depending on the device version.

Temp Probe Adjustment

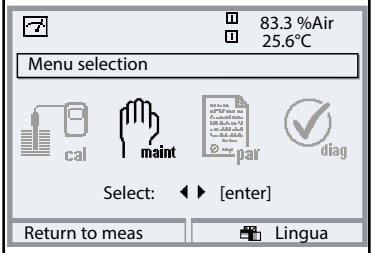
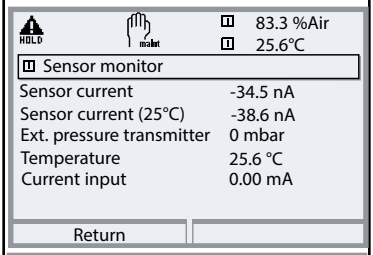
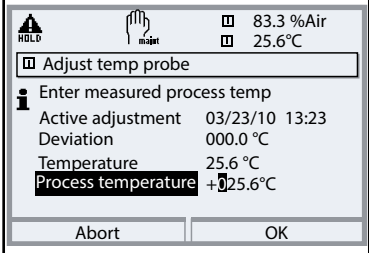
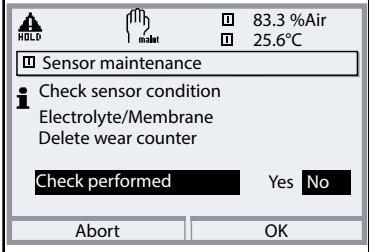
Note: With Protos II 4400(X) in the Calibration menu,
with Protos 3400(X) in the Maintenance menu.

This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. Make sure that the process temperature is precisely measured using a calibrated reference thermometer when performing an adjustment. The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display!

With Protos II 4400(X), the data from the last adjustment and the temperature offset can be called from the Diagnostics menu, see p. 82.

OXY Maintenance

Sensor monitor, temp probe adjustment, sensor maintenance
Note: Function check (HOLD) mode active

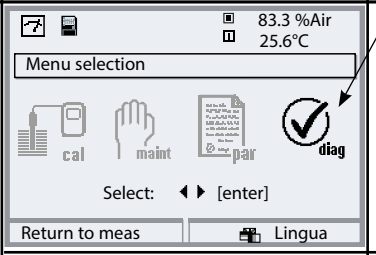
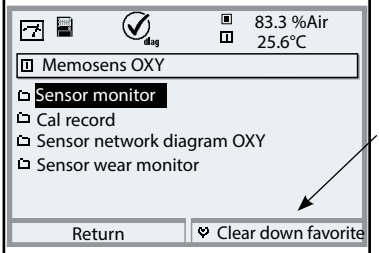
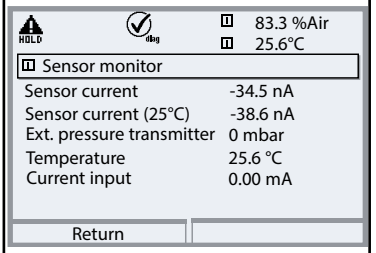
Menu	Display	Action
maint		From the measuring mode: Press **menu** key to select menu. Select maintenance using arrow keys, confirm by pressing **enter**. Passcode 2958 (To change passcode: Parameter setting > System control > Passcode entry) Then select "Memosens OXY".
		**Sensor monitor** During maintenance, the sensor monitor allows validation of the sensor by immersing it in a known solution, for example, and checking the values measured.
		**Temp probe adjustment** [1] Make sure that the process temperature is precisely measured using a calibrated reference thermometer (accuracy better than 0.1°C) when performing an adjustment. Adjustment without precise measurement might result in considerable deviations of the measured-value display! The adjustment value is stored in the Memosens.
		**Sensor maintenance** Here, you can reset the wear counter when you have checked the sensor or after having replaced the membrane or the electrolyte.

Note: The display may vary depending on the device version.

1) With Protos II 4400(X) in the Calibration menu

OXY Diagnostic Functions

Menu selection: Diagnostics > Module MS ... > Memosens OXY

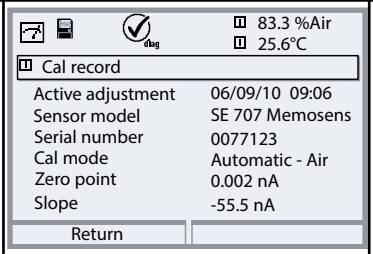
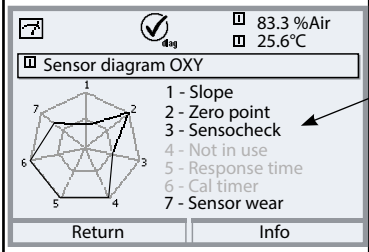
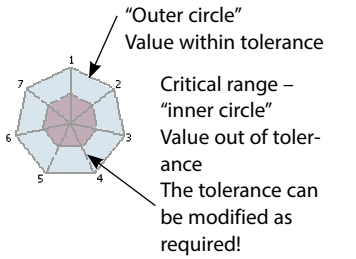
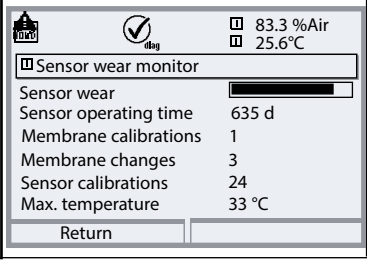
Menu	Display	Action
diag		**Opening the Diagnostics menu** From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, press **enter** to confirm. Then select "Memosens OXY".
		The Diagnostics menu gives an overview of all diagnostics functions available. Messages set as "Favorite" can be called directly from the measuring mode using a softkey. To configure, select: Parameter setting > System control > Function control matrix.
		**Sensor monitor** Shows the values for current and temperature coming from the sensor. Important function for diagnostics and validation!

Note: The display may vary depending on the device version.

OXY Diagnostic Functions

Menu selection: Diagnostics > Module MS ... > Memosens OXY

Note: The display may vary depending on the device version.

Menu	Display	Action
diag		**Calibration/Adjustment Record** Data of last calibration/adjustment **Temp. Offset Log** Shows the data from the last temperature adjustment performed on the currently connected sensor.[1)]
		**Sensor diagram OXY** The measured values are continuously monitored during the measurement process. The sensor diagram provides at-a-glance information about critical parameters. If a tolerance limit has been exceeded, the respective parameter is flashing. Values in gray: Monitoring switched off.
		
		**Sensor wear monitor** In addition to the current sensor wear, the sensor operating time as well as the number of membrane replacements and calibrations can be seen at a glance.

1) With Protos II 4400(X)

OXY Messages

OXY Messages with Protos 3400(X)

No.	OXY messages	Message type
D008	Meas. processing (factory settings)	FAIL
D009	Module failure (Firmware Flash check sum)	FAIL
D010	Saturation %Air Range	FAIL
D011	Saturation %Air Alarm LO_LO	FAIL
D012	Saturation %Air Alarm LO	WARN
D013	Saturation %Air Alarm HI	WARN
D014	Saturation %Air Alarm HI_HI	FAIL
D015	Temperature range	FAIL
D016	Temperature Alarm LO_LO	FAIL
D017	Temperature Alarm LO	WARN
D018	Temperature Alarm HI	WARN
D019	Temperature Alarm HI_HI	FAIL
D020	Concentration range	FAIL
D021	Concentration Alarm LO_LO	FAIL
D022	Concentration Alarm LO	WARN
D023	Concentration Alarm HI	WARN
D024	Concentration Alarm HI_HI	FAIL
D025	Part. press. range	FAIL
D026	Part. press. Alarm LO_LO	FAIL
D027	Part. press. Alarm LO	WARN
D028	Part. press. Alarm HI	WARN
D029	Part. press. Alarm HI_HI	FAIL
D030	Zero range	WARN
D035	Slope range	WARN
D040	Air pressure range	WARN
D041	Air pressure Alarm LO_LO	FAIL

No.	OXY messages	Message type
D042	Air pressure Alarm LO	WARN
D043	Air pressure Alarm HI	WARN
D044	Air pressure Alarm HI_HI	FAIL
D045	Saturation %O2 Range	FAIL
D046	Saturation %O2 Alarm LO_LO	FAIL
D047	Saturation %O2 Alarm LO	WARN
D048	Saturation %O2 Alarm HI	WARN
D049	Saturation %O2 Alarm HI_HI	FAIL
D050	Air pressure Manual range	WARN
D060	SAD SENSOFACE: Slope	WARN
D061	SAD SENSOFACE: Zero	WARN
D062	SAD SENSOFACE: Sensocheck	User-defined
D063	SAD SENSOFACE: Response time	WARN
D064	SAD SENSOFACE: Calibration timer	WARN
D070	SAD SENSOFACE: Sensor wear	User-defined
D080	Range (sensor current)	WARN
D090	Vol% range (measurement in gases)	WARN
D091	Vol% Alarm LO_LO (measurement in gases)	FAIL
D092	Vol% Alarm LO (measurement in gases)	WARN
D093	Vol% Alarm HI (measurement in gases)	WARN
D094	Vol% Alarm HI_HI (measurement in gases)	FAIL
D095	ppm range (measurement in gases)	FAIL
D096	ppm Alarm LO_LO (measurement in gases)	FAIL
D097	ppm Alarm LO (measurement in gases)	WARN
D098	ppm Alarm HI (measurement in gases)	WARN
D099	ppm Alarm HI_HI (measurement in gases)	FAIL
D110	CIP counter	User-defined
D111	SIP counter	User-defined
D112	Autoclaving counter	User-defined
D113	Sensor operating time (duration of use)	User-defined
D114	Membrane body changes	User-defined

No.	OXY messages	Message type
D115	Inner body changes	User-defined
D120	Wrong sensor	FAIL
D121	Sensor (error in factory settings/characteristics)	FAIL
D122	Sensor memory (error in cal data records)	WARN
D123	New sensor, adjustment required	WARN
D130	SIP cycle counted	Text
D131	CIP cycle counted	Text
D200	Temp O2 conc/SAT	WARN
D201	Cal temp	Text
D203	Cal: Identical media	Text
D204	Cal: Media interchanged	Text
D205	Cal: Sensor unstable	Text
D254	Module reset	Text

No.	Calculation Block OXY/OXY Messages	Message type
H010	%AIR-Diff Range	FAIL
H011	%AIR-Diff Alarm LO_LO	FAIL
H012	%AIR-Diff Alarm LO	WARN
H013	%AIR-Diff Alarm HI	WARN
H014	%AIR-Diff Alarm HI_HI	FAIL
H015	Temperature-Diff Range	FAIL
H016	Temperature-Diff Alarm LO_LO	FAIL
H017	Temperature-Diff Alarm LO	WARN
H018	Temperature-Diff Alarm HI	WARN
H019	Temperature-Diff Alarm HI_HI	FAIL
H020	Concentration-Diff Range	FAIL
H021	Concentration-Diff Alarm LO_LO	FAIL

No.	Calculation Block OXY/OXY Messages	Message type
H022	Concentration-Diff Alarm LO	WARN
H023	Concentration-Diff Alarm HI	WARN
H024	Concentration-Diff Alarm HI_HI	FAIL
H045	%O2-Diff Range	FAIL
H046	%O2-Diff Alarm LO_LO	FAIL
H047	%O2-Diff Alarm LO	WARN
H048	%O2-Diff Alarm HI	WARN
H049	%O2-Diff Alarm HI_HI	FAIL
H090	Vol%-Diff range (measurement in gases)	WARN
H091	Vol%-Diff Alarm LO_LO (measurement in gases)	FAIL
H092	Vol%-Diff Alarm LO (measurement in gases)	WARN
H093	Vol%-Diff Alarm HI (measurement in gases)	WARN
H094	Vol%-Diff Alarm HI_HI (measurement in gases)	FAIL
H095	ppm-Diff range (measurement in gases)	FAIL
H096	ppm-Diff Alarm LO_LO (measurement in gases)	FAIL
H097	ppm-Diff Alarm LO (measurement in gases)	WARN
H098	ppm-Diff Alarm HI (measurement in gases)	WARN
H099	ppm-Diff Alarm HI_HI (measurement in gases)	FAIL

OXY Messages with Protos II 4400(X)

⊗ Failure ⚠ Out of Specification ◈ Maintenance Required

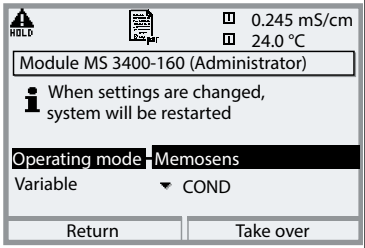
No.	Message Type	OXY Messages
D008	Failure	Meas. Processing (Factory Settings)
D009	Failure	Firmware Error
D010	Failure	Saturation %air range
D011	Failure	Saturation %Air Alarm LO_LO
D012	Out of Specification	Saturation %Air Alarm LO
D013	Out of Specification	Saturation %Air Alarm HI
D014	Failure	Saturation %Air Alarm HI_HI
D015	Failure	Temperature Range
D016	Failure	Temperature Alarm LO_LO
D017	Out of Specification	Temperature Alarm LO
D018	Out of Specification	Temperature Alarm HI
D019	Failure	Temperature Alarm HI_HI
D020	Failure	Concentration Range
D021	Failure	Concentration Alarm LO_LO
D022	Out of Specification	Concentration Alarm LO
D023	Out of Specification	Concentration Alarm HI
D024	Failure	Concentration Alarm LO_LO
D025	Failure	Partial Pressure Range
D026	Failure	Partial Pressure Alarm LO_LO
D027	Out of Specification	Partial Pressure Alarm LO
D028	Out of Specification	Partial Pressure Alarm HI
D029	Failure	Partial Pressure Alarm HI_HI
D045	Failure	Saturation %O2 Range
D046	Failure	Saturation %O2 Alarm LO_LO
D047	Out of Specification	Saturation %O2 Alarm LO
D048	Out of Specification	Saturation %O2 Alarm HI
D049	Failure	Saturation %O2 Alarm HI_HI
D060	Failure/Maintenance Required	Sad Sensoface: Slope
D061	Failure/Maintenance Required	Sad Sensoface: Zero Point
D062	User-defined	Sad Sensoface: Sensocheck
D063	Maintenance Required	Sad Sensoface: Response Time
D064	Maintenance Required	Sad Sensoface: Calibration timer

No.	Message Type	OXY Messages
D070	User-defined	Sad Sensoface: Sensor Wear
D080	Maintenance Required	Sensor Current Range
D110	User-defined	CIP Counter
D111	User-defined	SIP Counter
D112	User-defined	Autoclaving Counter
D113	User-defined	Sensor Operating Time
D120	Failure	Wrong Sensor (Sensor Verification)
D121	Failure	Sensor Error (Factory/Characteristic Data)
D122	Maintenance Required	Sensor Memory Error (Cal Data)
D123	Maintenance Required	New Sensor, Adjustment Required
D124	Maintenance Required	Sensor Date
D130	Info	SIP Cycle Counted
D131	Info	CIP Cycle Counted
D200	Maintenance Required	Temp O2 Conc/Sat
D201	Maintenance Required	Cal Temperature
D203	Info	Cal: Identical Media
D204	Info	Cal: Cal: Media Interchanged
D205	Info	Cal: Sensor Unstable
D254	Info	Module Reset

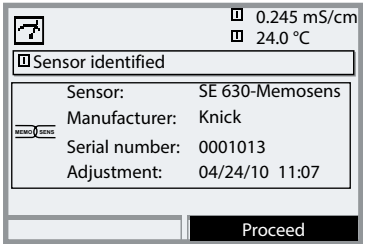
No.	Message Type	Calculation Block OXY / OXY Messages
H010	Failure	Saturation %AIR Diff Range
H011	Failure	Saturation %AIR Diff Alarm LO_LO
H012	Out of Specification	Saturation %AIR Diff Alarm LO
H013	Out of Specification	Saturation %AIR Diff Alarm HI
H014	Failure	Saturation %AIR Diff Alarm HI_HI
H015	Failure	Temperature Diff Range
H016	Failure	Temperature Diff Alarm LO_LO
H017	Out of Specification	Temperature Diff Alarm LO
H018	Out of Specification	Temperature Diff Alarm HI
H019	Failure	Temperature Diff Alarm HI_HI
H020	Failure	Concentration (Liquid) Diff Range
H021	Failure	Concentration (Liquid) Alarm LO_LO
H022	Out of Specification	Concentration (Liquid) Diff Alarm LO
H023	Out of Specification	Concentration (Liquid) Diff Alarm HI_HI
H024	Failure	Concentration (Liquid) Diff Alarm HI_HI
H045	Failure	%O2 Diff Range
H046	Failure	%O2 Diff Alarm LO_LO
H047	Out of Specification	%O2 Diff Alarm LO
H048	Out of Specification	%O2 Diff Alarm HI
H049	Failure	%O2 Diff Alarm HI_HI
H090	Failure	Vol% Diff Range (Measurement in Gases)
H091	Failure	Vol% Diff Alarm LO_LO (Measurement in Gases)
H092	Out of Specification	Vol% Diff Alarm LO (Measurement in Gases)
H093	Out of Specification	Vol% Diff Alarm HI (Measurement in Gases)
H094	Failure	Vol% Diff Alarm HI_HI (Measurement in Gases)
H200	Maintenance Required	Calculation Block Configuration

COND Parameter Setting

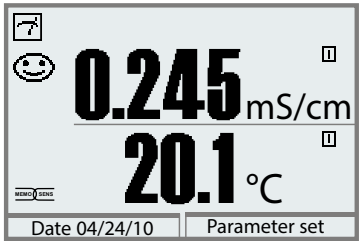
Selecting the mode and process variable (conductivity).
Note: Function check (HOLD) mode active

Menu	Display	Action
		**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: Conductivity Operating mode: Memosens Functionality: 2-Electr. Sensor / 4-Electr. Sensor Protos 3400(X): Operating mode: Memosens Variable: COND

A connected Memosens sensor is displayed immediately:



All sensor-typical parameters are automatically sent to the analyzer.
Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected.
With "Plug&Measure", premeasured Memosens sensors can immediately be used for measurement without previous calibration.

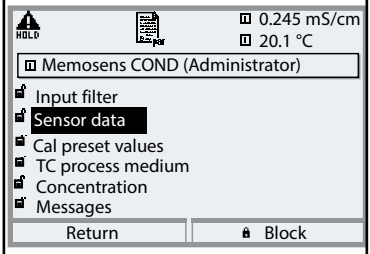
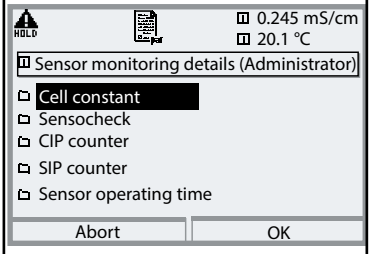


With Protos 3400(X): The Memosens icon is displayed as long as a Memosens sensor is connected.

Note: The display may vary depending on the device version.

COND Parameter Setting

Note: Function check (HOLD) mode active

Menu	Display	Action
		**Sensor data** Memosens sensors provide most of the parameters automatically.
		Sensoface provides information on the sensor condition. In measuring mode a smiley face is displayed ☺ (friendly, neutral, sad) depending on the sensor data. To display the "Sensoface" icon, you must activate it in the Sensor Data menu.
		**Sensor monitoring details** Auto: The parameters are read out directly from the sensor or are adjusted by the system. They are displayed in gray and cannot be edited. Individual: You must enter the parameters. In addition, you can specify values for SIP counter, CIP counter and sensor operating time which will trigger a message.

Note: The display may vary depending on the device version.

COND Parameter Setting

Default Setting and Selection Range
Note: Function check (HOLD) active

Note: The menus may vary depending on the device version.

Parameter	Default	Selection / Range
Input Filter		
Noise Suppression	Off	On, Off
Sensor Data		
Sensoface	On	On, Off
Sensor Monitoring Details		
Cell Constant	Auto	Auto, Individual
Sensocheck	Off	Off, On (Message Off/Failure/Maintenance Required)
CIP counter	Off	0, Max. Number of Cycles
SIP counter	Off	0, Max. Number of Cycles
Sensor Operating Time	Off	Entry, max. 9999 d
Protos II 4400(X): Cal Presettings		
Calibration Mode	Automatic	Automatic, Manual, Product, Data Entry, Temperature
Automatic: Cal Solution	NaCl saturated	NaCl 0.01 m: 1183 µS/cm NaCl 0.1 m: 10.683 mS/cm NaCl Sat: 251.3 mS/cm KCl 0.01 m: 1413 µS/cm KCl 0.1 m: 12.88 mS/cm KCl 1m: 111.80 mS/cm
Product: Conductivity Concentration[1)]	Conductivity Without TC NaCl (0...26 %)	Conductivity, Concentration[1)] Without TC, with TC Medium, see next page.
Protos 3400(X): Cal preset values		
Calibration solution	NaCl saturated	NaCl 0.01 m: 1183 µS/cm NaCl 0.1 m: 10.683 mS/cm NaCl Sat: 251.3 mS/cm KCl 0.01 m: 1413 µS/cm KCl 0.1 m: 12.88 mS/cm KCl 1m: 111.80 mS/cm
Product calibration	Without TC	Without TC, with TC

1) With add-on function FW4400-009

COND Parameter Setting

Note: Function check (HOLD) active

Parameter	Default	Selection / Range
TC Process Medium		
Temperature Compensation	Off	Off, Linear, EN27888, Ultrapure Water [1] Ultrapure Water: Impurity: NaOH, NaCl, HCl, NH_3
Concentration		
Concentration [2]	Off	On, Off Medium: NaCl (0-28 %), HCl (0-18 %), NaOH (0-24 %), H_2SO_4 (0-37 %), HNO_3 (0-30 %), H_2SO_4 (89-99 %), HCl (22-39 %), HNO_3 (35-96 %), H_2SO_4 (28-88 %), NaOH (15-50 %), Oleum $H_2SO_4 \cdot SO_3$ (12-45 %) Table
Messages		
Messages	Temperature: Max. Device Limits	Conductivity, Resistivity, Concentration, Temperature, Salinity. Monitoring is adjustable: Off, Max. Device Limits, Variable Limits
USP Function		

Note: The menus may vary depending on the device version.

1) With add-on function SW3400-008/FW4400-008
2) With add-on function SW3400-009/FW4400-009

Concentration Table (COND)

Select menu: Parameter setting > System control > Concentration table
Specifying a concentration solution for conductivity measurement

Concentration Table [1)]

To specify the customer-specific solution, 5 concentration values A-E are entered in a matrix together with 5 temperature values 1-5. To do so, first enter the 5 temperature values, then enter the respective conductivity values for each concentration A-E.

These solutions will then be available in addition to the permanently stored standard solutions (select "Table").

Note: The display may vary depending on the device version.

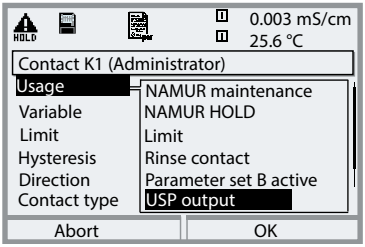
Menu	Display	Action
par	HOLD 0.245 mS/cm 25.6 °C System control (Administrator) Calculation Blocks Point of measurement Release of options Logbook Concentration table Factory setting Return	**Enter values** • Open parameter setting • System control • Select "Concentration table"
	HOLD 0.245 mS/cm 25.6 °C Concentration table (Administrator) Temperature 1 +000.0 °C Temperature 2 +005.0 °C Temperature 3 +010.0 °C Temperature 4 +015.0 °C Temperature 5 +020.0 °C Abort OK	Enter 5 temperature values (right/left arrow keys to select position, up/down arrow keys to edit number, press **enter** to confirm).
	HOLD 0,245 mS/cm 25.6 °C Concentration table (Administrator) Concentration A: 05.00 % by wt 1. Cond at +000.0 °C 0.000 µS/cm 2. Cond at +005.0 °C 0.000 µS/cm 3. Cond at +010.0 °C 0.000 µS/cm 4. Cond at +015.0 °C 0.000 µS/cm 5. Cond at +020.0 °C 0.000 µS/cm Abort OK	Enter values for concentrations A-E for the respective temperatures. The table values must be continuous. Maxima/minima are not permitted. Incorrect entries are marked with ✕.

The concentration table is selected as follows:
Parameter setting > Module COND > Concentration = ON / Medium = Table.

1) With add-on function SW3400-009/FW4400-009

USP Function (COND)

Monitoring of ultrapure water in the pharmaceutical industry
(Select: Parameter setting > Memosens COND)



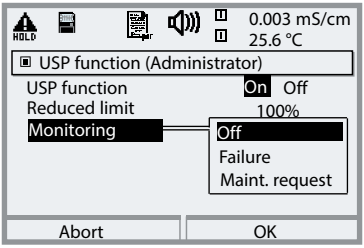
USP function, define switching output
When a Memosens COND is installed, one of the floating relay outputs of the BASE module (K1, K2 or K3) can be assigned to the USP function.

- Select parameter setting:
- Administrator level (HOLD active!)
- Module BASE: Define contact "Usage"

The USP can be selected as USP% process variable for output (display, current output, limit value, measurement recorder)

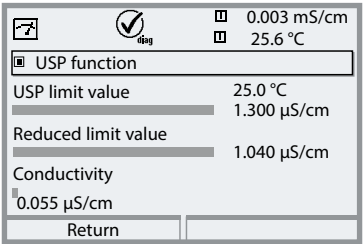
According to the "USP" directive (U.S.Pharmacopeia), Appendix 5, Section 645 "Water Conductivity" the conductivity of pharmaceutical waters can be monitored online.
To do so, the conductivity is measured without temperature compensation and compared with limit values . The water is usable without further test steps when the conductivity is below the USP limit.

Reduced limit:
The USP limit can be reduced down to 10 % (Parameter setting).



Select USP function

- Select parameter setting, then:
- Administrator level (HOLD active!)
- Memosens COND: USP function



USP function. Diagnostics

- Select diagnostics:
- Memosens COND
- USP function: Display of USP limit, reduced limit, conductivity

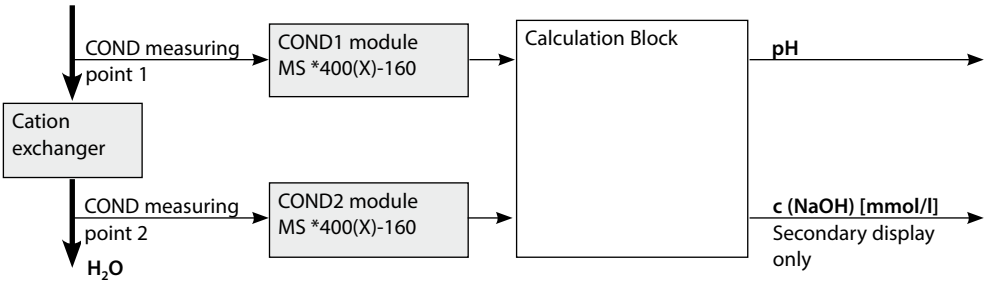
Note: The display may vary depending on the device version.

pH Value Calculation (COND)

Note: 2 conductivity modules required

pH value calculation by means of dual conductivity measurement
When monitoring boiler feed water in power plants, the pH value can be calculated by means of a dual conductivity measurement. For that purpose, the boiler feed water conductance is measured before and after the ion exchanger. This commonly used method of indirect pH value measurement does not require much maintenance and has the following advantage:
Normal pH measurement in ultrapure water is very critical. Boiler feed water does not contain many ions. This requires the use of a special electrode, which must be calibrated constantly and the service life of which is generally rather short.

Function
The conductivity before and after the ion exchanger is measured using two MS modules. From the two calculated conductivity values, a "Calculation Block" determines the concentration of sodium hydroxide solution and the pH value according to the calculation formulas shown below:



Calculating the concentration of sodium hydroxide solution / pH value:

$$c(NaOH) = \frac{COND1 - 1/3\ COND2}{243}$$

$$pH = 11 + \log[c(NaOH)]$$

pH Value Calculation (COND)

Recommended pH ranges:

10 ± 0.2 for < 136 bar operating overpressure or
9.5 ± 0.2 for > 136 bar operating overpressure

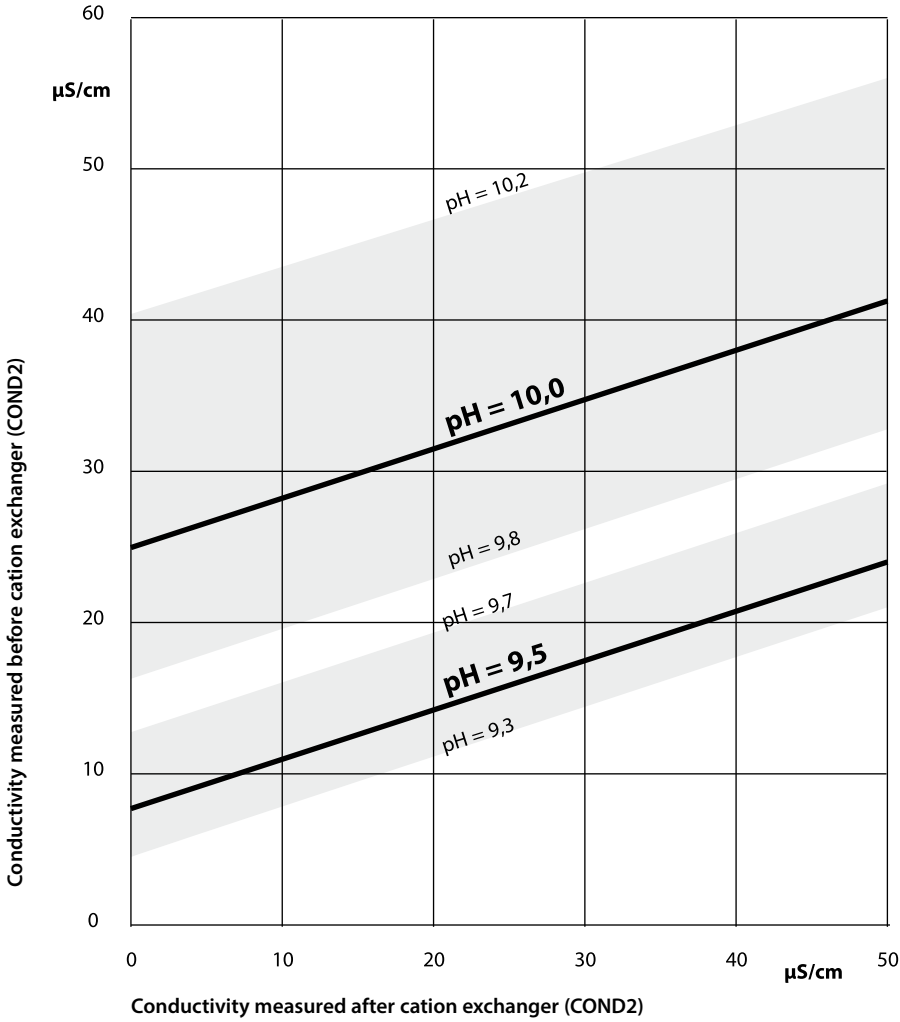


Figure:
Conditioning the feed water of natural circulation boilers with sodium hydroxide. Relationship between the pH value and the conductivity measured before and after the cation exchanger.
Source: Appendix to VGB guideline for boiler feed water, boiler water, and steam of steam generators above 68 bar permissible operating overpressure (VGB-R 450 L, edition 1988)

Calculation Blocks (COND)

Select menu: Parameter setting > System control > Calculation Blocks
Calculation of new variables from measured variables

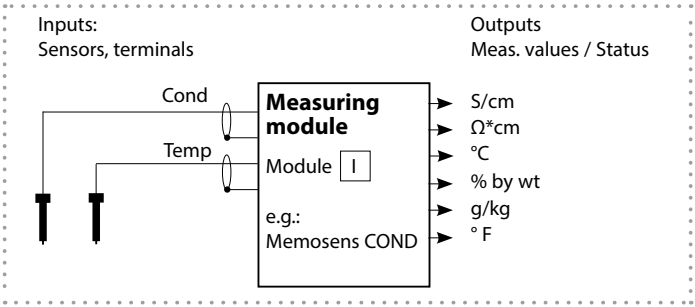
Calculation Blocks
Two measuring modules with all their measured values serve as input for the calculation block. In addition, the general device status (NAMUR signals) is taken into account. The difference between the existing values is calculated:

Current outputs
All current outputs can be set to output the new process variables formed by the Calculation Blocks.

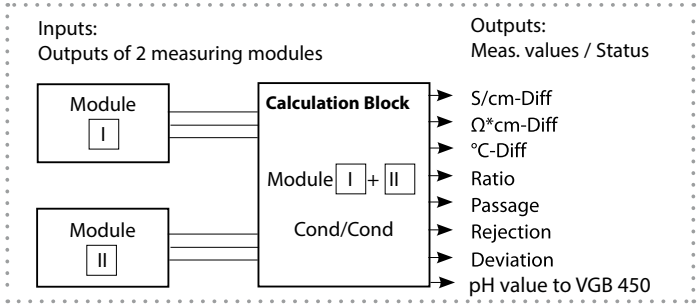
Measurement display
All new process variables can be displayed as primary or as secondary value.

Controller
Controller functions are not supported.

Functionality of measuring module



Functionality of Calculation Block

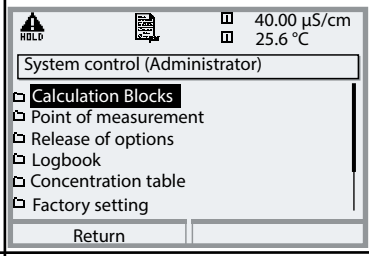
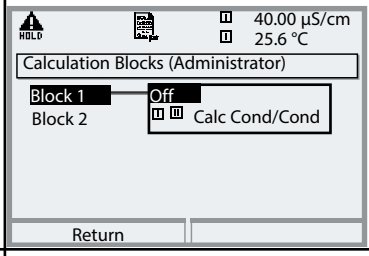
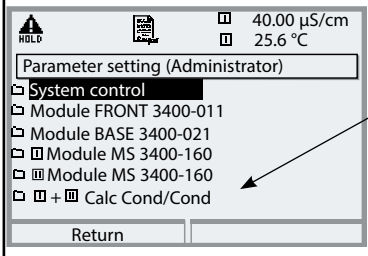


Calculation Blocks (COND)

Select menu: Parameter setting > System control > Calculation Blocks

Combining 2 COND modules (e.g. Memosens COND)
With three measuring modules, the following Calculation Block combinations are possible: [I] + [II] , [I] + [III] , [II] + [III]

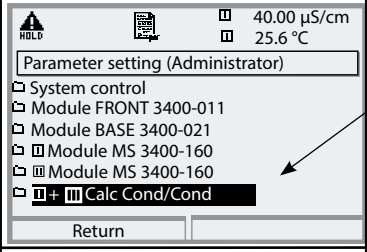
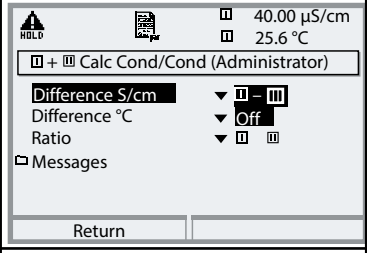
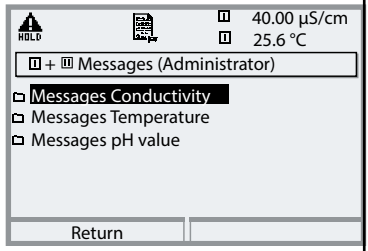
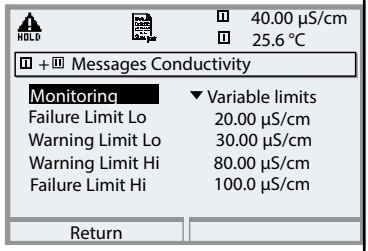
Two Calculation Blocks can be activated.

Menu	Display	Action
par		**Calculation Blocks** • Open parameter setting • System control • Select "Calculation Blocks"
		Depending on the modules installed, the possible combinations for Calculation Blocks are offered.
		During parameter setting the Calculation Blocks are displayed like modules.

Note: The display may vary depending on the device version.

Calculation Blocks (COND)

Setting the process variable to be calculated

Menu	Display	Action
par		**Select Calculation Block** • Open parameter setting • Select module
		Depending on the modules installed, the possible combinations for Calculation Blocks are offered.
	 	**Messages** You can activate messages for the selected variables. Variables which have been set as "Off" cannot be processed further. The measured values which shall release a message are set using the arrow keys (left/right: select position, up/down: edit number). Press **enter** to confirm.

Note: The display may vary depending on the device version.

COND Calibration / Adjustment

Note: Function check (HOLD) mode active for the currently calibrated module
Current outputs and relay contacts behave as configured

Note: With Memosens sensors, the calibration data are stored in the sensor.
This allows using precalibrated sensors.
When the Protos is used for precalibrating sensors in the lab,
you can use the calibration routines described below.

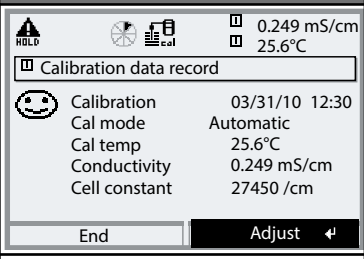
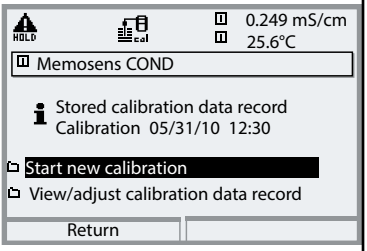
- **Calibration:** Detecting deviations without readjustment
- **Adjustment:** Detecting deviations with readjustment

NOTICE! Without adjustment every conductivity meter delivers an imprecise or wrong output value! Every conductivity sensor has its individual cell constant. To determine the correct conductivity value, the conductivity meter must be adjusted to the sensor. From the sensor signal and the cell constant, the meter calculates the conductivity value to be displayed.

Procedure
Every conductivity sensor has its individual cell constant.
Depending on the sensor design, the cell constant may vary over a wide range. As the conductivity is calculated from the measured conductance and the cell constant, this must be known to the measuring system. For calibration or sensor standardization, either the known (stamped on) cell constant of the conductivity sensor used is entered in the measuring system or it is determined automatically by measuring a calibration solution with a known conductivity. The data are stored in a calibration record. By "Adjustment" the determined calibration data can be used for correction (see following page).

- Use fresh calibration solutions only!
- The calibration solution used must have been selected during parameter setting.
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature. Using the measured or entered temperature, the Protos determines the nominal value for the calibration solution from a stored table.
- Observe response time of temperature probe!
- For exact determination of the cell constant, wait until the temperature probe and calibration solution have the same temperature.

Adjustment
means that the cell constant determined by a calibration is taken over. It is entered in the calibration record. (Cal record can be called in the Diagnostics menu for Memosens COND.) The value is only effective for calculating the measured variables when the calibration has been terminated with an adjustment and the data have been saved in the Memosens sensor.
A passcode ensures that an adjustment can only be performed by an authorized person (Administrator).
The Operator can check the current sensor data by a calibration and inform the Administrator when there are deviations.
You can use the add-on function SW3400-107[1)] for granting access rights (passcodes) and for AuditTrail (continuous data recording and backup according to FDA 21 CFR Part 11).

Menu	Display	Action
cal		**Administrator** With the corresponding access rights, the device can immediately be adjusted after calibration. The calibration values are taken over for calculating the measured variables.
		**Operator** (without administrator rights) After calibration, change to measuring mode. Inform Administrator. When opening the menu (Calibration, respective module), the Administrator sees all data of the last calibration and can take over the values or perform a new calibration.

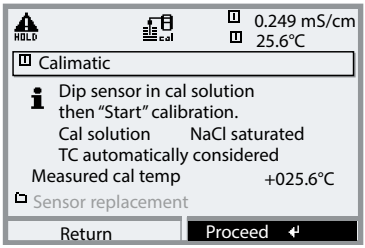
Note: The display may vary depending on the device version.

1) With Protos 3400(X)

Temperature compensation during calibration/adjustment

The conductivity value of the calibration solution is temperature-dependent. For calibration, the calibration solution temperature must therefore be known in order to choose the actual value from the conductivity table.

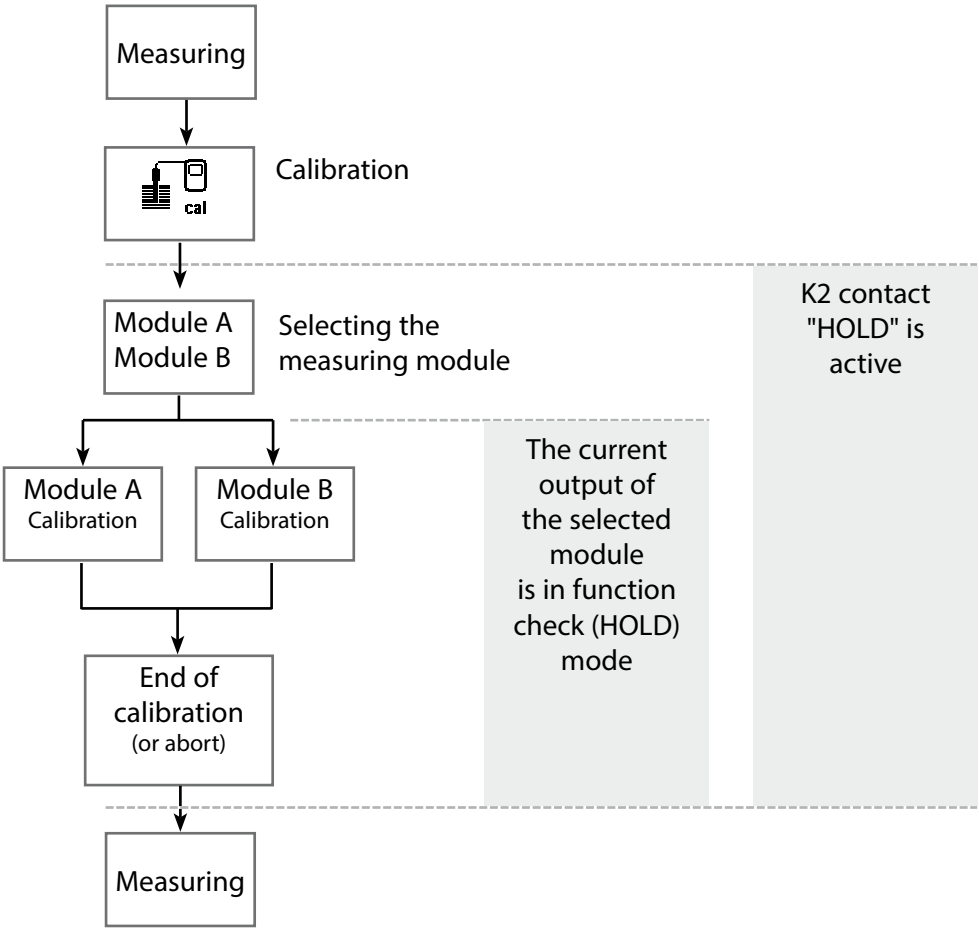
Automatic temperature compensation

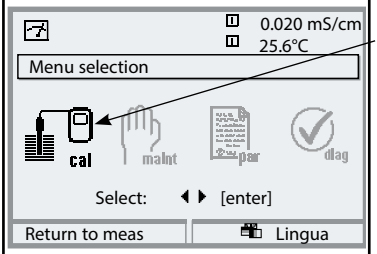
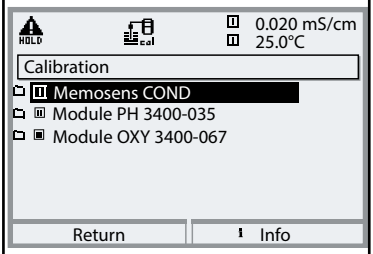
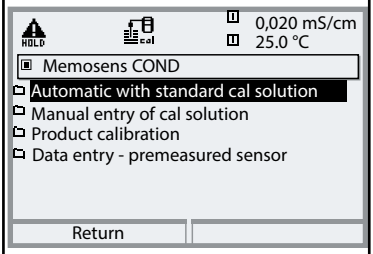


For automatic cal temp detection, the Protos measures the temperature of the calibration solution using the temperature detector integrated in the Memosens sensor.

HOLD Function During Calibration/Adjustment

Behavior of the signal and relay outputs during calibration/adjustment



Menu	Display	Action
	  	**Open Calibration** Press **menu** key to select menu. Select calibration using arrow keys, press **enter** to confirm, passcode 1147 (The passcode can be edited by the administrator.) Calibration: Select "Memosens COND" Select calibration method: • Automatic with standard cal solution • Manual entry of cal solution • Product calibration • Data entry - premeasured sensor • Temp probe adjustment (with Protos II 4400(X)) When you access calibration, the analyzer automatically proposes the previous calibration method. If you do not want to calibrate, "Return" with the left softkey. **During calibration the module is in function check (HOLD) mode.** Current outputs and relay contacts of the module behave as configured (Module BASE).

Note: The display may vary depending on the device version.

COND Calibration / Adjustment

Automatic calibration with standard calibration solution

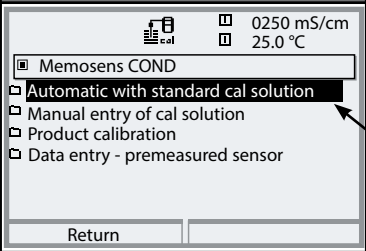
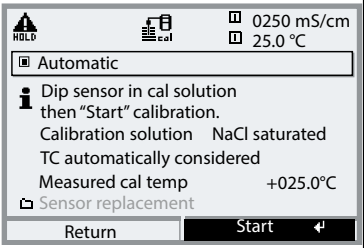
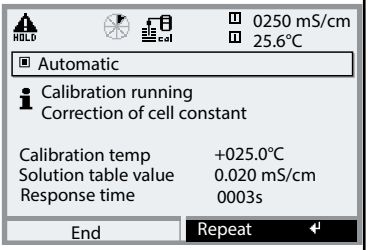
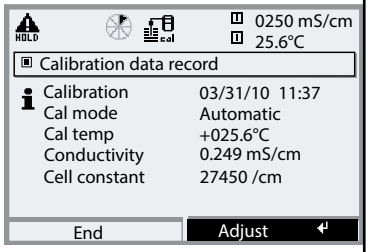
Automatic with standard cal solution
For automatic calibration, the conductivity sensor is immersed in a standard calibration solution (NaCl or KCl, selected during parameter setting: From the measured conductance and temperature, the Protos automatically calculates the cell constant. The temperature dependence of the calibration solution is taken into account.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
- Use fresh calibration solutions only! The calibration solution used must have been selected during parameter setting.
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature. Using the measured or entered temperature, the Protos determines the nominal value for the calibration solution from a stored table.
- Observe response time of temperature probe!
- For exact determination of the cell constant, wait until the temperature probe and calibration solution have the same temperature.

Be sure to observe during calibration:
- If the measured conductance or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
- If an error message appears, you have to repeat calibration.

Adjustment: Taking over the values determined by calibration
- When the values determined by calibration are correct, they must be taken over to adjust the analyzer. The data are saved in the Memosens sensor.

Menu	Display	Action
cal		Select calibration menu Select "Memosens COND" Select calibration method: "Automatic with standard cal solution", confirm by pressing **enter**.
		The module is in function check (HOLD) mode! Display of selected calibration solution. Immerse sensor in calibration solution. Start calibration by pressing softkey or **enter**.
		Calibration is running. The display shows: • Calibration temperature • Solution table value (conductivity versus cal temperature) • Response time
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables and to save the data in the Memosens sensor.

Note: The display may vary depending on the device version.

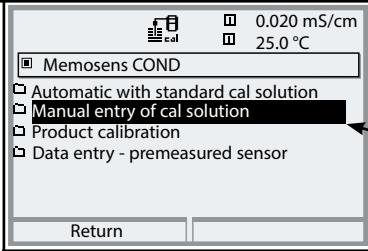
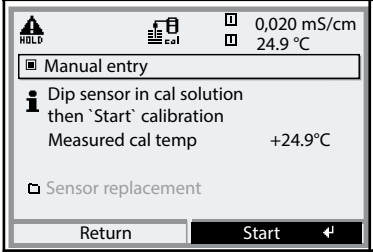
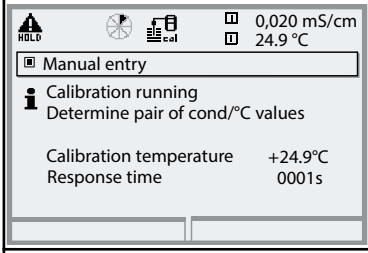
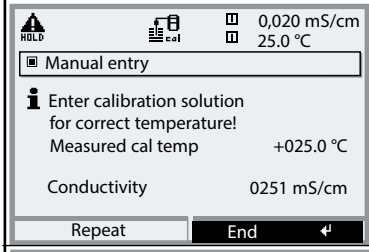
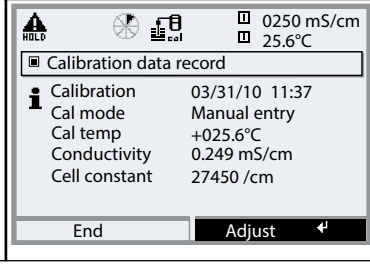
Manual entry of cal solution
For calibration with manual entry of the calibration solution's conductivity, the sensor is immersed in a calibration solution. Protos determines a conductivity/ calibration temperature value pair. Then, the temperature-corrected conductivity value of the solution must be entered. To do this, read off the conductivity for the temperature displayed from the TC table of the calibration solution. Intermediate conductivity values must be interpolated. Protos automatically calculates the cell constant.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
- Use fresh calibration solutions only!
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature.
- Observe response time of temperature probe!
- For exact determination of the cell constant, wait until the temperature probe and calibration solution have the same temperature.

Be sure to observe during calibration:
- If the measured conductance or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
- If an error message appears, you have to repeat calibration.

Adjustment: Taking over the values determined by calibration
- When the values determined by calibration are correct, they must be taken over to adjust the analyzer. The data are saved in the Memosens sensor.

Menu	Display	Action
cal		Select calibration menu Select "Memosens COND" Select calibration method: "Manual entry of cal solution", confirm by pressing **enter**.
		The module is in function check (HOLD) mode! Immerse sensor in cal solution. Start calibration by pressing softkey or **enter**.
		Calibration is running. The display shows: • Calibration temperature • Response time
		Enter conductivity. End calibration by pressing the "End" softkey.
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables and to save the data in the Memosens sensor.

Note: The display may vary depending on the device version.

Product calibration
When the sensor cannot be removed, e.g. for sterility reasons (for biotechnical processes), its cell constant can be determined with “sampling”.
To do so, the currently measured process value (conductivity or concentration [1)]) is saved by the Protos.
Immediately afterwards, you take a sample from the process. The sample value should be measured at process conditions (same temperature!). The determined value is entered in the measuring system. From the difference between process value and sample value, the Protos calculates the cell constant of the conductivity sensor.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

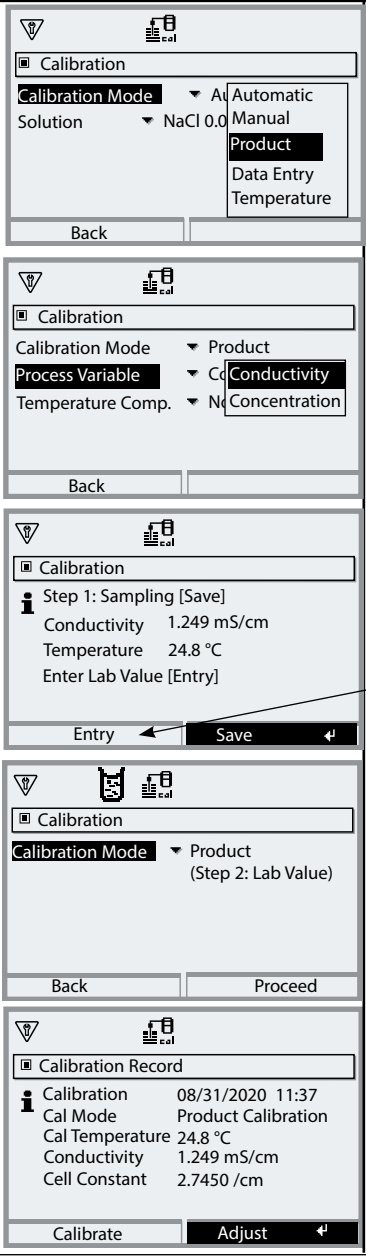
Product calibration without TC correction (for conductivity)
Take a sample from the process. Measure its value at the temperature at which the sample has been taken ("Sample temp", see display). To do so, it may be necessary to thermostat the sample correspondingly in the lab. Temperature compensation must be turned off at the comparison meters (TC = 0 %/K).

Product calibration with TC correction Tref = 25 °C/77 °F (for conductivity)
Take a sample from the process. When measuring in the lab (TC linear), be sure that the same values are set for reference temperature and temperature coefficient in the comparison meter and in the Protos. Furthermore, the measuring temperature should correspond to the sample temperature (see display). Transport the sample in an insulated container (Dewar).

NOTICE!
Product calibration can only be performed if the process medium is stable. That means, for example, that there are no chemical reactions which have an effect on the process conductivity. At higher temperatures, the sample values can also be invalidated due to evaporation.

 1) With Protos II 4400(X) and add-on function FW4400-009

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Select calibration. Select COND module. Select Calibration Mode > Product and press **enter** to confirm. Select Process Variable > Conductivity or Concentration[1]. Conductivity: calibration with/without temperature compensation Concentration: Select the medium. **Step 1** Take sample. Store measured value and temperature at the moment of sampling ("Save" softkey or **enter**). The analyzer automatically returns to calibration mode selection. Press **meas** to return to measurement. **Exception:** Sample value can be determined and entered on site: Left softkey: "Input" **Step 2** Lab value has been measured. Open the calibration menu again. Right softkey: "Input" Enter reference value ("Lab value"). Confirm with "OK" or repeat calibration. **Adjustment** Press "Adjust" softkey to take over the values determined during calibration for calculating the measured variables.

1) with Protos II 4400(X) and add-on function FW4400-009

COND Calibration / Adjustment

Data entry of premeasured sensors

Data entry of premeasured sensors
Entry of cell constant and zero point of a sensor, related to 25 °C / 77 °F, 1013 mbar /14.69 psi.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

If **concentration measurement** is activated , this menu also shows the concentration value and directly adjusts it depending on the cell constant. This allows direct calibration of the concentration value.

Menu	Display	Action
cal	0.225 mS/cm 25.0°C Calibration Memosens COND Module PH 3400-035 Module OXY 3400-067 Return Info	Select "Memosens COND" During calibration, the output currents (1 and 2), limit contacts and controller output are in function check (HOLD) mode. Press **enter** to confirm.
	0.225 mS/cm 25.0 °C Memosens COND Automatic with standard cal solution Manual entry of cal solution Product calibration Data entry - premeasured sensor Return	Select "Data entry" calibration method. Press **enter** to confirm. The module is in function check (HOLD) mode.
	HOLD 0.225 mS/cm 25.6°C Data entry Temperature +25.6°C Conductivity 0.225 mS/cm Sensor replacement Cell constant 1.000 End	Enter cell constant of premeasured sensor. Confirm by pressing "OK" or repeat calibration. The cell constant is saved in the Memosens sensor.

Note: The display may vary depending on the device version.

Temp Probe Adjustment

Note: With Protos II 4400(X) in the Calibration menu,
with Protos 3400(X) in the Maintenance menu.

This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. Make sure that the process temperature is precisely measured using a calibrated reference thermometer when performing an adjustment. The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display!

With Protos II 4400(X), the data from the last adjustment and the temperature offset can be called from the Diagnostics menu, see p. 118.

Sensor calibration

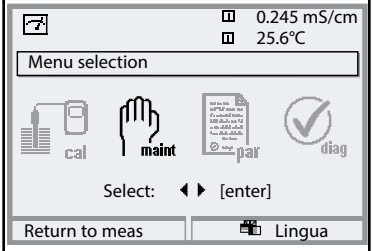
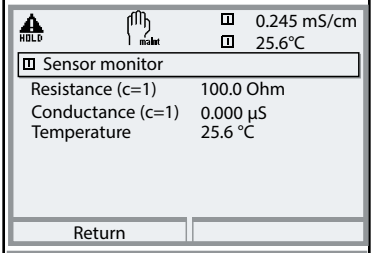
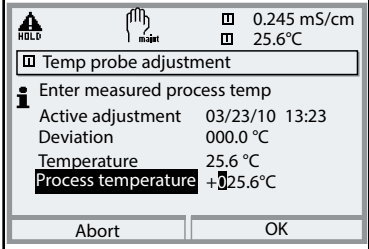
Since the cell constant is subject to production-related variances, the dismounted sensor should be calibrated with a calibration solution (e.g. NaCl saturated). The cell constant of the sensor – particularly of a fringe-field sensor – depends on the type of installation:

- When the sensor is mounted in a free space (minimum distances exceeded), the cell constant can be entered directly as given in the specifications. Calibration method: “Data entry”

- When mounted in restricted space (minimum distances not kept), the sensor must be calibrated when mounted since the resulting cell constant has changed. Calibration method: "Product calibration"

COND Maintenance

Sensor monitor / Temp probe adjustment
Note: Function check (HOLD) mode active

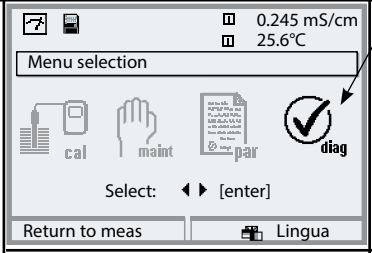
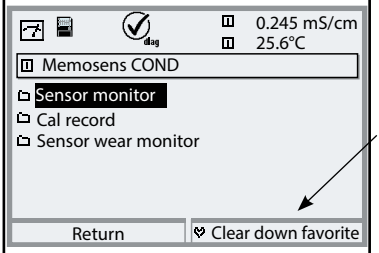
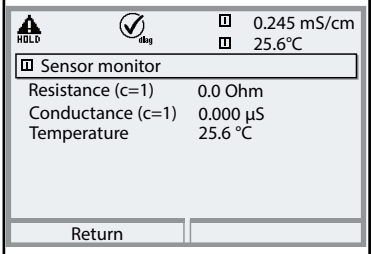
Menu	Display	Action
maint		From the measuring mode: Press **menu** key to select menu. Select maintenance using arrow keys, confirm by pressing **enter**. Passcode 2958 (To change passcode: Parameter setting > System control > Passcode entry) Then select "Memosens COND".
		**Sensor monitor** During maintenance, the sensor monitor allows validation of the sensor by immersing it in a known solution, for example, and checking the values measured.
		**Temp probe adjustment** [1] Make sure that the process temperature is precisely measured using a calibrated reference thermometer (accuracy better than 0.1°C) when performing an adjustment. The data are stored in the Memosens sensor. Adjustment without precise measurement might result in considerable deviations of the measured value display!

Note: The display may vary depending on the device version.

1) With Protos II 4400(X) in the Calibration menu

COND Diagnostics

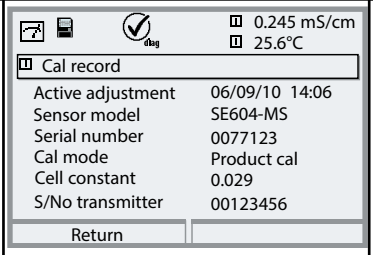
Menu selection: Diagnostics > Module MS ... >Memosens COND

Menu	Display	Action
diag		**Opening the diagnostics menu** From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, confirm by pressing **enter**. Then select Memosens COND.
		The Diagnostics menu gives an overview of all diagnostics functions available. Messages set as "Favorite" can be called directly from the measuring mode using a softkey. Select: Parameter setting > System control > Function control matrix.
		**Sensor monitor** Shows the values for resistance, conductance and temperature coming from the sensor. Important function for diagnostics and validation!

Note: The display may vary depending on the device version.

COND Diagnostics

Menu selection: Diagnostics > Module MS ... >Memosens COND

Menu	Display	Action
diag		**Calibration/Adjustment Record** Data of the last adjustment/calibration **Temp. Offset Log** Shows the data from the last temperature adjustment performed on the currently connected sensor.[1)]

Note: The display may vary depending on the device version.

1) With Protos II 4400(X)

COND Messages

COND Messages with Protos 3400(X)

No.	COND messages	Message type
C008	Meas. processing (factory settings)	FAIL
C009	Module failure (Firmware Flash check sum)	FAIL
C010	Conductivity range	FAIL
C011	Conductivity Alarm LO_LO	FAIL
C012	Conductivity Alarm LO	WARN
C013	Conductivity Alarm HI	WARN
C014	Conductivity Alarm HI_HI	FAIL
C015	Temperature range	FAIL
C016	Temperature Alarm LO_LO	FAIL
C017	Temperature Alarm LO	WARN
C018	Temperature Alarm HI	WARN
C019	Temperature Alarm HI_HI	FAIL
C020	Resistivity range	FAIL
C021	Resistivity Alarm LO_LO	FAIL
C022	Resistivity Alarm LO	WARN
C023	Resistivity Alarm HI	WARN
C024	Resistivity Alarm HI_HI	FAIL
C025	Concentration range	FAIL
C026	Concentration Alarm LO_LO	FAIL
C027	Concentration Alarm LO	WARN
C028	Concentration Alarm HI	WARN
C029	Concentration Alarm HI_HI	FAIL
C035	Cell constant range	WARN
C040	Salinity range	FAIL
C041	Salinity Alarm LO_LO	FAIL
C042	Salinity Alarm LO	WARN
C043	Salinity Alarm HI	WARN

No.	COND messages	Message type
C044	Salinity Alarm HI_HI	FAIL
C045	Conductance range	FAIL
C050	Man. temperature range	FAIL
C060	SAD SENSOFACE: Polarization	User-defined
C061	SAD SENSOFACE: Cable	User-defined
C090	USP limit value	User-defined
C120	Wrong sensor	FAIL
C121	Sensor	FAIL
C122	Sensor memory	WARN
C123	New sensor, adjustment required	WARN
C130	SIP cycle counted	Text
C131	CIP cycle counted	Text
C200	Reference temperature	WARN
C201	TC correction	WARN
C202	TC range	WARN
C203	TC range	FAIL
C204	Cal: Sensor unstable	Text
C205	Cal: Sensor failure	Text
C254	Module reset	Text

No.	Calculation Block COND/COND messages	Message type
E010	Conductivity-Diff Range	FAIL
E011	Conductivity-Diff Alarm LO_LO	FAIL
E012	Conductivity-Diff Alarm LO	WARN
E013	Conductivity-Diff Alarm HI	WARN
E014	Conductivity-Diff Alarm HI_HI	FAIL
E015	Temperature-Diff Range	FAIL
E016	Temperature-Diff Alarm LO_LO	FAIL
E017	Temperature-Diff Alarm LO	WARN
E018	Temperature-Diff Alarm HI	WARN
E019	Temperature-Diff Alarm HI_HI	FAIL

No.	Calculation Block COND/COND messages	Message type
E020	Resistivity-Diff range	FAIL
E021	Resistivity-Diff Alarm LO_LO	FAIL
E022	Resistivity-Diff Alarm LO	WARN
E023	Resistivity-Diff Alarm HI	WARN
E024	Resistivity-Diff Alarm HI_HI	FAIL
E030	RATIO range	FAIL
E031	RATIO Alarm LO_LO	FAIL
E032	RATIO Alarm LO	WARN
E033	RATIO Alarm HI	WARN
E034	RATIO Alarm HI_HI	FAIL
E035	PASSAGE range	FAIL
E036	PASSAGE Alarm LO_LO	FAIL
E037	PASSAGE Alarm LO	WARN
E038	PASSAGE Alarm HI	WARN
E039	PASSAGE Alarm HI_HI	FAIL
E045	REJECTION range	FAIL
E046	REJECTION Alarm LO_LO	FAIL
E047	REJECTION Alarm LO	WARN
E048	REJECTION Alarm HI	WARN
E049	REJECTION Alarm HI_HI	FAIL
E050	DEVIATION range	FAIL
E051	DEVIATION Alarm LO_LO	FAIL
E052	DEVIATION Alarm LO	WARN
E053	DEVIATION Alarm HI	WARN
E054	DEVIATION Alarm HI_HI	FAIL
E055	c(NaOH) range	FAIL
E060	pH value range	FAIL
E061	pH value Alarm LO_LO	FAIL
E062	pH value Alarm LO	WARN
E063	pH value Alarm HI	WARN
E064	pH value Alarm HI_HI	FAIL

COND Messages with Protos II 4400(X)

⊗ Failure ⚠ Out of Specification ◈ Maintenance Required

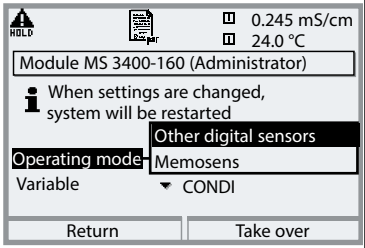
No.	Message Type	COND Messages
C008	Failure	Meas. Processing (Factory Settings)
C009	Failure	Firmware Error
C010	Failure	Conductivity Range
C011	Failure	Conductivity Alarm LO_LO
C012	Out of Specification	Conductivity Alarm LO
C013	Out of Specification	Conductivity Alarm HI
C014	Failure	Conductivity Alarm LO_LO
C015	Failure	Temperature Range
C016	Failure	Temperature Alarm LO_LO
C017	Out of Specification	Temperature Alarm LO
C018	Out of Specification	Temperature Alarm HI
C019	Failure	Temperature Alarm HI_HI
C020	Failure	Resistivity Range
C021	Failure	Resistivity Alarm LO_LO
C022	Out of Specification	Resistivity Alarm LO
C023	Out of Specification	Resistivity Alarm HI
C024	Failure	Resistivity Alarm HI_HI
C025	Failure	Concentration Range
C026	Failure	Concentration Alarm LO_LO
C027	Out of Specification	Concentration Alarm LO
C028	Out of Specification	Concentration Alarm HI
C029	Failure	Concentration Alarm LO_LO
C040	Failure	Salinity Range
C041	Failure	Salinity Alarm LO_LO
C042	Out of Specification	Salinity Alarm LO
C043	Out of Specification	Salinity Alarm HI
C044	Failure	Salinity Alarm HI_HI
C045	Failure	Conductance Range
C060	User-defined	Sad Sensoface: Polarization
C061	User-defined	Sad Sensoface: Cable
C062	Maintenance Required	Sad Sensoface: Cell Constant
C070	Failure	TDS Range

No.	Message Type	COND Messages
C071	Failure	TDS Alarm LO_LO
C072	Out of Specification	TDS Alarm LO
C073	Out of Specification	TDS Alarm HI
C074	Failure	TDS Alarm HI_HI
C090	User-defined	USP Limit
C091	User-defined	Reduced USP Limit
C110	User-defined	CIP Counter
C111	User-defined	SIP Counter
C113	User-defined	Sensor Operating Time
C120	Failure	Wrong Sensor (Sensor Verification)
C121	Failure	Sensor Error (Factory/Characteristic Data)
C122	Maintenance Required	Sensor Memory Error (Cal Data)
C123	Maintenance Required	New Sensor, Adjustment Required
C124	Maintenance Required	Sensor Date
C130	Info	SIP Cycle Counted
C131	Info	CIP Cycle Counted
C200	Out of Specification	Reference Temperature
C201	Out of Specification	Temperature Compensation
C202	Out of Specification	TC Adjustment Range
C203	Failure	TC Adjustment Range (Failure)
C204	Info	Cal: Sensor Unstable
C205	Info	Cal: Sensor Failure
C254	Info	Module Reset

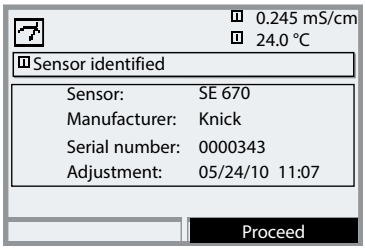
No.	Message Type	Calculation Block COND / COND Messages
E021	Failure	Resistivity Diff Alarm LO_LO
E022	Out of Specification	Resistivity Diff Alarm LO
E023	Out of Specification	Resistivity Diff Alarm HI
E024	Failure	Resistivity Diff Alarm HI_HI
E030	Failure	RATIO Range
E031	Failure	RATIO Alarm LO_LO
E032	Out of Specification	RATIO Alarm LO
E033	Out of Specification	RATIO Alarm HI
E034	Failure	RATIO Alarm HI_HI
E035	Failure	PASSAGE Range
E036	Failure	PASSAGE Alarm LO_LO
E037	Out of Specification	PASSAGE Alarm LO
E038	Out of Specification	PASSAGE Alarm Hi
E039	Failure	PASSAGE Alarm HI_HI
E045	Failure	REJECTION Range
E046	Failure	REJECTION Alarm LO_LO
E047	Out of Specification	REJECTION Alarm LO
E048	Out of Specification	REJECTION Alarm Hi
E049	Failure	REJECTION Alarm HI_HI
E050	Failure	DEVIATION Range
E051	Failure	DEVIATION Alarm LO_LO
E052	Out of Specification	DEVIATION Alarm LO
E053	Out of Specification	DEVIATION Alarm Hi
E054	Failure	DEVIATION Alarm HI_HI
E055	Failure	c(NaOH) Range
E060	Failure	pH Value Range
E061	Failure	pH Value Alarm LO_LO
E062	Out of Specification	pH Value Alarm LO
E063	Out of Specification	pH Value Alarm HI
E064	Failure	pH Value Alarm HI_HI
E200	Maintenance Required	Calculation Block Configuration

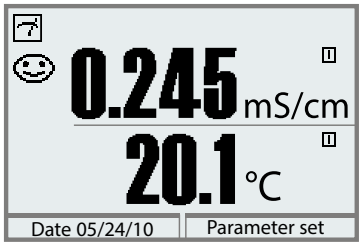
CONDI Parameter Setting

Selecting the mode and process variable (inductive conductivity).
Note: Function check (HOLD) mode active

Menu	Display	Action
		**Select mode and process variable.** Select: Parameter setting MS 3400-160/MS 4400-160 Module Protos II 4400(X): Variable: Conductivity (Ind.) Operating mode: Memosens / SE670/SE680K Functionality: CondI Protos 3400(X): Operating mode: Other digital sensors/ Memosens Variable: CONDI

The connected digital toroidal sensor is displayed immediately:

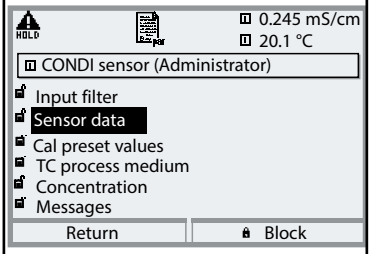
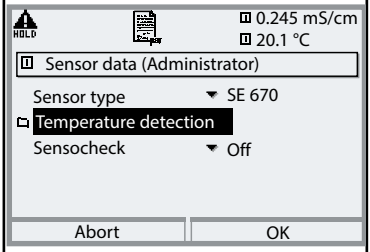
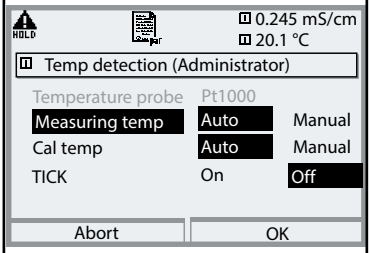




All sensor-typical parameters are automatically sent to the analyzer.
Without any further parameter setting, measurement starts at once, the measuring temperature is simultaneously detected (see also: TICK procedure, next page).

Note: The display may vary depending on the device version.

Note: Function check (HOLD) mode active

Menu	Display	Action
	  	**Sensor data** Memosens sensors and the SE 670 digital sensor automatically provide the required parameters. **Sensocheck** monitors the cell factor for deviation. **Sensoface** provides information on the sensor condition. In measuring mode a smiley face is displayed ☺ (friendly, neutral, sad) depending on the sensor data. To display the "Sensoface" icon, you must activate it in the Sensor Data menu. **Temperature detection:** **TICK Procedure (SE 670)** 1) Conductivity measurement is very temperature-dependent The temperature detector, however, is very slow. Therefore, it would take quite some time to achieve correct values. The patented TICK procedure allows considerably faster measurement by precalculating the temperature.

Note: The display may vary depending on the device version.

1) With Protos 3400(X)

CONDI Parameter Setting

Parameter	Default	Selection / Range
Input Filter		
Noise Suppression	Off	On, Off
Sensor Data		
Sensoface	On	On, Off
Sensor Monitoring Details • Cell Factor • Sensocheck • CIP Counter • SIP Counter • Sensor Operating Time	Auto	09900 ... 3.9600 /cm
Temperature detection (SE 670 only)	Meas. and cal temperature: Auto, TICK = Off	
Protos II 4400(X): Cal Presettings		
Calibration Mode	Automatic	Automatic, Manual, Product, Data Entry, Temperature
Automatic: Cal Solution	NaCl saturated	NaCl 0.01 m: 1183 µS/cm NaCl 0.1 m: 10.683 mS/cm NaCl Sat: 251.3 mS/cm KCl 0.01 m: 1413 µS/cm KCl 0.1 m: 12.88 mS/cm KCl 1m: 111.80 mS/cm
Product: Conductivity Concentration[1)]	Conductivity Without TC NaCl (0...26 %)	Conductivity, Concentration[1)] Without TC, with TC Medium, see next page.
Protos 3400(X): Cal preset values		
Calibration solution	NaCl Sat	NaCl 0.01 m: 1183 µS/cm NaCl 0.1 m: 10.683 mS/cm NaCl Sat: 251.3 mS/cm KCl 0.01 m: 1413 µS/cm KCl 0.1 m: 12.88 mS/cm KCl 1m: 111.80 mS/cm
Product calibration	Without TC	Without TC, with TC

Note: The menus may vary depending on the device version.

1) with add-on function FW4400-009

CONDI Parameter Setting

Note: Function check (HOLD) active

Parameter	Default	Selection / Range
TC Process Medium		
Temperature Comp.	Off	Off, Linear, EN27888, Ultrapure Water [1] Ultrapure Water: Impurity: NaOH, NaCl, HCl, NH_3
Concentration		
Concentration [2]	Off	On, Off Medium: NaCl (0-28 %), HCl (0-18 %), NaOH (0-24 %), H_2SO_4 (0-37 %), HNO_3 (0-30 %), H_2SO_4 (89-99 %), HCl (22-39 %), HNO_3 (35-96 %), H_2SO_4 (28-88 %), NaOH (15-50 %), Oleum $H_2SO_4 \cdot SO_3$ (12-45 %) Table
Messages		
Messages	Temperature: Max. Device Limits	Conductivity, Resistivity, Concentration, Temperature, Salinity. Monitoring is adjustable: Off, Max. Device Limits, Variable Limits

Note: The menus may vary depending on the device version.

1) With add-on function SW3400-008/FW4400-008
2) With add-on function SW3400-009/FW4400-009

Concentration Table (CONDI)

Select menu: Parameter setting > System control > Concentration table
Specifying a concentration solution for conductivity measurement

Concentration Table [1)]
To specify the customer-specific solution, 5 concentration values A-E are entered in a matrix together with 5 temperature values 1-5. To do so, first enter the 5 temperature values, then enter the respective conductivity values for each concentration A-E.
These solutions will then be available in addition to the permanently stored standard solutions (select "Table").

Menu	Display	Action
par	HOLD 0.245 mS/cm 25.6 °C System control (Administrator) Calculation Blocks Point of measurement Release of options Logbook Concentration table Factory setting Return	**Entering values** • Open parameter setting • System control • Select "Concentration table"
	HOLD 0.245 mS/cm 25.6 °C Concentration table (Administrator) Temperature 1 +000.0 °C Temperature 2 +005.0 °C Temperature 3 +010.0 °C Temperature 4 +015.0 °C Temperature 5 +020.0 °C Abort OK	Enter 5 temperature values (right/left arrow keys to select position, up/down arrow keys to edit number, press **enter** to confirm).
	HOLD 0.245 mS/cm 25.6 °C Concentration table (Administrator) Concentration A: 05.00 % by wt 1. Cond at +000.0 °C 0.000 µS/cm 2. Cond at +005.0 °C 0.000 µS/cm 3. Cond at +010.0 °C 0.000 µS/cm 4. Cond at +015.0 °C 0.000 µS/cm 5. Cond at +020.0 °C 0.000 µS/cm Abort OK	Enter values for concentrations A-E for the respective temperatures. The table values must be continuous. Maxima/minima are not permitted. Incorrect entries are marked with ✕.

The concentration table is selected as follows:
Parameter setting > CONDI sensor > Concentration = ON / Medium = Table.

Note: The display may vary depending on the device version.

1) With add-on function SW3400-009/FW4400-009

CONDI Calibration / Adjustment

Note: Function check (HOLD) mode active for the currently calibrated module
Current outputs and relay contacts behave as configured

Note: With Memosens sensors, the calibration data are stored in the sensor.
This allows using precalibrated sensors.
When the Protos is used for precalibrating sensors in the lab,
you can use the calibration routines described below.

- **Calibration:** Detecting deviations without readjustment
- **Adjustment:** Detecting deviations with readjustment

NOTICE!
Without adjustment every conductivity meter delivers an imprecise or wrong output value! Every conductivity sensor has its individual cell factor. To determine the correct conductivity value, the conductivity meter must be adjusted to the sensor. From the sensor signal and the cell factor, the analyzer calculates the conductivity value to be displayed.

Procedure
Every inductive conductivity sensor has its individual cell factor.
Depending on the sensor design, the cell factor may vary. As the conductivity is calculated from the measured conductance and the cell factor, this must be known to the measuring system. For calibration or sensor standardization, either the known (stamped on) cell factor of the conductivity sensor used is entered in the measuring system or it is determined automatically by measuring a calibration solution with a known conductivity. The data are stored in a calibration record. By "Adjustment" the determined calibration data can be used for correction (see following page).

- Use fresh calibration solutions only!
- The calibration solution used must have been selected during parameter setting.
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature. Using the measured or entered temperature, the Protos determines the nominal value for the calibration solution from a stored table.
- Observe response time of temperature probe!
- For exact determination of the cell factor, wait until the temperature probe and calibration solution have the same temperature.

Adjustment
means that the cell factor determined by a calibration is taken over.
It is entered in the calibration record. (Cal record can be called in the Diagnostics menu for the CONDI sensor.) The value is only effective for calculating the measured variables when the calibration has been terminated with an adjustment.
A passcode ensures that an adjustment can only be performed by an authorized person (Administrator).
The Operator can check the current sensor data by a calibration and inform the Administrator when there are deviations.
You can use the add-on function SW3400-107 1) for granting access rights (passcodes) and for AuditTrail (continuous data recording and backup according to FDA 21 CFR Part 11).

Menu	Display	Action
cal	HOLD 0.249 mS/cm 25.6°C Calibration data record Calibration 03/31/10 12:30 Cal mode Automatic Cal temp 25.6°C Conductivity 0.249 mS/cm Cell factor 27450 /cm End Adjust	**Administrator** With the corresponding access rights, the device can immediately be adjusted after calibration. The calibration values are taken over for calculating the measured variables.
	HOLD 0.249 mS/cm 25.6°C CONDI sensor Stored calibration data record Calibration 05/31/10 12:30 Start new calibration View/adjust calibration data record Return	**Operator** (without administrator rights) After calibration, change to measuring mode. Inform Administrator. When opening the menu (Calibration, respective module), the Administrator sees all data of the last calibration and can take over the values or perform a new calibration.

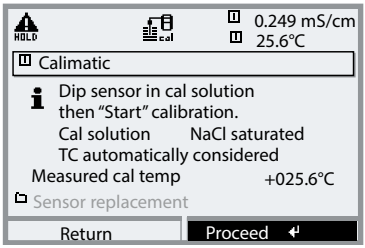
Note: The display may vary depending on the device version.

1) With Protos 3400(X)

Temperature compensation during calibration/adjustment

The conductivity value of the calibration solution is temperature-dependent. For calibration, the calibration solution temperature must therefore be known in order to choose the actual value from the conductivity table.

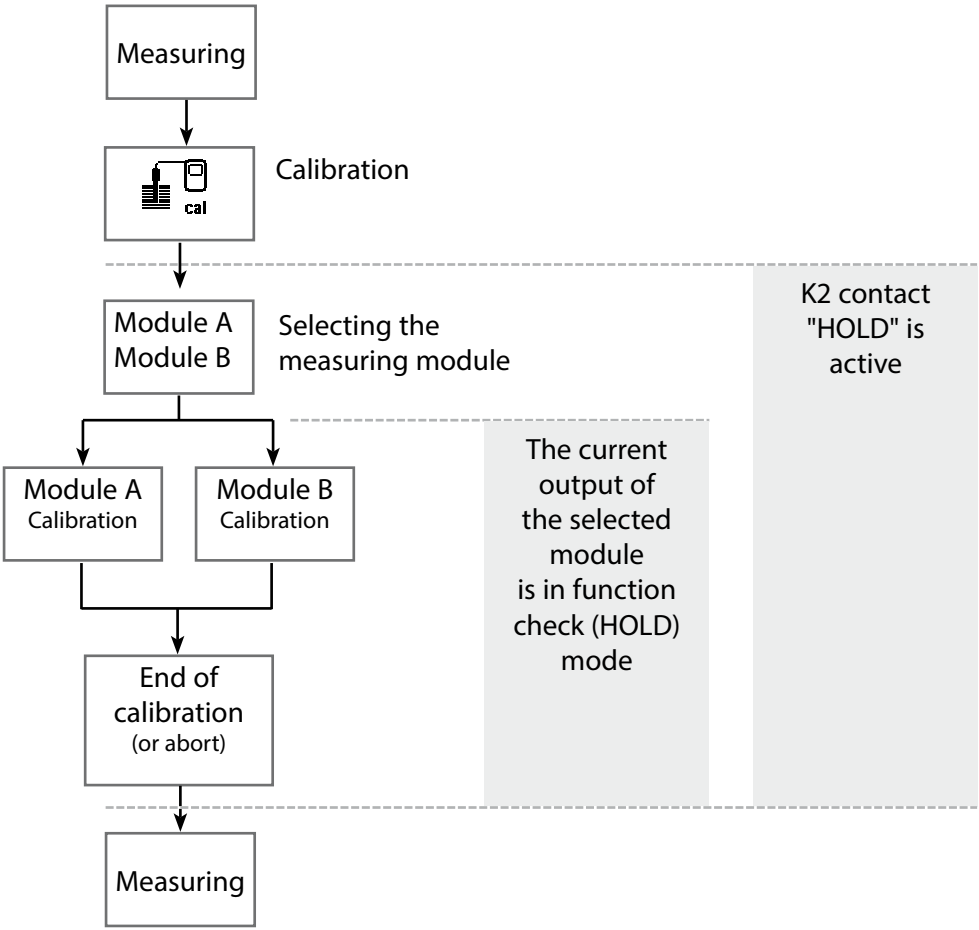
Automatic temperature compensation

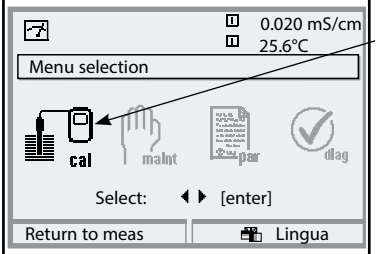
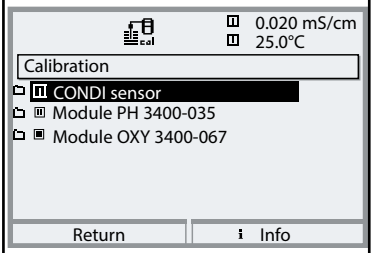
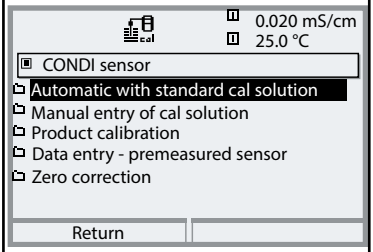


For automatic cal temp detection, the Protos measures the temperature of the calibration solution using the temperature detector integrated in the sensor.

HOLD Function During Calibration/Adjustment

Behavior of the signal and relay outputs during calibration/adjustment



Menu	Display	Action
	  	**Open Calibration** Press **menu** key to select menu. Select calibration using arrow keys, press **enter** to confirm, passcode 1147 (The passcode can be edited by the administrator.) Calibration: Select "CONDI sensor" or "Memosens sensor", resp. Select calibration method: • Automatic with standard cal solution • Manual entry of cal solution • Product calibration • Data entry - premeasured sensor • Zero correction • Temp probe adjustment (with Protos II 4400(X)) When you access calibration, the analyzer automatically proposes the previous calibration method. If you do not want to calibrate, "Return" with the left softkey. **During calibration the module is in function check (HOLD) mode.** Current outputs and relay contacts of the module behave as configured (Module BASE).

Note: The display may vary depending on the device version.

CONDI Calibration / Adjustment

Automatic calibration with standard calibration solution

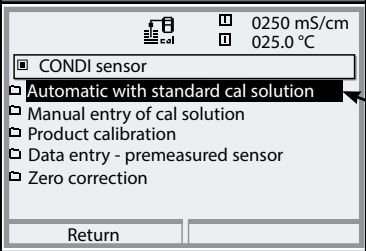
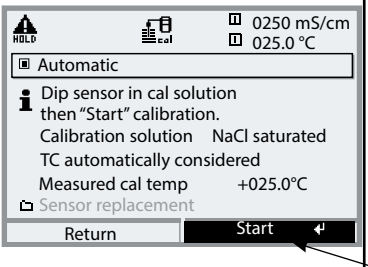
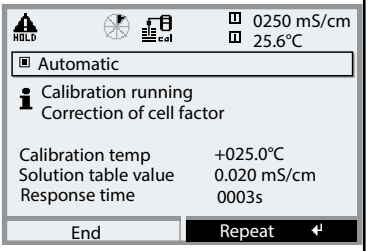
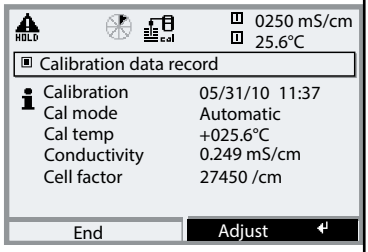
Automatic with standard cal solution
For automatic calibration, the conductivity sensor is immersed in a standard calibration solution (NaCl or KCl, selected during parameter setting: From the measured conductance and temperature, the Protos automatically calculates the cell factor. The temperature dependence of the calibration solution is taken into account.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
- Use fresh calibration solutions only! The calibration solution used must have been selected during parameter setting.
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature. Using the measured or entered temperature, the Protos determines the nominal value for the calibration solution from a stored table.
- Observe response time of temperature probe!
- For exact determination of the cell factor, wait until the temperature probe and calibration solution have the same temperature.

Be sure to observe during calibration:
- If the measured conductance or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
- If an error message appears, you have to repeat calibration.

Adjustment: Taking over the values determined by calibration
- When the values determined by calibration are correct, they must be taken over to adjust the analyzer.

Menu	Display	Action
cal		Select calibration menu Select "CONDI sensor" Select calibration method: "Automatic with standard cal solution", confirm by pressing **enter**. The module is in function check (HOLD) mode.
		Display of selected calibration solution. Enter process temperature, if manual temperature adjustment has been selected. Dip sensor in calibration solution. Start calibration by pressing softkey or **enter**.
		Calibration is running. The display shows: • Calibration temperature • Solution table value (conductivity versus cal temperature) • Response time
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables.

Note: The display may vary depending on the device version.

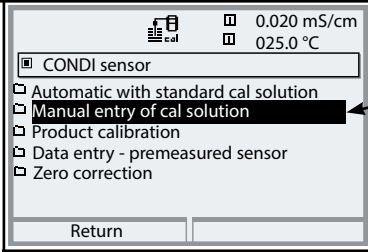
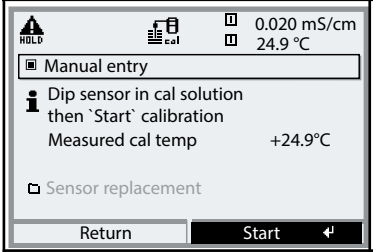
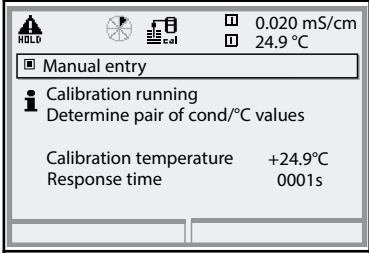
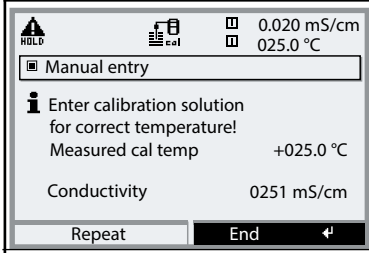
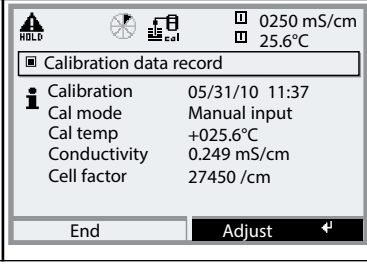
Manual entry of cal solution
For calibration with manual entry of the calibration solution's conductivity, the sensor is immersed in a calibration solution. Protos determines a conductivity/ calibration temperature value pair. Then, the temperature-corrected conductivity value of the solution must be entered. To do this, read off the conductivity for the temperature displayed from the TC table of the calibration solution. Intermediate conductivity values must be interpolated. Protos automatically calculates the cell factor.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

NOTICE!
- Use fresh calibration solutions only!
- Calibration accuracy decisively depends on the exact detection of the calibration solution's temperature.
- Observe response time of temperature probe!
- For exact determination of the cell factor, wait until the temperature probe and calibration solution have the same temperature.

Be sure to observe during calibration:
- If the measured conductance or the measured temperature fluctuate greatly, the calibration procedure is aborted after 2 min.
- If an error message appears, you have to repeat calibration.

Adjustment: Taking over the values determined by calibration
- When the values determined by calibration are correct, they must be taken over to adjust the analyzer.

Menu	Display	Action
cal		Select calibration menu Select CONDI sensor Select calibration method: "Manual entry of cal solution", confirm by pressing **enter**. The module is in function check (HOLD) mode.
		Enter process temperature, if manual temperature adjustment has been selected. Immerse sensor in cal solution. Start calibration by pressing softkey or **enter**.
		Calibration is running. The display shows: • Calibration temperature • Response time
		Enter conductivity. End calibration by pressing the "End" softkey.
		**Adjustment** Press "Adjust" to take over the values determined during calibration for calculating the measured variables.

Note: The display may vary depending on the device version.

Product calibration
When the sensor cannot be removed, e.g. for sterility reasons (in biotechnical processes), its cell factor can be determined with “sampling”.
To do so, the currently measured process value (conductivity or concentration [1)]) is saved by the Protos.
Immediately afterwards, you take a sample from the process. The sample value should be measured at process conditions (same temperature!). The determined value is entered in the measuring system. From the difference between process value and sample value, the Protos calculates the cell factor of the conductivity sensor.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

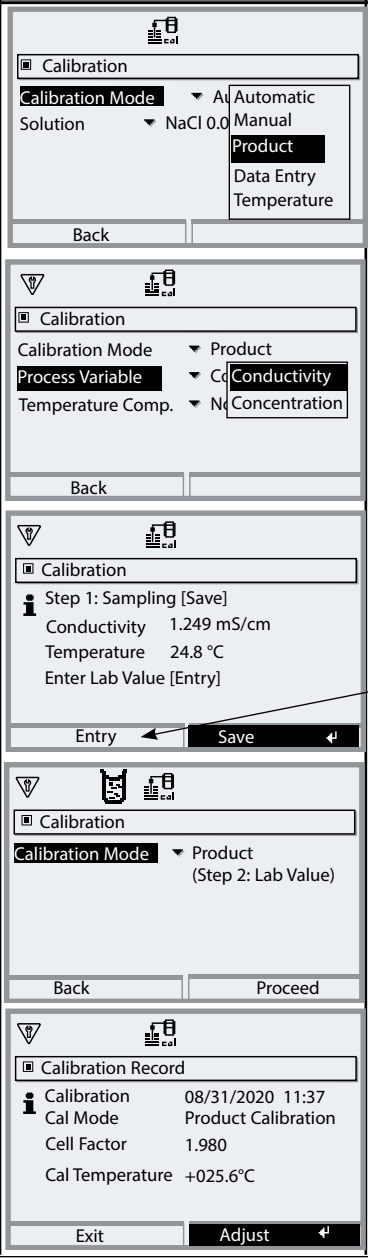
Product calibration without TC correction (for conductivity)
Take a sample from the process. Measure its value at the temperature at which the sample has been taken ("Sample temp", see display). To do so, it may be necessary to thermostat the sample correspondingly in the lab. Temperature compensation must be turned off at the comparison meters (TC = 0 %/K).

Product calibration with TC correction Tref = 25 °C/77 °F (for conductivity)
Take a sample from the process. When measuring in the lab (TC linear), be sure that the same values are set for reference temperature and temperature coefficient in the comparison meter and in the Protos. Furthermore, the measuring temperature should correspond to the sample temperature (see display). Transport the sample in an insulated container (Dewar).

NOTICE!
Product calibration can only be performed if the process medium is stable. That means, for example, that there are no chemical reactions which have an effect on the process conductivity. At higher temperatures, the sample values can also be invalidated due to evaporation.

1) With Protos II 4400(X) and add-on function FW4400-009

Note: The display may vary depending on the device version.

Menu	Display	Action
cal		Select calibration. Select COND module. Select Calibration Mode > Product and press **enter** to confirm. Select Process Variable > Conductivity or Concentration[1)]. Conductivity: calibration with/without temperature compensation Concentration: Select the medium. **Step 1** Take sample. Store measured value and temperature at the moment of sampling ("Save" softkey or **enter**). The analyzer automatically returns to calibration mode selection. Press **meas** to return to measurement. **Exception:** Sample value can be determined and entered on site: Left softkey: "Entry" **Step 2** Lab value has been measured. Open the calibration menu again. Right softkey: "Entry" Enter reference value ("Lab value"). Confirm with "OK" or repeat calibration. **Adjustment** Press "Adjust" softkey to take over the values determined during calibration for calculating the measured variables.

1) with Protos II 4400(X) and add-on function FW4400-009

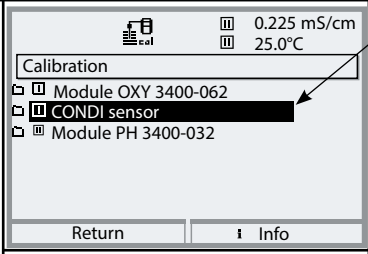
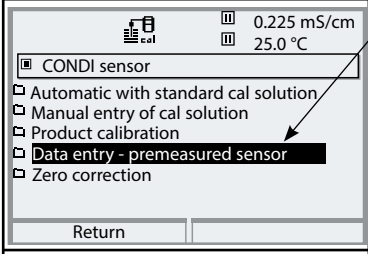
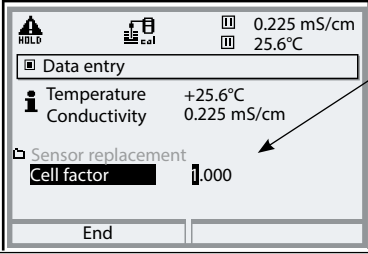
CONDI Calibration / Adjustment

Data entry of premeasured sensors

Data entry of premeasured sensors
Entry of cell fator and zero point of a sensor, related to 25 °C / 77 °F, 1013 mbar /14.69 psi.

During calibration the module is in function check (HOLD) mode.
Current outputs and relay contacts of the module behave as configured (Module BASE).

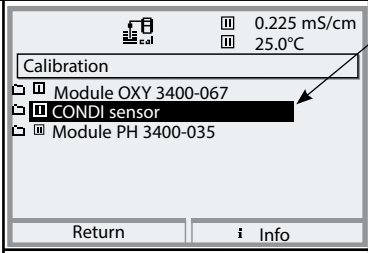
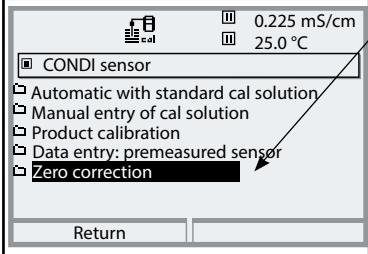
If **concentration measurement** is activated , this menu also shows the concentration value and directly adjusts it depending on the cell factor. This allows direct calibration of the concentration value.

Menu	Display	Action
cal		**Select: CONDI sensor** During calibration, the output currents (1 and 2), limit contacts, and controller output are in function check (HOLD) mode. Press **enter** to confirm.
		Select "Data entry" calibration method. Press **enter** to confirm.
		The module is in function check (HOLD) mode. Enter cell factor of premeasured sensor Confirm by pressing "OK" or repeat calibration.

Note: The display may vary depending on the device version.

Zero Correction (CONDI)

Note: The display may vary depending on the device version.

Menu	Display	Action
		**Select: CONDI sensor** During calibration, the output currents (1 and 2), limit contacts, and controller output are in function check (HOLD) mode. Press **enter** to confirm.
		Select "Zero correction" calibration method. Press **enter** to confirm. The module is in function check (HOLD) mode. Permissible zero point deviation depends on the sensor type. For the SE 670, it is ± 0.050 mS/cm. Press **Adjust** to take over the calibration data.

Temp Probe Adjustment

Note: With Protos II 4400(X) in the Calibration menu,
with Protos 3400(X) in the Maintenance menu.

This function allows compensating for the individual temperature probe tolerance and the influence of the lead resistances to increase the accuracy of temperature measurement. Make sure that the process temperature is precisely measured using a calibrated reference thermometer when performing an adjustment. The measurement error of the reference thermometer should be less than 0.1 °C. Adjustment without precise measurement might result in considerable deviations of the measured value display!

With Protos II 4400(X), the data from the last adjustment and the temperature offset can be called from the Diagnostics menu, see p. 147.

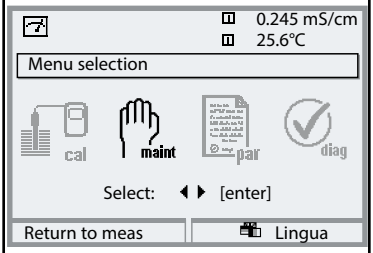
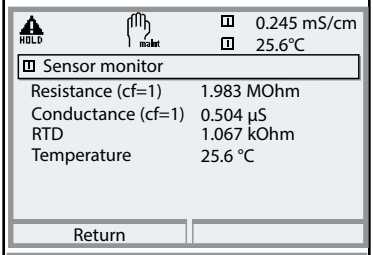
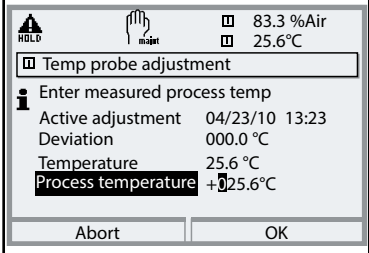
Calibrating the Sensors

Since the cell constant is subject to production-related variances, the dismounted sensor should be calibrated with a calibration solution (e.g. NaCl saturated).

- When mounted in restricted space (minimum distances not kept), the sensor must be calibrated when mounted since the resulting cell factor has changed. Calibration method: "Product calibration"

CONDI Maintenance

Sensor monitor / Temp probe adjustment
Note: Function check (HOLD) mode active

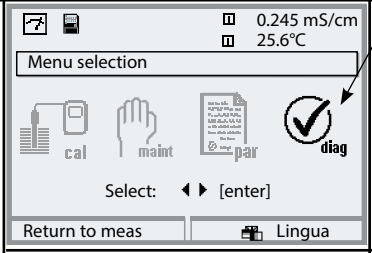
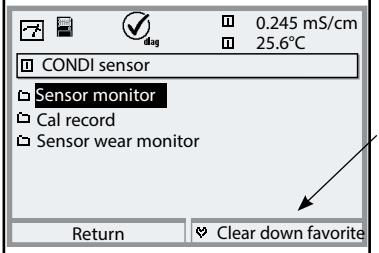
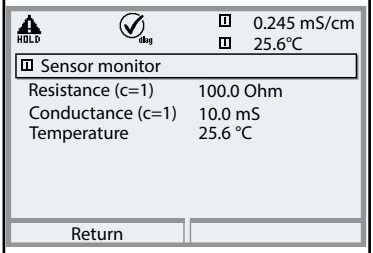
Menu	Display	Action
maint		From the measuring mode: Press **menu** key to select menu. Select maintenance using arrow keys, confirm by pressing **enter**. Passcode 2958 (To change passcode: Parameter setting > System control > Passcode entry) Then select "CONDI sensor".
		**Sensor monitor** During maintenance, the sensor monitor allows validation of the sensor by immersing it in a known solution, for example, and checking the values measured.
		**Temp probe adjustment** [1)] Make sure that the process temperature is precisely measured using a calibrated reference thermometer (accuracy better than 0.1°C) when performing an adjustment. Adjustment without precise measurement might result in considerable deviations of the measured value display!

Note: The display may vary depending on the device version.

1) With Protos II 4400(X) in the Calibration menu

CONDI Diagnostics

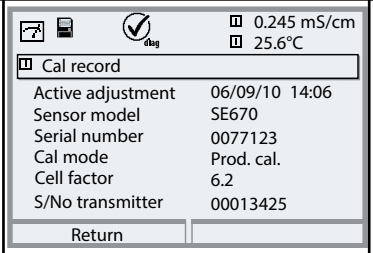
Menu selection: Diagnostics > Module MS ... > CONDI sensor

Menu	Display	Action
diag		**Opening the diagnostics menu** From the measuring mode: Press **menu** key to select menu. Select diagnostics using arrow keys, confirm by pressing **enter**. Then select CONDI sensor.
		The Diagnostics menu gives an overview of all diagnostics functions available. Messages set as "Favorite" can be called directly from the measuring mode using a softkey. Select: Parameter setting > System control > Function control matrix.
		**Sensor monitor** Shows the values currently measured by the sensor. Important function for diagnostics and validation!

Note: The display may vary depending on the device version.

CONDI Diagnostics

Menu selection: Diagnostics > Module MS ... > CONDI sensor

Menu	Display	Action
diag		**Calibration/Adjustment Record** Data of last calibration/adjustment (S/No transmitter only displayed for Memosens) **Temp. Offset Log** Shows the data from the last temperature adjustment performed on the currently connected sensor.[1)]

Note: The display may vary depending on the device version.

1) With Protos II 4400(X)

CONDI Messages

CONDI Messages with Protos 3400(X)

No.	CONDI messages	Message type
T008	Meas. processing (factory settings)	FAIL
T009	Module failure (Firmware Flash check sum)	FAIL
T010	Conductivity range	FAIL / WARN
T011	Conductivity Alarm LO_LO	FAIL
T012	Conductivity Alarm LO	WARN
T013	Conductivity Alarm HI	WARN
T014	Conductivity Alarm HI_HI	FAIL
T015	Temperature range	FAIL
T016	Temperature Alarm LO_LO	FAIL
T017	Temperature Alarm LO	WARN
T018	Temperature Alarm HI	WARN
T019	Temperature Alarm HI_HI	FAIL
T020	Resistivity range	FAIL / WARN
T021	Resistivity Alarm LO_LO	FAIL
T022	Resistivity Alarm LO	WARN
T023	Resistivity Alarm HI	WARN
T024	Resistivity Alarm HI_HI	FAIL
T025	Concentration range	FAIL / WARN
T026	Concentration Alarm LO_LO	FAIL
T027	Concentration Alarm LO	WARN
T028	Concentration Alarm HI	WARN
T029	Concentration Alarm HI_HI	FAIL
T030	Zero range	WARN
T035	Cell factor range	WARN
T040	Salinity range	FAIL / WARN
T041	Salinity Alarm LO_LO	FAIL
T042	Salinity Alarm LO	WARN
T043	Salinity Alarm HI	WARN

No.	CONDI messages	Message type
T044	Salinity Alarm HI_HI	FAIL
T045	Conductance range	FAIL
T050	Man. temperature range	FAIL
T060	SAD SENSOFACE: Primary coil	User-defined
T061	SAD SENSOFACE: Secondary coil	User-defined
T062	SAD SENSOFACE: SensoLoop	User-defined
T130	SIP cycle counted	Text
T131	CIP cycle counted	Text
T200	Reference temperature	WARN
T201	TC correction	WARN
T202	TC range	WARN
T203	TC range	FAIL
T204	Sensor coding	WARN
T205	Cal: Sensor unstable	Text
T254	Module reset	Text

CONDI Messages with Protos II 4400(X)

⊗ Failure ⚠ Out of Specification ◈ Maintenance Required

No.	Message Type	CONDI Messages
T008	Failure	Meas. Processing (Factory Settings)
T009	Failure	Firmware Error
T010	User-defined	Conductivity Range
T011	Failure	Conductivity Alarm LO_LO
T012	Out of Specification	Conductivity Alarm LO
T013	Out of Specification	Conductivity Alarm HI
T014	Failure	Conductivity Alarm LO_LO
T015	Failure	Temperature Range
T016	Failure	Temperature Alarm LO_LO
T017	Out of Specification	Temperature Alarm LO
T018	Out of Specification	Temperature Alarm HI
T019	Failure	Temperature Alarm HI_HI
T020	User-defined	Resistivity Range
T021	Failure	Resistivity Alarm LO_LO
T022	Out of Specification	Resistivity Alarm LO
T023	Out of Specification	Resistivity Alarm HI
T024	Failure	Resistivity Alarm HI_HI
T025	User-defined	Concentration Range
T026	Failure	Concentration Alarm LO_LO
T027	Out of Specification	Concentration Alarm LO
T028	Out of Specification	Concentration Alarm HI
T029	Failure	Concentration Alarm LO_LO
T040	Failure	Salinity Range
T041	Failure	Salinity Alarm LO_LO
T042	Out of Specification	Salinity Alarm LO
T043	Out of Specification	Salinity Alarm HI
T044	Failure	Salinity Alarm HI_HI
T045	Failure	Conductance Range
T060	User-defined	Sad Sensoface: Primary Coil
T061	User-defined	Sad Sensoface: Secondary Coil
T063	Maintenance Required	Sad Sensoface: Zero Point
T064	Failure/Maintenance Required	Cell Factor

No.	Message Type	CONDI Messages
T070	Failure	TDS Range
T071	Failure	TDS Alarm LO_LO
T072	Out of Specification	TDS Alarm LO
T073	Out of Specification	TDS Alarm HI
T074	Failure	TDS Alarm HI_HI
T110	Maintenance Required	CIP Counter
T111	Maintenance Required	SIP Counter
T113	Maintenance Required	Sensor Operating Time
T120	Failure	Wrong Sensor (Sensor Verification)
T121	Failure	Sensor Error (Factory/Characteristic Data)
T122	Maintenance Required	Sensor Memory Error (Cal Data)
T123	Maintenance Required	New Sensor, Adjustment Required
T124	Maintenance Required	Sensor Date
T130	Info	SIP Cycle Counted
T131	Info	CIP Cycle Counted
T200	Out of Specification	Reference Temperature
T201	Out of Specification	Temperature Compensation
T202	Out of Specification	TC Range
T203	Failure	TC Range (Failure)
T204	Maintenance Required	Sensor Coding
T205	Info	Cal: Sensor Unstable
T254	Info	Module Reset

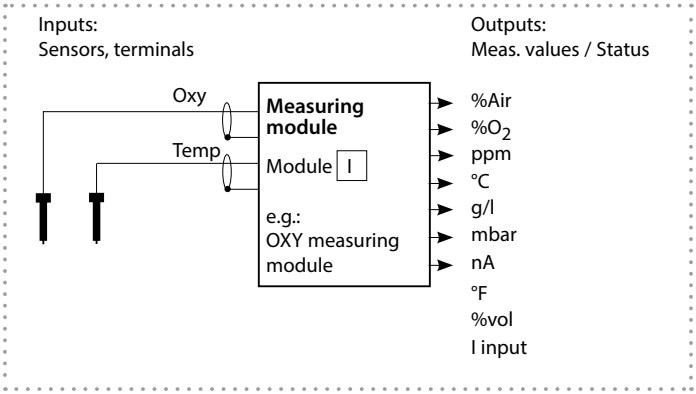
Calculation Blocks

Select menu: Parameter setting > System control > Calculation Blocks
Calculation of new variables from measured variables

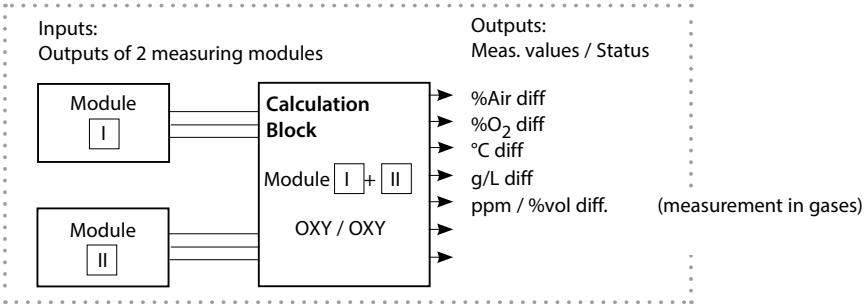
Calculation Blocks

Two measuring modules with all their measured values serve as input for the calculation block. In addition, the general device status (NAMUR signals) is taken into account. The difference between the existing values is calculated: These output variables are then available in the system and can be assigned to the outputs (current, limit values, display ...)

Functionality of measuring module



Functionality of Calculation Block



Calculation Blocks

Select menu: Parameter setting > System control > Calculation Blocks

Combining measuring modules
With three measuring modules the following Calculation Block combinations are possible: [I] + [II], [I] + [III], [II] + [III]

Up to two Calculation Blocks can be activated.
All current outputs can be set to output the new process variables formed by the Calculation Blocks.
All new process variables can be displayed as primary or as secondary value.
Controller functions are not supported.

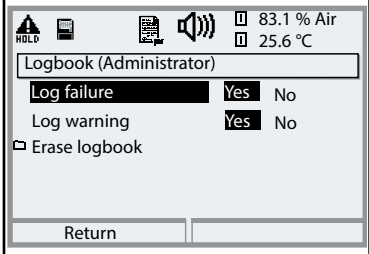
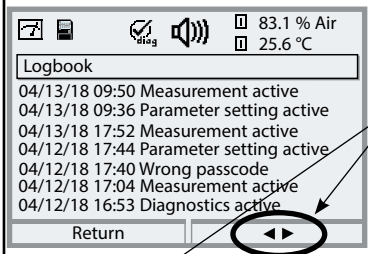
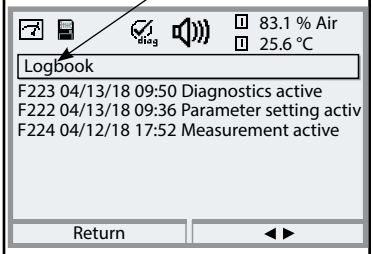
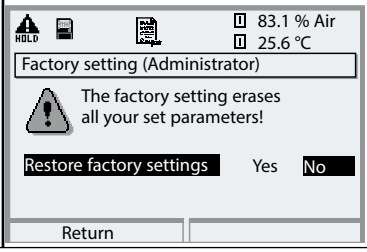
Menu	Display	Action
par	HOLD 83.1 % Air 19.2°C System control (Administrator) Calculation Blocks Point of measurement Release of options Logbook Buffer table Concentration table Return	**Calculation Blocks** • Open parameter setting • System control • Select "Calculation Blocks"
	HOLD 83.1 % Air 19.2°C Calculation Blocks (Administrator) Block 1 Off Block 2 Calc OXY/OXY Return	Depending on the modules installed, the possible combinations for Calculation Blocks are offered.
	HOLD 83.1 % Air 19.2°C Parameter setting (Administrator) System control Module FRONT 3400-011 Module BASE 3400-021 Module MS 3400-160 Module MS 3400-160 Calc OXY/OXY Return	During parameter setting the Calculation Blocks are displayed like modules.

Note: The display may vary depending on the device version.

Parameter Setting, General

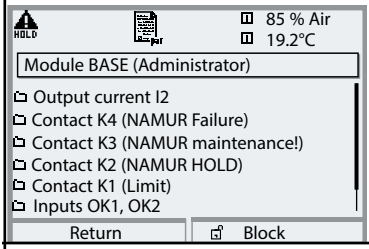
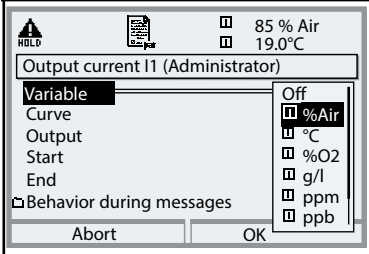
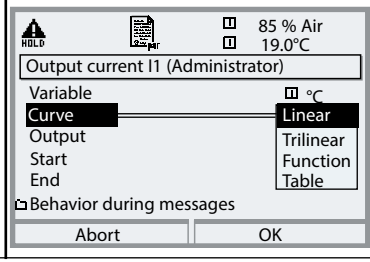
Parameter setting > System control
Note: Function check (HOLD) mode active

Note: The display may vary depending on the device version.

Menu	Display	Action
par		**Logbook** Select which messages are to be recorded in the logbook. The logbook directly displays the last events with date and time (Protos 3400(X): 50, Protos II 4400(X): 100 events).
		The logbook entries can be called from the Diagnostics menu (Fig.). Pressing the right softkey displays the message identifier. SW3400-104: Extended logbook / FW4400-104: Logbook With SmartMedia Card and Protos 3400(X) or Data Card and Protos II 4400(X), max. 50,000 entries (Protos 3400(X)) or min. 20,000 entries (Protos II 4400(X)) can be saved on a memory card.
		
		**Restore Factory Settings** Allows resetting the parameters to their factory setting.

Current Outputs

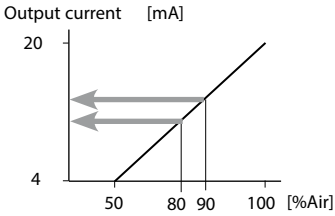
Select menu: Parameter setting > BASE module
Note: Function check (HOLD) mode

Menu	Display	Action
par		**Configuring a Current Output** • Open parameter setting • Enter passcode • Select BASE module • Select "Output current ..."
		• Select process variable Gas measurement in %/ppm: (liquids: ppm/ppb) You can set Start and End of current output to different variables because also the measured value switches automatically. The decimal point can be moved using the arrow keys.
		• Select Curve, e.g. "linear": The process variable is represented by a linear output current curve. The desired range of the measured variable is specified by the values for "Start" and "End".

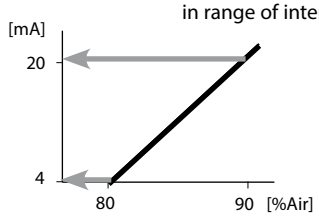
Note: The display may vary depending on the device version.

Assignment of measured values: Start (4 mA) and end (20 mA)

Example 1: Range %Air 50 ... 100



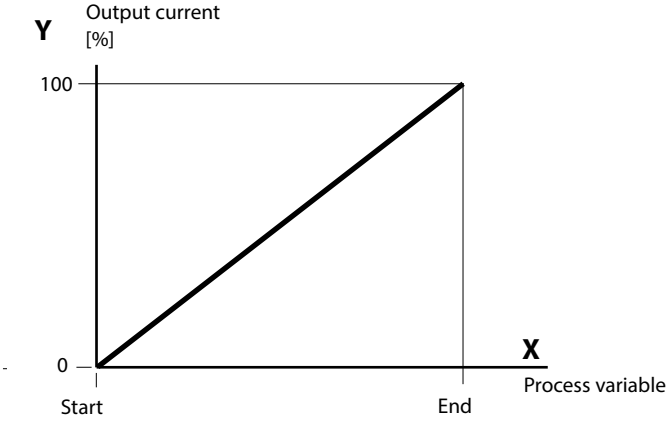
Example 2: Range %Air 80 ... 90
Advantage: Higher resolution in range of interest



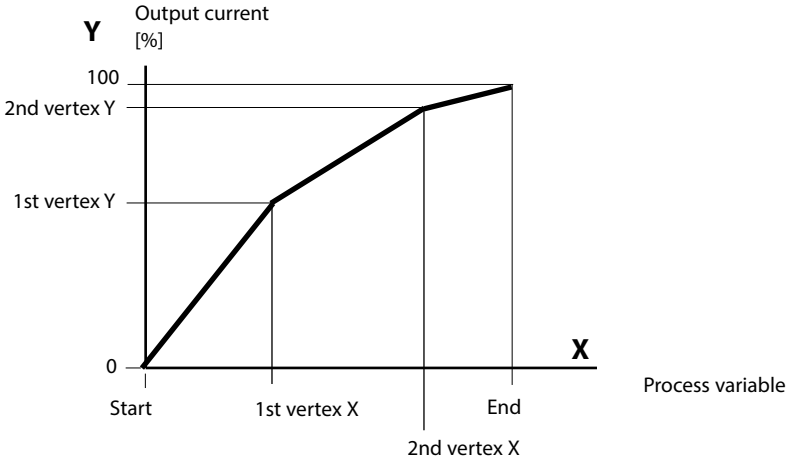
Current Outputs: Characteristics

Menu selection: Parameter setting > BASE module
Note: Function check (HOLD) mode active

- **Linear characteristic**
  The process variable is represented by a linear output current curve.



- **Trilinear characteristic**
  Two additional vertices must be entered:

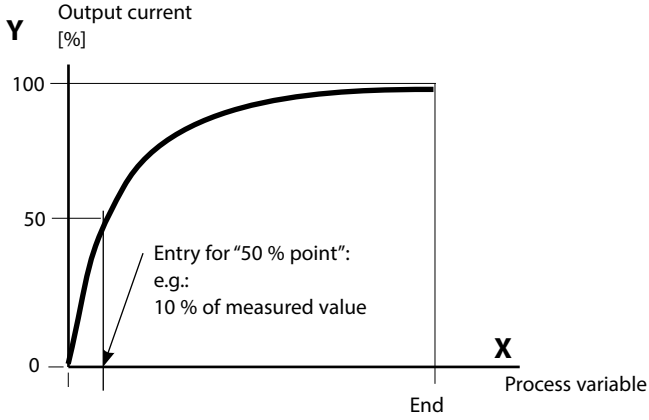


- **Note: Bilinear characteristic**
  For a bilinear characteristic, identical parameters are entered for the two vertices (1st vertex, 2nd vertex).

- **Function characteristic**

  Nonlinear output current characteristic: allows measurements over several decades, e.g. measuring very low values with a high resolution and high values with a low resolution.

  Required: Entering a value for 50 % output current.



Equation

$$\text{Output current (4 to 20 mA)} = \frac{(1+K)x}{1+Kx} \cdot 16\ \text{mA} + 4\ \text{mA}$$

$$K = \frac{E + S - 2 * X50\%}{X50\% - S} \qquad x = \frac{M - S}{E - S}$$

S: Start value at 4 mA
X50%: 50% value at 12 mA (output current range 4 to 20 mA)
E: End value at 20 mA
M: Measured value

Logarithmic output curve over one decade:
S: 10 % of maximum value
X50%: 31.6 % of maximum value
E: Maximum value

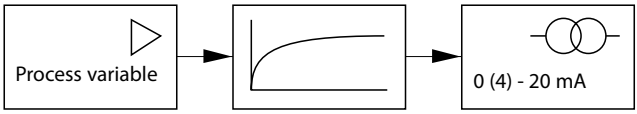
Logarithmic output curve over two decades:
S: 1 % of maximum value
X50%: 10 % of maximum value
E: Maximum value

Current Outputs: Output Filter

Parameter setting > BASE module > Output current I... > Output filter
Note: Function check (HOLD) mode active

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

Note:
The filter only acts on the current output and the current value of the secondary display, not on the measurement display, the limit values or the controller!



Time interval 0 ... 120 sec

Note:
For further BASE module settings (behavior during messages, contacts, optocoupler inputs) refer to the user manual of the basic device.

Specifications

Memosens	Interface for Memosens
Power supply	U_0 = 3.05 … 3.15 V/R_i < 5 Ω / I ≥ 6 mA
Ex (MS 3400X-160/ MS 4400X-160)	Ex ia IIC T4; U_{max} = 5,1 V / I_{max} = 130 mA / P_{max} = 166 mW
Interface	RS-485
Transfer rate	9,600 Bd
Max. cable length	100 m

I input	Current input 0/4 ... 20 mA / 100 ohms e.g., for external pressure signal with OXY
Start/end of scale	Can be configured within range
Characteristic curve	Linear
Measurement error	< 1% of current value + 0.1 mA (± 1 count, plus sensor error)

General Data

RoHS conformity	According to EU directive 2011/65/EU
EMC	EN 61326-1, EN 61326-2-3, NAMUR NE 21
Emitted interference	Industrial applications[1)] (EN 55011 Group 1 Class A)
Interference immunity	Industrial applications
Lightning protection	to EN 61000-4-5, Installation class 2
Rated operating conditions (module installed)	
Ambient temperature	Safe area: -20 ... 55 °C / -4 ... 131 °F Ex: -20 ... 50 °C / -4 ... 122 °F
Relative humidity	5 ... 95 %
Climatic class	3K5 according to EN 60721-3-3
Location class	C1 according to EN 60654-1
Transport/storage temperature	-20 ... 70 °C / -4 ... 158 °F
Screw clamp connectors	Single or stranded wires 0.2 ... 2.5 mm^2 Tightening torque 0.5 ... 0.6 Nm
Wiring	Stripping length max. 7 mm Temperature resistance > 75 °C / 167 °F
Power supply (KBUS)	6.8 … 8.0 V / 20 mA

1) This equipment is not designed for domestic use, and is unable to guarantee adequate protection of the radio reception in such environments.

Buffer Tables

Buffer table "Mettler-Toledo"

°C	pH			
0	2,03	4,01	7,12	9,52
5	2,02	4,01	7,09	9,45
10	2,01	4,00	7,06	9,38
15	2,00	4,00	7,04	9,32
20	2,00	4,00	7,02	9,26
25	**2,00**	**4,01**	**7,00**	**9,21**
30	1,99	4,01	6,99	9,16
35	1,99	4,02	6,98	9,11
40	1,98	4,03	6,97	9,06
45	1,98	4,04	6,97	9,03
50	1,98	4,06	6,97	8,99
55	1,98	4,08	6,98	8,96
60	1,98	4,10	6,98	8,93
65	1,99	4,13	6,99	8,90
70	1,99	4,16	7,00	8,88
75	2,00	4,19	7,02	8,85
80	2,00	4,22	7,04	8,83
85	2,00	4,26	7,06	8,81
90	2,00	4,30	7,09	8,79
95	2,00	4,35	7,12	8,77

Buffer Tables

Buffer table "Knick CaliMat"

°C	pH				
Order No.	CS-P0200A/...	CS-P0400A/...	CS-P0700A/...	CS-P0900A/...	CS-P1200A/...
0	2.01	4.05	7.09	9.24	12.58
5	2.01	4.04	7.07	9.16	12.39
10	2.01	4.02	7.04	9.11	12.26
15	2.00	4.01	7.02	9.05	12.13
20	**2.00**	**4.00**	**7.00**	**9.00**	**12.00**
25	2.00	4.01	6.99	8.95	11.87
30	2.00	4.01	6.98	8.91	11.75
35	2.00	4.01	6.96	8.88	11.64
40	2.00	4.01	6.96	8.85	11.53
50	2.00	4.01	6.96	8.79	11.31
60	2.00	4.00	6.96	8,73	11.09
70	2.00	4.00	6.96	8,70	10.88
80	2.00	4.00	6.98	8,66	10.68
90	2.00	4.00	7.00	8,64	10.48

Buffer Tables

Buffer table "DIN 19267"

°C	pH				
0	1,08	4,67	6,89	9,48	13,95*
5	1,08	4,67	6,87	9,43	13,63*
10	1,09	4,66	6,84	9,37	13,37
15	1,09	4,66	6,82	9,32	13,16
20	1,09	4,65	6,80	3,27	12,96
25	**1,09**	**4,65**	**6,79**	**9,23**	**12,75**
30	1,10	4,65	6,78	9,18	12,61
35	1,10	4,65	6,77	9,13	12,45
40	1,10	4,66	6,76	9,09	12,29
45	1,10	4,67	6,76	9,04	12,09
50	1,11	4,68	6,76	9,00	11,98
55	1,11	4,69	6,76	8,96	11,79
60	1,11	4,70	6,76	8,92	11,69
65	1,11	4,71	6,76	8,90	11,56
70	1,11	4,72	6,76	8,88	11,43
75	1,11	4,73	6,77	8,86	11,31
80	1,12	4,75	6,78	8,85	11,19
85	1,12	4,77	6,79	8,83	11,09
90	1,13	4,79	6,80	8,82	10,99
95	1,13*	4,82*	6,81*	8,81*	10,89*

* extrapoliert / extrapolated / extrapolée

Buffer Tables

Buffer table "NIST standard" (DIN 19266: 2000-01)

°C	pH			
0				
5	1.668	4.004	6.950	9.392
10	1.670	4.001	6.922	9.331
15	1.672	4.001	6.900	9.277
20	1.676	4.003	6.880	9.228
25	**1.680**	**4.008**	**6.865**	**9.184**
30	1,685	4.015	6.853	9.144
37	1,694	4.028	6.841	9.095
40	1.697	4.036	6.837	9.076
45	1.704	4.049	6.834	9.046
50	1.712	4.064	6.833	9.018
55	1.715	4.075	6.834	9.985
60	1.723	4.091	6.836	8.962
70	1.743	4.126	6.845	8.921
80	1.766	4.164	6.859	8.885
90	1.792	4.205	6.877	8.850
95	1.806	4.227	6.886	8.833

Notice:
The pH(S) values of the individual charges of the secondary reference materials are documented in a certificate of an accredited laboratory. This certificate is supplied with the respective buffer materials. Only these pH(S) values shall be used as standard values for the secondary reference buffer materials. Correspondingly, this standard does not include a table with standard pH values for practical use. The table above ony provides examples of pH(PS) values for orientation.

Buffer Tables

Buffer table "Techn. buffers to NIST"

°C	pH		
0	4.00	7.14	10.30
5	4.00	7.10	10.23
10	4.00	7.04	10.11
15	4.00	7.04	10.11
20	4.00	7.02	10.05
25	4.01	7.00	10.00
30	4.01	6.99	9.96
35	4.02	6.98	9.92
40	4.03	6.98	9.88
45	4.05	6.98	9.85
50	4.06	6.98	9.82
55	4.07	6.98	9.79
60	4.09	6.99	9.76
65	4.09 *	6.99 *	9.76 *
70	4.09 *	6.99 *	9.76 *
75	4.09 *	6.99 *	9.76 *
80	4.09 *	6.99 *	9.76 *
85	4.09 *	6.99 *	9.76 *
90	4.09 *	6.99 *	9.76 *
95	4.09 *	6.99 *	9.76 *

* Values complemented

Buffer Tables

Buffer table "Hamilton"

°C	pH				
0	1,99	4,01	7,12	10,19	12,46
5	1,99	4,01	7,09	10,19	12,46
10	2,00	4,00	7,06	10,15	12,34
15	2,00	4,00	7,04	10,11	12,23
20	2,00	4,00	7,02	10,06	12,11
25	**2,00**	**4,01**	**7,00**	**10,01**	**12,00**
30	1,99	4,01	6,99	9,97	11,90
35	1,98	4,02	6,98	9,92	11,80
40	1,98	4,03	6,97	9,86	11,70
45	1,97	4,04	6,97	9,83	11,60
50	1,97	4,06	6,97	9,79	11,51
55	1,97	4,08	6,98	9,77	11,51
60	1,97	4,10	6,98	9,75	11,51
65	1,97	4,13	6,99	9,74	11,51
70	1,97	4,16	7,00	9,73	11,51
75	1,97	4,19	7,02	9,73	11,51
80	1,97	4,22	7,04	9,73	11,51
85	1,97	4,26	7,06	9,74	11,51
90	1,97	4,30	7,09	9,75	11,51
95	1,97	4,35	7,09	9,75	11,51

Buffer Tables

Buffer table "Kraft"

°C	pH				
0	2.01	4.05	7.13	9.24	11.47*
5	2.01	4.04	7.07	9.16	11.47
10	2.01	4.02	7.05	9.11	11.31
15	2.00	4.01	7.02	9.05	11.15
20	**2.00**	**4.00**	**7.00**	**9.00**	**11.00**
25	2.00	4.01	6.98	8.95	10.85
30	2.00	4.01	6.98	8.91	10.71
35	2.00	4.01	6.96	8.88	10.57
40	2.00	4.01	6.95	8.85	10.44
45	2.00	4.01	6.95	8.82	10.31
50	2.00	4.00	6.95	8.79	10.18
55	2.00	4.00	6.95	8.76	10.18*
60	2.00	4.00	6.96	8.73	10.18*
65	2.00	4.00	6.96	8.72	10.18*
70	2.01	4.00	6.96	8.70	10.18*
75	2.01	4.00	6.96	8.68	10.18*
80	2.01	4.00	6.97	8.66	10.18*
85	2.01	4.00	6.98	8.65	10.18*
90	2.01	4.00	7.00	8.64	10.18*
95	2.01	4.00	7.02	8.64	10.18*

* Values complemented

Buffer Tables

Buffer table "Hamilton A"

°C	pH				
0	1.99	4.01	7.12	9.31	11.42
5	1.99	4.01	7.09	9.24	11.33
10	2.00	4.00	7.06	9.17	11.25
15	2.00	4.00	7.04	9.11	11.16
20	2.00	4.00	7.02	9.05	11.07
25	**2.00**	**4.01**	**7.00**	**9.00**	**11.00**
30	1.99	4.01	6.99	8.95	10.93
35	1.98	4.02	6.98	8.90	10.86
40	1.98	4.03	6.97	8.85	10.80
45	1.97	4.04	6.97	8.82	10.73
50	1.97	4.05	6.97	8.78	10.67
55	1.98	4.06	6.98	8.75	10.61
60	1.98	4.08	6.98	8.72	10.55
65	1.98	4.10	6.99	8.70	10.49
70	1.99	4.12	7.00	8.67	10.43
75	1.99	4.14	7.02	8.64	10.38
80	2.00	4.16	7.04	8.62	10.33
85	2.00	4.18	7.06	8.60	10.28
90	2.00	4.21	7.09	8.58	10.23
95	2.00	4.24	7.12	8.56	10.18

Buffer Tables

Buffer table "Hamilton B"

°C	pH				
0	1.99	4.01	6.03	9.31	11.42
5	1.99	4.01	6.02	9.24	11.33
10	2.00	4.00	6.01	9.17	11.25
15	2.00	4.00	6.00	9.11	11.16
20	2.00	4.00	6.00	9.05	11.07
25	**2.00**	**4.01**	**6.00**	**9.00**	**11.00**
30	1.99	4.01	6.00	8.95	10.93
35	1.98	4.02	6.00	8.90	10.86
40	1.98	4.03	6.01	8.85	10.80
45	1.97	4.04	6.02	8.82	10.73
50	1.97	4.05	6.04	8.78	10.67
55	1.98	4.06	6.06	8.75	10.61
60	1.98	4.08	6.09	8.72	10.55
65	1.98	4.10	6.11	8.70	10.49
70	1.99	4.12	6.13	8.67	10.43
75	1.99	4.14	6.15	8.64	10.38
80	2.00	4.16	6.18	8.62	10.33
85	2.00	4.18	6.21	8.60	10.28
90	2.00	4.21	6.24	8.58	10.23
95	2.00	4.24	6.27	8.56	10.18

Buffer Tables

Buffer table "HACH"

T [°C]	pH		
0	4,00	7,118	10,30
5	4,00	7,087	10,23
10	4,00	7,059	10,17
15	4,00	7,036	10,11
20	4,00	7,016	10,05
25	**4,01**	**7,000**	**10,00**
30	4,01	6,987	9,96
35	4,02	6,977	9,92
40	4,03	6,970	9,88
45	4,05	6,965	9,85
50	4,06	6,964	9,82
55	4,07	6,965	9,79
60	4,09	6,968	9,76
65	4,10	6,980	9,71
70	4,12	7,000	9,66
75	4,14	7,020	9,63
80	4,16	7,040	9,59
85	4,18	7,060	9,56
90	4,21	7,090	9,52
95	4,24	7,120	9,48

Buffer Tables

Buffer table "Ciba"

°C	pH			
0	2,04	4,00	7,10	10,30
5	2,09	4,02	7,08	10,21
10	2,07	4,00	7,05	10,14
15	2,08	4,00	7,02	10,06
20	2,09	4,01	6,98	9,99
25	2,08	4,02	6,98	9,95
30	2,06	4,00	6,96	9,89
35	2,06	4,01	6,95	9,85
40	2,07	4,02	6,94	9,81
45	2,06	4,03	6,93	9,77
50	2,06	4,04	6,93	9,73
55	2,05	4,05	6,91	9,68
60	2,08	4,10	6,93	9,66
65	2,07*	4,10*	6,92*	9,61*
70	2,07	4,11	6,92	9,57
75	2,04*	4,13*	6,92*	9,54*
80	2,02	4,15	6,93	9,52
85	2,03*	4,17*	6,95*	9,47*
90	2,04	4,20	6,97	9,43
95	2,05*	4,22*	6,99*	9,38*

* Extrapolated

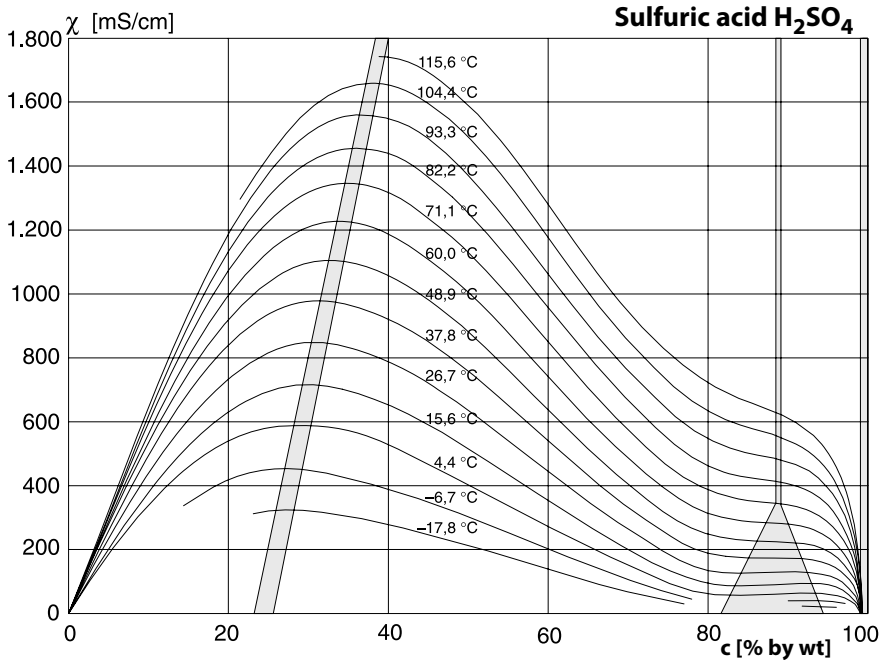
Buffer Tables

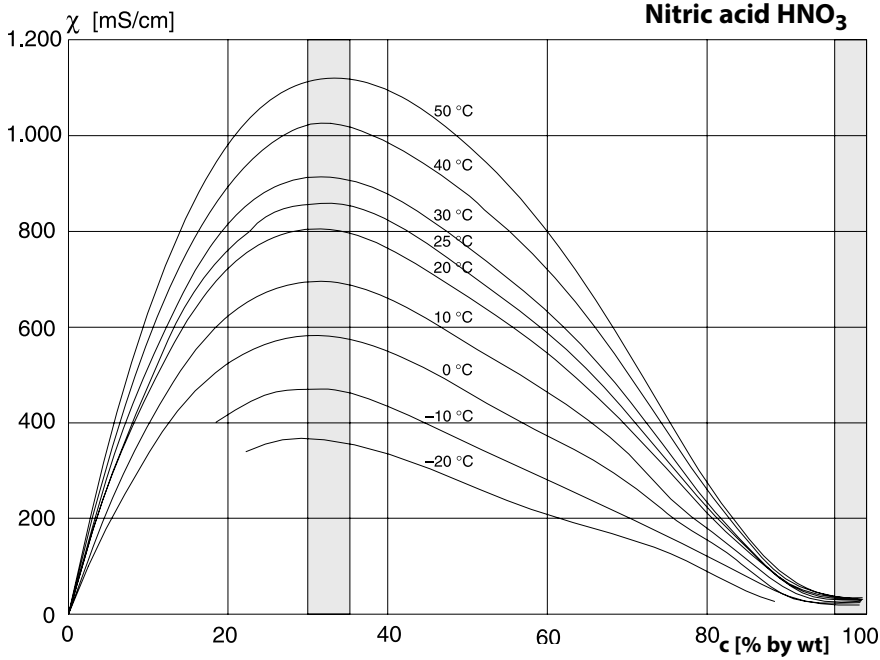
Buffer table "Reagecon"

°C	pH				
0°C	*2,01	*4,01	*7,07	*9,18	*12,54
5°C	*2,01	*4,01	*7,07	*9,18	*12,54
10°C	2,01	4,00	7,07	9,18	12,54
15°C	2,01	4,00	7,04	9,12	12,36
20°C	2,01	4,00	7,02	9,06	12,17
25°C	**2,00**	**4,00**	**7,00**	**9,00**	**12,00**
30°C	1,99	4,01	6,99	8,95	11,81
35°C	2,00	4,02	6,98	8,90	11,63
40°C	2,01	4,03	6,97	8,86	11,47
45°C	2,01	4,04	6,97	8,83	11,39
50°C	2,00	4,05	6,96	8,79	11,30
55°C	2,00	4,07	6,96	8,77	11,13
60°C	2,00	4,08	6,96	8,74	10,95
65°C	*2,00	*4,10	*6,99	*8,70	*10,95
70°C	*2,00	*4,12	*7,00	*8,67	*10,95
75°C	*2,00	*4,14	*7,02	*8,64	*10,95
80°C	*2,00	*4,16	*7,04	*8,62	*10,95
85°C	*2,00	*4,18	*7,06	*8,60	*10,95
90°C	*2,00	*4,21	*7,09	*8,58	*10,95
95°C	*2,00	*4,24	*7,12	*8,56	*10,95

* Values complemented

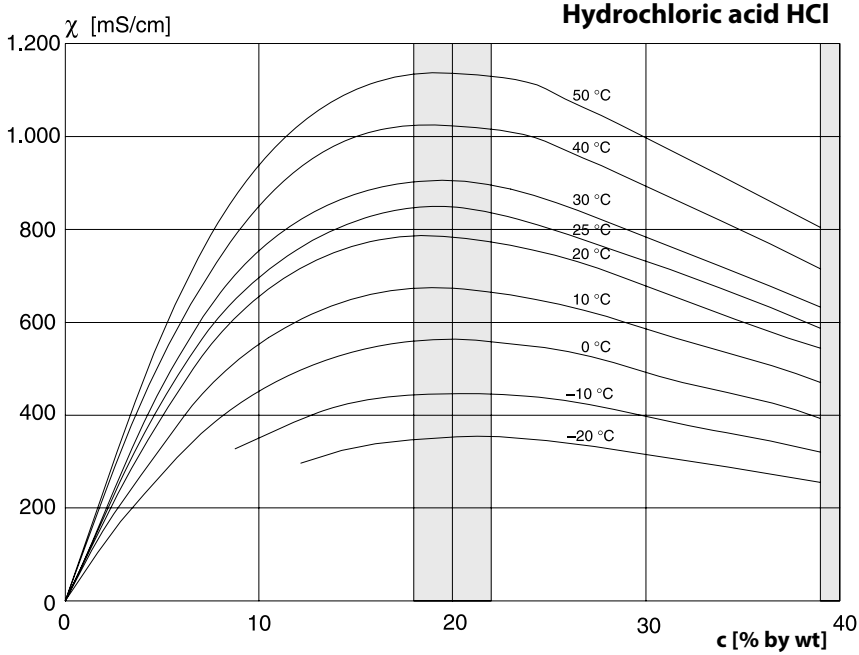
Concentration Curves (Conductivity)



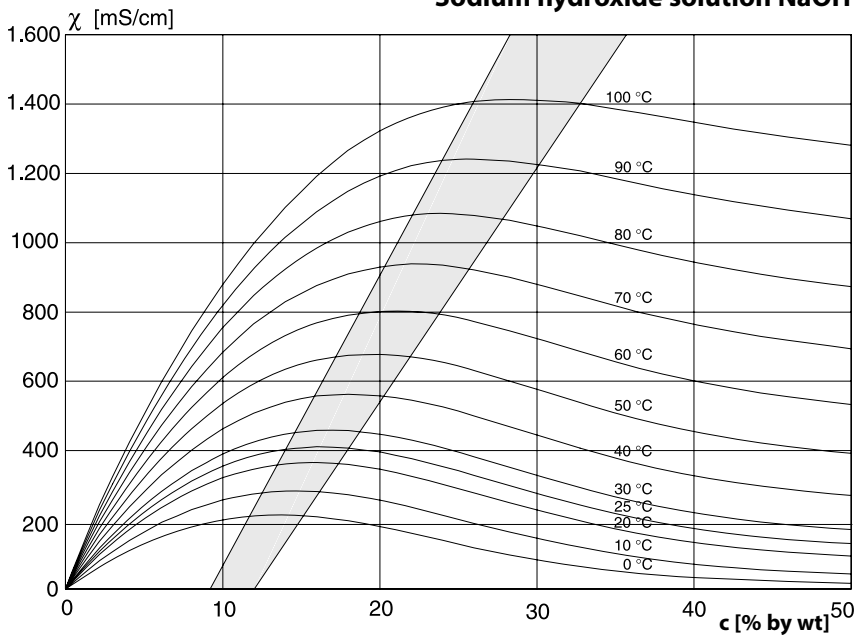


Concentration Curves (Conductivity)

Hydrochloric acid HCl

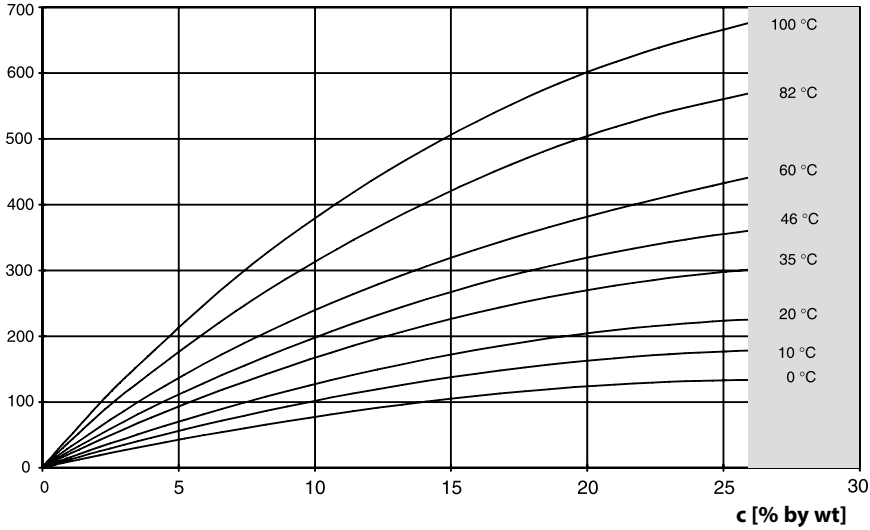


Sodium hydroxide solution NaOH

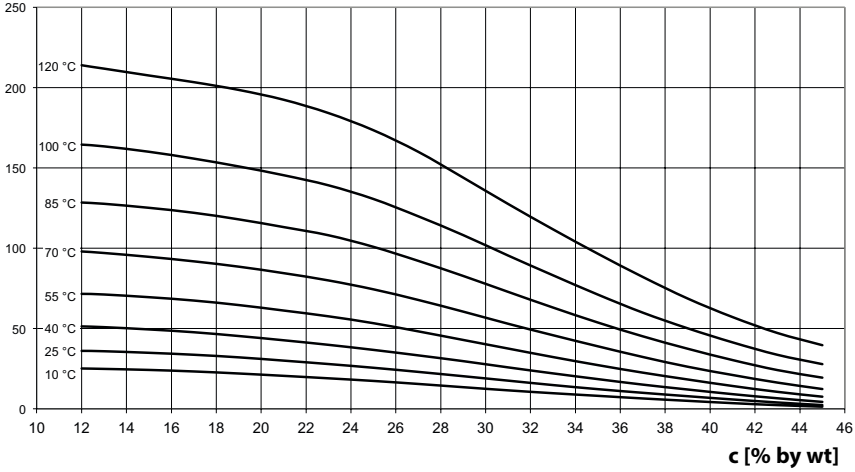


Concentration Curves (Conductivity)

Table salt solution NaCl



Oleum $H_2SO_4 \cdot SO_3$



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