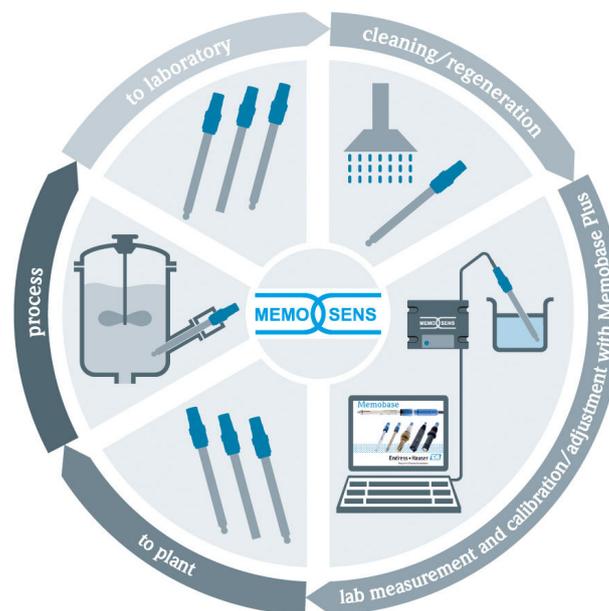


# Operating Instructions

## Memobase Plus CYZ71D

PC-based multichannel liquid analysis with database



## Revision history

Date	Version	Software modifications	Documentation
04/2019	02.00.xx	<p>Expansion</p> <ul style="list-style-type: none"> <li>▪ Implementation of sensor COS81D</li> <li>▪ Microsoft SQL Server (instead of PostgreSQL)</li> <li>▪ "Restricted user" mode</li> </ul> <p>Improvement</p> <p>Revised reports for .pdf, .xml and .csv file formats</p> <ul style="list-style-type: none"> <li>▪ Chlorine sensors not supported</li> <li>▪ Windows 8 not supported</li> </ul>	BA00502C/07/..06.19
12/2017	01.06.xx	<p>Expansion</p> <p>"Administrator" user role</p>	BA00502C/07/..05.17
09/2016	01.05.xx	<p>Expansion</p> <ul style="list-style-type: none"> <li>▪ Central database installation</li> <li>▪ Operation with a central database and at least one local database (Master-Slave operation)</li> <li>▪ Data of Endress+Hauser testing equipment and samples recorded by scanning the bar code ("Advanced diagnostics" license)</li> <li>▪ Measuring range monitoring ("Advanced diagnostics" license)</li> <li>▪ Validity of sensor calibration checked on an hourly basis ("Advanced diagnostics" license)</li> <li>▪ Monitoring limits for deviation ("Advanced diagnostics" license)</li> <li>▪ Sensor-specific identification label assigned</li> </ul>	BA00502C/07/..04.16
11/2015	01.04.xx	<p>Expansion</p> <ul style="list-style-type: none"> <li>▪ Multi-point calibration (pH sensors)</li> <li>▪ Sensor condition appraised and displayed</li> <li>▪ Implementation of sensor CLS82D</li> <li>▪ .XML export of measurement and calibration data</li> <li>▪ Installation possible on Windows 10</li> </ul>	BA00502C/07/..03.14
10/2013	01.02.xx	<p>Expansion</p> <ul style="list-style-type: none"> <li>▪ Interface to connect to an Oracle database</li> <li>▪ Implementation of the CPSx6D combination electrode</li> <li>▪ Interface for data exchange with the W@M Portal</li> <li>▪ Tag name and Memoclip in the calibration report</li> <li>▪ Graphic display of all calibrations in the calibration report</li> <li>▪ Calibration result displayed in the calibration report</li> </ul> <p>Improvement</p> <ul style="list-style-type: none"> <li>▪ Easier installation on Windows XP and Windows 7</li> <li>▪ Unrestricted use of automatic logout function</li> <li>▪ Enhanced database structure</li> </ul> <p>Update of connected network clients required</p>	BA00502C/07/..02.13
01/2013	01.01.01	Original software	BA00502C/07/..01.12

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# 1 About this document

## 1.1 Warnings

Structure of information	Meaning
 <p><b>Causes (/consequences)</b> If necessary, Consequences of non-compliance (if applicable) ▶ Corrective action</p>	<p>This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation <b>will</b> result in a fatal or serious injury.</p>
 <p><b>Causes (/consequences)</b> If necessary, Consequences of non-compliance (if applicable) ▶ Corrective action</p>	<p>This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation <b>can</b> result in a fatal or serious injury.</p>
 <p><b>Causes (/consequences)</b> If necessary, Consequences of non-compliance (if applicable) ▶ Corrective action</p>	<p>This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or more serious injuries.</p>
 <p><b>Cause/situation</b> If necessary, Consequences of non-compliance (if applicable) ▶ Action/note</p>	<p>This symbol alerts you to situations which may result in damage to property.</p>

## 1.2 Symbols used

Symbol	Meaning
	Additional information, tips
	Permitted or recommended
	Not permitted or not recommended
	Reference to device documentation
	Reference to page
	Reference to graphic
	Result of a step

## 2 Basic safety instructions

### 2.1 Requirements for personnel

- Installation, commissioning, operation and maintenance of the measuring system may be carried out only by specially trained technical personnel.
- The technical personnel must be authorized by the plant operator to carry out the specified activities.
- The electrical connection may be performed only by an electrical technician.
- The technical personnel must have read and understood these Operating Instructions and must follow the instructions contained therein.
- Faults at the measuring point may only be rectified by authorized and specially trained personnel.

 Repairs not described in the Operating Instructions provided must be carried out only directly at the manufacturer's site or by the service organization.

### 2.2 Designated use

Memobase Plus is a measurement and calibration software offering central database management for sensors incorporating Memosens technology. It can be used to calibrate, adjust and manage sensors in a laboratory.

Memobase Plus is designed for use in the following applications:

- Laboratories
- Process-oriented workbench applications in non-hazardous areas

 Memobase Plus cannot be used to replace a process transmitter, as communication with the control system is not supported.

MemoLink acts as the Memosens/USB interface converter for the Memobase Plus software. MemoLink supports Memosens sensors with Ex approval and without Ex approval. Recommended areas of application are preferably laboratory applications for calibration and functional testing.

Use of the device for any purpose other than that described, poses a threat to the safety of people and of the entire measuring system and is therefore not permitted. The manufacturer is not liable for damage caused by improper or non-designated use.

### 2.3 Occupational safety

As the user, you are responsible for complying with the following safety conditions:

- Installation guidelines
- Local standards and regulations

## 2.4 Operational safety

### Before commissioning the entire measuring point:

1. Verify that all connections are correct.
2. Ensure that electrical cables and hose connections are undamaged.
3. Do not operate damaged products, and protect them against unintentional operation.
4. Label damaged products as defective.

### During operation:

- ▶ If faults cannot be rectified:  
products must be taken out of service and protected against unintentional operation.

## 2.5 Product safety

### 2.5.1 IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

## 2.6 Safety instructions for electrical equipment in hazardous areas

- The MemoLink must never be used in hazardous areas! The MemoLink is not designed as a field device for installation in industrial environments.
- The MemoLink, which is approved in accordance with EC type-examination certificate BVS 12 ATEX 079 X, ensures that the "intrinsic safety" protection type of the Memosens measuring cable and the Memosens sensor is not compromised during calibration and functional testing. The relevant EU Declaration of Conformity is an integral part of this document.
- The computer, USB cable, MemoLink, Memosens measuring cable and Memosens sensor must be located outside the hazardous area during calibration and functional testing.
- Memosens cables with Memosens sensors may be connected to the Memosens interface of the Memolink.
- The internal electronics of the Ex-approved Memosens/USB interface converter MemoLink makes it possible to connect Ex-approved and non-Ex-approved, passive Memosens measuring cables with Memosens sensors. The connection of non-Ex-approved Memosens sensors does not interfere with the intrinsic safety of Ex-approved Memosens sensors connected at a later stage.
- MemoLink may only be connected to the USB interface of a commercially available computer.

## 3 Product description

### 3.1 Software function

Memobase Plus is a software package offering central management of measurement data, calibration data and sensor data for sensors with Memosens technology.

It allows end-to-end documentation of data relevant to the sensor and measuring point, e.g.:

- Calibration history including information on the reference solutions used
- Sensor utilization data such as total operating hours, operating hours under extreme process conditions
- Assignment of a sensor to a measuring point or a group of measuring points

The MemoLink sensor terminal box only transmits data digitally so no measured data can be corrupted. The measuring signal is converted to digital data in the sensor, which means that the MemoLink sensor terminal box, cable and PC software do not affect the measured values.

#### 3.1.1 Licenses

The functional range depends on the order configuration.

The following functional packages are available:

License	Function range
Memobase Plus Basic	Measure, calibrate, document
Advanced diagnostics	Functional range of the "Memobase Plus Basic" license and also: <ul style="list-style-type: none"> <li>■ Detection and assessment of sensor condition</li> <li>■ Multipoint calibration and adjustment of pH sensors</li> <li>■ Monitoring of defined limits for measurements and adjustments</li> <li>■ Data for Endress+Hauser reference solutions and sample data transferred via barcode</li> </ul>
Pharmaceuticals compliance	Functional range of the "Memobase Plus Basic" license and also: Advanced user administration

### 3.1.2 User roles

To protect Memobase Plus against unauthorized or undesired modifications, you can allow database access only to certain users who have a database password, and assign user roles to these users.

You can use the following user roles:

	Administrator	Expert/Service	Maintenance	Operator	Restricted user
Calibrate (all parameters)		x	x	x	x
Change calibration settings		x			
Change client alias	x				
Change language of user interface	x	x	x	x	x
Change language of reports	x	x			
Configure advanced diagnostics		x			
Activate automatic data export		x			
Determine settings for data export	x				
Configure diagnostic settings		x	x	x	
Database administration	x				
Global data access	x	x	x		
Local data access	x	x	x	x	x
Manage connected sensors (including deactivation)		x	x		
Manage license information	x				
Manage non-connected sensors (including deactivation)		x			
Manage reference solutions		x	x		
Scan testing and inspection equipment using barcode <sup>1)</sup>					x

	Administrator	Expert/Service	Maintenance	Operator	Restricted user
Manage sensor templates		x			
Measure		x	x	x	x <sup>2)</sup>
Set up barcode reader		x			
Set up user interface	x	x	x		
Set up Master-Slave operation	x				
Set up connection to W@M Portal	x				
Use Master-Slave operation		x	x	x	
Set up connection to W@M Portal		x	x	x	
User administration	x				
View and export reports		x	x		
View audit trail log		x	x		
View sensor information		x	x	x	x

1) Calibration settings are locked

2) Can only measure with the parameters defined by the Expert/Service, Maintenance or Operator user roles in the menu, **MEASURE**, in the **Measurements** box

## 4 Incoming acceptance and product identification

### 4.1 Incoming acceptance

1. Verify that the packaging is undamaged.
  - ↳ Notify the supplier of any damage to the packaging.  
Keep the damaged packaging until the issue has been resolved.
2. Verify that the contents are undamaged.
  - ↳ Notify the supplier of any damage to the delivery contents.  
Keep the damaged goods until the issue has been resolved.
3. Check that the delivery is complete and nothing is missing.
  - ↳ Compare the shipping documents with your order.
4. Pack the product for storage and transportation in such a way that it is protected against impact and moisture.
  - ↳ The original packaging offers the best protection.  
Make sure to comply with the permitted ambient conditions.

If you have any questions, please contact your supplier or your local Sales Center.

### 4.2 Product identification

#### 4.2.1 MemoLink nameplate

The nameplate provides you with the following information on your device:

- Manufacturer identification
  - Order code
  - Extended order code
  - Serial number
  - Firmware version
  - Ambient and process conditions
  - Input and output values
  - Safety information and warnings
  - Ex labeling on hazardous area versions
- ▶ Compare the information on the nameplate with the order.

#### 4.2.2 Nameplate: DVD with software

The following information concerning the DVD with the software can be found on the nameplate:

- Serial number
- License key
- Software version

#### 4.2.3 Product identification

Product page

[www.endress.com/cyz71d](http://www.endress.com/cyz71d)

### Interpreting the order code

The order code and serial number of your product can be found in the following locations:

- On the nameplate
- In the delivery papers
- On the packaging

### Obtaining information on the product

1. Go to [www.endress.com](http://www.endress.com).
2. Call up the site search (magnifying glass).
3. Enter a valid serial number.
4. Search.
  - ↳ The product structure is displayed in a popup window.
5. Click on the product image in the popup window.
  - ↳ A new window (**Device Viewer**) opens. All of the information relating to your device is displayed in this window as well as the product documentation.

## 4.3 Scope of delivery

The scope of delivery comprises:

- Installation DVD with "Memobase Plus" setup, Operating Instructions and video clips
- Serial number and license key
- Quick installation guide
- Operating Instructions for MemoLink
- Depending on the version ordered:
  - License
    - 0 to 4 MemoLink sensor terminal boxes
    - 0 to 4 Memosens cable CYK20
    - 0 to 4 USB cables
- ▶ If you have any queries:  
Please contact your supplier or local sales center.

## 4.4 Certificates and approvals

### 4.4.1 CE mark

#### Declaration of conformity

The Memosens/USB interface converter meets the requirements of the harmonized European standards. As such, it complies with the legal specifications of the EC directives. The manufacturer confirms successful testing of the product by affixing to it the **CE** mark.

### 4.4.2 Ex approval

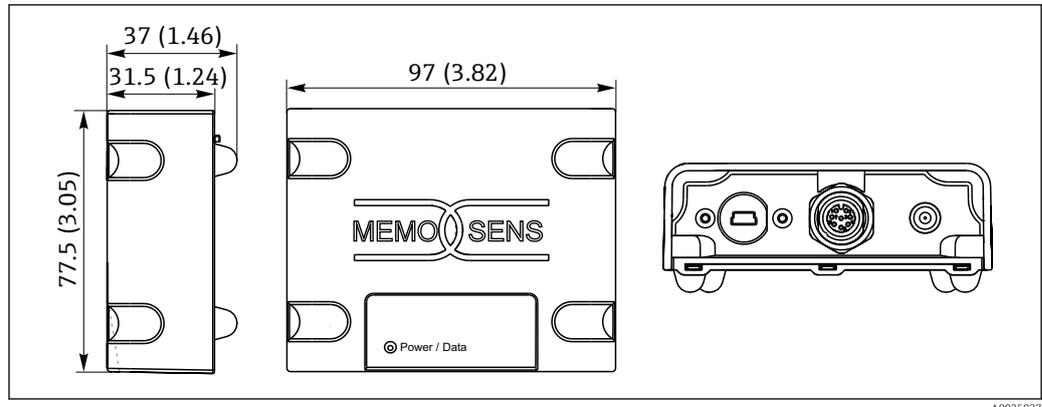
ATEX II 2G Ex ia IIC

-  The PC, USB cable and MemoLink may be used only in non-hazardous areas. Memosens cables and sensors with Ex approval may also be operated in a hazardous area, e. g. in flues.

If using cables with Ex approval in combination with sensors without Ex approval, it is possible to continue using the cables in combination with Ex-approved sensors on Memobase Plus. The sensors do not lose their Ex approval. The cables may not be used subsequently in a hazardous zone.

## 5 Installation

### 5.1 Dimensions



1 Dimensions of MemoLink in mm (in)

- i** The MemoLink sensor terminal boxes can be stacked on top of one another. In such situations, the "Power / Data" LED is still easily visible.

## 6 Electrical connection

### 6.1 Measuring system

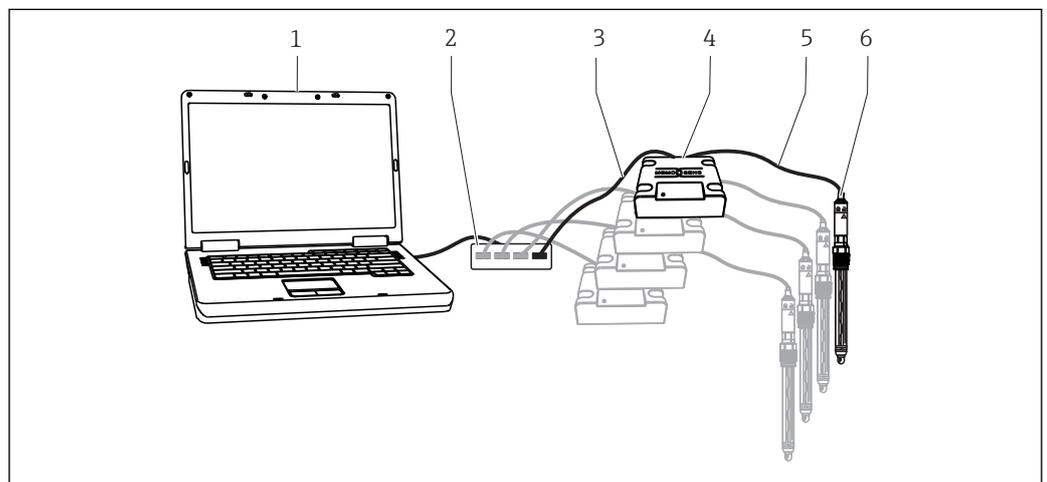
A complete measuring system consists of:

- PC or Windows-based tablet with Memobase Plus software package installed and database connected
- MemoLink sensor terminal box (connection to PC, Ex barrier)
- Thin, flexible CYK20 Memosens laboratory cable or CYK10 Memosens process cable
- USB cable to connect the MemoLink sensor terminal box and PC
- Memosens sensor

**i** A PC or Windows-based tablet is not included in the delivery.

Memosens sensors must be ordered separately. Information on this can be found at:

[www.endress.com/memosens](http://www.endress.com/memosens)



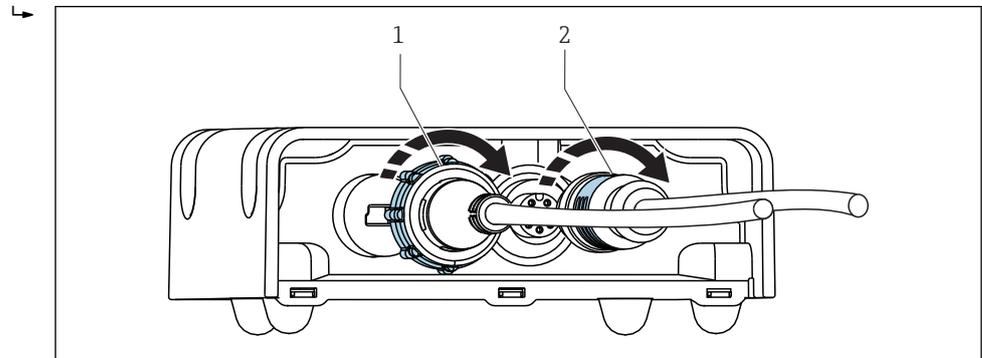
A0031652

**2** Measuring system for Memobase Plus CYZ71D

- 1 PC (not supplied)
- 2 USB hub (optional, not supplied)
- 3 1 to 4 USB cables
- 4 1 to 4 MemoLink sensor terminal boxes
- 5 1 to 4 CYK20 Memosens laboratory cables or CYK10 Memosens process cables
- 6 1 to 4 Memosens sensors

## 6.2 Connecting the cables

1. Connect the mini USB connector to the mini USB jack on the MemoLink.
2. Connect the M12 connector to the M12 jack on the MemoLink. Use the flexible Memosens laboratory cable CYK20 or the Memosens process cable CYK10.



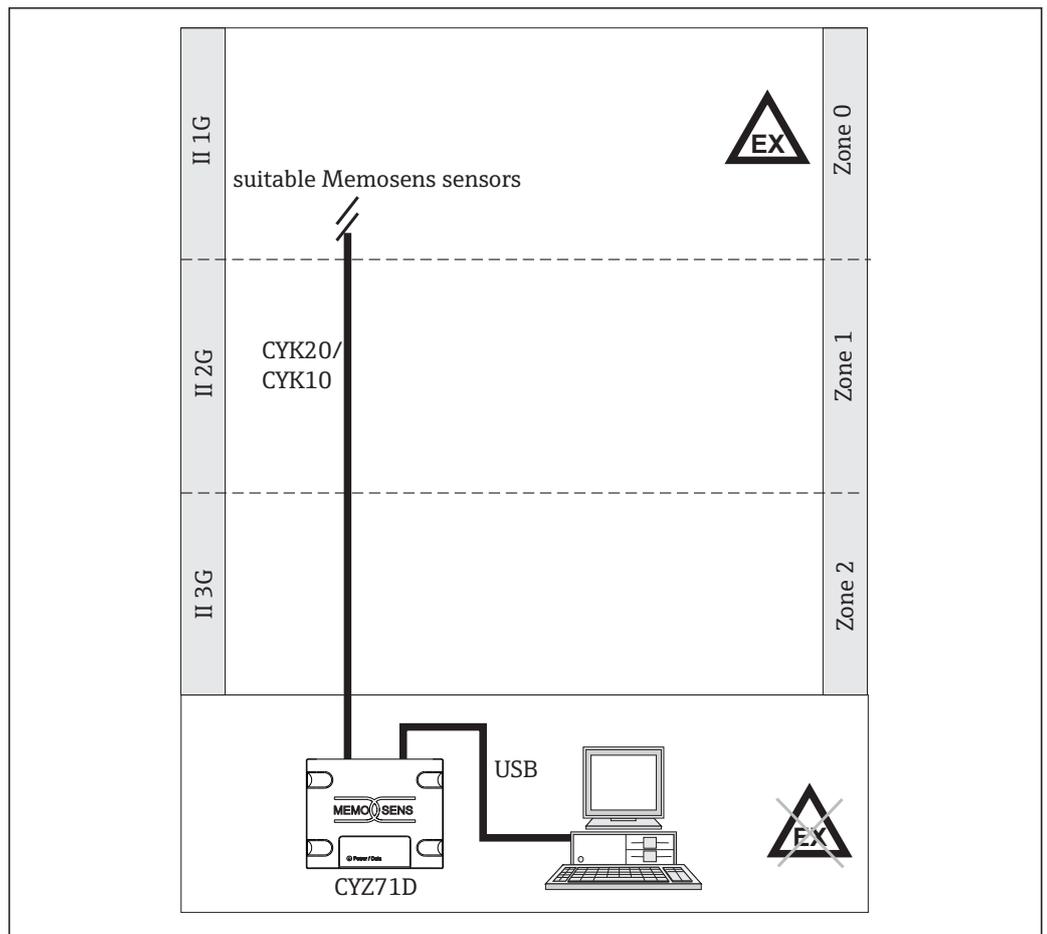
A0031653

- 1 Cable with mini USB plug
- 2 Cable with M12 plug

3. Connect the USB connector to the USB jack on your computer.
4. Connect the sensor with Memosens protocol to the Memosens plug-in head of process cable CYK10 or laboratory cable CYK20. Ex sensors can also be connected without losing their approval.

**i** A cable with Ex approval must be used when using sensors with Ex approval. Where the use of the cable is mixed with sensors that do not have Ex approval, this cable may no longer be used in the hazardous zone afterwards.

### 6.3 Connection in hazardous areas



A0018322-EN

3 Connection in hazardous areas

**i** The PC, USB cable and MemoLink may be used only in non-hazardous areas. Memosens cables and sensors with Ex approval may also be operated in a hazardous area, e. g. in flues.

If using cables with Ex approval in combination with sensors without Ex approval, it is possible to continue using the cables in combination with Ex-approved sensors on Memobase Plus. The sensors do not lose their Ex approval. The cables may not be used subsequently in a hazardous zone.

## 7 Installation

### 7.1 System requirements

*System requirements for installation and use of Memobase Plus:*

#### System requirements

Operating system	Windows 7 Service Pack 1 (32- and 64-bit) <sup>1)</sup> Windows 10 (32 and 64 bit) <sup>1)</sup>
Monitor	At least 1280×1024 pixel, also suitable for touchscreen
Processor	Minimum clock speed of 1 GHz Not a virtual machine
Free hard disk memory	At least 3 GB for the program and database
RAM	1 GB <sup>2)</sup>
USB	At least a type A USB interface At least USB 2.0
Barcode reader	Supported interfaces: <ul style="list-style-type: none"> <li>▪ USB-HID interface</li> <li>▪ USB-COM interface</li> </ul>  The interface must be configured on the barcode reader.  Minimum resolution: 0.254 mm (10.0 mil)
Other	<ul style="list-style-type: none"> <li>▪ CD-/DVD drive or internet access for program installation</li> <li>▪ Adobe Reader</li> <li>▪ Printer driver</li> <li>▪ Microsoft .NET Framework 4.7</li> </ul>

1) Windows Home Edition is not supported

2) Recommended: 4 GB

## 7.2 Installing the software

### 7.2.1 Installation wizard

The installation wizard contains the following functions:

- Step-by-step installation of the Memobase Plus software
- Update function to update the Memobase Plus software

► To update your Memobase Plus software, you should also start the installation wizard.

 It is not possible to install on a virtual machine. You require administrator rights to run the installation. Please contact your system administrator if problems occur during the installation.

Only connect the USB cable and MemoLink sensor terminal box to the computer once the software has been installed successfully.

1. During the installation process, follow all the instructions step by step.
2. Select **Next** to continue the installation.
3. Select **Back** to return to the previous installation step (if possible).
4. Select **Cancel** to cancel the installation.

#### **Windows license information:**

If the license information is not retained following installation, proceed as follows:

- After installation, right-click the Memobase Plus desktop icon: "Run as administrator".
- Enter the license information again.
- Restart Memobase Plus.

The license information should now be retained.

### 7.2.2 Installing Memobase Plus

 You can download updates to the software from the product page [www.endress.com/cyz71d](http://www.endress.com/cyz71d) under **Documents / Manuals / Software** .

1. Insert the DVD into your CD/DVD drive. The installation procedure starts automatically if the Autostart function is enabled. If the autostart function is not enabled, start the **memobase\_plus\_x86\_x64\_full\_ui.exe** program located in the main directory of the DVD.
2. Follow the instructions shown.

► Contact your IT department for a central server installation.

 Make sure your user name and password are stored in a safe place. If you lose this information it is not possible to recover the saved data.

### 7.2.3 Activating the license

Functions of Memobase Plus that are independent of the sensor, e.g. user administration, are available following installation.

To be able to use the complete range of functions of the Memobase Plus version you have purchased, register your license via the Internet. This can be done on the PC or Windows-based tablet on which you installed the software or on any other PC or Windows-based

tablet with Internet access. For this, you require the serial number and the license key on the back of the DVD cover.

**i** If you want to enter a new license key to extend a temporary license, for example, proceed as you would for a new license. The software does not need to be reinstalled and the database is retained and remains in operation.

1. Enter the serial number and the license key in step 1.

Step 1

Please enter the serial number and the license key. You'll find this information on the CD/DVD cover. Afterwards press the OK button at the bottom.

Serial number: K9000105GY

License key: CAA8 6DC7 40DB 9E74 2567 83A3

Step 2

With internet access on this computer:  
Save the activation code to clipboard. Click on the following [link](#) to register the software online.

Without internet access on this computer:  
Please use another PC and register under <https://www.software-products.endress.com/MemobasePlus>.  
In both cases you will receive an unlock code. Enter the unlock code in step 3.

Activation code: [empty]

Step 3

Please enter the unlock code you have received per e-mail from Endress+Hauser. Afterwards the full functionality of Memobase Plus is activated.

Unlock code: [empty]

2. Click **OK**.

↳ The activation code is generated.

3. Follow the instructions shown. You can copy the activation code to the clipboard via the **Copy to clipboard** button.

Step 1

Please enter the serial number and the license key. You'll find this information on the CD/DVD cover. Afterwards press the OK button at the bottom.

Serial number: K9000105GY

License key: CAA8 6DC7 40DB 9E74 2567 83A3

Step 2

With internet access on this computer:  
Save the activation code to clipboard. Click on the following [link](#) to register the software online.

Without internet access on this computer:  
Please use another PC and register under <https://www.software-products.endress.com/MemobasePlus>.  
In both cases you will receive an unlock code. Enter the unlock code in step 3.

Activation code: 572FAA7C14962635DEBB2F73DF796A88C689E44C2E3A9B

Step 3

Please enter the unlock code you have received per e-mail from Endress+Hauser. Afterwards the full functionality of Memobase Plus is activated.

Unlock code: [empty]

4. Click the link in step 2.

↳ The software opens a window for activating the software.

5. Enter your activation code and follow the instructions shown. If you have copied the activation code to the clipboard, you can paste it using the CTRL + V key combination.

6. Enter the activation code in the **Unlock code** field. Endress+Hauser will have sent you this code to the e-mail address you specified.

Step 1

Please enter the serial number and the license key. You'll find this information on the CD/DVD cover. Afterwards press the OK button at the bottom.

Serial number: K9000105GY

License key: CAA8 6DC7 40DB 9E74 2567 83A3

Step 2

With internet access on this computer:  
Save the activation code to clipboard. Click on the following [link](#) to register the software online.

Without internet access on this computer:  
Please use another PC and register under <https://www.software-products.endress.com/MemobasePlus>.  
In both cases you will receive an unlock code. Enter the unlock code in step 3.

Activation code: 572FAA7C14962635DEBB2F73DF796A88C689E44C2E3A9B

Step 3

Please enter the unlock code you have received per e-mail from Endress+Hauser. Afterwards the full functionality of Memobase Plus is activated.

Unlock code: LYCAA JVAF 2NVAJ 6GYAJ K2KQG Y4EXR

**7.** Click **OK**.

↳ You can now access the range of functions of the Memobase Plus license you purchased.

Your activated Memobase Plus licenses are displayed under **SETUP > LICENSE > Features** in the **Active features**.



The screenshot shows a window titled "Active features" with a pink header bar containing the text "Select one or more features to remove the corresponding license keys". Below this is a table with three columns: "Feature", "License key", and "Valid until".

Feature	License key	Valid until
Memobase Plus (basic)	CAA8 6DC7 40DB 9E74 2567 83A3	Unlimited
Pharma Conformity	18A6 7E65 8787 49DB 4888 8117	Unlimited
Advanced Diagnostics	DACC 5060 5450 87E7 5AFD 8D39	Unlimited

## 7.3 Updating the software

The installation wizard of the Memobase Plus software contains the update function with which the Memobase Plus software can be updated.

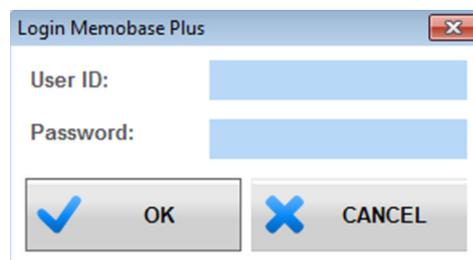
1. To update the software, also start the installation wizard.
2. Follow the instructions given by the wizard.

## 8 Operation

### 8.1 Starting the program

1. Make sure that Memobase Plus has been installed on your computer as specified in the installation instructions.
2. Make sure that the MemoLink sensor terminal box is connected via the USB port of your computer.
3. Start Memobase Plus by clicking the desktop icon, for example.
  - ↳ When you start Memobase Plus for the first time, a message appears prompting you to activate the license you have purchased → 17.
4. **OK**.
5. Follow the instructions shown.

For subsequent starts and when user administration is activated:



4 Login window when user administration is activated

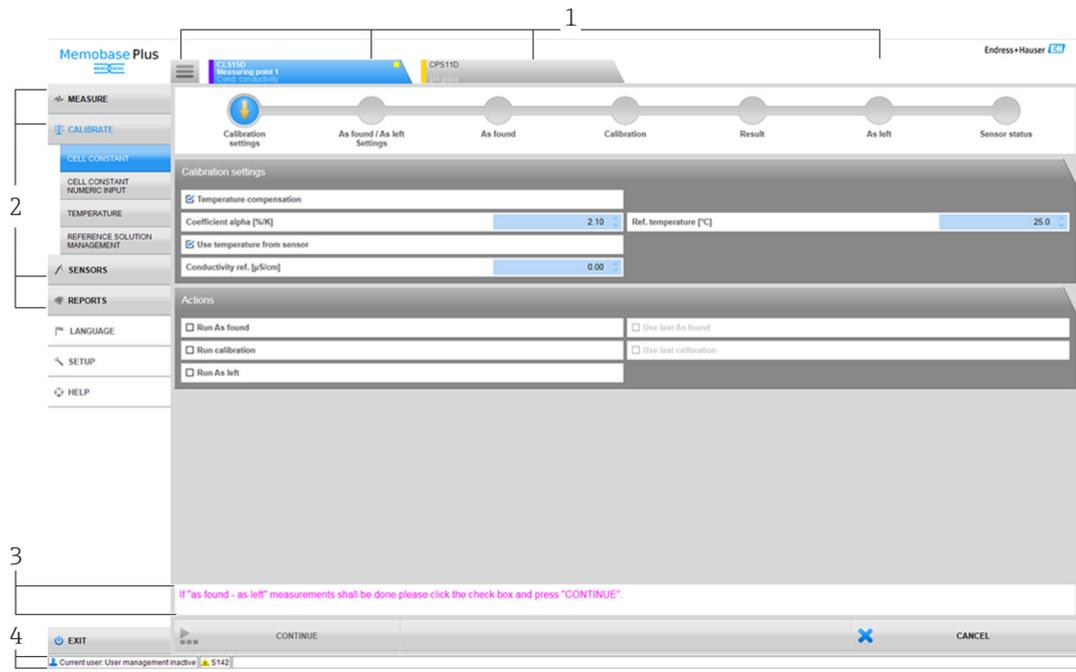
1. Enter the user ID.
2. Enter the password.
3. Click OK.
  - ↳ The Memobase Plus user interface that opens reflects the rights of the user role that has been assigned to you.

- i** If you have forgotten your password:
- User role **Operator, Maintenance Engineer** and **Expert / Service engineer**:
    - Contact your system administrator.
    - The Admin user role can reset users' passwords.
  - Admin user role:
    - Contact Endress+Hauser Service.
    - In this case, it is not possible to recover a password if you have forgotten it.
    - For more information, see [www.endress.com](http://www.endress.com)

## 8.2 User interface

The user interface contains the following elements:

- Tabs
- Main menu
- Instruction area
- Status bar



5 Program structure

- 1 Tabs
- 2 Main menu
- 3 Instruction area
- 4 Status bar

### 8.2.1 Tabs

A tab appears for every MemoLink sensor terminal box that is connected. As soon as a sensor is connected to MemoLink, the tab displays information about the sensor.

The tab displays the following information depending on the setting selected in the setup:

- Serial number or
- Memoclip or
- Sensor identifier

**i** If sensor simulation for the Memocheck product family is connected, the letters "SIM" appear before the serial number in the tab.

- Blue tab:
  - Main menus (Measure, Calibrate, Sensors and Reports) are active for this sensor
- Gray tab:
  - The system continues to measure and calibrate in the background. Ongoing actions are not interrupted.
- Square tab :
  - Enables access to non-sensor-specific data and settings, e.g. reference solution management
  - Sensor-specific data and calibration methods are only available for the selected sensor

## 8.2.2 Main menu

The main menu contains the four main functions:

- Measure: measurement incl. graph and description of sample
- Calibrate: several calibration methods and reference solution management
- Sensors: settings, administration, status and information
- Reports: database view, report creation and export function

In addition, the main menu also contains the following items:

- Language: configure the language of the user interface and of the reports
- Setup: database settings, settings for the management of users and licenses
- Help: call up the help

## 8.2.3 Instruction area

The instruction area displays step-by-step instructions during various actions, e.g. a calibration.

## 8.2.4 Status bar

Current information concerning user administration and active error messages are displayed in the status bar.

- ▶ Click the error message for more detailed information and remedial measures.

If user administration is activated, click **Current user: {0}** on the bottom left. A window opens with the following options:

- Changing the user
- Change password
- Logging out a user

### Changing the user

Proceed as follows if you want to change the user:

1. Click **Change user...**
2. Enter the user ID of the user who should be logged in.
3. Enter the password.
4. Click **OK**.

### Change password

Proceed as follows if you want to change the password:

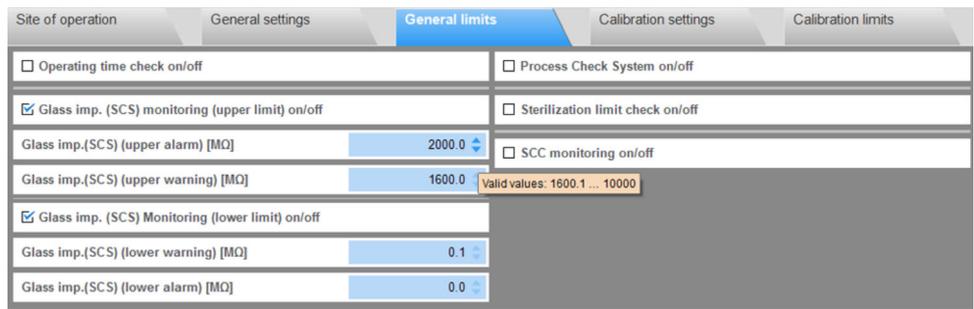
1. Click "Change Password".
2. Enter the old password.
3. Enter the new password.
4. Confirm the password by entering the new password a second time.
5. Click **OK**.

### Logging out a user

Proceed as follows if you want to log out a user:

1. Click "Logout User".
  - ↳ The current user is logged out immediately.
2. To log in a user, enter the user ID.
3. Enter the password.
4. Click **OK**.

### 8.2.5 Edit fields

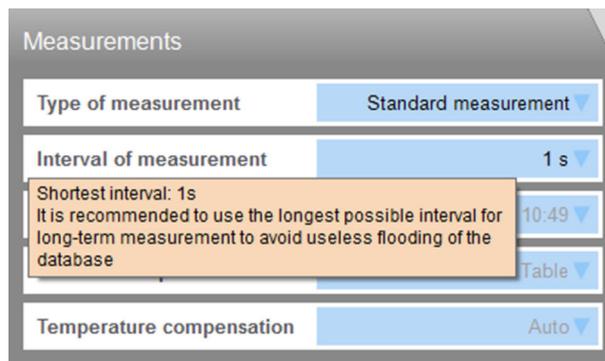


6 Example: Edit fields in Memobase Plus

There are edit fields at various points in the program. With these fields, you can set the desired values using the arrows. If the cursor is in front of the decimal point you only change the whole numbers with the arrow keys. If the cursor is located one place behind the decimal point, then you only change the value for the tenths.

Hover the mouse over the arrows to display the range for the permitted values.

### 8.2.6 Help text



7 Example: Tool tip in Memobase Plus

Tool tips with help text are available for some text fields. If you position the cursor over such a field, a question mark is displayed beside the cursor. Right-click to display the tool tip. The tool tip disappears as soon as you move the mouse.

- ▶ Press F1 to open the entire content of the Help.

## 8.2.7 Symbols

Symbol	Meaning
	Action has been performed successfully
	Value entered or perform action
	Action is currently being performed
	Action has failed.
	Indicates a setting that has been chosen as a favorite setting
	Barcode reader connected with Memobase Plus
	No barcode reader connected with Memobase Plus
	Connected to the server
	Not connected to the server
	Master-slave mode: slave is connected
	Master-slave mode: slave is not connected

## 9 Operation

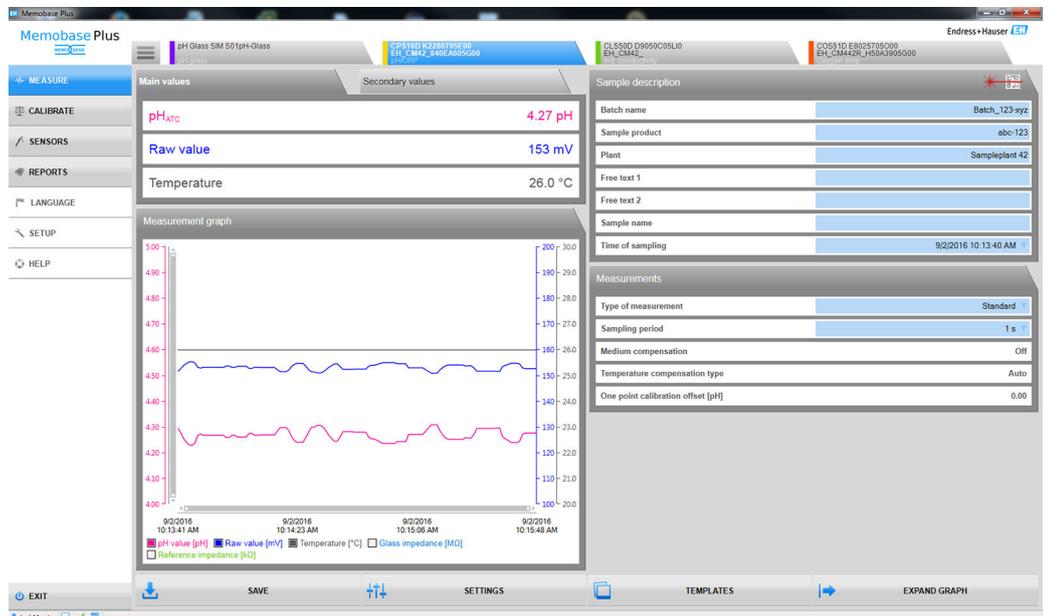
### 9.1 Measure

The following boxes are displayed in the **MEASURE** item:

- Main values
- Secondary values
- Measurement graph
- Sample description
- Measurements

The following buttons are displayed:

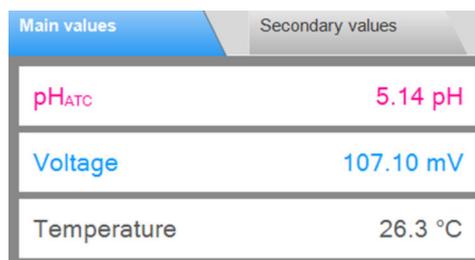
- SAVE
- SETTINGS
- TEMPLATES
- **Expand Graph / Shrink Graph**



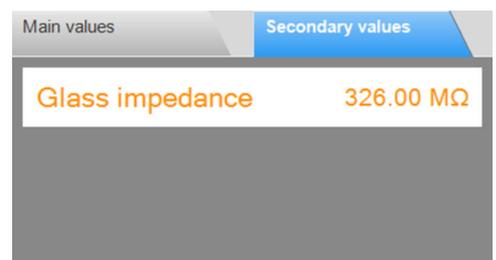
8 Menu **MEASURE**

**i** If the calibration has expired, measured data can no longer be saved ( **SAVE** button is grayed out).

#### 9.1.1 Measure: Main and secondary values



9 Menu **MEASURE**, box **Main values**



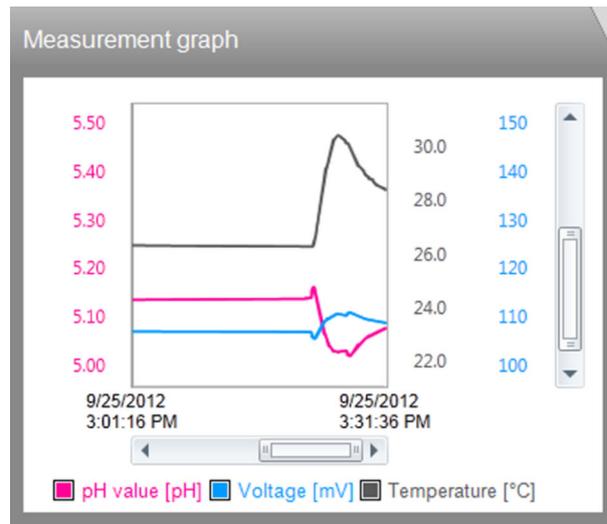
10 Menu **MEASURE**, box **Secondary values**

Displays the main values and secondary values of the connected sensor, e.g.:

- Raw value
- Temperature
- Glass impedance

In the case of pH sensors, automatic temperature compensation (ATC) is enabled in the default settings. Here, the pH value refers to a reference temperature of 25 °C. The raw value - the voltage in the example above - always refers to the real fluid temperature.

### 9.1.2 Measure: Measurement graph



The measured values and a graph of the measured value trends are displayed. Measurement starts automatically as soon as a sensor is connected and stops when a sensor is removed.

The display can be changed as follows:

- Zoom in/out using the scroll bar and mouse wheel
  - Click the boxes in the legend to hide or display the measured values.
- Right-click the measurement graphs to add a comment. The comment is listed in the measurement report.

#### **i** Operation with a central database and multiple clients:

- If several clients add comments simultaneously, the system saves the data of the client that is the first to save the data.
- The other clients get a message stating that the data have already been changed by another client in the meantime.

### 9.1.3 Measure: Sample description

11 Menu **MEASURE**, box **Sample description**

Function	Info
Lot	▶ Enter the name of the batch.
Sample product	▶ Enter an optional product description.
Plant	▶ Enter the name of the system.
Free text 1	▶ Add notes if necessary.
Free text 2	
Sample name	▶ Enter the name of the sample.
Time of sampling	▶ Enter the date and time of sampling.

You can record sample data in two different ways:

- Enter the sample data manually (not the **Restricted Operator** user role)
- Record the sample data using the barcode (all user roles)

#### Enter the sample data manually

You can enter data about the sample manually in the edit fields in the **Sample description** field.

**i** Once the data have been entered, they are only saved after you have clicked the **SAVE**.

1. Select the **MEASURE** menu option.
2. Fill in the edit fields in the **Sample description** box.
3. Click the **SAVE** button.
  - ↳ A data record containing the data entered has been generated. You can view the data record under **REPORTS > MEASURE**.

#### Record the sample data using the barcode

**i** The following barcode readers are supported in Memobase Plus:

- Barcode reader with USB-COM interface
- Barcode reader with USB-HID interface

The interface must be configured on the barcode reader.

**i** The following symbols indicate whether Memobase Plus is connected to a barcode reader or not:

- (barcode reader connected)
- (barcode reader not connected)

If the barcode reader is not connected with Memobase Plus, you must connect it → 68.

Sample description box with "Barcode reader connected" symbol

**i** The system requirements for the barcode reader are provided in the "System requirements" section (→ 16)

Guidelines for generating 2-D barcodes recorded in Memobase Plus can be found under "Guidelines for generating 2-D barcodes" → 28.

Data in 1-D barcodes are recorded depending on which data field the cursor is located.

**i** Once the barcode has been scanned, the data are only saved after you have clicked the **SAVE**.

1. Select the **MEASURE** menu item .
2. Scan the barcode using a barcode reader.
3. Click the **SAVE** button.
  - ↳ A data record containing the data entered has been generated.

**Guidelines for generating 2-D barcodes**

Any encoding scheme (e.g. ASCII, C40, Text, Base256) can be used to encode the data.

The data in the individual fields (batch, plant, sample description etc.) are separated by:

- An identifier (see the next table)
  - A semicolon after the data in the individual field
- Not every field must be used. Unused fields remain empty.

Name of the data field	Identifier	Format	Length
Lot	B	Unicode (up to 64 characters)	Variable
Sample product	P		
Plant	R		
Free text 1	1	Unicode (up to 255 characters)	
Free text 2	2		
Sample name	N	Unicode (up to 64 characters)	
Time of sampling	T	YYDDD	5

**Example of the encoding of data:**

The sample values for the relevant fields in the table result in the following coding as text:

**[M>**BB1;PPR1;RPL1;1F123;2F234;NABC;T16366

**i** **[M>** must be set as the prefix.

Name of the field in the box Sample description	Values
Lot	B1
Sample product	PR1
Plant	PL1
Free text 1	F123
Free text 2	F234
Sample name	ABC
Time of sampling	16366 (31/12/2016)

### Saving the sample data as a template

The data entered in the edit fields can be saved as a template for future measurements.

Proceed as follows:

1. Fill in the edit fields manually or by scanning the barcode.
2. Click the **TEMPLATES** button.
  - ↳ The Templates dialog box is displayed.
3. Under **New template name** enter a name for the template.
4. Click the **SAVE** button.
  - ↳ The data entered are saved in the template.

### Loading sample data from a template

Data can be loaded from an existing template.

Proceed as follows:

1. Click the **TEMPLATES** button.
  - ↳ The Templates dialog box is displayed.
2. Select a template.
3. Click the **Load** button.
  - ↳ The data of the selected template are displayed in the edit fields.

### 9.1.4 Measure: Measurements

Measurements	
Type of measurement	Standard ▾
Sampling period	1 s ▾
Medium compensation	Off
Temperature compensation type	Auto
One point calibration offset [pH]	0.00

12 Menu MEASURE, box Measurements

You can make different settings for the measurement:

Function	Options	Info
Type of measurement	<b>Selection</b> <ul style="list-style-type: none"> <li>▪ Standard</li> <li>▪ Long term</li> <li>▪ Interval</li> <li>▪ Stable value</li> </ul> <b>Factory setting</b> Standard	<ul style="list-style-type: none"> <li>▪ <b>Standard:</b> <ul style="list-style-type: none"> <li>▪ Runs as long as the sensor is connected</li> <li>▪ Current measured values are saved in the database via the <b>SAVE</b> function</li> </ul> </li> <li>▪ <b>Long term:</b> <ul style="list-style-type: none"> <li>▪ Measurement must be started</li> <li>▪ Timer can be set for the end of the measurement and to save data automatically</li> </ul> </li> <li>▪ <b>Interval:</b> <ul style="list-style-type: none"> <li>▪ Interval must be set</li> <li>▪ Measurement must be started</li> </ul> </li> <li>▪ <b>Stable value</b> (pH and ORP only)               <ul style="list-style-type: none"> <li>▪ Scan period must be configured</li> <li>▪ The measurement ends automatically as soon as a stability criterion is met</li> </ul> </li> </ul>
Sampling period	<b>Selection</b> 1 s to 1 h  <b>Factory setting</b> 1 s	
Interval of measurement [min]	<b>Selection</b> 1 to 15 min  <b>Factory setting</b> 1 min	<ul style="list-style-type: none"> <li>▪ Settings concerning the measuring interval can be changed during the measurement</li> <li>▪ Select as large an interval as possible to avoid unnecessary use of disk space</li> <li>▪ The measured value curve up to this point is saved</li> </ul>
Stop measurement	DD.MM.YYYY HH:MM	<ul style="list-style-type: none"> <li>▪ It is possible to predefine when measurement should be stopped. This value can also be changed during the measurement process</li> <li>▪ The measured value curve up to this point is saved</li> </ul>

Function	Options	Info
Medium comp. (only for pH sensors)		<ul style="list-style-type: none"> <li>▪ The dissociation of water changes with increasing temperature. The balance shifts towards the protons; the pH value drops</li> <li>▪ You can balance out this effect with the <b>Medium comp.</b> function</li> <li>▪ You can make changes to medium compensation under <b>SENSORS &gt; SETTINGS</b></li> </ul>
Temperature compensation		<ul style="list-style-type: none"> <li>▪ Measured value is converted to a reference temperature of 25°C / 77°F</li> <li>▪ This can be used as the basis for comparing values</li> <li>▪ This function is always active if manual temperature compensation is switched off</li> <li>▪ You can make changes to temperature compensation under <b>SENSORS &gt; SETTINGS</b></li> </ul>



You can make the settings for the units or compensation under **SENSORS > SETTINGS**.

The **SETTINGS** button also takes you to **SENSORS > SETTINGS**.

## 9.1.5 Measure: Buttons

### Save

- **Standard, Interval and Stable value** measurement methods:
  - The measured values are saved in the ring memory (temporary memory)
  - The ring memory can contain up to 900 entries: with a scan rate of 1 second, the measured values recorded within 15 minutes can be saved
  - The user must first click **SAVE** before the measured values are saved to the database according to the set measurement interval, where they can then be downloaded or exported
  - If you click **SAVE** a second time, a new data record is generated. The generated data records can be viewed under **REPORTS > MEASUREMENT**
- **Long term** measurement method:
  - The measured values are saved directly to the database

### Settings

Under **SENSORS > SETTINGS** you can:

- View the general information about the sensor
- Load the sensor settings from a template or save them in a template
- Define different sensor settings

### Templates

By clicking the **TEMPLATES** button you can:

- Save the data entered as a template
- Load a template. The edit fields are populated with the values from the template
- Delete a template

In the **TEMPLATES** dialog, you can filter the view by clicking the filter icons. You can display the data grouped by a specific attribute by dragging and dropping data to the field above the table header.

### Expand graph, shrink graph

Clicking the **Expand Graph** button expands the displayed measurement graph to the width of the screen. The **Sample description** and **Measurements** boxes are hidden.

Clicking the **Shrink Graph** button resets the displayed measurement graph to the preset width. The **Sample description** and **Measurements** boxes are displayed again.

## 9.2 Calibrate

Background information concerning calibrations is provided in the "Background information concerning calibrations" section in the Appendix (→ 86).

You can find the following information in this section:

- Definition of the terms "Calibration" and "Adjustment" (→ 86)
- Explanation of the terms "Zero point" and "Slope" (→ 86)
- Calibration examples for standard operating procedures (→ 86)

### 9.2.1 Functions in the "Calibrate" menu

Different functions are available in the **CALIBRATE** menu depending on the sensor type.

Function/sensor type	pH	ISFET	ORP	Combin ed	Cond. conduc tivity	Ind. conduc tivity	Oxygen amp.	Oxygen opt.
TEMPERATURE	x	x	x	x	x	x	x	x
ONE-POINT	x	x		x				
ONE-POINT			x <sup>1)</sup>					
TWO-POINT	x	x	x <sup>2)</sup>	x				
MULTI-POINT	x	x		x				
NUMERIC INPUT	x	x	x	x				x
CELL CONSTANT					x	x		
CELL CONSTANT NUMERIC INPUT					x	x		
CHANGE ELECTROLYTE							x	
CHANGE SENSOR CAP							x	x
SLOPE AIR 100%							x	x
SLOPE H2O AIR-SATURATED							x	x
Test gas								x
SLOPE AIR VARIABLE							x	x
ZERO-POINT ONE-POINT							x	x
RESET TO FACTORY CALIBRATION								x
REFERENCE SOLUTION	x	x	x	x	x	x	x	x

1) For mV measuring mode

2) For % measuring mode

### 9.2.2 Calibrate > Temperature

- ▶ Determine the temperature of your process medium with an alternative measurement, e.g. a precision thermometer.

It is possible to calibrate the temperature sensor to ensure the measured value is not corrupted by incorrect temperature measurement.

### 9.2.3 Calibrate > Offset

Offset calibration is particularly useful if the deviation of the pH value from a reference value, and not the absolute pH value itself, is of interest to the user. Applications for single-point calibration include:

- Process control
- Quality assurance

 The offset calibration is temporary and is saved in the transmitter. It is not permanently written to the sensor. Therefore this type of calibration is only suitable if the sensor is then used with Memobase Plus for measurement purposes. Offset calibration in the laboratory is not suitable for operation on a conventional process device, e.g. Liquiline.

### 9.2.4 Calibrate > Two-point

Two-point calibration is the preferred method for pH sensors, particularly in the following applications:

- Municipal and industrial wastewater
- Natural waters and drinking water
- Boiler feedwater and condensates
- Beverages

Calibration with buffers with a pH of 7.0 and 4.0 is recommended for most applications. Alkaline buffer solutions have the disadvantage that carbon dioxide from the air can alter the pH value of the buffer on the long term. If calibrating with alkaline buffers it is best to do so in closed systems, such as flow assemblies or retractable assemblies with a rinse chamber, to minimize the effect of air.

### 9.2.5 Calibrate > Multi-point

More than 2 reference buffer solutions are used for multi-point calibration. The distance between the pH reference values of two reference solutions must be at least 1.5 pH. The difference in the pH values between more than two reference solutions must be at least 0.5 pH. The calibration line is determined using linear regression through all the measuring points.

### 9.2.6 Calibrate > Numeric input

- For pH: you enter the slope, zero point and temperature manually. The function for determining the pH value is calculated from these values. Thus, the data entry returns the same result as two-point calibration.
- The slope characterizes the sensor condition. The greater the deviation from the ideal value (-59.16 mV/pH), the poorer the condition of the sensor. You must determine the slope and zero point in an alternative way.
- The zero point characterizes the condition of the sensor reference. The bigger the deviation from the ideal value (pH 7.00) the poorer the condition. The deterioration can be caused, for example, by KCl dissolving away or reference contamination.
- For ORP: you enter the offset directly with this type of calibration. Use the measured value of a reference measurement, for example, to determine the offset.

Fluctuations in the process value should not exceed  $\pm 0.5$  pH and the process temperature must remain relatively constant. As the measuring range is limited as a result, it is possible to set the slope to -59.16 mV/pH (at 25 °C). To adjust the sensor, you enter an offset or a reference value.

### 9.2.7 Calibrate > Cell constant

A conductivity measuring system is generally calibrated in such a way that the exact cell constant is determined or checked using suitable calibration solutions. This process is described in the standards EN 7888 and ASTM D 1125, for example, and the method for producing a number of calibration solutions is explained. Another alternative is to purchase international calibration standards from national measurement institutes. This is particularly important in the pharmaceutical industry, which requires a calibration to be traced to internationally recognized standards. To calibrate its inspection unit, Endress+Hauser uses SRM (Special Reference Material) from the US NIST authority (National Institute of Standards and Technology).

### 9.2.8 Calibrate > Change electrolyte

- The internal sensor counter for calibrations with the electrolyte used is reset (not visible in the sensor information).
- Use this function after changing the electrolyte without replacing the membrane cap.

### 9.2.9 Calibrate > Change sensor cap

- The counter for sensor cap calibrations is used to set warning limits and alarm limits for changing the membrane cap. This ensures that exhausted membrane caps are replaced in time.
- The internal sensor counter for calibrations with the membrane cap used is reset. The number of calibrations performed with the current membrane cap is indicated in the sensor information.
- Select this function after replacing the membrane cap.

### 9.2.10 Calibrate > Point in oxygen > Air 100% rH

In this calibration model, the percentage of water vapor is deducted on the basis of the altitude and temperature so that information is available on the oxygen partial pressure actually present. For this model to work correctly, the sensor to be calibrated must be close to a water surface or be located in the headspace of a vessel partially filled with water, for example. In this way, oxygen sensors can be precisely calibrated in a wide variety of applications, ranging from power stations to water treatment.

### 9.2.11 Calibrate > Point in oxygen > Air variable

This calibration model is for all applications in which the air pressure and air humidity in the vicinity of the sensor do not correspond to the standard atmospheric values previously mentioned, but are still known. Both variables can be specified here.

The model is used, for example, for installed sensors that should be calibrated in operation at known conditions, such as in dry rinse air at 1020 hPa.

### 9.2.12 Calibrate > Point in oxygen > H<sub>2</sub>O air-saturated

After an adequate amount of time, water which has been aerated sufficiently is in equilibrium with the oxygen partial pressure of the air above the water. The "H<sub>2</sub>O air saturated" calibration model uses this property. Here too, the model uses the temperature value to automatically reference back to the expected oxygen partial pressures. This model is often used to measure oxygen in closed vessels, such as fermenters filled with water.

### 9.2.13 Calibrate > Point in oxygen > Test gas

This calibration model allows the user to calibrate the slope of the sensor using a defined oxygen gas mixture. Traceable calibration can be performed in conjunction with an absolute pressure measurement (to determine the gas pressure at the sensor membrane)

and a certified calibration gas. The reference variable in oxygen volume concentration and the gas pressure are entered here as input variables in the transmitter. The model assumes a dry gas mixture with 0% humidity.

### 9.2.14 Calibrate > Zero point sample

Zero point calibration is particularly important if measurements are to be compared to one another, or in the event of measurements near the zero point.

A zero point shift in amperometric sensors is primarily caused by fouling on the cathode. The special mechanical construction of the sensor with the membrane cap and electrolyte almost completely eliminates such fouling.

Calibration is possible both in the medium and in air. For this purpose, you measure the raw value of the parameter using a reference measurement. You use this reference value to adjust the sensor. You can either calibrate the slope or the zero point with the reference value.

### 9.2.15 Calibrate > Reference solution management

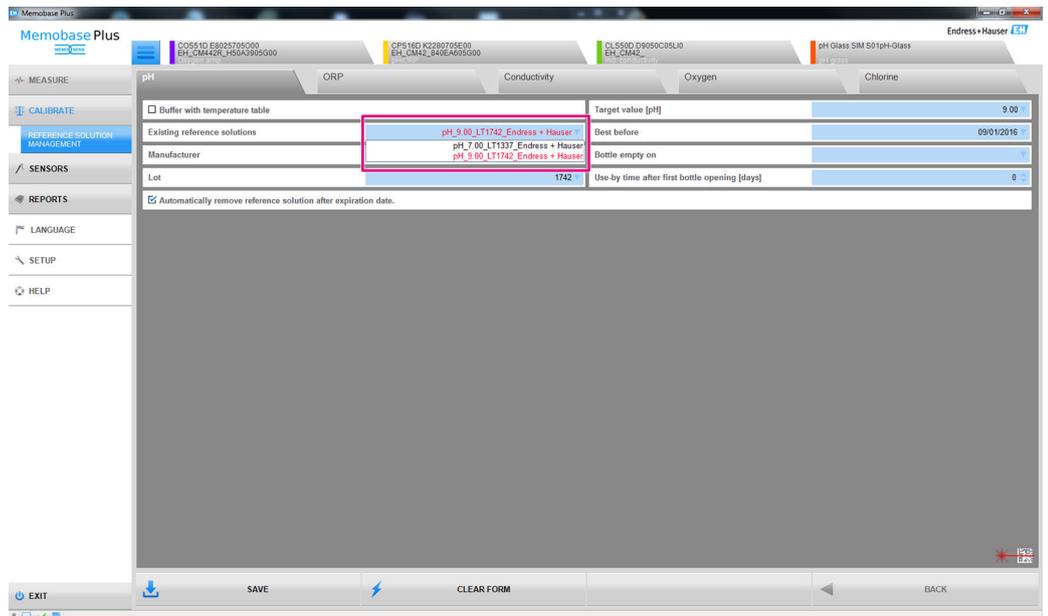
Reference solution management is used for the following purposes:

- Manage reference solutions
- To monitor reference solutions
  - Documentation of producer, batch number and shelf life
  - Assignment of buffer solution (batch) to calibration process
- To create a proprietary process solution with a known target value as the reference solution

Each parameter has a tab, e.g. pH.

 No additional changes can be made to a reference solution that is already created. This prevents any tampering and data manipulation. If, however, you would like to make a correction, then flag the buffer to be changed as "Bottle empty on" and create a new buffer.

In the default setting, the **Automatically remove reference solution after expiration date** function is enabled. In addition, the expired reference solution is displayed in red in the **Existing reference solutions** picklist in the calibration menu but can be selected, however.



 13 Dialog CALIBRATE > 'REFERENCE SOLUTION' dialog, reference solution displayed in red on expiration of the shelf life

### Recording a reference solution

You can record reference solution data in two different ways:

- Enter the reference solution data manually (reference solutions of any make)
- Record reference solution data via the barcode (Endress+Hauser reference solutions only)

### Recording reference solution data manually

You can enter reference solution data manually in **CALIBRATE > 'REFERENCE SOLUTION** field.

 Once the data have been entered, they are only saved after you have clicked the **SAVE** .

1. Select the **CALIBRATE > 'REFERENCE SOLUTION** menu item.
2. Fill in the edit fields for the relevant parameter.
3. Click the **SAVE** button.
  - ↳ A data record containing the data entered has been generated.  
You can view the data record under **REPORTS > REFERENCE SOLUTION**.

### Recording Endress+Hauser reference solution data via the barcode

You can record reference solution data via a barcode affixed to the Endress+Hauser reference solutions.

The following Endress+Hauser reference solutions can be recorded using a barcode reader:

- pH buffer solutions CPY20
- Conductivity calibration solutions CLY11
- Zero point gel for oxygen sensors COY8

 Prerequisite: current Endress+Hauser reference solution with relevant barcode

The following data can be recorded by scanning the barcode:

- Manufacturer
- Batch
- Target value
- Best before
- Shelf life after opening

 The following barcode readers are supported in Memobase Plus:

- Barcode reader with USB-COM interface
- Barcode reader with USB-HID interface

The interface must be configured on the barcode reader.

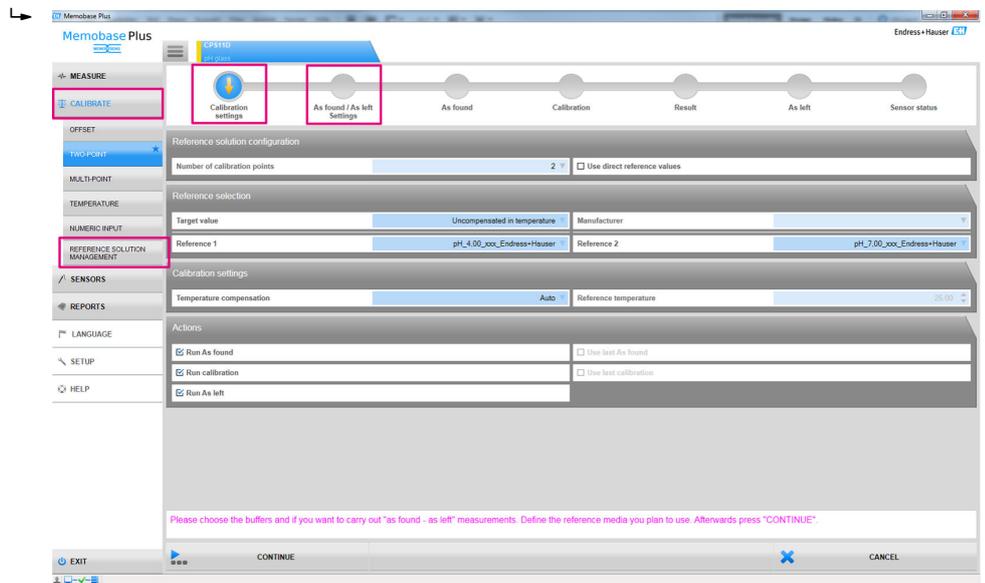
 The following symbols indicate whether Memobase Plus is connected to a barcode reader or not:

-  (barcode reader connected)
-  (barcode reader not connected)

If the barcode reader is not connected with Memobase Plus, connect it →  68.

Proceed as follows:

1. You are in the dialog **CALIBRATE > 'REFERENCE SOLUTION** or **CALIBRATE** in 'Calibration or "As found - as left"



 14 Dialogs in which the barcodes of Endress+Hauser reference solutions can be recorded

2. Scan the barcode on an Endress+Hauser reference solution with a barcode reader.
  - ↳ An icon is displayed to indicate that the data have been recorded via the barcode.



## 9.2.16 Application examples for calibrations

 Calibration examples for standard operating procedures are provided in the Appendix (→  86).

### General information on performing a calibration

The following rules apply for all parameters:

- Calibrate in a way that reflects conditions in the process.
  - If the process medium is constantly moving, also move the calibration solution accordingly (e.g. use a magnetic stirrer if calibrating in the laboratory).
  - If your medium is relatively stationary, calibrate in solutions that are also stationary.
- Always make sure that the samples are homogeneous for reference measurements, sample calibration etc.
- Avoid changes in the medium samples resulting from ongoing biological activity.  
Example: Use outlet water instead of a sample from the aeration basin for nitrate calibration.
- Use the same menu settings as those in the process to perform the calibration.  
Example: If you automatically compensate for the temperature effect during pH measurement, switch on automatic temperature compensation for the calibration also.

### General calibration procedure (independent of the parameter)

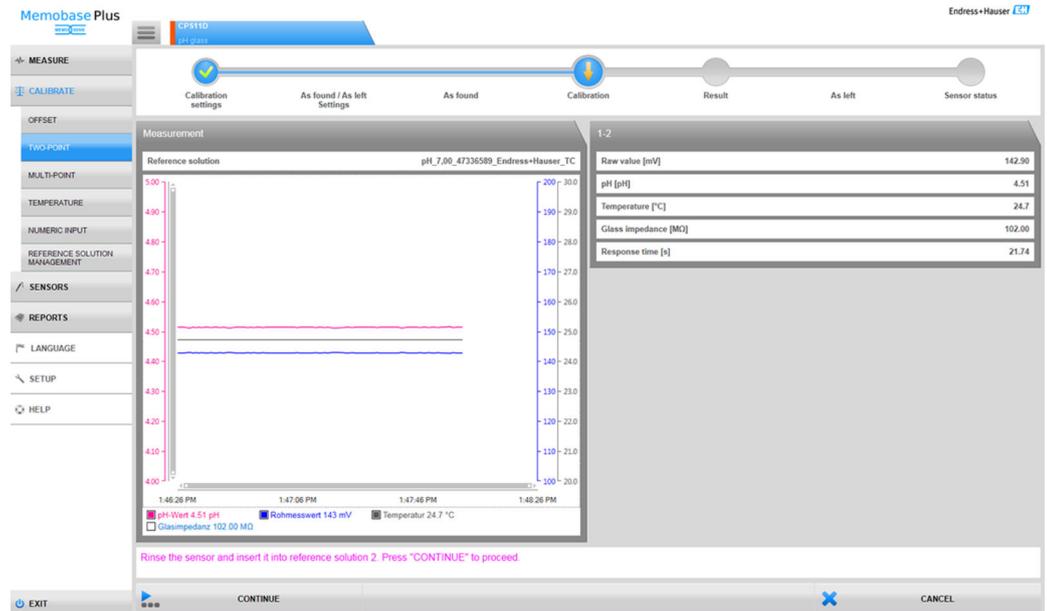
1. Select the sensor to be calibrated in the tab.
2. Click **CALIBRATE** and select a calibration type. If you want to perform an "As found - as left" measurement in addition to the calibration:
3. First define a reference under **CALIBRATE** > **REFERENCE SOLUTION** (see "Reference solution management" section). You can also use a calibration reference solution, such as a buffer, as a reference.
4. Click "As found"- start the measurement. If you do not want to perform an "As found - as left" measurement:
5. Click **CONTINUE** .
6. Follow the instructions displayed in the instructions part of the program.

After the calibration, you can view or print out a calibration report or export it to PDF format.

You can cancel the calibration any time by clicking **CANCEL** . No data are then used to adjust the sensor.

 It makes sense to perform an offset calibration if the sensor for measurement remains connected to this specific computer. This is because the data are not written to the sensor head and are therefore not available at a transmitter.

## Performing two-point calibration



### 15 Dialog CALIBRATE > TWO-POINT

 When using buffer solutions from Endress+Hauser with a barcode reader, you can record the reference solutions directly during a calibration.

1. Select the sensor to be calibrated.
2. Click **CALIBRATE > TWO-POINT**.
3. Select two buffers whose pH values are at least pH 1.5 apart. If more than two buffers are used, the pH values of the buffers must be at least pH 0.5 apart.
4. For temperature compensation, select the **Off**, **Auto** or **Manual** option.
5. Decide whether you want to perform an As found - as left measurement before the calibration (see the "As found - as left measurement" section).
6. Follow the instructions displayed in the instructions part of the program.

After the adjustment, you can view or print out a calibration report or export it to PDF format.

You can cancel the calibration any time by clicking **CANCEL**. No data are then used to adjust the sensor.

**Performing multipoint calibration ("Advanced diagnostics" license)**

**i** Before you can start multipoint calibration, you must create at least three buffers under **CALIBRATE > REFERENCE SOLUTION** (cf. "Reference solution management" section) whose values differ by  $\geq$  pH 0.5.

1. Select the sensor to be calibrated.
2. Click **CALIBRATE > MULTI-POINT > Number of calibration points** .
3. Select the number of calibration points. Possible values: 3 to 10.
4. Select 3 to 10 reference solutions or enter the pH reference values manually. To enter manually, tick the **Use direct reference values** check box.
5. For temperature compensation, select the **Off, Auto** or **Manual** option.
6. Decide whether you want to perform an As found - as left measurement before the calibration (see the "As found - as left measurement" section).
7. Follow the instructions displayed in the instructions part of the program.

In the result graph, adjustment points can be deselected or used as calibration points.



**16** Multipoint calibration: buffers 4 and 7 selected as the adjustment points, buffer 9 as the calibration point

After the adjustment, you can view or print out a calibration report or export it to PDF format. You can cancel the calibration any time by clicking CANCEL. No data are then used to adjust the sensor.

**Performing As found - as left measurement**

As found-as left measurements document changes to the sensor while it is used in the process and during maintenance in the laboratory. Therefore the as found - as left measurement is used to document the sensor condition directly before and after the adjustment to ensure full traceability.

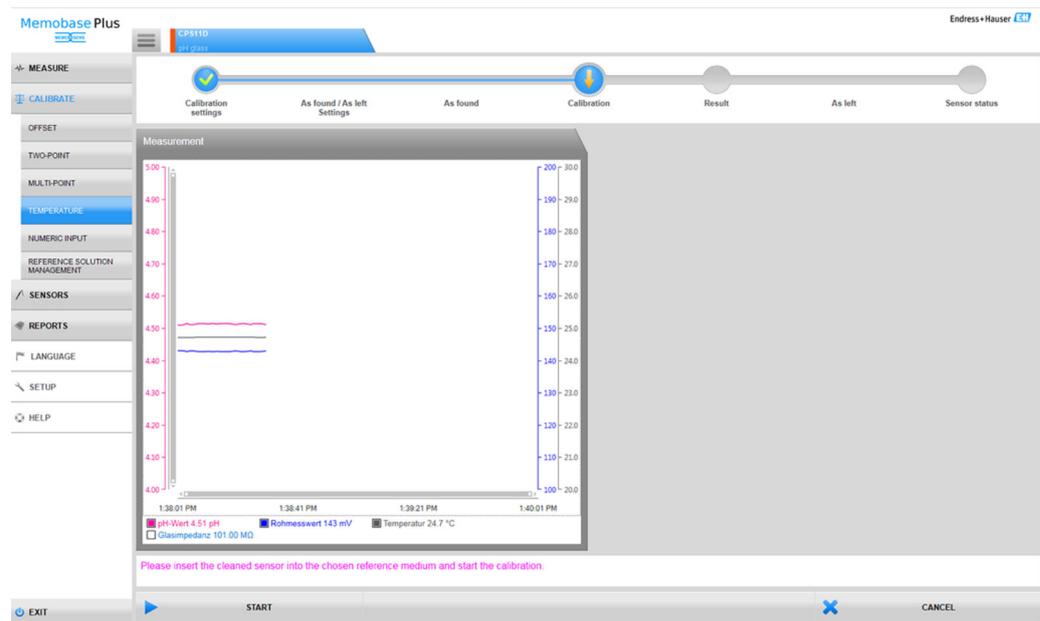
The as found measurement is performed with a reference solution before cleaning and adjusting the sensor. In the case of pH sensors the mV and pH value of the reference solution is determined in the process. Other primary values are determined for other sensor types.

Procedure for as found - as left measurements:

1. As found: do not clean the sensor. The last measurement performance of the sensor at the measuring point is determined by measuring a reference solution. A buffer solution or any other medium whose value is known can be used.
2. Follow the instructions displayed in the instructions part of the program.
3. Clean the sensor.
4. As left: determine the measurement quality directly after the adjustment. The measuring performance is documented before installation in the process. Use the same medium as for "as found". Do not use the same sample as this has been changed by the uncleaned sensor.

The results are displayed in tabular form in the calibration reports.

## Performing temperature adjustment

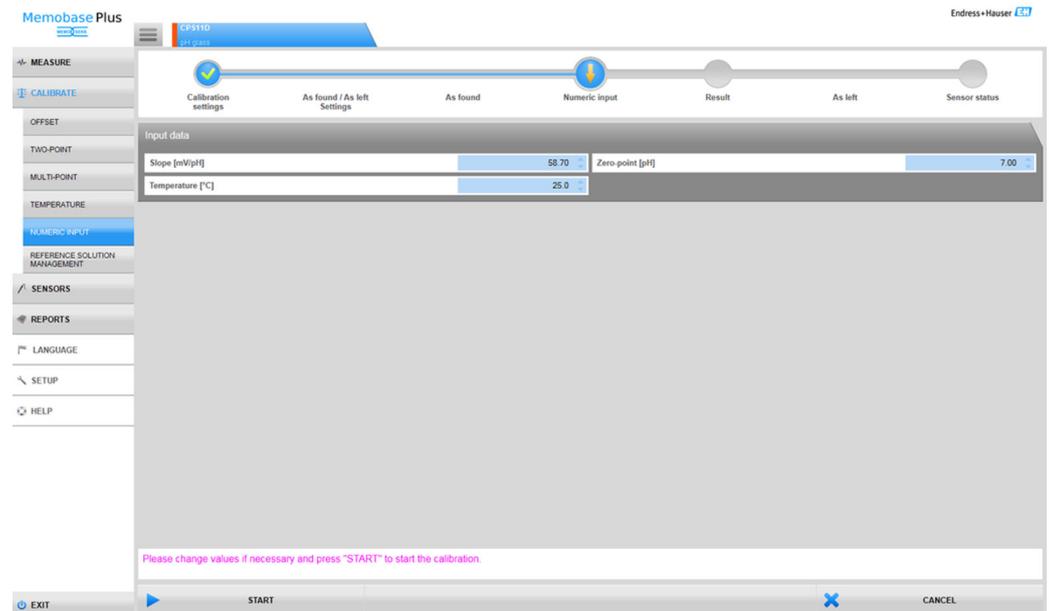


17 Dialog CALIBRATE > TEMPERATURE

1. Click **CALIBRATE > TEMPERATURE**.
2. Follow the instructions displayed in the instructions part of the program.
  - ↳ After the adjustment, you can view or print out a calibration report or export it to PDF format.

You can cancel the calibration any time by clicking **CANCEL**. No data are then used to adjust the sensor.

## Performing numeric input



18 Dialog CALIBRATE > NUMERIC INPUT

1. Click **CALIBRATE > NUMERIC INPUT** .
2. Click **CONTINUE** .
3. Follow the instructions displayed in the instructions part of the program.

After the adjustment, you can view or print out a calibration report or export it to PDF format.

You can cancel numeric input any time by clicking **CANCEL** .

**Example of reference solution entry for oxygen**

Ambient air, pure oxygen or sodium sulfite solution are generally available for the calibration of oxygen sensors. The creation of "ambient air" as a reference is given by way of example here for the "As found - as left measurement" for an oxygen sensor.

1. Under **Manufacturer** enter a value of your choice.
2. Under **Best before** enter the next day. If you want to use the reference frequently, enter a date in the future.
3. Under **Target value unit** select the unit of the target value.
4. Under **Target value** enter 20.95.
5. Under **Lot** enter a value of your choice.

**Replacing the electrolyte or sensor cap**

1. Select the relevant oxygen sensor in the tab.
2. Click **Change electrolyte** or **Change sensor cap** .
3. Follow the instructions displayed in the instructions part of the program.

## 9.3 Sensors

### 9.3.1 Access to data from sensors that are not connected

In the database, you can access saved data from sensors that are not connected. By clicking the square tab  in the main menu section, you can select the sensors whose data you want to access.

Proceed as follows:

1. Click the square tab  in the main menu section.
2. Click **SENSORS** .
3. If **Select sensor by** enable the **Serial number** to activate.
  - ↳ A table overview of the sensors by serial number is displayed.
4. Select a sensor from the table by clicking a row in the table.
  - ↳ You can access the data saved for the sensor in the **SETTINGS, INFORMATION** and **ADMINISTRATION**.

### 9.3.2 Access to data from sensors that are connected

The software imports any data from the sensor that has changed since the last time the sensor was connected.

#### Sensor COS81D

- If a sensor is connected to a specific sensor cap for the first time, the serial number of the sensor cap must be entered manually.
- Data relating to the status of the sensor and sensor cap are recorded separately.

### 9.3.3 Sensors > Settings

Under **SENSORS > SETTINGS** you can:

- View the general information about the sensor
- Load the sensor settings from a template or save them in a template
- Define different sensor settings

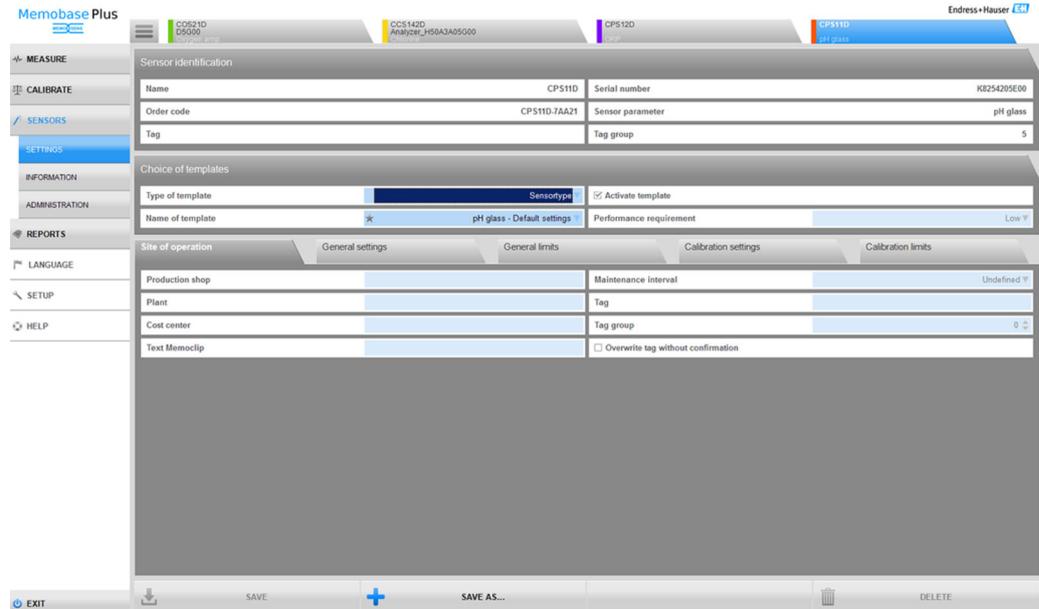
#### **SENSORS > SETTINGS: Choice of templates**

- The type of template indicates whether the template is generally used for one sensor type (e.g. pH glass) or whether it has been created specifically for a measuring point or a sensor (serial number).
- The template is displayed with the template type and name. From the name you can see whether the template in question is a template with standard settings or a new template that has been created with modified settings.

#### **Settings**

You can make and change the following parameter-dependent settings for connected sensors:

- Information on site of operation
- Limit values
- Calibration settings
- Measurement settings (only pH and ORP in the case of "Advanced diagnostics" license)



19 Dialog SENSORS > SETTINGS

## Templates

All the settings which form the basis of the **MEASURE** and **CALIBRATE** main menus are made in the template.

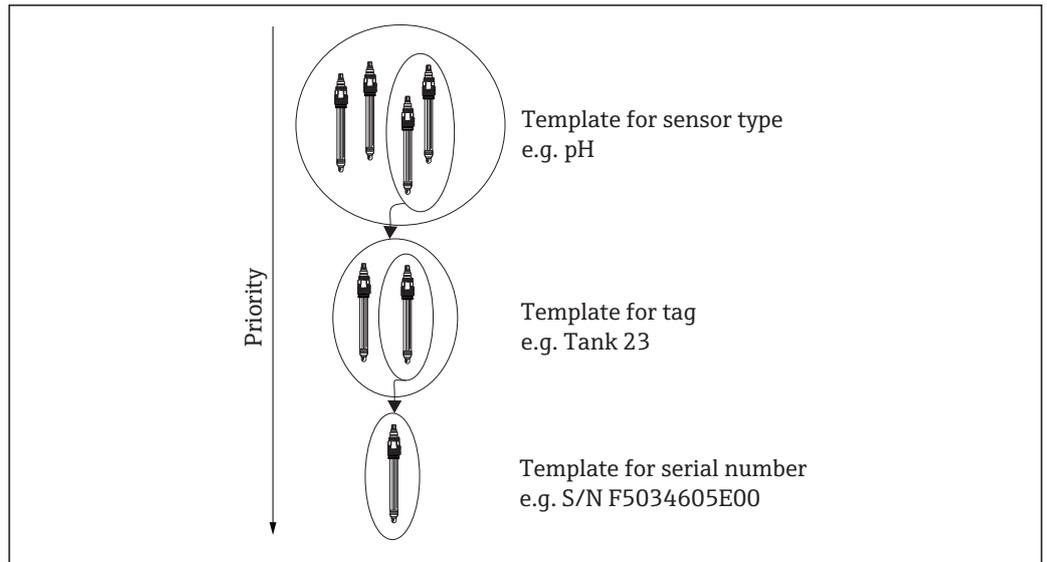
The type of template indicates whether the template is generally used for one sensor type (e.g. pH glass) or whether it has been created specifically for a measuring point or a sensor (serial number). The settings for a special sensor can differ from the settings for a special measuring point. These, in turn, can differ from the general settings for a sensor type. Accordingly, when assigning a template Memobase Plus checks the serial number, tag name and sensor type in that specific order.

The sensor data are synchronized with the active template. Once saved, any changes to an active template take effect immediately.

**i** The user can mark an existing template as active. An asterisk indicates the active template in the list. There is one active template in each category.

If different template types have been saved, the template with the highest priority is used.

This means that if a sensor type template exists, a measuring point template, for example, can rule out all the associated sensors from the sensor type template.

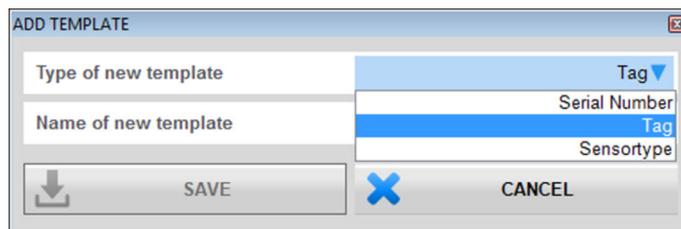


A0030910-EN

20 Template priority

*Creating a template*

Each new template is created on the basis of the standard settings.



21 Window Add template

1. Click **SAVE AS...** .  
↳ The **Add template**.
2. Select the new template type.
3. Click **SAVE** .
4. Define the settings for this template.
5. Click **SAVE** to save all the entries.
6. To enable a new template or another template, tick the check box for **Activate template** .

*Editing or deleting templates*

A template can be created, modified or deleted via **SENSORS > SETTINGS** . If settings for a certain template are to be changed, select the template from the drop-down menu, make the changes and then click **SAVE** . A new data record with a time stamp is created in the

database for the modified template. The existing data records are therefore retained. To delete a template, click **DELETE** .

#### **Operation with a central database and multiple clients:**

- A session opens as soon as a client starts editing the sensor settings. Editing is blocked for all other clients while this client edits the settings.
- The other clients get a message stating that another client is already editing the sensor settings. Another client can only edit the sensor settings when this client's session ends.

If there is no activity, a timer ends the client's session after 8 minutes.

#### **Sensors > Settings: Site of operation**

You can specify information for the following points here:

- Production shop
- Plant
- Cost center
- Text Memoclip
- Maintenance interval
- Tag
- Tag group
- Overwrite tag without confirmation

Then click **SAVE** .

#### **Maintenance interval**

- The following options are possible:
  - **Not defined** (no maintenance interval is specified)
  - **Fixed** (a maintenance interval is specified)
  - **Fixed (Batch process)** (a maintenance interval is specified for the batch process)
- Once **Fixed** or **Fixed (Batch process)** has been selected, additional operating hours warning limits can be configured **General limits** in the tab depending on the parameter.
- A value can be set for each specific operating hours counter than can be configured in the **General limits** tab, e.g. for **Operation at > 80°C/176°F**. This value is subtracted from the global operating hours counter **Operating time (warning)** .
- Once a calibration has been completed, the difference between the global operating hours counter **Operating time (warning)** and the specific operating hours counter is calculated. This difference is compared as a dynamic limit value with the current operating hours counter of the sensor.
- If a dynamic limit value is violated following completion of a calibration, the software issues a diagnostic message specific to the limit value. This is a warning from the software that a global limit value will be exceeded in the subsequent measuring phase.

#### **Sensors > Settings: General settings**

Among other things, you can make settings for the following points here (depends on sensor):

- Operating mode
- Medium comp.
- Damping temperature
- Damping pH
- Temperature compensation type

#### **Sensors > Settings: General limits**

##### *Operating hours limits*

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

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

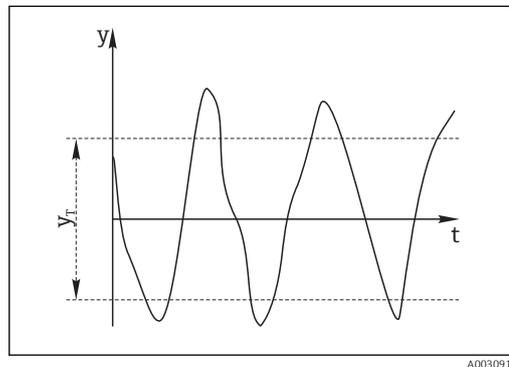
#### Sensor check system

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

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

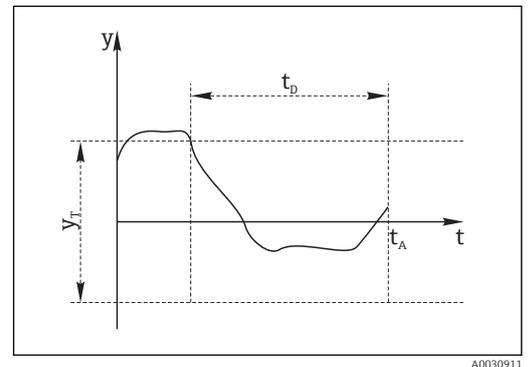
#### Process check system

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



22 Normal measuring signal, no alarm

$y$  Measuring signal  
 $y_T$  Minimum signal variation



23 Stagnating signal, alarm is triggered

$t_D$  Defined time interval  
 $t_A$  Time when the alarm is triggered

The main causes of stagnating measured values are:

- Contaminated sensor, or sensor outside of medium
- Sensor defective
- Process error (e.g. through control system)

#### Remedial action

- Clean the sensor.
- Check positioning of sensor in medium.
- Check measuring chain.

#### Sensor condition check

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

The main reasons for a deteriorating electrode status are:

- Glass membrane blocked or dry
- Diaphragm (reference) blocked

#### Remedial action

- Clean or regenerate the sensor.
- If this does not have the desired effect, replace the sensor.

### Sensors > Settings: Calibration settings

You can make settings for the following points here (depends on the sensor):

- Calibration method
- Stability criterion (band width)
- Stability criterion (duration)

The permitted measured value fluctuation that may not be exceeded within a specific timeframe (**Stability criterion (duration)**) during the calibration is the deviation from the end value configured under **Stability criterion (band width)** .

If the permitted difference (=band width) is exceeded, then the necessary level of stability was not achieved. The calibration is aborted automatically after three attempts, i.e. after three times the duration value entered.

Example:

- Stability criterion (duration) (s) = 20
- Stability criterion (bandwidth) (mV) = 2

**Example:**

- The measured value fluctuates by 2.5 mV for 30 s
- After 30 s the measured value fluctuation is < 2 mV
- The calibration continues after 50 s now that the measured value fluctuation has been < 2 mV for 20 s, in line with the stability criterion

### Sensors > Settings: Calibration limits

Among other things, you can make settings for the following points here (depends on sensor):

- **Calibration validity check on/off** (the calibration validity check for the temperature adjustment must be performed separately)
- Calibration constraints
- Delta zero-point check on/off
- Delta slope check on/off

*Calibration validity check (only for pH sensors)*

Here you can configure that the validity of the sensor calibration is checked on an hourly basis. If no sensor calibration is performed during the set interval, the software displays a warning or an alarm.

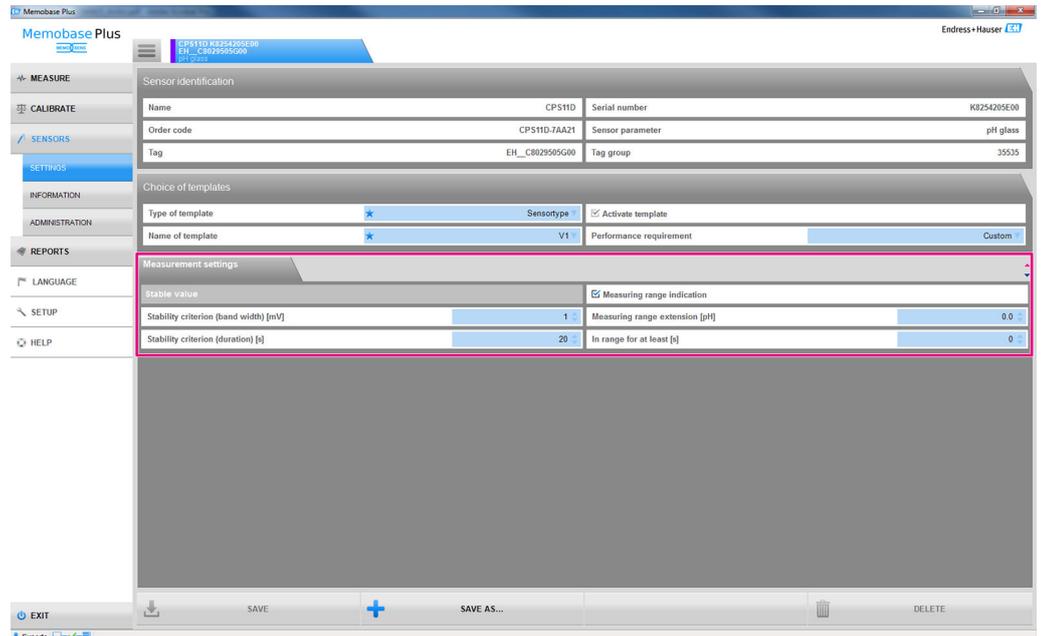
*Calibration constraints (only for pH sensors)*

Memobase Plus determines the deviation at the calibration points. The deviation is the difference between the value measured by the sensor and the known value of the standard.

After checking the **Calibration constraints** check box you can define the maximum permissible deviation between the measured value and the known standard in pH units.

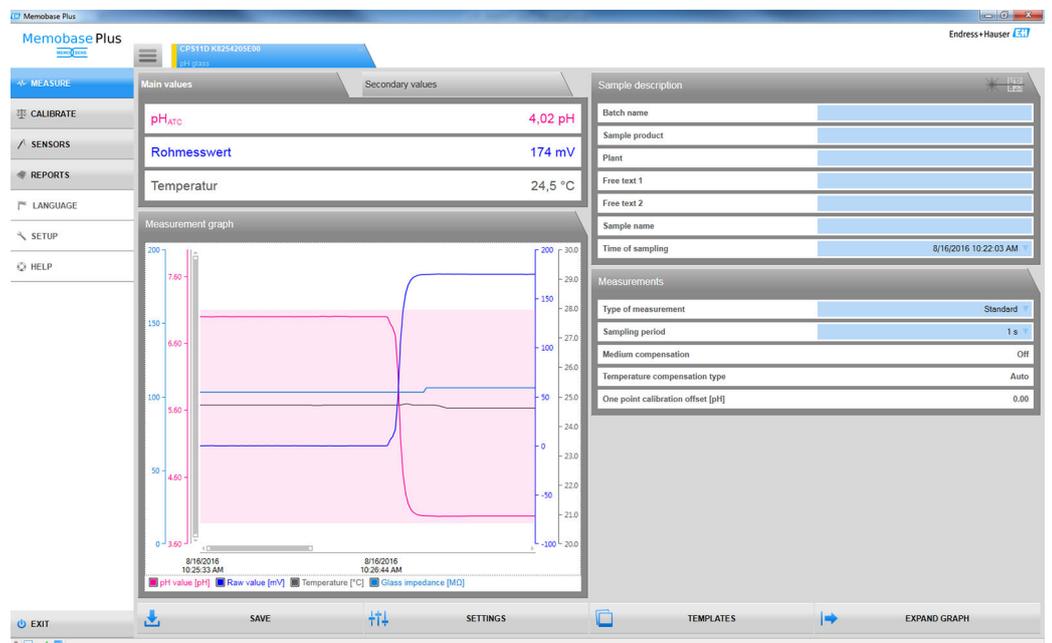
Sensors > Settings: Measurement settings

Measuring range indication



24 Dialog SENSORS >SETTINGS, tab Measurement settings

You can specify tolerances for the sensor measuring range here. The measuring range is based on the values of the last two-point or multipoint calibration. In the case of a multipoint calibration the measuring range is based on the highest and lowest value. The measuring range is highlighted in color in the measurement graph.



25 Measurement graph view: monitoring of measuring range with measuring range extended by 0.1 pH units

You can save and export measured values within the tolerance range. You cannot save and export measured values outside the tolerance range.

If measured values are outside the measuring range, the **Value out of range** message appears in the measurement graph.

### *Stable value*

You can define the following parameters here:

- Stability criterion (band width)
- Stability criterion (duration)

The permitted measured value fluctuation which must not be exceeded in a certain timeframe [=Stability criterion (duration)] during calibration is the deviation from the end value which is configured under Stability criterion (bandwidth).

If the permitted difference (=band width) is exceeded, then the necessary level of stability was not achieved. The calibration is aborted automatically after three attempts, i.e. after three times the duration value entered.

Example:

- Stability criterion (duration) (s) = 20
- Stability criterion (bandwidth) (mV) = 2

If the measured value fluctuates by 2.5 mV for 30 seconds and is then < 2 mV afterwards, calibration resumes after 50 s. The reason is that the measured value was outside the permitted range for 30 s and was then inside the permitted range for 20 s.

## **9.3.4 Sensors > Information**

After connecting the sensor, you can read out the following information from the plug-in head:

- Identification and specification
- "Advanced diagnostics" license: Sensor status
- Information concerning calibrations
- Information concerning operation

### **Sensors > Information > General**

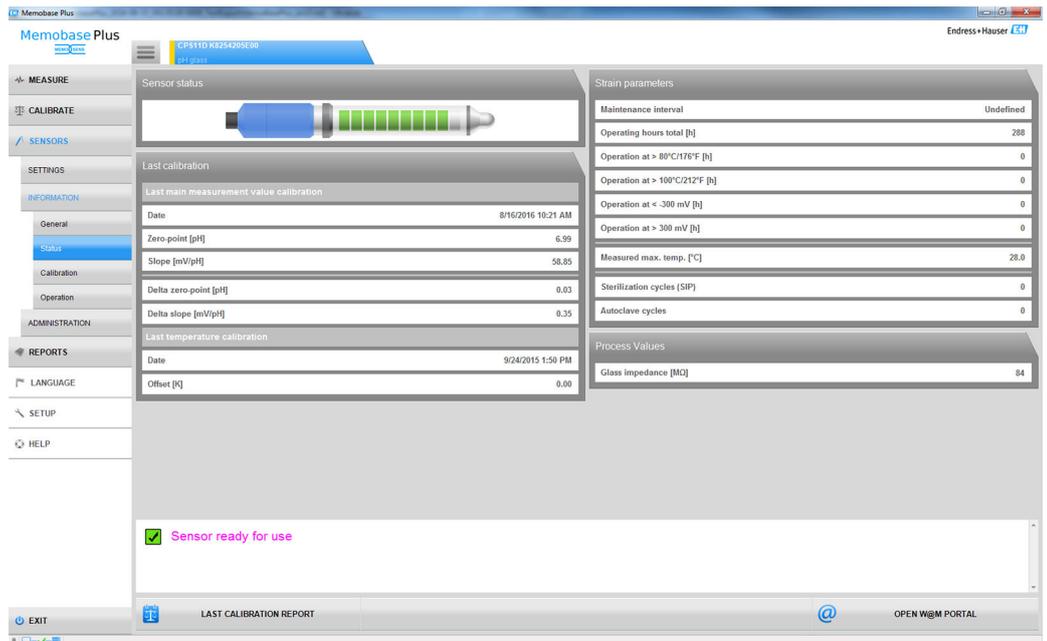
You can find information on the identification and specification of the sensor here.

### **Sensors > Information > Status**

Data relating to the last calibration and stress parameters are displayed here.

"Advanced diagnostics" license:

The sensor status is also indicated graphically and evaluated e.g. with **Sensor ready for next batch**.



26 "Advanced diagnostics" license: evaluation and graphic indication of the sensor status

**i** You can change the graphic indication of the sensor status under **SETUP > SETTINGS** in the **Theme**.

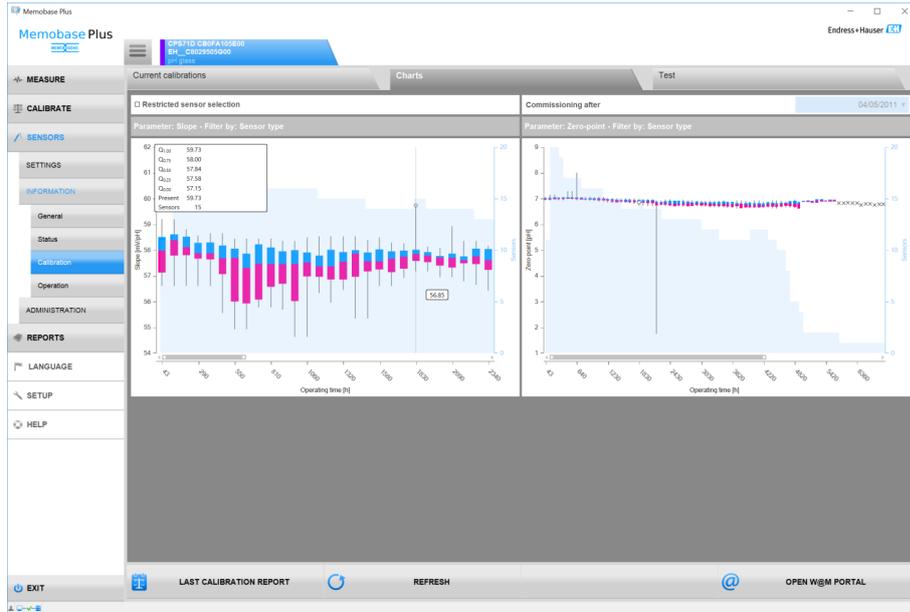
**Sensors > Information > Calibration**

Data relating to the last main measured value and temperature calibration are displayed here.

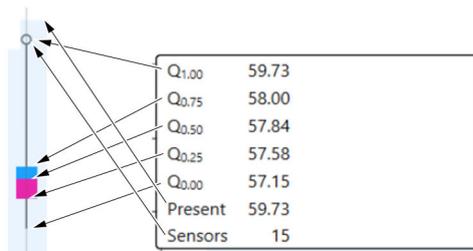
**i** "Advanced diagnostics" license: you can make settings concerning the display format and number of graphs shown under **SETUP > SETTINGS** in the **Advanced diagnosticstab**. You can display 1-4 diagrams.

**pH sensors:**

- The **Charts** tab shows the distribution of the recorded data for zero point and slope over time. Quantiles indicate the % of data recorded at a particular time that is above or below a threshold value.
- The graphs show the quantiles Q0, Q0,25, Q0,50, Q0,75 and Q1.00.
- Quantiles subdivide the data of the recorded data series:
  - The 25% quantile is the value below which at least 25% of the data lie. The remaining % of the values (at maximum) lies above this value.
  - The 50% quantile is the value below which 50% of the data lie etc.
  - The lower quartile is the 25% quantile, the median is the 50 % quantile, the upper quartile is the 75% quantile.



27 Calibration diagram



28 Calibration diagram, detailed view

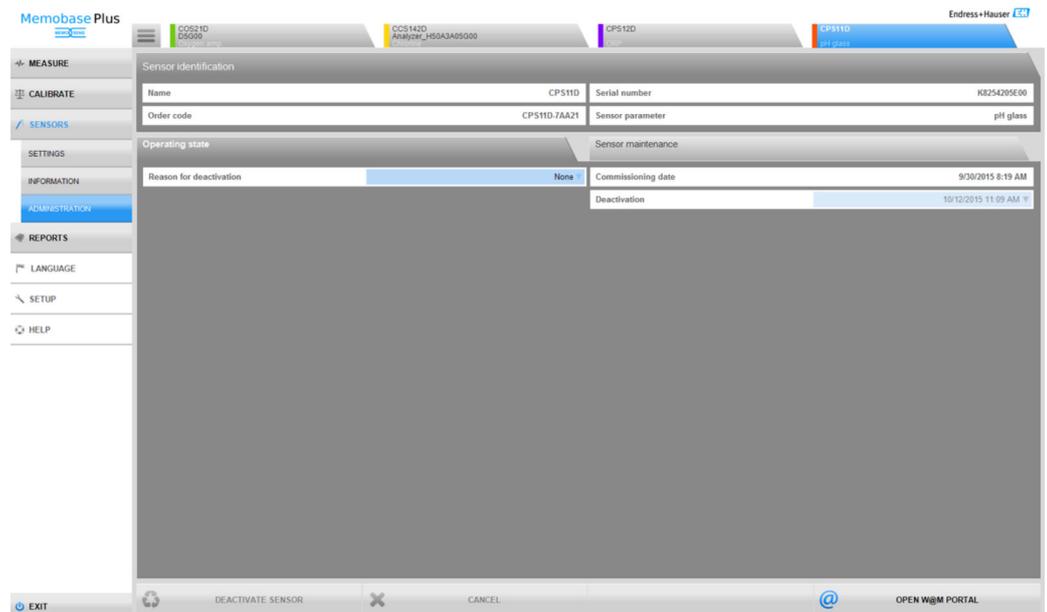
**Sensor COS81D:**

Displays the reference calibrations (the first calibration following a cap replacement is regarded as a reference calibration)

**Sensors > Information > Operation**

Information about the stress parameters and process values is displayed here.

### 9.3.5 Sensors > Administration



29 Dialog **SENSORS > ADMINISTRATION**

You can open the W@M PORTAL directly from here.

**i** First enter your access data (once only) for the W@M-Portal under **SETUP > SETTINGS > W@M Portal** field.

**i** **Operation with a central database and multiple clients:**

- If multiple clients change data simultaneously in the **SENSORS > ADMINISTRATION** dialog, the system rejects the data of the client that is the first to save the data.
- The clients get a message stating that the data have already been changed by another client in the meantime.

#### Sensors > Administration: Sensor identification

You can read the following information under **Sensor identification** :

- Name
- Order code
- Serial number
- Sensor parameter

#### Sensors > Administration: Operating state

You can provide information for the following points under the **Operating state** tab:

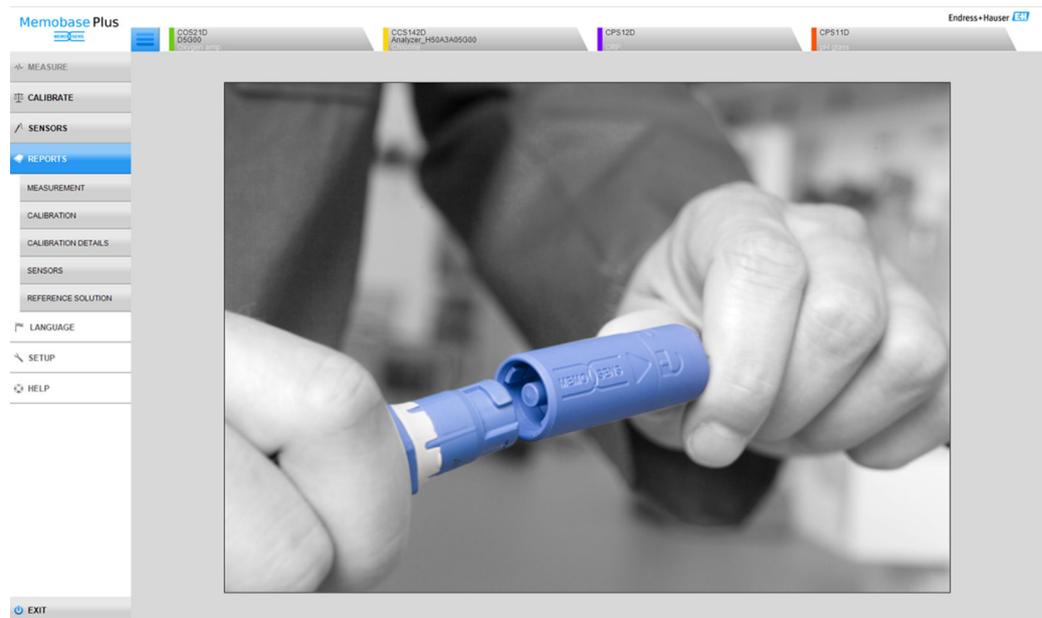
- Date of commissioning  
First time connecting to a transmitter or Memobase Plus
- Deactivation  
Database will cease to recognize the sensor
- Reason for deactivation  
For your statistics

### Sensors > Administration: Sensor maintenance

You can provide information for the following points under the **Sensor maintenance** tab:

- Site of operation
  - Memoclip text
  - Identifier
  - Device tag
  - Device tag group
- Autoclave
  - Autoclaving cycles

## 9.4 Reports



30 Menu **REPORTS**

Detailed parameter-dependent information concerning:

- MEASUREMENT
- CALIBRATION
- CALIBRATION DETAILS
- SENSORS
- REFERENCE SOLUTION

Ways to customize the table:

- Use drag & drop to change the order of the tabs (is saved individually when user administration is switched on)
- Right-click the column headers to sort or group the information, or to remove columns from the view
- Click the arrow button beside each tab to change how the entries are sorted (in ascending or descending order)
- Drag to adjust the column width
- The first row contains a search function. You can search for specific entries via the search box.
- By dragging the column headers into the area above the column head, it is possible to display data grouped by measuring type, measured variable, sensor type etc.

The individual reports can be:

- Viewed by double-clicking the relevant data record or clicking the button **CALIBRATION REPORT**
- Printed out
- Exported to PDF format
- Exported in XML format to a predefined directory
- Exported to CSV format

The report is always created for the highlighted data record.

Furthermore, you also have the option of exporting the entire data record to CSV or XML format.

 When user administration is activated, the user performing the action is automatically entered. You can specify who checked and approved the report.

### Adding information to the report

You can add the following information for the reports:

- Comments
- information **Performed by:**
- information **Checked by:**
- information **Approved by:**

1. If necessary: Enter a comment using the **Comment** button.
2. If necessary: After opening the report, enter information for **Performed by:** .
3. If necessary: After opening the report, enter information for **Checked by:** .
4. If necessary: After opening the report, enter information for **Approved by:** .

### Exporting the report as a PDF file

- ▶ A printer must be installed on the computer to export reports to PDF format. This can also be a virtual printer, such as PDFCreator.

### Exporting the report as an XML file

- ▶ Reports can be exported to a directory as an XML file. Under **SETUP > SETTINGS** in the **Export** tab.

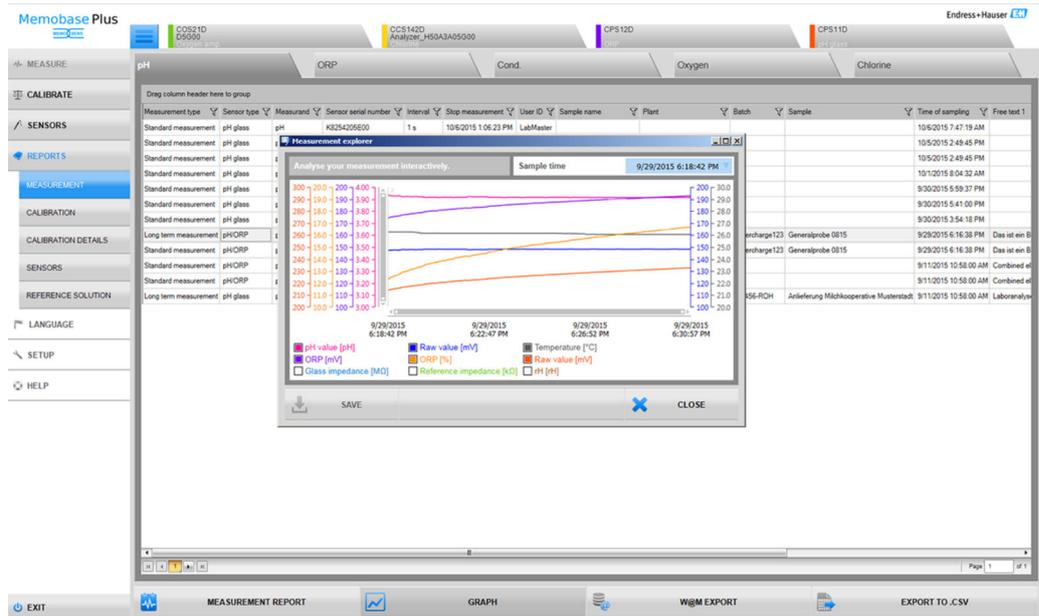
By checking the **Export automatically** box, Memobase Plus exports the data automatically after every measurement or calibration. If the **Export automatically** box is not checked, you must press the **Export to directory** button to trigger the export.

### Opening CSV files in Excel

Proceed as follows to ensure the CSV files are displayed correctly in Excel:

1. Open Excel.
2. Click **Data > From Text**.
3. Select the CSV file and click **Open**.
  - ↳ The text conversion wizard opens.
4. Select **File source: 65001: Unicode (UTF-8)**.
5. Click **Finish**.

### 9.4.1 Reports > Measure



31 Dialog **REPORTS > MEASURE**

Here you can find various items of information on the measurements made and saved. Clicking **GRAPH** opens a window in which you can analyze your measurements interactively.

### 9.4.2 Reports > Calibration

Here you can find various items of information on the calibrations made and saved.

A calibration report is generated by clicking the **CALIBRATION REPORT** button or double-clicking a row in the table.

### 9.4.3 Reports > Calibration details

Here you can find various items of information on the calibrations made and saved.

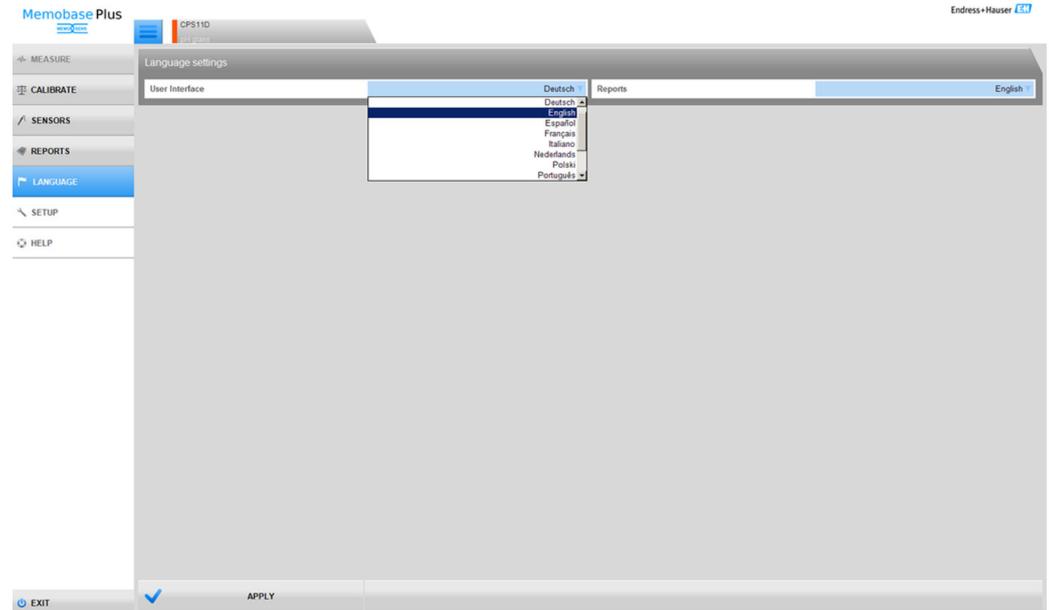
### 9.4.4 Reports > Sensors

Here you can find various items of information saved about the sensors.

### 9.4.5 Reports > Reference solutions

Here you can find various items of information saved about the reference solutions.

## 9.5 Language



32 LANGUAGE menu

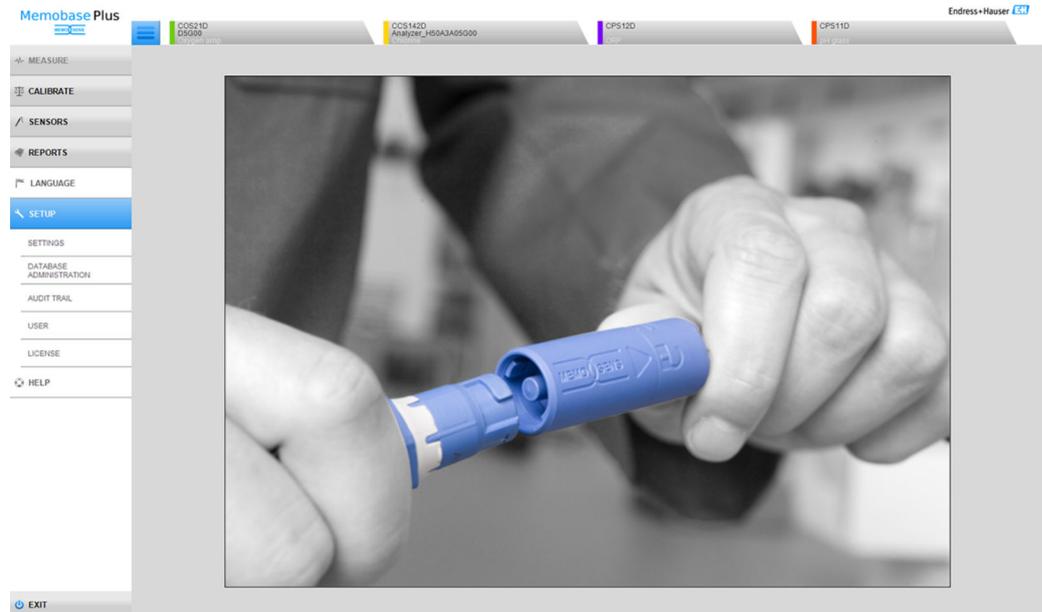
The language of the user interface can be easily changed if users who speak another language would like to work with the database.

The language in which the reports appear can also be changed.

### Change language

1. Click **LANGUAGE**.
  - ↳ The language settings are displayed.
2. Select the desired language for the user interface or reports, e.g. German.
3. Click **Apply**.
  - ↳ The software switches to the new language selected. This does not affect the saved data.

## 9.6 setup



33 Menu **SETUP**

You can configure the following points here:

- SETTINGS
- DATABASE ADMINISTRATION
- **AUDIT TRAIL** ("Pharmaceutical compliance" license)
- USER
- LICENSE

### 9.6.1 Setup > Settings

#### Working with databases in Memobase Plus

Memobase Plus is based on a client-server architecture and allows several clients to access a shared central database.

#### Supported databases:

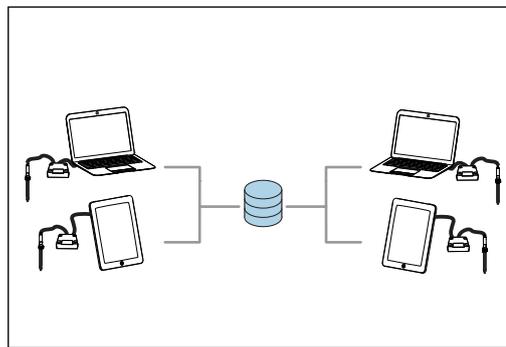
- Microsoft SQL Server (included in delivery)
- Oracle (interface available)

#### Possible installations:

- Local installation on a PC or Windows-based tablet
- Central installation for simultaneous use by multiple PCs or Windows-based tablets

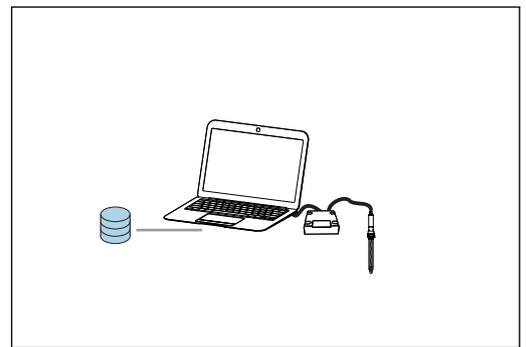
#### Possible operating modes:

- Master mode:
  - A local or central database is connected to Memobase Plus
- Master-slave mode:
  - A central database is set up as the "master" and one or more local databases act as the "slave"
  - Data can be saved in a local database and transmitted to a central database at a later stage



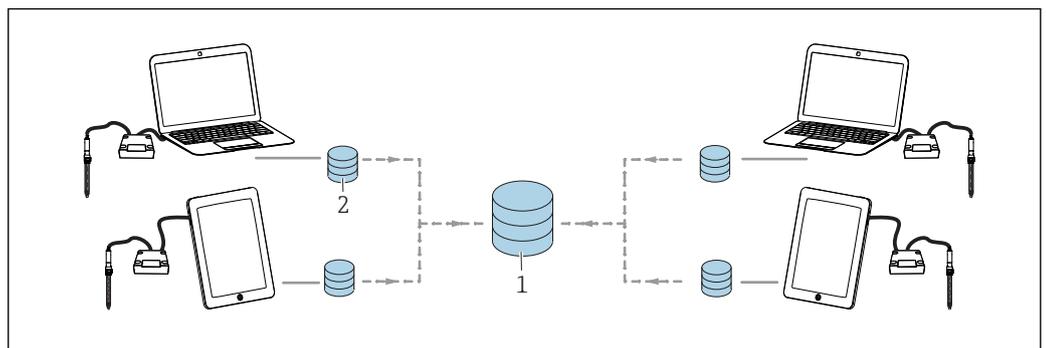
A0031877

34 Example 1 for master mode: installation with 1 central database which 4 clients access



A0031878

35 Example 2 for master mode: installation with 1 local database



A0031870

36 Example for master-slave mode: installation with 1 central and 4 local databases

- 1 Central database (master)
- 2 Local databases (slaves)

#### Migrating the PostgreSQL database

From version 02.00.00, the database provided is Microsoft SQL Server instead of PostgreSQL.

The data from earlier versions of Memobase Plus, an existing PostgreSQL database or Oracle database are migrated when Memobase Plus is started.



The data for the chlorine parameter are deleted during migration.

The data are backed up, thus enabling a downgrade to the previous release of Memobase Plus.

### Setting up operation with master database

In the master mode, you can connect a local or central database with Memobase Plus. You need to initialize the master database in Memobase Plus for this purpose.

If you prefer to work with one central and one or more local databases, set up the master-slave mode (→ 65).

The following data can be saved in a database running in master mode:

- Measured data
- Calibration data
- Sensor data
- User administration data
- Reference solution

### Initializing the master database

1. Go to the **SETUP > SETTINGS** in the **Master database** .
2. Configure local database as master database: accept the standard settings.
3. Configure central database as master database: make user-defined settings for the central database. For information on how to connect to different types of database, see the "Connecting the database with Memobase Plus" section (→ 67)
4. The connection to the database can be tested by clicking the **TEST**.
5. Then initialize the master database via the **Initialize master database** button.

 For the master mode, you must go to **SETUP > SETTINGS** , select the **Slave database** tab and uncheck the **Activate master-slave mode** box.



 37 Disabled Activate master-slave mode

### Setting up operation with master and slave database

The master-slave mode allows you to work with one central and one or more local databases. In this mode, you assign the role of "Master" to the central database and the role of "Slave" to the local database.

Synchronization must be triggered to exchange data between the master and slave database. For more information, see the "Synchronizing databases" section (→ 71).

The following data can be saved in a database running in master mode:

- Measured data
- Calibration data
- Sensor data
- User administration data

The following data can be saved in a database running in slave mode:

- Measured data
- Calibration data
- Sensor data
- Reference solution

### Initializing the master database

1. Go to the **SETUP > SETTINGS** in the **Master database** .
2. Specify the central database which is to be configured as the master. For information on how to connect to different types of database, see the "Connecting the database with Memobase Plus" section (→ 67).

3. The connection to the database can be tested by clicking the **TEST**.
4. Then initialize the master database via the **Initialize master database** button.

#### Setting up the slave database

1. Go to the **SETUP > SETTINGS** in the **Slave database** .
2. Activate the master-slave mode by ticking the **Activate master-slave mode** check box.
3. Adopt the standard settings or make user-defined settings. For information on how to connect to different types of database, see the "Connecting the database with Memobase Plus" section(→  67).
4. The connection to the database can be tested by clicking the **TEST**.
5. Then initialize the slave database via the **SETUP SLAVE DATABASE** button.
  - ↳ The message **The slave database has been successfully set up.** appears.

## Connecting the database with Memobase Plus

### Connecting the Microsoft SQL Server



For detailed information on the Microsoft SQL Server, see the Microsoft SQL documentation

To connect a Microsoft SQL Server with Memobase Plus, proceed as follows:

1. Click **SETUP > SETTINGS** .
2. Depending on whether you want to connect a database in the master or master-slave mode, go to the **Master database** or **Slave database** tab.
3. Under **Database management system** select the database type.
4. **Custom** Select the option.
5. Enter a database name that matches the name of the relevant Microsoft SQL Server.
6. Specify a user name that is registered on the relevant Microsoft SQL Server.
7. Specify a password for authentication.
8. Specify the server address in the form of the IP address\InstanceID, e.g. localhost \SQLEXPRESS.
9. Specify the time until the connection times out.
10. Specify the time until the command times out.
11. The **TEST** button.
12. Click **APPLY** .
13. Click **OK** . Memobase Plus must be restarted before it can accept the changes.
  - ↳ A dialog box to confirm the program restart is displayed.
14. Click **OK** .

### Connecting the Oracle database

Proceed as follows to connect an Oracle database with Memobase Plus:

1. Click **SETUP > SETTINGS** .
2. Depending on whether you want to connect a database in the master or master-slave mode, go to the **Master database** or **Slave database** tab.
3. Under **Database management system** select the **Oracle Database 10g 10.2.x or higher** .
4. **Custom** option.
5. Select a type of connection.
6. Provide more specifics on the Oracle database used in line with the type of connection selected.
7. Specify a user name that is registered on the Oracle server.
8. Specify a password for authentication.
9. The **TEST** button.
10. Click **APPLY** .
11. Click **OK** . Memobase Plus must be restarted before it can accept the changes.
  - ↳ A dialog box to confirm the program restart is displayed.
12. Click **OK** .

### Setup > Settings: User administration

If you want to protect the system against unauthorized operation, enable the security system by using the user administration function. After you have installed the software for the first time user administration is disabled by default.

Under **SETUP > SETTINGS > User administration** you can enable the user administration function and make various settings concerning the password, password protection and user settings.

 Make sure your user name and password are stored in a safe place. If you lose this information it is not possible to recover the saved data.

In addition to enabling user administration, you also define the requirements which the passwords must meet.

 First create a user with the Expert/Service role under **SETUP > USER** to be able to use the user administration function.

### Setup > Settings: Reports

Under **SETUP > SETTINGS > REPORTS** you can choose whether you want to insert the standard logo or another logo on the reports.

### Setup > Settings: General

You can make the following settings under **SETUP > SETTINGS > General** :

- Select the unit for temperature:
  - Degrees Celsius [°C]
  - Degrees Fahrenheit [°F]
  - Kelvin [K]
- Select the sensor identification that is displayed in the tab:
  - Serial number
  - Memoclip
  - Identification string
- Assign the client an alias:
 

Assign a name to the client so that the client can be clearly identified in a network. The serial number is entered here by default.
- Connecting the barcode reader with Memobase Plus:
 

If the barcode reader is not recognized automatically, it must be connected with Memobase Plus by scanning a barcode in Memobase Plus

#### *Connecting the barcode reader with Memobase Plus*

 The following barcode readers are supported in Memobase Plus:

- Barcode reader with USB-COM interface
- Barcode reader with USB-HID interface

The interface must be configured on the barcode reader.

You can use a barcode reader for the following actions:

- Recording the data of Endress+Hauser reference solutions
- Recording sample data

 The following symbols indicate whether Memobase Plus is connected to a barcode reader or not:

-  (barcode reader connected)
-  (barcode reader not connected)

If the barcode reader is not connected with Memobase Plus, you must connect it.

#### **Connecting the barcode reader with Memobase Plus**

1. Install the USB-COM driver for the barcode reader as described in the technical documentation provided by the barcode reader manufacturer.
2. Set the interface settings for the barcode reader to USB-COM-STD.

3. In Memobase Plus go to **SETUP > SETTINGS** .
4. Connect the barcode reader with Memobase Plus by scanning the QR code displayed in Memobase Plus.
  - ↳ The barcode reader is now connected with Memobase Plus.

### Setup > Settings : W@M Portal

Under **SETUP > SETTINGS > W@M Portal** you can access the Endress+Hauser W@M Portal. This portal contains additional information and documents for your sensors.

#### Setting up W@M access

1. Enter your W@M user ID.
2. Enter your W@M password.
3. Enter the browser address.
4. Enter the URL.
5. Click OK.
  - ↳ Now you can access W@M information directly.



To access W@M information, the computer must have Internet access and an appropriate contract must be agreed with Endress+Hauser.

### Setup > Settings: Export

Under **Export** , you can specify a directory into which measuring and calibration data are exported. The data are saved as a PDF file and an XML file in the directory indicated.

By checking the **Export automatically** box, you enable automatic export after every measurement or calibration.

### Setup > Settings: Design

Under **Theme** , you can set the optical display format for the sensor condition and the signal colors.

### Setup > Settings: Advanced diagnostics ("Advanced diagnostics" license)

Under Advanced diagnostics, you specify the type and number of graphs displayed for a certain sensor type.

### Setup > Settings: Diagnostics

Memobase Plus continuously monitors its own functions. Diagnostic messages are displayed in the status bar.

Here you can also specify which diagnostic messages should be confirmed in a pop-up window if they occur.



Select several diagnostic messages by pressing the Shift key or the Ctrl key.

### *Classification of diagnostic messages*

In accordance with Namur specification NE 107, the diagnostic messages are characterized by:

- Message number
- Error category (letter in front of the message number)
  - F = (Failure) a malfunction has been detected
  - S = (Out of specification), the measuring point is being operated outside its specifications. Operation can continue. However, you run the risk of increased wear, shorter operating life or lower measurement accuracy. The cause of the problem is to be found outside the measuring point.
  - M = (Maintenance required), action should be taken as soon as possible
- Message text

### *Adapting the diagnostic behavior*

All the diagnostic messages are assigned to specific error categories at the factory. If a message occurs, a window opens which must be confirmed. This function can be enabled or disabled individually for every diagnostic message by checking or unchecking the box.

### **Example**

Memobase Plus returns the diagnostic message F100 **Sensor no communication**. You want to change this message so that it does not have to be acknowledged, for instance.

1. Go to the **SETUP > SETTINGS > Diagnostics** .
2. Select the diagnostic message.
3. Deactivate the message (uncheck the diagnostic message).
4. Click **APPLY** .
  - ↳ The message now only appears in the status bar.

### **Changing the view**

The messages can be sorted in ascending or descending order using the bar.



Select several diagnostic messages by pressing the Shift key or the Ctrl key.

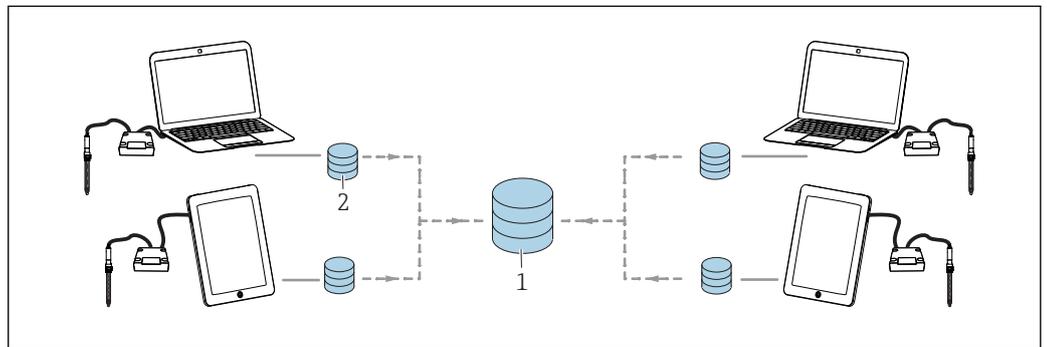
## 9.6.2 Setup > Database administration

### Synchronizing the databases

You can synchronize the data in a local database (database configured as a slave) with a central database (database configured as a master). This can be necessary if you have saved measurement or calibration data, for example, in a local database on a Windows-based tablet. These data can be transmitted to a central database. The local database is emptied after synchronization and can be populated with new data.

*Data transmitted during synchronization:*

Master to slave	Slave to master
<ul style="list-style-type: none"> <li>■ Templates</li> <li>■ Reference solution</li> <li>■ Specifications from user administration</li> </ul>	<ul style="list-style-type: none"> <li>■ Sensor data</li> <li>■ Measuring and calibration data</li> <li>■ Reference solutions recorded in slave database</li> <li>■ Data recorded in the audit trail ("Pharmaceutical compliance" license)</li> </ul>



38 Master-slave mode with synchronization: 4 local databases are synchronized with 1 central database

**i** The local slave database is emptied and re-initialized after synchronization.

### Synchronizing the local database (slave database) with the central database (master database)

1. Remove all connected Memolink sensor terminal boxes and sensors.
2. Click **SETUP > DATABASE ADMINISTRATION**. The settings made under **SETUP > SETTINGS** for the master and slave database are displayed.
3. Click **SYNCHRONIZE**.
  - ↳ A dialog box appears with a warning that the slave database will be emptied and re-initialized.
4. Confirm the dialog.
  - ↳ A dialog box with the message **The master - slave database synchronization has completed successfully** appears.
5. Confirm the dialog box with **OK**.

### Copying the database

You can copy the data from a source database to a target database.

 When you copy the data, the data of the target database are overwritten.

1. Click **SETUP > DATABASE ADMINISTRATION** .
2. When configuring the database connection to the source database, specify the source database to be copied.
3. When configuring the database connection to the target database, specify the target database into which the data should be copied.
4. Click **COPY** .
  - ↳ A dialog box appears warning the user that the data in the target database will be overwritten.
5. Confirm the dialog.
  - ↳ A dialog box with the message "The database has been copied successfully" appears.
6. Confirm the dialog box with **OK** .

### Importing and exporting data

You can export data from a source database to another target database. You can export a copy of your Postgre SQL database to an Oracle database server, for example.

1. Click **SETUP > DATABASE ADMINISTRATION** .
2. Under **Database management system** select the type of database management system.
3. Select the **Standard** or **User defined** option button to adopt the standard settings or to make user-defined settings.
4. Specify the source database. You can test the connection to the server of the source database with the **TEST SOURCE CONNECTION** button.
5. Under **Destination database connection settings** specify the database into which the data should be exported.
6. Click **COPY** .

### 9.6.3 Setup > Audit trail

 Memobase Plus supports user administration functions, electronic documentation and signatures in accordance with "Food and Drug Administration (FDA)" – 21 CFR Part 11

The complete range of functions of the audit trail is available only with the "Pharmaceutical compliance" license.

The "Memobase Plus Basic" and "Advanced Diagnostics" licenses allow read-only access to the diagnostic messages in the audit trail.

The audit trail is needed for traceability purposes. It constitutes a chronological account in table form of all the actions and events that have occurred. The most recent action is listed at the top. All the actions are displayed in the table.

If user administration is activated, details on the current user are saved for every entry. This is in addition to the chronological audit trail logging. To ensure full and complete documentation, it is not possible to manipulate or delete entries.

There are various ways to search for a specific entry:

- Client alias
- Start (time stamp)
  - Date and time
- End (time stamp)
  - Date and time
- User ID
  - Users created
- Category
  - Application
  - Diagnostics
  - Sensors
  - User administration
  - Templates
  - Measurement
  - Calibration
- Text
  - Free text

Furthermore, the arrangement and the width of the tabs can be modified. The order of the entries can be sorted and changed using the arrow symbol on the tab. You can print out and export the desired entries.

### 9.6.4 Setup > Users

To protect Memobase Plus against unauthorized or undesired modifications, you can allow database access only to certain users who have a database password, and assign user roles to these users. For the user roles, see the "User roles" section.

## Adding users

### Creating new users

1. Click **SETUP > USER > NEW** .  
↳ The **Create new user** dialog appears.

39 Dialog box **Create new user**

2. Enter User ID, name and password. You can specify the requirements for the password under **SETUP > SETTINGS > User administration** .
3. Assign a role to the user.
4. Click **OK** to save the settings made.

### Editing users

1. **SETUP > USER > EDIT** option.
2. The **Edit user** dialog appears.

40 Dialog box **Edit user**

3. Make the desired changes.
4. Click **OK** to save the settings made.

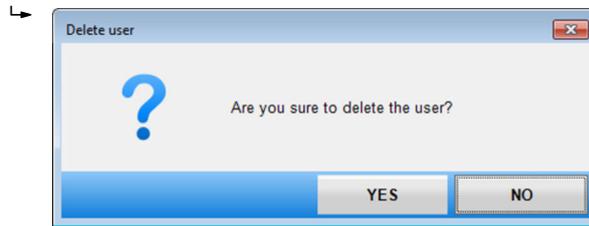


#### **Operation with a central database and multiple clients:**

- If several clients change the user data simultaneously, the system rejects the data of the client that is the first to save the data.
- The clients get a message stating that the data have already been changed by another client in the meantime.

### Deleting users

1. Under **SETUP > USER** select the user that you want to delete in the table.
2. Click **DELETE** .
3. The **Delete user** dialog appears.



41 Dialog box Delete user

4. If you want to delete the user, click **YES** .

### Password forgotten

- i** If you have forgotten your password:
  - User role **Restricted Operator, Operator, Maintenance Engineer** and **Expert / Service engineer**:
    - Contact your system administrator.
    - The **Administrator** user role can reset users' passwords.
  - **Administrator** user role:
    - Contact Endress+Hauser Service.
    - In this case, it is not possible to recover a password if you have forgotten it.
    - For more information, see [www.endress.com](http://www.endress.com)

### Settings

Here you can make the same settings as under **SETUP > SETTINGS > User administration**.

## 9.6.5 Setup > License

### Setup > License > Licensing

A detailed description of the licensing process is provided in the "License activation" section.

If you have already activated Memobase Plus, you can find information on the license here.

### Setup > License > Functions

Here you can enable functions, view active and inactive functions and remove and add licenses.

The functional range depends on the order configuration. For function packages, see the "Software function section".

- ▶ Follow the instructions displayed in the instructions part of the program.

## 9.7 Help

If you click **HELP** the Operating Instructions open in PDF format.

## 10 Accessories

The following are the most important accessories available at the time this documentation was issued.

- ▶ For accessories not listed here, please contact your Service or Sales Center.

### 10.1 Kits

#### **Kit CYZ71D MemoLink for Memosens (incl. USB cable)**

Order No. 71163002

#### **Kit CYZ71D USB cable**

Order No. 71162980

### 10.2 Measuring cable

#### **Memosens laboratory cable CYK20**

- For digital sensors with Memosens technology
- Product Configurator on the product page: [www.endress.com/cyk20](http://www.endress.com/cyk20)

#### **Memosens data cable CYK10**

- For digital sensors with Memosens technology
- Product Configurator on the product page: [www.endress.com/cyk10](http://www.endress.com/cyk10)



Technical Information TI00118C

### 10.3 Standard solutions

#### **High-quality buffer solutions from Endress+Hauser - CPY20**

The secondary buffer solutions have been referenced to primary reference material of the PTB (German Federal Physico-technical Institute) or to standard reference material of NIST (National Institute of Standards and Technology) according to DIN 19266 by a laboratory accredited by the DAkkS (German accreditation body) according to DIN 17025. Product Configurator on the product page: [www.endress.com/cpy20](http://www.endress.com/cpy20)

#### **Conductivity calibration solutions CLY11**

Precision solutions referenced to SRM (Standard Reference Material) by NIST for qualified calibration of conductivity measuring systems in accordance with ISO 9000

- CLY11-A, 74  $\mu\text{S}/\text{cm}$  (reference temperature 25 °C (77 °F)), 500 ml (16.9 fl.oz)  
Order No. 50081902
- CLY11-B, 149.6  $\mu\text{S}/\text{cm}$  (reference temperature 25 °C (77 °F)), 500 ml (16.9 fl.oz)  
Order No. 50081903
- CLY11-C, 1.406 mS/cm (reference temperature 25 °C (77 °F)), 500 ml (16.9 fl.oz)  
Order No. 50081904
- CLY11-D, 12.64 mS/cm (reference temperature 25 °C (77 °F)), 500 ml (16.9 fl.oz)  
Order No. 50081905
- CLY11-E, 107.00 mS/cm (reference temperature 25 °C (77 °F)), 500 ml (16.9 fl.oz)  
Order No. 50081906



Technical Information TI00162C

#### **COY8**

Zero-point gel for oxygen and disinfection sensors

- Oxygen-free and chlorine-free gel for the verification, zero point calibration and adjustment of oxygen and disinfection measuring points
- Product Configurator on the product page: [www.endress.com/coy8](http://www.endress.com/coy8)



Technical Information TI01244C

## 10.4 Sensors

### 10.4.1 Glass electrodes

#### Orbisint CPS11D

- pH sensor for process technology
- Optional SIL version for connecting to SIL transmitter
- With dirt-repellent PTFE diaphragm

 Technical Information TI00028C

#### Memosens CPS31D

- pH electrode with gel-filled reference system with ceramic diaphragm
- Product Configurator on the product page: [www.endress.com/cps31d](http://www.endress.com/cps31d)

 Technical Information TI00030C

#### Ceraliquid CPS41D

pH electrode with ceramic junction and KCl liquid electrolyte

 Technical Information TI00079C

#### Ceragel CPS71D

pH electrode with reference system including ion trap

 Technical Information TI00245C

#### Memosens CPS171D

- pH electrode for bio-fermenters with digital Memosens technology
- Product Configurator on the product page: [www.endress.com/cps171d](http://www.endress.com/cps171d)

 Technical Information TI01254C

#### Orbipore CPS91D

pH electrode with open aperture for media with high dirt load

 Technical Information TI00375C

#### Orbipac CPF81D

- Compact pH sensor for installation or immersion operation
- In industrial water and wastewater
- Product Configurator on the product page: [www.endress.com/cpf81d](http://www.endress.com/cpf81d)

 Technical Information TI00191C

### 10.4.2 Enamel pH electrodes

#### Ceramax CPS341D

- pH electrode with pH-sensitive enamel
- Meets highest demands of measuring accuracy, pressure, temperature, sterility and durability
- Product Configurator on the product page: [www.endress.com/cps341d](http://www.endress.com/cps341d)

 Technical Information TI00468C

### 10.4.3 ORP sensors

#### Orbisint CPS12D

ORP sensor for process technology

 Technical Information TI00367C

**Ceraliquid CPS42D**

ORP electrode with ceramic junction and KCl liquid electrolyte



Technical Information TI00373C

**Ceragel CPS72D**

ORP electrode with reference system including ion trap



Technical Information TI00374C

**Orbipac CPF82D**

- Compact ORP sensor for installation or immersion operation in process water and wastewater

- Product Configurator on the product page: [www.endress.com/cpf82d](http://www.endress.com/cpf82d)



Technical Information TI00191C

**Orbipore CPS92D**

ORP electrode with open aperture for media with high dirt load



Technical Information TI00435C

#### 10.4.4 pH ISFET sensors

**Tophit CPS441D**

- Sterilizable ISFET sensor for low-conductivity media
- Liquid KCl electrolyte



Technical Information TI00352C

**Tophit CPS471D**

- Sterilizable and autoclavable ISFET sensor for food and pharmaceuticals, process engineering
- Water treatment and biotechnology



Technical Information TI00283C

**Tophit CPS491D**

ISFET sensor with open aperture for media with high dirt load



Technical Information TI00377C

#### 10.4.5 pH and ORP combined sensors

**Memosens CPS16D**

- Combined pH/ORP sensor for process technology
- With dirt-repellent PTFE diaphragm
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cps16D](http://www.endress.com/cps16D)



Technical Information TI00503C

**Memosens CPS76D**

- Combined pH/ORP sensor for process technology
- Hygienic and sterile applications
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cps76d](http://www.endress.com/cps76d)



Technical Information TI00506C

**Memosens CPS96D**

- Combined pH/ORP sensor for chemical processes
- With poison-resistant reference with ion trap
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cps96d](http://www.endress.com/cps96d)



Technical Information TI00507C

**10.4.6 Conductivity sensors with inductive measurement of conductivity****Indumax CLS50D**

- High-durability inductive conductivity sensor
- For standard and hazardous area applications
- Product Configurator on the product page: [www.endress.com/cls50d](http://www.endress.com/cls50d)



Technical Information TI00182C

**Indumax H CLS54D**

- Inductive conductivity sensor
- With certified, hygienic design for foodstuffs, beverages, pharmaceuticals and biotechnology
- Product Configurator on the product page: [www.endress.com/cls54d](http://www.endress.com/cls54d)



Technical Information TI00508C

**10.4.7 Conductivity sensors with conductive measurement of conductivity****Condumax CLS15D**

- Conductive conductivity sensor
- For pure water, ultrapure water and hazardous area applications
- Product Configurator on the product page: [www.endress.com/CLS15d](http://www.endress.com/CLS15d)



Technical Information TI00109C

**Condumax CLS16D**

- Hygienic, conductive conductivity sensor
- For pure water, ultrapure water and Ex applications
- With EHEDG and 3A approval
- Product Configurator on the product page: [www.endress.com/CLS16d](http://www.endress.com/CLS16d)



Technical Information TI00227C

**Condumax CLS21D**

- Two-electrode sensor in plug-in head version version
- Product Configurator on the product page: [www.endress.com/CLS21d](http://www.endress.com/CLS21d)



Technical Information TI00085C

**Memosens CLS82D**

- Four-electrode sensor
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cls82d](http://www.endress.com/cls82d)



Technical Information TI01188C

## 10.4.8 Oxygen sensors

### **Oxymax COS22D**

- Sterilizable sensor for dissolved oxygen
- With Memosens technology or as an analog sensor
- Product Configurator on the product page: [www.endress.com/cos22d](http://www.endress.com/cos22d)



Technical Information TI00446C

### **Oxymax COS51D**

- Amperometric sensor for dissolved oxygen
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cos51d](http://www.endress.com/cos51d)



Technical Information TI00413C

### **Memosens COS81D**

- Sterilizable, optical sensor for dissolved oxygen
- With Memosens technology
- Product Configurator on the product page: [www.endress.com/cos81d](http://www.endress.com/cos81d)



Technical Information TI01201C

# 11 Technical data

## 11.1 MemoLink input

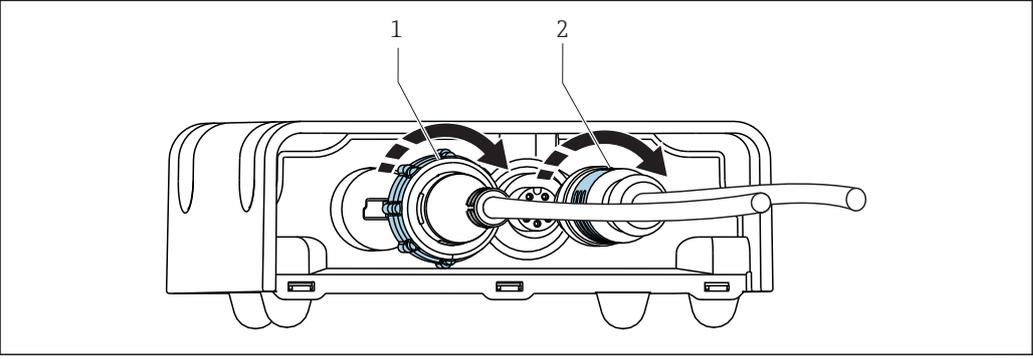
Type of input	Memosens port : M12 socket
Measured values	<p>All sensors with an inductive Memosens plug-in head are suitable for connection (pH/ ORP, conductive conductivity and dissolved oxygen) and inductive conductivity with a fixed cable and M12 connector. All sensors contain a temperature sensor.</p> <p> For detailed information on "Measured variables", see the Operating Instructions for the connected sensor.</p>

## 11.2 MemoLink output

Output type	<ul style="list-style-type: none"> <li>■ USB port: mini USB 2.0 Type B</li> <li>■ USB class: HID</li> </ul>
Output voltage	2.8 to 3.3 V
Output current	10 mA

## 11.3 Power supply

Supply voltage	The PC powers the sensor(s) and the MemoLink sensor terminal box(es) via the USB cable and enables the bidirectional transfer of Memosens data. If a USB hub is used, it must have a power unit.
----------------	--

Connection	 <p style="text-align: right; font-size: small;">A0031653</p> <ol style="list-style-type: none"> <li>1 Cable with mini USB plug</li> <li>2 Cable with M12 plug</li> </ol>
------------	---

Power connection	<ul style="list-style-type: none"> <li>■ 5 V DC via USB</li> <li>■ Low power mode: max. 100 mA as per USB specification 2.0</li> </ul>
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**Cable length**

- USB cable: 2.0 m (6.6 ft)
- Memosens lab cable CYK20: 1.5 m (4.9 ft) or 3.0 m (9.8 ft) (depending on order version)
- Memosens process cable CYK10: 3 to 100 m (9.8 to 328.1 ft) (depending on order version)

## 11.4 Performance characteristics

Maximum measured error



For detailed information on "Measured error", see the documentation for the connected sensor.

MemoLink only transmits data digitally so no measured data can be corrupted. The measuring signal is converted to digital data in the sensor, which means that the measured values are not affected by MemoLink, the cable or the software.

## 11.5 Environment

Ambient temperature range

- MemoLink: -10 to 50 °C (14 to 122 °F)
- Memosens lab cable CYK20: -10 to 50 °C (14 to 122 °F)
- Memosens process cable CYK10: -25 to 135 °C (-13 to 277 °F)

Storage temperature

- MemoLink: -25 to 85 °C (-13 to 185 °F)
- Memosens lab cable CYK20: -10 to 50 °C (14 to 122 °F)
- Memosens process cable CYK10: -25 to 135 °C (-13 to 277 °F)

Relative humidity

Maximum 85 %, non-condensating

Degree of protection

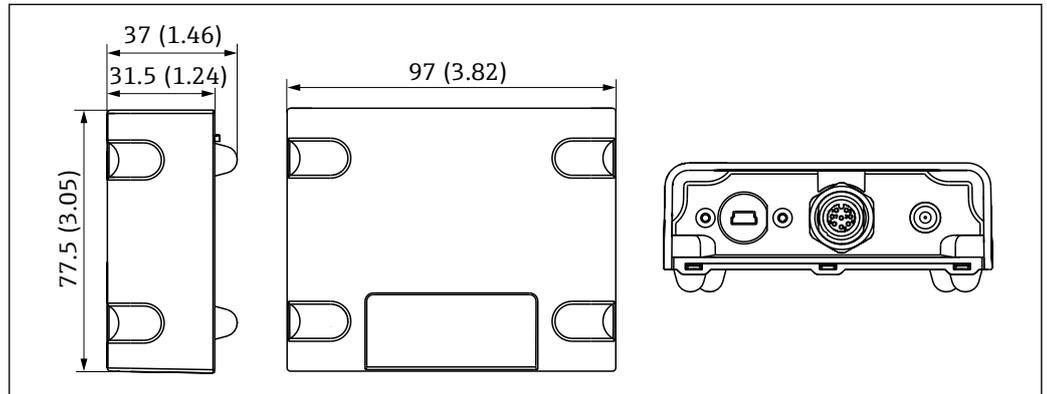
- MemoLink: IP 65 (mated, i.e. when cables are connected) in accordance with EN 60529 and Type 2 in accordance with UL
- CYK20 Memosens laboratory cable: IP 68
- CYK10 Memosens process cable: IP 68

Electromagnetic compatibility

Interference emission and interference immunity as per EN 61326-1:2006, Class B (Industrial)

## 11.6 Mechanical construction

### Dimensions



42 Dimensions of MemoLink in mm (in)

**i** The MemoLink sensor terminal boxes can be stacked on top of one another. In such situations, the "Power / Data" LED is still easily visible.

Weight 0.24 kg (0.53 lb.) not including cable

Materials

- Housing: PBT
- Housing feet: EPDM

## 12 Appendix

### 12.1 Background information concerning calibrations

#### 12.1.1 Definitions

##### Calibration (as per 1319)

A calibration is defined as an operation to establish the relationship between the measured value or expected value of the output variable and the related true or correct value of the measured variable (input variable) for a measuring system under specified conditions. A calibration does not alter the performance of the measuring device.

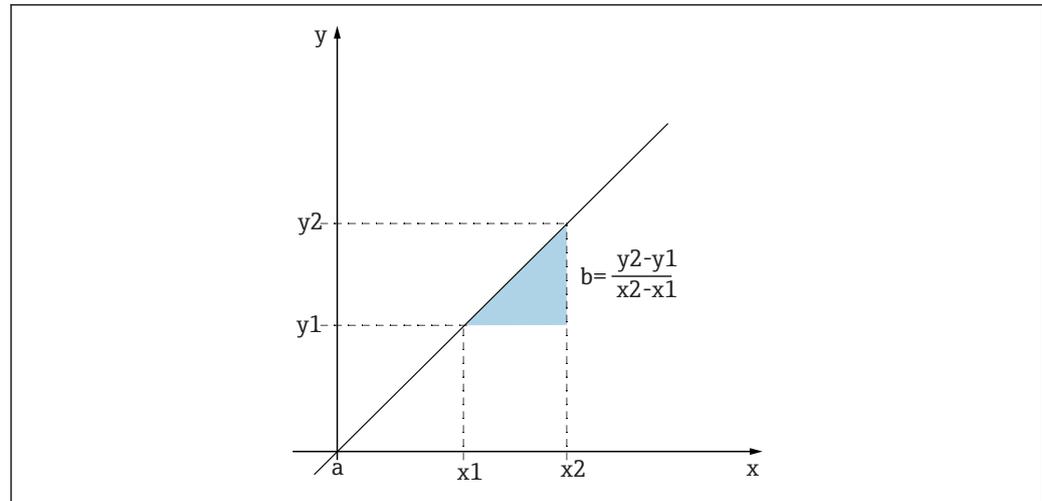
##### Adjustment

An adjustment corrects the value displayed by a measuring device, in other words the measured/displayed value (the actual value) is corrected so that the reading agrees with the correct, set value. The value determined during calibration is used to calculate the correct measured value and saved in the sensor.

#### 12.1.2 Terminology

##### Zero point and slope

Using a mathematical function, the software converts the input signal of the sensor  $y$  (raw measured value) to the measured value  $x$ . In many cases, this function is a simple linear function with the form  $y = a + b \cdot x$ . The linear element "a" is usually equivalent to the zero point and the factor "b" is the slope of the line.



43 Linear function

$a$  Zero point

$b$  Slope

The Nernst equation, which is used to calculate the pH value, is a typical linear relationship:

$$U_i = U_0 - \frac{2.303 RT}{F} \text{pH}$$

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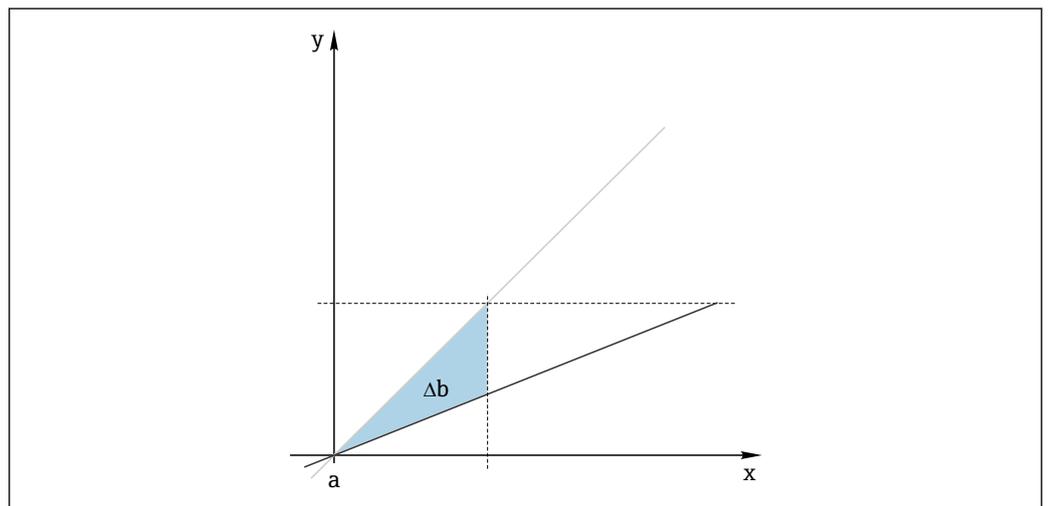
pH = -lg(a <sub>H+</sub> ), a <sub>H+</sub>	Activity of the hydrogen ions
U <sub>i</sub>	Raw measured value in mV
U <sub>0</sub>	Zero point (=voltage at pH 7)
R	Relative gas constant (8.3143 J/molK)
T	Temperature [K]
F	Faraday constant (26.803 Ah)

**i** The slope of the Nernst equation (-2.303RT/F) is known as the **Nernst factor** and has the value -59.16 mV/pH at 25 °C.

*Delta slope*

The software determines the difference in the slope between the currently valid calibration and the last calibration. Depending on the sensor type, this difference is an indicator of the condition of the sensor. The smaller the slope, the less sensitive the measurement, and the accuracy deteriorates particularly in the low measuring range.

Depending on the operating conditions, users can define limit values that represent the still tolerable absolute values of the slope and/or slope differentials. If the limit values are exceeded, maintenance must be performed on the sensor at the very least. The sensor must be replaced if the insensitivity problems persist after maintenance has been carried out.



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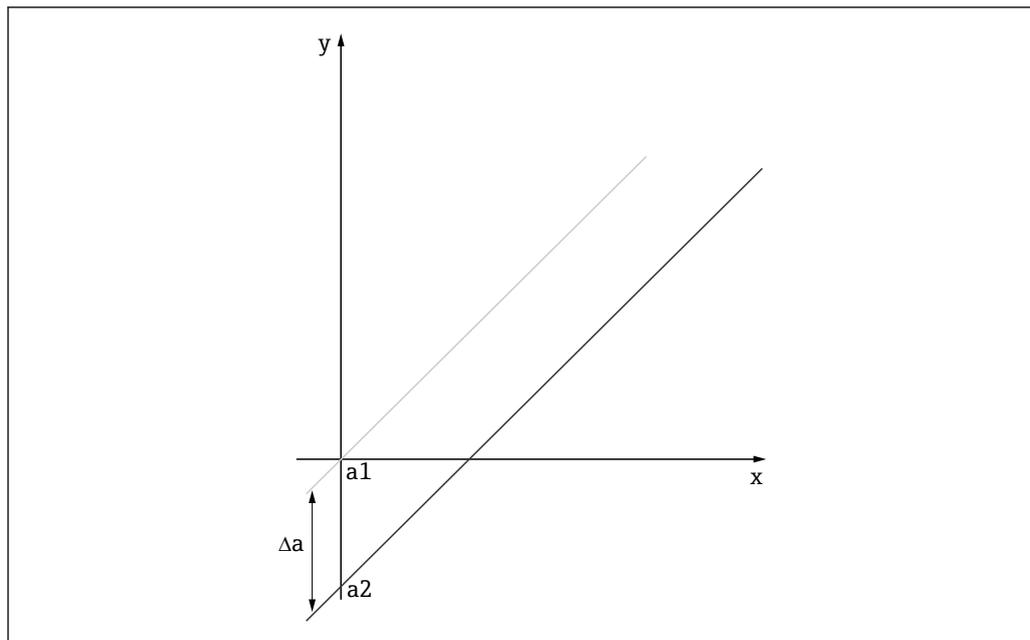
**44** *Delta slope*

*Gray line: last calibration  
Black line: calibration currently valid  
Δb: delta slope*

*Delta zero point*

The software determines the difference between the zero points and the operating points (ISFET sensor) of the last and second-last calibration. A shift in the zero point or operating point (offset) does not alter the sensitivity of the measurement. However, if the offset is not corrected this can corrupt the measured value.

As with the slope, you can also define and monitor limit values for the offset. If the limit values are exceeded, this means that maintenance must be performed on the sensor. For example, you may have to eliminate a blockage in the reference for the pH sensor.



A0030909

45 Delta zero point or operating point (ISFET sensor)

*a1* Zero point (operating point) of the second-last calibration

*a2* Zero point (operating point) of the last calibration

$\Delta a$  Delta zero point (operating point)

### 12.1.3 Calibration examples for standard operating procedures (SOP)

The work with Memobase Plus can be embedded in a standard operating procedure (SOP). The standard operating procedure is created individually depending on the application and in line with company specifications. The following chapters are sample templates that can be used and adapted for a standard operating procedure.

Only the steps that are performed in the laboratory are included. Additional steps regarding process control and the removal and installation of the sensor are required for the maintenance of a process measuring point.

#### Preparation (taking the example of a pH sensor)

The necessary accessories must be provided.

Buffer solutions: The Endress+Hauser quality buffers used are traceable to PTB reference material or standard NIST reference material. Two suitable buffers must be selected.

Buffer 1 can (but does not necessarily have to) be buffer pH 7.00 as this is closest to the zero point of conventional pH electrodes. Buffer 2 should be approximately the value that would later be present at the process operating point. The process value should ideally be between the two buffer values used.

2.00 and 4.00 buffers are available in the acid range. 9.00, 9.22, 10.00 and 12.00 buffers are available in the alkaline range. Alkaline buffers are not stable. They change the pH value as a result of dissolved CO<sub>2</sub> which is absorbed from the ambient air. It is advisable to only procure alkaline buffers in small containers and only use them once.

The batch number and expiry date of the buffer solutions must be indicated on the certificate of calibration. Do not use the buffers beyond their expiry date. The buffer solutions must be entered in the Memobase Plus reference solution management system.

Cleaning agents:

- Distilled or deionized water
- 3 M KCl solution
- Soft brush
- 3 % hydrochloric acid to clean hard deposits such as limescale or hydroxides

- 3 % hydrochloric acid and thiocarbamide (saturated) to clean sulfidic deposits on the glass and diaphragm
- 3 % hydrochloric acid and pepsin (saturated) to clean protein deposits
- Agents containing surfactants (alkaline agents) or water-soluble organic solvents to clean buildup of greases and oils
- Pressurized water to clean biological deposits, fibers and suspended substances

Comply with protection regulations when working with acidic solutions. After cleaning, always rinse all parts with deionized water and condition the parts for a few minutes in 3 M KCl or a buffer solution.

### **pH sensor adjustment including monitoring of sensor changes during the process and in the laboratory**

1. Make sure that the necessary accessory is provided.
2. Select the sensor to be calibrated in Memobase Plus.
3. Click **CALIBRATE > TWO-POINT** .
4. Select two buffers. The pH value of buffer 1 should be lower than that of buffer 2.
5. For temperature compensation, select the **Auto** option.
6. Tick the **Run "as found"** check box.
7. Only clean the sensor of large, stubborn dirt particles and rinse it with water.
8. Start the calibration with an "As found" measurement.
9. Follow the instructions displayed in the instructions part of the program.
10. If the measured value does not stabilize, repeat the calibration with an "As found" measurement.
11. Clean the sensor. In the event of deviations of more than 0.5 pH, regenerate the sensor for approx. 3 hours in KCl solution.
12. Start the two-point calibration again.
13. Tick the **Run "as left"** and **Run calibration** check boxes.
14. Start the calibration with an "As left" measurement.
15. Follow the instructions displayed in the instructions part of the program.
16. If the measured value does not stabilize, repeat the calibration with an "As left" measurement.
  - ↳ The new values for the sensor zero point and slope are displayed as the result.

Assessment of the results:

- The zero point should be between 6 and 8 pH. The delta in relation to the last adjustment should be less than 0.5 pH units
- The slope should be greater than 53 mV/pH. The delta in relation to the last adjustment should be less than 3 mV/pH
- Depending on the assessment of the sensor condition, accept the calibration values for sensor adjustment, clean and regenerate the sensor again or deactivate the sensor and replace it with a new sensor.

In the case of an adjustment, perform an "As left" measurement.

All the measurements are fully documented automatically by the Memobase Plus software. The result and the calibration and adjustment report are available at all times.

### **pH sensor adjustment excluding monitoring of sensor changes during the process and in the laboratory**

1. Make sure that the necessary accessory is provided.

2. Select the sensor to be calibrated in Memobase Plus.
3. Click **CALIBRATE > TWO-POINT** .
4. Select two buffers. The pH value of buffer 1 should be lower than that of buffer 2.
5. For temperature compensation, select the **Auto** option.
6. Only clean the sensor of large, stubborn dirt particles and rinse it with water. In the event of deviations of more than 0.5 pH, regenerate the sensor for approx. 3 hours in KCl solution.
7. Start the two-point calibration.
8. Follow the instructions displayed in the instructions part of the program.
9. If the measured value does not stabilize, repeat the calibration with an "As left" measurement.
  - ↳ The new values for the sensor zero point and slope are displayed as the result.

Assessment of the results:

- The zero point should be between 6 and 8 pH. The delta in relation to the last adjustment should be less than 0.5 pH units
- The slope should be greater than 53 mV/pH. The delta in relation to the last adjustment should be less than 3 mV/pH
- Depending on the assessment of the sensor condition, accept the calibration values for sensor adjustment, clean and regenerate the sensor again or deactivate the sensor and replace it with a new sensor.

All the measurements are fully documented automatically by the Memobase Plus software. The result and the calibration and adjustment report are available at all times.

#### Deactivate the old sensor and replace it with a new sensor

1. Connect the sensor to Memobase Plus via MemoLink.
2. To deactivate a sensor that is not connected, click the square tab  in the main menu area. Select the sensor to be deactivated under **SENSORS** .
3. Click **SENSORS > ADMINISTRATION** .
4. Click the **Operating state** tab.
5. Select the reason for deactivating.
6. Clicking **DEACTIVATE SENSOR** deactivates the sensor for the Memobase Plus software. Its entries and reports are retained in the database but it cannot be recalibrated. "Re-activation" is currently not possible.
7. Dispose of the sensor after deactivation.
8. Connect the new sensor to Memobase Plus via MemoLink.
9. Click **SENSORS > ADMINISTRATION** in the **Sensor maintenance** .
10. In the **Tag** field, enter the text of the measuring point at which the sensor is to be used.
11. In the **Text Memoclip** field, enter the text that describes the sensor or the measuring point. This text should also appear on the attached sensor Memoclip.
12. If desired, perform an initial sensor calibration.

The sensor is now ready for use in the process.

All the measurements are fully documented automatically by the Memobase Plus software. The result and the calibration and adjustment report are available at all times.

The sensor is now ready for use in the process.

## Oxygen

The voltage applied at the sensor by MemoLink causes polarization of the amperometric measuring system. For this reason, after switching on MemoLink and the Memobase Plus software when the sensor is attached, you must first wait for the polarization time to elapse before you can begin the calibration. The polarization is not lost if the sensor is briefly unplugged and plugged into an opposite slot (max. 1 minute). Please refer to the documentation of the individual sensor for the polarization time.

Before the calibration, decide whether you want to perform an "As found - as left" measurement. If you do, **CALIBRATE** create a reference under > **'REFERENCE SOLUTION** (see "Reference solution management" section).

 For a zero point calibration, you can use a sodium sulfite solution, N2 gas bottles or the zero point gel COY8 as the reference. The medium can be used as a reference for calibrations in the air or in air-saturated water. Use the "Comment" function to make a record of conditions during the calibration.

Calibration should always be performed in the environment in which measurement will take place. For example, perform a calibration in air if measuring at values above 1 mg/l, and perform a zero point calibration if measuring at values below 1 mg/l.

### Air 100% RH

► See the "Notes on performing a calibration".

1. Select the sensor to be calibrated by clicking the appropriate tab.
2. Click **CALIBRATE** and select the calibration type **SLOPE AIR 100%** .
3. Decide whether you want to perform an "As found - as left" measurement in addition to the calibration.

#### If you do:

4. Tick the check box for "With "As found - As left" measurements".
5. Select the unit of the target value, e. g. %Vol.
6. Select the reference you want to use, e. g. ambient air.
7. Insert the uncleaned sensor into the selected reference.
8. Continue with Point 9.

#### If you do not:

9. Click **START** .
10. Select the medium pressure (process, ambient air, altitude).
11. Specify the process pressure [hPa], air pressure [hPa] or altitude [m].
12. Clean the sensor before introducing it into the medium or the air.
13. Click **CONTINUE**.
14. Wait until a stable measured value is reached.
15. Click **APPLY** if the calibration was successful.

You have the following options after the calibration:

- You can view or print a calibration report, or export it to PDF format.
- You can view or print the calibration result, or export it to PDF format.

## Conductivity

Before the calibration, decide whether you want to perform an "As found - as left" measurement. If you do, **CALIBRATE** create a reference under > **'REFERENCE SOLUTION** (→  37).

*Cell constant*

 See the "Notes on performing a calibration" (→  40).

1. Select the sensor to be calibrated by clicking the appropriate tab.
2. Click **CALIBRATE** and select the calibration type **CELL CONSTANT** .
3. Decide whether you want to perform an "As found - as left" measurement in addition to the calibration.

**Start the calibration with an "As found" measurement.**

4. Tick the **"As found"** check box.
5. Enter the target value of the reference solution being used for the calibration.
6. For reference solutions with a constant laboratory temperature, disable the **Temperature compensation** check box.
7. Click **CONTINUE** .
8. Select the reference solution.
9. Click **CONTINUE** .
10. Insert the uncleaned sensor into the reference solution.
11. Click **START** .
12. Wait until a stable measured value is reached.
13. Click **CONTINUE** .
14. Clean the sensor.
15. Insert the cleaned sensor into the reference solution.
16. Click **CONTINUE** .
17. Wait until a stable measured value is reached.
18. Click **APPLY** to adopt the calibration data for adjustment.

**Performing calibration with As found - as left measurement**

19. Tick the **"As found"** and **"As left"** check box.
20. Enter the target value of the reference solution that is being used for the calibration.
21. For reference solutions with a constant laboratory temperature, disable the **Temperature compensation** measuring mode.
22. Click **CONTINUE** .
23. Select the reference solution.
24. Click **CONTINUE** .
25. Insert the uncleaned sensor into the reference solution.
26. Click **START** .
27. Wait until a stable measured value is reached.
28. Click **CONTINUE** .
29. Clean the sensor.
30. Insert the cleaned sensor into the reference solution.
31. Click **CONTINUE** .
32. Wait until a stable measured value is reached.
33. Click **APPLY** to adopt the calibration data for adjustment.
34. Click **CONTINUE** .

35. Insert the calibrated and cleaned sensor into the reference solution.
36. Click **START** .
37. Wait until a stable measured value is reached.
38. Click **CONTINUE** .

#### **Performing calibration without As found - as left measurement**

1. Tick the **With "as found - as left" measurement** check box.
2. Enter the target value of the reference solution that is being used for the calibration.
3. For reference solutions with a constant laboratory temperature, disable the **Temperature compensation** check box.
4. Click **CONTINUE** .
5. Select the reference solution.
6. Click **CONTINUE** .
7. Clean the sensor.
8. Insert the cleaned sensor into the reference solution.
9. Click **START** .
10. Wait until a stable measured value is reached.
11. Click **APPLY** to adopt the calibration data for adjustment.

After the calibration, you can view or print out a calibration report or export it to PDF format.

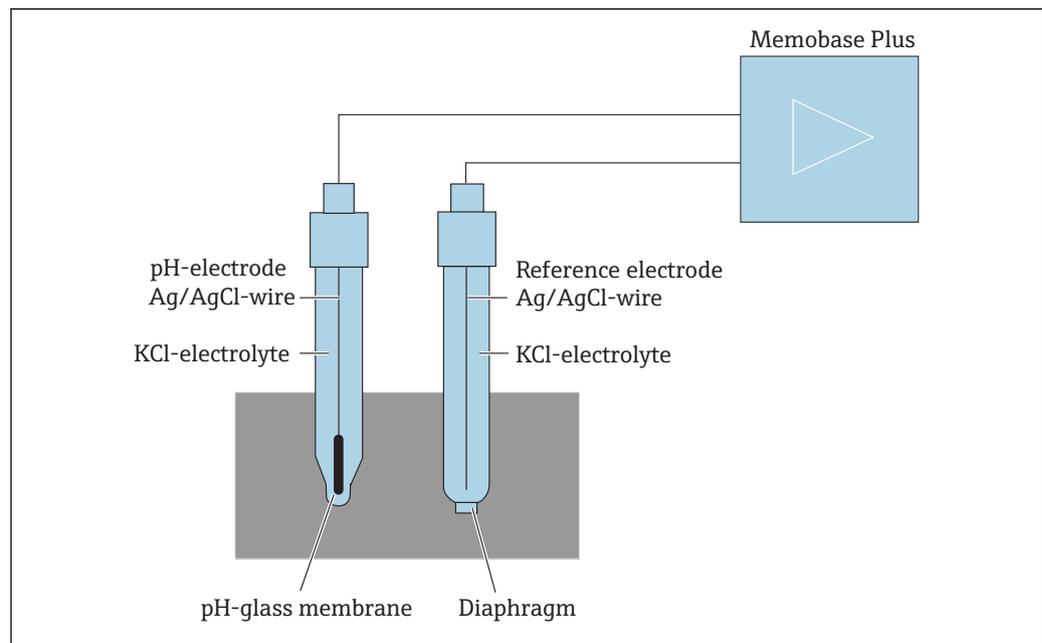
## 12.2 Operating principles

### 12.2.1 pH measuring technology

The pH value is measured potentiometrically to accurately measure aqueous and non-aqueous solutions. The electrode system consists of a glass electrode (pH electrode) and a reference electrode. The difference in voltage  $\Delta E$  between these two electrodes is measured with high impedance and is a function of the pH value of the solution.

$$\Delta E = f(\text{pH}) = E_{\text{Glass}} - E_{\text{Ref}}$$

#### Electrode structure

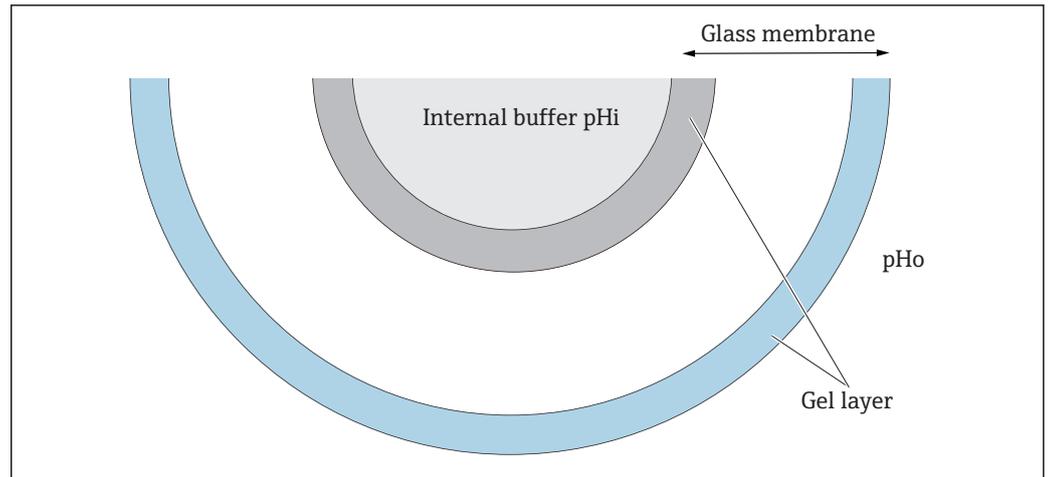


46 pH measuring device

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#### The glass electrode

The glass electrode has a "pH-sensitive" membrane that forms a gel layer in water. The relatively small  $\text{H}^+$  ions can nest in this gel layer and the larger negatively charged ions remain in the solution. This creates electrical potential which depends on the pH value of the outer solution. The glass electrode is filled with a buffer solution, i.e. with a solution containing  $\text{H}^+$  ions with a constant pH value (inner buffer with constant pH value). This results in constant electric charging of the inner gel-like layer. The inner buffer is connected to the instrument via a reference silver wire. In this way, a voltage can be measured with the glass membrane which is a measure for the difference between the pH value of the inner buffer and the pH value of the solution.



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47 Electrode - gel layer

### The reference electrode

The reference electrode provides a stable potential compared to the working electrode. In industrial instrumentation, only the silver/silver chloride system (Ag/AgCl) with KCl solution is important.

A silver wire coated with silver chloride responds to the chloride ion activity of the surrounding solution. A capillary connection, known as the diaphragm, separates the electrolyte/solution contact point.

On the one hand, the diaphragm separates the internal electrolyte of the reference electrode from the solution. On the other hand, it should electrically connect the two solutions, i.e. make ionic conduction possible.

That is why a range of diaphragms are available for different tasks:

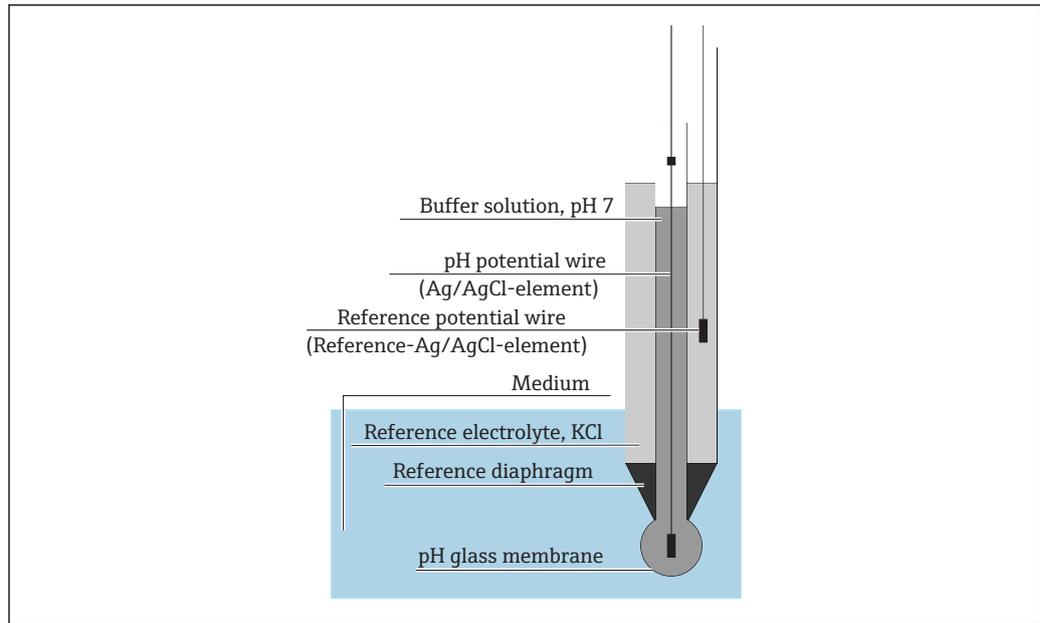
- Ceramic diaphragms are chemically resistant, suitable for oxidizing measuring solutions but tend to clog under certain circumstances. Areas of application include hygiene applications, lab applications and applications in water and swimming pools.
- Open ring junctions are particularly suited to applications in the wastewater industry. The construction prevents clogging taking place to a large extent. Open ring junctions can only be used for gel-filled electrodes.
- Teflon diaphragms made of sintered PTFE are dirt-repellent, almost free from clogging, chemically resistant and temperature-resistant. Due to the large pores, electrodes with a Teflon diaphragm are generally not hygienic even though the electrode can be sterilized. Teflon diaphragms have a shorter response time than electrodes with other diaphragm types.
- Open aperture diaphragms are suitable for applications in contaminated media. The medium is in direct contact with the gel. For this reason, the electrode has a very rapid response behavior. The open pore structure of the gel is very stable with regards blocking.

The maintenance effort needed can be reduced by selecting the right reference system and the appropriate diaphragm.

### Combination electrode

To make it more easy to use, the two electrode types are often combined in an electrode system. An electrode system where the reference silver wires of the glass electrodes and reference electrodes are the same is called a symmetric electrode system. If both electrode versions are combined in one model, this is called a combination electrode. The shaft of the glass electrode is made smaller and it and its reference silver wire are located as a second thin pipe inside the outer shaft which is 12 mm thick. The resulting intermediate space contains the reference electrolyte and the reference system. The lower end is sealed apart from the diaphragm. The combination electrode is sealed at the top with a multi-

pole plug-in head. Since the pH value of the electrode system depends on the temperature, a temperature sensor (usually Pt 100 or Pt 1000) is often integrated in the electrode.



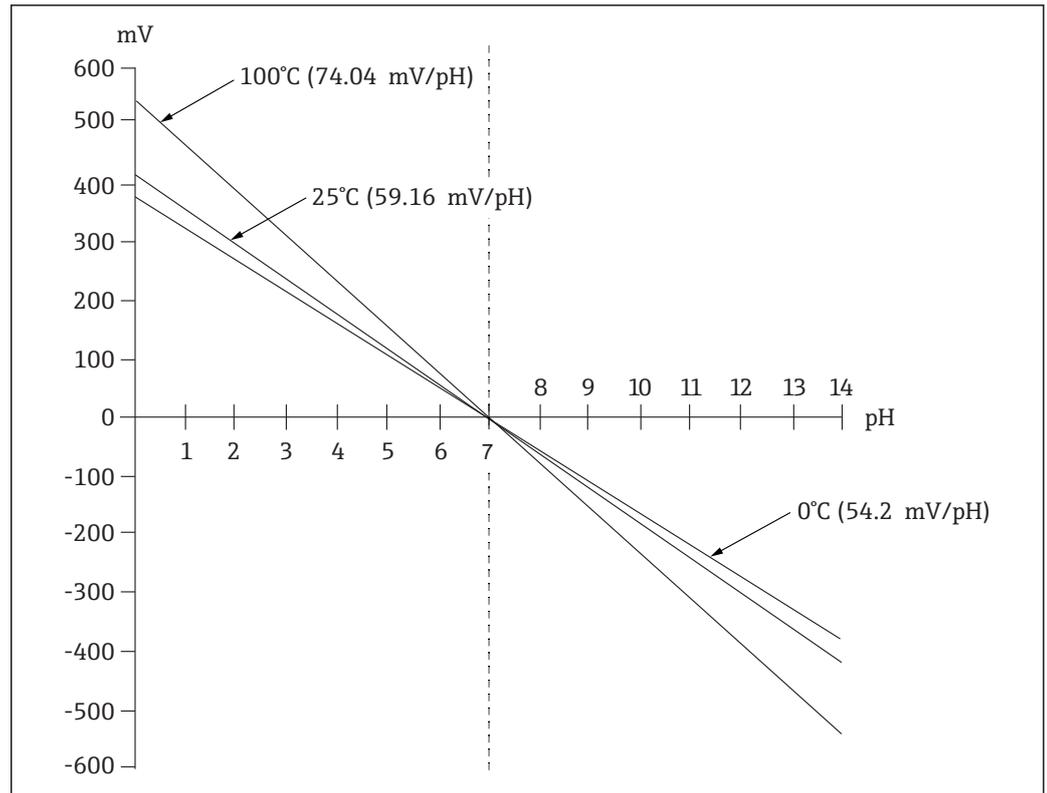
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48 Combination electrode

### pH value and temperature

The electrode slope (mV/pH) depends on the temperature. At a solution temperature of 25 °C (77 °F), the electrode returns a voltage of 59.16 mV per pH difference between the inner buffer and the solution. The theoretical slopes at various temperatures are:

Temperature	Slope
0 °C (32 °F)	54.2 mV/pH
20 °C (68 °F)	58.2 mV/pH
25 °C (77 °F)	59.2 mV/pH
50 °C (122 °F)	64.1 mV/pH
75 °C (167 °F)	69.1 mV/pH



49 Nernst voltage dependence on temperature

A0030919-EN

This effect is corrected with automatic or manual temperature compensation in the transmitter.

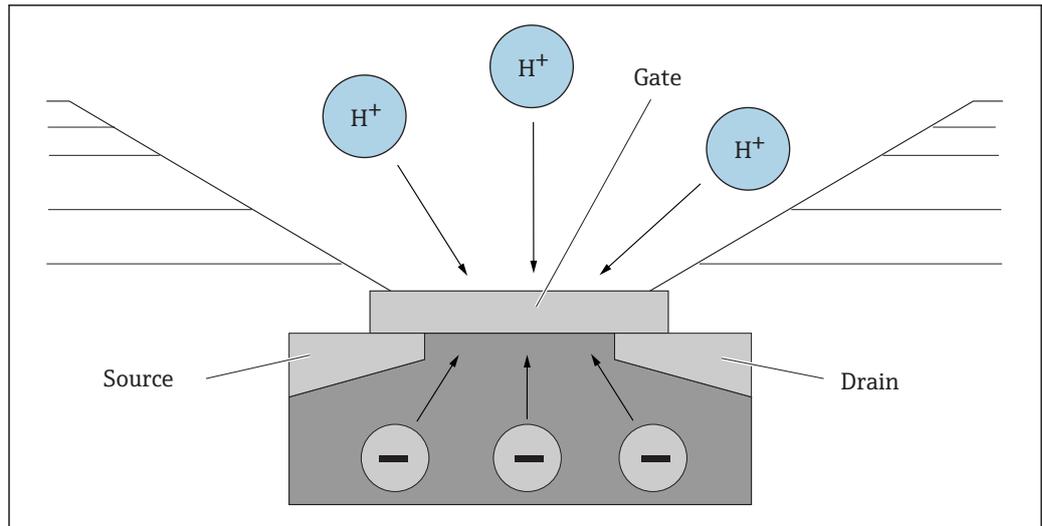
Ideally, the various Nernst lines (isotherms) of different temperatures cut at one point which is known the isotherm intersection point. This is at 0 mV = pH 7 for electrodes with inner buffer pH 7. However, since the individual potentials of an electrode system have different temperature dependencies in real-case scenarios, the real isotherm intersection point deviates from the ideal value.

Every measuring solution has its own temperature/pH behavior (temperature coefficient). This temperature coefficient results in different pH values at different temperatures for the same measuring solution. This phenomenon is a real pH change and cannot be compensated or corrected with measuring devices (in contrast to conductivity measurement). It can only be compensated for  $\mu$ P-driven devices (during calibration) if the temperature coefficient is known (e.g. buffer solutions). Thus, you can only compare pH values that were also measured at the same temperature.

### ISFET sensors

In contrast to glass electrodes, ISFET sensors use a pH-sensitive semi-conductor to determine the pH value.

Ion-selective field effect transistors are based on an MOS transistor arrangement. Here the gate is replaced by a tantalum pentoxide layer that is sensitive to protons. The electrostatically bonded  $H^+$  ions create a positive charge at the gate which induces negative charges in the semi-conductor. This makes the semi-conductor conductive and the current measured between the source and drain is proportional to the amount of protons and therefore to the pH value.



50 ISFET sensor design

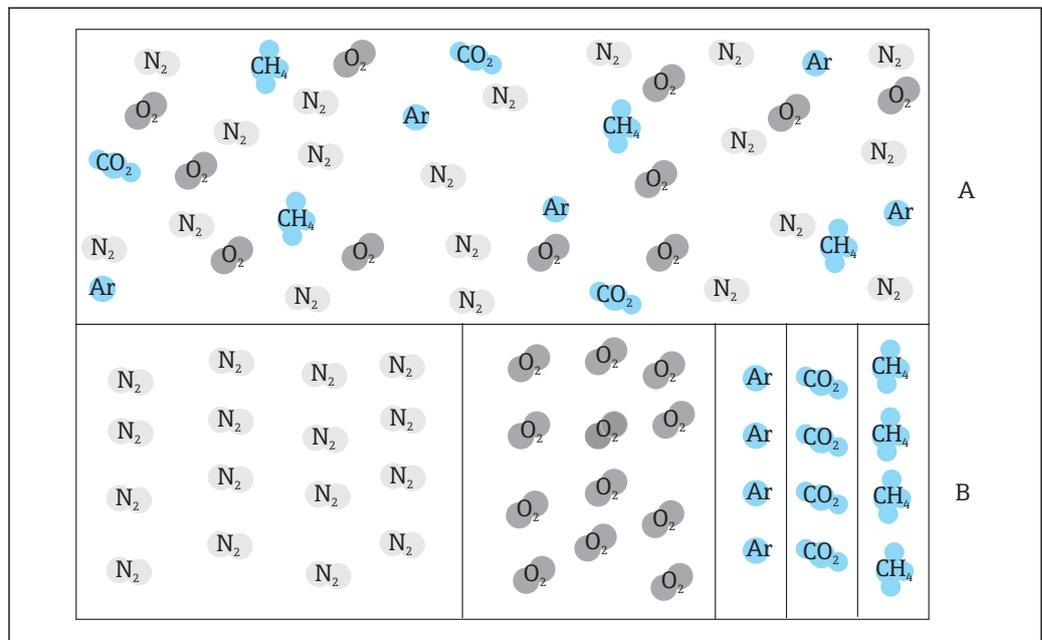
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However, all types of charge affect the gate (e. g. also static charge). Temperature, drift and the influence of light would also affect the result. For this reason, a reference electrode is also used here to compensate for such effects.

### 12.2.2 Dissolved oxygen

#### General principles

The example of air is useful in explaining oxygen partial pressure. Partial pressure is the portion of oxygen in air which, together with the other gases such as nitrogen, inert gases and carbon dioxide, makes up the total pressure of the air.



51 Composition of air

A0030927

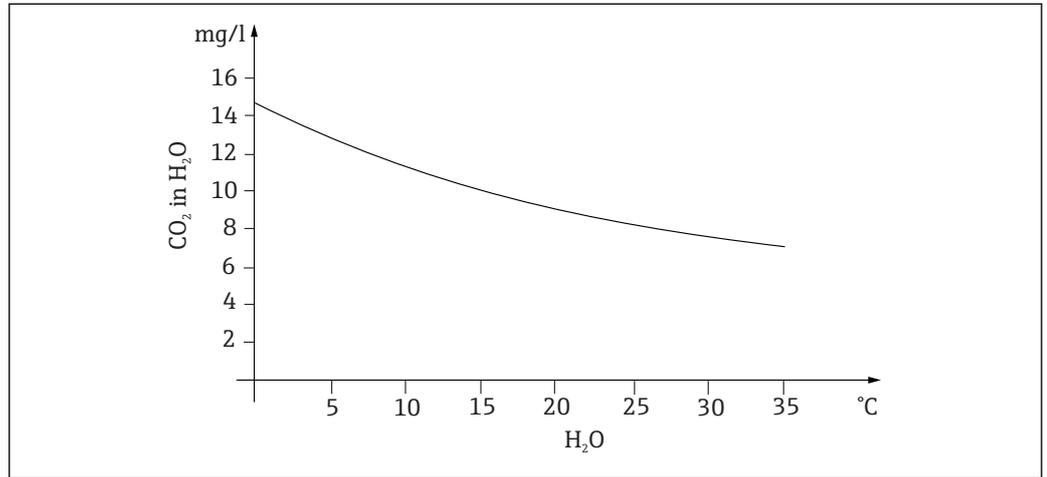
A Total pressure of air

B Diagram of the partial pressures of the substances occurring in air

How does oxygen come to be in liquids and what influences this?

The partial pressure of oxygen, together with the laws of physics governing gas exchange, has the effect that oxygen dissolves in a liquid until such time as the partial pressure of oxygen in the liquid is the same as in the atmosphere above it. The liquid now has the same proportion of oxygen as the atmosphere above it. The oxygen concentration both in water and in air thus depends on atmospheric pressure and humidity. As already mentioned, the temperature of the water is also a factor.

Large quantities of oxygen are stored or dissolve in water at lower temperatures. As the ambient temperature increases, the solubility of oxygen decreases.



52 Oxygen content in water in relation to the temperature

Maximum solubility is reached when the oxygen partial pressure in the water is the same as in the atmospheric layer above it. The concentration of oxygen in the water is then identical to the solubility.

The following units are used to define the results achieved when measuring the levels of oxygen in liquids:

- Oxygen partial pressure (pO<sub>2</sub> in hPa)
- Oxygen concentration (CO<sub>2</sub> in mg/l)
- Oxygen saturation (SAT in %)

As is the case with every other type of pressure, the partial pressure of oxygen (pO<sub>2</sub>) is specified in hectopascal (hPa) and is an absolute measurement.

Oxygen concentration is the mass-related portion of oxygen in water and is specified in milligram per liter (mg/l).

$$\text{Concentration O}_2 \text{ (mg/l)} = \frac{\text{Solubility} \cdot p_{\text{O}_2}}{0.2095 \cdot p_{\text{amb}}}$$

p<sub>amb</sub> = Ambient pressure

Another common way to show the concentration of oxygen is in parts per million (ppm). This is merely another way of writing mg/l; the numerical values are the same.

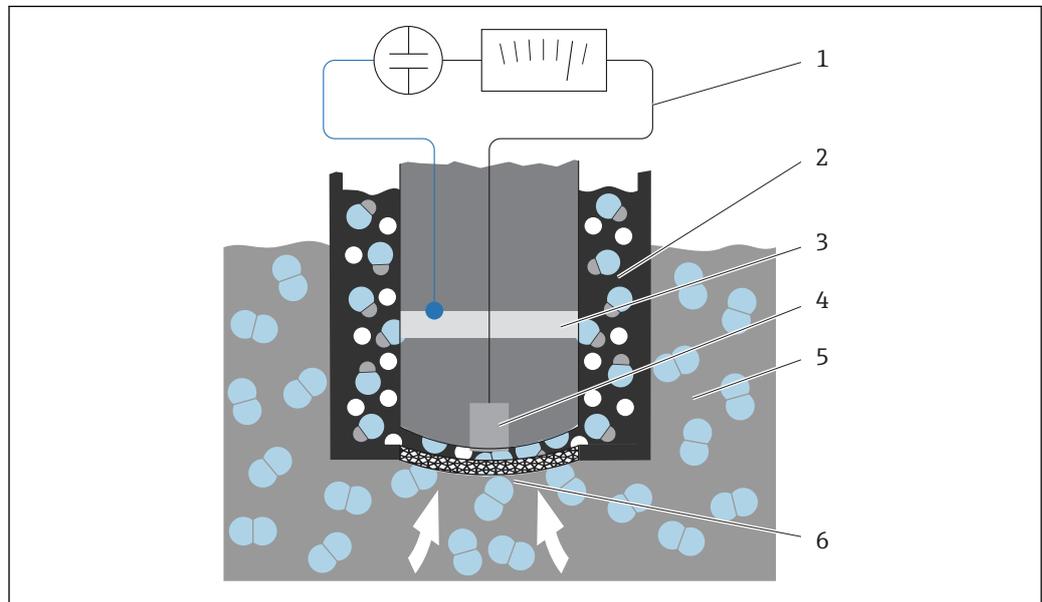
Oxygen saturation (SAT in %) describes, as a percentage, the ratio of the actual partial pressure of oxygen to the theoretical value expected in humid air. Oxygen partial pressure is 212 hPa at an ambient pressure of 1013 hPa (at sea level). This means an oxygen content of 20.95 %. This value is what practitioners refer to as 100 % saturation.

$$\%SAT = \frac{pO_2}{(0.2095 \cdot (p_{amb} - p_{H_2O}))}$$

A0031018-EN

### Amperometric oxygen measurement

The amperometric measurement of oxygen is an electrochemical method whereby a current flow generated electrochemically is used for the quantitative measurement of oxygen. A basic, two-electrode amperometric oxygen sensor consists of a gold cathode (also known as working electrode) and a silver anode (also known as counter electrode). The cathode and anode are located in a reaction chamber, which is filled with an electrolyte solution. Direct current is applied across the two electrodes. A membrane which separates the sensor from the medium to be measured is stretched across the reaction chamber. The membrane allows dissolved oxygen to diffuse into the cell. If this measurement cell is placed in a medium containing oxygen, the difference in the partial pressure of oxygen between the inner and outer wall of the membrane results in the diffusion of oxygen through the membrane. In the medium, the partial pressure of oxygen is present in front of the membrane. This pressure is approx. 209 hPa pO<sub>2</sub> in water vapor-saturated air under reference conditions (1013 hPa, 20°C) and acts as the force to drive oxygen molecules through the membrane. The membrane acts as a diffusion barrier in this case, i.e. oxygen molecules pass through the membrane in accordance with the difference in partial pressure. The oxygen diffused through the membrane is reduced at the cathode in the electrolyte chamber of the sensor. This means that there is practically no molecular oxygen at the cathode. Significant consumption occurs here, the partial pressure of oxygen is virtually zero and oxygen molecules constantly diffuse in accordance with the oxygen partial pressure. Oxygen reduction results in a flow of current that is proportional to the quantity of transformed oxygen. This current is processed in the transmitter and is made accessible in the specified units.



A0030929

53 Design of a two-electrode sensor

- 1 Direct current
- 2 Electrolyte chamber
- 3 Anode
- 4 Cathode
- 5 Medium
- 6 Membrane

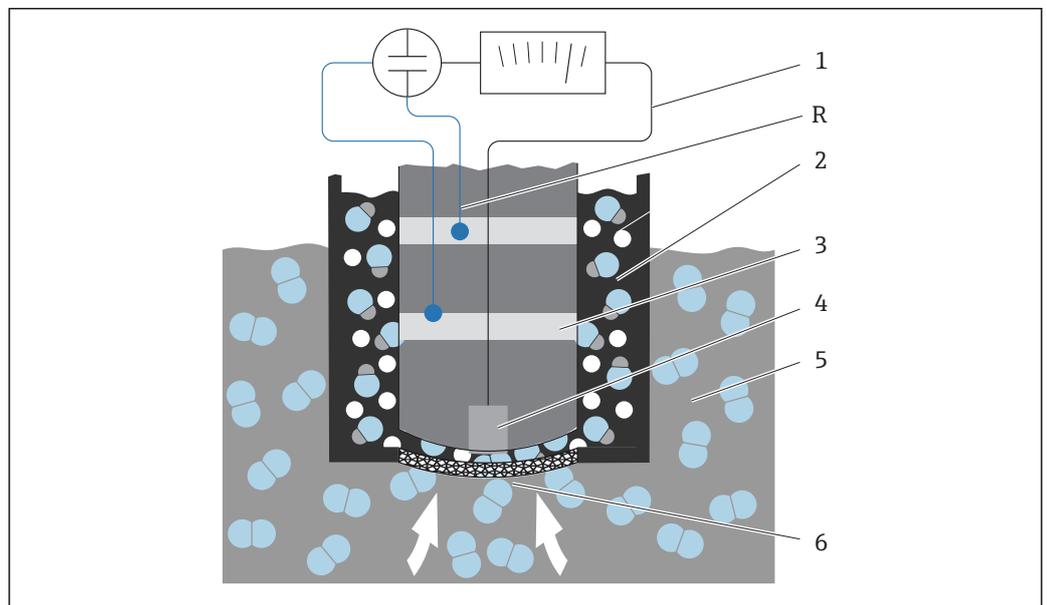
- Cathode reaction  

$$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$$
- Anode reaction  

$$4\text{Ag} + 4\text{Br}^- \rightleftharpoons 4\text{AgBr} + 4\text{e}^-$$

A feature of two-electrode sensors is that, while the oxygen is reduced to hydroxide ions and electrons at the cathode, at the anode, bromide or chloride ions are deposited from the electrolyte as silver bromide or silver chloride. This silver bromide or silver chloride layer at the anode becomes thicker over time and forms additional resistance after a number of months. This reduces the effective polarization voltage between the cathode and anode. The associated flow of oxygen is also reduced. This results in increased signal drift.

Three-electrode sensors provide a solution. They operate on the same principle as two-electrode sensors. However, the third electrode, the reference electrode, is particularly important. As is the case with the two-electrode sensor, the silver bromide layer forms at the anode. This leads to signal drift in the case of two-electrode sensors. There is no signal drift with the three-electrode system. The change in the silver bromide layer is detected by the reference electrode. An internal regulating circuit keeps the working electrode at constant potential. The need for a service at the sensor is thus halved.



54 Design of a three-electrode sensor

- 1 Direct current
- 2 Electrolyte chamber
- 3 Anode
- 4 Cathode
- 5 Medium
- 6 Membrane
- R reference electrode

### Calibration

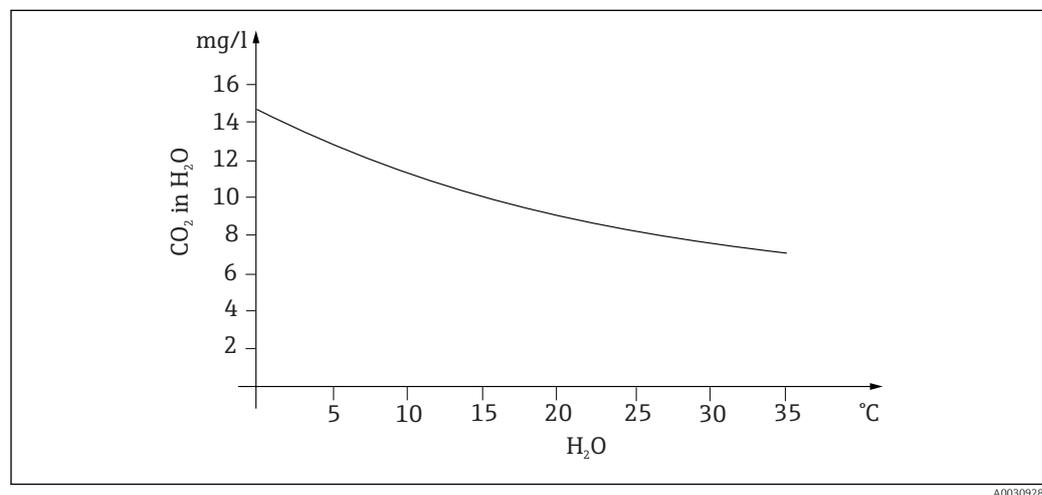
The oxygen sensors must be calibrated to ensure that they supply accurate measured values. The slope of an oxygen sensor can, in principle, be calibrated in three ways:

- in an atmosphere saturated with water vapor
- in air-saturated water
- or by entering a reference measured value at the transmitter

Given that both amperometric and optical oxygen sensors are oxygen partial pressure sensors, this characteristic is used when calibrating the slope. Air is used as a readily available and known reference.

Therefore, air calibration is the most commonly used and easiest method of calibration. Air is ideal for calibration as it contains a known quantity of oxygen. In the case of dry air, the composition is known (20.95% O<sub>2</sub>, remainder N<sub>2</sub> and other gases) and the absolute pressure of air and the partial pressures of the components are otherwise only dependent on altitude and the current absolute atmospheric pressure. This partial pressure of oxygen is then approximately 212 hPa at sea level at 1013 hPa. The absolute pressure and thus also oxygen partial pressure change depending on the altitude. Using the Boltzmann barometric equation, the expected partial pressure of oxygen can be shown up to a height of several kilometers with only minor errors. Calibration is thus independent of the altitude and is always possible anywhere.

To look at a practical example: the atmosphere always contains water which, in a gaseous form as water vapor, represents part of the total pressure. In other words, water vapor contained in the atmosphere changes the partial pressure of oxygen. A characteristic of air is that it can store a specific maximum quantity of water. More water is then deposited in liquid form as condensation (e. g. drops). The maximum content of water vapor in the atmosphere depends on the temperature and is based on known functions.



55 Water vapor in the atmosphere in relation to the temperature

This factor is used in the "water-saturated air" ("air 100 %rF") calibration method. In this case, the proportion of water vapor is calculated based on the altitude and the temperature so that information is available about the actual oxygen partial pressure present.

The ambient pressure ( $p_{amb}$ ), which can be determined using a pressure gauge, for example, is converted to ambient pressure in dry air:

$$p_{ambient\_dry} = p_{ambient} - p_{water\_vapor}$$

Now how high is the atmospheric pressure of dry air at sea level at 35 °C?

$$p_{ambient\_dry} = 1013 \text{ hPa} - 56.21 \text{ hPa}$$

$$p_{ambient\_dry} = 956.76 \text{ hPa}$$

At sea level, 20.95% of the ambient pressure of dry air is oxygen. The estimated oxygen partial pressure can now be calculated as follows:

$$p_{oxygen\_estimated} = 0.2095 p_{ambient\_dry}$$

Now how high is the partial pressure of oxygen at sea level at 35 °C?

$$p_{ambient\_dry} = 1013 \text{ hPa} - 56.21 \text{ hPa}$$

$$p_{ambient\_dry} = 956.76 \text{ hPa}$$

For this model to work correctly, the sensor to be calibrated must be close to a water surface or be located in the headspace of a vessel partially filled with water, for example. In this way, oxygen sensors can be precisely calibrated in a wide variety of applications, ranging from power stations to water treatment.

Another calibration method, "air-saturated water" is based on the characteristic that water which is sufficiently ventilated is in equilibrium with the oxygen partial pressure of the atmospheric layers above it after an appropriate time period. In this case, the temperature is used for reverse calculations to the expected oxygen partial pressures. This method is often used for oxygen measurements in closed containers such as water-filled fermenters. Another option available is sample calibration whereby the measured value of the sensor is compared to a reference value for the same medium obtained externally.

There are two ways to achieve reliable values for absolute pressure:

- Using the altitude and the barometric formula which provide the correlation between the expected value for the average absolute air pressure and the altitude (also preprogrammed into the transmitter or sensor and thereby accessible).
- By measuring the absolute pressure of air with a pressure cell, for example.

The relative atmospheric pressure reverse-calculated to sea level is often available with the weather information. Converted to the absolute value using the Boltzmann barometric equation, this relative atmospheric pressure can also be used in applications as the default value for atmospheric pressure.

#### *Zero point calibration*

The zero point is not so important when working with relatively high concentrations of oxygen. This changes, however, once oxygen sensors are used for trace quantities and zero point calibration of the sensors is required.

Zero point calibration is challenging insofar as the surrounding medium - as a rule air - already contains large quantities of oxygen. To ensure correct zero point calibration, this oxygen must be blocked from accessing the sensor and residual oxygen must be eliminated from the area surrounding the sensor.

There are the following ways to do this:

- Zero point calibration in a flow cell which has gaseous nitrogen (N<sub>2</sub>) of sufficient quality passing through it
- Calibration in oxygen-free zero solution (aqueous solution of sodium sulphide Na<sub>2</sub>SO<sub>3</sub>)
- The zero point gel COY8 can be used for a high-quality zero point calibration (see the "Accessories" section).

Information relating to zero solution:

The following rule of thumb applies: 1g Na<sub>2</sub>SO<sub>3</sub> in 1 l water at approx. 30 °C in a vessel that narrows towards the top (Erlenmeyer flask or similar) is free from oxygen after approx. 1/2 hour, and remains so for around 24 hours if the vessel is sealed airtight. This time is reduced if air is admitted.

It is worthwhile to take a look at the behavior of the sensor signal prior to calibration of the sensor's zero point:

Is it stable and in a steady state, is the displayed value plausible?

If the oxygen sensor is calibrated too quickly (prematurely), falsification of the zero point results! The rule of thumb here also is to operate the sensor for 1/2 hr in zero solution and then to evaluate the signal current in the steady state. If the sensor was previously operated around zero, the specified time is sufficient as a rule. If the sensor was operated in air, significantly more time must be factored in to remove residual oxygen from design-related dead volumes where necessary. Here, the rule of thumb is 2 hours.

The zero point can be calibrated as soon as the sensor signal has settled. Here, the current measured value is calibrated to the zero value.

The comparison method (zero point sample calibration) can also be used here if the relevant sample collectors or a corresponding reference measurement is available.

### 12.2.3 Electrolytic conductivity

#### General principles

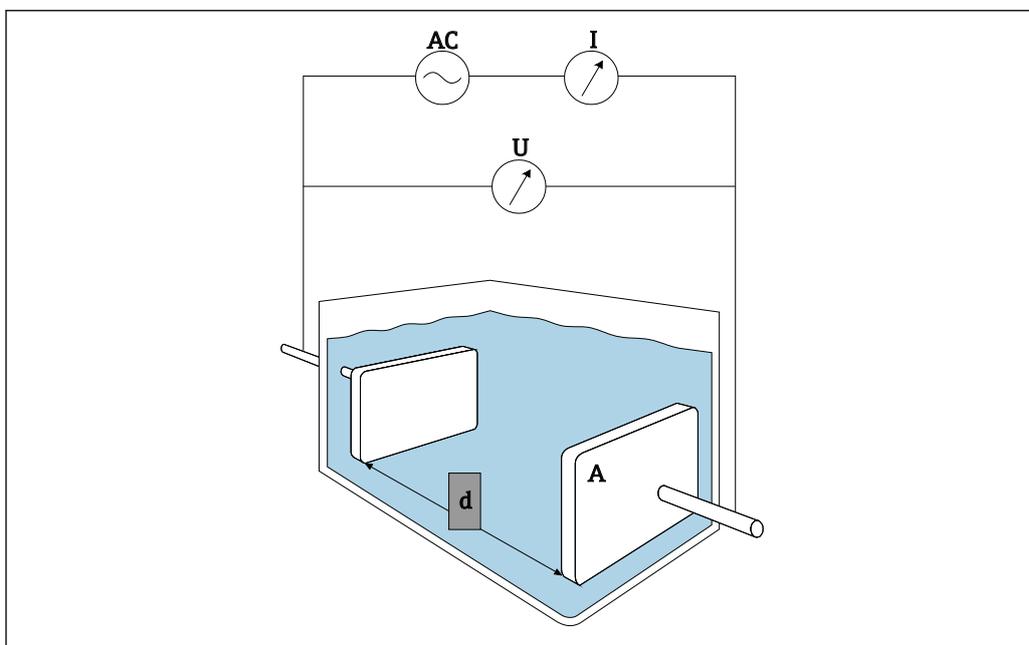
Electrolytic conductivity in liquids comes about through the dissociation of acid, alkali or salt molecules to form positively charged cations and negatively charged anions. Just like electrons in wires, these ions contribute to charge transportation in the electric field and thus to the current flow.

In addition, there is also a certain, if quite low, degree of intrinsic conductivity in water as the  $\text{H}_2\text{O}$  water molecules dissociate to a small extent to  $\text{H}^+$  and  $\text{OH}^-$  ions. This is very important if the purity of ultrapure water is to be determined for the pharmaceutical or semi-conductor industry.

Organic solvents have practically no electrical conductivity.

The conductivity is basically determined by applying an alternating voltage  $U$  to two electrodes immersed in the solution and measuring the current  $I$ . Taking Ohm's Law, resistance  $R$  can be derived or conductance  $G$  as its reciprocal value:

$$G = I/U$$



56 Measuring principle

It is common to calculate material-dependent conductivity  $\kappa$  (Greek kappa) with the aid of the cell constant  $k$  which describes the geometry of the measuring arrangement:

$$\kappa = G \cdot k$$

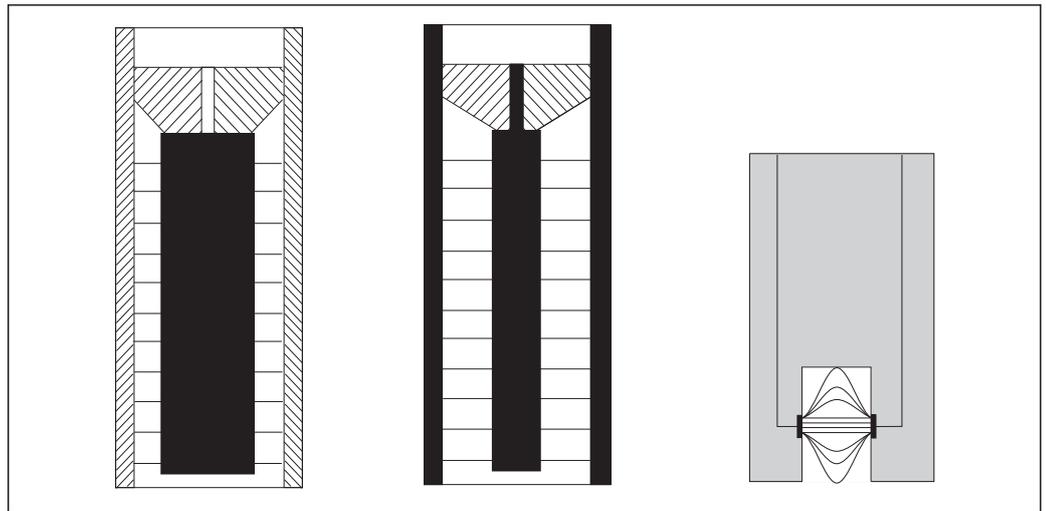
The cell constant  $k$  is small for large electrode surfaces and a small electrode separation distance and vice versa. It is usually given in the unit  $\text{cm}^{-1}$ .

Conductivity  $\kappa$  only describes the properties of the solution and mainly depends on the concentration of the dissolved substances but also on the temperature of the solution. It is mostly given in the unit  $\text{mS/cm}$  or  $\mu\text{S/cm}$ .

#### Conductivity sensors

The choice of conductivity sensor is mainly based on the measuring range required. Sensors with a cell constant  $k$  of  $0.01 \text{ cm}^{-1}$  or  $0.1 \text{ cm}^{-1}$  are used for applications in demineralized water or ultrapure water. Their electrodes consist of pipes concentrically arranged towards one another. For average conductivities (e. g. drinking water and very

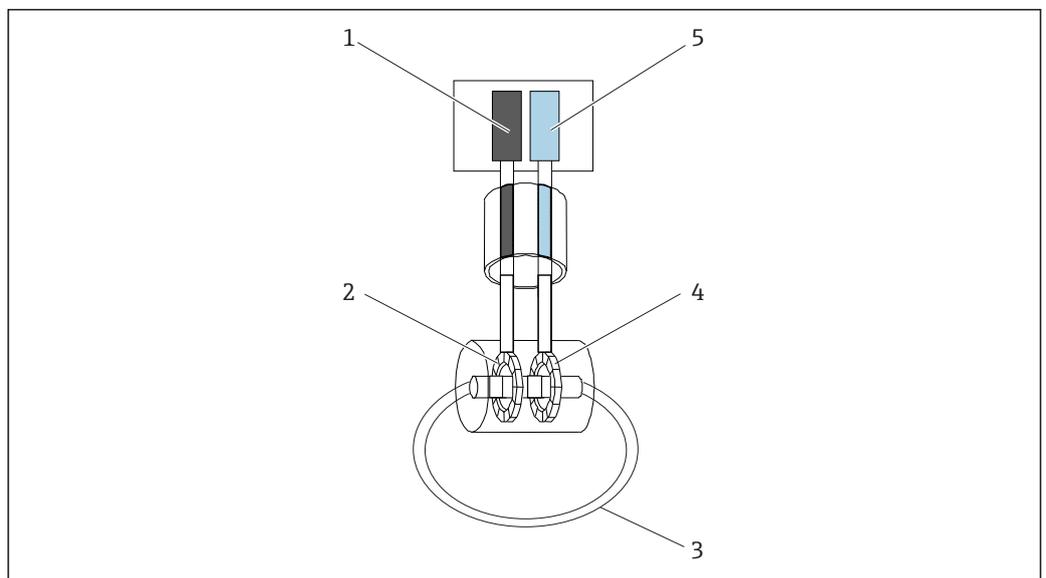
dilute solutions), the electrodes are punctiform. Sensors with electrodes in contact with the product are known as conductive conductivity sensors.



A0030932

57 Structure of conductive sensors

Inductive conductivity sensors are used for higher conductivities. They do not contain wetted electrodes. Instead, an ionic current is induced in the liquid (3) by means of an oscillator (1) and a primary coil (2). The strength of the current depends on the conductivity and thus on the ion concentration in the medium. The current flow in the medium, in turn, generates a magnetic field in the secondary coil (4). The associated induction current is measured in the receiver (5) and the conductivity is determined from this.



A0030934

58 Structure of inductive sensors

The advantages of inductive sensors are:

- Insensitive to contamination
- No upward measuring range restriction due to the polarization effect. This occurs with conductive sensors in higher conductivities if charge clouds form in front of the electrodes due to the current density and thereby screen the electrodes.

On the other hand, inductive sensors are not suitable for pure water and ultrapure water applications.

### Temperature influence quantity

Like many other measured variables, electrolytic conductivity in liquids depends on the temperature: the mobility of the ions is affected by the temperature. In the case of weak electrolytes (i.e. electrolytes that only partially dissociate), the number of ions depends on the temperature. This effect is particularly strong with ultrapure water as the (very weak) intrinsic dissociation of water into  $H^+$  and  $OH^-$  depends heavily on the temperature. For this reason, the temperature is also measured and assessed in conductivity measurement systems.

It is common to refer the conductivity displayed by the device to a reference temperature  $T_{ref}$  of generally 25 °C. In other words, the conductivity the medium would have at 25 °C is shown. The temperature coefficient  $\alpha$  is also used. It describes the relative change in conductivity per degree of temperature change and is indicated in %/K:

$$\kappa_T = \kappa_{ref} \left( 1 + \frac{\alpha}{100\%} \cdot (T - T_{ref}) \right)$$

A0031019-EN

$\kappa_T$  = (uncompensated) conductivity at medium temperature

$\kappa_{ref}$  = (displayed) conductivity at reference temperature (generally 25 °C)

T = medium temperature

$T_{ref}$  = reference temperature (generally 25 °C)

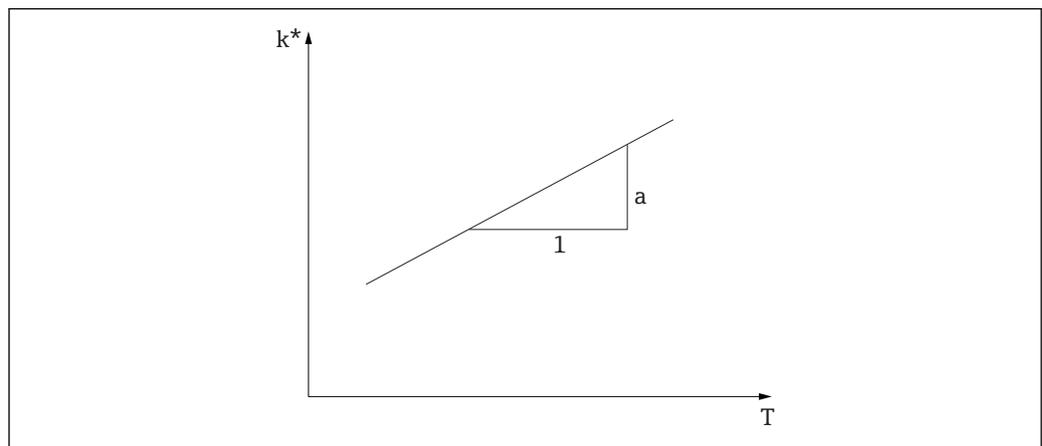
$\alpha$  = temperature coefficient (in %/K)

Typical values for  $\alpha$  are 2.1 %/K for salts and alkalis and 1.2 %/K for acids. In the case of ultrapure water  $\alpha$  ranges to over 7 %/K, depending on the temperature.

Several types of temperature compensation are available:

#### Linear compensation

The change in conductivity at different temperatures is taken to be constant, i.e.  $\alpha$  is constant with regard to temperature and concentration. The  $\alpha$  value can be entered directly in the device. Linear compensation is particularly suitable for a restricted medium temperature range. The numerical value is taken from literature on the subject or is determined experimentally.



A0030935

59 Linear temperature compensation

\* Uncompensated conductivity

*NaCl compensation as per IEC 746-3*

In the case of NaCl compensation, the device contains a fixed non-linear compensation algorithm which considers the dependency of the temperature coefficient  $\alpha$  on the temperature. This compensation applies to low concentrations up to approx. 5 % NaCl.

*Compensation for natural waters as per EN 27888 / ISO 7888*

This non-linear type of compensation is optimized for surface waters of rivers and lakes as well as ground water and spring water.

*Ultrapure water compensation*

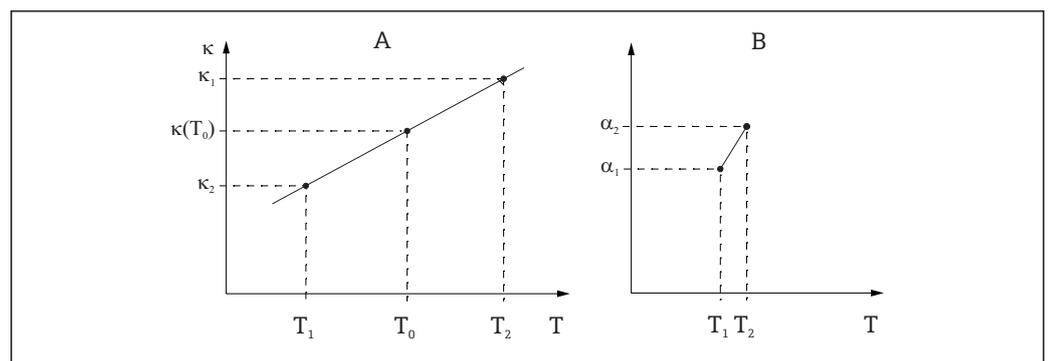
For pure and ultrapure water, the device contains algorithms that consider the self-dissociation of ultra pure water and its strong temperature dependency. It is used for conductivity levels of approx. 100  $\mu\text{S}/\text{cm}$ .

Two types of compensation are available:

- NaCl ultrapure water compensation is optimized for pH-neutral contamination.
- HCl ultrapure water compensation is optimized for measuring the acid conductivity after a cation exchanger. It is also suited for  $\text{NH}_3$  and NaOH.

*Temperature compensation using user tables*

Users can enter a tables for their own special media. The temperature coefficients are entered depending on the temperature or also depending on the temperature and the (compensated) conductivity (two or three-dimensional tables).



60 Determination of the temperature coefficient

- A Required data
- B Calculated  $\alpha$  values

The numerical values are taken from literature on the subject or are determined experimentally:

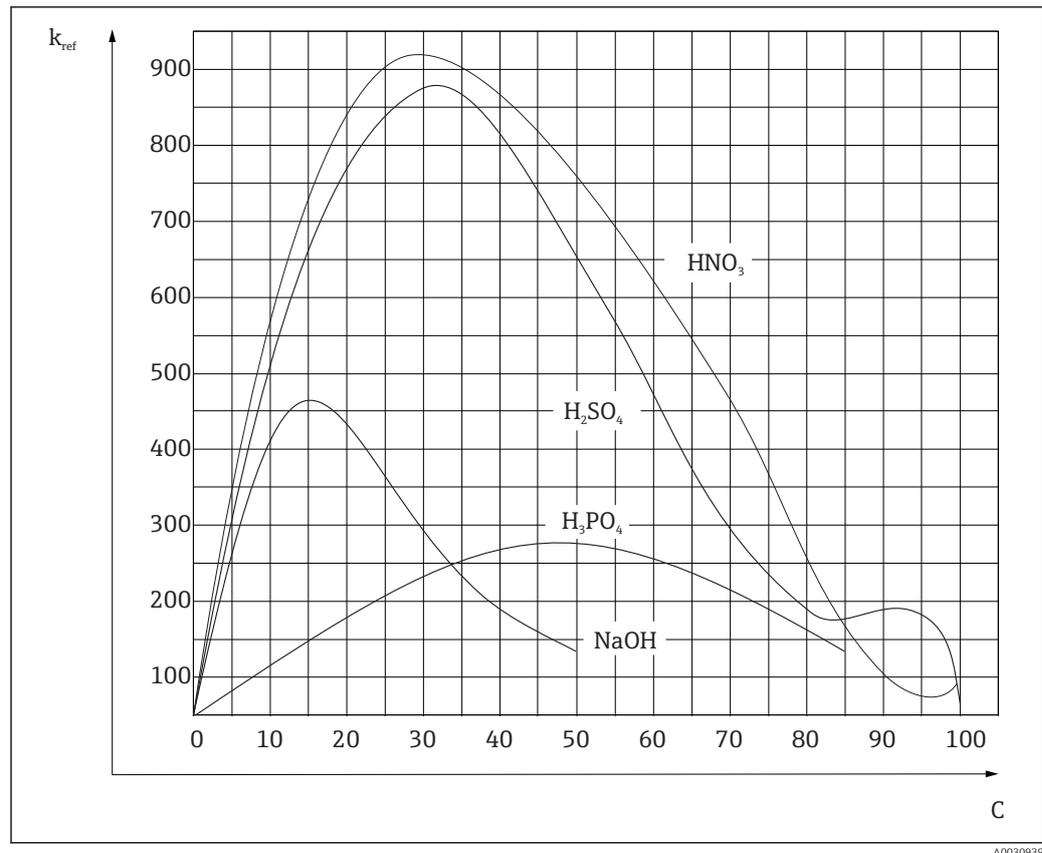
$$\alpha_T = \frac{100\%}{k_{ref}} \cdot \frac{k_T - k_{ref}}{T - T_{ref}}; T \neq T_{ref}$$

**Determining the concentration using the conductivity**

Since the number of ions in the solution determine the conductivity, conductivity measuring systems are often used to directly display the concentration of acids, alkalis or salts.

The conductivity first increases quickly with increasing ion concentration. However, at higher concentrations the ions obstruct one another. In addition, there is a drop in the number of water molecules which are needed for dissociation. This is why concentration curves typically have a maximum. Concentration measurement requires that you are either

to the left or right of the maximum; measurement in the area of the maximum is not possible.



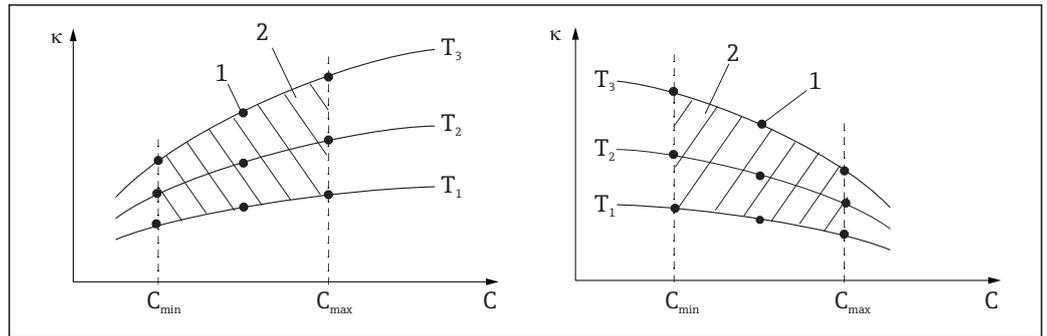
61 Conductivities of strong electrolytes

CIP (Clean In Place) liquids with common concentrations are always to the left of the maximum and can be easily measured.

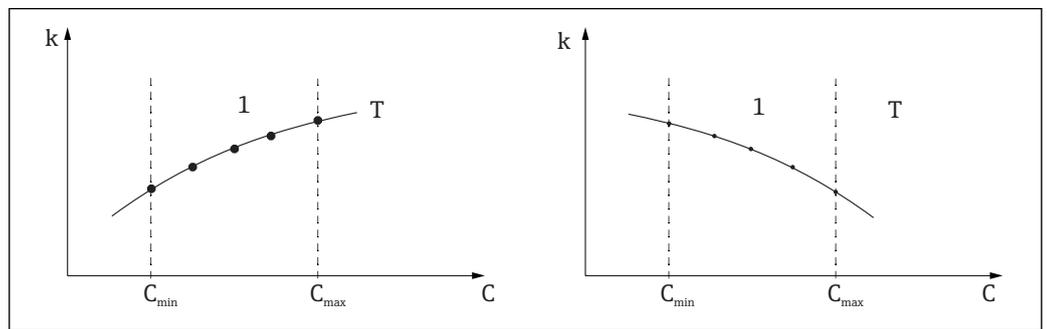
A number of concentration algorithms are saved in the devices, depending on how the devices are equipped. In addition, users can enter triple-value tables taking the conductivity (uncompensated raw value), concentration and temperature. Since the temperature is taken into account here, there is no need for temperature compensation. To enter the table, you need the conductivity characteristics of the medium. You can either refer to your data sheets for these characteristic curves or determine the characteristic curves yourself.

1. To do so, you create samples of the medium in the concentrations occurring in the process. A sample must be available with the minimum and maximum concentration occurring in the process.
2. Then measure the uncompensated conductivity of these samples at temperatures that also occur in the process.
3. For variable process temperatures: If variable process temperatures should be taken into consideration, you must measure the conductivity of each sample created at two temperatures at least (ideally the minimum and maximum process temperature). The temperature values of the various samples must be identical in each case. The temperatures must be at least 0.5 °C apart. At the very least, you need two samples of different concentrations at two different temperatures since the transmitter needs at least four support points.
4. For constant process temperatures: Measure the differently concentrated samples at this temperature. At least two samples are required.

In the end, you should have measuring data which appear as illustrated in the following two graphics.



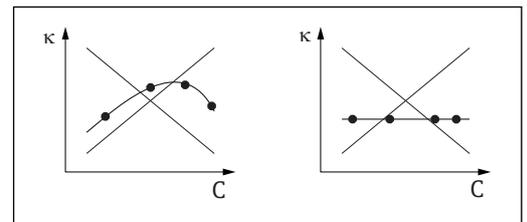
62 Example of measured data for variable temperatures



63 Example of measured data for constant temperatures

- κ Conductivity
- C Concentration
- T Constant temperature
- 1 Measuring range

The characteristic curves received from the measuring points must increase or decrease very monotonically in the range of the process conditions, i.e. neither maximum points, nor minimum points, nor ranges with a constant behavior can occur. The curve profiles opposite are therefore not permitted.



64 Impermissible curve profiles

- κ Conductivity
- C Concentration

**Limit values as per USP (United States Pharmacopoeia)**

In the case of conductive sensors, Memobase Plus has a function for monitoring WFI water (Water for Injection) as per the USP standard (United States Pharmacopoeia), Part 645.

The following table displays the limit value for WFI water as per USP at the corresponding temperature. This table is preprogrammed into Memobase Plus.

Temperature [°C]	Conductivity [μS/cm]	Temperature [°C]	Conductivity [μS/cm]
0	0.6	55	2.1
5	0.8	60	2.2
10	0.9	65	2.4

Temperature [°C]	Conductivity [ $\mu\text{S}/\text{cm}$ ]	Temperature [°C]	Conductivity [ $\mu\text{S}/\text{cm}$ ]
15	1.0	70	2.5
20	1.1	75	2.7
25	1.3	80	2.7
30	1.4	85	2.7
35	1.5	90	2.7
40	1.7	95	2.9
45	1.8	100	3.1
50	1.9		

The measurement is performed in the following steps:

- Measurement of the uncompensated conductivity and water temperature
- Memobase Plus rounds off the temperature to the nearest 5 °C and compares the measured conductivity to the associated value in the preprogrammed table
- An alarm is triggered if the measured value is bigger than the value in the table

A USP early warning is also available. This is activated at a configurable switch-on point (e. g. 80 % of the USP value). This means that the user is alerted to be able to regenerate the plant in time.

### Calibration and adjustment of conductivity systems

#### *Accurate determination of cell constant*

Calibration of a conductivity measurement system takes place in such a way that the exact cell constant is determined and checked with suitable calibration solutions. This process is described in the standards EN 7888 and ASTM D 1125, for example, and the method for producing a number of calibration solutions is explained. Another alternative is to purchase international calibration standards from national measurement institutes. This is particularly important in the pharmaceutical industry, which requires a calibration to be traced to internationally recognized standards. To calibrate its testing units, Endress +Hauser uses special reference material (SRM) from the US National Institute of Standards and Technology (NIST).

#### *Calibration in practice - temperature effect*

In practice, the temperature effect of the calibration solution must be taken into account. Users can choose from the following options:

- Tempering the calibration solution to the reference temperature of 25 °C
- Calibrating with compensated conductivity. For this purpose, the temperature coefficient  $\alpha$  is entered in the calibration menu as per the specifications of the reference solution manufacturer and the user works with the nominal value of the conductivity of the reference solution.
- Calibrating with uncompensated conductivity. For this purpose, temperature compensation is switched off in the general settings of the template for conductivity sensors and the uncompensated conductivity is determined as per the instructions of the reference solution manufacturer. This is generally the easiest and most practical method since the temperature dependence of the solution does not have to be taken into account.

#### *Calibration and adjustment of temperature measurement*

As the electrolytic conductivity is subject to a temperature influence, it makes sense to also calibrate, and where necessary adjust, the temperature sensor, which is integrated in the sensor, together with Memobase Plus. This is done by comparing the measurement with a reference temperature measuring system in a liquid. Adjustment takes place by entering the temperature displayed by the reference system in the calibration menu. From this,

Memobase Plus calculates the offset for future measurements using the following equation:

$$T_{\text{display}} = T_{\text{raw value}} + \text{offset}$$

It is better to calibrate near the planned process temperature. If the process temperature covers a large area, it is recommended to calibrate the temperature measurement at different temperatures. In the case of two-point adjustment, the temperature measurement can be set accurately at 25 °C and 80 °C for instance. From the two points, Memobase Plus calculates an offset at 0 °C and a slope for future measurements using the following equation:

$$T_{\text{display}} = T_{\text{raw value}} \cdot \text{slope} + \text{offset}$$

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