

Operating Instructions

Memosens COS51E

Amperometric oxygen sensor with Memosens 2.0 technology



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1 About this document

1.1 Safety information

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

1.2 Symbols used

	Additional information, tips
	Permitted
	Recommended
	Forbidden or not recommended
	Reference to device documentation
	Reference to page
	Reference to graphic
	Result of a step

1.2.1 Symbols on the device

	Reference to device documentation
	Minimum immersion depth
	Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

1.3 Supplementary documentation

The following manuals which complement these Operating Instructions can be found on the product pages on the Internet:

- Technical Information for the relevant sensor
- Operating Instructions for the transmitter used
- Operating Instructions for the cable used
- Safety Datasheet for the relevant electrolyte solutions

In addition to these Operating Instructions, an XA with "Safety instructions for electrical apparatus in the hazardous area" is also included with sensors for use in the hazardous area.

- Please follow instructions on use in the hazardous area carefully.

2 Basic safety instructions

2.1 Requirements for the 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 Intended use

The sensor is suitable for continuous measurement of dissolved oxygen in aqueous solutions.

The sensor is particularly suitable for:

- Measuring, monitoring and regulating the oxygen content in activated sludge basins
- Monitoring the oxygen content in the wastewater treatment plant outlet
- Monitoring, measuring and regulating the oxygen content in public waters and fish farming water

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 Workplace safety

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

- Installation guidelines
- Local standards and regulations
- Regulations for explosion protection

Electromagnetic compatibility

- The product has been tested for electromagnetic compatibility in accordance with the applicable international standards for industrial applications.
- The electromagnetic compatibility indicated applies only to a product that has been connected in accordance with these Operating Instructions.

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.

⚠ CAUTION**Cleaning not switched off during calibration or maintenance activities**

Risk of injury due to medium or cleaning agent!

- ▶ If a cleaning system is connected, switch it off before removing a sensor from the medium.
- ▶ If you need to test the cleaning function while cleaning is in progress, wear protective clothing, goggles and gloves or take other suitable measures to protect yourself.

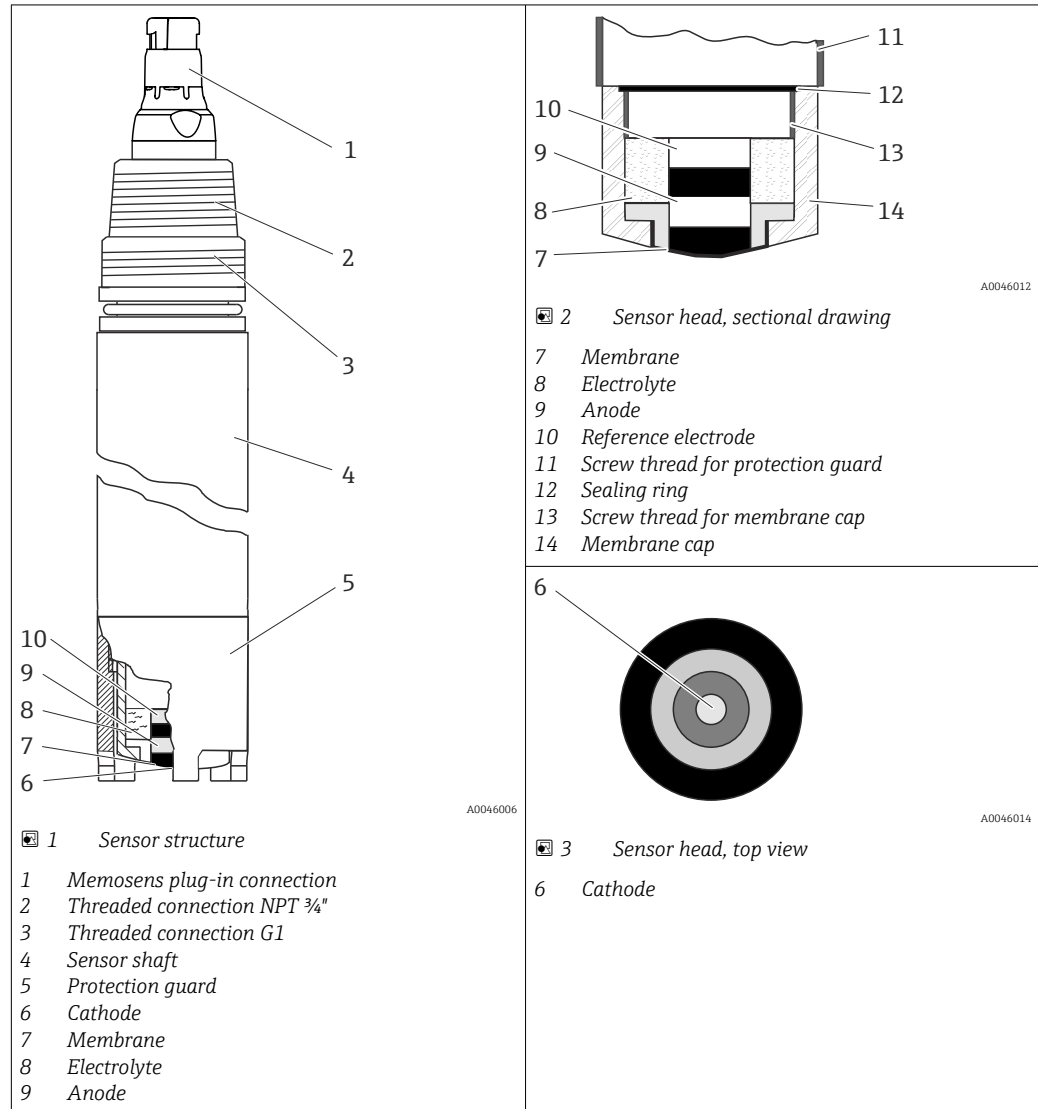
2.5 Product safety

2.5.1 State of the art

The product is designed to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. The relevant regulations and international standards have been observed.

3 Product description

3.1 Product design



The sensor consists of the following functional units:

- Sensor shaft
- Sensor head with cathode, anode and reference electrode
- Membrane cap with electrolyte filling
- Protection guard

Please note the following:

- As an alternative to the protection guard, a spray head can be used for immersion operation with cleaning.
- The membrane cap screwed onto the sensor head contains the electrolyte. The screw plug seals off the membrane cap from the medium.
- The sensor is ready for use immediately.

3.2 Measuring principle

3.2.1 Amperometric measuring principle

During amperometric oxygen measurement, oxygen molecules diffuse through the membrane and are reduced to hydroxide ions (OH^-) at the working electrode. At the counter-electrode, silver is oxidized to silver ions (Ag^+) (this forms a silver halide layer). The associated release of electrons at the working electrode and absorption of electrons at the counter-electrode causes a current to flow. Under constant conditions, this current flow is proportional to the oxygen content of the medium. The current is converted in the transmitter and indicated on the display as an oxygen concentration in mg/l, $\mu\text{g/l}$, ppm, ppb or Vol%, ppmVol, raw value nA, as a saturation index in % SAT or as an oxygen partial pressure in hPa.

3.3 Potentiostatic three-electrode system

The high-impedance, current-free reference electrode plays an important role. The formation of the silver bromide or silver chloride layer at the anode causes the electrolyte's bromide or chloride ions to be depleted. With conventional membrane-covered sensors with a two-electrode system, this results in increased signal drift.

Not so with the three-electrode system:

The change in the bromide or chloride concentration is recorded by the reference electrode and an internal regulator circuit keeps the working electrode at a constant potential. The advantages are a much higher signal accuracy and significantly extended calibration intervals.

3.4 Membrane body

The oxygen dissolved in the medium is transported to the membrane by the necessary flow. The membrane is permeable for dissolved gases only. Other substances dissolved in the liquid phase, e.g. ionic substances, will not penetrate through the membrane. Therefore, medium conductivity has no impact on the measuring signal.

The sensor is shipped with a membrane body, which can be used for both measuring ranges. The membrane is pretensioned at the factory and is ready for use immediately.



Electrolytes are measuring range-specific and **cannot** be mixed in a single application!

Also pay attention to the safety datasheet of the electrolyte on www.endress.com/downloads.

3.5 Polarization

When the sensor is connected to the transmitter, a fixed voltage is applied between the working electrode and the counter-electrode. The resulting polarization current can be identified on the transmitter by a reading that is initially high, but decreases over time. The reading must be stable before the sensor can be calibrated and a reliable measurement is possible.

3.6 Memosens technology

Sensors with Memosens protocol have an integrated electronics unit that stores calibration data and other information. Once the sensor has been connected, the sensor data are transferred automatically to the transmitter and used to calculate the measured value and for Heartbeat Technology functions.

- Call up the sensor data via the corresponding DIAG menu.

Digital sensors can store measuring system data in the sensor. These include the following:

- Manufacturer data
- Serial number
- Order code
- Date of manufacture
- Digital sensor label
- Calibration data of the last eight calibrations including factory calibration with calibration date and calibration values
- Serial number of the transmitter used to perform the last calibration
- Possibility to reset to factory calibration
- In the case of sensors with replaceable measuring elements, the number of calibrations per measuring element and for the entire sensor
- Application data
- Temperature application range
- Date of first commissioning
- Hours of operation under extreme conditions
- Number of sterilizations and CIP cycles (with hygienic sensors)

All Memosens 2.0 E sensors offer these advantages with the latest Liquiline transmitter software. All Memosens 2.0 sensors are backward-compatible with previous software versions and offer the usual Memosens benefits of the D generation.

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 Identifying the product

Product page

www.endress.com/cos51e

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

Obtaining information on the product

1. Open 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.

4.2.2 Nameplate

The following information on the device can be found on the nameplate:

- Manufacturer identification
- Order code
- Extended order code

- Serial number
 - Safety information and warnings
 - Certificate information
- Compare the information on the nameplate with the order.

4.2.3 Manufacturer address

Endress+Hauser Conducta GmbH+Co. KG
Dieselstraße 24
D-70839 Gerlingen

4.3 Scope of delivery

The scope of delivery comprises:

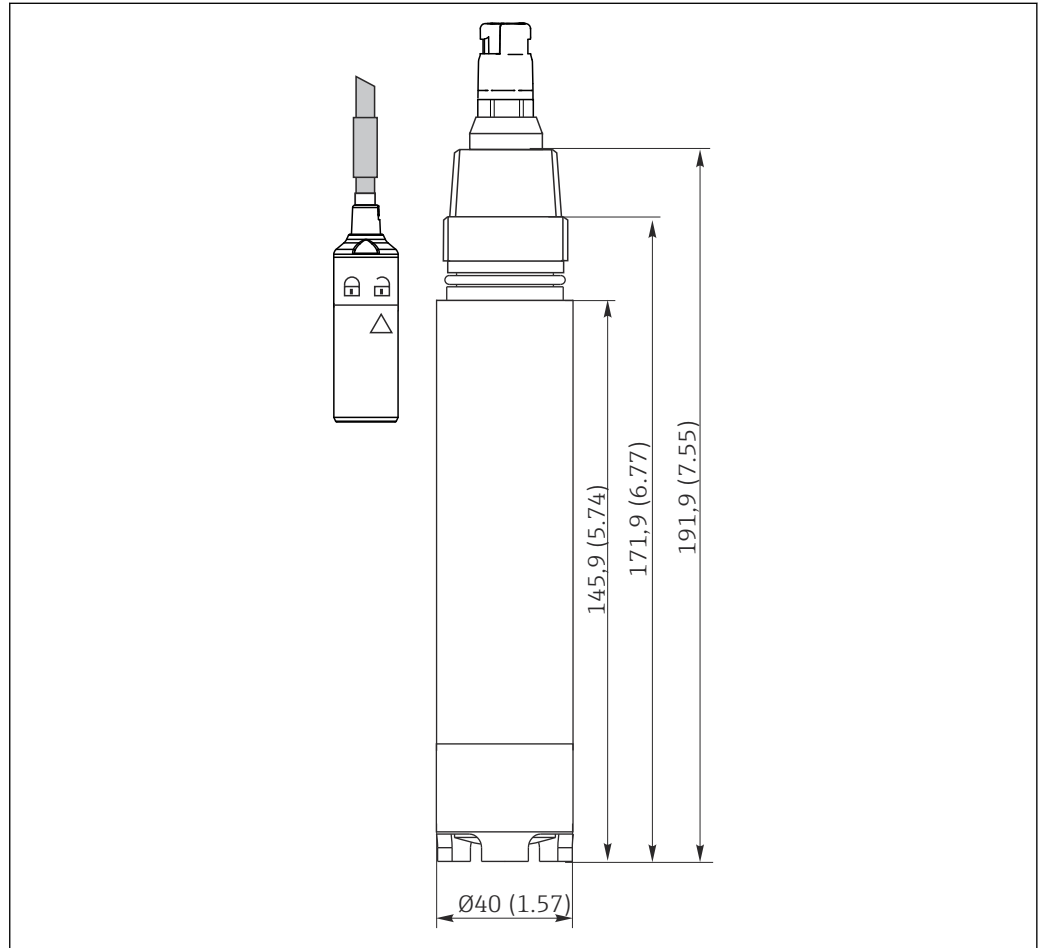
- Ordered version of the sensor with protective cap (filled with tap water) to protect the membrane
- Accessories set with the following contents:
 - 2 replacement membrane caps
 - Electrolyte, 1 bottle, 10 ml (0.34 fl.oz.)
 - Seal set with 3 O-rings
 - 6 polishing foils in 2 grit sizes
- Safety instructions for the hazardous area (for sensors with Ex approval)
- Brief operating instructions
- Optional: cleaning unit
- Optional: replacement caps

If you have any questions, please contact the Endress+Hauser Sales Center.

5 Installation

5.1 Installation requirements

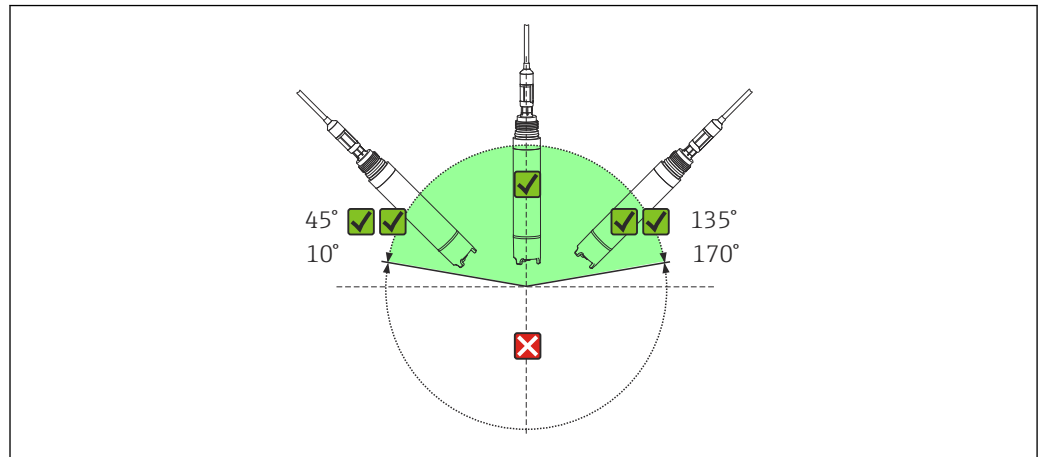
5.1.1 Dimensions



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4 Dimensions in mm (inch)

5.1.2 Orientation



A0030544

-  5 Permitted orientations
-  Recommended installation angle
-  Possible installation angle
-  Inadmissible installation angle

The sensor must be installed at an angle of inclination of 10° to 170° in an assembly, holder or suitable process connection. Recommended angle: 45° to prevent the attachment of air bubbles.

Inclination angles other than those mentioned are not permitted. Do **not** install the sensor upside down.

-  Follow the instructions for installing sensors in the Operating Instructions for the assembly used.

5.1.3 Installation location

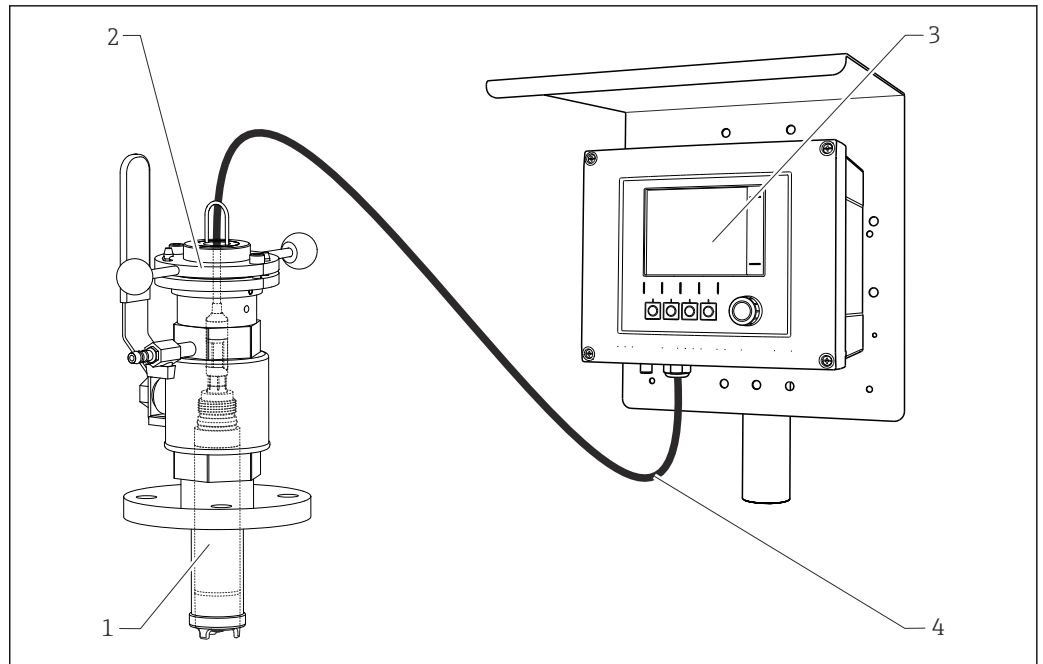
1. Choose a mounting location that is easy to access.
2. Ensure that upright posts and assemblies are fully secured and vibration-free.
3. Choose a mounting location with an oxygen concentration that is typical for the application.

5.2 Installing the sensor

5.2.1 Measuring system

A complete measuring system comprises:

- a Memosens COS51E oxygen sensor
- a transmitter, e.g. Liquiline CM44
- a measuring cable e.g. CYK10
- Optional: an assembly, e.g. CYA112 immersion assembly or COA451 retractable assembly
- Optional: a CYH112 assembly holder
- Optional: a cleaning unit with compressed air system
- Optional: other protection cages (71096199)



6 Example of a measuring system with Memosens COS51E digital oxygen sensor

- 1 Memosens COS51E oxygen sensor
- 2 COA451 retractable assembly
- 3 Liquiline CM44
- 4 CYK10 measuring cable

5.2.2 Installing at a measuring point

i Mount the assemblies away from the basin on a solid base. Only carry out the final assembly at the assigned mounting location. Select an installation location that will ensure proper handling of the assembly (mounting, operation, maintenance).

Must be installed in a suitable assembly (depending on the application).

WARNING

Electrical voltage

In the event of a fault, non-grounded metallic assemblies may be live and as such are not safe to touch!

- When using metallic assemblies and installation equipment, national grounding provisions must be observed.

For complete installation of a measuring point with a flow assembly or retractable assembly, follow the steps below in the order given.

1. Install the retractable assembly or flow assembly (if used) into the process.
2. Install the oxygen sensor in the assembly.
3. Connect the cable to the sensor and transmitter.
4. Connect the water supply to the rinse connections (if using an assembly with a cleaning function).
5. Supply power to the transmitter.

For complete installation of a measuring point with a suspended assembly or immersion assembly, follow the steps below in the order given:

1. Install the oxygen sensor in the assembly.
2. Connect the cable to the sensor and transmitter.
3. Install the suspended or immersion assembly in the process.

4. Supply power to the transmitter.

NOTICE

Installation errors

Cable break, loss of sensor due to cable separation, unscrewing of the membrane cap in the assembly!

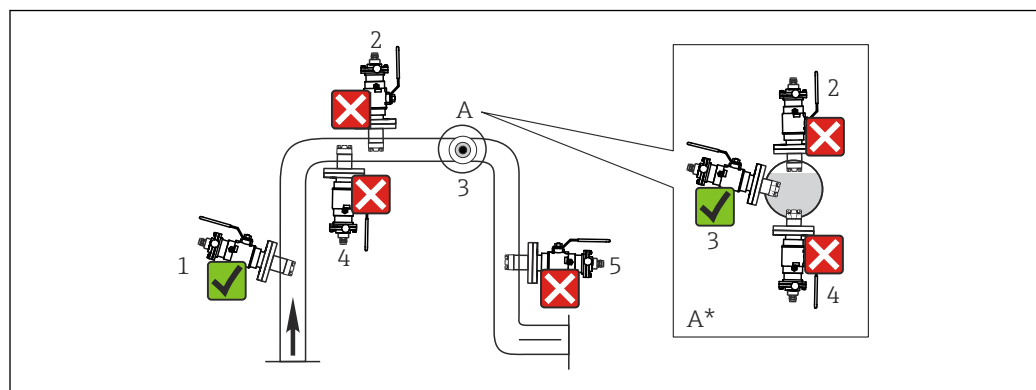
- ▶ For immersion operation, the sensor must be installed in an immersion assembly (such as CYA112). Do not install the sensor freely suspended from the cable!
- ▶ Avoid exerting excessive tensile force on the cable (e.g. through jerky pulling movements).
- ▶ Choose an installation location that is easy to access for later calibrations.
- ▶ Follow the instructions for installing sensors in the Operating Instructions for the assembly used.

5.3 Installation examples

5.3.1 Retractable assembly COA451

The assembly is designed for installation on vessels and pipes. This requires the availability of suitable process connections.

Install the assembly in a place with uniform flow conditions. The pipe diameter must be at least DN 80.



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7 Permissible and impermissible sensor installation positions with retractable assembly

- 1 Ascending pipe, best position
 - 2 Horizontal pipe, sensor top down, impermissible due to air cushion or foam bubble forming
 - 3 Horizontal pipe, lateral installation with permissible installation angle (acc. to sensor version)
 - 4 Upside-down installation, unsuitable
 - 5 Down pipe, impermissible
 - A Detail A (top view)
 - A* Detail A, turned by 90° (side view)
- ✓ Possible installation angle
 ✗ Inadmissible installation angle

NOTICE

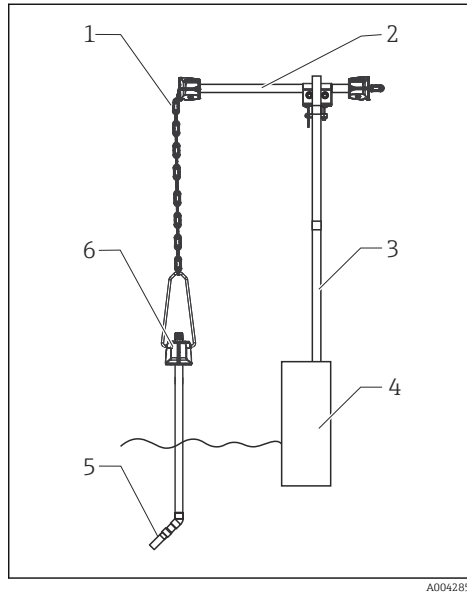
Sensor not fully immersed in the medium, buildup, upside-down installation

These can all cause incorrect measurements!

- ▶ Do not install assembly at points where air pockets or bubbles may form.
- ▶ Avoid buildup on the sensor membrane or remove it at regular intervals.
- ▶ Do not install sensor upside down.

5.3.2 Immersion operation

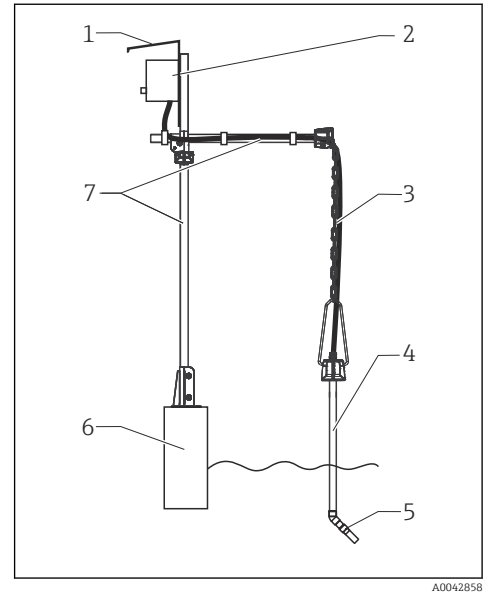
Universal holder and chain assembly



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8 Chain holder on railing

- 1 Chain
- 2 Holder Flexdip CYH112
- 3 Rail
- 4 Basin rim
- 5 Oxygen sensor
- 6 Wastewater assembly Flexdip CYA112

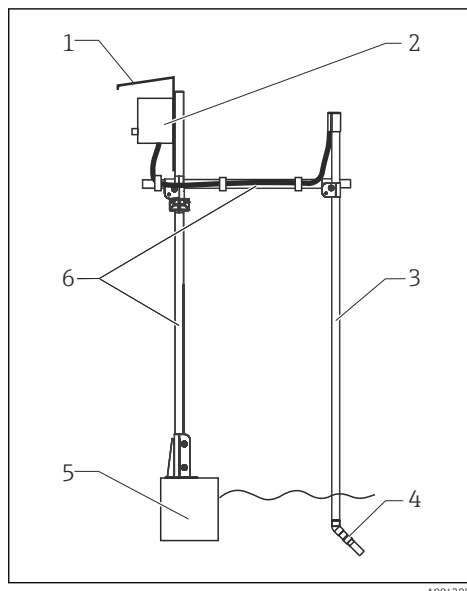


A0042858

9 Chain holder on upright post

- 1 Weather protection cover CYY101
- 2 Transmitter
- 3 Chain
- 4 Wastewater assembly Flexdip CYA112
- 5 Oxygen sensor
- 6 Basin rim
- 7 Holder Flexdip CYH112

Universal holder and fixed immersion tube

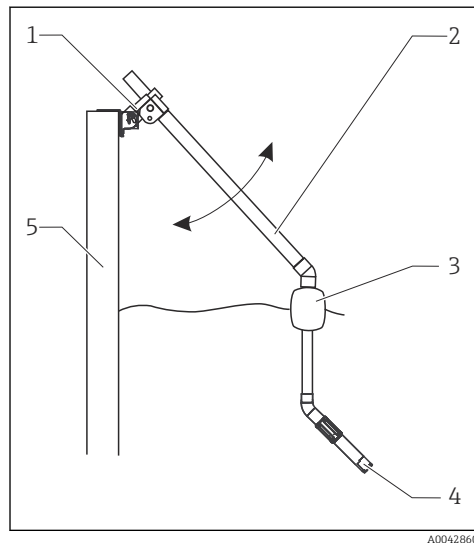


A0042859

10 Assembly holder with immersion tube

- 1 Protective cover
- 2 Transmitter
- 3 Flexdip CYA112 immersion assembly
- 4 Oxygen sensor
- 5 Basin rim
- 6 Assembly holder Flexdip CYH112

Basin rim mounting with immersion tube



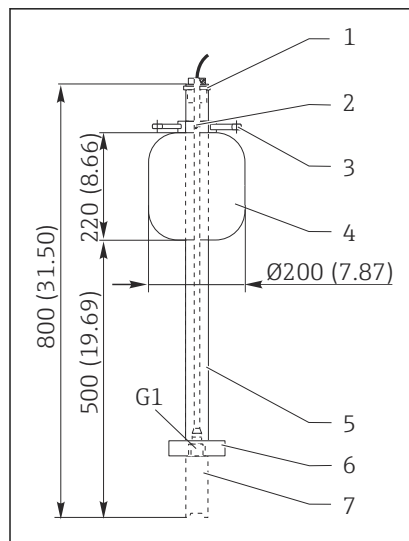
A0042860

11 Basin rim mounting

- 1 Pendulum holder CYH112
- 2 Assembly Flexdip CYA112
- 3 Assembly float
- 4 Oxygen sensor
- 5 Basin rim

Float

The CYA112 float is for use in the case of large fluctuations in water level, for example in rivers or lakes.



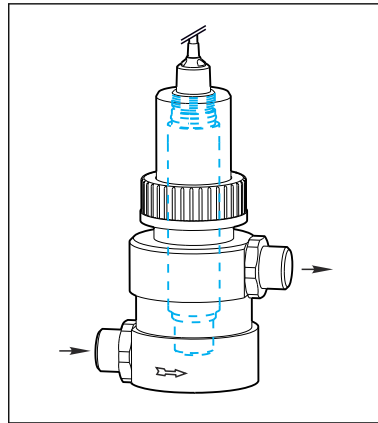
A0032159

12 Dimensions in mm (inch)

- 1 Cable run with strain relief and rain shield
- 2 Fixing ring for rope and chains with terminal screw
- 3 Eyelets Ø15, 3 x 120 °for anchoring
- 4 Plastic float, resistant to salt water
- 5 Pipe 40 x 1, stainless steel 1.4571
- 6 Bumper and ballast
- 7 Oxygen sensor

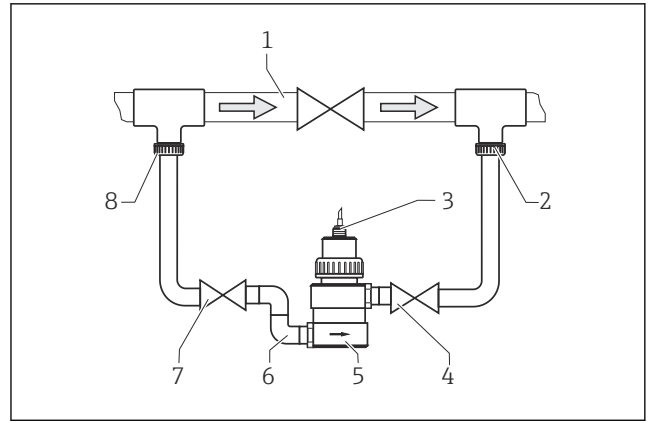
5.3.3 Flow assembly COA250

The COA250 flow assembly with automatic self-venting is suitable for use in pipelines or at hose connections. The inlet is at the bottom of the assembly and the outlet is at the top (G $\frac{3}{4}$ connection thread). It is installed in a pipe using two 90° pipe brackets at the inlet of assembly (item 6).



A0013319

13 COA250

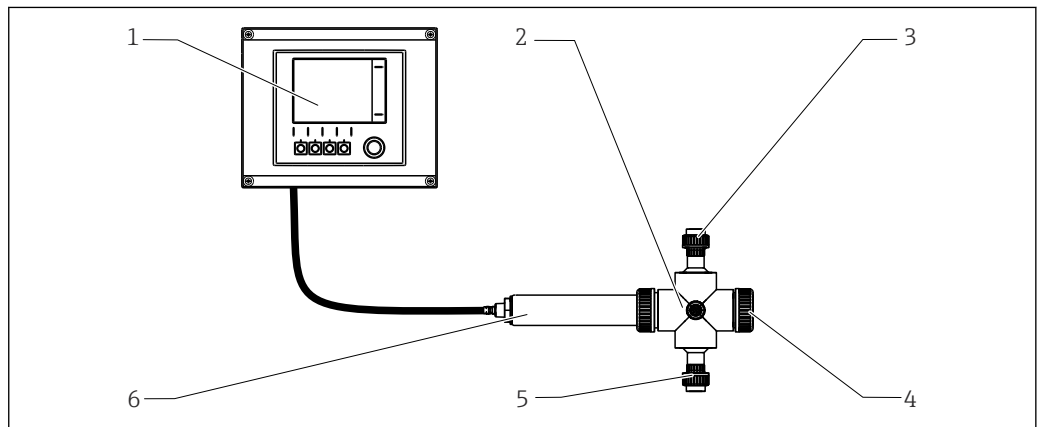


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14 Bypass installation with manually actuated valves or solenoid valves

- 1 Main pipe
- 2 Medium return
- 3 Oxygen sensor
- 4, 7 Manually actuated or solenoid valves
- 5 Flow assembly COA250-A
- 6 90 ° pipe elbow
- 8 Medium removal

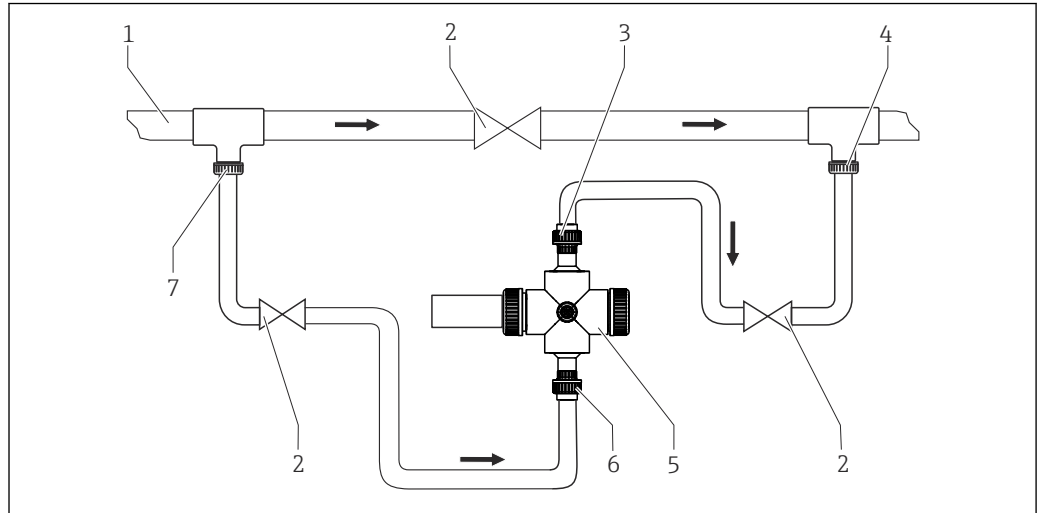
5.3.4 Universal flow assembly Flowfit CYA251



A0032917

15 Measuring system with CYA251

- 1 Transmitter
- 2 Flow assembly
- 3 Medium outlet
- 4 Cap
- 5 Medium inflow
- 6 Memosens COS51E



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16 Connection diagram

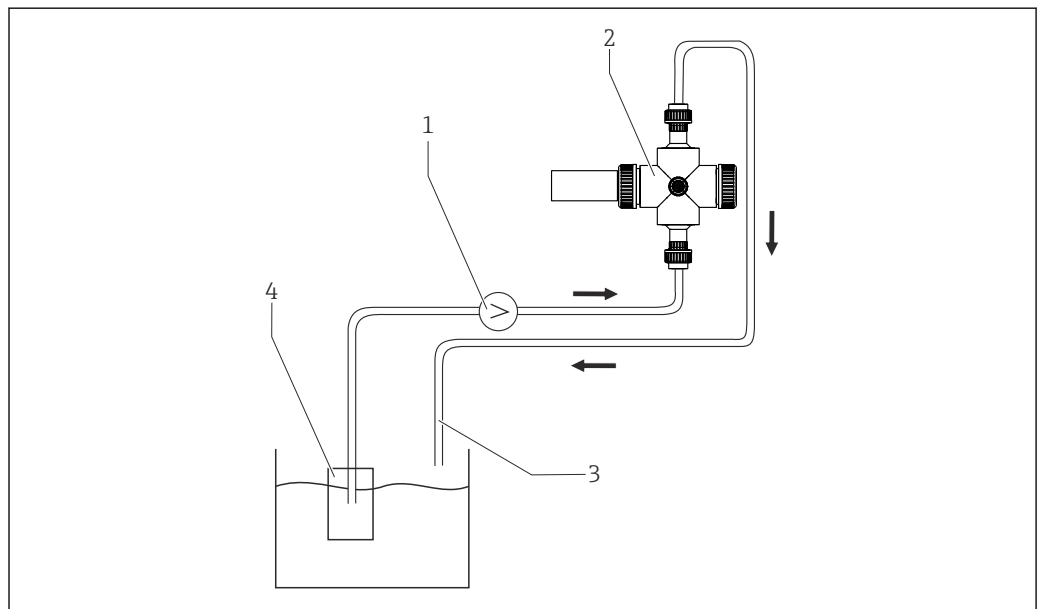
- | | | | |
|---|--------------------------------------|---|----------------|
| 1 | Main pipe | 5 | Medium inflow |
| 2 | Manually actuated or solenoid valves | 6 | Flow assembly |
| 3 | Medium outlet | 7 | Medium removal |
| 4 | Medium return | | |

 Mount the sensor in the assembly in accordance with the Operating Instructions (BA00495C).

There must be a minimum flow rate of 100 ml/h (0.026 gal/h).

► Take increased response times into account.

As an alternative to bypass operation, direct the sample flow from a filter unit with an open outlet through the assembly:



A0032921

17 Flow assembly with open outlet

- | | |
|---|-------------|
| 1 | Pump |
| 2 | Assembly |
| 3 | Open outlet |
| 3 | Filter unit |

5.4 Post-installation check

1. Are the sensor and cable undamaged?
2. Is the orientation correct?
3. Is the sensor installed in an assembly and is not suspended from the cable?
4. Avoid the penetration of moisture.

6 Electrical connection

⚠ WARNING

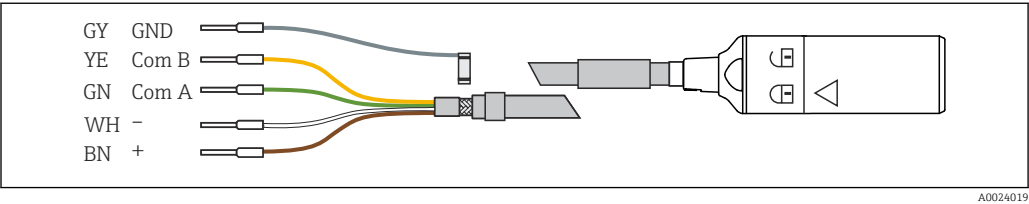
Device is live!

Incorrect connection may result in injury or death!

- ▶ The electrical connection may be performed only by an electrical technician.
- ▶ The electrical technician must have read and understood these Operating Instructions and must follow the instructions contained therein.
- ▶ **Prior** to commencing connection work, ensure that no voltage is present on any cable.

6.1 Connecting the sensor

The electrical connection of the sensor to the transmitter is established using measuring cable CYK10.



18 Measuring cable CYK10

6.2 Ensuring the degree of protection

Only the mechanical and electrical connections which are described in these instructions, and which are necessary for the required intended use, may be established on the device delivered.

- ▶ Exercise care when carrying out the work.

Otherwise, the individual types of protection (Ingress Protection (IP), electrical safety, EMC interference immunity) agreed for this product can no longer be guaranteed due, for example, to covers being left off or cable (ends) that are loose or insufficiently secured.

6.3 Post-connection check

Device health and specifications	Action
Is the outside of the sensor, assembly or cable free from damage?	▶ Perform a visual inspection.
Electrical connection	Action
Are the mounted cables strain-relieved and not twisted?	▶ Perform a visual inspection. ▶ Untwist the cables.
Is a sufficient length of the cable cores stripped, and are the cores positioned in the terminal correctly?	▶ Perform a visual inspection. ▶ Pull gently to check they are seated correctly.
Are all screw terminals tightened?	▶ Tighten the screw terminals.
Are all cable entries mounted, firmly tightened and leak-tight?	▶ Perform a visual inspection. In the case of lateral cable entries:
Are all cable entries mounted on the side or pointing downwards?	▶ Point cable loops downward so that water can drip off.

7 Commissioning

7.1 Installation and function check

Prior to initial commissioning, ensure that:

- Is the sensor correctly installed?
- Is the electrical connection correct?

If using an assembly with automatic cleaning function:

- ▶ Check that the cleaning medium (water or air, for example) is connected correctly.

WARNING

Escaping process medium

Risk of injury from high pressure, high temperatures or chemical hazards!

- ▶ Before applying pressure to an assembly with cleaning system, ensure that the system has been connected correctly.
- ▶ If you cannot reliably establish the correct connection, do not install the assembly in the process.

1. At the transmitter, enter all the settings specific to the parameters and measuring point. These include the air pressure during calibration and measurement or the salinity, for instance.
2. Check whether a calibration/adjustment is necessary.

The oxygen measuring point is then ready to measure.



After commissioning, maintain the sensor at regular intervals to ensure reliable measurement.



- Operating Instructions for Memosens COS51E, BA02146C
- Operating Instructions for the transmitter used, such as BA01245C if using the Liquiline CM44x or Liquiline CM44xR.

7.2 Sensor polarization and preparation for calibration/adjustment

NOTICE

Incorrect measurements due to ambient influences!

- ▶ It is essential to avoid strong sunlight on the sensor.
- ▶ Comply with the instructions for commissioning in the Operating Instructions of the transmitter used.

The sensor has been tested at the factory to ensure it is functioning correctly and is delivered ready for operation.

To prepare for measuring and/or calibration:

1. Remove the sensor protective cap.
2. Expose the sensor, which is dry on the outside, to the air atmosphere.
 - ↳ The air should be saturated with water vapor. Therefore, install the sensor as close as possible to a water surface. However, the sensor membrane must remain dry during calibration. Therefore, avoid direct contact with the water surface.
3. Connect the sensor to the transmitter.
4. Switch on the transmitter.
 - ↳ When the sensor is connected to the transmitter, polarization takes place automatically once the transmitter has been switched on.

5. Wait for the polarization time to elapse .

7.3 Calibration and adjustment

During calibration, the measured value is compared to the value expected under specified conditions (depending on the calibration method, e.g. in air with 100% rh at sea level).

A zero point calibration is not necessary. Perform a single-point calibration of the sensor in the presence of oxygen.

A calibration must be performed after the following activities:

Cap change

A calibration is recommended after the following:

- Initial commissioning
- Replacement of membrane or electrolyte
- Cleaning of cathode
- Long pauses in operation without power supply

Calibration can also be monitored or renewed cyclically (at typical time intervals, depending on operating experience), e.g. within the context of system monitoring..

Calibrate the sensor at least once a year.

Fully polarize the sensor prior to calibration.

7.3.1 Types of calibration

A slope or zero point calibration can be carried out for the sensor.

In most applications, single-point calibration in the presence of oxygen is sufficient (=calibration of the sensor slope). When changing from process to calibration conditions, a longer polarization time and an adjustment of the temperature to the environment must be taken into account with the sensor.

The additional calibration of the zero point improves the accuracy of the measurement results at trace concentrations. Zero point calibration, e.g. with nitrogen (min. 99.995%) or COY8 zero-point gel. To prevent incorrect measurements in the trace range later on, make sure that the sensor is polarized and the measured value has settled at the zero point .

The following describes calibration of the slope in air (saturated with water vapor) as the easiest and recommended calibration method. However, this type of calibration is possible only if the air temperature is $\geq 0\text{ }^{\circ}\text{C}$ (32 $^{\circ}\text{F}$).

Before calibration, enter the air pressure/process pressure at the transmitter.

7.3.2 Calibration intervals

Specifying the intervals

If you want to calibrate the sensor intermittently for a special application and/or on account of a special type of installation, you can calculate the intervals using the following method:

1. Remove the sensor from the medium.
2. Clean the outside of the sensor with a damp cloth.
3. Then dry the sensor diaphragm carefully with a soft paper towel for example.

4. NOTICE**Incorrect measurements caused by atmospheric influences!**

- ▶ Protect the sensor against external influences such as sunlight and wind.
- ▶ Prior to calibration, adjust the atmospheric pressure if it does not match the process pressure.

After 20 minutes, measure the oxygen saturation index in air.

5. Decide using the results:

- a) Measured value is **not** $102 \pm 2 \% \text{SAT}$ → Calibrate sensor (adjust if necessary).
- b) If the values are within the specified interval, the sensor does not need to be calibrated. The time period between inspections can be extended.

6. Repeat the steps specified after two, four or eight months to determine the optimum calibration interval for your sensor.**7.3.3 Calibration in air with 100% rH**

1. Remove the sensor from the medium.
 2. Clean the outside of the sensor carefully with a damp cloth.
 3. Allow a temperature compensation time of approx. 20 minutes for the sensor in the ambient air. Make sure that the sensor is not exposed to any direct ambient effects (direct sunlight, drafts) during this time.
 4. Is the measured value display on the transmitter stable:
Perform the calibration in accordance with the Operating Instructions for the transmitter. Pay particular attention to the software settings for the stability criteria for calibration and for the ambient pressure.
 5. Where necessary:
Adjust the sensor by accepting the calibration data.
 6. Then place the sensor back into the medium.
 7. Deactivate the hold status at the transmitter.
- ▶ Follow the calibration instructions in the Operating Instructions for the transmitter used.

7.3.4 Calculation example for the calibration value

As a check, you can calculate the expected calibration value (transmitter display) as shown in the following example (salinity is 0).

1. Determine the following:

- Ambient temperature for the sensor (air temperature for **Air 100% rh** or **Air variable** calibration types, water temperature for **H2O air-saturated** calibration type)
- The altitude above sea level
- The current air pressure (= relative air pressure based on sea level) at the time of calibration. (If indeterminable, use 1013 hPa.)

2. Determine the following:

- The saturation value S acc. to Table 1
- The altitude factor K acc. to Table 2

Table 1

T [°C (°F)]	S [mg/l=ppm]	T [°C (°F)]	S [mg/l=ppm]	T [°C (°F)]	S [mg/l=ppm]	T [°C (°F)]	S [mg/l=ppm]
0 (32)	14.64	11 (52)	10.99	21 (70)	8.90	31 (88)	7.42
1 (34)	14.23	12 (54)	10.75	22 (72)	8.73	32 (90)	7.30
2 (36)	13.83	13 (55)	10.51	23 (73)	8.57	33 (91)	7.18
3 (37)	13.45	14 (57)	10.28	24 (75)	8.41	34 (93)	7.06
4 (39)	13.09	15 (59)	10.06	25 (77)	8.25	35 (95)	6.94
5 (41)	12.75	16 (61)	9.85	26 (79)	8.11	36 (97)	6.83
6 (43)	12.42	17 (63)	9.64	27 (81)	7.96	37 (99)	6.72
7 (45)	12.11	18 (64)	9.45	28 (82)	7.82	38 (100)	6.61
8 (46)	11.81	19 (66)	9.26	29 (84)	7.69	39 (102)	6.51
9 (48)	11.53	20 (68)	9.08	30 (86)	7.55	40 (104)	6.41
10 (50)	11.25						

Table 2

Height [m (ft)]	K	Height [m (ft)]	K	Height [m (ft)]	K	Height [m (ft)]	K
0 (0)	1.000	550 (1800)	0.938	1050 (3450)	0.885	1550 (5090)	0.834
50 (160)	0.994	600 (1980)	0.932	1100 (3610)	0.879	1600 (5250)	0.830
100 (330)	0.988	650 (2130)	0.927	1150 (3770)	0.874	1650 (5410)	0.825
150 (490)	0.982	700 (2300)	0.922	1200 (3940)	0.869	1700 (5580)	0.820
200 (660)	0.977	750 (2460)	0.916	1250 (4100)	0.864	1750 (5740)	0.815
250 (820)	0.971	800 (2620)	0.911	1300 (4270)	0.859	1800 (5910)	0.810
300 (980)	0.966	850 (2790)	0.905	1350 (4430)	0.854	1850 (6070)	0.805
350 (1150)	0.960	900 (2950)	0.900	1400 (4600)	0.849	1900 (6230)	0.801
400 (1320)	0.954	950 (3120)	0.895	1450 (4760)	0.844	1950 (6400)	0.796
450 (1480)	0.949	1000 (3300)	0.890	1500 (4920)	0.839	2000 (6560)	0.792
500 (1650)	0.943						

3. Calculate factor **L**:

$$L = \frac{\text{Relative air pressure at calibration}}{1013 \text{ hPa}}$$

4. Determine the **M** factor:

- **M** = 1.02 (for **Air 100% rh** calibration type)
- **M** = 1.00 (for **H2O air-saturated** calibration type)

5. Calculate calibration value **C**:

$$C = S \cdot K \cdot L \cdot M$$

Example

- Air calibration at 18 °C (64 °F), altitude 500 m (1650 ft) above sea level, current air pressure 1009 hPa
- $S = 9.45 \text{ mg/l}$, $K = 0.943$, $L = 0.996$, $M = 1.02$
- Calibration value $C = 9.05 \text{ mg/l}$.



Factor K in the table is not required if the measuring device returns the absolute air pressure L_{abs} (air pressure depending on altitude) as the measured value. The formula for calculation is then: $C = S \cdot L_{\text{abs}}$.

8 Diagnostics and troubleshooting

8.1 Checking the sensor

Only authorized and trained personnel may test the sensor. A multimeter (voltage, resistance) is required for testing.

Test	Required action	Set point
Slope check	Expose the sensor to air and dry with a paper towel.	approx. 102 % SAT
Zero-point check	Immerse the sensor in COY8 zero-point gel or nitrogen.	Display close to 0 mg/l (0 % SAT)

 In the event of deviations from the setpoint, perform troubleshooting →  28 or contact the Service department.

8.2 General troubleshooting

- If one of the following problems is present:
Check the measuring system in the order shown.

Problem	Test	Remedy
Blank display, no sensor reaction	Power supplied to the transmitter?	► Establish the power supply. ► Switch on channel on transmitter.
	Sensor cable connected correctly?	► Establish correct connection.
	Insufficient medium flow?	► Create flow.
	No electrolyte in the bypass?	► Refill or replace electrolyte.
	Buildup on the membrane cap?	► Clean sensor carefully.
Displayed value too high	Polarization ended?	► Wait for polarization time to finish.
	Is sensor calibrated/adjusted?	► Recalibrate/readjust. ↳ When calibrating, enter the current air pressure at the transmitter.
	Displayed temperature clearly too low?	► Check sensor; contact the Endress+Hauser Sales Center if necessary.
	Membrane visibly stretched?	► Replace membrane cap.
	Electrolyte contaminated?	► Replace electrolyte.
	Working electrode coated with buildup?	► Cleaning the working electrode.
	Internal body defective?	► Change the internal body.
	Anode coating worn off? Is the anode silver instead of brown?	► Send sensor in for re-coating.
Displayed value too low	Polarization ended?	► Wait for polarization time to finish.
	Is sensor calibrated/adjusted?	► Recalibrate/readjust. ↳ When calibrating, enter the current air pressure at the transmitter.
	Insufficient medium flow?	► Create flow.
	Displayed temperature clearly too high?	► Check sensor; contact the Endress+Hauser Sales Center if necessary.
	Electrolyte contaminated?	► Replace electrolyte.

Problem	Test	Remedy
	Buildup on the membrane?	► Clean sensor carefully.
Display value fluctuating	Membrane visibly stretched?	► Replace membrane cap.

 Pay attention to the troubleshooting information in the Operating Instructions for the transmitter. Check the transmitter if necessary.

If one of the errors mentioned occurs:

1. Unscrew the membrane cap from the sensor.
2. Dry the electrodes.
 - ↳ Does the transmitter display 0?

If the transmitter does **not** display 0:

3. Check the electrical connection.
 - ↳ Does the transmitter display 0?

If the transmitter does **not** display 0:

4. Contact Endress+Hauser Service.

9 Maintenance

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

NOTICE

Effects on process and process control!

- ▶ When carrying out any work on the system, bear in mind any potential impact this could have on the process control system and the process itself.
- ▶ For your own safety, only use genuine accessories. With genuine parts, the function, accuracy and reliability are also ensured after maintenance work.

9.1 Maintenance schedule

Maintenance cycles depend to a great extent on the operating conditions.

The following rule of thumb applies:

- Constant conditions, e.g. = long cycles (6 months)
- Widely varying conditions, e.g. fluctuating process pressure = short cycles (1 month or less)

The following method helps you determine the necessary intervals:

1. Inspect the sensor one month after commissioning. To do so, remove the sensor from the medium and dry it carefully.
2. To avoid measured errors in the transmitter, change the process pressure to the atmospheric pressure if not already the same.
 - ↳ If the process pressure and atmospheric pressure are the same, this step is not required.
3. After 10 minutes, measure the oxygen saturation index in air.
 - ↳ Decide using the results:
 - a) Measured value is not $100 \pm 2 \text{ \% SAT}$? → Service the sensor.
 - b) Measured value = $100 \pm 2 \text{ \% SAT}$? → Double the length of time to the next inspection.
4. Proceed as indicated in Step 1 after two, four and eight months.
 - ↳ This allows you to determine the optimum maintenance interval for your sensor.

 Especially in the case of widely fluctuating process conditions, damage to the may also occur within a maintenance cycle. This is indicated by implausible sensor behavior.

9.2 Maintenance tasks

The following tasks must be performed:

1. Clean the sensor and .
2. Replace wear parts or consumables.
3. Check measurement function.
4. Recalibrate (if desired or necessary).
 - ↳ Follow the Operating Instructions for the transmitter.

9.2.1 Cleaning the exterior of the sensor

Dirt on the sensor can impact the measurement and even cause a malfunction. Examples include buildup on the sensor membrane, which can cause a longer response time.

The sensor must be cleaned at regular intervals for reliable measurement results. The frequency and intensity of the cleaning process depend on the medium.

Clean the sensor:

- Before every calibration
- At regular intervals during operation as necessary
- Before returning it for repair

Type of contamination	Cleaning
Salt deposits	1. Immerse the sensor in drinking water. 2. Then rinse it with copious amounts of water.
Dirt particles on the sensor shaft and shaft sleeve (not membrane!)	► Clean sensor shaft and sleeve with water and a suitable sponge.
Dirt particles on the membrane or membrane body	► Clean the membrane carefully with water and a soft cloth

- After cleaning:
Rinse with copious amounts of clean water.

 Use a fully automated cleaning system for regular automated cleaning.

9.2.2 Cleaning the cathode

 The cathode only needs to be cleaned if it is coated or silver-plated.

CAUTION

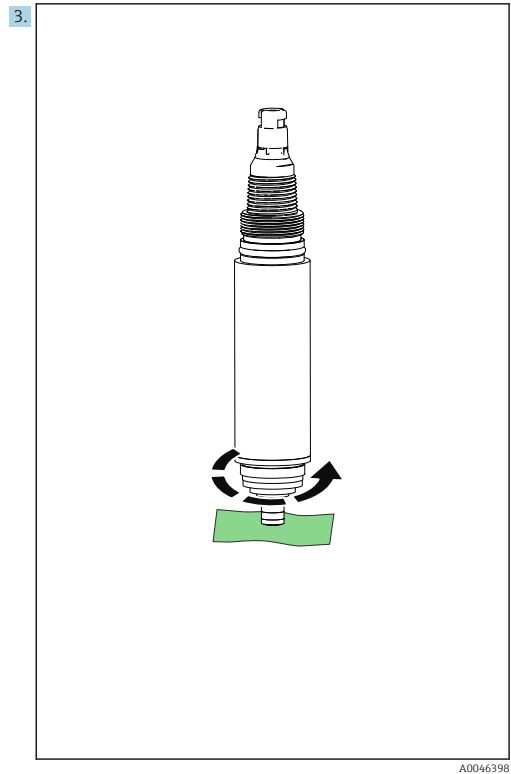
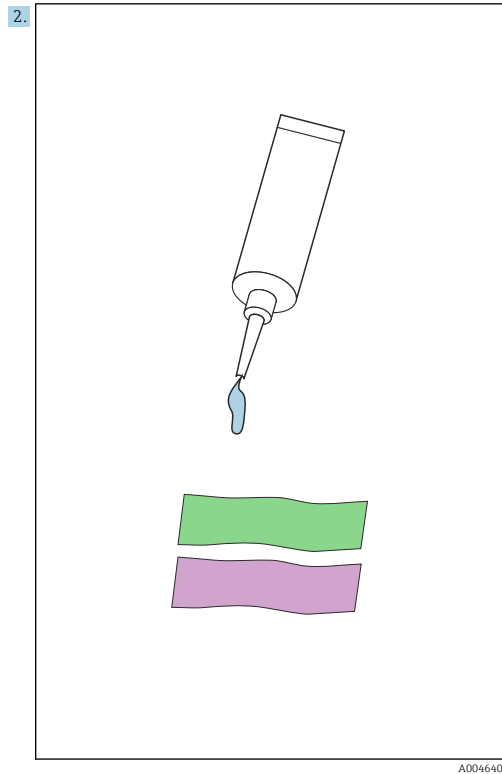
The standard electrolyte is a strong irritant

Danger of severe skin and eye irritation!

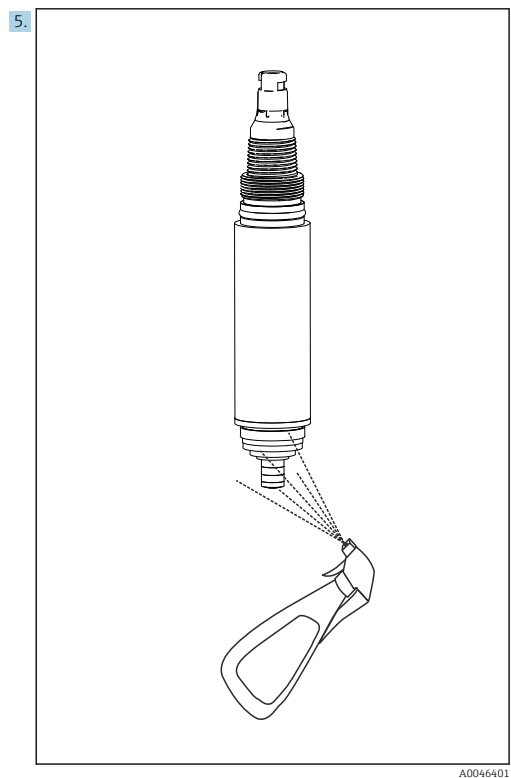
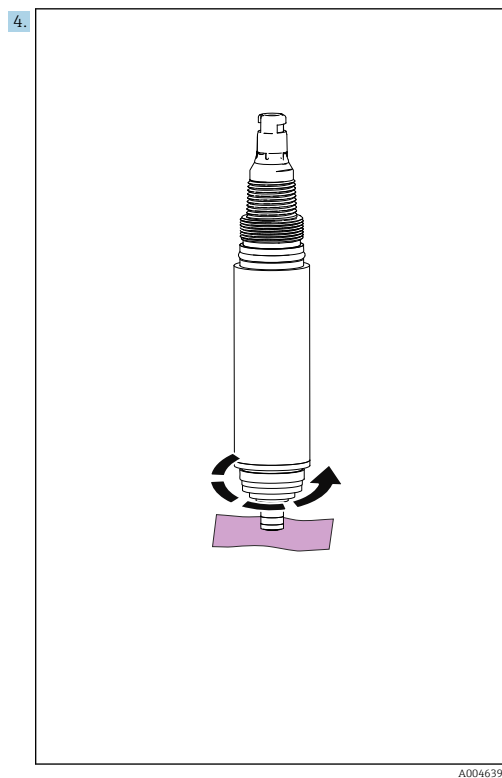
- Be absolutely certain to observe the corresponding workplace safety regulations.
- Wear protective gloves and goggles when handling the electrolyte.
- In case of eye contact: Remove contact lenses, rinse eyes with water for a few minutes and contact a doctor.
- In case of skin contact: Take off wet clothing immediately, wash the skin or take a shower.

 Also pay attention to the safety datasheet of the electrolyte on www.endress.com/downloads.

1. Disassemble the sensor →  35.



2. Moisten the polishing foil (green and pink) with a drop of electrolyte.
3. Clean the cathode surface with the green polishing foil.
- ↳ Hold the sensor as vertically as possible.
Move the cathode in small circles over the polishing foil.



4. Clean the cathode surface with the pink polishing foil.
- ↳ Hold the sensor as vertically as possible.
Move the cathode in small circles over the polishing foil.
5. Rinse the open sensor head with drinking water or distilled water.

6. Mount the sensor →  37.

10 Repair

10.1 General information

- Only use spare parts from Endress+Hauser to guarantee the safe and stable functioning of the device.

Detailed information on the spare parts is available at:

www.endress.com/device-viewer

10.2 Return

The product must be returned if repairs or a factory calibration are required, or if the wrong product was ordered or delivered. As an ISO-certified company and also due to legal regulations, Endress+Hauser is obliged to follow certain procedures when handling any returned products that have been in contact with medium.

To ensure the swift, safe and professional return of the device:

- Check the website www.endress.com/support/return-material for information on the procedure and general conditions.

10.3 Spare parts and consumables

Parts of the sensor are subject to wear during operation. By taking suitable measures, you can restore the normal operating function.

Action required	Reason
Replace sealing rings	Visible damage to a sealing ring
Replace electrolyte	Unstable or implausible measuring signal or fouling of the electrolyte
Replace membrane body	Membrane is damaged or can no longer be cleaned (hole or overstretching)

COV45 maintenance kits for COS41/COS51X

- Maintenance kit for COS51D and COS51E
 - Scope of delivery of the COV45 maintenance kit based on configuration:
 - Maintenance kit, complete
 - with 10x sensor electrolyte
 - with 2x membrane cap
 - with seal set
 - with polishing foil
 - Or each can be ordered individually
- Ordering information: www.endress.com/cos51e under "Accessories/Spare parts"

10.3.1 Disassembling the sensor

The sensor must be disassembled if:

- Replacing the sealing ring for the shaft sleeve
- Replacing the electrolyte
- Replacing the membrane body

⚠ CAUTION**The standard electrolyte is a strong irritant**

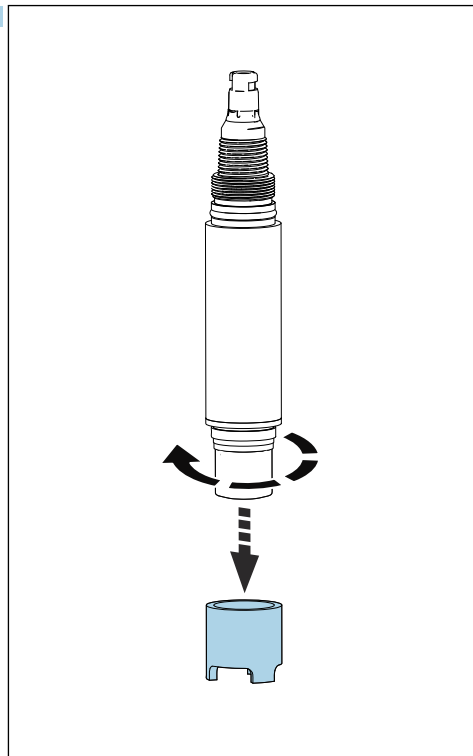
Danger of severe skin and eye irritation!

- ▶ Be absolutely certain to observe the corresponding workplace safety regulations.
- ▶ Wear protective gloves and goggles when handling the electrolyte.
- ▶ In case of eye contact: Remove contact lenses, rinse eyes with water for a few minutes and contact a doctor.
- ▶ In case of skin contact: Take off wet clothing immediately, wash the skin or take a shower.

i Also pay attention to the safety datasheet of the electrolyte on www.endress.com/downloads.

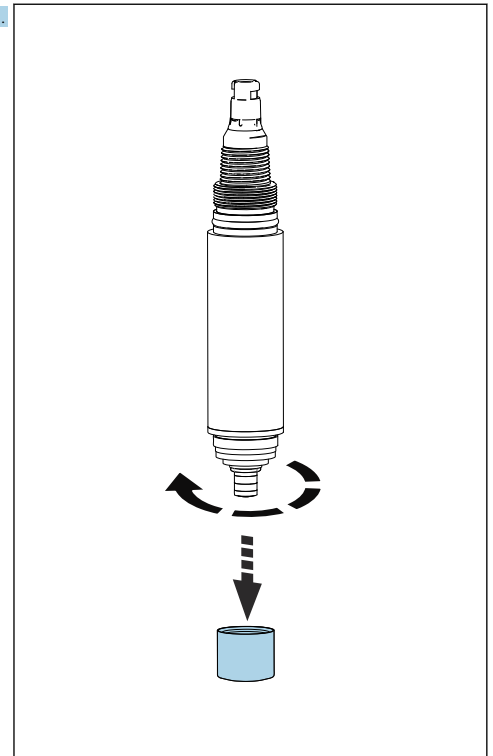
1. Remove the sensor from the process and clean it.

2.



A0046335

3.

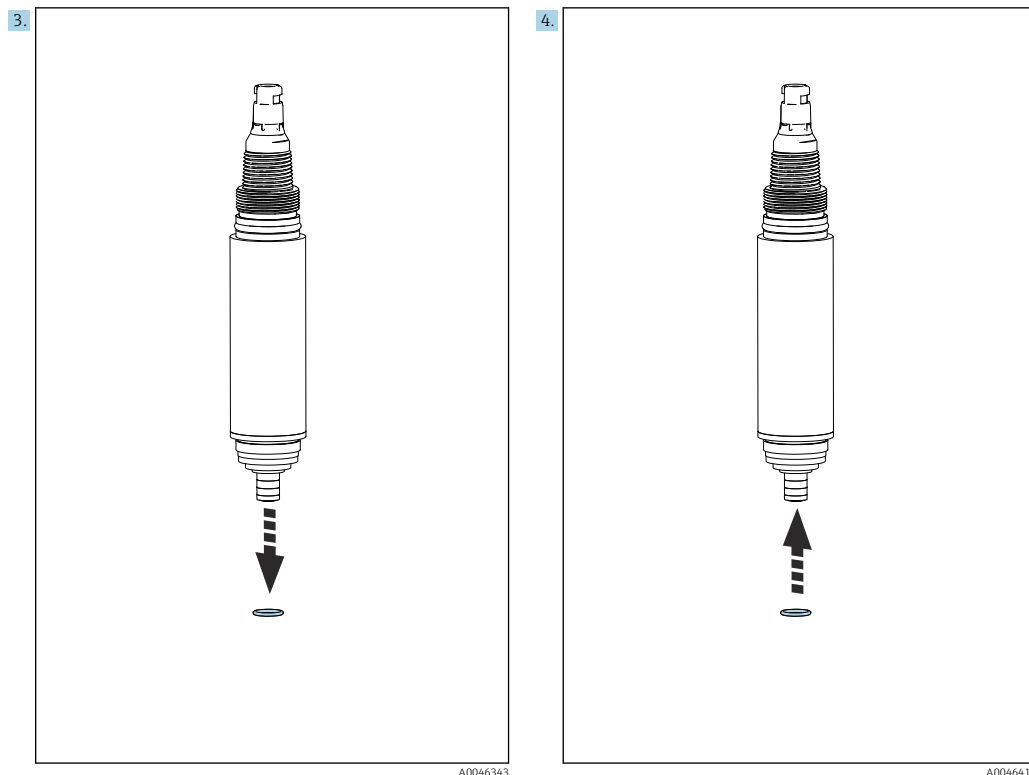


A0046336

2. Unscrew the protection guard or cleaning unit.
3. Unscrew the membrane cap from the sensor head.

10.3.2 Replacing sealing rings

1. Remove the sensor from the process and clean it.
2. Disassemble the sensor → 35.



3. Remove the old O-ring.
4. Carefully pull the new O-ring into position.
5. Mount the sensor → 37.

10.3.3 Replacing the electrolyte

The electrolyte is used up gradually during operation. This is caused by electrochemical substance reactions. In de-energized state, no substance reactions take place, and the electrolyte is not used up. The operating time of the electrolyte is shortened by diffusion of dissolved gases such as H_2S , NH_3 or high concentrations of CO_2 .

Particular loads therefore occur especially in the case of:

- anaerobic stages (e.g. denitrification)
- heavily polluted industrial wastewater, particularly at elevated temperatures

i The electrolyte depletion can be logged using a suitable transmitter. By setting warning limits it is possible to properly schedule sensor maintenance.

Theoretical operating time at $p_{O_2} = 210 \text{ mbar}$ and $T = 20 \text{ °C}$ (68 °F)

COS51E-***TN 5 years

COS51E-***TF 1 year

i Each change in the concentration and temperature affects the operating time.

i Also pay attention to the safety datasheet of the electrolyte on www.endress.com/downloads.

Generally, the following applies:

- Sensors operated close to the lower measuring range limit have a low rate of chemical electrolyte consumption. The electrolyte does not have to be replaced for a long period.
- Sensors operated at high oxygen partial pressures (> 100 hPa) consume a significant amount of electrolyte. The electrolyte has to be replaced frequently.
- 25 ml electrolyte (available in the maintenance kit) is enough to fill the membrane body approx. 15 times.

1. Disassemble the sensor → 34

2. Dispose of the old electrolyte.
3. Install the sensor with fresh electrolyte →  37.

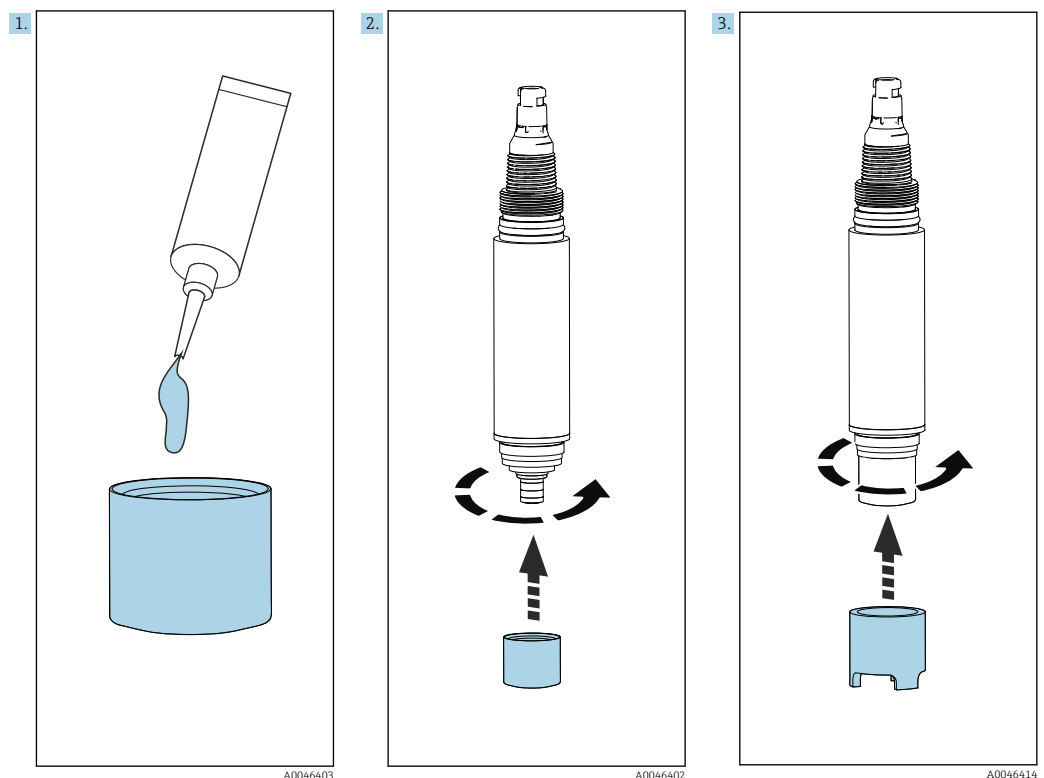
10.3.4 Installing the sensor

CAUTION

The standard electrolyte is a strong irritant

Danger of severe skin and eye irritation!

- ▶ Be absolutely certain to observe the corresponding workplace safety regulations.
- ▶ Wear protective gloves and goggles when handling the electrolyte.
- ▶ In case of eye contact: Remove contact lenses, rinse eyes with water for a few minutes and contact a doctor.
- ▶ In case of skin contact: Take off wet clothing immediately, wash the skin or take a shower.



1. Fill the membrane cap halfway with fresh electrolyte.
 - ↳ Remove any air bubbles by tapping the side of the membrane body (e.g. using a pen/pencil).
2. Slowly screw the membrane cap onto the sensor head as far as it will go.
 - ↳ Collect the escaping electrolyte with a paper towel.
3. Screw on the protection guard or cleaning unit.
4. Put the sensor back into operation →  37.

10.3.5 Putting the sensor back into operation

After replacing the electrolyte, follow the steps below.

1. Re-immers the sensor into the medium.
2. Reset the counter on the transmitter.
For example, CM44x: **Menu/Calibration/Oxygen (amp.)/Electrolyte-change**

3. Confirm and save the operation.
 - ↳ The sensor is ready for operation.

After replacing the sensor cap, follow the steps below.

1. Re-immerses the sensor into the medium.
2. Reset the counter on the transmitter.
For example, CM44x: **Menu/Calibration/Oxygen (amp.)/Sensor cap change**
3. Confirm and save the operation.
 - ↳ The sensor is ready for operation.

10.4 Checking the measurement function

1. Remove the sensor from the medium.
2. Clean and dry the membrane.
3. Adjust the process pressure on the transmitter if it differs from the atmospheric pressure, as otherwise no comparison is possible.
4. After about 10 minutes, measure the oxygen saturation index in air (without recalibration).
 - ↳ The measured value should be at $100 \pm 2 \text{ \%SAT}$.

10.5 Disposal



If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to Endress+Hauser for disposal under the applicable conditions.

11 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.

11.1 Device-specific accessories

11.1.1 Assemblies (selection)

Flowfit CYA251

- Connection: See product structure
- Material: PVC-U
- Product Configurator on the product page: www.endress.com/cya251



Technical Information TI00495C

Flowfit COA250

- Flow assembly for oxygen measurement
- Product Configurator on the product page: www.endress.com/coa250



Technical Information TI00111C

Cleanfit COA451

- Manual retractable assembly made of stainless steel with ball valve shutoff
- For oxygen sensors
- Product Configurator on the product page: www.endress.com/coa451



Technical Information TI00368C

Flexdip CYH112

- Modular holder system for sensors and assemblies in open basins, channels and tanks
- For Flexdip CYA112 water and wastewater assemblies
- Can be affixed anywhere: on the ground, on the capstone, on the wall or directly onto railings.
- Plastic or stainless steel version
- Product Configurator on the product page: www.endress.com/cyh112



Technical Information TI00430C

Flexdip CYA112

- Immersion assembly for water and wastewater
- Modular assembly system for sensors in open basins, channels and tanks
- Material: PVC or stainless steel
- Product Configurator on the product page: www.endress.com/cya112



Technical Information TI00432C

Membrane protection guard

- For using the sensor in fish farming tanks
- Order No.: 50081787

11.1.2 Measuring cable

Memosens data cable CYK10

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



Technical Information TI00118C

Memosens data cable CYK11

- Extension cable for digital sensors with Memosens protocol
- Product Configurator on the product page: www.endress.com/cyk11



Technical Information TI00118C

11.1.3 Cleaning**Compressed air cleaning for COSXX**

- Connection: OD 6/8 mm (incl. reduction hose coupling) or OD 6.35 mm (1/4")
- Materials: POM/V4A
- Order No.
 - AD 6/8 mm: 71110801
 - AD 6.35 mm (1/4"): 71110802

Compressor

- For compressed air cleaning
- Order No.
 - 230 V AC order no. 71072583
 - 115 V AC order no. 71194623

Spray cleaning for CYA112 assembly

Order No.

- Assembly length 600 mm (23.62 in): 71158245
- Assembly length 1200 mm (47.42 in): 71158246

Chemoclean CYR10B

- Cleaning injector for spray cleaning and retractable assemblies
- Product Configurator on the product page: www.endress.com/CYR10B



Technical Information TI01531C

11.1.4 Transmitter**Liquiline CM44**

- Modular multi-channel transmitter for hazardous and non-hazardous areas
- HART®, PROFIBUS, Modbus or EtherNet/IP is possible
- Order according to product structure



Technical Information TI00444C

Liquiline CM42

- Modular two-wire transmitter for hazardous and non-hazardous areas
- HART®, PROFIBUS or FOUNDATION Fieldbus is possible
- Order according to product structure



Technical Information TI00381C

Liquiline Mobile CML18

- Multiparameter mobile device for laboratory and field
- Reliable transmitter with display and app connection
- Product Configurator on the product page: www.endress.com/CML18



Operating Instructions BA02002C

Liquiline Compact CM82

- Configurable 1-channel multiparameter transmitter for Memosens sensors
- Ex- and non-ex applications possible in all industries
- Product Configurator on the product page: www.endress.com/CM82



Technical Information TI01397C

Liquiline Compact CM72

- 1-channel single parameter field device for Memosens sensors
- Ex- and non-ex applications possible in all industries
- Product Configurator on the product page: www.endress.com/CM72



Technical Information TI01409C

Memobase Plus CYZ71D

- PC software to support laboratory calibration
- Visualization and documentation of sensor management
- Sensor calibrations stored in database
- Product Configurator on the product page: www.endress.com/cyz71d



Technical Information TI00502C

11.1.5 Maintenance kit**COV45 maintenance kits for COS41/COS51X**

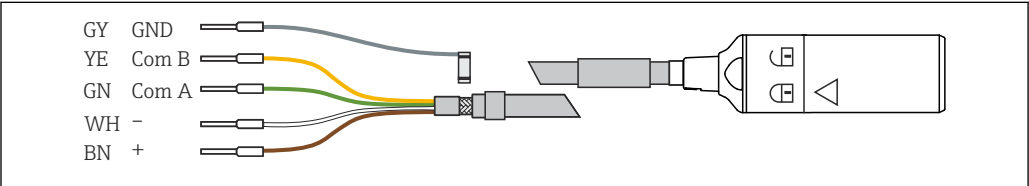
- Maintenance kit for COS51D and COS51E
 - Scope of supply of maintenance kit COV45 is based on the configuration:
 - Maintenance kit, complete
 - with 10x sensor electrolyte
 - with 2x membrane cap
 - with seal set
 - with polishing foil
 - Or each can be ordered individually
- Ordering information: www.endress.com/cos51e under "Accessories/Spare parts"

12 Technical data

12.1 Input

Measured variables	Dissolved oxygen [mg/l, µg/l, ppm, ppb, %SAT, %Vol, ppmVol] Temperature [°C, °F]
measuring range	■ 0 to 100 mg/l ■ 0 to 2000 hPa ■ 0.00 to 1000 % SAT

12.2 Power supply

Electrical connection	The electrical connection of the sensor to the transmitter is established using measuring cable CYK10. GY GND YE Com B GN Com A WH - BN +  A0024019 19 Measuring cable CYK10
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12.3 Performance characteristics

Response time ¹⁾	At 20 °C (68 °F): ■ COS51E-****TN (black membrane cap for standard response time): t₉₀ : 3 minutes t₉₈ : 8 minutes ■ COS51E-****TF (white membrane cap for rapid response time): t₉₀ : 30 seconds t₉₈ : 90 seconds
Reference operating conditions	Reference temperature: Reference pressure: Reference application: 20 °C (68 °F) 1013 hPa (15 psi) Air-saturated water
Signal current in air	COS51E-****TN (black membrane cap): COS51E-****TF (white membrane cap): approx. 300 nA approx. 1100 nA
Zero current	< 0.1 % of the signal current in air

1) Average of all sensors that have undergone a final inspection

Measurement error ²⁾	COS51E-****TN (black membrane cap): COS51E-****TF (white membrane cap):	$\leq \pm 1$ % of the measured value $\leq \pm 1$ % of the measured value
Limit of detection (LOD) ³⁾	COS51E-****TN (black membrane cap): COS51E-****TF (white membrane cap):	10 ppb 5 ppb
Limit of quantification (LOQ) ³⁾	COS51E-****TN (black membrane cap): COS51E-****TF (white membrane cap):	20 ppb 10 ppb
Repeatability	COS51E-****TN (black membrane cap): COS51E-****TF (white membrane cap):	20 ppb 100 ppb
Long-term drift ⁴⁾	Zero-point drift: Measuring range drift:	< 0.1 % per week < 0.1 % per week
Polarization time	< 60 minutes	
Intrinsic oxygen consumption	■ COS51E-****TN: approx. 90 ng/h in air at 25 °C (77 °F) ■ COS51E-****TF: approx. 270 ng/h in air at 25 °C (77 °F)	
Electrolyte	Alkaline saline solution	

12.4 Environment

Ambient temperature range	-5 to 60 °C (23 to 140 °F)	
Storage temperature range	■ Filled with electrolyte: -5 to 60 °C (20 to 140 °F) ■ Without electrolyte: -20 to 60 °C (0 to 140 °F)	
Degree of protection	IP68 (2 m (6.5 ft) water column, 21 °C (70 °F), 24 hours)	

12.5 Process

Process temperature range	-5 to 60 °C (41 to 140 °F)	
Process pressure range	5 bar (72.5 psi) abs.	

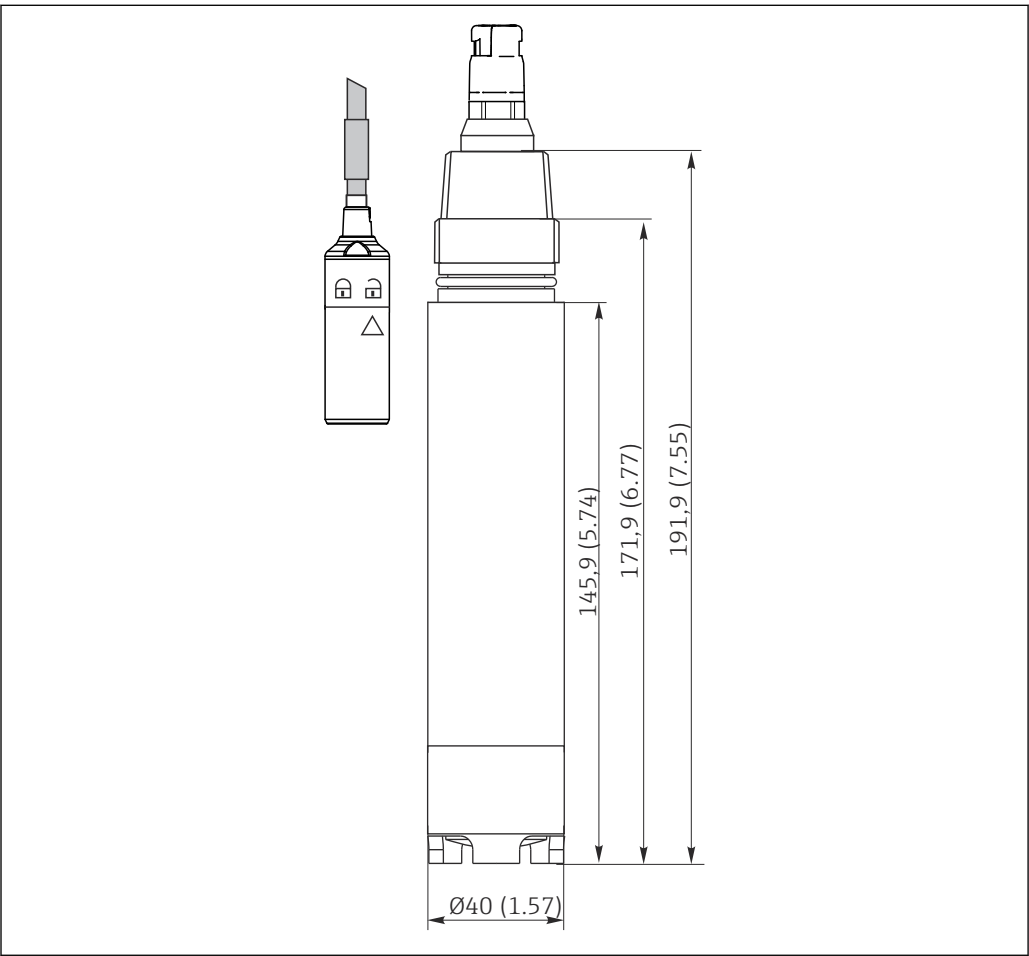
2) In accordance with IEC 60746-1 under rated operating conditions

3) According to DIN EN ISO 15839. The measurement error contains all the uncertainties of the sensor and transmitter (measuring chain). It does not contain all the uncertainties caused by the reference material and adjustments that may have been performed.

4) Under constant conditions

12.6 Mechanical construction

Dimensions



20 Dimensions in mm (inch)

Weight 0.3 kg (0.7 lbs)

Materials	Parts in contact with medium	
	Sensor shaft	POM
	Membrane cap	POM
	Working electrode	Gold
	Counter-electrode and reference electrode	Silver/Silver halide
	Membrane	ETFE (COS51-****TN)
		FEP (COS51-****TF)

Process connection G1, NPT 3/4"

Temperature sensor NTC 30KΩ

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