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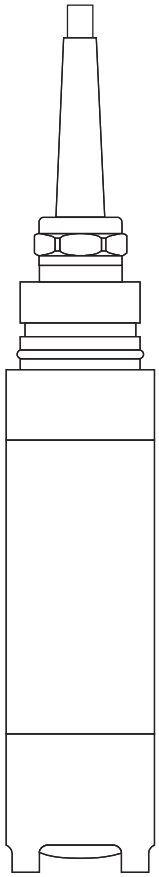
COS 3 / COS 3S / COS 3HD
Sensor for Dissolved Oxygen

Operating Instructions



Endress+Hauser
The Power of Know How

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1 General information

1.1 Symbols used

Warning:

This symbol alerts to hazards. Failure to observe these warnings may result in injury or damage to the equipment.

Caution:

This symbol alerts to possible malfunction due to operator error.

Note:

This symbol indicates important items of information.

1.2 Safety notes

Caution:

- The notes and warnings in these operation instructions must be strictly adhered to!
- Faults on the measuring system may only be remedied by authorised and properly trained personnel.
- If faults cannot be remedied, the sensor must be removed from service and secured to prevent from accidential start-up.
- Repairs may only be carried out by the manufacturer or by the Endress+Hauser Service Organization (see back page of these operating instructions).

2 Description

The oxygen sensor COS 3 / 3S / 3HD is intended for continuous measurement of oxygen dissolved in water.

Typical applications are, for example:
- Measurement of O_2 content in activated sludge basins. Here, the measuring signal is used for monitoring and as a control parameter.
- Checking of O_2 concentration in sewage treatment plant effluent.
- Monitoring of public waters, e.g. rivers, lakes, reservoirs.
- Measurement and control of O_2 content in sweet water or salt water fish ponds and fish farms.
- Enrichment of drinking water with O_2.

2.1 Scope of supply

The scope of supply comprises:
- 1 oxygen sensor COS 3 / 3S / 3HD with permanently attached 1.5 m, 7 m or 15 m cable and 7-pin plug
- 1 shipping cap for membrane protection
- 1 threaded protection guard for measuring operation (screwed onto the sensor)
- 1 spare replacement cartridge COY 3-WP or COY 3S-WP
- 10 plastic ampoules with filling electrolyte COY 3-F (for COS 3 / 3S) or COY 3HD-F (for COS 3HD)
- 1 copy of operating instructions for COS 3 / 3S / 3HD.

2.2 Product structure

Oxygen sensor COS 3 / COS 3S / COS 3HD

Cable length
0 1.5 m
2 7 m
4 15 m

COS 3- ☐ ⇐ **complete order code**

or

COS 3S- ☐ ⇐ **complete order code**

or

COS 3HD- ☐ ⇐ **complete order code**

2.3 Measuring system

The complete measuring system consists of:
- Oxygen sensor COS 3 / 3S / 3HD
- Transmitter Mycom COM 121 / 141 / 151 or Mypex COM 340 or Liquisys COM 220 / 240 S
- Universal suspension assembly holder CYH 101 for immersion operation
- Immersion assembly COA 110 or CYA 611 or flow assembly COA 250 or retractable assembly Probfit COA 461
- Corresponding mounting accessories.

Additionally recommended under extreme operating conditions:
- Automatic spray cleaning system Chemoclean.

The sensor versions differ as follows:
- **COS 3**
  Standard rate of response.
  For applications with low to medium load regarding H_2S or NH_3.
  Spare parts: Membrane cap COY 3-WP and filling electrolyte COY 3-F.
- **COS 3S**
  High rate of response.
  For applications with low to medium load regarding H_2S or NH_3.
  Spare parts: Membrane cap COY 3S-WP and filling electrolyte COY 3-F.
- **COS 3HD**
  Standard rate of response.
  For applications with high load regarding H_2S or NH_3.
  Spare parts: Membrane cap COY 3-WP and filling electrolyte COY 3HD-F.
  Marking: red colour ring.

3 Design and function

3.1 Design

The sensor consists of the following function units (see figures 3.1 and 3.2):
- Sensor body with integrated pre-amplifier, working electrode, reference electrode and counter-electrode
- Membrane cap with electrolyte
- Protection cover.

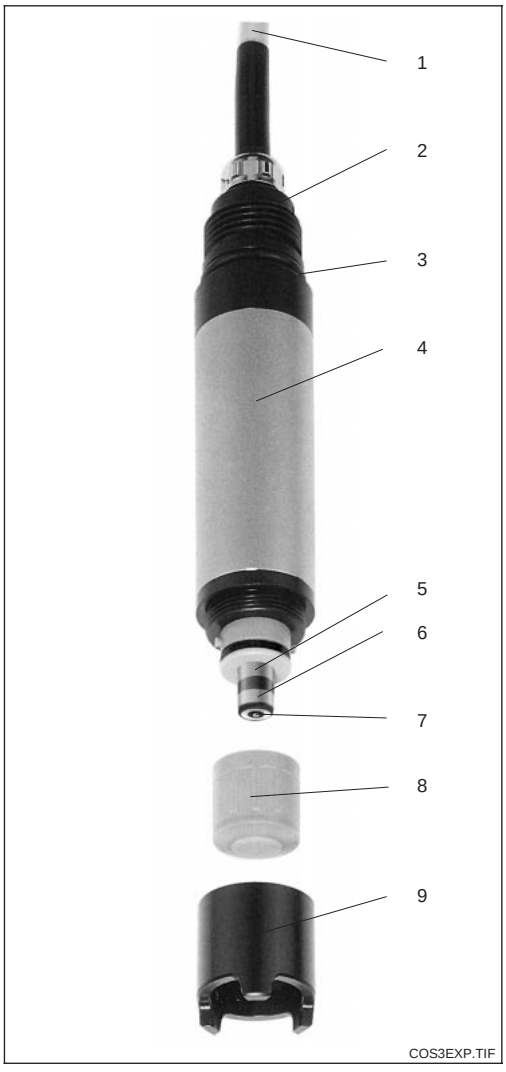
The connecting cable (1), supplied in lengths of 1.5 m, 7 m or 15 m, is permanently attached to the sensor body. For simple installation in immersion or flow assemblies, the sensor is equipped with a G 1 thread (2).

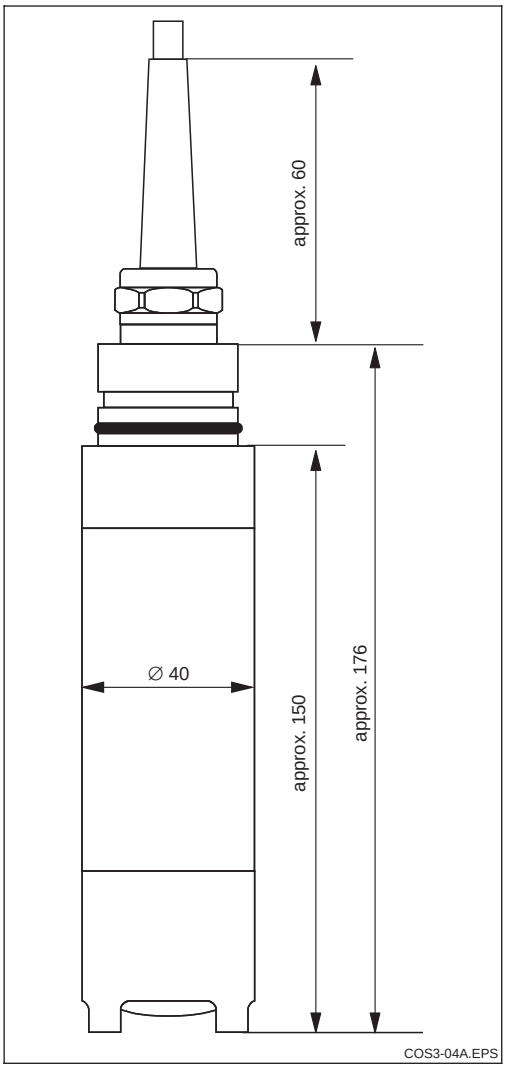
A pre-amplifier is installed inside the stainless steel body (4). The stainless steel body also serves as an electrode for membrane rupture monitoring. For this reason it must contact the medium at all times.

The thread at the bottom is used to attach the protection guard (9) or spray head COR 3 (option) when the sensor is immersed in the medium and equipped with the cleaning function.

The measuring signal proportional to the oxygen content is generated in an electrolyte-filled measuring chamber sealed off towards the outside by a membrane cap (8). The measuring chamber holds a working electrode (7) made of gold, a counter-electrode (6) and a reference electrode (5) made of silver/silver bromide (COS 3 / 3S) or silver/silver chloride (COS 3HD).

A bayonet lock with a trapezoid seal provides a high-resistance seal between the measuring chamber and the medium. The membrane cap holds a membrane pretensioned at the factory and therefore permits easy replacement without need for tools.





Oxygen sensor
COS 3 / 3S / 3HD

left:
1 Sensor cable with 7-pin connector
2 Internal thread G 1
3 O-ring 28 × 3.5
4 Stainless steel body
5 Reference electrode
6 Counter-electrode
7 Working electrode
8 Membrane cap with bayonet lock
9 Protection guard

right:
Dimensioned drawing of

Fig. 3.1 oxygen sensor

3.2 Function

Polarisation

When the sensor is connected to the corresponding transmitter, a fixed external voltage is applied between the cathode and the anode. The polarisation current that flows for this reason is indicated on the transmitter by an initially very high display value which drops off over time. Calibration can only take place after complete polarisation.

Membrane

Oxygen is present in the medium to be measured as a physically dissolved gas and is transported towards the membrane by the medium flow required for this measuring principle. Due to the materials used in the membrane and the way in which the membrane is made, only dissolved gases can pass through it but no liquid constituents. Dissolved salts and ionic substances are also held back; this explains why (contrary to the open measuring principle) the conductivity of the medium does not affect the measuring signal in the case of the membrane-covered sensor.

Amperometric measuring principle

The oxygen molecules diffused through the membrane are reduced to hydroxide ions (OH^-) at the working electrode. At the counter-electrode, silver is oxidised to silver bromide (COS 3 / 3S) or silver chloride (COS 3HD). The resulting electron release at the working electrode and electron acceptance at the counter-electrode produce a current flow that is proportional to the external oxygen concentration in the medium under constant conditions. The current flow is converted in the pre-amplifier and in the measuring instrument and indicated on the display as the dissolved oxygen content in mg/l or oxygen saturation index in % SAT.

Potentiostatic three-electrode-system

The reference electrode aditionally installed in the measuring chamber plays an important role. High-resistance wiring prevents current flow through this electrode. The formation of a silver bromide or silver chloride coating on the counter-electrode uses up the bromide or chloride ions dissolved in the electrolyte in the course of the electrolyte life. In the case of conventional membrane-covered sensors working with the two-electrode system, this causes an increase in signal drift. This is not the case with the three-electrode system employed here: the change in bromide or chloride ion concentration is registered by the reference electrode, and an internal control circuit holds the working electrode potential constant. The advantages of this principle are significantly increased accuracy of the signal and considerably extended calibration intervals.

Self-monitoring

Another beneficial technical feature is the built-in membrane rupture self-monitoring function. Continual measurement of the resistance between the electrolyte chamber and the outside permits unequivocal detection of any damage to the membrane without any delay. This guarantees a high degree of protection against inaccurate measurement due to electrolyte loss or penetration of medium into the electrolyte space.

A membrane rupture alarm issued by the sensor is maintained regardless of a subsequent membrane cap change until the current is briefly removed from the sensor by interrupting the supply of power to the sensor (in general, this can be achieved by disconnecting the plug connector for approx. 30 s). This feature assures that alarm indications cannot be ignored, e.g. when the sensor is removed for calibration in air.

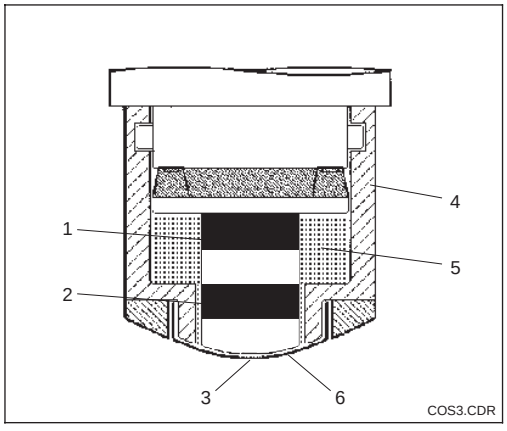


Fig. 3.2 Measuring chamber of oxygen sensor COS 3 / 3S / 3HD with the potentiostatically operated three-electrode system

1 Reference electrode (Ag/AgBr or Ag/AgCl)
2 Counter-electrode (Ag/AgBr or Ag/AgCl))
3 Working elektrode (Au)
4 Membrane cap with bayonet lock
5 Electrolyte
6 “Elephant skin” membrane

4 Installation

4.1 General installation notes

The sensor is equipped with an internal G 1 thread (see fig. 3.1) and may be used either for immersion or for flow installation in conjunction with the appropriate assembly. Please observe the following notes:

Caution:

To avoid tress building (clogging of the sensor, e.g. with rest of plants) and the following error measurings do not fix the sensor only at the cable (use mounting accessories).

Sensor mounting position

The sensor should always be installed upright, with the membrane at the bottom unless this is not possible for some specific reason. Deviations from this mounting position up to horizontal installation (but no further) are permissible in the case of unfavourable flow conditions. The membrane must never be on top!

Sensor removal and installation

Please make sure the connecting cable turns freely with the sensor and is not twisted when unscrewing or installing the sensor. Alternatively, it is advisable to screw the assembly onto the hand held sensor, especially with immersion assemblies. High tensile forces on the cable, e.g. from abrupt pulling, are to be avoided.

Pre-assembly

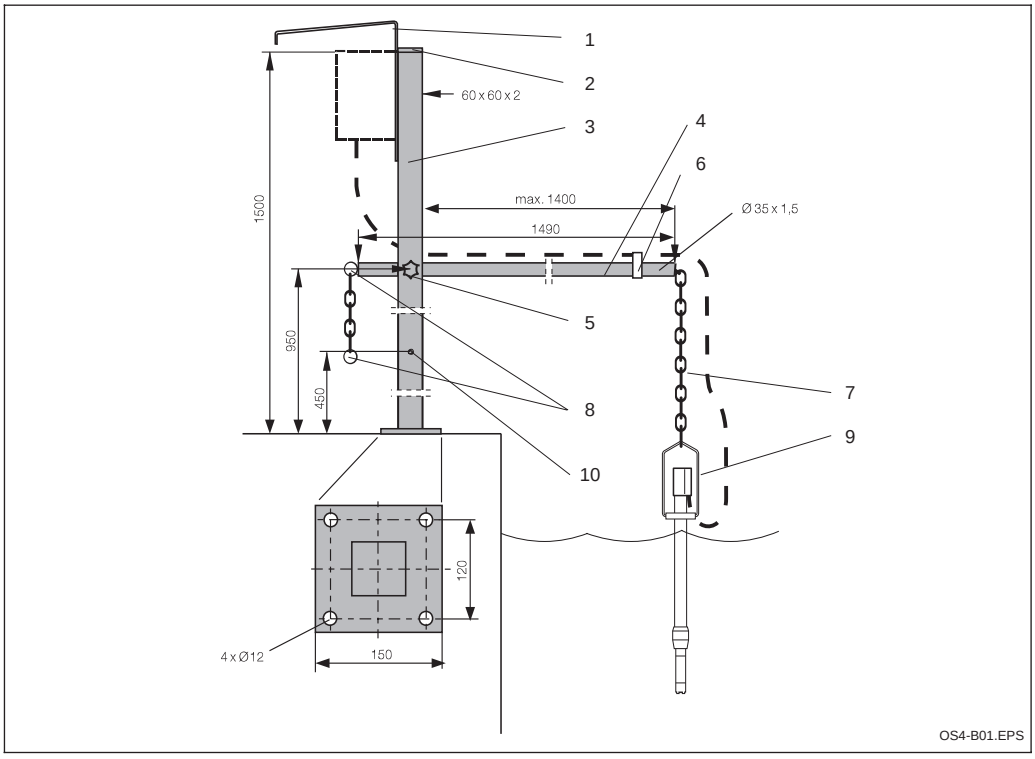
Immersed installation: For safety reasons, the individual assemblies should be pre-assembled on solid ground outside the basin or tank. Only perform the final assembly at the place of installation.

Placement

The place of assembly installation is to be chosen such as to assure good accessibility for calibration. Sturdy and vibration-free installation of upright posts and assemblies is to be assured. For immersion operating in activated sludge tanks select a typical place for oxygen concentration to install the sensor.

Shock hazard protection

Observe national grounding regulations for metallic upright posts and assemblies.



Universal suspension assembly holder CYH 101-A with pendulum immersion assembly CYA 611

1 Weather protection cover
2 Dummy plug
3 Upright post, square tube of stainless steel 1.4301 (AISI 304)
4 Transverse pipe of stainless steel 1.4301 (AISI 304)
5 Star handle
6 Velcro strap
7 Plastic chain, length 5 m
8 Plastic shackle
9 Immersion assembly CYA 611, not supplied with assembly holder CYH 101-A
10 Second attachment position for transverse pipe

Fig. 4.1

4.2 Immersed installation

Upright post and chain assembly

Construction: Universal suspension assembly holder CYH 101-A (see fig. 4.1) in conjunction with pendulum immersion assembly CYA 611 (see fig. 4.2).This type of installation should be chosen for larger basins where an adequate distance between the sensor and basin wall is assured. Vibration of the upright post is virtually impossible due to the pendulous suspension of the immersion assembly.

Upright post and fixed immersion tube

Construction: Universal suspension assembly holder CYH 101-D (immersion tube length 2 m, see fig. 4.3) or CYH 101-E (immersion tube length 3.5 m, see fig. 4.3).
Preferable type of mounting for flow rates above 0.5 m/s or turbulent flow in basins or for installation in open channels. A second transverse pipe with a holder of its own should be installed in pos. 10 in the case of very high flow rates or considerable turbulence.

Accessories

- Weather protection cover CYY 101
- Automatic cleaning system Chemoclean CYR 10 / CYR 20
- Spray head COR 3

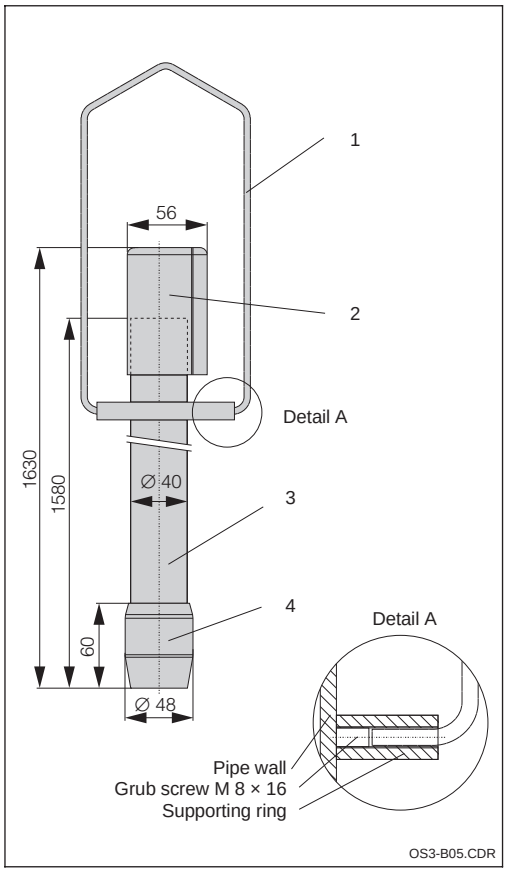


Fig. 4.2 CYA 611: Components and dimensions

1 Suspension bracket
2 Protective cap
3 PVC pipe
4 Threaded coupling

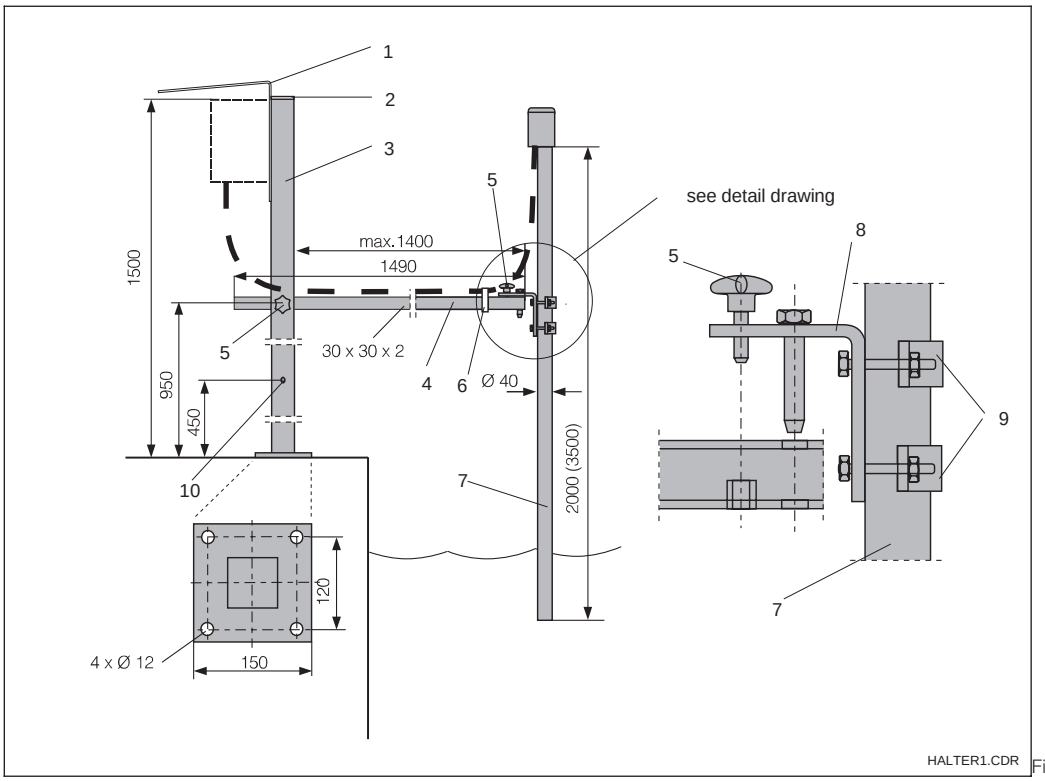


Fig. 4.3 Universal suspension assembly holder CYH 101-D or -E

1 Weather protection cover
2 Dummy plug
3 Upright post, square tube of stainless steel 1.4301 (AISI 304)
4 Transverse pipe of stainless steel 1.4301 (AISI 304)
5 Star handle
6 Velco strap
7 Immersion tube of stainless steel 1.4301 (AISI 304)
8 Tube holder
9 Mounting bracket
10 Second attachment position for transverse pipe

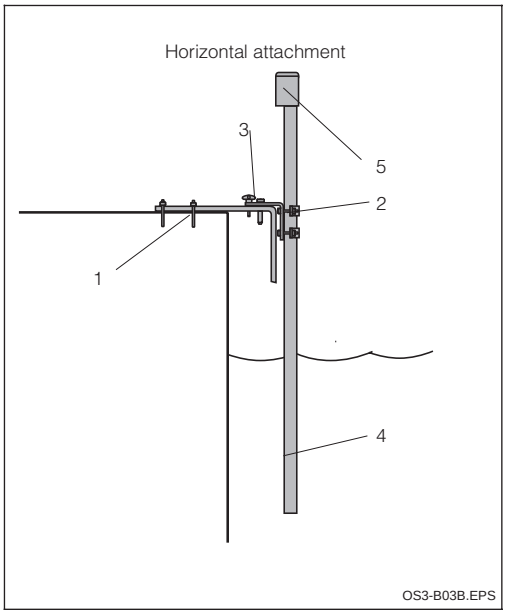
Basin wall mount

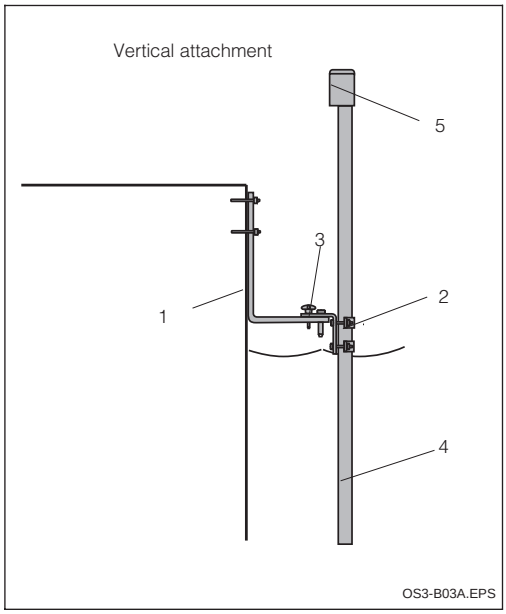
Construction: Basin wall mount CYY 106-A with immersion tube CYY 105-A (immersion tube length 2 m) or CYY 105-B (immersion tube length 3.5 m, see fig. 4.4)

Simple installation on basin or channel walls with fixed distance from wall, no possibility for attachment of transmitter.

Caution:

In the case of strong turbulences or high flow rates, two basin wall mounts should be used for safe mounting of the immersion tube.

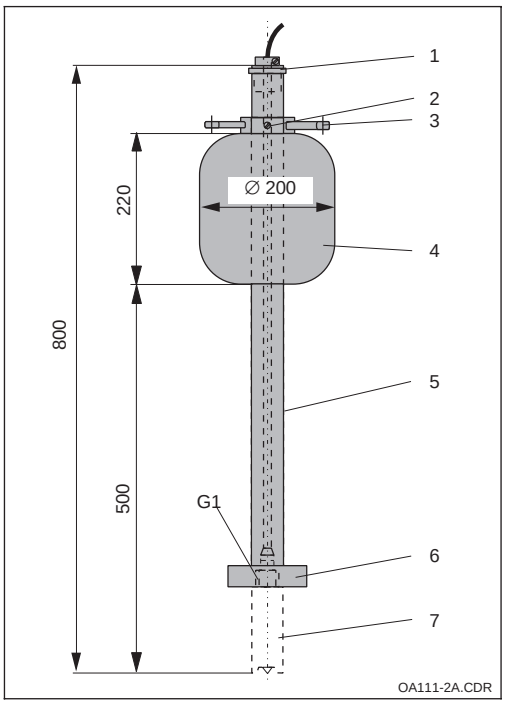




Basin wall attachment of CYY 106-A with immersion tube CYY 105-A or -B

1 Basin wall mount
2 Tube holder
3 Star handle
4 Immersion tube of stainless steel 1.4301 (AISI 304)
5 Cover for cable entry

Fig. 4.4



Float body COA 110-50

1 Cable clamp with strain relief and rain protection
2 Fixing ring with clamping screw
3 Eyes Ø 15; 3 × 120° for anchorage
4 Saltwater-resistant plastic float
5 Tube 40 × 1 of stainless steel 1.4571 (AISI 316Ti)
6 Shock absorber and weight for stability
7 Oxygen sensor COS 3 / 3S / 3HD

Fig. 4.5

Float body

Construction: Float body COA 110-50. This assembly is used with widely fluctuating water levels, e.g in rivers or lakes (see fig. 4.5).

Note:

Further information on assembly mounting and the order code of the mounting kits are available in the Operating Instructions CYA 611 (BA 166C/07/en) and in the Technical Information COA 110 (TI 035C/07/en).

4.3 Flow installation

Assembly for pipe or hose connection

Construction: Flow assembly COA 250-A. Assembly with bottom inlet and top outlet (connection via G ¾ thread) for automatic self-venting. Installation on one plane is possible when using two commercial 90° elbows.

Accessories

- Spray head CUR 3
- Pipe clamp COY 250

Caution:

If pressure > air pressure:
There is no problem for the sensor with raising or holding at pressure. If there is a quick pressure drop at the measuring point it is possible that there is a gas evolution of air in the electrolyte or blowing up of the membrane due to a reduced dissolubility. These effect will be suppressed if the pressure keeped up at the sensor (manual: hand valve; automatic: solenoid valve).

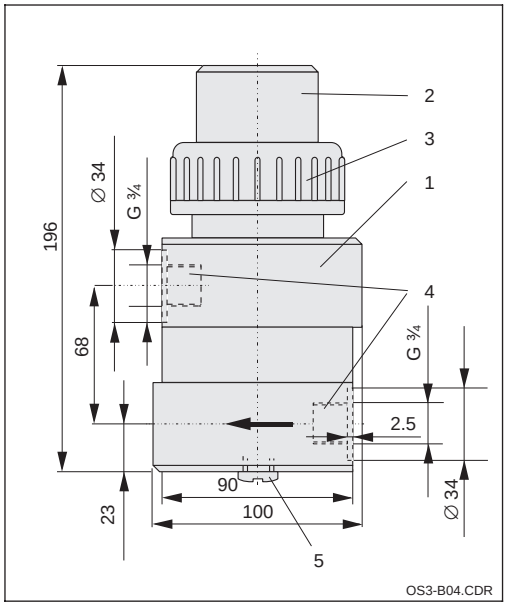


Fig. 4.6 Flow assembly COA 250-A

1 Basic body
2 Sensor adapter
3 Union nut
4 G ¾ thread
5 Dummy plug on installation thread for spray nozzle

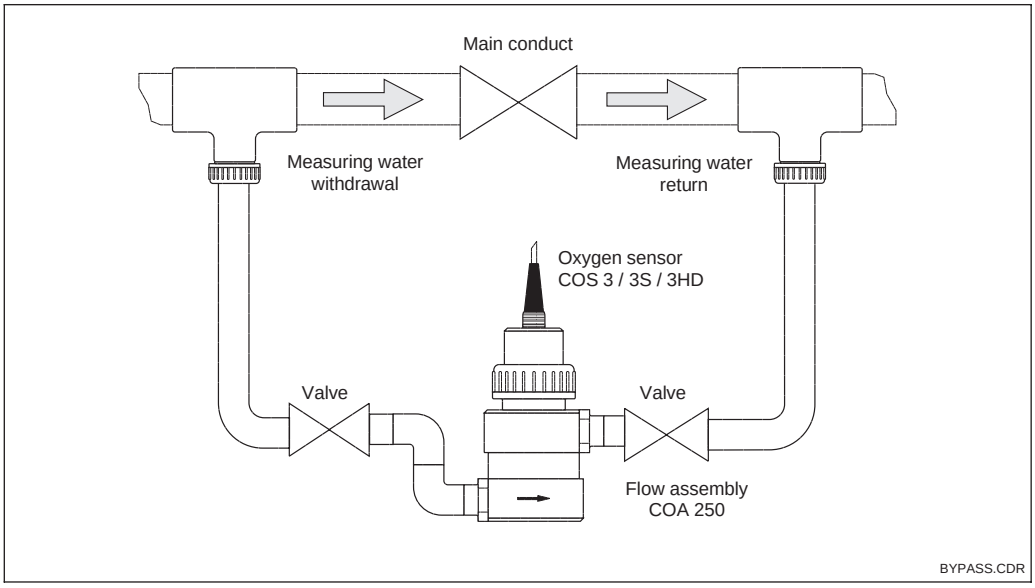
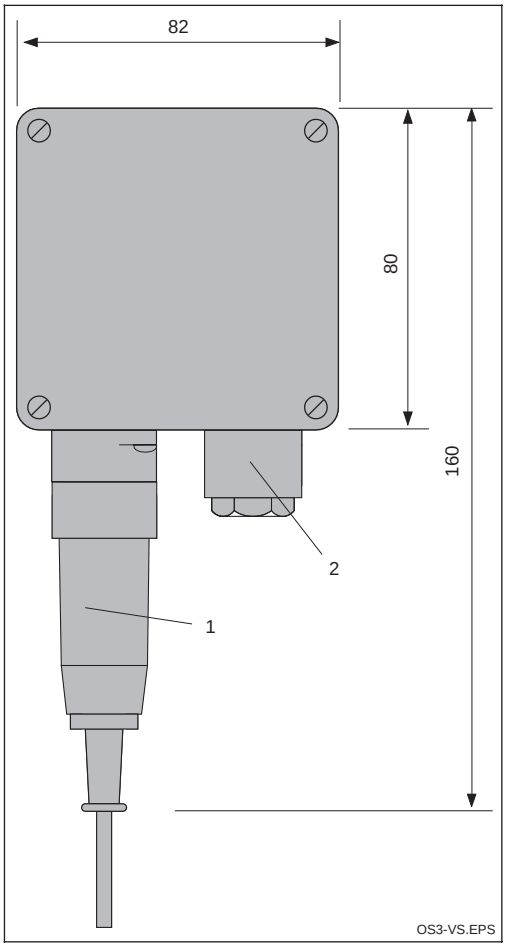


Fig. 4.7 Bypass installation with hand or solenoid valve if process pressure > atmospheric pressure

5 Electrical connection



Junction box VS for extension of connecting cable between oxygen sensor COS 3 / 3S / 3HD and transmitter

1 Sensor connector SXP
2 Pg 13.5 cable gland

Fig. 5.1

5.1 Direct connection

Please refer to the wiring diagram in the operating instructions of the corresponding transmitter, e.g.:

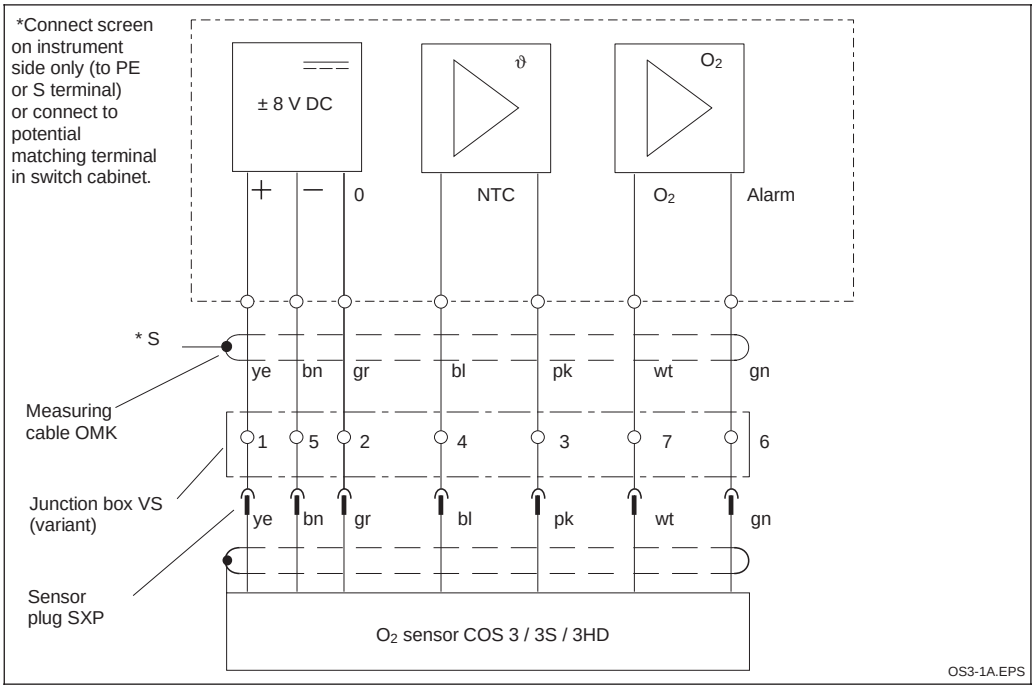
- Mycom COM 121 / 141 / 151
- Mypex COM 340
- Liquisys COM 220 / 240 S.

The sensor can be connected directly to COM 151, COM 340 and COM 240 S series oxygen instruments via a 7-pin plug-in socket.

5.2 Connection via junction box VS

Junction box VS (see fig. 5.1) is to be installed in order to connect the cable from the COS 3 / 3S / 3HD oxygen sensor to a panel-mounted instrument (e.g. Mycom COM 121 or Liquisys COM 220) or for extended distances between the sensor and instrument according to chpt. 5.1 (see fig. 5.2).

Junction box VS is equipped with a 7-pin receptacle for the sensor cable. The OMK measuring cable to the instrument is connected via the terminal strip in the junction box. When the extension cable is used for connection to an instrument with a connecting socket, the end of the cable must be fitted with an SXP-type connector.



Connection diagram

Note:
An SXP-type plug must be connected to the end of cable OMK when used as an extension cable to instruments equipped with a receptable.

Fig. 5.2

6 Start-up

6.1 Polarisation

The sensor has been tested for proper operation at the factory and is shipped ready for operation. Proceed as follows to prepare the sensor for calibration:

- Pull off the sensor protection cap.
- The sensor should be dry on the outside. Most accurate calibration results are obtained if the air surrounding the sensor is saturated with water vapour. Therefore the sensor should be mounted close to a water surface but far enough above it to assure that the membrane stays dry during the entire calibration process.
- Apply the operating voltage.
- Wait for 60 min for the sensor to polarise (see chpt. 3.2).

The end of polarisation can be identified by a stable, practically constant measured value display following initially elevated values that decrease over time. It follows the calibration.

Note:

Observe the start-up notes in the transmitter operating instructions.

Caution:

Do not expose sensor to direct sunlight!

6.2 Calibration

During calibration, the transmitter is adapted to the characteristic values of the sensor. Since the COS 3 / 3S / 3HD sensors do not require zero calibration, the calibration can be performed as a one-point calibration in the presence of oxygen.

Two different calibration methods can be used:

- In air (saturated with water vapour if at all possible, e.g. above a water surface)
- In air-saturated water.

Since the preparation of air-saturated water is cumbersome, the simple air calibration is recommended for routine measurement. The following prerequisites for calibration must exist:

- The sensor is completely polarised.
- The sensor is clean and dry on the outside.
- The sensor is located in air as close to a water surface as possible.

The sensor should be calibrated in the following cases:

- At start-up
- After membrane or electrolyte replacement
- After cleaning of the gold cathode or counter-electrode
- Following extended interruptions in operation (sensor disconnected from power source)
- At regular intervals depending on experience.

Typical recalibration cycles for different applications are:

- Drinking water: 1 ... 6 months
- Water monitoring (rivers, lakes): 1 ... 4 months
- Municipal waste water: 1 ... 3 months
- Industrial waste water: 1 ... 2 months.

6.3 Air calibration sequence

Calibration	
1. Remove te sensor from the medium.	4. Wait approx. 20 min for the sensor to adapt to the ambient air temperature. Avoid direct exposure to sunlight.
2. Clean the sensor on the outside with a moist cloth or sponge and dry (particularly the membrane).	5. When the measured value display on the transmitter is stable, perform calibration according to transmitter Operating Instructions.
3. If the sensor has been removed for calibration from a closed pressure system with an operating pressure higher than the atmospheric pressure: Briefly open membrane cap for pressure compensation and clean if required. Replace filling electrolyte, then close up. Wait until the sensor is polarised.	6. Return the sensor to the medium after successful completion of calibration.

6.4 Example for computation of oxygen calibration value

For purposes of verification, the measuring transmitter display value to be expected for the calibration can be computed as shown in the following example (salinity = 0):

a) Determine the following:
- Sensor temperature in air
- Altitude above sea level
- Atmospheric pressure at time of calibration **(comparative atmospheric pressure related to sea level)** in mbar. If not available, assume an air pressure of 1013 mbar for rough calculation.

b) Use these value to determine:
- Saturation value **S** according to table 1
- Factor **K** according to table 2
- **L** = $\frac{\text{rel. atm. pressure during calibration}}{1013\ \text{mbar}}$
- **M** = 1.02 for air calibration
  1.00 for calibration in air-saturated water

c) Compute calibration value

Calibration value = S • K • L • M

Example: Air calibration with:
Temperature: 18 °C
Altitude ab. sea level: 500 m
Atmospheric pressure: 1022 mbar

Thus: S = 9.45 mg/l
K = 0.943
L = 1.0089
M = 1.02

Calibration value = 9.17 mg/l

°C	mg O_2/l	°C	mg O_2/l	°C	mg O_2/l	°C	mg O_2/l
0	14,64	10,5	11,12	21	8,90	31,5	7,36
0,5	14,43	11	10,99	21,5	8,82	32	7,30
1	14,23	11,5	10,87	22	8,73	32,5	7,24
1,5	14,03	12	10,75	22,5	8,65	33	7,18
2	13,83	12,5	10,63	23	8,57	33,5	7,12
2,5	13,64	13	10,51	23,5	8,49	34	7,06
3	13,45	13,5	10,39	24	8,41	34,5	7,00
3,5	13,27	14	10,28	24,5	8,33	35	6,94
4	13,09	14,5	10,17	25	8,25	35,5	6,89
4,5	12,92	15	10,06	25,5	8,18	36	6,83
5	12,75	15,5	9,95	26	8,11	36,5	6,78
5,5	12,58	16	9,85	26,5	8,03	37	6,72
6	12,42	16,5	9,74	27	7,96	37,5	6,67
6,5	12,26	17	9,64	27,5	7,89	38	6,61
7	12,11	17,5	9,54	28	7,82	38,5	6,56
7,5	11,96	18	9,45	28,5	7,75	39	6,51
8	11,81	18,5	9,35	29	7,69	39,5	6,46
8,5	11,67	19	9,26	29,5	7,62	40	6,41
9	11,53	19,5	9,17	30	7,55	40,5	6,36
9,5	11,39	20	9,08	30,5	7,49		
10	11,25	20,5	8,99	31	7,42		

Table 1: Atmospheric oxygen saturation value S in mg O_2/l of water as a function of temperature for an atmospheric pressure of 1013 mbar

Alt. in m	K	Alt. in m	K	Alt. in m	K	Alt. in m	K
0	1,000	360	0,959	720	0,919	1160	0,873
20	0,998	380	0,957	740	0,917	1200	0,869
40	0,995	400	0,954	760	0,915	1240	0,865
60	0,993	420	0,952	780	0,913	1280	0,861
80	0,991	440	0,950	800	0,911	1320	0,857
100	0,988	460	0,948	820	0,909	1360	0,853
120	0,986	480	0,946	840	0,907	1400	0,849
140	0,984	500	0,943	860	0,904	1440	0,845
160	0,981	520	0,941	880	0,902	1480	0,841
180	0,979	540	0,939	900	0,900	1520	0,837
200	0,977	560	0,937	920	0,898	1560	0,833
220	0,975	580	0,935	940	0,896	1600	0,830
240	0,972	600	0,932	960	0,894	1700	0,820
260	0,970	620	0,930	980	0,892	1800	0,810
280	0,968	640	0,928	1000	0,890	1900	0,801
300	0,966	660	0,926	1040	0,886	2000	0,792
320	0,963	680	0,924	1080	0,882		
340	0,961	700	0,922	1120	0,877		

Table 2: Correction factor K as a function of mean altitude (above sea level)

7 Maintenance

The following maintenance is to be performed at regular intervals. To assure regular maintenance, we recommend entering the maintenance dates in an operator's log or calendar beforehand.

1. Check the measuring function at regular intervals. The length of these intervals depends on the medium (soiling, waste load). **The measuring function can be checked very simply by removing the sensor from the medium and exposing it to air.** Following membrane cleaning and drying, a measured value as close as possible to the calibration value for the existing conditions (acc. to chpt. 6.4) in mg/l (waiting time 45 min) or to a saturation index of 102% (waiting time 10 min) should be displayed within a short period.
2. External cleaning, especially if the membrane is soiled. Dirt deposits and grease on the membrane may cause inaccurate measured values.
3. Recalibration (see chpt. 6.2 and 6.3).
4. Replacement of a membrane that is defective, extremely soiled or can no longer be cleaned.

7.1 External cleaning

Clean the sensor with the following agents according to the type of soiling:

Type of soiling	Cleaning measures
Salt deposits	Immerse sensor in drinking water or 1 ... 5% hydrochloric acid (for a few minutes only) and rinse
Dirt particles, dirt adhering to sensor body **(not membrane!)**	Clean sensor with water using brush
Dirt particles, dirt adhering to membrane cap or membrane	Clean sensor with water using a sponge

7.2 Membrane rupture alarm handling

The electrolyte-filled measuring chamber in the oxygen sensor COS 3 / 3S / 3HD is sealed off from the medium very tightly. Due to the built-in membrane rupture monitoring function, the transmitter reports an alarm condition without any delay as soon as the tightness of the measuring chamber is no longer guaranteed, e.g. if the membrane is damaged.

Proceed as follows to eliminate a membrane rupture alarm:

Elimination of membrane rupture alarm
1. De-energise the sensor for at least 30 s by disconnecting the plug from the transmitter. 2. Reconnect the plug. No further measures are required if the alarm is cleared. 3. If the alarm is still signalled, repeat steps 1 and 2 one to two times. 4. If the alarm persists, disconnect the sensor from power and remove from the medium. 5. Clean and dry the sensor on the outside. 6. Replace the membrane cap and fill in electrolyte acc. to chpt. 8.3 and 8.4. 7. Leave the sensor in air and reconnect to the measuring transmitter. 8. Wait until the sensor is polarised and perform calibration according to chpt. 6. 9. Return the sensor to the medium.

Caution:

Do not touch the membrane with sharp-edged or pointed objects. Do not injure the membrane!

The sensor can be retrofitted with the Chemoclean cleaning system for regular automatic cleaning (see accessories).

A membrane rupture alarm may be signalled even though the membrane is intact when the silicone sealing ring that seals off the measuring chamber from the medium is soiled. If none of the above measures for elimination of a membane rupture alarm have been successful, proceed as described in the table below for further clarification:

Measure	Check	Result	
		yes	no
1. Remove the sensor from the medium, clean, dry carefully and leave in air.			
2. Unplug connector from transmitter for at least 30 s, then reconnect (repeat several times if necessary)	Alarm should be cleared.	Continue with step 3.	Return sensor to manufacturer.
3. Fill tap water into beaker or bucket. Establish a conductive connection between the stainless steel sensor body and the water acc. to fig. 7.1 (e.g. with a wire)			
4. Immerse membrane cap halfway acc. to fig. 7.2	Alarm signalled?	Replace membrane cap acc. to chpt. 8.	Continue with step 5.
5. Immerse sensor acc. to fig. 7.3	Alarm signalled?	Check and clean measuring chamber seal, replace sealing ring if necessary.	Sensor is OK.

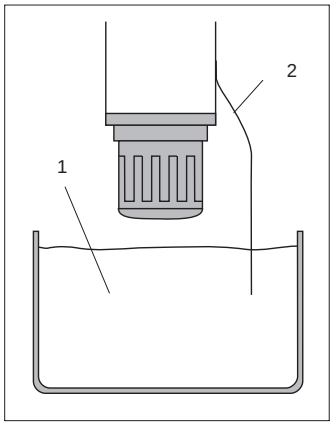


Fig. 7.1 1 Beaker or bucket filled with tap water
2 Conductive connection (e.g. wire)

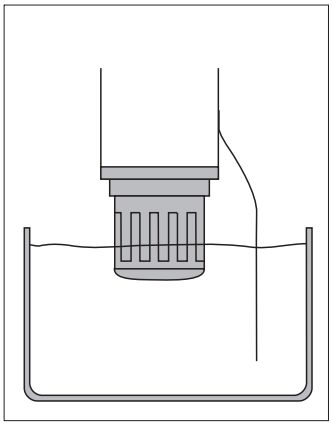


Fig. 7.2 Membrane cap immersed halfway

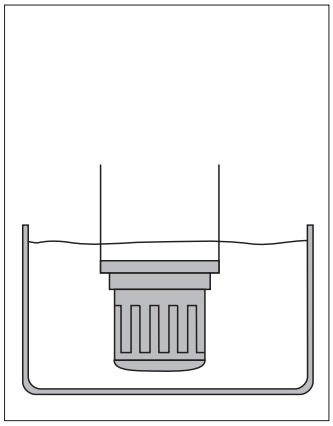


Fig. 7.3 Sensor immersed until stainless steel body contacts water

8 Regeneration

Different parts of the sensor are subject to natural wear during operation. Normal operation may be restored by the use of accessories or by replacing worn parts. The following simple remedial measures are described in the sections below:

Measure	Cause
Electrode cleaning (gold electrode) Chpt. 8.1	Gold electrode soiled or has silver coating
Sealing ring replacement Chpt. 8.2	Membrane rupture alarm is signalled even though membrane is intact
Electrolyte replacement Chpt. 8.3	Rapidly changed implausible signal (e.g. too high) or electrolyte contaminated
Membrane cap replacement Chpt. 8.4	Membrane rupture alarm or membrane • heavily soiled • can no longer be cleaned • is overstretched • is damaged (hole)

8.1 Electrode cleaning

Cleaning of the **gold electrode** is only required when this electrode is visibly soiled or has a silver coating.

- Clean gold surface carefully with fine abrasive paper (approx. 2400 grain) until the (silver) coating is completely removed.
- Rinse electrodes with pure water.
- Fill fresh electrolyte COY 3-F (for sensor COS 3 / 3S) or COY 3HD-F (for sensor COS 3HD) into membrane cap and close up cap.

Caution:

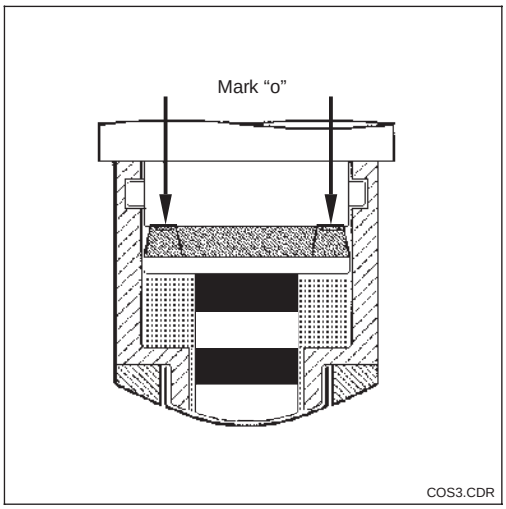
A brownish silver bromide (COS 3 / 3S) or silver chloride coat (COS 3HD) is applied to the **reference electrode** and the **counter-electrode** at the factory; therefore these electrodes **must never be cleaned.** When this coating comes off in the course of operation, the sensor can no longer be used for measurement and must be returned to the manufacturer for recoating.

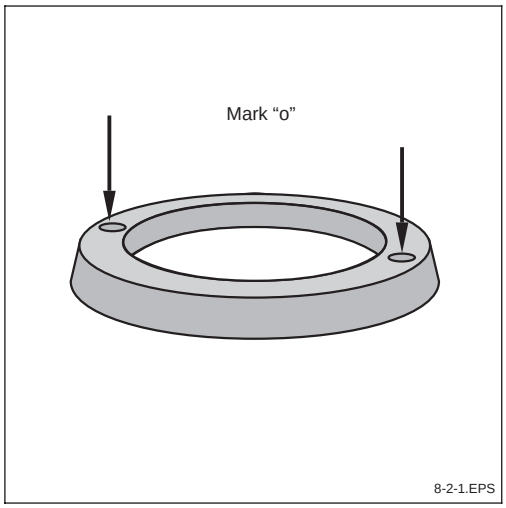
8.2 Sealing ring replacement

Sealing ring replacement becomes necessary when the sealing ring is visibly damaged or when the transmitter indicates a membrane rupture alarm even though the membrane is intact. Use pre-greased sealing rings COY 3-TR (see accessories)!

Caution:

The sealing ring may only be installed as shown in fig. 8.1.





left:
Install sealing ring with marks pointing upward

right:
Marks on top of trapezoid sealing ring

Fig. 8.1

8.3 Electrolyte replacement

The electrolyte is slowly used up during measuring operation due to electrochemical processes at the electrodes. No electrolyte is consumed when the sensor is disconnected from power.

The theoretical operating time of an electrolyte filling for air-saturated water and 20 °C is:
- Sensor COS 3: max. 5 years
- Sensor COS 3S: max. 1.5 years
- Sensor COS 3HD: max. 5 years.

Please note that penetration of foreign substances, e.g. H_2S, NH_3 or large quantities of CO_2, may shorten the operating time of the electrolyte.

Therefore, particular attention should be paid to:
- anaerobic stages (e.g., denitrification),
- strongly polluted industrial waste water, especially in conjunction with elevated medium temperatures.

Warning:

The COY 3-F and COY 3HD-F electrolyte are strong alkalis. Observation of applicable protective regulations is therefore mandatory (e.g. wear protective clothing, protective goggles, protective gloves).

Caution:

- Only use filling electrolyte COY 3-F for the COS 3 and COS 3S sensors.
- Only use filling electrolyte COY 3HD-F for the COS 3HD sensor.

The exact quantity required for **one** filling is contained in one plastic ampoule.

8.4 Membrane cap replacement

Removal of old membrane cap

- Remove sensor from medium
- Unscrew protection guard
- Clean sensor carefully on the outside
- Remove membrane cap (bayonet lock)
- Clean the gold cathode if required or replace the sealing ring (only if damaged)
- Rinse the electrode holder with pure water

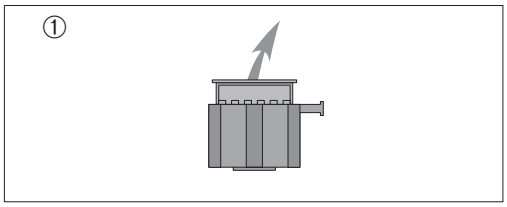
Installation of new membrane cap

- Inspect visually for dirt particles adhering to the sealing surfaces.
- Install the membrane cap according to fig. 2 ... 6 using fresh electrolyte.
- Screw the protection guard back on.
- Allow the sensor to polarise, then perform air calibration.

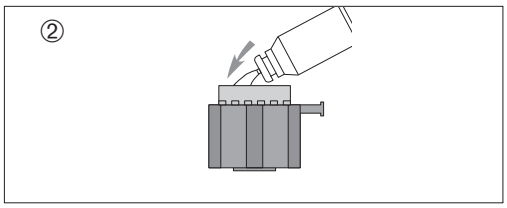
Return sensor to medium. Verify that the measuring transmitter does not indicate an alarm condition. If an alarm is indicated see chpt. 9, troubleshooting.

Caution:

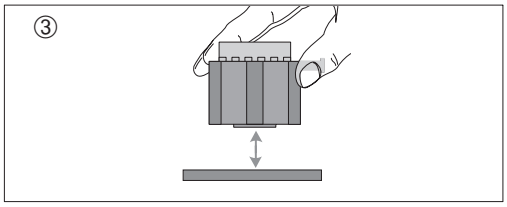
Use only membrane cap COY 3-WP (yellow lid) for the COS 3 and COS 3HD sensors.
Use only membrane cap COY 3S-WP (white lid) for the COS 3S sensor.



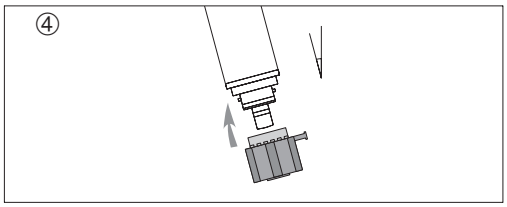
Remove lid.



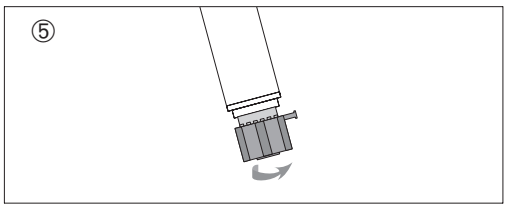
Pour entire contents of a plastic ampoule with liquid electrolyte COY3-F (for COS 3 / 3S) or COY 3HD-F (for COS 3HD) into membrane cap.



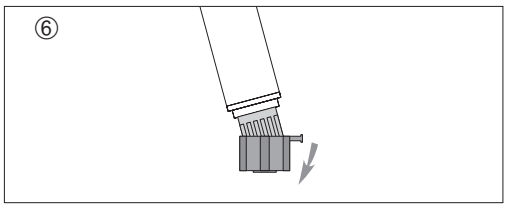
Tap membrane cap against a flat surface until electrolyte is completely free of air bubbles.



Insert membrane cap **very slowly** all the way into sensor body **held at angle**.



Turn membrane cap until latched in.



Remove mounting cap from sensor using pull tab.

9 Troubleshooting

9.1 Measuring system check

The measures described below, taken in the indicated sequence, can be used to pinpoint and possibly eliminate the source of the problems listed.

Check	Problem elimination
No display, no sensor response	
1. Is transmitter supplied with power? 2. Is sensor connected to transmitter correctly? 3. Is medium flow adequate? 4. Is membrane completely coated? 5. Does measuring chamber contain electrolyte?	• Switch power on. • Connect sensor or check the electrical connection. • Establish medium flow. • Clean sensor (s. chpt. 7.1). • Fill electrolyte into measuring chamber.
Display value too high	
1. Is polarisation time over? 2. Has the instrument been calibrated before (with a different sensor)? 3. Is the temperature display on the transmitter conspicuously low? 4. Remove sensor from medium and dry. Correct membrane cap installed on sensor? 5. Does membrane have a visible bulge? 6. Open measuring chamber. Is the electrolyte soiled? 7. Dry electrodes. Does the transmitter display go back to zero? 8. Is the brown reference electrode coating gone, silver coating on electrode? 9. Silver coating on gold cathode?	• Wait until sensor is completely polarised. • Perform calibration. • Return sensor to manufacturer • COY 3-WP cap for COS 3 / 3HD COY 3S-WP cap for COS 3S • Install new membrane cap (s. chpt. 8.4). • Clean measuring chamber and fill in fresh electrolyte (s. chpt. 8.3). • Check connecting line (and junction box where used) for shunt. If not OK, return sensor to manufacturer. • Return sensor to manufacturer for recoating. • Clean gold cathode (s. chpt. 8.1).
Display value too low	
1. Has sensor been calibrated? 2. Is medium flow adequate? 3. Is the temperature display on the transmitter conspicuously high? 4. Correct membrane cap installed on sensor? 5. Visible coating on membrane? 6. Open measuring chamber. Is the electrolyte soiled?	• Perform calibration. • Establish required medium flow. • Return sensor to manufacturer. • COY 3-WP cap for COS 3 / 3HD COY 3S-WP cap for COS 3S • Clean membrane or replace membrane cap (s. chpt. 7.1 and 8.4). • Clean measuring chamber and fill in fresh electrolyte (s. chpt. 8.4).
Display value fluctuates considerably	
1. Does membrane have a visible bulge? 2. Open measuring chamber and dry electrodes. Does the transmitter display go back to zero? 3. Existing of EMC dispersion to the transmitter?	• Install new membrane cap. • Check connecting line (and junction box where used) for shunt. If not OK, return sensor to manufacturer. • Ground the transmitter (specially on site housing). • Connect outer screen of the sensor and extension cord (if available) to terminal “S” resp. “PE”. • Install measuring signal wires separately from high voltage wires.
Membrane rupture alarm	
see chpt. 7.2	see chpt. 7.2
Pitting in stainless steel body	
1. Direct voltage of more than approx. 0.5 V between medium and protective earth? 2. Direct voltage of more than approx. 0.5 V between stainless steel body (in air) and medium?	Ground medium. Establish potential matching connection between medium and transmitter.

9.2 Transmitter check

Caution:

Requirements for transmitter check:

- Basic electrical knowledge
- Multimeter.

The following resistors are also required:

- 10 kΩ
- 37 kΩ
- 82 kΩ

Measure	Effect / values measured
Voltage check	
Disconnect oxygen sensor COS 3 / 3S / 3HD and measure sensor power supply on: – Mypex COM 340 – Mycom 121 / 141 / 151 – Liquisys COM 220 / 240S	 –8.0 V: between terminals 4 and 2 +8.0 V: between terminals 4 and 3 –8.5 V: between terminals 0 and 84 +8.5 V: between terminals 0 and 83 –8.2 V: between terminals 11 and 9 +8.2 V: between terminals 11 and 10
Zero check	
Switch off unit (power OFF) and connect 37 kΩ resistance (33 ... 39 kΩ is permissible) on: – Mypex COM 340 – Mycom 121 / 141 / 151 – Liquisys COM 220 / 240S Connect aditionally 10 kΩ resistance on: – Mypex COM 340 – Mycom 121 / 141 / 151 – Liquisys COM 220 / 240S Switch on unit (power ON):	 between terminals 6 and 7 between terminals 11 and 12 between terminals 13 and 14 between terminals 4 and 5 between terminals 13 and 0 between terminals 11 and 12 Value on display: **0.00 mg/l** (or **0.0% SAT**) and **20 °C** Current output: **0** or **4** mA
Slope check	
Switch off unit (power OFF) and connect 82 kΩ resistor on: – Mypex COM 340 – Mycom 121 / 141 / 151 – Liquisys COM 220 / 240S Switch on unit (power ON):	between terminals 2 and 5 between terminals 13 and 84 between terminals 9 and 12 Value on display (depending on last calibration) on: – Mypex COM 340 between approx. 6.5 and 13 mg/l – Mycom 121 / 141 / 151 between approx. 7 and 14 mg/l – Liquisys COM 220 / 240S Display adjustable via “span” potentiometer between 4.5 and 13.5 mg/l
The instrument may signal a membrane rupture (sensor) alarm while these tests are being performed.	

9.3 Sensor check

Measure	Desired value
Temperature sensor check	
Resistance measurement on round sensor connector between terminals 3 and 4	at: 5 °C: 74.4 kΩ 10 °C: 58.8 kΩ 15 °C: 46.7 kΩ 20 °C: 37.3 kΩ 25 °C: 30.0 kΩ
Voltage check	
Open up sensor plug housing for signal measurement. Connect sensor to instrument, switch on measuring instrument and measure on round connecting plug:	–8 ... –8.5 V between terminals 2 and 1 +8 ... +8.5 V between terminals 2 and 5 If the auxiliary voltage is available during the transmitter check (s. chpt. 9.2) and no longer available when connecting the sensor, the defect is in the oxygen sensor, connecting line or junction box VS.
Zero check	
Open measuring chamber and dry electrodes. **or:** Immerse sensor in zero solution and move around in solution.	Voltage from terminal 2 to terminal 7 on sensor plug must be approx. 0 V. Voltage from terminal 2 to terminal 7 in sensor plug should move towards 0 V after some time.
Slope check	
Remove sensor from medium and dry with paper towel (particularly in membrane area).	Voltage from terminal 2 to terminal 7 on sensor plug should be between –415 and –913 mV after some time.

10 Technical data

General specifications

Manufacturer	Endress+Hauser
Product designation	COS 3 / COS 3S / COS 3HD

Technical data for COS 3 / COS 3HD

Measuring principle	membrane-covered amperometric sensor with potentiostatic operating principle (three-electrode system)
Materials	sensor body: POM, stainless steel 1.4571 (AISI 316Ti) membrane cap: PEEK
Lower measuring range limit	0.070 mg/l at 5 °C 0.035 mg/l at 20 °C 0.015 mg/l at 40 °C
Upper measuring range limit	60 mg/l
Response time	90% of upper range-value after 3 min at 20 °C 99% of upper range-value after 9 min at 20 °C
Polarisation time	< 60 min
Minimum flow velocity	typically 0.5 cm/s for 95% measured value display
Self-monitoring	detection of membrane perforation
Drift	under continuous polarisation: < 1%/month
Zero current	none
Operating time of one filling with COY 3-F (COS 3 / 3S) or COY 3HD-F (COS 3HD)	max. 5 years (theoretical electrolytic reserve with air saturation at 20 °C)
Nominal operating temperature	–5 ... 50 °C
Max. permissible overpressure	10 bar
Ingress protection	IP 68
Temperature compensation	dual thermistor system, 0 ... 50 °C
Storage temperature	filled: –5 ... 50 °C, unfilled: –20 ... 60 °C
Membrane thickness	approx. 50 µm
Threaded connection	G 1
Connection	screened 7-core measuring cable with 7-pin connector
Cable lenghts	1.5 m, 7 m, 15 m
Max. tot. cable length with cable extension	100 m
Weight (incl. 1.5 m measuring cable)	1.2 kg

Technical data different for COS 3S

Lower measuring range limit	0.020 mg/l at 5 °C 0.010 mg/l at 20 °C 0.005 mg/l at 40 °C
Response time	90% of upper range-value after 30 s at 20 °C 99% of upper range-value after 95 s at 20 °C
Minimum flow velocity	typically 2.5 cm/s for 95% measured value display
Operating time of one filling with COY 3-F	max. 1.5 years
Membrane thickness	approx. 25 µm

Subject to modifications.

11 Accessories

The following accessories can be ordered separately:

- Replacement cartridge COY 3-WP
  (with yellow cap)
  2 replacement cartridges, ready for use, with pre-tensioned membrane
  for COS 3 / COS 3HD
  Order No.: 50053348

- Replacement cartridge COY 3S-WP
  (with white cap)
  2 replacement cartridges, ready for use, with pre-tensioned membrane
  for COS 3S
  Order No.: 50060714

- Filling electrolyte COY 3-F
  for COS 3 / COS 3S
  10 plastic ampoules
  Order No.: 50053349

- Filling electrolyte COY 3HD-F
  for COS 3HD
  10 plastic ampoules
  Order No.: 51503267

- Trapezoid seal COY 3-TR
  for COS 3 / COS 3S / COS 3HD
  3 pcs., pre-greased,
  Order No.: 50080252

- Membrane protection guard COY 3-SK
  for use in fish ponds
  for COS 3 / COS 3S
  Order No.: 50081787

- Baffle plate OP
  Baffle plate for additional mechanical protection under extreme flow rates (optional accessory for assembly COA 110)
  Order No.: 50028712

- Zero solution
  Three bottles for production of 3 × 1 litre oxygen-free solution
  Order No.: 50001041

Electrical equipment and cables

- Junction box VS
  Junction box for cable extension, with receptacle and plug, type SXP for plug-in connection between oxygen sensor COS 3 / 3S / 3HD and transmitter
  Dimensions: 160 × 105 × 46 mm (L × W × D)
  Material: plastic
  Ingress protection: IP 65
  Order No.: 50001054

- Junction box VBO
  for Mypex COM 340 with 2 measuring circuits

- Measuring cable OMK
  Special cable for extension of connecting line between oxygen sensor COS 3 / 3S / 3HD and transmitter; 7 cores (0.38 mm^2 per core) and outer screen, cable sheath made of smooth PUR.
  Cable diameter: approx. 8.6 mm
  Order No.: 50004124

- Chemoclean
  Injector unit CYR 10
  Programme sequencer CYR 20

- Spray head COR 3

- Spray head CUR 3 for connection at the bottom of assembly COA 250

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BA 065C/07/en/09.00
Printed in Germany / CV 5 / DT