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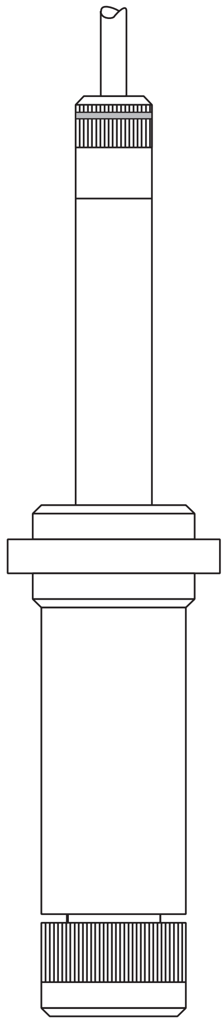
OCS 140 / 141
Sensors for Free Chlorine

Operating Instructions



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1 General information

1.1 Symbols used

Warning:

This symbol alerts to hazards which may cause serious personal injuries or material damage.

Caution:

This symbol alerts to possible malfunction due to operator error.

Note:

This symbol indicates important items of information.

1.2 Safety notes

The intended use is described in these operating instructions.

Warning:

- Operating the device in a manner other than as described in these instructions may compromise the safety and function of the sensor and connected systems and is therefore impermissible.
- Connection and maintenance work on the device must be carried out by trained personnel.
- Repair work must be carried out directly by the manufacturer or by authorised service organisations. Interventions in or changes to the device except for required maintenance work according to the operating instructions are impermissible and will void the warranty.
- The operator is liable for the observance of local safety regulations.

1.3 Declaration of conformity

The chlorine sensors OCS 140 / 141 have been developed in accordance with the applicable European standards and directives and are subject to corresponding manufacture.

Note:

The corresponding declaration of conformity may be requested from your dealer.

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1.4 Unpacking

- Verify that the contents are undamaged. Inform the post office or freight carrier as well as the supplier of any damage.
- Check that the delivery is complete and agrees with the shipping documents and your order (see chapter 1.5).
- Save the original package in case the device must be stored or shipped at a later time.

If you have any questions, please consult your supplier.

1.5 Scope of delivery

- Chlorine sensor OCS 140-A without or OCS 140-N or OCS 141-N with integrated temperature sensor

Note:

Distinction is possible by the nameplate and by a coloured ring at the cable gland:

red – OCS 140

blue – OCS 141

- Cap to protect the diaphragm or for storage
- Spare electrolyte in a washing bottle (50 ml)
- Spare replacement cartridge with pretensioned diaphragm
- Operating instructions

1.6 Product structure

Chlorine sensor OCS 140

Version
A without temperature sensor
N with NTC temperature sensor

Cable length
01 with 1 m fixed cable
03 with 3 m fixed cable
10 with 10 m fixed cable

OCS 140- ☐☐ ⇐ **complete order code**

Trace chlorine sensor OCS 141

Version
N with NTC temperature sensor

Cable length
01 with 1 m fixed cable
03 with 3 m fixed cable
10 with 10 m fixed cable

OCS 141- ☐☐ ⇐ **complete order code**

2 Description

2.1 Areas of application

Drinking water, water for industrial/domestic use and bath water must be sterilised by the addition of appropriate disinfectants such as gaseous chlorine or inorganic chlorine compounds. At the same time, the dosages must be adapted to the constantly changing operating conditions. Too low concentrations in the water jeopardise successful disinfection, while too high concentrations may not only result in superfluous expenditure but may also cause corrosion and detrimentally affect taste.

The chlorine sensor OCS 140 / 141 has been specially developed for this purpose and enables continuous measurement of the freely active chlorine content. When used in connection with a measurement and control system, it permits the required optimum disinfection status to be maintained.

Sensor	Measuring range [mg Cl_2/l]
OCS 140	0.05 ... 20 (e.g. pool water)
OCS 141	0.01 ... 5 (e.g. drinking water)

Caution:

Perfect operation of the measuring system requires the following operating conditions:

- Constant pH value after chlorine calibration (see chapter 2.6). Not required for measurement in the “pH compensated” mode of operation.
- Constant temperature after chlorine calibration, except for ATC option (see chapter 2.6). Not required for measurement in the “temperature compensated” mode of operation.
- Minimum flow rate of measured water 30 l/h (red bar mark when using the flow assembly OCA 250, see chapter 2.6 and operating instructions OCA 250, no. 51503342).
- No use of organic chlorination agents (see chapter 4.3).

2.2 Dimensions

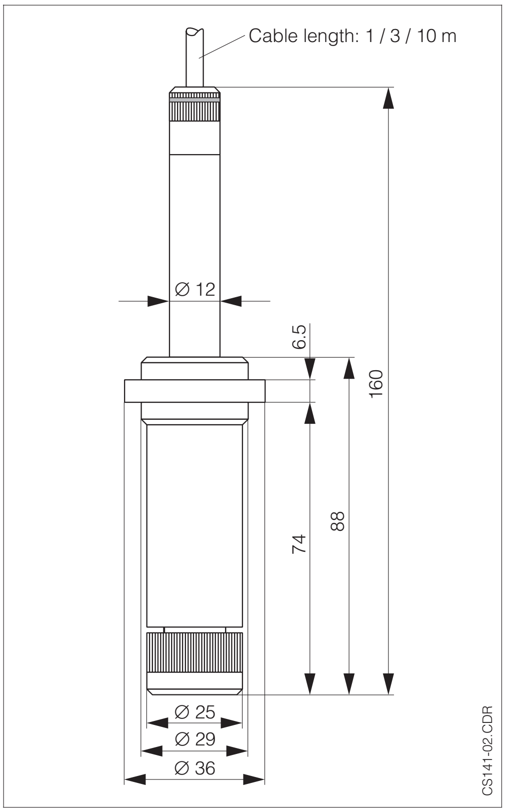

Fig. 2.1 Dimensions of OCS 140 / OCS 141

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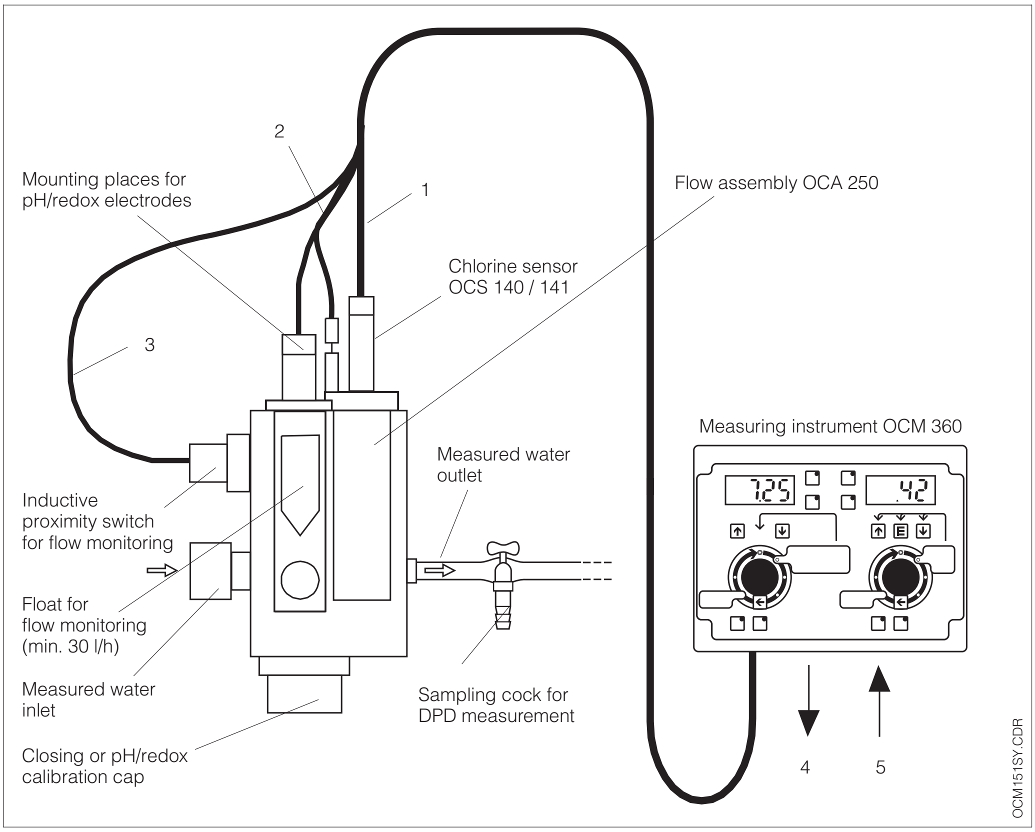
2.3 Measuring system

The complete measuring system comprises:

- Chlorine sensor OCS 140 / 141 with connection cable (1 m, 3 m or 10 m)
- Flow assembly OCA 250
- Transmitter OCM 360
- If required, measuring cable OCK for extension (max. total cable length 30 m)
- Measuring implements for determination of the reference value according to the DPD method, e.g. microprocessor photometer.

It can be completed by:

- pH measuring chain (only in connection with a transmitter with pH input)
- Redox measuring chain (only in connection with a transmitter with redox input)
- Flow monitoring with inductive proximity switch.



Complete measuring system, e.g. with measuring instrument OCM 360, assembly OCA 250, pH, redox and chlorine sensors and proximity switch INS

1 Connection cable OCK
2 Connection cable OPK 1 with PM connection
3 Connection cable for INS
4 Signal output chlorine, pH, mV or temperature (0/4 ... 20 mA)
5 Power supply with PM

Fig. 2.2

2.4 Construction of sensors

The chlorine sensor OCS 140 or OCS 141 is easy to handle and can be dismantled into components for filling, to replace the diaphragm or for regeneration (see Fig. 2.3). The measuring electrodes are located in a measuring chamber sealed off from the medium, separated by a PTFE membrane which is extremely resistant both chemically and mechanically.
The gold cathode, embedded in plastic, and the silver / silver chloride anode are situated at the lower end of the shaft piece with the connection cable. A special support grid between gold cathode and PTFE membrane maintains a specified spacing thus ensuring a constant electrolyte film with the advantage of a relatively constant indication even for varying pressures or flows. A long operating time is achieved by the large electrolyte volume combined with a large anode surface and a small cathode surface. The membrane cap can be replaced after removal of the screw cap.

Version with temperature sensor (OCS 140-N or OCS 141)
An NTC temperature sensor is embedded in the lower third of the shaft. This allows an automatic compensation of the temperature dependence of the measuring signal and additionally an indication of the measured water temperature.

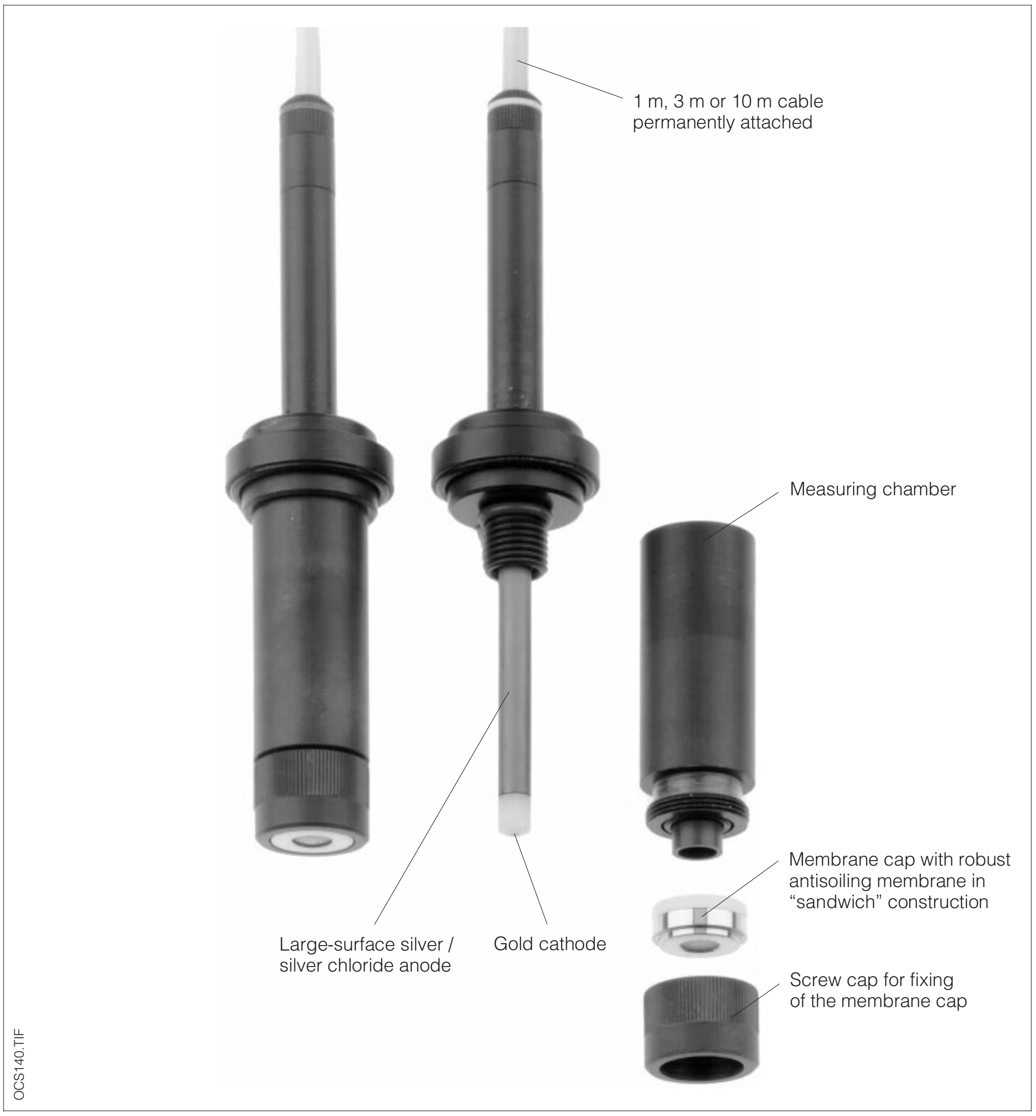


Fig. 2.3 Chlorine sensor OCS 140 or OCS 141 in operating state and dismantled into components

2.5 Operating principle

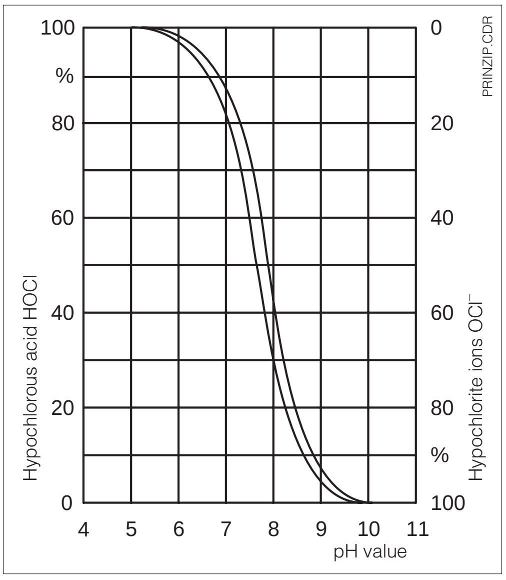


Fig. 2.4 Proportions of HOCl and OCl^- in water of 0 °C and 20 °C as functions of the pH value

The designation “freely active chlorine” is given to the sum of molecular chlorine solute (Cl_2), hypochlorous acid (HOCl) and hypochlorite ions (OCl^-). Molecular chlorine only occurs at acid pH values (pH < 4), but not at applied neutral pH values. Hypochlorous acid and hypochlorite ions are in pH value-dependent equilibrium (see Fig. 2.4).

The diagram illustrates that the proportion of hypochlorous acid (HOCl) decreases as the pH value increases. At pH 6, this proportion amounts to 97%, while it drops to approx. 3% at pH 9. The disinfecting effect of chlorine in water is based on the proportion of hypochlorous acid, whereas the disinfecting power of hypochlorite ions is only very low.

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When a sensor is connected to the corresponding transmitter, a fixed external voltage is applied to the electrodes. Due to the difference in electrode surfaces, this results in a polarisation at the gold cathode. The polarisation current generated during this process is visible on the transmitter by very high display values which decrease over time and eventually stabilise. Polarisation must be complete before the sensor can be calibrated.

Free chlorine in the form of hypochlorous acid (HOCl) is transported towards the membrane by the medium flow which is required for measurement. Materials and manufacturing process ensure that only dissolved gases but no liquid-phase constituents can pass through the membrane. Dissolved salts and ionic substances are also held back. This is the reason why – contrary to the open measuring principle – the conductivity of the medium does not influence the measuring signal.

The free chlorine diffusing through the membrane is reduced to chloride ions (Cl^-) and hydroxide ions (OH^-) at the gold cathode while silver is oxidised to silver chloride at the anode. The related electron release of the cathode and electron acceptance of the anode cause a current flow which – under constant conditions – is proportional to the external concentration of free chlorine in the medium. Therefore the term *amperometric* measuring principle is used in connection with the chlorine sensors described here. The current flow is converted in the transmitter and displayed as the dissolved free chlorine concentration in mg/l.

2.6 Influences on the measuring signal

pH value

As the chlorine sensor OCS 140 / 141 only detects hypochlorous acid (HOCl), but not hypochlorite ions (OCl^-), the measuring signal alters with changing pH values, even if measurements according to the DPD method indicate no alteration of the chlorine content (the DPD method includes buffering of the measured water to approx. pH 6.3).

An increased pH value therefore causes a decreased measurement value and vice versa. For this reason, the pH value must be kept constant after calibrating the chlorine measuring unit. Calibration must be repeated if the pH value is altered.

When operating a transmitter in the “pH compensated” mode, this dependence is eliminated by calculation of the DPD-analogue measured value. Optionally, a pH compensated or an uncompensated chlorine measurement signal is displayed and emitted as control signal.

Flow

The membrane-covered sensor requires a minimum flow velocity of 15 cm/s in order to function. When using the flow assembly OCA 250, this value corresponds to a flow rate of 30 l/h (upper edge of float at level of red bar mark). At higher flow rates, the measuring signal is virtually flow-independent, while a flow dependence arises when falling short of the above-mentioned value. If an INS proximity switch is installed in the assembly, this unacceptable operating state can reliably be detected, thereby allowing to signal an alarm or, if required, to block the dosage pumps.

Temperature

Changes in the temperature of the measured water also influence the measurement signal. A temperature rise causes the measured value to increase (approx. 4% per K), a fall causes it to decrease. Therefore the temperature should remain constant after calibration of the chlorine measurement, or a recalibration must be performed if the temperature has changed. This is not required for chlorine measurement with automatic temperature compensation (ATC).

3 Mounting and installation

3.1 Installation in flow assembly OCA 250

The flow assembly OCA 250 is designed for on-site installation of the sensor.
In addition to the chlorine sensor, a pH and redox electrode can be installed.
A needle valve regulates the flow within the range of 30 ... 120 l/h. If the value drops below 30 l/h or flow stops completely, this can be detected by an inductive proximity switch (version OCA 250-x1) and used for alarm signalling with blocking of the dosage pumps.

For installation in the flow assembly, the chlorine sensor is fastened by the union nut (see operating instructions of the flow assembly for details of installation).

3.2 Installation in other flow assemblies

When using other flow assemblies, ensure a minimum flow velocity of 15 cm/s against the membrane. Installation must performed in such a way that the flow direction is upward, so that carried air bubbles are removed and do not collect in front of the membrane. This should be struck directly by the flow.

3.3 Measured water discharge

The measured water discharge can be realized as a free outlet or as measured water recirculation.

Caution:

Ensure for measured water recirculation into a surge tank, a pipeline or the like that the generated counterpressure at the sensor does not exceed 1 bar and remains constant.

Negative pressure at the sensor, e.g. by measured water recirculation to the suction side of a pump, must be avoided.

4 Start-up and calibration

4.1 Connection to the transmitter

Terminal assignment of the measuring cable:

Cable	Colour / marking	Assignment
Coaxial inner conductor	transparent / "**K**"	gold cathode
Coaxial screen	red / "**A**"	silver / silver chloride anode
Auxiliary cores	green, brown	NTC temperature sensor (connection polarity free)
Outer screen	wire mesh	screening

4.2 Polarisation

The voltage applied between cathode and anode by the transmitter polarises the surface of the gold electrode. After switching on the transmitter with connected sensor, the polarisation period (see right) must therefore elapse before starting the calibration.

- Polarisation period for first start-up:
  30 minutes (OCS 140)
  90 minutes (OCS 141)

- Polarisation period for subsequent start-up:
  10 minutes (OCS 140)
  45 minutes (OCS 141)

4.3 Reference measurement according to the DPD method

The calibration of the measuring system requires a colorimetric reference measurement according to the DPD method. Free chlorine reacts with diethyl-p-phenylenediamine (DPD) by producing a red dye, the intensity of the red colour being proportional to the chlorine concentration.
Simple visual methods using comparators are inaccurate and depend on the considerably varying subjective evaluation by the operator. Today, the chlorine concentration can be determined objectively and accurately using low-cost microprocessor photometers.

An important fact must be kept in mind:
The DPD method is not a selective measuring method for free chlorine alone, but other oxidants present in the medium can also be registered (see DIN 38408, part 5, section 4). Moreover, the measuring range of the photometers has a lower limit and does not permit measurements in the very low trace range. In addition to the chlorinated probe, a sample of the medium without added chlorine should be checked by a DPD measurement if possible. The measured value must lie near zero and differ significantly from the chlorinated sample.

The measured water is always buffered to a pH value of 6.3 with the DPD method, so the measurement is independent of the pH value of the measured water.

Caution:

The DPD method cannot be applied if organic chlorination agents are used. In this case it causes a higher measured value compared to the actual free active chlorine value (cf. also note in DIN 38408, part 4, section 5).

4.4 Calibration

Zero adjustment

Not required due to the zero stability of the membrane-covered sensor.

Slope adjustment (sensitivity)

- Ensure constant operating data of the measured water regarding pH value and temperature.
- Take a medium sample from the sampling cock and read the actual free chlorine value on the transmitter display.
- Use the photometer to determine the free chlorine concentration according to the DPD method.
- Set the transmitter to the determined DPD value if there is a difference from the read actual value.
- Check calibration after several hours or one day and repeat it if required.

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5 Operation and maintenance

5.1 Routine check

- Check the measurement at regular intervals, dependent on the respective conditions, at least once a month.
- Perform recalibration if required.
- If the membrane is visibly soiled, remove the sensor from the flow assembly. Only clean the membrane mechanically with a gentle water jet or for some minutes in 1 to 10% hydrochloric acid (observe safety regulations!) without chemical additives. Chemicals reducing the surface tension must not be used.
- Replace a heavily soiled or damaged membrane (see chapter 5.2).
- Refill the sensor with electrolyte once per season or every 12 months. Depending on the chlorine content on site, this period can be reduced or extended (procedure see chapter 5.3).

5.2 Membrane replacement

Replacement of a heavily soiled or leaky membrane:
- First unscrew the measuring chamber, then the front screw cap (see Fig. 2.3).
- Replace the membrane cap by the replacement cartridge OCY 14-WP.
- Refill the measuring chamber with electrolyte OCY 14-F (see chapter 5.3).

5.3 Filling with electrolyte

To replace the electrolyte OCY 14-F, proceed as follows:

- Unscrew the measuring chamber from the shaft.
- Hold the measuring chamber at an angle and fill in approx. 7 to 8 ml electrolyte, up to approx. 1 cm under the top edge.
- Tap the filled chamber several times on a flat surface, so that adherent air bubbles can detach and rise.
- Screw the electrode shaft into the measuring chamber vertically from above, ensuring that all inside air is displaced.
- As soon as the inserted O-ring begins to seal, tighten slowly to the stop.
- The sensor is now ready for operation.

5.4 Storage

If the sensor is not in use, it must be stored as follows:

- The sensor can remain in the flow assembly for short-term interruptions in measurement. To prevent diaphragm dehydrating, the assembly must not drain off. If this is not ensured, then remove the sensor from the assembly. To keep the diaphragm wet, slide the yellow protection cap, previously moistened at the inner sponge, onto the measuring chamber.
- If the measurement is interrupted for longer periods, then empty the sensor, particularly if dehydration is possible. For cleaning, rinse the measuring chamber and electrode shaft with cold water and let them dry. Then screw the sensor down loosely and not to the stop, so that the membrane remains unstressed. Proceed according to chapter 5.3 for subsequent start-up.

5.5 Regeneration

During measurement, the electrolyte in the chlorine sensor is gradually exhausted by chemical reactions. The silver chloride layer, applied to the anode at the factory, continues to grow epitaxially during operation. This has no effect on the reaction of the hypochlorous acid at the cathode.

For maintenance work, the grey-brown state of the anode must be ensured by visual inspection. If the colour of the anode has operationally changed (e.g. spotted, white or silvery), then a regeneration of the sensor is required. Send it to the manufacturer for this purpose.

6 Troubleshooting

Malfunctions are basically possible in three areas of the measuring system:

- Transmitter
- Supply lines and connections
- Chlorine sensor and measured water

First determine if there is a malfunction in the transmitter or in the supply lines and connections. In this case, proceed as described in the operating instructions of the transmitter.

Before starting troubleshooting at the sensor, check if the operating conditions listed in chapter 2.1 are always fulfilled. If this is not the case, then establish the required conditions. Should this not remedy the malfunctions, then proceed according to the following search plan.

Malfunction	Possible causes	Remedy
No display, no sensor current	No supply voltage at the transmitter	Establish mains connection
	Connection cable between sensor and transmitter interrupted	Establish cable connection
	No electrolyte filled into the measuring chamber	Fill measuring chamber (see chapter 5.3)
	No input flow of measured water	Establish flow, clean filter
Display value too high	pH value dropped since calibration	Raise pH value or recalibrate
	Temperature rised since calibration (without option “temperature compensation”)	Reduce temperature or recalibrate
	Polarisation of the sensor not yet completed	Wait for complete polarisation (see chapter 4.2)
	Membrane defective	Replace membrane cap
	Shunt resistance (e.g. moisture contact) in the sensor, at the connections or in the connection cable	Open measuring chamber, rub gold cathode dry. If the indication on the transmitter does not return to zero, then there is a shunt.
	Disturbance of the sensor by foreign oxidants	Examine measured water, check chemicals

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Malfunction	Possible causes	Remedy
Display value too low	pH value rised since calibration	Reduce pH value or recalibrate
	Temperature dropped since calibration (without option “temperature compensation”)	Raise temperature or recalibrate
	Measuring chamber not closed completely	Tighten measuring chamber or screw cap tight
	Membrane soiled	Clean membrane
	Air bubble in front of the membrane	Release air bubble
	Air bubble inside between cathode and membrane	Open measuring chamber, fill in some electrolyte, tap
	Input flow of measured water too low	Establish correct input flow (see chapter 2.6)
	Interference of foreign oxidants on the DPD reference measurement	Examine measured water, check chemicals
	Use of organic chlorination agents	Use agents according to DIN 19643 (previous water replacement may be required)
Display value fluctuates considerably	Hole in membrane	Replace membrane cap
	External voltage in medium	Disconnect wire from PM pin on assembly OCA 250. Measure voltage between PM pin and protective earth of transmitter (both AC and DC ranges). For values exceeding approx. 0.5 V, trace and eliminate external source
Temperature display **– too low** **– too high**	Supply line to NTC temperature sensor – broken – short-circuited	Test wires (green/brown) and measure resistance (NTC), replace sensor if required

7 Appendix

7.1 Technical data

Electrical connection

Cable	3 m four-core, double-screened cable, low noise
Depolarisation current OCS 140	approx. 25 nA per mg Cl_2/l (25 °C, pH 7.2)
Depolarisation current OCS 141	approx. 80 nA per mg Cl_2/l (25 °C, pH 7.2)

Measuring system

Electrodes	passive-operated sensor with gold cathode and silver / silver chloride anode
Operating time of filling electrolyte	typically 12 months
Minimum flow velocity	15 cm/s
Minimum flow for assembly OCA 250	30 l/h
Maximum counterpressure	1 bar
Measuring range OCS 140	0.05...20 mg Cl_2/l (25 °C, pH 7.2)
Measuring range OCS 141	0.01...5 mg Cl_2/l (25 °C, pH 7.2)
Polarisation voltage OCS 140	–20 mV
Polarisation period OCS 140	first polarisation 30 min subsequent polarisation 10 min
Polarisation voltage OCS 141	–20 mV
Polarisation period OCS 141	first polarisation 90 min subsequent polarisation 45 min
Drift	< 1.5% per month
Step function response upward	90% < 2 min, 99% < 5 min
Step function response downward	90% < 0.5 min, 99% < 3 min
Temperature sensor (version -N)	NTC, 10 kΩ at 25 °C

Materials

Shaft	PVC
Membrane	PTFE
Membrane cap (replaceable)	PBT (GF 30), PVDF

Subject to modifications.

7.2 Accessories

Measuring cable OCK
Special measuring cable for extension of the connection between chlorine sensor and measuring instrument.
Order No. 51500490

Junction box VBC
Installation box for measuring cable extension up to max. 30 m total length.
Dimensions (W × H × D): 125 × 80 × 54 mm

OCY 14-WP
2 replacement cartridges, ready-made, for sensors OCS 140 / 141 / 240 / 241.
Order No. 51500461

OCY 14-F
50 ml filling electrolyte, ready-made, for sensors OCS 140 / 141.
Order No. 51500462

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7.3 Index