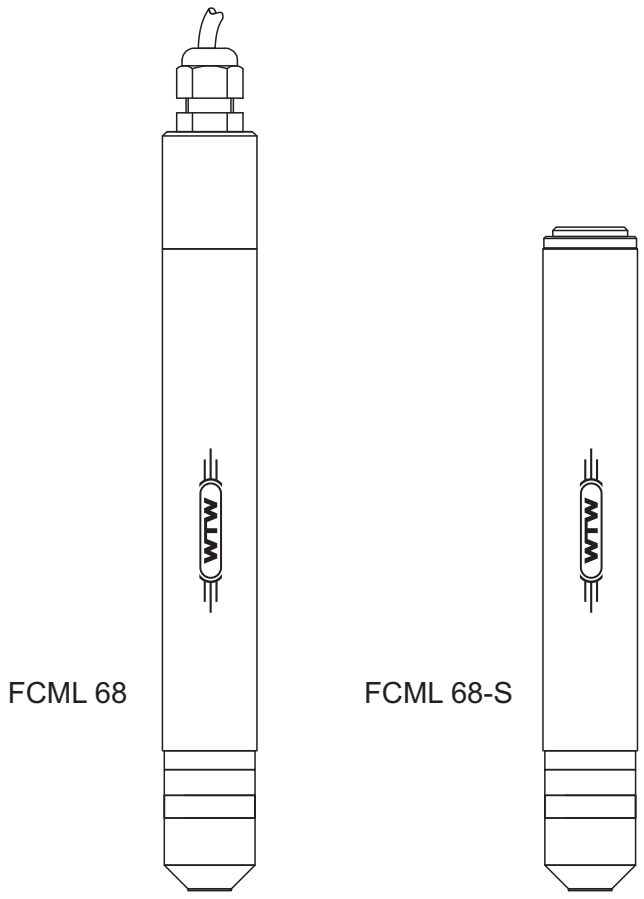
FCML 68
FCML 68-S



Sensor for free chlorine

Accuracy when going to press

The use of advanced technology and the high quality standard of our instruments are the result of continuous development. This may result in differences between this operating manual and your instrument. Also, we cannot guarantee that there are absolutely no errors in this manual. Therefore, we are sure you will understand that we cannot accept any legal claims resulting from the data, figures or descriptions.

Copyright

© Weilheim 2008, WTW GmbH
Reprinting - even as excerpts - is only allowed with the explicit written authorization of WTW GmbH, Weilheim.
Printed in Germany.

FCML 68(-S) - Contents

1 Overview 26

2 Safety 28
2.1 General information on safety 28
2.2 Authorized use 28
2.3 General safety instructions 29

3 Commissioning 30
3.1 Scope of delivery 30
3.2 Filling the membrane cap with electrolyte solution 30
3.3 Electrical connection 32
3.4 Installation in the flow through vessel D-CL 33

4 Measuring / Operation 35
4.1 Run-in period 35
4.2 Chlorine measurement with the FCML 68(-S) 35

5 Maintenance, cleaning, storage 38
5.1 Cleaning the measurement electrode / exchanging the membrane cap and electrolyte 38
5.2 Cleaning 39
5.3 Storage 40
5.4 Maintenance equipment and replacement parts 40

6 Technical data 41
6.1 Measurement characteristics 41
6.2 Application characteristics 41
6.3 General data 42
6.4 Electrical data 43

1 Overview

The FCML 68(-S) is a membrane-covered, amperometric sensor for the determination of free chlorine.

Structure

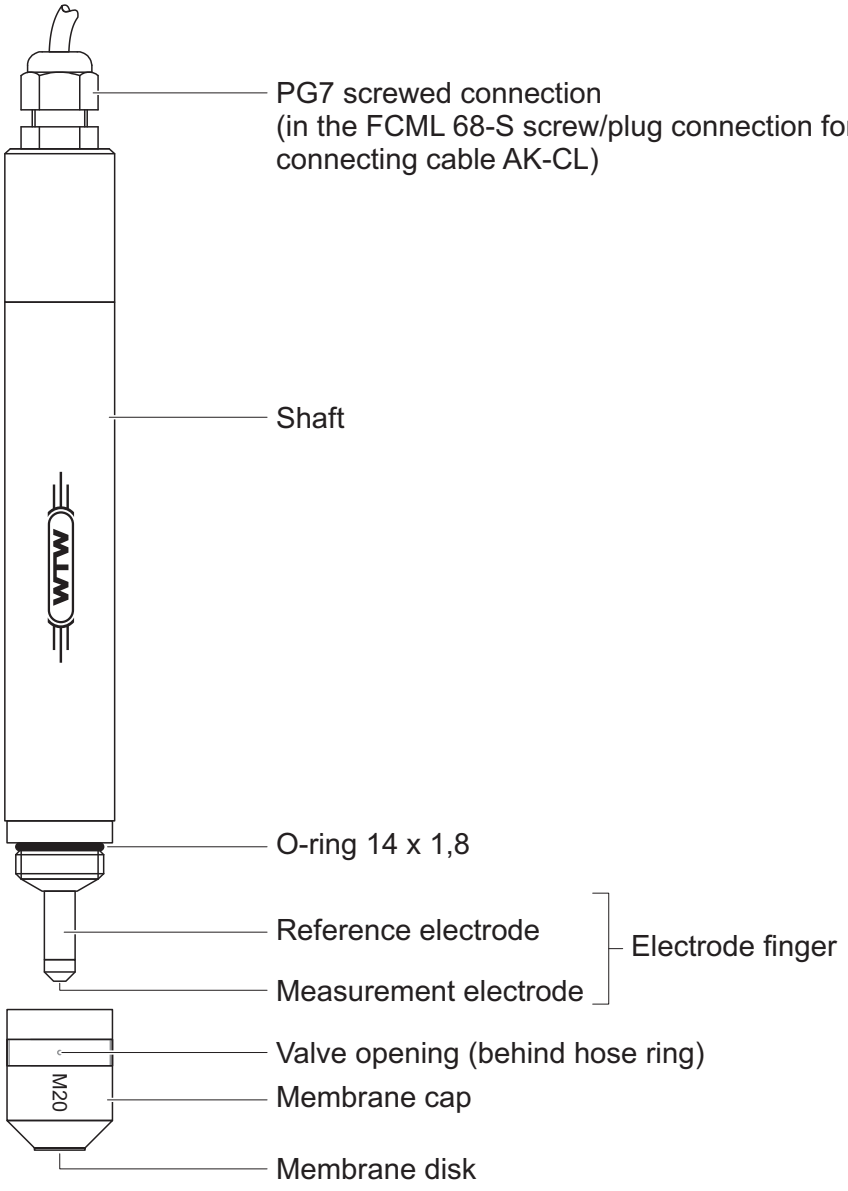


Fig. 1-1 Structure: Example showing FCML 68

The electrochemical measuring system is separated from the test sample by a special membrane. The free chlorine (hypochloric acid) present in water diffuses through the membrane and creates a current flow between the electrodes that is amplified in the sensor electronics.

The sensor has integrated measuring electronics and delivers a measuring signal that is already temperature compensated. A zero

point adjustment is not required. Routine calibration is done by comparison with the photometric DPD method according to DIN 38408.

Electrical connection of FCML 68

The FCML 68 sensor is connected with the monitor (e.g. MULTILINE 1000) via a two line connection. The wires are used for the power supply of the monitor and for the transmission of measurement signals (4 - 20 mA current signal).

Electrical connection of FCML 68-S

The FCML 68-S sensor has a four-pin socket for connecting with the monitor (e.g. CL 7010) via the AK-CL cable (not included in the scope of delivery). The power supply and the transmission of the measured signal (0 to -1500 mV voltage signal) are carried out separately over two lines.



Note
Apart from their different electrical connections, the FCML 68 and FCML 68-S sensors are identical. For simplification, the designation FCML 68(-S) used in this operating manual refers equally to both variants.

2 Safety

2.1 General information on safety

These safety instructions include all instructions that have to be followed for the safe operation of the FCML 68(-S) sensor. Before starting any work with the FCML 68(-S), carefully read the safety instructions and absolutely follow all mentioned protective measures.

Always keep these safety instructions together with the operating manual in the vicinity of the place of installation.

Special user qualifications

The commissioning and changing of the membrane cap of the sensor require the safe handling of chemicals. Thus, we assume that the personnel is familiar with the necessary precautions to take when dealing with chemicals as a result of their professional training and experience.

General safety instructions

Safety instructions in this operating manual are indicated by the warning symbol (triangle) in the left column. The signal word (e.g. "CAUTION") indicates the danger level:

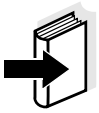


CAUTION
indicates instructions that must be followed precisely in order to avoid slight injuries or damage to the instrument or the environment.

Other labels



Note
indicates notes that draw your attention to special features.



Note
indicates cross-references to other documents, e.g. operating manuals.

2.2 Authorized use

Authorized use of the FCML 68(-S) is the stationary measurement of chlorine in drinking water, swimming pool water and process water.

Please observe the technical specifications according to chapter 6 TECHNICAL DATA. Only operation according to the instructions given in this operating manual is considered to be authorized.

Any other use is considered to be **unauthorized**. Unauthorized use invalidates any claims with regard to the guarantee.

2.3 General safety instructions

Function and operational safety

The sensor left the factory in a safe and secure technical condition.

The failure-free function and operational safety of the sensor is only guaranteed if the generally applicable safety measures and the special safety instructions in this operating manual are followed during its use.

The failure-free function and operational safety of the sensor is only guaranteed under the environmental conditions that are specified in chapter 6 TECHNICAL DATA.

The specified temperature (chapter 6 TECHNICAL DATA) must be maintained during the operation and transport of the sensor. Protect the sensor, particularly against frost or overheating.

Safe operation

If safe operation is no longer possible, the sensor must be taken out of operation and secured against inadvertent operation.

Safe operation is no longer possible if the sensor:

- has been damaged in transport
- has been stored under adverse conditions for a lengthy period of time
- is visibly damaged
- no longer operates as described in this manual.

If you are in any doubt, contact the supplier of your sensor.

Obligations of the operator

The operator of the sensor must ensure that the following rules and regulations are followed when dealing with hazardous substances:

- EEC directives for protective labor legislation
- National protective labor legislation
- Safety regulations
- Safety data sheets of the chemical manufacturer.

3 Commissioning

3.1 Scope of delivery

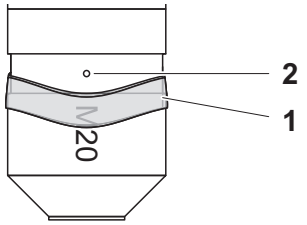
- Sensor FCML 68(-S) with membrane cap M20
- Dropping bottle with 100 ml electrolyte solution ELY-FCML 68
- Polishing strip
- Operating manual

3.2 Filling the membrane cap with electrolyte solution

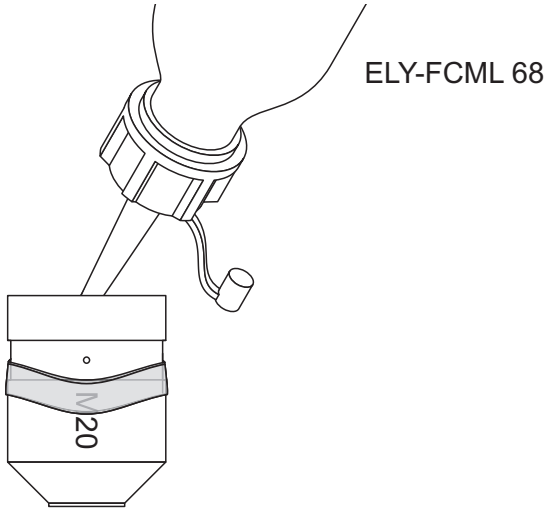
CAUTION
Risk of damage for the sensor in the case of improper handling.
- **Do not touch the electrode finger with your fingers.**
- **Do not apply pressure to the membrane disk.**

In the delivery condition, the membrane cap is not filled with electrolyte and loosely screwed on the shaft. In order to put the sensor into operation, fill the membrane head as follows:

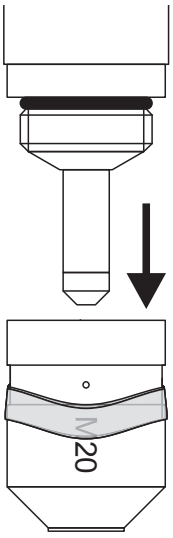
Filling the membrane cap



1	Using a blunt object, lift the hose ring (pos. 1) out of the guiding groove and push it to the side so that the valve opening (pos. 2) is uncovered.



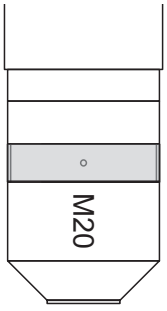
2	Cut off the tip of the dropping bottle until the opening in the tip is visible, then fill the membrane cap completely with electrolyte solution, bubble free. Remove any air bubbles by knocking.



3	Hold the sensor shaft in an upright position and place it on the filled membrane cap. Some of the electrolyte solution will leak over the upper edge of the membrane cap while this is being done. Then screw the electrode shaft into the membrane cap. For this, first turn the electrode shaft anti-clockwise until the thread catches; then slowly screw in the electrode shaft as far as it will go until no gap can be seen between the sensor shaft and membrane cap.

CAUTION

Overpressure in the membrane cap can destroy the membrane disk. Therefore, make sure the valve opening is not inadvertently closed by your fingers. Excess electrolyte solution must be able to escape freely at any time. Screw slowly so that no back pressure can develop.



4	Using a blunt object, slide the hose ring over the valve opening and insert it evenly in the groove.
5	Rinse off any electrolyte solution adhering on the outside.

3.3 Electrical connection

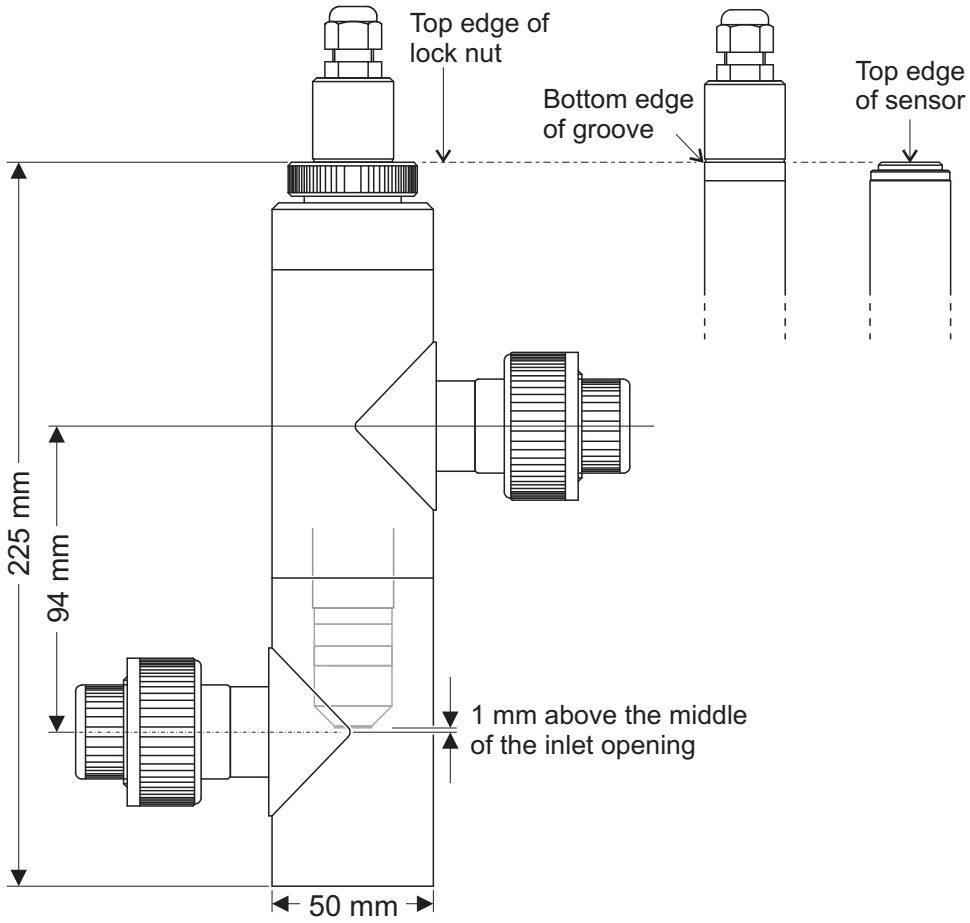
How to connect it to the monitor is described in the operating manual of the monitor.

3.4 Installation in the flow through vessel D-CL

Note
The position in the flow through vessel has a considerable effect on the approach flow and, hence, the measuring function of the sensor. Therefore carefully position the sensor as described below.

Proceed as follows to install the sensor:

1	Insert the black O-ring, then the PVC slide ring in the 1" installation opening of the flow through vessel.
2	Attach the coupling ring loosely.
3	Slide in and position the sensor. For the optimum measuring position align the following parts of the sensor flush with the top edge of the lock nut: ● FCML 68: The bottom edge of the groove on the connecting head. ● FCML 68-S: The top edge of the sensor. In this position the sensor membrane is located approx. 1 mm above the middle of the inlet opening.



4	Tighten the lock nut by hand. Make sure the sensor is attached firmly. Otherwise, it can be pressed out of the flow through vessel by pressure.



CAUTION

When commissioning, always open the feed slowly. A strong shock pressure can destroy the membrane.

4 Measuring / Operation

4.1 Run-in period

Polarization

Each time the sensor is refilled it must be polarized. To do this, immerse the connected and voltage-supplied sensor in a well-stirred chlorine solution with at least 5 mg/l chlorine for an hour. Then put the sensor into use (measuring position). The sensor can be calibrated after a stabilizing time of approx. 5 minutes. After approx. one day a post-calibration should be performed.



Note
The sensor filled with electrolyte must not be dry and has to be permanently supplied with supply voltage. Otherwise the characteristics of the membrane cap, electrode finger and electrolyte will be changed (partly irreparably). The sensor may only be stored while it is not filled (see also section 5.3 STORAGE).

4.2 Chlorine measurement with the FCML 68(-S)

Free chlorine in water is present in three different forms, depending on the pH value:

- as gaseous, dissolved chlorine Cl_2
- as hypochloric acid HOCl
- as hypochlorite OCl^-

Above pH = 5 gaseous dissolved chlorine is almost completely converted to hypochloric acid and hypochlorite. Both forms are balanced pH-dependent:

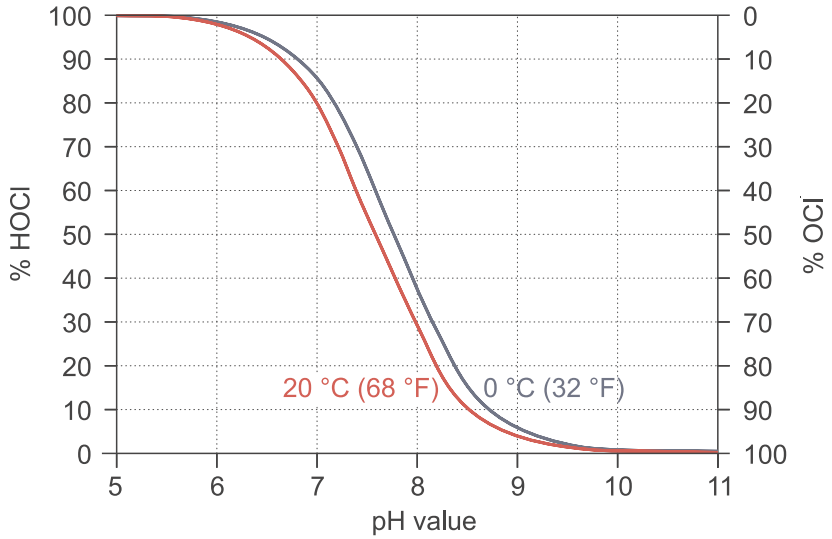


Fig. 4-1 Chemical balance of hypochloric acid and hypochlorite

The chlorine sensor FCML 68(-S) exclusively measures hypochloric acid (HOCl). Within the application range of the sensor, hypochloric acid reacts to hypochlorite with an increasing pH value. Hypochlorite is not measured by the sensor (see Fig. 4-1). Therefore, the pH value of the test sample has to be known and taken into account in order to accurately determine free chlorine.

Note
The chlorination with organic chlorine compounds, e.g. chlorinated cyanuric acid derivates will result in erroneous measurements with the FCML 68(-S), and can therefore not be used for desinfection.

pH compensation and calibration with the DPD method

The chlorine sensor has a linear characteristic curve. Calibration of the chlorine sensor is carried out as a single-point calibration. The calibration value (nominal value) is usually determined photometrically. A common procedure for this is the DPD method for free chlorine. The photometer and test sets for this are described in the WTW catalog or on the Internet.

Note
For measurements without automatic pH compensation the pH value must be determined and entered immediately prior to the calibration. Only then the pH compensation by readjusting the pH value during the following measurement operation will be accurate.

The calibration value is calculated as follows:

$$calibration\ value = free\ chlorine(\ photometer\ ) \bullet factor_{pH\ value}$$

The value for the $factor_{pH\ value}$ can be taken from the following table:

pH value	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8
$Factor_{pH\ value}$	0.97	0.95	0.93	0.89	0.86	0.82	0.77	0.70	0.65	0.60	0.55	0.48	0.43	0.37

Example:
The result of the photometric measurement is 0.8 mg/L free chlorine. The pH value of the test sample is 7.0.

This results in a calibration value of

0.8 mg/L • 0.82 = 0.656 mg/L



Note
How to carry out the calibration is described in detail in the operating manual of the monitor.

Measuring without pH compensation

The value measured by the chlorine sensor is pH dependent even after proper calibration. In the range pH 6.5 ... pH 7.8, the concentration of free chlorine can be calculated with the following equation. Thus you can compare the value to that of a photometric measurement according to the DPD method:

$$free\ chlorine = \frac{[HOCl]_{FCML\,68}}{factor_{pH\ value}}$$

Below pH 6.5, the value measured by the chlorine sensor approximates the concentration of free chlorine.

Operation with automatic pH compensation

With the MULTILINE 1000 monitor the pH value of the test sample can be taken into account for the calculation of the chlorine value. This means the measured value can be directly compared to that of the photometric DPD method.

A "virtual channel" is created at the MULTILINE 1000 monitor for automatic pH compensation. More detailed information is given in the operating manual of the MULTILINE 1000 monitor.

Interfering factors

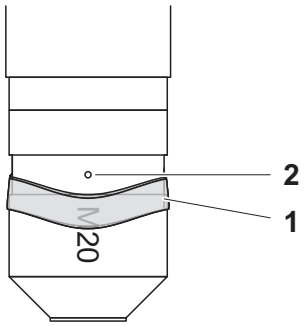
- Tensides
- Chlorine dioxide
- Ozone
- organic chlorine compounds (e.g. chlorinated isocyanuric acid derivates)

5 Maintenance, cleaning, storage

5.1 Cleaning the measurement electrode / exchanging the membrane cap and electrolyte

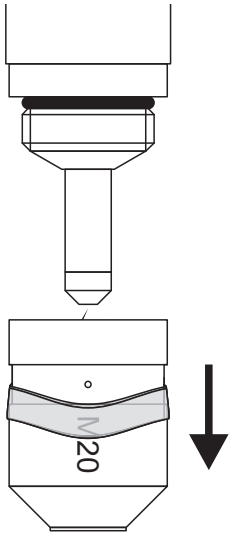
Note
We recommend to disconnect the sensor from the monitor before starting any maintenance work.

If calibration is not possible due to readings too low, the measurement electrode has to be cleaned with the enclosed polishing strip. To do so, proceed as follows:



1	Using a blunt object, lift the hose ring (pos. 1) out of the guiding groove and push it to the side so that the valve opening (pos. 2) is uncovered.

CAUTION
Negative pressure in the membrane cap can destroy the membrane disk. Therefore, make sure the valve opening is not inadvertently closed by your fingers while unscrewing the membrane cap.



2	Unscrew the membrane cap by hand and pour away the electrolyte solution.
3	Rinse the electrode finger and membrane cap with clean water and dab them dry with a clean paper towel.
4	Clean the measurement electrode with the polishing strip. To do so, place the polishing strip on a paper towel and hold it at a corner. Then hold the electrode finger vertically with the tip down and run the tip over the polishing strip two or three times.



CAUTION
The brown coating on the shell (reference electrode) of the electrode finger must not be polished off. This would destroy the sensor!

5	Fill the membrane cap with fresh electrolyte solution as described in section 3.2, screw it on the sensor shaft and make the sensor ready for measurement.



Note
After exchanging the electrolyte solution and/or membrane cap the sensor has to be repolarized (see section 4.1 RUN-IN PERIOD).



Note
If calibration is still not possible after cleaning the measurement electrode change the membrane cap.

5.2 Cleaning

Removing lime deposits on the membrane cap

Remove lime deposits on the membrane cap as follows:

1	Unscrew the membrane cap from the sensor shaft and pour away the electrolyte solution (see section 5.1).
2	Put the membrane cap into 10 % acetic acid for some hours.
3	Then thoroughly rinse the membrane cap with clean water.
4	Fill the membrane cap with fresh electrolyte solution as described in section 3.2, screw it on the sensor shaft and make the sensor ready for measurement.

5.3 Storage

Note
The sensor may only be stored in an unfilled condition.

Proceed as follows to store the sensor:

1	Unscrew the membrane cap from the sensor shaft and pour away the electrolyte solution (see section 5.1).
2	Put the membrane cap into 10 % acetic acid for some hours.
3	Thoroughly rinse the membrane cap and electrode finger with clean water and dry them dust free.
4	Loosely screw the dry membrane cap on the sensor shaft. The membrane disk must not touch the electrode finger.

Recommissioning

For recommissioning clean the electrode tip with the polishing strip and use a new membrane cap (see section 5.1). The membrane cap can be put into 10 % acetic acid for some hours to remove any lime deposits (see section 5.1).

5.4 Maintenance equipment and replacement parts

Description	Model	Order no.
Accessory kit for chlorine sensor FCML 68(-S), including: – 1x membrane cap M20 – 100 ml ELY-FCML 68 electrolyte solution – Polishing strip	ZBK-FCML 68	205 248

6 Technical data

6.1 Measurement characteristics

Measuring principle

membrane-covered amperometric sensor with integrated measuring electronics

Measuring range

FCML 68	0.01 ... 2.00 mg/L Cl_2
FCML 68-S	0.01 ... 10.00 mg/L Cl_2 (upper limit depends on the slope)

Response time

t_{90} (90 % of the final value display after) approx. 30 s

Temperature compensation

Internal, automatic, by means of integrated temperature sensor

Polarization time

approx. 1 hour on commissioning or after exchanging the electrolyte

Calibration procedure

Single-point calibration, e.g. with photometric measurement according to the DPD method as a reference

6.2 Application characteristics

Temperature range

0... 45 °C (32 ... 113 °F) with automatic temperature compensation

pH application range

pH 6 ... 8

Max. allowed overpressure

10^5 Pa (1 bar), pressure free operation in the D-Cl flow through vessel recommended

Working life of the membrane cap

typically 1 year (depending on measuring medium)

Approach flow

Recommended minimum flow rate in the D-CL flow through vessel: > 30 l/h

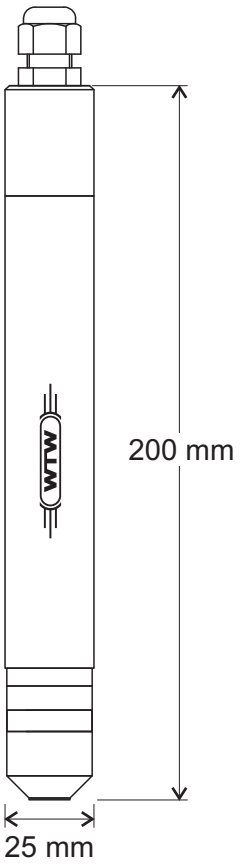
Typical application range

Drinking water, swimming pool water and mains water in the flow through vessel

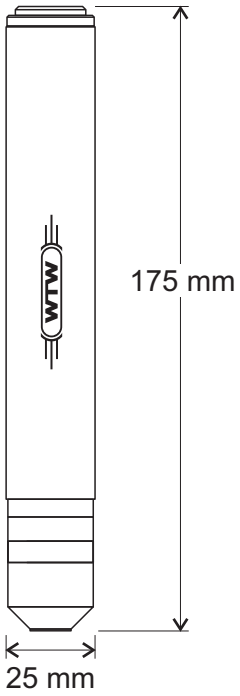
6.3 General data

Dimensions

FCML 68:



FCML 68-S:



Membrane cap M20

Membrane type Hydrophobic PTFE membrane

Electrolyte ELY-FCML 68 (from ZBK-FCML 68)

Material

Shaft	PVC
Membrane cap	PVC
Working electrode	Gold
Reference electrode	Ag/AgCl
Hose ring	Silicone
Cable gland	Polyamide

6.4 Electrical data

FCML 68

- 2-wire connection via permanently mounted cable
- 12 ... 30 V DC power supply by the monitor
- Output signal 4 ... 20 mA

FCML 68-S

- 4-wire connection via AK-CL cable by means of screwed connection/plug connection
- +/- 6 ... 12 V DC power supply by the monitor
- Output signal: approx. -100 mV per mg/l chlorine (0 ... -1500 mV)