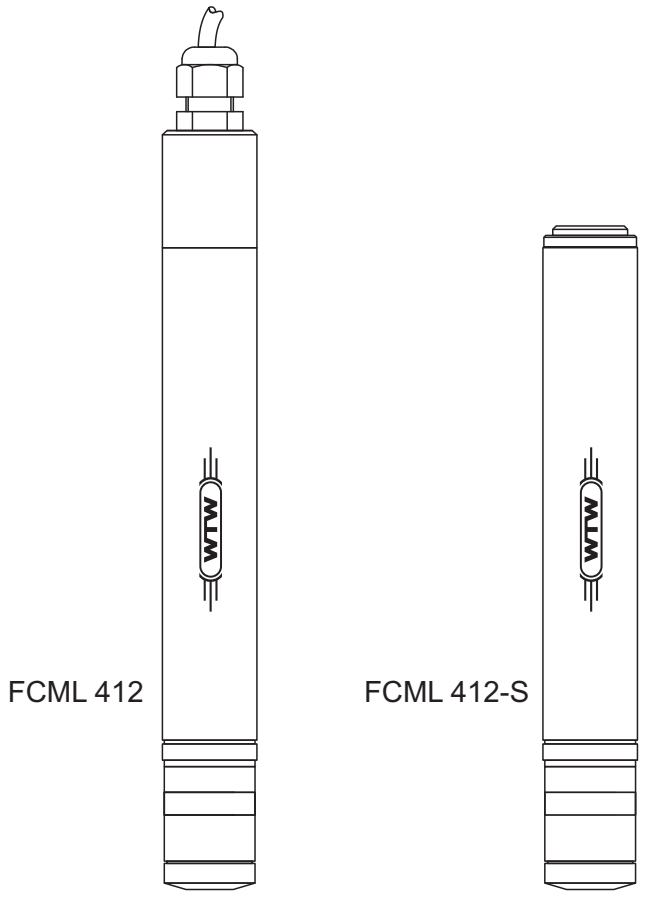
Operating instructions

FCML 412
FCML 412-S



ph-independent 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. Consequently, this may result in some 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.

FCML 412(-S) - Contents

1 Overview

The FCML 412(-S) is a membrane-covered, amperometric sensor for the determination of free chlorine.

Structure

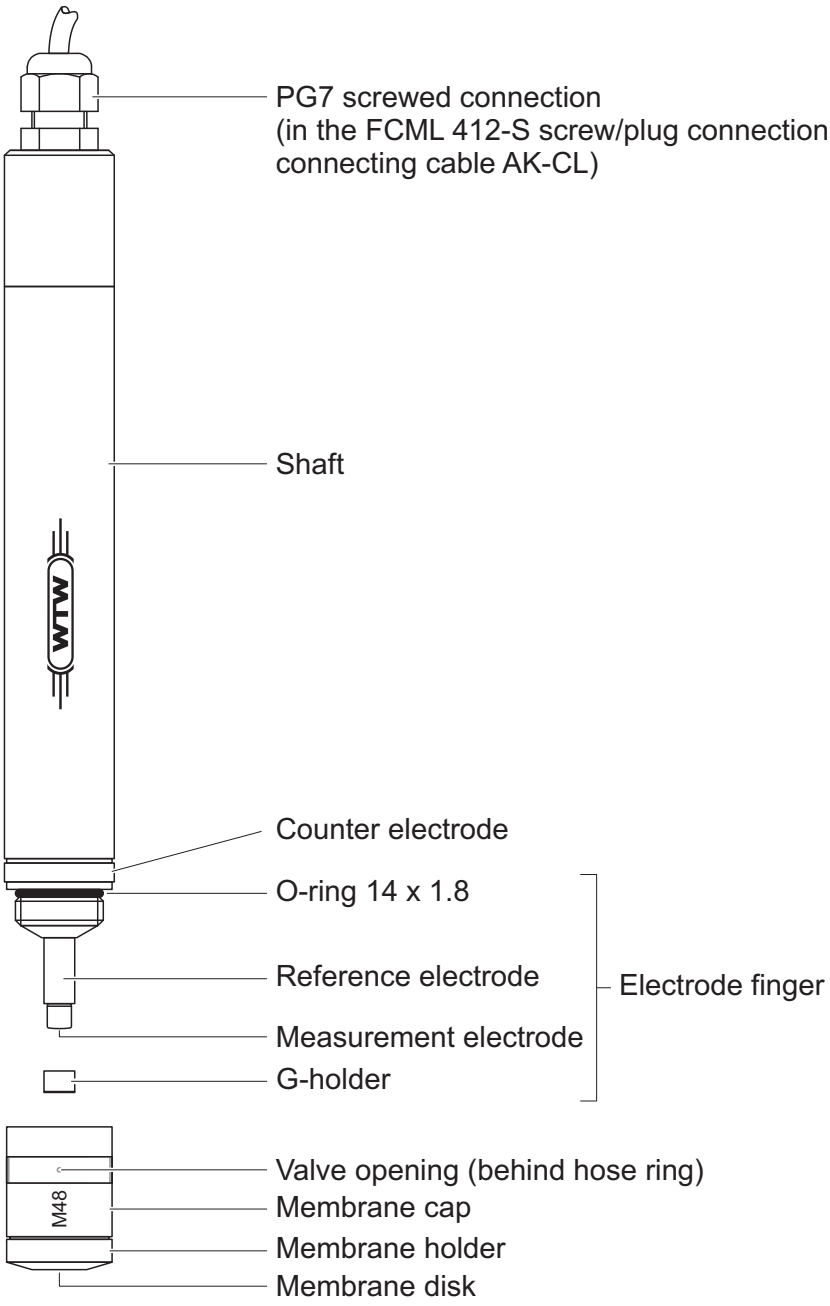


figure 1-1 Structure: Example showing FCML 412

With its special design (potentiostatic three-electrode system), the sensor measures all the free chlorine present (sum of gaseous dissolved chlorine, hypochloric acid and hypochlorite) and the chlorine

that is bonded to isocyanuric acid. The sensor is distinguished by a greatly reduced dependency on the pH value.

The sensor has integrated measuring electronics and delivers a measuring signal that is already temperature compensated. It does not require a zero point adjustment. The routine calibration is carried out through comparison with the photometric DPD method according to DIN 38408.

Electrical connection of FCML 412

The FCML 412 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 412-S

The FCML 412-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 412 and FCML 412-S sensors are identical. For simplification, the designation FCML 412(-S) used in this operating manual refers equally to both variants.

2 Safety instructions

2.1 General information on safety

These safety instructions include all instructions that have to be followed for the safe operation of the FCML 412(-S) sensor. Before starting any work with the FCML 412(-S), carefully read the safety instructions and strictly follow all protective measures that are mentioned.

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 level of danger:

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

The authorized use of the FCML 412(-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 fault-free functioning 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 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

- FCML 412(-S) sensor with membrane cap M48 and G-holder
- Dropping bottle with 100 ml ELY-FCML 412 electrolyte solution
- Polishing strip
- Operating manual

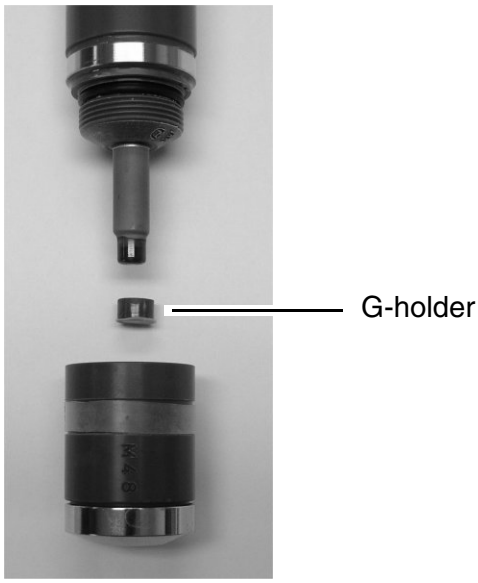
3.2 Filling the membrane cap with electrolyte solution

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.**
- **Do not unscrew the membrane holder.**

When it is delivered, the membrane cap is not filled with electrolyte and is loosely screwed onto the shaft. In order to put the sensor into operation, fill the membrane head as follows:

Filling the membrane cap

1	Unscrew the membrane cap from the shaft of the electrode. Place the membrane cap and the G-holder on a clean (non absorbent) surface.



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 making sure it is bubble free.

3	Fill the G-holder with ELY-FCML 412 electrolyte making sure it contains no bubbles.

4	Hold the shaft of the electrode vertical and carefully press the finger of the electrode into the filled G-holder.

5	Raise the hose ring of the membrane cap that closes the valve opening at the side so that the valve opening is uncovered (see figure below). 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 doing this. Then screw the electrode shaft into the membrane cap. To do 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 <u>slowly</u> so that no back pressure can develop.

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

3.3 Electrical connection

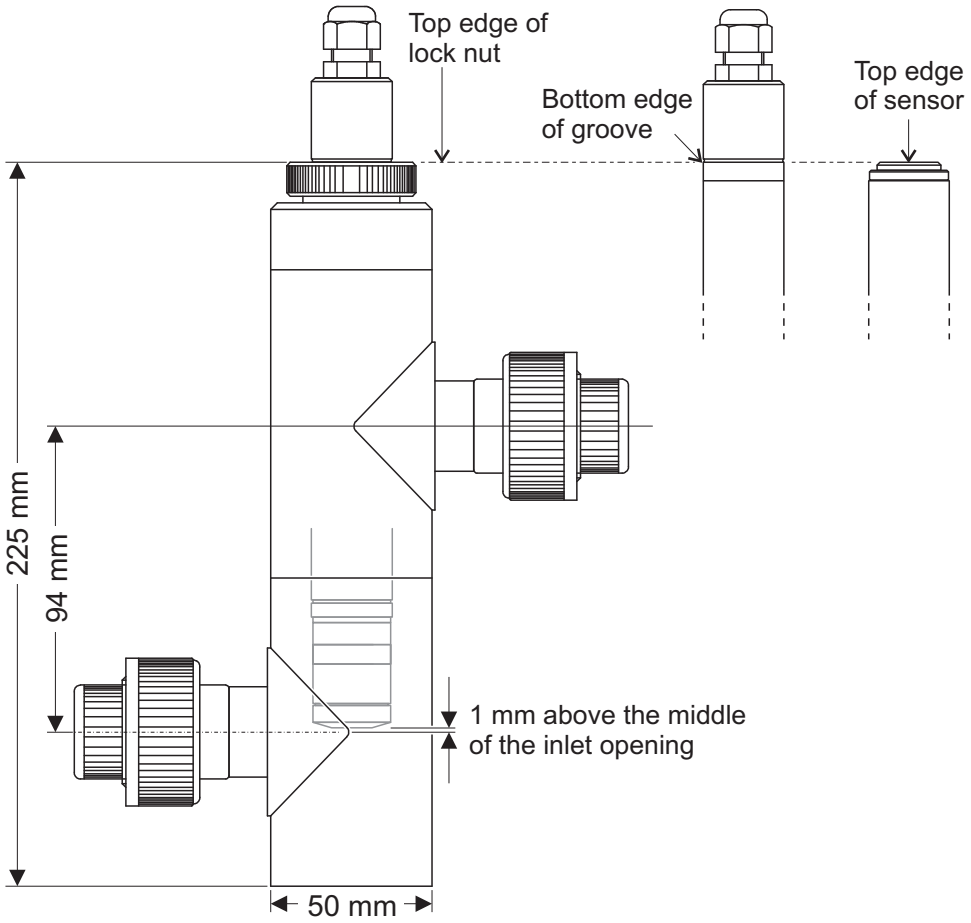
How to connect it to the monitor is described in the operating manual of the monitor.

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 412: The bottom edge of the groove on the connecting head. ● FCML 412-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 firmly attached. 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

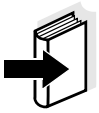
Each time the sensor is refilled it must be polarized. To do this, immerse the connected and voltage-supplied sensor in a well-stirred chlorine solution with at least 5 mg/l chlorine for an hour. Then put the sensor into use (measuring position). The sensor can be calibrated after a stabilizing time of approx. 20 minutes. After approx. one day a post-calibration should be performed.

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

4.2 Check of the sensor / analysis

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

4.3 Chlorine measurement with the FCML 412(-S)

The chlorine sensor FCML 412(-S) detects anorganic chlorine compounds dissolved in water. The measured values determined with the photometer according to the DPD-1 method (free chlorine) are directly comparable to the values determined by the sensor.

5 Maintenance, cleaning, storage

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

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

If calibration is not possible due to readings that are 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 out of the guiding groove and push it to the side so that the valve opening 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 from the sensor shaft, pull the G-holder off the electrode finger or remove from the membrane cap and pour away the electrolyte solution.
3	Rinse the electrode finger, the G-holder and the 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 by 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, pull the G-holder off the electrode finger or remove from the membrane cap and pour away the electrolyte solution (see section 5.1).
2	Put the membrane cap into 10 % acetic acid for several 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, pull the G-holder off the electrode finger or remove from the membrane cap and pour away the electrolyte solution (see section 5.1).
2	Thoroughly rinse the membrane cap, electrode finger and G-holder with clean water and dry them with a dust free cloth or paper.
3	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 several hours to remove any lime deposits (see section 5.2).

5.4 Maintenance equipment and replacement parts

Description	Model	Order no.
Accessory kit for chlorine sensor FCML 412(-S), including: – 1x membrane cap M48 – 1x G-holder – 100 ml ELY-FCML 412 electrolyte solution – Polishing strip	ZBK-FCML 412	205 247

6 Technical data

6.1 Measuring characteristics

Measuring principle

Membrane-covered, amperometric sensor with potentiostatic three-electrode system and integrated measuring electronics

Measuring range

FCML 412	0.01 ... 2.00 mg/L Cl_2
FCML 412-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. 120 s

pH dependency

Approx. 10 % slope loss per increasing pH unit

Temperature compensation

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 4... 9

Max. allowed overpressure

$5 \cdot 10^4$ Pa (0.5 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

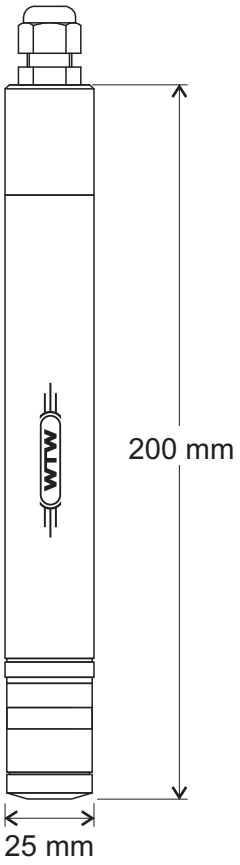
Typical application range

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

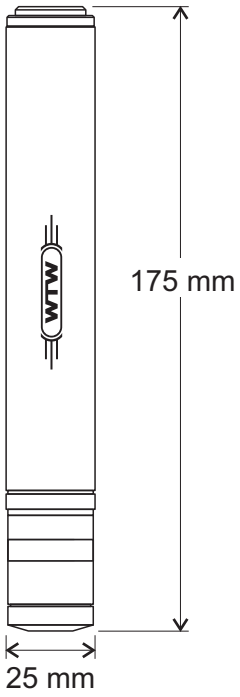
6.3 General data

Dimensions

FCML 412:



FCML 412-S:



Membrane cap M48

Membrane type Microporous, hydrophilic membrane

Electrolyte ELY-FCML 412 (from ZBK-FCML 412)

Material

Shaft	PVC
Membrane cap	PVC
Membrane holder, auxiliary electrode	Stainless steel
Working electrode	Gold
Reference electrode	Ag/AgCl
Hose ring	Silicone
Cable gland	Polyamide

6.4 Electrical data

FCML 412

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

FCML 412-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)