Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

CCS140 and CCS141

Sensors for free chlorine
Amperometric, membrane-covered sensors for installation in the CCA250 assembly

Application

Oxidising agents such as chlorine or anorganic chlorine compounds are used for disinfection of water. Their dosing must be carefully controlled to suit the application. Too low a concentration makes the degree of disinfection questionable. Too high a concentration can result in corrosion effects, impairment of taste or skin irritation.
The CCS140 and CCS141 chlorine sensors are applied for measurement of free active chlorine in the following fields:

- Drinking water treatment
- Pool water treatment
- Industrial water treatment

Your benefits

- Measurement in the CCA250 flow assembly is almost independent of flow rate in the range above 30 l/h
- No zero point calibration necessary. This means complicated installation of an active carbon filter, as in open chlorine sensors, is not necessary.
- Measured values are not affected by conductivity fluctuation of the medium.
- The CCS140 sensor is ready for measurement after a polarisation time of approx. 30 ... 60 minutes. The CCS141 sensor requires 45 ... 90 min.
- Easy membrane replacement thanks to ready-made membrane head
- Recalibration intervals approx. 1 ... 4 months under constant operating conditions

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Function and system design

Function

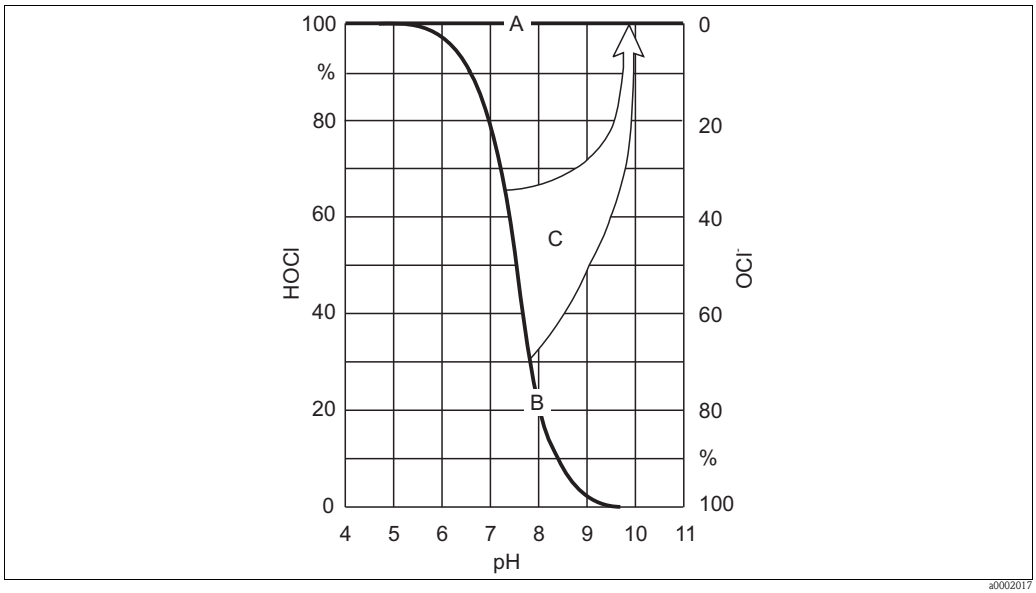
The CCS140 and CCS141 sensors are used for measurement of free chlorine. The membrane-covered CCS140 and CCS141 sensors consist of a cathode serving as the working electrode and an anode acting as the counter electrode. These electrodes are immersed in an electrolyte. Electrodes and electrolyte are separated from the medium by a membrane. The membrane prevents the loss of electrolyte and the penetration of contaminants, but free chlorine will pass.
To calibrate the measuring system, determine the content of free chlorine using the DPD method. You need a photometer with the pertaining reagents. The determined value is the calibration value for the transmitter.

Measuring principle

The concentration of free chlorine is determined according to the amperometric measuring principle. The hypochlorous acid (HOCl) contained in the medium diffuses through the sensor membrane and is reduced to chloride ions (Cl^-) on the gold cathode. On the silver anode, silver is oxidized to silver chloride. The electron release of the gold cathode and electron acceptance on the silver anode result in a current flow which is proportional to the free chlorine concentration in the medium under constant conditions. The concentration of hypochlorous acid in the medium depends on the pH value. This dependence can be compensated by measuring the pH value in the flow assembly.
The transmitter transforms the current signal into the measuring unit concentration in mg/l.

Measuring of free chlorine

Molecular chlorine (Cl_2) has pH values of < 4. Hypochlorous acid (HOCl) and hypochlorite (OCl^-) remain within the range of pH 4 to 11 as components of free chlorine. As hypochlorous acid dissociates with an increasing pH value to form hypochlorite ions (OCl^-) and hydrogen ions (H^+), the amounts of the individual components in free chlorine change with the pH value (Fig.). For example, if the amount of hypochlorous acid is 97% at pH 6, it drops to about 3% at pH 9.
Hypochlorous acid has a highly disinfecting effect in an aqueous solution but the disinfecting effect of hypochlorite is extremely low. Therefore, chlorine is not suitable as a disinfecting agent at high pH values.



Schematic diagram of pH compensation

A *Measured value* **with** *pH compensation*
B *Measured value* **without** *pH compensation*
C *pH compensation*

The CCS140 or CCS141 chlorine sensors selectively measure the amount of hypochlorous acid in amperometric measurement. They do not measure the amount of hypochlorite ions because these ions do not permeate through the sensor membrane.

pH compensation of chlorine sensor signal for free chlorine
(for transmitter Liquisys CCM223 or CCS253 only on ES and EP versions)
To calibrate and inspect the chlorine measuring system, a colorimetric reference measurement must be carried out using the DPD method. Free chlorine in the form of hypochlorous acid reacts with diethyl-p-phenylenediamine and forms a red dye. The intensity of the red pigmentation increases proportionally to the chlorine content. In the DPD method the measuring water is constantly buffered to a pH value of about 6.3. Free chlorine is available as nearly 100 % hypochlorous acid HOCl. Therefore, the pH value of the measuring water is not included in the DPD measurement. Due to the buffer function in the DPD method, all components of free chlorine are detected and thus the total free chlorine is measured.
If you select pH compensation in the transmitter, the sum of hypochlorous acid and hypochlorite corresponding to the DPD measurement is calculated from the hypochlorous acid measured by the sensor and the pH value in the region of pH 4 to 9. For this calculation, the curve shown in Fig. is stored in the transmitter.

When free chlorine is measured with the pH compensation function on, always perform calibration in the pH-compensated operating mode.

When you use pH compensation, the measured chlorine value displayed and applied to the instrument output corresponds to the DPD measured value even if the pH values fluctuate. If you do not use pH compensation, the measured chlorine value only corresponds to the DPD measurement if the pH value remains unchanged compared with the calibration. Without pH compensation the chlorine measuring system must be recalibrated when the pH value changes.

Accuracy of pH compensation
The accuracy of the pH compensated measured chlorine value depends on the sum of several single measured deviations (chlorine, pH, Temperature, DPD measurement etc.).
High amounts of hypochlorous acid (HOCl) during chlorine calibration have positive effects on the accuracy whereas low amounts of hypochlorous acid have negative effects.
Inaccuracy of the pH compensated chlorine value increases the bigger the pH difference between operation and calibration gets or the more inaccurate the single measured values are.

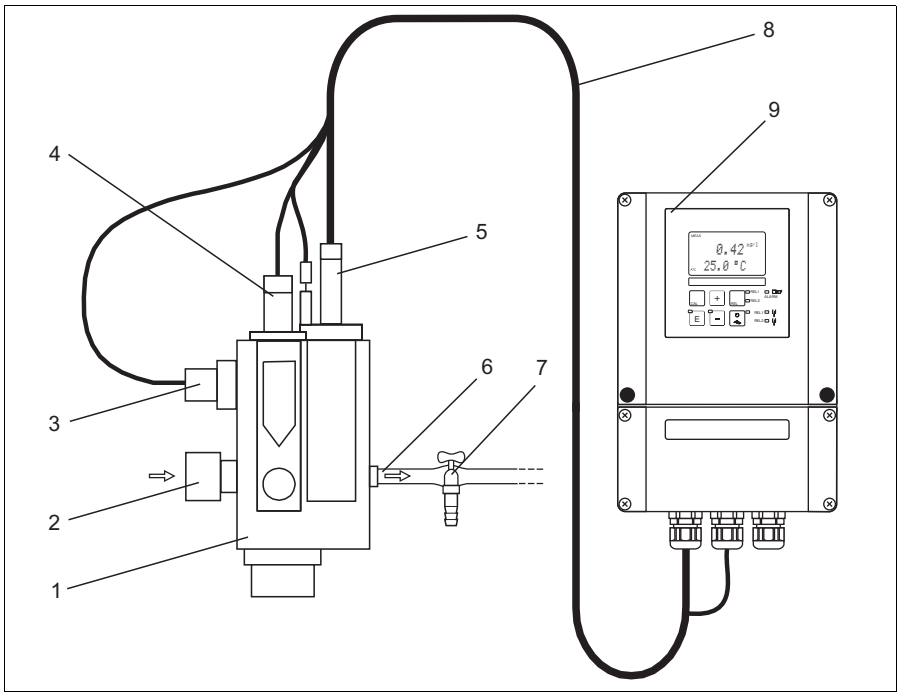
Calibration of free chlorine measurement taking into account the pH value
The reference measurement (DPD method, photometer) determines the complete free chlorine by buffering to pH 6.2. In contrast to this, amperometric measurement only determines the HOCl components.
The pH compensation causes the HOCl value to be increased to the actual value of free chlorine. During operation, pH compensation is active up to a pH value of 9. Since there is hardly any HOCl left at this pH value and the measured current is very low. Calibration of the complete measuring system makes sense only up to a pH value of the medium of 8 or 8.2.

Sensor	pH value	HOCl content	uncompensated value	compensated value
CCS141	8.2	15 %	12 nA	80 nA
CCS140	8	20 %	4 nA	20 nA

Above these pH values the total measured error of the measuring system is inacceptable.

Measuring system

A complete measuring system comprises at least:
- Chlorine sensor
- Liquisys M CCM223/253 transmitter
- Special measuring cable
- Flow assembly
- Reference measuring instrument for determination of free chlorine according to the DPD method



Measuring system in the flow mode (example)

1 CCA250 flow assembly
2 Medium inlet
3 Inductive proximity switch for flow
4 monitoring
5 Mounting places for pH/ORP sensors
Chlorine sensor
6 Medium outlet
7 Sampling tap
8 Sensor cable
9 Transmitter

Input

Measured variable

Free chlorine: hypochlorous acid (HOCl)

Measuring range

CCS140 (for industrial water, pool water): 0.05 to 20 mg Cl_2/l (25 °C (77 °F), pH 7.2)
CCS141 (for drinking water applications): 0.01 to 5 mg Cl_2/l (25 °C (77 °F), pH 7.2)

Signal current

CCS140: approx. 25 nA per mg Cl_2/l (25° C (77 °F), pH 7.2)
CCS141: approx. 80 nA per mg Cl_2/l (25 °C (77 °F), pH 7.2)

Performance characteristics

Response time

T_{90} < 2 min
in applications involving mainly active chlorination

Polarisation time

CCS140:
- First polarization: 60 min
- Repolarization: 30 min

CCS141:
- First polarization: 90 min
- Repolarization: 45 min

Drift

typically < 1.5 % per month

Electrolyte service life

typically 12 months

Installation

Installation instructions

The flow assembly CCA250 is designed for on-site installation of the sensor. In addition to the chlorine or chlorine dioxide sensor, a pH and an ORP sensor can be installed. A needle valve regulates the flow within the range of 30 to 120 l/h (7.9 to 31.7 US.gal/h).

When installing the sensor, note the following:
- The flow must be at least 30 l/h (7.9 US.gal/h).
  If the flow drops below this value or stops completely, this can be detected by an inductive proximity switch and an alarm signal plus locking of the dosage pumps can be triggered.
- If the medium is fed back into a surge tank, pipeline or the like, ensure that the thus generated back pressure on the sensor does not exceed 1 bar (14.5 psi) and remains constant.
- Negative pressure at the sensor, e.g. by feedback of medium to the suction side of a pump, must be avoided.

For further installation instructions, see the Operating Instructions of the flow assembly.

Environment

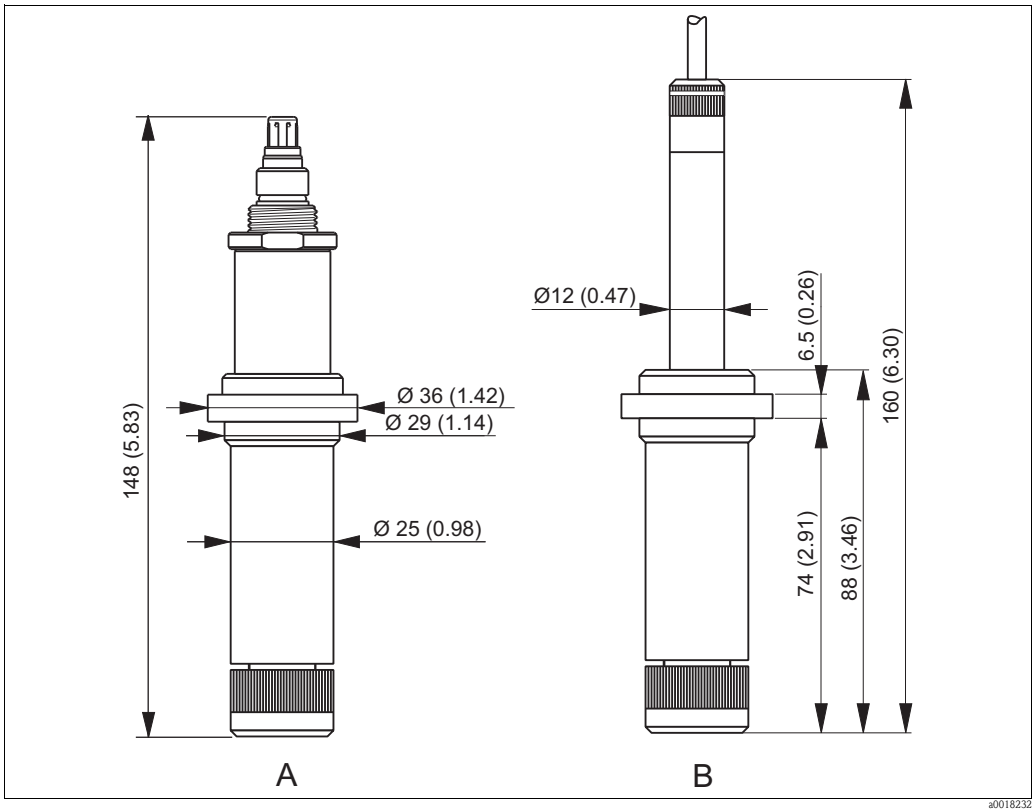
Storage temperature	Filled with electrolyte: 5 to 50 °C (41 to 122 °F) Without electrolyte: –20 to 60 °C (–4 to 140 °F)
Ingress protection	IP 68 (membrane side up to the mounting collar Ø 36 mm (Ø 1.42"))

Process

Temperature range	CCS140: 10 to 45 °C (50 to 113 °F) CCS141: 2 to 45 °C (36 to 113 °F)
pH range	Calibration CCS140: 4 to 8 pH CCS141: 4 to 8.2 pH Measurement: 4 to 9 pH **Note!** Chlorine measurement in the range of pH 8.2 to pH 9 with limited accuracy.
Pressure	Medium in the CCA250 assembly: max. 1 bar (14.5 psi)
Flow	in the CCA250 assembly: min. 30 l/h (8 US.gal./h)
Flow velocity	min. 15 cm/s (0.5 ft/s)

Mechanical construction

Dimensions



Dimensions

A Version with TOP68 plug head
B Version with fixed cable

Weight	approx. 0.5 kg (1.1 lb.)
Material	Sensor shaft: PVC Membrane: PTFE Membrane cap: PBT (GF 30), PVDF Cathode: Gold Anode: Silver / silver chloride
Cable connection	Version with fixed cable (3 m (9.84 ft)), four cores, double-screened, low noise Version with TOP68: To be used with CPK9-N*A1B (* = length of cable)
Cable length	max. 30 m (98 ft) (cable extension included)
Temperature sensor	NTC, 10 kΩ at 25 °C (77 °F)

Ordering information

Order code

You can create a valid and complete order code using the Endress+Hauser Configurator tool on the Internet.

Enter the following address into your browser to access the relevant product page:
www.products.endress.com/ccs140 or
www.products.endress.com/ccs141

1. You can choose from the following options on the product page located on the right:

Product page function
:: Add to product list
:: Price & order information
:: Compare this product
:: Configure this product

2. Click "Configure this product".
3. The configurator opens in a separate window. You can now configure your device and receive the complete order code that applies for the device.
4. Afterwards, export the order code as a PDF or Excel file. To do so, click the appropriate button at the top of the page.

Product structure CCS140

The following product structure represents the status of printing. You can create a complete and valid order code on the Internet using the configurator tool.

	Version	
	A	without temperature sensor, 3 m cable
	N	with NTC temperature sensor, 3 m cable
	P	plug TOP68, with NTC temperature sensor
CCS140-		complete order code

Product structure CCS141

The following product structure represents the status of printing. You can create a complete and valid order code on the Internet using the configurator tool.

	Version	
	N	with NTC temperature sensor, 3 m cable
	P	plug TOP68, with NTC temperature sensor
CCS141-		complete order code

Scope of delivery

The scope of delivery comprises:
- 1 chlorine sensor
- 1 bottle filled with electrolyte (50 ml)
- 1 cap for protection and storage
- 1 replacement cartridge with pretensioned membrane
- Operating Instructions, English

Accessories

Installation accessories

Flowfit CCA250
- Flow assembly for chlorine, chlorine dioxide, pH and ORP sensors
- Ordering acc. to product structure (–> online Configurator, www.products.endress.com/cca250)
- Technical Information TI062C/07/EN

Compact measuring station CCE10/CCE11
- Panel mounted ready for connection for holding one transmitter, with flow assembly CCA250
- Ordering acc. to product structure, s. Technical Information TI440C/07/EN

Connection accessories

Junction box VBC
- Metallic junction box for cable extension,
- Dimensions (W x D x H): 125 x 80 x 54 mm / 4.92 x 3.15 x 2.13 inches
- Order no. 50005181

CYK71 measuring cable
- Non-terminated cable for the connection of sensors (e.g. conductivity sensors) or the extension of sensor cables
- Sold by the meter, order numbers:
  - non-Ex version, black: 50085333
  - Ex version, blue: 51506616

CPK9 special measuring cable
- For sensors with TOP68 plug-in head, for high-temperature and high-pressure applications, IP 68
- Ordering acc. to product structure, see Technical Information (TI118C/07/en)

Transmitter

Liquisys M CCM223/253
- Transmitter for chlorine, field or panel-mounted housing, Hart® or PROFIBUS available
- Ordering acc. to product structure (–> online Configurator, www.products. endress.com/ccm223 or www.products. endress.com/ccm253)
- Technical Information TI214C/07/EN

Maintenance /calibration

CCM182
- Microprocessor-controlled photometer for determining chlorine and pH value
- Measuring range for chlorine: 0.05 - 6 mg/l
- Measuring range for pH value: 6.5 - 8.4
- Order no.: CCM182-0

Service kit CCS14x
- For chlorine sensors CCS140/CCS141/CCS142D
- 2 replacement cartridges, filling electrolyte 50 ml, polishing sheets
- Order no. 71076921

Polishing sheets COY31-PF
- 10 pieces for cleaning of the gold cathode
- For oxygen and chlorine sensors
- Order no. 51506973

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