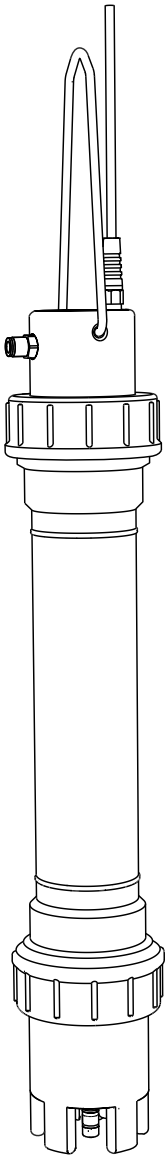
Operating Instructions
ISEmax CAS40D

Ion-selective sensor for continuous measurement of ammonium, nitrate and other ions



Endress+Hauser
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1 Document information

1.1 Warnings

Structure of information	Meaning
DANGER **Causes (/consequences)** Consequences of non-compliance (if applicable) ▶ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation **will** result in a fatal or serious injury.
WARNING **Causes (/consequences)** Consequences of non-compliance (if applicable) ▶ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation **can** result in a fatal or serious injury.
CAUTION **Causes (/consequences)** Consequences of non-compliance (if applicable) ▶ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or more serious injuries.
NOTICE **Cause/situation** Consequences of non-compliance (if applicable) ▶ Action/note	This symbol alerts you to situations which may result in damage to property.

1.2 Symbols

Additional information, tips

Permitted or recommended

Forbidden or not recommended

2 Basic safety instructions

2.1 Requirements for the personnel

- Installation, commissioning, operation and maintenance of the measuring system may be carried out only by specially trained technical personnel.
- The technical personnel must be authorized by the plant operator to carry out the specified activities.
- The electrical connection may be performed only by an electrical technician.
- The technical personnel must have read and understood these Operating Instructions and must follow the instructions contained therein.
- Measuring point faults may be repaired only by authorized and specially trained personnel.

Repairs not described in the Operating Instructions provided may only be carried out directly by the manufacturer or by the service organization.

2.2 Designated use

The ion-selective sensor is designed for measuring tasks in the activated sludge basin and in the inlet to the activated sludge basin of municipal sewage treatment plants.

The following parameters can be monitored and regulated depending on the device version:
- Nitrate
- Ammonium
- Potassium (also to compensate ammonium)
- Chloride (also to compensate nitrate)
- pH value
- ORP

Use of the device for any purpose other than that described, poses a threat to the safety of people and of the entire measuring system and is therefore not permitted.

The manufacturer is not liable for damage caused by improper or non-designated use.

2.3 Workplace safety

As the user, you are responsible for complying with the following safety conditions:
- Installation guidelines
- Local standards and regulations

Electromagnetic compatibility
- The product has been tested for electromagnetic compatibility in accordance with the applicable European standards for industrial applications.
- The electromagnetic compatibility indicated applies only to a product that has been connected in accordance with these Operating Instructions.

2.4 Operational safety

1. Before commissioning the entire measuring point, verify that all connections are correct. Ensure that electrical cables and hose connections are undamaged.
2. Do not operate damaged products, and safeguard them to ensure that they are not operated inadvertently. Label the damaged product as defective.
3. If faults cannot be rectified:
   Take the products out of operation and safeguard them to ensure that they are not operated inadvertently.

⚠ CAUTION

Cleaning not switched off during calibration or maintenance activities

Risk of injury due to medium or cleaning agent

- If a cleaning system is connected, switch if off before removing a sensor from the medium.
- If you wish to check the cleaning function and have therefore not switched off the cleaning system, please wear protective clothing, goggles and gloves or take other appropriate measures.

2.5 Product safety

The device is designed to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. The relevant regulations and European standards have been observed.

3 Incoming acceptance and product identification

3.1 Incoming acceptance

1. Verify that the packaging is undamaged.
   ↳ Notify your supplier of any damage to the packaging.
   Keep the damaged packaging until the matter has been settled.
2. Verify that the contents are undamaged.
   ↳ Notify your supplier of any damage to the delivery contents.
   Keep the damaged packaging until the matter has been settled.
3. Check the delivery for completeness.
   ↳ Check it against the delivery papers and your order.
4. Pack the product for storage and transportation in such a way that it is protected against impact and moisture.
   ↳ The original packaging offers the best protection.
   The permitted ambient conditions must be observed (see "Technical data").

If you have any questions, please contact your supplier or your local sales center.

3.2 Product identification

3.2.1 Nameplate

The nameplate provides you with the following information on your device:
- Manufacturer identification
- Order code
- Extended order code
- Serial number
- Environment
- Input and output values
- Safety information and warnings

Compare the data on the nameplate with your order.

3.2.2 Product identification

Product page

www.endress.com/cas40d

Interpreting the order code

The order code and serial number of your device can be found in the following locations:
- on the nameplate
- in the delivery papers

Obtaining information on the device

1. Go to the product page for your device on the internet.
2. In the navigation area on the right-hand side, select "Check your device features" under "Device support".
   ↳ An additional window opens.

3. Enter the order code from the nameplate into the search field.
   ↳ You will receive information on each feature (selected option) of the order code.

3.3 Scope of delivery

The scope of delivery comprises:
- 1 sensor, version as ordered
- 1 socket wrench
- 1 tube silicone grease
- 1 Operating Instructions

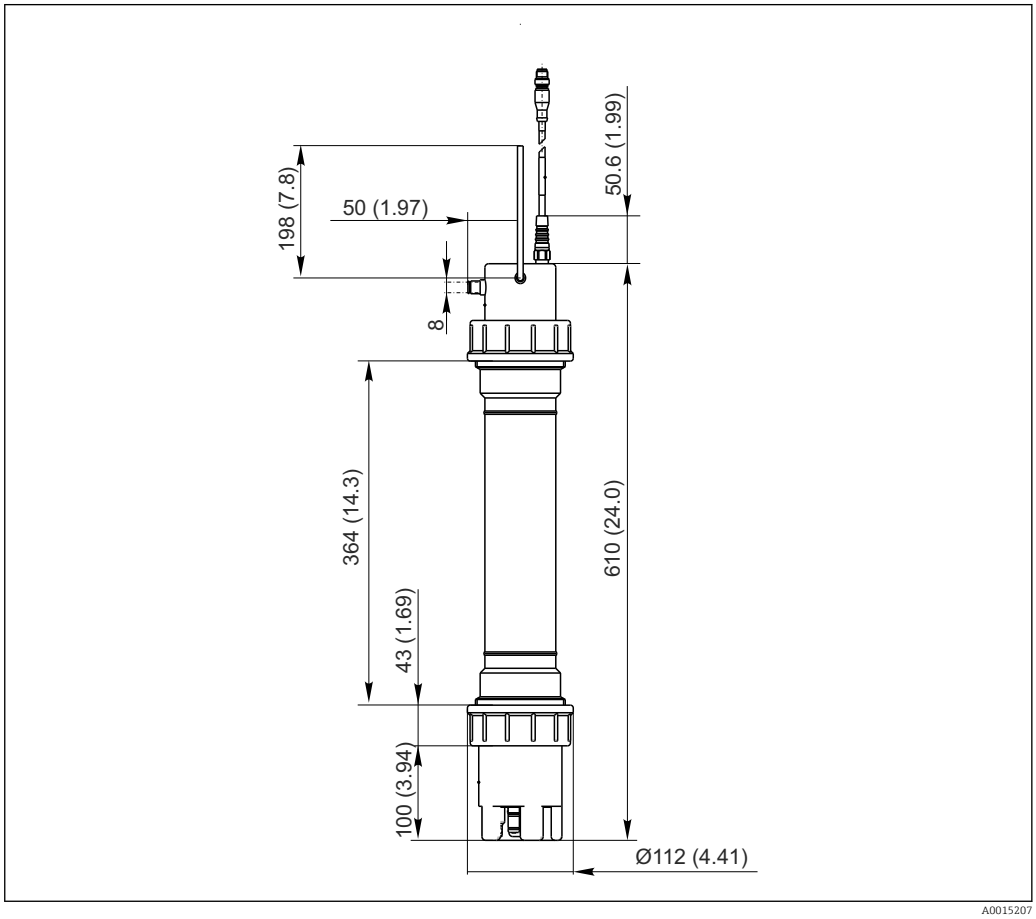
3.4 Certificates and approvals

The product meets the requirements of the harmonized European standards. As such, it complies with the legal specifications of the EC directives. The manufacturer confirms successful testing of the product by affixing to it the CE mark.

4 Installation

4.1 Installation conditions

4.1.1 Dimensions



1 *Dimensions in mm (inch)*

4.1.2 Mounting location

Choose a mounting location that can be easily accessed at a later stage.

▶ Ensure that upright posts and fittings are fully secured and vibration-free.

4.2 Mounting the sensor

4.2.1 Electrode installation

NOTICE

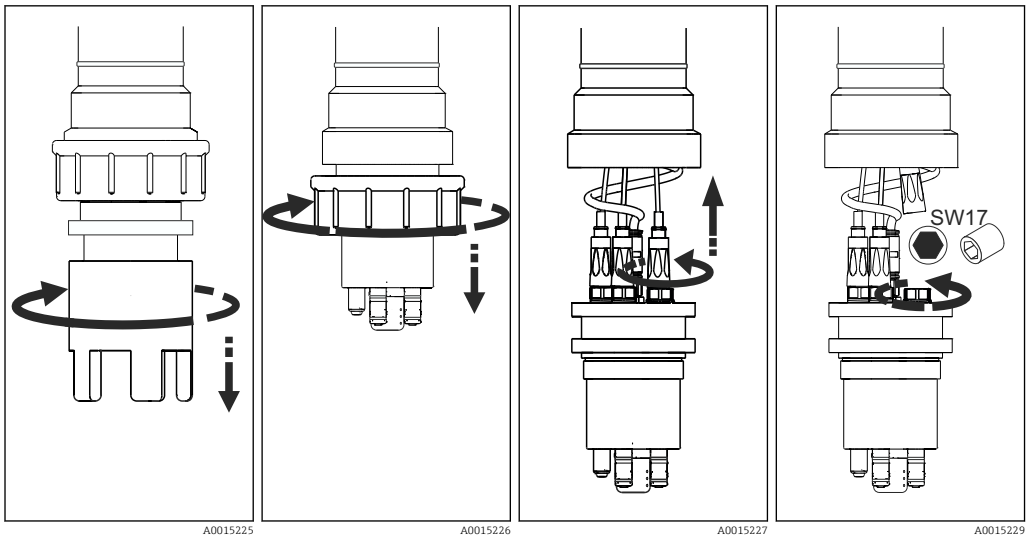
Electrode protection caps not used or incorrectly used

Drying out of pH electrode or damage to ion-selective membrane

- Remove the protection cap from the pH electrode before immersing the sensor in the medium.
- Retain the protection cap.
- If you remove the sensor from the medium for longer than 20 minutes, replace the protection cap filled with 1-3 M KCl solution on the pH electrode. This prevents the electrode from drying out.
- pH electrodes which have dried out due to incorrect storage can be made ready for measurement again by leaving them in 3 M KCl solution for up to 12 hours.
- The ion-selective electrodes do not have a protection cap. Never put such a cap on the electrodes.

All electrodes are installed and wired in the factory in accordance with the version ordered.

Installing an additional electrode (optional)



2 Release protection guard *3 Remove coupling nut* *4 Release cable.* *5 Remove electrode.*

1. Release and remove the protection guard (→ 2, 10).
2. Unscrew the coupling nut (→ 3, 10).
3. Pull the electrode holder out of the sensor and release the electrode cable on a dummy electrode (placeholder, must be present for impermeability reasons, (→ 4, 10)).
4. Remove the dummy electrode using a socket wrench, 17 mm AF (→ 5, 10).
5. Screw the new electrode into the free space and hand-tighten using the socket wrench, 17 mm AF.
6. Attach the electrode connector.
   ↳ The color coding of the electrodes and the cable identification can be found in the following table.
7. Carefully push the electrode holder and the air hose back into the sensor.
8. Screw on the coupling nut and then the protection guard.

NOTICE

Air bubbles

Air bubbles may accumulate in the electrodes following transportation and if they have been stored in a horizontal position. These air bubbles cause measuring errors.

- ▶ Before installing the sensor, eliminate any air bubbles e.g. by shaking gently.
- ▶ Then make sure to hold the sensor in an upright position (electrodes facing downwards) at all times until the sensor is installed at the measuring point.

Electrode identification

Electrode	Color of membrane ring and marking on screw head [1]	Cable identification
Ammonium	RD	1, 2 or 3
Nitrate	BU	
Potassium	YE	
Chloride	GN	
pH (incl. reference)	No marking	R
Temperature	No marking	T

1) color codes as per IEC 757

4.2.2 Installing at the measuring point

NOTICE

Compressed air

Damage to the relay

- ▶ The compressed air supply must not exceed 3.5 bar (50 psi).
- ▶ The compressed air must be supplied through an air filter (5 µm). This filter is already installed in the optional cleaning unit(→ 29).

Installing at the measuring point

1. If need be, install additional electrodes in the sensor and connect these to the appropriate cable connector.
2. **NOTICE!** Sensor too deep in the medium, tension in sensor cable. Failure of sensor due to penetration of medium or damage to cable. ▸ Do not use the cable to hang the sensor into the medium. ↳ Use a suitable holder. ▸ Never use the cable to pull the sensor out of the medium. ▸ Never immerse the sensor completely in the medium.

   Hang the sensor onto the chain of the holder.
3. Adjust the chain length and the cross bearer for the holder in such a way that the sensor is immersed approx. 0.5 m (1.64 ft) in the medium and the sensor is approx. 0.5 m (1.64 ft) from the basin rim.
4. Route the cables in such a way that no mechanical damage or interference influences can arise from other cables.
5. Connect the optional cleaning unit to the transmitter and the pressure hose (OD 8) to the sensor.

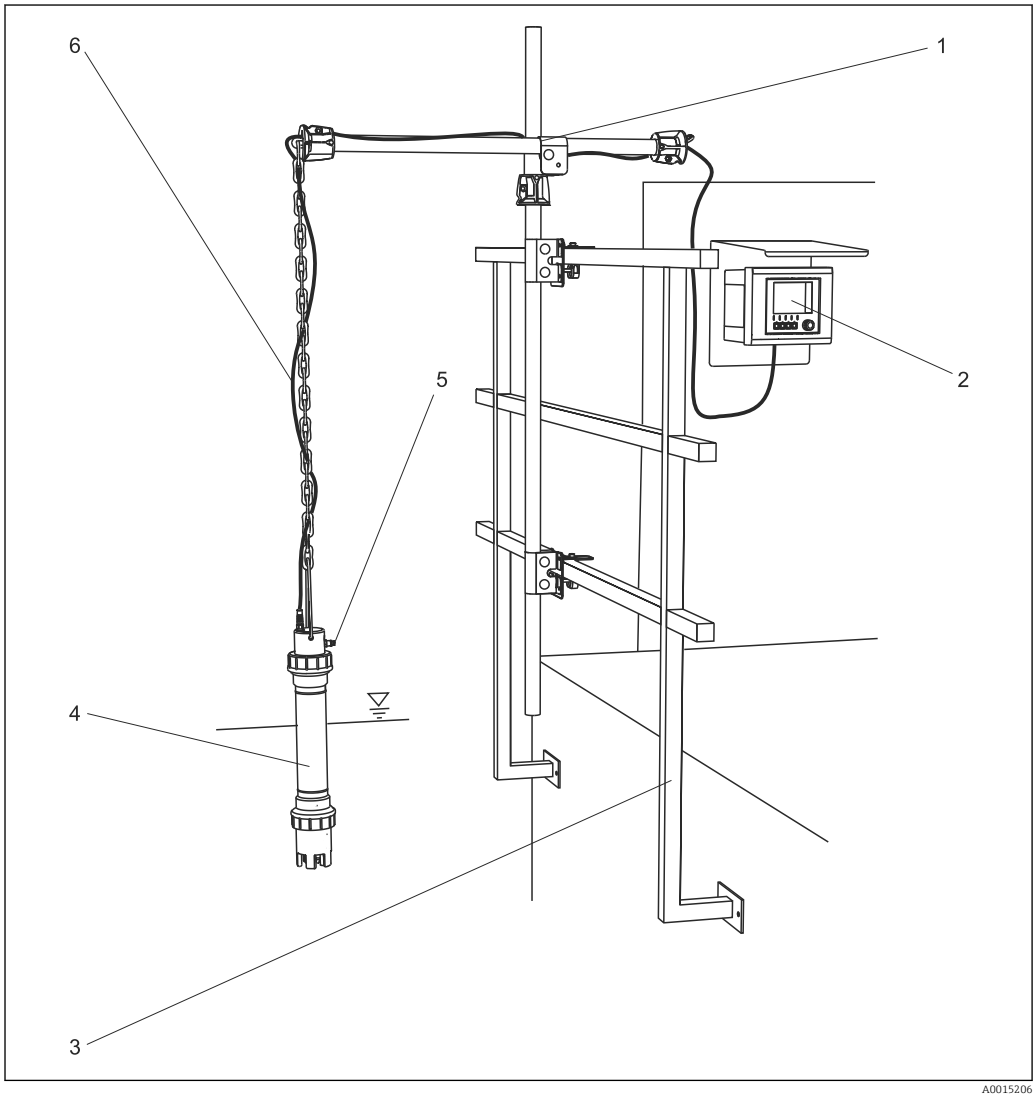
Connecting an optional cleaning unit or an external compressed air supply

1. Remove the watertight plug seal from the sensor's compressed air connection.
   ↳ To do so, press against the black ring and pull out the plastic plug seal.
2. Plug the compressed air hose (OD 8) belonging to the cleaning unit or compressed air supply into the compressed air connection.
3. Only optional cleaning unit:
   Connect the cleaning unit to the transmitter (for additional information, see BA00444C, Liquiline CM44x).

4.3 Installation example

A complete measuring system comprises:
- Sensor CAS40D
  - Ion-selective electrode(s) for ammonium, nitrate, potassium or chloride
  - pH glass electrode, Orbisint CPS11-1AT2GSA
  - Temperature sensor, CTS1
- Liquiline CM44x transmitter

Optional:
- Assembly holder, e.g. CYH112
- Weather protection cover - absolutely essential if mounting the transmitter outdoors!
- Compressed air generator (if no compressed air available on site)



6 *Example: measuring system on basin rim*

1 *Wastewater assembly holder, secure to rail, with transverse pipe and chain*
2 *Liquiline CM44x transmitter (in graphic: wall-mounted with weather protection cover)*
3 *Rail*
4 *Sensor CAS40D with ion-selective electrodes*
5 *Connection for optional compressed air cleaning (not in graphic)*
6 *Sensor cable*

4.4 Post-installation check

1. After mounting, check all the connections to ensure they are secure and leak-tight.

2. Check all cables and hoses for damage.
3. Check whether the cables are routed such that they are free from electromagnetic interference influences.

5 Electrical connection

⚠ WARNING

Device is live

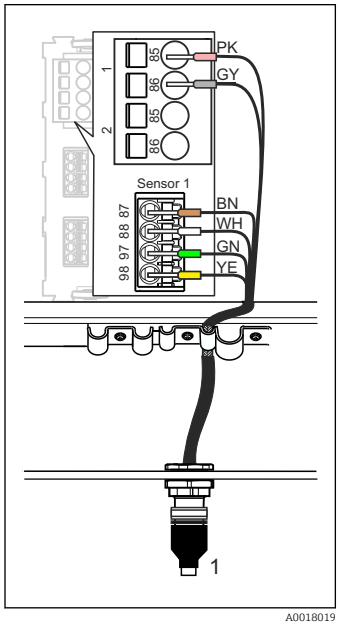
Incorrect connection may result in injury or death.

- ▶ The electrical connection may be performed only by an electrical technician.
- ▶ The electrical technician must have read and understood these Operating Instructions and must follow the instructions contained therein.
- ▶ **Prior** to commencing connection work, ensure that no voltage is present on any cable.

5.1 Connecting the sensor

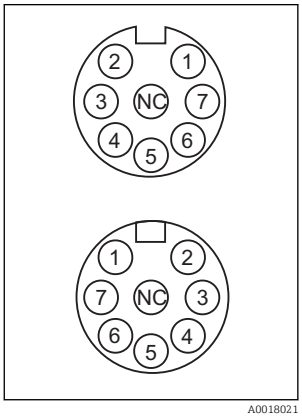
When connecting to the Liquiline CM44x transmitter, there are two options:

1. M12 plug (version: fixed cable, M12 plug)
   ↳ The wiring for the M12 socket is inside the device. Only the sensor plug is connected to the socket.
2. Direct connection of the fixed cable to the plug-in terminals (version: fixed cable, ferrules)



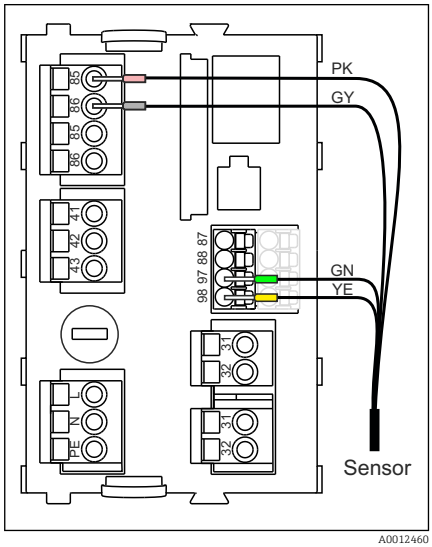
7 Connection e.g. at sensor module 2DS

1 Sensor with M12 plug



8 Plug assignment Above: socket Below: plug

1 PK (24 V)
2 GY (Shield 24 V)
3 BN (3 V)
4 WH (Shield 3 V)
5 GN (Memosens)
6 YE (Memosens)
7, NC Not connected



9 Connection e.g. at basic module

The maximum cable length is 100 m (328 ft).

5.2 Connecting additional electrodes in the sensor

All electrodes are connected in the factory prior to delivery.

Connecting additional electrodes:

1. Remove the sensor from the medium.
2. Take the sensor apart by unscrewing it, and pull out the sensor holder.
3. Remove a dummy electrode from the sensor to free up the space for the new electrode.
4. Install the new electrode in the free space. Tighten it by hand.

5. Remove the transport guard from the electrode head.
6. Connect the new electrode to the electrode connector.
7. Fit the sensor back together, and return it to the medium.

You must then reset your electrode configuration at the transmitter.

Electrode identification

Electrode	Color of membrane ring and marking on screw head [1]	Cable identification
Ammonium	RD	1, 2 or 3
Nitrate	BU	
Potassium	YE	
Chloride	GN	
pH (incl. reference)	No marking	R
Temperature	No marking	T

1) color codes as per IEC 757

5.3 Ensuring the degree of protection

Only the mechanical and electrical connections which are described in these instructions and which are necessary for the required, designated use, may be carried out on the device delivered.

▶ Exercise care when carrying out the work.

Otherwise, the individual types of protection (Ingress Protection (IP), electrical safety, EMC interference immunity) agreed for this product can no longer be guaranteed due, for example, to covers being left off or cable (ends) which are loose or insufficiently secured.

5.4 Post-connection check

Device status and specifications	Notes
Are the sensor and cable free from damage on the outside?	Visual inspection

Electrical connection	Notes
Does the supply voltage of the connected transmitter match the data on the nameplate?	Visual inspection
Are the installed cables strain-relieved and not twisted?	
Is the cable type route completely isolated on site?	Power cables / signal lines
Are all cable entries installed, tightened and sealed?	In the case of lateral cable entries: Cable loops facing downwards to allow water to drip off.
Are all cable entries facing downwards or mounted laterally?	

6 Calibration

6.1 Factory calibration

Before being delivered, the sensor is checked in the factory and precalibrated with regard to the sensor slope and zero point.

Since the correct calibration state depends on the medium matrix (ionic strength, concentration of interference ions etc.), users must always calibrate the sensor themselves after commissioning in order to adjust the zero point so that it suits the users' particular application conditions. The manual offset is set to zero upon delivery. If you do not use a compensation electrode for automatic interference ion compensation, the offset must be set before the first calibration is performed if working with ammonium and nitrate electrodes.

6.2 Calibration recommendations

Application	Variables to be calibrated	Recommended calibration types
Commissioning	Zero point, manual offset	Single-point calibration
Maintenance	Slope	Data entry Set the slope specified on the manufacturer's certificate in the transmitter
	Zero point	Single-point calibration
Routine calibration	Zero point	Single-point calibration

6.3 Calibration modes

- pH electrode:
  - Two-point calibration (recommended)
  - Single-point calibration
- Ion-selective electrodes:
  - Single-point calibration (recommended)
  - Data entry
  - Two-point calibration
  - Standard addition ("Expert" only)
- ORP sensor:
  Single-point calibration
- Temperature adjustment by entering a reference value

6.4 Calibration parameters

When determining ion concentrations potentiometrically, the voltage supplied by the electrochemical measuring cell (consisting of the ion-selective electrode and a reference electrode) within the "linear" or preferably "NERNST“ range is proportional to the logarithm of the concentration (or activity) of the ions to be determined. The slope and zero point calibration parameters refer to this logarithmic relationship, which gives these parameters a completely different meaning in this measurement method compared with other measurement methods.

6.4.1 Slope

The slope is specified as a %, based on the theoretical slope according to Nernst.
Example: 98% slope = 59.16 mV/pX · 0.98 = 57.98 mV/pX

The slope affects the linearity of the measurement.

If the slope set at the transmitter is less than or greater than the actual slope of the ion-selective electrode, measured errors can occur due to non-linearities. The greater the concentration range in which the measured values vary, the greater the possible non-linearities. If, on the other hand, the measured values only vary in a small range, even larger slope errors will not result in discernible non-linearities. The slope is determined in the factory for every ion-selective electrode and every membrane cap and is indicated on the manufacturer's certificate supplied with the device. The user simply has to enter the slope data to communicate the supplied slope value to the transmitter. As the slope only changes marginally while the unit is in operation, the user does not normally have to perform a calibration. The slope is a property of the ion-selective electrode. Therefore the reference electrode does not affect the slope.

Slope of ion-selective electrodes

Electrode	Maximum	Minimum
Ammonium	110%	90%
Nitrate		90%, typically 98 - 100%
Potassium		90%
Chloride		

If the calibrated slope is outside the table values, the calibration conditions must be taken into account. Check if the manual offset or calibration of the compensation electrode is correct.

6.4.2 Zero point

The zero point determines the sensitivity of the measurement. If the configured zero point is too low or too high in relation to the actual zero point of the ion-selective electrode system, all the measured values are either too high or too low by a certain percentage. The zero point depends on the internal solution used by the ion-selective electrode and the reference electrode. As a result of the ion-selective electrode and the reference electrode aging, the zero point gradually changes over time and must be calibrated periodically. The zero point depends on both the ion-selective electrode and the reference electrode.

Typical zero points

Electrode	Typical zero point [1)]
Ammonium	1.1
Nitrate	1.4
Potassium	3.55
Chloride	-0.5

1) for new reference electrode (electrode aging affects the zero point)

6.5 Sequence for calibration/adjustment of measuring point

Some measured values from other electrodes or sensors are used for measured value compensation of ion-selective electrodes:
- Measured value of temperature sensor for temperature compensation
- pH measured value for pH compensation of ammonium (optional)
- Potassium or chloride measured value for compensation of interference ions in the case of ammonium or nitrate (optional)

For this reason, there is a sequence for calibration and adjustment that must be followed in order to achieve a reliable measurement:

1. Temperature adjustment (precalibrated in the factory, therefore not necessary for initial calibration)
2. Calibration and adjustment of pH electrode
3. Depending on whether compensation electrodes are used:
   Calibration and adjustment of ion-selective compensation electrodes (potassium, chloride)
4. If no compensation electrodes are used:
   A correct manual offset is configured for the ammonium and nitrate electrode
5. Calibration and adjustment of ion-selective measuring electrodes (ammonium, nitrate)

6.6 Calibrate

For single- and two-point calibration, the following minimum concentrations apply:
- 6.4 mg/l ammonium or 5 mg/l ammonium-nitrogen
- 22.1 mg/l nitrate or 5 mg/l nitrate-nitrogen
- 20 mg/l potassium
- 100 mg/l chloride

The values are benchmarks which may change over time due to the influence of interference ions or the aging of ion-selective electrodes. If the calibration concentrations are too low, the measured values will be incorrect.

Stability criterion
The factory setting on the transmitter is "weak". It takes approx. 4 min for the stability of the measured value of an ion-selective electrode to reach an adequate level. Therefore, wait for a stable measuring signal before starting calibration.

6.6.1 Data entry

The zero point and the slope of the ion-selective electrode system can be entered directly and modified using the "Data entry" method. If you are installing a new ion-selective electrode or membrane cap in the sensor, or replacing an old one, you must set the electrode slope, which is indicated on the manufacturer's certificate, for the slot in question using the "Data entry" function. Afterwards, you must calibrate the zero point with another method.

6.6.2 Single-point calibration

In the case of single-point calibration, the zero point of the ion-selective electrode system is calibrated in a solution with a known concentration.

Enter the reference value either before or after the measured value is recorded. When using single-point calibration, it is necessary to have already correctly set the slope and the

manual offset or carried out a calibration of the compensation electrodes for ammonium and nitrate.

Using the Liquiline CM44x transmitter, you can calibrate two ion-selective electrodes at the same time (ammonium and nitrate or potassium and chloride).

1. Hang the sensor into a container or into a process with a known concentration.
   ↳ Experience shows that at 7 mg/l good values are produced during calibration for ammonium and nitrate.
2. Start the single-point calibration in the menu.
   ↳ Select whether or not the measured value of the reference medium is known.
3. Wait for the signal (mV value) to stabilize (approx. 4 min for new membrane caps).
4. Start the calibration procedure.
   ↳ Accept the calibration data.

6.6.3 Two-point calibration

In the case of two-point calibration, the zero point and the slope of the ion-selective electrode system are determined using two solutions whose concentrations are known. The two concentrations in the two solutions should be in the upper and lower measuring range. When using two-point calibration, the manual offset must already be set correctly, as non-linearities would otherwise not be corrected by the two-point calibration.

With two-point calibration, the concentration should at least double. In this case, the change in the mV signal is approx. 1/3 of the slope in mV.

1. Hang the sensor into a container or into a process with a known concentration.
   ↳ Experience shows that at 7 mg/l good values are produced during calibration for ammonium and nitrate.
2. Start two-point calibration in the menu.
   ↳ Select whether or not the measured value of the reference medium is known.
3. Wait for the signal (mV value) to stabilize (approx. 4 min for new membrane caps).
4. Start the calibration procedure.
5. Clean the sensor, and quickly wipe it dry.
   ↳ Hang the sensor into the container with the second concentration.
6. Wait for the signal (mV value) to stabilize (approx. 4 min for new membrane caps).
7. Start the calibration procedure.
   ↳ Accept the calibration data.

6.6.4 Potassium and chloride compensation

Depending on the selectivity of the ion-selective electrode vis-à-vis other ions (interference ions), and the concentration of these ions, such ions could also be interpreted as part of the measuring signal and thus cause measuring errors. When measuring in wastewater, the potassium ion which is chemically similar to the ammonium ion can cause higher measured values. High concentrations of chloride may result in the measured values for nitrate being too high. To reduce measuring errors resulting from such cross-interference, the concentration of the potassium or chloride interference ion can be measured and compensated for with a suitable additional electrode. As a alternative to using compensation electrodes, you can also enter a manual offset.

If you use compensation electrodes, there is no need to set the manual offset.
- Use of the potassium electrode for compensation:
  For concentrations > 40 mg/l (> 40 ppm) with simultaneously fluctuating values of ± 20 mg/l (± 20 ppm)
- Use of the chloride electrode for compensation:
  For concentrations > 500 mg/l (> 500 ppm) with simultaneously fluctuating values of ± 100 mg/l (± 100 ppm)

6.6.5 Manual offset

Constant systematic measured errors, which occur over the entire concentration range, can be corrected by setting a suitable manual offset. Here, the set offset is added to the measured value. To correct the measured error, a suitable negative value (often ranging from - 0.2 to 2 mg/l (- 0.2 to 2 ppm) for municipal wastewater) must be set as the manual offset for the specific ion-selective electrodes.

Using the offset for potassium or chloride values that do not fluctuate.
When determining ammonium, a manual offset of -1 mg/l NH_4-N (-1 ppm NH_4-N) should be set per 20 mg/l (20 ppm) of potassium for complete compensation. When determining nitrate, the manual offset should be - 1 mg/l NO_3-N (-1 ppm NO_3-N) per 200 mg/l (200 ppm) chloride. It is normally not necessary to set a manual offset when using ion-selective electrodes for potassium and chloride, as the effect of interference ions on the measured value for potassium or chloride is too small. The offset value can be left at zero.

6.7 Checking the calibration

1. Extract a sample of approx. 3 liters (0.79 US gal.) from the outlet of the wastewater treatment plant and prepare a bucket of drinking water.
2. Put exactly 2 liters (0.53 US gal.) of the sample into a suitable container and immerse the sensor in it. Make sure there is convection in the solution (use a magnetic stirrer with a magnetic stir bar or constantly move the sensor slightly by hand).
   ↳ After a few minutes the measured value should match the reference measured value (laboratory value) within the normal tolerance for measured value fluctuations.
3. Have some of the sample analyzed in the laboratory for the parameter to the calibrated.
4. Gradually increase the concentration of the ion to be measured in the sample by adding defined volumes of standard solution - preferably using a microliter pipette - and recording the stable measured value after 5 to 10 minutes.
   ↳ The increase in the measured value should be as expected. The increase in concentration is calculated using the following formula: concentration increase = volume added x standard concentration x molar mass of parameter / (volume presented + total volume added)
5. Immerse the sensor in a bucket of drinking water and check the concentration and raw values.
   ↳ Typically, the values for ammonium are close to 0 mg/l for raw values of -170 mV or less. With 3 mg/l of nitrate, a raw value of at least +150 mV or higher should be achieved.

Example
In five individual steps, 0.5 mlof 1M ammonium nitrate standard solution is added each time to 2 liters of sample solution. The molar mass of NH_4-N and NO_3-N is 14 g/mol in each case. As the volume added is so small, the increase in the volume of sample solution can be disregarded. Each time standard solution is added, the presented concentration of

NH_4-N and NO_3-N increases by
0.5 ml x 1 mol/l x 14 g/mol / 2000 ml = 3.5 mg/l (3.5 ppm).

If the measured values do not increase as expected or are systematically too high or too low, refer to the table for suitable measures which can be taken:

Problem	Reason	Action
Measured values are always too high by the same amount	Manual offset setting is not negative or not negative enough	Make manual offset more negative
Measured values are always too low by the same amount	Manual offset setting is too negative	Reduce the manual offset setting based on the amount
Measured values are always too high by a certain percentage	Zero point setting is too low	Calibrate the zero point
Measured values are always too low by a certain percentage	Zero point setting is too high	
Measured values are too high when concentrations are low and too low when concentrations are high	Manual offset setting is not negative enough and zero point set too high	Make manual offset more negative and repeat the calibration (preferably sample calibration or standard addition)
Measured values are too low when concentrations are low and too high when concentrations are high	Manual offset setting is too negative and zero point set too low	Reduce the manual offset setting based on the amount and repeat the calibration (preferably sample calibration or standard addition)
Nonlinear activation, average measured values too high	Slope setting is too high	Calibrate the slope and zero point (preferably using standard addition with at least 2 volumes of standard added)
Nonlinear activation, average measured values too low	Slope setting is too low	

7 Troubleshooting

For troubleshooting purposes, you must take the entire measuring point into account:
- Transmitter
- Electrical connections and cables
- Assembly
- Sensor

The possible causes of error in the following table relate mainly to the sensor.

Problem	Testing	Solution
No display, no sensor reaction	Line voltage at transmitter?	Apply line voltage
	Sensor connected correctly?	Make the right connection
	Medium flow present?	Create medium flow
	Formation of build-up	Clean sensor
Display value too high or too low	Air bubbles present?	Remove air bubbles by tapping on the sensor shaft.
	Sensor calibrated?	Calibrate
Display value fluctuating greatly	Air bubbles present?	Remove air bubbles by tapping on the sensor shaft.
	Check mounting location.	Select a different mounting location
Display value is always in the range of 0 ± 15 mV	Moisture on the electrode plug-in head	Remove moisture or, if necessary, replace electrode
	Has the membrane cap been tightened by hand?	Verify that the membrane cap is hand-tight.

Please observe the troubleshooting information in the Operating Instructions for the transmitter. If need be, carry out a test on the transmitter.

8 Maintenance

Take all the necessary precautions in time to ensure the operational safety and reliability of the entire measuring system.

NOTICE

Effects on process and process control

- When carrying out any work on the system, take into account possible repercussions for process control or the process itself.
- For your own safety, only use genuine accessories. With genuine parts, the function, accuracy and reliability are also ensured after maintenance work.

8.1 Maintenance schedule

NOTICE

Moisture on the electrode contacts

Results in short-circuits and consequently in drifting or unstable measured values

- When working with ion-sensitive electrodes, verify that the contacts are dry.
- Do not touch the plug contacts using bare hands.

	Cleaning	Membrane cap and electrolyte replacement			Crystal polishing	Replacing	
Maintenance interval	**Membrane**	**Ammonium**	**Nitrate**	**Potassium**	**Chloride**	**pH electrode**	**O-rings**
Fortnightly	☑						
Biannually		☑	☑	☑	☑		
Annually						☑	☑

The intervals indicated are average empirical values and can be shorter or longer depending on the operating conditions. You, or the plant operator, are responsible for adapting the intervals to suit your conditions.

8.2 Cleaning the membrane

If the membrane is very contaminated, you have to clean it regardless of the maintenance intervals.

- Do not touch the membrane with your hands.
- Use a clean tissue and water for cleaning purposes.

The optional chloride electrode has a crystal instead of a membrane. To clean it, place some sandpaper (600-grit) on an even surface. Now rub the sensor with the crystal area facing downwards on the paper until all residues of fouling are removed (visual inspection, rubbing the sensor for a few seconds usually suffices).

8.3 Replacing membrane cap and electrolyte

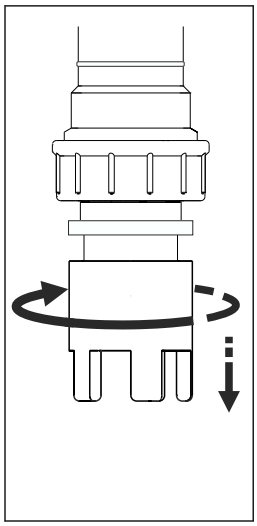
NOTICE

Sensor out of medium for longer than 15 minutes and did not wait for conditioning

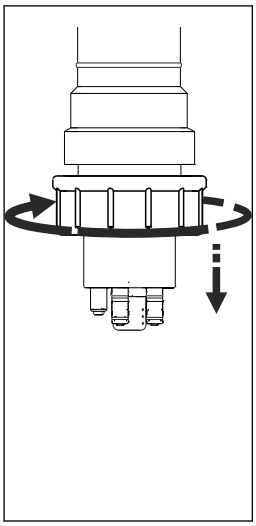
Results in measurement errors

- After submerging the sensor in the medium, you must allow it time for conditioning. Allow approx. 12 hours for this.

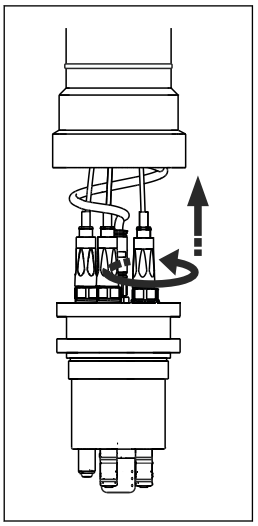
Remove electrode.



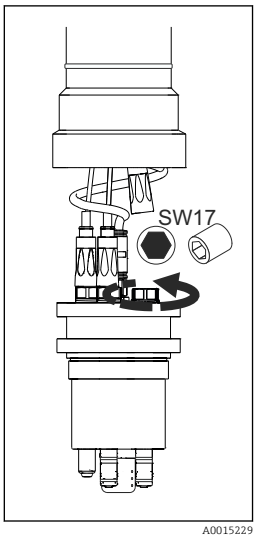
10 Release protection guard



11 Remove coupling nut



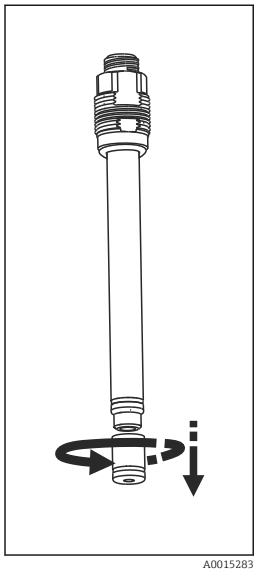
12 Release cable.



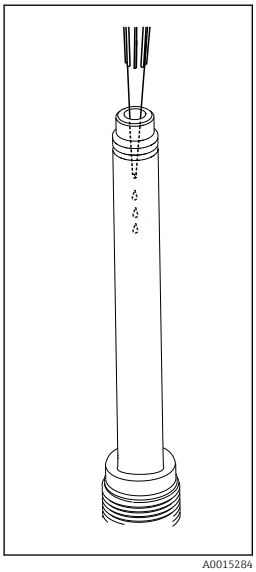
13 Remove electrode.

1. Remove the sensor from the medium.
2. Clean the sensor with water.
3. Release and remove the protection guard (→ 10, 24).
4. Unscrew the coupling nut (→ 11, 24).
5. Pull the electrode holder out of the sensor and release the electrode cable on a dummy electrode (→ 12, 24)(placeholder, must be present for impermeability reasons).
6. Remove the dummy electrode using a socket wrench, 17 mm AF (→ 13, 24).

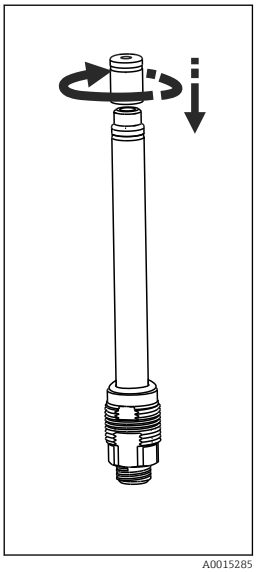
Replacing membrane cap and electrolyte



14 Remove cap



15 Fill with electrolyte



16 New cap

1. Unscrew the membrane cap from the electrode (→ 10, 24).
   ↳ The membrane cap is waste that you must dispose of properly.
2. Drain the electrolyte from the electrode body.

3. Extract fresh electrolyte using the pipette included in the kit, and fill the electrode body with electrolyte to approx. 2-3 mm (0.08 - 0.12") below the rim(→ 🖼 11, 🖹 24).
4. Dry the thread of the electrode carefully.
5. Continue to hold the electrode upright, with the cable connection head facing downwards, and screw on the membrane cap until it is hand-tight (→ 🖼 16, 🖹 24).
6. Turn the electrode around, and remove any air bubbles on the inner membrane surface by holding the electrode vertically and shaking it vigorously several times (as in the case of a clinical thermometer).

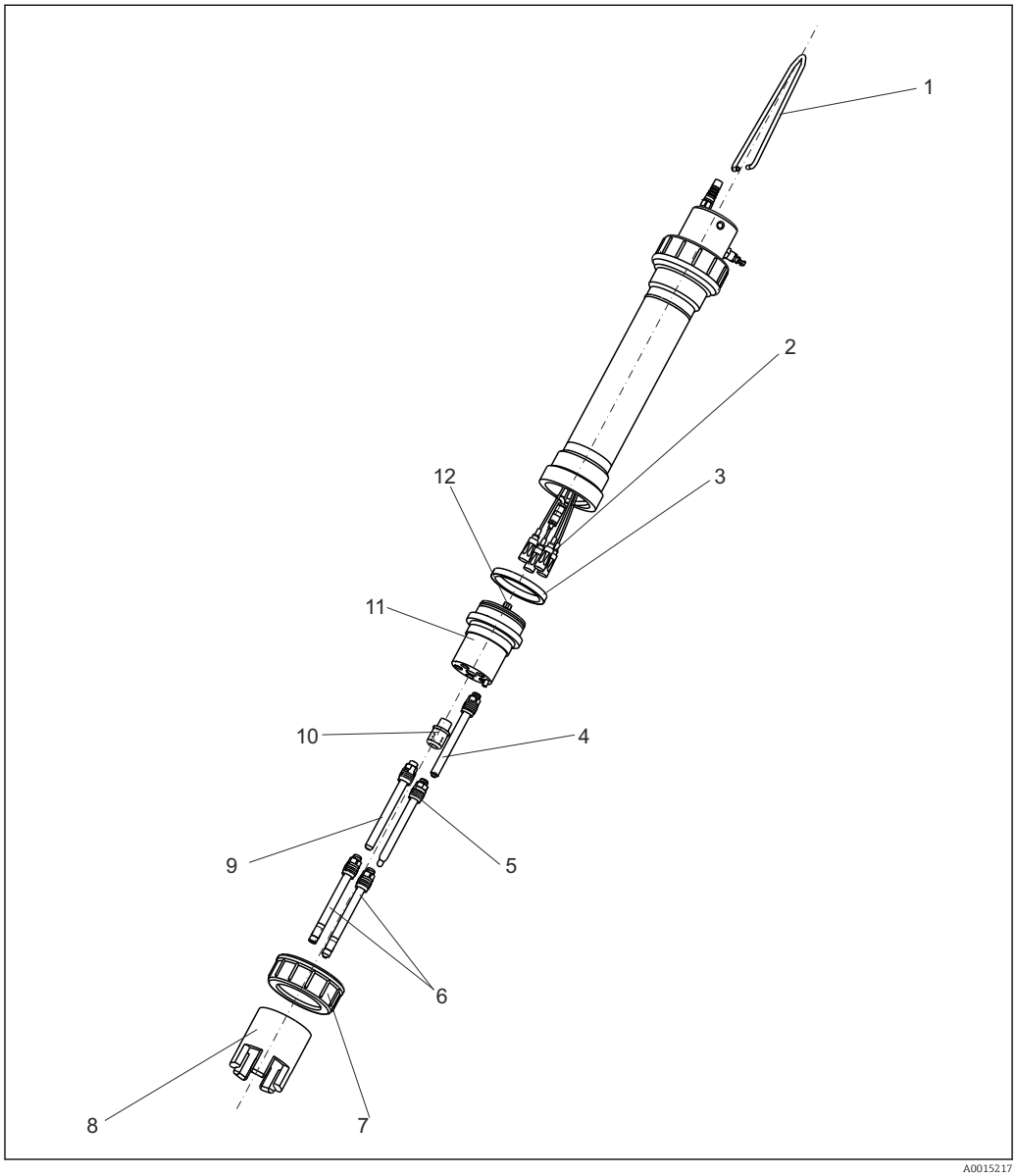
From now until it is installed in the process, always hold the electrode and sensor upright, to avoid the accumulation of new air bubbles on the inner membrane surface.

Installing the electrode

1. Screw the electrode into the electrode holder, and hand-tighten using the socket wrench, 17 mm AF, ((→ 🖼 13, 🖹 24), but in the opposite direction).
2. Attach the electrode connector to the cable ((→ 🖼 12, 🖹 24), opposite direction).
3. Carefully push the electrode holder and the air hose back into the sensor.
4. Screw on the coupling nut ((→ 🖼 11, 🖹 24), opposite direction). When doing so, check the radial seal on the electrode holder, and reapply grease if necessary.
5. Screw on the protection guard ((→ 🖼 10, 🖹 24), opposite direction).
6. Carry out a calibration(→ 🖹 16).

9 Repair

9.1 Spare parts



17 *Spare parts CAS40D*

No.	Description	Order no.
1	Kit CYH112 suspension bracket for chain	71096714
2,	Kit CAS40D multi-conductor cable for electrodes	71130358
3 7	Kit CAS40D seal set ▪ Radial seal for electrode holder (3) ▪ Seals for electrodes, 5x ▪ Seal for cleaning nozzle ▪ Coupling nut, 2x (7)	71260474
4	Temperature sensor	CTS1-A2GSA
5	pH single-rod measuring cell with reference	CPS11-1AT2GSA

No.	Description	Order no.
6	Ion-selective electrodes, electrode complete, length 120 mm ▪ Ammonium ▪ Nitrate ▪ Potassium ▪ Chloride	 71109938 71109937 71109936 71109939
8	Kit CAS40D electrode protection guard	71130354
9	Kit CAS40D dummy electrode (needed to seal off unused slots)	71123812
10	Kit CAS40D cleaning nozzle incl. seal	71130359
11 12	Kit CAS40D electrode holder ▪ Electrode holder ▪ Seals for electrodes ▪ Cleaning nozzle (10) incl. seal ▪ Radial seal for electrode holder (3) ▪ Check valve (12)	71260473

9.2 Return

The product must be returned if repairs or a factory calibration are required, or if the wrong product was ordered or delivered. As an ISO-certified company and also due to legal regulations, Endress+Hauser is obliged to follow certain procedures when handling any returned products that have been in contact with medium.

To ensure swift, safe and professional device returns, please read the return procedures and conditions at www.endress.com/support/return-material.

9.3 Disposal

The device contains electronic components and must therefore be disposed of in accordance with regulations on the disposal of electronic waste.

Observe the local regulations.

10 Accessories

The following are the most important accessories available at the time this documentation was issued. For accessories not listed here, please contact your service or sales office.

10.1 Assembly holder

Flexdip CYH112
- Modular holder system for sensors and assemblies in open basins, channels and tanks
- For Flexdip CYA112 water and wastewater assemblies
- Can be affixed anywhere: on the ground, on the capstone, on the wall or directly onto railings.
- Stainless steel version
- Product Configurator on the product page: www.endress.com/cyh112

Technical Information TI00430C

10.2 Maintenance kits

Membrane kit
- 2 membrane caps (apart from chloride, where there is only one cap, with crystal)
- Electrolyte
- Order numbers:
  - Ammonium: 71072574
  - Nitrate: 71072575
  - Potassium: 71072576
  - Chloride: 71072577

Maintenance kit for chloride electrode
- Sandpaper
- Electrolyte
- Order number: 71085727

10.3 Electrodes

Ion-selective electrode
- Electrode, complete, length 120 mm
- Order numbers:
  - Ammonium: 71109938 (color identification red)
  - Nitrate: 71109937 (color identification blue)
  - Potassium: 71109936 (color identification yellow)
  - Chloride: 71109939 (color identification green)

pH electrode with reference
Order number: CPS11-1AT2GSA

Temperature sensor
Order number: CTS1-A2GSA

Dummy electrode
Order number: 71123812

10.4 Standard solutions

CAY40
- Standard solutions for ammonium, nitrate, potassium and chloride
- Ordering information: www.endress.com/cas40d under "Accessories/spare parts"

High-quality buffer solutions from Endress+Hauser - CPY20
The secondary buffer solutions have been referenced to primary reference material of the PTB (German Federal Physico-technical Institute) and to standard reference material of NIST (National Institute of Standards and Technology) according to DIN 19266 by a DKD (German Calibration Service) accredited laboratory.
Product Configurator on the product page: www.endress.com/cpy20

10.5 Compressed air cleaning

Not suitable for continuous operation!
- Operating interval: max. 3 minutes cleaning, break for at least six times the cleaning time.
- Avoid condensation in the pressurized hoses.

Cleaning unit in the housing
- 230 V or 115V, IP 65
- Conveying rate at atmospheric pressure: 50 l/min (13.2 gal/min)
- Power consumption: 240 W
- Current consumption: 1.3 A
- Overheating protection: automatic switch off at T > 130 °C (266 °F)
- Order no.
  - 230 V: 71072583
  - 115 V: 71194623
  - Hose reducer coupling AD 8/6 mm: 71082499

11 Technical data

11.1 Input

Measured variables

Depending on version:
- Ammonium: NH_4-N, NH_4^+ [mg/l]
- Nitrate: NO_3-N, NO_3^- [mg/l]
- Potassium, K^+ [mg/l]
- Chloride, Cl^- [mg/l]
- pH value
- Temperature

Measuring ranges

- Ammonium:
  0.1 to 1000 mg/l (NH_4-N)
- Nitrate:
  0.1 to 1000 mg/l (NO_3-N)
- Potassium:
  1 to 1000 mg/l
- Chloride:
  1 to 1000 mg/l

11.2 Performance characteristics

Response time t_{90} of the ion-selective sensors

< 2 min.

For a change between 0.5 and 1 mmol/l in both directions, at 25 °C (77 °F).

Maximum measured error

± 5 % of the measured value ± 0.2 mg/l

Repeatability

±3 % of the display value

Compensation

Sensor	Temperature	pH	Potassium [1) 2)]	Chloride [3) 4)]
Ammonium	2 to 40 °C (36 to 100 °F)	pH 8.3 to 10	1 to 1000 mg/l (ppm)	-
Nitrate		-	-	10 to 1000 mg/l (ppm)
Potassium		-	-	-
Chloride		-	-	-

1) The concentration fluctuations, not the absolute value, are decisive
2) Recommendation: Use as compensation electrode for potassium concentrations > 40 mg/l in the case of simultaneously fluctuating values of ± 20 mg/l, or apply an offset in the case of non-fluctuating values.
3) The concentration fluctuations, not the absolute value, are decisive
4) Recommendation: Use as compensation electrode for chloride concentrations > 500 mg/l in the case of simultaneously fluctuating values of ± 100 mg/l, or apply an offset in the case of non-fluctuating values.

Max. operating life

Membrane and electrolyte
- Use:
  approx. 0.5 years
- Storage:
  2 years

Automatic cleaning	▪ Cleaning medium: Air ▪ Pressure: 3 to 3.5 bar (45 to 50 psi) ▪ Volume of air required per cleaning cycle: 3 to 4 l (0.8 to 1 US gal) ▪ Cleaning duration: 4 to 15 s ▪ Cleaning intervals (at T > 10 °C (50 °F)): Sludge activation inlet: 15 s cleaning, 30 min pause Sludge activation: 15 s cleaning, 1 hr pause

11.3 Environment

Ambient temperature	-20 to 50 °C (-4 to 120 °F)
Storage temperature	2 to 40 °C (36 to 100 °F)
Degree of protection	IP68 (2 m water column, 25 °C, 48 h)
Electromagnetic compatibility	Interference emission and interference immunity as per EN 61 326, Namur NE21

11.4 Process

Process temperature	2 to 40 °C (36 to 100 °F)
Process pressure	400 mbar (160 in H_2O) max. permitted overpressure
pH value of the medium	▪ Ammonium: pH 5 to 8.3 (without pH compensation) pH 5 to 10 (with pH compensation) ▪ Nitrate: pH 2 to 12 ▪ Potassium: pH 2 to 12 ▪ Chloride: pH 1 to 10

11.5 Mechanical construction

Design, dimensions	(→ 9)
Weight	Approx. 3.5 kg (7.7 lbs)

Materials	**Sensor:**	
	Protective cage:	POM
	Electrode holder:	POM
	Radial seal for sensor head and electrode holder:	Silicone
	O-rings in ISE holder:	EPDM
	O-rings for air nozzle:	VITON
	Sensor pipe with coupling nut:	PP
	Retaining bracket:	Stainless steel
	Sensor head:	POM
	Temperature sensor:	Glass
	pH single-rod measuring cell with reference electrode:	Glass, PTFE
	Ion-selective electrodes	
	Membrane cap:	POM
	Shaft:	POM
	Color ring:	PP
	Membrane:	PVC, plasticizer
	O-rings:	EPDM
Electrode process connection	Pg 13.5	
Compressed air connection	For hose, OD 8 mm	

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