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# Operating Instructions
# **Memosens Wave CAS80E**

Spectrometer for water analysis

Endress+Hauser
People for Process Automation

# Table of contents

# 1 About this document

## 1.1 Safety information

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

## 1.2 Symbols used

- Additional information, tips
- Permitted
- Recommended
- Not permitted or not recommended
- Reference to device documentation
- Reference to page
- Reference to graphic
- Result of an individual step

### 1.2.1 Symbols on the device

- Reference to device documentation
- Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

# 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.
- Faults at the measuring point may only be rectified by authorized and specially trained personnel.

Repairs not described in the Operating Instructions provided must be carried out only directly at the manufacturer's site or by the service organization.

## 2.2 Intended use

The spectrometer is used to measure a variety of parameters in liquid media with UV-VIS spectroscopy.

The spectrometer is particularly suitable for measurements in the following applications:
- Inlet and outlet of wastewater treatment plants
- Drinking water
- Surface water

Any use other than that intended puts the safety of people and the measuring system at risk. Therefore, any other use is not permitted.

The manufacturer is not liable for harm caused by improper or unintended use.

## 2.3 Workplace safety

**⚠ CAUTION**

**UV light**

UV light can damage the eyes and skin!

▶ Never look into the measuring gap while the device is in operation.

The operator is responsible for ensuring compliance with the following safety regulations:
- Installation guidelines
- Local standards and regulations

**Electromagnetic compatibility**
- The product has been tested for electromagnetic compatibility in accordance with the applicable international 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

**Before commissioning the entire measuring point:**

1. Verify that all connections are correct.
2. Ensure that electrical cables and hose connections are undamaged.

**Procedure for damaged products:**

1. Do not operate damaged products, and protect them against unintentional operation.
2. Label damaged products as defective.

**During operation:**

- If errors cannot be rectified,
  take products out of service and protect them against unintentional operation.

## 2.5 Product safety

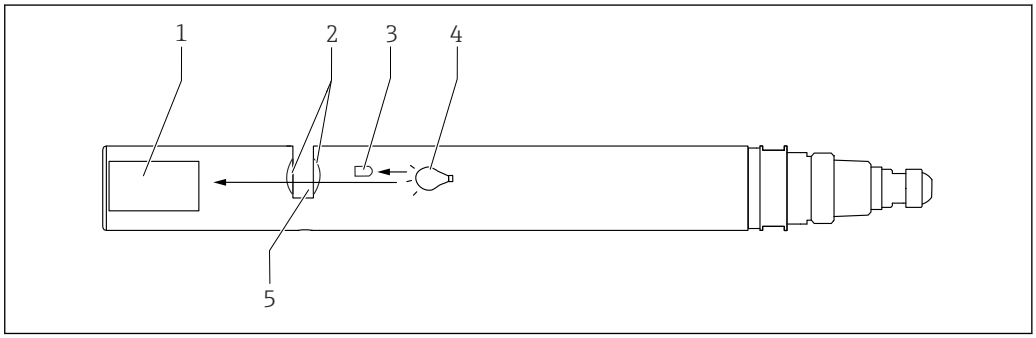
The product is designed to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. The relevant regulations and international standards have been observed.

# 3 Product description

## 3.1 Product design

The spectrometer consists of the following modules:
- Power supply
- High-voltage generation for the strobe lamp
- Xenon strobe lamp
- Monitor diode
- Measurement gap
- Spectrometer: UV-VIS 200 to 800 nm
- Microcontroller

All data - including the calibration data - are stored in the spectrometer. The spectrometer can be precalibrated and used at a measuring point, calibrated externally, or used for several measuring points with different calibrations.



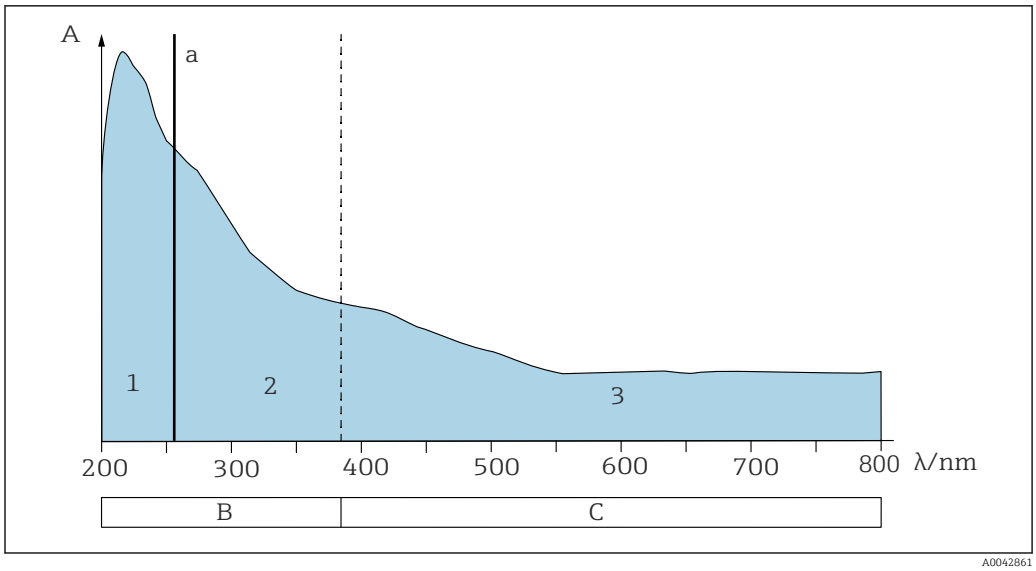

*1 Product design*

*1 Spectrometer module*
*2 Lens*
*3 Monitor diode*
*4 Light source*
*5 Measurement gap*

A light source sends a beam of light through the medium via the lenses. The medium under analysis is located in the measurement gap. In the spectrometer module, the beam of light is converted to electrical, measurable signals. A two-beam principle with compensation for lamp changes is applied → 1, 7.

### 3.1.1 Measuring principle

The spectrometer uses the substance-specific absorption of electromagnetic radiation to indicate the measurement parameters from the recorded spectrum.




*2 Ranges of parameters in the absorption spectrum*

*λ Wavelength range*
*A Absorption*
*B Ultraviolet light (UV)*
*C Visible light (VIS)*
*a 254 nm, SAC, SSK*
*1 Nitrate*
*2 Sum parameters BODeq, CODeq, TOCeq, DOCeq*
*3 Color, turbidity, TSS*

A specific absorption spectrum can be assigned to every molecule. By comparing a zero spectrum $I_0$ determined previously in ultrapure water and the measuring spectrum with the intensity I, the absorption A can be calculated as follows:

$A = -\log_{10} (I/I_0) = \varepsilon \cdot c \cdot d$

The absorption A depends directly on the concentration c, the optical path length d and the extinction coefficient ε.

Analytical models programmed into the spectrometer calculate the concentration of the parameters from the absorption spectra. These analytical models have been determined by correlating known parameter concentrations with their related absorption spectra.

The calculation uses the same wavelengths to determine different parameters. This results in what are termed "cross-sensitivities". For example, if turbidity increases less light is detected when determining the chemical oxygen demand (COD).

# 4 Incoming acceptance and product identification

## 4.1 Incoming acceptance

On receipt of the delivery:

1. Check the packaging for damage.
   ↳ Report all damage immediately to the manufacturer.
   Do not install damaged components.
2. Check the scope of delivery using the delivery note.
3. Compare the data on the nameplate with the order specifications on the delivery note.
4. Check the technical documentation and all other necessary documents, e.g. certificates, to ensure they are complete.

If one of the conditions is not satisfied, contact the manufacturer.

## 4.2 Product identification

### 4.2.1 Nameplate

The following information on the device can be found on the nameplate:
- Manufacturer identification
- Extended order code
- Serial number
- Safety information and warnings

▶ Compare the information on the nameplate with the order.

### 4.2.2 Identifying the product

**Product page**

www.endress.com/cas80e

**Order code**

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

**Obtaining information on the product**

1. Go to www.endress.com.
2. Page search (magnifying glass symbol): Enter valid serial number.
3. Search (magnifying glass).
   ↳ The product structure is displayed in a popup window.
4. Click the product overview.
   ↳ A new window opens. Here you will find information pertaining to your device, including the product documentation.

### 4.2.3 Manufacturer address

Endress+Hauser Conducta GmbH+Co. KG
Dieselstraße 24
70839 Gerlingen
Germany

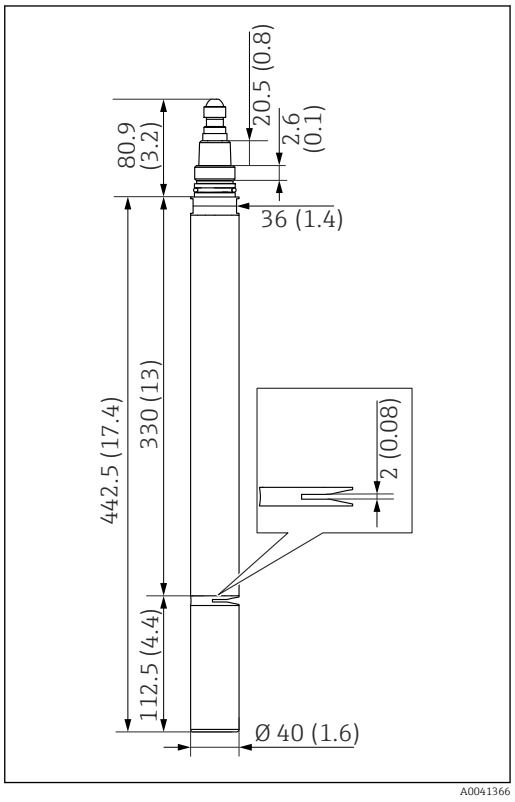
## 4.3 Scope of delivery

The delivery comprises:
- Spectrometer, version as ordered
- Cleaning brush (x 2)
- 32GB SD card for data logging
- Operating Instructions

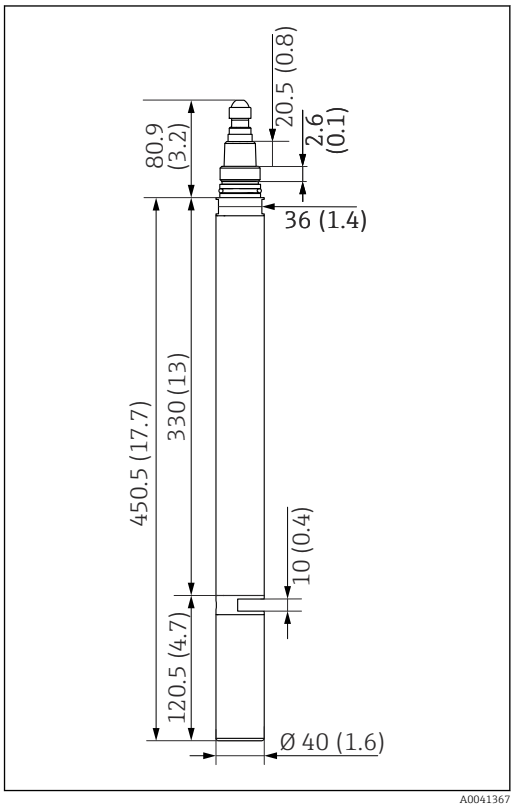
# 5 Installation

## 5.1 Installation requirements

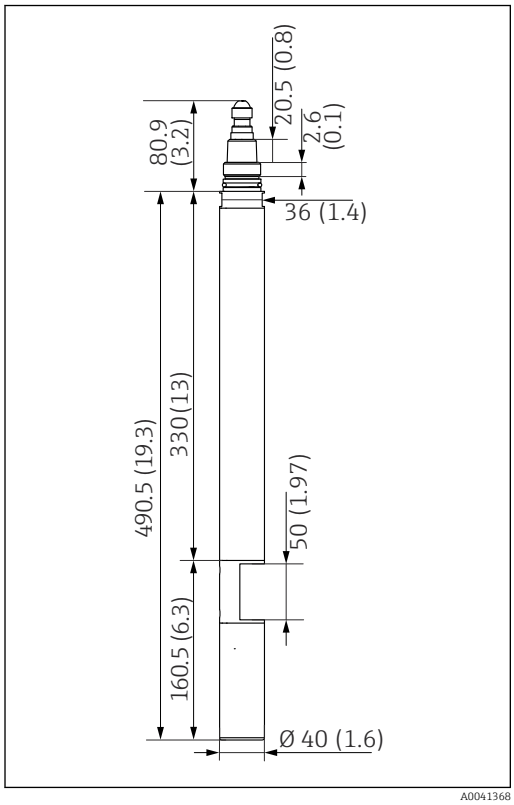
### 5.1.1 Dimensions




3 *Dimensions of spectrometer with 2 mm (0.08 in) optical path length. Unit: mm (in)*




4 *Dimensions of spectrometer with 10 mm (0.4 in) optical path length. Unit: mm (in)*




*5 Dimensions of spectrometer with 50 mm (1.97 in) optical path length. Unit: mm (in)*

### 5.1.2 Installation instructions

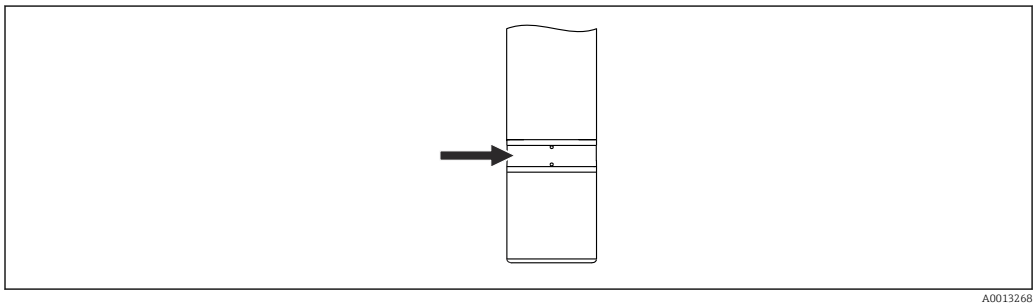
1. Do not install the device in places where air pockets and foam bubbles form.
2. Choose a mounting location that can be easily accessed at a later stage.
3. Ensure that upright posts and assemblies are fully secured and vibration-free.
4. Align the device so that the measurement gap is rinsed by the flow of medium.

To ensure correct measurement, the windows at the measurement gap must be free from any sedimentation. Compressed air or mechanical cleaning units (accessories) ensure that the windows remain free of deposits.

For horizontal orientations:

- Mount the spectrometer in such a way that air bubbles can escape from the measurement gap (do not point it downwards).

### 5.1.3 Orientation



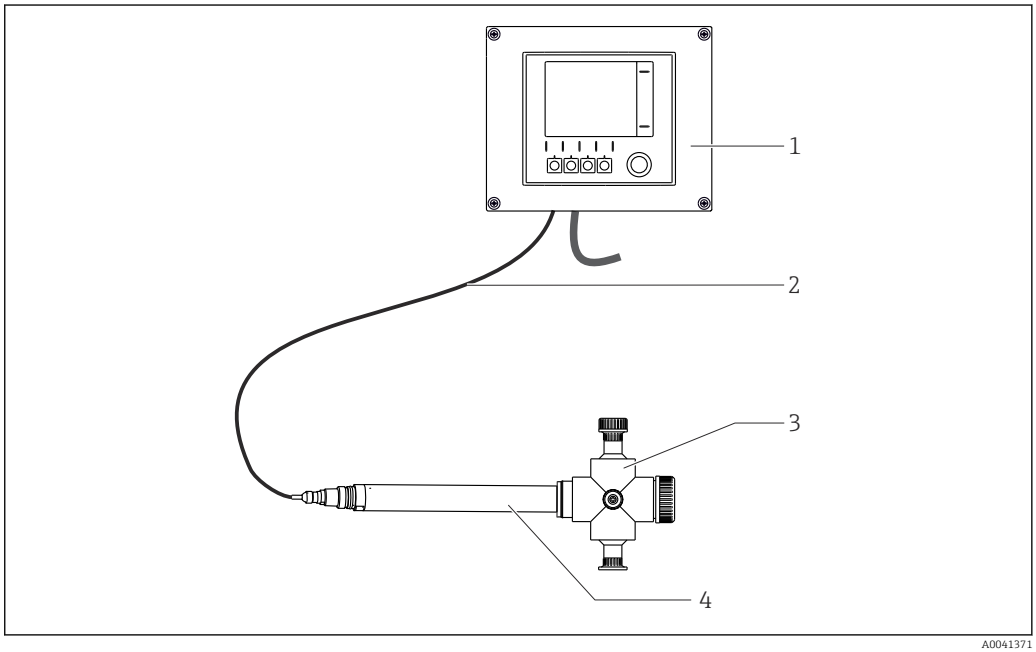

*6 Alignment, arrow points in the flow direction*

When aligning the spectrometer, pay attention to the following:
- The measurement gap is rinsed by the flow of medium
- Air bubbles can be rinsed away properly

## 5.2 Mounting the device

### 5.2.1 Measuring system

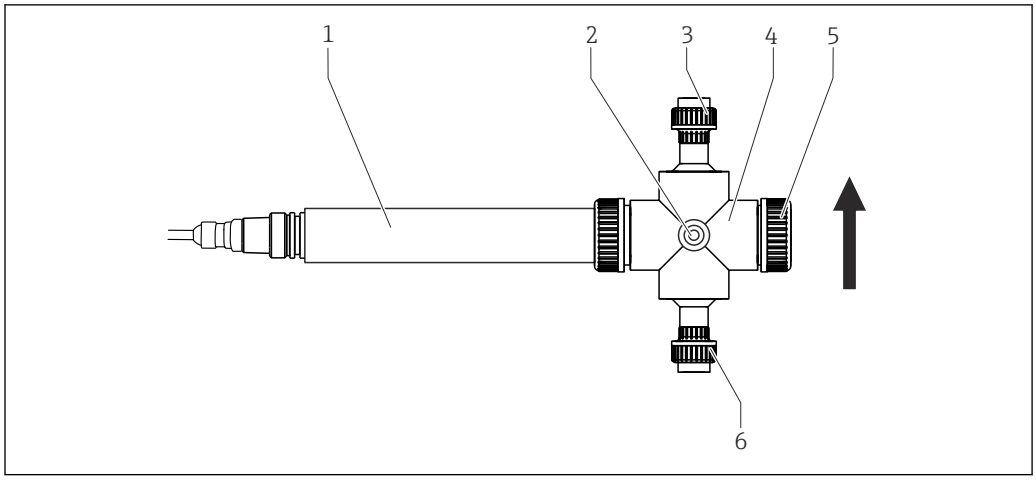
The complete measuring system comprises at least:
- Memosens Wave CAS80E spectrometer
- Liquiline CM44x transmitter
- Assembly, e.g. Flowfit CYA251 flow assembly




*7 Example of a measuring system*

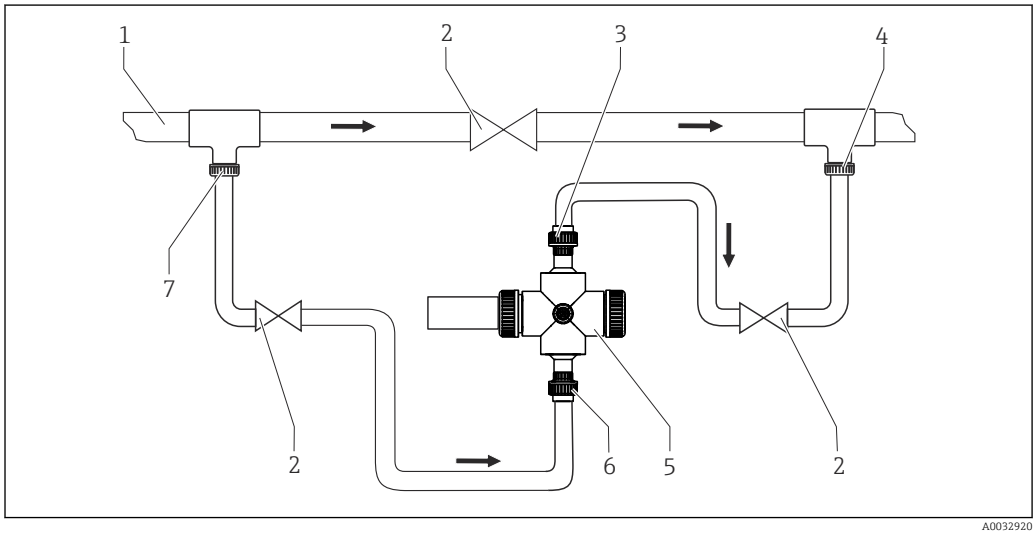
*1 Liquiline CM44x transmitter*
*2 Fixed cable*
*3 CYA251 assembly*
*4 Memosens Wave CAS80E spectrometer*

### 5.2.2 Flowfit CYA251 flow assembly




*8 Spectrometer with CYA251 flow assembly, arrow indicates the flow direction*

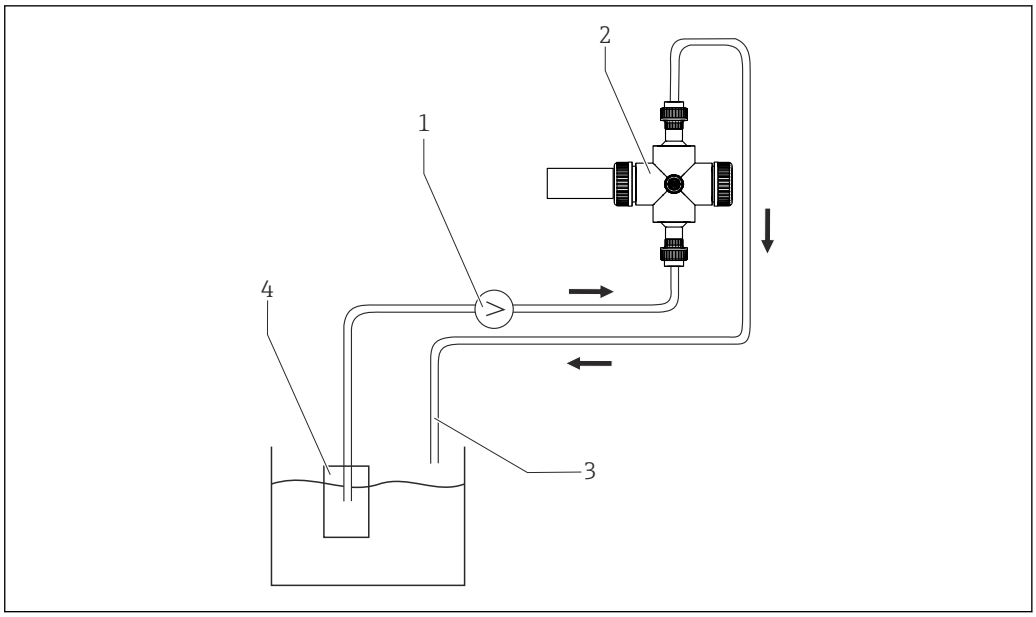
*1 Memosens Wave CAS80E spectrometer*
*2 Purge connection*
*3 Medium outlet*
*4 Flow assembly*
*5 Cap*
*6 Medium inlet*




*9 Connection diagram with bypass*

*1 Main pipe*
*2 Adjustment and shut-off valve*
*3 Medium outlet*
*4 Medium return*
*5 Flow assembly*
*6 Medium inlet*
*7 Medium sampling*

- The flow rate must be at least 100 l/h (26.5 gal/h).
- Take the extended response times into consideration.



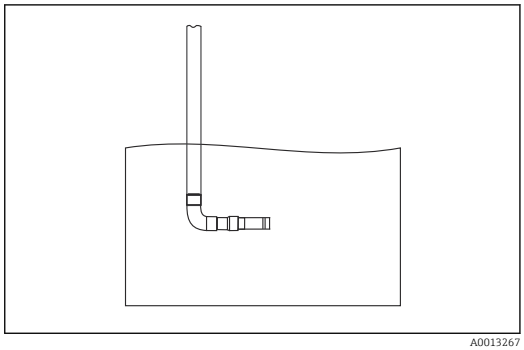

10 *Connection diagram with open outlet, arrow points in the flow direction*

1 *Pump*
2 *Flow assembly*
3 *Open outlet*
4 *Filter unit*

As an alternative to operation in the bypass, it is also possible to direct the sample flow from a filter unit with an open outlet through the assembly → 8, 14.

For detailed information on installing the flow assembly: BA00495C

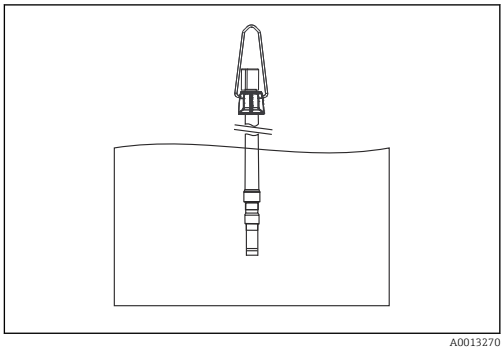
### 5.2.3 Immersion assembly




11 *CYA112 immersion assembly and CYH112 holder installed horizontally, fixed installation*

The installation angle is 90°.

- Align the spectrometer in such a way that the measurement gap is rinsed with the flow of medium and air bubbles are removed.



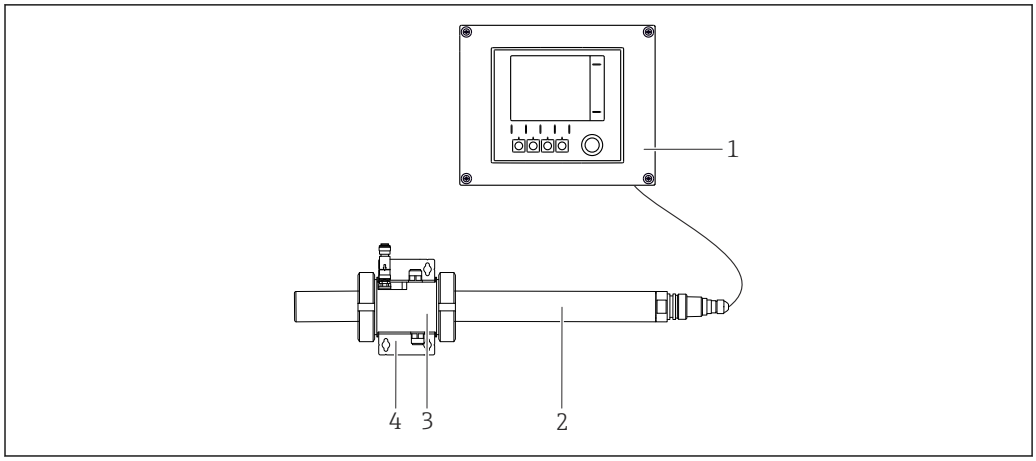

12 *CYA112 immersion assembly and CYH112 holder installed vertically, suspended from a chain*

The installation angle is 0°.

- Ensure that the spectrometer is adequately cleaned. There must be no buildup on the optical windows.

For detailed information on installing the immersion assembly and the holder, see BA00432C and BA00430C

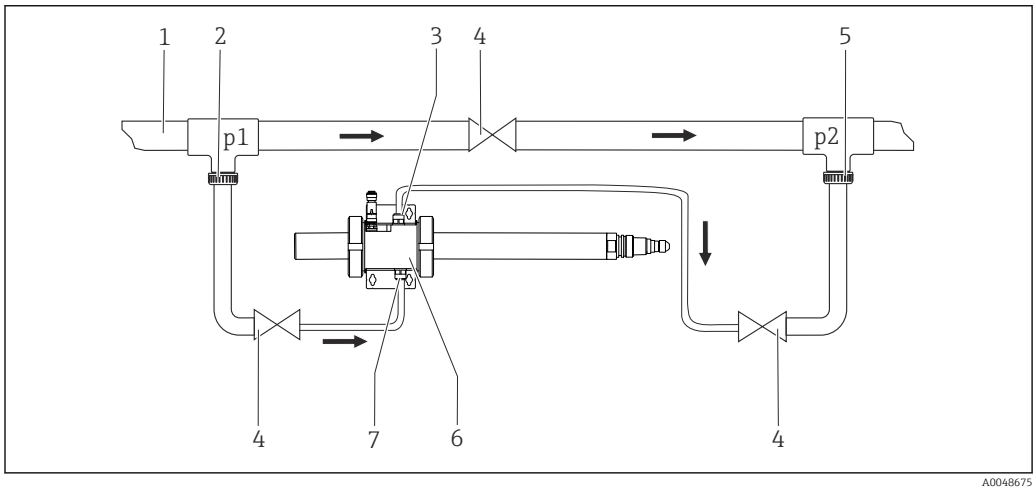
### 5.2.4 Flow assembly CAV01




13 *Measuring system*

1 *Transmitter*
2 *Sensor*
3 *Flow assembly*
4 *Holder*

#### Assembly in the bypass




14 *Connection diagram with bypass*

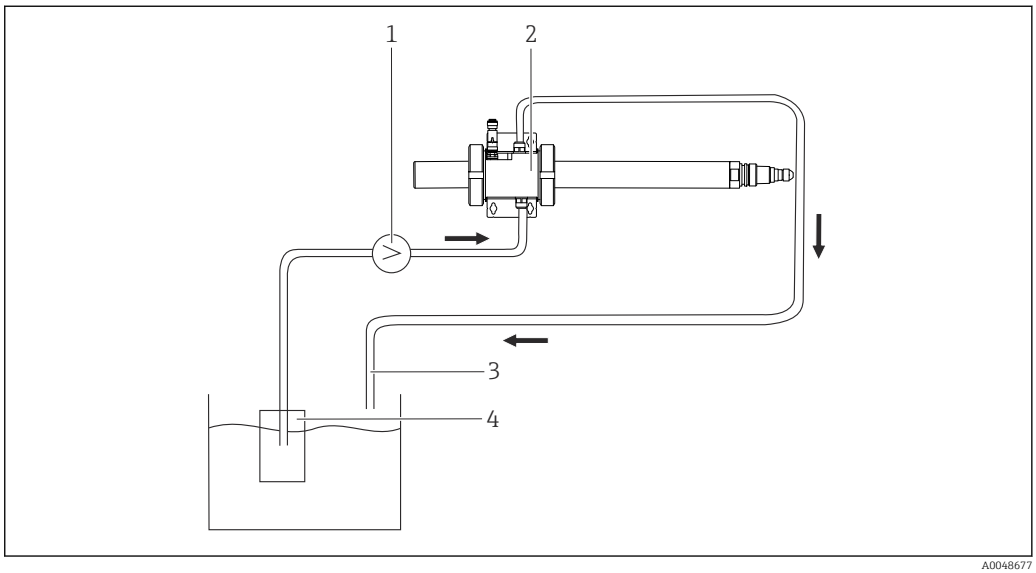
1 *Main pipe*
2 *Medium sampling*
3 *Medium outlet*
4 *Adjustment and shut-off valve or orifice plate*
5 *Medium return*
6 *Flow assembly*
7 *Medium inlet*

To achieve flow through the assembly with a bypass, pressure p1 must be higher than pressure p2. No measures to increase pressure are required for branch pipes that branch off from the main pipe (no return medium).

1. Connect the medium inlet and outlet to the hose connections of the assembly.
   ↳ The assembly is filled from below and is therefore self-venting.
2. Install an orifice plate or adjustment valve in the main pipe to ensure that pressure p1 is higher than pressure p2.
3. Ensure that the flow rate is at least 100 ml/h (0.026 gal/h).

4. Take the extended response times into consideration.

**Assembly in open outlet**

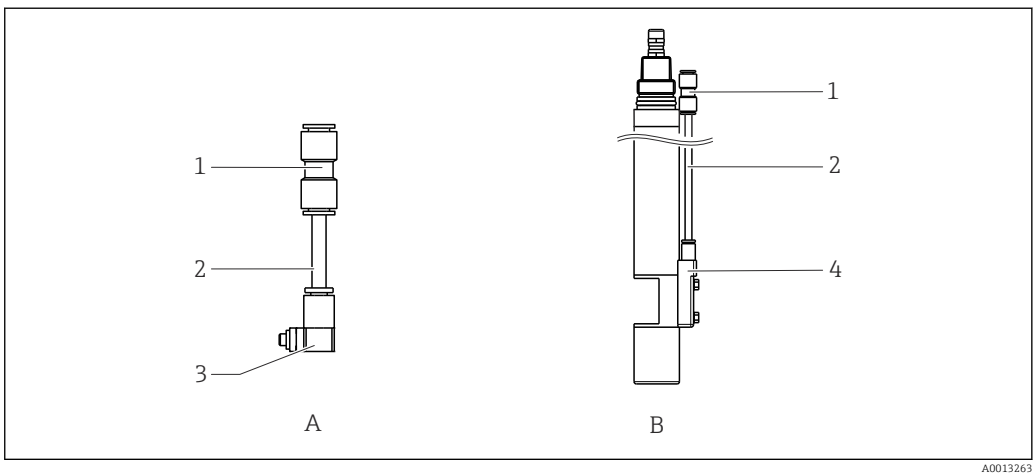



15 *Connection diagram with open outlet using the example of CAS80E, arrow indicates the flow direction*

*1 Pump*
*2 Flow assembly*
*3 Open outlet*
*4 Filter unit*

As an alternative to operation in the bypass, it is also possible to direct the sample flow from a filter unit with an open outlet through the assembly.

## 5.2.5 Cleaning unit




16 *Compressed air cleaning*

*A Cleaning for optical path length 2 mm (0.08 in) and 10 mm (0.4 in)*
*B Cleaning for optical path length 50 mm (1.97 in)*
*1 Adapter 8 mm (0.31)*
*2 300 mm (11.81 in) hose (Ø = 6 mm (0.24 in))*
*3 Gland 6 mm (0.24 in) or 6.35 mm (0.25 in) for optical path length 2 mm (0.08 in) and 10 mm (0.4 in)*
*4 Gland 6 mm (0.24 in) or 6.35 mm (0.25 in) for optical path length 50 mm (1.97 in)*

The air cleaning system is not suitable for use in drinking water according to NSF/ANSI Standard 61.

**⚠ CAUTION**

**Residual medium and high temperatures**

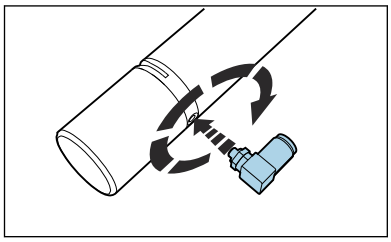
Risk of injury!

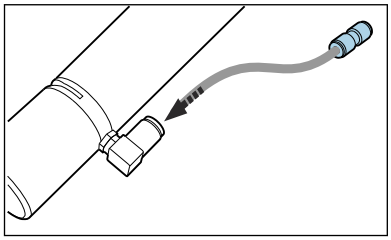
- ▶ When working with parts that are in contact with the medium, protect against residual medium and elevated temperatures.
- ▶ Wear safety goggles and safety gloves.

Preparatory steps:

1. Mount the compressed air cleaning on the spectrometer before installing in the measuring point.
2. Remove the spectrometer from the medium if the device is already in the process.
3. Clean the spectrometer.

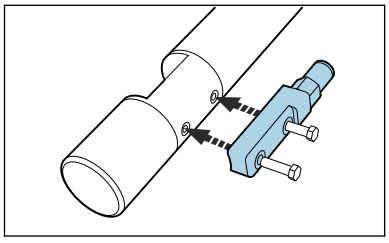
**Spectrometer with 2 mm (0.08 in) or 10 mm (0.4 in) optical path length:**

1. 

   Insert the elbow plug into the mounting borehole behind the measurement gap as far as the end stop (hand-tight).
2. Screw the elbow plug tight.
3. 

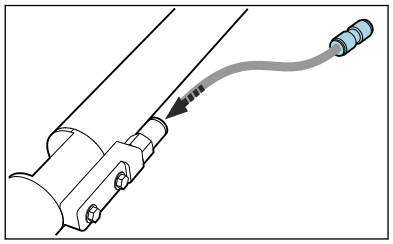
   Connect the hose of the compressed air supply at the installation location to the opening of the elbow plug.
4. Use the hose piece with hose coupling provided with the sensor if desired.

**Spectrometer with 50 mm (2 in) optical path length:**

1. 

   Insert the air distributor into the mounting boreholes behind the measurement gap as far as the end stop (hand-tight).

2.



Connect the hose of the compressed air supply to the opening of the elbow plug.

3. Use the hose piece with hose coupling provided with the sensor if desired.

## 5.3 Post-installation check

Put the spectrometer into operation only if you can answer "yes" to the following questions:
- Are the spectrometer and cable undamaged?
- Is the orientation correct?
- Is the spectrometer installed in an assembly and not freely suspended from the cable?
- Is the cable routed so that it is completely dry (routed inside an assembly if necessary)?

# 6 Electrical connection

**⚠ WARNING**

**Device is live!**

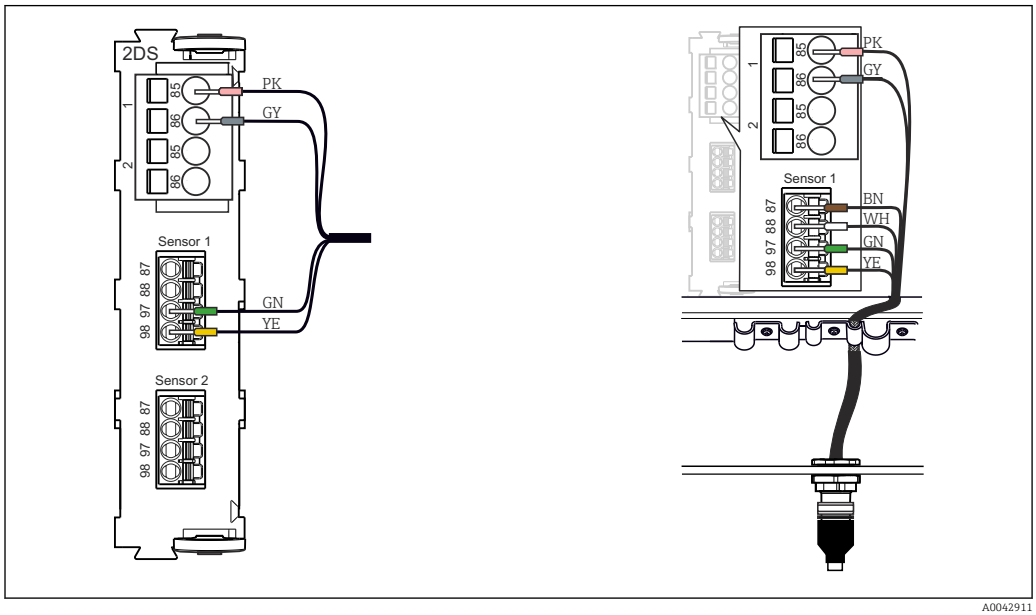
Incorrect connection may result in injury or death!

- ▶ 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.

## 6.1 Connecting the device

The following connection options are available:

- Via M12 plug (version: fixed cable, M12 plug)
- Via the cable of the spectrometer to the plug-in terminals of a transmitter input (version: fixed cable, wire end ferrules)




17 *Spectrometer connection to input (left) or via M12 plug (right)*

The maximum cable length is 100 m (328.1 ft).

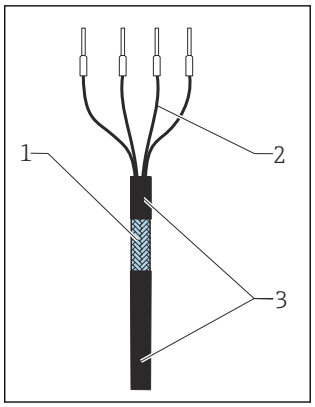
### 6.1.1 Connecting the cable shield

Device cable must be shielded cables.

Only use terminated original cables where possible.

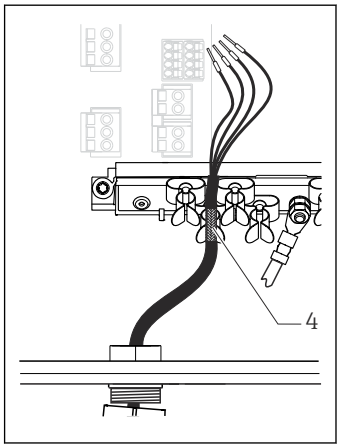
Clamping range of cable clamps: 4 to 11 mm (0.16 to 0.43 in)

*Cable sample (does not necessarily correspond to the original cable supplied)*



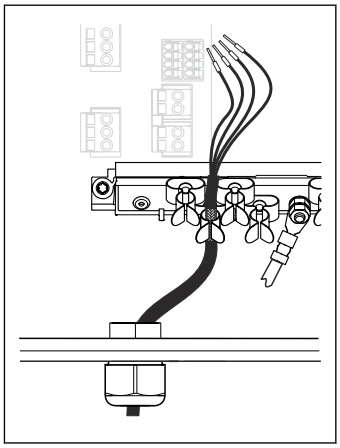

*18 Terminated cable*

*1 Outer shield (exposed)*
*2 Cable cores with ferrules*
*3 Cable sheath (insulation)*




*19 Connect the cable to the grounding clamp*

*4 Grounding clamp*




*20 Press the cable into the grounding clamp*

*The cable shield is grounded using the grounding clamp* [1)]

1) Please note the instructions in the "Ensuring the degree of protection" section

1. Loosen a suitable cable gland on the bottom of the housing.
2. Remove the dummy plug.
3. Attach the gland to the cable end, making sure the gland is facing the right direction.
4. Pull the cable through the gland and into the housing.
5. Route the cable in the housing in such a way that the **exposed** cable shield fits into one of the cable clamps and the cable cores can be easily routed as far as the connection plug on the electronics module.
6. Connect the cable to the cable clamp.
7. Clamp the cable.
8. Connect cable cores as per the wiring diagram.
9. Tighten the cable gland from outside.

## 6.2 Ensuring the degree of protection

Only the mechanical and electrical connections which are described in these instructions, and which are necessary for the required intended use, may be established 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) that are loose or insufficiently secured.

## 6.3 Post-connection check

| **Device health and specifications** | **Action** |
|---|---|
| Is the outside of the spectrometer, assembly or cable free from damage? | ▶ Perform a visual inspection. |
| **Electrical connection** | **Action** |
| Are the mounted cables strain-relieved and not twisted? | ▶ Perform a visual inspection.<br>▶ Untwist the cables. |

| Device health and specifications | Action |
|---|---|
| Is a sufficient length of the cable cores stripped, and are the cores positioned in the terminal correctly? | ▶ Perform a visual inspection.<br>▶ Pull gently to check they are seated correctly. |
| Are the power supply and signal lines correctly connected? | ▶ Refer to the wiring diagram for the transmitter. |
| Are all screw terminals tightened? | ▶ Tighten the screw terminals. |
| Are all the cable entries installed, tightened and leak-tight? | ▶ Perform a visual inspection.<br>In the case of lateral cable entries: |
| Are all cable entries mounted on the side or pointing downwards? | ▶ Point cable loops downward so that water can drip off. |

# 7 Commissioning

## 7.1 Installation and function check

Prior to initial commissioning, ensure that:
- The spectrometer has been installed correctly
- The electrical connection is correct

▶ Before commissioning, check the chemical material compatibility, the temperature range and the pressure range.

# 8 Operation

## 8.1 Adapting the measuring instrument to the process conditions

### 8.1.1 Calibration

The spectrometer offers a variety of options for an application-specific calibration. Each parameter can be calibrated individually.

Example: It is possible to calibrate the turbidity with an offset and the COD with a factor.

- The use of the factor calibration and offset calibration is recommended.
- Do not use multiple point calibration in combination with the factor calibration or offset calibration.

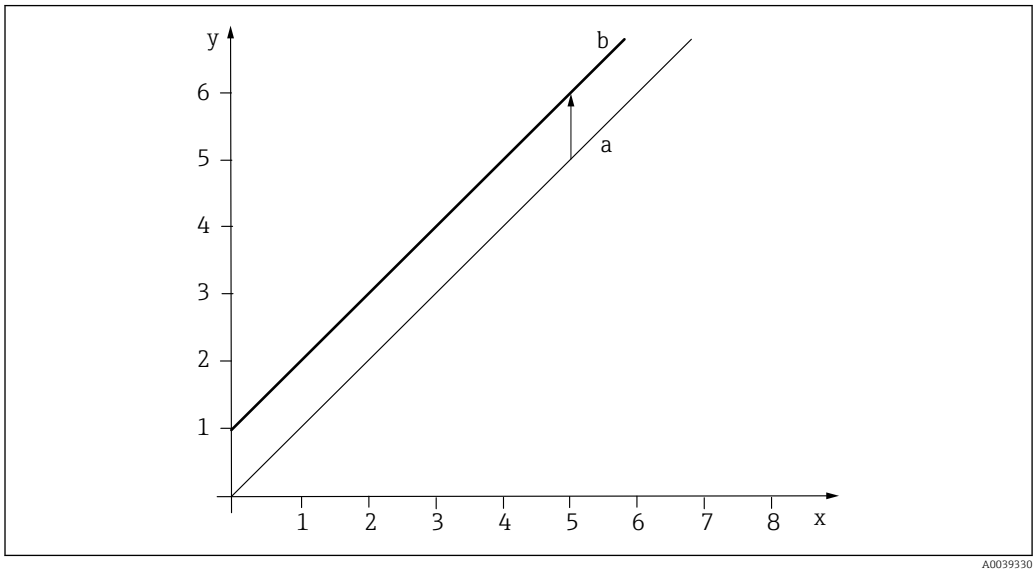
If it is not possible to bring the parameters to the process values using these methods, an application-specific model adjustment is recommended.

► Contact your Endress+Hauser representative for information on application-specific model adjustments.

#### Offset

Measured values that always deviate by a constant value can be corrected with an offset calibration (e.g. if the measured values for TOC are always 1 mg/l (1 ppm) above the laboratory value).

With the "Offset" function, the measured values are offset by a constant amount (added or subtracted).




*21 Principle of an offset*

*x Measured value*
*y Target sample value*
*a Factory calibration*
*b Offset calibration*

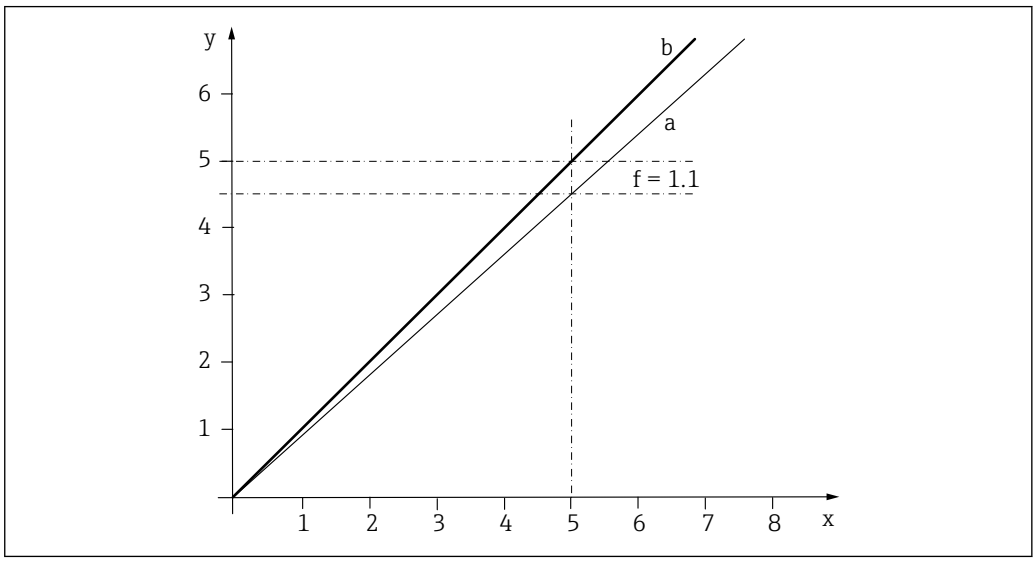
#### Factor

With the "Factor" function, the measured values are multiplied by a constant factor. The functionality corresponds to that of a 1-point calibration.

Example:

This type of adjustment can be selected if the measured values are compared to the laboratory values over a longer period of time and all values are too low by a constant factor, e.g. 10%, in relation to the laboratory value (target sample value).

In the example, the adjustment is made by entering the factor 1.1.

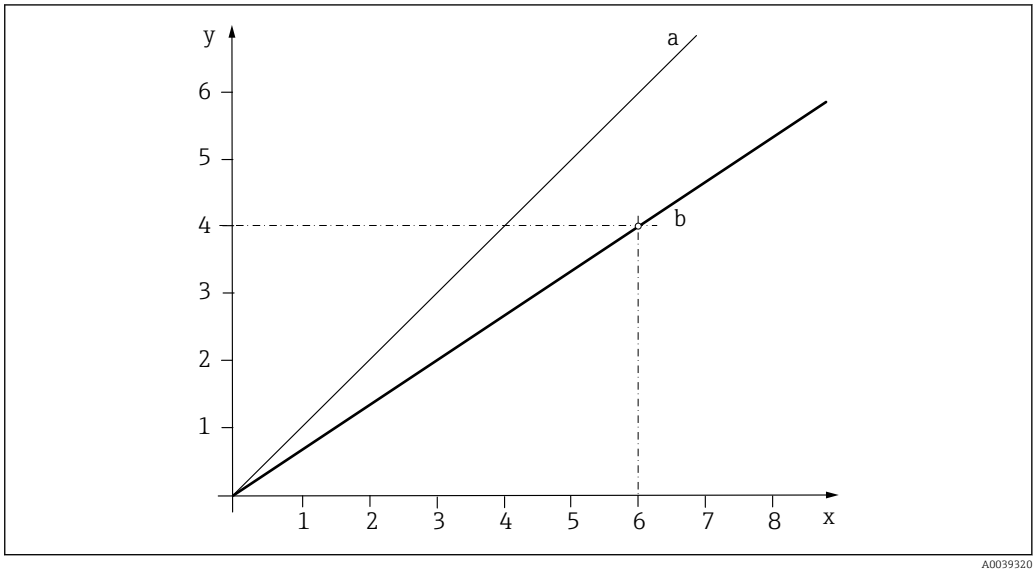



*22 Principle of factor calibration*

*x Measured value*
*y Target sample value*
*a Factory calibration*
*b Factor calibration*

### One-point calibration

The measured error between the measured value of the device and the laboratory measured value is too large. This is corrected by a 1-point calibration.



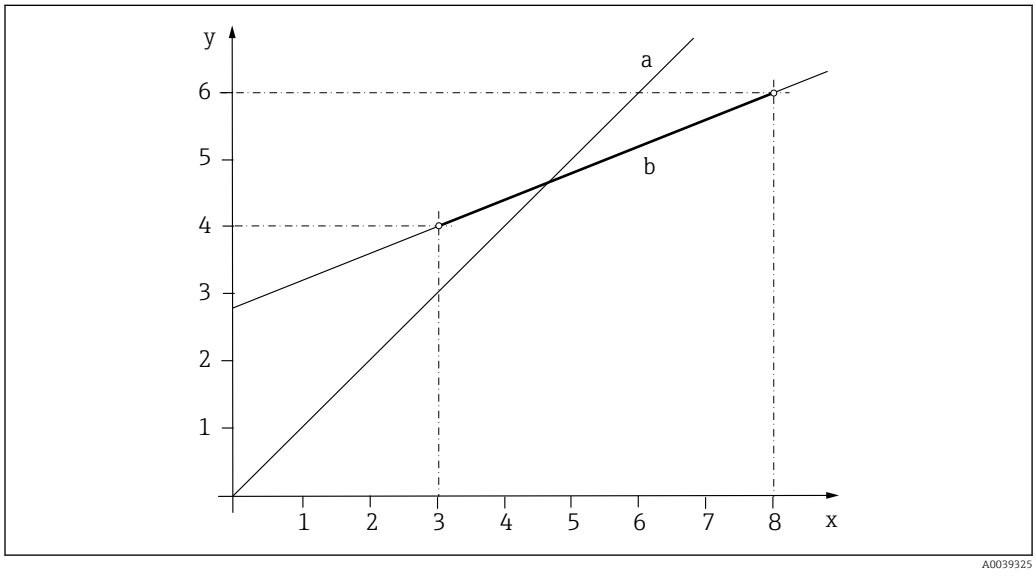

*23 Principle of a 1-point calibration*

*x Measured value*
*y Target sample value*
*a Factory calibration*
*b Application calibration*

1. Select data record.
2. Set the calibration point in the medium and enter the target sample value (laboratory value).

### Two-point calibration

Measured value deviations are to be compensated at 2 different points in an application (e.g. maximum and minimum value of the application). This aims to ensure a maximum level of measurement accuracy between these two extreme values.




24 *Principle of a two-point calibration*

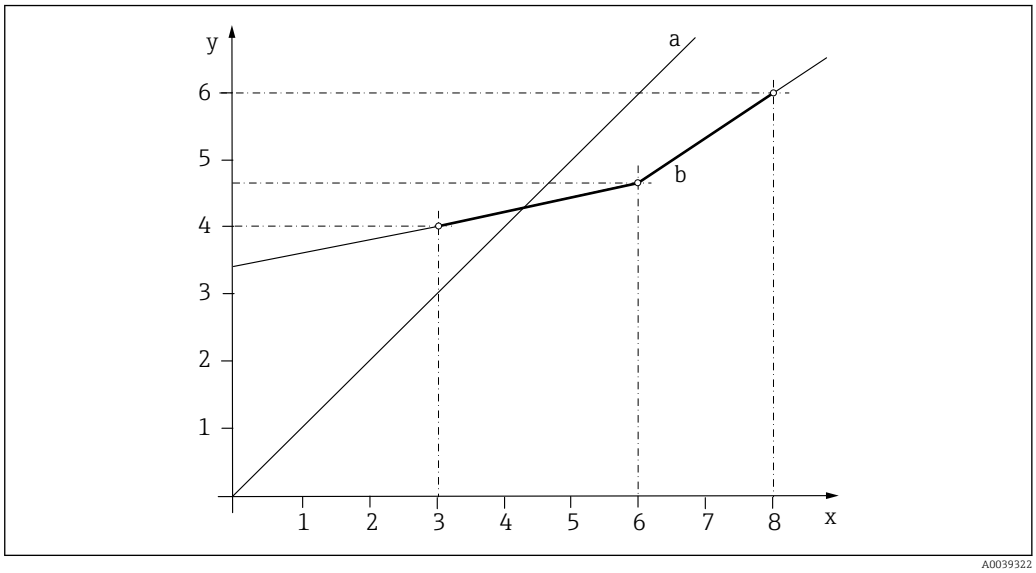
*x* *Measured value*
*y* *Target sample value*
*a* *Factory calibration*
*b* *Application calibration*

1. Select a data set.
2. Set 2 different calibration points in the medium and enter the corresponding set points.

A linear extrapolation is performed outside the calibrated operational range.

The calibration curve must be monotonically increasing.

**Three-point calibration**




25 *Principle of multipoint calibration (3 points)*

*x Measured value*
*y Target sample value*
*a Factory calibration*
*b Application calibration*

1. Select the data set.
2. Set 3 different calibration points in the medium and specify the corresponding set value.

A linear extrapolation is performed outside the calibrated operational range.

The calibration curve must be monotonically increasing.

**Zero calibration**

The zero calibration is the reference calibration on which the calculations are based. The spectrometer leaves the factory with a zero calibration performed in ultrapure water.

Zero calibration is performed as a recording of an ultrapure water spectrum. Proceed as follows for this:

1. Clean the spectrometer → 31.
2. Record a reference spectrum in ultrapure water.

For detailed information on the settings on the CM44x transmitter, see BA00444C

## 8.2 Cyclic cleaning

### 8.2.1 Compressed air

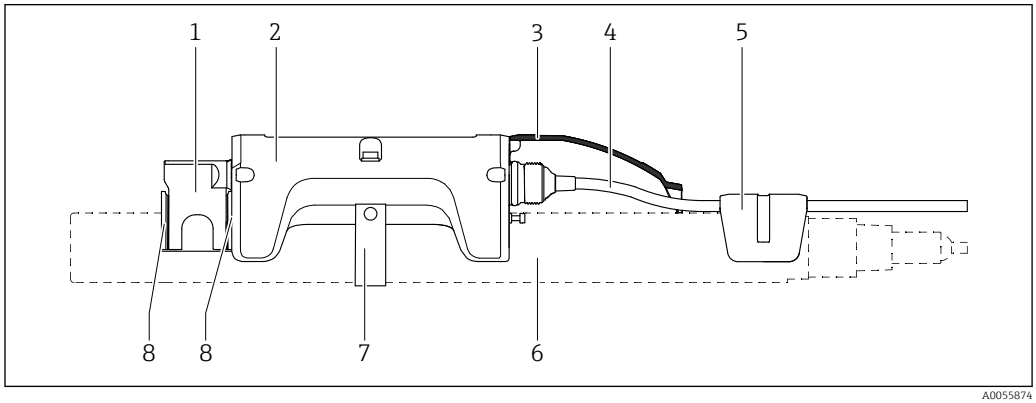
Compressed air is most suitable for automatic cyclic cleaning. The connection for compressed air is provided on the spectrometer behind the measurement gap. The air

cleaning system (supplied with device or retrofitted) works at a capacity of 20 l/min (76 gal/min).

| Type of fouling | Cleaning interval | Cleaning duration |
|---|---|---|
| Severe fouling with rapid buildup of deposits | 5 minutes | 10 seconds |
| Low risk of fouling | 10 minutes | 10 seconds |

## 8.2.2 Mechanical cleaning unit

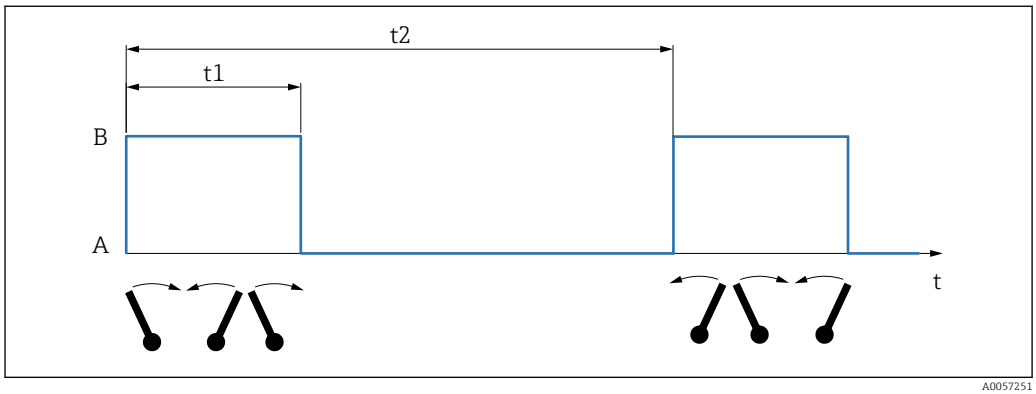
The CYR51 mechanical cleaning unit facilitates easy and proper cleaning of optical windows. The mechanical cleaning unit is attached to the sensor and secured. During each cleaning cycle, the wiper arm moves over the optical windows and cleans them. Replaceable brushes or wiper blades are used depending on the order option.




26 *CYR51 using CAS51D as an example*

1 *Wiper arm*
2 *Wiper unit*
3 *Tressing protection (optional for "Wastewater" order version)*
4 *Cable for wiper*
5 *Cable clip*
6 *Sensor*
7 *Mounting bracket with 2x O-ring + 2x screw*
8 *Wiper blade or brush*

Mechanical cleaning is switched on cyclically for a few seconds via the transmitter. Once the transmitter activates the cleaning interval, cleaning starts automatically. The wiper arm moves three times per cleaning interval.




27 *Cleaning interval*

*A Wiper arm with no movement*
*B Wiper arm moving*
*t1 Cleaning time*
*t2 Cleaning interval*

The cleaning time (t1) is preset and lasts for a maximum of 10 seconds.

The cleaning interval (t2) can be shortened if necessary. A DIO card must be used in the transmitter for cleaning intervals that are shorter than 5 minutes.

*Recommendation for good cleaning power and maximum service life:*

| Application | Cleaning interval (t2) |
|---|---|
| Wastewater | 5 minutes |
| Process water | 10 minutes |
| Drinking water | 20 minutes |

The cleaning cycle is configured in the transmitter in the **Menu/Setup/Additional functions/Cleaning** menu.

Follow the Operating Instructions for the transmitter.

# 9 Diagnostics and troubleshooting

## 9.1 General troubleshooting

When troubleshooting, the entire measuring point must be taken into account:
- Transmitter
- Electrical connections and cables
- Assembly
- Spectrometer

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

| Problem | Check | Remedial action |
|---|---|---|
| Nothing displayed, no reaction from the spectrometer | ▪ Mains voltage at transmitter?<br>▪ Current transmitter software incorporated?<br>▪ Spectrometer connected correctly?<br>▪ Buildup on optical windows? | ▶ Connect mains voltage.<br>▶ Perform software update.<br>▶ Establish correct connection.<br>▶ Clean the spectrometer. |
| Display value too high or too low | ▪ Buildup on optical windows?<br>▪ Spectrometer calibrated? | ▶ Clean the windows.<br>▶ Calibrate the spectrometer. |
| Display value fluctuating greatly | ▪ Air bubbles in the measurement gap?<br>▪ Is the mounting location correct? | ▶ Clean the windows.<br>▶ Select a different mounting location.<br>▶ Adjust measurement filter. |
| Measured value drift | Buildup on optical windows? | ▶ First clean the spectrometer.<br>▶ Record the reference spectrum. |

Pay attention to the troubleshooting information in the Operating Instructions for the transmitter. Check the transmitter if necessary.

# 10 Maintenance

**⚠ CAUTION**

**Acid or medium**

Risk of injury, damage to clothing and the system!

- ▶ Switch off the cleaning unit and spectrometer before removing the spectrometer from the medium.
- ▶ Wear protective goggles and safety gloves.
- ▶ Clean away splashes on clothes and other objects.

- ▶ You must perform maintenance tasks at regular intervals.

We recommend setting the maintenance times in advance in an operations journal or log.

The maintenance cycle primarily depends on the following:

- The system
- The installation conditions
- The medium in which measurement takes place

## 10.1 Maintenance schedule

Monthly:
Visual inspection, cleaning of the optical windows.
The maintenance intervals depend on the medium. If a cleaning unit is connected, the maintenance intervals can be extended.

## 10.2 Maintenance tasks

**NOTICE**

**Dirt on the optical components**

- ▶ Perform maintenance work at a clean workplace.

**NOTICE**

**Work performed carelessly**

Damage to the optical components!

- ▶ Ensure that maintenance work is carried out by qualified specialists only.

### 10.2.1 Cleaning the device

Spectrometer fouling can affect the measurement results and even cause a malfunction.

The spectrometer must be cleaned regularly to ensure reliable measurement results. The frequency and intensity of the cleaning process depend on the medium.

Clean the spectrometer:

- As specified in the maintenance schedule
- Before every calibration
- Before returning it for repairs

| Type of fouling | Cleaning measure |
|---|---|
| Lime deposits | ▶ Immerse the spectrometer in 1-5% hydrochloric acid (for a few minutes). |
| Deposit buildup on the optics | There may be deposit buildup in the non-visible range (UV). Therefore, always clean the optics.<br>▶ Rinse the spectrometer with copious amounts of water.<br>▶ Wet a lint-free cloth with 5-10% phosphoric acid or 5-10% hydrochloric acid.<br>▶ Insert the cloth into the measurement gap and leave for a maximum of 10 minutes.<br>▶ Move the cloth back and forth to remove dislodged dirt particles.<br>▶ Wet the brush supplied with acid.<br>▶ Use the brush to clean the windows. |
| After cleaning:<br>▶ Rinse the spectrometer with copious amounts of water. | |

# 11 Repair

## 11.1 General notes

- Only use spare parts from Endress+Hauser to guarantee the safe and stable functioning of the device.

Detailed information on the spare parts is available at:
www.endress.com/device-viewer

## 11.2 Spare parts

For more detailed information on spare parts kits, please refer to the "Spare Part Finding Tool" on the Internet:

www.products.endress.com/spareparts_consumables

## 11.3 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.

www.endress.com/support/return-material

## 11.4 Disposal

The device contains electronic components. The product must be disposed of as electronic waste.

- Observe the local regulations.

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

# 12 Accessories

The following are the most important accessories available at the time this documentation was issued.

Listed accessories are technically compatible with the product in the instructions.

1. Application-specific restrictions of the product combination are possible.
   Ensure conformity of the measuring point to the application. This is the responsibility of the operator of the measuring point.
2. Pay attention to the information in the instructions for all products, particularly the technical data.
3. For accessories not listed here, please contact your Service or Sales Center.

## 12.1 Device-specific accessories

### 12.1.1 Assemblies

**Flexdip CYA112**
- Immersion assembly for water and wastewater
- Modular assembly system for sensors in open basins, channels and tanks
- Material: PVC or stainless steel
- Product Configurator on the product page: www.endress.com/cya112

Technical Information TI00432C

**Flowfit CYA251**
- Connection: See product structure
- Material: PVC-U
- Product Configurator on the product page: www.endress.com/cya251

Technical Information TI00495C

**CAV01**
- Flow assembly
- Material: POM-C
- Product Configurator on the product page: www.endress.com/cav01

Technical Information TI01797C

### 12.1.2 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 coping stone, on the wall or directly onto railings.
- Stainless steel version
- Product Configurator on the product page: www.endress.com/cyh112

Technical Information TI00430C

### 12.1.3 Cleaning

**CYR51 mechanical cleaning**
- Sensors immersed in liquid can be cleaned directly in the basin or vessel.
- The mechanical cleaning unit is clipped onto the sensor and secured.
- Product Configurator on the product page: www.endress.com/cyr51

Technical Information TI01821C

**Manual cleaning**
- Cleaning brushes to clean the measurement gap (for all gap sizes)
- Order number: 71485097

**Compressed air cleaning**
- Connection: 6 mm (0.24 in) or 8 mm (0.31 in) (metric) or 6.35 mm (0.25 in)
- Optical path length 2 mm (0.08 in) or 10 mm (0.4 in):
  - 6 mm (0.24 in) (with 300 mm (11.81 in) hose and 8 mm (0.31) adapter)
    Order number: 71485094
  - 6.35 mm (0.25 in)
    Order number: 71485096
- Optical path length 50 mm (1.97 in):
  - 6 mm (0.24 in) (with 300 mm (11.81 in) hose and 8 mm (0.31) adapter)
    Order number: 71485091
  - 6.35 mm (0.25 in)
    Order number: 71485093

**Compressor**
- For compressed air cleaning
- 115 V AC, order number: 71194623

### 12.1.4 Additional accessories

**Sensor adapter CYA251 for CAS80E**
Order number: 71475982

**Spray nozzle for CAS80E with optical path length 2 mm (0.08 in) or 10 mm (0.4 in)**
- Material: stainless steel
- Order number: 71144328

**Spray nozzle for CAS80E with optical path length 50 mm (1.97 in)**
- Material: PVC
- Order number: 71144330

**32GB SD card**
Order number: 71467522

# 13 Technical data

## 13.1 Input

Measured variable

- CODeq [1] (mg/l)
- BODeq (mg/l)
- TOCeq (mg/l)
- TSS (mg/l)
- TU (FAU)
- APHA Hazen [2] (TU compensated/True Color or TU uncompensated/Apparent Color)
- SAC [3] (1/m)
- SSK [4] (1/m)
- Nitrate NO3-N (mg/l)
- Nitrate NO3 (mg/l)

Measuring range

The measuring range that can actually be achieved can depend on the composition of the water matrix and the application. The data apply to homogeneous media.

The selection of the optimal optical measuring path length is based on the measuring ranges of the respective parameters. A longer measuring path length results in a smaller measuring range (measurement at low concentrations) and low limits of quantification and detection. A shorter measuring path length results in a larger measuring range (measurement at high concentrations) and higher limits of quantification and detection.

*Wastewater treatment plant inlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| TSS | 0 to 10 000 mg/l | 0 to 2 000 mg/l | 0 to 400 mg/l |
| SAC | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| CODeq | 0 to 20 000 mg/l | 0 to 4 000 mg/l | 0 to 800 mg/l |
| TOCeq | 0 to 8 000 mg/l | 0 to 1 600 mg/l | 0 to 320 mg/l |
| BODeq | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |

*Wastewater treatment plant outlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 0 to 4 000 FAU | 0 to 800 FAU | 0 to 160 FAU |
| TSS | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |
| SAC | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| CODeq | 0 to 3 000 mg/l | 0 to 600 mg/l | 0 to 120 mg/l |
| TOCeq | 0 to 1 200 mg/l | 0 to 240 mg/l | 0 to 48 mg/l |
| BODeq | 0 to 450 mg/l | 0 to 90 mg/l | 0 to 18 mg/l |
| Nitrate NO3-N | 0 to 1 000 mg/l | 0 to 200 mg/l | 0 to 40 mg/l |

1) eq = equivalent
2) According to US Standard Methods 2120C (Single Wavelength Method) 23. Edition
3) Spectral absorption coefficient$_{SAK_254}$ according to DIN ISO 38404-3
4) Spectral attenuation coefficient$_{SSK_254}$ according to DIN ISO 38404-3

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| APHA Hazen true | 0 to 12 500 Hazen [1)] | 0 to 2 500 Hazen [1)] | 0 to 500 Hazen |
| APHA Hazen apparent | 0 to 12 500 Hazen [1)] | 0 to 2 500 Hazen [1)] | 0 to 500 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd Edition

*Drinking water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 0 to 4 000 FAU | 0 to 800 FAU | 0 to 160 FAU |
| TSS | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |
| SAC | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| SSK | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| TOCeq | 0 to 2 000 mg/l | 0 to 400 mg/l | 0 to 80 mg/l |
| Nitrate NO3-N | 0 to 1 000 mg/l | 0 to 200 mg/l | 0 to 40 mg/l |
| Nitrate NO3 | 0 to 4 000 mg/l | 0 to 800 mg/l | 0 to 160 mg/l |
| APHA Hazen true | 0 to 12 500 Hazen [1)] | 0 to 2 500 Hazen [1)] | 0 to 500 Hazen |
| APHA Hazen apparent | 0 to 12 500 Hazen [1)] | 0 to 2 500 Hazen [1)] | 0 to 500 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd edition

*Surface water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 0 to 4 000 FAU | 0 to 800 FAU | 0 to 160 FAU |
| TSS | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |
| SAC | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| CODeq | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |
| BODeq | 0 to 750 mg/l | 0 to 150 mg/l | 0 to 30 mg/l |
| Nitrate NO3-N | 0 to 1 000 mg/l | 0 to 200 mg/l | 0 to 40 mg/l |

*Industrial wastewater*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| TSS | 0 to 10 000 mg/l | 0 to 2 000 mg/l | 0 to 400 mg/l |
| SAC | 0 to 1 000 1/m | 0 to 200 1/m | 0 to 40 1/m |
| CODeq | 0 to 20 000 mg/l | 0 to 4 000 mg/l | 0 to 800 mg/l |
| TOCeq | 0 to 8 000 mg/l | 0 to 1 600 mg/l | 0 to 320 mg/l |
| BODeq | 0 to 5 000 mg/l | 0 to 1 000 mg/l | 0 to 200 mg/l |

## 13.2 Power supply

| | |
|---|---|
| Power consumption | 24V DC (-15 %/+ 20 %), 5 watt |
| Overvoltage protection | Overvoltage category 1 |

## 13.3 Performance characteristics

| | |
|---|---|
| Reference operating conditions | 20 °C (68 °F), 1013 hPa (15 psi) |
| Maximum measurement error | The maximum measurement error, defined in accordance with ISO 15839, was determined using standard solutions (nitrate or KHP) under laboratory conditions [5]:<br>▪ NO3-N: ≤ 3 % of the measured value<br>▪ COD: ≤ 3 % of the measured value |
| Long-term drift | The drift over 100 days is less than the limit of quantification multiplied by factor k. See the following table for factor k: |

| Measured variable | Factor k |
|---|---|
| TSS (Wastewater treatment plant inlet) | 1.1 |
| TSS (Wastewater treatment plant outlet, drinking water, surface water) | 1 |
| SAC | 1 |
| CODeq | 1 |
| TOCeq | 1 |
| BODeq | 1 |
| Turbidity | 1 |
| Nitrate NO3-N | 1 |
| APHA Hazen true | 1 |
| APHA Hazen apparent | 1.5 |
| SSK | 2 |
| Nitrate NO3 | 1 |

Limit of detection

The limits of detection were determined for the individual measured variables in ultrapure water under laboratory conditions based on DIN ISO 15839.

*Wastewater treatment plant inlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| TSS | 20 mg/l | 4 mg/l | 0.8 mg/l |
| SAC | 1 1/m | 0.2 1/m | 0.04 1/m |
| CODeq | 10 mg/l | 2 mg/l | 0.4 mg/l |

5) 24 °C (75.2 °F), 1 bar, using a laboratory model

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| TOCeq | 4 mg/l | 0.8 mg/l | 0.16 mg/l |
| BODeq | 2.5 mg/l | 0.5 mg/l | 0.1 mg/l |

*Wastewater treatment plant outlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 12.5 FAU | 2.5 FAU | 0.5 FAU |
| TSS | 11.5 mg/l | 2.3 mg/l | 0.46 mg/l |
| SAC | 1 1/m | 0.2 1/m | 0.04 1/m |
| CODeq | 2 mg/l | 0.4 mg/l | 0.08 mg/l |
| TOCeq | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| BODeq | 0.5 mg/l | 0.1 mg/l | 0.02 mg/l |
| Nitrate NO3-N | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| APHA Hazen true | 62.5 Hazen [1)] | 12.5 Hazen [1)] | 2.5 Hazen |
| APHA Hazen apparent | 62.5 Hazen [1)] | 12.5 Hazen [1)] | 2.5 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd edition

*Drinking water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 12.5 FAU | 2.5 FAU | 0.5 FAU |
| TSS | 11.5 mg/l | 2.3 mg/l | 0.46 mg/l |
| SAC | 1 1/m | 0.2 1/m | 0.04 1/m |
| SSK | 1 1/m | 0.2 1/m | 0.04 1/m |
| TOCeq | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| Nitrate NO3-N | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| Nitrate NO3 | 4.5 mg/l | 1 mg/l | 0.2 mg/l |
| APHA Hazen true | 62.5 Hazen [1)] | 12.5 Hazen [1)] | 2.5 Hazen |
| APHA Hazen apparent | 62.5 Hazen [1)] | 12.5 Hazen [1)] | 2.5 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd edition

*Surface water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 12.5 FAU | 2.5 FAU | 0.5 FAU |
| TSS | 11.5 mg/l | 2.3 mg/l | 0.46 mg/l |
| SAC | 1 1/m | 0.2 1/m | 0.04 1/m |
| CODeq | 2 mg/l | 0.4 mg/l | 0.08 mg/l |

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| BODeq | 0.5 mg/l | 0.1 mg/l | 0.02 mg/l |
| Nitrate NO3-N | 1 mg/l | 0.2 mg/l | 0.04 mg/l |

Limit of quantification

The limits of quantification were determined for the individual measured variables in ultrapure water under laboratory conditions based on DIN ISO 15839.

*Wastewater treatment plant inlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| TSS | 66.7 mg/l | 13.3 mg/l | 2.7 mg/l |
| SAC | 3.5 1/m | 0.7 1/m | 0.15 1/m |
| CODeq | 33.3 mg/l | 6.7 mg/l | 1.35 mg/l |
| TOCeq | 13.3 mg/l | 2.7 mg/l | 0.55 mg/l |
| BODeq | 8.3 mg/l | 1.7 mg/l | 0.35 mg/l |

*Wastewater treatment plant outlet*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 42.5 FAU | 8.5 FAU | 1.7 FAU |
| TSS | 37.5 mg/l | 7.5 mg/l | 1.5 mg/l |
| SAC | 3.5 1/m | 0.7 1/m | 0.15 1/m |
| CODeq | 7.5 mg/l | 1.5 mg/l | 0.3 mg/l |
| TOCeq | 3.25 mg/l | 0.75 mg/l | 0.15 mg/l |
| BODeq | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| Nitrate NO3-N | 3.5 mg/l | 0.7 mg/l | 0.15 mg/l |
| APHA Hazen true | 167.5 Hazen [1)] | 33.5 Hazen [1)] | 6.7 Hazen |
| APHA Hazen apparent | 167.5 Hazen [1)] | 33.5 Hazen [1)] | 6.7 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd edition

*Drinking water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 42.5 FAU | 8.5 FAU | 1.7 FAU |
| TSS | 37.5 mg/l | 7.5 mg/l | 1.5 mg/l |
| SAC | 3.5 1/m | 0.7 1/m | 0.15 1/m |
| SSK | 3.5 1/m | 0.7 1/m | 0.15 1/m |
| TOCeq | 3.25 mg/l | 0.75 mg/l | 0.15 mg/l |
| Nitrate NO3-N | 3.5 mg/l | 0.7 mg/l | 0.15 mg/l |
| Nitrate NO3 | 14.8 mg/l | 3 mg/l | 0.6 mg/l |

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| APHA Hazen true | 167.5 Hazen [1)] | 33.5 Hazen [1)] | 6.7 Hazen |
| APHA Hazen apparent | 167.5 Hazen [1)] | 33.5 Hazen [1)] | 6.7 Hazen |

1) A minimum path length of 25 mm (0.98 in) is required in US Standard Methods 2120C (Single Wavelength Method) 23rd edition

*Surface water*

| Measured variable | 2 mm (0.08 in) gap | 10 mm (0.4 in) gap | 50 mm (1.97 in) gap |
|---|---|---|---|
| Turbidity | 42.5 FAU | 8.5 FAU | 1.7 FAU |
| TSS | 37.5 mg/l | 7.5 mg/l | 1.5 mg/l |
| SAC | 3.5 1/m | 0.7 1/m | 0.15 1/m |
| CODeq | 7.5 mg/l | 1.5 mg/l | 0.3 mg/l |
| BODeq | 1 mg/l | 0.2 mg/l | 0.04 mg/l |
| Nitrate NO3-N | 3.5 mg/l | 0.7 mg/l | 0.15 mg/l |

## 13.4 Environment

| | |
|---|---|
| Ambient temperature range | −20 to 60 °C (−4 to 140 °F) |
| Storage temperature | −20 to 70 °C (−4 to 158 °F) |
| Relative humidity | Humidity 0 to 100 % |
| Operating height | 3 000 m (9 842.5 ft) maximum |
| Degree of protection | ▪ IP 68 (1.83 m (6 ft) water column over 24 hours, 1 mol/l KCl)<br>▪ Type 6P (for housing material 1.4404/1.4571) |
| Fouling | Degree of fouling 2 (micro environment) |
| Ambient conditions | For use in indoor and outdoor areas |

## 13.5 Process

| | |
|---|---|
| Process temperature range | 0 to 50 °C (32 to 122 °F) |
| Process pressure range | 0.5 to 10 bar (7.3 to 145 psi) absolute |

Flow limit

**Minimum flow**

No minimum flow required.

For media that have a tendency to form deposits, ensure that the medium is mixed sufficiently.

## 13.6 Mechanical construction

Design, dimensions

Measurement gap with 3 optical path lengths:
- 2 mm (0.08 in)
- 10 mm (0.4 in)
- 50 mm (1.97 in)

Spectrometers with 1 mm (0.04 in) and 100 mm (3.9 in) optical path lengths are available on request.

Dimensions

→ Section "Installation"

Weight

1.6 kg (3.5 lb), without cables

Materials

**Wetted materials**

| | |
|---|---|
| Housing: | Stainless steel 1.4404 / AISI 316L and 1.4571 / AISI 316Ti or titanium 3.7035 |
| Optical windows: | Quartz glass or sapphire |
| O-rings: | EPDM |

Process connections

G1 and NPT ¾"

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