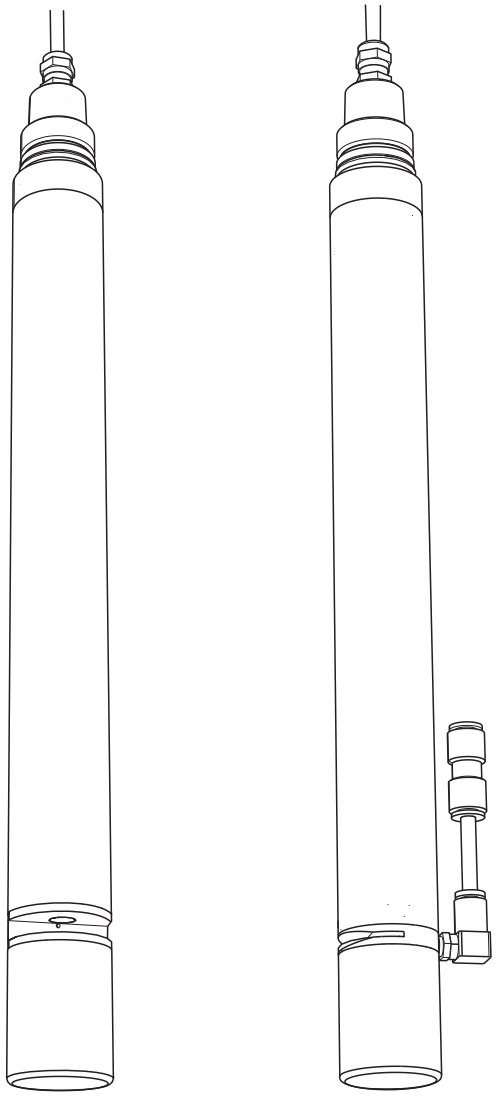
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

Viomax CAS51D

Photometric sensor for SAC or nitrate measurement



BA459C/07/EN/13.10
71125768

Endress+Hauser

People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

CAS51D is a photometric sensor for measuring SAC or nitrate in liquid media.

The sensor is particularly suited for use in the following applications:
- Monitoring and regulating water treatment plants
- Monitoring surface water

Nitrate measurement
- Nitrate measurement in natural bodies of water
- Monitoring the nitrate contents in the outlet of wastewater treatment plants
- Monitoring the nitrate contents in aeration basins
- Monitoring and optimizing the denitrification phases

SAC measurement
- Organic load in WWTP inlet
- Organic load in WWTP outlet
- Discharger monitoring
- Organic load in drinking water

Any other use than the one described here compromises the safety of persons and the entire measuring system and is not permitted.
The manufacturer is not liable for damage caused by improper or non-designated use.

1.2 Installation, commissioning and operation

Please note the following items:
- The measurement process in the sensor uses UV light. UV light can damage the eyes. Never look into the cuvette while the sensor is in operation.
- Installation, commissioning, operation and maintenance of the measuring system must only be carried out by trained technical personnel.
  Trained personnel must be authorized for the specified activities by the system operator.
- Electrical connection must only be carried out by a certified electrician.
- Technical personnel must have read and understood these Operating Instructions and must adhere to them.
- Before commissioning the entire measuring point, check all the connections. Ensure that electrical cables and hose connections are not damaged.
- Do not operate damaged products and secure them against unintentional commissioning. Mark the damaged product as being defective.
- Measuring point faults may only be rectified by authorized and specially trained personnel.
- If faults can not be rectified, the products must be taken out of service and secured against unintentional commissioning.
- Repairs not described in these Operating Instructions may only be carried out at the manufacturer's or by the service organization.

1.3 Operational safety

The sensor has been designed and tested according to the state of the art and left the factory in perfect functioning order.
Relevant regulations and European standards have been met.

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

1.4 Return

If the device is in need of repair, first contact your local sales center.
Please proceed as follows if you are returning the sensor for repair:
Please return the sensor *cleaned* to your local sales center.
Use the original packaging to return the device.

Before returning the device, please clarify all formalities – such as obtaining an identification number – with your sales center.
Please enclose the duly completed "Declaration of Contamination" (copy the second-last page of these Operating Instructions) with the packaging and the shipping documents. **The sensor cannot be repaired without a duly completed Declaration of Contamination form.**

1.5 Notes on safety icons and symbols

Warning!
This symbol alerts you to hazards that can cause serious damage to the instrument or to persons if ignored.

Caution!
This symbol alerts you to possible faults which could arise from incorrect operation. They could cause damage to the instrument if ignored.

Note!
This symbol indicates important items of information.

2 Identification

2.1 Nameplate

Compare the order code indicated on the nameplate to the product structure and your order.

The nameplate contains the following information:
- Manufacturer data
- Order code (device version)
- Extended order code
- Serial number

Note!
To discover what sensor version you have, enter the order code on the nameplate into the search screen at the following address:
www.products.endress.com/order-ident

2.2 Scope of delivery

The scope of delivery comprises:
- 1 CAS51D sensor (in the version ordered)
- 1 set of Operating Instructions BA459C/07/en

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

2.3 Certificates and approvals

Declaration of conformity
The product meets the requirements of the harmonized European standards. It thus complies with the legal requirements of the EC directives.
The manufacturer confirms successful testing of the product by affixing the CE symbol.

3 Installation

3.1 Incoming acceptance, transport, storage

- Make sure the packaging is undamaged!
  Inform the supplier about any damage to the packaging.
  Keep the damaged packaging until the matter has been settled.
- Make sure the contents are undamaged!
  Inform the supplier about damage to the contents. Keep the damaged products until the matter has been settled.
- Check that the order is complete and agrees with your shipping documents.
- The packaging material used to store or to transport the product must provide shock protection and humidity protection. The original packaging offers the best protection. Also, keep to the approved ambient conditions (see "Technical data").
- If you have any questions, please contact your supplier or your local sales center.

3.2 Installation conditions

3.2.1 Dimensions

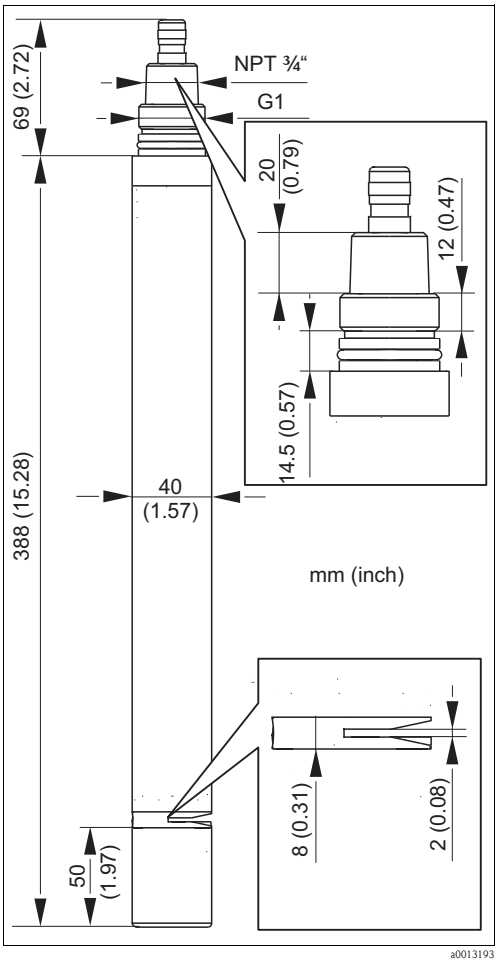


Fig. 1: Dimensions of CAS51D (2 mm gap)

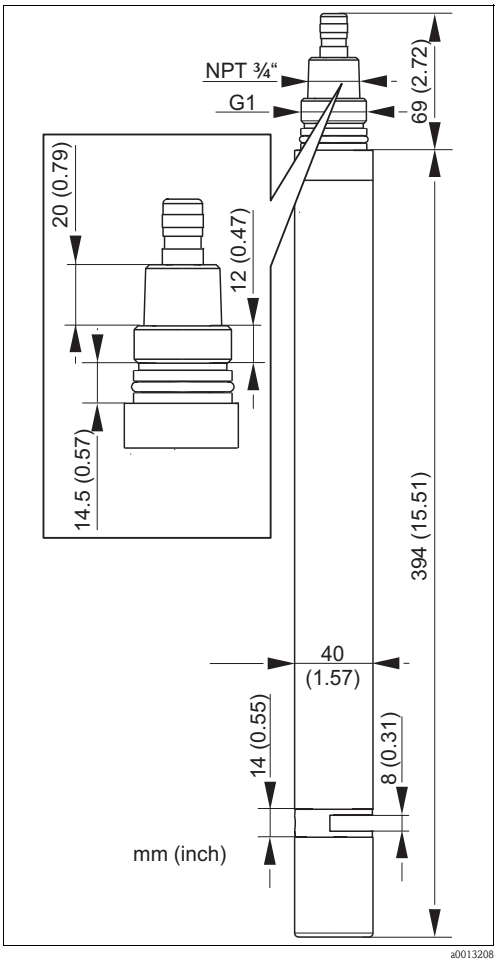


Fig. 2: Dimensions of CAS51D (8 mm gap)

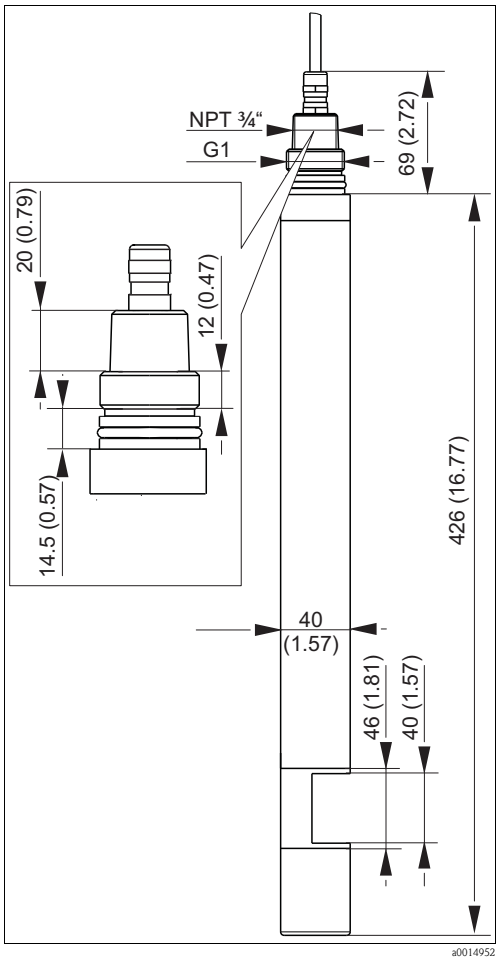


Fig. 3: Dimensions of CAS51D (40 mm gap)

3.2.2 Mounting location

- Select a mounting location that can also be easily accessed later on.
- Make sure upright posts and assemblies are securely fastened and free from vibrations.
- Select a mounting location where the nitrate concentration is representative of the application.
- Do not install the sensor above aeration discs. Oxygen bubbles can accumulate on the cuvette and distort the measured value.

3.2.3 Orientation

- Flow assembly 71110000 for small sample volumes
  Horizontal installation with bushes on a panel.
- Flow assembly Flowfit CYA251
  Horizontal installation
- Immersion operation in an open basin
  – Suspended vertically from a chain
  – Horizontal, fixed installation

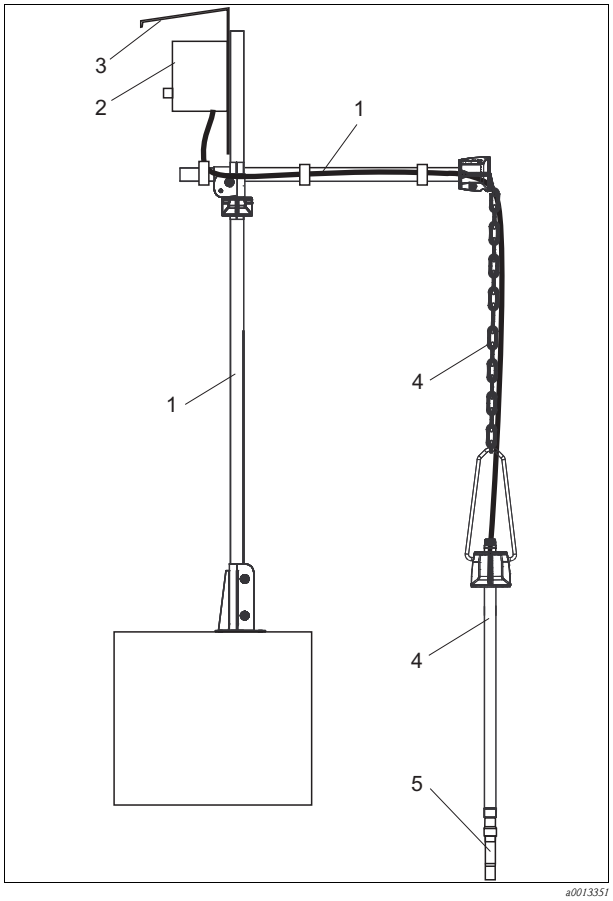
3.2.4 Installation instructions

For correct measurement to take place, the windows of the cuvette have to be clear of any sedimentation. This is best achieved by the cleaning unit (accessory) which uses compressed air for cleaning.
With horizontal orientations, mount the sensor in such a way that the cuvette is located at the side.

3.3 Installation instructions

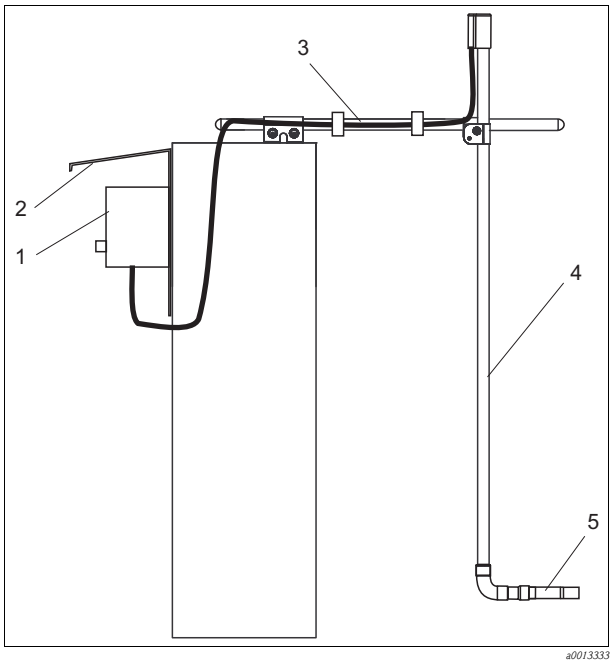
3.3.1 Measuring system

A complete measuring system consists of:
- Viomax CAS51D sensor
- Liquiline transmitter
- Flexdip CYA112 assembly and Flexdip CYH112 holder or
- Flow assembly (Flowfit CYA251 or 71110000)



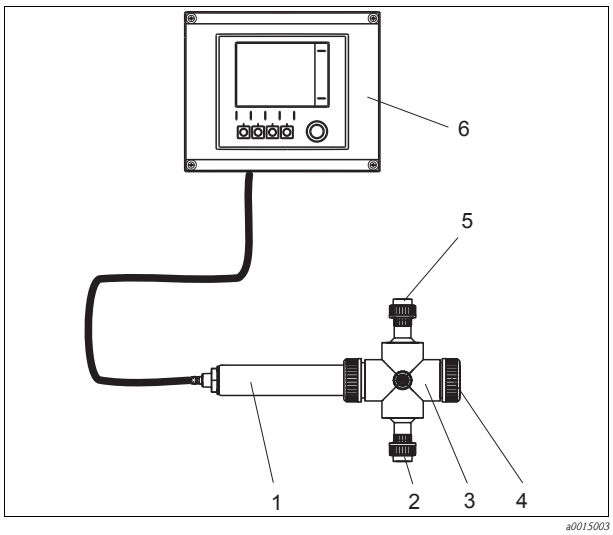
1 Holder system Flexdip CYH112
2 Transmitter Liquiline
3 Weather protection roof
4 Assembly Flexdip CYA112
5 Viomax CAS51D sensor

Fig. 4: Measuring system with immersion assembly (example)



1 Transmitter Liquiline
2 Weather protection roof
3 Holder system Flexdip CYH112
4 Assembly Flexdip CYA112
5 Viomax CAS51D sensor

Fig. 5: Measuring system with immersion assembly (example)



1 Viomax CAS51D sensor
2 Medium inlet
3 Flowfit CYA251 flow assembly
4 Cap
5 Medium outlet
6 Liquiline transmitter

Fig. 6: Measuring system with flow assembly (example)

3.4 Installation examples

3.4.1 Immersion operation

Fixed installation with wastewater assembly

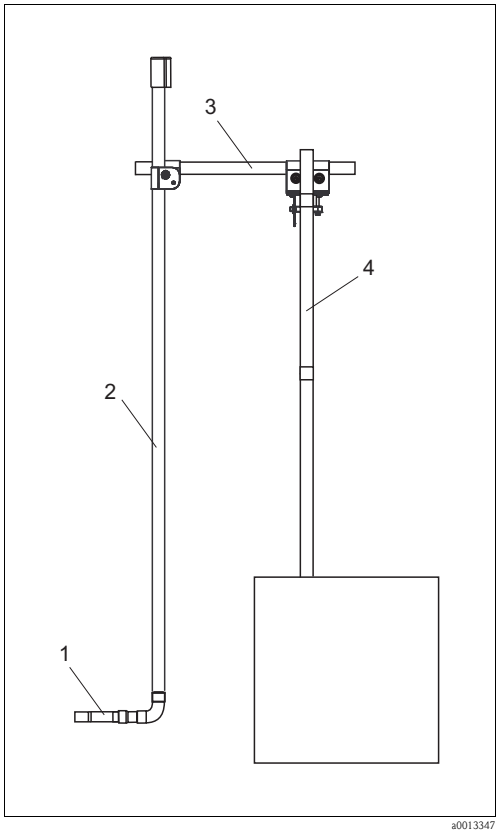


Fig. 7: 90° installation secured on railing

1 Viomax CAS51D nitrate sensor
2 Flexdip CYA112 wastewater assembly
3 Flexdip CYH112 holder
4 Railing

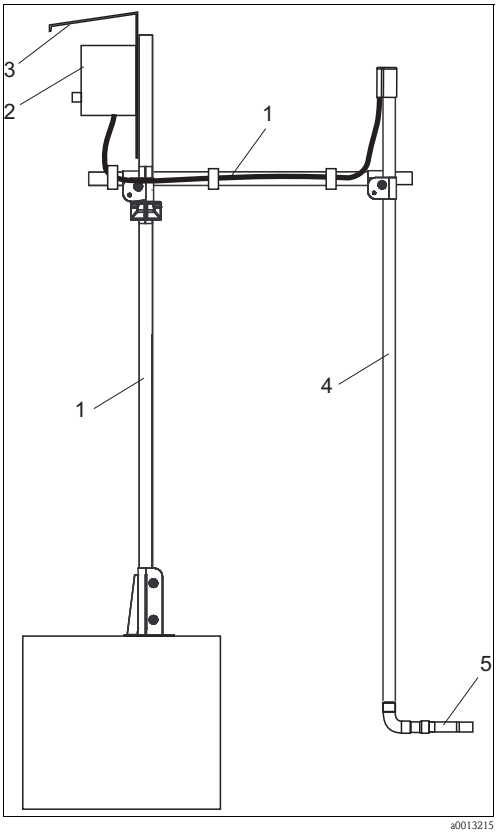


Fig. 8: 90° installation with upright post

1 Flexdip CYH112 holder
2 Liquiline transmitter
3 Weather protection cover
4 Flexdip CYA112 wastewater assembly
5 Viomax CAS51D nitrate sensor

This type of installation is particularly suitable for strong or turbulent medium flow (>0.5 m/s (1.6 ft/s)) in the basin or channels.
A cleaning unit (accessory) that uses compressed air significantly extends the maintenance intervals for the sensor.

Installation with chain retainer

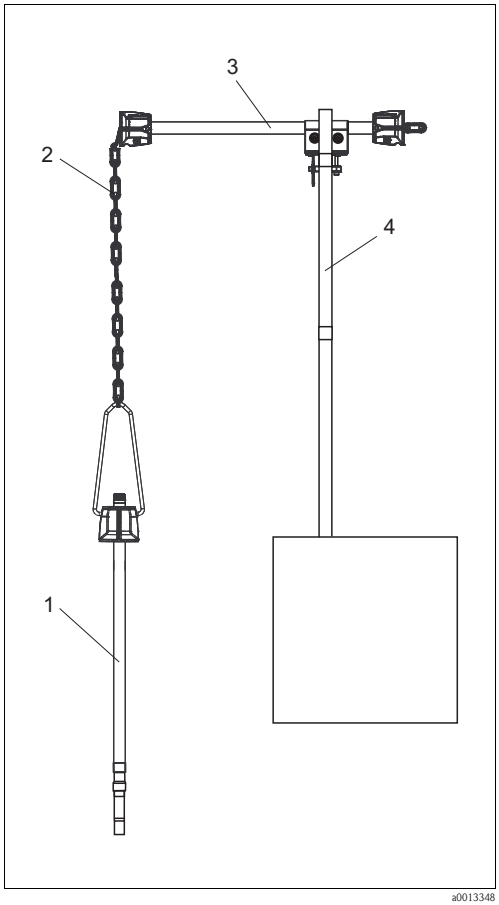


Fig. 9: Chain retainer on railing

1 Flexdip CYA112 wastewater assembly with Viomax CAS51D nitrate sensor
2 Chain
3 Flexdip CYH112 holder
4 Railing

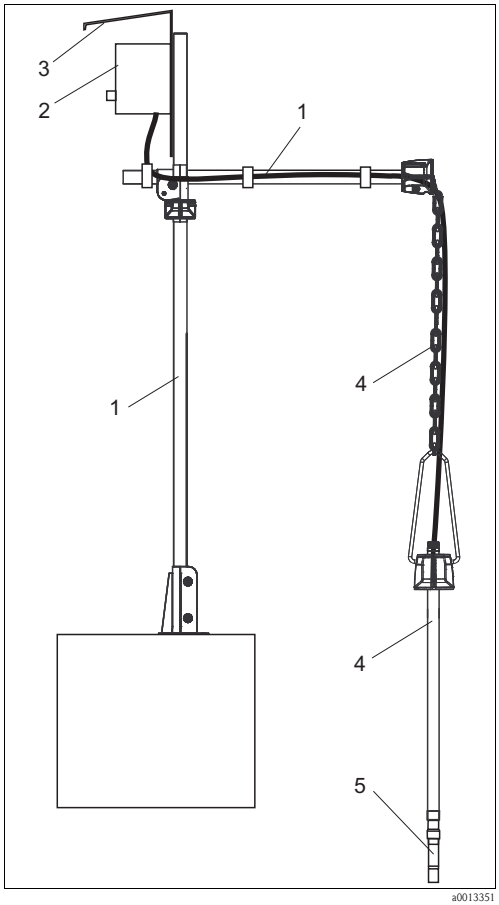


Fig. 10: Chain retainer on upright post

1 Flexdip CYH112 holder
2 Liquiline transmitter
3 Weather protection cover
4 Flexdip CYA112 wastewater assembly
5 Viomax CAS51D nitrate sensor

The chain retainer is particularly suitable for applications that require a sufficient distance between the mounting location and the edge of the aeration basin. As the assembly is freely suspended, any vibration of the upright post is practically ruled out.
The swinging movement of the chain retainer enhances the self-cleaning effect.
A cleaning unit (accessory) that uses compressed air significantly extends the maintenance intervals for the sensor.

Cleaning unit

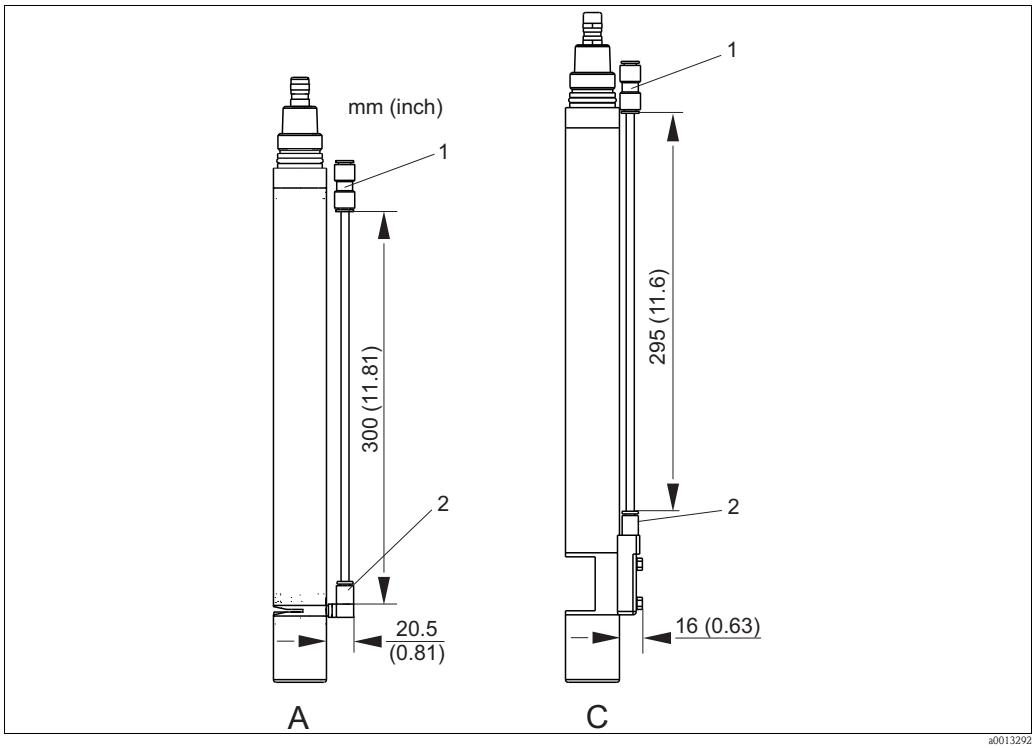


Fig. 11: CAS51D with compressed air cleaning

1 Adapter 8 mm with 300 mm hose (only for 8 mm connection)
2 6 mm or 6.35 mm (¼") connection
A Sensor (2mm or 8 mm gap)
C SAC sensor (40 mm gap)

3.4.2 Bypass operation

Flow assembly for clear water and small sample volumes

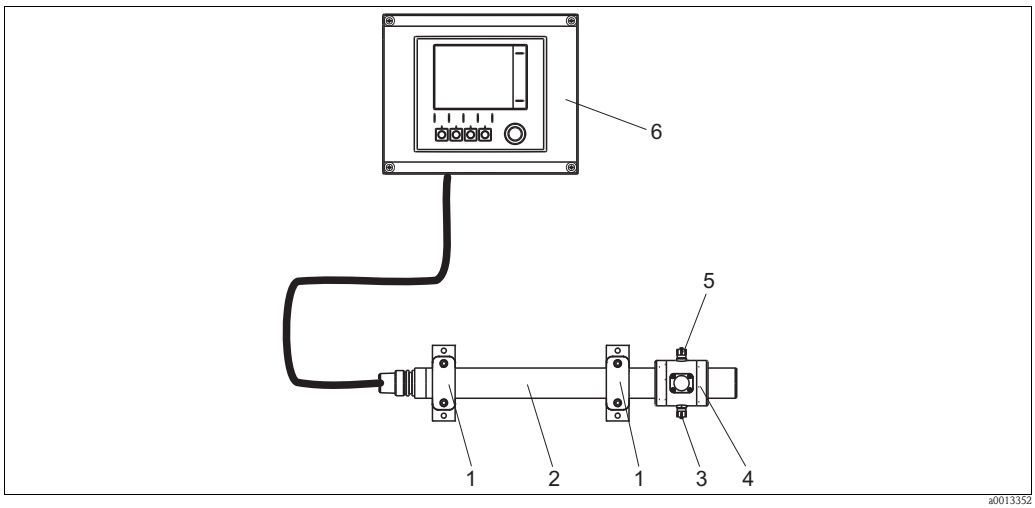


Fig. 12: Sensor with flow assembly

1 Sensor holder
2 Viomax CAS51D nitrate sensor
3 Medium inlet
4 Flow assembly
5 Medium outlet
6 Liquiline transmitter

Installation

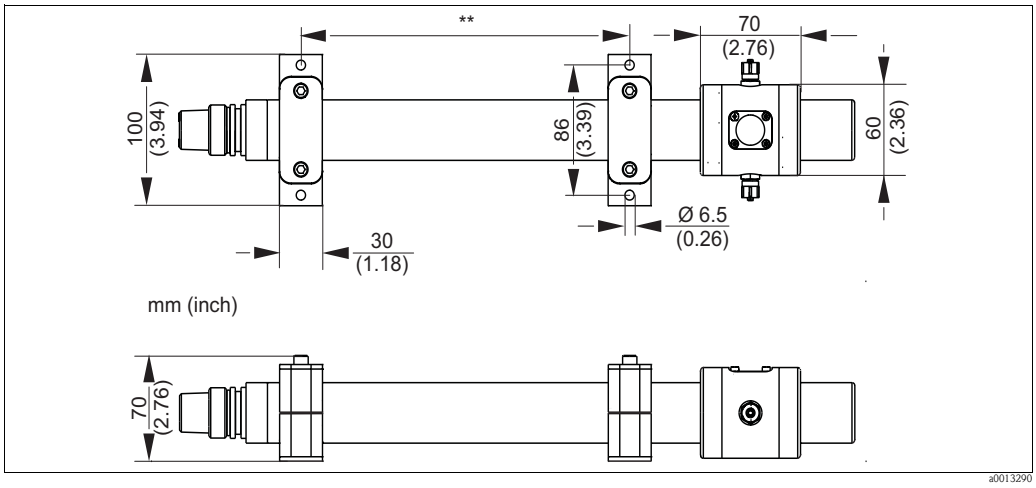


Fig. 13: Dimensions

Mount the sensor along with the flow assembly as follows:

1. Slide the flow assembly over the sensor.
2. Align the sensor in such a way that the cuvette is in the direction of flow (check the position through the window in the assembly)
3. Secure the position of the assembly with the two thread adapter nuts.
4. Mount the sensor horizontally on a panel on directly on the wall. Use the bushes supplied.

Connecting the flow assembly

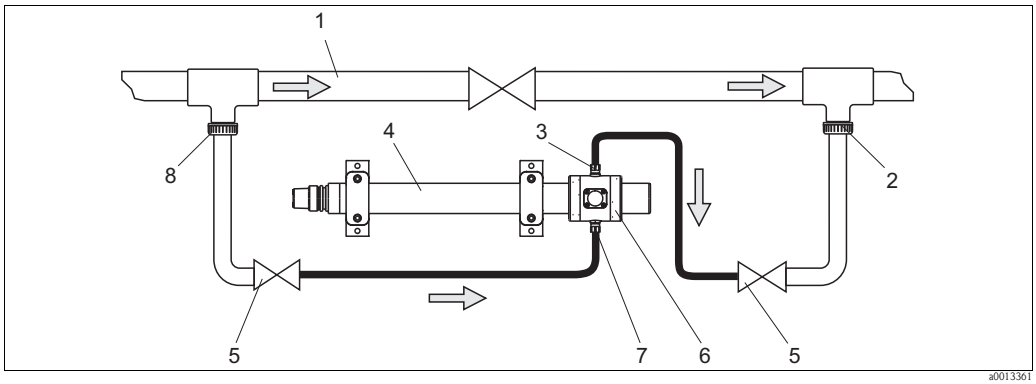


Fig. 14: Flow assembly in the bypass

1 Main pipe
2 Medium return
3 Medium outlet
4 Viomax CAS51D nitrate sensor
5 Manual or solenoid valves
6 Flow assembly
7 Medium inlet
8 Medium sampling

Connect the flow assembly as illustrated in Fig. 14 or Fig. 15. This fills the assembly from below and ensures the assembly is self-venting.
The minimum flow rate must be 250 ml/h (0.066 gal/hr).
Consider the extended response time!

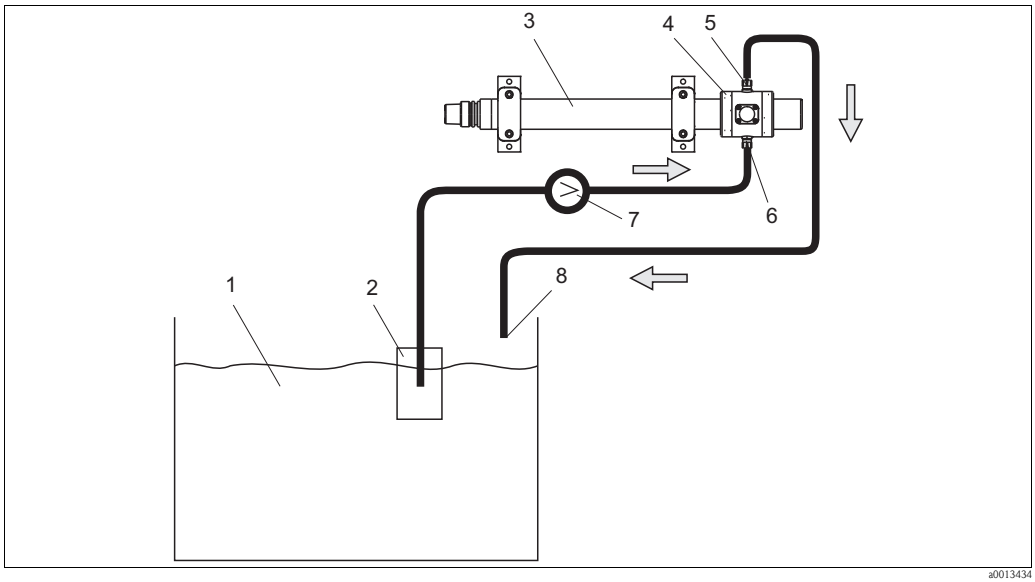


Fig. 15: Flow assembly with open outlet

1 Basin
2 Filter unit
3 Viomax CAS51D nitrate sensor
4 Flow assembly
5 Medium outlet
6 Medium inlet
7 Pump
8 Open outlet

Flowfit CYA251 flow assembly

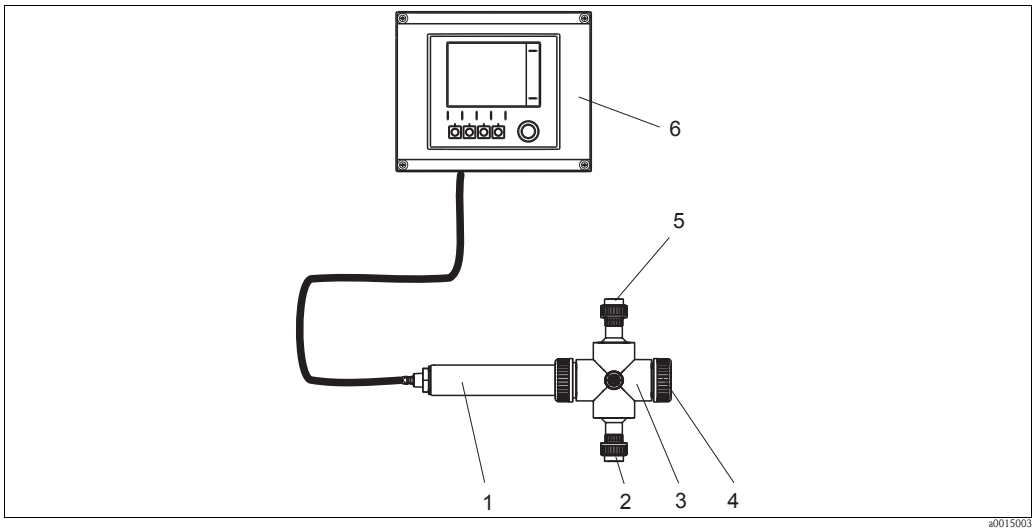


Fig. 16: Sensor with Flowfit CYA251 flow assembly

1 Viomax CAS51D nitrate sensor
2 Medium inlet
3 Medium inlet
4 Cap
5 Medium outlet
6 Liquiline transmitter

Connecting the Flowfit CYA251 flow assembly

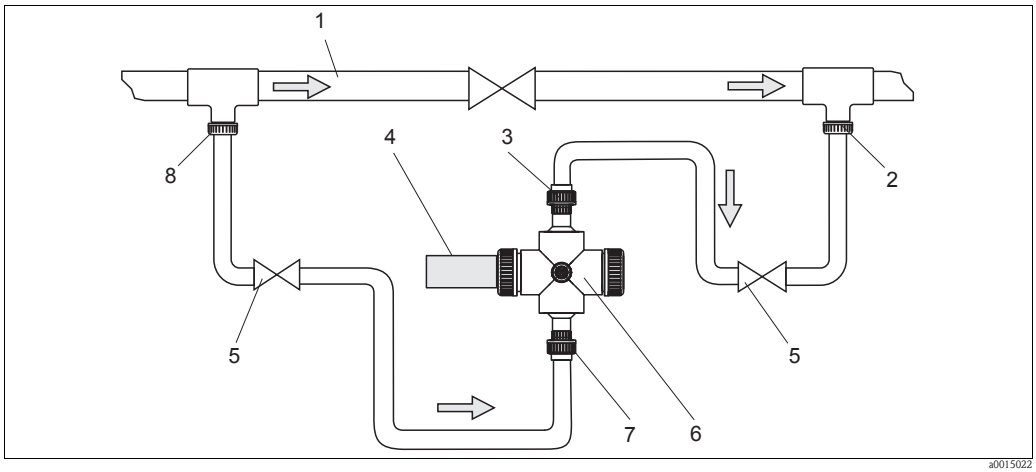


Fig. 17: Flowfit CYA251 flow assembly in the bypass

1 Main pipe
2 Medium return
3 Medium outlet
4 Viomax CAS51D nitrate sensor
5 Manual or solenoid valves
6 Flowfit CYA251 flow assembly
7 Medium inlet
8 Medium sampling

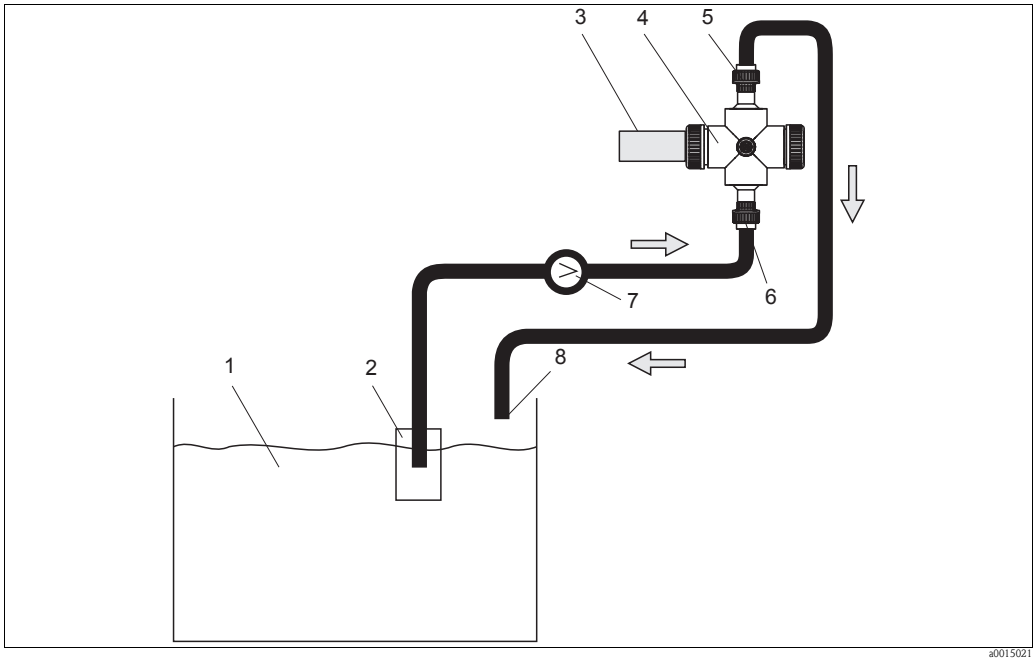


Fig. 18: CYA251 flow assembly with open outlet

1 Basin
2 Filter unit
3 Viomax CAS51D nitrate sensor
4 CYA251 flow assembly
5 Medium outlet
6 Medium inlet
7 Pump
8 Open outlet

3.5 Post-installation check

- Sensor and cable undamaged?
- Cap undamaged?
- Compliance with permissible sensor installation position?
- Is the sensor installed in an assembly and is not suspended from the cable?
- Avoid moisture by rain by putting the protective cap on the assembly?

4 Wiring

Inappropriate connection can cause serious injuries or death The electrical connection must only be carried out by a certified electrician. Technical personnel must have read and understood the instructions in this manual and must adhere to them. Prior to beginning make sure voltage is not applied to any of the cables.

4.1 Connecting to the transmitter

The sensor will be connected to the transmitter as follows:

- With the M12 plug (version: fixed cable, M12 plug) or
- With the fixed cable connected to the terminal strips (version: fixed cable, end sleeves):

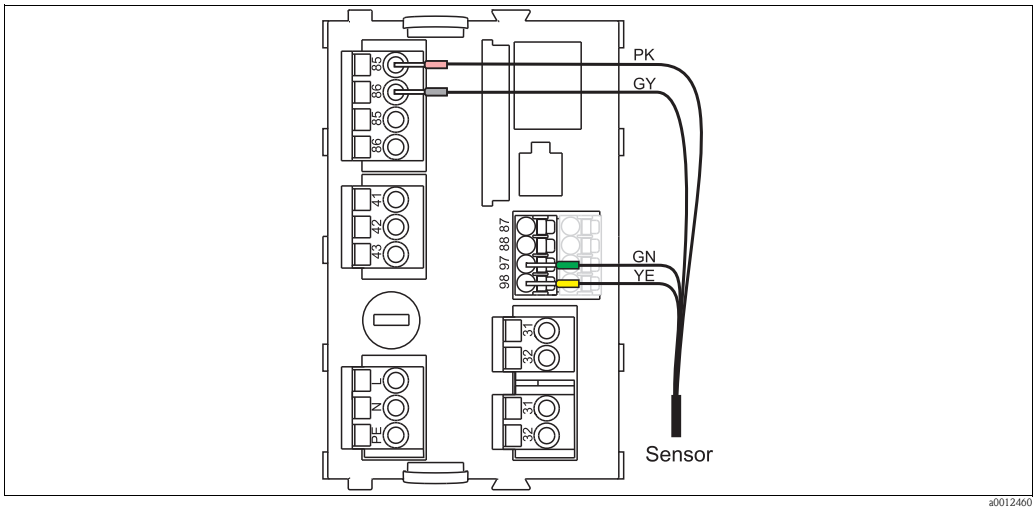


Fig. 19: Sensor connection

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

4.2 Post-connection check

Device condition and specifications	**Notes**
Is damage visible on the outside of the sensor, assembly, junction box or cable?	Visual inspection
Electrical connection	**Notes**
Does the transmitter supply voltage match the specifications on the nameplate?	
Are the installed cables strain-relieved and not twisted?	
Is the cable type route completely isolated at the mounting location?	Power cables / signal cables
Are the cable cores stripped sufficiently and installed correctly in the terminal?	Check if seated correctly (pull gently)
Are all the screw terminals firmly tightened?	Tighten
Are all the cable entries installed, firmly tightened and leak-tight?	For lateral cable entries, make sure the cable loops downwards to ensure water can drain off.
Are all the cable entries mounted on the side or pointing downwards?	
Are the power supply and signal cables connected correctly?	If detected by the CM44x: Periodic flashing in the cuvette (audible and visible)

5 Device description

5.1 Sensor design

The sensor is designed for the continuous in-situ measurement of process values. One version of the sensor measures the amount of nitrate in the medium. The other version of the sensor measures the SAC value in the medium.
The sensor is designed as a 40 mm sensor that can be operated directly and completely in the process without the need for further sampling (in situ).
As an open measuring cell, the cuvette is the central component of the system. This is the area in which the measuring light can interact with the medium.

All the necessary modules are contained in the sensor:
- Power supply
- High-voltage generation for the strobe lamp
- Cuvette
- Detectors detect the measuring signals, digitize them and process them to form a measured value.
- The sensor controller is responsible for controlling the internal processes and transmitting the data.

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

5.2 Function

5.2.1 Measuring principle

The light from a pulsed, high-stability strobe lamp (item 5) passes through the measurement section (items 3 and 4).
The beam splitter (item 2) directs the light beam to the two receivers (items 1 and 6). A filter is arranged upstream of each receiver. The filter upstream of the measuring receiver (item 1) only lets through light in the measuring wavelength range, while the filter upstream of the reference receiver (item 6) only lets through light in the reference wavelength range.

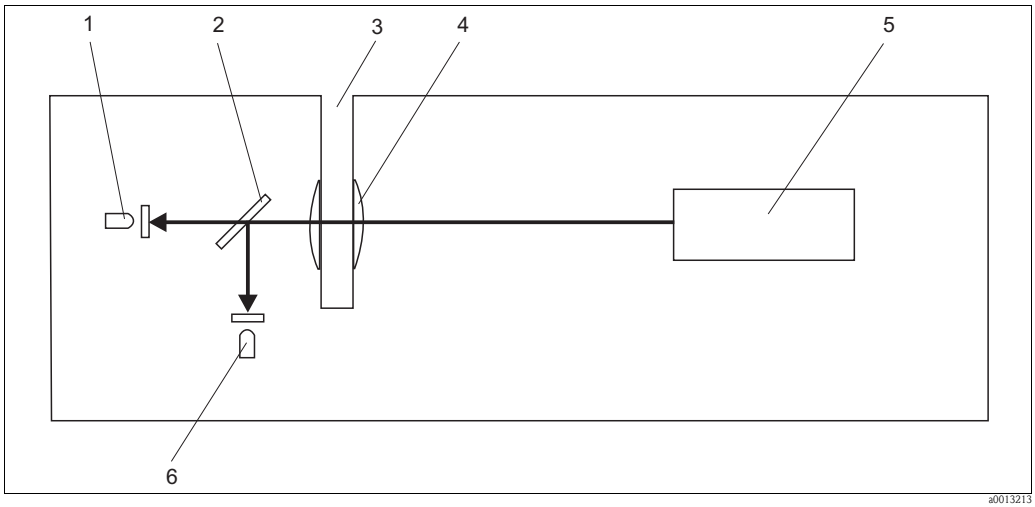


Fig. 20: Principal mode of operation of the nitrate sensor

1 Measuring receiver with filter
2 Beam splitter
3 Cuvette
4 Lens
5 Strobe lamp
6 Reference receiver with filter

Within the measurement section – i.e. the open path through the cuvette – parts of the light interact with the medium.
While the medium in the cuvette (water and particles) attenuates the light across the entire spectrum, another factor comes into play in the measuring wavelength range, as the measured component in the medium takes some of the energy from the light and causes additional attenuation of the light beam.
The ratio of the light signal of the measuring wavelength to the reference wavelength is used to calculate the measured value. If only water and turbidity are present, both signals are attenuated to the same extent and the ratio remains constant. If the medium contains the measured component, the signal for the measuring wavelength is attenuated more and the ratio changes. This change in the ratio can be converted to determine the concentration of nitrate or the SAC value. This dependency is non-linear.

Conclusion: Long measurement paths are required for high resolutions. In the case of nitrate measurement, this is achieved with the 8-mm cuvette for clear water measurements, and with the 40 mm cuvette in the case of SAC measurement for clear water. If turbidity values are high, longer measurement paths result in the total absorption of light, and the measured values are not valid. For media with high turbidity values (activated sludge applications), the nitrate sensor with the 2 mm cuvette returns good, reliable measured values.
Therefore the SAC sensor with the 2-mm cuvette is ideal for measuring the organic load in the inlet of municipal wastewater treatment plants.

5.2.2 Nitrate measurement

Nitrate ions absorb UV light in the range from approx. 190 to 230 nm. Nitrite ions have a similar absorption rate in the same range.
In the cuvette, the nitrate and nitrite ions absorb the UV light in the 214 nm measuring wavelength range in proportion to the nitrate and nitrite concentration, while the UV light in the 254 nm reference channel remains virtually unchanged.
Interference factors such as turbidity, fouling or organic hydrocarbons are eliminated by mathematical means.
The signal ratio between the reference channel and the measuring channel is used as the measurement result. This ratio is converted to the concentration of nitrate using the calibration curve programmed into the sensor.

5.2.3 Cross-interference when measuring nitrate

The following directly affect the measuring range:
- Total solids (TS) and turbidity
- Sludge properties
- Temperature
- Nitrite

Trends:
- Higher percentage of TS and turbidity reduces the upper end of the measuring range, i.e. the measuring range is smaller.
- The same percentage of TS and turbidity but different colors results in different measuring ranges/measured values.
- High COD rates reduce the upper end of the measuring range.

The following can be deduced from the interdependencies cited above:
- An increase in the turbidity value in the medium does not affect the measured value.
- Organic substances in the sludge floc absorb light in the measuring wavelength and simulate the presence of nitrate. Sludge floc transported through the cuvette can thus cause an increase in the measured value.
- High concentrations of COD in the medium can increase the measured value.
- Nitrite absorbs light in a similar wavelength range as nitrate and is measured along with the nitrate. The rate is constant: 1.0 mg/l nitrite is indicated as 0.8 mg/l nitrate.

5.2.4 SAC measurement

Many organic substances absorb electromagnetic radiation around the 254 nm range. The SAC sensor uses the absorption on the measuring wavelength (254 nm) with the largely unaffected reference measurement in the 550 nm range.
KHP (potassium hydrogen phthalate $C_8H_5KO_4$) is the established organic reference in SAC measurement operations. The sensor is calibrated with KHP at the factory.
The values are converted to COD_{254nm} and TOC_{254nm} using predefined, yet adjustable factors:
c (TOC) = 0.4705 * c (KHP)
c (COD) = 1.176 * c (KHP)
The relation to SAC (based on KHP) is calculated as follows:
1 (1/m) = 1.487 mg/l CSB_{254nm} = 0.595 mg/l TOC_{254nm}
With regard to their absorption behavior many measurable components deviate greatly from KHP. For this reason it makes sense to calibrate the sensor so it is adjusted to the customer's specific process.

5.2.5 Cross-interference when measuring SAC

The measuring range is affected by the:
- COD
- Color

Trends:
- COD, absorbing at 550 nm, distorts the measurement result. In instances of this nature, a comparison or calibration is necessary.
- Coloration which absorbs in the green spectral range reduces the measured value.
- COD with spectral properties other than KHP (potassium hydrogen phthalate) for the measuring or reference wavelength distorts the measurement result. In instances of this nature, a comparison or calibration is necessary.

5.3 Calibration

Calibration helps to adjust the precalibrated sensor more precisely to the given situation.

Types of calibration:
- The sensor measures the concentration of nitrate or the SAC value in a medium. The actual value is determined by external wet-chemical analysis (e.g. photometric measurement with a reaction indicated by a change in color). This value is then assigned.
- You specify a parent solution with a known nitrate or KHP concentration (e.g. one prepared in the laboratory). This parent solution can be designed as a single-point or multi-point system by diluting the solution.

In addition to the factory calibration data, which cannot be modified, the sensor has six other data records to be used for storing calibrations. Each calibration data record can contain up to five calibration points.
Single-point calibration causes a change in the slope. This type of calibration is used if the measured value concentration in the medium only changes to a limited extent.
Two-point calibration causes a change in the slope and the zero point. This type of calibration is used if the measured value concentration in the medium changes to a large extent.
Both types of calibration are based on the data record stored internally in the device.
Calibration at three or more points always causes the measuring curve to be recalculated.

In the SAC sensor version, the calculated variables COD_{254nm} and TOC_{254nm} can also be output in addition ot the actual measured variable. These variables are based on the following relationship:

1 mg/l KHP = ~1.176 mg/l COD
1 mg/l KHP = ~ 0.4705 mg/l TOC

The SAC sensor can be calibrated in the measured variables SAC, COD and TOC. The conversion factor can also be edited after calibration to adapt the COD and TOC variables if the sensor is calibrated as an SAC sensor. If the sensor is calibrated to TOC or COD, only the TOC or COD factor can be changed subsequently.

5.3.1 Factory calibration

The sensor is precalibrated on leaving the factory. As a nitrate sensor, it can be used in a wide range of clear water measurements without the need for additional calibration. In the case of a SAC sensor, it is advantageous to calibrate to the customer's specific process in the majority of cases. The factory calibration is based on a three-point calibration of a reference sample.
The factory calibration cannot be deleted and can be retrieved at any time. All other calibrations – performed as customized calibrations – are referenced to this factory calibration.

5.3.2 Stability criterion

During the calibration process, the measured values returned by the sensor are checked to ensure they remain constant. The stability criterion defines the maximum amount the measured values may deviate during calibration and still be accepted.

The data comprise:
- The maximum permissible deviation in temperature measurement
- The maximum permissible deviation in the measured value in %
- The minimum timeframe in which these values must be maintained

If the signal values or temperatures deviate more than is permitted in a maximum timeframe of 60 seconds, this calibration point becomes invalid and a warning is issued.
The stability criteria monitor the quality of the individual calibration points in the course of the calibration. The aim is to achieve the best possible calibration quality in a short timeframe while taking external conditions into account.
For high-precision calibrations in the laboratory, the measured value windows can be kept as small as possible and the time selected can be as long as possible.
For calibrations in the field under tough weather and environmental conditions, the measured value windows selected can be large and the timeframe short.

Note!
The stability criteria have a direct impact on the quality of the calibration, and thus on the quality of the subsequent measured values. A calibration based on one point reflects the process around this single point, while a multi-point calibration maps the specific range.

5.3.3 Nitrate calibration in the process

Calibration is performed in the process by comparing the sensor measured values to an external standard method. A sample of the process medium is taken and analyzed in the laboratory for nitrate. Colorimetric measurement with a cuvette test is common practice and is a standard method in accordance with DIN 38405 Part 9.

Note!
- Drinking water can contain larger concentrations of nitrate and is not suitable as a blank value. Use fully deionized water as your blank value.
- During calibration, make sure the sample is homogeneous.
- When calibrating, start with a low concentration and increase the concentrations gradually to prevent nitrate carryover.
- Clean and dry the sensor after a calibration. Make sure there is no residue in the cuvette. In this way, you avoid mixing the different samples and changing the concentration of nitrate.

Performing the calibration

1. Select a data record.
2. Put the sensor into the medium.
3. During calibration, make sure the medium is as homogeneous as possible.
4. Start the calibration for the measuring point.
5. Save the data for the measuring point. For this purpose, enter the measured value that is roughly expected. The plausibility of the data is checked before the data are saved. The data are not saved if the values are not plausible. You might have to adapt the stability criterion to the ambient conditions.
6. Take a sample of your medium and measure it with a reference electrode.
7. Start the calibration again. Select the same data record and edit the data record with the result of the reference method.

- Processes with relatively high nitrate values
  Take, measure and calibrate a sample with a high concentration. To ensure the measured value obtained is correct, the concentration of nitrate should not drop below a value of 0.1 mg/l.
- Processes with very different nitrate values
  At time A, take a sample with a high concentration, and measure and calibrate the sample. At time B – which can by all means be a few days after time A – take a sample with a low concentration, and measure and calibrate the sample.
- Calibration with the addition of standard
  If the sludge parameters tend to be constant, you can perform the calibration with a sample with a low concentration of nitrate and then add standard to the sample.
  Take a larger sample (bucket) and analyze some of it by colorimetric means. Calibrate this value in the sensor.
  Now add standard to the sample, check the sample in the laboratory and calibrate the value in the sensor.

Additional calibration points, recalibration
Points can be added to an existing calibration. The maximum number of points per data record is also limited to 5 here.
In this way, different media or concentrations can be included in the calibration at different times.

5.3.4 SAC calibration in the process

The SAC sensor is calibrated in the same way as the nitrate sensor. However, some features specific to SAC measurement must be taken into consideration.

- Standard methods: SAC, COD, TOC
- The sensor is calibrated in the factory on the basis of KHP as the reference material. Other organic components in the matrix will react differently in the spectrum. Therefore, the measurement result primarily depends on the matrix, which is why a multipoint calibration is recommended.

  ✎ Note!
  Drinking water contains many organic elements. The use of fully deionized water as a blank is also recommended here.
  During calibration, make sure the medium is homogeneous.
  Avoid any carryover of organic elements during the calibration.

- In addition, the factors for converting KHP to CSB_{254nm} and TOC_{254nm} are also available in a calibrated data record. The slope of the calibrated data records can be adapted to the process with these factors.
  Some of the factors for converting to COD_{254nm} and TOC_{254nm} are prespecified by control bodies. In such instances, these settings can be used as follows:

1. Copy the factory data record to a free data record of your choice in the SAC basic setting.
2. Activate this data record.
3. Set the desired factor.
4. Set your device to the preferred measured variable.

✎ Note!
Alternatively, you can also calibrate the sensor to the desired measured variable and then adjust the factor.

Another completely different calibration method entails mapping different operating states of the medium. For this purpose, you must record calibration points at different operating states (example: wastewater treatment plant inlet):

- After a period of rain
- In the "normal state"
- After a dry spell

Save the points in a data record of your choice and add the associated laboratory results. Activate the calibration once you have set a sufficient number of points.

✎ Note!
This kind of calibration can be more time-consuming but it allows the precise adjustment of the measuring system to the operating conditions of the plant.

5.3.5 Calibration in the laboratory

Calibration is performed in the laboratory using ready-prepared parent solutions with different concentrations.

Note!
Please note that drinking water can contain larger concentrations of nitrate and organic substances and is not suitable as a blank sample. Use fully deionized water as your blank sample.

Make a serial dilution of a parent solution, putting the range of dilutions in beakers (prepared internally or purchased from a specialist shop). Immerse the sensor in the beakers in succession and calibrate the sensor to the set concentrations. In this way, you can calibrate up to 5 points.

Note!
Note the following to avoid incorrect calibration resulting from carryover of the measuring component:
- Always go from a low concentration to a high concentration.
- Clean and dry the sensor after a calibration. Make sure there is no residue in the cuvette. In this way, you avoid mixing the different samples and changing the nitrate concentration of the measured component.

5.4 Cyclic cleaning

Compressed air is most suitable for cyclic automatic cleaning. There is a connection for compressed air on every sensor. The optional cleaning unit is either ready-supplied or can be retrofitted, and operates effectively at a rate of 20 l/min (5.4 US gal/min).

Recommended settings for the cleaning unit:

Type of fouling	Cleaning interval	Cleaning duration
Severe fouling with rapid buildup	5 min	10 s
Low degree of fouling	10 min	10 s

Cyclic cleaning can also be performed manually at set intervals.

6 Maintenance

The sensor is a very low-maintenance unit, particularly if a cleaning unit is connected. Nevertheless, you still have to perform maintenance tasks at regular intervals.
Set the maintenance times in advance in an operations journal or log.

Monthly:	Visual inspection, clean the sensor if necessary The cleaning intervals depend on the medium.
Every two years:	Replace the optic filters (Endress+Hauser Service)
Every four years:	Replace the strobe lamp (Endress+Hauser Service)

The process for performing the tasks listed is described in the following sections.

6.1 Cleaning the sensor

Sensor fouling can affect the measurement results and even cause a malfunction.
The sensor must be cleaned at regular intervals to ensure reliable measurement results. The frequency and intensity of the cleaning process depends on the medium.

Clean the sensor:
- As specified in the maintenance schedule
- Before every calibration
- Before returning the sensor for repair

Type of fouling	Cleaning measure
Lime deposits	Immerse the sensor in 1 ... 5 % hydrochloric acid (for a few minutes).
Dirt particles on the optical windows	Fold a cloth and pass it through the cuvette.
Buildup on the optical windows	Wet a cotton bud with 1 ... 5% hydrochloric acid and use it to clean the optical windows.

Note!
You must rinse the sensor thoroughly with water after cleaning.

6.2 Maintenance of the optical filters and strobe lamp

These maintenance tasks can only be performed by Endress+Hauser Service. Please contact your local sales center.

When returning the device, make sure the delivery contains the following:
- Clean sensor
- Shipping documents
- Duly completed "Declaration of Hazardous Material and Decontamination" (copy the second-last page of these Operating Instructions).

Note!
Replacing the optical filter and strobe lamp also comprises a new basic sensor configuration.

7 Accessories

7.1 Assemblies

Wastewater assembly Flexdip CYA112
- Modular assembly system for sensors in open basins, channels and tanks
- Versions in stainless steel or PVC
- Ordering acc. to product structure (Technical Information TI432C/07/en)

Flow assembly for CAS51D
- For small flow quantities
- Connection: hose 6 mm OD
- Material: PVC-U
- Two holders for CAS51D
- Order number: 71110000

Flowfit CYA251 flow assembly for CAS51D
- Connection: see product structure
- Material: PVC-U
- Order as per product structure

7.2 Holder

Holder system Flexdip CYH112 for water and wastewater assembly Flexdip CYA112
- Modular holder system for sensors and assemblies in open basins, channels and tanks
- The holder system CYH112 works for nearly any type of fixing – fixing on the floor, wall or directly on a rail.
- Material: stainless steel
- Ordering acc. to product structure (Technical Information TI430C/07/en)

7.3 Compressed air cleaning

Compressed air cleaning for CAS51D
- Connection: 6 or 8 mm or 6.35 mm (¼")
- Order numbers for sensor with 2 mm gap or 8 mm gap:
- 6 mm (with 300 mm hose and 8 mm adapter) Order No.: 71110787
- 6.35 mm (¼") Order No.: 71110788
- Order numbers for sensor with 40 mm gap:
- 6 mm (with 300 mm hose and 8 mm adapter) Order No.: 71126757
- 6.35 mm (¼") Order No.: 71126758

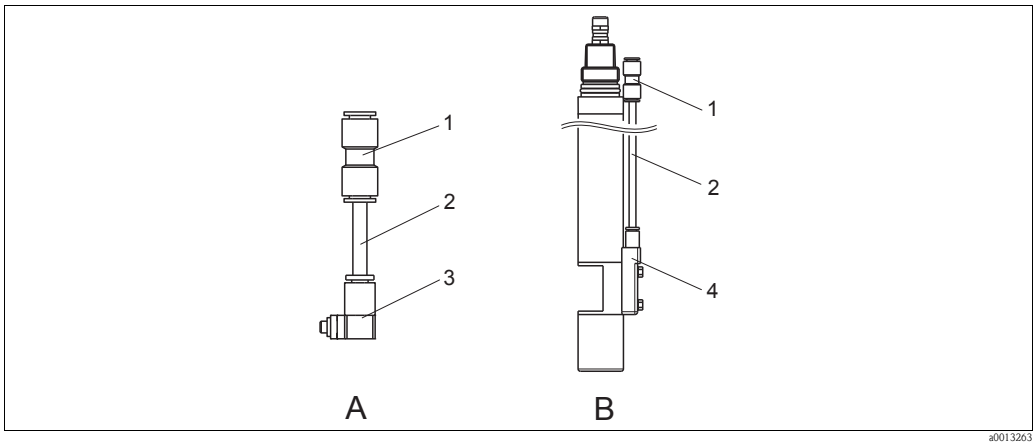


Fig. 21: Compressed air cleaning for CAS51D

A Cleaning for sensors with 2 mm and 8 mm gap
B Cleaning for sensors with 40 mm gap
1 8 mm adapter
2 300 mm hose (Ø = 6 mm)
3 6 mm or 6.35 mm (¼") gland for 2 mm and 8 mm gap
4 6 mm or 6.35 mm (¼") gland for 40 mm gap

Compressor
- For cleaning system
- Including 10 m (32.8 ft) pneumatic hose
- 230 V AC order number: 51504764
- 115 V AC order number: 51504765

7.4 Transmitter

Liquiline CM44x
- Multiple-channel transmitter for the connection of digital sensors with Memosens technology
- Power supply: 85 to 265 V AC, 18 to 36 V DC or 20 to 28 V AC (not CM448)
- Universally upgradeable
- SD card slot
- Alarm relay
- IP 66
- Ordering acc. to product structure (Technical Information TI444C/07/en)

7.5 Standard solutions

Nitrate standard solutions, 1 liter
- Standard 5 mg/l NO_3 - N; Order No. CAY342-V10C05AAE
- Standard 10 mg/l NO_3 - N; Order No. CAY342-V10C10AAE
- Standard 15 mg/l NO_3 - N; Order No. CAY342-V10C15AAE
- Standard 20 mg/l NO_3 - N; Order No. CAY342-V10C20AAE
- Standard 30 mg/l NO_3 - N; Order No. CAY342-V10C30AAE
- Standard 40 mg/l NO_3 - N; Order No. CAY342-V10C40AAE
- Standard 50 mg/l NO_3 - N; Order No. CAY342-V10C50AAE

	Standard solution				
	1	Ammonium nitrate, 1 molar			
		Container size			
		A	250 ml (8.45 fl.oz.)		
			Transport documents		
			1	Standard documents	
			2	Incl. dangerous goods sheets	
			3	Safety data sheet	
				Certificate	
				A	None
				B	Manufacturer's certificate
CAY40-					Complete order code

Standard solution potassium hydrogen phthalate KHP
- CAY451-V10C01AAE, 1000 ml parent solution 5 000 mg/l TOC

8 Troubleshooting

8.1 Troubleshooting instructions

You must take the entire measuring point into account when troubleshooting:
- Transmitter
- Electrical connections and cables
- Assembly
- Sensor

The possible causes of error indicated in the table below primarily refer to the sensor.

Problem	Check	Remedial measures
Nothing displayed, no reaction from the sensor	Power supplied to the transmitter? Sensor connected correctly? Medium flow present? Buildup on optical windows?	Connect the mains voltage Connect sensor correctly Ensure medium is flowing Clean sensor
Display value too high or too low	Buildup on optical windows? Gas bubbles present? Sensor calibrated? Check data record. Check with test unit.	Clean Eliminate gas bubbles Calibrate Change if necessary Examine in workshop
Display value fluctuates a lot	Gas bubbles present? Check mounting location.	Eliminate gas bubbles Select other mounting location

Note!
Please observe the troubleshooting instructions provided in the transmitter operating manual. Examine the transmitter if necessary.

8.2 Return

If the device is in need of repair, first contact your local sales center.
Please proceed as follows if you are returning the sensor for repair:
Please return the sensor *cleaned* to your local sales center.
Use the original packaging to return the device.

Before returning the device, please clarify all formalities – such as obtaining an identification number – with your sales center.
Please enclose the duly completed "Declaration of Contamination" (copy the second-last page of these Operating Instructions) with the packaging and the shipping documents. **The sensor cannot be repaired without a duly completed Declaration of Contamination form.**

8.3 Disposal

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

9 Technical Data

9.1 Input

Measured variable (nitrate)	NO_3-N (mg/l), NO_3 (mg/l)	
Measured variable (SAC)	$SAC_{254\ nm}$ (1/m), $COD_{254\ nm}$ (mg/l), $TOC_{254\ nm}$ (mg/l), transmission (%)	
Measuring ranges	CAS51D-**A2 (2 mm gap width)	0.1 to 50 mg/l NO_3-N or 0.4 to 200 mg/l NO_3
	CAS51D-**A1 (8 mm gap width)	0.01 to 20 mg/l NO_3-N or 0.04 to 80 mg/l NO_3 Clear water (for a content of COD (KHP) up to 125 mg/l and 50 FNU turbidity based on mineralic kaolin)
	CAS51D-**C1 (40 mm gap)	SAC 0.1 to 50 m 1/m COD 0.15 to 75 mg/l equiv. KHP TOC 0.06 to 30 mg/l equiv. KHP Clear water, small measuring range; drinking water
	CAS51D-**C2 (8 mm gap)	SAC 0.5 to 250 m 1/m COD 0.75 to 370 mg/l equiv. KHP TOC 0.3 to 150 mg/l equiv. KHP Clear water, average measuring range; drinking water, WWP outlet, monitoring of waters
	CAS51D-**C3 (2 mm gap)	SAC 1.5 to 700 m 1/m COD 2.5 to 1000 mg/l equiv. KHP TOC 0.9 to 410 mg/l equiv. KHP Organic load in inlet, discharger control, industrial processes

9.2 Performance characteristics

Measured error (nitrate)	For 0.1 to 50 mg/l NO_3-N (2 mm cuvette): 2 % of full-scale value above 10 mg/l ±0.2 mg/l below 10 mg/l For 0.01 to 20 mg/l NO_3-N (8 mm cuvette): 2 % of full-scale value above 2 mg/l ±0.04 mg/l below 2 mg/l	
Measured error (SAC)	2 % of full-scale value above mg/l when measuring with potassium hydrogen phthalate (KHP) as the standard	
Detection limits (nitrate)	CAS51D-AA**A1** CAS51D-AA**A2**	0.003 mg/l NO_3-N 0.013 mg/l NO_3-N
Detection limits (SAC)	CAS51D-AA**C1** CAS51D-AA**C2** CAS51D-AA**C3**	0.045 mg/l COD 0.3 mg/l COD 1.5 mg/l COD
	in relation to the standard potassium hydrogen phthalate (KHP)	
Limit of quantitation (nitrate)	CAS51D-AA**A1** CAS51D-AA**A2**	0.01mg/l NO_3-N 0.043 mg/l NO_3-N
Limit of quantitation (SAC)	CAS51D-AA**C1** CAS51D-AA**C2** CAS51D-AA**C3**	0.15 mg/l COD 1.0 mg/l COD 5.0 mg/l COD
	in relation to the standard potassium hydrogen phthalate (KHP)	
Repeatability (nitrate)	Min. ±0.2 mg/l NO_3-N	
Repeatability (SAC)	0.5 % of end of measuring range (for homogeneous media)	
Drift (nitrate)	Better than 0.1 mg/l NO_3-N over one week	
Drift (SAC)	Better 0.2 % of end of measuring range over one week	
Cross-interference (nitrate)	1.0 mg/l nitrite is indicated as 0.8 mg/l nitrate.	

9.3 Environment

Ambient temperature range	-20 to 60 °C (-4 to 140 °F)
Storage temperature	-20 to 70 °C (-4 to 158 °F)
Degree of protection	IP 68 (testing conditions: 1 m (3.3 ft) water column over 60 days, 1 mol/l KCl)

9.4 Process

Process temperature range	+5 to 50 °C (41 to 120 °F)
Process pressure	0.5 to 10 bar (145 psi) absolute
Minimum flow	No minimum flow necessary. In the case of solids that tend to settle and cause sedimentation, make sure the solids are sufficiently intermixed in the medium.

9.5 Mechanical construction

Dimensions	See "Installation conditions"	
Weight	Approx. 1.6 kg (3.5 lbs) without cable	
Materials	Sensor Optical windows O-rings	Stainless steel 1.4404 (AISI 316 L) Quartz glass EPDM
Process connections	G1 and NPT ¾''	

Index

Endress+Hauser

People for Process Automation

Declaration of Hazardous Material and De-Contamination
Erklärung zur Kontamination und Reinigung

RA No. ☐☐☐☐☐☐☐☐

Please reference the Return Authorization Number (RA#), obtained from Endress+Hauser, on all paperwork and mark the RA# clearly on the outside of the box. If this procedure is not followed, it may result in the refusal of the package at our facility.
Bitte geben Sie die von E+H mitgeteilte Rücklieferungsnummer (RA#) auf allen Lieferpapieren an und vermerken Sie diese auch außen auf der Verpackung. Nichtbeachtung dieser Anweisung führt zur Ablehnung ihrer Lieferung.

Because of legal regulations and for the safety of our employees and operating equipment, we need the "Declaration of Hazardous Material and De-Contamination", with your signature, before your order can be handled. Please make absolutely sure to attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination und Reinigung", bevor Ihr Auftrag bearbeitet werden kann. Bringen Sie diese unbedingt außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp _____

Serial number
Seriennummer _____

☐ Used as SIL device in a Safety Instrumented System / *Einsatz als SIL Gerät in Schutzeinrichtungen*

Process data/ *Prozessdaten*
Temperature / *Temperatur* _____ [°F] _____ [°C]
Pressure / *Druck* _____ [psi] _____ [Pa]
Conductivity / *Leitfähigkeit* _____ [µS/cm]
Viscosity / *Viskosität* _____ [cp] _____ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	flammable *entzündlich*	toxic *giftig*	corrosive *ätzend*	harmful/ irritant *gesundheits-schädlich/ reizend*	other * *sonstiges**	harmless *unbedenklich*
Process medium / *Medium im Prozess*								
Medium for process cleaning / *Medium zur Prozessreinigung*								
Returned part cleaned with / *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include safety data sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Description of failure / *Fehlerbeschreibung* _____

_____

_____

Company data / *Angaben zum Absender*

Company / *Firma* _____

_____

Address / *Adresse*

_____

_____

Phone number of contact person / *Telefon-Nr. Ansprechpartner:*

_____

Fax / E-Mail _____

Your order No. / *Ihre Auftragsnr.* _____

"We hereby certify that this declaration is filled out truthfully and completely to the best of our knowledge.We further certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free of any residues in dangerous quantities."
"Wir bestätigen, die vorliegende Erklärung nach unserem besten Wissen wahrheitsgetreu und vollständig ausgefüllt zu haben. Wir bestätigen weiter, dass die zurückgesandten Teile sorgfältig gereinigt wurden und nach unserem besten Wissen frei von Rückständen in gefahrbringender Menge sind."

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

BA459C/07/EN/13.10
71125768
FM+SGML 6.0

71125768