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Operating Instructions
Turbimax CUS52D

Turbidity sensor

Endress+Hauser
People for Process Automation

Table of contents

1 About this document

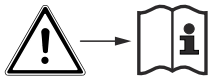
1.1 Safety information

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

1.2 Symbols used

- Additional information, tips
- Permitted
- Recommended
- Forbidden or not recommended
- Reference to device documentation
- Reference to page
- Reference to graphic
- Result of a step

1.3 Symbols on the device

Symbol	Meaning
	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.

1.4 Documentation

The following manuals, which complement these Operating Instructions, can be found on the product pages on the Internet:

Technical Information Turbimax CUS52D, TI01136C

2 Basic safety instructions

2.1 Requirements of 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

CUS52D is a sensor for measuring turbidity and low solids content in drinking water and process water applications.

The sensor is particularly suited for use in the following applications:
- Final turbidity measurement in outlet of waterworks
- Turbidity measurement in inlet of waterworks
- Turbidity measurement at all process stages
- Turbidity measurement for filter monitoring and filter backwashing
- Turbidity measurement in drinking water networks
- Turbidity measurement in saline media (plastic sensor only)

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

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

2.3 Workplace safety

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

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

During operation:

- If faults cannot be rectified:
  products must be taken out of service and protected against unintentional operation.

2.5 Product safety

2.5.1 State-of-the-art technology

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.

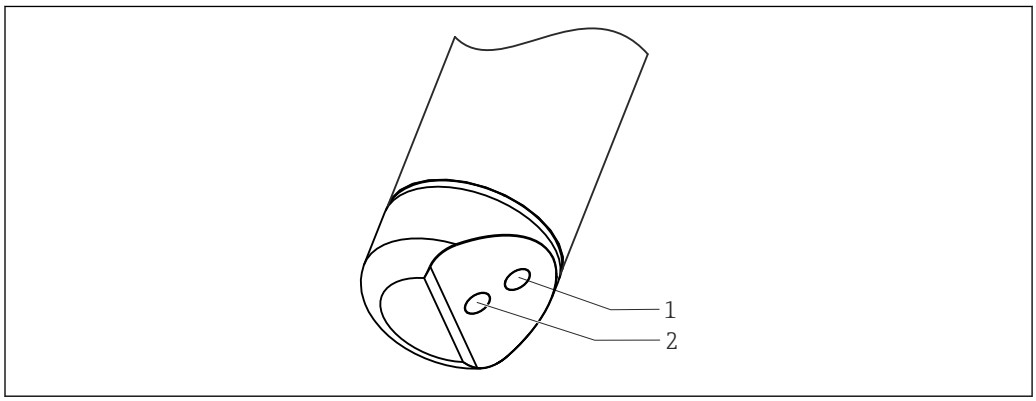
3 Product description

3.1 Product design

The sensor with the 40 mm (1.57 in) diameter can be operated directly and completely in the process without the need for further sampling (in-situ).

The sensor includes all necessary modules:
- Power supply
- Light sources
- Detectors
  Detectors detect the measuring signals, digitize them and process them to form a measured value.
- Sensor microcontroller
  This is responsible for controlling internal processes and transmitting data.

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

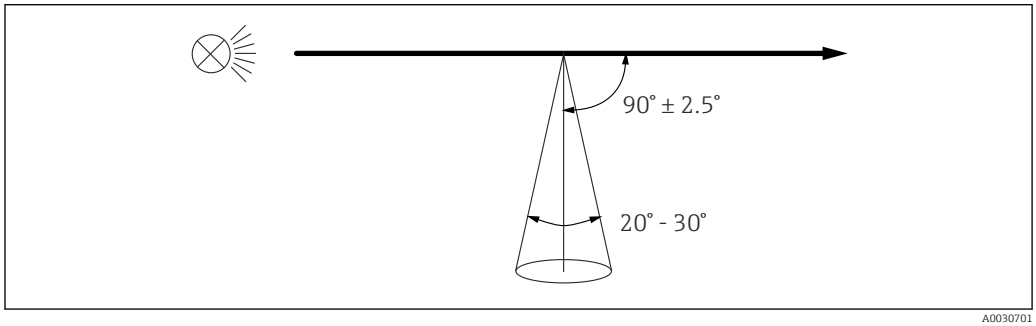


1 Arrangement of light source and light receiver

1 Light receiver
2 Light source

3.1.1 Measuring principle

The sensor works using the 90° light scattering principle in accordance with ISO 7027 and meets all the requirements of this standard (no divergence and a maximum convergence of 1.5°). The ISO 7027 standard is obligatory for turbidity measurements in the drinking water sector.



2 Measurement in accordance with ISO 7027

Measurement is done using a wavelength of 860 nm.

4 Incoming acceptance and product identification

4.1 Incoming acceptance

1. Verify that the packaging is undamaged.
   ↳ Notify the supplier of any damage to the packaging.
   Keep the damaged packaging until the issue has been resolved.
2. Verify that the contents are undamaged.
   ↳ Notify the supplier of any damage to the delivery contents.
   Keep the damaged goods until the issue has been resolved.
3. Check that the delivery is complete and nothing is missing.
   ↳ Compare the shipping documents with your order.
4. Pack the product for storage and transportation in such a way that it is protected against impact and moisture.
   ↳ The original packaging offers the best protection.
   Make sure to comply with the permitted ambient conditions.

If you have any questions, please contact your supplier or your local Sales Center.

4.2 Product identification

4.2.1 Nameplate

The nameplate provides you with the following information on your device:
- Manufacturer identification
- Order code
- 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/cus52d

Interpreting the 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 fill information pertaining to your device, including the product documentation.

Manufacturer's address

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

4.3 Scope of delivery

The scope of delivery comprises:
- 1 sensor, version as ordered
- 1 x Operating Instructions

▶ If you have any queries:
Please contact your supplier or local sales center.

4.4 Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

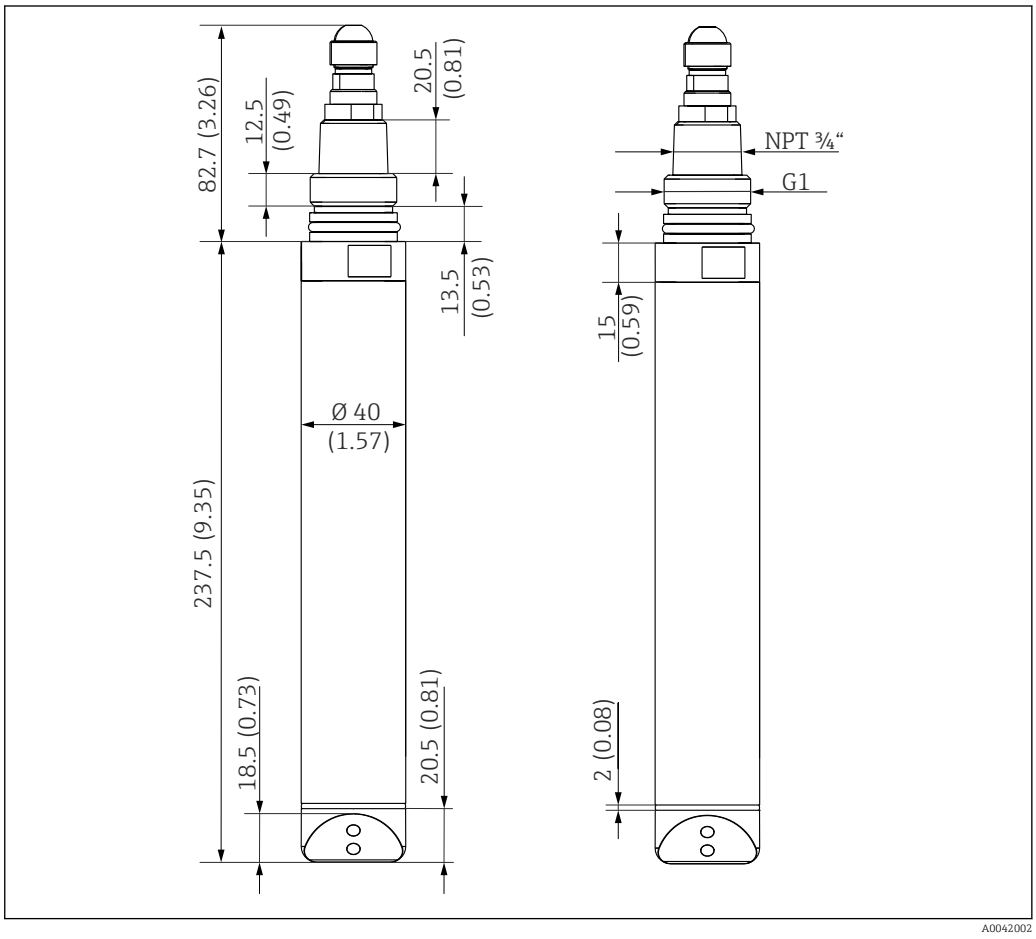
1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

5 Mounting

5.1 Mounting requirements

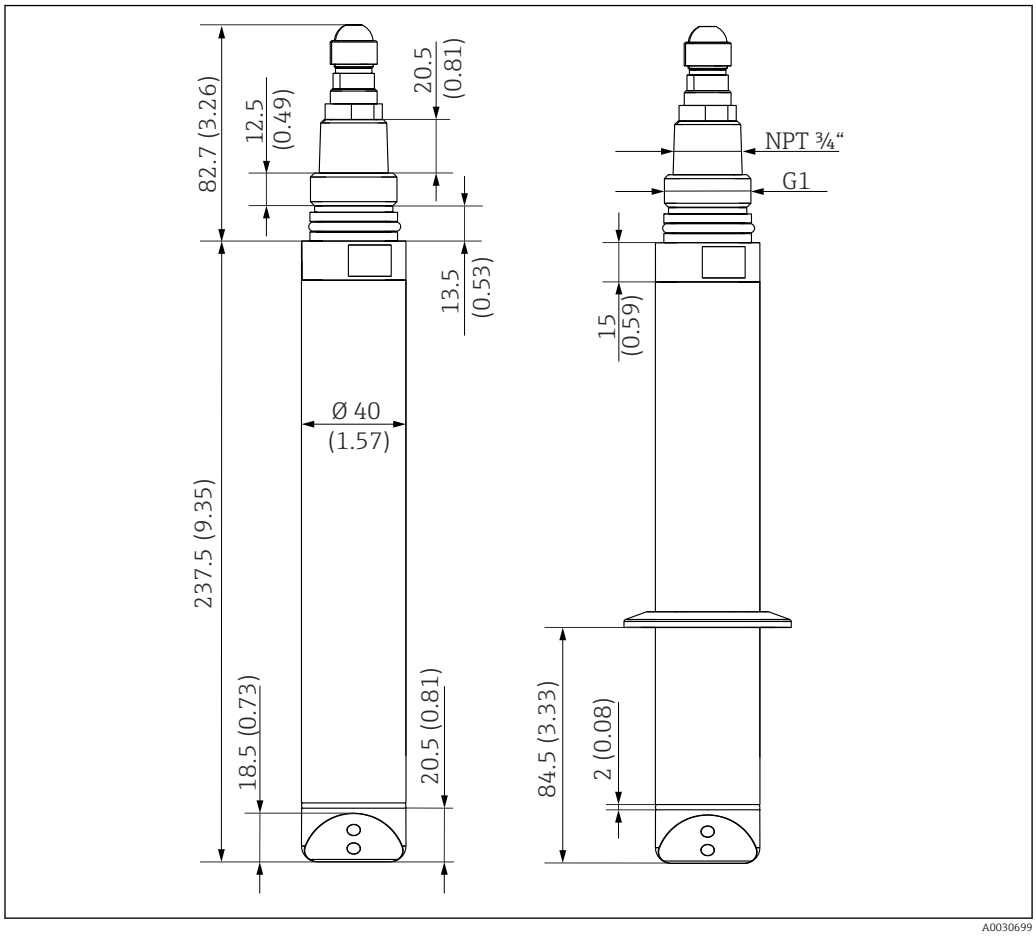
5.1.1 Dimensions

Plastic sensor

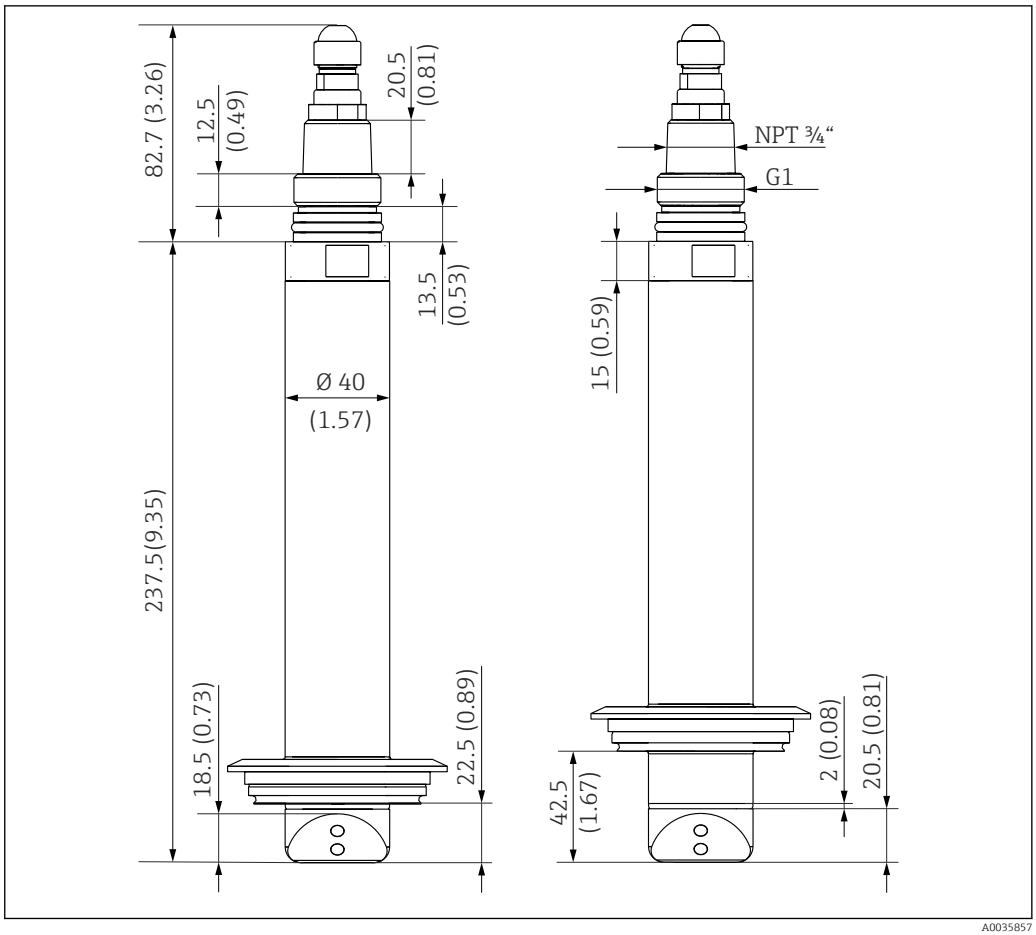


3 Dimensions of plastic sensor. Dimensions: mm (in)

Stainless steel sensor

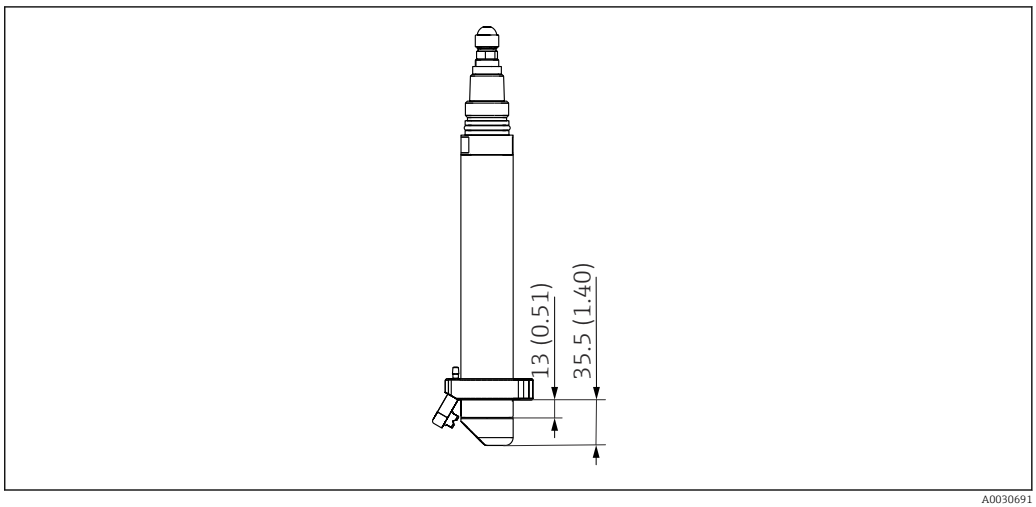


4 Dimensions of stainless steel sensor and stainless steel sensor with clamp connection (right). Dimensions: mm (in)



5 *Dimensions of stainless steel sensor with standard Varivent connection (left) and extended shaft (right). Dimensions: mm (in)*

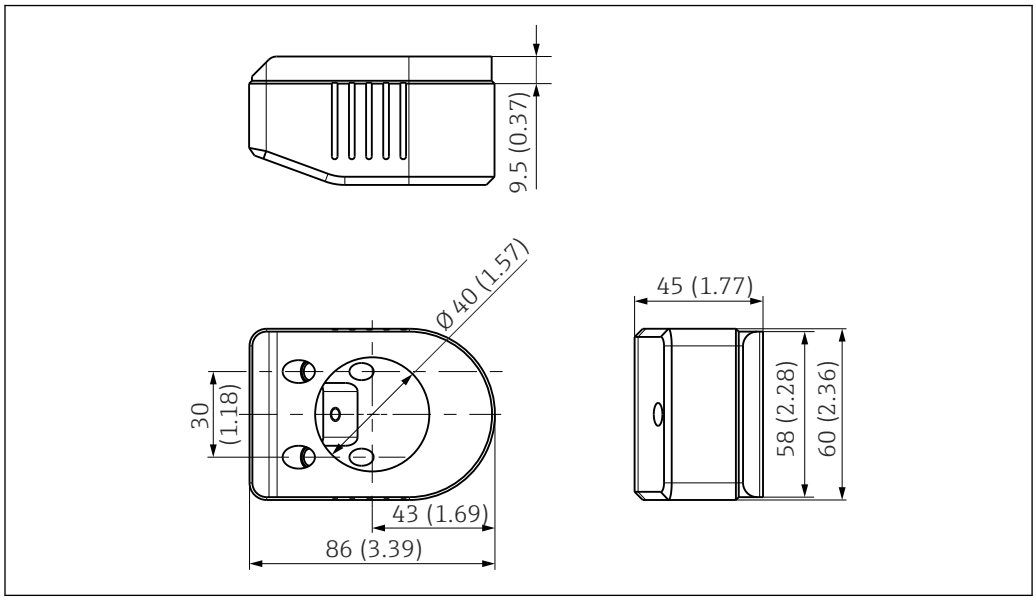
Compressed air cleaning



6 *Dimensions of sensor with compressed air cleaning. Dimensions: mm (in)*

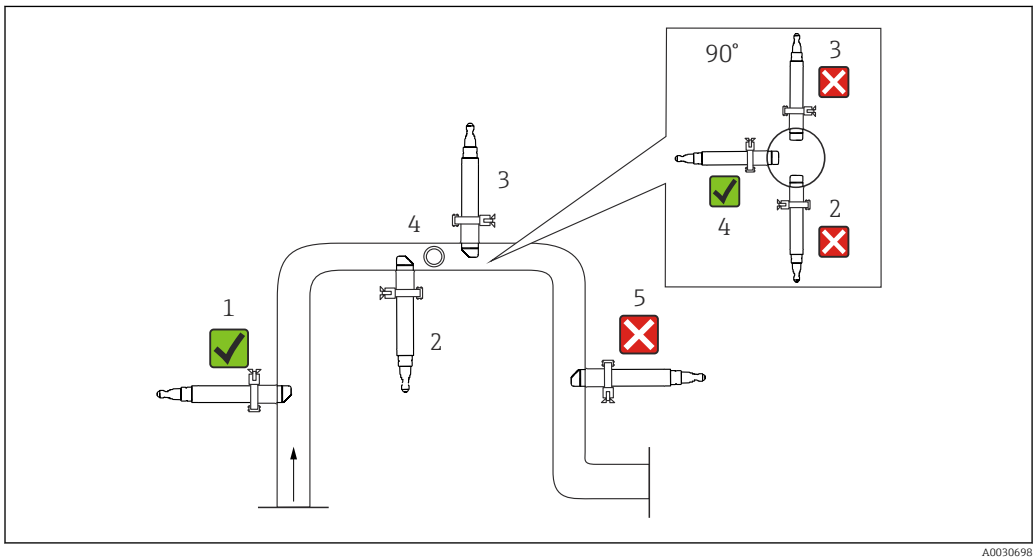
Compressed air cleaning accessory → 42

Solid state reference



7 Solid state reference Calkit CUS52D. Engineering unit: mm (in)

5.1.2 Orientation in pipes



8 Permitted and unacceptable orientations in pipes

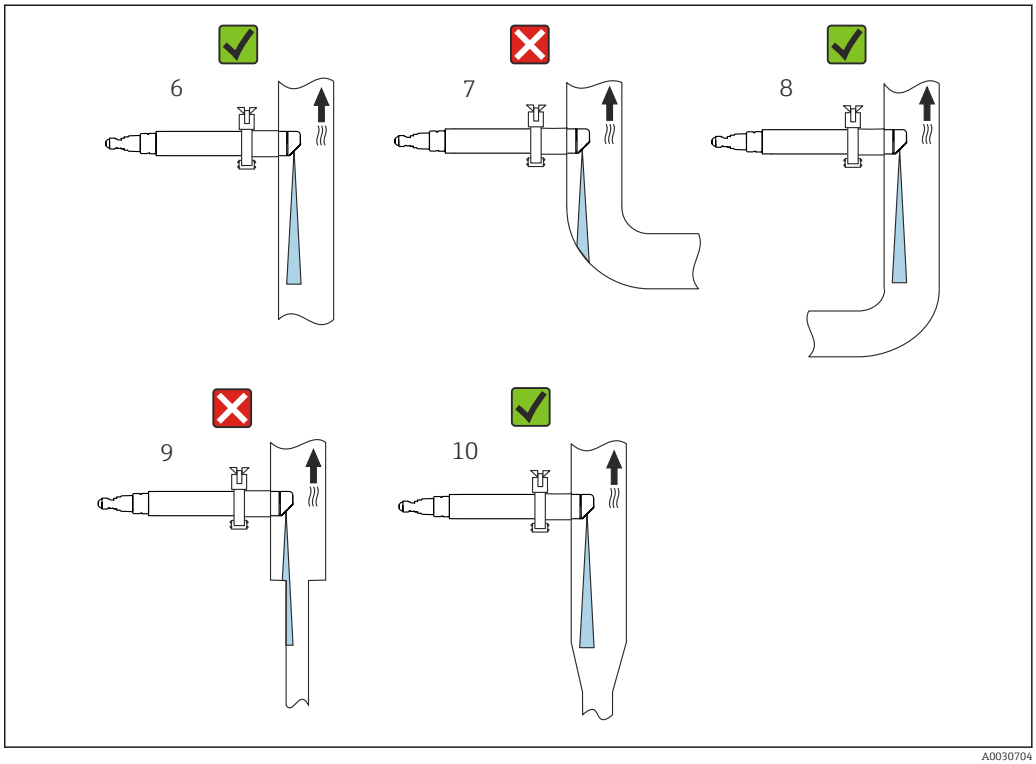
- Install the sensor in places with consistent flow conditions.
- The best installation location is in the ascending pipe (item 1). Installation in the horizontal pipe (item 4) is also possible.
- Do not install the sensor in places where air spaces or bubbles occur (item 3) or where sedimentation may occur (item 2).
- Avoid installation in the down pipe (item 5).
- Avoid fittings downstream from pressure reduction stages which can lead to outgassing.

Wall effects

Backscattering on the pipe wall may result in the distortion of measured values in the case of turbidity values < 200 FNU. Therefore a pipeline diameter of at least 100 mm (3.9 in) is recommended for reflecting materials (e.g. stainless steel). An assembly adjustment onsite is also recommended.

Pipes made of stainless steel with diameter >DN 300 exhibit hardly any wall effects.

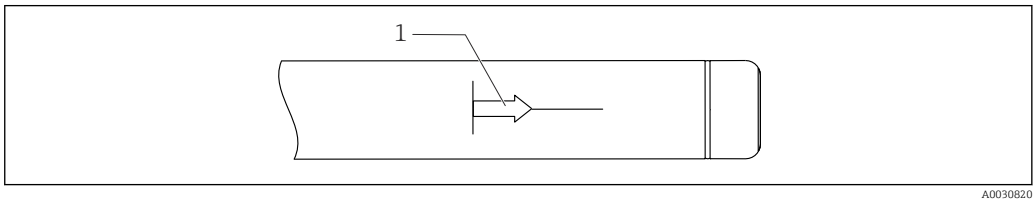
Black plastic pipes with diameter > DN 60 exhibit hardly any wall effects (<0.05 FNU). For this reason, the use of black plastic pipes is recommended.



9 *Orientations for pipes and assemblies*

- Install the sensor in such a way that the light beam is not reflected → 9, 15 (item 6).
- Avoid sudden changes in cross-section (item 9). Changes in cross-section should be gradual and located as far away as possible from the sensor (item 10).
- Do not install the sensor directly downstream from a bend (item 7). Instead position it as far away as possible from the bend (item 8).

Installation marking



10 *Installation marking for sensor alignment*

1 Installation marking

The installation marking on the sensor is aligned opposite the optical system.

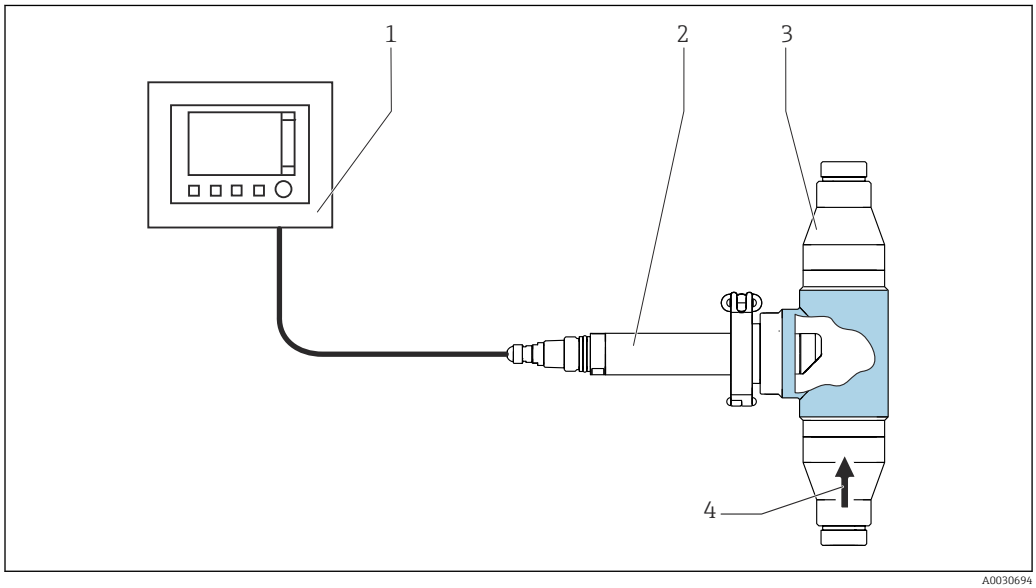
▶ Align the sensor against the flow direction.

5.2 Mounting the sensor

The sensor can be installed with different assemblies or directly in a pipe connection. However, the CYA112 immersion assembly must be used for continuous operation of the sensor under water.

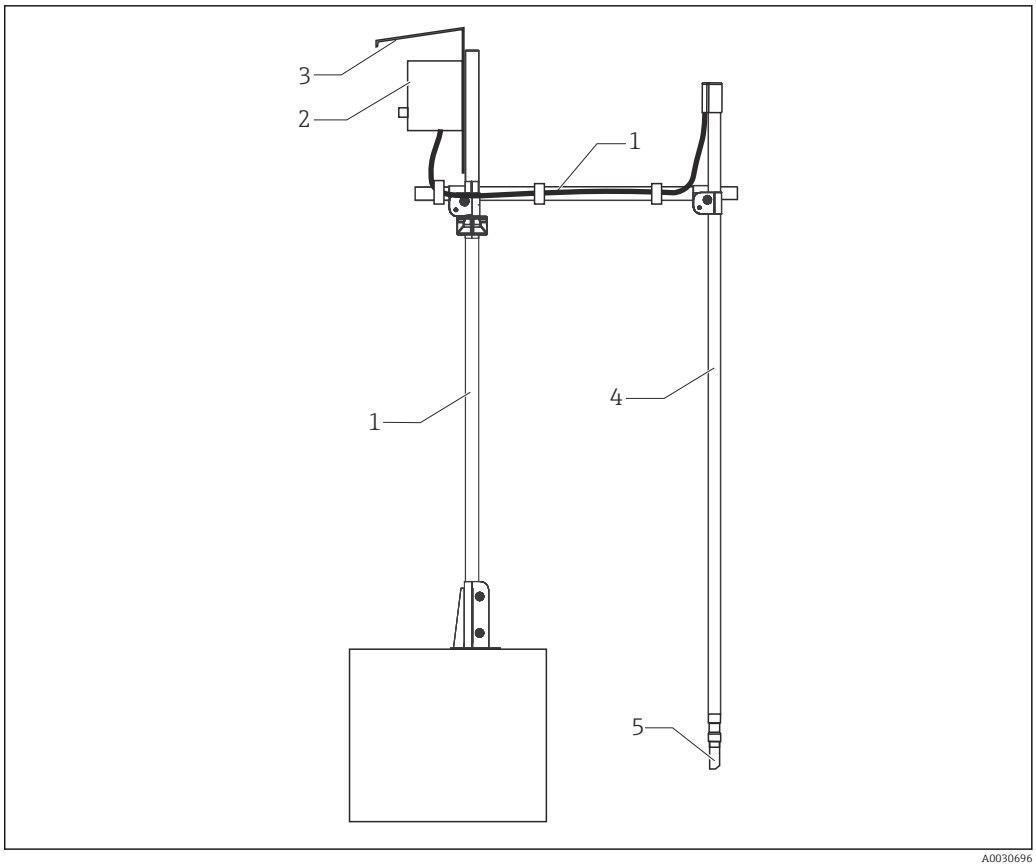
5.2.1 Measuring system

A complete measuring system comprises:
- Turbimax CUS52D turbidity sensor
- Liquiline CM44x multichannel transmitter
- Assembly:
  - CUA252 flow assembly (only possible for stainless steel sensor) or
  - CUA262 flow assembly (only possible for stainless steel sensor) or
  - Flexdip CYA112 immersion assembly and Flexdip CYH112 holder or
  - Retractable assembly, e.g., Cleanfit CUA451
- Or direct installation via pipe connection (only possible for stainless steel sensor)
  - Clamp 2" or
  - Varivent



11 Example of measuring system with CUA252 flow assembly, for stainless steel sensor

1 Liquiline CM44x multichannel transmitter
2 Turbimax CUS52D turbidity sensor
3 CUA252 flow assembly
4 Direction of flow



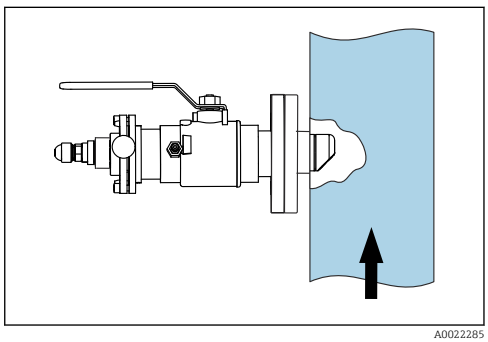
12 *Example of measuring system with immersion assembly*

1 *Flexdip CYH112 holder*
2 *Liquiline CM44x multichannel transmitter*
3 *Weather protection cover*
4 *Flexdip CYA112 immersion assembly*
5 *Turbimax CUS52D turbidity sensor*

This type of installation is particularly suitable for strong or turbulent flow > 0.5 m/s (1.6 ft/s) in basins or channels.

5.2.2 Mounting options

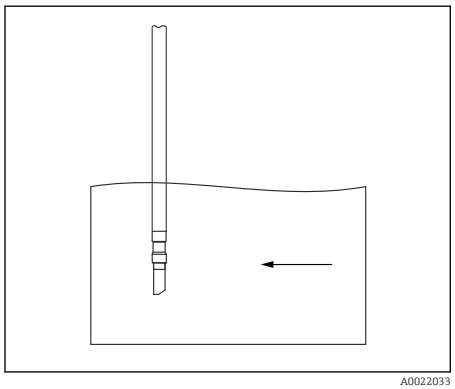
Installing with CUA451 retractable assembly



13 *Installing with CUA451 retractable assembly*

The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.
The medium pressure may not exceed 2 bar (29 psi) for manual assembly retraction.

Installing with Flexdip CYA112 immersion assembly and Flexdip CYH112 holder

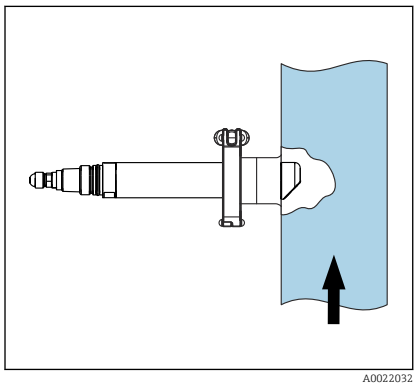


The installation angle is 0°.
The arrow points in the direction of flow.

14 Installing with immersion assembly

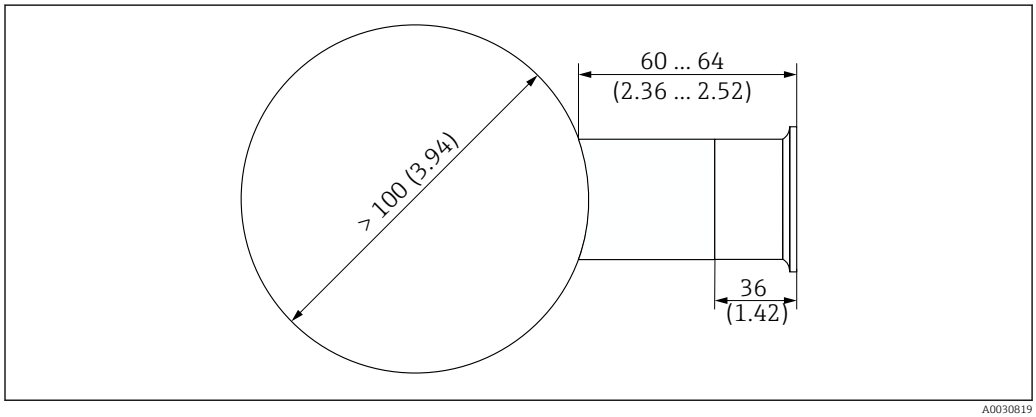
- If the sensor is being used in open basins, install the sensor in such a way that air bubbles cannot accumulate on it.

Installing with 2" clamp connection



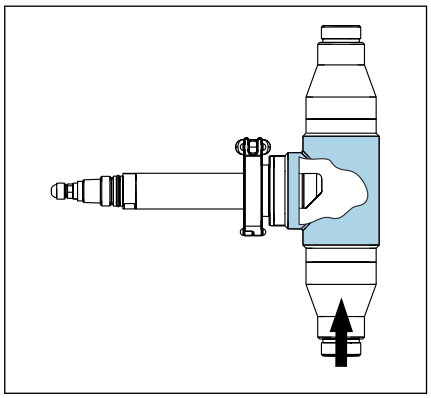
The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.
A weld-in adapter is available as an accessory for the installation → 41.

15 Installing with 2" clamp connection



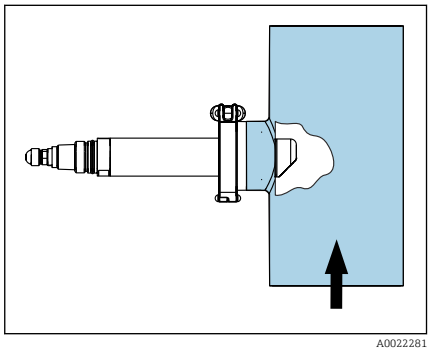
16 Pipe connection with weld-in adapter. Dimensions: mm (in)

Installing with CUA252 or CUA262 flow assembly



17 *Installing with CUA252 flow assembly*

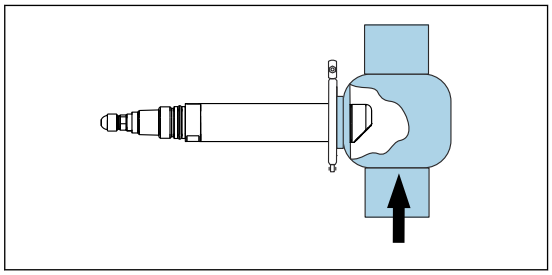
The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.



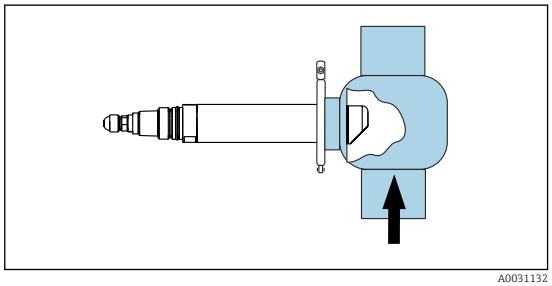
18 *Installing with CUA262 flow assembly*

The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.

Installing in Varivent assemblies



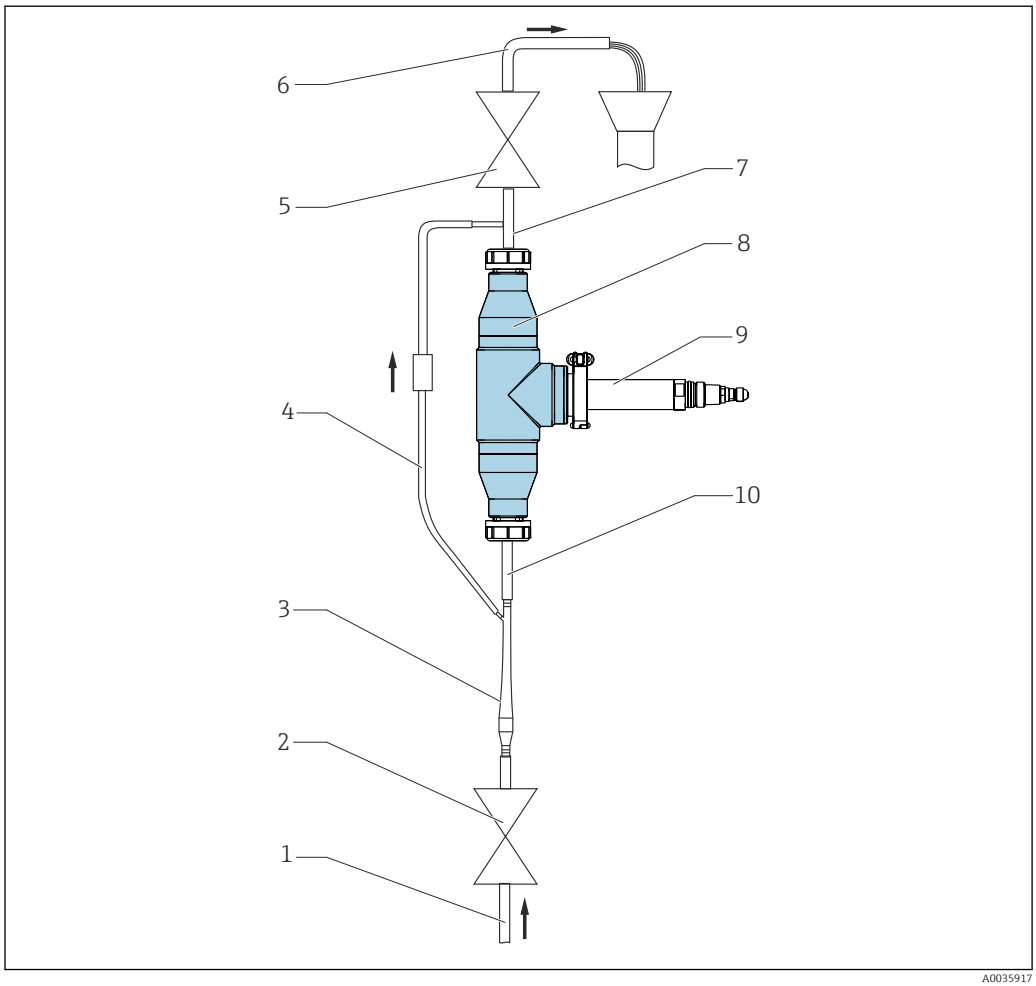
19 *Installing with standard Varivent connection*



20 *Installing with Varivent connection with extended shaft*

The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.

Installing with CUA252 flow assembly and bubble trap

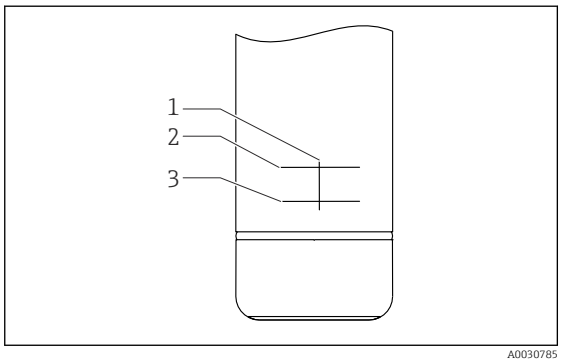


21 Connection example with bubble trap and CUA252 flow assembly

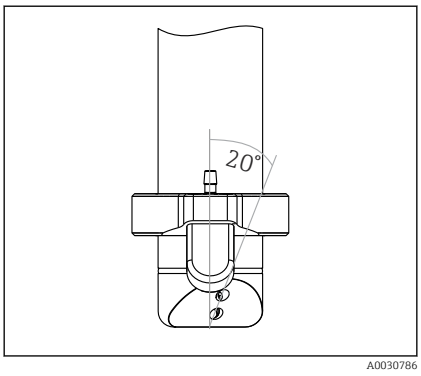
1 *Inlet from below*
2 *Shutoff valve*
3 *Bubble trap*
4 *Venting of bubble trap (included in scope of delivery)*
5 *Shut-off valve (throttle for increasing pressure)*
6 *Outlet*
7 *D 12 adapter with connection for vent pipe (included in scope of delivery)*
8 *CUA252 flow assembly*
9 *CUS52D turbidity sensor*
10 *D 12 adapter*

For detailed information on installing the assembly and the bubble trap, see BA01281C

Compressed air cleaning



22 *Installation markings 1 to 3*



23 *Mounting position*

Mount the compressed air cleaning system as follows:

1. Fit the compressed air cleaning system on the sensor (→ 23).
2. Position the securing ring for the compressed air cleaning system between installation marks 2 and 3 (→ 22).
3. Using a 4 mm (0.16 in) Allen key, tighten the securing screw of the compressed air cleaning system slightly so that the compressed air cleaning system can still be rotated.
4. Turn the compressed air cleaning system so that the slit on the black ring is on installation mark 1 (→ 22).
   ↳ This way the nozzle is offset by 20° when blowing air at the optical windows.
5. Tighten the securing screw.
6. Fit the compressed air hose on the hose connection.

5.3 Post-mounting check

Put the sensor into operation only if the following questions can be answered with "yes":
- Are the sensor and cable undamaged?
- Is the orientation correct?
- Has the sensor been installed in the process connection, and does not suspend freely from the cable?

6 Electrical connection

⚠ WARNING

Device is live!

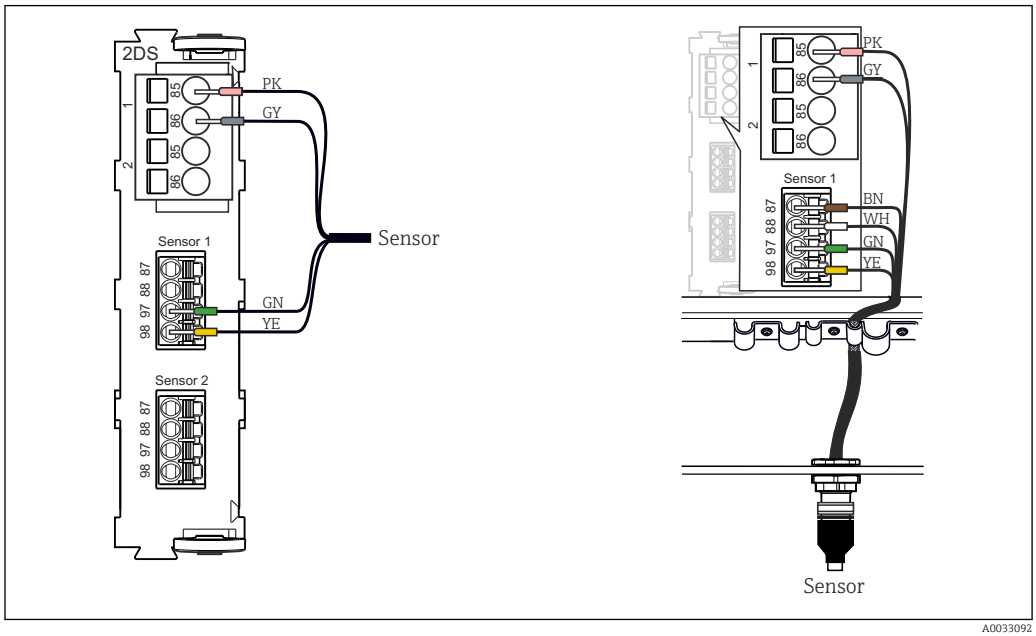
Incorrect connection may result in injury or death!

- ▶ 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 sensor

The following connection options are available:

- Via M12 plug (version: fixed cable, M12 plug)
- Via sensor cable to the plug-in terminals of a sensor input on the transmitter (version: fixed cable, end sleeves)



24 *Sensor connection to sensor input (left) or via M12 plug (right)*

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

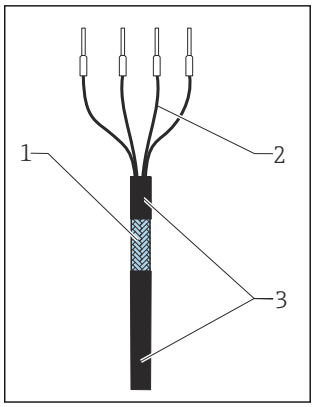
6.1.1 Connecting the cable shield

Device cable must be shielded cables.

Only use terminated original cables where possible.

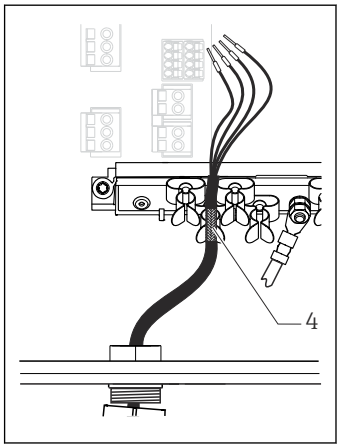
Clamping range of cable clamps: 4 to 11 mm (0.16 to 0.43 in)

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



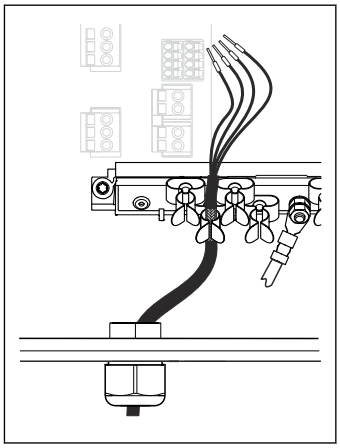
25 Terminated cable

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



26 Connect the cable to the grounding clamp

4 Grounding clamp



27 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, designated use, may be carried out on the device delivered.

▶ Exercise care when carrying out the work.

Individual types of protection permitted for this product (impermeability (IP), electrical safety, EMC interference immunity) can no longer be guaranteed if, for example :
- Covers are left off
- Different power units to the ones supplied are used
- Cable glands are not sufficiently tightened (must be tightened with 2 Nm (1.5 lbf ft) for the permitted level of IP protection)
- Unsuitable cable diameters are used for the cable glands
- Modules are not fully secured
- The display is not fully secured (risk of moisture entering due to inadequate sealing)
- Loose or insufficiently tightened cables/cable ends
- Conductive cable strands are left in the device

6.3 Post-connection check

Device health and specifications	Action
Is the outside of the sensor, 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. ▶ Untwist the cables.
Is a sufficient length of the cable cores stripped, and are the cores positioned in the terminal correctly?	▶ Perform a visual inspection. ▶ Pull gently to check they are seated correctly.
Are the power supply and signal lines connected correctly?	▶ Use the transmitter wiring diagram.
Are all screw terminals tightened?	▶ Tighten the screw terminals.
Are all cable entries mounted, firmly tightened and leak-tight?	▶ Perform a visual inspection. 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 Function check

Prior to initial commissioning, ensure that:
- The sensor is correctly installed
- 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 device to the process conditions

8.1.1 Applications

The formazine factory calibration is used as the basis for precalibrating additional applications and optimizing them for the different media characteristics.

Application	Specified operational range
Formazine	0.000 to 1000 FNU
Kaolin	0 to 150 mg/l
PSL	0 to 125 度
Diatomite	0 to 550 mg/l

To adapt to a specific application, customer calibrations can be carried out with up to 6 points.

NOTICE

Multiple scattering

If the specific operational range is exceeded, the measured value displayed by the sensor can decrease despite increasing turbidity. The indicated operational range is reduced in the case of highly absorbing (e.g. dark) media.

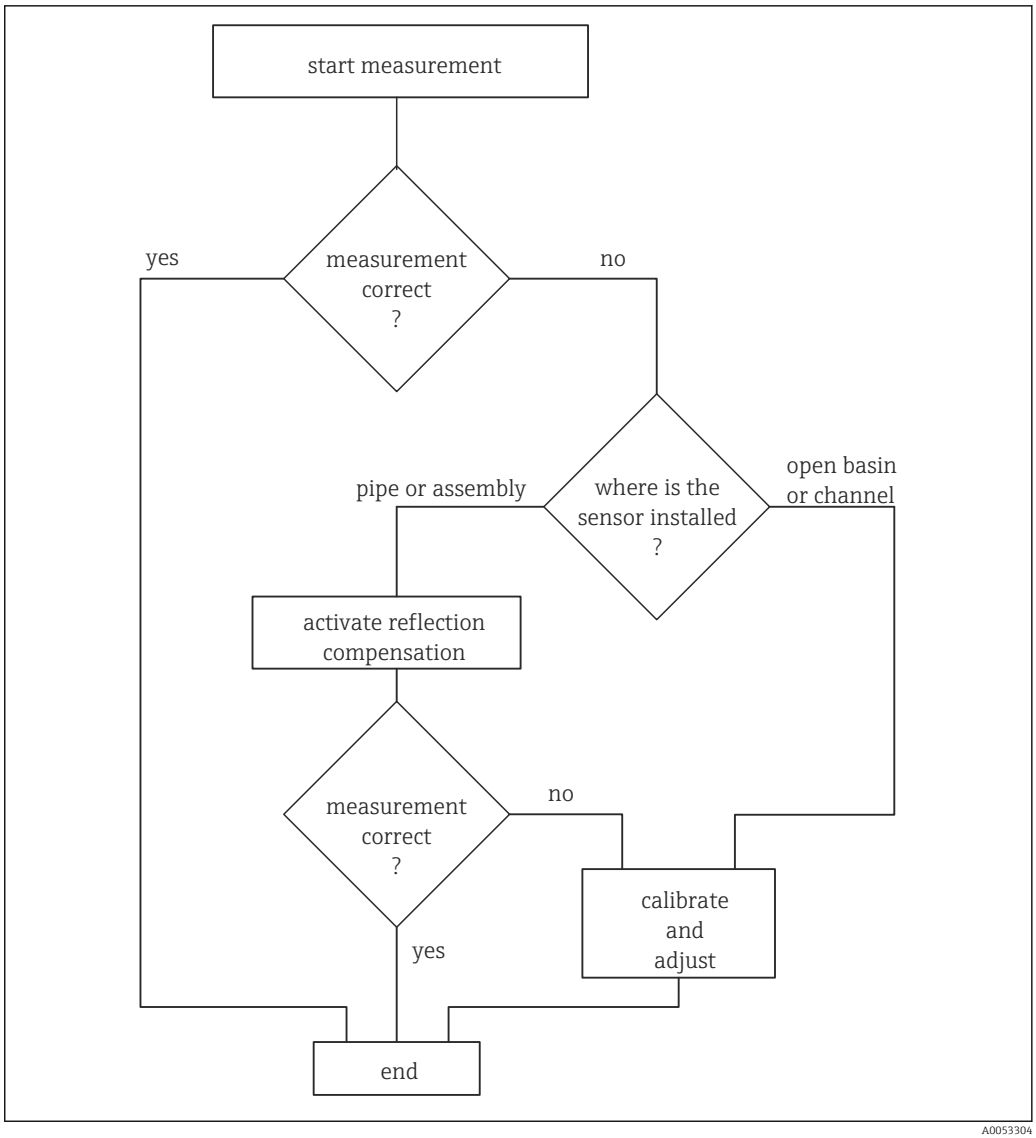
- ▶ In the case of highly absorbing (e.g. dark) media, determine the operational range experimentally beforehand.

8.1.2 Calibration

The sensor is precalibrated on leaving the factory. As such, it can be used in a wide range of applications without the need for additional calibration.

The sensor offers the following options for adapting the measurement to the specific application:

- Assembly adjustment (compensation for wall effects in pipes and assemblies)
- Calibration or adjustment (1 to 6 points)
- Entry of a factor (multiplication of the measured values by a constant factor)
- Entry of an offset (addition/subtraction of a constant value to/from the measured values)
- Duplication of factory calibration data records



28 *Flowchart*

In order to be able to use the "Offset", "Factor" or "Assembly adjustment" functions, a new data record must first be generated by means of a 1 to 6-point calibration or by duplication of a factory data record.

Assembly adjustment

Both the optical design of the CUS52D turbidity sensor and the CUA252 and CUA262 flow assemblies are optimized to minimize measured errors from the effects of walls in assemblies or pipes (measured error in CUA252 < 0.02 FNU).

The **Assembly adjustment** function can automatically compensate for the remaining measured errors caused by wall effects. The functionality is based on formazine measurements and may thus require a calibration downstream in order to adapt the measurement to the corresponding application or medium.

Adjustment	Description
PE 100	Adjustment to CUA252 flow assembly (material: polyethylene)
1.4404 (AISI 316 L)	Adjustment to CUA262 weld-in flow assembly (material: stainless steel 1.4404)
Customization, standard	Adjustment to any pipe/assembly
Customization, specialist	Adjustment only recommended for Endress+Hauser Service staff

- **PE100 and 1.4404/316L**
  All of the parameters are assigned default values in the firmware and cannot be changed.
- **Standard customization**
  It is possible to select the material, surface (matte/shiny) and the internal diameter of the assembly in which the sensor is installed.
- **Customized advanced**
  For special adjustments, the following table provides recommendations. Alternatively, adjustments can be performed by the manufacturer's service department.

Assembly/pipe built-in adapter	Zero adjustment	Upper limit	Adjustment characteristic
CUA250 [1)]	0.14	33	1.001
CYA251 [1)]	0.075	25	1.5
VARIVENT N DN 65	1.28	500	6
VARIVENT N DN 80	0.75	500	6
VARIVENT N DN 100	0.35	500	6
VARIVENT N DN 125	0.20	500	6

1) Sensor adapter required for the installation of CUS52D in this assembly,

Application selection

▶ During initial commissioning or calibration at the CM44x , select the appropriate application for your area of operation.

Application	Field of application	Unit
Formazine	Drinking water, process water	FNU; FTU; NTU; TE/F; EBC; ASBC
Kaolin	Drinking water, filterable matter, industrial water	mg/l; g/l; ppm
PSL	The calibration standard commonly used in Japan for drinking water turbidity	度 (dough)
Diatomite	Mineral-based solids (sand)	mg/l; g/l; ppm

1 to 6 points can be calibrated for all applications.

In addition to the factory calibrations, which cannot be changed, the sensor contains 6 additional data records for storing process calibrations or for adjusting them to the relevant measuring point (application).

1-point and multipoint calibration

1. Before a calibration, rinse the system until all air pockets and fouling have been removed.
2. In the calibration table, edit the actual values as well as the set points (right and left columns).
3. Add additional pairs of calibration values, even without measurement in a medium.

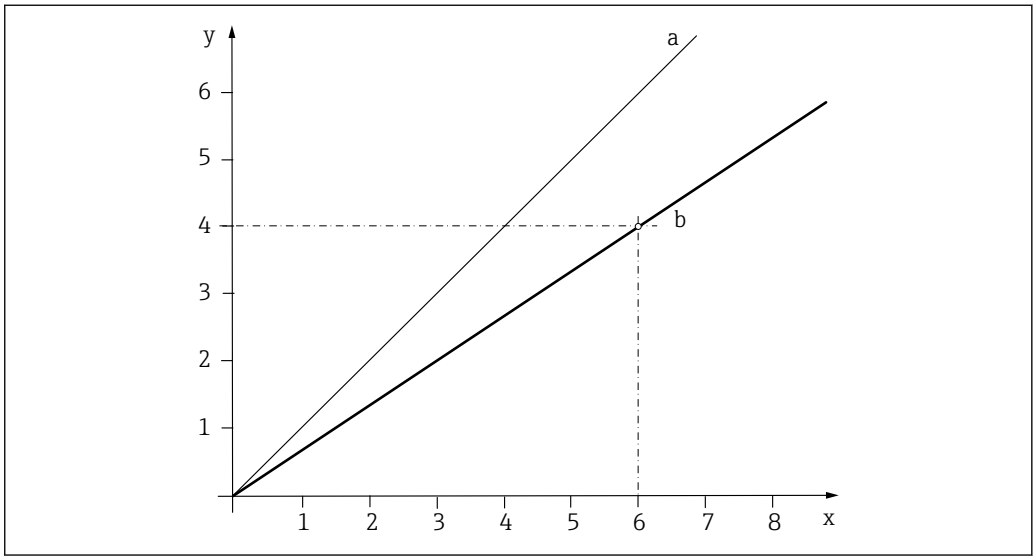
When factory calibration data records are duplicated, the value pair 1000/1000 is automatically generated to map the factory data record 1:1 to the duplicated record.

▶ If a single-point or multipoint calibration is performed following duplication, delete the value pair (1000/1000) in the calibration table

Lines interpolate between the calibration points.

1-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.



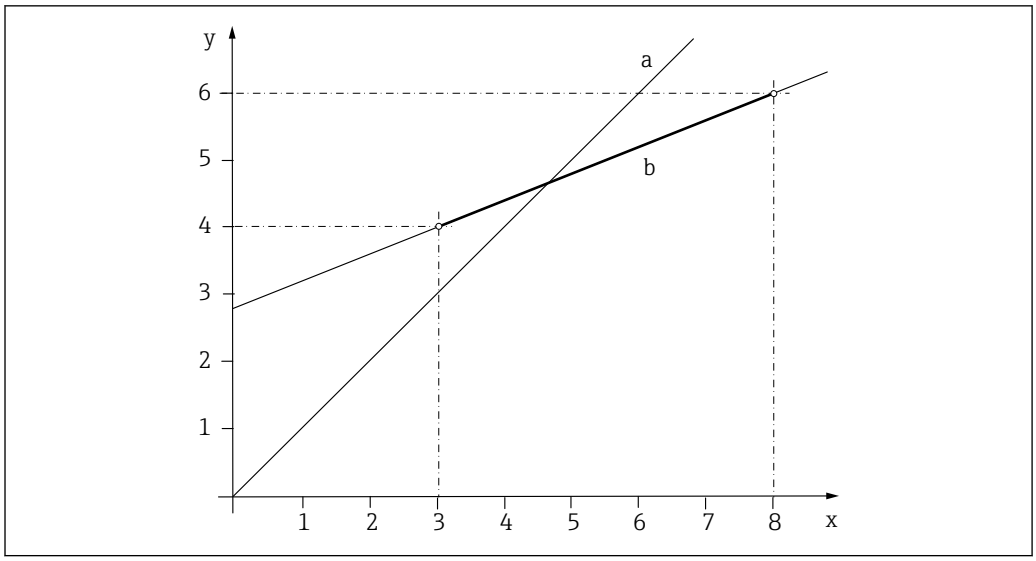
29 *Principle of a 1-point calibration*

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).

2-point calibration

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



30 Principle of a 2-point calibration

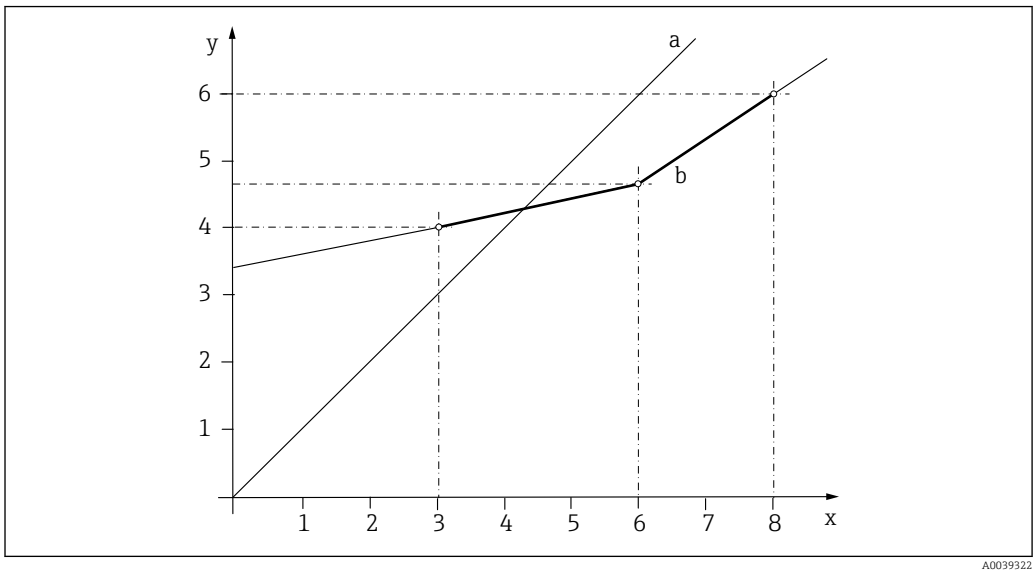
x Measured value
y Target sample value
a Factory calibration
b Application calibration

1. Select a data record.
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 (gray line).

The calibration curve must be monotonically increasing.

3-point calibration



31 Principle of multipoint calibration (3 points)

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

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

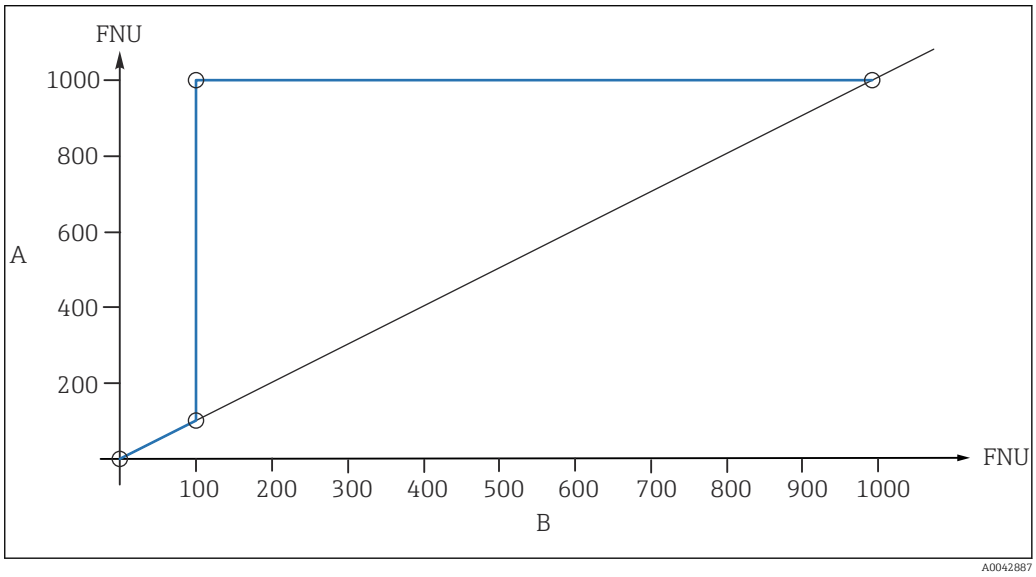
A linear extrapolation is performed outside the calibrated operational range (gray line).

The calibration curve must be monotonically increasing.

Calibration example for filter monitoring

Application example:

If a threshold is exceeded, the measured value is set to a maximum regardless of the actual turbidity.



32 *Example for filter monitoring*

A Application calibration
B Factory calibration

The following table shows the values in the example (→ 32):

Measured value	Target sample value
0	0
100	100
101	1000
1000	1001

Stability criterion

During calibration, the measured values provided by the sensor are checked to ensure they are constant. The maximum deviations that may occur in measured values during a calibration are defined in the stability criterion.

The specifications comprise the following:
- The maximum permitted deviation in temperature measurement
- The maximum permitted deviation in measured value as a %
- The minimum time frame in which these values must be maintained

The calibration resumes as soon as the stability criteria for signal values and temperature have been reached. If these criteria are not met in the maximum time frame of 5 minutes, no calibration is performed - a warning is issued.

The stability criteria are used to monitor the quality of the individual calibration points in the course of the calibration process. The aim is to achieve the highest possible calibration quality in the shortest possible time frame while taking external conditions into account.

For calibrations in the field in adverse weather and environmental conditions, the measured value windows selected can be suitably large and the time frame selected can be suitably short.

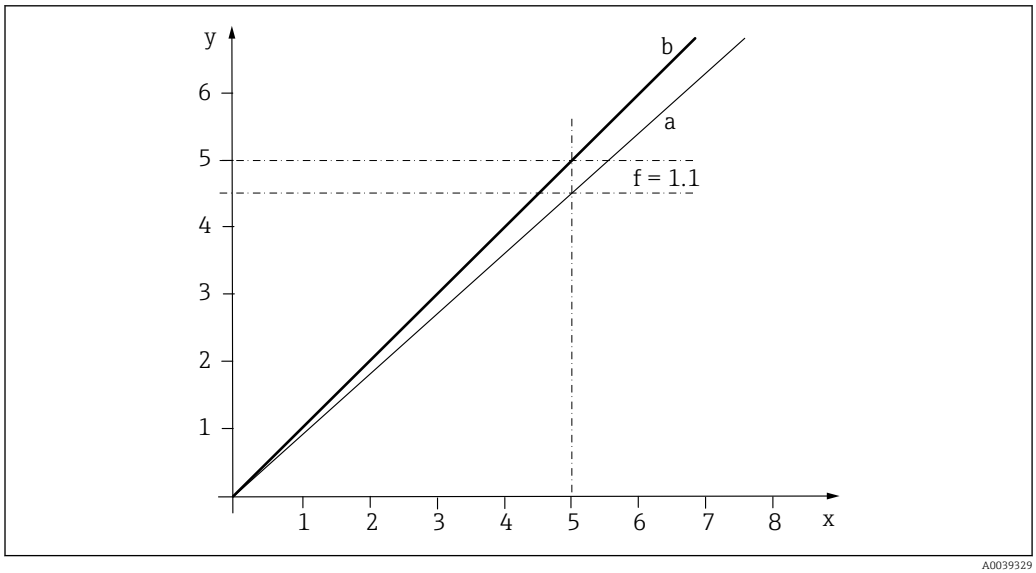
Factor

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.

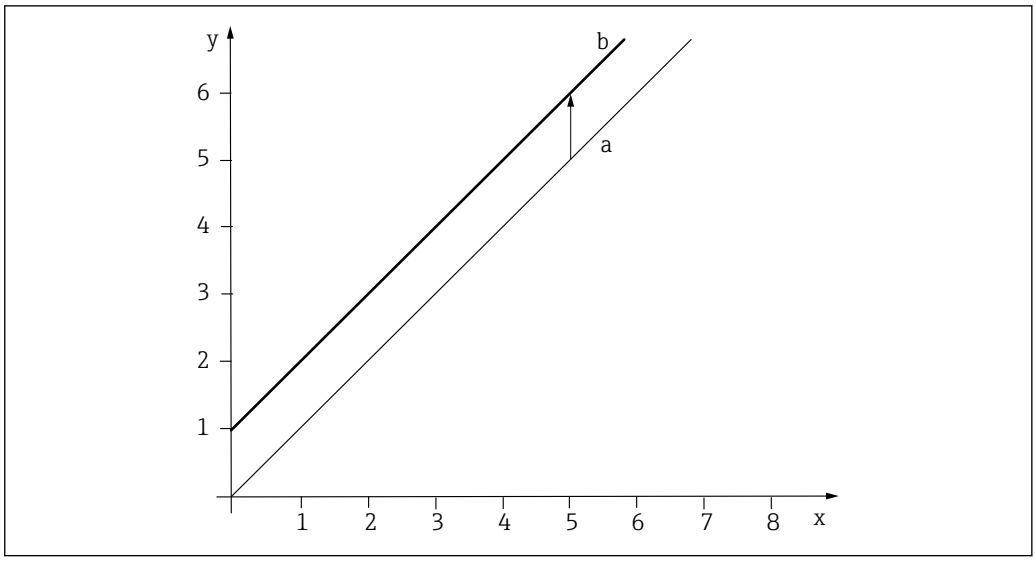


33 *Principle of factor calibration*

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

Offset

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



34 *Principle of an offset*

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

8.1.3 Cyclic cleaning

For cyclic cleaning in open basins or channels, compressed air is the most suitable option. The cleaning unit is either supplied or can be retrofitted, and is attached to the sensor head. The following settings are recommended for the cleaning unit:

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

The CYR52 ultrasonic cleaning unit is suitable for cyclic cleaning in pipes or assemblies. The cleaning unit (which can also be retrofitted) can be mounted on the CUA252, CUA262 flow assemblies or on any customer pipes.

The following cleaning settings are recommended to prevent the ultrasonic transducer from overheating:
- Cleaning duration: maximum 5 seconds
- Cleaning interval: minimum 5 minutes

8.1.4 Signal filter

The sensor is fitted with an internal signal filter function in order to adapt the measurement flexibly to different measuring requirements. Turbidity measurements based on the principle of scattered light may have a low signal-to-noise ratio. In addition, there may be disturbances from air bubbles or contamination for example.

However, a high level of damping affects the sensitivity of the measured value required in applications.

Measured value filter

The following filter settings are available:

Measured value filter	Description
Weak	Low filtering, high sensitivity, fast response to changes (2 seconds)
Normal (default)	Medium filtering, 10-second response time
Strong	Strong filtering, low sensitivity, slow response to changes (25 seconds)
Specialist	This menu is designed for the Endress+Hauser Service Department.

8.1.5 Solid state reference

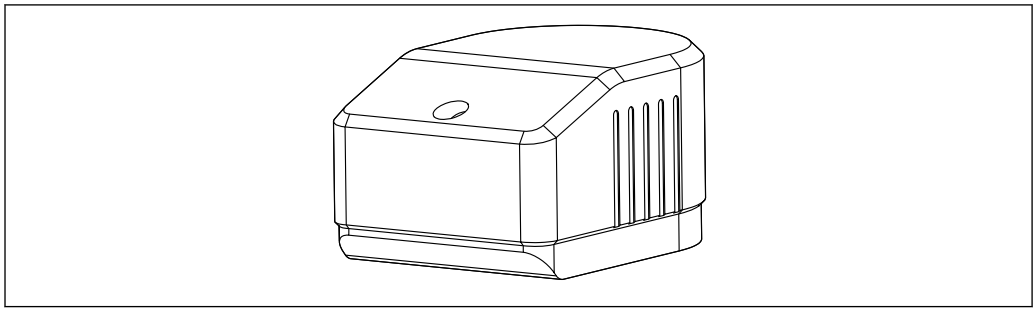
The solid state reference can be used to check the functional integrity of the sensor.

During factory calibration, each Calkit solid state reference is matched specifically to a special CUS52D sensor and can be used only with this sensor. Therefore, the Calkit solid state reference and the sensor are permanently assigned (married) to one another.

The following Calkits solid state references are available:
- 5 FNU (NTU)
- 20 FNU (NTU)
- 50 FNU (NTU)

The reference value indicated on the Calkit solid state reference is reproduced with an accuracy of ± 10% when the sensor is operating correctly.

The CUY52 solid state reference with approx. 4.0 FNU/NTU is used to check the functionality of any CUS52D sensors. The standard is not assigned to a specific sensor and delivers measured values in the range of 4.0 FNU ± 1.5 FNU/NTU with all CUS52D sensors.



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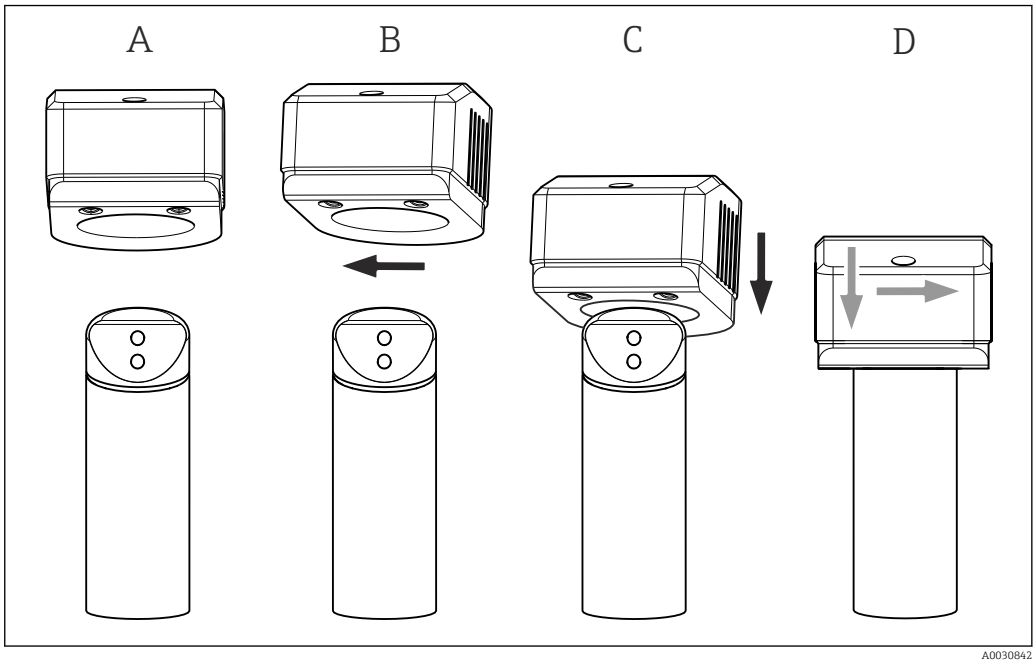
35 Solid state reference

Function check with solid state reference



36 *Fitting the solid state reference on the sensor*

Preparation:

1. Clean the sensor → 38.
2. Fix the sensor in place (e.g. with a laboratory stand).
3. With the solid state reference turned slightly (→ 36, B), fit it gently on the sensor (C).
4. Slide the solid state reference into the final position (D).

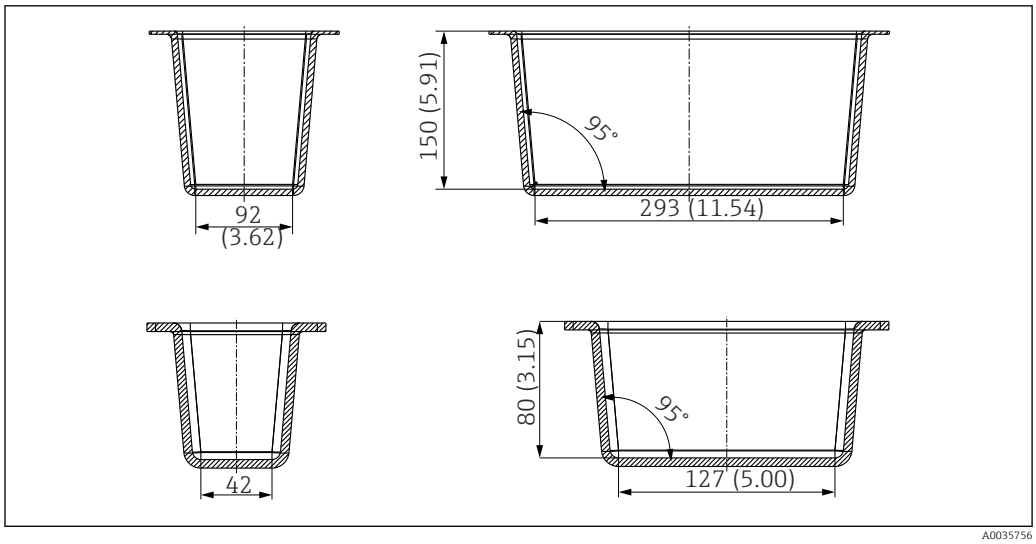
Function check:

1. Enable the factory calibration on the transmitter.
2. Read the measured value at the transmitter (depending on the signal filter settings, it can take 2 to 25 seconds until the correct measured value appears).
3. Compare the measured value with the reference value on the solid state reference.
   ↳ The sensor is working correctly if the value deviation is within the imprinted tolerance.

If you activate a calibration data record, other measured values will result. Therefore, always select the factory calibration (formazine) when checking the function with the calibration kit.

Calibration vessel

The CUY52 calibration vessel allows the sensors to be validated quickly and reliably. This makes it easier to adapt to the actual measuring point by creating basic conditions that are reproducible (e.g., vessels with the least backscattering or shadowing of interfering light sources). There are two different types of calibration vessel into which the calibration solution (e.g., formazine) can be filled.



37 *Large calibration vessel (top) and small calibration vessel (bottom). Engineering unit: mm (in)*

For detailed information on calibration tools, see BA01309C

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
- Sensor

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

Problem	Check	Remedial action
Blank display, no sensor reaction	▪ Line voltage at transmitter? ▪ Sensor connected correctly? ▪ Buildup on optical windows?	▸ Connect mains voltage. ▸ Establish correct connection. ▸ Clean sensor.
Display value too high or too low	▪ Buildup on optical windows? ▪ Sensor calibrated?	▸ Clean device. ▸ Calibrate device.
Display value fluctuating greatly	Is the mounting location correct?	▸ Select a different mounting location. ▸ Adjust measured value filter.

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 cleaning before the sensor is removed 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 tasks

NOTICE

Disassembly at sensor head

Sensor can leak!

- ▶ Turn by the shaft only.
- ▶ Never turn by the sensor head!

10.1.1 Cleaning the sensor

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

- ▶ To ensure reliable measurements, clean the sensor at regular intervals. The frequency and intensity of the cleaning depend on the medium.

Clean the sensor:

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

Type of fouling	Cleaning measure
Lime deposits	▶ Immerse the sensor in 1 to 5% hydrochloric acid (for several minutes).
Dirt particles on the optics	▶ Clean the optics with a cleaning cloth.

After cleaning:

- ▶ Rinse the sensor thoroughly with 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.

To ensure the swift, safe and professional return of the device:

- Refer to the website www.endress.com/support/return-material for information on the procedure and conditions for returning devices.

11.4 Disposal

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

- Observe the local regulations.

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

FlowFit CUA120
- Flange adapter for mounting turbidity sensors
- Product Configurator on the product page: www.endress.com/cua120

Technical Information TI096C

Flowfit CUA252
- Flow assembly
- Product Configurator on the product page: www.endress.com/cua252

Technical Information TI01139C

Flowfit CUA262
- Weld-in flow assembly
- Product Configurator on the product page: www.endress.com/cua262

Technical Information TI01152C

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

Cleanfit CUA451
- Manual retractable assembly made of stainless steel with ball valve shut-off for turbidity sensors
- Product Configurator on the product page: www.endress.com/cua451

Technical Information TI00369C

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

Technical Information TI00495C

Flowfit CUA250
- Flow assembly for water and wastewater applications
- Product Configurator on the product page: www.endress.com/cua250

Technical Information TI00096C

Built-in adapter
- For installing CUS52D in CUA250 or CYA251 assembly
- Order number: 71248647

12.1.2 Cable

Memosens data cable CYK11
- Extension cable for digital sensors with Memosens protocol
- Product Configurator on the product page: www.endress.com/cyk11

Technical Information TI00118C

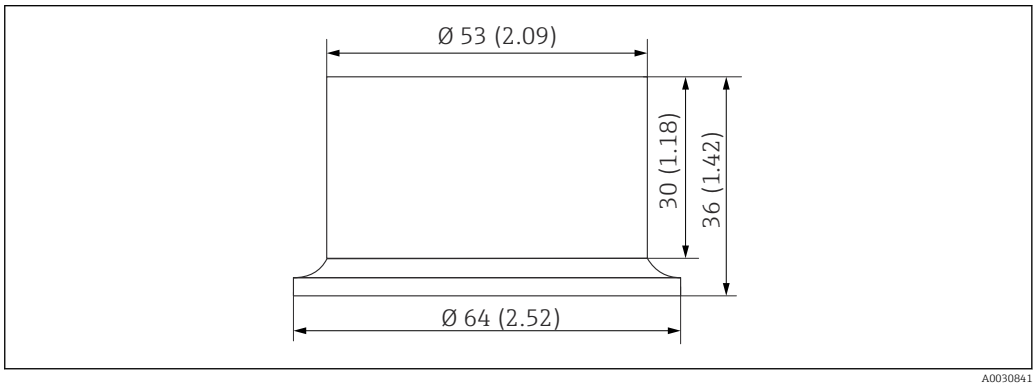
12.1.3 Holder

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

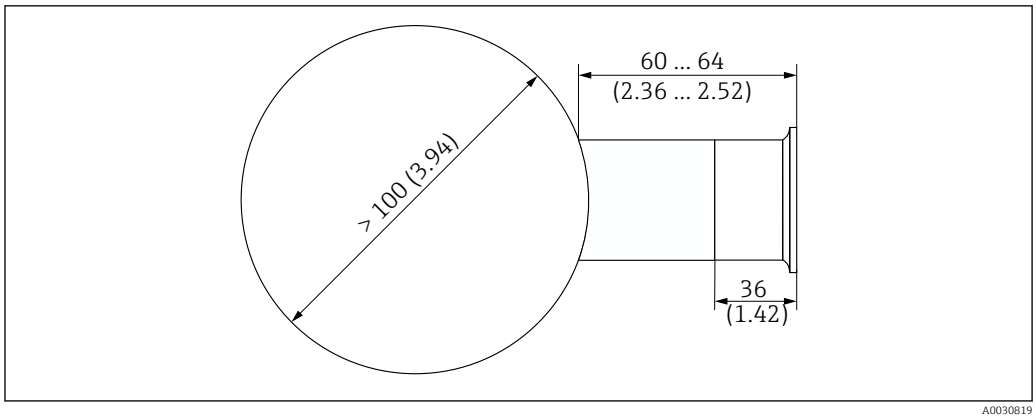
Technical Information TI00430C

12.1.4 Mounting material

Weld-in adapter for clamp connection DN 50
- Material: 1.4404 (AISI 316 L)
- Wall thickness 1.5 mm (0.06 in)
- Order number: 71242201



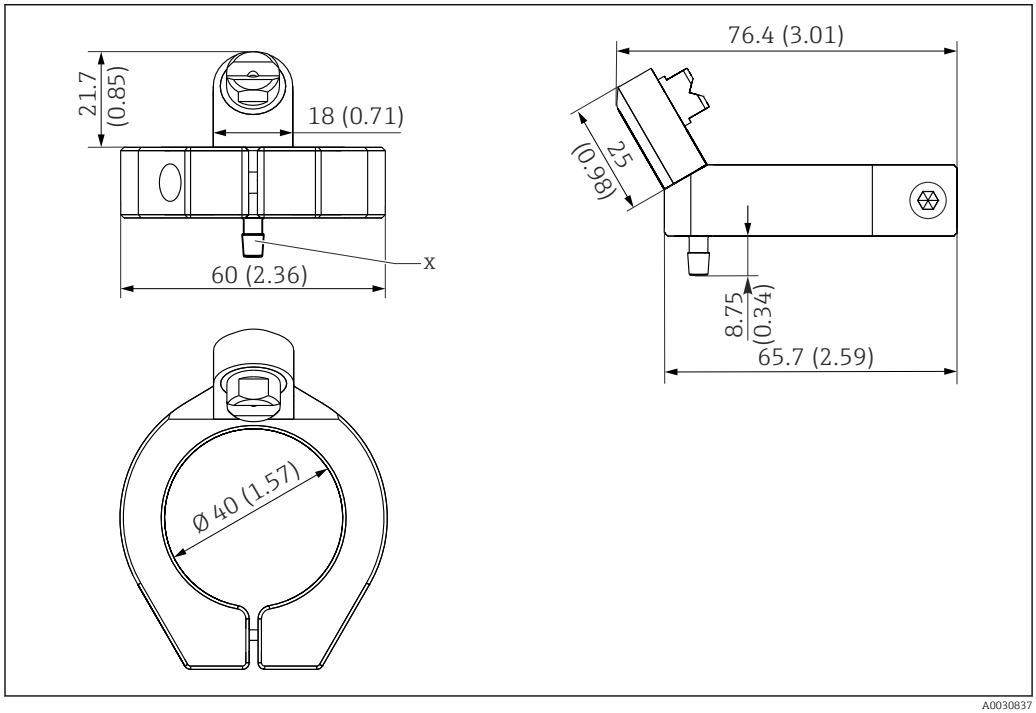
38 Weld-in adapter. Dimensions: mm (in)



39 Pipe connection with weld-in adapter. Dimensions: mm (in)

12.1.5 Compressed air cleaning

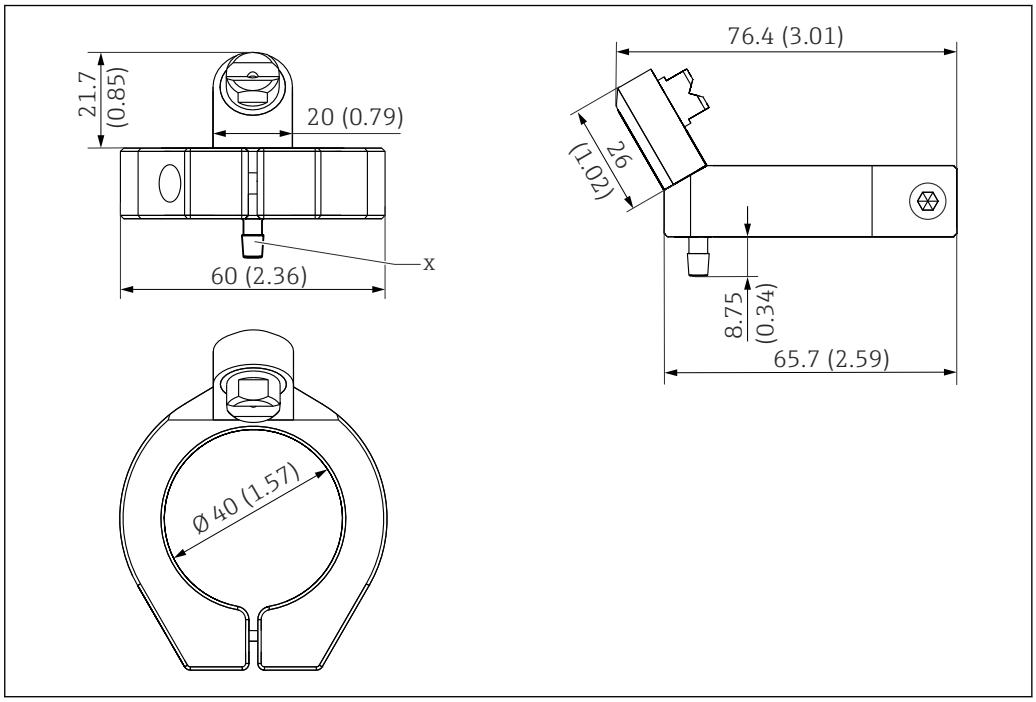
Compressed air cleaning for stainless steel sensors
- Pressure 1.5 to 2 bar (21.8 to 29 psi)
- Connection: 6 mm (0.24 in) or 8 mm (0.31 in)
- Materials: POM black, stainless steel
- Order number: 71242026



40 Compressed air cleaning for stainless steel sensors. Dimensions: mm (in)

X 6 mm (0.2 in) hose barb

Compressed air cleaning for plastic sensor
- Pressure 1.5 to 2 bar (21.8 to 29 psi)
- Connection: 6 mm (0.24 in) or 8 mm (0.31 in)
- Materials: PVDF, titanium
- Order number: 71478867



41 *Compressed air cleaning for plastic sensor. Dimensions: mm (in)*

X 6 mm (0.2 in) hose barb

Compressor
- For compressed air cleaning
- 230 V AC, order number: 71072583
- 115 V AC, order number: 71194623

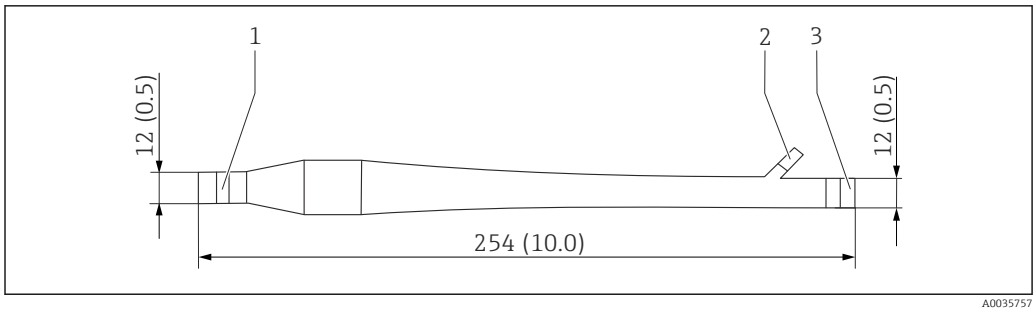
12.1.6 Ultrasonic cleaning

Ultrasonic cleaning system CYR52
- For attachment to assemblies and pipes
- Product Configurator on the product page: www.endress.com/cyr52

Technical Information TI01153C

12.1.7 Bubble trap

Bubble trap
- For sensor CUS52D
- Process pressure: up to 3 bar (43.5 psi)
- Process temperature: 0 to 50 °C (32 to 122 °F)
- Material: Polycarbonate
- D 12 adapter with connection for degassing line (upper connection on the CUA252) is included in the scope of delivery.
- Orifice plates for the following volume flows:
  - < 60 l/h (15.8 gal/h)
  - 60 to 100 l/h (15.8 to 26.4 gal/h)
  - 100 l/h (26.4 gal/h)
- The degassing line is fitted with a PVC hose, backpressure hose valve and luer lock adapter.
- Order number, suitable for CUA252 assembly: 71242170
- Order number, suitable for assembly S of CUS31: 71247364



42 *Bubble trap. Engineering unit: mm (in)*

1 Inlet for medium (without hose system)
2 Outlet for bubbles (hose system is included in scope of delivery)
3 Outlet for medium (without hose system)

12.1.8 Solid state reference

CUY52-AA+560

- Calibration tool for CUS52D turbidity sensor
- Easy and reliable validation and calibration of CUS52D turbidity sensors.
- Product Configurator on the product page: www.endress.com/cuy52

Technical Information TI01154C

12.1.9 Calibration vessel

CUY52-AA+640

- Calibration vessel for CUS52D turbidity sensor
- Easy and reliable validation and calibration of CUS52D turbidity sensors.
- Product Configurator on the product page: www.endress.com/cuy52

Technical Information TI01154C

13 Technical data

13.1 Input

Measured variables

- Turbidity
- Temperature
- Solids content

Measuring range

CUS52D		Application
Turbidity	0.000 to 4000 FNU Display range up to 9999 FNU	Formazine
Solids	0 to 1 500 mg/l Display range up to 3 g/l	Kaolin
	0 to 2 200 mg/l Display range up to 10 g/l	Diatomite
Temperature	–20 to 85 °C (–4 to 185 °F)	

Factory calibration

The sensor has been calibrated in the factory for "formazine" applications.

Basis: internal 20 point characteristic curve

13.2 Energy supply

Power consumption

24V DC (-15 %/+ 20 %), 1.8 watt

13.3 Performance characteristics

Reference operating conditions

20 °C (68 °F), 1013 hPa (15 psi)

Maximum measured error

Turbidity	2 % of the measured value or 0.01 FNU (the greater value applies in each case). Reference: Measured value in specified measuring range of 0 to 1000 FNU, factory calibration
Solids	< 5% of measured value or 1 % of the end of measuring range (the greater value applies in each case). Applies for sensors that are calibrated to the particular measuring range under analysis.

The measured error encompasses all inaccuracies of the measuring chain (sensor and transmitter). However, it does not include the inaccuracy of the reference material used for calibration.

For solids, the achievable measured errors depend very much on the media that are actually present and may differ from the specified values. Extremely inhomogeneous media cause the measured value to fluctuate and increase the measured error.

Repeatability

< 0.5 % of the measured value

Long-term reliability

Drift

Working on the basis of electronic controls, the sensor is largely free of drifts.

Response time

> 1 second, adjustable

Limit of detection

Detection limit in accordance with ISO 15839 in ultrapure water:

Application	Measuring range	Detection limit
Formazine	0 to 10 FNU (ISO 15839)	0.0015 FNU

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

Fouling

Degree of fouling 2 (micro environment)

Ambient conditions

- For use in indoor and outdoor areas
- For use in wet environments

For continuous operation underwater → 16

Degree of protection

- IP 68 (1.83 m (6 ft) water column over 24 hours)
- IP 66
- Type 6P

Electromagnetic compatibility (EMC)

Interference emission and interference immunity according to:
- EN 61326-1:2013
- EN 61326-2-3:2013
- NAMUR NE21: 2012

13.5 Process

Process temperature range

Stainless steel sensor

−20 to 85 °C (−4 to 185 °F)

Plastic sensor

−20 to 60 °C (−4 to 140 °F)

Under high temperatures combined with extremely high or low pH values and chemical boundary conditions, e.g. during CIP cleaning processes, the sensor has limited long-term stability.

To avoid damage to the sensor, only use the sensor in combination with a retractable assembly in CIP cleaning processes. The retractable assembly allows the sensor to be removed from the process during cleaning.

Process pressure range

Stainless steel sensor

0.5 to 10 bar (7.3 to 145 psi) (abs.)

Plastic sensor

0.5 to 6 bar (7.3 to 87 psi)

Flow limit

Minimum flow

No minimum flow required.

For solids which have a tendency to form deposits, ensure that sufficient mixing is performed.

13.6 Mechanical construction

Dimensions

→ Section "Installation"

Weight

Plastic sensor

Plastic sensor: 0.72 kg (1.58 lb)

The specifications apply to the sensor with a 7 m (22.9 ft) cable.

Stainless steel sensor

With clamp	1.54 kg (3.39 lb)
Without clamp	1.48 kg (3.26 lb)
With Varivent connection, standard	1.84 kg (4.07 lb)
With Varivent connection, extended shaft	1.83 kg (4.04 lb)

The specifications apply to the sensor with a 7 m (22.9 ft) cable.

Materials

	Plastic sensor	Stainless steel sensor
Sensor head:	PEEK GF30	Stainless steel 1.4404 (AISI 316 L)
Sensor housing:	PPS GF40	Stainless steel 1.4404 (AISI 316 L)
O-rings:	EPDM	EPDM
Optical windows:	Sapphire	Sapphire
Window adhesive:	Epoxy resin	Epoxy resin

Process connections

Plastic and stainless steel sensor
G1 and NPT ¾'

Stainless steel sensor
- Clamp 2" (depending on sensor version)/DIN 32676
- Varivent N DN 65 - 125 standard immersion depth 22.5 mm
- Varivent N DN 65 - 125 immersion depth 42.5 mm

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