

Operating Instructions

Turbimax CUS52D

Turbidity sensor



Table of contents

1	About this document	4	11.2	Spare parts	40
1.1	Warnings	4	11.3	Return	40
1.2	Symbols used	4	11.4	Disposal	40
1.3	Symbols on the device	4			
1.4	Documentation	4	12	Accessories	41
2	Basic safety requirements	5	12.1	Device-specific accessories	41
2.1	Requirements concerning personnel	5	13	Technical data	46
2.2	Intended use	5	13.1	Input	46
2.3	Workplace safety	5	13.2	Power supply	46
2.4	Operational safety	6	13.3	Performance characteristics	46
2.5	Product safety	6	13.4	Environment	47
3	Product description	7	13.5	Process	47
3.1	Product design	7	13.6	Mechanical construction	48
4	Incoming acceptance and product identification	8	Index		49
4.1	Incoming acceptance	8			
4.2	Product identification	8			
4.3	Scope of delivery	9			
4.4	Certificates and approvals	9			
5	Installation	10			
5.1	Installation requirements	10			
5.2	Installing the sensor	15			
5.3	Post-installation check	22			
6	Electrical connection	23			
6.1	Connecting the sensor	23			
6.2	Ensuring the degree of protection	24			
6.3	Post-connection check	25			
7	Commissioning	26			
7.1	Function check	26			
8	Operation	27			
8.1	Adapting the measuring instrument to the process conditions	27			
9	Diagnostics and troubleshooting ...	37			
9.1	General troubleshooting	37			
10	Maintenance	38			
10.1	Maintenance work	38			
11	Repair	40			
11.1	General information	40			

1 About this document

1.1 Warnings

Structure of information	Meaning
 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.
 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.
 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.
 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
-  Not permitted or not recommended
-  Reference to device documentation
-  Reference to page
-  Reference to graphic
-  Result of an individual step

1.3 Symbols on the device

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

1.4 Documentation

In addition to the Operating Instructions and depending on the relevant approval, XA "Safety instructions" are supplied with products for the hazardous area.

- Please follow the XA instructions when using the device in the hazardous area.

2 Basic safety requirements

2.1 Requirements concerning 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)

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

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

2.3 Workplace safety

The operator is responsible for ensuring compliance with the following safety regulations:

- 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.

Procedure for damaged products:

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

During operation:

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

2.5 Product safety

2.5.1 State-of-the-art

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:

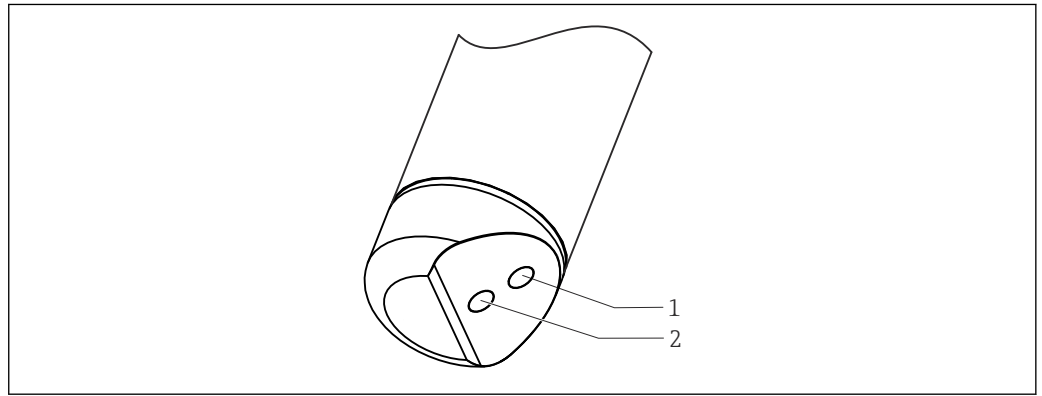
- Power supply
- Light sources
- Detectors

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.



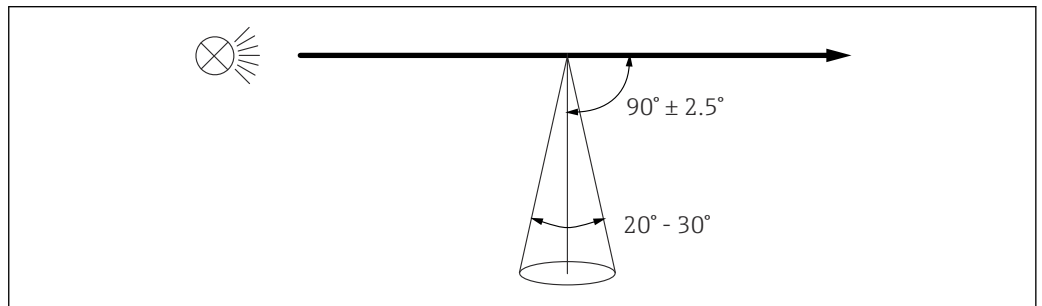
A0030692

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.



A0030701

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

On receipt of the delivery:

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

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

4.2 Product identification

4.2.1 Nameplate

The 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 Product identification

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 will find 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:

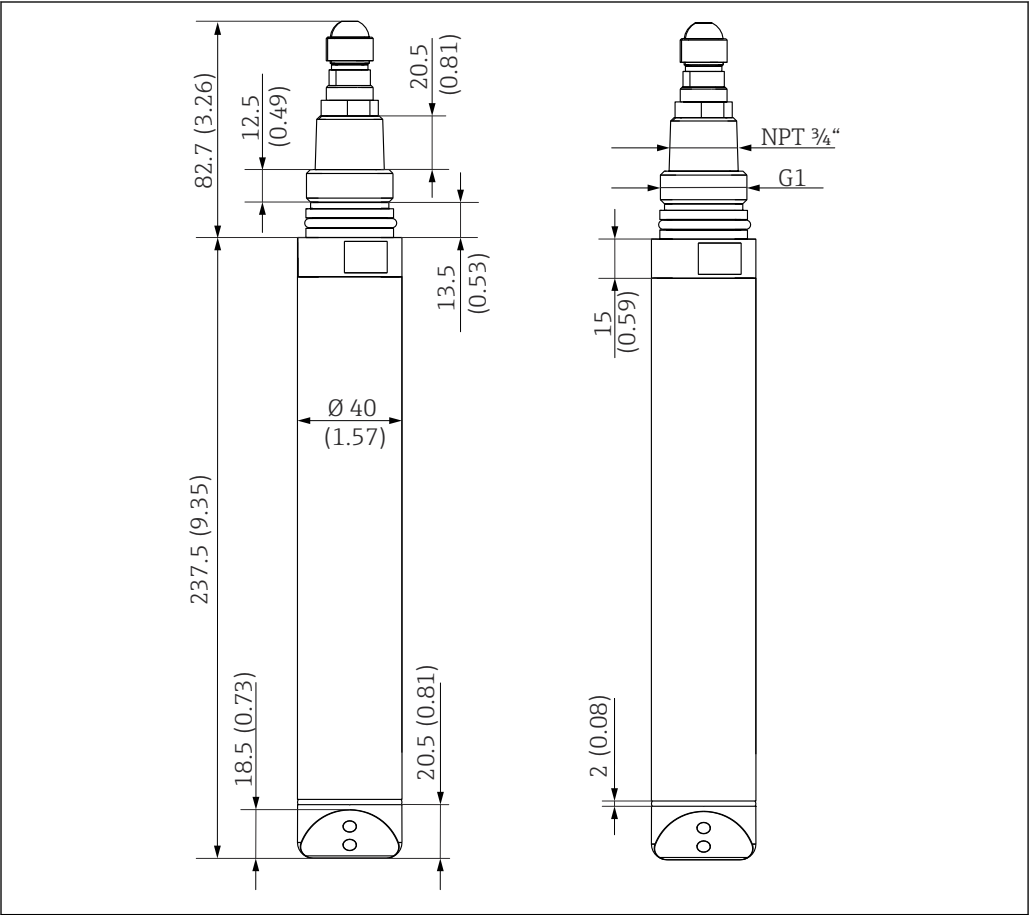
1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

5 Installation

5.1 Installation requirements

5.1.1 Dimensions

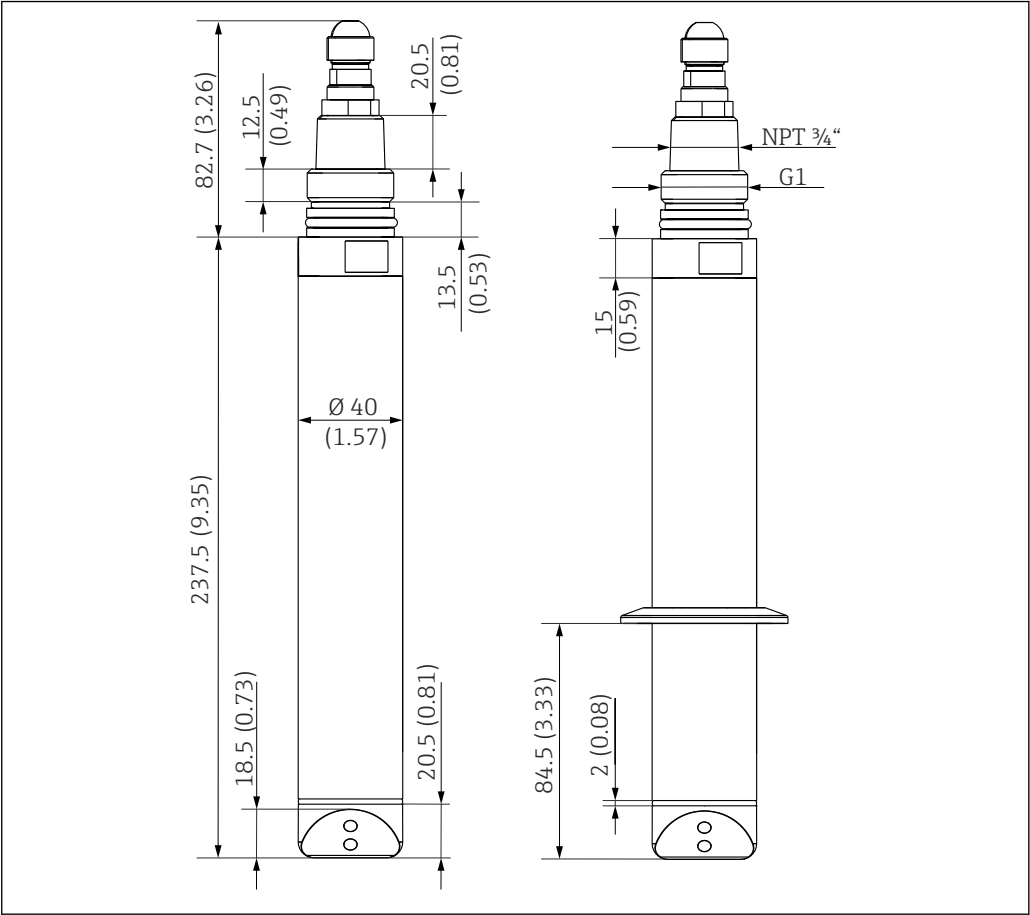
Plastic sensor



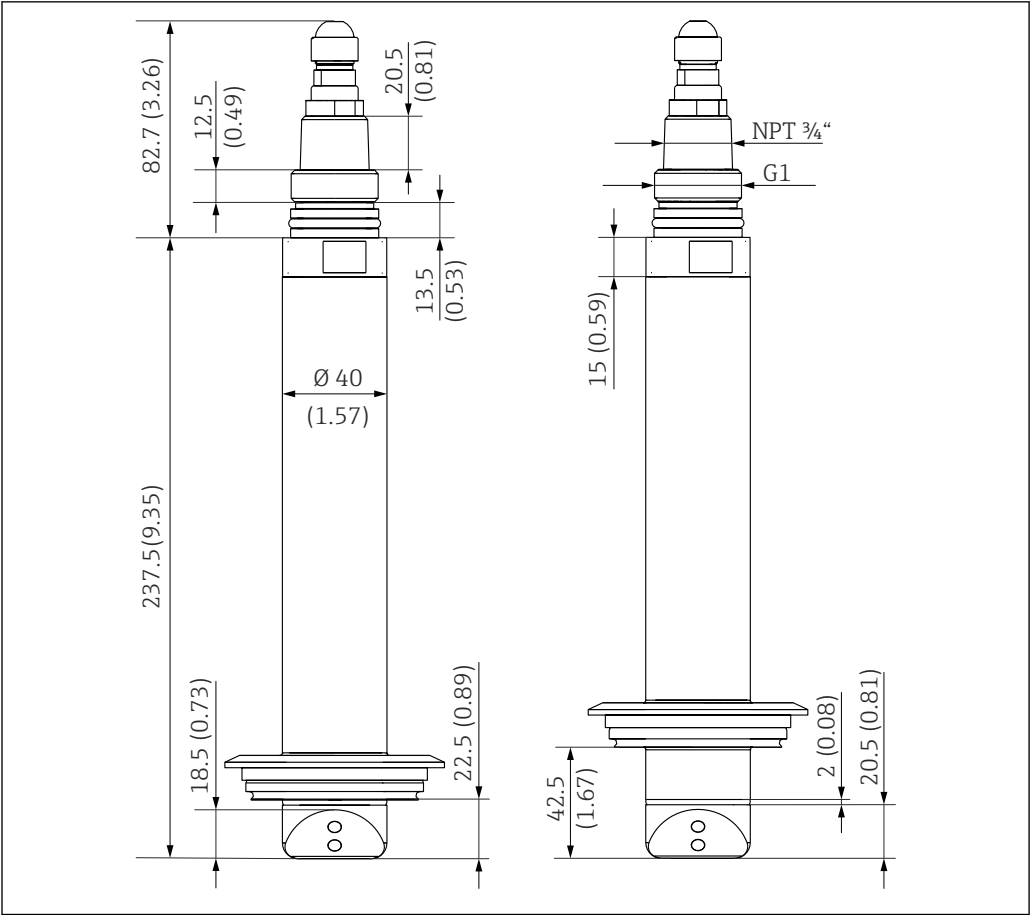
3 Dimensions of plastic sensor. Dimensions: mm (in)

A0042002

Stainless steel sensor

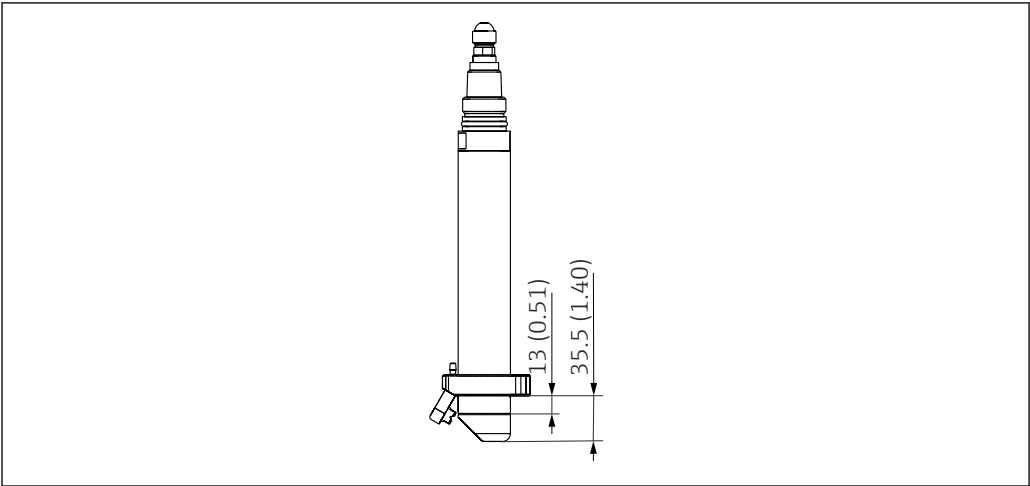


4 Dimensions of stainless steel sensor and stainless steel sensor with clamp connection (right). Dimensions: mm (in)



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

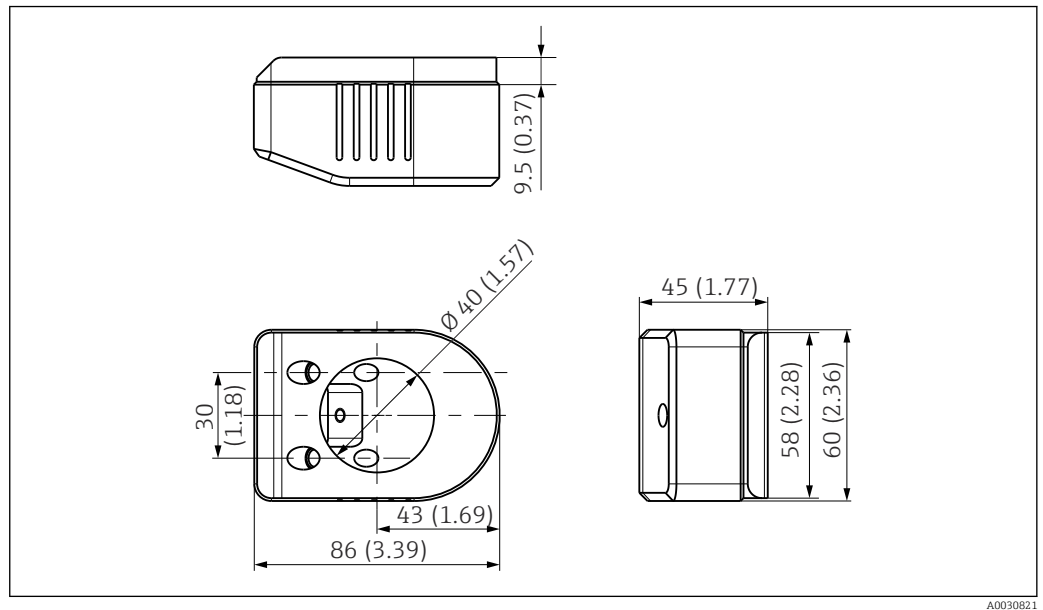
Compressed air cleaning



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

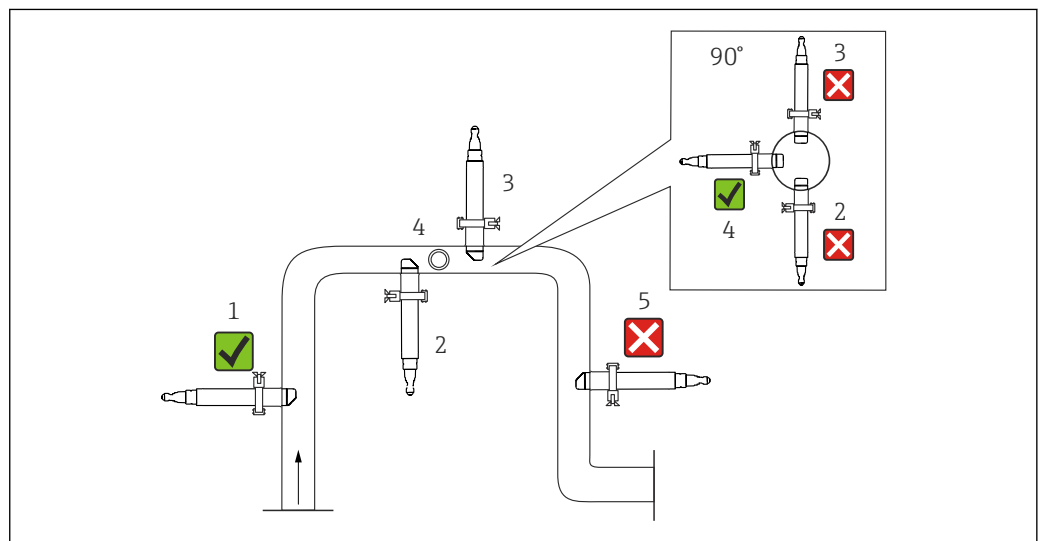
i Compressed air cleaning accessory → 43

Solid state reference



7 Calkit CUS52D solid state reference. Unit: mm (in)

5.1.2 Orientation in pipes



8 Permitted and unacceptable orientations in pipes

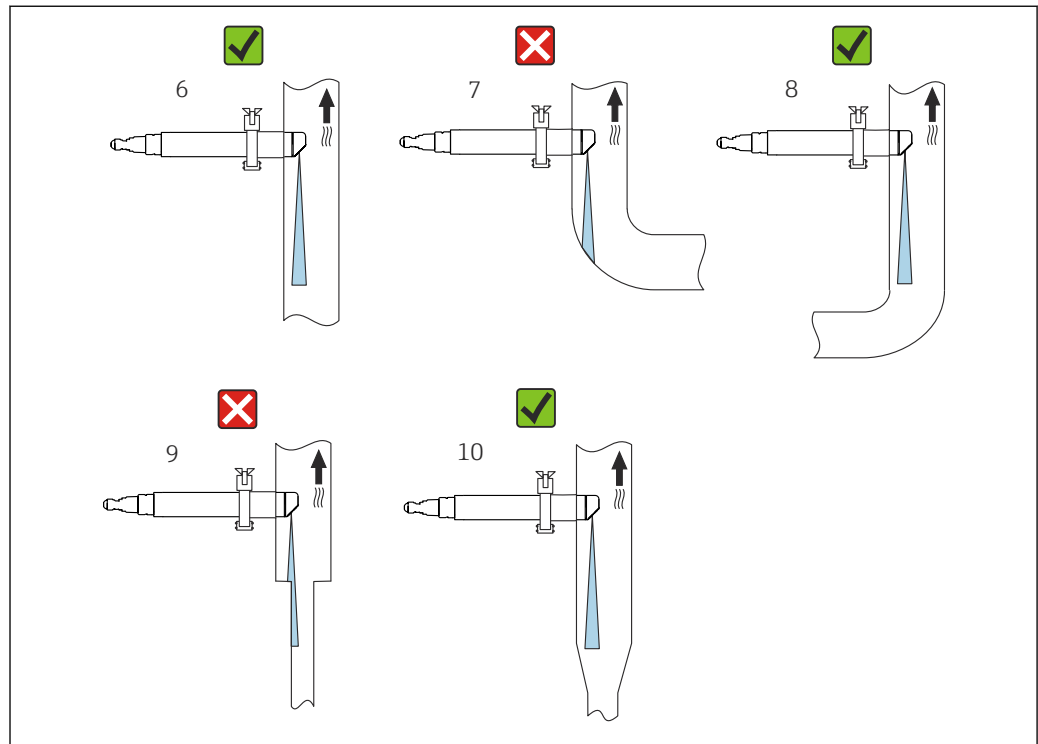
- Install the sensor in places with consistent flow conditions.
- The best installation location is in the ascending pipe (item 1). Installation in the horizontal pipe (item 4) is also possible.
- Do not install the sensor in places where air spaces or bubbles occur (item 3) or where sedimentation may 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 $> \text{DN } 300$ exhibit hardly any wall effects.

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

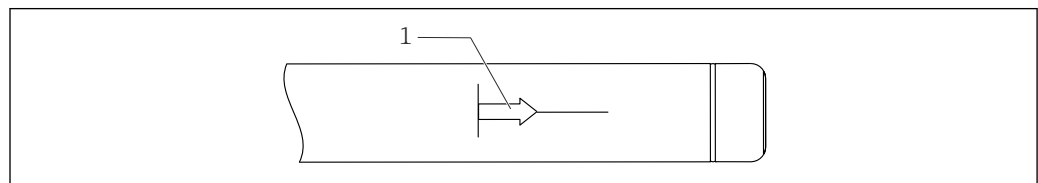


A0030704

9 Orientations for pipes and assemblies

- Install the sensor in such a way that the light beam is not reflected → 9, 14 (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



A0030820

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 Installing the sensor

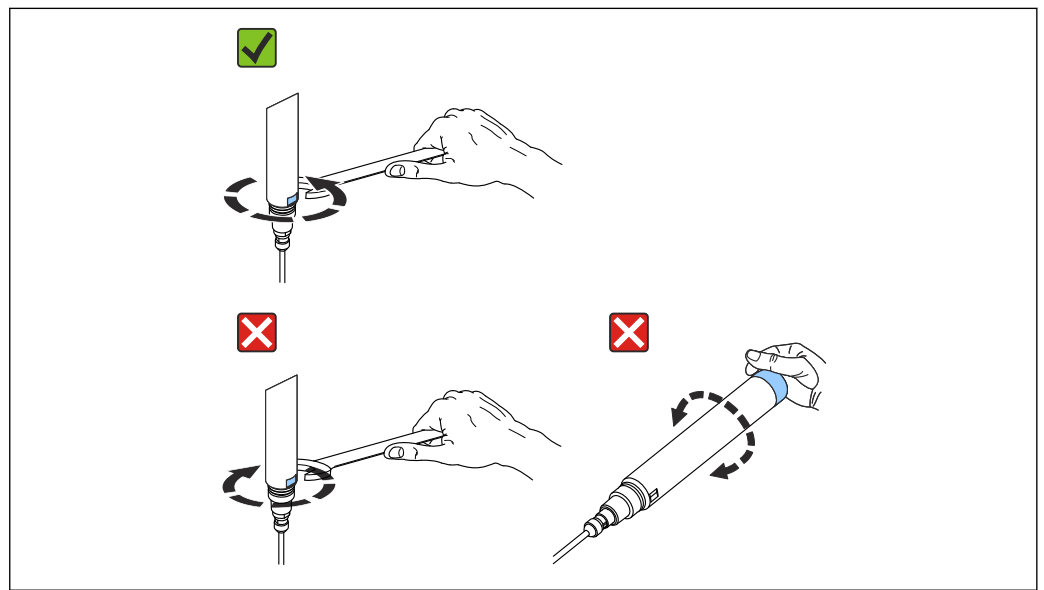
5.2.1 Installation instructions

The sensor can be installed with different assemblies or directly in a pipe connection. For continuous underwater operation, however, the CYA112 immersion assembly must be used.

When inserting or removing a sensor from a flow assembly, observe the following:

- Do not twist the sensor head or sensor tube.
- Do not apply rotational force.

Insert the sensor into the opening of the flow assembly, pushing past the resistance of the internal sealing ring.



A0060371

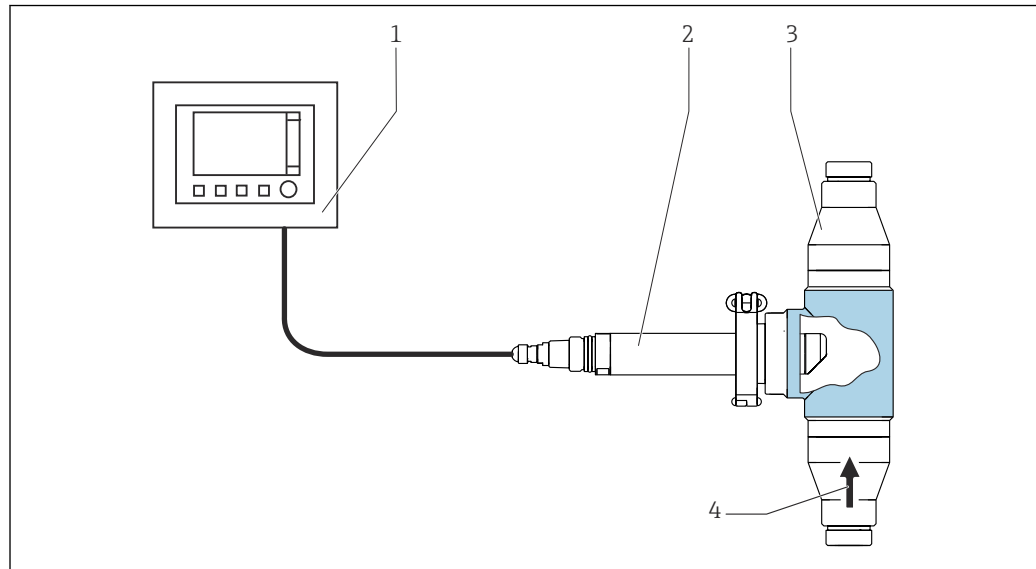
If the sensor is turned counterclockwise, the sensor head may come loose. This can cause the sensor to leak or the cable plug to tear off:

1. Only screw the sensor in or out using the wrench flat.
2. Only turn the sensor clockwise.

5.2.2 Measuring system

A complete measuring system comprises:

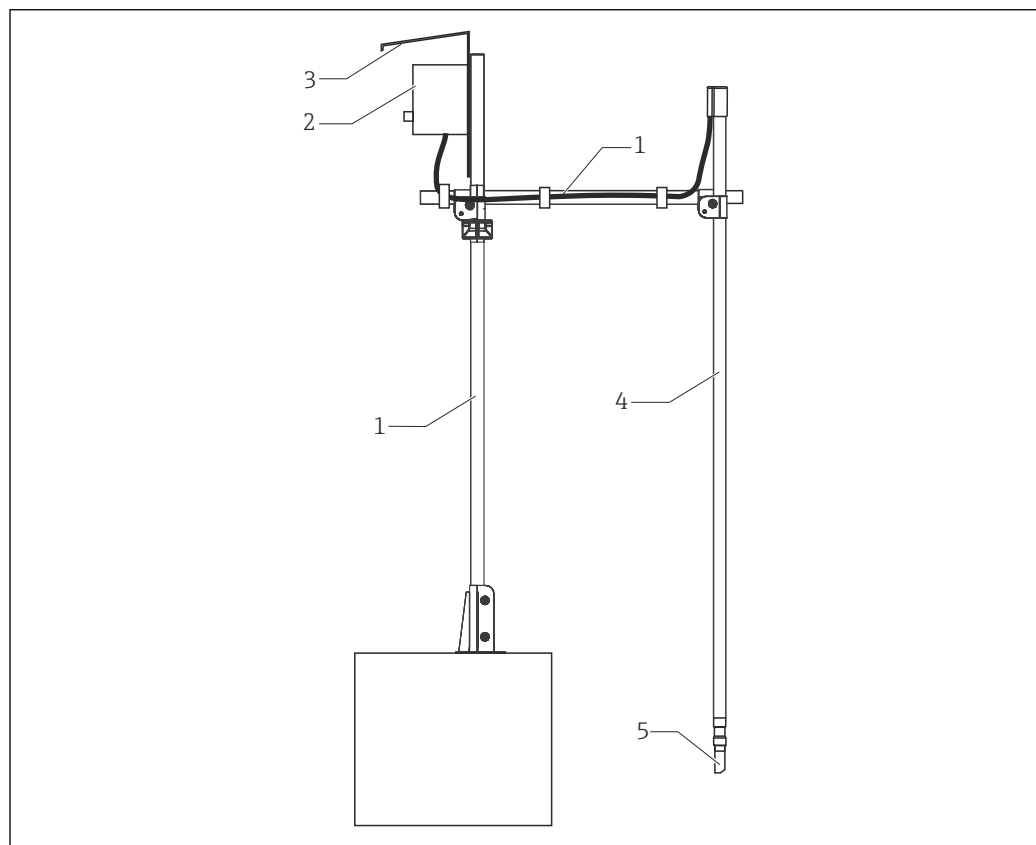
- Turbimax CUS52D turbidity sensor
- Liquiline CM44x multichannel transmitter
- Assembly:
 - CUA252 flow assembly (only possible for stainless steel sensor) or
 - CUA262 flow assembly (only possible for stainless steel sensor) or
 - Flexdip CYA112 immersion assembly and Flexdip CYH112 holder or
 - Retractable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



A0030694

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



A0030696

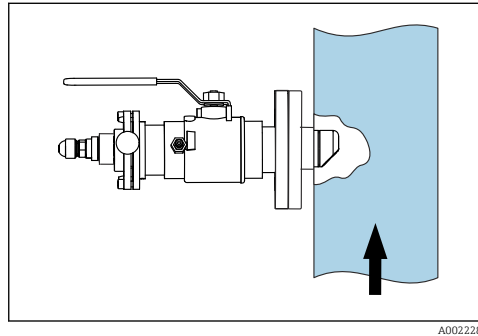
12 Example of measuring system with immersion assembly

- 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
 $> 0.5 \text{ m/s}$ (1.6 ft/s) in basins or channels.

5.2.3 Installation options

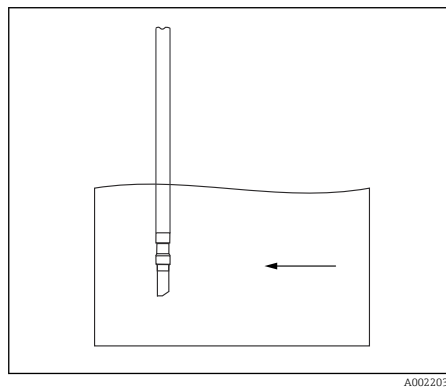
Installing with CUA451 retractable assembly



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.

 13 Installing with CUA451 retractable assembly

Installing with Flexdip CYA112 immersion assembly and Flexdip CYH112 holder

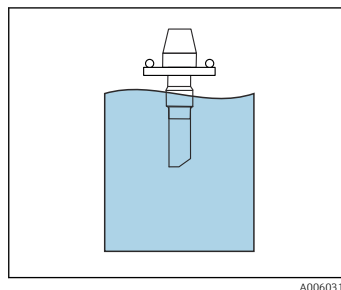


The installation angle is 0° .
 The arrow points in the direction of flow.

 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.

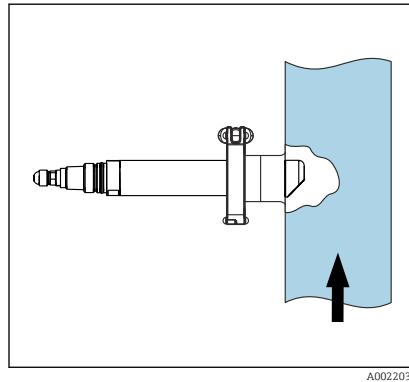
Dipfit CLA140 immersion assembly



No special installation angle required.
 No flow.
 If the sensor is used in open basins, install the sensor in such a way that air bubbles cannot accumulate on it.

 15 CLA140 immersion assembly

Installing with 2" clamp connection



A0022032

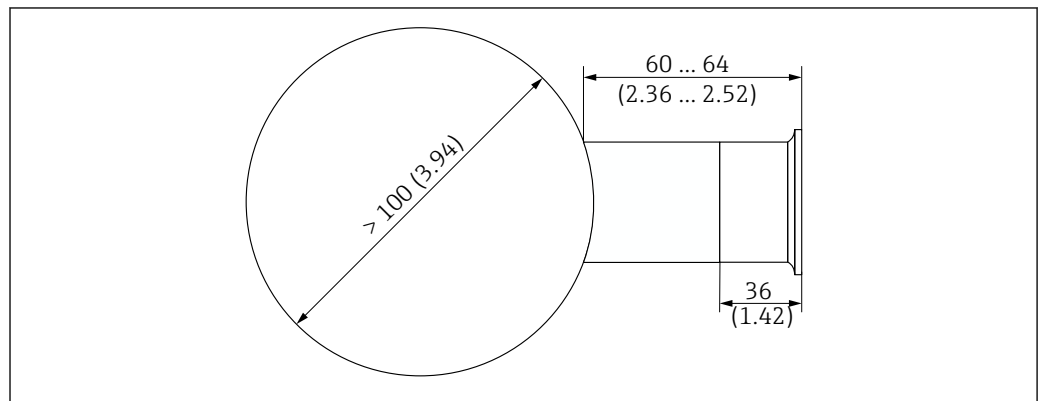
16 Installing with 2" clamp connection

The installation angle is 90°.

The arrow points in the direction of flow.

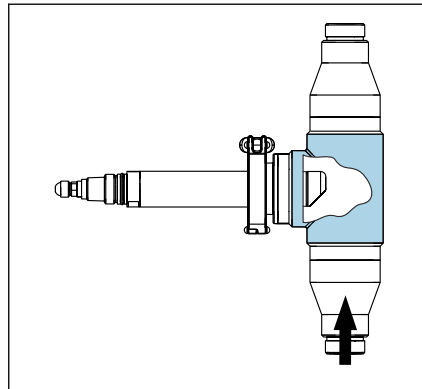
The optical windows in the sensor must be aligned against the direction of flow.

A weld-in adapter is available as an accessory for the installation → 42.



A0030819

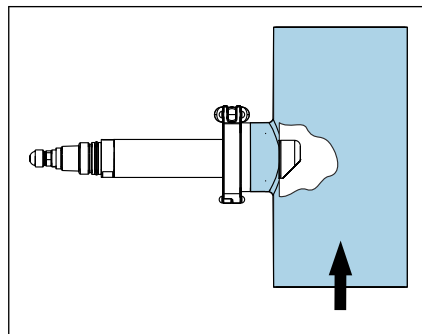
17 Pipe connection with weld-in adapter. Dimensions: mm (in)

Installing with CUA252, CUA262 or CYA251 flow assembly

A0022034

18 Installing with CUA252 flow assembly

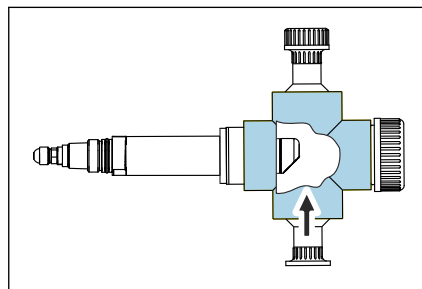
The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.



A0022281

19 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.

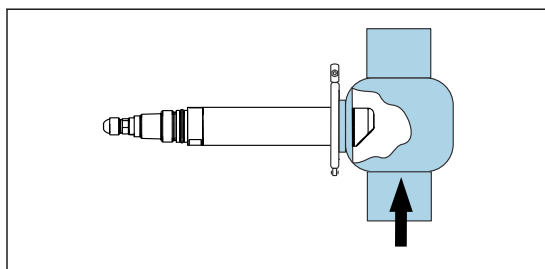


A0060277

20 Installing with CYA251 flow assembly

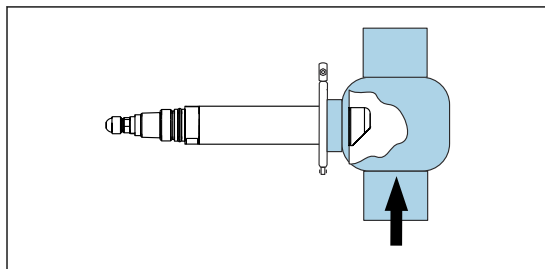
The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.

Installing in Varivent assemblies



A0031130

21 Installing with standard Varivent connection

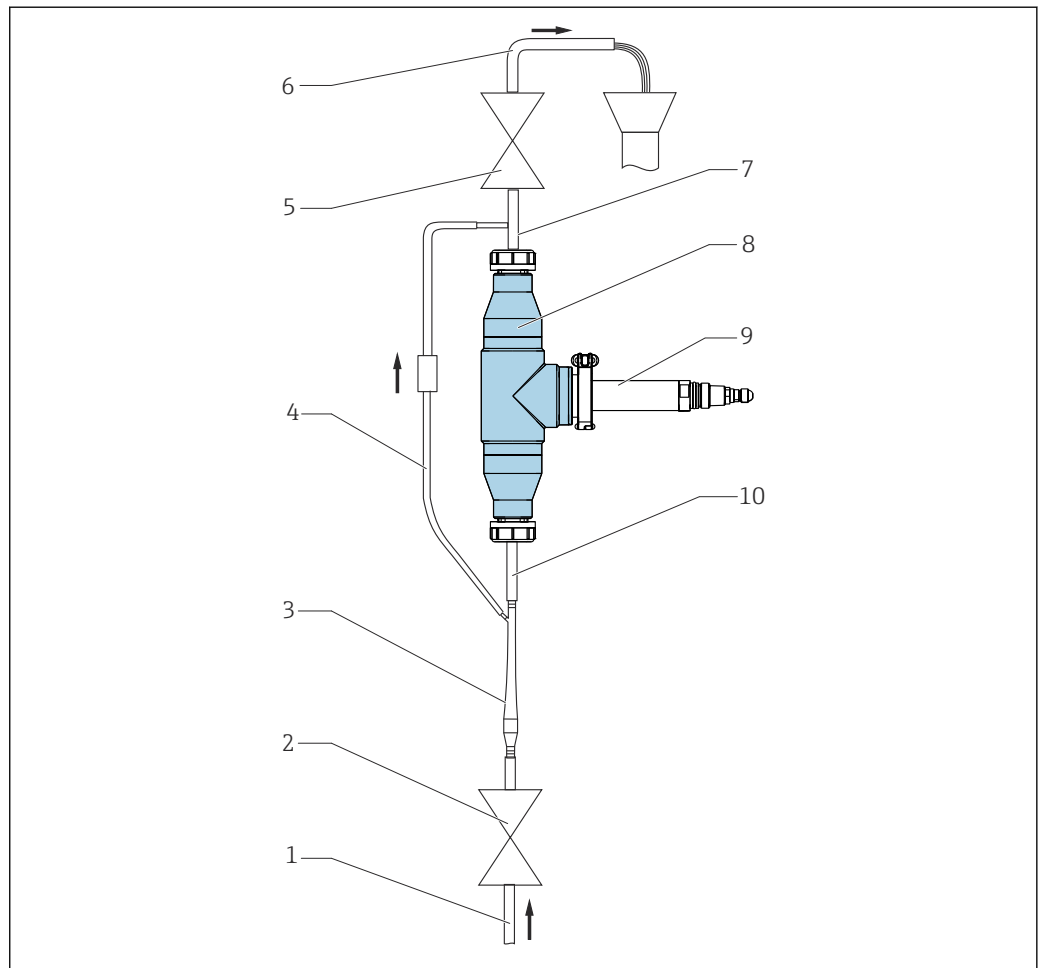


A0031132

22 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



A0035917

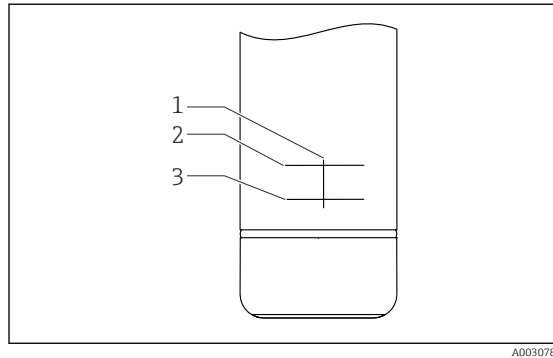
23 Connection example with bubble trap and CUA252 flow assembly

- 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

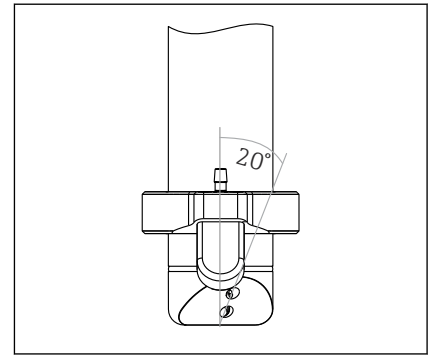


For detailed information on installing the assembly and the bubble trap, see BA01281C

Compressed air cleaning



24 Installation markings 1 to 3



25 Mounting position

Mount the compressed air cleaning system as follows:

1. Fit the compressed air cleaning system on the sensor (→ 25).
2. Position the securing ring for the compressed air cleaning system between installation marks 2 and 3 (→ 24).
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.
 ↳ This way the nozzle is offset by 20° when blowing air at the optical windows.
4. Turn the compressed air cleaning system so that the slit on the black ring is on installation mark 1 (→ 24).
5. Tighten the securing screw.
6. Fit the compressed air hose on the hose connection.

5.3 Post-installation 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!

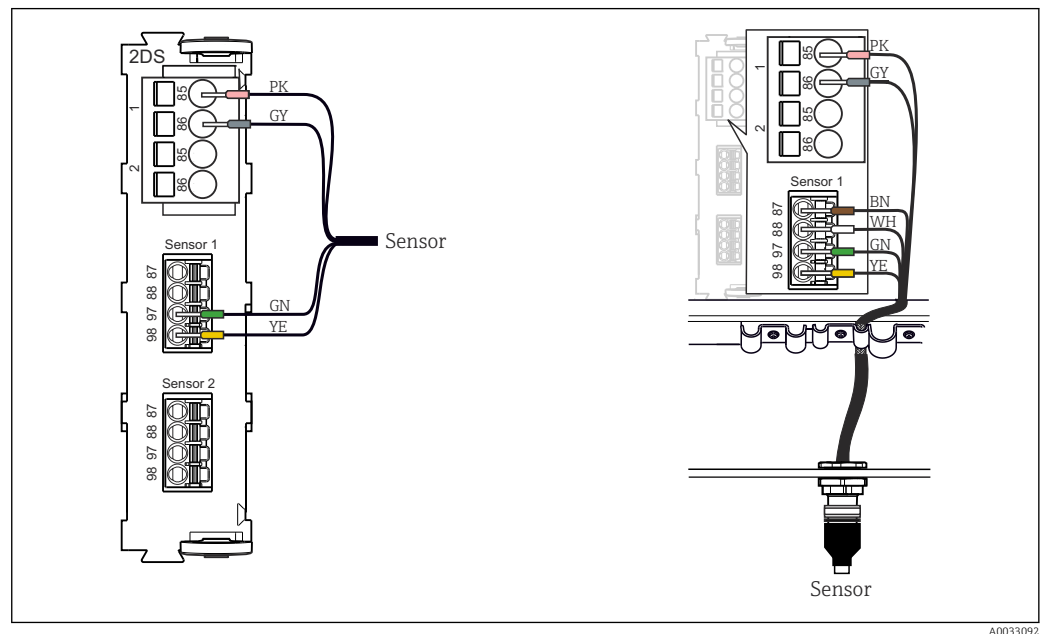
Incorrect connection may result in injury or death!

- ▶ 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)



26 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

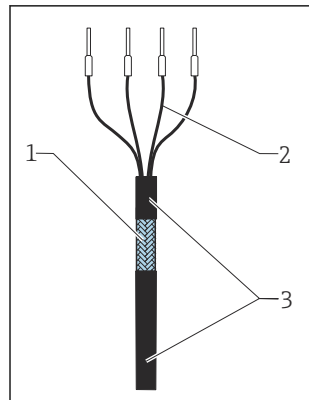
Device cable must be shielded cables.



Only use terminated original cables where possible.

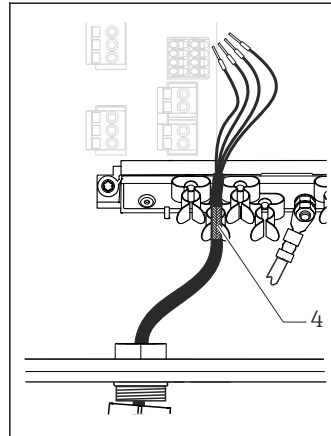
Clamping range of cable clamps: 4 to 11 mm (0.16 to 0.43 in)

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



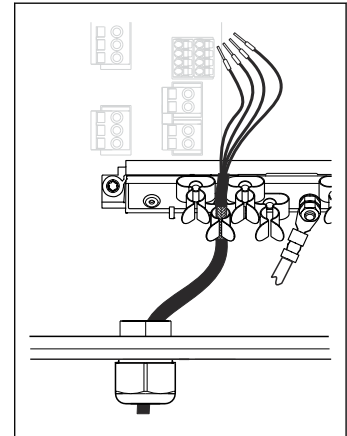
27 Terminated cable

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



28 Connect the cable to the grounding clamp

- 4 Grounding clamp



29 Press the cable into the grounding clamp

The cable shield is grounded using the grounding clamp ¹⁾

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

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

6.2 Ensuring the degree of protection

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

- Exercise care when carrying out the work.

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)
- Cables/cable ends are loose or insufficiently tightened
- 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 correctly connected?	▶ Refer to the wiring diagram for the transmitter.
Are all screw terminals tightened?	▶ Tighten the screw terminals.
Are all the cable entries installed, tightened and leak-tight?	In the case of lateral cable entries: ▶ Point cable loops downward so that water can drip off.
Are all cable entries mounted on the side or pointing downwards?	

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 instrument 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 1 000 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

 Before the **Offset**, **Factor** or **Assembly adjustment** functions can be used, a new data record must first be generated by duplicating a factory data record or by using a one-point to six-point calibration.

Assembly adjustment

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

The **Assembly adjustment** function can automatically compensate for the remaining measurement 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
PE100	Adjustment to CUA252 flow assembly (material: polyethylene)
1.4404 / 316L	Adjustment to CUA262 weld-in flow assembly (material: stainless steel 1.4404)
Customized	Adjustment to any pipe/assembly
Customized advanced	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.

■ Customized

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
CYA251	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

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).

One-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.

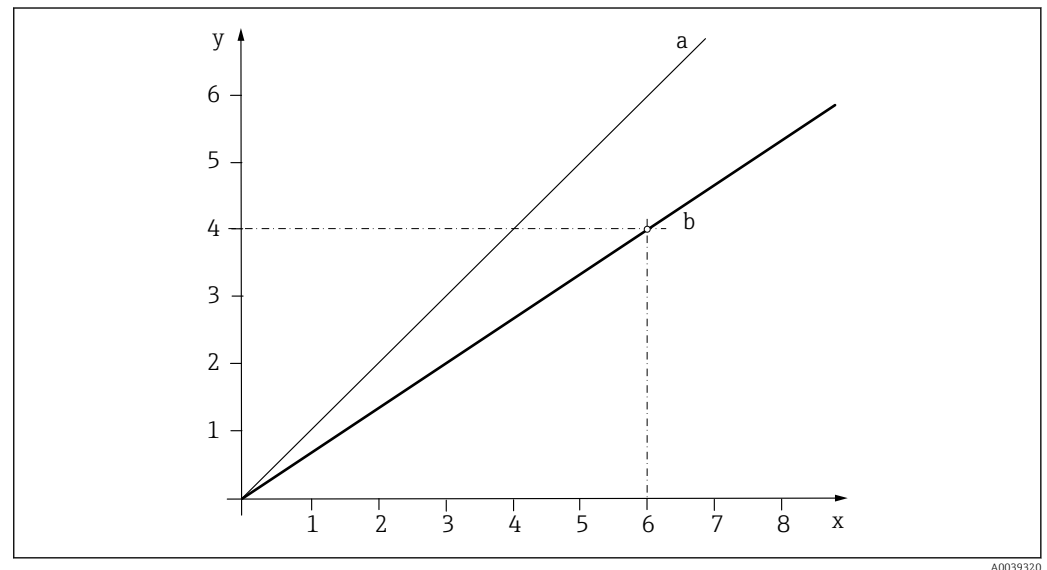
When factory calibration data records are duplicated, the value pair 1000/1000 is automatically generated to map the factory data record 1:1 to the duplicated record.

- 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.

One-point calibration

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



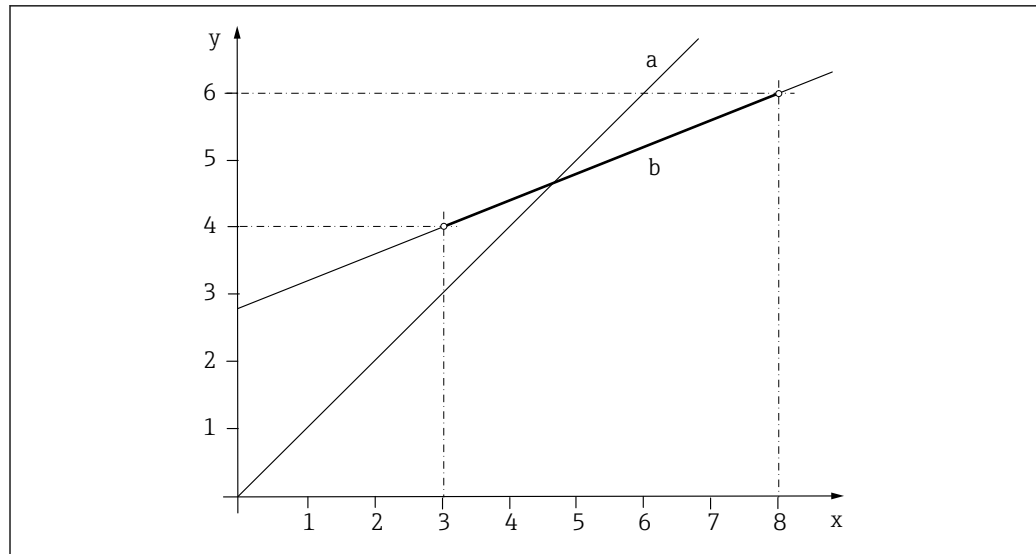
 30 Principle of a one-point calibration

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

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

Two-point calibration

Measured value deviations are to be compensated at 2 different points in an application (e.g. maximum and minimum value of the application). In this way, maximum measurement accuracy is ensured between these two extreme values.



A0039325

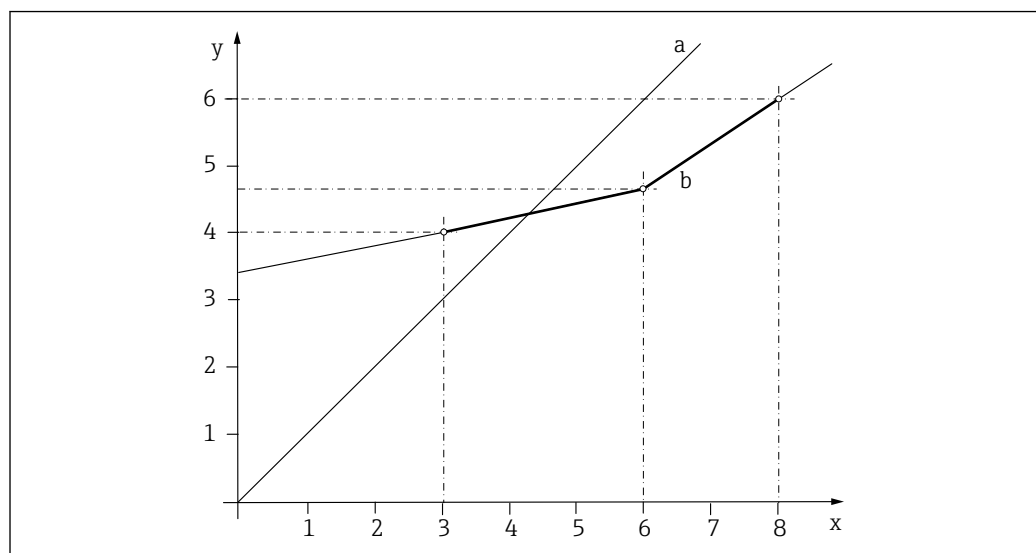
31 Principle of a two-point calibration

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

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

i A linear extrapolation is performed outside the calibrated operational range.
 The calibration curve must be monotonically increasing.

Three-point calibration



A0039322

32 Principle of multipoint calibration (3 points)

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

1. Select the data set.

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



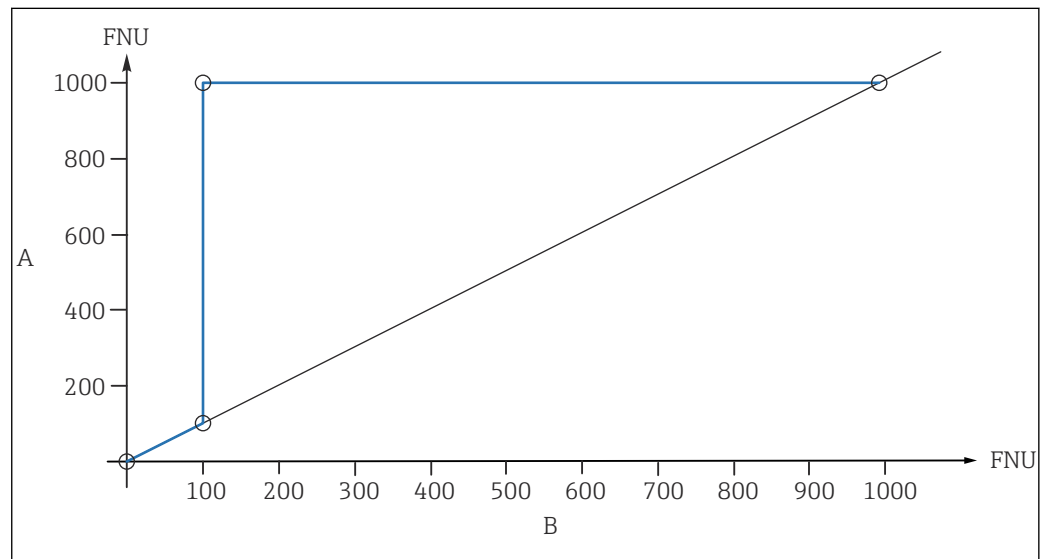
A linear extrapolation is performed outside the calibrated operational range.

The calibration curve must be monotonically increasing.

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.



33 Example for filter monitoring

A Application calibration

B Factory calibration

The following table shows the values in the example (→ 33):

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.

i 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.

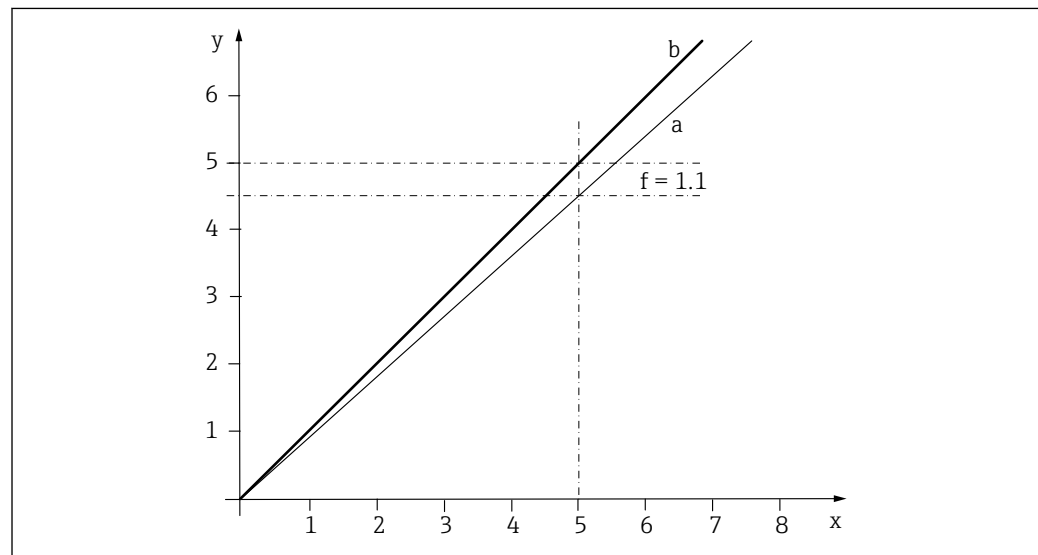
Factor

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

Example:

This type of adjustment can be selected when the measured values are compared with the laboratory values over an extended period and all measured values deviate from the laboratory value (target sample value) e.g. are 10 % too low, by a constant factor.

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



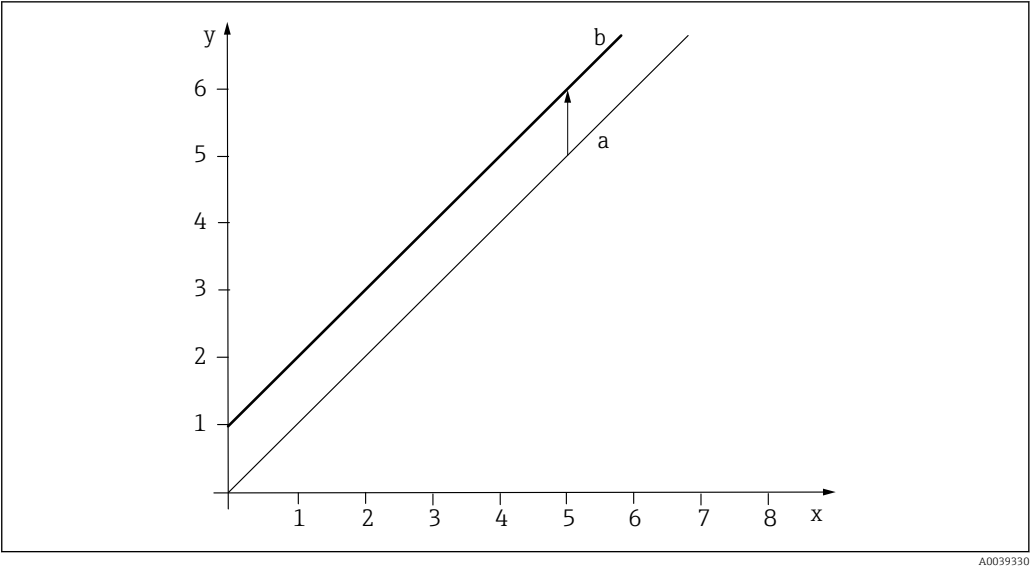
A0039329

34 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).



35 Principle of an offset

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

8.1.3 Cyclic cleaning

Compressed air

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

Ultrasonic cleaning

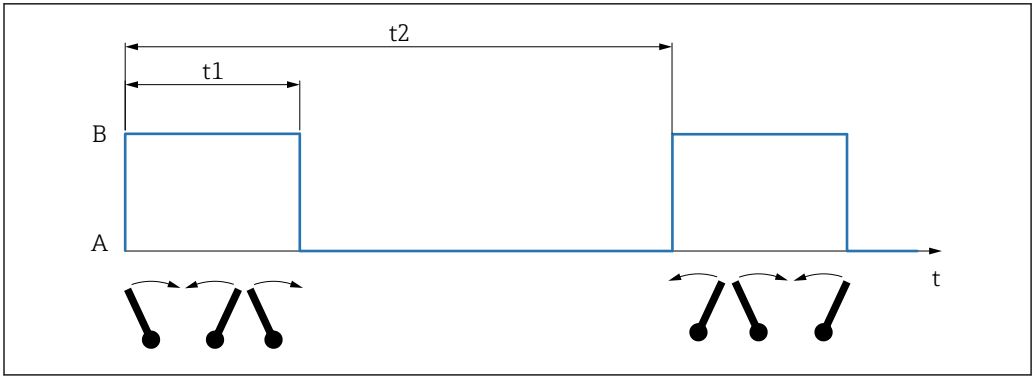
The CYR52 ultrasonic cleaning unit is suitable for cyclic cleaning in pipes or assemblies. The cleaning unit (which can also be retrofitted) can be mounted on the CUA252, CUA262 flow assemblies or on any customer pipes.

The following cleaning settings are recommended to prevent the ultrasonic transducer from overheating:

Cleaning interval	Cleaning duration
Minimum 5 minutes	Maximum 5 seconds

Mechanical cleaning unit

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



AA0057251

36 Cleaning interval

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

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

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

Recommendation for good cleaning power and maximum service life:

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

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

 Follow the Operating Instructions for the transmitter.

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
Low	Low filtering, high sensitivity, fast response to changes (2 seconds)
Medium	Medium filtering, 10-second response time
High	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 functionality of the sensor.

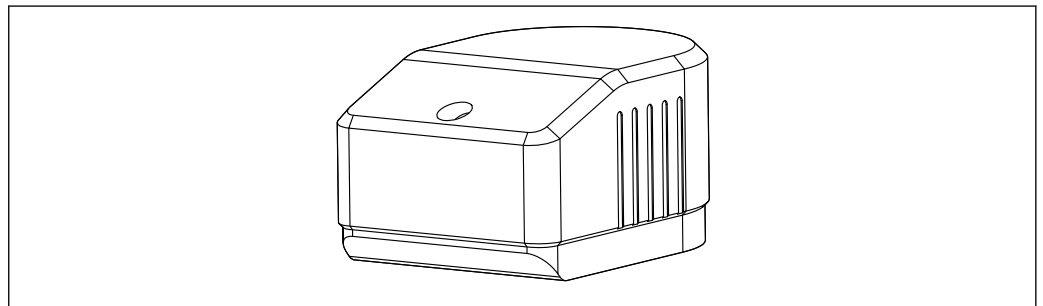
During factory calibration, each Calkit solid state reference is matched specifically to a special CUS52D sensor and can be used only with this sensor. Therefore, the Calkit solid state reference and the sensor are permanently assigned (married) to one another.

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 $\pm 10\%$ when the sensor is operating correctly.

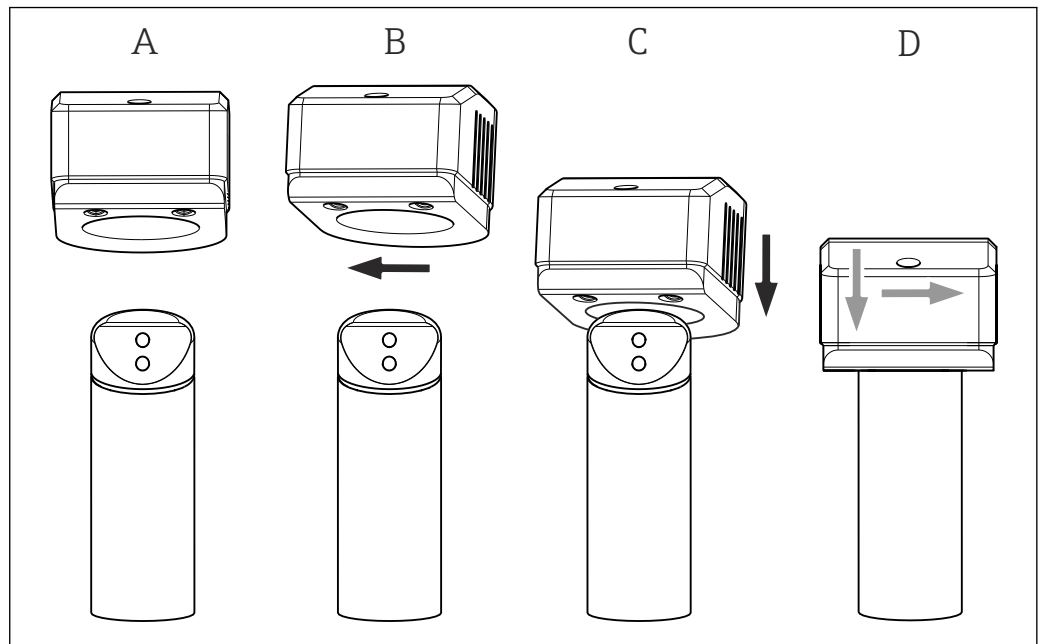
The CUY52 solid state reference with approx. 4.0 FNU/NTU is used to check the function of any turbidity sensors CUS52D sensors. The solid state reference is not assigned to a specific sensor and delivers measured values in the range of $4.0 \text{ FNU} \pm 1.5 \text{ FNU/NTU}$ with all turbidity sensors CUS52D sensors.



A0035755

37 Solid state reference

Function check with solid state reference



A0030842

38 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. Turn the solid state reference slightly (→  38, B), fit it gently on the sensor (C).
4. Slide the solid state reference into the final position (D).

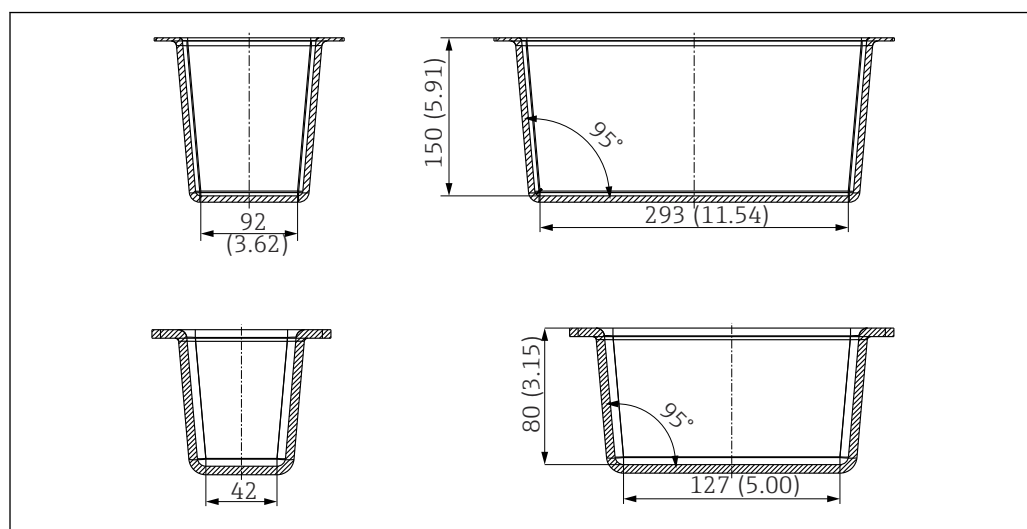
Function check:

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 solid state reference.

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.



A0035756

 39 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:

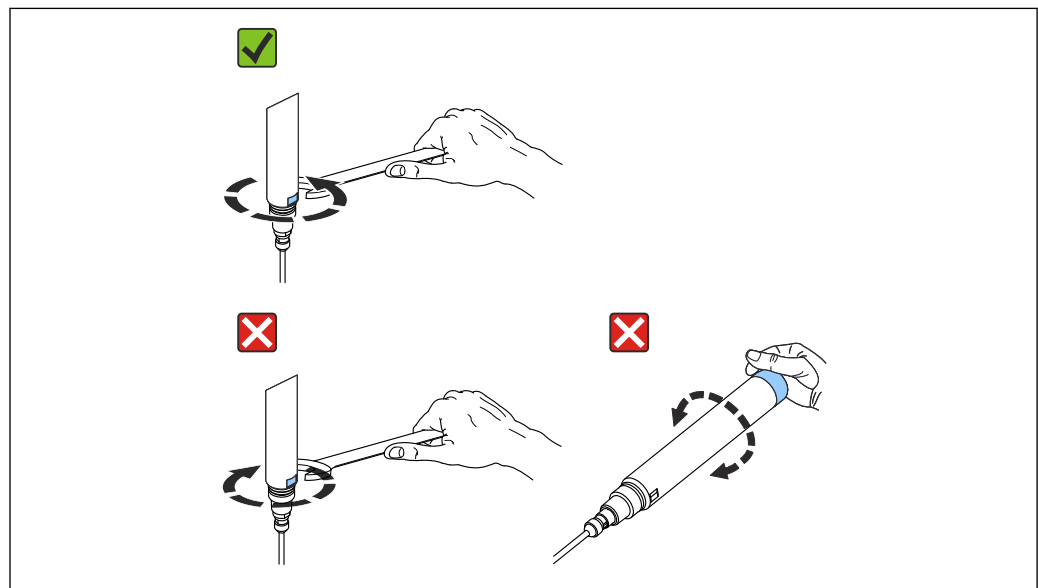
- The system
- The installation conditions
- The medium in which measurement takes place

10.1 Maintenance work

When inserting or removing a sensor from a flow assembly, observe the following:

- Do not twist the sensor head or sensor tube.
- Do not apply rotational force.

Insert the sensor into the opening of the flow assembly, pushing past the resistance of the internal sealing ring.



A0060371

If the sensor is turned counterclockwise, the sensor head may come loose. This can cause the sensor to leak or the cable plug to tear off:

1. Only screw the sensor in or out using the wrench flat.
2. Only turn the sensor clockwise.

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 repair

Type of contamination	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 information

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

Detailed information on the spare parts is available at:

www.endress.com/device-viewer

11.2 Spare parts

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

www.products.endress.com/spareparts_consumables

11.3 Return

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

www.endress.com/support/return-material

11.4 Disposal

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

- Observe the local regulations.

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

Dipfit CLA140

- Immersion assembly with flange connection for very demanding processes
- Product Configurator on the product page: www.endress.com/cla140



Technical Information TI00196C

12.1.2 Cables**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**

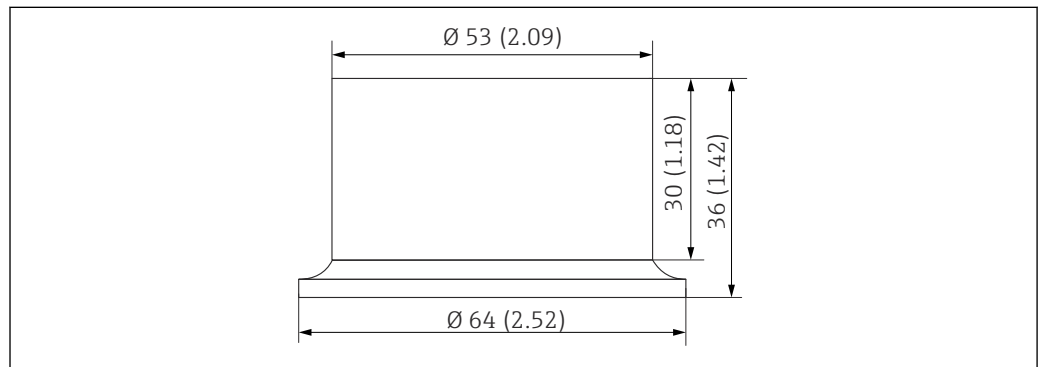
- Modular holder system for sensors and assemblies in open basins, channels and tanks
- For Flexdip CYA112 water and wastewater assemblies
- Can be affixed anywhere: on the ground, on the coping stone, on the wall or directly onto railings.
- Stainless steel version
- Product Configurator on the product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



Technical Information TI00430C

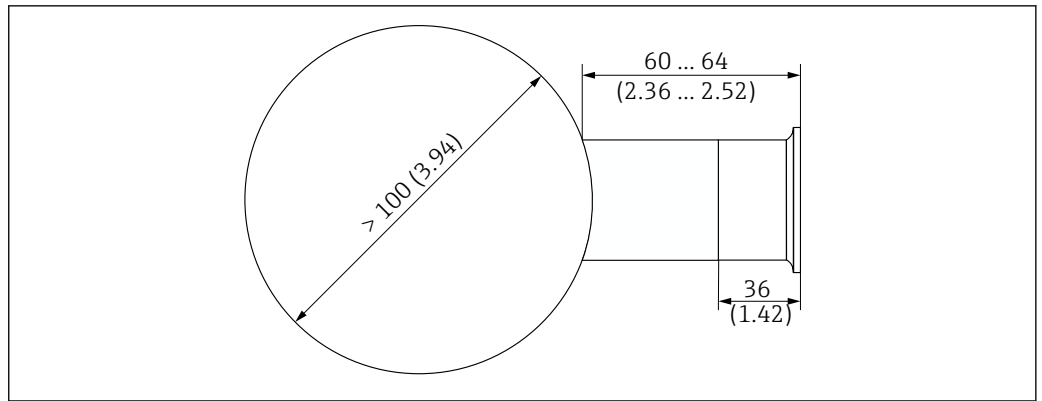
12.1.4 Mounting material**Weld-in adapter for clamp connection DN 50**

- Material: 1.4404 (AISI 316 L)
- Wall thickness 1.5 mm (0.06 in)
- DIN 32676
- Order number: 71242201



A0030841

40 Weld-in adapter. Unit: mm (in)



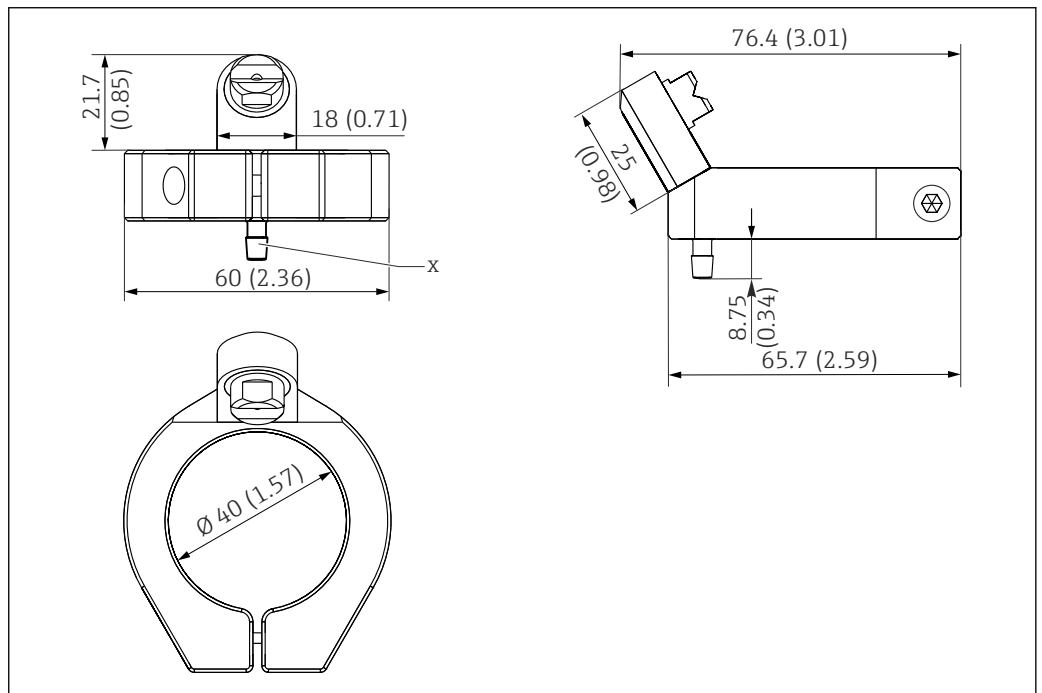
A0030819

41 Pipe connection with weld-in adapter. Unit: 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



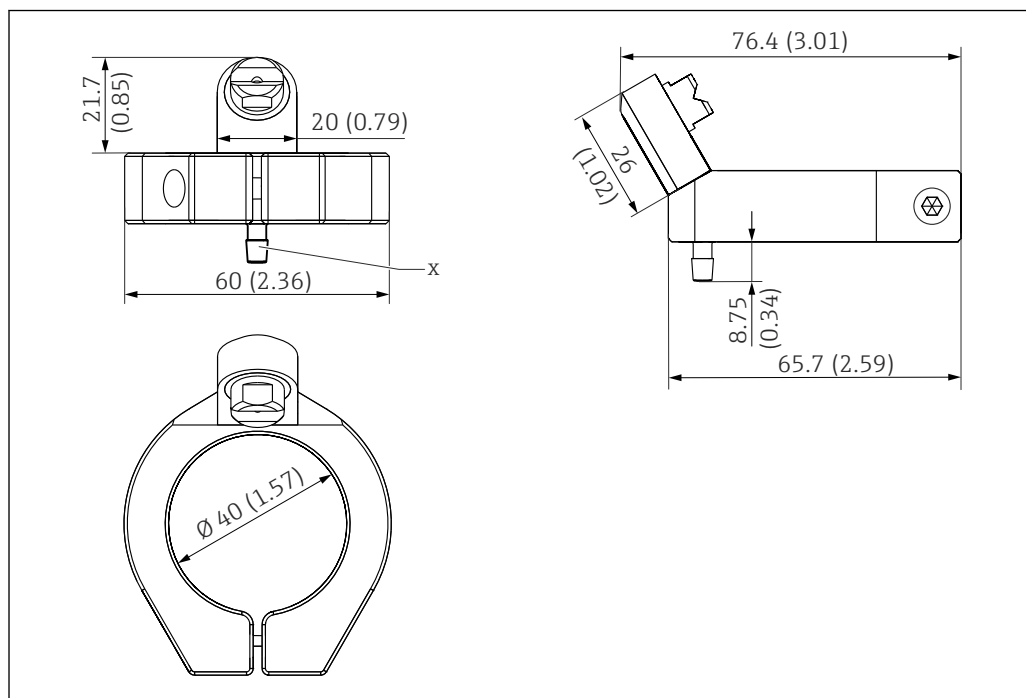
A0030837

42 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



A0042878

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

X 6 mm (0.2 in) hose barb

Compressor

- For compressed air cleaning
- 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 Mechanical cleaning

CYR51 mechanical cleaning

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

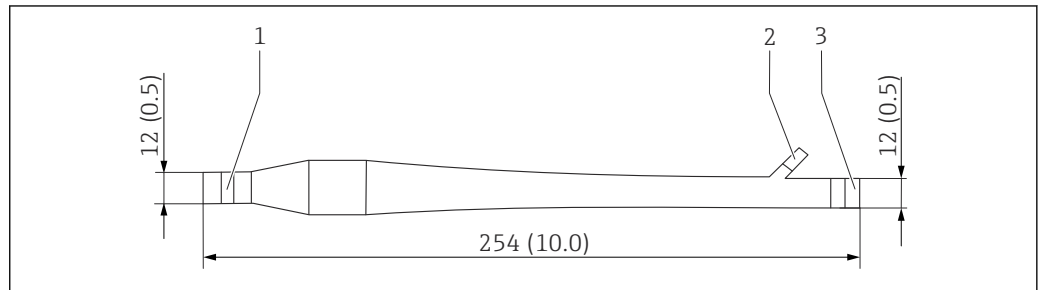
 Technical Information TI01821C

12.1.8 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



44 Bubble trap. 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)

12.1.9 Solid state reference

CUY52-AA+560

- Easy and safe verification with the solid state reference of CUS52D turbidity sensors.
- Product Configurator on the product page: www.endress.com/cuy52

 Technical Information TI01154C

12.1.10 Calibration vessel

CUY52-AA+640

- Calibration vessel for CUS52D turbidity sensor
- Easy and reliable 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 4 000 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 Power supply

Power consumption

24V DC (20.4 to 28.8 V), 1.8 W

13.3 Performance characteristics

Reference operating conditions

20 °C (68 °F), 1013 hPa (15 psi)

Maximum measurement 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 *Limit of detection in accordance with ISO 15839 in ultrapure water:*

Application	Measuring range	Limit of detection
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

- Non-Ex-version: maximum 3 000 m (9 842.5 ft)
- Ex-version: maximum 2 000 m (6 561.7 ft)

Fouling Degree of fouling 2 (micro environment)

Environmental conditions

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

 For continuous operation underwater →  15

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
- EN 61326-2-3
- NAMUR NE21

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)

Process pressure range **Stainless steel sensor**
0.5 to 10 bar (7.3 to 145 psi) absolute

Plastic sensor
0.5 to 6 bar (7.3 to 87 psi) absolute

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
Cable-end fitting:	Stainless steel 1.4404 (AISI 316 L)	Stainless steel 1.4404 (AISI 316 L)

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

Temperature sensor NTC 30K

Index

A

Accessories	41
Applications	28
Assembly adjustment	27

B

Bubble trap	21
-----------------------	----

C

Calibration	27
Calibration vessel	36
Certificates, approvals	9
Cleaning	33, 38
Compressed air cleaning	22
Cyclic cleaning	33

D

Diagnostics	37
Dimensions	10
Disposal	40

E

Electrical connection	23
Environment	47

F

Factor	32
Filter monitoring	31
Function	
Factor	32
Offset	32
Function check	26

I

Immersion operation	17
Incoming acceptance	8
Input	46
Installation	10
Installation options	17
Installation procedure	15
Intended use	5

M

Maintenance	38
Measuring principle	7
Measuring system	15
Mechanical construction	48

N

Nameplate	8
---------------------	---

O

Offset	32
One-point calibration	29

P

Performance characteristics	46
---------------------------------------	----

Post-connection check	25
Post-mounting check	22
Power supply	46
Process	47
Product description	7
Product design	7
Product identification	8

R

Repair	40
Return	40

S

Safety requirements	5
Scope of delivery	9
Sensor structure	7
Signal filter	34
Solid state reference	35
Spare parts kit	40
Stability criterion	31
Symbols	4

T

Technical data	46
Three-point calibration	30
Troubleshooting	37
Two-point calibration	29

U

Use	5
---------------	---

W

Warnings	4
Wiring	23



71744234

www.addresses.endress.com
