



Technical Information

Turbimax CUS52D

Turbidity sensor



Application

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

- Turbidity measurement at all stages of the water treatment process
- Final turbidity measurement in outlet of waterworks
- Turbidity measurement in inlet of waterworks
- Turbidity measurement for filter monitoring and filter backwashing
- Turbidity measurement in drinking water networks
- Turbidity measurement in saline media (plastic sensor only)

Your benefits

- Turbidity measurement in accordance with ISO 7027
- The hygienic design with the 2" clamp means it can be mounted directly in pipes and fits into CUA252 (PE 100) and CUA262 (stainless steel) flow assemblies
- Immersion version can be installed in open channels and basins
- Can be used at high temperatures and high pressures
- Standardized communication (Memosens technology) enables "plug and play"
- Intelligent sensor - all characteristics and calibration values are stored in the sensor
- Customer calibrations with 1 to 6 points can be performed in the lab or at place of installation
- Completely safe, as the optical source requires little power to operate

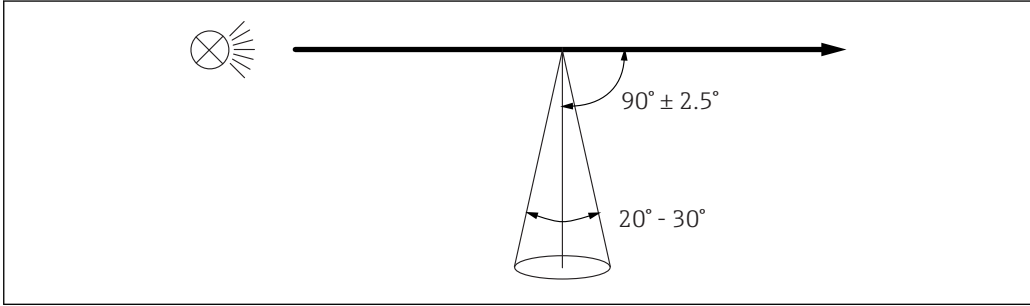
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Function and system design

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.



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1 Measurement in accordance with ISO 7027

Measurement is done using a wavelength of 860 nm.

Sensor monitoring

The optical signals are continuously monitored and analyzed for plausibility. If inconsistencies occur, an error message is output via the transmitter. The function is disabled by default.

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.

- During initial commissioning or calibration at the CM44x, select the appropriate application for your field of application.

Application	Field of application	Unit
Formazine	Drinking water, process water	FNU; 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.

NOTICE

Multiple scattering

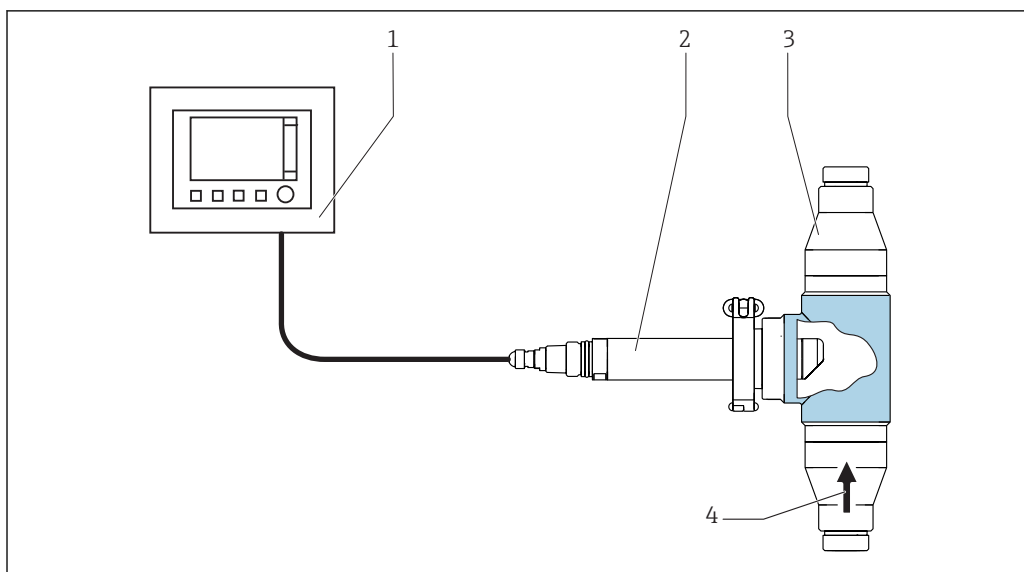
If the specific operational range is exceeded, the measured value displayed by the sensor can decrease despite increasing turbidity. The indicated operational range is reduced in the case of highly absorbing (e.g. dark) media.

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

Measuring system

A complete measuring system comprises:

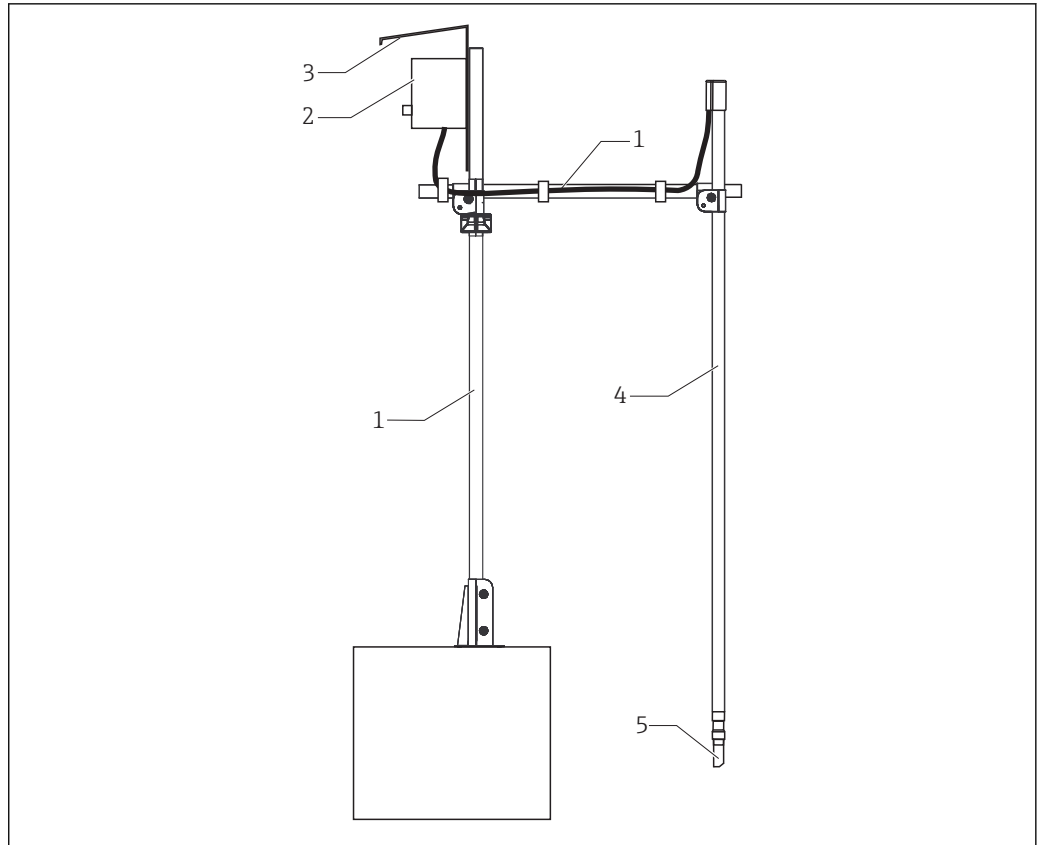
- Turbimax CUS52D turbidity sensor
- Liquiline CM44x multi-channel transmitter
- Assembly:
 - CUA252 flow assembly (only possible for stainless steel sensor) or
 - CUA262 flow assembly (only possible for stainless steel sensor) or
 - Flexdip CYA112 assembly and Flexdip CYH112 holder or
 - Retractable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



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

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



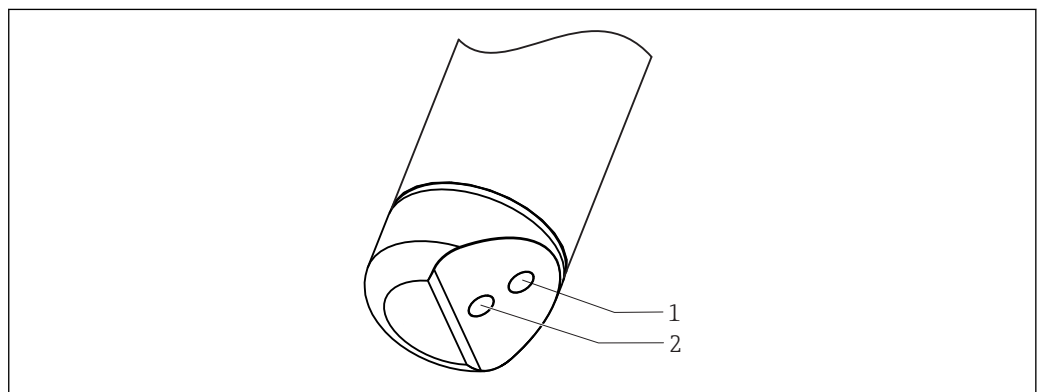
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3 Example of measuring system with immersion assembly

- 1 Flexdip CYH112 holder
- 2 Liquiline CM44x multi-channel transmitter
- 3 Protective cover
- 4 Flexdip CYA112 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.

Sensor structure



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4 Arrangement of light source and light receiver

- 1 Light receiver
- 2 Light source

Solid state reference

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

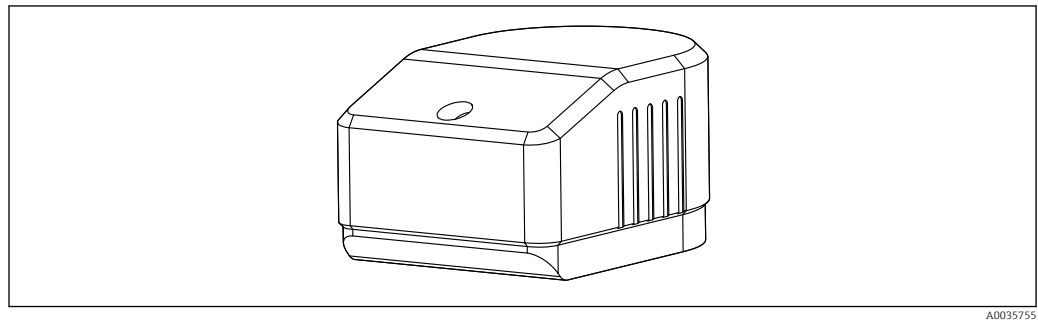
During factory calibration, each Calkit solid state reference is matched specifically to a special CUS52D sensor and can be used only with this sensor. Therefore, the Calkit solid state reference and the CUS52D sensor are permanently assigned (married) to one another.

The following Calkit 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 CUS52D sensors. The standard 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 CUS52D sensors.

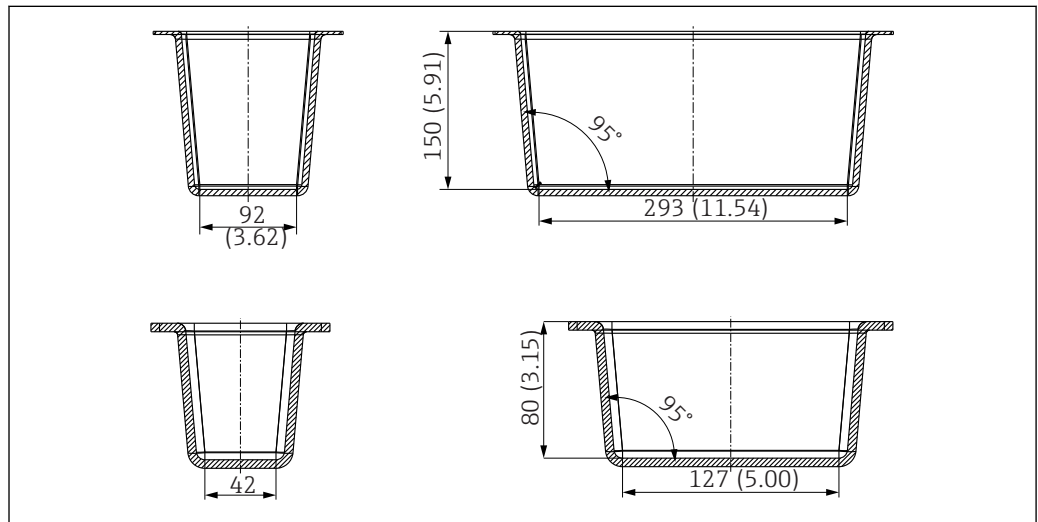


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5 Solid state reference

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 minimal backscattering, shade from interfering light sources etc.). There are two different types of calibration vessel into which the calibration solution (e.g. formazine) can be transferred.



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6 Large calibration vessel (top) and small calibration vessel (bottom). Dimensions: mm (in)



For detailed information on calibration tools, see BA01309C

Communication with the transmitter



Always connect digital sensors with Memosens technology to a transmitter with Memosens technology. Data transmission to a transmitter for analog sensors is not possible.

Digital sensors can store measuring system data in the sensor. These include the following:

- Manufacturer data
 - Serial number
 - Order code
 - Date of manufacture
- Calibration data
 - Calibration date
 - Number of calibrations
 - Serial number of the transmitter used to perform the last calibration or adjustment
- Operating data
 - Temperature application range
 - Date of initial commissioning

Dependability

Maintainability

Easy handling

Sensors with Memosens technology have integrated electronics that store calibration data and other information (e.g. total hours of operation or operating hours under extreme measuring conditions). Once the sensor has been connected, the sensor data are transferred automatically to the transmitter and used to calculate the current measured value. As the calibration data are stored in the sensor, the sensor can be calibrated and adjusted independently of the measuring point. The result:

- Easy calibration in the measuring lab under optimum external conditions increases the quality of the calibration.
- Pre-calibrated sensors can be replaced quickly and easily, resulting in a dramatic increase in the availability of the measuring point.
- Thanks to the availability of the sensor data, maintenance intervals can be accurately defined and predictive maintenance is possible.
- The sensor history can be documented on external data carriers and in evaluation programs.
- Thus, the current application of the sensors can be made to depend on their previous history.

Input

Measured variable

- Turbidity
- Temperature
- Solids content

Measuring range

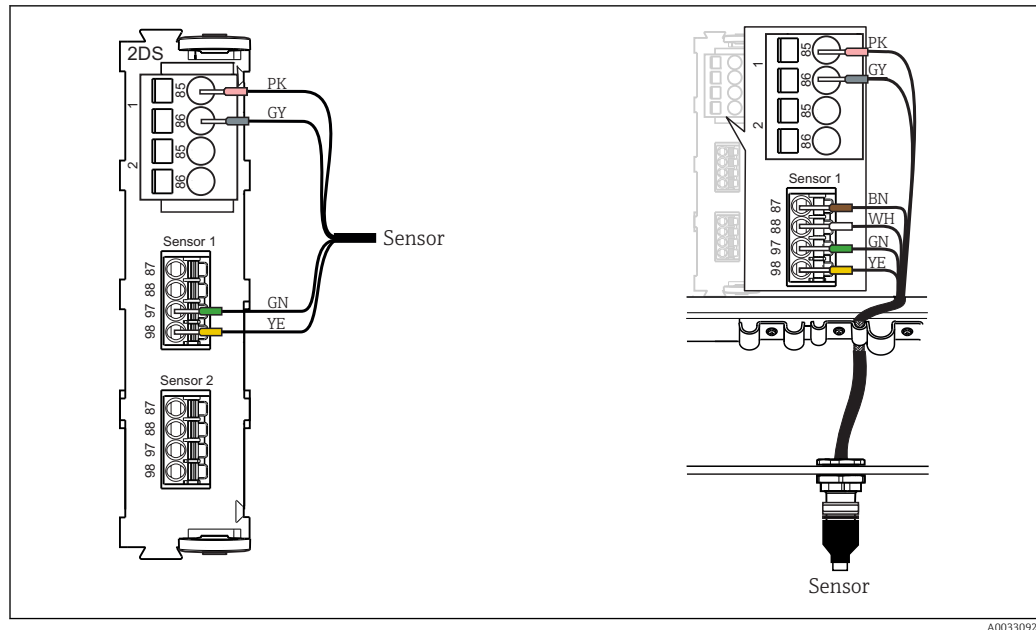
CUS52D		Application
Turbidity	0.000 to 4000 FNU Display range up to 9999 FNU	Formazine
Solids	0 to 600 mg/l Display range up to 3 g/l	Kaolin
	0 to 2200 mg/l Display range up to 10 g/l	Diatomite
Temperature	–20 to 85 °C (–4 to 185 °F)	

Power supply

Electrical connection

The following connection options are available:

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

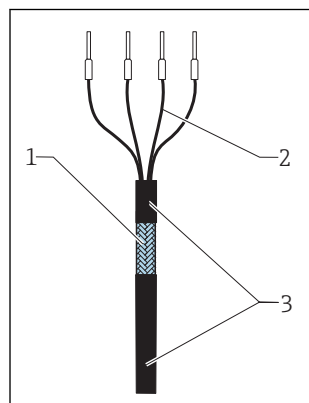


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7 Sensor connection to sensor input (left) or via M12 connector (right)

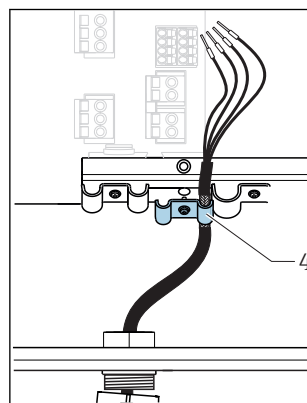
Connecting the cable shield

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



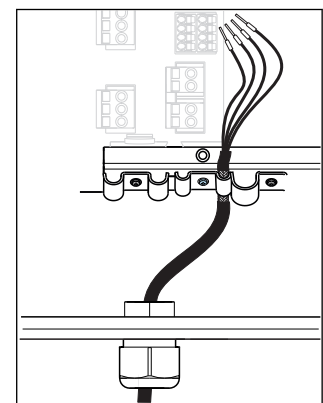
8 Terminated cable

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



9 Inserting the cable

- 4 Grounding clip



10 Tightening the screw
(2 Nm (1.5 lbf ft))

The cable shield is grounded by the grounding clip

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

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 recommended operational range, 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	<i>Detection limit in accordance with ISO 15839 in ultrapure water:</i> <table><tr><th>Application</th><th>Measuring range</th><th>Detection limit</th></tr><tr><td>Formazine</td><td>0 to 10 FNU (ISO 15839)</td><td>0.0015 FNU</td></tr></table>		Application	Measuring range	Detection limit	Formazine	0 to 10 FNU (ISO 15839)	0.0015 FNU
Application	Measuring range	Detection limit						
Formazine	0 to 10 FNU (ISO 15839)	0.0015 FNU						

Installation

Orientation	Orientation in pipes 11 Permitted and unacceptable orientations in pipes
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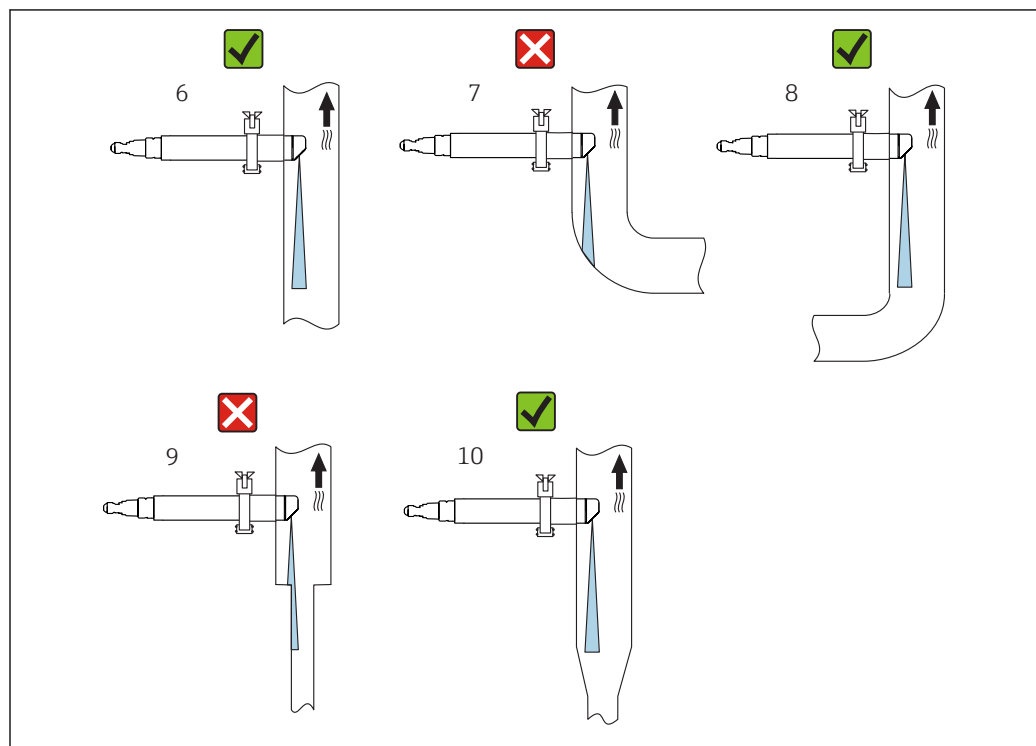
- Install the sensor in places with consistent flow conditions.
- The best installation location is in the ascending pipe (item 1). Installation in the horizontal pipe (item 4) is also possible.
- Do not install the sensor in places where air spaces or bubbles occur (item 3) or where sedimentation may 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.

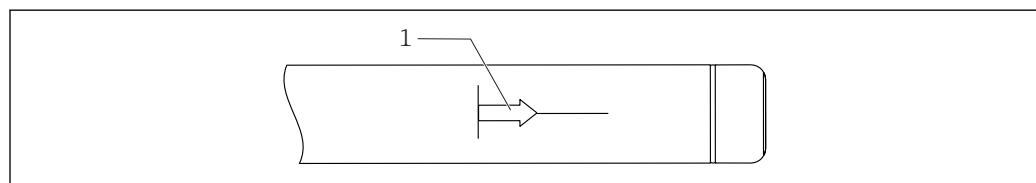


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12 Orientations for pipes and assemblies

- Install the sensor in such a way that the light beam is not reflected → 12, 10 (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



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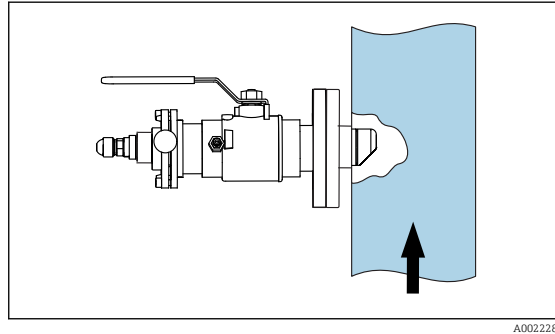
13 Installation marking for sensor alignment

1 Installation marking

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

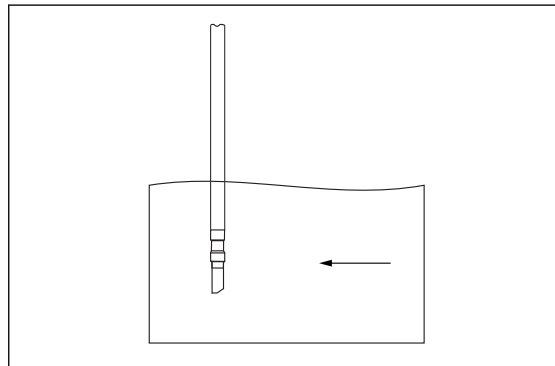
- Align the sensor against the flow direction.

Mounting options



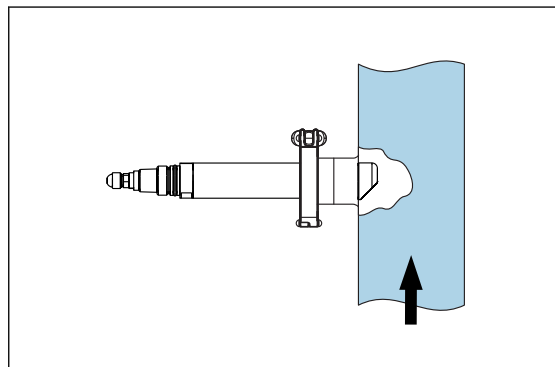
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14 Installing with CUA451 retractable assembly



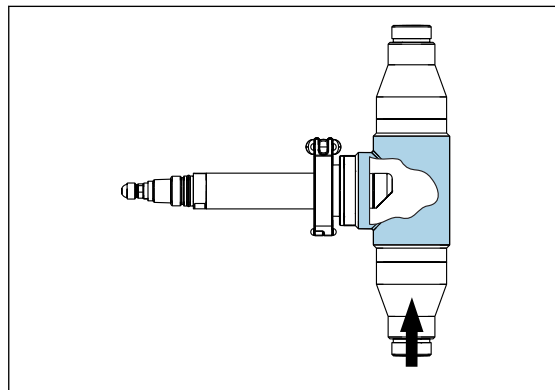
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15 Installing with immersion assembly



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16 Installing with 2" clamp connection



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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. The medium pressure may not exceed 2 bar (29 psi) for manual assembly retraction.

The installation angle is 0°.

The arrow points in the direction of flow.

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

The installation angle is 90°.

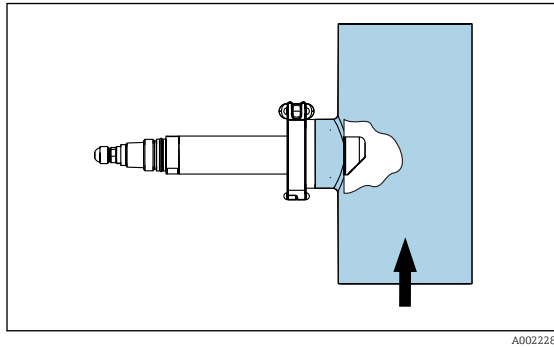
The arrow points in the direction of flow.

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 → 11.

The installation angle is 90°.

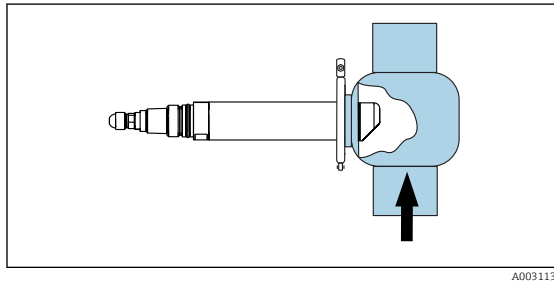
The arrow points in the direction of flow.

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



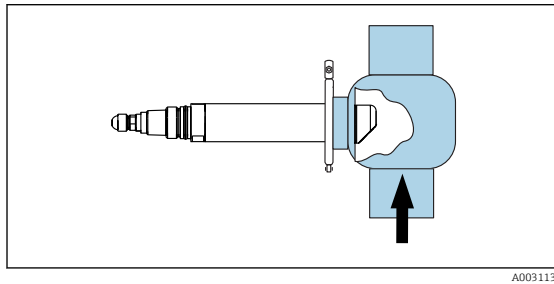
The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.

18 Installing with CUA262 flow assembly

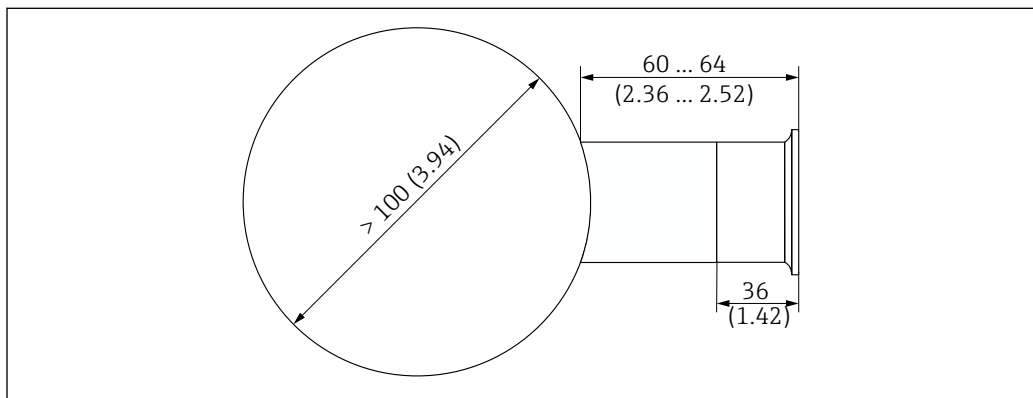


The installation angle is 90°.
The arrow points in the direction of flow.
The optical windows in the sensor must be aligned against the direction of flow.

19 Installing with standard Varivent connection



20 Installing with Varivent connection with extended shaft



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

For automatic sensor operation in pipe fittings or flow assemblies, there is the option of using the ultrasonic cleaning system CYR52 (→ 21).

Bubbles result in errors in turbidity measurements. The effect of this interference can be minimized by using a bubble trap (→ 21).

Environment

Ambient temperature range	–20 to 60 °C (–4 to 140 °F)
Storage temperature	–20 to 70 °C (–4 to 158 °F)
Degree of protection	IP 68 (1.8 m (5.91 ft) water column over 20 days, 1 mol/l KCl)
Electromagnetic compatibility (EMC)	Interference emission and interference immunity as per ■ EN 61326-1:2013 ■ EN 61326-2-3:2013 ■ NAMUR NE21: 2012

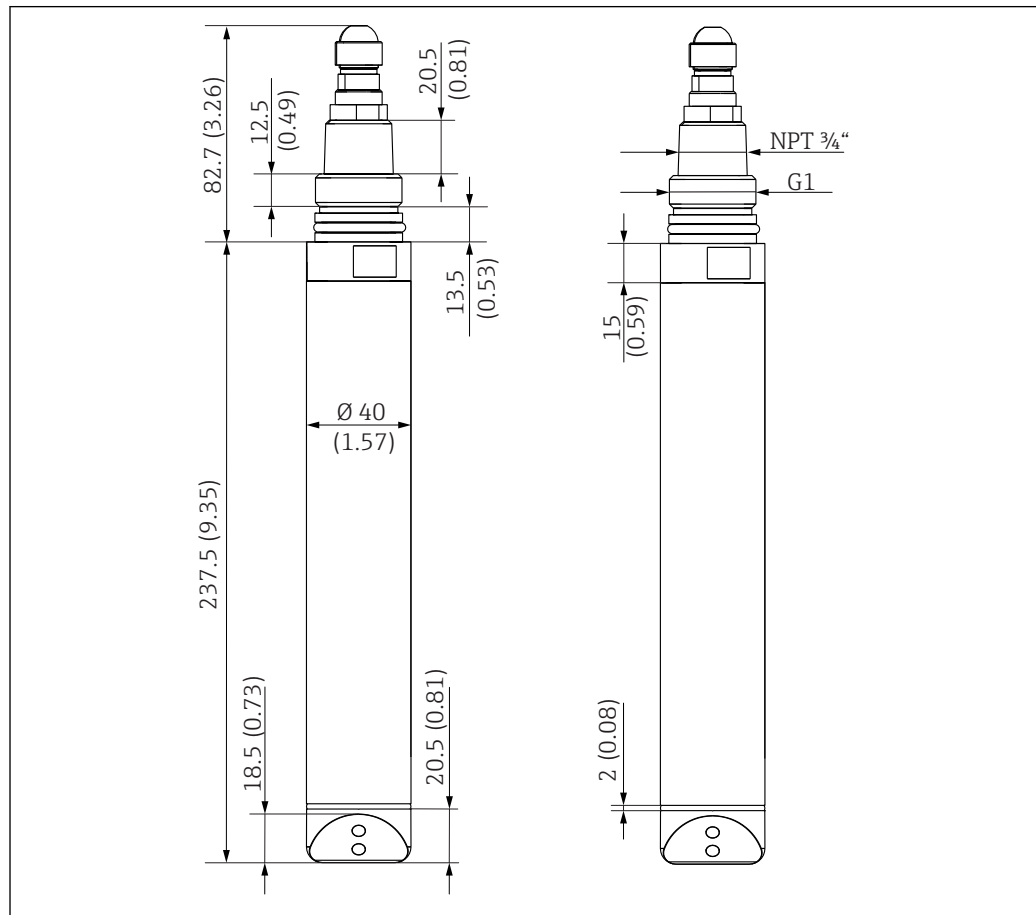
Process

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.

Mechanical construction

Dimensions

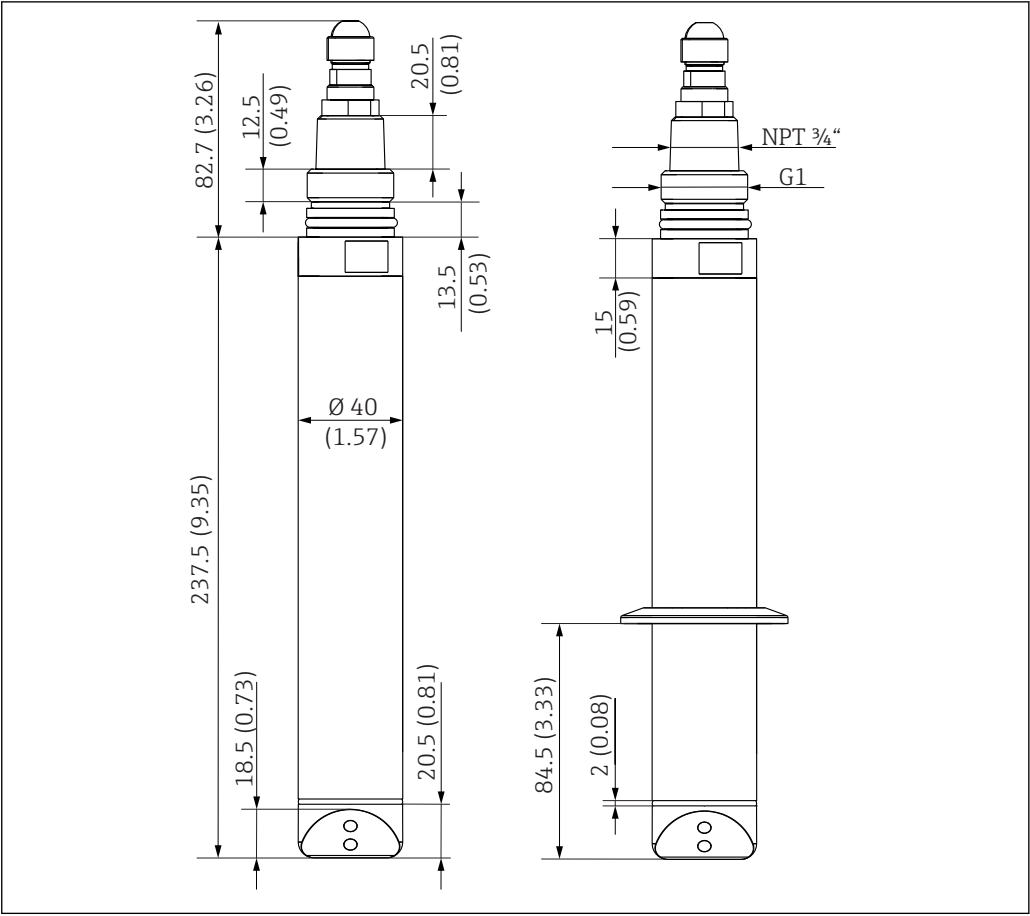
Plastic sensor



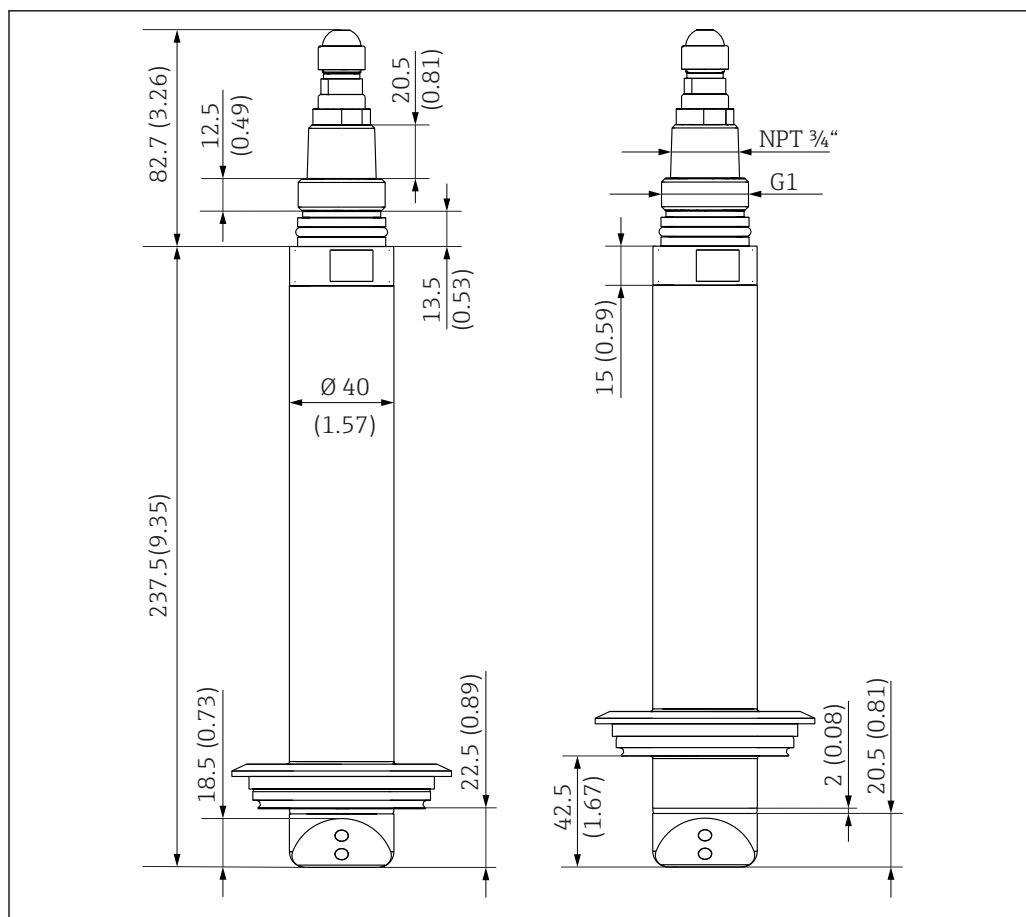
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22 Dimensions of plastic sensor. Dimensions: mm (in)

Stainless steel sensor



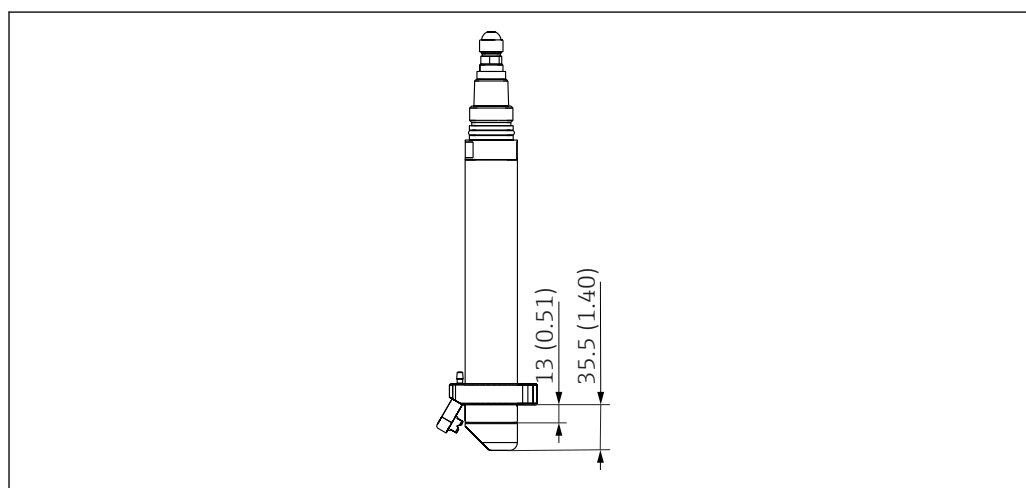
23 Dimensions of stainless steel sensor and stainless steel sensor with clamp connection (right). Dimensions: mm (in)



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

Compressed air cleaning

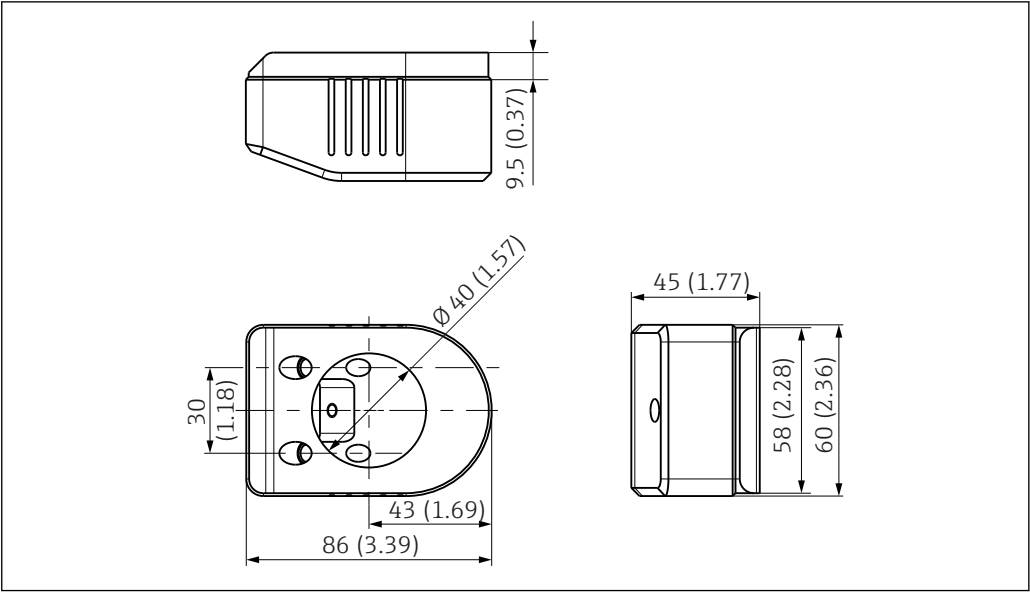


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25 Dimensions of sensor with compressed air cleaning. Dimensions: mm (in)

 Compressed air cleaning accessory →  20

Solid state reference



26 Solid state reference Calkit CUS52D. Dimensions: mm (in)

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

Process connections

Plastic and stainless steel sensor

G1 and NPT 3/4"

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

Certificates and approvals

CE mark	The product meets the requirements of the harmonized European standards. As such, it complies with the legal specifications of the EU directives. The manufacturer confirms successful testing of the product by affixing to it the CE mark.
ISO 7027	The measurement method used in the sensor corresponds to the nephelometric turbidity method according to ISO 7027-1:2016.
EAC	The product has been certified according to guidelines TP TC 004/2011 and TP TC 020/2011 which apply in the European Economic Area (EEA). The EAC conformity mark is affixed to the product.
Marine approvals	A selection of the devices and sensors have type approval for marine applications, issued by the following classification societies: ABS (American Bureau of Shipping), BV (Bureau Veritas), DNV-GL (Det Norske Veritas-Germanischer Lloyd) and LR (Lloyd's Register). Details of the order codes of the approved devices and sensors, and the installation and ambient conditions, are provided in the relevant certificates for marine applications on the product page on the Internet.

Ordering information

Scope of delivery	The delivery comprises: ■ 1 sensor, version as ordered ■ 1 Operating Instructions BA01275C
Product page	www.endress.com/cus52d
Product Configurator	On the product page there is a Configure button to the right of the product image. 1. Click this button. ↳ The Configurator opens in a separate window. 2. Select all the options to configure the device in line with your requirements. ↳ In this way, you receive a valid and complete order code for the device. 3. Export the order code as a PDF or Excel file. To do so, click the appropriate button on the right above the selection window.  For many products you also have the option of downloading CAD or 2D drawings of the selected product version. Click the CAD tab for this and select the desired file type using picklists.

Accessories

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

- For accessories not listed here, please contact your Service or Sales Center.

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
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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

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

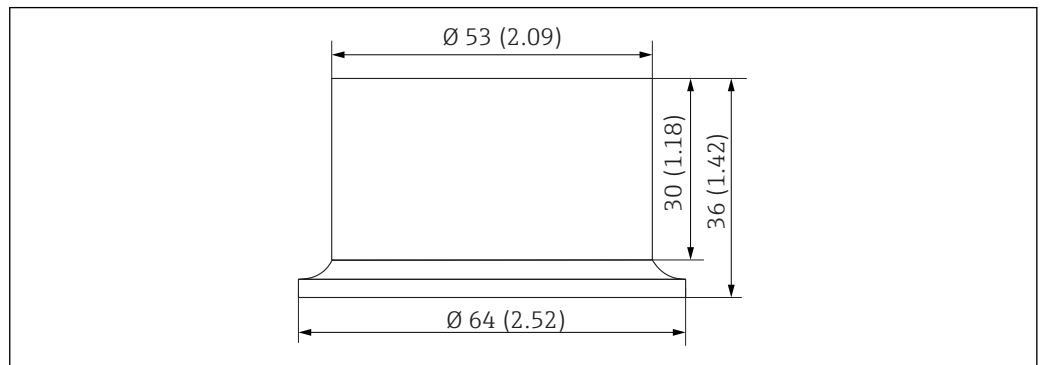


Technical Information TI00430C

Mounting material

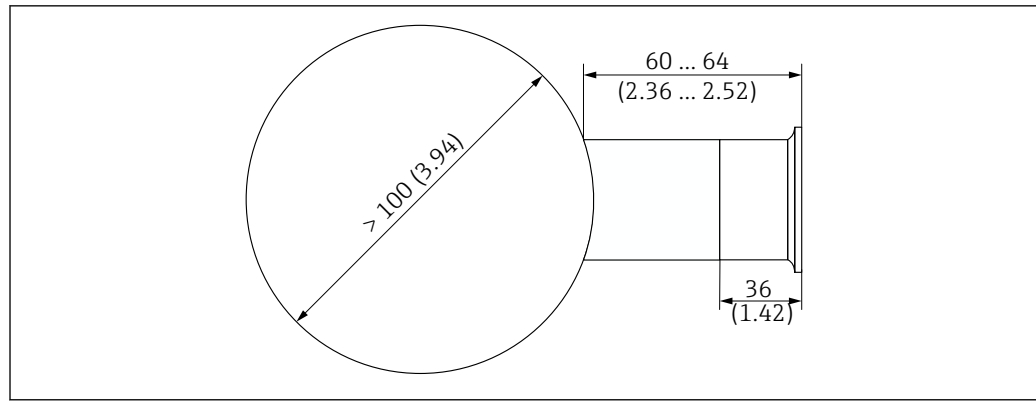
Weld-in adapter for clamp connection DN 50

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



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

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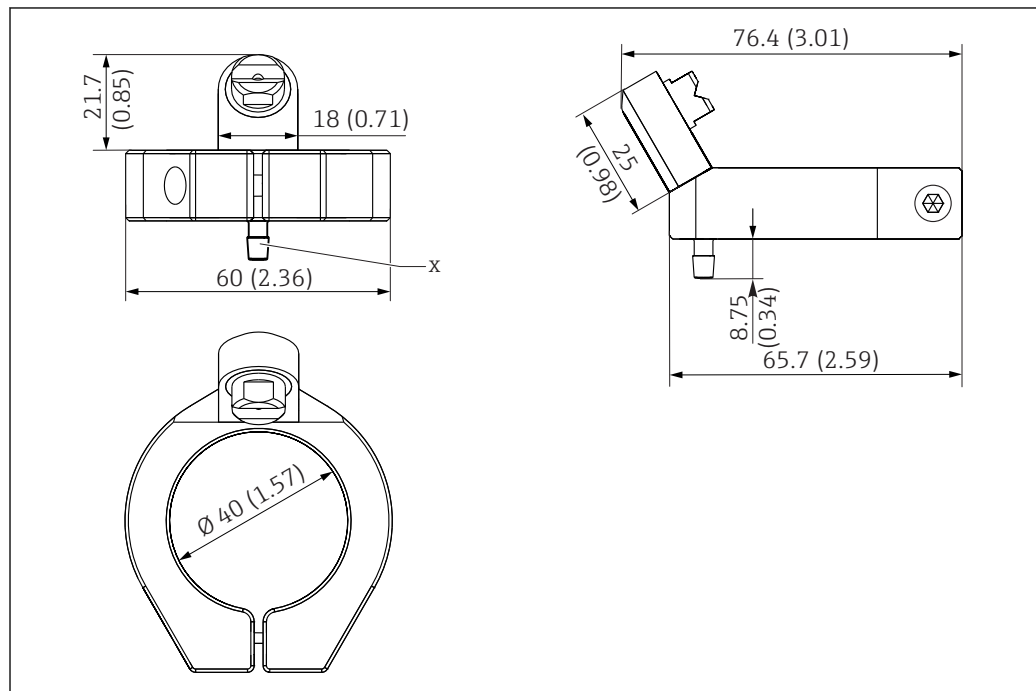
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28 Pipe connection with weld-in adapter. Dimensions: mm (in)

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



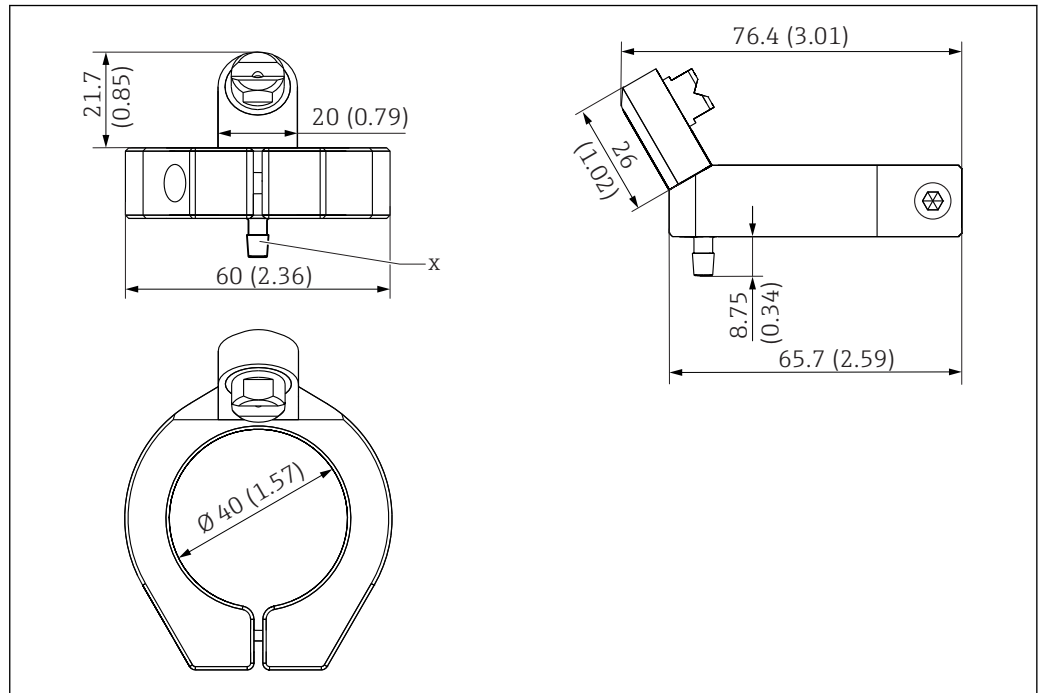
A0030837

29 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

30 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

Ultrasonic cleaning

Ultrasonic cleaning system CYR52

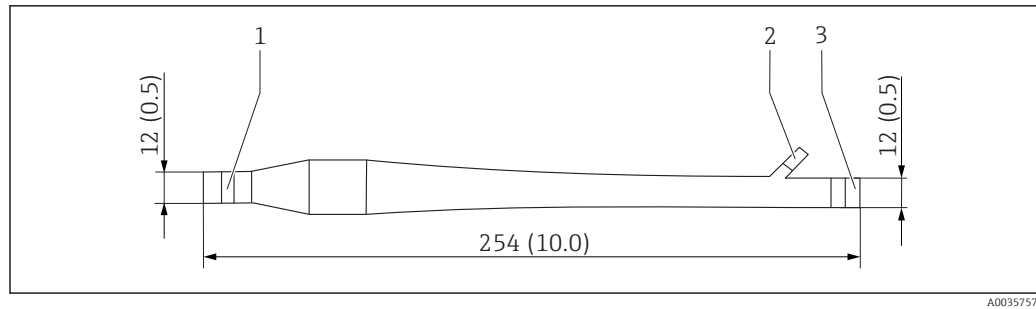
- For attachment to assemblies and pipes
- Product Configurator on the product page: www.endress.com/cyr52

Technical Information TI01153C

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)
- 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



31 Bubble trap. Dimensions: 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)

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

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



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