Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Turbimax CUS51D

Sensor for turbidity and solids content
Installation and immersion sensor for low, middle and high turbidity and solids concentrations

Application

Turbimax CUS51D is a sensor for all applications of wastewater treatment.

- Turbidity measurement in the outlet
- Suspended solids in the activated sludge basin and in the recirculation
- Suspended solids in the sludge treatment
- Filterable solids in the outlet

Your benefits

- All sensor principles (90°, 135° and four-beam pulsed light) are included in the sensor head and allow optimal adaption to the measurement task.
- The sensor is factory-calibrated (basis formazine). All selectable applications (e.g. activated sludge) are precalibrated and allow quick and easy commissioning.
- Standardized communication (Memosens technology) allows "plug and play".
- Intelligent sensor – all characteristics and calibration values are stored in the sensor.
- Calibrations provided by the customer with up to 5 points – realizable in lab or on site.

TI461C/07/en/13.11
71129663

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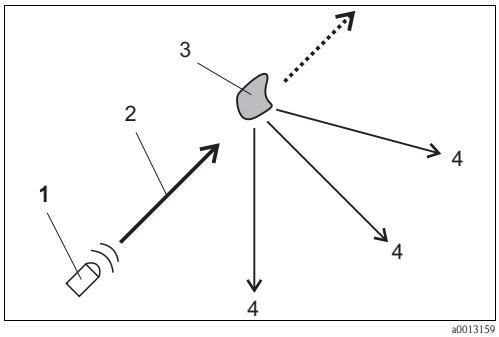
Function and system design

Measuring principle

For turbidity measurement a light beam is sent through the medium and is diverted from its original direction by optically denser particles, e.g. solid matter particles. This process is also called scattering.

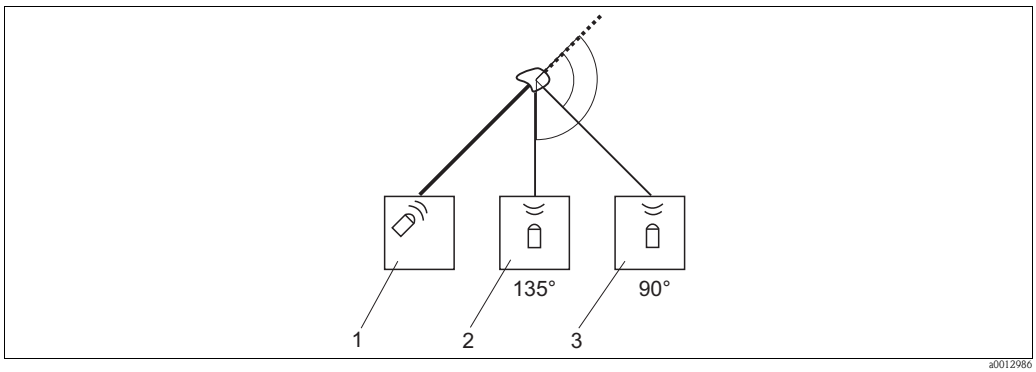


1 Light source
2 Light beam
3 particle
4 Scattered light

Deflection of the light

The impinging light will be scattered in different angles. Two angles are of interest in this matter:

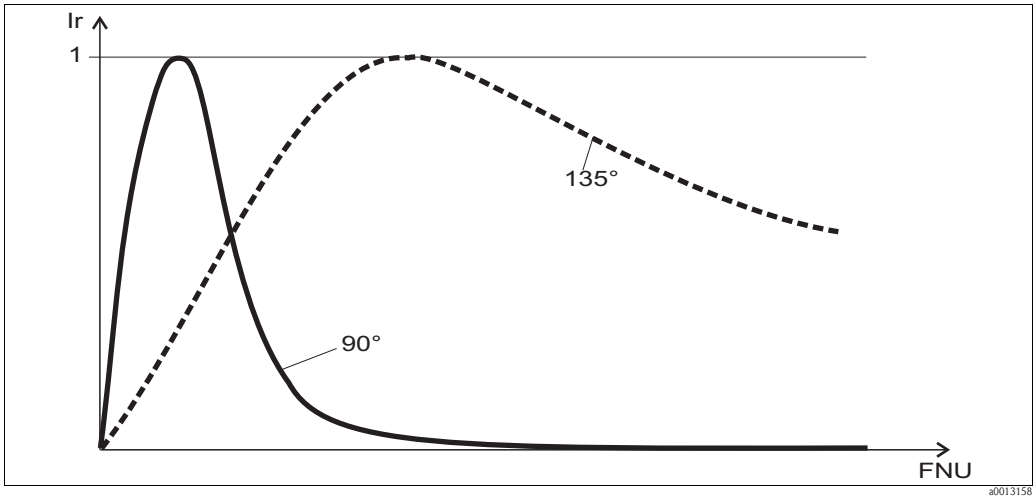
- The scattered light in the 90° direction is less influenced by the size of the particles.
- The scattered light in the 135° direction gives enough information also at a high number of particles.



Principle operating mode of the turbidity sensor

1 Light source
2 135° light receiver
3 90° light receiver

If only a small number of particles is in the medium, most of the light will be scattered to the 90° channel and less light will be scattered to the 135° channel. When the number of particles increases the relationship will change (more light scattered to the 135° channel, less light scattered to the 90°channel).

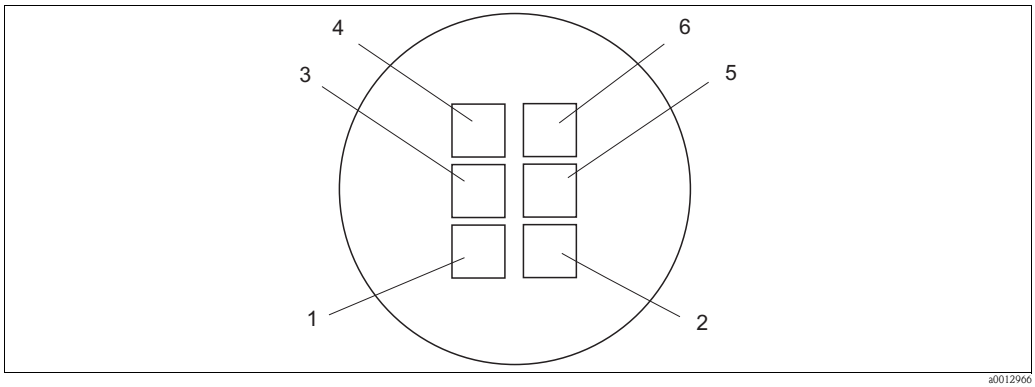


Signal distribution depending on the number of particles

Ir Relative intensity

Sensor design

The turbidity sensor CUS51D is equipped with two independing sensor units that are arranged in parallel. The application-specific analysis of both signals results in stable measured values.



Arrangement of the light souces and the light receivers

1,2 Light sources 1 and 2
3,5 135° light receivers
4,6 90° light receivers

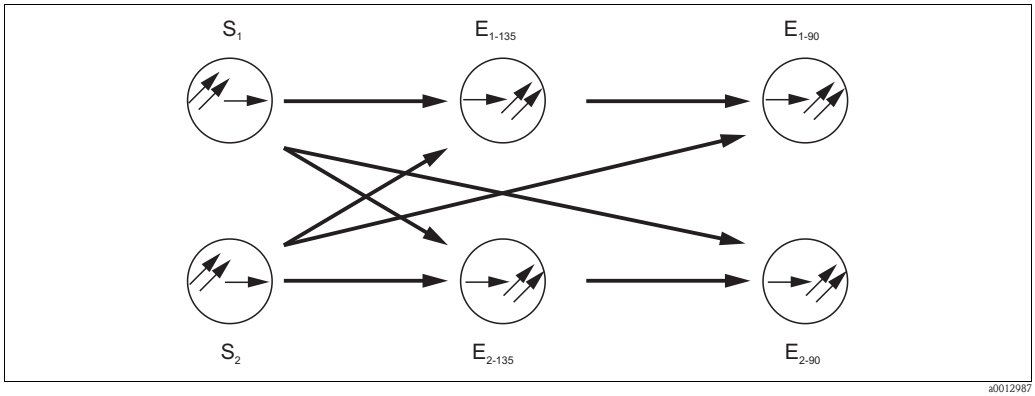
This allows the optimal turbidity and suspended solids measurement:
- For low turbidity values preferably the 90° channel is used.
- For average and high turbidity values and for suspended solids measurement the 135° channel is used.
- The dual sensor technology allows operation with a large range of soiling compensation, e.g. suspended solids measurement in the activated sludge basin (basis: four-beam pulsed light).

Based on the chosen application the appropriate model is used automatically inside the sensor.

Note!
The available sensor types differ in their measuring ranges and therefore in the selection of the available applications.

Measurement methods

Four-beam pulsed light method
The method is based on two light sources and four light receivers. Long-life LEDs are used as monochromatic light sources. To eliminate interference from extraneous light sources, these LEDs are pulsed.
Two measuring signals are detected at the four light receivers. The eight measuring signals are processed in the sensor and are converted into turbidity units and solids concentrations.
The four-beam pulsed light method compensates the sensor soiling as well as the wearing of the optical components.
The number of the used signals depends on the application.

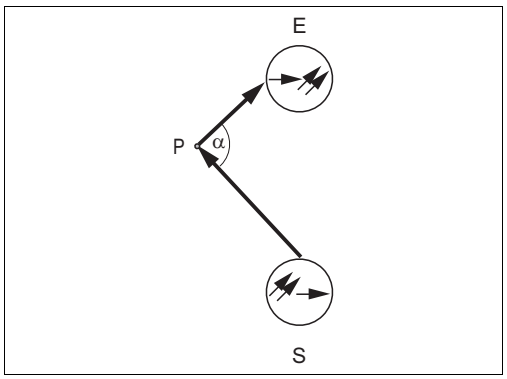


Four-beam pulsed light method

S_1 S_2 Light sources
E_{90} 90° channel light-receiver
E_{135} 135° channel light-receiver

90° scattered light method

The measurement uses a wavelength of 860 nm like described in ISO 7027 / EN 27027.
The transmitted light beam is scattered by the solid matter particles in the medium. The scattered beams are detected by scattered light receivers which are arranged at an angle of 90 ° to the light sources. The turbidity of the medium is determined by the amount of the scattered light.

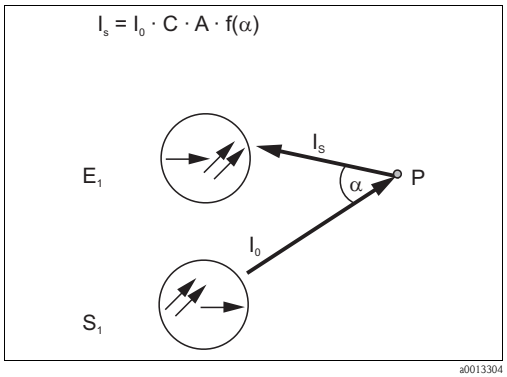


S = Light source
E = Light receiver
P = Particle

Principle of the 90° scattered light method

135° backscattered light method

The transmitted light beam is scattered by the solid matter particles in the medium. The backscattered beams are detected by scattered light receivers, which are arranged next to the light sources. The turbidity of the medium is determined by the amount of backscattered light.
This method is used to measure high turbidity values.



I_0 = Intensity of transmitted light
I_S = Intensity of backscattered light
A = Geometric factor
C = Concentration
P = Particle
f(α) = Angle dependence

Principle of backscattered light method

Sensor monitoring

The optical signals are continuously monitored und checked for plausibility
Discrepancies are reported via error messages by the transmitter.

The sensor check system of the Liquiline M reports the following failure conditions:
- Implausible high or low measuring values
- Disturbed controlling due to erroneous measuring values

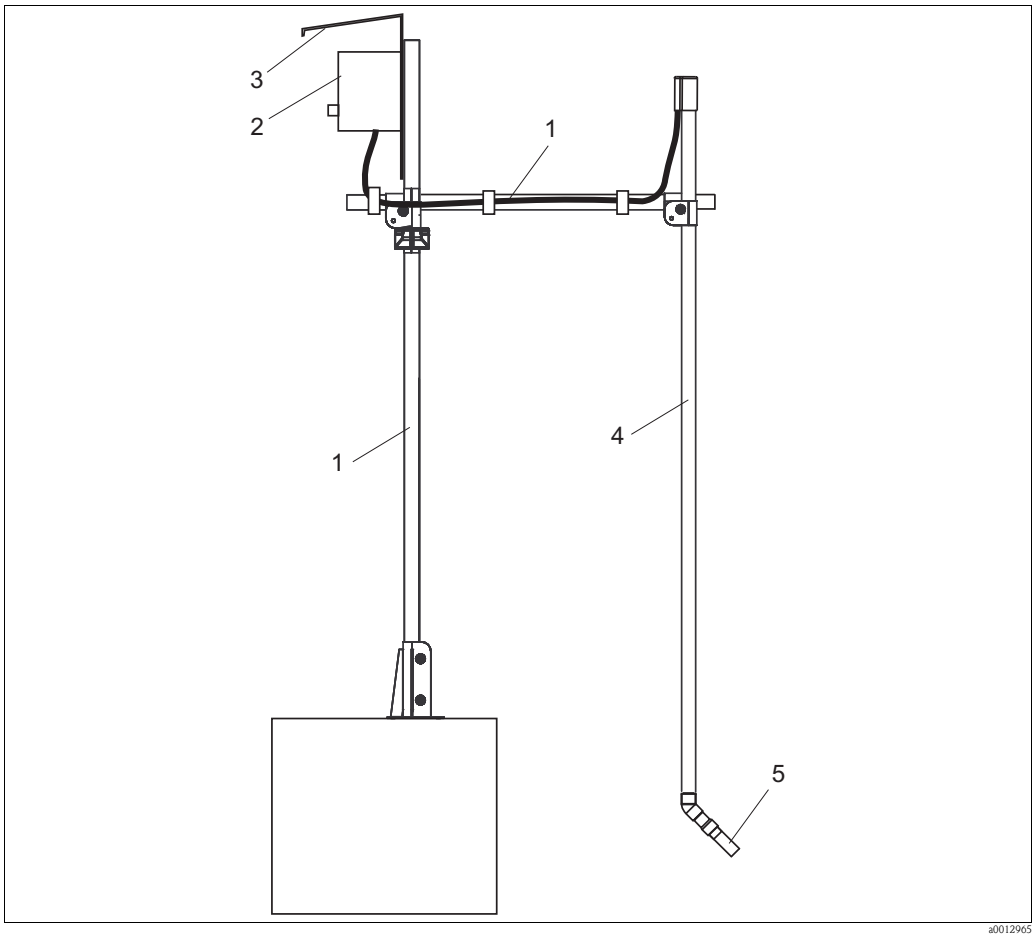
Applications

Model name	Application	Unit	Compensation*
Formazine	Process water, sewage treatment plant outlet	FTU / FNU	
Kaolin	Filterable solids, process water, sewage treatment plant outlet, activated sludge in low concentration	mg/l ; g/l; ppm; %	
SiO_2	SiO_2, mineralic solids (sands)	g/l; ppm; %	X
TiO_2	TiO_2, (white medium)	g/l; ppm; %	X
Activated sludge	Activated sludge basin and comparable medium	g/l; ppm; %	X
Excess sludge	Excess sludge, primary sludge, thickened sludge	g/l; ppm; %	X
Digested sludge	Digested sludge, black – homogeneous	g/l; ppm; %	

* compensation of contamination with four-beam pulsed light

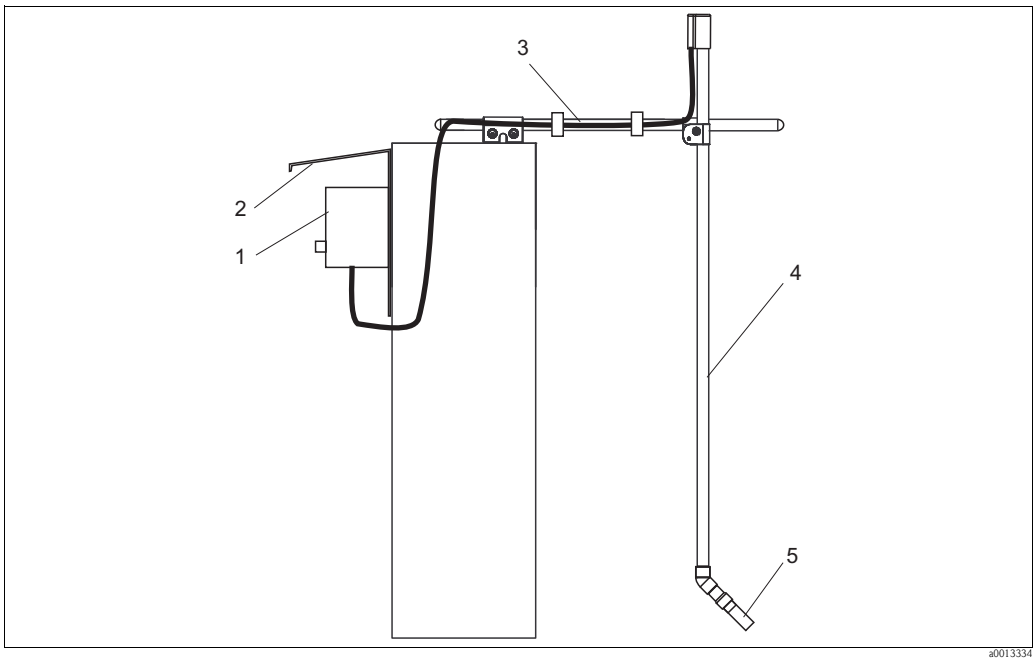
Measuring system

A complete measuring system comprises:
- Turbidity sensor Turbimax CUS51D
- Transmitter Liquiline
- Assembly:
  - Assembly Flexdip CYA112 and holder system Flexdip CYH112 or
  - Retractable assembly , e.g. Cleanfit CUA451



Measuring system with immersion assembly (example)

1 Holder system Flexdip CYH112
2 Transmitter Liquiline
3 Weather protection roof
4 Assembly Flexdip CYA112
5 Turbidity sensor Turbimax CUS51D



Measuring system with immersion assembly (example)

1 Transmitter Liquiline
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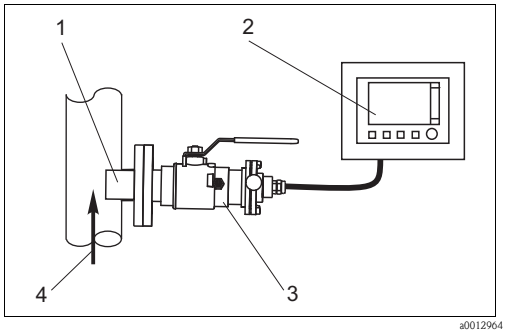
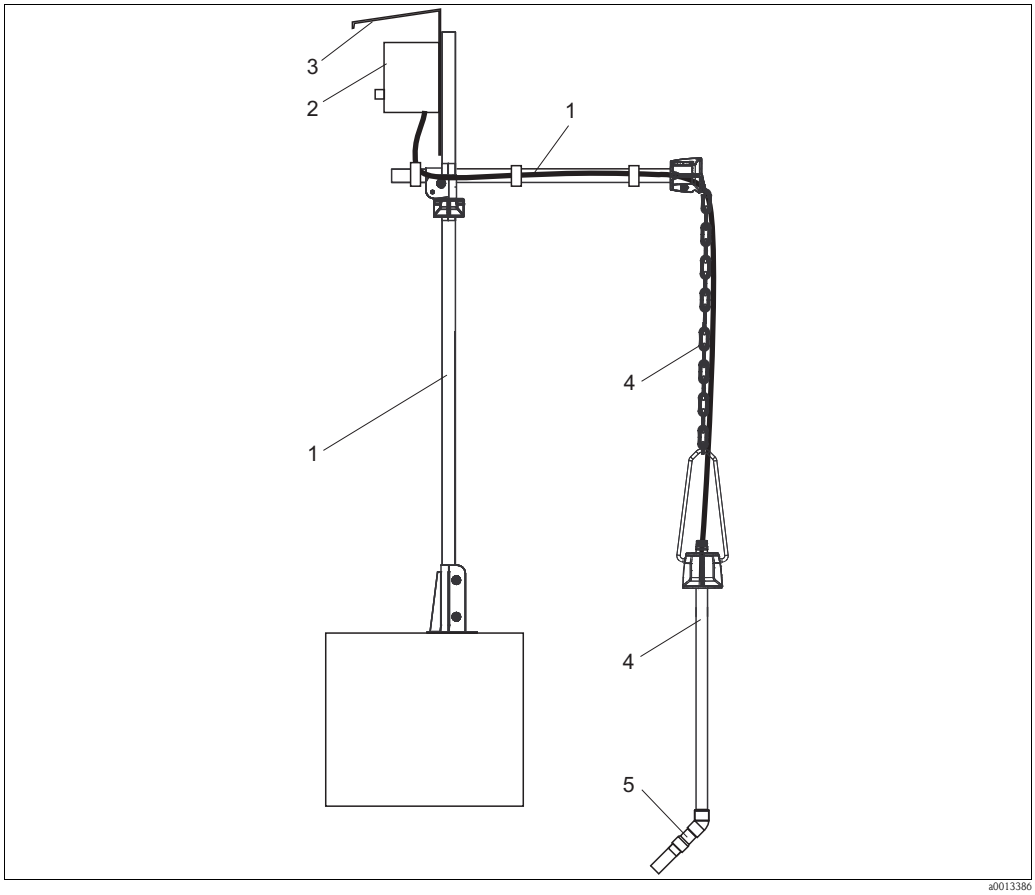


Measuring system with retractable assembly (example)

1 Turbidity sensor Turbimax CUS51D
2 Transmitter Liquiline
3 Retractable assembly Cleanfit CUA451
4 Flow direction



Measuring system with immersion assembly and chain holder system

1	*Holder system Flexdip CYH112*	*4*	*Assembly Flexdip CYA112*
2	*Transmitter Liquiline CM44x*	*5*	*Turbidity sensor Turbimax CUS51D*
3	*Weather protection roof*		

Input

Measuring variables

Turbidity
Solids content

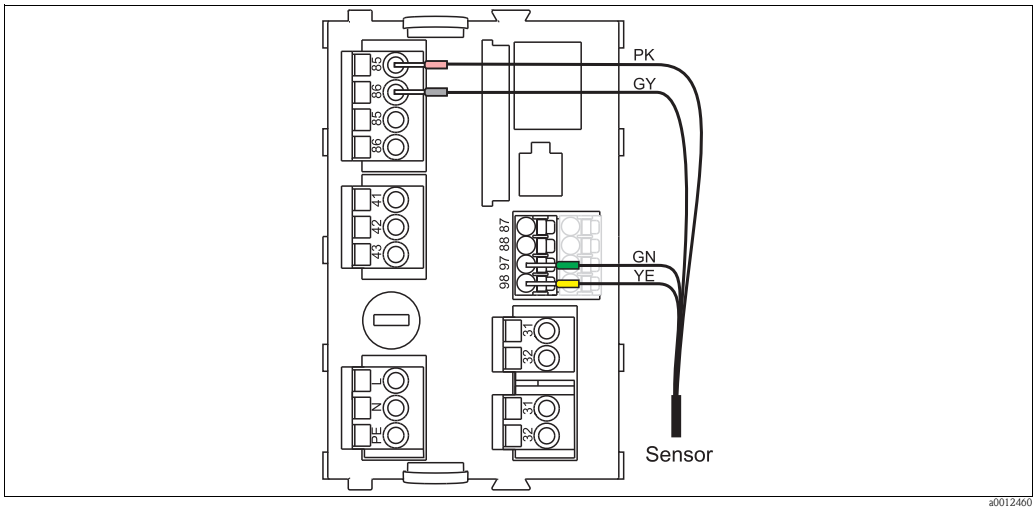
Measuring range

CUS51D-**C1		Application
Turbidity	0 to 4000 FNU display range up to 9999 FNU	Formazine
Solids content	0 to 4 g/l	Kaolin, filterable solids
CUS51D-**D1		
Turbidity	0 to 4000 FNU display range up to 9999 FNU	Formazine
Solids content	0 to 300 g/l 0 to 15 %	Solids content according to chosen application (see list)

Power supply

The sensor will be connected to the transmitter as follows:

- With the M12 plug (version CUS51D-xxxxBxxx) or
- the fixed cable has to be connected to the terminal as follows (version CUS51D-xxxxAxxx):



Sensor connection

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

Performance characteristics

Maximum measured error

Turbidity	< 2% of the measured value or 0.1 FNU (the respectively larger value is valid)
Solids	< 5 % of the measured value or 1 % of full scale (the respectively larger value is valid); valid for sensors in the calibrated measuring range

Wavelength

860 ± 30 nm

Factory calibration

FNU, FTU and solids concentration according to the application table
Standard: 3 points

Applications

The sensor is factory calibrated in the application "formazine" and hereof derived for "kaolin filterable solids)". Further precalibrated applications are optimized for the corresponding medium.
The calibration can be performed up to 5 points.

Application	Recommended working ranges	CUS51D-	
		C1	D1
Factory calibration formazine	0 to 4000 FNU	X	X
Factory calibration kaolin	0 to 4 g/l	X	X
Application SiO_2	5 to 100 g/l		X
Application titanium dioxide	0.2 to 150 g/l		X
Application activated sludge	0.5 to 15 g/l		X
Model return sludge	3 to 50 g/l		X
Application digested sludge / ooze	5 to 100 g/l / 300 g/l		X

Note!
For solids the achievable measuring ranges are depending of the actual medium and can deviate from the recommended operating ranges. In this case a 3-point-calibration is recommended.

Drift

Thanks to electronic control the sensor works drift compensated in a wide range.

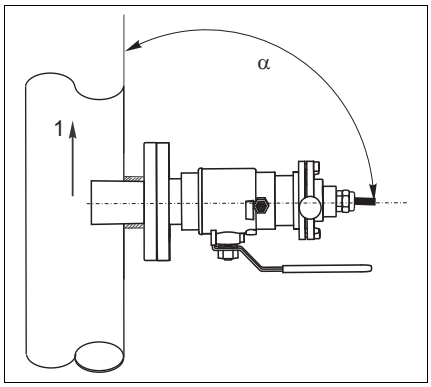
Limit of detection

Application	Measuring range	Limit of detection
Formazine	0 to 50 FNU	0.006 FNU
	0 to 9999 FNU	0.4 FNU
Kaolin	0 to 4000 mg/l	0.85 mg/l

Installation conditions

Installation instructions

Mounting applications:
- with retractable assembly Cleanfit W CUA451
- with wastewater assembly Flexdip CYA112 and holder system Flexdip CYH112
- with flow assembly Flowfit W CUA250



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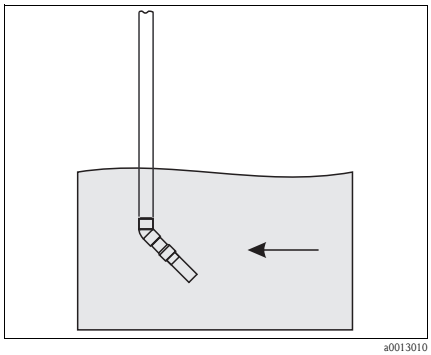
Installation with retractable assembly

Arrow 1 shows the flow direction.
The installation angle α must not exceed 90°.
The recommended installation angle is 75°.
The optical windows of the sensor have to be aligned parallel to the flow direction (α = 90°) or face the flow direction (α < 90°).
For manual insertion/retraction of the assembly the medium pressure may not exceed 2 bar (29 psi).



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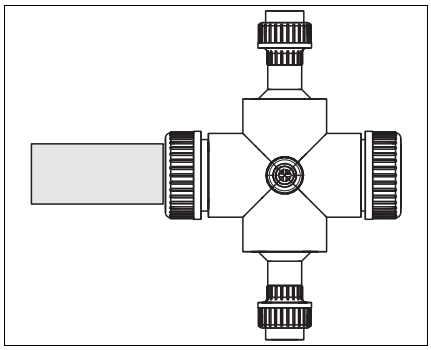
Installation with wastewater assembly

The arrow shows the flow direction.
The installation angle is 45° (recommended) or 90°.
If you use the sensor in open basins, install the sensor in a way no bubbles can build up around the optical windows.
If you use the sensor in strong aerated basins install the sensor in an installation angle of 90° to minimize the influence of bubbles.



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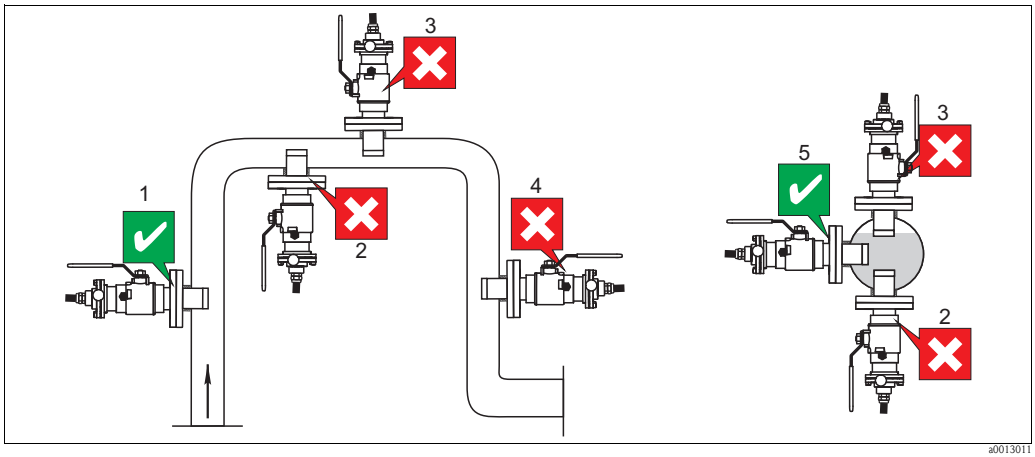
Installation with flow assembly CYA251

The installation angle is 90°.

Pipe installation

The following figure illustrates various installation positions in pipes and indicates whether they are permitted or not.



Orientation and installation positions (with retractable assembly CUA451)

- The pipeline diameter must be at least 100 mm (4") if reflective materials (e.g. stainless steel) are used. An onsite calibration is recommended.
- Install the sensor in places with uniform flow conditions.
- The best installation location is in the ascending pipe (it. 1). Installation is also possible in the horizontal pipe (it. 5).
- Do not install the sensor in places where air may collect or foam bubbles form (it. 3) or where suspended particles may settle (it. 2).
- Avoid installation in the down pipe (it. 4).
- Turbidity measurement < 200 FNU will result in erroneous measuring results due to backscattering of pipe wall. Therefore a multipoint calibration is recommended.
- Avoid installations behind pressure reduction steps which can outgas.

Environment

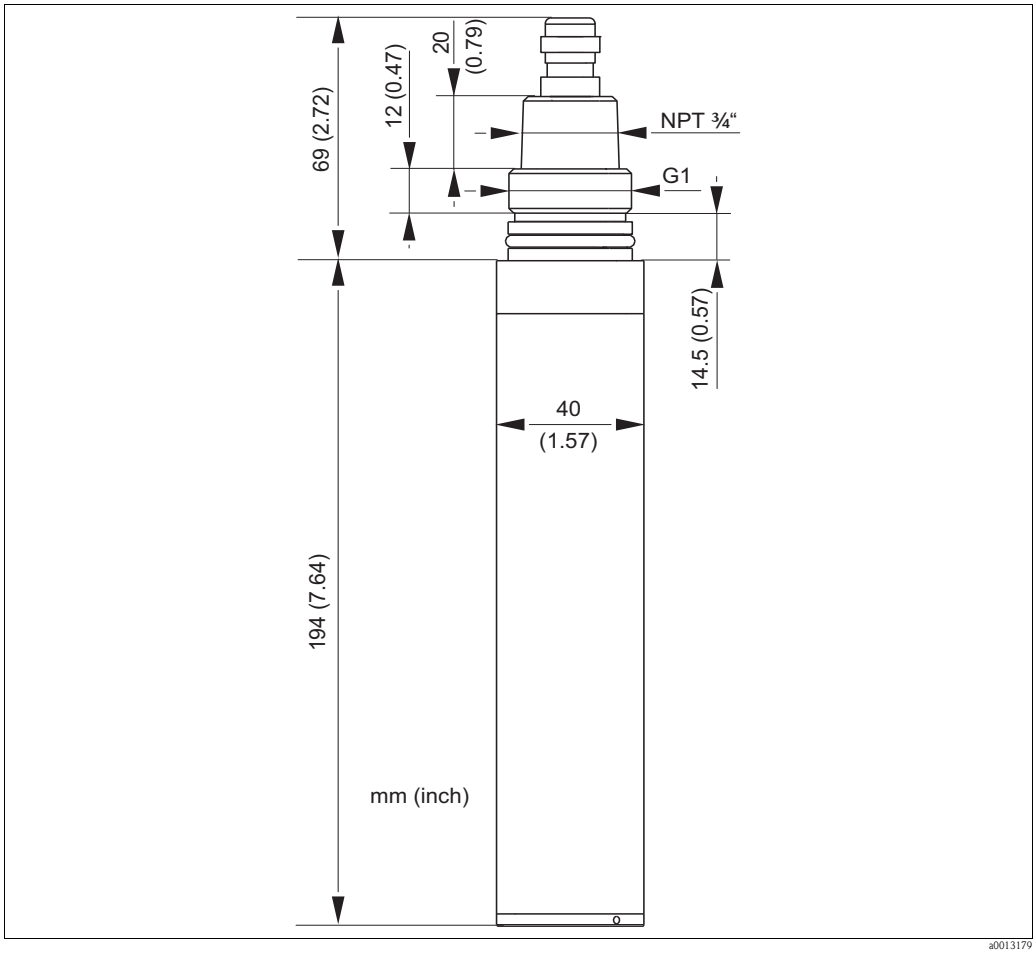
Ambient temperature	-20 to 60 °C (-4 to 140 °F)
Storage temperatur	-20 to 70 °C (-4 to 158 °F)
Ingress protection	IP 68 (test conditions: 1 m (3.3 ft) water column during 60 days, 1 mol/l KCl)

Process

Process temperature	-5 to 50 °C (23 to 120 °F) max. 80 °C (175 °F) short term(1 h)
Process pressure	0.5 to 10 bar (7 to 145 psi) absolute
Minimum flow	No minimum flow required. Make sure that there is a sufficient turbulence for solids with a tendency to sedimentation.

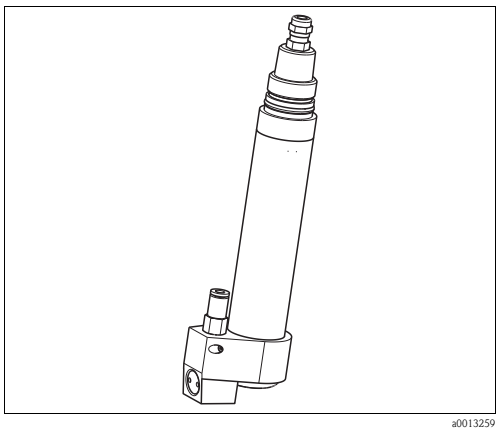
Mechanical construction

Dimensions



Dimensions

Cleaning system



CUS51D with cleaning system

Cleaning system with pressurized air
Consumption: 50 l/min (13.2 gal/min)
Primary pressure: 1.5 to 2 bar (22 to 30 psi)
Connection: 6/8 mm or 6.35 mm (¼")

Weight

approx. 0.7 kg (1.5 lbs) without cable

Materials

Sensor	Stainless steel 1.4404 (AISI 316 L) or Stainless steel 1.4571 (AISI 316 L)
Optical windows	Sapphire
O-rings	EPDM

Process connections

G1 and NPT ¾"

Certificates and approvals

EMC compatability

Interference emission and interference immunity complies with EN 61326: 2005, Namur NE 21:2007

Ordering information

Product structure

	Approval					
	AA	Non-harzadous area				
		Application, measuring range				
		C1	Process water			
		D1	Process water; solids			
			Adaption cable			
			A	Fixed cable, crimp sleeves		
			B	Fixed cable, M12-plug		
				Cable length		
				2	3 m (9.9 ft)	
				3	7 m (23 ft)	
				4	15 m (49.2 ft)	
CUS51D-						**order code**

Accessories code	Accessories mounted
IA	Air cleaning, 6/8 mm
IB	Air cleaning, 6.35 mm (1/4")

Note!
To complete your order code, simply add the accessories code to the end of order code. If you have any questions, please contact your local sales office.

Scope of delivery

The scope of delivery comprises:
- 1 sensor Turbimax CUS51D in the ordered version
- 1 Operating Instructions BA461C/07/en

Accessories

Assemblies

Retractable assembly Cleanfit CUA451
- retractable assembly with ball valve; for turbidity sensors; material: stainless steel
- ordering acc. to product structure (Technical Information TI369C/07/en)

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

Flow assembly Flowfit CUA250
- for CUS31/CUS41/CUS51D
- ordering acc. to product structure (Technical Information TI096C/07/en)

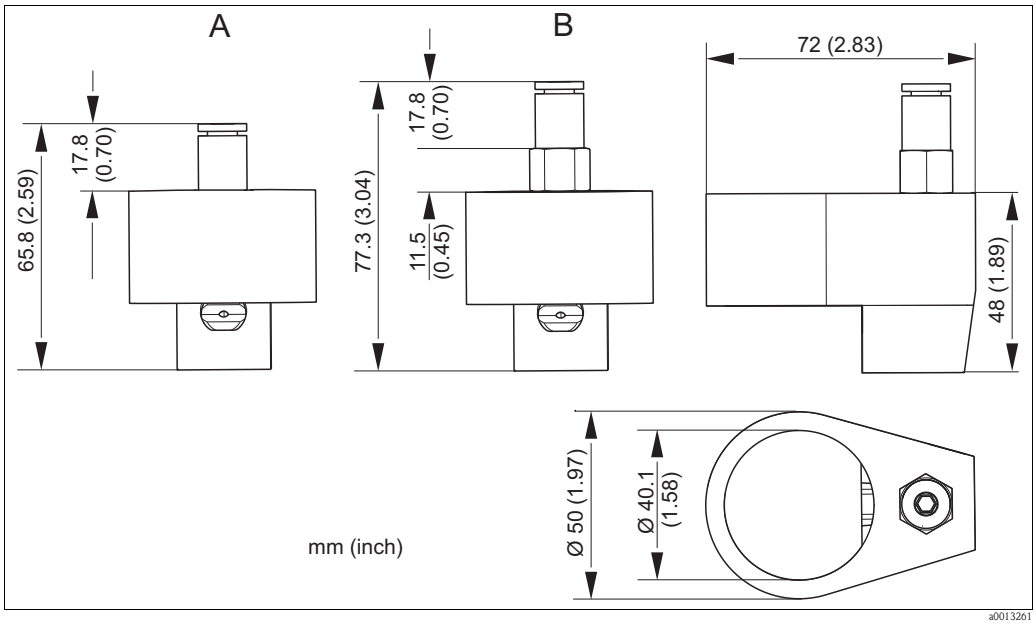
Flowfit CYA251 flow assembly
- Connection: see product structure
- Material: PVC-U
- Order as per product structure

Holder system

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

Cleaning system

Cleaning system with pressurized air
- Connection: 6/8 mm or 6.35 mm (¼")
- Materials: POM/V4A
- 6/8 mm order number: 71110782
- 6.35 mm (¼") order number: 71110783



Cleaning system

A Version 6 mm
B Version 6.35 mm (¼")

Compressor
- For cleaning system
- 230 V AC order number: 71072583
- 115 V AC order number: 71096199

Transmitter

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

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