Technical Information TI 370C/07/en/07.03 51512873

# Turbidity and Solids Content Sensor TurbiMax W CUS 65

Installation and immersion sensor for low, medium and high concentrations using the four-beam pulsed light method























## Application

The TurbiMax W CUS 65 sensor is used for optical turbidity and solids content measurement. Due to various sensor heads the sensor is suitable for use from low to high concentration ranges.

- Wastewater clarification / sludge treatment
- Boiler feedwater monitoring
- Condensate monitoring
- Service water monitoring

## Your benefits

- Four-beam pulsed light method for compensation of sensor soiling and wearing of optical components
- Sensor body made of stainless steel
  - No mechanically moving parts, therefore no sensor blocking
  - Measured value processing in sensor resulting in low signal transmission sensitivity
  - Aeration systems do not affect measurement
  - Plug system for quick commissioning







# Function and system design

## Measuring principle

## Turbidity measurement

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.

## Four-beam pulsed light method

The method is based on two light sources and two photo receivers. Long-life LEDs are used as monochromatic light sources. To eliminate interference from extraneous light sources, these LEDs are pulsed at a rate of several kHz.

Two measuring signals are detected at the two photo receivers. The four measuring signals are processed in the sensor and are converted into proportional frequencies. The transmitter assigns the frequencies to the appropriate turbidity units and solids concentrations.

The four-beam pulsed light method compensates the sensor soiling as well as the wearing of the optical components.



Four-beam pulsed light method

S = Light sourceE = Light receiver

## Measuring methods

Depending on the selected measuring range, the TurbiMax W CUS 65 sensor uses the absorption light method (CUS 65-A, -B, -C) or the scattered light method (CUS 65-D, -E).

#### Absorption light method

The measuring principle is based on the Lambert-Beer law. The turbidity of the medium is determined by the weakening of the light beam.

The sensor LEDs send a directed light beam to the light receivers. The light beam intensity is weakened by the solid matter particles in the medium.



Absorption light method acc. to Lambert-Beer law

- $I_0$  = Intensity of transmitted light
- $I_A = Intensity of absorbed light$
- $I_T$  = Intensity of light transmitted
- $I_{s} = Intensity of scattered light$
- $\breve{E} = Extinction coefficient$
- C = Concentration
- D = Optical path length

#### 90° scattered light method

The measurement uses the standardised 90° scattered light method acc. to ISO 7027 / EN 27027. The turbidity of the medium is determined by the amount of scattered light. 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.



90° scattered light method

$$\begin{split} I_0 &= \text{Intensity of transmitted light} \\ I_S &= \text{Intensity of scattered light} \\ A &= \text{Geometrical factor} \\ C &= \text{Concentration} \\ P &= \text{Particle} \\ f(\alpha) &= \text{Angle correlation} \end{split}$$

#### Backscattered light method

The measurement uses the backscattered light method.

The turbidity of the medium is determined by the amount of backscattered light. 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.



Backscattered light method

```
I_0 = Intensity of transmitted light
I_S = Intensity of scattered light
A = Geometrical factor
C = Concentration
P = Particle
f(\alpha) = Angle correlation
```



Note: The CUS 65-E sensor has a reversal point at approx. 0.8% of solid matter (as dry substance) and can thus not be calibrated with water. Therefore only use the sensor starting from a concentration >10 g/l.

I = Intensity of transmitted light C = Concentration P = Reversal point Cal = Calibration range

#### Measuring system

- A complete measuring system comprises:
- Turbidity transmitter CUM 740
- Turbidity sensor TurbiMax W CUS 65
- Immersion pipe CYY 105 or
- Retractable assembly CleanFit CUA 451
- Extension cable (optional)
- Junction box (optional)



Example for a measuring system CUS 65 Exam

with immersion pipe CYY 105

- 1 Turbidity transmitter CUM 740
- 2 Immersion pipe CYY 105

3 Turbidity sensor TurbiMax W CUS 65-C

4 Basin or channel



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Example for a measuring system CUS 65 with retractable assembly CleanFit CUA 451

1 Turbidity sensor CUM 740

2 Retractable assembly CleanFit CUA 451

- 3 Turbidity sensor TurbiMax W CUS 65-A
- 4 Pipe

# Input

Measured variables	Turbidity Solids content	
Measuring ranges	0 12 g/l (ppm) 0 40 g/l (ppm) 0 50 g/l (ppm) 1 1000 FNU 10 150 g/l (ppm)	Activated sludge, centrate Return sludge Primary sludge, digested sludge Wastewater outlet, service water, condensate, boiler feedwater Centrifuge inlet, press inlet

# **Performance characteristics**

Measuring light	Infrared light at 880 nm		
Reference	by four-beam pulsed light method		
Measured error	< 1% of measuring range end		
Factory calibration	SiO <sub>2</sub> Formazine acc. to ISO 7027 / EN 27027	CUS 65-A, -B, -C, -E CUS 65-D	

## **Electrical connection**

## **Cable connection**

The CUS 65 sensor is connected to the CUM 740 transmitter by the sensor cable with SXP plug. Simply plug the SXP plug into the socket of the transmitter. The extension cables (version CUS 65-xxx3) are also terminated with SXP plugs ex factory.



Cable connection CUS 65

## **Cable lenghts**

15m / 49.2 ft 7m / 23.0 ft 1m / 3.3 ft + 10m / 32.8 ft extension cable max. cable length: 200m / 656.2 ft recommended for immersion recommended for immersion recommended for installation cable diameter up to 50m / 164.1 ft:  $5 \times 0.35$  mm<sup>2</sup> cable diameter up to 100m / 328.1 ft:  $5 \times 0.5$  mm<sup>2</sup> cable diameter up to 200m / 656.2 ft:  $5 \times 1.0$  mm<sup>2</sup>

## Installation

## Installation instructions

You can install the CUS 65 sensor in two different ways: Installation with retractable assembly CUA 451 and installation with immersion pipe CYY 105.



- Observe the required mounting clearance for the installation mode selected. Installing the sensor in pipes or close to a wall can lead to backscattering resulting in signal increase, mainly with measurements in low turbidity ranges (<100 FNU).</li>
- Make sure the sensor is completey immersed at changing water levels.

# Installation

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Installation with retractable assembly CUA 451 and installation with immersion pipe CYY 105.

#### Note!

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- Make sure the sensor is completey immersed at changing water levels.





Mounting of CUS 65 sensor with CUA 451 assembly

The arrow shows the flow direction of the medium Installation angle  $\alpha$  dependent on sensor version: CUS 65-A  $\alpha = 80^{\circ}$  from pipe wall

0000071	$\alpha = 00$ from pipe wait
CUS 65-B	$\alpha = 90^{\circ}$ from pipe wall
CUS 65-C, E	$\alpha$ = 100° from pipe wall
CUS 65-D	$\alpha = 110^{\circ}$ from pipe wall

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Mounting of CUS 65 sensor with CYY 105 immersion pipe

20 cm / 7.9"	
0 cm / 3.9"	
5°	
0°	
80 °(straight)	

# Environment

Ambient temperature	-20 +60 °C / 68 140 °F
Storage temperature	-20 +60 °C / 68 140 °F
Relative humidity	5 95 %
Ingress protection	IP 68 / NEMA 6

# Process

Process temperature	0 +50 °C / 32 122 °F
Process pressure	max. 6 bar / 87 psi
Flow	no minimum flow required Make sure that there is a sufficient turbulence for solids with a tendency to sedimentation.



# Mechanical construction

## Design, dimensions

TurbiMax W CUS 65: Dimensions of sensor versions (versions see Ordering Information)







Materials in contact with medium

Sensor Optical windows

O-rings

Stainless steel 1.4404 (AISI 316L) CUS 65-A, -C, -E: Epoxy resin CUS 65-B, -D: Polyoxymethylene (POM) Viton® Product structure

TurbiMax W CUS 65

#### Measuring range / Application 0 ... 12 g/l (ppm): Activated sludge, centrate А В 0 ... 40 g/l (ppm): Return sludge С 0 ... 50 g/l (ppm): Primary sludge, digested sludge D 1 ... 1000 FNU: Wastewater effluent, service water, condensate, boiler feedwater E 10 ... 150 g/l (ppm): Centrifuge inlet, press inlet Certificates 1 Factory calibration certificate **Process connection** Process connection G1 + NPT 3/4 thread А Special version acc. to customer specification Υ **Connecting cable** Connecting cable 7m / 23.0 ft, SXP plug 1 2 Connecting cable 15m / 49.2 ft, SXP plug 3 Connecting cable 1m / 3.3 ft + extension cable 10m / 32.8 ft, both with SXP plug Seal Viton А Y Special version acc. to customer specification CUS 65complete order code

# **Ordering information**

# Scope of delivery

# Scope of deliveryThe scope of delivery comprises:• 1 CUS 65 sensor, cable length depending on version• 1 extension cable (only version CUS 65-xxx3)

- 1 Quality Certificate
- 1 Technical Information TI 370C/07/en

# Accessories

## **Immersion pipes**

## Immersion pipe CYY 105

Immersion pipe for sensor immersion in basins. Material: stainless steel 1.4404 (AISI 316L) (pipe), stainless steel 1.4571 (AISI 316Ti) (fitting).

	Ve	rsion
	А	Length 2.0m / 6.6 ft, straight (CUS 65-B, -C, -E)
	В	Length 3.5m / 11.5 ft, straight (CUS 65-B, -C, -E)
	С	Length 2.0m / 6.6 ft, 45° angle (CUS 65-A)
	D	Length 3.5m / 11.5 ft, 45° angle (CUS 65-A)
	Е	Length 2.0m / 6.6 ft, 90° angle (CUS 65-D)
	F	Length 3.5m / 11.5 ft, 90° angle (CUS 65-D)
1 1		





Immersion pipe CYY 105: straight, 45° angle, 90° angle The arrows show the flow direction.

## Attachment

## Wall attachment for immersion pipes

Wall attachment for immersion pipe attachment to basins or channels. Material: stainless steel 1.4301 (AISI 304) Order No.: 51503581

#### Counter plate

□ Counter plate to fix the immersion pipe attachment. Material: stainless steel 1.4301 (AISI 304). Order No.: 51512992





Wall attachment

Counter plate

Measuring and monitoring	<ul> <li>Transmitter</li> <li>CUM 740         Transmitter for turbidity and solids content measurement see Technical Information     </li> </ul>		
Assemblies	Installation assembly CleanFit CUA 451 Retractable assembly with ball valve for pipe installation Material: stainless steel 1.4404 (AISI 316L) see Technical Information		
Connection accessories	Extension cable		
	Extension cable length 10m / 32.8 ft, shielded, with SXP plug and SXK coupling. Ingress protection IP 67. Order No.: 51503633		
	Plugs		
	<ul> <li>SXP plug, 7-pole</li> <li>Order No.: 51504027</li> <li>SXK coupling, 7-pole</li> <li>Order No.: 51504025</li> </ul>		
	Junction box		
	<ul> <li>Junction box for extension of cable connection between sensor and instrument. Sensor cable input SXB socket, cable output Pg 11 cable gland. Material: Makrolon<sup>®</sup>. Ingress protection IP 67.</li> <li>Order No.: 51503632</li> </ul>		

# Supplementary documentation

CUM 740, Technical Information TI 232C/07/en; Order No. 51504297

CleanFit CUA 451, Technical Information TI 396C/07/en; Order No. 51512836

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