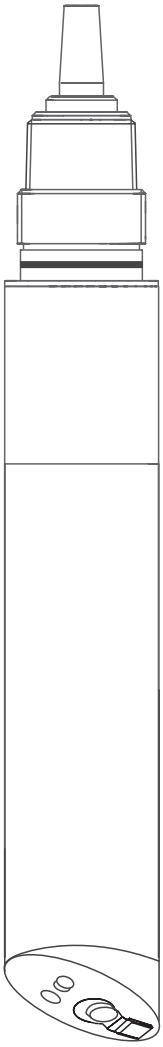
Operating Instructions

OUS31

Turbidity sensor



BA176e/00//01.02

Table of contents

1 Safety instructions

1.1 Designated use

OUS31 is a sensor for nephelometric turbidity measurement in water and wastewater.

The sensor is designed for the following applications:
- All phases of drinking water processing
- Coagulation and flocculation
- Filter rupture monitoring
- Filter backwash
- Control of clear rinsing cycles
- Monitoring of phase separation processes
- Boiler feedwater
- Monitoring of cooling water
- Monitoring of surface waters
- Outlet monitoring of sewage treatment plants
- Monitoring of industrial water discharge
- Recycling of industrial water

Any other use than the one described here compromises the safety of persons and the entire measuring system and is, therefore, not permitted.

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

1.2 Installation, commissioning and operation

Please note the following items:
- Installation, electrical connection, commissioning, operation and maintenance of the measuring system must only be carried out by trained technical personnel.
  The technical personnel must be authorised for the specified activities by the system operator.
- Technical personnel must have read and understood theses Operating Instructions and must adhere to them.
- Before commissioning the entire measuring point, check all the connections for correctness. Ensure that electrical cables and hose connections are not damaged.
- Do not operate damaged products and secure them against unintentional commissioning.
- Measuring point faults may only be rectified by authorised and specially trained personnel.
- If faults can not be rectified, the products must be taken out of service and secured against unintentional commissioning.
- Repairs not described in these Operating Instructions may only be carried out at the manufacturer’s service organisation.

1.3 Operational safety

The sensor has been designed and tested according to the state of the art and left the factory in perfect functioning order.
Relevent regulations and European standards have been met.

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

1.4 Return

If the sensor has to be repaired, please return it *cleaned* to the sales centre responsible. Please use the original packaging, if possible.

Please enclose the completed Dangerous Goods sheet (copy the second last page of these Operating instructions) with the packaging and also the shipping documents.

1.5 Notes on safety conventions and icons

Warning!
This symbol alerts you to hazards which could cause serious injuries as well as damage to the instrument if ignored.

Caution!
This symbol alerts you to possible faults which could arise from incorrect operation. They could cause damage to the instrument if ignored.

Note!
This symbol indicates important items of information.

2 Identification

2.1 Product structure

	Sensor
A	Sensor in standard version
W	Sensor with integrated wiper

		Cable length
2		Connecting cable 7 m
4		Connecting cable 15 m
9		Connecting cable to customer's specifications

			Assembly
A			Without assembly
E			Assembly for bubble-free media
S			Assembly with integrated gas bubble elimination

OUS31-				Complete order code

2.2 Scope of delivery

The scope of delivery comprises:
- OUS31-xxA
  – 1 OUS31 turbidity sensor, factory-calibrated
- OUS31-xxE
  – 1 OUS31 turbidity sensor, installed and factory-calibrated in assembly E
  – Flow assembly for bubble-free media
  – Fixing bracket
- OUS31-xxS
  – 1 OUS31 turbidity sensor, installed and factory-calibrated in assembly S
  – Flow assembly with gas bubble trap
  – Fixing bracket
- Operating Instructions BA176e00

If you have any questions, please contact your supplier or your sales centre responsible (see back page of these Operating Instructions).

3 Installation

3.1 Incoming acceptance, transport, storage

- Make sure the packaging is undamaged!
  Inform the deliverer about damage to the packaging.
  Keep the damaged packaging until the matter has been settled.
- Make sure the contents are undamaged!
  Inform the deliverer about damage to the delivery contents.
  Keep the damaged products until the matter has been settled.
- Check that the scope of delivery is complete and agrees with your order and the shipping documents.
- The packaging material used to store or to transport the product must provide shock protection and humidity protection. The original packaging offers the best protection. Also, keep to the approved ambient conditions (see "Technical data").
- If you have any questions, please contact your supplier or your sales centre responsible, (see the back page of these Operating Instructions).

3.2 Measuring system

A measuring system consists of:

- OUS31 turbidity sensor in an assembly
- Transmitter, e.g. OUM223/253

Optional:

- OYH101 universal suspended assembly holder for immersion operation
- OYA611 immersion assembly or OUA250 flow assembly or OUA461 retractable assembly
- VBM or RM junction box
- Chemoclean automatic spray cleaning system

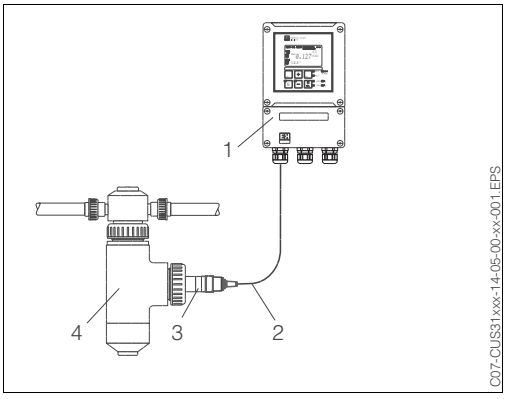


Fig. 1: Flow measurement

1 Transmitter, e.g. OUM223/253
2 Sensor cable
3 OUS31
4 Flow assembly S (see Page 10)

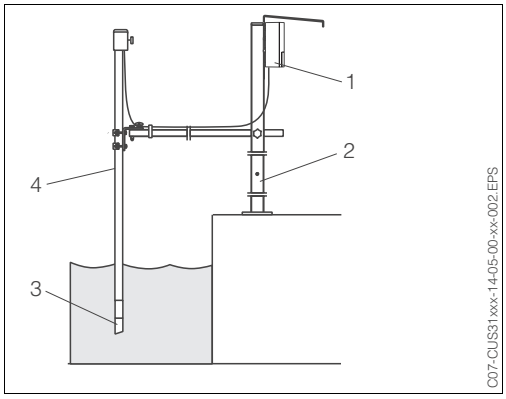


Fig. 2: Measuring system with immersion assembly

1 Transmitter, e.g. OUM253
2 OYH101 assembly holder (with OYY101 weather protection cover)
3 OUS31
4 OYA611 immersion assembly

3.3 Installation conditions

3.3.1 Dimensions

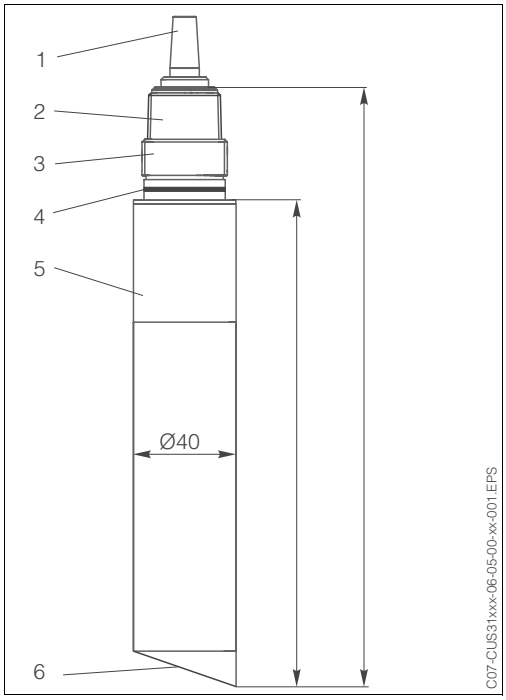


Fig. 3: OUS31 dimensions

1 Fixed cable
2 NPT ¾" - thread
3 G1 - thread
4 O-ring
5 Sensor shaft
6 Sensor carrier plate

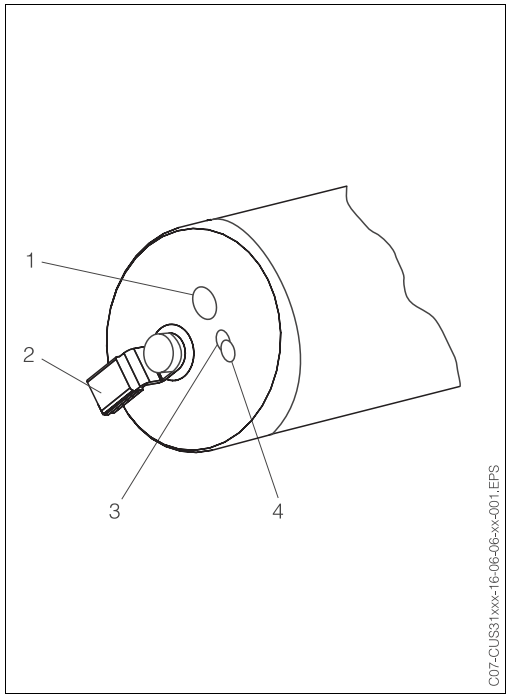


Fig. 4: Sensor head detailed view

1 Photodiode (receiver)
2 Wiper (optional)
3 Photodiode (receiver)
4 LED (IR transmitter)

3.3.2 Installation examples

Installation in immersion assemblies

When installing the OUS31 in immersion assemblies, such as OYA611 with pendulum frame, please ensure that a sufficient wall distance is observed during operation. For this reason, select an installation location in which **a minimum wall distance of 15 cm** is observed even with varying levels or altered flow profiles. Mounting in a suspended assembly with chain must therefore be avoided.
The sensor must immerse at least 4 cm into the medium.

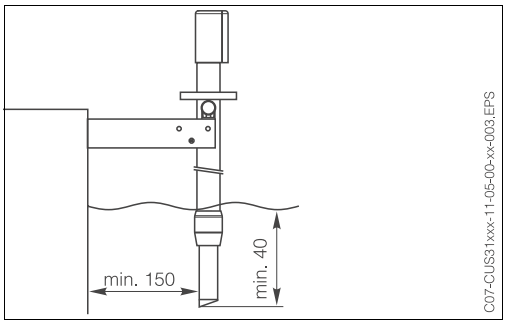


Fig. 5: Minimum distance when installing in -OYA 611 with pendulum frame

Pipe installation

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

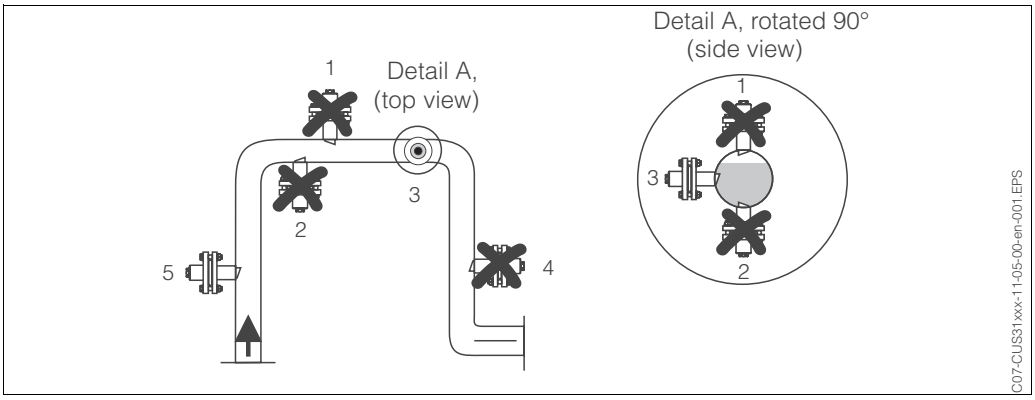


Fig. 6: Orientation and installation positions of OUS31 with OUA120-A/B adapter or with OUA461 retractable assembly

- The pipeline diameter must be at least DN 100 if reflective materials (e.g. stainless steel) are used.
- Install the sensor in places with uniform flow conditions and not in places where air may collect or foam bubbles form (→ Fig. 6, it. 1) or where suspended particles may settle (it. 2).
- The best installation location is in the ascending pipe (it. 5). Installation is also possible in the horizontal pipe (it. 3), but should be avoided in the down pipe (it. 4).
- Orientate the sensor surface against the medium flow (self-cleaning effect).

Wall distance

Installing the sensor in pipework or very close to the wall can cause backscatter which results in a higher sensor signal (→ Fig. 7).
The effective wall or bottom distance can be optimised by aligning the flat sensor side.

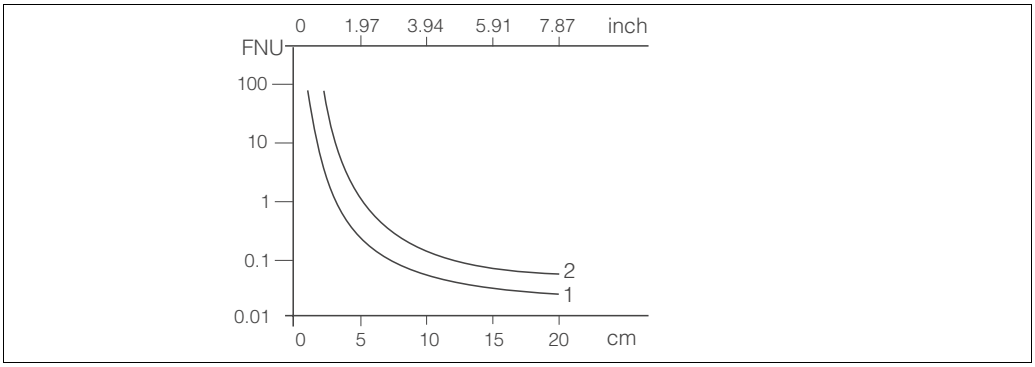


Fig. 7: Effect of the distance from the wall or bottom

Note!
The following generally applies:
The lower the turbidity to be measured, the darker the vessel walls should be and the greater the wall distance should also be.
When measuring in drinking water, the wall distance to **a dark wall must be at least 8 cm**.
Bright pipes are not suitable for the drinking water sector.

Installation in flow assemblies

- Install the flow assembly as vertical as possible so that the medium flows to the sensor from below. Alternatively, the assembly can also be installed horizontally.
- Two sensor orientations are possible for every installation (→ Fig. 8, Abb. 9):
  – parallel to the medium flow
  – against the medium flow
- Orientation *parallel* to the medium flow is required when using the OUR 3 spray head.
- Orientation *against* the medium flow is used to increase the self-cleaning effect in heavily-soiled media (> 15 FNU). The wall reflection is negligible here due to the high absorption tendency.

For turbidities < 5 FNU, use the sensor versions OUS31-xxE or OUS31-xxS.

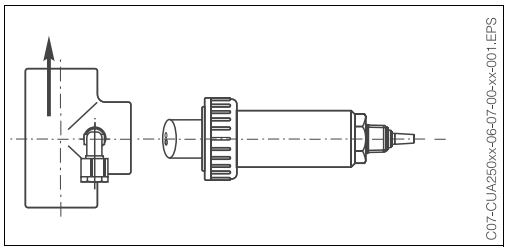


Fig. 8: Parallel sensor orientation
↑ *Medium flow direction*

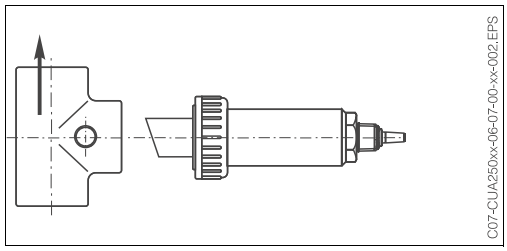


Fig. 9: Sensor orientation against the medium flow

Use in the drinking water sector with special calibration

When the OUS31 sensor is ordered with assembly E or S, the sensor is **individually calibrated** in the factory with the assembly ordered.
Therefore, no initial calibration on site is necessary.

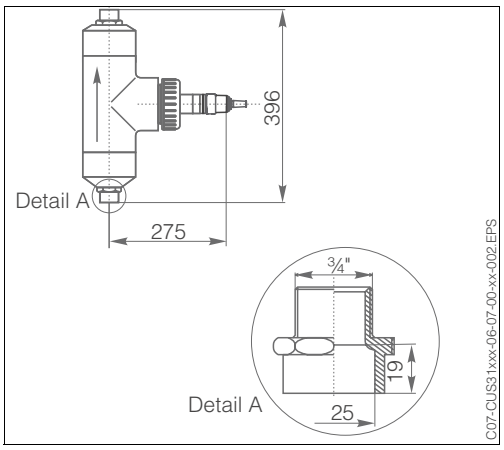


Fig. 10: Flow assembly E

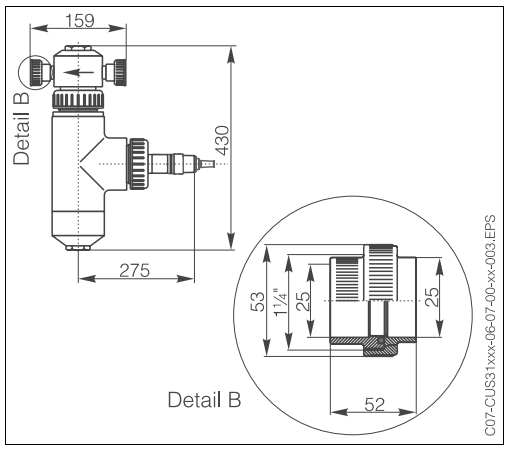


Fig. 11: Flow assembly S

- When installing **assembly E**, the in-flow and out-flow is vertical (flow direction from bottom to top, → Fig. 10), and horizontal (→ Fig. 11) when installing **assembly S**.
- The inlet and outlet pipes (nominal diameter DN 20) are each to be glued into the PVC adhesive threaded joints. A wall support can be mounted if necessary.
- The minimum flow for assembly S is 50 l/h.

Recommended installation with assembly E or S

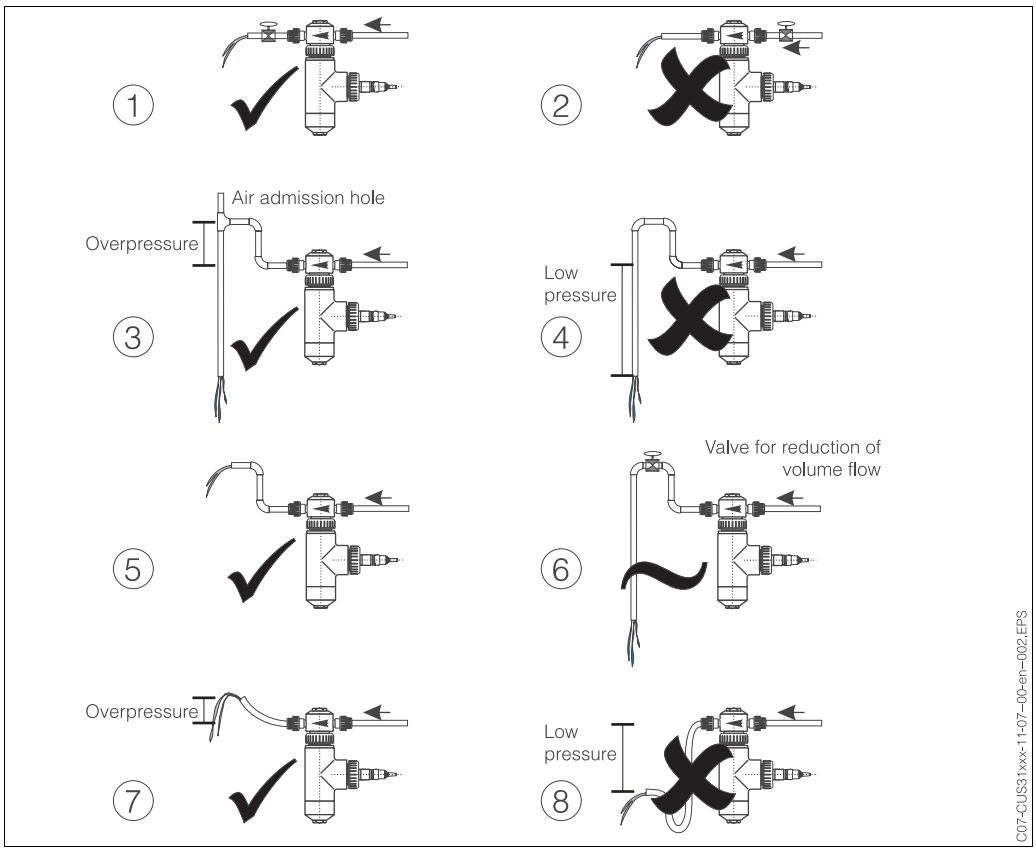


Fig. 12: Permissible and impermissible sensor installation positions in flow assembly E or S

Caution!
When installing the sensor in conjunction with the flow assembly (OUS31-xxE or OUS31-xxS) in pipes and plants, please pay special attention to the permissible and impermissible installation positions illustrated in Fig. Abb. 12.

1. Correct
   Pressure reduction after measurement. Premature degassing is avoided; the gas in the water remains dissolved.
2. Incorrect
   Pressure reduction before measurement. The pressure reduction creates favourable conditions for gas bubble formation at the measuring place.
3. Correct
   Outlet (assembly) raised. Gas cannot collect in the upper section of the assembly. The outlet pipe is vented at the highest point. A slight overpressure forms in the assembly as a result of the height difference of the raised outlet.
4. Incorrect
   Outlet raised but not vented. A low pressure forms in the assembly if venting via the downcomer outlet pipe does not take place due to too small a cross-section.
5. Correct
   Standard application in event of little initial pressure. Slight overpressure due to raised outlet level, no gas collecting in the upper section of the assembly.

6. Limited application:
   The valve reduces the volume flow. The outlet line may not be too thin or too long as otherwise a low pressure forms in the assembly.
   A vent for the drain line must be present. The outlet must be completely opened at regular intervals as otherwise the raising of the outlet level would not make any sense.

   ☝ Caution!
   If using a tube as the drain line, avoid formation of siphon draw (low points in the tube)! Otherwise venting does not take place.

7. Correct
   Tube as outlet line. Must be raised!

8. Incorrect
   Tube not raised. A low pressure forms in the assembly which favours gas bubble formation. In addition, low points in the tube result in siphon draw and thereby prevent venting. This results in pressure changes in the assembly.

3.4 Installation instructions

Proceed as follows for complete installation of a measuring point:

1. Install the retractable or flow assembly (if used) into the process.
2. Connect the water to the rinsing nozzles (if using assembly with cleaning).
3. Install and connect the turbidity sensor.
4. Install the suspended or immersion assembly (if used) into the process.

⚠ Warning!
Please follow national grounding regulations when using metal assemblies and installation devices.

☝ Caution!
- The sensor must be installed in an immersion assembly (e.g. OYA 611) for immersion operation. Do not install the sensor suspended freely from the cable.
- Screw the sensor into the assembly in such a way that the cable does not become twisted.
- Avoid large traction (e.g. by tugging) on the cable.
- Select a mounting location which can be easily accessed for later calibrations.
- When installing without an assembly, the sensor optics must be immersed **at least 4 cm** into the medium.

✎ Note!
Please pay special attention to the installation instructions in the Operating Instructions of the assembly used.

3.5 Post-installation check

Checks	Info
General: Optical windows free of film? Permissible orientation observed? Medium present?	Cleaning necessary in event of film formation. → Chap. 3.3.2, P. 8 Is the assembly or piping completely filled with medium?
Immersion assembly: Sensor installed in immersion assembly? Protection cap on immersion assembly?	Do not install the sensor suspended freely from the cable. Prevent moisture penetrating the assembly!
Flow assembly/retractable assembly: Sensor installed in flow or retractable assembly?	Ensure the sensor is aligned correctly to the flow direction!
Sensors with wiper	→ Chap. 6.3, P. 18

4 Wiring

4.1 Connecting to the transmitter

The OUS31 sensor is connected to the transmitter by means of a multi-core, screened measuring cable (fixed cable at the sensor, OYK 8).
To extend the measuring cable, a VBM or RM junction box and a OYK 81 extension cable must be used.

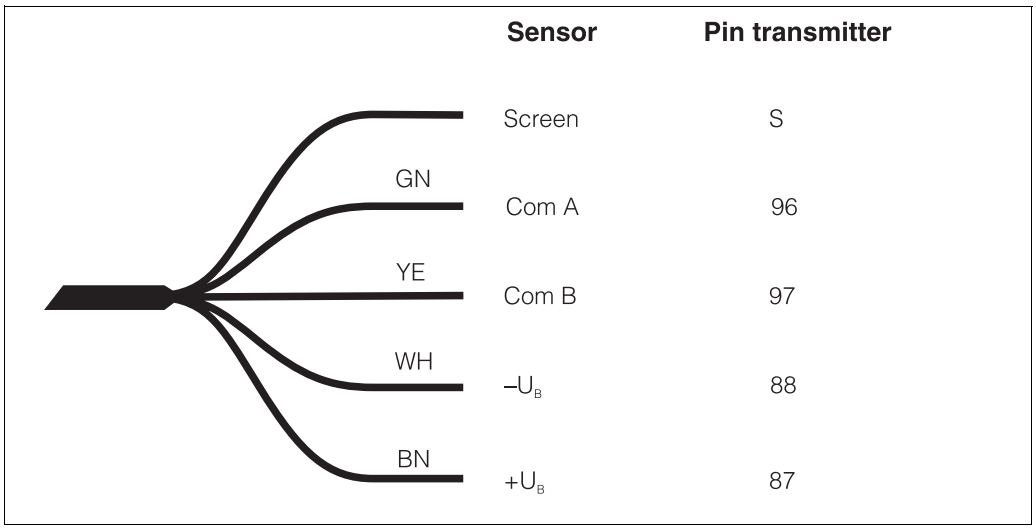


Abb. 13: Measuring cable OYK 8 (fixed cable) or OYK 81 (extension cable)

Note!
Please pay special attention to the instructions on sensor connection in the Operating Instructions of the transmitter.

4.2 Post-connection check

After the electrical connection of the sensor, carry out the following checks:

Checks	Info
Sensor, assembly, junction box or cable undamaged?	Visual inspection, replace if necessary
Does the supply voltage of the transmitter match the specifications on the nameplate?	230 V / 115 V / 100 V AC 24 V AC / DC
Are the mounted cables strain-relieved and not twisted?	
Is the cable type route completely isolated?	Power cable / weak current cable
Are the power supply and signal cables correctly connected to the transmitter?	Use OUM2x3 wiring diagram
Are all the screw terminals securely tightened?	
Are all the cable entries mounted, tightened and sealed?	
Are all the cable entries mounted downwards or laterally?	If lateral: Cable circuits hanging down so that water drips off.

5 Commissioning

Note!
Please pay special attention to the instructions on commissioning and operation in the Operating Instructions of the transmitter.

5.1 Function check

Prior to initial commissioning, ensure the following:
- The sensor has been installed correctly, (post-installation checks, → Page 13)
- The electrical connection is correct, (post-connection check, → Page 14)

When using an assembly with automatic cleaning, make sure the water is connected correctly to the rinse connection of the assembly.

Warning!
Danger of medium leaking
Prior to subjecting an assembly with a cleaning unit to pressure, please ensure that the unit is connected correctly! Otherwise the assembly may not be brought into the process!

5.2 Calibration

Each sensor is calibrated in the factory according to standard procedures (ISO 7027 / EN 27027). The wavelength of 880 nm is in the near-infrared range.
The sensor zero point adjustment relates to almost particle-free water (< 0.2 µm).
The calibration data are saved internally in the sensor as data record 1 and are also documented at the factory by means of the serial number (data cannot be modified).
You can operate the sensor in the “formazine” transmitter operating mode using the factory calibration. The calibration data are automatically taken over by the transmitter once the sensor is connected to the OUM2x3 transmitter and power-up takes place. The measuring point is immediately operational.
You can save some calibration data as data record 2 or 3 (data changeable) without losing the factory calibration in data record 1.

Note!
- Please pay special attention to the instructions in → Chap. 3.3.2 on wall distance. An installation adjustment, (see Operating Instructions BA200e00 for OUM2x3), may have to be performed.
- **For drinking water applications, versions OUS31-xxE or OUS31-xxS:** The sensor is already installed in the assembly and is calibrated with the assembly. Recalibration at a later stage is always performed in conjunction with the assembly.

5.3 Setting the wiper

Note!
Only for versions OUS31-Wxx!

You can set the wiping duration and the wiping intervals via the transmitter, (see OUM2x3 Operating Instructions).
The factory setting specifies a wiping time of 30 seconds and an interval of 120 minutes. These settings are optimum for drinking water applications with little gas-bubble formation. This prevents film formation from the build-up of lime, metal oxides etc. and biological growth. The interval time must be reduced to 20 or 30 minutes for more heavily-soiled media (higher levels of lime, oxide and biological growth). The wiping time can be reduced to 20 seconds. Rapidly-forming gas bubbles which distort the measurements can occur in some applications. In such instances, set the interval time to 3 to 5 minutes and the wiping time to 5 seconds. The gas bubbles can be removed by turning the wiper.

Caution!
Never move the wiper manually!

6 Maintenance

You must carry out maintenance tasks at regular intervals. For this, specify the maintenance times in an operations logbook or operations calendar.

The following tasks must be carried out:
- Cleaning the sensor, (→ Chap. 6.1)
- Checking the measuring function, (→ Chap. 6.2)
- Checking the wiper, (only OUS31-Wxx, → Chap. 6.3)
- Annual replacement of the wiper seal, (OUS31-Wxx only)
- Recalibration, (→ Chap. 6.4)

6.1 Cleaning the sensor

Contamination of the sensor can impact the measurement up to the point that measurement no longer functions, e.g. by:
- Thick film build-up on the sensor optics
- Wiper clogging

The sensor must be cleaned regularly to ensure reliable measurement. The frequency and intensity of the cleaning depend on the medium.

The sensor must be cleaned:
- prior to every calibration
- if necessary, regularly during the operation
- prior to returning the sensor for repair.

Proceed as follows depending on the type of contamination:

Type of contamination	Cleaning measures
Lime deposits	Immerse the sensor in 1-5 % hydrochloric acid (a few minutes). Then rinse it with water.
Dirt particles on the optics	Mechanically clean the sensor head with water and a suitable brush or sponge.
Fibres on the wiper axis	Remove manually.

Note!
For automatic cleaning we recommend equipping the measuring point with a fully-automatic cleaning system, e.g. Chemoclean (→ Chap. 7, Accessories).

6.2 Checking the measuring function

1. Remove the sensor from the medium.
2. Clean and dry the sensor.
3. Check the slope using OUY22 check unit. A stable measured value must register.

Caution!
If measuring at air, a reliable measured value will not register, (due to undefined refractive conditions).

6.3 Checking the wiper

Note!
Only for versions OUS31-Wxx

Remove the sensor from the medium and carry out the following checks:

Visual inspection	• Is the wiper still present? • Is the cap on the screw still present? • Is the screw or wiper arm secure? • What is the condition of the wiper rubber? Replace missing or worn parts. If necessary, retighten the screw (holding the wiper arm in position). For sensors with lip seal: Visually inspect the seal. Replace a seal which may be worn!
Function checks	When voltage is applied, the wiper moves to the end position (at the side of the optical windows). The check can be carried out using the ''AUTO'' function in the operating menu of the OUM2x3 transmitter. First press “AUTO” and then keep the “REL” key pressed until the wiper function appears on the display. The wiper can be switched on or off using the [+] or [−] keys. The wiper should not turn 360 °, but should only go from end position to end position and back.

6.4 Recalibration

In the factory

Remove the sensor (versions OUS31-xxE/S including the assembly) and send it cleaned to your supplier or to your sales centre for recalibration, (Order No. 50081264). Please use the original packaging, if possible. Please enclose of a copy of the duly completed Dangerous Goods sheet (second-last page of these Operating Instructions) with the packaging and delivery documents.
Recalibration is carried out in the factory as per ISO 7027 / EN 27027 (traceable to formazine standard).

On-site

Note!
Please refer to the Operating Instructions of the OUM2x3 transmitter for detailed instructions!

You have the following options in the "Calibration" menu of the transmitter:
- One-point calibration
- Three-point calibration
- Installation adjustment
- Correction function
- Adjust calibration data

7 Accessories

7.1 Connection accessories

- VBM junction box
  for extension with OYK 81 special measuring cable
  Junction box for extending the measuring cable connection between sensor and transmitter; Order No. 50003987
- OYK 81 extension cable
  Unterminated special cable for extension between VBM junction box and transmitter; Order No. 50089633

7.2 Installation accessories

- OYH 101 universal suspended assembly holder
- OYA611 immersion assembly
- OUA250 flow assembly
- OUA461 retractable assembly
- OUR3 spray head for flow assemblies; order no. OUR 3-1
- OUR4 spray head for immersion assemblies; order no. OUR 4-A
- Welding rinse socket DN 65; order no. 51500912
- Welding socket DN 50 / PN 16; order no. 55001306

7.3 Other accessories

- OUY31 service kit
  3 spare wiper arms; Order No. 50089252
- OUY22
  Check unit for OUS31 for checking the sensor; Order No. 51504477
- OUS31 recalibration
  Calibration as per ISO 7027 / EN 27027; Order No. 50081264
- RM shunt resistance; Order No. 51500836
- RM junction box ; Order No. 51500832
- RM sensor holder; Order No. 51500734

7.4 Measurement and monitoring

- OUM223/253
  Transmitter for turbidity measurement
  Technical Information TI 200e00

8 Trouble-shooting

8.1 Trouble-shooting instructions

Problem	Check	Remedy
No display, no sensor reaction	Line voltage at transmitter? Sensor connected correctly? Medium flow present? Film formation on optical windows?	Apply line voltage. Connect correctly. Produce flow. Clean sensor.
Reading too high	Film formation on optical windows? Gas bubbles present? Sensor calibrated? Check data record. Check with check unit.	Clean. Remove gas bubbles. Calibrate. Change, if necessary. Check in factory.
Reading too low	Film formation on optical windows? Gas bubbles present? Sensor calibrated? Check data record. Check with check unit.	Clean. Remove gas bubbles. Calibrate. Change, if necessary. Check in factory.
Reading greatly fluctuating	Gas bubbles present? Check mounting location.	Remove gas bubbles. Select other mounting location.
Measured value jump to 9999 FNU	Gas bubble formation on the optical windows?	Change orientation. Adjust wiper interval. Increase gas bubble factor in OUM2x3 menu.
Error 8	Water in sensor? Cable breakage? Incorrect cable connection?	Send sensor to service. Check cable. Check wiring.
Wiper does not find end position	Visual inspection Initial position not in end position.	Send sensor to service.

Note!
Please pay special attention to the instructions on handling errors in the Operating Instructions of the transmitter. Check the transmitter, if necessary.

8.2 Checking the sensor

Caution!
The sensor may only be checked by authorised and specially trained personnel.
You also require a voltmeter.

Check	Measure	Set point
Voltage check	Check supply voltage at transmitter, (sensor connected)	– 8.5 V between terminals 87 and 0 + 8.5 V between terminals 88 and 0
Slope check	Check slope using OUY22 check unit	Stable measured value (approx. 2 FNU)
Zero point check	Produce zero water by filtration (0.2 µm)	< 0.1 FNU

Note!
If the values deviate from the set points, carry out trouble-shooting as per the trouble-shooting instructions (s. 8.1) or contact your sales centre.

9 Technical data

9.1 Input

Measuring principle	Nephelometric as per ISO 7027 / EN 27027
Measured variable	Turbidity
Wavelength	880 nm
Measuring range	0.000 ... 9999 FNU 0.00 ... 3000 ppm 0.0 ... 3.0 g/l 0.0 ... 200 %
Factory calibration	Traceable to formazine standard and SiO_2

9.2 Electrical connection

Cable type	Four-core. Screened fixed cable (2x2 cores twisted) with free cable ends, TPEO, temperature range –40 ... 130 °C
Cable length	Max. 200 m

9.3 Performance characteristics

Maximum measured error	< 5 % (min. 0.02 FNU) of the measured value (system measured error related to the primary formazine standard / tracing according to ISO 5725 and ISO 7027 / EN 27027)
Repeatability	< 1 % (min. 0.01 FNU) of the measured value

9.4 Environment

Storage temperature	– 20 ... 60 °C
Ingress protection	IP 68

9.5 Process

Process temperature range	–5 ... 50 °C
Process pressure range (temperature-dependent)	1 (50 °C) ... 6 (25 °C) bar
Process connection	G1 and NPT ¾"

9.6 Mechanical construction

Design, dimensions	→ Chap. 3, Page 7 ff.	
Material	Sensor carrier plate, shaft	PVC / PPS GF 40 (polyphenylene sulfide with 40% glass-fibre)
	Optical windows	Sapphire
	Flow assemblies E and S	PVC
	Cable	TPEO –40 ... 130 °C (elastomer on polyolefine base)
Temperature sensor	NTC-resistance 30K at 25 °C	
Wiper cleaning (optional)	Rubber wiper	

Index

Declaration of contamination

Dear customer,
Because of legal determinations and for the safety of our employees and operating equipment, we need this "Declaration of contamination" with your signature before your order can be handled. Please, include the completely filled in declaration with the device and the shipping documents in any case. Add also safety sheets and / or specific handling instructions if necessary.

Type of device / sensor:		Serial no.:			
Medium / concentration:		Temperature:		Pressure:	
Cleaned with:		Conductivity:		Viscosity:	

Warning hints for medium used (mark the appropriate hints)

☐	☐	☐	☐	☐	☐	☐	☐
radioactive	explosive	caustic	poisonous	harmful to health	biologically hazardous	inflammable	safe

Reason for return

Company data

Company:		Contact person:	
		Department:	
Address:		Phone:	
		Fax / e-mail:	
		Your order no.:	

I hereby certify that the returned equipment has been cleaned and decontaminated acc. to good industrial practices and is in compliance with all regulations. This equipment poses no health or safety risks due to contamination.

(Place, date)

(Company stamp and legally binding signature)

BA176e/00//01.02
Printed in Germany / FM+SGML 6.0 / DT