

- **Ultralow back scatter**
  - very accurate readings as only light scattering due to turbidity is measured.
- **Dry secondary standards supplied for zero and span verification**
  - accurate, repeatable, simple; eliminates the need for formazine solutions
- **Ultra-stable electronics**
  - practically no drift
  - infrequent calibration required
- **Auto-clean systems**
  - optimizes performance and reduces maintenance on low and high turbidity samples
- **On-line diagnostics**
  - provides assurance of performance of the auto-clean function
- **Flow and dip systems**
  - versatile design
  - satisfies a wide range of applications
- **Bubble rejection function**
  - compensation for erroneous readings due to degassing



Long-term, reliable performance  
turbidity systems with  
low cost of ownership

## 4670 Series Turbidity Systems

An ABB turbidity system comprises a 4670 wall-mounting, or 4675 panel-mounting, analyzer together with one of four sensor types designed to meet specific applications.

### Turbidity Sensors

The sensors are available in flow and dip versions and, where appropriate, are supplied with auto-cleaning to minimize maintenance to overcome optical fouling and optimize performance.

#### **Model 7997-202 (used on 4670/221 & 4675/221)**

A flow-through system, utilizing the 90 ° scattered light principle. It is designed specifically for monitoring final-treated potable water and filtered water where accurate results below 0.1 NTU are demanded. The unit operates over the range 0...30 NTU with a minimum operating range of 0...1 NTU.

High stability is the key to the virtual lifetime zero and the ultra-low backscatter permits the unit to be used with full confidence below 0.1 NTU.

#### **Model 7997-201 (used on 4670/211 & 4675/211)**

A flow-through system utilizing the 90 ° scattered light principle, designed to operate over the range 0...30 NTU with a minimum operating range of 0...1 NTU. It is the ideal solution for clean water applications. Auto-cleaning is a standard feature, together with on-line diagnostics.

#### **Model 7997-200 (used on 4670/201 & 4675/201)**

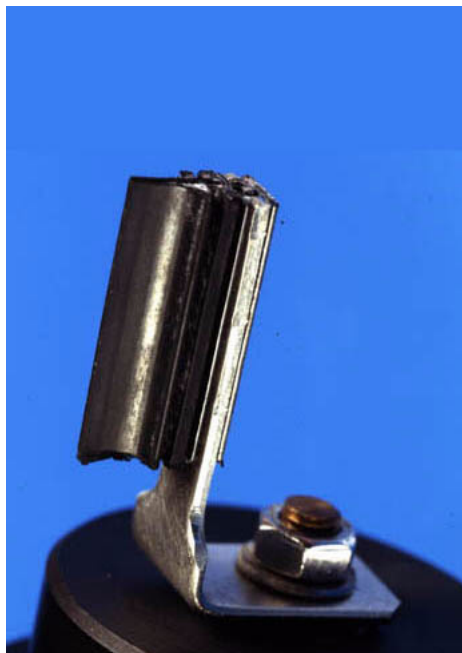
A flow-through system, utilizing the 90 ° scattered light principal, designed to operate over the range 0...250 NTU. It is ideal for monitoring raw water on potable water treatment plants.

Incorporates auto-cleaning as standard and, used with the 4670 or 4675 Analyzers, operates from 0...25 NTU; up to 250 NTU, by programming the 4600 Series to the required range.

#### **Model 7997-300 (used on 4670/301 & 4678/301)**

A flow-through system designed for high levels of turbidity and utilizes the absorption principal of measurement. It operates over the range of 0...500 FTU with a minimum range of 0...100 FTU.

This model incorporates auto-cleaning as standard and is used primarily for effluent discharge monitoring and on water intakes where the river water can become very turbid. It is also used extensively on Filter Backwash applications.



*Wiper Cleaning Module*

#### **7997-4XX Series**

Three dip versions are available. All three operate over the range of 0...2000FTU with an increased accuracy specification when used over the range of 0...1000FTU (the minimum range is 0...100FTU). These systems are completely unaffected by ambient light:

#### **7997/400 (used on 4670/401 & 4675/401)**

Dip stem length of 1 m (39.3 in.) Designed primarily for use in open channels and tanks.

#### **7997/401 (used on 4670/411 & 4675/411)**

Dip stem length of 2 m (78.7 in.) Designed primarily for use in open channels and tanks.

#### **7997/450 (used on 4670/450 & 4675/450)**

Flow-through system designed for water applications that have high turbidity values.

### **Dry Secondary Calibration Standard**

A key feature of the system is the dry secondary calibration standard, which simplifies routine calibration and virtually eliminates the need for chemical standards....a major safety factor.

This is available for all models, including the dip system, and provides a very convenient, repeatable and safe calibration technique.

### **Ease of Maintenance**

As with all analyzers, the key to success is the reliability of the sensing device coupled with simple maintenance procedures. The sensing systems are very easy to maintain and can be site-serviced without the need of a skilled technician.

### **Automatic Cleaning**

Automatic cleaning is an essential feature which overcomes the problem of optical fouling and ensures that performance is maintained for long periods (up to 6 months) without the need for manual intervention. This feature has proven invaluable even on apparently 'clean' water samples where small amounts of iron/ manganese can cause fouling problems.

### **Confidence in Service**

To complement the system's well proven design, unrivalled accuracy and reliability in service, the entire sensing loop is regularly self-monitored to ensure the light source is operating within specification, thereby eliminating the risk of electrical drift. In addition, the function of the wiper module is continuously validated by the processor, thereby assuring the correct performance of the cleaning function.

### **Ease of Calibration**

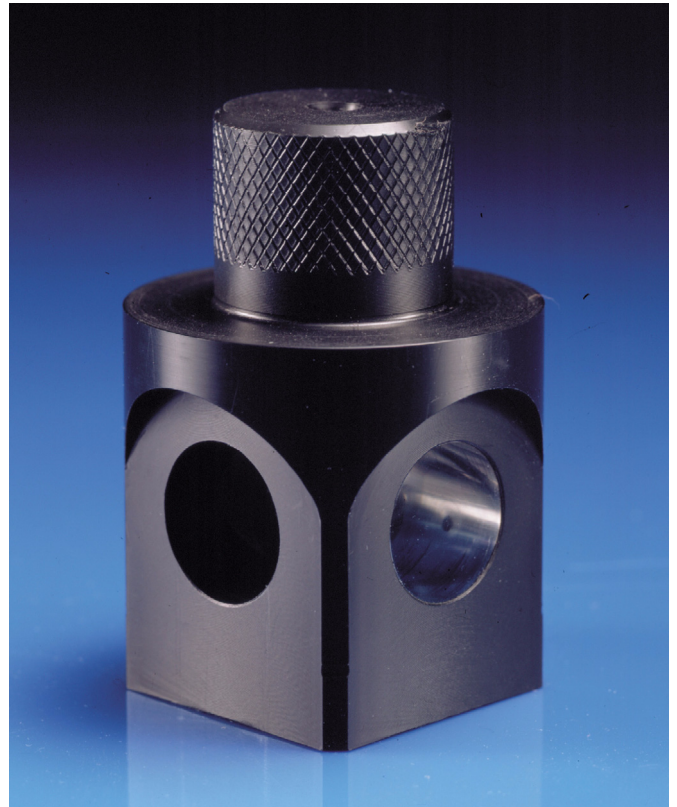
Calibration can be carried out using Formazine standard or by using the optional secondary calibration device, which can be ordered separately.

This enables both zero and span checks to be carried out.

### **Bubble Rejection**

Readings are often affected by short-term spikes, usually due to the effect of degassing. These occur even though the sample is passed through a debubbler.

The transmitter can be programmed for bubble rejection by taking several readings in short succession and rejecting any spurious high readings. An average is taken to give a steady result.



*Dry secondary calibration standard*

**Practical On-line Systems**

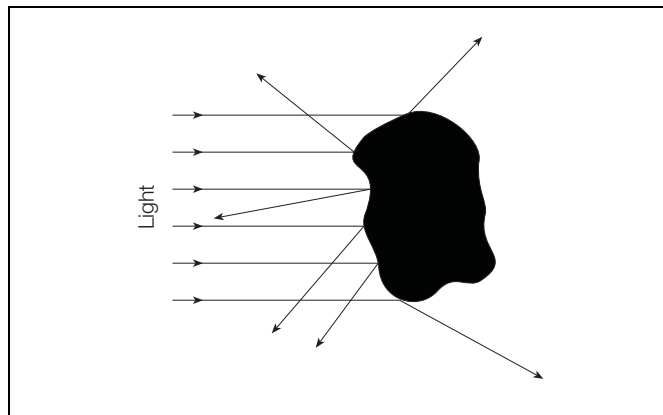
Turbidity sensors are roughly divided into two main types:

- a Nephelometers, which measure the proportion of light scattered at a specific angle, that is, 90 ° from the incident beam. For example, 4670/211 and 4670/201
- b Absorptiometers, which depend upon the measurement of the absorption (or attenuation) of a light beam passing through the sample. For example, 4670/300 and 4670/400.

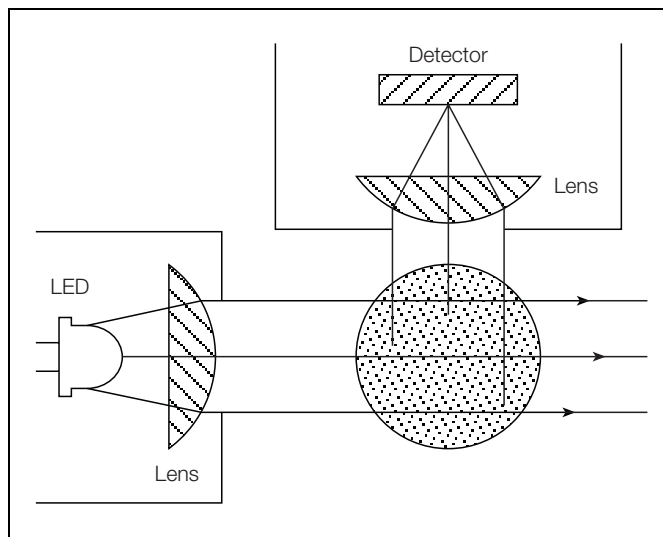
**Nephelometers**

This type of turbidity meter detects light scattered by the suspended particles in the sample.

The most widely used optical arrangement for scattered-light turbidity meters is the 90 ° Nephelometer design. This must not be confused with instruments that are based on forward or backwards light scatter. Nephelometers overcome many problems such as colour and lack of sensitivity.



*Light Scattered by Suspended Particles*



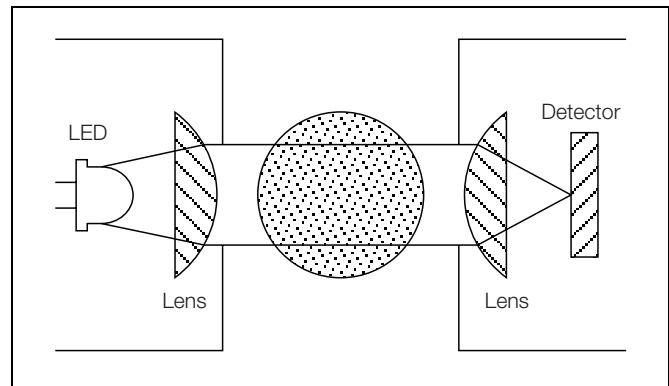
*Nephelometric Turbidity Monitor*

**Absorptiometers**

This is probably the most straightforward method of measuring turbidity. A light beam is transmitted through the sample, the intensities of which are measured by a photodetector in line with the light source.

The measurement of turbidity using Absorptiometers can be affected by the presence of dissolved colour. However, such effects are minimized by performing the measurement at a wavelength of 880 nm which is in the infrared region.

The system can also be insensitive because changes in turbidity at low levels only give a very small change in output from the detector which is difficult to resolve. At medium and high levels of turbidity this is usually not a problem, so this technique provides a reliable method for many applications.



*Absorption Turbidity Monitor*

## Applications of Turbidity Measurement

The majority of turbidity monitor installations in the water industry are in potable water treatment plants, although some turbidity measurements are carried out on sewage/waste water treatment plants.

Normally, the instruments used for sewage/waste water treatments plants are calibrated to find suspended solids, that is, mg/l rather than turbidity.

In potable water treatment there is an increasing requirement for turbidity measurement in raw water abstraction, through the water treatment process, and finally the treated water quality.

## Choice of System

The range of ABB turbidity systems include sensors based on both Absorption and Nephelometric techniques. The choice of a suitable system to use for a given application depends on the application itself and is generally dependent on two factors:

### ■ Measurement Range

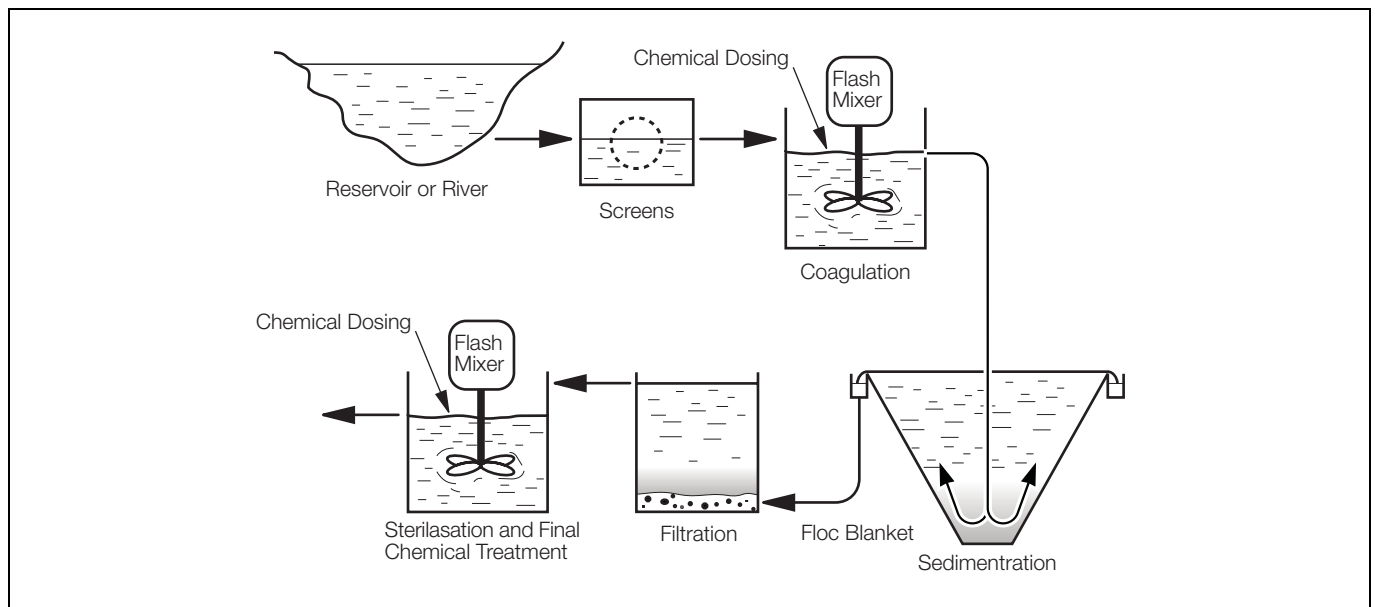
As a general guide turbidities below 100 would use a Nephelometric type sensor; above 100 an Absorption type sensor would be more appropriate.

### ■ Independent site laboratory method or standard

If the above criteria was strictly followed there could be a situation where the level of turbidity is low, such as 10 NTU, but an Absorption instrument is used in the independent laboratory or reference method. Conversely, a Nephelometric instrument in the laboratory could be used on samples at 200 NTU.

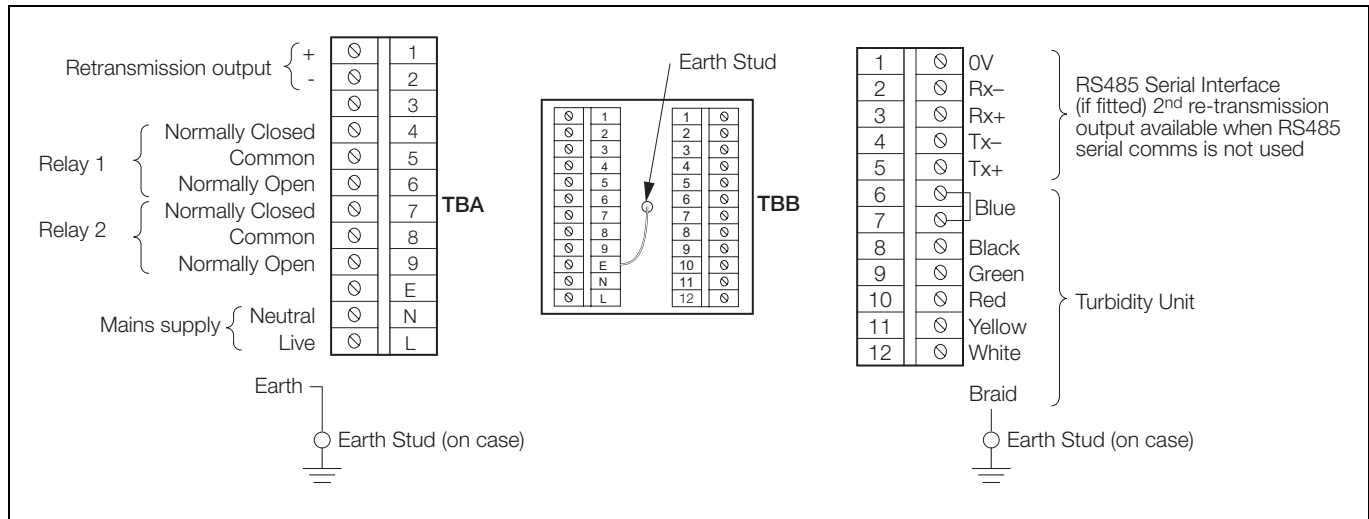
Both Absorptimeters and Nephelometers are calibrated against formazine suspensions. They will, therefore, give good agreement on different formazine values. It must be noted that the results provided by any two different turbidity methods, calibrated on formazine, generally differ when used on samples.

Exactly what happens to the light beam when it encounters a particle depends upon many parameters, such as the wavelength of the light source, particle size and shape and the refractive index of the particle.

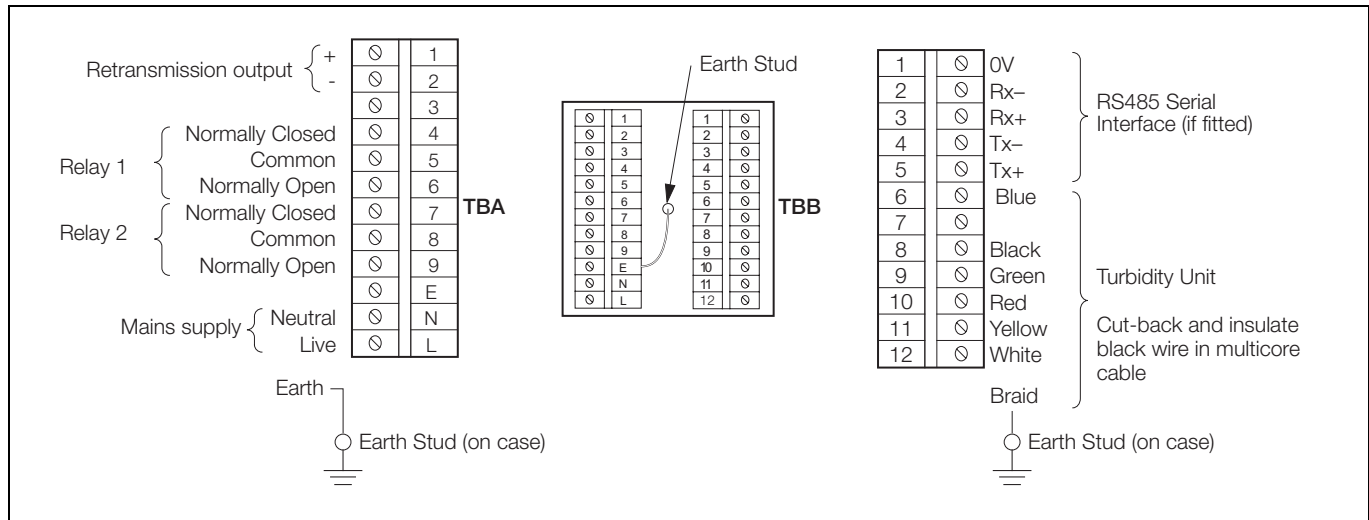


*Turbidity Measurement in Potable Water Treatment*

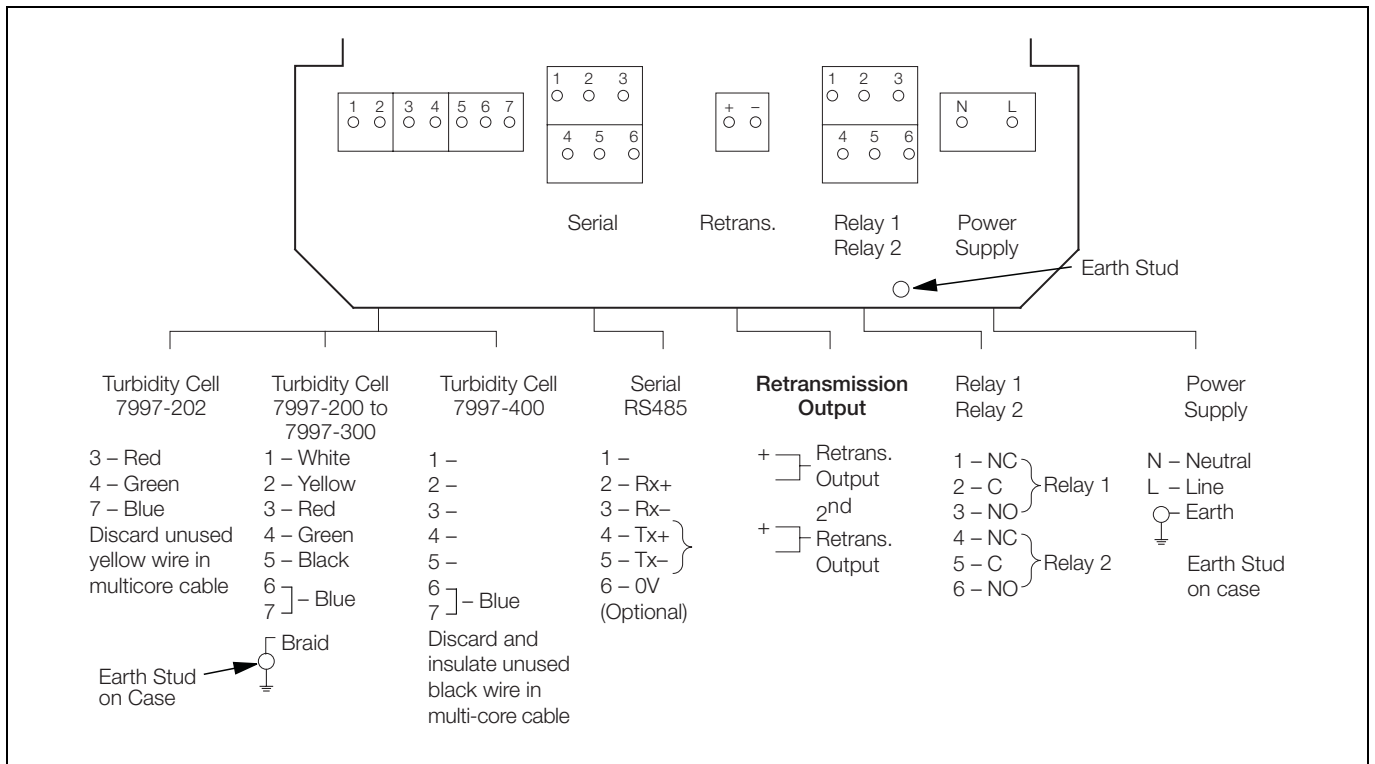
### Electrical Connections



4670 Panel-mount Version for use with 7997 200 Series and 300 Sensors



4675 Panel-mount Version for use with 7997 400 Series and 410 Sensors



4670/500 Wall-mounting Version for use with 7997-202, 7997 201 and 7997-200 series, 7997-300 and 7997-410 Sensors

Mounting	Terminal Number						
	Wall	**1	**2	**3	4	5	6
Panel	**12	**11	**10	9	8	7	6
	Cleaner initiate pulse	+12 V switched emitter supply	+12 V cleaner/receiver supply	Signal input	Cleaner* Detect signal		0 V common

\* Link  
(not on 7997-400/400 sensors)

\* Not used on 7997 400  
\*\* Not used on 7997 202

## Specification

### 7997-200 Turbidity Sensor

**Range**

Programmable 0...25 NTU to 0...250 NTU and 0...500 mg/l (or p.p.m.)

**Note.** The maximum range for suspended solids measurement is dependent upon the coefficient value of the sample.

**Measurement Principle**

90 ° scattered light measurement. Compliant to ISO7027

**Measurement Characteristic**

Linear based on Formazine

**Resolution**

0.1 NTU

**Repeatability**

Better than 1 % of span

**Accuracy**

±2 % of reading (limited by uncertainty in Formazine standards)

from 0...100 NTU

±5 % from 100...250 NTU

**Temperature drift**

0.005 NTU/10 °C (0.003 NTU/10 °F)

**Response time**

Varies with flow rate, typically 90 % step change in

2 minutes at 1 l/min-1.

**Flow rate**

0.5...1.5 l/min-1

**Integral wiper cleaning system**

Programmable operational frequency every 0.25 hour, 0.5 hour,

0.75 hour or multiples of 1 hour up to 24 hours

**Sample operating temperature**

0...50 °C (32...122 °F)

**Sample Pressure**

Up to 3 bar (43.5 psi)

### 7997-201 & 7997-202 Turbidity Sensors

**Range**

Programmable 0...1 NTU to 0...30 NTU

**Measurement Principle**

90 ° scattered light measurement. Compliant to ISO7027

**Measurement Characteristic**

Linear based on Formazine

**Resolution**

0.01 NTU

**Repeatability**

Better than 1 % of span

**Accuracy**

±2 % of reading (limited by uncertainty in Formazine standards)

**Temperature drift**

0.005 NTU/10 °C (0.003 NTU/10 °F)

**Response time**

Varies with flow rate, typically 90 % step change in less than 45 s at 1 l/min

**Flow rate**

0.5...1.5 l/min<sup>-1</sup>

**Integral wiper cleaning system (7997-201 only)**

Programmable operational frequency every 0.25 hour, 0.5 hour,

0.75 hour or in multiples of 1 hour up to 24 hours

**Sample operating temperature**

0...50 °C (32...122 °F)

**Sample pressure**

Up to 3 bar (43.5 psi)



**7997-300 Turbidity Sensor****Range**

Programmable 0...100 FTU to 0...500 FTU  
and 0...1000 mg/l (or ppm) (See Note.)

**Measurement Principle**

Transmitted light

**Measurement Characteristic**

Logarithmic based on Formazine

**Resolution**

1 FTU

**Repeatability**

Better than 1 % of span

**Accuracy**

$\pm 2$  % of FSD

(limited by uncertainty in Formazine standards)

**Temperature drift**

0.2 FTU/°C (0.1 FTU/°F)

**Response time**

Varies with flow rate, typically 90 % step change in  
2 minutes at 1 l/min<sup>-1</sup>

**Flow rate**

0.5...1.5 l/min<sup>-1</sup>

**Integral wiper cleaning system**

Programmable operational frequency every 0.25 hour, 0.5 hour,  
0.75 hour or in multiples of 1 hour up to 24 hours

**Sample operating temperature**

0...50 °C (32...122 °F)

**Pressure**

Up to 3 bar (43.5 psi)

**7997-400, 7997-401 Dip & 7997-405  
Flow Turbidity Sensors****Range**

Programmable 0...100 to 0...1000 FTU  
and 0...2000 mg/l (See Note.)

**Extended Range**

0...2000 FTU

**Measurement Principle**

Transmitted light

**Measurement Characteristic**

Logarithmic, based on Formazine

**Resolution**

1 FTU

**Repeatability**

Better than 1 % of span

**Accuracy (0 to 1000 FTU)**

$\pm 2$  % FSD

(limited by the uncertainty of Formazine)

**Accuracy (0 to 2000 FTU)**

Better than  $\pm 10$  % of span

**Temperature drift**

0.2 FTU/°C (0.1 FTU/°F)

**Flow rate (7997-405 only)**

0.5...2 l/min<sup>-1</sup>

**Integral wiper cleaning system**

Programmable operational frequency every 0.25 hour, 0.5 hour,  
0.75 hour or in multiples of 1 hour up to 24 hours

**Sample operating temperature**

0...50 °C (32...122 °F)

**Dip stem length**

7997-400 1 m (3.3 ft)

7997-401 2 m (6.6 ft)

**Pressure (7997-405 only)**

Up to 3 bar (43.5 psi)

**Note.** The maximum range for suspended solids measurement is dependent upon the coefficient value of the sample.

## 4670-5/500 Analyzer Models Display

### Measured value

5-digit x 7-segment backlit LCD

### Information

16-character, single line, dot matrix, backlit LCD

### Ranges

Used with 7997-202/201	0...1 to 0...30 NTU
Used with 7997-200	0...25 to 0...250 NTU
Used with 7997-300	0...100 to 0...500 FTU and 0...1000 mg/l
Used with 7997-400/401/405	0...100 to 0...1000* FTU and 0...2000 mg/l

\* 0...2000 FTU with reduced accuracy

### Units of measurement

NTU and FTU all models  
mg/l on models 7997-300 and 7997-400

### Accuracy

±0.2 % of reading, ±1 digit

### Linearity

±0.1 % FSD

### Auto-clean timing

Programmable 15 min, 30 min, 45 min or 1 hour up to  
24 hours in 1 hour increments

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## Environmental Data

### Operating temperature limits

-20...55 °C (-4...131 °F)

### Storage temperature limits

-25...55 °C (-13...131 °F)

### Operating humidity limits

Up to 95 % RH non-condensing

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## Power Supply

### Voltage requirements

100...130 V, 200...260 V, 50/60 Hz

### Power consumption

< 6 VA AC

### Error due to power supply variation

Less than 0.1 % for +6 % -20 % variation from nominal supply

### Insulation

Mains to earth (line to ground) 2 kV RMS

## Relay Outputs and Set Points

### No. of relays

Two

### Relay contacts

Single pole changeover  
Rating 250 V AC 250 V DC max.  
3 A AC, 3 A DC max.  
Loading (non-inductive) 750 VA 30 W max.  
(inductive) 750 VA 3 W max.

### Insulation

2 kV RMS contacts to earth (ground)

### No. of set points

Two

### Set point adjustment

Programmable

### Set point hysteresis

±1 % fixed

### Local set point annunciation

Red LED

---

## Retransmission

### No. of retransmission signals

One fully isolated programmable 0...10 mA, 0...20 mA or 4...20 mA  
Optional second current output

### Accuracy

±0.25 % FSD ±0.5 % reading

### Resolution

0.1 % at 10 A, 0.05 % at 20 mA

### Max. load resistance

750 Ω (20 A max.)

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## Mechanical Data

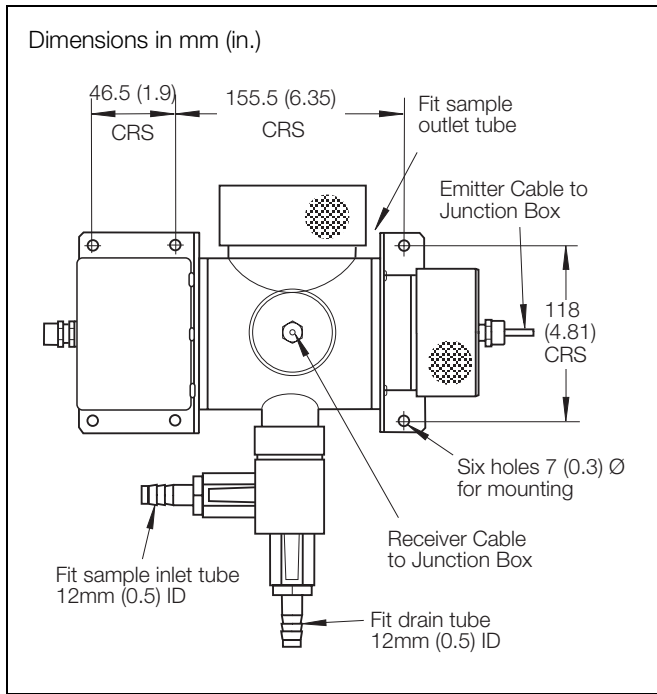
### Model 4670/500

Wall-mounting	
Protection	IP66/NEMA4X
Dimensions	160 mm (6.30 in.) wide x 214 mm (8.43 in.) high x 68 mm (2.68 in.) deep
Weight	2 kg (4½ lb)

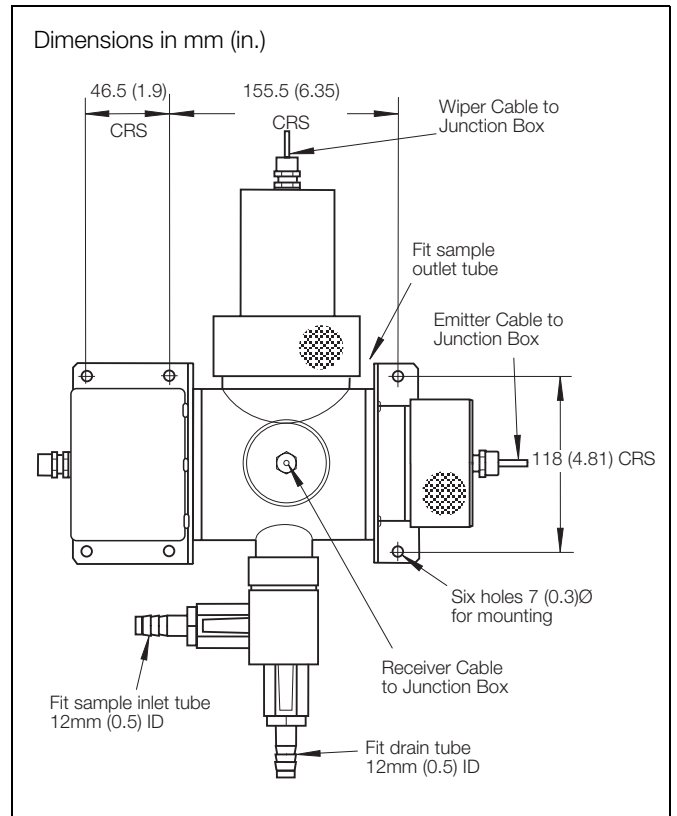
### Model 4675/500

Panel-mounting	(¼ DIN)
Protection	IP66/NEMA4X front
Dimensions	96 mm (3.78 in.) wide x 96 mm (3.78 in.) high x 191 mm (7.52 in.) deep
Weight	1.5 kg (3¼ lb)
Panel cut-out:	92 <sup>+0.8</sup> <sub>-0</sub> mm x 92 <sup>+0.8</sup> <sub>-0</sub> mm (3.62 <sup>+0.03</sup> <sub>-0</sub> in. x 3.62 <sup>+0.03</sup> <sub>-0</sub> in.)

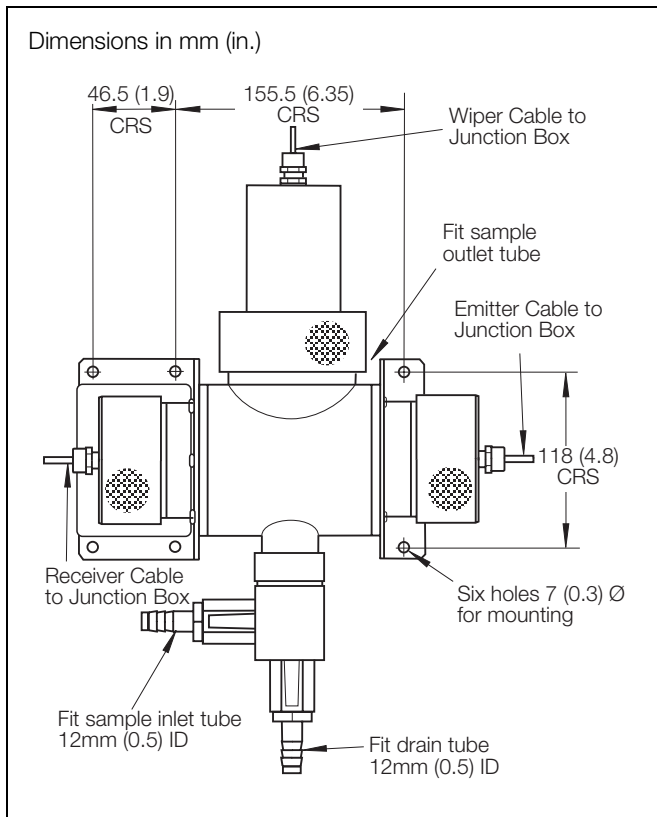
Overall Dimensions



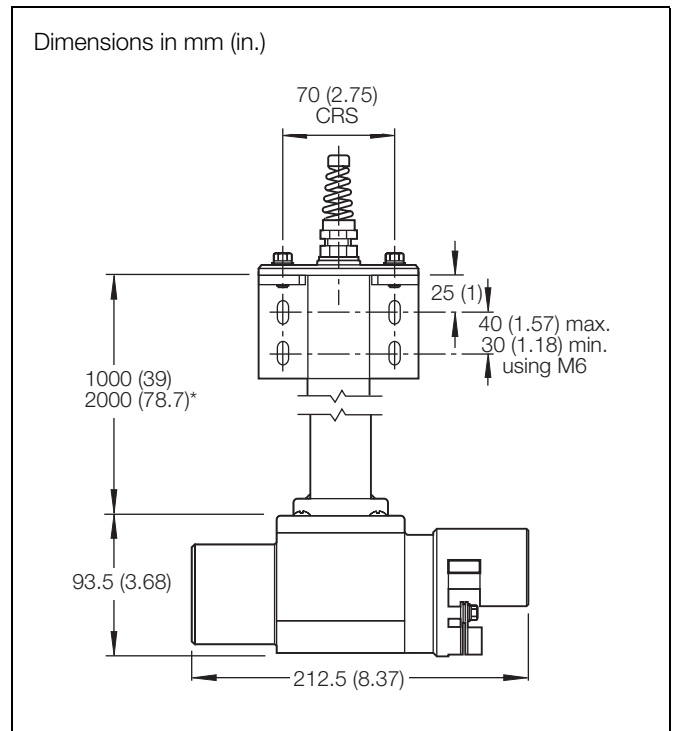
7997-202 Sensor



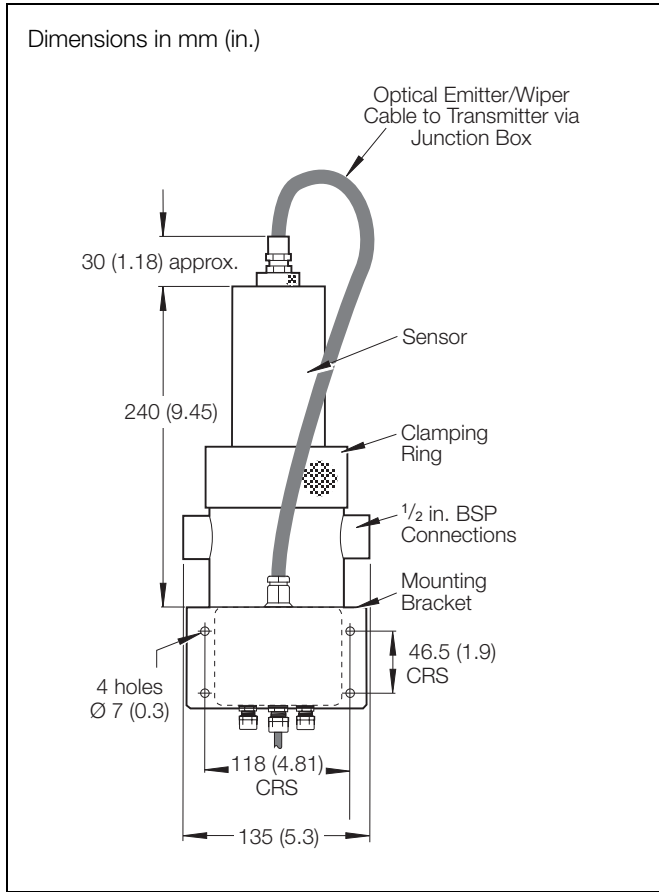
7997-200 & 7997-201 Sensors



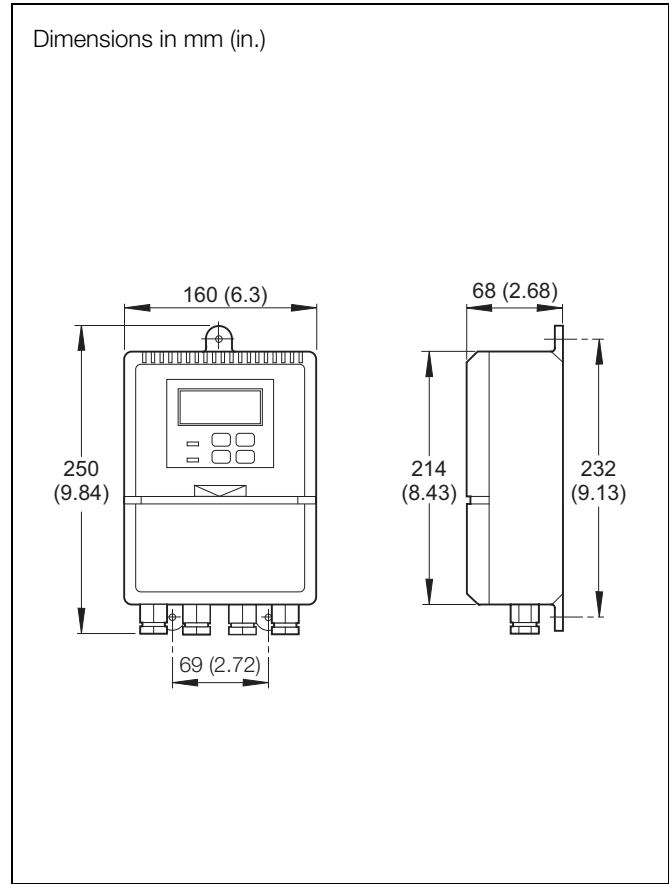
7997-300 Sensor



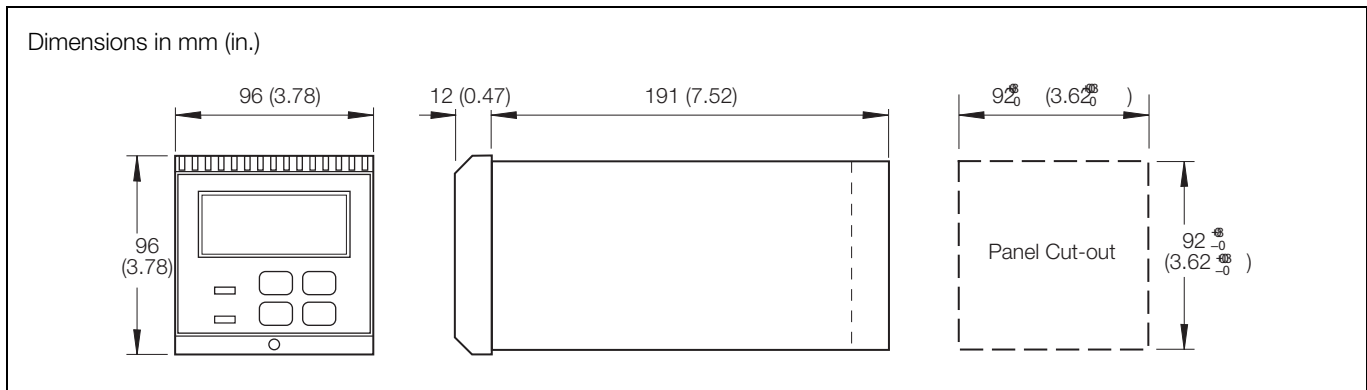
7997-400 & 7997-401 Sensors



7997-405 Sensor

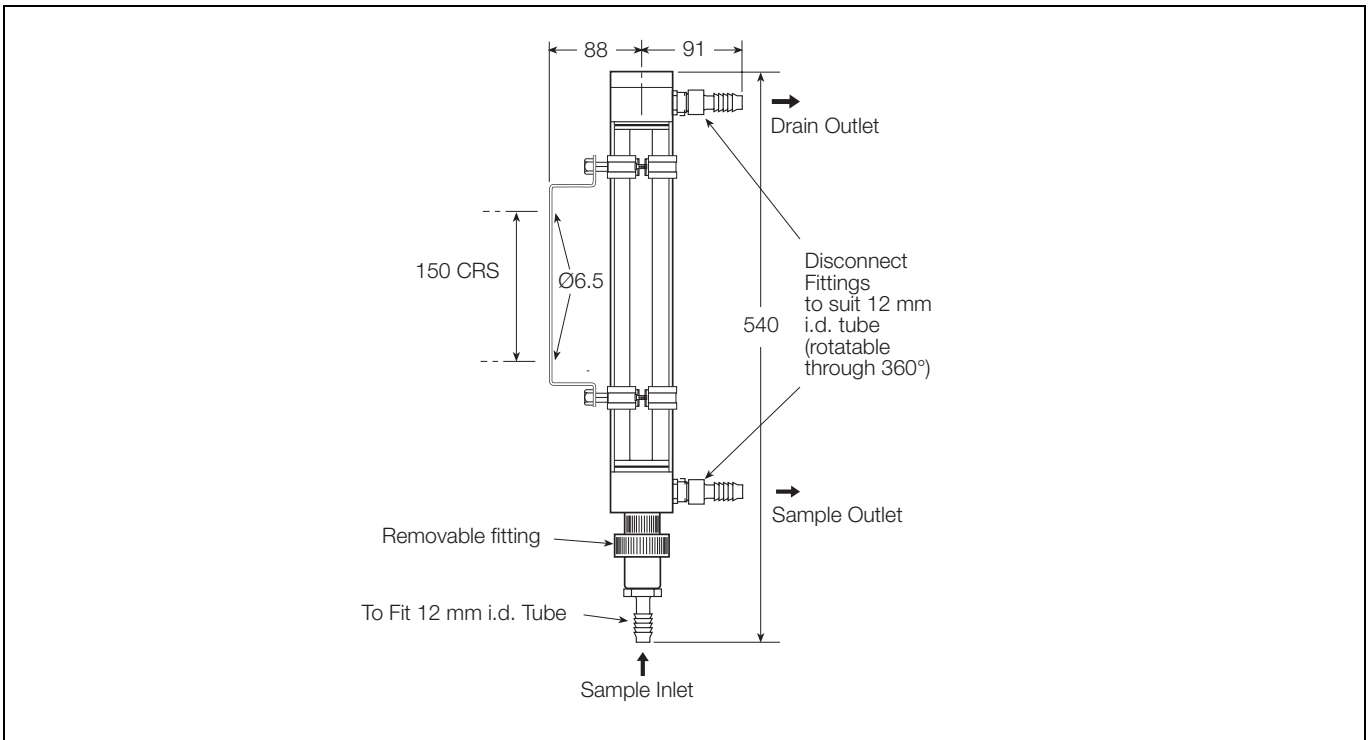


7997-405 Sensor

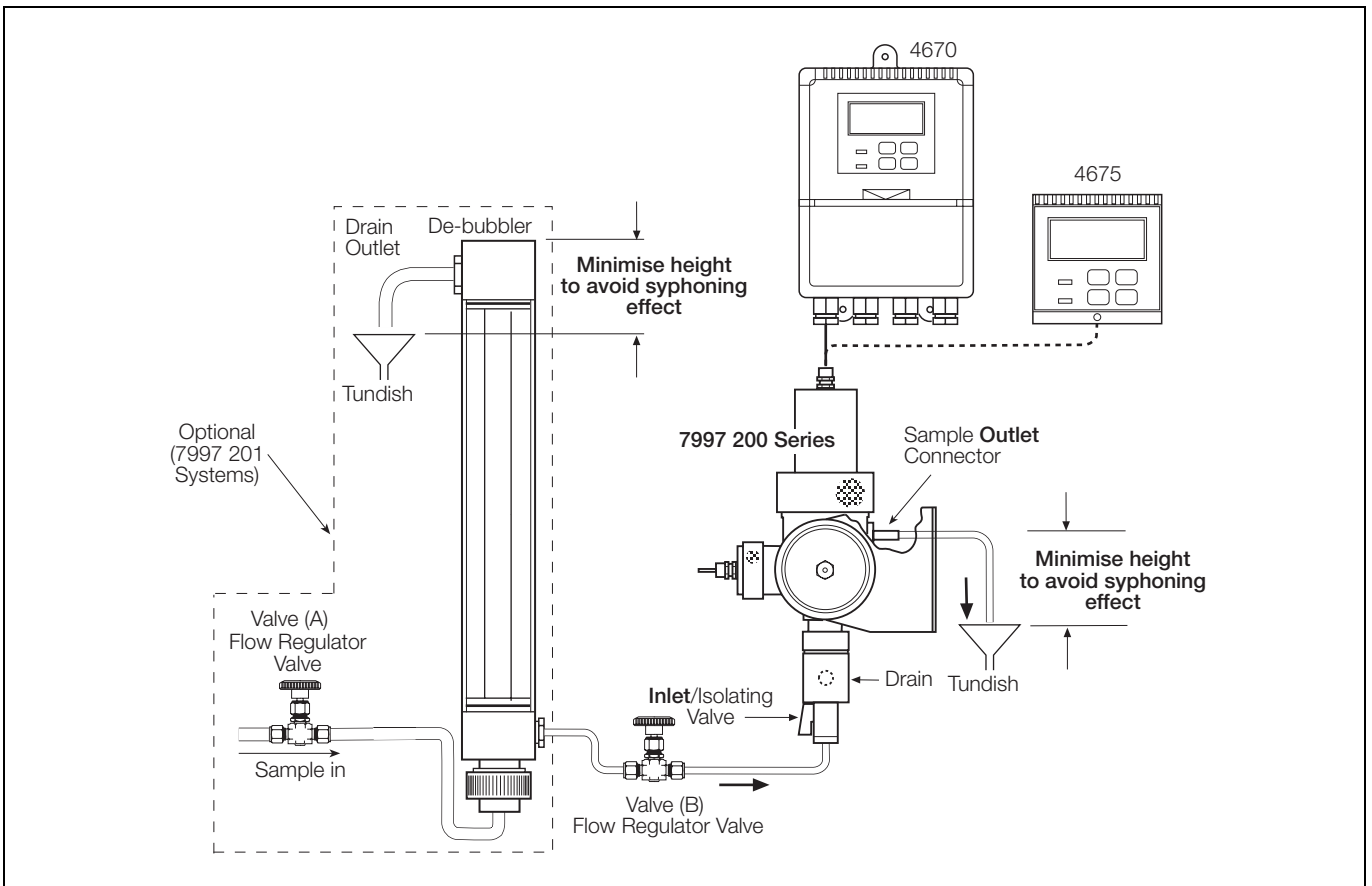


7997-405 Sensor

### Mounting the De-bubbler



Debubler Mounting Information (De-bubbler Part Number 7997 500)



Typical System Installation for 7997 200 Series and 7997 300 Flow Systems

### Ordering Information

Turbidity Systems	467	X/	X	X	X
<b>Analyzer Type</b>					
Wall-mounting Turbidity Analyzer case IP66/NEMA4X. Range programmable from 0...1 NTU to 0...250 NTU or 0...50 FTU to 0...1000 FTU (extended range 0...2000 FTU). Complete with High and Low alarm relays and isolated current output (programmable 0...10 mA, 0...20 mA or 4...20 mA) and auto-clean. Power supply 110/240 V AC	0				
As above with 2 outputs	1				
As above with Modbus	6				
Panel-mounting Turbidity Analyzer 96 x 96 mm DIN case IP66/NEMA4X. Range programmable from 0...1 NTU to 0...250 NTU or 0...50 FTU to 0...1000 FTU (extended range 0...2000 FTU). Complete with High and Low alarm relays and isolated current output (programmable 0...10 mA, 0...20 mA or 4...20 mA) and auto-clean. Power supply 110/240 V AC	5				
As above with 2 outputs	2				
As above with Modbus	7				
<b>Sensor Type</b>					
Flow-through system, range 0...30 NTU max., 0...1 NTU min., utilizing 90 ° scattered light. Process connections, inlet/outlet barb hose use 12 mm ID tube. (7997-202 sensor).	2		2		
Flow-through system, range 0...250 NTU max., 0...25 NTU min., utilizing 90 ° scattered light. Process connections, barb hose use 12 mm ID tube inlet/6 mm ID tube outlet. Complete with auto-clean. (7997-200 sensor).	2		0		
Flow-through system, range 0...30 NTU max., 0...1 NTU min., utilizing 90 ° scattered light. Process connections, barb hose use 12 mm ID tube inlet/6 mm ID tube outlet. Complete with auto-clean. (7997-201 sensor).	2		1		
Flow-through system, range 0...500 FTU max., 0...100 FTU min., 0...1000 mg/l utilizing light absorption. Process connections, barb hose use 12 mm ID tube inlet/6 mm ID tube outlet. Complete with auto-clean. (7997-300 sensor).	3		0		
1 m Dip system, range 0...1000 FTU max. (extended range 0...2000 FTU), 0...100 FTU min., 0...2000 mg/l utilizing light absorption. Process connections, N/A. Complete with auto-clean. (7997-400 sensor).	4		0		
2 m Dip system, range 0...1000 FTU max. (extended range 0...2000 FTU) 0...100 FTU min., 0...2000 mg/l utilizing light absorption. Process connections, N/A. Complete with auto-clean. (7997-401 sensor).	4		1		
Flow-through system, range 0...1000 FTU max. (extended range 0 to 2000 FTU) 0...100 FTU min., 0...2000 mg/l utilizing light absorption. Process connections, ½ in. BSP. Complete with auto-clean. (7997-405 sensor).	4		5		
<b>Language</b>					
English language manual					1
German language manual					2
French language manual					3
Spanish language manual					4

### Pipe-mounting Bracket

If required, part no. 4600/0138

### Connection Cable

All systems are supplied with 5 m (16.4 ft) of connection cable. For longer lengths, up to a maximum of 100 m (328 ft), please order:

For **Model 467X/1**

0233–840 Connection cable

For **Models 467X/2, 467X/3 and 467X/4**

0233–828 Connection cable

### Secondary Standard – supplied as an optional extra

7997/087	Secondary standard for 467X/20X (nom. value 50 to 150 NTU)
7997/170	Secondary standard for 467X/21X (nom. value 0.7 to 1.0 NTU)
7997/170	Secondary standard for 467X/22X (nom. value 0.7 to 1.0 NTU)
7997/160*	Secondary standard for 467X/4 (nom. value 60 to 80 FTU)
7997/161*	Secondary standard for 467X/4 (nom. value 600 to 700 FTU)
7997/162*	Secondary standard for 467X/4 (nom. value 800 to 900 FTU)
7997/163*	Secondary standard for 467X/4 (nom. value 120 to 160 FTU)
7997/165*	Secondary standard for 467X/3 (nom. value 150 to 200 FTU)
7997/166*	Secondary standard for 467X/3 (nom. value 300 to 360 FTU)

\* Instrument specific and must be ordered with the system.

Certificates of calibration are provided free of charge with all dry standards. Revalidation certificates are available only for 087 & 170 standards as 16X standards are system specific and would require the validation of the whole system.

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