



## OPTISENS TSS 7000 **Technical Datasheet**

### Hygienic suspended solid sensor

- Hygienic style with no optical windows
- Alternating light four beam technology
- Multiple path length for various concentration ranges

The documentation is only complete when used in combination with the relevant documentation for the signal converter.

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## 1.1 OPTISENS TSS 7000

The OPTISENS TSS 7000 sensor is manufactured using polypropylene (PP) as material. It features different sensor options with different path length between light source and detector for various measurement ranges.

With its alternating light 4 beam technology it improves the reliability of the sensor against the classic 2 beam technologies. It features 2 NIR LEDs (880nm) light sources and 2 detectors. With this technology it compensates for most errors due to dirt, aging of the detectors or even light source variations directly at the sensor itself.

No optical windows: The sensor features a windowless design by measuring directly through the PP material layer. This means no problems due to window material and its different characteristics or resistance. With its 2" and 3" Triclamp or Varivent<sup>®</sup> N connection it is easy adaptable to pipes for inline installation.

### Highlights

- Hygienic adaptations Triclamp and Varivent<sup>®</sup> N
- No optical windows, glass free
- Alternating light four beam technology
- 2x LEDs and 2x detectors
- Robust polypropylene body
- Multiple path length for various concentration ranges
- PVDF body version for up to 105°C use available

### Industries

- Food and beverage industry
- Chemical industry
- Metal and mining industry
- Pulp and paper industry

### Applications

- Fruit pulp monitoring
- Quality control and process monitoring in steam and cooling water circuits
- Milk fat concentration measurement
- Solids concentration control
- CIP control
- Separator monitoring
- Filtration monitoring
- Product loss monitoring in dairy factories
- Heat exchanger monitoring (product leaks detection into condensate/steam)

## 1.2 Measuring principle

The 4 beam alternating light principle compensates for variations in both light intensity and detector sensitivity. It features 2 light sources (LED's) which are switched on and off alternately and 2 detector.

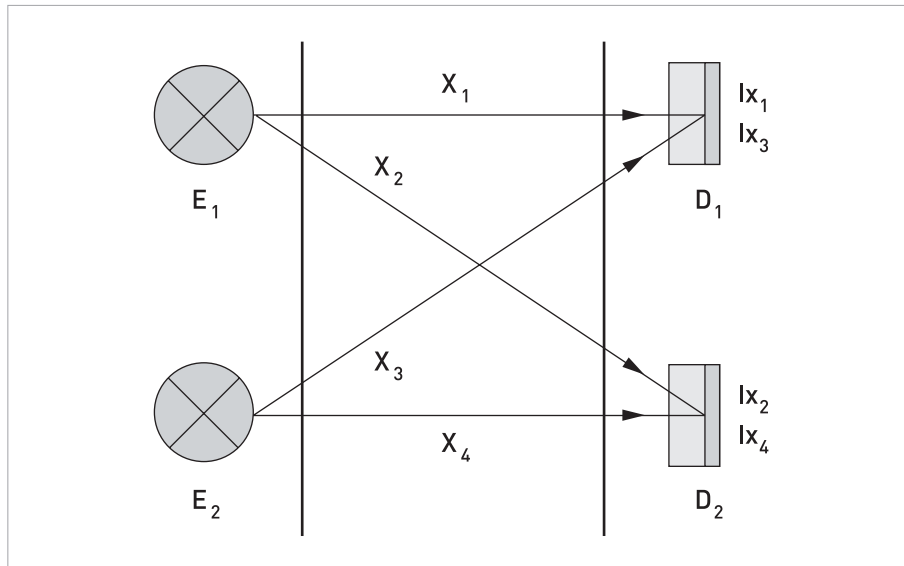


Figure 1-1: 2 lights and 2 detectors alternating light principle

When  $E_1$  is turned 'ON' light is transmitted through the process media and each photodetector ( $D_1$  and  $D_2$ ) receives the light via paths  $X_1$  and  $X_2$  respectively.  $D_1$  and  $D_2$  generate signals based on the amplitude of light each photodetector receives. A ratio ( $R_a$ ) is created by comparing these results.

$$R_a = I_{x_1}/I_{x_2} = 80\mu A/40\mu A = 2$$

Because any change in the characteristics of  $E_1$  (due to age or contamination) will, affect  $D_1$  and  $D_2$  equally, this ratio will remain constant. For example, if the light output of  $E_1$  is reduced by 25 %, the signals generated by  $D_1$  and  $D_2$  will both be reduced accordingly, but the ratio will remain the same. This eliminates the effects of contamination on  $E_1$ .

$$R_a = I_{x_1}/I_{x_2} = 60\mu A/30\mu A = 2$$

The same procedure is performed using  $E_2$ , across paths  $X_3$  and  $X_4$  and a similar ratio ( $R_b$ ) is created. This eliminates the effects of contamination on  $E_2$ .

$$R_b = I_{x_3}/I_{x_4} = 30\mu A/60\mu A = 0.5$$

To eliminate the effects of contamination or component aging on the detectors, a ratio comparing  $R_a$  and  $R_b$  is made.

$$R_a/R_b = 2/0.5 = 4$$

Because a change in the sensitivity of  $D_1$  or  $D_2$  (due to age or contamination) will reduce the light received from  $E_1$  and  $E_2$  equally, this ratio remains constant even if the characteristics of  $D_1$  or  $D_2$  change. For example if dirt covers 25% of  $D_1$ , light received from both  $E_1$  and  $E_2$  will be reduced by 25 % but the ratio will remain the same.

$$R_a = I_{x_1}/I_{x_2} = 60\mu\text{A}/40\mu\text{A} = 1.5$$

$$R_b = I_{x_3}/I_{x_4} = 22.5\mu\text{A}/60\mu\text{A} = 0.375$$

$$R_a/R_b = 1.5/0.375 = 4$$

By using these ratios, rather than the direct output from  $D_1$  and  $D_2$ , the effects of contamination and component aging are eliminated.

Ambient light is detected by  $D_1$  and  $D_2$  while  $E_1$  and  $E_2$  are off. The resulting "offset" signal is used to correct the measurement. All signals are linearised and combined to produce a reliable 0/4...20mA output signal which is proportional to solids concentration.

By using single wavelength diodes with 880 nm which are outside the visible light spectrum the sensors are also insensitive to colour. KROHNE designs sensors of different sensitivity and measuring range by changing the distances between the sensor's light sources and detectors. When they are far apart, the sensor is more sensitive to suspended solids because the longer optical path lengths increase the sensor's ability to detect small changes in suspended solids concentration. However, because an increase in distance reduces the amount of detected light intensity, optical path length also determines the measuring range. For example, in two sensors with identical light sources, the sensor with longer path lengths will detect less light therefore it reaches the upper limit of its measuring range at a lower concentration and has a smaller measuring range. The sensor with shorter path lengths can measure higher concentrations and has a larger measuring range.

## 2.1 Technical data

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

### Measuring system

|                     |   |
|---------------------|---|
| Parameter           | Suspended solids  |
| Measuring principle | Transmitted light absorption principle; pulsed NIR 880 nm; with reference measurement.<br>Reflection and absorption of light on suspended solids and sludge particles. The light passes the measured particles between the emitter and the detector in a straight line. |

### Design

|                   |   |
|-------------------|---|
| Measuring scale   | 0...25 g/L with the path length 10 mm activated sludge, 0...40% milk fat                      |
|                   | 0...10 g/L with the path length 20 mm activated sludge, 0...20% milk fat                      |
|                   | 0...2.5 g/L with the path length 40 mm activated sludge, 0...1.5% milk fat                    |
| Sensor connection | 2" Triclamp (10 mm version only)<br>3" Triclamp<br>Varivent® N (20 mm and 40 mm version only) |

### Operating conditions

|                                  |   |
|----------------------------------|---|
| Temperature range                | 0...85°C / +32...185°F<br>high temperature version 0...105°C / 32...221°F |
| Pressure range                   | 10 bar at 25°C / 145 psi at 77°F  |
| Accuracy                         | ± 2% of reading   |
| Repeatability                    | ± 1% of reading   |
| Air pressure cleaning (Optional) | 10 bar / 145 psi  |

### Installation conditions

|                    |      |
|--------------------|------|
| Ingress conditions | IP68 |
|--------------------|------|

### Materials

|             |  |
|-------------|--|
| Sensor body | PP - Polypropylene<br>PVDF (20 mm high temperature version only) |
|-------------|--|

### Electrical connection

|       |   |
|-------|---|
| Cable | 10 meter / 32.8 ft. (other lengths available)<br>10 m hard wired with amphenol connector for extension cables |
|-------|---|

### Approvals and certifications

|  |
|--|
| CE   |
| This device fulfils the statutory requirements of the EC directive. The manufacturer certifies successful testing of the product by applying the CE mark.      |
| For full information of the EU directives and standards and the approved certifications, please refer to the EU declaration or the website of the manufacturer |

## 2.2 Dimensions and weight

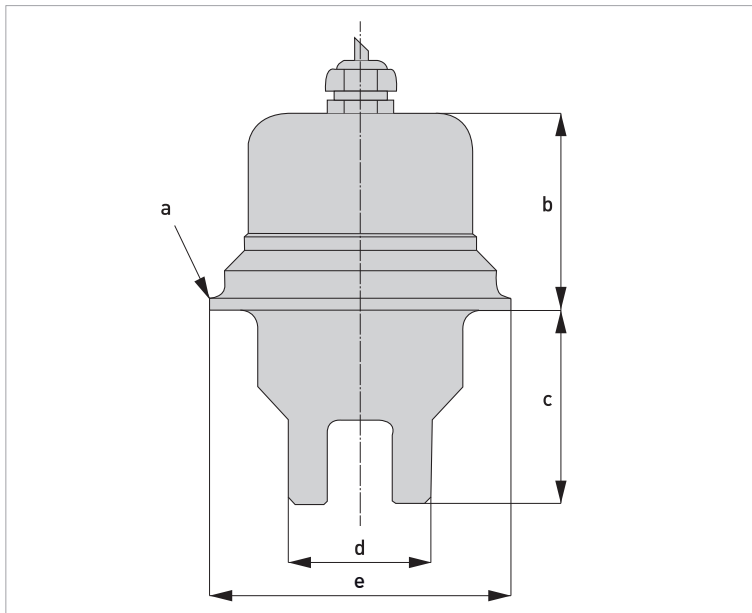


Figure 2-1: Dimensions

### Type 1 (path length 10 mm)

|   | Dimensions [mm] | Dimensions [inch] |
|---|-----------------|-------------------|
| a |                 | 2" or 3" Triclamp |
| b | 59              | 2.32              |
| c | 55              | 2.17              |
| d | 34              | 1.34              |
| e | 64 or 91        | 2.52 or 3.58      |

### Type 2 (path length 20 mm)

|   | Dimensions [mm] | Dimensions [inch] |
|---|-----------------|-------------------|
| a |                 | 3" Triclamp       |
| b | 59              | 2.32              |
| c | 55              | 2.17              |
| d | 43              | 1.69              |
| e | 91              | 3.58              |

### Type 3 (path length 40 mm)

|   | Dimensions [mm] | Dimensions [inch] |
|---|-----------------|-------------------|
| a |                 | 3" Triclamp       |
| b | 59              | 2.32              |
| c | 55              | 2.17              |
| d | 62              | 2.44              |
| e | 91              | 3.58              |

### 3.1 Intended use

*Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.*

*This device is a Group 1, Class A device as specified within CISPR11:2009. It is intended for use in industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.*

*The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.*

The intended use of OPTISENS TSS 7000 sensors is the continuous on-line monitoring of suspended solids in food and beverage industry and other hygienic applications. The sensor is suitable for connection to the MAC 300 signal converter.

### 3.2 Configuration of a measuring point

The sensor requires the external signal converter MAC 300 for setup, calibration and operation.

**A complete measuring point consists of at least two parts:**

- MAC 300 signal converter
- OPTISENS TSS 7000 sensor

### 3.3 Installation procedure

The sensor needs to be calibrated before it is installed into its final measuring location. To install the device in the correct way, follow the order and the following sections and their instructions.

1. Connect the sensor to the signal converter.
2. Calibrate the sensor.
3. Install the sensor into its final measuring location.



## 4.1 Connecting the power supply to the signal converter MAC 300

*The device must be grounded in accordance with regulations in order to protect personnel against electric shocks.*

*Never install or operate the device in potentially explosive areas, it might cause an explosion that can result in fatal injuries!*

*When connecting the power supply, always note the safety regulations of the current state of the art. Also note the following items to avoid fatal injuries, destruction or damage of the device or measuring errors:*

- *De-energise the cables of the power supply before you start any installation works!*
- *Always keep the housing of the device well closed if you do not perform any installation works. The function of the housing is to protect the electronic equipment from dust and moisture.*
- *Assure that there is a fuse protection for the infeed power circuit ( $I_{nom} \leq 16 A$ ) and a disconnecting device (switch, circuit breaker) to isolate the signal converter.*
- *Check the nameplate and assure that the power supply meets the voltage and frequency of the device.  
Universal 80-265 V AC or DC, 15 W max.  
Low voltage option 18– 32 V AC or DC, 20 W max.*
- *Assure that the protective earth conductor (PE) is longer than the L- and N-conductor.*

Wall mount (85-265V AC/DC)

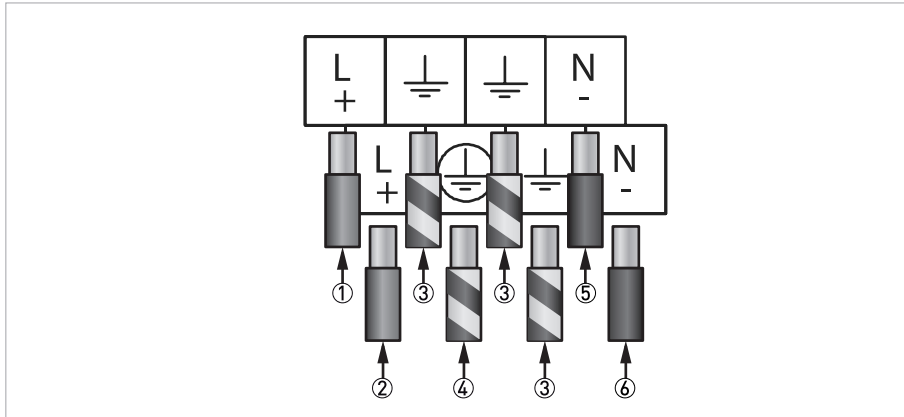


Figure 4-1: Power connector MAC 300 W

- ① Power supply "Live" out (for daisy chaining)
- ② Power supply "Live" in
- ③ Earth
- ④ Protective Earth (Must be connected)
- ⑤ Power supply "Neutral" out (for daisy chaining)
- ⑥ Power supply "Neutral" in

Wall mount (18-32V AC/DC)

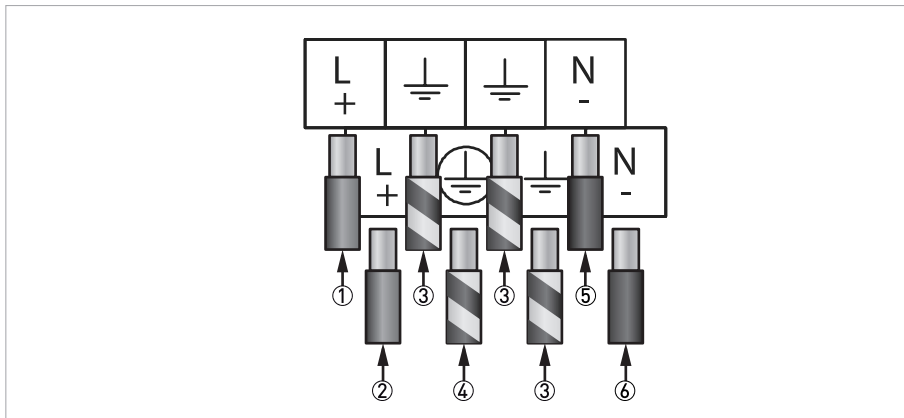


Figure 4-2: Power connector MAC 300 W

- ① Power supply "+" out (for daisy chaining)
- ② Power supply "+" in
- ③ Earth
- ④ Protective earth (Must be connected)
- ⑤ Power supply "-" out (for daisy chaining)
- ⑥ Power supply "-" in

## Rack mount (85-265V AC/DC)

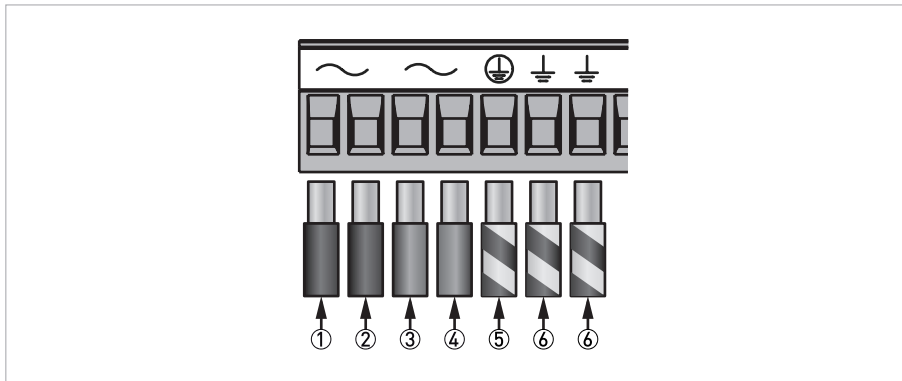


Figure 4-3: Main power connector MAC 300 R

- ① Power supply "Live" in
- ② Power supply "Live" out (for daisy chaining)
- ③ Power supply "Neutral" in
- ④ Power supply "Neutral" out (for daisy chaining)
- ⑤ Protective earth (must be connected)
- ⑥ Earth

## Rack mount (18-32V AC/DC)

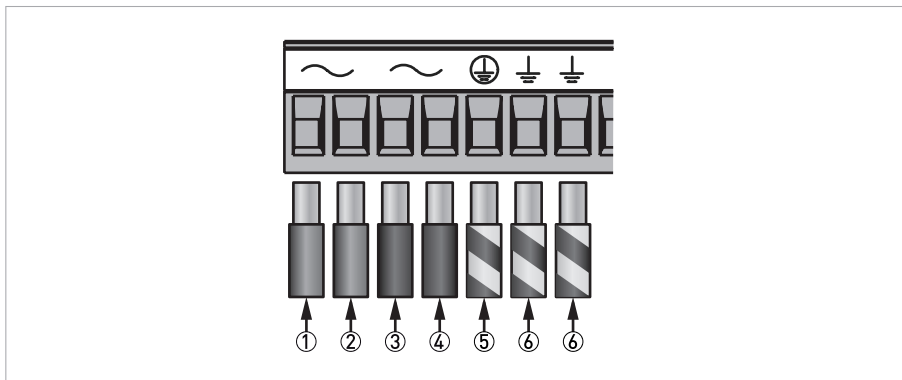


Figure 4-4: Main power connector MAC 300 R

- ① Power supply "+" in
- ② Power supply "+" out (for daisy chaining)
- ③ Power supply "-" in
- ④ Power supply "-" out (for daisy chaining)
- ⑤ Protective earth
- ⑥ Earth

*To prevent destruction or damage, never operate the device outside of its permissible mechanical, thermal or chemical limits.*

The power supply should be taken from an isolated spur and fused to a maximum of 3 Amps. If the relays require greater current, then a separate 5A fuse will be required. The incoming earth connection must be connected to the "Protective Earth" terminal.

## 4.2 Connecting the sensor cable to the signal converter

All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

Connect the sensor to the MAC 300 for optimal configurability and process control due to following features:

- scale selection flexibility
- digital input to hold signals during cleaning process
- easy calibration via zero point and sensitivity adjustment
- set minimum and maximum for alarm relays
- galvanic isolated 4...20 mA outputs
- error current

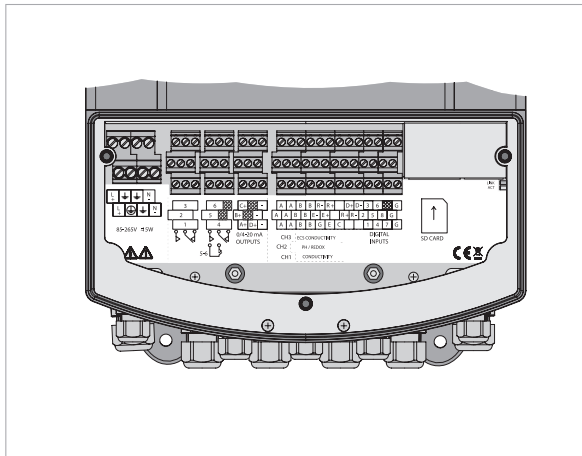


Figure 4-5: Overview terminal block MAC 300 W

### Wall mount termination information

| Suspended solids input connector |             |           |             |             |             |              |              |                       |
|----------------------------------|-------------|-----------|-------------|-------------|-------------|--------------|--------------|-----------------------|
| Blue                             | Green       | Red       | Black       | White       | Brown       | Orange       | Yellow       | Instrument earth stud |
|                                  | ↑           | ↑         | ↑           | ↑           | ↑           | ↑            | ↑            | ↑                     |
|                                  | Green cable | Red cable | Black cable | White cable | Brown cable | Orange cable | Yellow cable | Cable screen          |

### Rack mount termination information

| Suspended solids input connector |             |           |             |             |             |              |              |                |
|----------------------------------|-------------|-----------|-------------|-------------|-------------|--------------|--------------|----------------|
| Blue                             | Green       | Red       | Black       | White       | Brown       | Orange       | Yellow       | Earth terminal |
|                                  | ↑           | ↑         | ↑           | ↑           | ↑           | ↑            | ↑            | ↑              |
|                                  | Green cable | Red cable | Black cable | White cable | Brown cable | Orange cable | Yellow cable | Cable screen   |

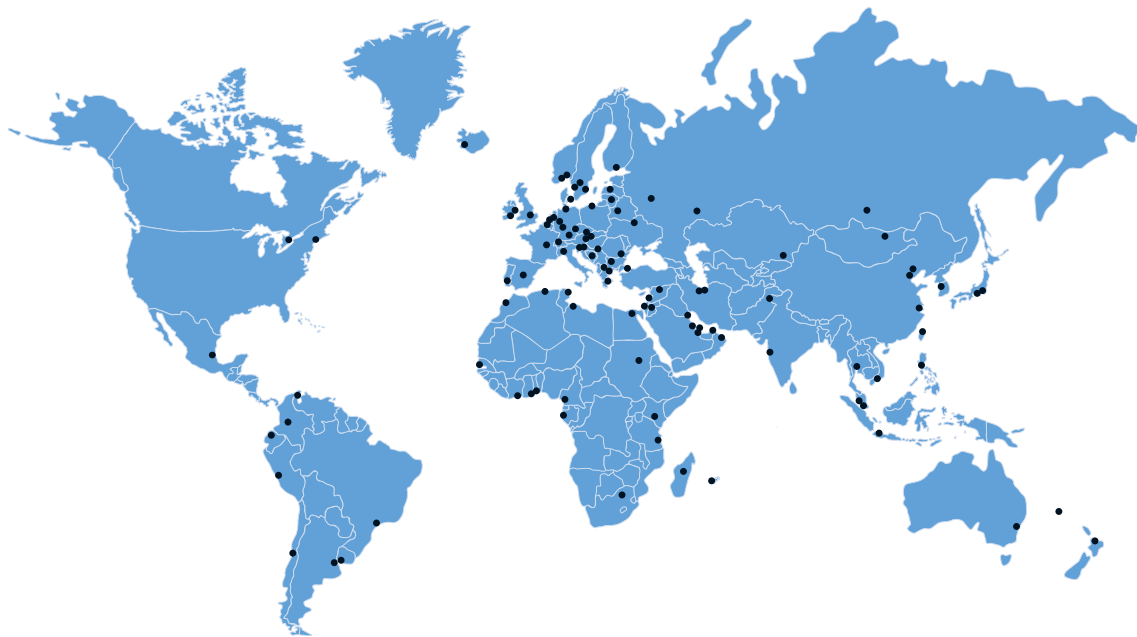
## 5.1 Order code

The characters of the order code highlighted in light grey describe the standard.

|       |   |                    |  |  |  |  |  |  |  |  |  |  |
|-------|---|--------------------|--|--|--|--|--|--|--|--|--|--|
| VGA Y | 4 | <b>Sensor type</b> |  |  |  |  |  |  |  |  |  |  |
|       |   | 7                  | OPTISENS TSS 7000  |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Wave length</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 2                  | 880 nm   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Optical path length (4 beam)</b>                                      |  |  |  |  |  |  |  |  |  |
|       |   | 2                  | 10 mm / approx. range 0...25 g/l activated sludge, 0...40% milk fat      |  |  |  |  |  |  |  |  |  |
|       |   | 3                  | 20 mm / approx. range 0...10 g/l activated sludge, 0...20% milk fat      |  |  |  |  |  |  |  |  |  |
|       |   | 4                  | 40 mm / approx. range 0...2.5 g/l activated sludge, 0...1.5% milk fat    |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Process conditions</b>  |  |  |  |  |  |  |  |  |  |
|       |   | 2                  | 0...+85°C, 10 bar / +32...+185°F, 145 psi                                |  |  |  |  |  |  |  |  |  |
|       |   | 3                  | 0...+105°C, 10 bar / +32...+221°F, 145 psi (only 20 mm 3" Triclamp type) |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Body material</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 2                  | PP - Polypropylene   |  |  |  |  |  |  |  |  |  |
|       |   | 3                  | PVDF (only 20 mm 3"Triclamp type)  |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Optical window</b>  |  |  |  |  |  |  |  |  |  |
|       |   | 0                  | None   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Process connection</b>  |  |  |  |  |  |  |  |  |  |
|       |   | 3                  | 2" Triclamp (only 10 mm type)  |  |  |  |  |  |  |  |  |  |
|       |   | 4                  | 3" Triclamp  |  |  |  |  |  |  |  |  |  |
|       |   | 5                  | Varivent® N (only 20 mm and 40 mm type)                                  |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Wetted sealing material</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 0                  | None   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Cable length / connection</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 1                  | 10 m hard wired core sleeve ends   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Hygiene certificates</b>  |  |  |  |  |  |  |  |  |  |
|       |   | 0                  | None   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Approvals</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 0                  | None   |  |  |  |  |  |  |  |  |  |
|       |   |                    | <b>Documentation</b>   |  |  |  |  |  |  |  |  |  |
|       |   | 0                  | None   |  |  |  |  |  |  |  |  |  |
|       |   | 1                  | English  |  |  |  |  |  |  |  |  |  |
|       |   | 2                  | German   |  |  |  |  |  |  |  |  |  |
|       |   | 3                  | French   |  |  |  |  |  |  |  |  |  |
|       |   | 4                  | Spanish  |  |  |  |  |  |  |  |  |  |
| VGA Y | 4 |                    |  |  |  |  |  |  |  |  |  |  |







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Head Office KROHNE Messtechnik GmbH  
Ludwig-Krohne-Str. 5  
47058 Duisburg (Germany)  
Tel.: +49 203 301 0  
Fax: +49 203 301 10389  
info@krohne.com

The current list of all KROHNE contacts and addresses can be found at:  
[www.krohne.com](http://www.krohne.com)

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