USER MANUAL

# u[sonic] Modbus

Ultrasonic Wind Sensor

aem | LAMBRECHT meteo

# Content

# 1 u[sonic] Modbus- Advantages at a glance

The ultrasonic wind sensor Modbus u[sonic] was specially designed for extreme environmental conditions. It comes without any moving measuring elements and is ideal for high wind speeds. The extreme robust, compact sensor has a high-quality, pollutant-resistant housing made of hard anodized aluminium and stainless steel.

- Three parameters in one device: wind direction, wind speed, virtual temperature
- Without movable measuring elements
- No abrasion, low maintenance
- Standard RS 485 interface with ESD protection
- Modbus data protocol
- Power supply (without heating) 6...60 VDC or 12...42 VAC
- Power supply (with heating) 24 V AC/DC ± 20 %
- Simple, space-saving assembly on 50 mm standard pipe
- Heating power 60 W

# 2 Warranty

**Please note the loss of warranty and non-liability by unauthorized manipulation of the system. You need a written permission of the LAMBRECHT meteo GmbH for changes of system components. These activities must be operated by a qualified technician.**

The warranty does not cover:

1. Mechanical damages caused by external impacts (e. g. icefall, rockfall, vandalism).
2. Impacts or damages caused by over-voltages or electromagnetic fields which are beyond the standards and specifications in the technical data.
3. Damages caused by improper handling, e. g. by wrong tools, incorrect installation, incorrect electrical installation (false polarity) etc.
4. Damages which are caused by using the device beyond the specified operation conditions.

# 3 Introduction

The wind sensor u[sonic] Modbus is very robust, compact and extremely reliable. When developing this sensor particular consideration has been given to highest quality for fulfilment of meteorological requirements. The system acquires the horizontal air flow and processes the measuring data to the meteorological parameters wind speed and wind direction. The sensor is mounted in a splash water- and dust proof metal housing (IP66 and IP67) and can be immersed temporarily.

The measuring data are automatically transmitted via serial interface RS 485 in talker mode, when power supply is switched on. Due to their shock- and vibration proof construction the sensor u[sonic] is particularly qualified for use under severe environmental conditions. The housing is made of anodised seawater-resistant aluminium and stainless steel. An electronically controlled heating device enables the sensor to operate in between the wide range of -40 up to 70 °C.

### ADVANTAGES OF THE STATIC MEASURING PRINCIPLE

The sensor u[sonic] is a modern system to carry out precise and reliable measurements under hardest application and environmental conditions. The wind measurements take place according to the principle “ultrasonic run-time measurement”, i. e. static, without moving parts.

**Static measuring principle** for wind measurements means:

- Determination of data works without moving measuring elements, i.e. none abrasion and least maintenance.
- The wind parameter can be measured also in winter time accurate and precise, because of the electronic controlled heating for the immovable measuring elements. This heating is particularly effective against ice and snow in all climatic zones.
- The measuring principle enables very low threshold values, distance- and attenuation constants as well as a very high repetition accuracy.

### ADVANTAGES OF THE SENSOR

- The built-in test function of the station, enabled by the tight integration of the meteorological sensors into the enclosure, can perform cyclic self-testing and notify the user of erroneous data or failure.
- The compact design of the sensor u[sonic] with 3 meteorological parameters is eliminating the installation work significantly.

# 4 Start-up

Wind can be represented by a vector quantity. For a complete description of the wind it is necessary to specify its speed and direction. The two components are subject to spatial and temporal variations; thus, strictly speaking, they are valid only for the site where the measuring instrument is installed. We therefore recommend selecting the place of installation very carefully.

## 4.1 Installation conditions

## 4.2 General

For professional wind measurements location and height of the wind sensor are important for accurate, correct results and representative wind conditions. Ideally, the sensor should be installed in 10 m above the ground on a mast. This may be buildings, trees, tall towers, lifting cranes, moving vehicles, aircrafts, helicopters and other obstructions.

In case of mobile measurements at vehicles often above mentioned conditions are not practicable. Then you have to find compromises.

Generally, wind measuring instruments should not measure the specific wind conditions of a limited area, but indicate the typical wind conditions of a wider area. The values measured at different places must be comparable. Thus, when installing the sensor you should make sure the place of installation is not under the lee of great obstacles. The distance between the obstacles and the sensor should be 10 times the height of the obstacles (this corresponds to the definition of an undisturbed terrain). If an undisturbed terrain of this kind does not exist the sensor must be put up at a height of at least 6 m above the obstacle height.

If the sensor must be installed on a roof top the place of installation must be in the middle of the roof to avoid predominant wind directions. If you want to measure both wind direction and wind speed, the sensors should be avoided. The sensor u[sonic] easily meets this requirement.

The place of installation should not be in the operation fields of radar devices (radar scanners or radar transmitters), generators or antennas. We recommend a minimum distance of 2 m to these installations. Furthermore a minimum distance of 5 m to MF-/ HF- and Satcom- (e. g. Inmatsat, VSat) antennas has to be kept. The maximum electric field intensity may not exceed 10 V/m (tested according to EMC standard). When indicated a greater distance should be kept.

## 4.3 Tools and installation material

There are no special tools or materials required for the installation works. All work can be carried out with standard tools, e.g. Allen key size 4.

## 4.4 Unpacking the sensor

The sensor is delivered in separate packaging, carefully protected against mechanical impact, to avoid damage during transport.

The package contains the following items:

- Sensor u[sonic]
- User manual

Accessories: (depending on the scope of delivery, packed separately if necessary)
Connection cable with cable plug

## 4.5 Incoming inspection

Please check the scope of delivery for completeness and possible transport damage. Please report any complaints immediately to us in writing.

## 4.6 Energy supply

The sensor requires at the input connector a 6...60 VDC or 12...42 VAC nominal power source for operation. For heating mode a 24 V AC/DC power supply is needed.

## 4.7 Current consumption

The current consumption of the u[sonic] is around approx. 25 mA at 24 VDC, without heating. With activated heating, the maximal current consumption is 2.5 A at 24 VDC.

## 4.8 Installation work (short description)

The sensor is installed in three steps:

1. Mounting the cable at the sensor and if necessary draw the cable through the mast.
2. Mounting the sensor at the mast, but before tightening the screws you must align the sensor to the north.
3. Attaching the cable to the power supply and the signal acquisition system.

## 4.9 Mounting the sensor

The sensor can be installed on a standard pipe with an outer diameter of 50 mm and an inner diameter of maximum 40 mm. Before tightening the two 8 mm-socket screws and attaching the sensor you have to draw the cable through the pipe and align the sensor into driving direction. For this purpose the housing is marked accordingly (see drawing). Before the screws of the sensor are tightened, the sensor is adjusted to north. In addition the sensor has a pin for the north direction. You can put this pin into the nick at the mast (if available). If needed you can turn in or unscrew the pin by means of allen key.

Please pay attention to a firm mounting of the sensor at the mast!

### 4.9.1 Sensor northing

For wind direction measurements the north mark on the sensor must be aligned with the geographical north direction. To adjust the wind sensor in a firm and correct manner into the north direction this item is equipped with an integrated mounting aid. Inside the inner bottom of the sensor a small bolt pointing to the north is integrated to be set into a corresponding slot of the mounting pipe (if available). Thus the sensor is safely attached. If needed you can turn in or unscrew the pin by means of allen key.

To set up the sensor's north orientation select a landmark which is as far as possible up north with regard to the final position of the wind direction sensor. The reference point can be selected using a topographical map (1:25000). The exact position of the reference point is determined using an amplitude compass that can be adjusted horizontally on a stand.

Compass declination has to be considered!

To align the sensor ahead (on ships) locate a point outside the ship in the landscape which is located in the ship ahead direction respectively in the centre line or in case of the sensor is mounted far away from the middle line a line parallel to the centre line. Once the sensor is adjusted, it can be fixed with the two hexagon socket screws. Finally the earth screw has to be connected to the ship's ground. Acid-free contact grease is recommended to protect contact surfaces against corrosion.

Follow all safety instructions while setting up the sensor onto a mast.

## 4.9.2 Power supply and signal cables

An 8-pole M16 cable connector is required for the electrical connection of the sensor. The shield of the cable must be clamped to the protective earth conductor (PE) at both ends.

*To reduce the risk of inductive interference a properly grounding of the sensor is recommended.*

The external connection is via central connector which is located in housing base. For further details about electrical connection please see chapter „Connecting diagrams". If the sensor is mounted in correct manner and connected with the right cable (accessory), you can attach the wires to power supply and signal outputs to data acquisition equipment (computer).

The typical power supply requirements of the u[sonic] sensors are 24 VDC with a typical current drain of 35 mA. The input range is 6...60 VDC or 12...42 VAC. The heater of the u[sonic] has to be supplied with 24 V AC/DC. In standard configuration the heating power is 240 W with a current drain of 10 A at 24 VDC. The signal output of the sensors is conform to the requirements of RS422 standard in talker mode. The line drivers are capable of transmitting data over cable lengths up to 1,220 meters (4,000 feet). This maximum distance will vary depending on the quality of the used cables. When the power supply of the sensor is switched on, after 2 seconds the sensor cyclically starts sending data protocols.

## 4.9.3 Safety regulations

*Because the wind sensor often is mounted on exposed locations in dangerous heights the installation personnel has to pay attention to the relevant safety regulations for such works. During the electrical installation and termination works the external circuit-breaker must be switched off. It is not permitted to open those housings by unauthorized persons!*

# 5 Maintenance

## 5.1 Regular maintenance and calibrations

The sensor u[sonic] is service reduced and designed for a very long lifetime. Recommended is a regular visual check regarding dirt of surface caused by the weather and if so, to clean up.

If reference measurements should be necessary stringently must be noted that a comparability of the measured values is given only if the measurements take place under same conditions. I.e. the reference equipment must be used very close to the sensor!

The sensor is a measuring instrument and thus apply user specific standards regarding period of recalibration. Recommendation: 2 years.

## 5.2 Visual inspections and cleaning

The use of the sensor under the respective environmental conditions requires certain steps. It is thus recommendable to clean the outside of the housing within specific intervals. The intervals are dependant on the environmental conditions and the degree of soiling. We recommend a regular sight check. In case you should be faced with any specific problems please contact the Lambrecht service under:
**Tel: +49 (0)551 49580** or **E-Mail: support@lambrecht.net**

# 6 Transports

In case the sensor should be shipped or transported by you, it has to be packed securely to avoid mechanical impact or other damages.

# 7 Disposal

LAMBRECHT meteo GmbH is listed and registered at the Stiftung Elektro-Altgeräte Register ear under:

**WEEE-Reg.-Nr. DE 45445814**

In the category of monitoring and control instruments, device type: “Monitoring and control instruments for exclusively commercial use”.

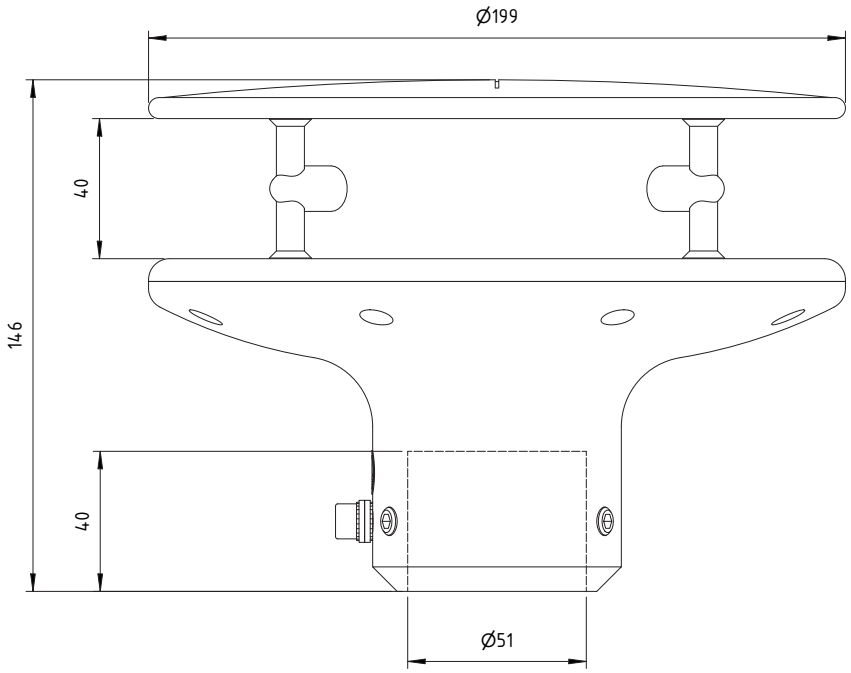
**Within the EU**

The device has to be disposed according to the European Directives 2002/96/EC and 2003/108/EC (Waste Electrical and Electronic Equipment). Do not dispose the old device in the household waste! For an environmentally friendly recycling and disposal of your old device, contact a certified disposal company for electronic waste.

**Outside the EU**

Please follow the regulations in your country regarding the appropriate disposal of waste electronic equipment.

# 8 Dimensional drawing

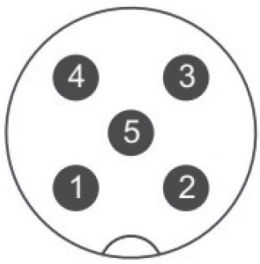


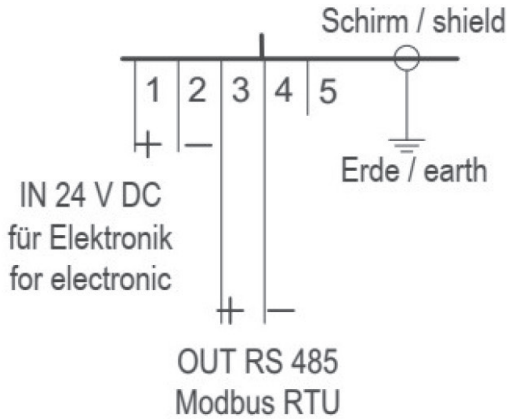

# 9 Connection diagram

Sensor-side plug (male),
M12, 4-pin, shielded

Cable-side socket (female),
M12, 4-pin, shielded

Cable color code




| PIN | color | Farbe |
|---|---|---|
| 1 | br | br |
| 2 | wt | ws |
| 3 | bl | bl |
| 4 | bk | sw |
| 5 | N/A | N/A |

# 10 Modbus protocol

Note: Modbus must be configured in default.

This manual covers the general Modbus specification common to all Modbus sensors from LAMBRECHT meteo. The manual allows easy operation of all LAMBRECHT meteo Modbus sensors. Some sensors of the Modbus family offer additional registers and functions, which are described in separate documents via the registers and functions described here. The registers and functions described in this manual are sufficient for general operation of Modbus sensors in a weather station or PLC.

## 10.1 General

The LAMBRECHT meteo Modbus sensors follow the specification of the Modbus organization: “MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3” (see www.modbus.org).

## 10.2 Data encoding

MODBUS uses the “Big-Endian” format for addresses and data. This means that if a value is transmitted with a number format which is larger than a single byte, that the “most significant byte” is sent first.

Example Big-Endian:

Register size value 16 - bits

0x1234 is transmitted in the sequence: 0x12 0x34.

To obtain the real measuring value, divide the received register value by the divisor.
Values of -9999 indicate an internal sensor error.

## 10.3 Standard configuration - Default

| | |
|---|---|
| Baud rate: | 19200 Baud |
| Byte frame: | 8E1 (1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit) |
| RTU Sensor address: | 9 |

### DEFAULT ADDRESSES OF THE LAMBRECHT SENSORS

| Address | Sensor |
|---|---|
| 1 | Wind speed |
| 2 | Wind direction |
| 3 | Precipitation rain[e] |
| 4 | THP |
| 5 | EOLOS IND; u[sonic]WS6 |
| 6 | com[b] |
| 7 | PREOS |
| 8 | ARCO |
| 9 | u[sonic] |
| 10 | Pyranometer 2nd Class |
| 11 | Secondary standard Pyranometer |
| 12 | PT100 ot Modbus converter (temperature) |
| 13 | u[sonic]WS7 |

## 10.4 Available Modbus commands

The LAMBRECHT Modbus sensors support the following commands:

- "Read Holding Register" command: 0x03 (descriptive sensor data registers)
- "Read Input Register" command: 0x04 (measured values registers)
  (every measured value is to be requested individually)
- "Write Multiple Register" command: 0x10 (Write to configuration registers)

## 10.5 Instantaneous values / real-time values ( Input Registers)

The following measured values are provided by the LAMBRECHT meteo sensors.

| Register address | Parameter name | Unit | Divisor | Quantity of registers | Access type |
|---|---|---|---|---|---|
| 30001 | Wind speed | m/s | 10 | 1 | Read only |
| 30201 | Wind direction | ° | 10 | 1 | Read only |

**Example:** Retrieving the wind speed

| 0D | 04 | 75 | 31 | 00 | 01 | 7A | C5 | 0D | 04 | 02 | 00 | 1F | E8 | F9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| LEN 6 | Transmission Query => | Source Master | Dest Slave 13 | Function Read Input Register (4) | Func Desk Address=30001, Quantity of Register=1 | Checksum OK:C57A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LEN 5 | Transmission Response <= | Source Slave 13 | Dest Master | Function Read Input Register (4) | Func Desk Byte count=2 | Data 00 1F | Checksum OK:F9E8 |

## 10.6 Period data - Average, maximum and minimum (Input Registers)

| Register | Parameter name | Unit | Divisor | Quantity of registers | Access type |
|---|---|---|---|---|---|
| 30002 | Wind speed average | m/s | 10 | 1 | Read only |
| 30003 | Wind speed maximum | m/s | 10 | 1 | Read only |
| 30004 | Wind speed minimum | m/s | 10 | 1 | Read only |
| 30202 | Wind direction average | ° | 10 | 1 | Read only |
| 30203 | Wind direction maximum | ° | 10 | 1 | Read only |
| 30204 | Wind direction minimum | ° | 10 | 1 | Read only |

The data are valid for the period between the current request and the previous request. The maximum range of a period is 1 hour. Recalling the average value of a minimum, maximum and average group will erase the appropriate registers.

Retrieve the values of a group in the sequence minimum, maximum, average.
Use command: 0x03

**Example**: Retrieve wind speed (min. max. avr.) and erase the register content

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 04 | 75 | 34 | 00 | 01 | 6A | 08 | 01 | 04 | 02 | 00 | 00 | B9 | 30 | 01 |
| 04 | 75 | 33 | 00 | 01 | DB | C9 | 01 | 04 | 02 | 00 | D6 | 38 | AE | 01 | 04 |
| 75 | 32 | 00 | 01 | 8A | 09 | 01 | 04 | 02 | 00 | 14 | B9 | 3F | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LEN 6 | Transmission Query => | Source Master | Dest Slave 1 | Function Read Input Register (4) | Func Desk Address=30004, Quantity of Register=1 | | Checksum OK:86A |
| LEN 5 | Transmission Response <= | Source Slave 1 | Dest Master | Function Read Input Register (4) | Func Desk Byte count=2 | Data 00 00 | Checksum OK:30B9 |
| LEN 6 | Transmission Query => | Source Master | Dest Slave 1 | Function Read Input Register (4) | Func Desk Address=30003, Quantity of Register=1 | | Checksum OK:C9DB |
| LEN 5 | Transmission Response <= | Source Slave 1 | Dest Master | Function Read Input Register (4) | Func Desk Byte count=2 | Data 00 D6 | Checksum OK:AE38 |
| LEN 6 | Transmission Query => | Source Master | Dest Slave 1 | Function Read Input Register (4) | Func Desk Address=30002, Quantity of Register=1 | | Checksum OK:98A |
| LEN 5 | Transmission Response <= | Source Slave 1 | Dest Master | Function Read Input Register (4) | Func Desk Byte count=2 | Data 00 14 | Checksum OK:3FB9 |

## 10.7 Descriptive sensor parameter registers ( Holding Registers)

| Register | Parameter name | Quantity of registers | Remark | Access type |
|---|---|---|---|---|
| 40050 | Device identification number<br>(15 characters) | 8 (2 characters in each register) | The returned data are in form of a 16 byte null terminated string | Read only |
| 40100 | Serial number<br>(11 characters) | 6 (2 characters in each register) | The returned data are in form of a 12 byte null terminated string | Read only |
| 40150 | Firmware version<br>(up to 25 characters) | 13 (2 characters in each register) | The returned data are in form of a 26 byte null terminated string | Read only |

**Example**: Retrieve the device identification number

(The identification number shown in the example is sensor-dependent. It is only used here for demonstration purposes).

| 0D | 03 | 9C | 72 | 00 | 08 | CA | 8B | 0D | 03 | 10 | 30 | 30 | 2E | 31 | 36 | □□□□□□□□□□□□□□□□ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 38 | 30 | 2E | 30 | 30 | 31 | 31 | 33 | 30 | 00 | E8 | 6B | | | | 00.16480.000130□□□ |

| LEN 6 | Transmission Query => | Source Master | Dest Slave 13 | Function Read Holding Register (3) | Func Desk Address=40050, Quantity of Register=8 | Checksum OK:8BCA |
|---|---|---|---|---|---|---|
| LEN 19 | Transmission Response <= | Source Slave 13 | Dest Master | Function Read Holding Register (3) | Func Desk Byte count=16 | Data 30 30 2E 31 36 34 38 30 2E 30 30 31 31 33 30 00 | Checksum OK:6BE8 |

## 10.8 Configuration registers (Holding Registers)

| Register | Parameter name | Allowed values | Quantity of registers | Access type |
|---|---|---|---|---|
| 40001 | Modbus device address | | 1 | Write only |
| 40200 | Baud rate | 96 = 9600<br>192 = 19200<br>384 = 38400 | 1 | Write only |
| 40201 | Parity | 1 = even<br>0 = none | 1 | Write only |

The device must be restarted after each change of a setting!

**Example:** Changing the RTU address from 4 to 1

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 | 10 | 9C | 41 | 00 | 01 | 02 | 00 | 01 | 06 | 48 | 05 | 10 | 9C | 41 | 00 |
| 01 | 7E | 09 | | | | | | | | | | | | | |

| LEN | Transmission | Source | Dest | Function | Func Desk | Byte count | Register values | Checksum |
|---|---|---|---|---|---|---|---|---|
| 9 | Query => | Master | Slave 5 | Write Multiple Register (16) | Address=40001, Quantity=1 | 2 | 00 01 | OK:4806 |

| LEN | Transmission | Source | Dest | Function | Func Desk | Checksum |
|---|---|---|---|---|---|---|
| 6 | Response <= | Slave 5 | Master | Write Multiple Register (16) | Address=40001, Quantity=1 | OK:097E |

## 10.9 Autoconfiguration

All Lambrecht Modbus sensors offer the experienced user the possibility to implement an auto-configuration in his Modbus master based on additional information stored in the sensor. The necessary information can be found in the document “Lambrecht_Modbus_Autoconfiguration”.

# 11 Technical data

| | Combined Ultrasonic Wind Sensor u[sonic] Modbus |
|---|---|
| **ID** | **00.16470.100130** |
| Measuring principle | ultrasound |
| Measuring range | wind direction: 0...359.9°<br>wind speed: 0...75 m/s |
| Survival wind speed | 100 m/s |
| Accuracy | wind direction: < 2° (> 1 m/s) RMSE<br>wind speed: 0.2 m/s RMSE (v < 10 m/s); 2 % RMSE (10 m/s < v < 65 m/s) |
| Resolution | wind direction: 0.1°<br>wind speed: 0.1 m/ |
| Response threshold | 0.1 m/s (adjustable for wind direction) |
| Output | RS 485 |
| Protocol | Modbus RTU |
| Internal measuring rate | 50 Hz |
| Operating conditions | -40...+70 °C (with heating -50...+70 °C); 0...100 % r. h. |
| Supply voltage | without heating: 6...60 VDC; with heating: 24 V AC/DC ± 20 % |
| Current consumption | sensor: typically 50 mA at 24 VDC and deactivated analog output;<br>heating: maximal 2,5 A at 24 V AC/DC |
| Heating data | 60 W (factory configurable) |
| Dimensions | Ø 199 mm; height 149 mm |
| Housing | seawater resistant aluminum; IP 66; IP 67 |
| Weight | approx. 2 kg |
| Standards | • VDE 0100<br>• Low voltage guide line: 72/23 EWG<br>• EMC/EMI: DIN EN 60945 and DIN EN 61000-4-2, -3, -4, -5, -6, -11<br>• Protection class: DIN EN 60529 |
| **Accessories** (please order separately) | |
| **ID 32.14567.060010** | Sensor cable; 15 m; 4-pole; M12 plug |



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