OTT HydroMet

Lufft
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WS Series Smart Weather Sensors

Operational Manual

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1 Scope of supply

The following item is included with delivery:

– Smart weather sensor

2 Order numbers and variant code

2.1 Product variants

Variant	Order number	Authorized region	Frequency range
WS200	8371.1	EU, NA (North America)	–
WS300	8372.1	EU, NA	–
WS301	8374.1	EU, NA	–
WS302	8374.2	EU, NA	–
WS310	8374.5	EU, NA	–
WS400	8369.2	EU	24.150 – 24.250 GHz
WS400-NA	8369.1	NA	24.075 – 24.175 GHz
WS401	8377.1	EU, NA	–
WS500	8373.1	EU, NA	–
WS501	8375.1	EU, NA	–
WS502	8375.2	EU, NA	–
WS510	8375.5	EU, NA	–
WS600	8370.2	EU	24.150 – 24.250 GHz
WS600-NA	8370.1	NA	24.075 – 24.175 GHz
WS601	8376.1	EU, NA	–
WS700	8380.2	EU	24.150 – 24.250 GHz
WS700-NA	8380.1	NA	24.075 – 24.175 GHz
WS800	8381.2	EU	24.150 – 24.250 GHz
WS800-NA	8381.1	NA	24.075 – 24.175 GHz

i Products are delivered and pre-configured with a UMB protocol standard configuration. The full article number for a WS200 is 8371.1-U5140000.The standard delivery does not contain a sensor cable (change in February 2024).

2.2 Accessories and spare parts

Item	Order number
Mast 4.5 m	8357450
Surge protection	8379.USP
Traverse	8367.TRAV1
ISOCON-UMB	8160.UISO
Power supply unit 24 V/100 VA	8366.USV1
External rain gauge WTB100	8353.10
External temperature sensor WT1	8160.WT1
External passive road surface temperature sensor WST1	8160.WST1
Connection cable 10 m	8370.UKAB10
Connection cable 20 m	8370.UKAB20
Connection cable 50 m	8370.UKAB50

3 About this manual

This operational manual is designed for WS devices manufactured from February 2024.

3.1 Other applicable documents and software

The following documents contain further information on installation, maintenance and calibration:

- User Manual Smart Weather Sensors
- Operating Manual UMB ISO Converter ISOCON
- Operating instructions surge protection

The following documents and software can be downloaded at www.lufft.com:

- ConfigTool.NET
- UMB protocol description
- Firmware

> The devices can be operated with various protocols, e.g. XDR and UMB-ASCII. Further information on the protocols and the full description of UMB channels, SDI-12 and Modbus protocol can be found in the User Manual Smart Weather Sensors.

3.2 General signs and symbols

The signs and symbols used in the operational manual have the following meaning:

Practical tip

> This symbol indicates important and useful information.

Action

✓ Prerequisite that must be met before performing an action.

▸ Step 1

⇨ Intermediate result of an action

▸ Step 2

⇨ Result of a completed action

List

- List item, 1st level
  - List item, 2nd level

3.3 Explanation of warnings

To avoid personal injury and material damage, you must observe the safety information and warnings in the operating manual. The warnings use the following danger levels:

WARNING

WARNING

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in death or serious injuries.

CAUTION

CAUTION

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in moderately serious or minor injuries.

NOTICE

NOTE

This indicates a situation from which damage may arise. If the situation is not avoided, products may be damaged.

4 General safety instructions

4.1 Intended use

The smart weather sensors are used outdoors to measure and report various environmental parameters.The sensors are mounted on a stable mast or side bracket and aligned to look vertically upwards. The meteorological measurement values provided are typical used in professional road traffic management systems, renewable energy systems, air quality stations and for different hydro-meteorological applications.

4.2 Potential misuse

Any use of the product that does not comply with the intended use, be this intentional or negligent, is forbidden by the manufacturer.

- Use the product only as described in the operational manual.

4.3 Personnel qualification

The equipment described in this manual must be installed, operated, maintained and repaired by qualified personnel only.

- Obtain training from OTT HydroMet if necessary.

4.4 Operator obligations

The installer is responsible for observing the safety regulations. Unqualified personnel working on the product can cause risks that could lead to serious injury.

- Have all activities carried out by qualified personnel.
- Ensure that everybody who works on or with the product has read and understood the operational manual.
- Ensure that safety information is observed.
- File the operational manual together with the documentation of the entire system and ensure that it is accessible at all times.
- The operational manual is part of the product, forward the operational manual together with the product.

4.5 Personnel obligations

To avoid equipment damage and injury when handling the product, personnel are obliged to the following:

- Read the operational manual carefully before using the product for the first time.
- Pay attention to all safety information and warnings.
- If you do not understand the information and procedure explanations in this manual, stop the action and contact the service provider for assistance.
- Wear the necessary personal protective equipment.
- Pay attention that the devices with precipitation radar (WS400, WS600, WS700, WS800) generate an electromagnetic field that can be harmful to health and can cause cardiac pacemakers to malfunction.

4.6 Correct handling

If the product is not installed, used and maintained correctly, there is a risk of injury. The manufacturer does not accept any liability for personal injury or material damage resulting from incorrect handling.

- Install and operate the product under the technical conditions described in the operational manual.
- Do not change or convert the product in any way.
- Do not perform any repairs yourself.

- Get OTT HydroMet to examine and repair any defects.
- Ensure that the product is correctly disposed of. Do not dispose of it in household waste.

4.7 Health hazards

4.7.1 Risk of electrical shock

Live parts can cause electric shocks in the event of contact.

- Never take measurements on live electrical parts.
- Never touch live electrical parts.

4.7.2 Beware of hair being sucked in

There is a small fan at the bottom of the device. Hair can be sucked into the fan when the device is connected to power.

- Tie up long hair.

4.7.3 Beware of hot surfaces

As soon the device is connected to power the dome gets heated up to approximately 40 °C. Touching the dome can be painful.

- Do not touch the dome.
- Wear protective gloves if necessary.

4.8 Working outdoor

4.8.1 Installation and maintenance at great heights

It is advised to mount the product in a certain height. Therefore, there is a risk of falling down.

- Observe and follow the local safety regulations.
- Use suitable safety equipment.
- Inspect the safety equipment before use.
- Secure the person mounting or maintaining the device against falling down.
- Secure the device against falling down.

4.8.2 Using long cables

Long cables are required to mount the product at great heights. Therefore, there is a risk of strangulation.

- Use long cables properly.
- Observe manufacturer's instructions.
- Observe safety regulations.

4.8.3 Working at roadside

The device can be installed on a mast at the roadside. Special safety regulations apply to prevent accidents and injuries.

- Observe the safety regulations for working at the roadside and in the vicinity of the road carriageway.

4.9 Certification

4.9.1 Europe, USA and Canada

CE (EU)
The equipment meets the essential requirements of EMC Directive 2014/30/EU.

FCC (US)
FCC Part 15, Class "B" Limits

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

IC (CA)
Canadian Radio Interference-Causing Equipment Regulation, ICES-003, "Class B"

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numèrique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

4.9.2 Devices with precipitation radar

Devices with precipitation radar (WS400, WS600, WS700, WS800) are subject to approval regulations which differ between countries. The radar modules have been certified for use in EU, USA and Canada.

If the devices are operated in other jurisdictions, the following must be observed:

- Clarify and ensure compliance with any additional regulatory requirements.
- Obtain any required approvals or certificates at own risk and cost.

CE (EU)
The equipment meets the essential requirements of EMC Directive 2014/30/EU.

FCC (US)
FCC Part 15C – Statement intentional radiator.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

> Unauthorized modification or changes to this wireless communication equipment will void the right to use it. Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment. Any change to the equipment will void the FCC grant.

IC (CA)
Canadian Radio Interference-Causing Equipment Regulation, ICES- 001

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

> Unauthorized modification or changes to this wireless communication equipment will void the right to use it. Changes or modifications to this unit not expressly approved by the party responsible for compliance will void the user's authority to operate the equipment. Any change to the equipment will void the Industry Canada grant.

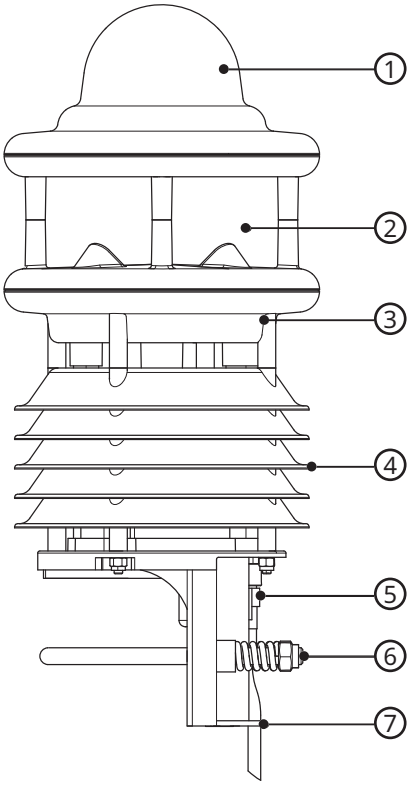
5 Product description

5.1 Design and function

The smart weather sensors can be used for the acquisition of a variety of measurement variables, as used for example for environmental data logging in road traffic management systems. Depending on the model, each device has a different combination of sensors for the various measurement variables.

The equipment is connected by way of an 8-pole screw connector and associated connection cable (10 m long). The measured values are requested over the RS485 interface in accordance with UMB protocol. During commissioning, configuration and measurement polling takes place using the ConfigTool.NET software.

5.2 Product overview



WS600

1	Precipitation sensor (heated)	5	Connector
2	Wind meter (heated)	6	Mounting bracket
3	Air pressure sensor	7	Notch for attaching connection cable
4	Air temperature and relative humidity sensor with fan		

6 Transport, storage, and unpacking

6.1 Unpacking

- Carefully remove the product from the packaging.
- Check that the delivery is complete and undamaged.
- If you find any damage or if the delivery is incomplete, then immediately contact the supplier and manufacturer.
- Keep the original packaging for any further transportation.

6.2 Storage

- Store within specified temperature ranges.
- Store in dry area.
- Store in original box where possible.

7 Installation

7.1 Mechanical installation

7.1.1 Required tools and aids

The following tools and aids are required:

- open-end or ring spanner, SW 13
- compass

7.1.2 Choosing a site

WARNING

Risk of injury due to improper installation!

If the mast or the device is installed improperly, damage to the device and injury to people may result.

- Ensure that the mast stands on a stable surface.
- Ensure that the mast is sized and anchored appropriately.
- Ensure that the mast is earthed in accordance with the regulations.
- Use only approved and tested appliances (conductors, risers etc.) to install the device on the mast.

- Ensure the following at the site:

- Free access to the equipment for maintenance works
- Reliable power supply for permanent operation
- Good network coverage when transmitting over a mobile communications network

7.1.2.1 Installing devices with wind measurement and compass

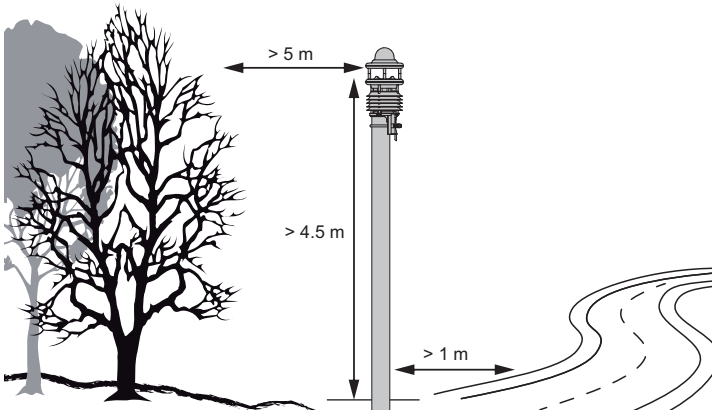
For accurate compass readings, an aluminium mast is recommended.

- Install the device on top of the mast at least 2 m above the ground.
- Ensure there is free field around the device.

Buildings, bridges, embankments and trees may corrupt the wind measurement. Passing traffic may cause gusts which may influence the wind measurement.

7.1.2.2 Installing devices with radar precipitation measurement

When selecting the installation site, take care that the device is set up at an appropriate distance from other systems with a 24 GHz radar sensor, e.g. traffic counting devices on overhead gantry signs. Otherwise, cross effects and system malfunctions may occur. The distance to other measuring systems depends on their range of coverage and signal strength.



Installation near the road, WS600

If the device is used to observe the weather for road and traffic control systems, carry out the following installation steps:

- Install the device at the top of the mast or on a suitable mast crossbeam with a clear view at least 4.5 m above the ground. If there are no moving objects in wider circumference of the device, a lower installation height is possible.
- Keep at least 1 m distance to the road carriageway.
- Keep at least 5 m distance at the height of the device from moving objects, e.g. trees, bushes and bridges.
- Keep at least 8 m distance between devices with radar precipitation measurement.

i Falling or moving objects, e.g. falling leaves or leaves blowing in the wind, may cause false measurements, e.g. incorrect precipitation types are measured.

i Strong wind may affect the accuracy of the precipitation measurement. Installation locations where wind turbulence is to be expected, e.g. due to buildings, are not suitable.

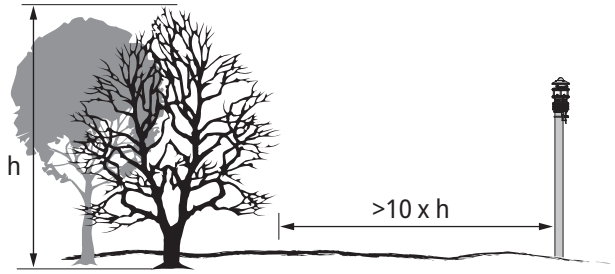
7.1.2.3 Installing devices with rain gauge

The site must be chosen in such a way that pollution of the rain gauge funnel e.g. by falling leaves is avoided.

- Install the device on top of the mast or on the crossbar with distance to the mast.
- Ensure that the device is mounted exactly perpendicular to the mast or the crossbar, otherwise the precision of the rain gauge may be influenced.

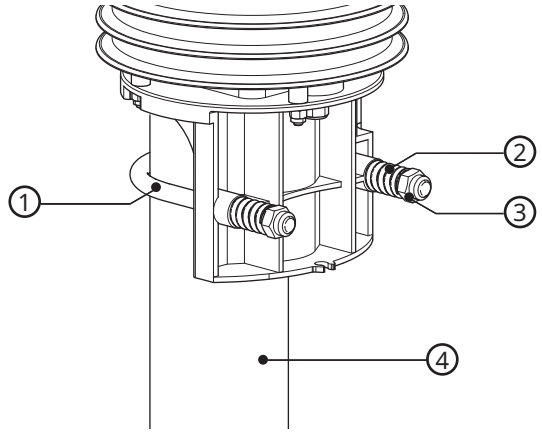
7.1.2.4 Installing devices with global radiation measurement

- Install the device on top of the mast.
- Chose a shadow free location with 360° free view to the horizon at the height of the pyranometer.
- Keep a distance of at least 10 times the object height relative to the device from shadowing objects, e.g. trees and buildings.



7.1.3 Fastening

The mounting bracket is designed to be installed on top of a mast with a diameter of 60 to 76 mm or on a suitable mast crossbeam.

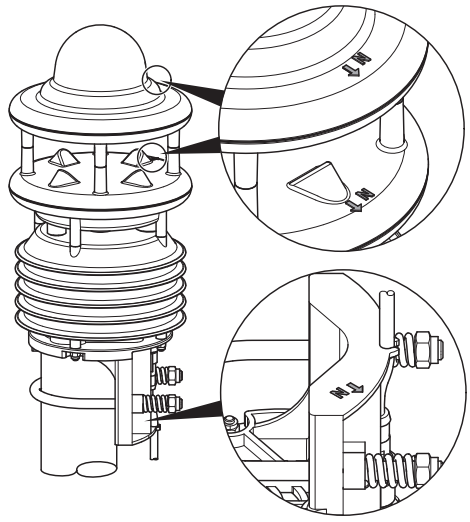


1	Mounting bracket	3	Nut with washer
2	Spring	4	Mast

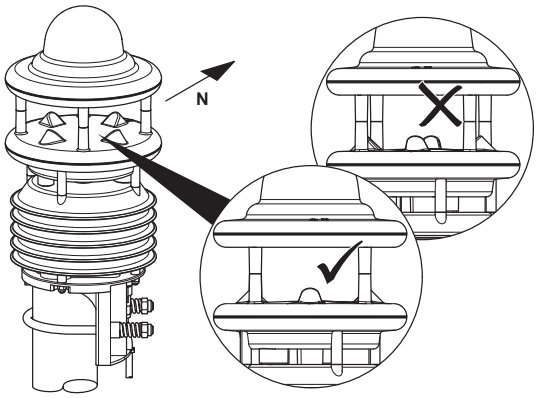
- Loosen the nuts.
- Push the device onto the top of the mast or crossbeam from above.
- Tighten the nuts evenly until they touch the springs but the device can still be moved easily.
- For wind meters, align the device to the north.
- Tighten both nuts with 3 revolutions.

7.1.4 Aligning to north

In order for the wind direction to be displayed correctly, the device must be aligned to the north. The device has a number of directional arrows for this purpose.



- If the device is already installed, loosen both nuts evenly until the device can be turned easily.
- Using the compass, identify the north and fix a point of reference on the horizon.
- Position the device in such a way that the south and north wind sensors are aligned with the fixed point of reference in the north.



- Tighten both nuts with 3 revolutions.

The magnetic North Pole displayed by the compass differs from the Geographic North Pole. When aligning the device, the declination (variation) at the location must be taken into account. Depending on the location, the deviation can be more than 15°, for example in North America. In Central Europe the variation is less than 3° and can be neglected.

7.1.5 Setting rain gauge

The devices with rain gauge can be operated with resolutions 0.2 mm and 0.5 mm. To change the resolution, the effective area of the funnel is modified using the reduction ring supplied.

- Mount the reduction ring on the funnel to set the resolution to 0.5 mm.
- Mount the funnel without the reduction ring to set the resolution to 0.2 mm.
- Set the resolution in the ConfigTool.NET software.

7.2 Electrical installation

Ultrasonic device do generate noise close-by the device and not hearable by humans.

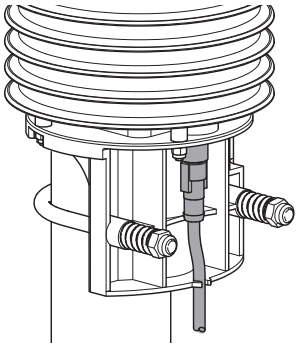
7.2.1 Electrical connections

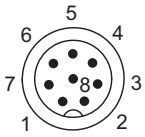
WARNING

Electric shock due to incorrectly connected device!
If the device is not connected correctly, it may be permanently damaged and an electric shock may result.

- Ensure that the device is connected correctly.
- Ensure that the cable shielding is connected to earth in the electrical cabinet.
- Remove the yellow protective cap before plugging the device in.

There is an 8-pole screw connector on the underside of the device. This serves to connect the supply voltage and the interfaces via the connection cable.





Pin assignment

Number	Color	Assignment
1	White	Supply voltage ground and SDI-12_GND
2	Brown	Positive supply voltage (through 2.5 A fuse where required)*
3	Green	RS485_A (+)
4	Yellow	RS485_B (-) or SDI-12 data line
5	Gray	External sensor a
6	Pink	External sensor b
7	Blue	Heating voltage ground
8	Red	Positive heating voltage (through 2.5 A fuse where required)*

*WS400, WS600, WS700, WS800: Supply voltage and heating voltage must be protected by a fuse 2.5 A (fine) each.

The supply voltage and the heating voltage are protected against polarity reversal.

7.2.1.1 Connecting devices in SDI-12 mode

- Connect the signal ground (SDI-12_GND) to line 1 (white), if the data logger and device supply voltage are DC-isolated.
- Do not connect the line 3 (green).

7.2.2 Supply voltage

The supply voltage is 4 to 30 V DC. The power supply unit used must be approved for operation with equipment of protection class III (SELV). Operation with a supply voltage of 24 V is recommended. Limitations apply in case of supply voltages lower than 12 V.

7.2.2.1 Limitations in 12 V mode

If the heating is operated on 12 V DC, the functional restrictions in winter operation has to be kept in mind. A heating voltage of 24 V DC is recommended to guarantee full heating duty.

7.2.2.2 Limitations with supply voltage below 12 V

When operating devices with a supply voltage lower than 12 V DC, the fan is not switched on regardless of the fan operating mode. This may influence the accuracy of the temperature and humidity measurement in case of intensive solar radiation or calm wind situations and lead to deviations of the compass measurement values.

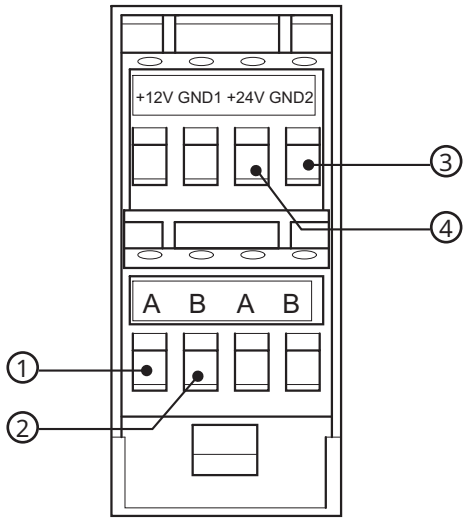
When operating devices in power save modes with supply voltages below 12 V, the minimal supply voltage depends on the length of the connection cable.

7.2.3 RS485 Interface

The device has a half-duplex, 2 wire RS485 interface for configuration, measurement polling and the firmware update.

7.2.4 Connecting ISOCON-UMB converter

The ISOCON-UMB communication module converts RS485 into RS232.



1	Green: RS485 interface A	3	White: supply voltage ground GND2
2	Yellow: RS485 interface B	4	Brown: positive supply voltage +24 V

- Connect the brown, white, green and yellow wires to the ISOCON-UMB converter.
- Connect the red and blue wire direct to the power supply unit, not to the ISOCON-UMB converter.
- Refer to the operating manual UMB ISO converter ISOCON.

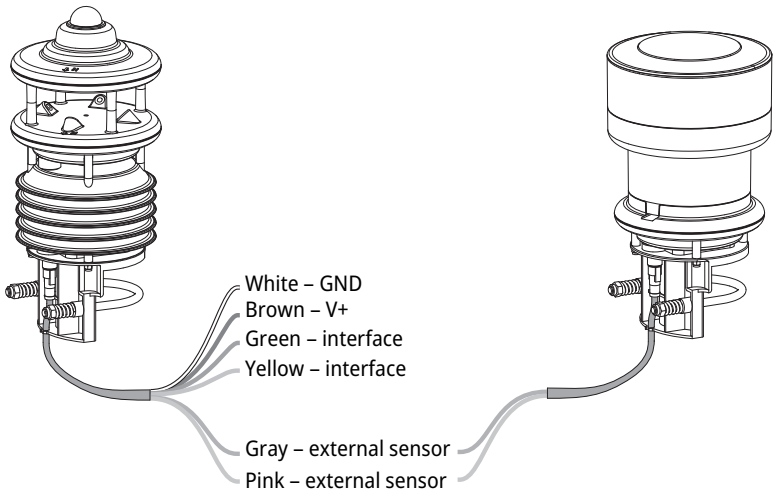
7.2.5 Installing surge protection

The surge protection serves to protect the device against voltage spikes.

- Install the surge protection between the device and ISOCON-UMB converter.
- Refer the operating instructions of the surge protection.

7.2.6 Connecting external sensors

External temperature and precipitation sensors can be connected to the device. The connection is made via the standard connector plug of the device and the external sensor will be connected at the end of the delivered cable. All external sensors are unipolar, so any connection sequence can be chosen.



Connection WS501 and external rain gauge (WTB100)

- Avoid parasitic coupling when connecting.
- Use a short cable for the connection.
- When the external sensor is mounted near to the device while the control cabinet is distant, install an additional distribution box.
- Connect the external sensor to the gray and pink wires of the connection cable.
- Set the type of the external sensor in the ConfigTool.NET software.

8 Commissioning for UMB data format

The devices can be operated with various protocols, e.g. XDR and UMB-ASCII. Further information on the protocols and the full description of UMB channels, SDI-12 and Modbus protocol can be found in the User Manual Smart Weather Sensors.

8.1 Device set-up

After the equipment has been installed and connected correctly, the device begins autonomously to take measurements. No protective cover needs to be removed from the device.

The following is required for configuration and testing purposes:

- Windows® PC with serial interface
- ConfigTool.NET software
- Interface cable: RS485 – USB interface adapter

Proceed as follows for commissioning:

- Check for correct equipment operation on site by carrying out a measurement request with the aid of the ConfigTool.NET software.
- Configure the local altitude to ensure the correct calculation of the relative air pressure.
- To ensure a correct wind measurement, align the device to the north or activate the automatic compass correction.
- Configure the local declination to get correct compass headings.
- If several smart weather sensors are operated on a UMB network, assign a unique device ID to each sensor.

8.2 Configuration and testing

For configuration and testing OTT HydroMet Fellbach GmbH provides the proprietary software ConfigTool.NET. ConfigTool.NET can also be used to update the firmware of the device.

- Download the ConfigTool.NET software: www.lufft.com/resources/
- Install the software on the computer.
- Get familiar with the software in general.
- Ensure to always use the latest version of ConfigTool.NET.
- During configuration and testing, disconnect other devices that poll the UMB-Bus, e.g. modem or LCOM.
- Ensure that the connection settings of ConfigTool.NET are conform to the settings of the device.

The functions explained below may not be available for all types of the smart weather sensor.

The operation of the ConfigTool.NET is described in detail in the help function of the Windows® PC software. For this reason only the menus and functions specific to the device are described below.

8.2.1 Factory settings

The device is delivered with the following settings:

Specification	Value
Class ID	7 (cannot be modified)
Device ID	1 (gives address 7001h = 28673d) 200 (fixed address since firmware 6.8)
Baudrate	19200
RS485 protocol	Binary
Calculation interval	10 measurements
Local altitude	0 m

8.3 Configuration using UMB binary protocol

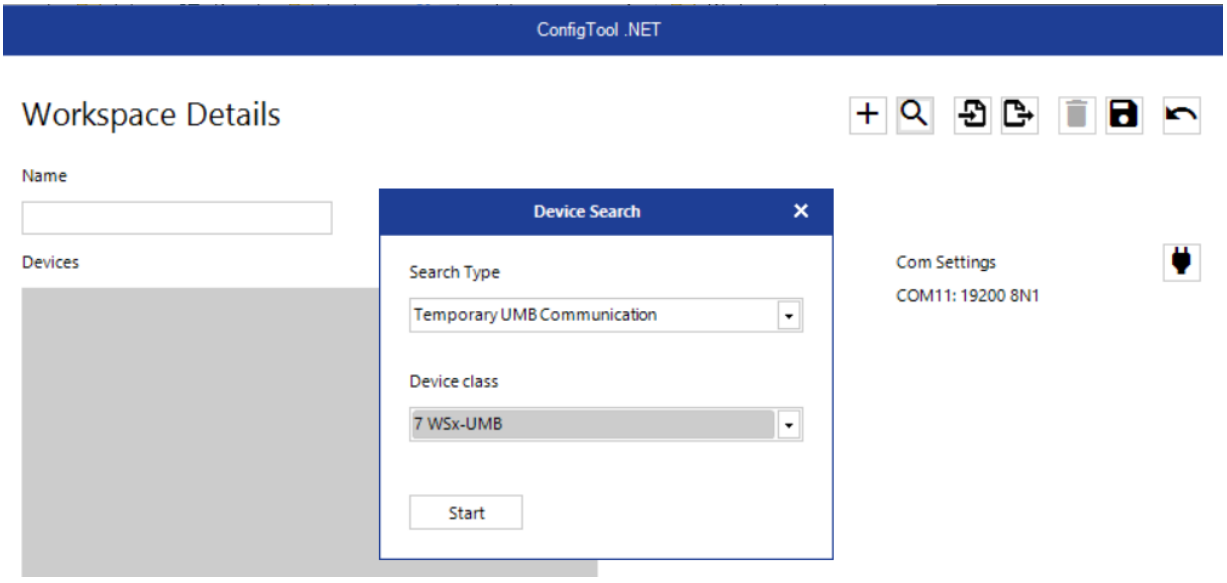
When the device is using UMB binary protocol the baudrates and the parity can be adjusted in the ConfigTool.NET software. The interface is operating in standard UMB mode (19200 8N1) and responds to the configured ID and additionally to ID 200 for the first 5 seconds after power up or reset. If a valid UMB telegram is received within these 5 seconds, the device will stay in UMB mode for the configured time (several minutes) so that the configuration can be modified.

> Starting with firmware version v6.8 WSx00 always responds to ID 200 additional to the configured ID. So ID 200 may be considered to be a broadcast address without functional restrictions. For communication via ID 200 only one device of a device class (in this case WSx00 and WS3000, device class 7) may be connected to one UMB bus. WSx00 with firmware version < v6.4: Devices configured for ID 1 will stay at ID 1.

8.3.1 Configuration using ConfigTool.NET Version 1.5.1693 or newer

With ConfigTool.NET Version 1.5.1693.0 or newer, the communication in UMB standard mode is as follows:

- Connect the PC to the device through a RS485 converter.
- Start the ConfigTool.NET software and create a new workspace with communication parameters set to 19200Bd, 8N1.
- On *Workspace Details* page click the magnifier button to open the *Device Search* window.



- In the *Search Type* section, select *Temporary UMB Communication*.
- In the *Device class* section, select *7 WSx-UMB*.
- Click on the **Start** button and restart the device (power off / on).

⇨ ConfigTool.NET establishes a connection (ID 1 or ID 200) within a few seconds and reads the channel list.

⇨ The device is ready for configuration work.

8.3.2 Configuration using older versions of ConfigTool.NET

When using older versions of ConfigTool.NET or other tools the communication can be opened by the following procedure:

- Connect the PC to the device through a RS485 converter.
- Start ConfigTool.NET and create a WSx00-UMB with ID 200 (device with firmware version < v6.4 and ID 1: use ID 1).
- Open the page *Device Settings*.
- Alternatively, start the measurement with at least one channel and with 1 second polling rate.
- Restart the device (power off / on).

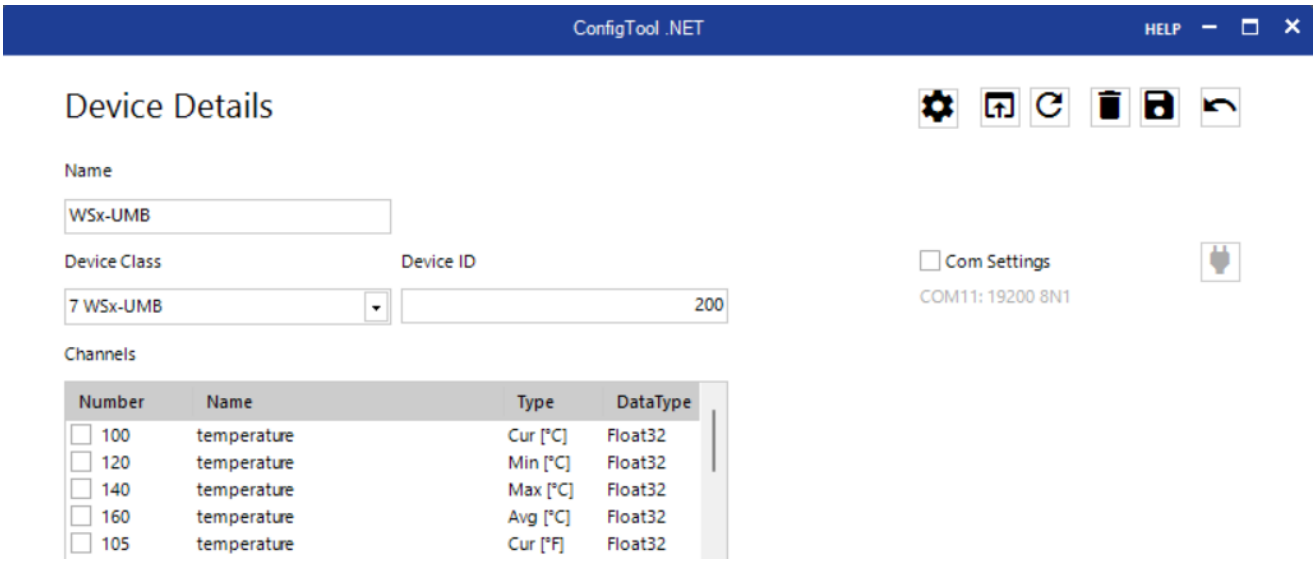
⇨ The device establishes the connection (green indicator, "Connected") within a few seconds.

⇨ When using the alternative method valid measurement values will be indicated within a few seconds. The ConfigTool.NET measurement can then be stopped.

⇨ The interface is now open for configuration.

8.3.3 Selecting device

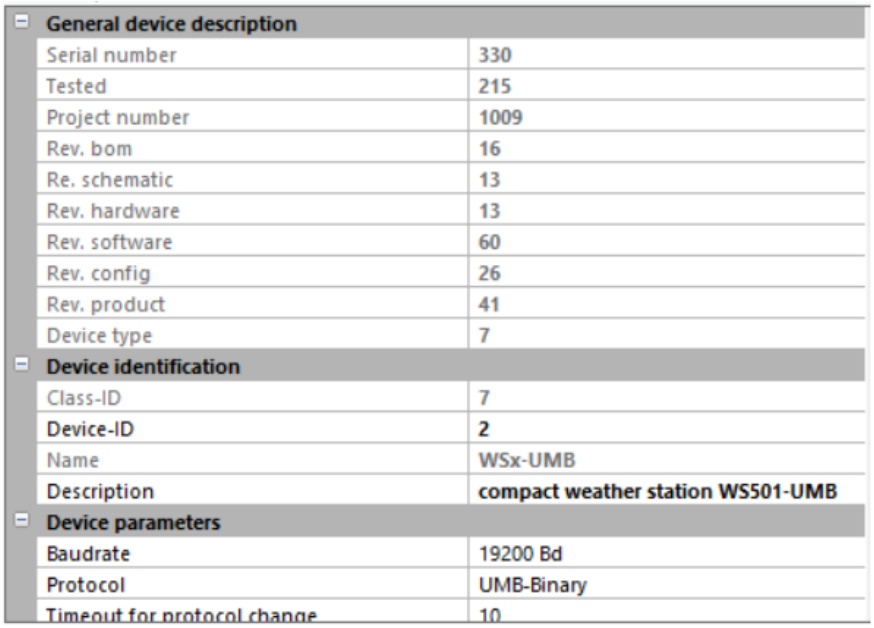
- Select an existing workspace or create a new one.
- Click the button to add a new device to the workspace.



⇨ The device appears in the selection menu as *WSx-UMB* (Class ID 7).

- Enter a *Name* for the new device and adjust the *Device ID* if necessary.
- Confirm with **OK**.

8.3.4 General settings



General device description	
Serial number	330
Tested	215
Project number	1009
Rev. bom	16
Re. schematic	13
Rev. hardware	13
Rev. software	60
Rev. config	26
Rev. product	41
Device type	7
Device identification	
Class-ID	7
Device-ID	**2**
Name	WSx-UMB
Description	**compact weather station WS501-UMB**
Device parameters	
Baudrate	19200 Bd
Protocol	UMB-Binary
Timeout for protocol change	10

Parameter	Description
Device-ID	Factory setting: 1 Assign the IDs for the devices in ascending order.
Description	To differentiate the devices enter a description, e.g. the location.
Baudrate	Transmission speed of the RS485 interface Factory setting: 19200 DO NOT change for operation with ISOCON-UMB.
Protocol	Communication protocol of the device: UMB-Binary, UMB-ASCII, SDI-12, MODBUS-RTU, MODBUS-ASCII, Terminal-Mode, XDR
Timeout for protocol change	In the event of a temporary changeover of the communication protocol, the system switches back to the configured protocol after this time (in minutes).

i If the baudrate is changed, after saving the configuration on the device, the device communicates at the new baudrate. When operating the device in a UMB network with ISOCON-UMB, this baudrate must not be changed; otherwise the device is no longer addressable and can no longer be configured.

8.3.5 Energy management

The energy consumption of the device can be adapted to the circumstances of the installation by setting the following parameters:

Generic Parameters	
Altitude	0
SDI-12 Units	Metric
Compass correction	Off
Operation mode	Normal
External sensor	**Rain gauge**
Rain gauge resolution	0.2 mm
TFF	
Temperature offset	0
Relative humidity offset	0
Temperature interval	10
Relative humidity interval	10
Fan	On
Temperature, ext.	
Temperature offset	0
Pressure	
Air pressure offset	0
Air pressure interval	10
Global radiation	
Global radiation interval	10
Wind	
Wind speed min.	0.3
Setpoint temperature	50
Wind interval	10
Heater mode	Auto
Heater temperature Mode 1	5
Eco Mode follow up time	30
Compass	
Compass offset	0

Parameter	Description
Operation mode	The power consumption of the device can be adjusted to the properties of the individual installation. The operation of the power save modes has certain constraints.
Fan	To reduce electrical power, the fan can be switched off. If the fan is switched off, all heaters will also be switched off. With the fan switched off deviations in temperature and humidity measurement can occur by solar radiation.
Heater mode	The heating is set to *Auto* on delivery. This is the recommended operating mode.

8.3.5.1 Normal operation mode

In normal operation mode, all specified properties of the devices are available. The power consumption is mainly determined by heating and fan operation.

8.3.5.2 Power saving mode 1

The power saving mode 1 has the following effects:

- The ventilation of the temperature and humidity unit is switched off.
- All heaters are switched off.
- The radar rain sensor of the following devices is not working continuously: WS800, WS700, WS600, WS400. The sensor is activated once per minute for one second. If precipitation is detected, it remains turned on until the end of the event. Otherwise the sensor is deactivated again after this second.
- Compass measurement is only performed once after power up. The deactivated fan automatically switches on for the duration of this measurement.
- The WS700 and WS800 increase the measuring cycle time for global radiation from 10 seconds to 1 minute.
- The lightning detection probe in the WS800 is activated once per minute for one second similar to the radar rain sensor.

The power saving mode 1 has the following restrictions:

- With the fan switched off deviations in temperature and humidity measurement can occur by solar radiation.
- Only limited winter operation is possible because any icing may prevent the correct operation of the rain sensor or wind meter.
- The rain detection may be delayed up to 2 minutes. Short events are possibly not detected. Thus, deviations in the accuracy of the precipitation quantity are possible.
- Short lightning events are possibly not detected.

8.3.5.3 Power saving mode 2

The power saving mode 2 permits further reduction of the power consumption. The device is almost completely switched off and only wakes up for 10 to 15 seconds when data is requested for one measurement cycle. The total consumption is mostly determined by the data request interval.

The power saving mode 2 has the following restrictions:

- All restrictions of power saving mode 1
- The power saving mode 2 is not available for devices with radar rain sensor: WS800, WS700, WS600, WS400. For low power applications, devices with tipping bucket rain gauge are recommended.
- The calculation of average, minimum and maximum as well as precipitation intensity are not available. Only instantaneous values will be transmitted.
- Compass measurement is only performed once after power up. The deactivated fan automatically switches on for the duration of this measurement.
- The communication protocol Modbus is not available.
- When using the UMB protocol, the interval length must be at least 15 seconds to ensure that the measurement and transmission cycle are completed. Otherwise, the device may stay in transmission state without starting a new measurement.
- Joint operation with other sensors in a UMB network is only possible, if each telegram wakes up the device for several seconds and the minimum interval length is observed. This increases the total power consumption.
- Mixed operation of devices in power saving mode 2 with devices in normal operation and fast request rates within the same UMB network is not possible.

8.3.6 Configuring external sensors

The device must be configured for the selected type of external sensor to enable the correct evaluation of the measurement data.

- Select the external sensor.

Generic Parameters	
Altitude	0
SDI-12 Units	Metric
Compass correction	Off
Operation mode	Normal
External sensor	**Rain gauge**
Rain gauge resolution	0.2 mm

If data is requested from the channels of an external sensor currently unselected, the device responds with "invalid channel".

8.3.7 Specific settings

8.3.7.1 Temperature, humidity and fan settings

TFF	
Temperature offset	0
Relative humidity offset	0
Temperature interval	10
Relative humidity interval	10
Fan	On

Parameter	Description
Temperature offset	
Relative humidity offset	Absolute offset on the measurement in the unit indicated in the parameter description field (for on-site calibration).
Interval	Time in minutes for the minimum, maximum and average value calculation interval.
Fan	To reduce electrical power, the fan can be switched off. If the fan is switched off, all heaters will also be switched off. With the fan switched off deviations in temperature and humidity measurement can occur by solar radiation.

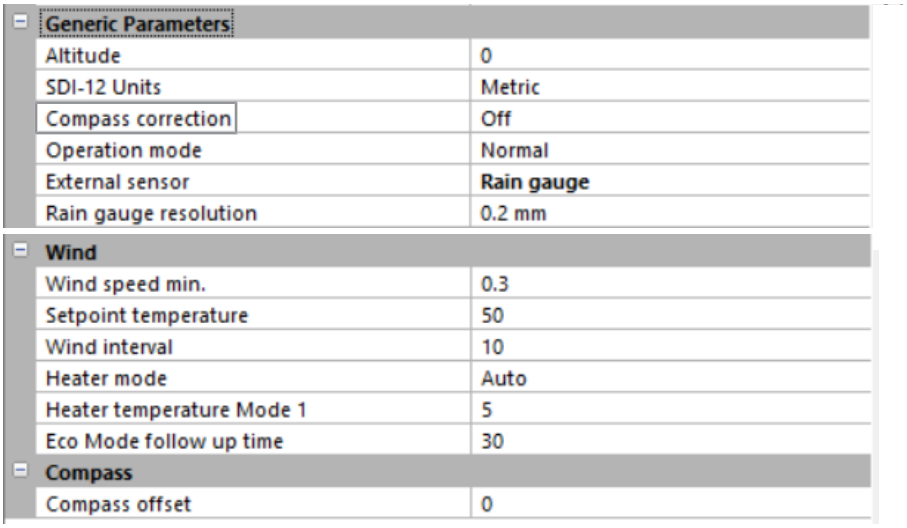
In order to calculate dew point, absolute humidity and mixing ratio, the temperature and humidity measurement always requires the same interval. For this reason different intervals cannot be set.

8.3.7.2 Pressure settings

Generic Parameters	
Altitude	0
SDI-12 Units	Metric
Compass correction	Off
Operation mode	Normal
External sensor	**Rain gauge**
Rain gauge resolution	0.2 mm
Pressure	
Air pressure offset	0
Air pressure interval	10

Parameter	Description
Altitude	Enter the local altitude in meters here for the correct calculation of relative air pressure (referenced to sea level).
Air pressure offset	Absolute offset on the measurement in the unit indicated in the parameter description field.
Air pressure interval	Time in minutes for the minimum, maximum and average value calculation interval.

8.3.7.3 Wind and compass settings



Parameter	Description
Compass correction	With activated compass correction all wind direction values will be corrected according to the alignment of the device, as evaluated by the compass.
Wind speed min.	Minimum wind speed from which a measurement is transmitted, in the unit indicated in the parameter description field.
Setpoint temperature	Setpoint temperature in °C for the wind sensor heater.
Wind interval	Time in minutes for the minimum, maximum and average value calculation interval.
Heater mode	The device can be configured for heating in different operating modes. Select *Auto* in normal operating mode.
Heater temperature Mode 1	Temperature in °C, below which the heating is active in Mode 1.
Eco Mode follow up time	Power-on time of the heating in Eco Mode 1
Compass deviation	Dependent on the location of the installation; the local declination of the earth magnetic field has to be considered.

8.3.7.4 Precipitation sensor settings (radar)

Radar rain sensor	
Evaporation per day	0.24
Rainfall correction factor	1
Snowfall correction factor	1
Follow up time	120
Shnow factor	20
Rain factor	50
Heater mode	Auto
Heater temperature Mode 1	5
Set point temperature	70
Follow up time Mode 1	30
Operation mode	Standard
Rain gauge resolution	0.2 mm

Parameter	Description
Heater mode	The device can be configured for heating in different operating modes. Select *Auto* in normal operating mode.
Follow up time	Shows the detected precipitation type for this time in seconds. To cover all events, this time must be adjusted to the poll rate.

The other parameters, e.g. evaporation or correction factors, can be used to adapt the precipitation detection to special local conditions. They should only be modified after consultation with OTT HydroMet Fellbach GmbH, as they have a major influence on the functioning and accuracy of the sensor.

8.3.7.5 Precipitation sensor settings (rain gauge)

Radar rain sensor	
Evaporation per day	0.24
Rainfall correction factor	1
Snowfall correction factor	1
Follow up time	120
Shnow factor	20
Rain factor	50
Heater mode	Auto
Heater temperature Mode 1	5
Set point temperature	70
Follow up time Mode 1	30
Operation mode	Standard
Rain gauge resolution	0.2 mm

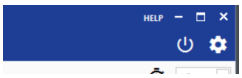
Parameter	Description
Rain gauge resolution	The resolution depends on whether the reduction ring is fitted or not. Funnel with reduction ring: 0.5 mm Funnel without reduction ring: 0.2 mm

If the mechanical setting and configuration setting do not conform, the sensor will deliver wrong precipitation values.

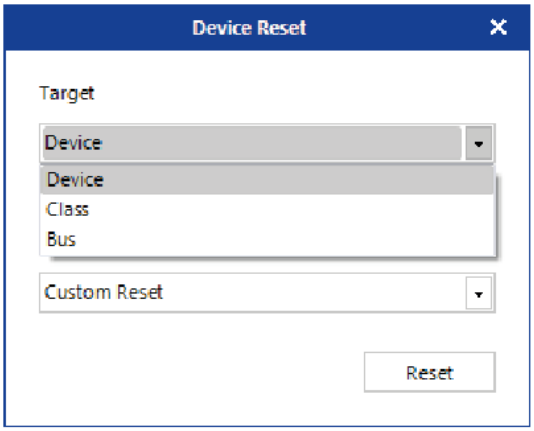
8.3.7.6 Reset precipitation quantity

To reset the accumulated absolute precipitation quantity, proceed as follows:

- Click the reset symbol in the ConfigTool.NET software, top right of the window header.

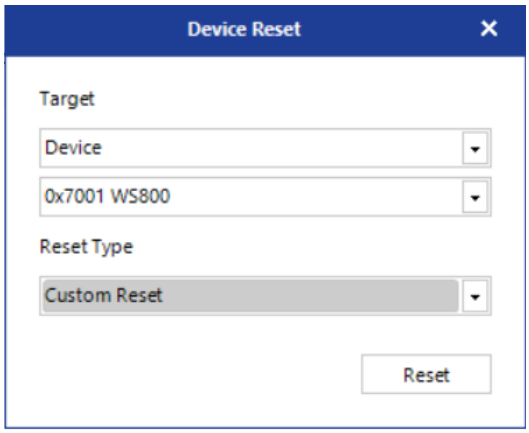


- In the *Target* section, select a new target from the drop-down menu.



Parameter	Description
Device	Currently used device
Class	Class of devices
Bus	All devices connected to the UMB network

- In the *Reset Type* section, select *Custom Reset*.



- Click the **Reset** button.

8.3.7.7 Global radiation settings

Parameter	Description
Global radiation interval	Time in minutes for minimum, maximum and average value calculation.

8.3.7.8 Lightning sensor settings

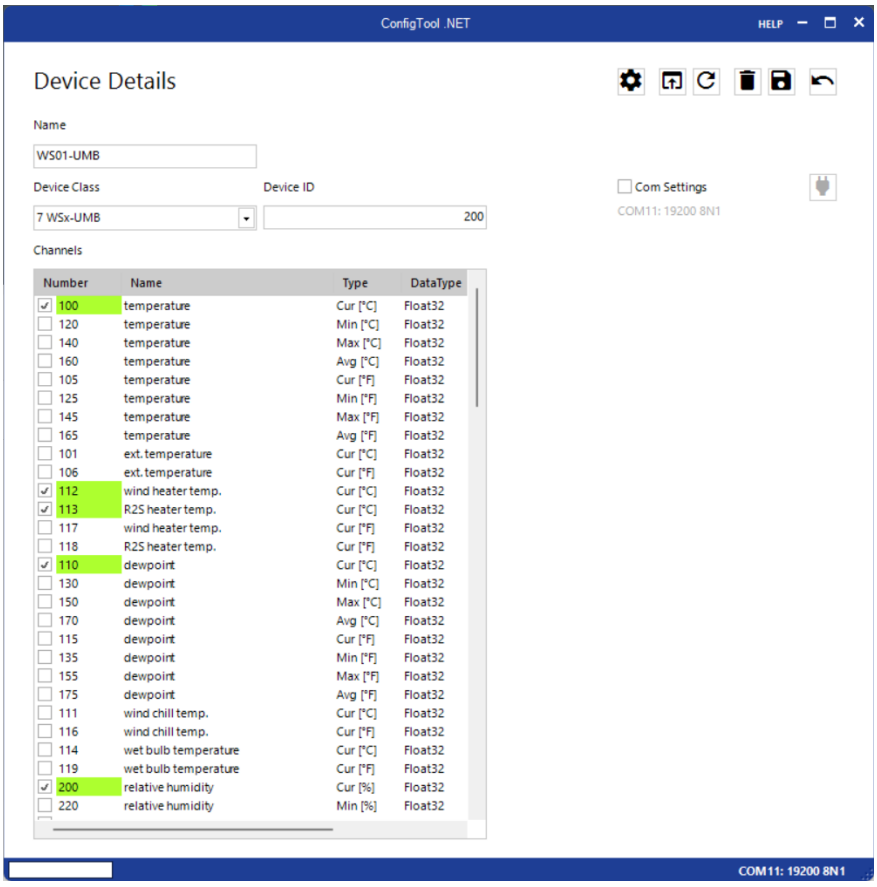
Lightning sensor	
Lightning interval	10

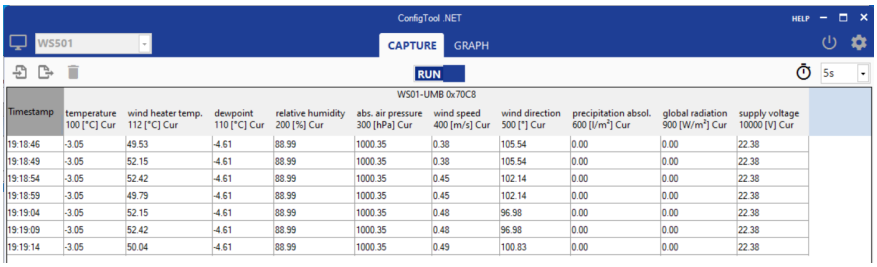
Parameter	Description
Lightning interval	Time in minutes for minimum, maximum and average value calculation.

8.4 Testing

The functions of the device can be tested with the ConfigTool.NET software by polling various channels.

- Click on the desired channel.





Example of measurement polling

The ConfigTool.NET software is provided for test and configuration purposes only. The tool is not suitable for the permanent acquisition of measurement data. For this purpose the use of professional software is recommended, e.g. Lufft SmartView3.

9 Commissioning for SDI-12 data format

The devices can be operated with various protocols, e.g. XDR and UMB-ASCII. Further information on the protocols and the full description of UMB channels, SDI-12 and Modbus protocol can be found in the User Manual Smart Weather Sensors.

9.1 Device set-up

Preconfigured smart weather sensors with the SDI-12 protocol are available upon request.

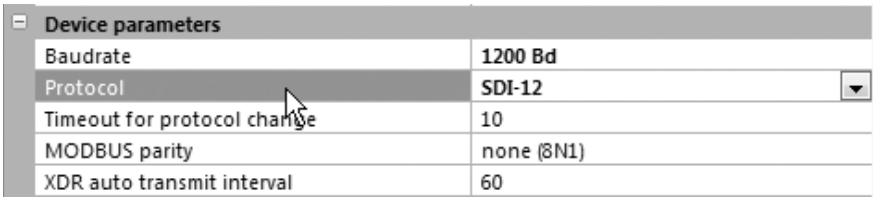
The communication in the SDI-12 mode of the smart weather sensor is conforming to the standard defined in "SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors Version 1.3 January 12, 2009" . The device may be operated in bus mode together with other SDI-12 sensors, connected to one SDI master (logger).

With firmware version v69, or higher an option for SDI-12 communication through RS485 is available. If this feature is also permitted by the SDI-12 logger in use, it allows communication over longer distances and reduces the susceptibility to electromagnetic interferences compared to the hardware interface defined by the SDI-12 standard.

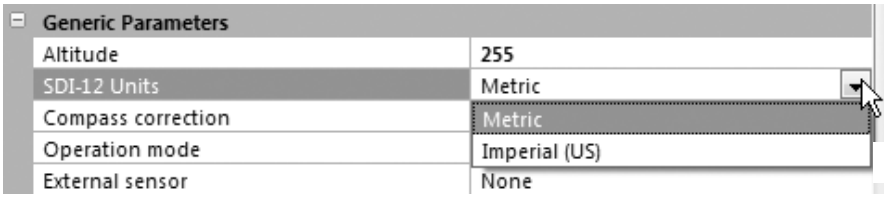
9.2 Configuration and testing

The parameters for SDI-12 must be set in the ConfigTool.NET software.

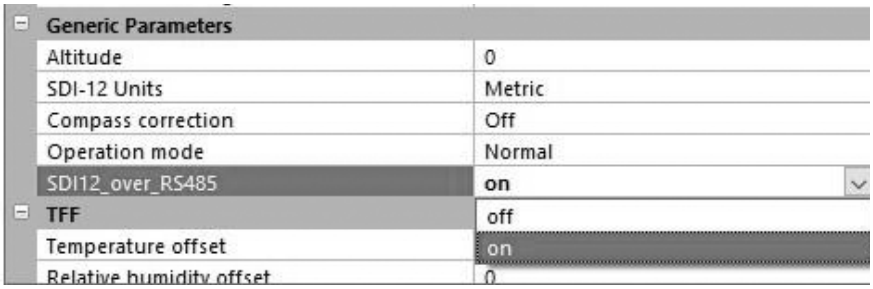
- Set the *Device Parameters* as follows:
  Baudrate: 1200 Bd
  Protocol: SDI-12



- Select the unit *Metric* or *Imperial (US)* of the transmitted measurement data.



- Select whether to communicate via the RS485 standard.



Using the ISOCON-UMB for SDI-12 over RS485 does not work because the RS485 interfaces of ISOCON-UMB are fixed to 19200 bd.

9.3 Command set

The commands listed below are available for devices of the smart weather sensors.

The composition of the minimal and the full basic data set depends on the respective device variant. The same applies to the availability of the additional measurement commands (aM1!, aC1!, etc.). Due to the measuring processes used, the devices measure continuously in normal operation mode.

This causes the following special properties while in normal operation mode:

- The device does not need a “Wakeup” and does not have a sleep mode. So the reactions to “Break” signals and any related timings are inapplicable. “Break” will be ignored by the devices.
- Data requested with M-commands or C-commands are always available immediately. The device will always respond with a000n resp. a000nn. This means the device will not send any service request and will ignore measurement abort signals. The logger should request the data immediately.
- M-command and C-command only differ in the number of values made available in the buffers (in both cases the maximum permitted by the standards of 9 resp. 20).
- The commands for continuous measurement (R-commands) are used to request the data.
- When in power saving mode 2 the device will wake up by a „Break“ signal. Other functions of the „Break“ signal are not implemented.
- When in power saving mode 2 the device responds to M-commands or C-commands with a002n resp. a002nn and holds the data available within 2 seconds. A service request is not sent, signals to abort the measurement are ignored.
- For the reduced data set in power saving mode 2 a unified data buffer structure for all device models has been defined. Depending on the individual model unused channels will be set to the “invalid” marker 999.9.

Command	Function	Details
?!	Address search (Wildcard request, one device only on bus!)	Standard
a!	Request device active?	Standard
aI!	Request device identification	all
aAb!	Address change to b (0 ... 9, A ...Z, a ... z)	Standard
aM!	Measurement basic minimal data set	WS200, WS300, WS301, WS302, WS310, WS400, WS401, WS500, WS501, WS502, WS510, WS600, WS601, WS700, WS800, PSM 2 all
aM1!	Measurement temperatures	all
aM2!	Measurement humidity	all
aM3!	Measurement air pressure	all
aM4!	Measurement wind	all
aM5!	Measurement compass	all
aM6!	Measurement precipitation	all
aM7!	Measurement global radiation	all
aM8!	Measurement external temperature	all
aMC!	Measurement, basic minimal data set, transmit values with CRC	see aM!
aMC1! ... aMC8!	Measurement (assignment of values as for aMn! commands), transmit values with CRC	see aM1! ... aM8!

Command	Function	Details
aC!	Concurrent measurement, full basic data set	see aM1!
aC1! ... aC8!	Concurrent measurement, assignment of values as for aMn! commands, partly extended data sets	see aM1! ... aM8!
aCC!	Concurrent measurement, transmit values with CRC	see aM!
aCC1! ... aCC8!	Concurrent measurement, assignment of values as for aMn! commands, partly extended data sets, transmit values with CRC	see aM1! ... aM8!
aD0!	Data request buffer 0	Standard
aD1!	Data request buffer 1	Standard
aD2!	Data request buffer 2	Standard
aD3!	Data request buffer 3	Standard
aD4!	Data request buffer 4	Standard
aR0!	Data request from continuous measurement, data set 0	WS200, WS300, WS301, WS302, WS310, WS400, WS401, WS500, WS501, WS502, WS510, WS600, WS601, WS700, WS800, PSM 2 all
aR1!	Data request from continuous measurement, data set 1	see R0!
aR2!	Data request from continuous measurement, data set 2	see R0!
aR3!	Data request from continuous measurement, data set 3	see R0!
aR4!	Data request from continuous measurement, data set 4	see R0!
aRC0!	Data request from cont. meas., data set 0 with CRC	see R0!
aRC1!	Data request from cont. meas., data set 0 with CRC	see R0!
aRC2!	Data request from cont. meas., data set 0 with CRC	see R0!
aRC3!	Data request from cont. meas., data set 0 with CRC	see R0!
aRC4!	Data request from cont. meas., data set 0 with CRC	see R0!
aV!	Command verification: Evaluate sensor status and heating temperatures, data request with aD0!, aD1!	all
aXU<m/u>!	Change the unit system for SDI data	all
aXH+nnnn!	Set local altitude of the device for calculation of rel. air pressure	all
aXD+nnn.n!	Set local compass deviation	all
aXW<c/u>!	Activate / deactivate compass correction	all
aXL<n/s/w>!	Set power saving mode	all
aXMn!	Set the heating mode of the device	all
aXK+n!	Set rain gauge resolution	all
aXA<t/p/w>+nn!	Integration time for average and min/max evaluation	all
aXC!	Clear the abs. precipitation amount (includes a device reset)	all
aXR!	Device reset	all
aXVd!	Read device version	all

Address configuration
The UMB device-ID and SDI-12 address are connected. The different address ranges and the fact that UMB IDs are integer numbers, while SDI-12 addresses are ASCII characters, have to be considered.

The SDI-12 address is built from the UMB device ID as follows: UMB device ID 1 (default) corresponds to SDI-12 address ‘0’ (SDI-12 default).

Changing the SDI-12 address by SDI-12 setting command also modifies the UMB device ID accordingly.

UMB (dec)			SDI-12 (ASCII)		
1	to	10	'0'	to	'9'
18	to	43	'A'	to	'Z'
50	to	75	'a'	to	'z'

Valid address ranges

9.4 Data messages
To simplify the evaluation, the assignment of measurement values to data buffers '0' ... '9' has been defined uniformly for all measurement commands. The responses to C-requests have been restricted to 35 characters. Buffers '0' to '4' are currently in use.

A maximum of 9 values can be transferred; the basic data set of 9 values has been assigned to buffers ‘0’ and ‘1’. The buffers ‘2’ to ‘4’ contain further measurement values. This ensures compatibility with loggers based on older versions of the SDI-12 standard.

The buffer assignment depends on the device variant. The complete set of measurement values defined for the UMB protocol is available in the SDI-12 environment and can be called up via the additional M-commands and C-commands: aM1! ... aM8!, aMC1! ... aMC8!, aC1! ... aC8!, aCC1! ... aCC8!.

If the measurement value is not available, e.g. through sensor failure, this is indicated by a value of +999.0. or -999.9. Using an aV! verification query, the logger evaluates the reason for failure. The following table shows the measurement values in the sequence they are arranged in the telegram (see example). Depending on the configuration of the device the values will be transmitted in metric or imperial US units.

The configured system of units is not indicated in the data messages. The logger may request this setting with the I-command and adjust the evaluation of the data messages accordingly.

The example uses italics to print the requests from the logger (*0M!*).

Example: M request from a WS600
OM!
00009<CR><LF> 9 measurement values are available.
0D0!
0+13.5+85.7+1017.0+2.5+3.7<CR><LF>
Air temperature 13.5 °C, rel. humidity 85.7 %, rel. air pressure 1017 hPa avg. wind speed 2.5 m/s, max wind speed 3.7 m/s.
0D1!
0+43.7+9.8+60+4.4<CR><LF>
Wind direction 43.7° wet bulb temperature 9.8 °C, type of precipitation 60 (rain), precipitation intensity 4.4 mm/h.

9.5 Additional measurement commands

The following additional measurement commands are available:

- aM1! ... aM8!
- aMC1! ... aMC8! (M-command, data transmission with CRC)
- aC1! ... aC8!
- aCC1! ... aCC8! (C- command, data transmission with CRC)

The complete data sets of the smart weather sensor, as defined for the UMB protocol are available in a SDI-12 environment as well. The measurement values are ordered according to sensor types. Equally to the base data sets maximum 9 values can be requested with an additional M-command, while an additional C-request allows for up to 20 values. The buffer assignment as documented in the following paragraphs has been structured in a way that with each M-command the buffers D0 and D1 are used. If the respective sensor type has more values available, the buffers D2 up to D4 will be occupied if required.

M1 / C1	Temperature	M: 9 values	C: 9 values
M2 / C2	Humidity	M: 9 values	C: 13 values
M3 / C3	Air pressure	M: 9 values	C: 9 values
M4 / C4	Wind	M: 9 values	C: 14 values
M5 / C5	Compass	M: 1 values	C: 1 values
M6 / C6			
WS401/601	Precipitation	M: 9 values	C: 9 values
Others	Precipitation	M: 4 values	C: 4 values
M7 / C7			
WS800	Global radiation Lightning sensor	M: 9 values	C: 10 values
Others	Global radiation	M: 4 values	C: 4 values
M8 / C8	Ext. temperature	M: 1 value	C: 1 value

If the sensor type requested with the measurement command is not available with the actual variant of the smart weather sensor, the device will respond as follows:
a0000<CR><LF> resp.
a00000<CR><LF>

Example: Buffer Assignment Additional Measurement Commands M1 / C1: Temperature

ℹ Further information can be found in the User Manual Smart Weather Sensors.

Device configured for measurement values in metric units (°C):

Measurement value	UMB channel	Minimum	Maximum
Buffer '0'			
Air Temperature (act)	100	-50.0	60.0
Air Temperature (min)	120	-50.0	60.0
Air Temperature (max)	140	-50.0	60.0
Air Temperature (avg)	160	-50.0	60.0
Dew Point (act)	110	-50.0	60.0
Buffer '1'			
Dew Point (min)	130	-50.0	60.0
Dew Point (max)	150	-50.0	60.0
Dew Point (avg)	170	-50.0	60.0
Wet Bulb Temperature (act)	114	-50.0	60.0

Example: Request with M command
0M1!
00009<CR><LF>
0D0!
0+12.5+10.7+13.5+11.8+5.3<CR><LF>
0D1!
0+4.2+5.9+5.6+9.8<CR><LF>

Device configured for measurement values in imperial US units (°F):

Measurement value	UMB channel	Minimum	Maximum
Buffer '0'			
Air Temperature (act)	105	-58.0	140.0
Air Temperature (min)	125	-58.0	140.0
Air Temperature (max)	145	-58.0	140.0
Air Temperature (avg)	165	-58.0	140.0
Dew Point (act)	115	58.0	140.0
Buffer '1'			
Dew Point (min)	135	-58.0	140.0
Dew Point (max)	155	-58.0	140.0
Dew Point (avg)	175	-58.0	140.0
Wet Bulb Temperature (act)	119	-58.0	140.0

9.6 Message device identification

The device responds to the identification request with following message ():

Example: SDI-12 device address ‘0’
0I!
013Lufft.deWSx00ynnn
x: device type (4, 5, 6, 2, 3)
y: Metric / US units (m = metric, u = US)
nnn: Software version

Example: WS600, configured for imperial US units
0I!
013Lufft.deWS600u022

9.7 Message verification

i Further information can be found in the User Manual Smart Weather Sensors.

The command verification aV! is used to evaluate status information of the device.

The device responds to the request as follows:
a0005<CR<LF>, i.e. 5 values are available in the buffers
a0006<CR<LF>, i.e. 6 values are available in the buffers (WS700 and WS800)

The first 3 or 4 measurement values, transmitted in buffer ‘0’ contain the status information of the measurement channels.

Buffer '0', status information:

Measurement channels	Measurement values	Comment
Status group1: +nnnn	Air temperature, air temperature buffer, dew point, dew point buffer	–
Status group1: +nnnnnn	Air temperature, air temperature buffer, dew point, dew point buffer, reserved, reserved	WS401 and WS601 only
Status group 2: +nnnnnn	Relative humidity, relative humidity buffer, absolute humidity, absolute humidity buffer, mixing ration, mixing ration buffer	–
Status group 3: +nnnnnn	Air pressure, air pressure buffer, wind, wind buffer, compass, precipitation	WS301 and WS501 transmit the global radiation status instead of the precipitation status.
Status group 4: +nnnn	Global radiation status, global radiation buffer status, lightning detector status, lightning detector buffer status	WS700 and WS800 only

The status data of the channels are assembled to form “fake measurement values”, where each digit represents one status.

Sensor status codes:

Sensor status	Code
OK	0
UNGLTG_KANAL	1
E2_CAL_ERROR E2_CRC_KAL_ERR FLASH_CRC_ERR FLASH_WRITE_ERR FLASH_FLOAT_ERR	2
MEAS_ERROR	3
MEAS_UNABLE	4
INIT_ERROR	5
VALUE_OVERFLOW CHANNEL_OVERRANGE	6
VALUE_UNDERFLOW CHANNEL_UNDERRANGE	7
BUSY	8
Other sensor status	9

Generally each sensor has two status values, one for the direct value and another for the measurement value buffer used for the evaluation of the average, minimum, and maximum values.

The last two values, transmitted in buffer ‘1’, show the heating temperatures of wind and precipitation sensor.

Buffer ‘1’, device configured for metric units (°C):

Measurement value	UMB channel	Minimum	Maximum
Heating temperature wind sensor	112	-50.0	150.0
Heating temperature percipitation sensor	113	-50.0	150.0

Buffer ‘1’, device configured for imperial US units (°F):

Measurement value	UMB channel	Minimum	Maximum
Heating temperature wind sensor	117	-58.0	302.0
Heating temperature percipitation sensor	118	-58.0	302.0

Example: WS600, SDI-12 address '0', no error
0V!
00005<CR><LF>
0D0!
0+0000+000000+00000<CR><LF>
0D1!
0+73.0+65.3<CR><LF>

10 Commissioning for MODBUS format

The devices can be operated with various protocols, e.g. XDR and UMB-ASCII. Further information on the protocols and the full description of UMB channels, SDI-12 and Modbus protocol can be found in the User Manual Smart Weather Sensors.

10.1 Device set-up
Preconfigured smart weather sensors with the MODBUS protocol are available upon request.

With the MODBUS communication protocol, the smart weather sensors can be simply integrated into a PLC environment.

Measurement values are mapped to MODBUS input registers. The range of values available is the same as for the UMB protocol, including different unit systems. The use of register pairs for floating point numbers or 32-bit integers, which are not part of the MODBUS standard, has been dispensed with. All measurement values are mapped to 16 bit integers using suitable scaling factors.

10.2 Configuration and testing
The smart weather sensors can be configured for MODBUS-RTU or for MODBUS-ASCII.

The base configuration must be set in the ConfigTool.NET software.

- Select under *Device parameters* the *Protocol MODBUS-RTU* or *MODBUS-ASCII*.
  - ⇨ The following communication parameters will be preselected: 19200 Bd, even parity.
- Select the *Baudrate*: 19200, 9600, 4800 or lower.
- Select the *Interface*: 8E1, 8N1, 8N2.

The MODBUS communication has been tested for a poll rate of 1 second. The proper function of the device with higher MODBUS poll rates has not been tested.

We suggest to set the poll rate to 10 seconds or slower. The update rate of the data is ≥10 seconds, with the exception of the channels "Wind speed / wind direction fast", which are provided for special purposes. For most of the weather data, significant changes have to be expected in the range of minutes.

10.3 Addressing
The MODBUS address is deducted from the UMB device ID .

A device with UMB device ID 1 also has the UMB address 1.

The valid address range of MODBUS from 1 to 247 is smaller than that of the UMB device IDs. If a UMB device ID > 247 has been selected, the MODBUS address will be set to 247.

10.4 MODBUS functions

Further information can be found in the User Manual Smart Weather Sensors.

For the smart weather sensors, the functions of conformance class 0 and 1 have been implemented, which operate at register level.

Starting with device version 227 / firmware version v60 additional coil functions are available.

Command	Function	Comment
Conformance Class 0		
0x03	Read holding registers	Selected configuration settings
0x16	Write multiple registers	Selected configuration settings
Conformance Class 1		
0x01	Read Coils	Selected additional operations (from device version 227)
0x04	Read input registers	Measurement values and status information
0x05	Write single coil	Selected additional operations (from device version 227)
0x06	Write single register	Selected configuration settings
0x07	Read exception status	Currently not used
Conformance Class 2		(partly)
0x0F	Write multiple coils	Selected additional operations (from device version 227)
Diagnostics		
0x11	Report responder ID	(responds also to broadcast address)

10.4.1 Function 0x04 read input registers

The input registers are containing the measurement values of the smart weather sensor and the related status information.

The measurement values are mapped to the 16 bit registers using the following scaling factors:

- 0 ... 65530 for unsigned values
- -32762 ... 32762 for signed values

The values 65535 (0xffff) and 32767 are used for the indication of erroneous or not available measurement values. A more detailed specification of the error can be evaluated from the status registers.

The assignment of the values to the register addresses (0 ... 124) has been arranged in a way so that the most frequently used data can be read out with just a few register block requests.

The following blocks have been defined:

- Status information
- Frequently used values which are independent of the unit system (metric / imperial) in use.

– Frequently used values in metric units
– Frequently used values in imperial units
– Other measurement values

When using the metric unit system the first three blocks can supply all data required with one request. There is no difference in the register assignment between the product variants. If, dependent on the variant, some value is not available, this will be indicated by setting the register to the error value.

i The following tables mainly show average values. Further values can be found in the User Manual Smart Weather Sensors.

Register number	Register address	Value (UMB channel)	Range	Scaling factor	Comment
		Status information			
1	0	Identification	High byte: WS-Type (2,3,4,5,6) Low byte: Software Version	Type coding	See Status and type coding [▶ 46]
2	1	Device Status	–	–	See Status and type coding [▶ 46]
3	2	Sensor Status 1	Air temperature buffer, air temperature, dew point buffer, dew point(high byte -> low byte)	Coding 4 bit per status	See Status and type coding [▶ 46]
4	3	Sensor Status 2	Relative humidity buffer, relative humidity, absolute humidity buffer, absolute humidity (high byte -> low byte)	Coding 4 bit per status	See Status and type coding [▶ 46]
5	4	Sensor Status 3	Mixing ratio buffer, mixing ration, air press. buffer, air pressure (high byte -> low byte)	Coding 4 bit per status	See Status and type coding [▶ 46]
6	5	Sensor Status 4	Wind buffer, wind, precipitation, compass (high byte -> low byte)	Coding 4 bit per status	See Status and type coding [▶ 46]
7	6	Sensor Status 5	Global radiation buffer, global radiation, reserved, reserved (high byte -> low byte)	Coding 4 bit per status	See Status and type coding [▶ 46]
8	7	Sensor Status 6	External temperature / external rain gauge, lightning sensor, lightning sensor buffer	Coding 4 bit per status	See Status and type coding [▶ 46]
9	8	Reserved	–	–	–
10	9	–	Diagnostic: run time in 10 seconds steps	–	–

Register number	Register address	Value (UMB channel)	Range	Scaling factor signed/unsigned	Comment
		Values independent of the unit system			
14	13	260	Relative humidity (avg.)	Factor 10, s	–
18	17	365	Relative air pressure (avg.)	Factor 10, s	–
20	19	520	Wind direction (min.)	Factor 10, s	–
21	20	540	Wind direction (max.)	Factor 10, s	–
25	24	510	Compass	Factor 10, s	–
26	25	700	Precipitation type	Factor 1, s	–
27	26	805	Wind measurement quality	Factor 1, u	–
31	30	960	Global radiation (avg.)	Factor 10, s	–
		Values in metric units			
35	34	160	Air temperature °C (avg.)	Factor 10, s	–
40	39	111	Wind chill-temperature °C	Factor 10, s	–
41	40	112	Heating temperature Wind °C	Factor 10, s	–
42	41	113	Heating temperature R2S °C	Factor 10, s	–
44	43	420	Wind speed m/s (min.)	Factor 10, s	–
45	44	440	Wind speed m/s (max.)	Factor 10, s	–
46	45	460	Wind speed m/s (avg.)	Factor 10, s	–
49	48	620	Precipitation absolute mm	Factor 100, u	Limited to 655.34 mm
50	49	625	Precipitation different mm	Factor 100, u	Limited to 100.00 mm
51	50	820	Precipitation intensive mm/h	Factor 100, u	Limited to 200.00 mm/h
		Values in imperial US units			
55	54	165	Air temperature °F (avg.)	Factor 10, s	–
59	58	175	Dew point °F (avg.)	Factor 10, s	–
60	59	116	Wind chill temperature °F	Factor 10, s	–
61	60	117	Heating temperature wind °F	Factor 10, s	–
62	61	118	Heating temperature R2S °F	Factor 10, s	–
64	63	430	Wind speed mph (min.)	Factor 10, s	–
65	64	450	Wind speed mph (max.)	Factor 10, s	–
66	65	470	Wind speed mph (avg.)	Factor 10, s	–
69	68	640	Precipitation absolute in	Factor 1000, u	Limited to 25.800 in
70	69	645	Precipitation different in	Factor 10 000, u	Limited to 3.9370 in
71	70	840	Precipitation intensive in/h	Factor 10 000, u	Limited to 6.5534 in
		Further values			
75	74	265	Absolute humidity (avg.)	Factor 10, s	–
79	78	270	Mixing rratio (avg.)	Factor 10, s	–
83	82	360	Absolute air pressure (avg.)	Factor 10, s	–
87	86	465	Wind speed km/h (avg.)	Factor 10, s	–
90	89	435	Wind speed kts (min.)	Factor 10, s	–
91	90	455	Wind speed kts (max.)	Factor 10, s	–

Register number	Register address	Value (UMB channel)	Range	Scaling factor signed/unsigned	Comment
92	91	475	Wind speed kts (avg.)	Factor 10, s	–
96	95	403	Wind speed standard deviation m/s	Factor 100, s	Standard deviation values are available after the first request.
97	96	413	Wind speed standard deviation mph	Factor 100, s	Standard deviation values are available after the first request.
98	97	503	Wind direction standard deviation	Factor 100, s	Standard deviation values are available after the first request.
99	98	114	Wet bulb temperature °C (act)	Factor 10, s	–
100	99	119	Wet bulb temperature °F (act)	Factor 10, s	–
101	100	215	Specific enthalpy (act)	Factor 10, s	–
102	101	310	Air density (act)	Factor 1000, s	–
105	104	750	Reserved	Factor 1, s	–
106	105	770	Reserved	Factor 1, s	–
107	106	711	Reserved	Factor 1, s	–
108	107	101	External temperature °C (act)	Factor 10, s	–
109	108	109	External temperature °F (act)	Factor 10, s	–
110	109	806	Wind value quality (fast)	Factor 1, u	–
111	110	617	Lightning events (minute)	Factor 1, u	–
112	111	677	Lightning Events (Intervall)	Factor 1, u	–
117	116	Reserved	–	–	–

10.5 Status and type coding

Further information can be found in the User Manual Smart Weather Sensors.

Device status

Under normal operating conditions, the device status is 0. If the device status is not 0, this may indicate a serious system error. Exception: Code 48 after performing a reset to factory settings.

- Perform another reset.
- If the device status is not 0, contact the Lufft support team.
- Consider measurement values collected during or after a non-zero device status to be unreliable.

Sensor status

Each register holds 4 sensor states, coded with 4 bits per state, which together form a 16-bit number. The sequence is defined from the most significant half-byte to the least significant half-byte. Most sensors have 2 status values, one for the sensor and the current measurement value, another one for the buffer, from which the average value and the minimum and maximum values are evaluated.

11 Maintenance

11.1 Maintenance schedule

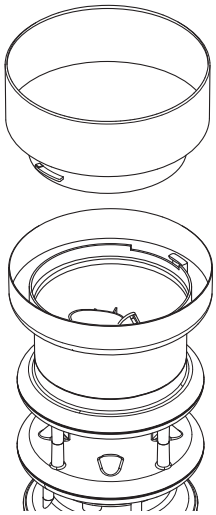
The frequency of cleaning is dependent upon the local weather and environmental conditions. Ideally, the dome of the device should be cleaned at regular intervals.

The following maintenance intervals are recommended:

Interval	Activity	Performed by
Twice a week	▸ Clean the dome using a dry and lint-free cloth. ▸ For persistent soiling, use additional distilled water. If the soiling is servere, pure alcohol can be used. ▸ Ensure that no streaks or deposits are left on the dome.	Operator
Monthly	▸ Clean the rain gauge funnel if dirty (only relevant for WS401 and WS-601).	Operator
Annually	▸ Check the device for cleanliness. ▸ Check the device by carrying out a measurement request. ▸ Check the operation of the fan (except for WS200).	Operator
Annually	▸ Have a calibration check performed (except for WS200).	OTT HydroMet

11.2 Checking rain gauge

The function of the rain gauge is influenced by pollution of the funnel or the tipping bucket mechanism. The cleaning of the rain gauge depends on the local conditions and seasons (with falling leaves, pollen, etc.) and becomes necessary, when the rain gauge is polluted.



WS601 with removed funnel

i Each movement of the bucket generates a counting pulse. Avoid moving the tipping mechanism as thus wrong counts can occur.

- Unlock funnel by turning it to the left and lift it off.
- Clean funnel, specially the sieve slots.
- Check the inside of the rain gauge for pollution, especially for spider webs and insects.
- Clean the rain gauge with a soft cloth/brush and water, if necessary.
- Check the tipping bucket for pollution.
- Wash the tipping bucket carefully with clean water, if necessary.
- Check the water drain.
- Clean the water drain with a soft cloth/brush and water, if necessary.
- Put the funnel back in place. Turn the funnel to the right and lock it.

11.3 Updating firmware

The firmware can be updated with the ConfigTool.NET software. The firmware is valid for all types of the device. The description of the update can be found in the ConfigTool.NET software.

- Download the latest version of the firmware and the ConfigTool.NET software: www.lufft.com/resources/.
- Install the update on a Windows® PC.

Under certain circumstances, the absolute precipitation quantities are reset (channel 600 - 660).

12 Troubleshooting

12.1 Error elimination

Error	Possible cause	Corrective action
Device does not allow polling or does not respond	Device does not work properly	▸ Check the power supply. ▸ Check the interface connection.
Device does not allow polling or does not respond	Incorrect device ID is applied	▸ Check if the correct device ID is assigned. Devices are delivered with ID 1.
Device measures precipitation, but it is not raining	Device installed incorrectly	▸ Check that the device was installed correctly in accordance with the instructions.
Measured temperature appears too high / measured humidity appears too low	Fan does not work properly	▸ Check whether the fan on the underside of the device is working.
Wind direction values are incorrect	Device is not aligned correctly	▸ Check that the device is aligned to the north.
Device transmits error value 24h (36d)	A channel is being polled that is not available on this device type	–
Device transmits error value 28h (40d)	Device is in the initialization phase following startup	▸ Wait for approx. 10 seconds. The device delivers measurements after approx. 10 seconds.
Device transmits error value 50h (80d)	Device is being operated above the limit of the specified measuring range	–
Device transmits error value 51h (81d)	Device is being operated below the limit of the specified measuring range	–
Device transmits error value 55h (85d) during wind measurement	Device is being operated well above the limit of the specified measuring range	–
Device transmits error value 55h (85d) during wind measurement	Very strong horizontal rain or snow	–
Device transmits error value 55h (85d) during wind measurement	There are foreign objects within the measuring section of the wind meter	–
Device transmits error value 55h (85d) during wind measurement	Wind meter sensors are very dirty	▸ Clean the sensor.
Device transmits error value 55h (85d) during wind measurement	Wind meter sensors are iced over	▸ Check the heating mode in the configuration and check the heating function / connection.
Device transmits error value 55h (85d) during wind measurement	One of the wind meter's sensors is faulty	▸ Return the device to the manufacturer for repair.

Error	Possible cause	Corrective action
Quality of the wind measurement is not always 100 %	In normal operation the device should always transmit 90 – 100 %. Values up to 50 % do not represent a general problem. When the error value 55h (85d) is transmitted, this value is 0 %. If the device permanently transmits values below 50 %, this may mean that there is a fault.	–
Device transmits an unknown error value	–	▸ Report any malfunction to the representative of OTT HydroMet.

13 Repair

13.1 Customer support

- Have repairs carried out by OTT HydroMet service personnel.
- Only carry out repairs yourself, if you have first consulted OTT HydroMet.
- Contact your local representative: www.otthydromet.com/en/contact-us
- Include the following information:

– instrument model
– instrument serial number
– details of the fault or problem
– examples of data files
– readout device or data acquistion system
– interfaces and power supplies
– history of any previous repairs or modifications
– pictures of the installation
– overview of the local environment conditions

14 Notes on disposing of old devices

Member States of the European Union

In accordance with the German Electrical and Electronic Equipment Act (ElektroG; national implementation of EU Directive 2012/19/EU), OTT HydroMet takes back old devices in the Member States of the European Union and disposes of them in the proper manner. The devices that this concerns are labeled with the following symbol:

- For further information on the take-back procedure contact OTT HydroMet:

OTT HydroMet Fellbach GmbH
Service & Technical Support
Gutenbergstraße 20
70736 Fellbach
Germany
phone: +49 711 518 22 0
email: met-support@otthydromet.com

All other countries

- Dispose of the product in the proper manner following decommissioning.
- Observe the country-specific regulations on disposing of electronic equipment.
- Do NOT dispose of the product in household waste.

15 Technical data

15.1 General technical data

Specification	Value
Fastening	Stainless steel bracket for mast with diameter 60 – 76 mm
Housing	Plastic (PC)
Protection class	III (SELV)
Protection type	IP66
Operating temperature range	-50 to +60 °C
Storage temperature range	-50 to +70 °C
Humidity range	0 to 100 %

15.2 Electrical data

Mode[1]	Normal operation mode		Power saving mode 1		Power saving mode 2	
Supply	24 V DC[2]	12 V DC	24 V DC	12 V DC	24 V DC	12 V DC
WS200	16 mA	25 mA	15 mA	24 mA	1 (4) mA[3]	2 mA
WS300	135 mA	70 mA	7 mA	7 mA	1 (4) mA[3]	2 mA
WS301 WS302 WS310	135 mA	70 mA	8 mA	8 mA	1 (4) mA[3]	2 mA
WS400	160 mA	110 mA	7 mA	7 mA	–	–
WS401	130 mA	65 mA	6 mA	6 mA	1 (4) mA[3]	2 mA
WS500	140 mA	85 mA	16 mA	25 mA	1 (4) mA[3]	2 mA
WS501 WS502 WS510	145 mA	85 mA	16 mA	25 mA	1 (4) mA[3]	2 mA
WS600 WS700 WS800	160 mA	130 mA	16 mA	25 mA	–	–
WS601	140 mA	85 mA	15 mA	24 mA	1 (4) mA[3]	2 mA

[1]Description of operating modes, see Energy management [▶ 27]

[2]Factory default, recommended setting

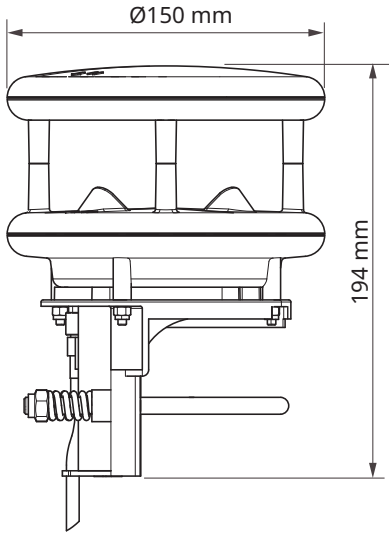
[3]Values for devices prior to version 037 in brackets

Variant	Current consumption	Power input - heating
WS200	833 mA	20 VA at 24 V DC
WS400	833 mA	20 VA at 24 V DC
WS500 WS501 WS502 WS510	833 mA	20 VA at 24 V DC

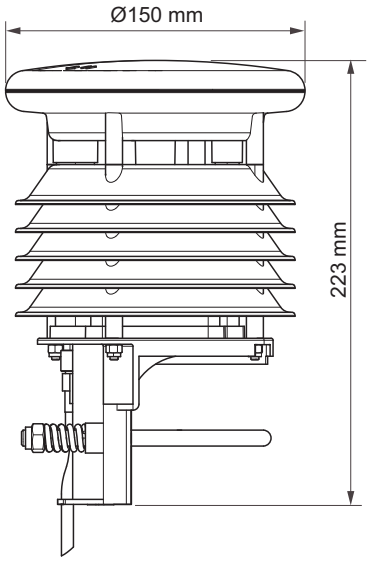
Variant	Current consumption	Power input - heating
WS600 WS700 WS800	1.7 A	40 VA at 24 V DC
WS601	833 mA	20 VA at 24 V DC

15.3 Dimensions and weight

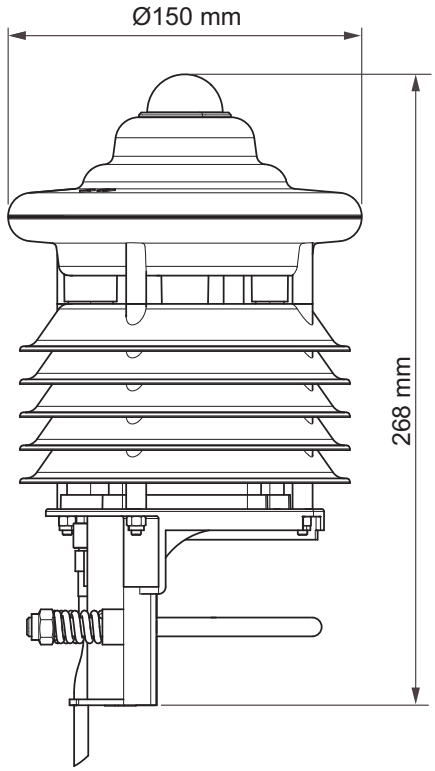
WS200, 800 g



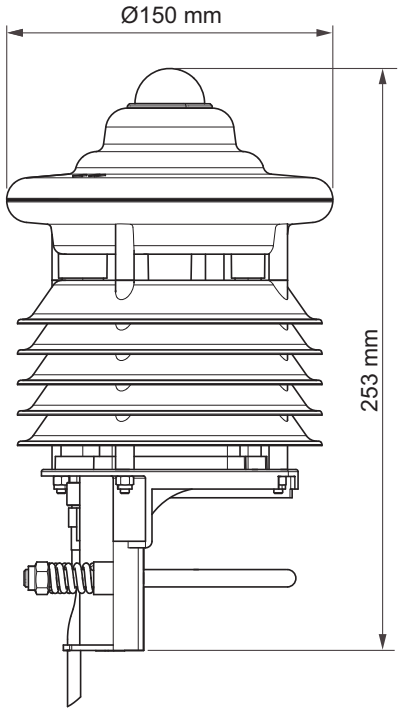
WS300, 1000 g



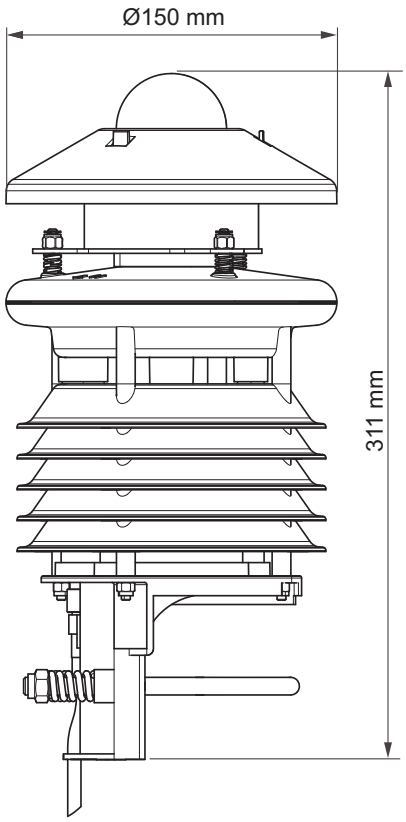
WS301, 1300 g



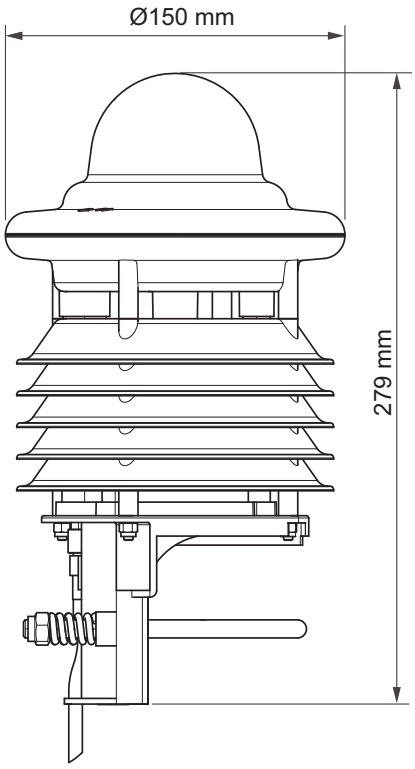
WS302, 1300 g



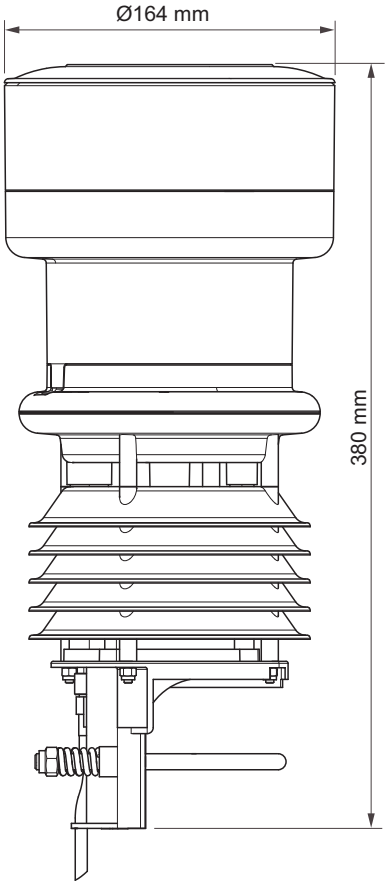
WS310, 1300 g



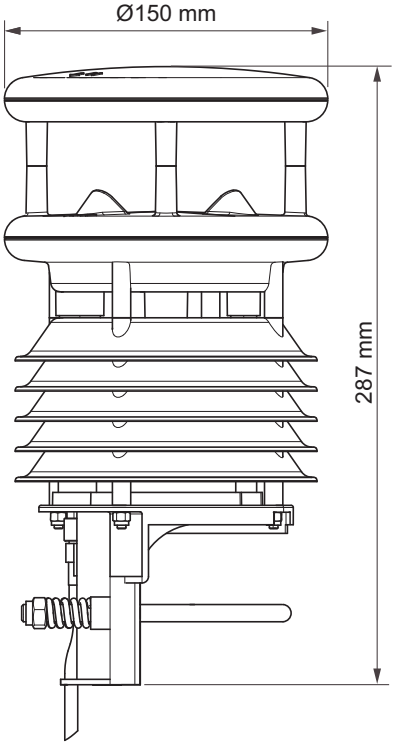
WS400, 1300 g



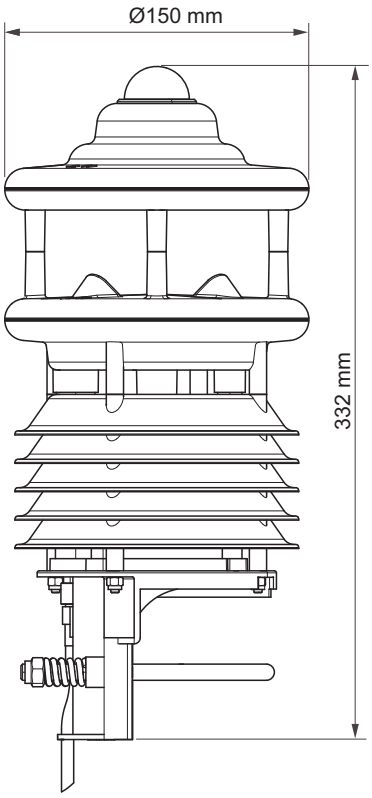
WS401, 1500 g



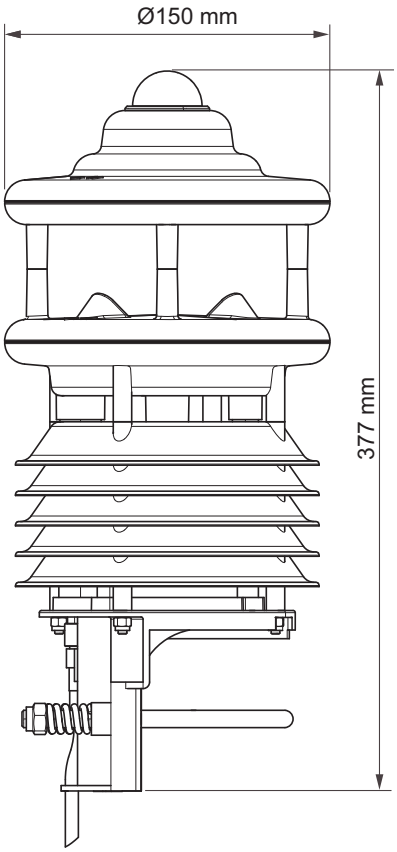
WS500, 1200 g



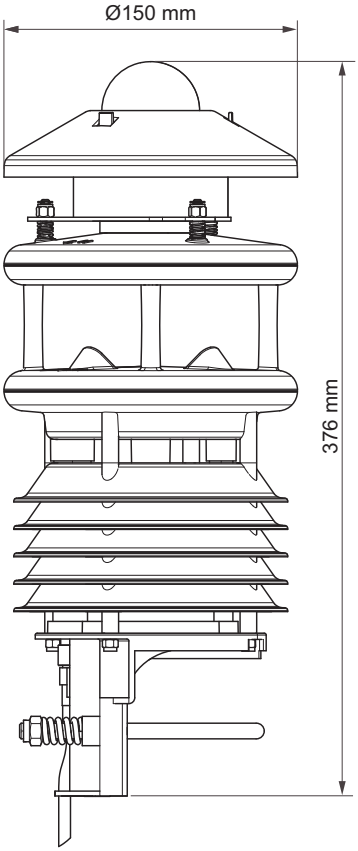
WS501, 1500 g



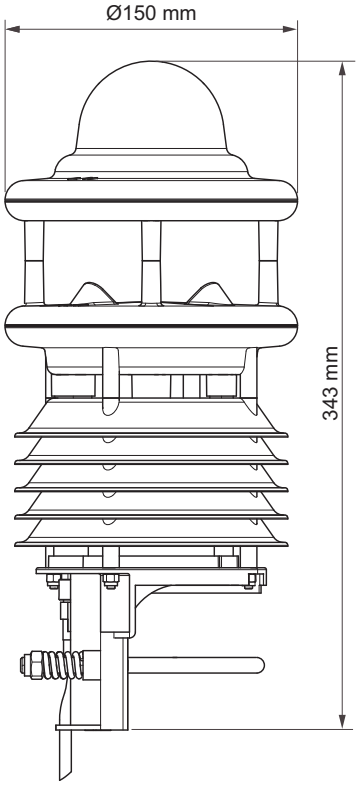
WS502, 1500 g



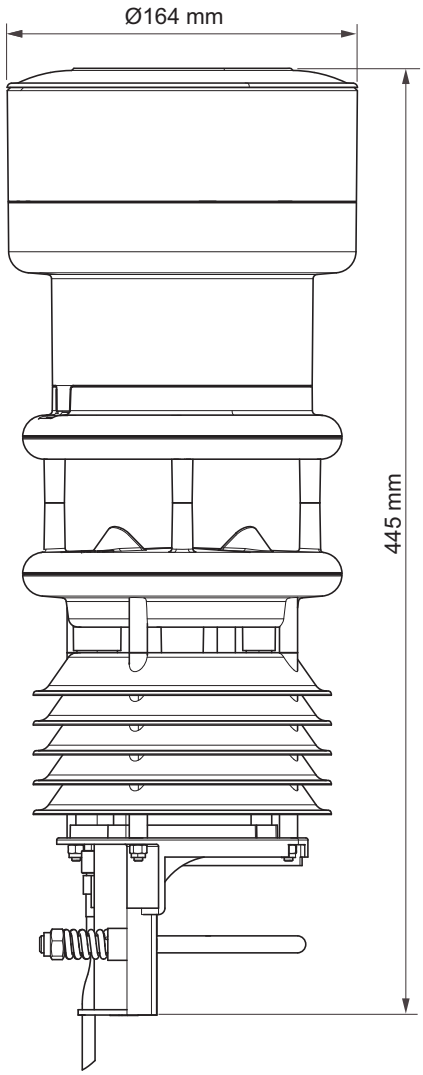
WS510, 1500 g



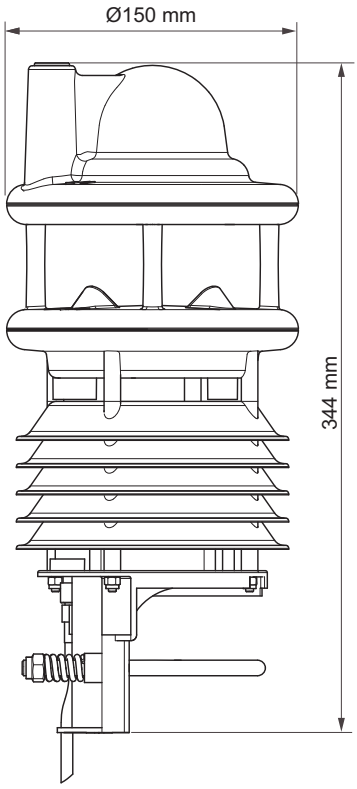
WS600, 1500 g



WS601, 1700 g



WS700, 1500 g



15.4 Measuring range and accuracy

Version	Air temperature	Humidity	Air pressure	Precipitation	Wind direction	Wind speed	Compass	Global radiation	Lightning sensor	Temperature (ext)	Rain gauge (ext)	Power save 2
WS200	–	–	–	–	x	x	x	–	–	x	x	x
WS300	x	x	x	–	–	–	–	–	–	x	x	x
WS301	x	x	x	–	–	–	–	x	–	x	x	x
WS302	x	x	x	–	–	–	–	x	–	x	x	x
WS310	x	x	x	–	–	–	–	x	–	x	x	x
WS400	x	x	x	x	–	–	–	–	–	x	–	–
WS401	x	x	x	x	–	–	–	–	–	x	–	x
WS500	x	x	x	–	x	x	x	–	–	x	x	x
WS501	x	x	x	–	x	x	x	x	–	x	x	x
WS502	x	x	x	–	x	x	x	x	–	x	x	x
WS510	x	x	x	–	x	x	x	x	–	x	x	x
WS600	x	x	x	x	x	x	x	–	–	x	–	–
WS601	x	x	x	x	x	x	x	–	–	x	–	x
WS700	x	x	x	x	x	x	x	x	–	x	–	–
WS800	x	x	x	x	x	x	x	x	x	x	–	–

i The external temperature sensor and rain gauge use the same input, so only one of them can be connected simultaneously.

Air temperature

Specification	Value
Measurement process	NTC
Measuring range	-50 °C to +60 °C
Resolution	0.1 °C (-20 °C to +50 °C) otherwise 0.2 °C
Sensor accuracy	+/-0.2 °C (-20 °C to +50 °C) otherwise +/-0.5 °C (> -30 °C)
Sampling rate	1 minute
Units	°C; °F

Humidity

Specification	Value
Measurement process	Capacitive
Measuring range	0 to 100 % RH
Resolution	0.1 % RH
Accuracy	+/-2 % RH
Sampling rate	1 minute
Units	% RH; g/m^3; g/kg

Dewpoint temperature

Specification	Value
Measurement process	Passive, calculated from temperature and humidity
Measuring range	-50 °C to +60 °C
Resolution	0.1 °C
Accuracy	Computed +/-0.7 °C
Units	°C; °F

Air pressure

Specification	Value
Measurement process	MEMS sensor - capacitive
Measuring range	300 to 1200 hPa
Resolution	0.1 hPa
Accuracy	+/-0.5 hPa (0 °C to +40 °C)
Sampling rate	1 minute
Units	hPa

Wind speed

Specification	Value
Measurement process	Ultrasonic
Measuring range	0 to 75 m/s except WS601: 0 to 30 m/s
Resolution	0.1 m/s
Accuracy	±0.3 m/s or ±3 % (0 to 35 m/s) ±5 % (> 35 m/s) RMS
Response threshold	0.3 m/s
Internal sampling frequency	15 Hz
Instantaneous value	1 sec / 10 sec
Output rate for average and peak gust values	1 to 10 minutes (peak calculated from 1 sec-values)
Units	m/s; km/h; mph; kts

Wind direction

Specification	Value
Measurement process	Ultrasonic
Measuring range	0 to 359.9°
Resolution	0.1°
Accuracy	< 3° (> 1 m/s) RMSE
Response threshold	0.3 m/s
Internal sampling frequency	15 Hz
Instantaneous value	1 sec / 10 sec
Output rate for average and peak gust values	1 to 10 minutes (peak calculated from 1 sec-values)

Precipitation

Specification	Value	
	WS400 WS600 WS700 WS800	WS401 WS601
Measurement process	Radar sensor	Rain gauge
Measuring range (drop size)	0.3 mm to 5.0 mm	–
Liquid precipitation resolution	0.01 mm	0.2 mm / 0.5 mm (adjustable by reduction ring)
Precipitation types	Rain, snow	Rain
Accuracy	–	2 %
Repeatability	Typically > 90 %	–
Response threshold	0.002 mm	–
Sampling rate	Event-dependent on reaching response threshold	1 minute
Precipitation intensity	0 to 200 mm/h; Sampling rate 1 min, resol. 0.01 mm/h	–

Compass

Specification	Value
Measurement process	Integrated electronic compass
Measuring range	0 to 359.9°
Resolution	1.0°
Accuracy	+/- 10°
Sampling rate	5 minutes

Global radiation

Specification	Value
Measurement process	Thermopile pyranometer
Measuring range	0.0 to 2000.0 W/m^2
Resolution	< 1 W/m^2
Sampling rate	10 seconds

Specification	Value		
	WS301 WS501	WS302 WS502 WS700 WS800	WS310 WS510
Response time (95 %)	18 s	< 1 s	5 s
Non-stability (change/year)	< 1 %	–	< 0.5 %
Non-linearity (0 to 1000 W/m^2)	< 1 %	–	< 0.2 %
Directional error (at 80 ° with 1000 W/m^2)	< 20 W/m^2	–	< 10 W/m^2
Temperature dependence of sensitivity	< 5 % (-10 °C to +40 °C)	–	< 1 % (-10 °C to +40 °C)
Tilt error (at 1000 W/m^2)	< 1 %	–	< 0.2 %
Spectral range (50 % points)	300 to 2800 nm	300 to 1100 nm	285 to 2800 nm

External temperature sensor WT1/WST1

Specification	Value
Measurement process	NTC
Measuring range	-40 °C to +80 °C
Resolution	0.25 °C
Sensor accuracy	+/-1 °C (WST1: +/-0.3 °C between -10 °C to +10 °C)
Sampling rate	1 minute
Units	°C; °F

External rain gauge WTB100

Specification	Value
Measurement process	Rain gauge with bounce-free reed contact (normally closed)
Liquid precipitation resolution	0.2 mm / 0.5 mm (adjustable by reduction ring)
Precipitation types	Rain
Accuracy	2 %
Sampling rate	1 minute

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Contact Information