J-Series WS Smart Weather Sensors

Operational Manual

48.7230-WS-S-EN | V1 (08/2026)

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1 Scope of supply

The following items are included with delivery:

- Smart weather sensor
- Manufacturing certificate
- Information sheet

NOTE: The connection cable is not included in the standard delivery and must be ordered separately if not already available.

2 Order numbers and variant code

2.1 Product variants

Variant	Order number	Authorized region*	Frequency range
WS200-J	J8371.1	EU, NA	–
WS300-J	J8372.1	EU, NA	–
WS400-J	J8369.2	EU	24.150 – 24.250 GHz
WS401-J	J8377.1	EU, NA	–
WS500-J	J8373.1	EU, NA	–
WS501-J	J8375.1	EU, NA	–
WS502-J	J8375.2	EU, NA	–
WS510-J	J8375.5	EU, NA	–
WS600-J	J8370.2	EU	24.150 – 24.250 GHz
WS600-J-NA	J8370.1	NA	24.075 – 24.175 GHz
WS601-J	J8376.1	EU, NA	–
WS700-J	J8380.2	EU	24.150 – 24.250 GHz
WS700-J-NA	J8380.1	NA	24.075 – 24.175 GHz
WS800-J	J8381.2	EU	24.150 – 24.250 GHz
WS800-J-NA	J8381.1	NA	24.075 – 24.175 GHz

*EU = Europe, NA = North America (USA + Canada)

Products are delivered and pre-configured with a UMB protocol standard configuration. The full article number for a WS200-J is J8371.1-U5140000. The standard delivery does not include the connection cable. Please order it separately, if required.

2.2 Accessories and spare parts

Item	Order number
Mast 4.5 m	8357.450
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 30 m	8370.UKAB30
Connection cable 50 m	8370.UKAB50
Connection cable 100 m	8370.UKAB100
Universal pole mount for WS series	6501005032

3 About this manual

This operational manual applies to devices with order numbers starting with J.

3.1 Other applicable documents and software

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

- Operating Manual UMB ISO Converter ISOCON
- Operating instructions surge protection
- Operating instructions UMB-Config-Tool
- UMB Configuration Software

The following documents and software can be downloaded at http://www.otthydromet.com:

- ConfigTool.NET
- UMB protocol description
- Firmware

The UMB controller library can be found at https://github.com/OttHydromet/UMBControllerLib.

3.2 General signs and symbols

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

Practical tip

i 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 this 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

NOTICE

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 typically 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 Kipp & Zonen if necessary.

4.4 Operator obligations

This section is addressed to the system operator or installer responsible for the safe installation, commissioning, and overall use of the product.

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.

4.5 Personnel obligations

This section is addressed to all personnel who operate, handle, or work with the product during its lifecycle.

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-J, WS600-J, WS700-J, WS800-J) 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 Kipp & Zonen 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.
- Connect the device while the power is off and then switch on.

4.7.2 Health hazard due to electromagnetic radiation

The devices with precipitation radar (WS400-J, WS600-J, WS700-J, WS800-J) generate an electromagnetic field that can be harmful to health and can cause cardiac pacemakers to malfunction.

WARNING

Pacemaker interference hazard

Electromagnetic fields generated by this device may interfere with cardiac pacemakers. Maintain a minimum distance of 27 cm between the device and the cardiac pacemaker.

- Use the device outdoors only.
- Align the radar beam vertically.
- Do not aim the top of the device towards any person.

4.7.3 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.

4.7.4 Beware of warm surfaces

Devices with radar can heat the dome up to 70 °C, while devices with ultrasonic transmitters can heat the transducers up to 50 °C. Incidental touch of the warm dome surface can be painful.

- Be careful of the warm surface when working on the device.
- Wear protective gloves if necessary.

4.8 Working Outdoors

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.

Specially for expressways usually it is required to have a general permission for working on the expressway, a permission for the special case, as well as warning and protection measures at the work location.

- 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 "A" 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, CAN ICES-003 (A) / NMB-003 (A)

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

4.9.2 Devices with precipitation radar

Devices with precipitation radar (WS400-J, WS600-J, WS700-J, WS800-J) 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 RED Directive 2014/53/EU.

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

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.

4.9.3 FCC Compliance Statement (US)

Product Name	Part	FCC
WS800-J-NA	J8381.1	FCC-ID: UF9-WSX00
WS700-J-NA	J8380.1	
WS600-J-NA	J8370.1	

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.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This device complies with part 18 of the FCC rules.
User Information according to §18.213 of FCC rules:
This device could interfere with other ultrasonic or radar devices working on the same frequency range (290-310 kHz ultrasonic or 24GHz radar), especially when using more than one weather station at the same spot.
This could lead to wrong measurement data of wind or rain of the weather station.
In case of interference please try to place the devices at least 2 m apart from each other.
If high emitting devices used next to the weather station, such as inductive ovens, the distance probably needs to be larger.

Note: This device may cause interference with other radar systems. It is not recommended to operate the device in close proximity to safety-critical radar applications.

For maintenance it is sufficient if the user is regularly cleaning the radar dome, gently cleaning the ultrasonic transducers and checking if the fan and ultrasonic area is free from obstacles.
Changes and modifications not expressly approved by manufacturer could void the user's authority to operate the equipment.

4.9.4 IC Compliance Statement (CA)

Product Name	Part	IC
WS800-J-NA	J8381.1	IC: 6650A-WSX00
WS700-J-NA	J8380.1	
WS600-J-NA	J8370.1	

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

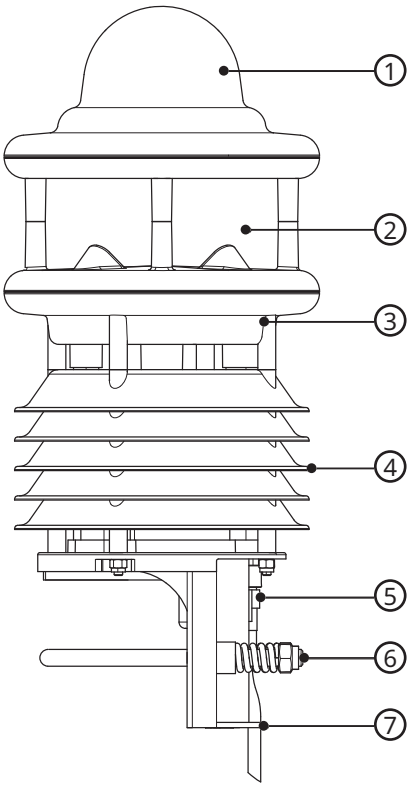
5 Product description

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 plug and associated connection cable. During commissioning, configuration and measurement polling takes place using the ConfigTool.NET software.

5.2 Product overview



WS600-J

1	Precipitation sensor (heated)	5	Plug
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 Transport

- Always transport the product in its original packaging.
- Ensure that the product is not mechanically stressed during transport.

6.2 Storage

- Store within the specified temperature ranges. See General technical data [▶ 107].
- Store in dry area.
- Store in original box where possible.

6.3 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 your supplier or manufacturer.
- Keep the original packaging for any further transportation.

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
- Reliable power supply for permanent operation

7.1.2.1 Installing devices with wind measurement and compass

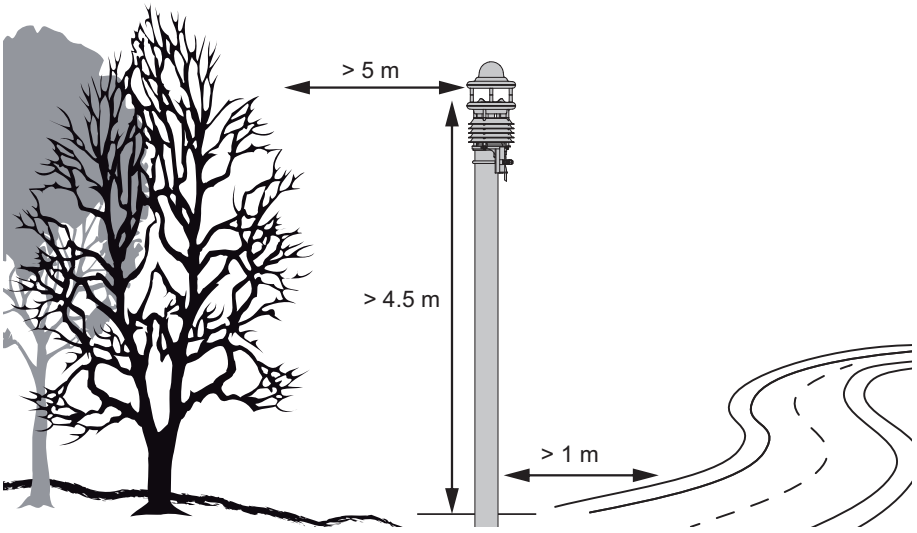
For accurate compass readings, an aluminium mast is recommended.

- Install the device on top of the mast at least 2 m above the ground.
- Keep distance from overhead electrical lines, especially high voltage types.
- For best wind measurement quality, ensure there is an open field around the device.

i Buildings, bridges, embankments and trees may affect 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 location, ensure that the device is at least 2 m away from 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-J

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. If the device is used in HydroMet applications the installation height can be reduced to 2 m above ground.
- Keep at least 2 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.

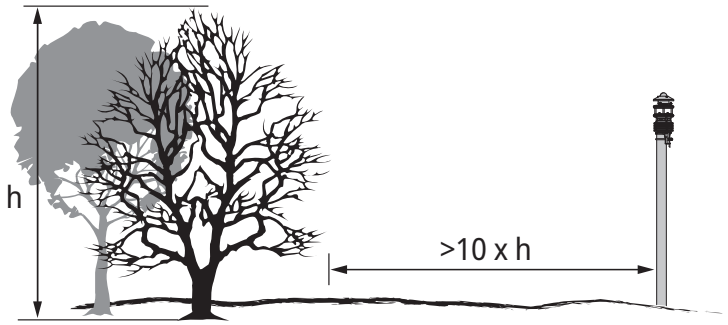
7.1.2.3 Installing devices with rain gauge

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

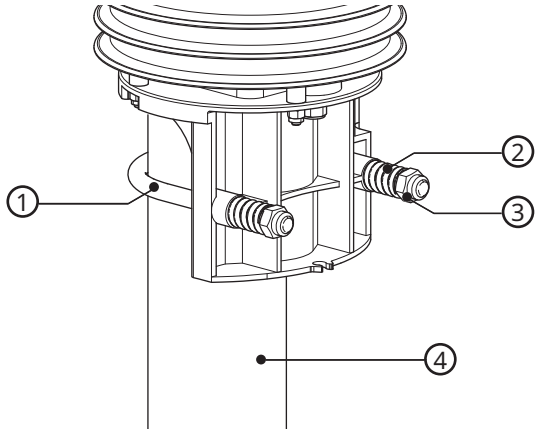
- Install the device on top of the mast.
- Chose a shadow free location with 360° free view to the horizon at the height of the pyranometer.
- Keep a distance of at least 10 times the object height relative to the device from shadowing objects, e.g. trees and buildings.



i For more information on sensor installation, refer to the WMO "Guide Instruments and Methods for Observation".

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.

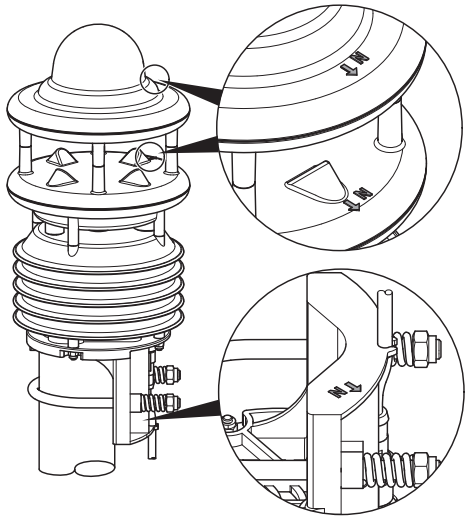


1	Mounting bracket	3	Nut with washer
2	Spring	4	Mast

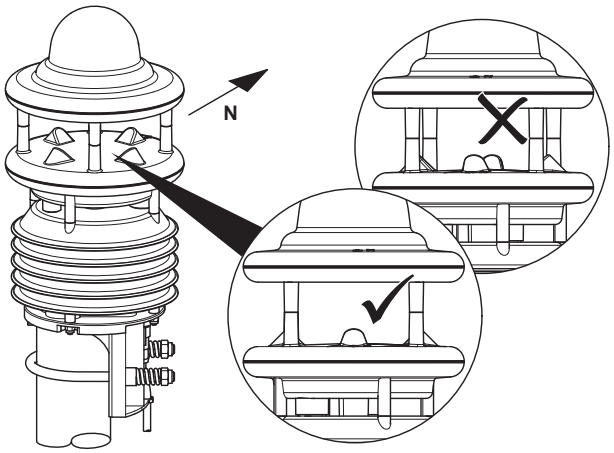
- Loosen the nuts.
- Push the device onto the top of the mast or crossbeam from above.
- Tighten the nuts evenly until they touch the springs but the device can still be moved easily.
- For sensors with wind measurements, align the device to the north with the north arrow markings.
- Tighten both nuts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

7.1.4 Aligning to north

It is recommended to align the device to the north using a reference compass. The device has a number of directional arrows for this purpose. For declination setting, refer to Wind and compass settings [▸ 27] (and compass settings [▸ 29]). If aligning to True North, ensure you use the most up to date magnetic declination for your geographic region.



- 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. It might be helpful to use a straight rod to assist with aligning the wind sensors.



- Tighten both nuts with 3 revolutions.

Magnetic North may differ from Geographic or True North. When aligning the device to True North, the magnetic 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. Some handheld compasses have a magnetic declination offset; ensure that the compass is properly configured for your geographic location and alignment methodology (Magnetic vs True North).

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 devices generate sound close to the device, which is not audible to humans.

7.2.1 Electrical connections

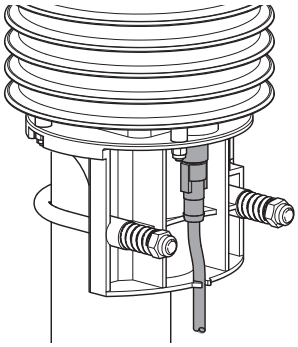
WARNING

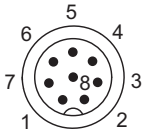
Electric shock due to incorrectly connected device!

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 plug 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, Type F where required)*
3	Green	RS-485_A (+)
4	Yellow	RS-485_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, Type F where required)*

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

7.2.1.1 Connecting devices in SDI-12 mode

- Additional connection of SDI-12 ground to pin 1 is only required if data logger and power supply are separate units.
- Connect the SDI-12 data line to line 4 (yellow).
- Do not connect the line 3 (green).

7.2.2 Supply voltage

The DC supply voltage is 4 to 28 V ⎓. The power supply unit used must be approved for operation with equipment of protection class III (SELV).

The power supply must be equipped with a disconnection device. The separator must meet the following requirements:

- Switch or circuit breaker in switch/distribution cabinet
- Easy accessible to the user
- Marked as a separator

7.2.2.1 Limitations in 12 V mode

If the heating is operated on 12 V ⎓, the functional restrictions in winter operation must be taken into account. A heating voltage of 24 V ⎓ is recommended to guarantee full heating duty.

Both heating and fan lose efficiency when operating below 24 V, which can affect temperature and humidity accuracy; therefore, a heating voltage of 24 V is recommended to ensure full heating performance, especially under winter conditions.

7.2.2.2 Limitations with supply voltage below 11 V

When operating devices with a supply voltage lower than 11 V ⎓, 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 RS-485 Interface

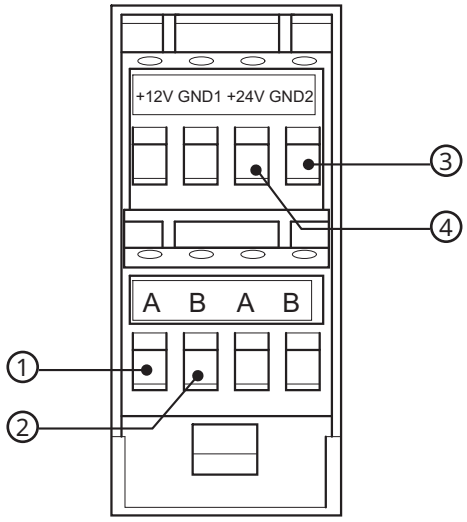
The device has a half-duplex, 2 wire RS-485 interface for configuration, measurement polling and the firmware update.

The sensor does not provide galvanic isolation between the RS-485 data lines and the power supply lines. Supply voltage ground and RS-485 reference are common. If a galvanic isolation is needed, it has to be installed separately.

For installations where multiple sensors are installed using the RS-485 interface, a galvanic isolator is recommended, such as the OTT HydroMet ISOCON. For installations that use long cable lengths > 20 m, it is also recommended to use galvanic isolators.

7.2.4 Connecting ISOCON-UMB converter

The ISOCON-UMB communication module converts RS-485 into RS-232. The main feature of the ISOCON is the galvanic isolation of the RS-485 connection to the sensor. The communication to logger and control devices is parallel available as RS-485 and RS-232. The 12 V power supply output is also isolated, the 24 V supply not.



1	Green: RS-485 interface A	3	White: supply voltage ground GND2
2	Yellow: RS-485 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 directly to the power supply unit, not to the ISOCON-UMB converter.
- Refer to the operating manual ISOCON-UMB converter.

7.2.5 Installing surge protection

Additional surge protection is optional, but recommended.

- Install the surge protection between the device and ISOCON-UMB converter.
- Refer to the operating instructions of the surge protection. Kipp & Zonen recommends using their surge protection (8379.USP).

7.2.6 Connecting external sensors

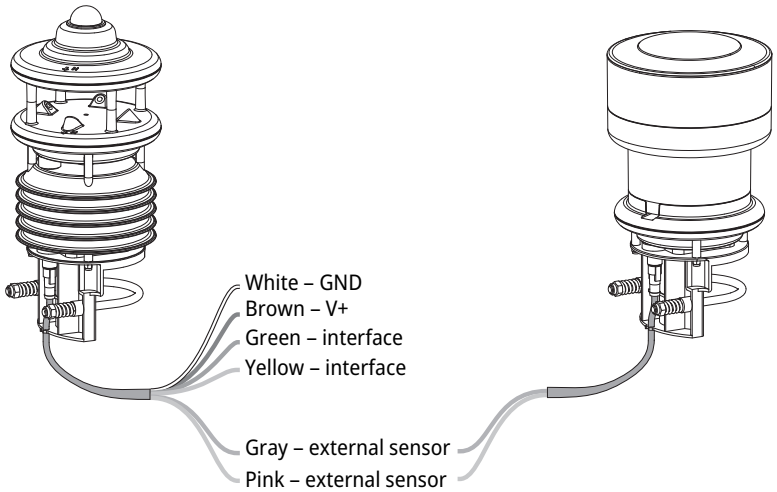
This extension provides one input, which can be used for either a temperature sensor or a precipitation sensor. The connection utilizes the standard connector plug of the Smart Weather Sensor. Typically, the external device is connected to the end of the cable, located in the control cabinet.

Note: An external precipitation sensor cannot be used with weather stations that already include a radar-based precipitation measurement or a tipping-bucket rain gauge.

As the cable forms part of the measuring line, care must be taken during cabling design to minimize external interference. The cable should be kept as short as possible.

In special cases, such as when the external sensor is installed close to the Smart Weather Sensor while the control cabinet is positioned at a distance, consider installing an additional distribution box to ensure proper connectivity.

All external sensors are nonpolar, so any connection polarity can be chosen.



Connection WS501-J and external rain gauge (WTB100)

- 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 sensor configuration.

8 Commissioning

8.1 Settings

In the following chapters all configuration parameters of the compact weather station are described in detail.

For correct operation at least the following parameters must be set when installing a new device:

- Local altitude (to ensure the correct calculation of the relative air pressure)
- Local compass offset (to consider the local deviation due to the declination of the earth magnetic field and thus get correct compass bearings)

8.1.1 General device description

The following device descriptions can be read out:

- Serial number
- Production month and year
- Project number
- BOM revision
- Schematic revision
- Hardware version
- Firmware version
- Setup version
- Device version
- Device type
- UMB device class ID (weather station = 7)

8.1.2 General settings

The general settings cover parameters to identify the device as well as the operating mode of the device.

Parameter	Factory setting	Range	Description
Device-ID	1	1 - 199 201 - 255	ID used to identify the device on a bus. We recommend assigning the IDs for the devices in ascending order. Do not use ID 200 as this ID is reserved for communication after startup
Device name	TBD	Read-only	Name given by the producer
Device description	Compact weather station	Max. 40 characters	Free text, e.g. the location of the station. Can be used to differentiate the devices
Operating mode	Normal	Normal Power save 1 Power save 2	For detailed description of the operating modes see Energy management [▶ 32]

8.1.3 Serial interface

Parameter	Factory setting	Range	Unit	Description
Protocol	UMB Binary	UMB Binary SDI-12 MODBUS NMEA ASCII-2	–	Protocol used on the serial interface
Transmission rate	19200	1200 2400 4800 9600 14400 19200 28800 38400 57600 115200	Baud	Transmission rate on the serial interface. ▸ DO NOT change for operation with ISOCON-UMB!
Transmission mode (bits, parity, stopbits)	8N1	8N1 (UMB default) 8E1 (MODBUS default) 7E1 (SDI-12) 8N2 7N2	–	Transmission mode used on the serial interface

i If the transmission parameters are changed, after saving the configuration on the device, the device communicates at the new transmission parameters.

i When operating the device in a UMB network with ISOCON-UMB, all devices including ISOCON must use the same transmission rate.

8.1.4 Location data

Parameter	Factory setting	Range	Unit	Description
Latitude	0	-90 to +90	°	Latitude of the station Can be used to identify a device
Longitude	0	-180 to +180	°	Longitude of the station Can be used to identify a device
Altitude	200	-100 to +5000	m	Altitude of the station (referenced to sea level) Used for calculation of the relative air pressure

8.1.5 Air temperature and humidity

Parameter	Factory setting	Range	Unit	Description
Temperature offset	0	-50 to +50	°C	Offset is added to the current air temperature
Humidity offset	0	-50 to +50	%	Offset is added to the current relative humidity
Temperature interval	10	1 to 10	min.	Interval for calculation of min., max. and avg air temperature
Humidity interval	10	1 to 10	min.	Interval for calculation of min., max. and avg humidity
Fan mode	ON	OFF, ON	–	Switch the fan off/on

i The humidity interval defines the interval for absolute and relative humidity as well as the interval for dewpoint.

8.1.6 Global radiation

Parameter	Factory setting	Range	Unit	Description
Offset	0	-500 to +500	W/m^2	Offset is added to the current global radiation
Interval	10	1 to 10	min.	Interval for calculation of min., max. and avg global radiation

8.1.7 Air pressure

Parameter	Factory setting	Range	Unit	Description
Offset	0	-500 to +500	hPa	Offset is added to the current air pressure
Interval	10	1 to 10	min.	Interval for calculation of min., max. and avg air pressure

i The pressure interval defines the interval for absolute and relative pressure as well as the interval for air density, mixing ratio, wet bulb temperature and specific enthalpy.
As for some of these values also air temperature and/or humidity are required, it is highly recommended to set the intervals for air temperature, humidity and air pressure to the same value.

8.1.8 Compass

Parameter	Factory setting	Range	Unit	Description
Offset	0	-180 to +180	°	Offset is added to the current compass bearing. Dependent on the location of the installation the local declination of the earth magnetic field must be considered.

8.1.9 Wind

Parameter	Factory setting	Range	Unit	Description
Measurement cycle	1000	250 1000	ms	For every measurement cycle a new wind speed and direction is evaluated (This is the duration of a fast/min./max. value).
Minimum speed	0.3	0.0 to 10.0	m/s	Minimum wind speed from which a measurement is transmitted
Hold last direction	OFF	OFF, ON	–	If the speed falls below the minimum speed, – the last measured direction is kept, if ON – the direction is set to 0, if OFF
Direction offset	0	-180 to +180	°	Offset is added to the current wind direction
Interval	10	1 to 10	min.	Interval for calculation of min., max., avg and vct wind speed and direction
Heater mode	AUTO	OFF, AUTO	–	For detailed information of the heater modes see Energy management [▶ 32]
Heater setpoint temperature	50	-10 to +50	°C	AUTO mode: Setpoint temperature the device regulates to
Heater min. temperature	40	-10 to +50	°C	AUTO mode: The heater is only switched on, if the air temperature is below this threshold

The wind interval also defines the interval for the wind chill temperature.
As for this value also the air temperature is required, it is highly recommended to set the intervals for air temperature and wind to the same value.

8.1.10 Precipitation

8.1.10.1 Radar sensor

Parameter	Factory setting	Range	Unit	Description
Interval	1	1 to 10	min.	Interval for calculation of the precipitation intensity
Evaporation per day	0.24	0 to 100	mm	Amount of precipitation evaporated automatically per day
Precipitation type follow-up time	120	0 to 3600	s	After the last detected precipitation, the precipitation type is still shown for this follow-up time. To cover all events, this time must be adjusted to the poll rate.
Heater mode	AUTO	OFF, AUTO, ECO	–	For detailed information of the heater modes see Energy management [▶ 32]
Heater setpoint temperature	70	-10 to +70	°C	AUTO mode: Setpoint temperature the device regulates to
Heater min. temperature	40	-10 to +70	°C	AUTO mode: The heater is only switched on, if the air temperature is below this threshold

8.1.10.2 Rain gauge

The rain gauge module can be operated with resolutions 0.2 mm or 0.5 mm.

The setting of the resolution is to be done in two steps:

- Mechanical setting
- Configuration setting

Mechanical setting

The mechanical setting works by modifying the effective area of the funnel. The sensor is delivered with a reduction ring, which can be mounted on the funnel to reduce the area.

Funnel with reduction ring: resolution 0.5 mm.

Funnel without reduction ring: resolution 0.2 mm.

Configuration setting

Parameter	Factory setting	Range	Unit	Description
Rain gauge resolution	0.2	0.1 0.2 0.5 1.0	mm	Resolution of the rain gauge. The resolution depends on whether the reduction ring is fitted or not. The resolution can be set to various values to also support external rain gauges.

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

8.1.11 Lightning

Parameter	Factory setting	Range	Unit	Description
Interval	10	1 to 30	min.	Interval for accumulated lightning events

8.1.12 External device

Parameter	Factory setting	Range	Unit	Description
External device	None	None NTC sensor SSI sensor PT1000 sensor Rain gauge	–	Selection of the external device to be used
Temperature offset	0	-50 to +50	°C	Offset is added to the current temperature measured by the external temperature sensor

i As all external devices are connected to the same pins, only 1 external device can be selected.

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

8.2 Energy management

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

- Device operating mode
- Heating mode
- Fan mode

> Operation in power save modes has certain constraints.

8.2.1 Device operating modes

8.2.1.1 Normal operating mode

In normal operation mode, all specified properties of the devices are available.

The power consumption is mainly determined by heating and fan operation, see chapters Heating modes [▶ 33] and Fan modes [▶ 34].

8.2.1.2 Power save mode 1

The power save mode 1 has got the following effects:

- The fan of the temperature and humidity unit is switched off.
- All heaters (wind unit, radar dome) are switched off.
- The radar rain sensor of the following devices is not working continuously: WS800-J, WS700-J, WS600-J, WS400-J.
- 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 radar rain sensor is deactivated again after this second. Sampling interval for global radiation is increased from 1 second to 1 minute.
- The lightning detection probe in the WS800-J is activated once per minute for 1 second like the radar rain sensor.

The power save mode 1 has got 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 or wind sensor.
- 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.

8.2.1.3 Power save mode 2

The power save 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 save mode 2 is not available for devices with radar rain sensor:
> WS800-J, WS700-J, WS600-J, WS400-J.
> For low power applications, devices with tipping bucket rain gauge are recommended.

The power save mode 2 has got the following restrictions:

- All restrictions of power save mode 1.
- The calculation of average, minimum and maximum as well as precipitation intensity are not available. Only instantaneous values are provided.
- When using any other protocol than SDI-12 use auto repeat mode on transmission failure as the first frame will wake up the processor and therefore won't be received completely by the device.
- Joint operation with other sensors operating in power save mode 2 is possible but be aware that each telegram wakes up the device for several seconds. This increases the total power consumption.
- Mixed operation of devices in power save mode 2 with devices in normal operation and fast request rates within the same network is not recommended.
- Functionality of external rain gauge (WTB100) is not provided in power save mode 2.

8.2.2 Heating modes

In normal device operating mode, the following heating operating modes are available:

Mode	AUTO	OFF	ECO
Wind heating	+	+	-
Radar heating	+	+	+

In both device power saving modes, all heaters are switched off.

All heaters are configured to "AUTO" by default. This is the recommended operating mode for heating the sensor in normal device operating mode.

8.2.2.1 AUTO mode

In this heater mode, the sensor is maintained constantly at the setpoint temperature, generally to prevent the effects of snow and ice.

The heating is only switched on, if the air temperature is below the minimal temperature threshold. This threshold must be reduced to reduce power consumption in frost-free situations without major restrictions on winter operation. In WS200 the temperature threshold is disregarded and the heating always switched on in AUTO mode.

Both parameters setpoint and minimal temperature can be adjusted in the settings, see chapters Wind [▶ 30] and Precipitation [▶ 30].

8.2.2.2 OFF mode

In the OFF operating mode heating is completely disabled.

Winter operation is not possible in this operating mode because any icing might prevent the correct operation of the rain sensor or wind meter.

8.2.2.3 ECO mode

The radar dome heating provides an additional power saving mode.

Heating is only switched on if one of the following conditions is met:

- The outside temperature is below the minimal threshold temperature and precipitation was detected: Heating then runs at the setpoint temperature and follows up for 30 minutes after the last precipitation event.
- There was no heating for more than 20 h and the air temperature was constantly below the minimal threshold temperature for this entire period: Then the heating is switched on for 30 minutes as a precautionary measure to thaw any icing.
- The system is restarted: At the system start the device starts with a 30 minutes heating period if the air temperature is below the minimal threshold.

8.2.3 Fan modes

To reduce electrical power consumption in normal device operating mode, the fan can be switched off.

i With the fan switched off deviations in temperature and humidity measurement can occur by solar radiation!

9 Commissioning for UMB protocol

The UMB is an open communication protocol for meteorological sensors. The reference manual is available at http://www.kippzonen.com.

9.1 UMB controller library

To support the integration of sensors a UMB controller library is available on https://github.com/OttHydromet/UMBControllerLib.

The library is written in the C language and available as a static or dynamic link library for the following operating systems/architectures:

Operating system	Windows	Linux	Linux/ARM
64 bit	UmbControllerLib.dll UmbControllerLib.lib	libUmbControllerLib.so	libUmbControllerLibArm_64.so
32 bit	UmbControllerLib_32.dll UmbControllerLib_32.lib	libUmbControllerLib_32.so	libUmbControllerLibArm_32.so

The library itself does not use dynamic memory allocation. For a detailed description see the documentation in the repository.

9.2 ConfigTool.NET installation

For configuration and testing purposes Kipp & Zonen provides the proprietary software ConfigTool.NET.

ConfigTool.NET can also be used to update the firmware of the device.

Installation

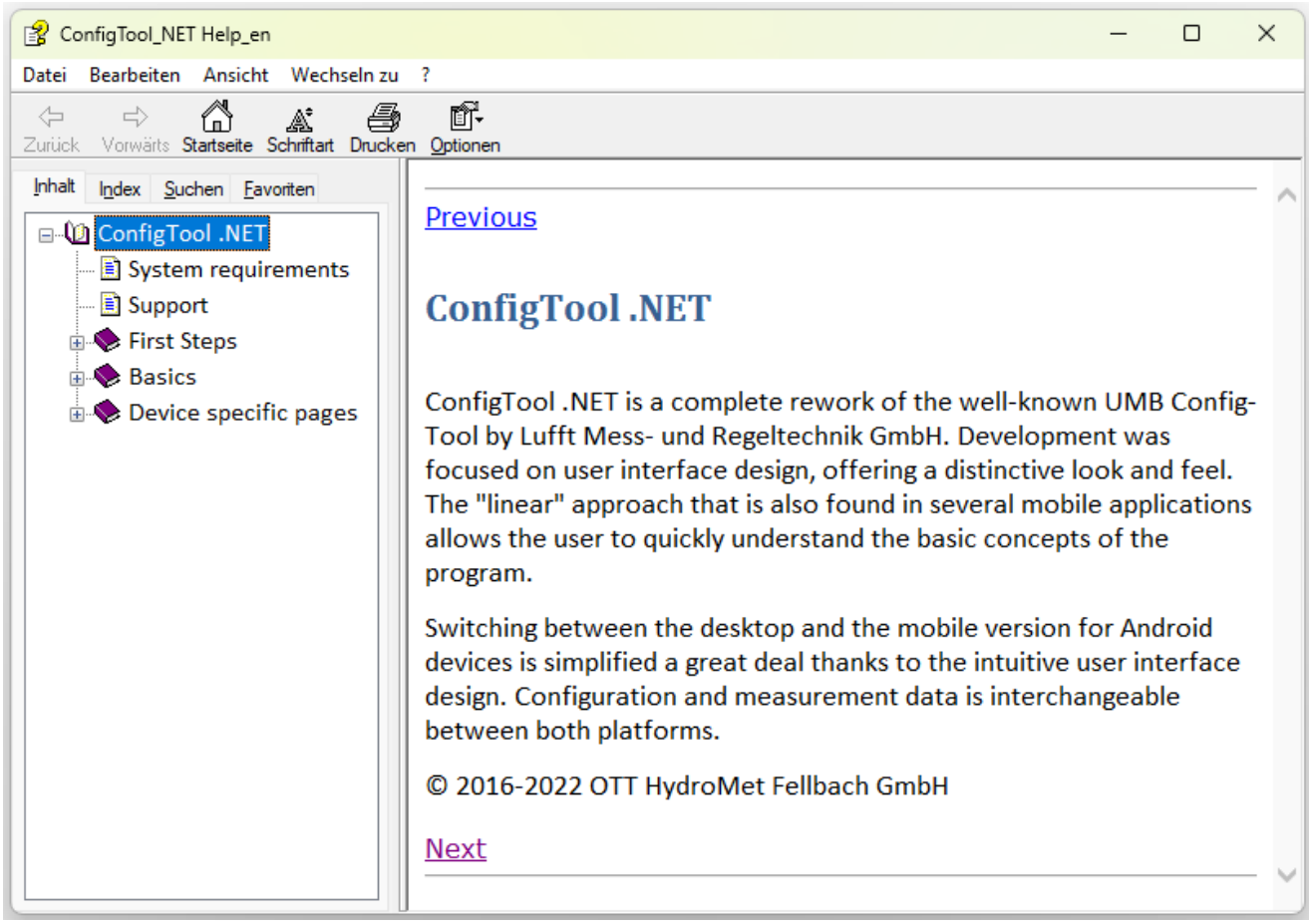
✓ COM port is selected.

- Download the ConfigTool.NET software from www.otthydromet.com.
- Ensure to always use the latest version of ConfigTool.NET.
- Install the software on the computer.
- Get familiar with the software in general using the online help of the tool.

- Click on the help button 

in the upper right corner of the menu.

⇨ The online help of ConfigTool.NET opens:



9.2.1 Configuration using ConfigTool.NET

For configuration and testing Kipp & Zonen provides the proprietary software ConfigTool.NET. The ConfigTool.NET software can communicate over a serial, a Bluetooth or a network interface and allows the following communication steps:

- Reading out the device's individual UMB channels
- Automatically querying, graphically displaying and storing the measured data
- Performing firmware updates
- Controlling the device using parameter lists
- Control commands, such as determining reference values, defrost mode, etc.

To use the ConfigTool.NET software, the following steps must be taken:

- Download the ConfigTool.NET software at: www.otthydromet.com
- Install the software on the computer.
- Get familiar with the software in general.
- Ensure to always use the latest version of ConfigTool.NET.
- Ensure that the connection settings of ConfigTool.NET are conform to the settings of the device.

9.3 Device set-up

9.3.1 Equipment

For setting up a device the following is required:

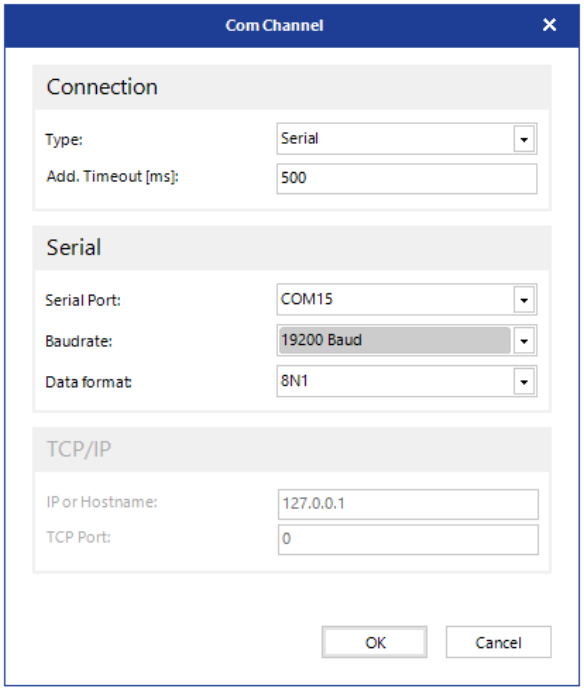
- The device including cabling for power supply
- A UMB controller tool. (The UMB controller can either be the ConfigTool.NET software or any other PC tool using the UMB protocol for communicating with a device. The UMB controller library can help to implement the UMB protocol into non-proprietary tools.)
- RS-485 USB interface adapter including cabling

In the following chapters ConfigTool.NET is used for setting up a device. The installation of ConfigTool.NET is described in more detail in the previous chapter ConfigTool.NET installation [▶ 35].

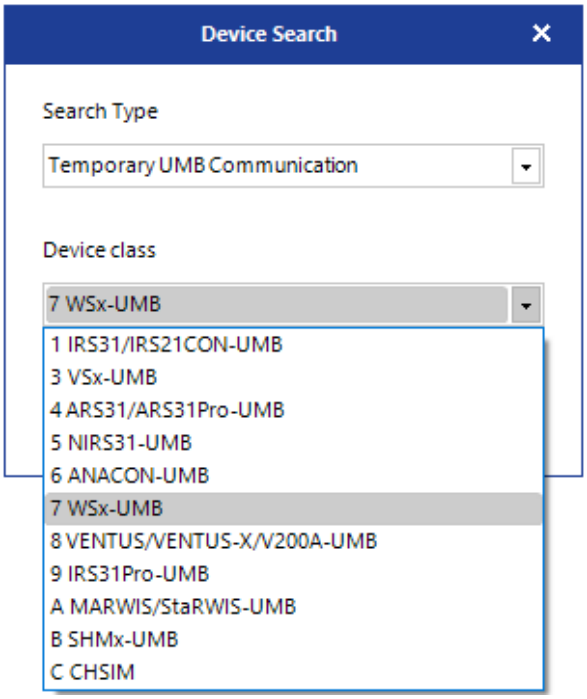
9.3.2 Getting started

To setup the device, the following steps must be taken:

- ✓ Equipment, see above
- ✓ Other devices that poll the UMB bus, e.g. modem or LCOM, must be disconnected
- ✓ Every device on the bus must have a unique Device ID
- ▸ Create a new workspace in ConfigTool.NET or open an existing workspace.
- ▸ Select the COM port for communicating with the device.
- ▸ Ensure that the connection settings are conform to the settings of the device. For a new device use the default settings of the device: 19200 Bd, 8N1.



- ▸ Add the new devices manually to the workspace or use the device search function to find devices on the bus:



- ▸ Read out the channel list of the device. If you use the device search function the channel list is updated automatically for every device found on the bus.

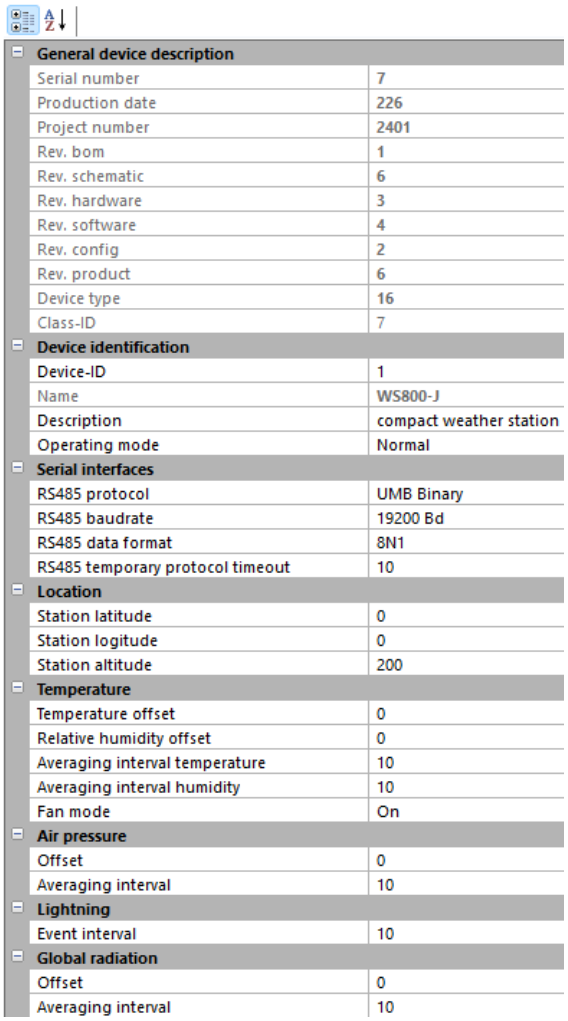
After startup the device communicates in UMB for the first 5 s using its default transmission parameters (19200bd, 8N1) and device ID 200. If it receives a UMB message during that time, it remains in that mode for 10 min.

This can be helpful if you need:

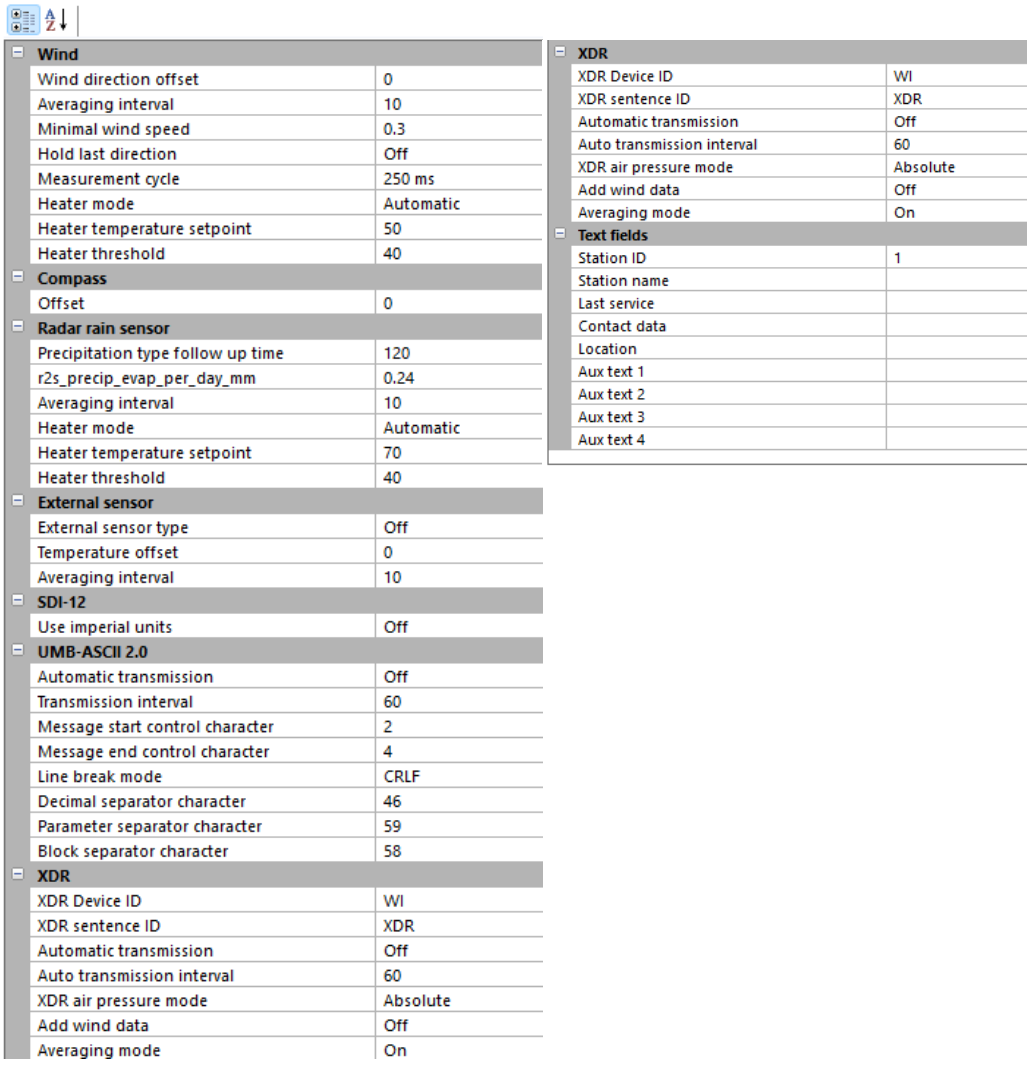
- to catch a device with unknown transmission parameters
- to configure a device which operates at another protocol

9.3.3 Configuration

Configuration of a device is done in the device settings menu of ConfigTool.NET.



General device description	
Serial number	7
Production date	226
Project number	2401
Rev. bom	1
Rev. schematic	6
Rev. hardware	3
Rev. software	4
Rev. config	2
Rev. product	6
Device type	16
Class-ID	7
Device identification	
Device-ID	1
Name	WS800-J
Description	compact weather station
Operating mode	Normal
Serial interfaces	
RS485 protocol	UMB Binary
RS485 baudrate	19200 Bd
RS485 data format	8N1
RS485 temporary protocol timeout	10
Location	
Station latitude	0
Station logitude	0
Station altitude	200
Temperature	
Temperature offset	0
Relative humidity offset	0
Averaging interval temperature	10
Averaging interval humidity	10
Fan mode	On
Air pressure	
Offset	0
Averaging interval	10
Lightning	
Event interval	10
Global radiation	
Offset	0
Averaging interval	10



Wind	
Wind direction offset	0
Averaging interval	10
Minimal wind speed	0.3
Hold last direction	Off
Measurement cycle	250 ms
Heater mode	Automatic
Heater temperature setpoint	50
Heater threshold	40
Compass	
Offset	0
Radar rain sensor	
Precipitation type follow up time	120
r2s_precip_evap_per_day_mm	0.24
Averaging interval	10
Heater mode	Automatic
Heater temperature setpoint	70
Heater threshold	40
External sensor	
External sensor type	Off
Temperature offset	0
Averaging interval	10
SDI-12	
Use imperial units	Off
UMB-ASCII 2.0	
Automatic transmission	Off
Transmission interval	60
Message start control character	2
Message end control character	4
Line break mode	CRLF
Decimal separator character	46
Parameter separator character	59
Block separator character	58
XDR	
XDR Device ID	WI
XDR sentence ID	XDR
Automatic transmission	Off
Auto transmission interval	60
XDR air pressure mode	Absolute
Add wind data	Off
Averaging mode	On

XDR	
XDR Device ID	WI
XDR sentence ID	XDR
Automatic transmission	Off
Auto transmission interval	60
XDR air pressure mode	Absolute
Add wind data	Off
Averaging mode	On
Text fields	
Station ID	1
Station name	
Last service	
Contact data	
Location	
Aux text 1	
Aux text 2	
Aux text 3	
Aux text 4	

All configuration parameters are described in chapter Settings [▶ 27].

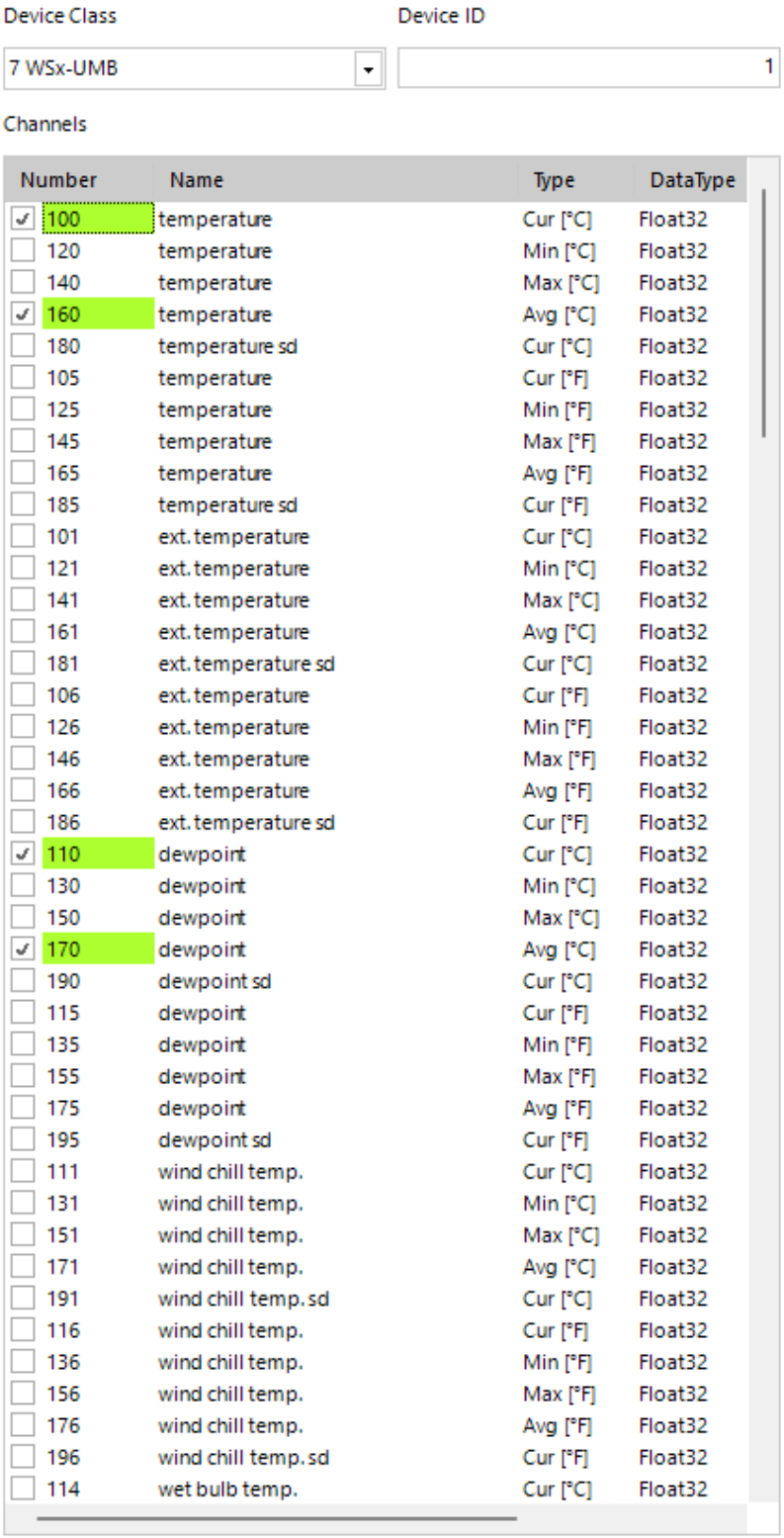
9.3.4 Testing

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.

✓ A ConfigTool.NET workspace containing the device to be tested including the channel list of the device

▸ Open the device details in the ConfigTool.NET workspace.

▸ Select all channels to be polled:



Number	Name	Type	DataType
☑ 100	temperature	Cur [°C]	Float32
☐ 120	temperature	Min [°C]	Float32
☐ 140	temperature	Max [°C]	Float32
☑ 160	temperature	Avg [°C]	Float32
☐ 180	temperature sd	Cur [°C]	Float32
☐ 105	temperature	Cur [°F]	Float32
☐ 125	temperature	Min [°F]	Float32
☐ 145	temperature	Max [°F]	Float32
☐ 165	temperature	Avg [°F]	Float32
☐ 185	temperature sd	Cur [°F]	Float32
☐ 101	ext. temperature	Cur [°C]	Float32
☐ 121	ext. temperature	Min [°C]	Float32
☐ 141	ext. temperature	Max [°C]	Float32
☐ 161	ext. temperature	Avg [°C]	Float32
☐ 181	ext. temperature sd	Cur [°C]	Float32
☐ 106	ext. temperature	Cur [°F]	Float32
☐ 126	ext. temperature	Min [°F]	Float32
☐ 146	ext. temperature	Max [°F]	Float32
☐ 166	ext. temperature	Avg [°F]	Float32
☐ 186	ext. temperature sd	Cur [°F]	Float32
☑ 110	dewpoint	Cur [°C]	Float32
☐ 130	dewpoint	Min [°C]	Float32
☐ 150	dewpoint	Max [°C]	Float32
☑ 170	dewpoint	Avg [°C]	Float32
☐ 190	dewpoint sd	Cur [°C]	Float32
☐ 115	dewpoint	Cur [°F]	Float32
☐ 135	dewpoint	Min [°F]	Float32
☐ 155	dewpoint	Max [°F]	Float32
☐ 175	dewpoint	Avg [°F]	Float32
☐ 195	dewpoint sd	Cur [°F]	Float32
☐ 111	wind chill temp.	Cur [°C]	Float32
☐ 131	wind chill temp.	Min [°C]	Float32
☐ 151	wind chill temp.	Max [°C]	Float32
☐ 171	wind chill temp.	Avg [°C]	Float32
☐ 191	wind chill temp. sd	Cur [°C]	Float32
☐ 116	wind chill temp.	Cur [°F]	Float32
☐ 136	wind chill temp.	Min [°F]	Float32
☐ 156	wind chill temp.	Max [°F]	Float32
☐ 176	wind chill temp.	Avg [°F]	Float32
☐ 196	wind chill temp. sd	Cur [°F]	Float32
☐ 114	wet bulb temp.	Cur [°C]	Float32

▸ Save the settings.

- Start the measurement polling.

Timestamp	WS800-J 0x7001				
	temperature 100 [°C] Cur	dewpoint 110 [°C] Cur	relative humidity 200 [%] Cur	abs. air pressure 300 [hPa] Cur	device status 4000 [digits] Cur
14:05:15	28.41	11.32	34.61	993.03	0
14:05:20	28.42	11.33	34.62	993.04	0
14:05:25	28.42	11.32	34.59	993.02	0
14:05:30	28.42	11.32	34.58	993.04	0
14:05:35	28.43	11.29	34.50	993.02	0
14:05:40	28.43	11.23	34.38	993.05	0
14:05:45	28.43	11.20	34.32	993.03	0
14:05:50	28.42	11.17	34.24	993.06	0
14:05:55	28.42	11.13	34.15	993.03	0
14:06:00	28.42	11.09	34.08	993.04	0
14:06:05	28.42	11.07	34.02	993.02	0
14:06:10	28.42	11.05	33.98	993.03	0
14:06:15	28.42	11.04	33.96	993.04	0
14:06:20	28.42	11.03	33.95	993.03	0
14:06:25	28.41	11.02	33.93	993.01	0
14:06:30	28.41	11.02	33.92	993.03	0
14:06:35	28.41	11.03	33.94	993.03	0
14:06:40	28.41	11.03	33.95	993.03	0

9.4 UMB channel list

The channel assignment applies to online data requests in UMB binary and UMB-ASCII 2 protocol.

Which channels are available depends on the WSxxx-UMB type in use.

9.4.1 General UMB channels

UMB channel						Measuring range		
act	min	max	avg	std dev	Measurement variable {float32}	min	max	unit
Temperature								
100	120	140	160	180	temperature	-50.0	60.0	°C
105	125	145	165	185	temperature	-58.0	140.0	°F
101	121	141	161		external temperature	-40.0	80.0	°C
106	126	146	166		external temperature	-40.0	176.0	°F
110	130	150	170		dewpoint	-50.0	60.0	°C
115	135	155	175		dewpoint	-58.0	140.0	°F

UMB channel						Measuring range		
act	min	max	avg	std dev	Measurement variable {float32}	min	max	unit
111	131	151	171		wind chill temperature	-60.0	70.0	°C
116	136	156	176		wind chill temperature	-76.0	158.0	°F
114	134	154	174		wet bulb temperature	-50.0	60.0	°C
119	139	159	179		wet bulb temperature	-58.0	140.0	°F
Humidity								
200	220	240	260	280	relative humidity	0.0	100.0	%
205	225	245	265		absolute humidity	0.0	1000.0	g/m^3
Mixing ratio								
210	230	250	270		mixing ratio	0.0	1000.0	g/kg
Specific enthalpy								
215	235	255	275		specific enthalpy	-100	1000.0	kJ/kg
Air pressure								
300	320	340	360	380	abs. air pressure	300	1200	hPa
305	325	345	365		rel. air pressure	300	1200	hPa
Air density								
310	330	350	370	390	air density	0.0	3.0	kg/m^3
Compass								
510					compass heading	0	359	°
Global radiation								
900	920	940	960	980	global radiation	0	2000	W/m^2

9.4.2 Wind UMB channels

Wind											
UMB channel									Measuring range		
fast	act	min	max	avg	vct	gust	std dev	Measurement variable {float32}	min	max	unit
401	400	420	440	460	480	443	461	wind speed	0	75.0	m/s
406	405	425	445	465	485	448	466	wind speed	0	270.0	km/h
411	410	430	450	470	490	453	471	wind speed	0	167.8	mph
416	415	435	455	475	495	458	476	wind speed	0	145.8	kts
501	500	520	540		580	543	581	wind direction	0	359.9	°
503	502	522	542		582	545		wind direction corr.	0	359.9	°

9.4.3 Precipitation UMB channels

Precipitation					
UMB channel			Measuring range		
Quantity					
absolute	**differential**	**Measurement variable {float32}**	**min**	**max**	**unit**
600	605	precipitation quantity	0	100000	liters/m^2
620	625	precipitation quantity	0	100000	mm
640	645	precipitation quantity	0	3937	inches
660	665	precipitation quantity	0	3937008	mil
Intensity					
Intensity		**Measurement variable {float32}**	**min**	**max**	**unit**
800		precipitation intensity	0.00	200.00	l/m^2/h
820		precipitation intensity	0.00	200.00	mm/h
825		precipitation intensity	0.00	3.3333	mm/min
840		precipitation intensity	0.00	7.8740	in/h
845		precipitation intensity	0.00	0.13123	in/min
860		precipitation intensity	0.00	7874.0	mil/h
Type					
Type		**Measurement variable {uint8}**	**code**	**description**	**intensity [mm/h]**
700		precipitation type	00	No precipitation	–
			40	Unspecified precipitation	–
			60	Liquid precipitation, e.g. rain	–
			70	Solid precipitation, e.g. snow	–
780		WMO synop code 4680 wawa (present weather, automated station)	00	no significant weather	–
			40	unspecified precipitation	–
			61	rain, not freezing, slight	< 2.5 mm/h
			62	rain, not freezing, moderate	2.5 mm/h ≤ < 10 mm/h
			63	rain, not freezing, heavy	≥ 10 mm/h
			67	rain + snow, slight	< 2.5 mm/h
			68	rain + snow, moderate/ heavy	≥ 2.5 mm/h
			71	snow, slight	< 1 mm/h
			72	snow, moderate	1 mm/h ≤ < 4.0 mm/h
			73	snow, heavy	> 4.0 mm/h

9.4.4 Lightning UMB channels

Lightning				
UMB channel		Measuring range		
Lightning events	Measurement variable (uint16)	min	max	unit
617	sum of lightning events (5 s)	0	255	–
677	sum of lightning events (interval)	0	65535	–

NOTE: WS800-J may accidentally detect lightning events when disturbances in the area are in the 500kHz frequency range.

9.4.5 TLS2002 FG3 channels

The following channels are available specifically for data requests for further processing in TLS format. These channels are only available in the UMB Binary protocol.

DE Type	UMB Channel	Meaning	Format	Range	Resolution	Value	Coding Decimal	Coding Hexadecimal
48	1048	Result message air Temperature LT	16 bit	-30 to +60 °C	0.1 °C	60.0 0.0 -0.1 -30.0	600d 0d -1d -300d	0258h 0000h FFFFh FED4h
53	1053	Result message Precipitation Intensity NI	16 bit	0 to 200 mm/h	0.1 mm/h	0.0 200.0	0d 2000d	0000h 07D0h
54	1054	Result message Air Pressure LD	16 bit	800 to 1200 hPa	1 hPa	800 1200	800d 1200d	0320h 04B0h
55	1055	Result message Relative Humidity RLF	8 bit	10 to 100 %	1 % RH	10 % 100 %	10d 100d	0Ah 64h
56	1056	Result message Wind Direction WR	16 bit	0 to 359°	1°	0° (N) 90° (O) 180° (S) 270° (W)	0d 90d 180d 270d not definable	0000h 005Ah 00B4h 010Eh FFFFh
57	1057	Result message Wind Speed. (average) WGM	16 bit	0.0 to 60.0 m/s	0.1 m/s	0.0 60.0	0d 600d	0000h 0258h
64	1064	Result message Wind Speed (peak) WGS	16 bit	0.0 to 60.0 m/s	0.1 m/s	0.0 60.0	0d 600d	0000h 0258h
66	1066	Result message Dewpoint Temperature TPT	16 bit	-30 to +60 °C	0.1 °C	60.0 0.0 -0.1 -30.0	600d 0d -1d -300d	0258h 0000h FFFFh FED4h
71	1071	Result message Precipitation Type NS	8 bit			0 40	No precipitation unspecified precipitation	

DE Type	UMB Channel	Meaning	Format	Range	Resolution	Value	Coding Decimal	Coding Hexadecimal
						60	Liquid precipitation, e.g. rain	
						70	Solid precipitation, e.g. snow	
90	1090	Result message Precipitation Intensity NI	16 bit	0 to 200 mm /h	0.1 mm/h	0.00 200.00	0d 20000d	0000h 4E20h

9.4.6 Service UMB channels

Device status				
UMB channel	Measurement variable (uint32)	Measuring range		
		min	max	unit
4000	device status	0	2047	–
4010	init status	0	4.294.967.295	–
4011	temperature status	0	4.294.967.295	–
4012	humidity status	0	4.294.967.295	–
4013	pressure status	0	4.294.967.295	–
4014	compass status	0	4.294.967.295	–
4015	wind status	0	4.294.967.295	–
4016	precipitation status	0	4.294.967.295	–
4017	global radiation status	0	4.294.967.295	–
4018	lightning	0	4.294.967.295	–
4024	heater status	0	4.294.967.295	–
4025	fan status	0	4.294.967.295	–
4050	reset cause (uint16)	0	65535	–

In error free operation all status channels report 0, any set bit indicates an error. The error bits of status channels 4000-4020 are coded as follows:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Device Status UMB channel 4000	Fan	Heater						Lightning	Global Radiation	Precipitation	Wind	Compass	Air Pressure	Air Humidity	Air Temperature	General
init Device UMB channel 4010		RTC Fast/ Slow	RTC Error	ADC Error	SPI Error	12C Error	Communication	Configuration Defaults	Configuration Out-of-Range	Configuration CRC	Adaption CRC	Adjustment CRC	NVMEM Error		Power Supply	Hardware

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Air Temperature UMB channel 4011													Measurement	Init	Adjustment	Hardware
Air Humidity UMB channel 4012													Measurement	Init	Adjustment	Hardware
Air Pressure UMB channel 4013													Measurement	Init	Adjustment	Hardware
Compass UMB channel 4014													Measurement	Init	Adjustment	Hardware
Wind UMB channel 4015													Measurement	Init	Adjustment	Hardware
Precipitation UMB channel 4016													Measurement	Init	Adjustment	Hardware
Global Radiation UMB channel 4017													Measurement	Init	Adjustment	Hardware
Lightning UMB channel 4018													Measurement	Init		Hardware
Heater UMB channel 4024							HW over-temperature	SW over-temperature					Measurement	Init		Hardware

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Fan UMB channel 4025													Measurement	Init		Hardware

The bits in the Global Device Status are set if there is at least 1 set bit in the respective measurement status channel.

All bits 16-31 are reserved.

Device info				
UMB channel	Measurement variable (uint32)	Measuring range		
		min	max	unit
4060	supply voltage (float32)	0.0	50.0	V
4061	heater supply voltage (float32)	0.0	50.0	V
4070	Fan speed (uint16)	0	65535	rpm
4080	attended time	0	4.294.967.295	h
4081	run time	0	4.294.967.295	s
4082	boot count	0	4.294.967.295	–
4083	watchdog reason	0	4.294.967.295	–
4084	cpu load	0	100	%

UMB channel	Measurement variable (float32)	Measuring range		
		min	max	unit
Temperatures				
4100	tff temperature	-40.0	80.0	°C
4105	tff temperature	-40.0	176.0	°F
4110	housing temperature	-40.0	60.0	°C
4115	housing temperature	-40.0	140.0	°F
4120	wind heater temperature	-50.0	150.0	°C

UMB channel	Measurement variable (float32)	Measuring range		
		min	max	unit
4125	wind heater temperature	-58.0	302.0	°F
4130	radar heater temperature	-50.0	150.0	°C
4135	radar heater temperature	-58.0	302.0	°F
Humidity and pressure				
4200	tff rel. humidity	0.0	100.0	%
4300	tff vap pressure	-10.0	1000.0	hPa
Wind				
4400	wind quality (cur)	0.0	100.0	%
4401	wind quality fast (cur)	0.0	100.0	%
4460	wind quality (avg)	0.0	100.0	%

UMB channel	Measurement variable (uint16)	Measuring range		
		min	max	unit
Precipitation				
4600	total particles	0	65535	–
4601	total drops	0	65535	–
4603	total snow flakes	0	65535	–
4620	drop class 0	0	65535	–
4621	drop class 1	0	65535	–
4622	drop class 2	0	65535	–
4623	drop class 3	0	65535	–
4624	drop class 4	0	65535	–
4625	drop class 5	0	65535	–
4626	drop class 6	0	65535	–
4627	drop class 7	0	65535	–
4628	drop class 8	0	65535	–

UMB channel	Measurement variable (uint16)	Measuring range		
		min	max	unit
Precipitation				
4629	drop class 9	0	65535	–
4630	drop class 10	0	65535	–
4631	drop class 11	0	65535	–

10 Commissioning for SDI-12 format

The communication using the SDI-12 protocol conforms to the standard ‘SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors Version 1.4 January 30, 2021’.The weather sensor may be used on a bus together with other SDI-12 sensors and an SDI-12 recorder (logger).

10.1 Configuration

10.1.1 Device address

UMB device ID and SDI-12 device address are tightly coupled. Both have different address spaces and it has to be noted that UMB device IDs are numbers, whereas SDI-12 addresses are ASCII characters.

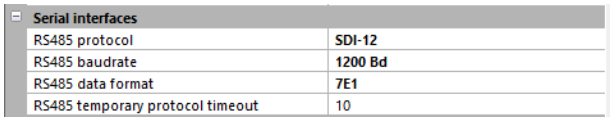
The SDI-12 address is therefore derived from the UMB device ID as follows: UMB device ID 1 (UMB default) corresponds to SDI-12 address '0' (SDI-12 default). A change of the SDI-12 address by the address change commands also changes the UMB device ID and vice versa.

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

10.1.2 Configuration parameters

As communication settings for SDI-12 differ from the default parameters of the weather station, they must be configured accordingly with <ConfigTool.NET>.

Protocol type needs to be SDI-12, baud rate 1200 Bd and data format 7E1.



Serial interfaces	
RS485 protocol	**SDI-12**
RS485 baudrate	**1200 Bd**
RS485 data format	**7E1**
RS485 temporary protocol timeout	10

Measurement data may be transmitted using metric or imperial units. This setting can be changed in the configuration, too.

SDI-12	
Use imperial units	Off

10.2 SDI-12 basic commands

Details on the SDI-12 protocol may be found in the standards document. The following section states all commands that are supported by the weather sensor.

Due to the measurement principles used in the weather sensor, certain aspects of the SDI-12 standard are implemented differently:

- In normal operation mode, the device takes measurements on a continuous basis. The device does not need to “wake up”. However, a “break” signal is still needed on the beginning of an SDI-12 request as it is part of the standard.
- •Data from M- and C-commands are available without any delay and the device responds with a000n or a000nn. Therefore, the device does not send a service request and ignores any signal to stop the current measurement. The recorder should issue D-commands immediately.
- M- and C-commands only differ in the number of measurement items that can be returned (max. 9 or 99).
- It is recommended to use the commands for continuous measurements (R-commands).

– In Power Save Mode 2, the device wakes up by a “break” signal.
– In Power Save Mode 2, the device takes 5 seconds to complete the measurement cycle. The response to M- or C-commands is therefore in the form of a005n or a005nn.
– Measurement data that is not available in Power Save Mode 2 is indicated by invalid data (999.9) in the buffer responses.

10.2.1 Address query (?-command)

This command performs an address query. It may be used to determine the address on a sensor with an unknown address.

i As this is a wildcard command it may only be used on installations where only one sensor is connected.

Command	Response	Description
?!	a<CR><LF>	a: Address of the sensor that responded

10.2.2 Acknowledge active (!-command)

This command ensures that the sensor is responding to the data recorder.

Command	Response	Description
a!	a<CR><LF>	a: Address of the sensor

10.2.3 Change address (A-command)

This command changes the address of the sensor.

Command	Response	Description
aAb!	b<CR><LF>	– a: Current address of the sensor – b: New address of the sensor (response will indicate the old address if the sensor was unable to change the address)

10.2.4 Send identification (I-command)

This command performs an identification of the sensor.

Command	Response	Description
aI!	a14Lufft.deWSmmmyvvvxxxxxxxxxxxxx<CR><LF>	– 14: The SDI-12 version number, version 1.4 is encoded as 14 – Lufft.de: 8 character vendor identification – WSmmm: 6 characters specifying the sensor model number m: device type (e.g. 400, 500, 600, 200, 300) – y: Metric and imperial units (m = metric, i = imperial) – vvv: 3 characters specifying the sensor firmware version – xxx . . . xx: 13 characters, used for the serial number

10.2.5 Start verification (V-command)

This command performs a verification of the sensor.

Status information is provided as “pseudo” measurement values. Each digit represents the status of a basic measurement value, where “OK” is represented as the value '0'. All other values indicate an issue with the measurement.

> i A status value of '1' (invalid channel or channel off) does usually not indicate an issue with the sensor. It is used on variants where the sensor does not support the specific measurement. Also, certain measurement values are not available in Power Save Mode 2.

Command	Response	Description
aV!	a0008<CR><LF>	Request a verification of the sensor and return status information on basic measurement values
aD0!	a<VALUE1><VALUE2><VALUE3><VALUE4><CR><LF>	– a: Sensor address – <VALUE1> Status group1: +nnnn (air temperature, relative humidity, relative air pressure, global radiation) – <VALUE2> Status group 2: +nnnnn (wind gust speed, wind gust direction, wind direction, precipitation wawa code, precipitation intensity) – <VALUE3> Status group 3: +nnnn (dew point, wet bulb temperature, wind chill temperature, external temperature) – <VALUE4> Status group 4: +nnnnn (absolute humidity, mixing ratio, specific enthalpy, absolute air pressure, air density)
aD1!	a<VALUE5><VALUE6><VALUE7><VALUE8><CR><LF>	– <VALUE5> Status group 5: +nnnn (average wind speed, wind quality, precipitation difference, precipitation absolute) – <VALUE6> Status group 6: +nn (compass heading, lightning events) – <VALUE7> Status group 7: +nnn (boot count, attended time, fan speed) – <VALUE8> Status group 8: +nnnn (wind heater temperature, radar heater temperature, supply voltage, heater supply voltage)

Sensor status	Code
OK	0
INVALID_CHANNEL CHANNEL_OFF	1

Sensor status	Code
FLASH_ERROR	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

10.2.6 Start basic measurement (M-, MC-, C-, CC-, R-, RC-command)

To simplify data retrieval, the mapping of measurement values to data buffers has been unified between M-, C- and R-commands.

Due to the fact that M-commands can transmit only 9 measurement values, only data buffers ‘0' and '1’ are available. Additional buffers may be retrieved by C- and R-commands. This was done to achieve compatibility with SDI-12 recorders that comply to standards lower that version 1.2 (1996).

The complete set of measurement values offered by the UMB protocol is available using additional M1- to M9- and C1- to C9- commands.

In case the measurement value is not available the data value is indicated as +999.9 or -999.9. The cause may be investigated by issuing the verification command (aV!). Also, depending on the sensor variant, some buffers may contain data that is marked as not valid (+999.9 or -999.9) as the specific sensor does not provide the measurement. In this case the verification digit for this measurement shows code ‘1' for 'invalid channel’.

The following commands are also available with CRC on response from the sensor. If this behavior is desired, use the C extension on each command.

Depending on the configuration of the unit system of the sensor, measurement values are provided in metric or imperial units.

> The configured unit system is not indicated in the data buffer telegrams. The SDI-12 recorder can query the setting with the I-command and change it with the XU-command.

Buffer definitions for measurement and verification values

For permissible minimum and maximum measurement values refer to the specified UMB channel General UMB channels [▶ 42].

10.2.7 SDI-12 buffer definitions

SDI-12 buffer definitions are provided in the tables below.

10.2.7.1 M-C-R

	M Command	C Command	Measurement Value	SHEF Physical Element	Format metric	Unit metric	SHEF Unit metric	UMB-Channel metric	Format imperial	Unit imperial	SHEF Unit imperial	UMB-Channel imperial
D0/R0 Most important Temperature, Humidity, Pressure, Radiation	Value 1	Value 1	Temperature cur	TA	2.1	°C	DC	100	3.1	°F	DF	105
	Value 2	Value 2	Humidity Relative cur	XR	3.1	%	%	200	3.1	%	%	200
	Value 3	Value 3	Air Pressure Relative cur	PL	4	hPa	HPA**	305	4	hPa		305
	Value 4	Value 4	Global Radiation cur	RW	4	W/m^2	W/M2	900	4	W/m^2	W/M2	900
D1/R1 Most important Wind, Precipitation	Value 5	Value 5	Wind Speed gust	UG	2.1	m/s	M/SEC	443	3.1	mph	MI/HR	453
	Value 6	Value 6	Wind Speed vct	US	2.1	m/s	M/SEC	480	3.1	mph	MI/HR	490
	Value 7	Value 7	Wind Dir vct	DU	3	°	DEG	580	3	°	DEG	580
	Value 8	Value 8	Precip WMO wawa code	XWA*	2	digit	DIGITS**	780	2	digit		780
	Value 9	Value 9	Precip Intensity	PR	3.1	mm/h	MM/HR	820	1.3	in/h	IN/HR	840
D2/R2 Other important Temperatures		Value 10	Dew Point cur	TD	2.1	°C	DC	110	3.1	°F	DF	115
		Value 11	Wet Bulb Temperature cur	TM	2.1	°C	DC	114	3.1	°F	DF	119

	M Command	C Command	Measurement Value	SHEF Physical Element	Format metric	Unit metric	SHEF Unit metric	UMB-Channel metric	Format imperial	Unit imperial	SHEF Unit imperial	UMB-Channel imperial
		Value 12	Wind Chill Temperature cur	TUC*	2.1	°C	DC	111	3.1	°F	DF	116
		Value 13	Temperature External cur	TXT*	2.1	°C	DC	101	3.1	°F	DF	106
D3/R3 Other important Humidity, Pressure		Value 14	Humidity Absolute cur	XU	4.1	g/m^3	G/M3**	205	4.1	g/m^3		205
		Value 15	Mixing Ratio cur	MIX*	4.1	g/kg	G/KG**	210	4.1	g/kg		210
		Value 16	Specific Enthalpy cur	MSE*	4.1	kJ/kg	KJ/KG**	215	4.1	kJ/kg		215
		Value 17	Air Pressure Absolute cur	PA	4	hPa	HPA**	300	4	hPa		300
		Value 18	Air Density cur	PAD*	1.2	kg/m^3	KG/M3**	310	1.2	kg/m^3		310
D4/R4 Other important Wind		Value 19	Wind Speed avg	US	2.1	m/s	M/SEC	460	3.1	mph	MI/HR	470
		Value 20	Wind Speed cur	US	2.1	m/s	M/SEC	400	3.1	mph	MI/HR	410
		Value 21	Wind Dir cur	DU	3	°	DEG	500	3	°	DEG	500
		Value 22	Wind Speed Fast	US	2.1	m/s	M/SEC	401	3.1	mph	MI/HR	411

	M Command	C Command	Measurement Value	SHEF Physical Element	Format metric	Unit metric	SHEF Unit metric	UMB-Channel metric	Format imperial	Unit imperial	SHEF Unit imperial	UMB-Channel imperial
			cur									
		Value 23	Wind Dir Fast cur	DU	3	°	DEG	501	3	°	DEG	501
D5/R5		Value 24	Precip Diff	PP	3.1	mm	MM	625	3.1	in	IN	645
Other important Precipitation, Compass, Lightning		Value 25	Precip Absolute	PC	6.1	mm	MM	620	4.1	in	IN	640
		Value 26	Compass cur	CHD*	3	°	DEG	510	3	°	DEG	510
		Value 27	Lightning cur	XG	3	events	EVTS**	617	3	events	EVTS**	617
D6/R6		Value 28	Device Status cur	DES	10	digits	DIGITS	4000	10	digits	DIGITS	4000
D7/R7		Value 29	Supply Voltage	VB	2.1	V	V	4060	2.1	V		4060
Device info		Value 30	Heater Voltage	VBH	2.1	V	V	4061	2.1	V		4061
		Value 31	Boot count	BCT*	4	digits	DIGITS**	4082	4	digits		4082
		Value 32	Attended time	DOT*	5	hours	HRS	4080	5	hours	HRS	4080
		Value 33	Fan speed	FSP*	4	rpm	RPM**	4070	4	rpm		4070
D8/R8		Value 34	Wind heater On	HOU	1	digits	DIGITS	4071	1	digits	DIGITS	4071
Heatings		Value 35	R2S heater On	HOR	1	digits	DIGITS	4072	1	digits	DIGITS	4072
		Value 36	Wind heater Temperature	THU*	3.1	°C	DC	4120	3.1	°F	DF	4125
		Value 37	R2S heater Temperature	THR*	3.1	°C	DC	4130	3.1	°F	DF	4135

	M Command	C Command	Measurement Value	SHEF Physical Element	Format metric	Unit metric	SHEF Unit metric	UMB-Channel metric	Format imperial	Unit imperial	SHEF Unit imperial	UMB-Channel imperial
D9/R9 Wind Quality		Value 38	Wind Quality avg	UQY	3	%	%	4460	3	%	%	4460
		Value 39	Wind Quality cur	UQY	3	%	%	4400	3	%	%	4400
		Value 40	Wind Quality Fast cur	UQY	3	%	%	4401	3	%	%	4401

*This is a Kipp & Zonen Physical Element.

**This is a Kipp & Zonen unit.

10.2.7.2 M1-C1

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Temperature cur	2.1	°C	100	3.1	°F	105
	Value 2	Value 2	Temperature min	2.1	°C	120	3.1	°F	125
	Value 3	Value 3	Temperature max	2.1	°C	140	3.1	°F	145
	Value 4	Value 4	Temperature avg	2.1	°C	160	3.1	°F	165
	Value 5	Value 5	Temperature sd	2.1	°C	180	3.1	°F	185
D1	Value 6	Value 6	Dewpoint cur	2.1	°C	110	3.1	°F	115
	Value 7	Value 7	Dewpoint min	2.1	°C	130	3.1	°F	135
	Value 8	Value 8	Dewpoint max	2.1	°C	150	3.1	°F	155
	Value 9	Value 9	Dewpoint avg	2.1	°C	170	3.1	°F	175
D2		Value 10	Wet Bulb Temperature cur	2.1	°C	114	3.1	°F	119
		Value 11	Wet Bulb Temperature min	2.1	°C	134	3.1	°F	139
		Value 12	Wet Bulb Temperature max	2.1	°C	154	3.1	°F	159
		Value 13	Wet Bulb Temperature avg	2.1	°C	174	3.1	°F	179
D3		Value 14	Wind Chill Temperature cur	2.1	°C	111	3.1	°F	116
		Value 15	Wind Chill Temperature min	2.1	°C	131	3.1	°F	136
		Value 16	Wind Chill Temperature max	2.1	°C	151	3.1	°F	156

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
		Value 17	Wind Chill Temperature avg	2.1	°C	171	3.1	°F	176

10.2.7.3 M2-C2

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Humidity Relative cur	3.1	%	200	3.1	%	200
	Value 2	Value 2	Humidity Relative min	3.1	%	220	3.1	%	220
	Value 3	Value 3	Humidity Relative max	3.1	%	240	3.1	%	240
	Value 4	Value 4	Humidity Relative avg	3.1	%	260	3.1	%	260
	Value 5	Value 5	Humidity Relative sd	3.1	%	280	3.1	%	280
D1	Value 6	Value 6	Humidity Absolute cur	4.1	g/m^3	205	4.1	g/m^3	205
	Value 7	Value 7	Humidity Absolute min	4.1	g/m^3	225	4.1	g/m^3	225
	Value 8	Value 8	Humidity Absolute max	4.1	g/m^3	245	4.1	g/m^3	245
	Value 9	Value 9	Humidity Absolute avg	4.1	g/m^3	265	4.1	g/m^3	265
D2		Value 10	Specific Enthalpy cur	4.1	kJ/kg	215	4.1	kJ/kg	215
		Value 11	Specific Enthalpy min	4.1	kJ/kg	235	4.1	kJ/kg	235

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
		Value 12	Specific Enthalpy max	4.1	kJ/kg	255	4.1	kJ/kg	255
		Value 13	Specific Enthalpy avg	4.1	kJ/kg	275	4.1	kJ/kg	275
D3		Value 14	Mixing Ratio cur	4.1	g/kg	210	4.1	g/kg	210
		Value 15	Mixing Ratio min	4.1	g/kg	230	4.1	g/kg	230
		Value 16	Mixing Ratio max	4.1	g/kg	250	4.1	g/kg	250
		Value 17	Mixing Ratio avg	4.1	g/kg	270	4.1	g/kg	270

10.2.7.4 M3-C3

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Absolute Air Pressure cur	4	hPa	300	4	hPa	300
	Value 2	Value 2	Absolute Air Pressure min	4	hPa	320	4	hPa	320
	Value 3	Value 3	Absolute Air Pressure max	4	hPa	340	4	hPa	340
	Value 4	Value 4	Absolute Air Pressure avg	4	hPa	360	4	hPa	360
	Value 5	Value 5	Absolute Air Pressure sd	4	hPa	380	4	hPa	380
D1	Value 6	Value 6	Relative Air Pressure cur	4	hPa	305	4	hPa	305
	Value 7	Value 7	Relative Air Pressure min	4	hPa	325	4	hPa	325

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
	Value 8	Value 8	Relative Air Pressure max	4	hPa	345	4	hPa	345
	Value 9	Value 9	Relative Air Pressure avg	4	hPa	365	4	hPa	365
D2		Value 10	Air Density cur	1.2	kg/m^3	310	1.2	kg/m^3	310
		Value 11	Air Density min	1.2	kg/m^3	330	1.2	kg/m^3	330
		Value 12	Air Density max	1.2	kg/m^3	350	1.2	kg/m^3	350
		Value 13	Air Density avg	1.2	kg/m^3	370	1.2	kg/m^3	370
		Value 14	Air Density sd	1.2	kg/m^3	390	1.2	kg/m^3	390

10.2.7.5 M4-C4

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Wind Speed cur	2.1	m/s	400	3.1	mph	410
	Value 2	Value 2	Wind Speed min	2.1	m/s	420	3.1	mph	430
	Value 3	Value 3	Wind Speed max	2.1	m/s	440	3.1	mph	450
	Value 4	Value 4	Wind Speed avg	2.1	m/s	460	3.1	mph	470
	Value 5	Value 5	Wind Speed vct	2.1	m/s	480	3.1	mph	490
D1	Value 6	Value 6	Wind Speed sd	2.1	m/s	461	3.1	mph	471
	Value 7	Value 7	Wind Gust cur	2.1	m/s	443	3.1	mph	453
	Value 8	Value 8	Wind Quality cur	3	%	4400	3	%	4400
	Value 9	Value 9	Wind Quality avg	3	%	4460	3	%	4460

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D2		Value 10	Wind Speed Fast cur	2.1	m/s	401	3.1	mph	411
		Value 11	Wind Quality Fast cur	3	%	4401	3	%	4401

10.2.7.6 M5-C5

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Wind Direction cur	3	°	500	3	°	500
	Value 2	Value 2	Wind Direction Fast cur	3	°	501	3	°	501
	Value 3	Value 3	Wind Direction min	3	°	520	3	°	520
	Value 4	Value 4	Wind Direction max	3	°	540	3	°	540
	Value 5	Value 5	Wind Direction vct	3	°	580	3	°	580
D1	Value 6	Value 6	Wind Direction sd	3	°	581	3	°	581
	Value 7	Value 7	Wind Gust Direction cur	3	°	543	3	°	543
	Value 8	Value 8	Compass Direction cur	3	°	510	3	°	510
	Value 9	Value 9	Wind Gust Corr Direction cur	3	°	545	3	°	545
D2		Value 10	Wind Corr Direction cur	3	°	502	3	°	502
		Value 11	Wind Corr Direction Fast cur	3	°	503	3	°	503

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
		Value 12	Wind Corr Direction min	3	°	522	3	°	522
		Value 13	Wind Corr Direction max	3	°	542	3	°	542
		Value 14	Wind Corr Direction vct	3	°	582	3	°	582

10.2.7.7 M6-C6

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Precip Absolute	6.1	mm	620	4.1	in	640
	Value 2	Value 2	Precip Diff	3.1	mm	625	3.1	in	645
	Value 3	Value 3	Precip Intensity	3.1	mm/h	820	1.3	in/h	840
	Value 4	Value 4	Precip Type	2	digit	700	2	digit	700
	Value 5	Value 5	Precip WMO wawa code	2	digit	780	2	digit	780

10.2.7.8 M7-C7

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Global Radiation cur	4	W/m^2	900	4	W/m^2	900
	Value 2	Value 2	Global Radiation min	4	W/m^2	920	4	W/m^2	920
	Value 3	Value 3	Global Radiation max	4	W/m^2	940	4	W/m^2	940
	Value 4	Value 4	Global Radiation avg	4	W/m^2	960	4	W/m^2	960
	Value 5	Value 5	Global Radiation sd	4	W/m^2	980	4	W/m^2	980

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D1	Value 6	Value 6	Lightning Events cur	3	events	617	3	events	617
	Value 7	Value 7	Lightning Events sum	3	events	677	3	events	677

10.2.7.9 M8-C8

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Ext. Temperature cur	2.1	°C	101	3.1	°F	106
	Value 2	Value 2	Ext. Temperature min	2.1	°C	121	3.1	°F	126
	Value 3	Value 3	Ext. Temperature max	2.1	°C	141	3.1	°F	146
	Value 4	Value 4	Ext. Temperature avg	2.1	°C	161	3.1	°F	166

10.2.7.10 M9-C9

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel	Format imperial	Unit imperial	UMB-Channel imperial
D0	Value 1	Value 1	Init Status	5	digit	4010	5	digit	4010
	Value 2	Value 2	Temperature Status	5	digit	4011	5	digit	4011
	Value 3	Value 3	Humidity Status	5	digit	4012	5	digit	4012
D1	Value 4	Value 4	Pressure Status	5	digit	4013	5	digit	4013
	Value 5	Value 5	Compass Status	5	digit	4014	5	digit	4014
	Value 6	Value 6	Wind Status	5	digit	4015	5	digit	4015
D2	Value 7	Value 7	Precipitation Status	5	digit	4016	5	digit	4016
	Value 8	Value 8	Radiation Status	5	digit	4017	5	digit	4017
	Value 9	Value 9	Lightning Status	5	digit	4018	5	digit	4018
D3		Value 10	Heater Status	5	digit	4024	5	digit	4024
		Value 11	Fan Status	5	digit	4025	5	digit	4025

	M Command	C Command	Measurement Value	Format metric	Unit metric	UMB-Channel	Format imperial	Unit imperial	UMB-Channel imperial
		Value 12	Reset Cause	5	digit	4050	5	digit	4050

10.2.7.11 V

	V Command	Measurement Value	Format metric	Unit metric	UMB-Channel metric	Format imperial	Unit imperial	UMB-Channel imperial
D0 Verification of D0-D5	Value 1	Status of Basic Buffer D0	04	digit	–	04	digit	–
	Value 2	Status of Basic Buffer D1	05	digit	–	05	digit	–
	Value 3	Status of Basic Buffer D2	04	digit	–	04	digit	–
	Value 4	Status of Basic Buffer D3	05	digit	–	05	digit	–
	Value 5	Status of Basic Buffer D4	05	digit	–	05	digit	–
	Value 6	Status of Basic Buffer D5	04	digit	–	04	digit	–
D1 Verification of D6-D9	Value 7	Status of Basic Buffer D6/D7	06	digit	–	06	digit	–
	Value 8	Status of Basic Buffer D8/D9	07	digit	–	07	digit	–

Channel Status	Code
ERROR_STATUS_OK	0
ERROR_STATUS_INVALID_CHANNEL ERROR_STATUS_CHANNEL_OFF	1
ERROR_STATUS_E2_CAL_ERROR ERROR_STATUS_E2_CRC_CAL_ERR ERROR_STATUS_FLASH_CRC_ERR ERROR_STATUS_FLASH_WRITE_ERR	2

Channel Status	Code
ERROR_STATUS_FLASH_FLOAT_ERR	
ERROR_STATUS_MEAS_ERROR	3
ERROR_STATUS_MEAS_UNABLE	4
ERROR_STATUS_INIT_ERROR	5
ERROR_STATUS_VALUE_OVERFLOW ERROR_STATUS_CHANNEL_OVERRANGE	6
ERROR_STATUS_VALUE_UNDERFLOW ERROR_STATUS_CHANNEL_UNDERRANGE	7
ERROR_STATUS_BUSY	8
other	9

10.2.8 Start additional measurement (Mn-, Cn-command)
In addition to M-, C- and R- commands, additional Mn- and Cn- commands are available. See the previous table for data buffer definition:

Measurement with statistical values	Command
Temperature	M1, MC1, C1, CC1
Humidity	M2, MC2, C2, CC2
Air pressure	M3, MC3, C3, CC3
Wind	M4, MC4, C4, CC4
Wind direction and compass	M5, MC5, C5, CC5
Precipitation	M6, MC6, C6, CC6
Global radiation and lightning	M7, MC7, C7, CC7
External temperature	M8, MC8, C8, CC8
Status values	M9, MC9, C9, CC9

10.2.9 Identify measurement and identify measurement parameter (IM-, IC- and IR-commands)
Additional information about the measurements may be provided by the identify measurement and identify measurement parameter commands. Each measurement command can be prefixed with 'I' to query the number of measurement parameters associated with it. In turn, individual measurement parameters may be retrieved by appending a three-digit number in the form of "_nnn" to the command.

The parameters consist of SHEF measurement identifier (where applicable), SHEF measurement unit (where applicable), and the measurement type (current, min., max., avg., etc.)

'C' variants add CRC to the sensor response of the identify measurement commands.

Command	Response	Description
aIM! / aIMC! aIMx! / aIMCx! aIC! / aICC! aICx! / aICCx! aIV!	atttn<CR><LF> atttnn<CR><LF>	– x: Number of the measurement buffer – ttt: Number of seconds until available – n: Number of available measurement parameters (nn for C- and Cn-commands)
aIM_00y! / aIMC_00y!	a,<VALUE1>,<VALUE2>,<VALUE3>;<CR><LF>	– x: Number of the measurement buffer

Command	Response	Description
aIMx_00y! / aIMCx_00y! aIC!_0yy / aICC_0yy! aICx_0yy! / aICCx_0yy! aIV_00y!		– y: Number of measurement parameter – <VALUE1>: SHEF / OTT measurement identifier – <VALUE2>: SHEF / OTT measurement unit – <VALUE3>: Measurement type

10.3 Extended SDI-12 commands

10.3.1 Set and read of unit system (XU-command)

Command	Response	Description
aXU<VALUE>!	a<VALUE><CR><LF>	Set unit: <VALUE>: Unit for level +0: Metric units +1: Imperial units
aXU!	a<VALUE><CR><LF>	Read unit

10.3.2 Set and read the averaging interval length (XI-command)

Command	Response	Description
aXI<VALUE1><VALUE2>!	a<VALUE1><VALUE2><CR><LF>	The avg, min, max and vct values of the measurement values are evaluated over a floating interval with a length of 1 to 10 min. The length of this interval can be adjusted separately for the groups temperature and humidity, air pressure and wind. (The averaging algorithm is not applied to precipitation and compass measurements). <VALUE1>: +0: Temperature +1: Humidity +2: Air pressure +3: Wind +4: Global radiation +6: External Temperature +7: Lightning (max. 30 minutes) <VALUE2>: Interval in minutes Value range: +1 ... +10
aXI<VALUE1>!	a<VALUE1><VALUE2><CR><LF>	Read averaging interval length

10.3.3 Set and read user offsets (XO-command)

Command	Response	Description
aXO<VALUE1><VALUE2>!	a<VALUE1><VALUE2><CR><LF>	The user can apply offsets to the measurement values

Command	Response	Description
		<VALUE1>: +0: Temperature -50 ... +50 °C +1: Humidity -50 ... +50 %rH +2: Air pressure -500 ... +500 hPa +3: Wind -180 ... +180 ° +4: Global radiation -500 ... +500 W/m^2 +5: Compass -180 ... +180° +6: Ext. Temperature -50 ... +50 °C <VALUE2>: +/- Offset in the given measurement unit
aXO<VALUE1>!	a<VALUE1><VALUE2><CR><LF>	Read measurement offset

10.3.4 Set and read of the local altitude (XA-command)

Command	Response	Description
aXA<VALUE>!	a<VALUE><CR><LF>	For the calculation of the relative air pressure the local altitude of the device is required. <VALUE>: Value range: -100 ... +5000 m
aXA!	a<VALUE><CR><LF>	Read local altitude

10.3.5 Set and read fan mode (XF-command)

Command	Response	Description
aXF<VALUE>!	a<VALUE><CR><LF>	Setting of the fan mode in addition to the power saving mode <VALUE>: Important: +0: Fan off +1: Fan on
aXF!	a<VALUE><CR><LF>	Read fan mode

10.3.6 Set and read external device type (XE-command)

Command	Response	Description
aXE<VALUE>!	a<VALUE><CR><LF>	Setting of the external device type <VALUE>: +0: None +1: NTC temperature +2: Rain gauge +3: NTC SSI temperature +4: Pt1000 temperature
aXE!	a<VALUE><CR><LF>	Read external device type

10.3.7 Set and read the power saving mode (XM-command)

Command	Response	Description
aXM<VALUE>!	a<VALUE><CR><LF>	For installations with limited power supply the smart weather sensor may be operated in power saving mode. <VALUE>: +0: Normal Operation +1: Power saving mode 1 (heating/fan off) +2: Power saving mode 2 (sleep mode)
aXM!	a<VALUE><CR><LF>	Read power saving mode

10.3.8 Set and read the heating mode (XH-command)

Command	Response	Description
aXH<VALUE1><VALUE2>!	a<VALUE1><VALUE2><CR><LF>	The heating of the precipitation and the wind sensors can be configured in different operation modes. Depending on the actual variant of the smart weather sensor only certain combinations of operating modes are available. The Smart Weather Sensor evaluates the valid combinations from the device heating mode requested in the command automatically. <VALUE1>: +0: Wind heater +1: Rain heater <VALUE2>: +0: Auto +1: Off +2: Eco (only available for rain heater)
aXH<VALUE1>!	a<VALUE1><VALUE2><CR><LF>	Response <VALUE1>: Selected heating for sensor <VALUE2>: Selected heating mode

10.3.9 Set and read rain gauge resolution (XT-command)

Command	Response	Description
aXT<VALUE>!	a<VALUE><CR><LF>	Set rain gauge resolution <VALUE>: Resolution of the rain gauge in 1/10 mm +0: 0.1 mm +1: 0.2 mm +2: 0.5 mm +3: 1.0 mm
aXT!	a<VALUE><CR><LF>	Read rain gauge resolution

10.3.10 Device reset (XR-command)

Command	Response	Description
aXR<VALUE1><VALUE2>!	a<VALUE1><VALUE2><CR><LF>	The command initiates a device reset. The response is followed by the device reset after the specified delay, i.e. the device will be offline for a few seconds. <VALUE1>: +0: Software reset +2: Device ID reset +3: Reset of the accumulated absolute precipitation amount to 0.0 mm <VALUE2>: Delay reset by <VALUE2> seconds

The value +1 (factory default reset) should not be used as this also clears the protocol parameters and communication over SDI-12 is not possible anymore.

10.3.11 Read the device version (XV-command)

Command	Response	Description
aXV!	a<Value><CR><LF>	The device version identifies the installed hardware version and the firmware version. <VALUE>: +hhh+-sss

11 Commissioning for MODBUS format

The Modbus protocol has been implemented to allow integration into a PLC environment. The weather station will function as a Modbus server device. Measurement values are mapped to one or more Modbus input registers. The range of values available is basically the same as for the UMB protocol, including metric and imperial units.

Although not part of the official Modbus standard, measurement values are mostly represented as 32-bit floating-point values to ensure the most precise data transmission and no disadvantages compared to using the UMB protocol. Therefore, the input register table follows a two register scheme, where unused registers read as the value 0.

11.1 Device address

The Modbus server address is derived from the UMB device ID. A device with UMB device ID 1 also has the Modbus server address 1, etc.

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

> The device ID 200 must not be used, as it is used for the UMB catch function during startup.

11.2 Standard data formats

Implementations are restricted to data points in the following standard data formats:

- int: signed integer value
- uint: unsigned integer value
- float: floating point value
- bitfield: a collection of bits, multi-valued alarms or state
- string: a null terminated or fixed length value

11.2.1 16-bit integer values

Values are stored in big-endian order per the Modbus specification and consist of single register.

All integer values are documented as signed or unsigned. All signed values are represented using two's compliment formats.

Modbus register	1															
Byte	0								1							
Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

int16 range:	-32768 to +32767	not implemented:	0x8000
uint16 range:	0 to 65534	not implemented:	0xFFFF
bitfield16 range:	0 to 0x7FFF	not implemented:	0xFFFF

11.2.2 32-bit integer values

32-bit integers are stored using two registers in big-endian order.

Modbus register	1		2	
Byte	0	1	2	3
Bits	31 ... 24	23 ... 16	15 ... 08	07 ... 00

int32 range:	-2147483647 ... 2147483647	not implemented:	0x80000000
uint32 range:	0 ... 4294967294	not implemented:	0xFFFFFFFF

11.2.3 Floating point values

Floating point values are 32 bits and encoded according to the IEEE 754 floating point standard.

Modbus register	1															
Byte	0								1							
Bits	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
IEEE 754	Sign	Exponent							Fraction							

Modbus register	2															
Byte	2								3							
Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
IEEE 754	Fraction															

float32 range:	see IEEE 754	not implemented:	0x7FC00000 (NaN)

11.2.4 String values

Store variable length string values in a fixed size register range using a NULL (0 value) to terminate or pad the string.

For example, up to 16 characters can be stored in 8 contiguous registers as follows:

Modbus register	1		2		3		4		5		6		7		8	
Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Character	E	X	A	M	P	L	E	spec	S	T	R	I	N	G	!	NULL

11.3 Supported Modbus functions

Function code	Name	Description
0x01	Read Coils	Read add. status information (implemented but always returns 0)
0x05, 0x15	Write Single/Multiple Coils	Execute device function
0x03	Read Holding Registers	Read configuration settings
0x06, 0x16	Write Single/Multiple Registers	Write configuration settings
0x04	Read Input Registers	Read measurement values and status information
0x11	Report Server ID	Find a device

Function code	Name	Description
		Responds to broadcast with address 0

11.3.1 Coils: FC 0x01, 0x05, 0x15

Coil address	Read function	Write function
0	None	Software reset
2	None	Device ID reset
3	None	Reset of the accumulated absolute precipitation amounts to 0.0 mm

The value 1 (factory default reset) must not be used as this also clears the protocol parameters and communication over Modbus is not possible anymore.

11.3.2 Holding registers: FC 0x03, 0x06, 0x16

Register address	Function R/W	Default	Values	Data type
0	Device ID	1	Protocol Device Identifier Value range: 1 ... 247 (200 should not be used)	U16
1	Protocol	0	Communication Protocol 0 = UMB 3 = SDI-12 5 = Modbus RTU 6 = Modbus ASCII 7 = NMEA / XDR 9 = UMB-ASCII2	U16
2	Baud Rate	6	Protocol Baud Rate 1 = 115200 2 = 57600 3 = 38400 4 = 28800 6 = 19200 8 = 14400 12 = 9600 24 = 4800 48 = 2400 96 = 1200	U16
3	Data Format	0	Protocol Data Format 0 = 8N1 1 = 8E1 2 = 7E1 3 = 8N2 4 = 7E2	U16
4	Location Altitude	200	For the calculation of the relative air pressure the local altitude of the device is required. Value range: -100 ... +5000 m	U16

Register address	Function R/W	Default	Values	Data type
5	Operating Mode	0	For installations with limited power supply the smart weather sensor may be operated in power saving mode. 0 = Normal Operation 1 = Power saving mode 1 (Heating/Fan off) 2 = Power saving mode 2 (Sleep mode)	U16
6	Wind Heater Mode	0: Auto	The heating of the precipitation and the wind sensors can be configured in different operation modes. Depending on the actual variant of the Smart Weather Sensor only certain combinations of operating modes are available. The smart weather sensor evaluates the valid combinations from the device heating mode requested in the command automatically. 0: Auto 1: Off	U16
7	R2S Heater Mode	0: Auto	0: Auto 1: Off 2: Eco	U16
8	Rain Gauge Resolution	0: 0.1mm	Set rain gauge resolution Resolution of the rain gauge in 1/10 mm 0: 0.1mm 1: 0.2mm 2: 0.5mm 3: 1.0mm	U16
9	Fan Mode	1	Setting of the fan mode in addition to the power saving mode 0: Fan off 1: Fan on	U16
10	External Sensor	0: None	Setting of the external device type 0: None 1: NTC temperature 2: Rain gauge 3: NTC SSI temperature 4: Pt1000 temperature	U16
20	Temperature Averaging Interval	10	The avg, min, max and vct values of the measurement values are evaluated over a floating interval. 1 ... 10 minutes	U16
21	Humidity Averaging Interval	10	1 ... 10 minutes	U16
22	Pressure Averaging Interval	10	1 ... 10 minutes	U16
23	Wind Averaging Interval	10	1 ... 10 minutes	U16

Register address	Function R/W	Default	Values	Data type
24	Global Radiation Averaging Interval	10	1 ... 10 minutes	U16
25	External Temperature Averaging Interval	10	1 ... 10 minutes	U16
26	Lightning Event Interval	10	1 ... 30 minutes	U16
30	Temperature User Offset	0	The user can apply offsets to the measurement values. -50 ... +50 °C	F32
32	Humidity User Offset	0	-50 ... +50 %rH	F32
34	Pressure User Offset	0	-500 ... +500 hPa	F32
36	Wind Direction User Offset	0	-180 ... +180°	F32
38	Global Radiation User Offset	0	-500 ... +500 W/m^2	F32
40	Compass Direction User Offset	0	-180 ... +180°	F32
42	External Temperature User Offset	0	-50 ... +50 °C	F32

11.3.3 Report server ID: FC 0x11

This function is used to read the Modbus server address from the device. It may be used with the wildcard address 0 to find the address of a device with unknown configuration. The response telegram is in the following form:

Function code	1 Byte	0x11
Byte count	1 Byte	2
Server ID	1 Byte	<device address>
Run indicator status	1 Byte	0

11.3.4 Input registers: FC 0x04

Standard Set Metric	Input Register Address	Data type	Measurement value	Unit	UMB channel
Most important Temperature, Humidity, Pressure, Radiation	1000	float32	Temperature cur	°C	100
	1002	float32	Humidity Relative cur	%	200
	1004	float32	Air Pressure Relative cur	hPa	305
	1006	float32	Global Radiation cur	W/m^2	900
Most important Wind, Precipitation	1008	float32	Wind speed gust	m/s	443
	1010	float32	Wind speed vct	m/s	480
	1012	float32	Wind dir vct	°	580
	1014	uint8	Precip WMO wawa code	digit	780
	1016	float32	Precip intensity	mm/h	820
Other important Temperatures	1018	float32	Dew Point cur	°C	110

Standard Set Metric	Input Register Address	Data type	Measurement value	Unit	UMB channel
	1020	float32	Wet Bulb Temperature cur	°C	114
	1022	float32	Wind Chill Temperature cur	°C	111
	1024	float32	Temperature External cur	°C	101
Other Important Humidity, Pressure	1026	float32	Humidity Absolute cur	g/m^3	205
	1028	float32	Mixing Ratio cur	g/kg	210
	1030	float32	Specific Enthalpy cur	kJ/kg	215
	1032	float32	Air Pressure Absolute cur	hPa	300
	1034	float32	Air Density cur	kg/m^3	310
Other important Wind	1036	float32	Wind Speed avg	m/s	460
	1038	float32	Wind Speed cur	m/s	400
	1040	float32	Wind Dir cur	°	500
	1042	float32	Wind Speed Fast cur	m/s	401
	1044	float32	Wind Dir Fast cur	°	501
	1046	float32	Wind Quality avg	%	4460
	1048	float32	Wind Quality cur	%	4400
	1050	float32	Wind Quality Fast cur	%	4401
Other important Precipitation, compass, lightning	1052	float32	Precip Diff	mm	625
	1054	float32	Precip Absolute	mm	620
	1056	float32	Compass cur	°	510
	1058	uint16	Lightning cur	events	617
Device Info	1060	uint32	Device Status	digits	4000
	1062	float32	Supply Voltage	V	4060

Standard Set Metric	Input Register Address	Data type	Measurement value	Unit	UMB channel
	1064	float32	Heater Voltage	V	4061
	1066	uint32	Boot count	digits	4082
	1068	uint32	Attended time	hours	4080
	1070	uint16	Fan speed	rpm	4070
Heatings	1072	uint8	Wind heater On	digits	4071
	1074	uint8	R2S heater On	digits	4072
	1076	float32	Wind heater Temperature	°C	4120
	1078	float32	R2S heater Temperature	°C	4130

Standard Set Imperial	Input Register Address	Data type	Measurement value	Unit	UMB channel
Most important Temperature, Humidity, Pressure, Radiation	2000	float32	Temperature cur	°F	105
	2002	float32	Humidity relative cur	%	200
	2004	float32	Air pressure relative cur	hPa	305
	2006	float32	Global radiation cur	W/m^2	900
Most important wind, precipitation	2008	float32	Wind speed gust	mph	453
	2010	float32	Wind speed vct	mph	490
	2012	float32	Wind dir vct	°	580
	2014	uint8	Precip WMO wawa code	digit	780
	2016	float32	Precip intensity	in/h	840
Other important Temperatures	2018	float32	Dew Point cur	°F	115
	2020	float32	Wet Bulb Temperature cur	°F	119
	2022	float32	Wind Chill Temperature cur	°F	116
	2024	float32	Temperature External cur	°F	106
Other important Humidity, Pressure	2026	float32	Humidity absolute cur	g/m^3	205
	2028	float32	Mixing ratio cur	g/kg	210

Standard Set Imperial	Input Register Address	Data type	Measurement value	Unit	UMB channel
	2030	float32	Specific enthalpy cur	kJ/kg	215
	2032	float32	Air pressure absolute cur	hPa	300
	2034	float32	Air density cur	kg/m^3	310
Other important Wind,	2036	float32	Wind speed avg	mph	470
	2038	float32	Wind Speed cur	mph	410
	2040	float32	Wind Dir cur	°	500
	2042	float32	Wind Speed Fast cur	mph	411
	2044	float32	Wind Dir Fast cur	°	501
	2046	float32	Wind Quality avg	%	4460
	2048	float32	Wind Quality cur	%	4400
	2050	float32	Wind Quality Fast cur	%	4401
Other important Precipitation, Compass, Lightning	2052	float32	Precip Diff	in	645
	2054	float32	Precip Absolute	in	640
	2056	float32	Compass cur	°	510
	2058	uint16	Lightning cur	events	617
Device Info	2060	uint32	Device Status	digits	4000
	2062	float32	Supply Voltage	V	4060
	2064	float32	Heater Voltage	V	4061
	2066	uint32	Boot count	digits	4082
	2068	uint32	Attended time	hours	4080
	2070	uint16	Fan speed	rpm	4070
Heatings	2072	uint8	Wind heater On	digits	4071
	2074	uint8	R2S heater On	digits	4072
	2076	float32	Wind heater Temperature	°C	4120
	2078	float32	R2S heater Temperature	°C	4130

Input Register Address	Data type	Measurement value	Unit	UMB channel
1100	float32	Temperature cur	°C	100
1102	float32	Temperature min	°C	120
1104	float32	Temperature max	°C	140
1106	float32	Temperature avg	°C	160
1108	float32	Temperature sd	°C	180
1110	float32	Dew point cur	°C	110
1112	float32	Dew point min	°C	130
1114	float32	Dew point max	°C	150
1116	float32	Dew point avg	°C	170
1118	float32	Dew point sd	°C	190
1120	float32	Wet Bulb Temperature cur	°C	114
1122	float32	Wet Bulb Temperature min	°C	134
1124	float32	Wet Bulb Temperature max	°C	154
1126	float32	Wet Bulb Temperature avg	°C	174
1128	float32	Wet Bulb Temperature sd	°C	194
1130	float32	Wind Chill Temperature cur	°C	111
1132	float32	Wind Chill Temperature min	°C	131
1134	float32	Wind Chill Temperature max	°C	151
1136	float32	Wind Chill Temperature avg	°C	171
1138	float32	Wind Chill Temperature sd	°C	191
1140	float32	Ext. Temperature cur	°C	101
1142	float32	Ext. Temperature min	°C	121
1144	float32	Ext. Temperature max	°C	141
1146	float32	Ext. Temperature avg	°C	161
1148	float32	Ext. Temperature sd	°C	181
1150	float32	Temperature cur	°F	105
1152	float32	Temperature min	°F	125
1154	float32	Temperature max	°F	145
1156	float32	Temperature avg	°F	165
1158	float32	Temperature sd	°F	185
1160	float32	Dew point cur	°F	115
1162	float32	Dew point min	°F	135

Input Register Address	Data type	Measurement value	Unit	UMB channel
1164	float32	Dew point max	°F	155
1166	float32	Dew point avg	°F	175
1168	float32	Dew point sd	°F	195
1170	float32	Wet Bulb Temperature cur	°F	119
1172	float32	Wet Bulb Temperature min	°F	139
1174	float32	Wet Bulb Temperature max	°F	159
1176	float32	Wet Bulb Temperature avg	°F	179
1178	float32	Wet Bulb Temperature sd	°F	199
1180	float32	Wind Chill Temperature cur	°F	116
1182	float32	Wind Chill Temperature min	°F	136
1184	float32	Wind Chill Temperature max	°F	156
1186	float32	Wind Chill Temperature avg	°F	176
1188	float32	Wind Chill Temperature sd	°F	196
1190	float32	Ext. Temperature cur	°F	106
1192	float32	Ext. Temperature min	°F	126
1194	float32	Ext. Temperature max	°F	146
1196	float32	Ext. Temperature avg	°F	166
1198	float32	Ext. Temperature sd	°F	186

Input Register Address	Data type	Measurement value	Unit	UMB channel
1200	float32	Humidity Relative cur	%	200
1202	float32	Humidity Relative min	%	220
1204	float32	Humidity Relative max	%	240
1206	float32	Humidity Relative avg	%	260
1208	float32	Humidity Relative sd	%	280
1210	float32	Humidity Absolute cur	g/m^3	205
1212	float32	Humidity Absolute min	g/m^3	225
1214	float32	Humidity Absolute max	g/m^3	245

Input Register Address	Data type	Measurement value	Unit	UMB channel
1216	float32	Humidity Absolute avg	g/m^3	265
1218	float32	Humidity Absolute sd	g/m^3	285
1220	float32	Specific Enthalpy cur	kJ/kg	215
1222	float32	Specific Enthalpy min	kJ/kg	235
1224	float32	Specific Enthalpy max	kJ/kg	255
1226	float32	Specific Enthalpy avg	kJ/kg	275
1228	float32	Specific Enthalpy sd	kJ/kg	295
1230	float32	Mixing Ratio cur	g/kg	210
1232	float32	Mixing Ratio min	g/kg	230
1234	float32	Mixing Ratio max	g/kg	250
1236	float32	Mixing Ratio avg	g/kg	270
1238	float32	Mixing Ratio sd	g/kg	290

Input Register Address	Data type	Measurement value	Unit	UMB channel
1300	float32	Absolute Air Pressure cur	hPa	300
1302	float32	Absolute Air Pressure min	hPa	320
1304	float32	Absolute Air Pressure max	hPa	340
1306	float32	Absolute Air Pressure avg	hPa	360
1308	float32	Absolute Air Pressure sd	hPa	380
1310	float32	Relative Air Pressure cur	hPa	305
1312	float32	Relative Air Pressure min	hPa	325
1314	float32	Relative Air Pressure max	hPa	345
1316	float32	Relative Air Pressure avg	hPa	365
1318	float32	Relative Air Pressure sd	hPa	385
1320	float32	Air Density cur	kg/m^3	310
1322	float32	Air Density min	kg/m^3	330
1324	float32	Air Density max	kg/m^3	350
1326	float32	Air Density avg	kg/m^3	370
1328	float32	Air Density sd	kg/m^3	390

Input Register Address	Data type	Measurement value	Unit	UMB channel
1400	float32	Wind Speed cur	m/s	400
1402	float32	Wind Speed Fast cur	m/s	401
1404	float32	Wind Speed min	m/s	420
1406	float32	Wind Speed max	m/s	440
1408	float32	Wind Speed avg	m/s	460
1410	float32	Wind Speed vct	m/s	480
1412	float32	Wind Speed sd	m/s	461
1414	float32	Wind Gust cur	m/s	443
1416	float32	Wind Speed cur	mph	410
1418	float32	Wind Speed Fast cur	mph	411
1420	float32	Wind Speed min	mph	430
1422	float32	Wind Speed max	mph	450
1424	float32	Wind Speed avg	mph	470
1426	float32	Wind Speed vct	mph	490
1428	float32	Wind Speed sd	mph	471
1430	float32	Wind Gust cur	mph	453
1432	float32	Wind Speed cur	km/h	405
1434	float32	Wind Speed Fast cur	km/h	406
1436	float32	Wind Speed min	km/h	425
1438	float32	Wind Speed max	km/h	445
1440	float32	Wind Speed avg	km/h	465
1442	float32	Wind Speed vct	km/h	485
1444	float32	Wind Speed sd	km/h	466
1446	float32	Wind Gust cur	km/h	448
1448	float32	Wind Speed cur	kts	415
1450	float32	Wind Speed Fast cur	kts	416
1452	float32	Wind Speed min	kts	435
1454	float32	Wind Speed max	kts	455
1456	float32	Wind Speed avg	kts	475
1458	float32	Wind Speed vct	kts	495
1460	float32	Wind Speed sd	kts	476
1462	float32	Wind Gust cur	kts	458
1464	float32	Wind Quality cur	%	4400
1466	float32	Wind Quality Fast cur	%	4401
1468	float32	Wind Quality avg	%	4460

Input Register Address	Data type	Measurement value	Unit	UMB channel
1500	float32	Wind Direction cur	°	500
1502	float32	Wind Direction Fast cur	°	501

Input Register Address	Data type	Measurement value	Unit	UMB channel
1504	float32	Wind Direction min	°	520
1506	float32	Wind Direction max	°	540
1508	float32	Wind Direction vct	°	580
1510	float32	Wind Direction sd	°	581
1512	float32	Wind Gust Direction cur	°	543
1514	float32	Compass Direction cur	°	510
1516	float32	Wind Gust Corr Direction cur	°	545
1518	float32	Wind Corr Direction cur	°	502
1520	float32	Wind Corr Direction Fast cur	°	503
1522	float32	Wind Corr Direction min	°	522
1524	float32	Wind Corr Direction max	°	542
1526	float32	Wind Corr Direction vct	°	582

Input Register Address	Data type	Measurement value	Unit	UMB channel
1600	float32	Precip Absolute	mm	620
1602	float32	Precip Diff	mm	625
1604	float32	Precip Intensity	mm/h	820
1606	float32	Precip Absolute	in	640
1608	float32	Precip Diff	in	645
1610	float32	Precip Intensity	in/h	840
1612	float32	Precip Absolute	l/m^2	600
1614	float32	Precip Diff	l/m^2	605
1616	float32	Precip Intensity	$l/m^2/h$	800
1618	float32	Precip Absolute	mil	660
1620	float32	Precip Diff	mil	665
1622	float32	Precip Intensity	mil/h	860
1624	uint8	Precip Type	digit	700
1626	uint8	Precip WMO wawa code	digit	780
1628	uint16	Lightning Events cur	events	617
1630	uint16	Lightning Events sum	events	677

Input Register Address	Data type	Measurement value	Unit	UMB channel
1900	float32	Global Radiation cur	W/m^2	900
1902	float32	Global Radiation min	W/m^2	920
1904	float32	Global Radiation max	W/m^2	940
1906	float32	Global Radiation avg	W/m^2	960
1908	float32	Global Radiation sd	W/m^2	980

Input Register Address	Data type	Measurement value	Unit	UMB channel
4000	uint32	Device Status	digit	4000
4002	uint32	Init Status	digit	4010
4004	uint32	Temperature Status	digit	4011
4006	uint32	Humidity Status	digit	4012
4008	uint32	Pressure Status	digit	4013
4010	uint32	Compass Status	digit	4014
4012	uint32	Wind Status	digit	4015
4014	uint32	Precipitation Status	digit	4016
4016	uint32	Radiation Status	digit	4017
4018	uint32	Lightning Status	digit	4018
4020	uint32	Heater Status	digit	4024
4022	uint32	Fan Status	digit	4025
4024	uint32	Reset Cause	digit	4050

11.4 General exceptions

The Modbus protocol specifies different exception states. The following exceptions are implemented and may be thrown when a failure occurs:

Exception	Exception code	Possible reason
Illegal function	1	Function code is not supported
Illegal data address	2	Requesting or writing less than 1 or more than 120 registers
		Requesting or writing data out of defined range of registers
		If the start-address is not the start of a mapped holding register
		Writing to read-only holding registers
Illegal data value	3	Transmitted values are illegal (not plausible)
Server device failure	4	Device failure, i.e. configuration write error

11.5 Modbus specification

Visit modbus.org for further information.

12 Commissioning for NMEA protocol

The XDR protocol allows to transmit a selected data set of the smart weather sensor in a NMEA compatible format. The data telegram can be transmitted on request, or the smart weather sensor can be set into auto transmit mode, where the data telegram will be triggered automatically at a configurable interval. A set of ASCII configuration messages allows to apply some configuration settings without leaving the XDR protocol. For configuration settings exceeding this command set use the UMB Config Tool. To change into the UMB protocol a UMB message must be addressed to the device with ID 200 within 5 seconds after power up or reset.

The NMEA 0183 standard has the following sentence (telegram) structure:

Element	Description
Sentence delimiter	'$' or '!' character for an encapsulation sentence
Address field	May not be null and contains digits and upper case letters in one of three ways:
– Approved address field	Two characters for the talker identifier (i.e. "WI" for weather instrument), three character for the sentence identifier (i.e. "XDR" for transducer measurement)
– Query address field	Two characters for the requesting device, two characters for the device being addressed and the query character 'Q'
– Proprietary address field	Proprietary character 'P' followed by a three-character manufacturer's mnemonic code and any required additional characters
Data fields	Are delimited by a ',' character, may be null/empty (",,") and may contain hex characters, escaped by '^'
Checksum field	Is delimited by a '*' character and is the 8-bit exclusive or of all characters between but not including the '$' or '!' and the '*' delimiters. It is represented in hex as two ASCII characters.
Termination delimiter	Is terminating the sentence by the ASCII characters <CR> and <LF>

The XDR protocol is similar, but not the same as the NMEA 0183 protocol with the following differences:

- The start character for most commands and messages is '*' instead of '$'.
- A checksum is not transmitted.
- Commands do not conform to NMEA, except WIXDR, WIMWD and PWSD.
- WIXDR, WIMWD and PWSD are prefixed with '$' but are lacking the checksum to be NMEA compliant.

The command set is taken from the MET4/MET4A sensors by Paroscientific Inc.

12.1 Basic protocol properties

- Destination ID equal to UMB device ID, but limited to 98. 99 is the broadcast ID
- Data output on request or continuously (configurable)
- Commands and messages use strictly ASCII text mode

12.1.1 Message format for commands and responses

Byte	Command	Description
0	'*'	Start character
1, 2	'01'	Destination ID
3,4,	'00'	Source ID
5 ... n		Command data (min. 2)

Byte	Command	Description
n+1, n+2	<CR><LF>	Termination characters

The command data field always starts with the 2-character command identifier, optionally followed by a parameter, starting with '='. If the device receives an invalid command (missing start or termination character, invalid ID, invalid structure etc.), it will not respond. If a setting command contains an invalid parameter value, the device will not respond.

Setting commands must usually be preceded by the “Write Enable” command EW. This command does not generate a response, and may be, different from other commands, transmitted without message terminators (<CR><LF>). I.e. the write enable, and the set command may be concatenated without terminators between the commands.

Example:
0100EW*0100J3=1<CR><LF>
0100EW<CR><LF>*0100J3=1<CR><LF>
Both are valid command sequences for setting the pressure mode.

Setting commands not requiring a preceding write enable are marked in the command description.

12.2 Device specific commands

Command	Function	Range	Comment
P9	Single measurement		Disable auto transmit, send XDR data
PP	Set auto transmit		Enable auto transmit, send XDR data
PB	Single measurement proprietary		Disable auto transmit, send 0R0 data
PC	Auto transmit proprietary		Enable auto transmit, send 0R0 data
VR	Get version		Returns HW/SW version
EW	Write enable		May be concatenated with set commands
MI	Get or set auto transmit interval	10 ... [60] ... 43200 seconds	Set needs write enable
BR	Set baud rate	115200, 57600, 38400, 28800, 19200, 14400, 9600, 4800, 2400, 1200	Only as broadcast, set only
ID	Set unit ID	1 ... 98	Only as broadcast (ID 99)
J3	Get or set pressure mode	0 = absolute pressure 1 = relative pressure	Set needs write enable
JW	Wind values as vct, avg	0 = averaging off 1 = averaging on	Set needs write enable
GW	Add WIMWD sentence to WIXDR	0 = don’t add wind data 1 = add wind data	Set needs write enable

Command	Function	Range	Comment
NH	Get or set prefix	5-character message prefix; default: “WIXDR”	Set needs write enable
JS	Get or set station altitude	-100 ... [200] ... 5000 m	Set needs write enable

12.2.1 Message format for measurement data XDR

The message format for P9 / PP measurement data follows the definition for NMEA WI (weather instrument) XDR messages. The message is field oriented, with variable length. The fields are separated by ','.

Message format $hhhhh,P,x.xxxx,B,0,C,yy.y,C,0,H,zz.z,P,0<CR><LF>

Message format	Description
$hhhhh	Message header, default $WIXDR (WI: Talker identifier “weather instruments”, XDR: sentence identifier “transducer measurements”)*
,	Separator
P	Transducer type “pressure”
,	Separator
x.xxxx	Air pressure value in bar
,	Separator
B	Unit: Bar
,	Separator
0	Transducer ID, set to 0
,	Separator
C	Transducer type temperature
,	Separator
yy.y	Temperature in °C
,	Separator
C	Unit: °C
,	Separator
0	Transducer ID, set to 0
,	Separator
H	Transducer type humidity
,	Separator
zz.z	Relative humiditiy in %
,	Separator
P	Unit: %
,	Separator
0	Transducer ID, set to 0
<CR><LF>	Sentence terminator

*The message header can be modified. The UMB config tool allows modifying the talker ID bytes. The XDR setting command NH allows changing the complete message header. The leading '$' is fixed and cannot be modified.

12.2.2 Message format for measurement data MWD

The P9 / PP measurement data transmission can be optionally extended by a MWD sentence containing wind data. The MWD sentence follows the definition for NMEA WI (weather instrument) messages. This option can be activated or deactivated by the GW command. The JW command selects between spot value and average value output of wind data. The message is field oriented, with variable length. The fields are separated by ',' .

Message format $hhhhh,aaa.a,T,bbb.b,M,cc.c,N,dd.d,M<CR><LF>

Message format	Description
$hhhhh	Message header, default $WIMWD (WI: Talker identifier “weather instruments”, MWD: sentence identifier “wind measurements”) *
,	Separator
aaa.a	Wind direction in ° **
,	Separator
T	Identifier “true north”
,	Separator
bbb.b	Wind direction in ° **
,	Separator
M	Identifier “magnetic north”
,	Separator
cc.c	Wind speed in knots
,	Separator
N	Unit: kts
,	Separator
dd.d	Wind speed in m/s
,	Separator
M	Unit: m/s
<CR><LF>	Sentence terminator

*The message header can be modified. The MWD sentence uses the same talker ID as the XDR sentence, which can be modified by the UMB config tool or the XDR setting command NH. The leading '$' and the identifier MWD are fixed and cannot be modified.

**The wind direction “true” and the wind direction “magnetic” are identical.

12.2.3 Message format for measurement data 0R0

The 0R0 sentence format is a proprietary format similar to NMEA 0183 rules. The 0R0 sentence contains essential measurement values of the compact weather station and is designed for compatibility with existing installations.

The sentence is requested by the PB command for single measurement and PC for cyclic transmission. If certain measurement values are not available for the sub-type of the individual weather station the related value will be replaced by 999999. The same applies for measurement values with status not “OK”.

The message is field oriented, with variable length. The fields are separated by ','.

Message format 0R0,Dm=aaaD,Sm=bb.bM,Ta=cc.cC,Ua=dd.dP,Pa=e.eeeeB,Rc=f.ffM,Pt=ggC<CR><LF>

Message format	Description
0R0	Message header
,	Separator
Dm	Identifier wind direction
=	Separator
aaa	Wind direction in °

Message format	Description
D	Unit: °
,	Separator
Sm	Identifier wind speed
=	Separator
bb.b	Wind speed in m/s
M	Unit: m/s
,	Separator
Ta	Identifier air temperature
=	Separator
cc.c	Air temperature in °C
C	Unit: °C
,	Separator
Ua	Identifier relative humidity
=	Separator
dd.d	Relative humiditiy in %
P	Unit: %
,	Separator
Pa	Identifier air pressure
=	Separator
e.eeee	Air pressure in bar
B	Unit: Bar
,	Separator
Rc	Identifier precipitation difference
=	Separator
f.ff	Precipitation difference (related to last transmission) in mm
M	Unit: mm
,	Separator
Pt	Identifier precipitation type
=	Separator
gg	Precipitation type as SYNOP 4680 wawa code
C	Unit: Code
<CR><LF>	Sentence terminator

13 Commissioning for UMB-ASCII 2.0

UMB-ASCII 2.0 provides query of measurement values and sensor configuration in a human readable format. Details and general commands can be found in the UMB-ASCII 2.0 manual on the website.

The separators used for the output strings can be adjusted to the requirements of a logger: <Configuration>

In addition to the general configuration commands described in the UMB-ASCII 2.0 manual, device specific commands for configuration have been specified.

In UMB-ASCII 2.0 mode predefined sets of measurement values can be transmitted automatically at adjustable intervals without further query commands.

13.1 Standard Sets

13.1.1 Format of the Standard Sets

The following list uses UMB-ASCII 2.0 factory setting separators.

Byte	Value	Description
0	<STX>	02 Hex
1-4	<Add>	Device address hex, e.g. 7001 for WSx-UMB with device ID 1
5	:	3A hex
6-7	<Nr>	Request number hex, always the same as the enable command on auto transmit.
8	:	3A hex
9-10	SS	<Cmd>, standard set
11	;	3B hex
12-...	<Set>	Standard set number
...	=	3D hex
	<TelNo>	Number of auto transmitted messages from start.
	;	3B hex
	<SerNo>	Device serial number
	;	3B hex
	<val1>	Measurement value 1
	;	3B hex
...		...
	<valn>	Measurement value n
	;	3B hex
	<Dev status>	Device status, hex
	:	3A hex
	<CmdStatus>	Command status, hex
	:	3A hex
	<Checksum>	Check sum, hex
	<CR><LF>	0D 0A hex
	<EOT>	04 hex

13.2 Standard Set Data

Depending on the measurement value type, the output is formatted as an integer or a fixed-point representation.

13.2.1 Standard Sets Metric

	Measurement Value	Format	Unit	UMB-Channel
SS1 Most important Temperature, Humidity, Pressure, Radiation, Wind, Precipitation	Temperature cur	+2.1	°C	100
	Humidity Relative cur	3.1	%	200
	Air Pressure Relative cur	4	hPa	305
	Global Radiation cur	4	W/m^2	900
	Wind Speed gust	2.1	m/s	443
	Wind Speed vct	2.1	m/s	480
	Wind Dir vct	3	°	580
	Precip WMO wawa code	2	digit	780
	Precip Intensity	3.1	mm/h	820
	Device Status	8 (hex)	digits	4000
SS2 Other important Temperatures, Humidity, Pressure	Dew Point cur	+2.1	°C	110
	Wet Bulb Temperature cur	+2.1	°C	114
	Wind Chill Temperature cur	+2.1	°C	111
	Temperature External cur	+2.1	°C	101
	Humidity Absolute cur	4.1	g/m^3	205
	Mixing Ratio cur	4.1	g/kg	210
	Specific Enthalpy cur	4.1	kJ/kg	215
	Air Pressure Absolute cur	4	hPa	300
	Air Density cur	1.2	kg/m^3	310
	Device Status	8 (hex)	digits	4000

	Measurement Value	Format	Unit	UMB-Channel
SS3 Other important Wind	Wind Speed avg	2.1	m/s	460
	Wind Speed cur	2.1	m/s	400
	Wind Dir cur	3	°	500
	Wind Speed Fast cur	2.1	m/s	401
	Wind Dir Fast cur	3	°	501
	Device Status	8 (hex)	digits	4000
SS4 Other important Precipitation, Compass, Lightning	Precip Diff	3.1	mm	625
	Precip Absolute	6.1	mm	620
	Compass cur	3	°	510
	Lightning cur	3	events	617
	Device Status	8 (hex)	digits	4000
SS5 Device Info	Supply Voltage	2.1	V	4060
	Heater Voltage	2.1	V	4061
	Boot count	4	digits	4082
	Attended time	5	hours	4080
	Fan speed	4	rpm	4070
	Device Status	8 (hex)	digits	4000
SS6 Wind Quality	Wind Heater On	1	digits	4071
	R2S Heater On	1	digits	4072
	Wind heater Temperature	+3.1	°C	4120
	R2S heater Temperature	+3.1	°C	4130
	Wind Quality avg	3	%	4460
	Wind Quality cur	3	%	4400
	Wind Quality Fast cur	3	%	4401
	Device Status	8 (hex)	digits	4000

13.2.2 Standard Sets Imperial

	Measurement Value	Format	Unit	UMB-Channel
SS11 Most important Temperature, Humidity, Pressure, Radiation, Wind, Precipitation	Temperature cur	+3.1	°F	105
	Humidity Relative cur	3.1	%	200
	Air Pressure Relative cur	4	hPa	305
	Global Radiation cur	4	W/m^2	900
	Wind Speed gust	3.1	mph	453
	Wind Speed vct	3.1	mph	490
	Wind Dir vct	3	°	580
	Precip WMO wawa code	2	digit	780
	Precip Intensity	1.3	in/h	840
	Device Status	8 (hex)	digits	4000
SS12 Other important Temperatures, Humidity, Pressure	Dew Point cur	+3.1	°F	115
	Wet Bulb Temperature cur	+3.1	°F	119
	Wind Chill Temperature cur	+3.1	°F	116
	Temperature External cur	+3.1	°F	106
	Humidity Absolute cur	4.1	g/m^3	205
	Mixing Ratio cur	4.1	g/kg	210
	Specific Enthalpy cur	4.1	kJ/kg	215
	Air Pressure Absolute cur	4	hPa	300
	Air Density cur	1.2	kg/m^3	310
	Device Status	8 (hex)	digits	4000
SS13 Other important Wind	Wind Speed avg	3.1	mph	470
	Wind Speed	3.1	mph	410

	Measurement Value	Format	Unit	UMB-Channel
	cur			
	Wind Dir cur	3	°	500
	Wind Speed Fast cur	3.1	mph	411
	Wind Dir Fast cur	3	°	501
	Device Status	8 (hex)	digits	4000
SS14 Other important Precipitation, Compass, Lightning	Precip Diff	3.1	in	645
	Precip Absolute	4.1	in	640
	Compass cur	3	°	510
	Lightning cur	3	events	617
	Device Status	8 (hex)	digits	4000
SS15 Device Info	Supply Voltage	2.1	V	4060
	Heater Voltage	2.1	V	4061
	Boot count	4	digits	4082
	Attended time	5	hours	4080
	Fan speed	4	rpm	4070
	Device Status	8 (hex)	digits	4000
SS16 Heatings, Wind Quality	Wind Heater On	1	digits	4071
	R2S Heater On	1	digits	4072
	Wind Heater Temperature	+3.1	°F	4125
	R2S heater Temperature	+3.1	°F	4135
	Wind Quality avg	3	%	4460
	Wind Quality cur	3	%	4400
	Wind Quality Fast cur	3	%	4401
	Device Status	8 (hex)	digits	4000

13.3 Device Specific Commands

Command	Function	Default	Values
ID	Device ID	1	Protocol Device Identifier Value range: 1 ... 247 (200 should not be used)

Command	Function	Default	Values
PRT	Protocol	0	Communication Protocol 0 = UMB 3 = SDI-12 5 = Modbus RTU 6 = Modbus ASCII 7 = NMEA / XDR 9 = UMB-ASCII2
BAU	Baud Rate	6	Protocol Baud Rate 1 = 115200 2 = 57600 3 = 38400 4 = 28800 6 = 19200 8 = 14400 12 = 9600 24 = 4800 48 = 2400 96 = 1200
PRY	Data Format	0	Protocol Data Format 0 = 8N1 1 = 8E1 2 = 7E1 3 = 8N2 4 = 7E2
ALT	Location Altitude	200	For the calculation of the relative air pressure the local altitude of the device is required. Value range: -100 ... +5000m.
DEM	Operating Mode	0	For installations with limited power supply, the Smart Weather Sensor may be operated in power saving mode. 0 = Normal Operation 1 = Power saving mode 1 (Heating/Fan off) 2 = Power saving mode 2 (Sleep mode)
WHM	Wind Heater Mode	0: auto	The heating of the precipitation and the wind sensors can be configured in different operation modes. Depending on the actual variant of the Smart Weather Sensor only certain combinations of operating modes are available. The Smart Weather Sensor evaluates the valid combinations from the device heating mode requested in the command automatically. 0: Auto 1: Off
RHM	R2S Heater Mode	0: auto	0: Auto 1: Off 2: Eco
RGR	Rain Gauge Resolution	0: 0.1mm	Set Rain Gauge Resolution resolution of the rain gauge in 1/10mm 0: 0.1mm

Command	Function	Default	Values
			1: 0.2mm 2: 0.5mm 3: 1.0mm
FAM	Fan Mode	1	Setting of the fan mode in addition to the power saving mode 0: Fan off 1: Fan on
EXT	External Sensor	0: none	Setting of the external device type 0: None 1: NTC temperature 2: Rain gauge 3: NTC SSI temperature 4: Pt1000 temperature
TEI	Temperature Averaging Interval	10	The avg, min, max and vct values of the measurement values are evaluated over a floating interval. 1 ... 10 minutes
HUI	Humidity Averaging Interval	10	1 ... 10 minutes
PRI	Pressure Averaging Interval	10	1 ... 10 minutes
WII	Wind Averaging Interval	10	1 ... 10 minutes
PYI	Global Radiation Averaging Interval	10	1 ... 10 minutes
EXI	External Temperature Averaging Interval	10	1 ... 10 minutes
LII	Lightning Event Interval	10	1 ... 10 minutes
TEO	Temperature User Offset	0	The user can apply offsets to the measurement values -50 ... +50 °C.
HUO	Humidity User Offset	0	-50 ... +50 %rH
PRO	Pressure User Offset	0	-500 ... +500 hPa
WDO	Wind Direction User Offset	0	-180 ... +180 °
PYO	Global Radiation User Offset	0	-500 ... +500 W/m²
COO	Compass Direction User Offset	0	0 -180 ... +180 °
EXO	External Temperature User Offset	0	-50 ... +50 °C

14 Maintenance

14.1 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.

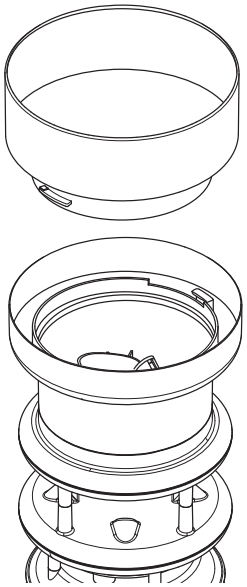
The following maintenance intervals are recommended:

Interval	Activity	Performed by
Once a week*	▸ Clean the dome using a dry and lint-free cloth. ▸ For persistent soiling, use additional distilled water. If the soiling is severe, 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-J and WS-601-J).	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-J).	Operator
Annually	▸ Perform a calibration check of the humidity sensor with a second device. ▸ In case the sensor needs to be calibrated, the complete WS must be sent to the manufacturer for calibration/adjustment.	Operator Kipp & Zonen

*Only applies to devices with global radiation measurement.

14.2 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-J with removed funnel

i Each movement of the bucket generates a counting pulse. Avoid moving the tipping mechanism as it can result in wrong counts.

- Unlock funnel by turning it to the left and lift it off.
- Clean funnel, especially the sieve slots.
- Check the inside of the rain gauge for pollution, especially for spider webs and insects.
- 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.

15 Troubleshooting

15.1 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	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.
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	–

Error	Possible cause	Corrective action
	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 Kipp & Zonen.

16 Repair

16.1 Customer support

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

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

OTT HydroMet repair service

17 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), Kipp & Zonen 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 Kipp & Zonen:

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.

18 Technical data

18.1 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	IEC/EN 60529: IP66 (IP6x: Dust tight, IPx6: Protection against powerful water jets)
Operating temperature range	-50 to +60 °C
Storage temperature range	-50 to +70 °C
Humidity range	0 to 100 %
Pollution degree	3
Operation altitude	up to 5000 m
Communication Interface	Non-Isolated RS485, SDI-12
Supply voltage range	4 to 28 V ⎓

18.2 Electrical data

Current consumption at the supply input

Variant	Normal operation mode		Power saving mode 1		Power saving mode 2	
	24 V ⎓	12 V ⎓	24 V ⎓	12 V ⎓	24 V ⎓	12 V ⎓
WS200-J	19 mA	38 mA	13 mA	25 mA	0.85 mA	1.7 mA
WS300-J	75 mA	65 mA	6 mA	12 mA	0.85 mA	1.7 mA
WS400-J	90 mA	100 mA	5 mA	10 mA	–	–
WS401-J	75 mA	65 mA	6 mA	12 mA	2 mA	4 mA
WS500-J WS501-J WS502-J WS510-J	85 mA	85 mA	15 mA	26 mA	0.85 mA	1.7 mA
WS600-J WS700-J WS800-J	100 mA	120 mA	13 mA	25 mA	–	–
WS601-J	85 mA	85 mA	15 mA	26 mA	2 mA	4 mA

The recommended setting is 24 V.

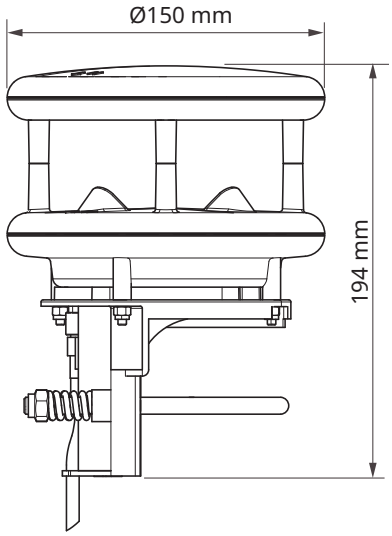
Heating

Variant	Current/power consumption at 24 V ⎓
WS200-J WS400-J WS500-J	850 mA/20 VA

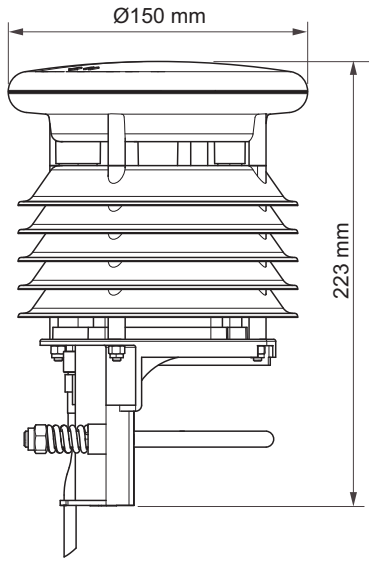
Variant	Current/power consumption at 24 V ⎓
WS501-J WS502-J WS510-J	
WS600-J WS700-J WS800-J	1.7 A/40 VA
WS601-J	850 mA/20 VA

18.3 Dimensions and weight

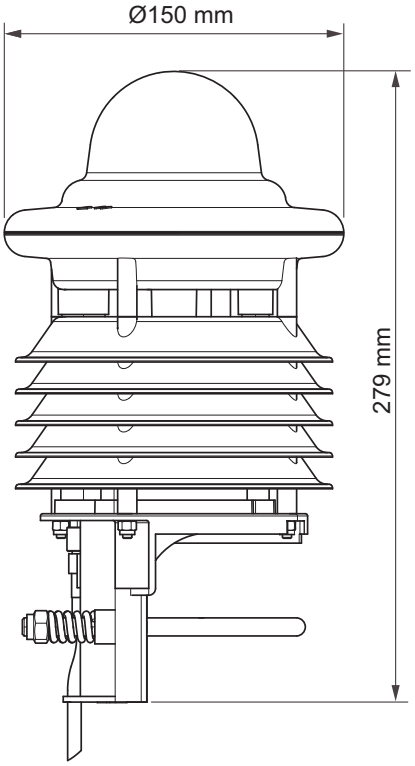
WS200-J, 720 g



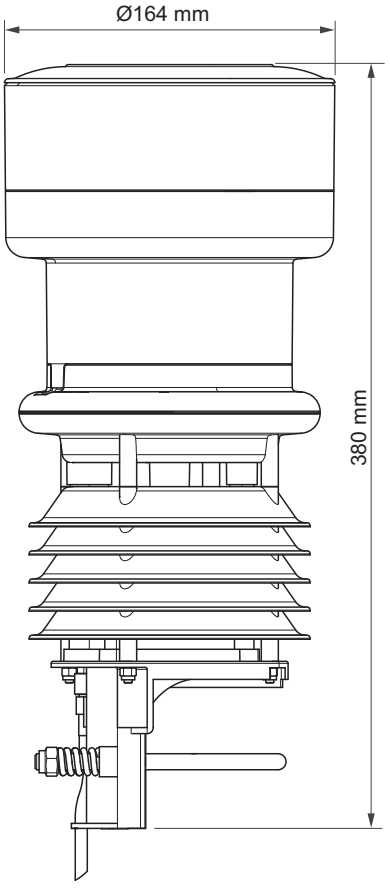
WS300-J, 840 g



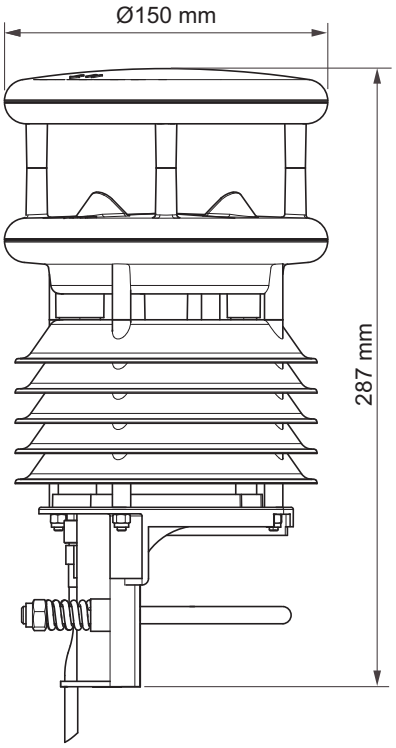
WS400-J, 1160 g



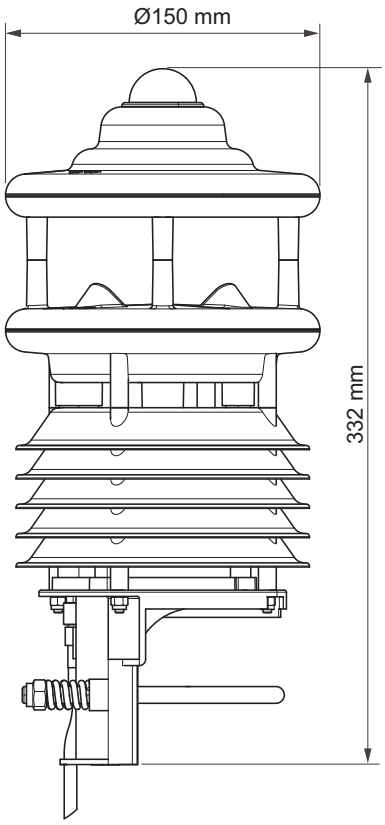
WS401-J, 1200 g



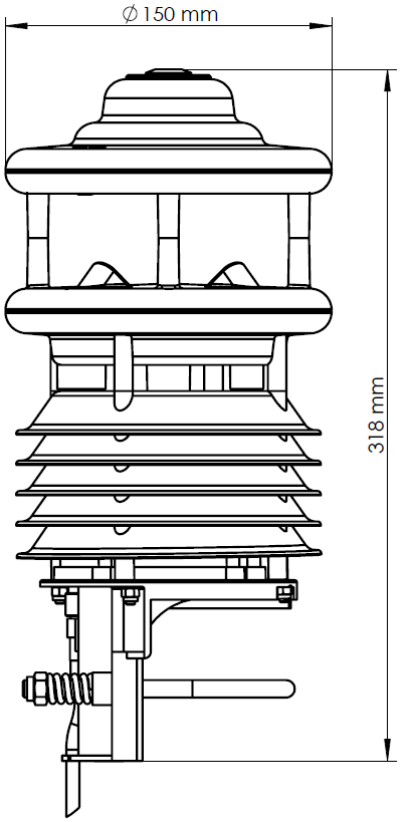
WS500-J, 1100 g



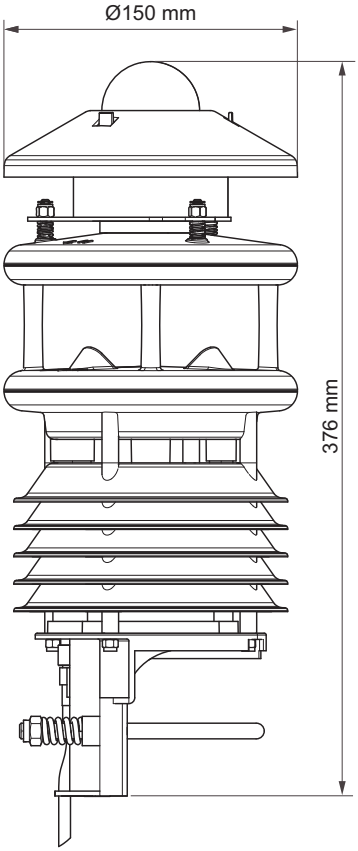
WS501-J, 1150 g



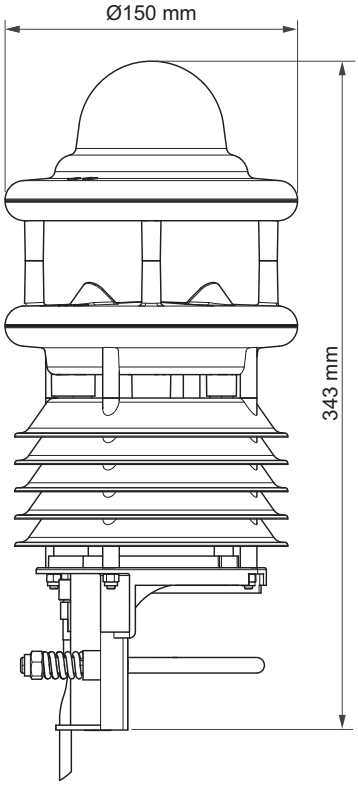
WS502-J, 1140 g



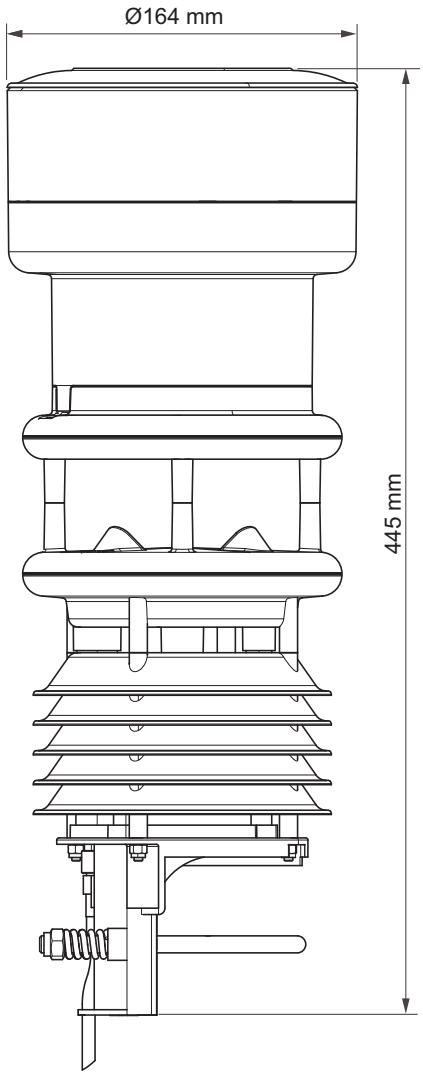
WS510-J, 1850 g



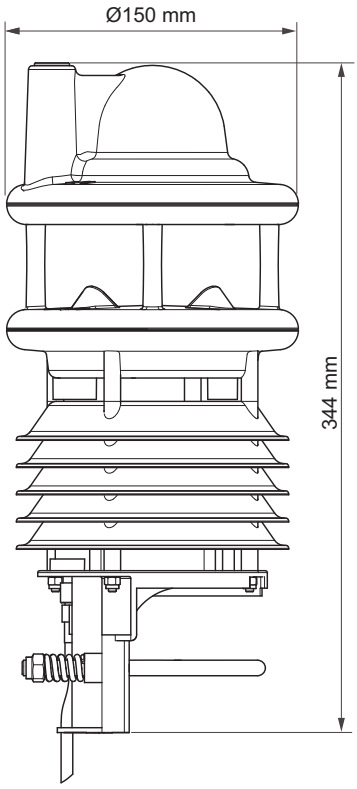
WS600-J, 1400 g



WS601-J, 1650 g



WS700-J, 1400 g



18.4 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-J	–	–	–	–	x	x	x	–	–	x	x	x
WS300-J	x	x	x	–	–	–	–	–	–	x	x	x
WS400-J	x	x	x	x	–	–	–	–	–	x	–	–
WS401-J	x	x	x	x	–	–	–	–	–	x	–	x
WS500-J	x	x	x	–	x	x	x	–	–	x	x	x
WS501-J	x	x	x	–	x	x	x	x	–	x	x	x
WS502-J	x	x	x	–	x	x	x	x	–	x	x	x
WS510-J	x	x	x	–	x	x	x	x	–	x	x	x
WS600-J	x	x	x	x	x	x	x	–	–	x	–	–
WS601-J	x	x	x	x	x	x	x	–	–	x	–	x
WS700-J	x	x	x	x	x	x	x	x	–	x	–	–
WS800-J	x	x	x	x	x	x	x	x	x	x	–	–

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

18.4.1 Air temperature

Specification	Value
Measurement process	NTC
Measuring range	-50 °C to +60 °C
Resolution	0.1 °C
Sensor accuracy	±0.2 °C

Specification	Value
Sampling rate	Once per second
Update rate	5 s
Units	°C; °F

18.4.2 Humidity

Specification	Value
Measurement process	Capacitive
Measuring range	0 to 100 % RH
Resolution	0.1 % RH
Accuracy	±2 % RH
Sampling rate	Once per second
Update rate	5 s
Units	% RH; g/m^3

18.4.3 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
Update rate	5 s
Units	°C; °F

18.4.4 Air pressure

Specification	Value
Measurement process	MEMS sensor - capacitive

Specification	Value
Measuring range	300 to 1200 hPa
Resolution	0.1 hPa
Accuracy	±0.5 hPa (0 °C to +40 °C)
Sampling rate	Once per second
Update rate	5 s
Units	hPa

18.4.5 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	60 Hz
Measurement cycle	250 ms/1 s (configurable)
Update rate	5 s
Units	m/s; km/h; mph; kts

The default measurement cycle is 1 second (1 s), which defines the duration of a fast value. Fast values serve as the basis for all statistical calculations, including the current, minimum, maximum, and average values.

18.4.6 Wind direction

Specification	Value
Measurement process	Ultrasonic

Specification	Value
Measuring range	0 to 359.9°
Resolution	0.1°
Accuracy	< 3° (> 1 m/s) RMSE
Response threshold	0.3 m/s
Internal sampling frequency	60 Hz
Measurement cycle	250 ms/1 s (configurable)
Output rate for average and peak gust values	5 s

18.4.7 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	20 %*	2 %
Repeatability	Typically > 90 %	–
Response threshold	0.002 mm	–
Sampling rate	Event-dependent on reaching response threshold	Event-dependent
Update rate	5 s	5 s
Precipitation intensity	0 to 200 mm/h; resol. 0.01 mm/h	–

* Intensity range: 0 - 200 mm/h

18.4.8 Compass

Specification	Value
Measurement process	Integrated electronic compass
Measuring range	0 to 359.9°
Resolution	1.0°
Accuracy	±10°
Sampling rate	1 s
Update rate	5 s

18.4.9 Global radiation

Specification	Value
Measurement process	Thermopile pyranometer: WS-501-J, WS510-J Silicon sensor: WS502-J, WS700-J, WS800-J
Global Radiation measuring range	Thermopile: 0.0 to 2000.0 W/m^2 Silicon (photodiode): 0.0 to 1400.0 W/m^2
Resolution	< 1 W/m^2
Sampling rate	1 s
Update rate	5 s

Specification	Value		
	WS501	WS502 WS700 WS800	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)

Specification	Value		
	WS501	WS502 WS700 WS800	WS510
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
Class	Class C	-	Class A

18.4.10 External temperature sensor WT1/WST1/PT1000

Specification	Value
Measurement process	NTC/PT1000
Measuring range	-40 °C to +80 °C
Resolution	0.1 °C
Sensor accuracy	±1 °C (WST1: ±0.3 °C between -10 °C to +10 °C)
Sampling rate	Once per second
Update rate	5 s
Units	°C; °F

18.4.11 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	Event-dependent
Update rate	5 s

18.4.12 Wind chill 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
Update rate	5 s
Units	°C; °F

18.4.13 Wet bulb 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
Update rate	5 s
Units	°C; °F

18.4.14 Absolute humidity

Specification	Value
Sampling rate	1 s
Update rate	5 s
Unit	g/m^3

18.4.15 Mixing ratio

Specification	Value
Measurement process	Value Passive, calculated from temperature, vapor pressure and air pressure

Specification	Value
Sampling rate	1 s
Update rate	5 s
Unit	g/kg

18.4.16 Specific enthalpy

Specification	Value
Measurement process	Value Passive, calculated from temperature and mixing ratio
Sampling rate	1 s
Update rate	5 s
Unit	kJ/kg

18.4.17 Relative air pressure

Specification	Value
Sampling rate	1 s
Update rate	5 s
Unit	hPa

18.4.18 Air density

Specification	Value
Sampling rate	1 s
Update rate	5 s
Unit	kg/m^3

18.4.19 Lightning events

Specification	Value
Sampling rate	1 s

Specification	Value
Update rate	5 s
Sum:	1 to 30 minutes
Unit:	Events

Lightning Sensor - Functional Description

WS800-J includes lightning detection by an integrated sensor analyzing the radio wave emission of lightning. It delivers a count of recognized lightnings. An external antenna is directly connected to the Analog Front-end (AFE), which amplifies and demodulates the received signal. The integrated sensor is based on narrowband receiving techniques with a center frequency of 500 kHz and a bandwidth of about 33 kHz. The output signal of the AFE is also used to measure the noise floor level. The noise floor is continuously compared to a reference voltage (noise threshold). Whenever the noise floor level crosses the noise threshold, the lightning sensor cannot operate properly due to the high input noise received by the antenna. In this case, the WS800-J reports error-code (0x54) on channel 617 and/or 677.

NOTE: It is possible that the WS800-J may accidentally detect lightning events when disturbances in the area are in the 500kHz frequency range

18.5 Additional Technical Reference Data

18.5.1 Backward Compatibility of MODBUS Output Values

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 16bit registers using scaling factors (0 ... max. 65530 for unsigned values, -32762 ... 32762 for signed values).

Values 65535 (0xffff) resp. 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 values to the available register addresses (0 ... 124) has been arranged in a way so that the user can read the most frequently used data with few (ideally only one) register block requests

Following blocks have been defined:

- Status information
- Frequently used values which are independent of the unit system (met./ imp.) 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 the supply all data usually required with one request.

There is no difference in the register assignment between the sub types of the WS family. If, dependent on the type, some value is not available, this will be indicated by setting the register to the error value.

Reg. No.	Reg. Addr.	Value (UMB Channel)	Range	Scaling Factor, Remarks
		Status Information		
1	0	Identification	High Byte: WS-Type (2,3,4,5,6) Low Byte: Software Version	Type coding, see 18.5.2
2	1	Device Status		See 18.5.2
3	2	Sensor Status 1	Air temperature buffer, air temperature, dew point buffer, dew point(high byte -> low byte, see table below)	Coding 4 bit per status, see 18.5.2
4	3	Sensor Status 2	Rel. humidity buffer, rel. humidity, abs. humidity buffer, abs. humidity(high byte -> low byte, see table below)	Coding 4 bit per status, see 18.5.2

5	4	Sensor Status 3	Mixing ratio buffer, mixing ration, air press. buffer, air press. (high byte -> low byte, see table below)	Coding 4 bit per status, see 18.5.2
6	5	Sensor Status 4	Wind buffer, wind, precipitation, compass(high byte -> low byte, see table below)	Coding 4 bit per status, see 18.5.2
7	6	Sensor Status 5	Global radiation buffer, global radiation, reserved, reserved (high byte -> low byte, see table below)	Coding 4 bit per status, see 18.5.2
8	7	Sensor Status 6	External temperature / external rain gauge, lightning sensor, lightning sensor buffer (see table below)	Coding 4 bit per status, see 18.5.2
9	8	Reserve		
10	9		Diagnostic: run time in 10sec steps	
		Values Independent of the Unit System		
11	10	200	Relative Humidity (act.)	Factor 10, s
12	11	220	Relative Humidity (min.)	Factor 10, s
13	12	240	Relative Humidity (max.)	Factor 10, s
14	13	260	Relative Humidity (avg.)	Factor 10, s
15	14	305	Rel. Air Pressure (act.)	Factor 10, s
16	15	325	Rel. Air Pressure (min.)	Factor 10, s
17	16	345	Rel. Air Pressure (max.)	Factor 10, s
18	17	365	Rel. Air Pressure (avg.)	Factor 10, s
19	18	500	Wind Direction (act.)	Factor 10, s
20	19	520	Wind Direction (min.)	Factor 10, s
21	20	540	Wind Direction (max.)	Factor 10, s
22	21	580	Wind Direction (vct.)	Factor 10, s
23	22	501	Wind Direction fast	Factor 10, s

24	23	502	Wind Direction compass corr.	Factor 10, s
25	24	510	Compass	Factor 10, s
26	25	700	Precipitation Type	Factor 10, s
27	26	805	Wind Measurement Quality	Factor 10, s
28	27	900	Global Radiation (act.)	Factor 10, s
29	28	920	Global Radiation (min.)	Factor 10, s
30	29	940	Global Radiation (max.)	Factor 10, s
31	30	960	Global Radiation (avg.)	Factor 10, s
		Values in Metric Units		
32	31	100	Air Temperature °C (act.)	Factor 10, s
33	32	120	Air Temperature °C (min.)	Factor 10, s
34	33	140	Air Temperature °C (max.)	Factor 10, s
35	34	160	Air Temperature °C (avg.)	Factor 10, s
36	35	110	Dew Point °C (akt.)	Factor 10, s
37	36	130	Dew Point °C (min.)	Factor 10, s
38	37	150	Dew Point °C (max.)	Factor 10, s
39	38	170	Dew Point °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
43	42	400	Wind Speed m/s (akt.)	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
47	46	480	Wind Speed m/s (vct.)	Factor 10, s
48	47	401	Wind Speed fast m/s	Factor 10, s
49	48	620	Precipitation abs. mm	Factor 100, u, limited to 655.34mm
50	49	625	Precipitation diff. mm	Factor 100, u, limited to 100.00mm

51	50	820	Precipitation intens. mm/h	Factor 100, u, limited to 200.00mm/h
		Values in Imperial Units		
52	51	105	Air Temperature °F (act.)	Factor 10, s
53	52	125	Air Temperature °F (min.)	Factor 10, s
54	53	145	Air Temperature °F (max.)	Factor 10, s
55	54	165	Air Temperature °F (avg.)	Factor 10, s
56	55	115	Dew Point °F (act.)	Factor 10, s
57	56	135	Dew Point °F (min.)	Factor 10, s
58	57	155	Dew Point °F (max.)	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
63	62	410	Wind Speed mph (act.)	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
67	66	490	Wind Speed mph (vct.)	Factor 10, s
68	67	411	Wind Speed fast mph	Factor 10, s
69	68	640	Precipitation abs. In Factor 1000, u, limited to 25.800	Factor 1000, u, limited to 25.800 in
70	69	645	Precipitation diff. in	Factor 10000, u, limited to 3.9370in
71	70	840	Precipitation Intens. in/h	Factor 10000, u, limited to 6.5534 in
		Further Values		
72	71	205	Absolute Humidity (act.)	Factor 10, s
73	72	225	Absolute Humidity (min.)	Factor 10, s
74	73	245	Absolute Humidity (max.)	Factor 10, s

75	74	265	Absolute Humidity (avg.)	Factor 10, s
76	75	210	Mixing Ratio (act.)	Factor 10, s
77	76	230	Mixing Ratio (min.)	Factor 10, s
78	77	250	Mixing Ratio (max.)	Factor 10, s
79	78	270	Mixing Ratio (avg.)	Factor 10, s
80	79	300	Abs. Air Pressure (act.)	Factor 10, s
81	80	320	Abs. Air Pressure (min.)	Factor 10, s
82	81	340	Abs. Air Pressure (max.)	Factor 10, s
83	82	360	Abs. Air Pressure (avg.)	Factor 10, s
84	83	405	Wind Speed km/h (act.)	Factor 10, s
85	84	425	Wind Speed km/h (min.)	Factor 10, s
86	85	445	Wind Speed km/h (max.)	Factor 10, s
87	86	465	Wind Speed km/h (avg.)	Factor 10, s
88	87	485	Wind Speed km/h (vct.)	Factor 10, s
89	88	415	Wind Speed kts (act.)	Factor 10, s
90	89	435	Wind Speed kts (min.)	Factor 10, s
91	90	455	Wind Speed kts (max.)	Factor 10, s
92	91	475	Wind Speed kts (avg.)	Factor 10, s
93	92	495	Wind Speed kts (vct.)	Factor 10, s
94	93	406	Wind Speed fast km/h	Factor 10, s
95	94	416	Wind Speed fast kts	Factor 10, s
96	95	403	Wind Speed Std. Dev. m/s *	Factor 100, s
97	96	413	Wind Speed Std. Dev. Mph *	Factor 100, s
98	97	503	Wind Dir. Standard Dev.*	Factor 100, s
99	98	114	Wet Bulb Temp. °C (act)	Factor 10, s
100	99	119	Wet Bulb Temp. °F (act)	Factor 10, s
101	100	215	Specific Enthalpy (act)	Factor 10, s
102	101	310	Air Density (act)	Factor 1000, s

Note: Standard deviation values are available after the first request.

Reg. No.	Reg. Addr.	Value (UMB Channel)	Range	Scaling Factor, signed/unsigned, Remarks
		Further Values		
103	102	825	Precipitation Int. **(WS100 only)**	Factor 10000, u
104	103	845	Precipitation Int. **(WS100 only)**	Factor 200000, u
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 (Interval)	Factor 1, u

18.5.2 Status and Type Coding

Device Status:
Under normal operation conditions the device status should always be 0. If the device status is not 0 this may indicate a serious system error.
(Excepted code 48 after performing a reset to factory settings. Device status should return to 0 after another normal reset)
Please contact the Kipp & Zonen Support Team, reporting the observed device status. Measurement values collected during or after a non-zero device status should be considered possibly unreliable.

Sensor Status:
Each register hoIds 4 sensor status coded with 4 bits per status, so that together they build one 16bit number. The sequence defined in the table above is to understand as from most significant half byte to least significant half byte. Most of the sensors have two status values, one for the sensor itself and the current measurement value, another one for the buffer, from which average, min. And max values are evaluated.

Assignment of Status Information to Status Register

Register	Byte	Half Byte	Status
Sensor Status 1	High	High	Temperature Buffer
		Low	Temperature
	Low	High	Dewpoint Buffer
		Low	Dewpoint
Sensor Status 2	High	High	Rel. Humidity Buffer
		Low	Rel. Humidity

Register	Byte	Half Byte	Status
	Low	High	Abs. Humidity Buffer
		Low	Abs. Humidity
Sensor Status 3	High	High	Mixing Ratio Buffer
		Low	Mixing Ratio
	Low	High	Air Pressure Buffer
		Low	Air Pressure
Sensor Status 4	High	High	Wind Buffer
		Low	Wind
	Low	High	Precipitation
		Low	Compass
Sensor Status 5	High	High	Global Radiation Buffer
		Low	Global Radiation
	Low	High	reserved
		Low	reserved
Sensor Status 6	High	High	
		Low	External Temperature
	Low	High	Lightning Sensor Buffer
		Low	Lightning Sensor

Example Sensor Status 1:
Temperature buffer status, temperature status, dewpoint buffer status, dewpoint status

High Byte		Low Byte	
High	Low	High	Low
Temperature-Buffer	Temperature	Dew point-Buffer	Dew point
5	3	0	7

The example values above (for illustration only, the given combination will not occur in reality) are combined to the register value 0x5307 = 21255.

The single status are retrieved from the register as integer part of
Status 1 = register / 4096
Status 2 = (register / 256) AND 0x000F
Status 3 = (register / 16) AND 0x000F
Status 4 = register AND 0x000F

Following table shows the status coding:

Sensor State	Code
OK	0
INVALID_CHANNEL	1

Sensor State	Code
E2_CAL_ERROR E2_CRC_CAL_ERR FLASH_CRC_ERR FLASH_WRITE_ERR FLASH_FLOAT_ERR	2
MEAS_ERROR, MEAS_UNABLE	3
INIT_ERROR	4
VALUE_OVERFLOW CHANNEL_OVERRANGE VALUE_UNDERFLOW CHANNEL_UNDERRANGE	5
BUSY	6
Other Sensor State	7

Smart Weather Sensor Type Code

WS100-UMB	24	WS303-UMB	33
WS200-UMB	2	WS304-UMB	43
WS300-UMB	3	WS501-UMB	15
WS400-UMB	4	WS502-UMB	25
WS500-UMB	5	WS503-UMB	35
WS600-UMB	6	WS504-UMB	45
WS700-UMB	7	WS510-UMB	95
WS800-UMB	8	WS401-UMB	14
WS303-UMB	33	WS601-UMB	16

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Contact Information