4 Equipment Description

The WS family is a range of low cost smart combination of weather sensors 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.

	WS100-UMB	WS200-UMB	WS300-UMB	WS301-UMB**	WS400-UMB	WS401-UMB	WS500-UMB	WS501-UMB***	WS600-UMB	WS601-UMB	WS700-UMB	WS800-UMB
Air temperature			●	●	●	●	●	●	●	●	●	●
Humidity			●	●	●	●	●	●	●	●	●	●
Air pressure			●	●	●	●	●	●	●	●	●	●
Precipitation	●				●	●*			●	●*	●	●
Wind direction		●					●	●	●	●	●	●
Wind speed		●					●	●	●	●	●	●
Compass		●					●	●	●	●	●	●
Global Radiation				●				●			●	●
Lightning Sensor												●
Temperature (ext)		●	●	●	●	●	●	●	●	●	●	●
Rain Gauge (ext)		●	●	●			●	●				
Power Save 2		●	●	●		●	●	●		●		

*) WS401-UMB and WS601-UMB use a rain gauge for precipitation measurement

**) is also valid for WS302-UMB, WS303-UMB, WS304-UMB, WS310-UMB

***) is also valid for WS502-UMB, WS503-UMB, WS504-UMB, WS510-UMB

Sensors marked (ext) in the table are additional accessories and not included with the device. The table shows which external sensors can be connected to the different models.

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

Attention: Please note that, due to the approval of the radar sensor used, there are different country options on equipment which includes precipitation measurement by radar technology.

The equipment is connected by way of an 8 pole screw connector and associated connection cable (length 10m).

The measured values are requested over the RS485 interface in accordance with UMB protocol.

During commissioning, configuration and measurement polling takes place using the UMB-Config-Tool (Windows® PC software) or the ConfigTool.NET (for WS100-UMB)

4.1 Air Temperature and Humidity

Temperature is measured by way of a highly accurate NTC-resistor while humidity is measured using a capacitive humidity sensor. In order to keep the effects of external influences (e.g. solar radiation) as low as possible, these sensors are located in a ventilated housing with radiation protection. In contrast to conventional non-ventilated sensors, this allows significantly more accurate measurement during high radiation conditions.

WS100-UMB is not intended for air temperature measurement, so it is not equipped with a radiation shield. Air temperature values with reduced accuracy are available as service channels for additional information.

Additional variables such as dewpoint, absolute humidity and mixing ratio are calculated from air temperature and relative humidity, taking account of air pressure.

4.2 Air Pressure

Absolute air pressure is measured by way of a built-in sensor (MEMS). The relative air pressure referenced to sea level is calculated using the barometric formula with the aid of the local altitude, which is user-configurable on the equipment.

4.3 Precipitation

Tried and tested radar technology from the R2S-UMB sensor is used to measure precipitation. The precipitation sensor works with a 24GHz Doppler radar, which measures the drop speed and calculates precipitation quantity and type by correlating drop size and speed.

Note: Devices with precipitation radar are subject to approval regulations which differ between countries. Please make sure to observe chapter 1.3!
WS401-UMB and WS601-UMB are using an unheated rain gauge for precipitation measurement. This version can be recommended for low power application etc.

4.4 Wet Bulb Temperature

The wet bulb temperature is the temperature of a moist or icy surface exposed to air flow.

4.5 Specific Enthalpy

Parameter of state of the humid air, composed of the specific enthalpies (heat capacity) of the components of the mixture and related to the mass fraction of the dry air (at 0°C).

4.6 Air Density

The air density indicates how much mass in a given volume of air is contained and it is calculated from the measured values of air temperature, humidity and air pressure.

4.7 Wind

The wind meter uses 4 ultrasonic sensors which take cyclical measurements in all directions. The resulting wind speed and direction are calculated from the measured run-time sound differential. The sensor delivers a quality output signal indicating how many good readings were taken during the measurement interval.

4.8 Compass

The integrated electronic compass can be used to check the north – south adjustment of the sensor housing for wind direction measurement. It is also used to calculate the compass corrected wind direction.

4.9 Heating

The precipitation sensor and wind meter are heated for operation in winter.

4.10 Global Radiation

The global radiation is measured by a pyranometer mounted in the top cover of the Smart Weather Sensor.

4.11 Lightning Sensor

WS800-UMB includes lightning detection by an integrated sensor analysing the radio wave emission of lightnings. It delivers a count of recognized lightnings.

The sensor analyses spectrum and wave form of the received signal to suppress the detection of man made electrical discharges. Nevertheless false detections can not be totally excluded specially in an environment with high power electrical equipment.

4.12 External Temperature Sensor

Optionally all models may be equipped with an external NTC temperature sensor for the acquisition from additional measurement points. The type of NTC is the same as used for the internal air temperature sensor.

External temperature sensor and external rain gauge can **not** be connected at the same time.

4.13 External Rain Gauge

Models without integrated precipitation acquisition can be equipped with an external rain gauge.

External rain gauge and external temperature sensor can **not** be connected at the same time.

4.14 (WS100-UMB only:) Impulse Output for Rain Gauge Simulation

WS100-UMB provides a digital impulse output for simulation of a rain gauge. Depending on configuration settings the output is pulsed once for each 1.0mm, 0.5mm, 0.2mm, 0.1mm or **0.01mm** (default) of precipitation.

If the WS100-UMB is configured for impulse output, the serial interface is **not** available for communication in UMB or other serial protocols.

5 Generation of Measurements

5.1 Current Measurement (act)

In accordance with the specified sampling rate, the value of the last measurement is transmitted when the current measurement value is requested. Each measurement is stored in a circular buffer for the subsequent calculation of minimum, maximum and average values.

5.2 Minimum and Maximum Values (min and max)

When requesting the minimum and maximum values, the corresponding value is calculated - via the circular buffer at the interval (1 – 10 minutes) specified in the configuration - and transmitted.

Note: In the case of wind direction, the minimum / maximum value indicates the direction at which the minimum / maximum wind speed was measured.

5.3 Average Value (avg)

When requesting the average value, this is calculated - via the circular buffer at the interval (1 – 10 minutes) specified in the configuration - and transmitted. In this way moving averages can also be calculated.

For some values the standard deviation is calculated for the same interval. The calculation of standard deviation will only be activated after the related UMB channel has been requested for the first time.

5.4 Vectorial Average Value (vct)

In the specific case of wind measurement, measurements are calculated vectorially. To this end, the average values of the vectors are generated internally. This calculation is performed with the same configured interval time as that for the minimum, maximum and average values. Hence the value (wind speed) and angle (wind direction) of the vector are calculated.

Note: On delivery, the interval for the calculation of minimum, maximum and average values is set at 10 minutes. If necessary, this can be adjusted to the particular requirements (1 – 10 minutes) with the aid of the UMB-Config-Tool (see page 34).

Note: The evaluation of the standard deviation values is deactivated after power on of the device. The function will be activated with the first request to any of the standard deviation channels.

To get standard deviation values of the first integration period after power on a dummy request to any one of the standard deviation channels should be inserted.

6 Measurement Output

Measurements are transmitted in accordance with UMB binary protocol (Factory Settings).

You can find an example of a measurement request in different protocols and a complete summary of the list of channels in the Appendix.

6.1 Air and Dewpoint Temperature

Sampling rate 1 minute

Generation of average value 1 – 10 minutes

Units °C; °F

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
100	120	140	160	Air temperature	-50.0	60.0	°C
105	125	145	165	Air temperature	-58.0	140.0	°F
110	130	150	170	Dewpoint temperature	-50.0	60.0	°C
115	135	155	175	Dewpoint temperature	-58.0	140.0	°F
101				External Temperature Sensor	-40.0	80.0	°C
106				External Temperature Sensor	-40.0	176.0	°F

6.2 Wind Chill Temperature

Sampling rate 1 minute, computed on base of the average temperature and average wind speed

Units °C; °F

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
111				Wind chill temperature	-60.0	70.0	°C
116				Wind chill temperature	-76.0	158.0	°F

6.3 Humidity

Sampling rate 1 minute

Generation of average value 1 – 10 minutes

Units %RH; g/m³; g/kg

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
200	220	240	260	Relative humidity	0.0	100.0	%
205	225	245	265	Absolute humidity	0.0	1000.0	g/m³
210	230	250	270	Mixing ratio	0.0	1000.0	g/kg

6.4 Air Pressure

Sampling rate 1 minute

Generation of average value 1 – 10 minutes

Unit hPa

Request channels:

UMB Channel					Measuring Range		
act	min	max	avg	Measurement Variable (float32)	min	max	unit
300	320	340	360	Absolute air pressure	300	1200	hPa
305	325	345	365	Relative air pressure	300	1200	hPa

Note: For the correct calculation of relative air pressure, the altitude of the sensor must be entered in the device configuration (see Figure 11 on page 37). The factory setting for altitude is 0m; in this way both measurement variables deliver the same values.

6.5 Wet Bulb Temperature

Sampling rate 1 minute

Units °C; °F

Request channels:

UMB Channel					Measuring Range		
act				Measurement Variable (float32)	min	max	unit
114				Wet Bulb Temperature	-50.0	60.0	°C
119				Wet Bulb Temperature	-58.0	140.0	°F

6.6 Specific Enthalpy

Sampling rate 1 minute

Unit kJ/kg

Request channels:

UMB Channel					Measuring Range		
act				Measurement Variable (float32)	min	max	unit
215				Specific Enthalpy	-100.0	1000.0	kJ/kg

6.7 Air Density

Sampling rate 1 minute

Unit kg/m³

Request channels:

UMB Channel					Measuring Range		
act				Measurement Variable (float32)	min	max	unit
310				Air Density	0.0	3.0	kg/m³

6.8 Wind Speed

Sampling rate 1 sec / 10 sec (internal sampling frequency 15Hz)

Generation of average value 1 – 10 minutes

Generation of max/min value 1 – 10 minutes based on the internal 1 sec measurements

Units m/s; km/h; mph; kts

Response threshold 0.3 m/s

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	vct	Measurement Variable (float32)	min	max	unit
400	420	440	460	480	Wind Speed	0	75.0	m/s
405	425	445	465	485	Wind Speed	0	270.0	km/h
410	430	450	470	490	Wind Speed	0	167.8	mph
415	435	455	475	495	Wind Speed	0	145.8	kts
401					Wind Speed Fast	0	75.0	m/s
406					Wind Speed Fast	0	270.0	km/h
411					Wind Speed Fast	0	167.8	mph
416					Wind Speed Fast	0	145.8	kts
403					Wind Speed Standard Deviation *	0	75.0	m/s
413					Wind Speed Standard Deviation *	0	167.8	mph

Note: The second measurements are averaged over 10 seconds for the output of the current (act) measurement. The 'fast' channels deliver every second a value.

6.9 Wind Direction

Sampling rate 1 sec / 10 sec (internal sampling frequency 15Hz)

Generation of average value 1 – 10 minutes

Generation of max/min value 1 – 10 minutes based on the internal 1 sec measurements

Unit °

Response threshold 0.3 m/s

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	vct	Measurement Variable (float32)	min	max	unit
500	520	540		580	Wind Direction	0	359.9	°
501					Wind Direction Fast	0	359.9	°
502					Wind Direction Corrected	0	359.9	°
503					Wind Dir. Standard Deviation *	0	359.0	°

Note: The second measurements are averaged over 10 seconds for the output of the current (act) measurement. The 'fast' channels deliver every second a value.

The minimum / maximum wind direction indicates the direction at which the minimum / maximum wind speed was measured.

The corrected wind direction is calculated from the wind direction measured by the wind sensor and the heading measured by the compass.

Optionally the compass correction of the wind direction can be activated for all wind direction values. (Settings by UMB Config Tool)

Note: The correction function is designed for correction of the wind direction of a statically mounted sensor. If the alignment of the sensor changes during the measurement (i.e. if the sensor is mounted on a rotating platform or similar) the correction function will not in all cases work properly, especially not for the vector average.

It is of course possible to use the correction function for mobile measurement units, where the alignment is changed between measurement periods.

***) Note:** The evaluation of the standard deviation values will be activated after the first request of a standard deviation channel. Please see p. 13.

6.10 Wind Measurement Quality

Sampling rate 10 seconds

Unit %

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	vct	Measurement Variable (float32)	min	max	unit
805					Wind Value Quality	0	100	%
806					Wind Value Quality (fast)	0	100	%

Note: The value is updated every 10 seconds and transmits the minimum wind measurement quality for the last 10 seconds interval.

The “fast” value indicates the measurement quality of the one second measurement value.

This value allows the user to assess how well the measurement system is functioning in the respective ambient conditions. In normal circumstances the value is 90 - 100%. Values up to 50% do not represent a general problem. If the value falls towards zero the measuring system is reaching its limits.

If during critical ambient conditions the system is no longer able to conduct reliable measurements, error value 55h (85d) is transmitted (device unable to execute valid measurement due to ambient conditions).

6.11 Compass

(only device version 030 or higher)

Sampling rate: 5 min

Unit °

Request channels:

UMB Channel						Measuring Range		
act	min	max	avg	vct	Measurement Variable (float)	min	max	unit
510					Compass Heading	0	359	°

Note: Reliable operation of the compass is only possible, if the sensor has been mounted according to the instructions in this manual, i.e. on top of the pole. Should the sensor be mounted on a traverse, the distribution of iron masses will be different from the situation during factory calibration. This may lead to additional deviation of the bearing. This also applies to lightning rods mounted at the pole top!

Dependent on the location of the installation the local declination of the earth magnetic field has to be considered. The declination value is entered using the UMB-Config-Tool (see page 37). The declination for the installation location can be found in the Internet, e.g. at

http://www-app3.gfz-potsdam.de/Declinationcalc/declinationcalc.html

http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp

Note: When the fan is not rotating the compass measurement value will be influenced by the magnetic field of the fan. Normally the compass measurement will be performed with the fan rotating to compensate this influence. If, starting from device version 037, the fan will not be switched on in case of low operating voltage (less than 12V) deviations of the compass measurement value must be accepted.

Note: When the device is operated in Power Saving Mode 1 or 2 the compass measurement is performed only once after power on. Later changes of the orientation of the device will not be recognized.

6.12 Precipitation Quantity - Absolute

Sampling rate Event-dependent on reaching the response threshold
Response threshold 0.01mm (Radar)
Response threshold 0.2 / 0.5 mm (Rain Gauge)
Units l/m²; mm; in; mil
Request channels:

UMB Channel	Measurement Variable (float32)	Unit
600	Precipitation Quantity - Absolute	l/m²
620	Precipitation Quantity - Absolute	mm
640	Precipitation Quantity - Absolute	in
660	Precipitation Quantity - Absolute	mil

Note: This measurement indicates the accumulated precipitation quantity since the last device reboot. The measurement is retained for the duration of a short power failure. To reset this value, use the corresponding function in the UMB-Config-Tool (see page 40) or disconnect the device from the power supply. The necessary disconnected time is device dependent from a few seconds up to 1 h.

6.13 Precipitation Quantity - Differential

Sampling rate Event-dependent on reaching the response threshold
Response threshold 0.01mm (Radar)
Response threshold 0.2 / 0.5 mm (Rain Gauge)
Units l/m²; mm; in; mil
Request channels:

UMB Chanel	Measurement Variable (float32)	Unit
605	Precipitation Quantity - Differential	l/m²
625	Precipitation Quantity - Differential	mm
645	Precipitation Quantity - Differential	in
665	Precipitation Quantity - Differential	mil

Note: Each request from a differential channel sets the accumulated quantity back to zero. If the response from the device is lost due to a transmission error (e.g. poor GPRS connection), the quantity accumulated to date is also lost. The quantity accumulated to date is also reset each time the equipment is rebooted.

6.14 Precipitation Intensity

Sampling rate 1 minute
Response threshold 0.01 mm/h
Units l/m²/h; mm/h; in/h; mil/h
Request channels:

UMB Channel	Measurement Variable (float32)	Range	Unit
800	Precipitation Intensity	0 … 200.00	l/m²/h
820	Precipitation Intensity	0 … 200.00	mm/h
825	Precipitation Intensity **(WS100 only)**	0 ... 3.3333	mm/min
840	Precipitation Intensity	0 … 7.8740	in/h
845	Precipitation Intensity **(WS100 only)**	0 ... 0.13123	in/min
860	Precipitation Intensity	0 … 7874.0	mil/h

Note: The lower resolution of the rain gauge would lead to high fluctuation of the intensity values, so the rain gauge versions (WS401-UMB and WS601-UMB), as well as the external rain gauge, use the accumulated precipitation of the last 60 minutes prior to the current measurement for intensity calculation.

6.15 Precipitation Type

Sampling rate Event-dependent on reaching the response threshold
Response threshold 0.002mm (Radar)
Response threshold 0.2 / 0.5 mm (Rain Gauge)
Follow-up time 2 minutes
Request channels:

UMB Channel	Measurement Variable (uint8)	Coding
700	Precipitation Type	0 = No precipitation 60 = Liquid precipitation, e.g. rain 70 = Solid precipitation, e.g. snow 40 = unspecified precipitation (WS401-UMB, WS601-UMB, external rain gauge) **WS100-UMB only:** 67 = freezing rain 69 = sleet 90 = hail

Note: A detected precipitation type remains valid for 2 minutes after the end of the precipitation event. In order to record precipitation types which only occur for a short period (e.g. short-term rain), the request interval should be 1 minute or shorter.

Ice, hail and sleet are transmitted as rain (60) by devices other than WS100-UMB.

The versions WS401-UMB and WS601-UMB as well as the external rain gauge do not include detection of precipitation type, so in this case only type 40 (unspecified precipitation) is indicated. Due to the function of the rain gauge only liquid or molten precipitation can be recognized.