



## Instruction Manual - Modbus®

WS50PV | Compact All-in-One Weather Sensor

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# 1 Introduction

This manual describes:

- Important device settings for correct operation and measurements (see below)
- Important notice for correct operation of the device (see below)
- Modbus® Communication settings (see chapter 2.1)
- Device settings (register map of holding register, chapter 2.2)
- Measured values (register map of input register, see chapter 2.3)
- Various causes of errors/ error messages of the software (see chapter 3)
- Technical specifications (see chapter 4)
- External sensors (see chapter 5)
- Firmware - Update (see chapter 6)

## Important settings that need to be checked and possibly adjusted for correct operation:

- Check serial port settings. They must be the same for both the host controller (Modbus® master simulator e.g., Modbus® Poll) and device (WS50PV). Default parameters for WS50PV: 19200 Baud, even parity, 1 stop bit.
- They can be adjusted via holding registers (register address 201- 203 in 2.2)
- If several WS50PV are operated on a Modbus® network, a unique device ID must be assigned to each device (register address 200)
- It is recommended to use RS-485 equipment that is able to handle different baud rates and parities automatically. This is especially required to support remote firmware updates.

## Important settings that need to be adjusted for correct measurements:

- The local altitude must be configured if the relative air pressure is to be measured (see register address 204).
- For correct wind measurements, WS50PV must be aligned to the North or the automatic compass correction must be activated (see register address 206).
- The local declination must be configured to obtain correct compass headings (see register address 205)
- If external sensor is used, it must be configured via holding Register (see register address 211)

## Web page

The latest versions of the following files can be found in the resources section on the WS50PV web page

<https://www.otthydromet.com/en/Ott/p-kippzonen-ws50pv-compact-all-in-one-weather-sensor/8373.PV#resource>

- WS50PV Instruction Manual – Modbus®
- Instruction Sheet
- Firmware
- Data Sheet
- Hexload Tool

**NOTE:** A heating voltage of 24V DC is recommended to guarantee full heating duty. When operating WS50PV with supply voltages lower than 12V DC, the fan will be automatically switched off. This may influence the accuracy of temperature and humidity measurement in case of solar radiation. Additionally, deviations of the compass measurement values have to be accepted.

**NOTE:** There are different tools available to communicate with the device via Modbus® interface (e.g., Modbus® Poll)

## 2 Communication in Modbus®-RTU

The WS50PV supports the serial transmission mode MODBUS-RTU. It is assumed the user has already basic knowledge of Modbus® RTU communications.

- The WS50PV settings could be read or changed by using Holding Registers (see chapter 2.2).
- Measurement values could be read by using Input Registers (see chapter 2.3).
- All measurement or setting values are mapped to 16-bit integers using suitable scaling factors.

In the interest of simple and safe integration, the use of register pairs for floating point values, which is not part of the Modbus® standard, has not been applied.

### 2.1 Modbus® Communication Parameters

Default communication parameters are in bold: 19200 Baud, even parity, 1 stop bit.

<b>Modbus® operating modes:</b>	Modbus®-RTU
<b>Baud rate:</b>	<b>19200</b> (2400, 4800, 9600,19200, 38400, 57600)
<b>Interface setting:</b>	<b>8E1</b> , 8N1, 8N2
<b>Device address range:</b>	<b>1 ... 245</b> (ascending order)
<b>Data interface</b>	<b>RS-485, 2 wire</b>

**NOTE:** The Modbus® communication has been tested for a poll rate of 1 sec.

#### 2.1.1 Addressing

Factory setting for device ID: 1. The valid range is from 1 ... 247.

Assign device IDs to additional Modbus® devices in ascending order (see register 200 in chapter 2.2).

#### 2.1.2 Supported Modbus® Functions

The functions of conformance class 0 and 1 have been implemented as far as they are applicable for the compact weather Sensor, i.e., all functions operating on register level.

Function Code	Conformance Class 0	Used for/ Explanation
0x03	Read Holding Registers	Reading configuration settings
0x16	Write Multiple Registers	Writing configuration settings
	<b>Conformance Class 1</b>	
0x04	Read Input Registers	Reading measurement values and status information
0x06	Write Single Register	Writing a single configuration setting
	<b>Diagnostics</b>	
0x11	Report Slave ID	Finding device Responds to broadcast with address 255

## 2.2 Holding Register

The Holding Registers are used to make a selected set of adjustable parameters available for Modbus® access.

Supported function codes are:

**function 0x03:** Read Holding Registers (to display configuration settings)

**function 0x06:** Write Single Register (to change single configuration setting, reset device, reset abs. rain)

**function 0x16:** Write Multiple Registers (to change configuration settings, reset device, reset abs. rain)

The holding parameters are mapped to 16-bit integers. Depending on the selected register the value must be scaled by the scaling factor.

**Example:** for temperature threshold for heating mode '**Model1**' (register address 209) the table shows a scaling factor of 10. If the temperature threshold is 4.8° a value of 48 shall be written into this register.

Reg. Addr.	Function R/W	Default	Values	Data Type	Scale	Restart required
200	R/W device ID	1	Value range: 1 ... 247 (ascending order)	U16	1	yes
201	R/W baud rate	6	2 = 57600 3 = 38400 6 = 19200 12 = 9600 24 = 4800 48 = 2400	U16	1	yes
202	R/W parity	1	0 = no 1 = even	U16	1	yes
203	R/W stop bits	1	1 = 1 Stop Bit 2 = 2 Stop Bit	U16	1	yes
204	R/W altitude	0	Local altitude in m, for calculation of relative air pressure (ref. to sea level) Value range: -99 ... 4999	S16	1	no
205	R/W compass deviation	0	Local deviation for the correction of compass heading. Dependent on the location of the installation the local declination of the earth magnetic field must be considered. Value range -359 ... 359	S16	1	no
206	R/W compass correction	0 (off)	0 = off/disabled 1 = on/enabled With activated compass correction all wind direction values will be corrected according to the alignment of the sensor, as evaluated by the compass. Reliable operation of the compass is only possible, if the sensor has been mounted according to the instruction sheet.	U16	1	no

Reg. Addr.	Function R/W	Default	Values	Data Type	Scale	Restart required
			<b>NOTE:</b> If compass correction is enabled, but the compass returns an error status, the wind direction will also return an error.			
207	R/W minimum wind speed	3 (is equal to 0.3 m/s)	Minimum wind speed in m/s from which a measurement is transmitted Value Range: 0 ... 100 (is equal to 0 ... 10 m/s) For example, the default setting 3 is equaling to 0.3 m/s. In this case the wind speed less than 0.3 m/s will be reported with 0 m/s by the device.	U16	10	yes
208	R/W Heating Mode	0 (auto)	0 = Auto (recommended) 1 = Mode1 2 = Off 3 = reserved <b>NOTE:</b> The power supply for the wind heater must be connected separately (see instruction sheet). A heating voltage of 24V DC is recommended to guarantee full heating duty. In 'Auto' operating mode, the sensor is maintained constantly at the control temperature (see register 210), generally in order to prevent the effects of snow and ice. In 'Mode 1' operating mode heating is only enabled when the outside temperature falls below the HeatingMode1 temperature in °C (see register 209). In this mode power consumption can be reduced in frost-free situations with no great restriction on winter operation. 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.	U16	1	no
209	R/W temperature threshold for heating mode 'Mode1'	50 (is equal to 5°C)	Environment temperature when the heater regulation should be active (only for Mode1 heating mode) If the heater Mode1 was selected (see Register 208) and Mode1 temperature is set to 50, the heater will be activated only below 5°C. Range: 0 ... 100 (is equal to 0 ... 10°C)	S16	10	no
210 210	R/W setpoint temperature for heating	500 (is equal to 50°C)	Target temperature in °C for the wind sensor heating Range: 50 ... 500 (is equal to 5 ... 50°C)	S16	10	no
211	R/W external sensor	0: none	0 = none 1 = temperature 2 = rain gauge <b>NOTE:</b> The external temperature sensor and the external rain gauge use the same input, so only one of them can be connected simultaneously.	U16	1	yes

Reg. Addr.	Function R/W	Default	Values	Data Type	Scale	Restart required
			If the data from the channels of the sensor type currently not selected are requested, the device will respond with 0.			
212	R/W rain gauge resolution	0: (is equal to 0.2mm)	Resolution setting for external rain gauge 0 = 0.2mm 1 = 0,5mm 2 = 0.1mm 3 = 1.0mm	U16	1	yes
213	R/W Reset abs. Rain	12871d (0x3247)	Function only when writing to the register, reading will give 0 always. When writing the value 0x3247 (12871d) to this register the stored absolute rain amount will be set to 0. Subsequently a device reset will be initiated.	U16	1	-
214	R/W Device reset	12871d (0x3247)	Function only when writing to the register, reading will give 0 always. When writing the value 0x3247 (12871d) to this register a device reset will be initiated.	U16	1	-

**NOTES:**

- **Some settings changes require a restart of WS50PV (see column 'Restart required' in the table above).**
- **Whenever a device reset is initiated (register addresses 213 or 214) the device will not respond for about 10 seconds. This is the time period the full reset will be performed.**

## 2.3 Input Registers

The input registers are containing the measurement values of WS50PV and the related status information.

Supported function code:

**function 0x04:** Read Input Register

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 (register address 70-88).

The assignment of values to the available register addresses 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:

- Basic Device Identification (see chapter 2.3.2)
- Frequently used current measurement values – Imperial (see chapter 2.3.3)
- Frequently used statistical measurement values – Imperial (see chapter 2.3.4)
- Device and sensor status (see chapter 2.3.5)
- Frequently used current measurement values – Metric (see chapter 2.3.6)
- Frequently used statistical measurement values – Metric (see chapter 2.3.7)
- Service channels (see chapter 2.3.8)
- Detailed Device information (see chapter 2.3.9)
- Not frequently used measurement values – Imperial (see chapter 2.3.10)
- Not frequently used unit system independent values (see chapter 2.3.11)
- Not frequently used measurement values – Metric (see chapter 2.3.12)

### 2.3.1 Measurement parameters

<b>CV</b>	Current value, value of the last measurement in accordance with the specified sampling rate.
<b>MIN/MAX</b>	Corresponding value is calculated via the circular buffer at 5-minute interval  In the case of wind direction, the MIN/MAX value indicates the direction at which the minimum / maximum wind speed was measured.
<b>AVG</b>	Moving average is calculated via the circular buffer at 5-minute interval.
<b>VCT</b>	Vectorially calculated measurements at 5-minute interval.

**NOTE:** Time interval for statistical values is not adjustable and is fixed to 5 min.

### 2.3.2 Basic Device Identification

Register Address	Description	Update Intvl.	Data Type	Scaling
0	Device Type ID, 933	--	u16	1
1	Version of data model (register definition), range 400 to 499, first production version 400	--	u16	1
2	Operation mode, Always 1 = Normal	--	u16	1
3	Device Status	on event	u16	1
4	Reserved	--	--	--
5	Consecutive number in batch	--	u16	1
6	Production year and month	--	u16	1
7	Firmware version	--	u16	1

### 2.3.3 Frequently used current measurement values – Imperial

Current value (CV): value of the last measurement in accordance with the specified sampling rate.

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
10	Device Status	CV	0	255	-	on event	u16	1
11	Air temperature	CV	-40	140	°F	1min	s16	10
12	Dew point temperature	CV	-40	140	°F	1min	s16	10
13	Relativ humidity	CV	0	100	%	1min	u16	10
14	Rel. air pressure	CV	500	1100	hPa	1min	u16	10
15	Abs. air pressure	CV	500	1100	hPa	1min	u16	10
16	Wind direction	CV	0	359	°	10s	u16	1
17	Wind speed	CV	0	111,9	mph	10s	u16	10
External sensors (requires additional accessories)								
23	External sensor temperature	-	-40	176	°F	1min	s16	10
24	Total precipitation high	-	0	4294967295	mil	on event	u16	1
25	Total precipitation low	-			mil	on event	u16	1
26	Precipitation Diff	-	0	65535	mil	on event	u16	1
27	Precipitation intensity mil/h	-	0	7874	mil/h	1min	u16	1
28	Precipitation type code	-	0	40	digits	on event	u16	1

### 2.3.4 Frequently used statistical measurement values – Imperial

Statistical value: minimum, maximum, or average values calculated over 5 minutes (time interval is not adjustable).

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
40	Device Status	CV	0	255	-	on event	u16	1
41	Air temperature	AVG	-40	140	°F	5min	s16	10
42	Dew point temperature	AVG	-40	140	°F	5min	s16	10
43	Relative humidity	AVG	0	100	%	5min	u16	10
44	Rel. air pressure	AVG	500	1100	hPa	5min	u16	10
45	Abs. air pressure	AVG	500	1100	hPa	5min	u16	10
46	Wind direction	AVG	0	359	°	5min	u16	1
47	Wind speed	AVG	0	111,9	mph	5min	u16	10
48	Wind speed	MIN	0	111,9	mph	5min	u16	10
49	Wind speed	MAX	0	111,9	mph	5min	u16	10
External sensors (requires additional accessories)								
53	External sensor temperature	CV	-40	176	°F	1min	s16	10
54	Total precipitation high	-	0	4294967295	mil	on event	u16	1
55	Total precipitation low	-			mil	on event	u16	1
56	Precipitation Diff	-	0	65535	mil	on event	u16	1
57	Precipitation intensity mil/h	CV	0	7874	mil/h	1min	u16	1
58	Precipitation type code	-	0	40	digits	on event	u16	1

### 2.3.5 Device and sensor status

Most of the sensors have two status values:

- status for the sensor itself and the current measurement value.
- status for the buffer, from which average, min. and max values are evaluated.

For status coding please see chapter 2.4

Register Address	Status	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
70	Status Device	CV	0	255	-	on event	u16	1
71	Status Temperature	CV	0	255	-	on event	u16	1
72	Status Temperature Buffer	CV	0	255	-	on event	u16	1
73	Status Humidity	CV	0	255	-	on event	u16	1
74	Status Humidity Buffer	CV	0	255	-	on event	u16	1
75	Status Wind Heater Temperature	CV	0	255	-	on event	u16	1

76	Status Dewpoint	CV	0	255	-	on event	u16	1
77	Status Dewpoint Buffer	CV	0	255	-	on event	u16	1
78	Status Abs. Humidity	CV	0	255	-	on event	u16	1
79	Status Abs. Humidity Buffer	CV	0	255	-	on event	u16	1
80	Status Pressure	CV	0	255	-	on event	u16	1
81	Status Pressure Buffer	CV	0	255	-	on event	u16	1
82	Status Wind	CV	0	255	-	on event	u16	1
83	Status Wind Buffer	CV	0	255	-	on event	u16	1
84	Status Wind Buffer Sec	CV	0	255	-	on event	u16	1
85	Reserved	-	0	255	-	on event	u16	1
86	Status Compass	CV	0	255	-	on event	u16	1
87	Status ext. Temperature	CV	0	255	-	on event	u16	1
88	Status ext. Precipitation	CV	0	255	-	on event	u16	1

### 2.3.6 Frequently used current measurement values – Metric

Current value (CV): value of the last measurement in accordance with the specified sampling rate.

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
110	Device Status	CV	0	255	-	on event	u16	1
111	Air temperature	CV	-40	60	°C	1min	s16	10
112	Dew point temperature	CV	-40	60	°C	1min	s16	10
113	Relativ humidity	CV	0	100	%	1min	u16	10
114	Rel. air pressure	CV	500	1100	hPa	1min	u16	10
115	Abs. air pressure	CV	500	1100	hPa	1min	u16	10
116	Wind direction	CV	0	359	°	10s	u16	1
117	Wind speed	CV	0	50	m/s	10s	u16	10
External sensors (requires additional accessories)								
123	External sensor temperature	CV	-40	80	°C	1min	s16	10
124	Total precipitation high	-	0	4294967295	mm	on event	u16	100
125	Total precipitation low	-			mm	on event	u16	100
126	Precipitation Diff	-	0	65535	mm	on event	u16	100
127	Precipitation intensity	CV	0	200	mm/h	1min	u16	100
128	Precipitation type code	-	0	40	digits	on event	u16	1

### 2.3.7 Frequently used statistical measurement values – Metric

Statistical value: minimum, maximum, or average values calculated over 5 minutes (time interval is not adjustable).

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
140	Device Status	CV	0	255	-	on event	u16	1
141	Air temperature	AVG	-40	60	°C	5min	s16	10
142	Dew point temperature	AVG	-40	60	°C	5min	s16	10
143	Relativ humidity	AVG	0	100	%	5min	u16	10
144	Rel. air pressure	AVG	500	1100	hPa	5min	u16	10
145	Abs. air pressure	AVG	500	1100	hPa	5min	u16	10
146	Wind direction	AVG	0	359	°	5min	u16	1
147	Wind speed	AVG	0	50	m/s	5min	u16	10
148	Wind speed	MIN	0	50	m/s	5min	u16	10
149	Wind speed	MAX	0	50	m/s	5min	u16	10
External sensors (requires additional accessories)								
153	External sensor temperature	CV	-40	80	°C	1min	s16	10
154	Total precipitation high	-	0	4294967295	mm	on event	u16	100
155	Total precipitation low	-			mm	on event	u16	100
156	Precipitation Diff	-	0	65535	mm	on event	u16	100
157	Precipitation intensity	CV	0	200	mm/h	1min	u16	100
158	Precipitation type code	-	0	40	digits	on event	u16	1

### 2.3.8 Service channels

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
180	Run time high	CV	0	4294967295	sec	1sec	u16	1
181	Run time low	CV			sec	1sec	u16	1
182	Supply voltage	CV	0	50	V	1min	u16	10
183	Reserved	-	-	-	-	-	-	-
184	SW Reset Counter	CV	0	65535	digits	on event	u16	1
185	Total operating hours high	CV	0	4294967295	h	1h	u16	1
186	Total operating hours low	CV			h	1h	u16	1

### 2.3.9 Detailed Device information

Register Address	Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
200	Device Type ID	-	933	933	-	-	u16	1
201	Consecutive number in batch	-	0	65535	-	-	u16	1
202	Production year and month	-	0	65535	-	-	u16	1
203	Project number	-	0	65535	-	-	u16	1
204	Hardware version	-	0	65535	-	-	u16	1
205	Firmware version	-	0	65535	-	-	u16	1
206	Config. structure version	-	0	65535	-	-	u16	1
207	Calibration structure version	-	0	65535	-	-	u16	1
208	Device version	-	0	65535	-	-	u16	1
209	Software release candidate version	-	0	65535	-	-	u16	1

**2.3.10 Not frequently used measurement values – Imperial**

Register Address	Current Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
1000	Air temperature	CV	-40	140	°F	1min	s16	10
1001	Air temperature	MIN	-40	140	°F	5min	s16	10
1002	Air temperature	MAX	-40	140	°F	5min	s16	10
1003	Air temperature	AVG	-40	140	°F	5min	s16	10
1004	Wind hetaer temperature	CV	-58	302	°F	1min	s16	10
1005	Dew point temperature	CV	-40	140	°F	1min	s16	10
1006	Dew point temperature	MIN	-40	140	°F	5min	s16	10
1007	Dew point temperature	MAX	-40	140	°F	5min	s16	10
1008	Dew point temperature	AVG	-40	140	°F	5min	s16	10
1009	Wind speed	CV	0	111,9	mph	10sec	u16	10
1010	Wind speed	MIN	0	111,9	mph	5min	u16	10
1011	Wind speed	MAX	0	111,9	mph	5min	u16	10
1012	Wind speed	AVG	0	111,9	mph	5min	u16	10
1013	Wind speed	VCT	0	111,9	mph	5min	u16	10
1014	Wind speed (fast interval)	CV	0	111,9	mph	1sec	u16	10
1016-1021	Reserved	-	-	-	-	-	-	-
External sensors (requires additional accessories)								
1022	External sensor temperature	-	-40	176	°F	1min	s16	10
1023	Total precipitation high	-	0	4294967295	mil	on event	u16	1
1024	Total precipitation low	-			mil	on event	u16	1
1025	Precipitation Diff	-	0	65535	mil	on event	u16	1
1026	Precipitation intensity mil/h	-	0	7874	mil/h	1min	u16	1
1027	Precipitation type code	-	0	40	digits	on event	u16	1

### 2.3.11 Not frequently used values with unit system independence

Register Address	Current Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
1050	Relativ humidity	CV	0	100	%	1min	u16	10
1051	Relativ humidity	MIN	0	100	%	5min	u16	10
1052	Relativ humidity	MAX	0	100	%	5min	u16	10
1053	Relativ humidity	AVG	0	100	%	5min	u16	10
1054	Absolute humidity	CV	0	1000	g/m <sup>3</sup>	1min	u16	10
1055	Absolute humidity	MIN	0	1000	g/m <sup>3</sup>	5min	u16	10
1056	Absolute humidity	MAX	0	1000	g/m <sup>3</sup>	5min	u16	10
1057	Absolute humidity	AVG	0	1000	g/m <sup>3</sup>	5min	u16	10
1058	Abs. air pressure	CV	500	1100	hPa	1min	u16	10
1059	Abs. air pressure	MIN	500	1100	hPa	5min	u16	10
1060	Abs. air pressure	MAX	500	1100	hPa	5min	u16	10
1061	Abs. air pressure	AVG	500	1100	hPa	5min	u16	10
1062	Rel. air pressure	CV	500	1100	hPa	1min	u16	10
1063	Rel. air pressure	MIN	500	1100	hPa	5min	u16	10
1064	Rel. air pressure	MAX	500	1100	hPa	5min	u16	10
1065	Rel. air pressure	AVG	500	1100	hPa	5min	u16	10
1066	Wind speed	CV	0	97,2	kts	10sec	u16	10
1067	Wind speed	MIN	0	97,2	kts	5min	u16	10
1068	Wind speed	MAX	0	97,2	kts	5min	u16	10
1069	Wind speed	AVG	0	97,2	kts	5min	u16	10
1070	Wind speed	VCT	0	97,2	kts	5min	u16	10
1071	Wind speed (fast interval)	CV	0	97,2	kts	1sec	u16	10
1072	Wind direction	CV	0	359	°	10sec	u16	1
1073	Wind direction	MIN	0	359	°	5min	u16	1
1074	Wind direction	MAX	0	359	°	5min	u16	1
1075	Wind direction	VCT	0	359	°	5min	u16	1
1076	Wind direction (fast interval)	CV	0	359	°	1sec	u16	1
1077	Wind direction corrected with compass	CV	0	359	°	10sec	u16	1
1078	Reserved	-	-	-	-	-	-	-
1079	Wind measurement quality	CV	0	100	%	10sec	u16	10
1080	Wind measurement quality (fast interval)	CV	0	100	%	1sec	u16	10
1081	Compass heading	CV	0	359.9	°	5min	u16	10

**NOTE:** Reliable operation of the compass is only possible if the sensor has been mounted according instruction sheet.

**NOTE:** 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 holding register address 205 (see chapter 2.2)

The declination for the installation location can be found on the Internet, e.g., at <http://www-app3.gfz-potsdam.de/Declinationcalc/declinationcalc.html>

**2.3.12 Not frequently used measurement values – Metric**

Register Address	Current Measurement Value	Meas. Type	Measuring Range			Update Intvl.	Data Type	Scaling
			min	max	unit			
1100	Air temperature	CV	-40	60	°C	1min	s16	10
1101	Air temperature	MIN	-40	60	°C	5min	s16	10
1102	Air temperature	MAX	-40	60	°C	5min	s16	10
1103	Air temperature	AVG	-40	60	°C	5min	s16	10
1104	Wind hetaer temperature	CV	-50	150	°C	1min	s16	10
1105	Dew point temperature	CV	-40	60	°C	1min	s16	10
1106	Dew point temperature	MIN	-40	60	°C	5min	s16	10
1107	Dew point temperature	MAX	-40	60	°C	5min	s16	10
1108	Dew point temperature	AVG	-40	60	°C	5min	s16	10
1109	Wind speed	CV	0	50	m/s	10sec	u16	10
1110	Wind speed	MIN	0	50	m/s	5min	u16	10
1111	Wind speed	MAX	0	50	m/s	5min	u16	10
1112	Wind speed	AVG	0	50	m/s	5min	u16	10
1113	Wind speed	VCT	0	50	m/s	5min	u16	10
1114	Wind speed (fast interval)	CV	0	50	m/s	1sec	u16	10
1115	Reserved	-	-	-	-	-	-	-
1116	Wind speed	CV	0	180	km/h	10sec	u16	10
1117	Wind speed	MIN	0	180	km/h	5min	u16	10
1118	Wind speed	MAX	0	180	km/h	5min	u16	10
1119	Wind speed	AVG	0	180	km/h	5min	u16	10
1120	Wind speed	VCT	0	180	km/h	5min	u16	10
1121	Wind speed (fast interval)	CV	0	180	km/h	1 sec	u16	10
External sensors (requires additional accessories)								
1122	External sensor temperature	CV	-40	80	°C	1min	s16	10
1123	Total precipitation high	-	0	4294967295	mm	on event	u16	100
1124	Total precipitation low	-			mm	on event	u16	100
1125	Precipitation Diff	-	0	65535	mm	on event	u16	100
1126	Precipitation intensity	CV	0	200	mm/h	1min	u16	100
1127	Precipitation type code	-	0	40	digits	on event	u16	1

## 2.4 Coding of Sensor Status

<Status>	Sensor State
00h (0d)	OK
24h (36d)	Invalid channel
28h (40d)	Busy, initialization running
2Ah (42d)	Hardware error
2Bh (43d)	Measurement error
2Ch (44d)	Error on device initialization
30h (48d)	Configuration error, default configuration was loaded
31h (49d)	Calibration error
32h (50d)	CRC error on loading configuration; default configuration was loaded
33h (51d)	CRC error on loading calibration; measurement not possible
50h (80d)	Value overflow
51h (81d)	Value underflow
52h (82d)	Channel overrange
53h (83d)	Chanel underrange
54h (84d)	Data error in measurement data or no valid data available
55h (85d)	Device / sensor is unable to execute valid measurement due to ambient conditions
0x60 (96d)	CRC-Error in Flash
0x61 (97d)	Error while writing to flash
0x62 (98d)	Flash contains invalid float values
0xFF (255d)	Unknown error

## 2.5 General exceptions

Exception	Exception Code	Possible reasons
Illegal function	1	Function code is not supported (please see chapter 2.1.2)
Illegal data address	2	Requesting/Writing less than 1 or more than 120 registers Requesting/Writing data out of defined range of registers If 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)

### 3 Fault description

<b>Error description</b>	<b>Cause - Remedy</b>
Device does not allow polling / does not respond	Check power supply Check interface connection Incorrect device ID → check ID; devices are delivered with ID 1.
The device measures precipitation but it is not raining	Check that the sensor was installed correctly in accordance with the instructions.
The measured temperature appears too high / measured humidity appears too low	Check the operation of the fan on the underside of the device.
Wind direction values are incorrect	Device is not correctly aligned → check that the device is aligned to the North.
The quality of the wind measurement is not always 100% (Input Register, register address 1079)	In normal operation the device should always transmit 90 ... 100%. Values up to 50% do not represent a general problem. If the device permanently transmits values below 50% this may mean that there is a fault.
Device transmits an error value not listed here (Device Status Register)	Check if the error is listed in chapter 2.3.8 If the error is not listed, then contact the manufacturer's technical support department.
Input Register transmits an error (65530 for unsigned and 32762 for signed values)	Please check the status of the corresponding input status register (register address: 70-88). The coding of the sensor status can be found in chapter 2.4
Modbus® Exception	The reasons for general exceptions can be found in chapter 2.5.

## 4 Technical Specifications

Measured value	Range	Resolution	Accuracy	Units	Measuring principle
Air temperature	-40 ... 60°C	0.1°C (-20°C ... +50°C) Otherwise 0.2°C	± 0.5°C	°C °F	NTC
Relative humidity	0 ... 100%	0.1%	± 3%	%	Capacitive
Barometric pressure	500-1100 hPa	0.1 hPa	± 0.5 hPa (0...40°C)	hPa	MEMS capacitive
Wind speed	0 ... 50m/s	0.1 m/s	± 0.3 m/s or ± 3% (0 ... 35m/s), otherwise ± 5% RMS	m/s, mph, knots	Ultrasonic
Wind direction	0 ... 359°	1°	< 5° RMSE (wind > 1.0 m/s)	°	Ultrasonic
External sensors (requires additional accessories)					
External Temperature Sensor WT1/WST1	-40 ... 80°C	0.25°C	± 1°C (WST1: ± 0.3°C between -10°C ... +10°C)	°C °F	NTC
External Rain Gauge WTB100		0.2mm / 0.5mm (adjustable by reduction ring)	2%		Rain Gauge with bounce-free reed contact (normally closed)

## 5 External Sensor

Additional external sensor can cover the requirements of special measurement requirements or extend the functionality of Compact All-in-One Weather Sensor.

Currently the accessory list includes:

- External Rain Gauge WTB100                      8353.10
- External Temperature Sensor WT1              8160.WT1

**NOTE:** External temperature sensor and external rain gauge cannot be connected at the same time.

The connection uses the standard connector plug of the WS50PV. Usually, the interconnection between the external sensor and the WS50PV is setup within the control cabinet. As this cable is part of the measuring line, care shall be taken when designing the cabling to avoid parasitic coupling, etc. The cable should be as short as possible. In special cases, e.g., when the external sensor is mounted near to the WS50PV while the control cabinet is distant, the installation of an additional distribution box should be considered.

The external sensor is connected to pins 5 and 6 of the connector plug, i.e., the grey and pink wires of the standard cable.

All sensors are unipolar, so the connection sequence is not relevant.

The WS50PV must be configured for the selected type of external sensor (temperature or precipitation) to enable the correct evaluation of the measurement data. The selection of the sensor type is done via Holding Register (please see chapter 2.2)

If no external sensor is connected, the according measurement values will report the value 0 and the according status code register value is set to 36 (0x24 – invalid channel).

### 5.1 External Temperature Sensor

WS50PV can be used with an external temperature sensor:

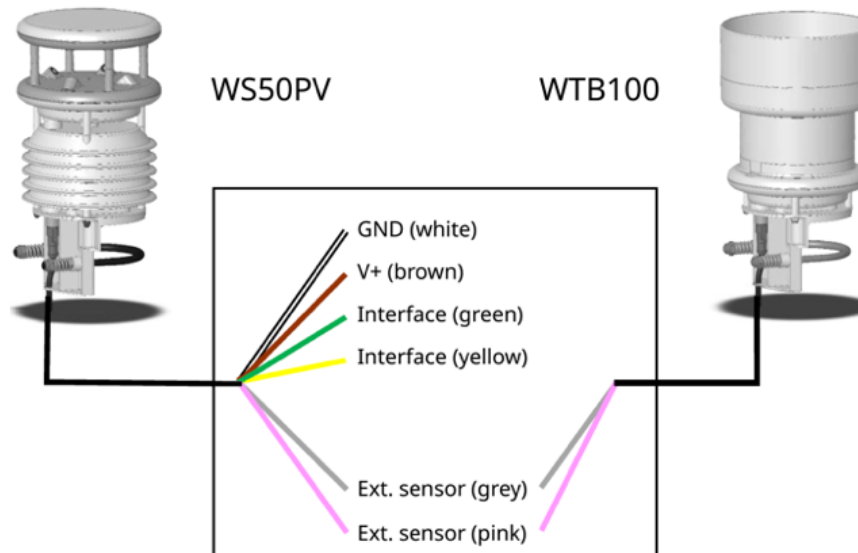
The Lufft WT1 is a backpanel temperature sensor for PV modules that can be connected directly to the WS50PV.

### 5.2 External Rain Gauge

The resolution of the rain gauge WTB100 can be modified by the reduction ring delivered with the sensor from 0.2mm to 0.5mm.

In principle, all rain sensors with bounce-free reed contact (normally open or normally closed) and with a resolution of 0.1 mm, 0.2 mm, 0.5 mm or 1.0 mm can be used.

**NOTE:** To get the correct amount of rain this 'mechanical' selection must be also be set in WS50PV configuration (please see register address 212 in chapter 2.2)



## 6 Firmware Update with HexLoad

### 6.1 Preparations / Requirements

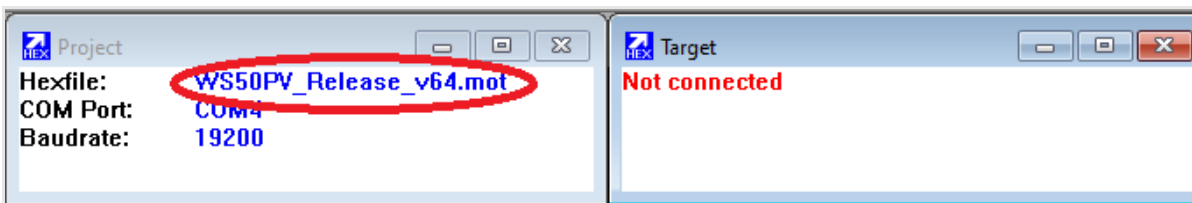
- Please make sure, that only one WS50PV is available on the RS-485-Bus
- No RS-485 master may be active during the firmware update of WS50PV
- The RS-485 infrastructure should be able to handle baud rate and parity settings automatically. 19200 baud and 8N1 must be supported.

If one of the above requirements isn't met by the available installation, the WS50PV must be connected separately with the PC the firmware update is executed on.

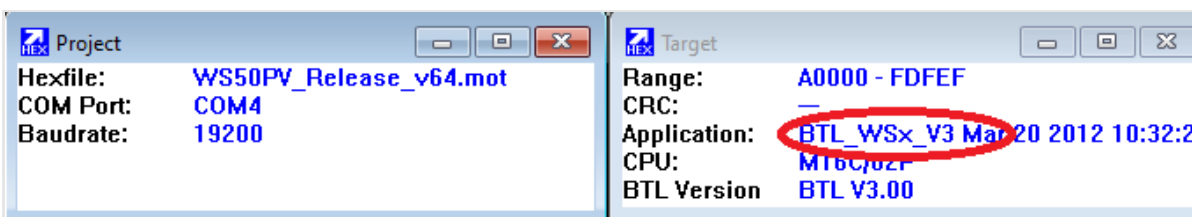
### 6.2 Perform firmware update

1. **Disconnect the power supply of the sensor**
2. Connect the PC with installed HexLoad application to the RS-485 interface of the sensor (green and yellow wires). The connection can be established through an USB/RS-485 converter, or through a PC RS232 interface and a RS232/RS-485 converter.
3. Start HexLoad
4. Load the latest firmware version (.mot file) with 'File' → 'Open'.

The following text must now be displayed by HexLoad in the 'Project' window next to 'Hexfile': 'WS50PV\_Release\_vxx.mot', where 'xx' specifies the version number.



5. Connect the power supply of the sensor
6. The 'Target' Window of HEXLOAD should change from red 'not connected' to blue and showing target information
7. The following text must now be displayed in HexLoad in the 'Target' window next to 'Application': BTL\_WSx\_V3 (please see screenshot below)



8. Start the programming with F9.
9. If programming is successful, the message 'Job succeed' is displayed; then exit HexLoad.
10. The device is now ready for operation with the new firmware.

**NOTE:** Please do not disconnect the sensor power supply or the supply of your RS-485 transceiver while the update is being performed.



# Insights for Experts



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