Manual R2S-UMB

Precipitation Sensor

Status V8 (04/2009)

CE UMB

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Table of Contents

Version history:

Version	Date	Compiled by	Comments
V1	6.7.2006	SH	First edition
V2	30.8.06	BEL	Screenshots for configuration and during communication
V3	16.01.2007	BEL	Integration of channels inch and mil
V4	21.08.2007	SH	Change in EC Certificate
V5	21.04.2008	BEL	Error depiction of data-type S.18 Channel 1053/1071 eliminated/Chapter 6 Comm. binary protocol only
V6	01.10.2008	BEL	Connection to ISOCON-UMB
V7	19.01.2009	SH	Addition note chapter 3 Installation
V8	24.04.2009	SH/BEL	Original chapters 9 und 10 taken out

1 Please read before use

Before using the equipment, please read the operating manual carefully and follow the instructions in every detail.

1.1 Symbols used

Important indication concerning possible hazards to the user

Important indication for the correct functioning of the equipment

1.2 Safety instructions

- Installation and commissioning must only be carried out by suitably qualified specialist personnel.
- Never take measurements on or touch live electrical parts.
- Pay attention to the technical data and storage and operating conditions.

1.3 Designated use

- The equipment must only be operated within the range of the specified technical data.
- The equipment must only be used under the conditions and for the purposes for which it was designed.
- The safety and operation of the equipment can no longer be guaranteed if it is modified or adapted.

1.4 Guarantee

The guarantee period is 24 months from the date of delivery. The guarantee is forfeited if the designated use is violated.

1.5 Incorrect use

If the equipment is installed incorrectly

- It may not function
- It may be permanently damaged
- Danger of injury may exist if the equipment falls

If the equipment is not connected correctly

- It may not function
- It may be permanently damaged
- The possibility of an electrical shock may exist

2 Equipment Description

The **R**adar **R**ain **S**ensor (**R2S**) is a precipitation sensor which can be used to determine both the type of precipitation and its quantity and intensity.

The R2S operates with a 24GHz Doppler radar, which records raindrop fall speed. The precipitation quantity is then calculated by means of the correlation of raindrop size and speed.

The measurements are made available via the RS485 interface or 2 digital outputs.

The equipment is connected by means of an 8-pole screw-in connector with the associated connection cable.

Windows PC software is available for configuration and measurement polling during commissioning.

The R2S has the following outstanding features:

- Maintenance-free precipitation sensor
- Differentiation between rain / snow / hail / freezing rain / sleet
- Calculation of quantity (choice of 1mm, 0.1mm or 0.01mm resolution)
- Calculation of intensity
- Interface: RS485 (half-duplex) and 2 digital outputs
- Configurable as a replacement for tipping bucket systems

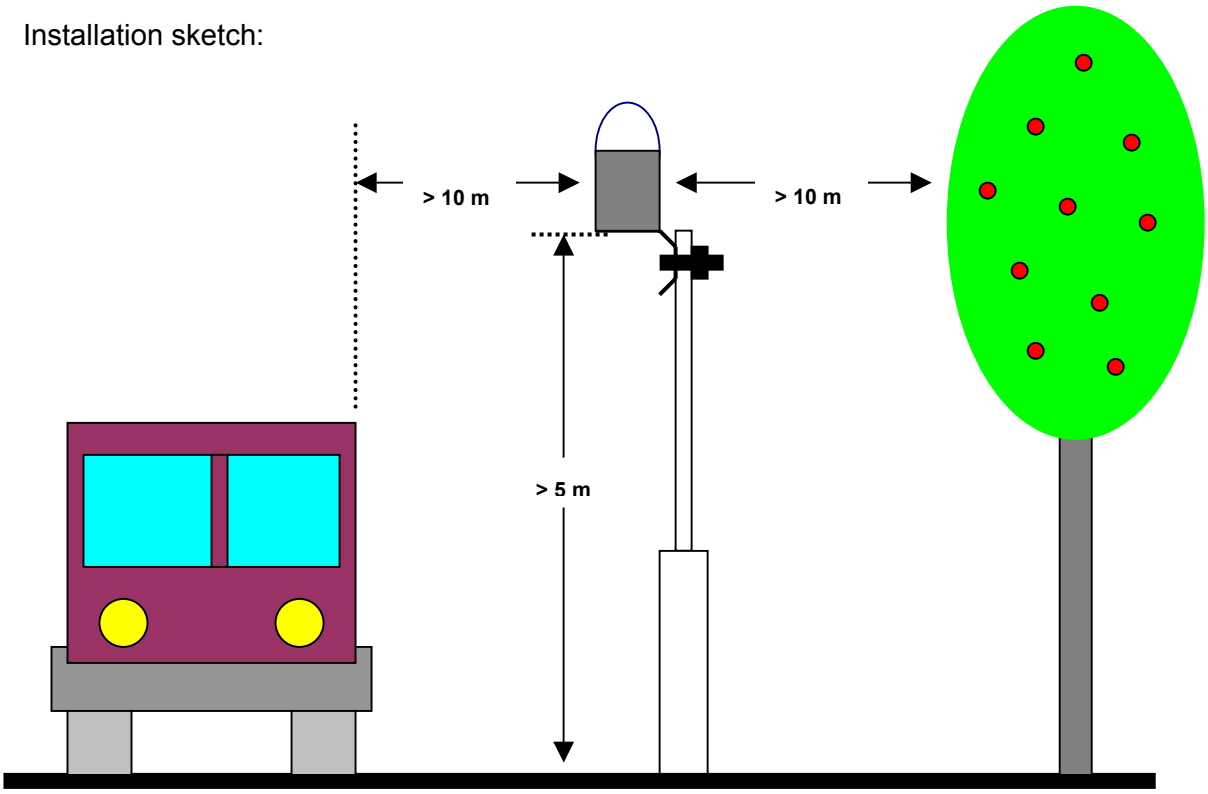
3 Installation

The device is installed on a mast (diameter 40mm ... 80mm) using the mast fitting provided.

Follow the instructions below to guarantee correct long-term operation:

- Installation height above the ground 5 metres
- Distance to road carriageway at least 10m
- Distance to trees or bushes at the height of the sensor at least 10m
- If it is not possible to maintain the required distances, the sensor can be provided with a shield (Order No.: 8367.SCHIRM). The shield must be installed on the side from which the interference is emanating (road or tree/bush).
- When selecting the installation location please take care to position the device at a suitable distance from other systems incorporating a 24GHz radar sensor, such as traffic counting devices on overhead gantry signs. Otherwise cross effects and system malfunctions may occur. In the final analysis, the distance to other measuring systems also depends on their range of coverage and signal strength.

Installation sketch:



WARNING:

- Only approved and tested appliances (conductors, risers etc.) should be used to install the device on the mast.
- All relevant regulations for working at this height must be observed.
- The mast must be sized and anchored appropriately.
- The mast must be earthed in accordance with regulations.
- The corresponding safety regulations for working at road side and in the vicinity of the road carriageway must be observed.

If the equipment is installed incorrectly

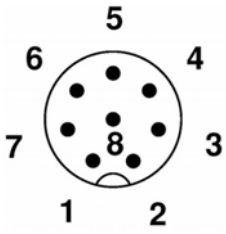
- It may not function
- It may be permanently damaged
- Danger of injury may exist if the equipment falls

4 Connections

There is an 8-pole screw-in connector on the underside of the device. This serves to connect the power supply and the interfaces using the associated connection cable.

Connection assignment:

1	white	negative power supply
2	brown	positive power supply
3	green	RS485_A
4	yellow	RS485_B
5	grey	not assigned
6	pink	Uout1
7	blue	GND reference potential for the digital outputs
8	red	Uout2



The cable marking is in accordance with DIN 47100.

The screening of the connection cable must not be laid to earth in the control cabinet!

If the device is not connected correctly

- It may not function
- It may be permanently damaged
- The possibility of an electrical shock may exist

4.1 Power supply

The power supply to the R2S is 24VDC. The power supply unit used must be approved for operation with equipment of protection class III (SELV).

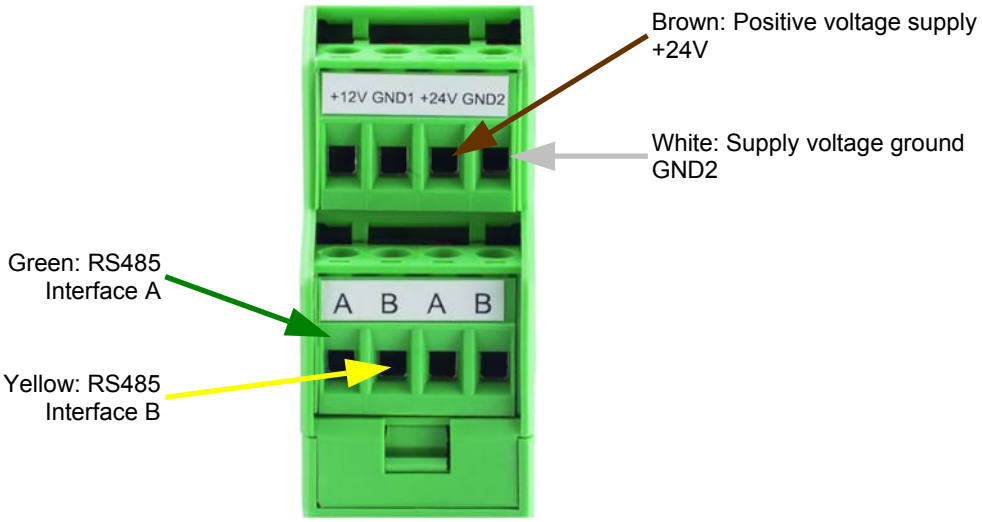
4.2 RS485 interface

The device has a DC-isolated half-duplex 2 wire RS485 interface with the following settings:

Data bits:	8
Stop bit:	1
Parity:	none
Settable baud rates:	1200, 2400, 4800, 9600, 14400, 19200*, 28800, 57600

- = factory setting and baud rate for firmware update

4.3 Connection to ISOCON-UMB (8160.UISO)



During installation please also refer to the operating manual for the ISOCON-UMB.

4.4 Digital outputs

The Uout1 and Uout2 digital outputs are short-circuit proof high side switches (12V) with integrated pull-down resistors. The reference potential is the same as for the RS485 interface.

The function of the outputs can be configured via software.

Possible configurations for Uout1 are:

- Tipping bucket simulation with 1mm resolution
- Tipping bucket simulation with 0.1mm resolution
- Tipping bucket simulation with 0.01mm resolution (factory setting)

The length of the output pulse for tipping bucket simulation is typically 50ms.

The type of precipitation is transmitted on output Uout2 in the form of different frequencies. The precipitation types are coded as follows:

Precipitation Type	Frequency/Hz
Dry	0
Rain	10
Snow	20
Sleet	30
Freezing Rain	40
Hail	50

If the accumulated precipitation quantity is greater than 0.01mm, the frequency signal is transmitted for 2 minutes. The output of the frequency signal is maintained if a precipitation quantity ≥ 0.01mm is measured within these 2 minutes.

In the case of data acquisition by datalogger, averaging should not be set during the recording of frequency. Averaging falsifies the actual precipitation type.

5 Configuration

Lufft provides PC software for configuration purposes. The user can set the device up in accordance with his requirements with the aid of this software.

5.1 Factory setting

The R2S is supplied with the following settings:

Device ID:	1
Baud rate:	19200
RS485 protocol:	binary
Uout1:	Precipitation quantity: 0.01mm
Uout2:	Precipitation type

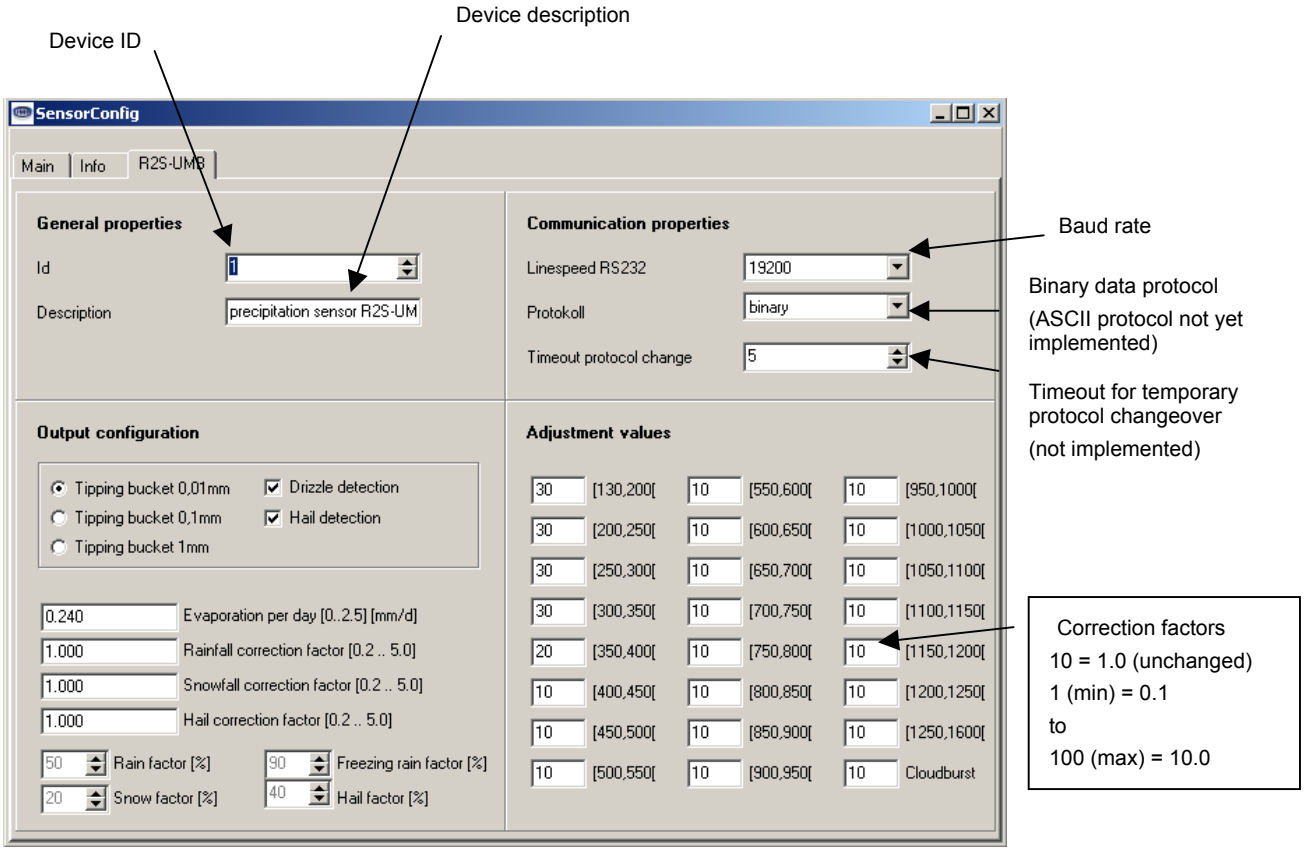
The ID must be changed if several R2S devices are operated in a UMB network as each device requires a unique ID. We suggest using ID's from 1 upwards.

5.2 Configuration using PC software

The principle mode of operation of the PC software is described in detail in the Online Help. For this reason only the menus and functions specific to the R2S are described here.

5.2.1 R2S configuration

All relevant settings and values can be adjusted after loading an R2S configuration.



Output configuration:

Tipping bucket simulation:

Resolutions of 0.01mm (condition as delivered), 0.1mm and 1mm can be set.

Drizzle detection:

Drizzle detection is activated when the box is checked (already activated in the delivered condition). When activated, measurement takes place with greater sensitivity in order to identify water droplets with a diameter of 0.3mm.

The only disadvantage is that the high sensitivity may cause a slightly higher water quantity to be measured.

Hail detection:

Hail detection is activated when the box is checked (already activated in the delivered condition). If hail detection is activated, the side shield (8367.SCHIRM) must be installed in all cases; otherwise, due to the fact that the measurement signal reacts to movement, movements (e.g. trucks) of up to 72 km/h are recorded and interpreted as precipitation.

Since the fall speed is identical, very large water droplets may be interpreted as small hailstones.

Evaporation per day:

In order to simulate the natural evaporation of a tipping bucket, a defined value is deducted from the rainfall quantity every minute. This is set at 0.24mm per day in the delivered condition.

Rainfall correction factor:
The water quantity of each measured droplet is assessed with this factor.
(Presetting 1.0 = unchanged)

Snowfall correction factor:
The water quantity of each measured snowflake is assessed with this factor.
(Presetting 1.0 = unchanged)

Hail correction factor:
The water quantity of each measured hailstone is assessed with this factor.
(Presetting 1.0 = unchanged)

The three particle types (rain, snow and hail) are added together and the precipitation type (**NA**) is assessed every minute.
In doing so, requests 1-4 are carried out in the following sequence. These requests only take place if previous conditions are unfulfilled.
The factors quoted below cannot be changed; however, for better understanding, the requests for the calculation of the precipitation type are performed as follows:

1) Number of hail particles per minute > 40% (**Hail factor)**
   (The hail factor of 40% cannot be changed)

   Precipitation type ⇒ Hail

2) Number of rain particles > 90% (**Freezing Rain factor**) and Tamb (ambient temp.) <= 0°C
   (The freezing rain factor of 90% cannot be changed)

   Precipitation type ⇒ Freezing rain

3) Number of rain particles >20 % (**Sleet factor**) and ambient temperature in the range from –5°C to 4°C:
   (The sleet factor of 20% cannot be changed)

   Precipitation type ⇒ Sleet

4) Number of rain particles > 50% (**Rain factor**) :
(The rain factor of 50% cannot be changed)

Precipitation type ⇒ Rain

If none of the 4 conditions is met but particles were measured, the precipitation type is snow.

Adjustment values:

The range of the rain sensor measurement spectrum is from 130Hz (drizzle) to 1600 Hz (heavy rain).

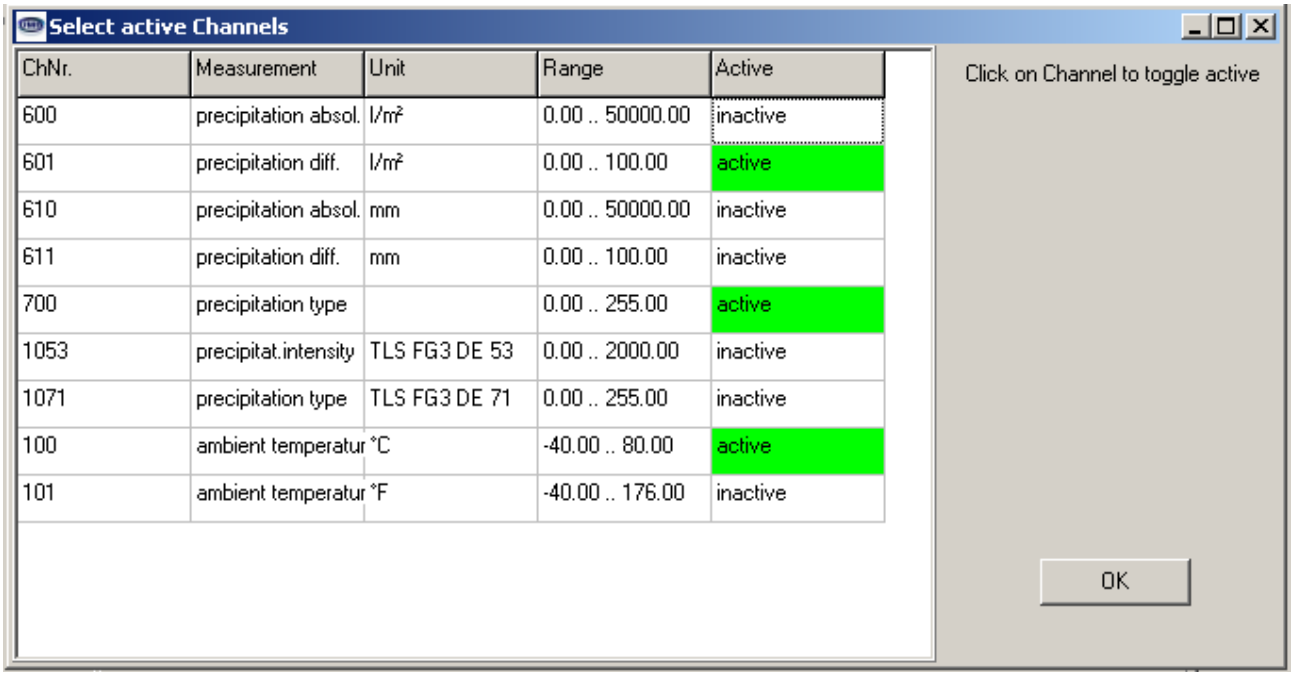
This range is divided into 23 zones, which can be individually corrected with factors from 0.1 to 10.

If a change is desired, the presetting (i.e. condition as delivered by Lufft) should be saved beforehand.

A separate factor is used in the case of cloudburst conditions.

5.2.2 Measurement request channels

The required channel for the measurement request can be activated by clicking on the respective channel.



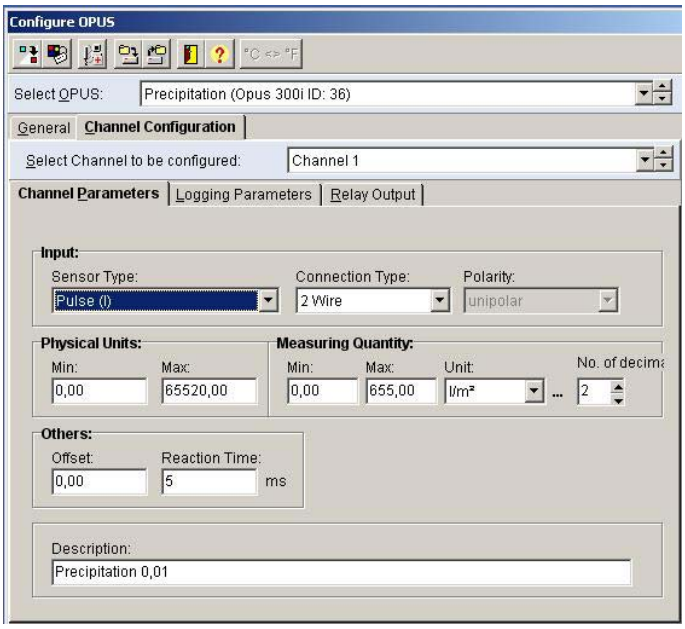
In order to record infrequent events relating to the type of precipitation (e.g. hail), the measurement request for this channel should take place at least every minute.

5.3 Configuring OPUS200/300 in conjunction with the R2S

If a resolution of 0.01mm is not required, the digital output Uout1 must be configured before the R2S can be put into operation with the OPUS200/300. Please use the UMB configuration software for this purpose.

The following configuration is necessary for setting the OPUS channels:

Example of the R2S factory setting R2S (Uout1: 0.01mm):



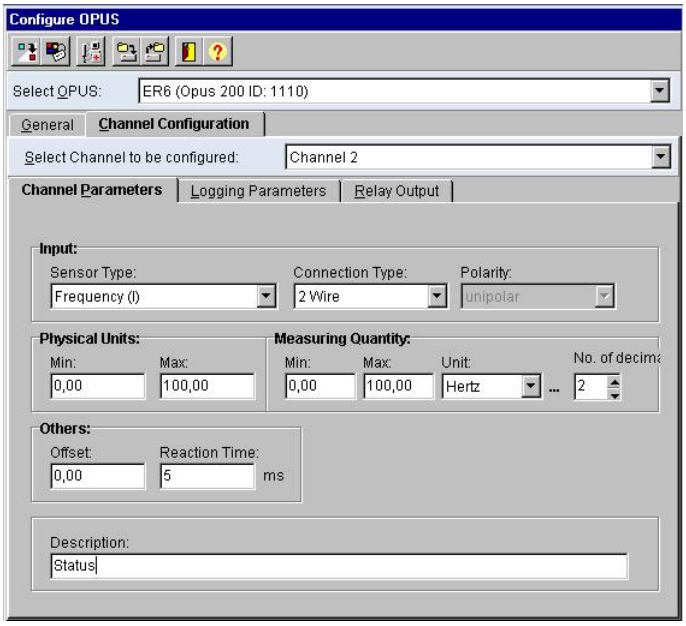
Measuring Quantity
Set Max. Value
Resolution 0.01mm : 655*
Resolution 0.1mm : 6552
Resolution 1.0mm : 65520

Set Min. Value:
0 for all sensors

Set Logging Parameters:
Saving of “Sum”

*** Factory setting**

Screenshot: Configuration of Channel A (1) in SmartControl



The following electrical connections must be made between R2S and OPUS:

R2S	OPUS200
Pin6/pink	Pin7/Channel A
Pin7/blue	GND-OPUS
Pin8/red	Pin7/Channel B

Screenshot: Configuration of Channel B (2) in SmartControl

In order to record short-term events (e.g. hail), the sampling and storage rates should be set to 1min.

5.4 Firmware update

The description of the firmware update can be found in **Firmwareupdate.pdf**.

6 Communication

Depending on the configuration of the device, the precipitation quantity or precipitation type can be requested in binary-protocol.

6.1 Binary protocol

This operating manual only describes an example of an online data request. Please refer to the current version of the document "**UMB Protocol**" for the exact mode of operation.

6.1.1 Framing

The data frame is constructed as follows:

1	2	3 - 4	5 - 6	7	8	9	10	11 ... (8 + len) optional	9 + len	10 + len 11 + len	12 + len
SOH	<ver>	<to>	<from>	<len>	STX	<cmd>	<verc>	<payload>	ETX	<cs>	EOT

SOH Control character for the start of a frame (01h) 1 byte
<ver> Header version number, e.g.: V 1.0 → <ver> = 10h = 16d; 1 byte
<to> Receiver address, 2 bytes
<from> Transmitter address, 2 bytes
<len> Number of data bytes between STX and ETX; 1 byte
STX Control character for the start of the payload data transmission (02h); 1 byte
<cmd> Command; 1 byte
<verc> Version number of the command; 1 byte
<payload> Data bytes; 0 – 210 bytes
ETX Control character for the end of the payload data transmission (03h); 1 byte
<cs> Check sum, 16 bit CRC; 2 bytes
EOT Control character for the end of the frame (04h); 1 byte

Control characters: SOH (01h), STX (02h), ETX (03h), EOT (04h).

6.1.2 Addressing with class and device ID

Addressing takes place by means of a 16 bit address. This is divided into a sensor class ID and a device ID.

Address (2 bytes = 16 bits)			
Bits 15 – 12 (upper 4 bits)		**Bits 11 – 0 (lower 12 bits)**	
Class ID (0 to 15)		**Device ID** (0 – 4095)	
0	Broadcast	0	Broadcast
2	R2S	1 - 4095	Available
15	Master or control devices		

ID = 0 is provided as broadcast for classes and devices respectively. Thus it is possible to transmit a broadcast on a specific class. However this is only feasible if there is only one device of this class on the bus.

6.1.3 Examples for the formation of addresses

If for example an R2S with the device ID (serial number) 0001 is to be addressed, this takes place as follows:

The class ID for R2S is 2d = 2h
Device ID (serial number) is for example 001d = 001h

Putting the class and device ID's together gives the following address: 2001h (8193d).

6.1.4 Example of a binary protocol request

If, for example, a PC is to request an R2S with the device ID (serial number) 0001 to provide the precipitation in litres/m² since the last request, this takes place as follows:

Sensor:

Class ID for **R2S** is 2 = 2h
Device ID (serial number) is 0001 = 0001h

Putting the class and device ID's together gives the destination address 2001h.

PC:

Class ID for **PC (master equipment)** is 15 = Fh
PC ID is e.g. 22 = 016h

Putting the class and device PC ID's together gives the transmitter address F016h

The length <len> for the online data request command 4d = 04h,

the command for the online data request is 23h,

the version number of the command is 1.0 = 10h.

The channel number is in the <payload>; as can be seen from the channel list, the precipitation in litres/m² since the last request is in channel 601d = 259h

The calculated CRC is 065Fh

The request to the device:

SOH	<ver>	<to>		<from>		<len>	STX	<cmd>	<verc>	<channel>		ETX	<cs>		EOT
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
01h	10h	01h	20h	16h	F0h	04h	02h	23h	10h	59h	02h	03h	5Fh	06h	04h

The response from the device:

SOH	<ver>	<to>		<from>		<len>	STX	<cmd>	<verc>	<status>	<channel>		<typ>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
01h	10h	16h	F0h	01h	20h	0Ah	02h	23h	10h	00h	59h	02h	16h

<value>				ETX	<cs>		EOT
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1Fh	85h	ABh	3Fh	03h	5Fh	97h	04h

<status> = Device o.k.

<typ> = Data type of the following value; 16h = float (4 bytes, IEEE format)

<value> = 3FAB851Fh as float value corresponds to 1.34

The precipitation in litres/m² since the last request from the PC is 1.34 litres/m².

The correctness of the data transmission can be checked with the aid of the checksum (975Fh).

ATTENTION: Little endian (Intel, lowbyte first) applies to the transmission of word and float variables, e.g. addresses or checksum. This means first the LowByte and then the HighByte.

6.1.5 CRC calculation

The CRC is calculated in accordance with the following rules:

Norm: CRC-CCITT

Polynomial: 1021h = $x^{16} + x^{12} + x^5 + 1$ (LSB first mode)

Start value: FFFFh

(Attention! In contrast to earlier Lufft protocols, the start value for the CRC calculations in this case is not 0h but FFFFh in accordance with CCITT)

Further information can be found in the description of a CRC calculation in the UMB Protocol from version V1.5.

6.2 Channel assignment for data requests

The channel assignment described here applies to online data requests in binary protocol.

Channel	Data Type	Measurement Variable	Measurement Range
current			
100	float	Ambient temperature in °C	-40°C...+80°C
101	float	Ambient temperature in °F	-40°F…+176°F
Precipitation Type			
700	unsigned char	No unit	0 = No precipitation 60 = Rain 67 = Freezing rain 69 = Sleet 70 = Snow 90 = Hail
Precipitation Quantity			
600	double	Litres / m²	0....100 000 litres/m²
610	double	Water film level in mm	0....100 000 mm
620	double	Water film level in inch	0….3937 inch
630	double	Water film level in mil	0….3 937 008 mil
601	float	Litres/m² since last request	0...100 litres/m²
611	float	Water film level in mm since last request	0...100 mm
621	float	Water film level in mm since last request	0….3,937 inch
631	float	Water film level in mm since last request	0….3937 mil
TLS FG3			
1053	unsigned short	TLS code DE type 53 FG3 (NI)	0…200mm (200mm=2000d)
1071	unsigned char	TLS code DE-type 71 FG3 (NS)	0 = No precipitation 60 = Rain (incl. freezing rain and sleet) 70 = Snow (incl. hail)
1153	float	Precipitation intensity in inch/h derived from channel 1053 (TLS-Code DE Typ 53 FG3)	0….7,874 inch/h
1253	float	Precipitation intensity in mil/h derived from channel 1053 (TLS-Code DE Typ 53 FG3)	0….7 874 mil/h

In order to record precipitation types (channels 700 and 1071) which only occur for a short period (e.g. short-term hail), the request time should be <= 1min. The same also applies in the case of precipitation intensity (channel 1053).

The precipitation type is calculated from a precipitation quantity of 0.01mm. This precipitation type is retained for at least 2 minutes. The precipitation type is recalculated if the quantity of 0.01mm is reached again within these 2 minutes.

Gaps may appear in the precipitation type for quantities of less than 0.01mm in 2 minutes.

7 Technical Data

7.1 Precipitation quantity / type

Measurement process:	24GHz Doppler radar
Measurement value:	mm/m², mm/h
Measurement range:	0...200 mm/h
Repeatability:	> 90%

7.2 Storage conditions

Permissible storage temperature:	-40°C ... +70°C
Permissible relative humidity:	0 ... 100% RH

7.3 Operating conditions

Permissible operating temperature:	-40°C ... +60°C
Permissible relative humidity:	0 ... 100% RH

7.4 Electrical data

Power supply:	20 ... 30 VDC; typically 24 VDC
Power consumption:	< 100 mA (heating off)
Heating duty	30VA
Protection class:	III (SELV)

7.5 Interfaces

RS485 (2 wire, half-duplex) for configuration, measurement polling and software update
2 digital outputs

7.6 Mechanical data

Dimensions (d x L):	d=90mm, L=220mm
Weight:	approx. 4.5 kg
Protection class:	IP66

8 EC Certificate of Conformity

Product: **Precipitation Sensor**
Type: **R2S-UMB (Order No.: 8367.Uxx)**

We herewith certify that the above mentioned equipment complies in design and construction with the Directives of the European Union and specifically the EMC Directive in accordance with 89/336/EC and the Low Voltage Directive in accordance with 73/23/EC.

The above mentioned equipment conforms to the following specific Standards:

24 GHz-Radar
EN 300 440-1
EN 301 489-1
EN 301 489-3
EN 60950

Immunity (EN 61 000-6-2):

EN 61 000-4-2	ESD
EN 61 000-4-3	Radiated electromagnetic field
EN 61 000-4-4	Burst
EN 61 000-4-5	Surge
EN 61 000-4-6	Line-conducted interference
EN 61 000-4-29	DC power supply interference

Emission (EN 61 000-6-3):
IEC / CISPR 22 Klasse B

Fellbach, 31.08.2007 Axel Schmitz-Hübsch

9 Disposal

The device must be disposed of in accordance with European Directives 2002/96/EC and 2003/108/EC (waste electrical and electronic equipment). Waste equipment must not be disposed of as household waste! For environmentally sound recycling and the disposal of your waste equipment please contact a certified electronic waste disposal company.

10 Manufacturer

In matters of guarantee or repair please contact:

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