Weighing Precipitation Gauges

TRwS_10	**TRwS_10.200**
	TRwS_10.500
TRwS_30	**TRwS_30.200**
	TRwS_30.314
	TRwS_30.400

Self-Emptying Weighing Precipitation Gauges

TRwS_E	**TRwS_E.200**
	TRwS_E.314
	TRwS_E.400

USER GUIDE

v.01.02

Meets the requirements as per WMO CIMO guidelines No. 8

Table of Contents

1 USEFUL INFORMATION

WARNING
A full bucket can be very heavy, it can weigh more than 25 kg! Be careful while emptying the bucket! Accidentally dropping the bucket on the load cell can damage the sensor.

WARNING
The internal heater of an E-series precipitation gauge can be hot! Be careful and don't touch it when handling the instrument or turn off the heating to prevent an injury.

RoHS Compliance Statement
The instruments are in conformity with Directive 2015/863/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

IPC-A-610G Compliance
The electronic unit PCBs are manufactured in conformity with the IPC-A-610G standard.

Table 1 Factory settings

Factory settings						
Protocol	**SDI-12**		**MODBUS**		**MPS**	
Interface	**Settings**	**Address**	**Settings**	**Address**	**Settings**	**Address**
SDI-12	1200,7,E,1	0	N/A	N/A	N/A	N/A
RS-485	9600,8,E,1	0	9600,8,E,1	1	9600,8,N,1	0

2 PRODUCT DESCRIPTION

TRwS is a precipitation gauge for measuring liquid, solid and mixed precipitation based on weighing principle. The amount and the intensity of precipitation is determined by collecting precipitation in a bucket and continuous measuring of weight increments. Sophisticated algorithms are implemented to suppress impact of temperature fluctuations, vibrations caused by wind, evaporation and other external factors (e.g. unexpected objects fallen into the bucket).

Additionally, the **E-series** rain gauges boast a unique self-emptying bucket making possible measurement of precipitation which is not limited by the bucket capacity.

A *MPS AiO* mobile application (for both Android and iOS) is available to check the functionality and to view/change configuration parameters of the instrument via Bluetooth (Chapter 26).

2.1 Range of TRwS precipitation gauges

Four models of the TRwS precipitation gauge (with various orifice areas and bucket capacities) as well as three models of the E-series self-emptying TRwS precipitation gauge (with various orifice areas) are available (see tables below).

Table 3 Range of TRwS precipitation gauges

Model	TRwS_10.200	TRwS_30.200	TRwS_30.400	TRwS_10.500	TRwS_30.314
Orifice area [cm²]	200	200	400	500	314
Bucket capacity [l]	10	30	30	10	30
Approximate amount of precipitation for full bucket [mm]	500	1500	750	200	955

Table 4 Range of E-series TRwS precipitation gauges

Model	TRwS_E.200	TRwS_E.314	TRwS_E.400
Orifice area [cm²]	200	314	400
Bucket capacity [l]	self-emptying bucket, unlimited precipitation amount		
Approximate amount of precipitation for full bucket [mm]			

2.2 Measurements

Principal measurements provided by a TRwS are:

- Amount of precipitation registered since previous reading
- Total amount of precipitation (since power-on)
- Amount of precipitation registered during current or previous precipitation
- Precipitation intensity
- Temperature (internal or ambient, depending on configuration)
- Weight of the bucket content
- Status values (e.g. heater on/off, 80% of bucket capacity reached)

2.3 Interfaces

A TRwS is equipped with the SDI-12 version 1.4 interface, the RS-485 interface and a contact voltage-free pulse output for emulation of a tipping-bucket rain gauge. Over RS-485 various protocols can be used, e.g.

MODBUS RTU, MODBUS ASCII, SDI-12 and legacy MPS protocol. For comfortable maintenance work the Bluetooth LE and optionally USB interface is available.

Note: If the standard manufacturer-provided cable is used, the RS-485 interface and the pulse output can't be used simultaneously, because they share the same brown/grey wire pair (8). If the optional M12 connectors are used all interfaces are available (9).

2.4 Heating

Any TRwS model can be equipped with a heater; a classical TRwS with an orifice rim heater and an E-series TRwS with an internal heater to prevent snow and/or frost from accumulating on the rim, in the funnel as well as in the bucket (E-series only). The heater is powered from a separate power supply and is switched on automatically if the temperature falls below a preset threshold. The heating supply voltage can range from 10 to 30 V_{DC}. The heating power depends on the voltage, there is no power regulator.

2.5 Mounting

A TRwS can be mounted on a stainless steel pedestal (9) supplied by the manufacturer for either 1 meter or 1.5 meter orifice height or on a Ø 50...60 mm user-supplied pole using a pole-mounting adapter (11). The latter is the only option for an E-series TRwS.

2.6 Wind shield

An optional Tretyakov wind shield can be used with the TRwS precipitation gauge to reduce the effects of the wind on the precision of measurement. If a pedestal for 1.5 m installation is used it's highly recommended to anchor it with a set of guy wires to improve stability of the structure.

1. Rim
2. Enclosure
3. Bucket
4. Support triangle
5. Electronic unit housing
6. Base plate
7. Load cell
8. Upper (instrument) flange
9. Pedestal
10. Lower (base) flange
11. Mounting adapter
12. Internal heater connector
13. Funnel
14. Balance weight
15. Heater (optional)
16. Outlet
17. Spirit level
18. Main connector
19. Heater connector
20. Cable gland PG11

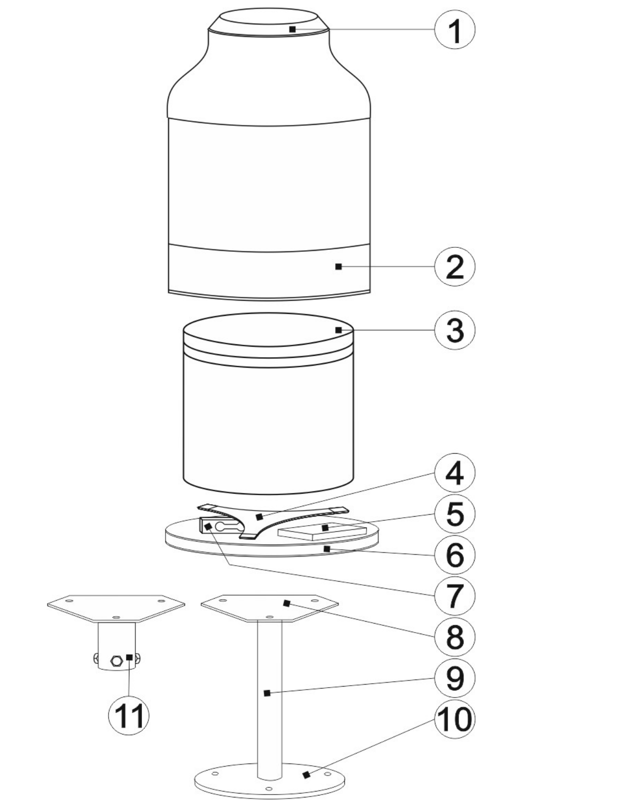


Figure 1: TRwS_10 and TRwS_30 precipitation gauge

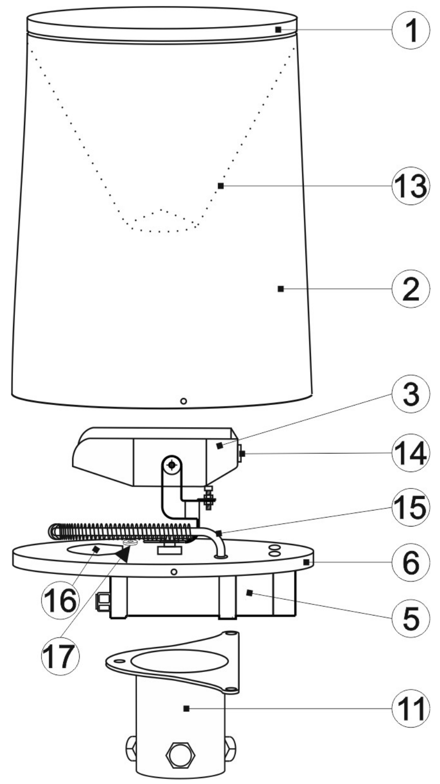


Figure 2: E-series TRwS self-emptying precipitation gauge

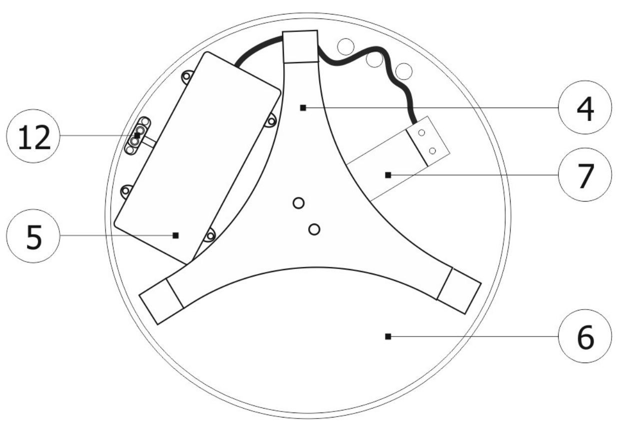


Figure 3: Top view of TRwS precipitation gauge

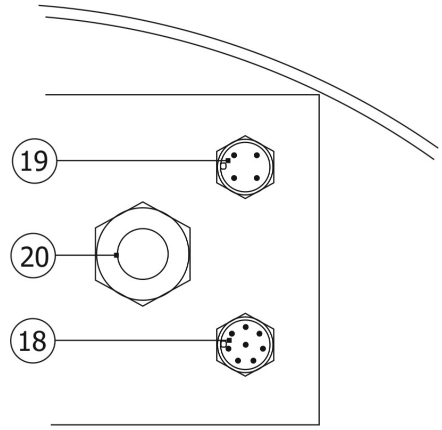


Figure 4: Connection on base plate

3 INSTALLATION

3.1 General requirements

The site for installing a precipitation gauge should be open but not too windy. The distance from the gauge to any surrounding object should be at least twice the height of the object above the gauge orifice. As for the height of the orifice please follow local regulations and/or requirements. The most commonly used height varies between 0.5 and 1.5 m above the surrounding terrain. In any case the orifice must be placed above the maximum expected depth of snow cover. Avoid installing the precipitation gauge on a slope or the roof of a building.

The precipitation gauge can be mounted either on the pedestal (9) or on an Ø 50...60 mm user-supplied pole using a pole-mounting adapter (11) .

3.2 Mounting the pedestal

1. Prepare a concrete base and attach three M8 bolts to it (e.g. use wall plugs and hanger bolts).

2. Screw three M8 nuts onto the bolts and place the lower flange (10) of the pedestal (9) on them (5). Note: the lower flange is round but the upper one (8) is hexagonal.

3. Make the upper (instrument) flange (8) of the pedestal horizontal using a spirit level in two directions perpendicular to each other. Fix the pedestal using another 3 nuts and washers. Do not tighten the nuts yet.

3.3 Preparing the precipitation gauge for mounting

Detach the enclosure (2) from the rain gauge base plate (6) loosing the screws at the bottom edge of the enclosure. Remove the bucket (3) from the base plate (not applicable to E-series precipitation gauges).

3.4 Mounting the precipitation gauge on the pedestal

Attach the base plate (6) to the pedestal using three M8 screws. Place a spirit level on two ends of the support triangle (4) and adjust the level with the lower flange nuts if necessary. Place the spirit level on another two ends of the support triangle and repeat the procedure. Now tighten the nuts thoroughly.

3.5 Mounting the precipitation gauge on a pole using the pole-mounting adapter

Put the mounting adapter (11) on the pole. Do not tighten the fixing screws yet. Attach the base plate (6) to the adapter using three M8 screws. Now level the base plate (6) using a spirit level and fixing screws of the adapter. Place the spirit level on two ends of the support triangle (4) or use the built-in spirit level (17) of the E-series precipitation gauge. Finally tighten the fixing screws of the mounting adapter.

3.6 Finishing installation

1. A classical precipitation gauge is fitted with two transport screws and a transport bracket to prevent damage of the load cell during transport (6). Loosen both screws so that there is a space of at least 1 millimetre between the tip of the screw and the body of the gauge (or the load cell, depending on TRwS model). Remove the transport bracket.

2. Put back the bucket (3) and the enclosure (2). Mind the right position of the enclosure: the male part of the internal heater connector has to be plugged into the female one located at the base plate of the rain gauge (applies to the classical precipitation gauges only). Fix the enclosure tightening the screws around the lower edge.

2. Use your finger to check if the rain gauge has been assembled correctly: the rim of the enclosure must not touch the bucket!

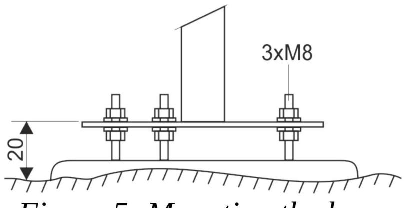


Figure 5: Mounting the lower flange of the pedestal onto a concrete base

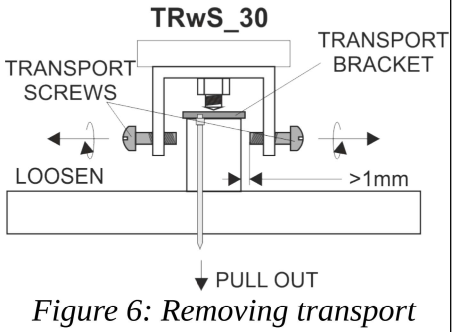


Figure 6: Removing transport elements

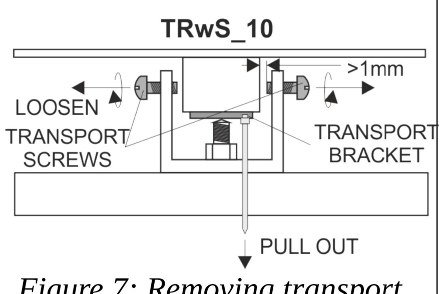


Figure 7: Removing transport elements

4 WIRING

4.1 External wiring

The TRwS precipitation gauge is equipped either with a cable which enters the electronic unit housing through a cable gland PG11 (20) or with a pair of M12 connectors: an 8-pin main connector and a 4-pin heater one (18 and 19).

Terminal	Description	8 wire cable connection	M12 8-pin	M12 4-pin
GND	Operating voltage, ground	BLUE	7 (BLUE)	-
PWR+	Operating voltage +5..+30V_{DC}	RED	8 (RED)	-
HT-IN	Heating voltage +5..+30$V_{AC/DC}$ (any polarity)	VIOLET	-	2+3 (WHITE+BLUE)
HT-IN		ORANGE	-	1+4 (BROWN+BLACK)
GND	SDI-12 ground	GREEN	3 (GREEN)	-
SDI-12	SDI-12 data	YELLOW	4 (YELLOW)	-
RS485-B	RS-485, negative	BROWN	2 (BROWN)	-
RS485-A	RS-485, positive	GREY	5 (GREY)	-
CONT-B	Contact (pulse) output	-	1 (WHITE)	-
CONT-A		-	6 (PINK)	-
SHIELD	Cable shield	SHIELD		

4.2 Internal wiring

The cable as well as M12 connectors are connected to a terminal block on the electronic unit PCB. The terminal block is accessible after removing the lid of the electronic unit housing. If the standard 8-wire cable is used then there are two possible wirings depending on whether the RS-485 interface or the pulse output can be used besides the SDI-12 interface. (figure 8).

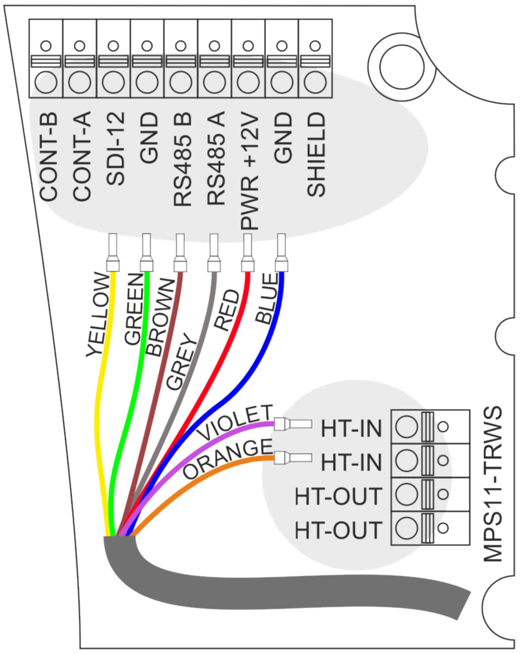


Figure 8:8 wire cable connection, SDI-12 + RS-485 (Contact not wired)

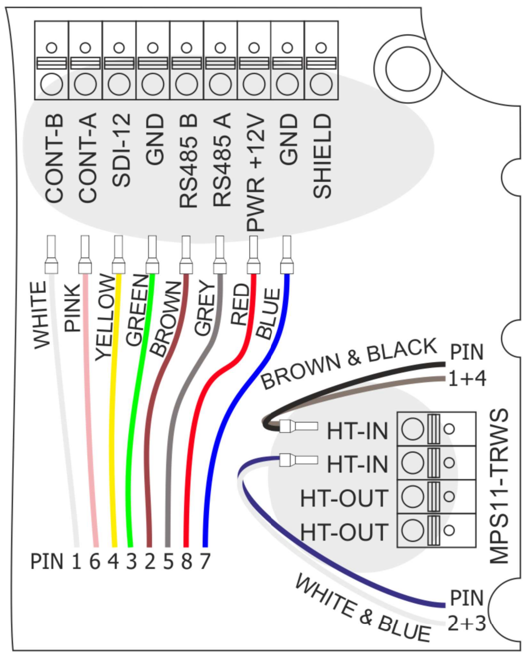


Figure 9: Wiring with M12 connectors

5 PRINCIPLE OF OPERATION

The measurement of precipitation amount is based on continuous measuring of weight of the bucket content. One **measurement cycle** takes **10 seconds**. At the end of each cycle all measured values are updated and prepared to be sent via a communication protocol used. Any value can be read in any period greater or equal 10 seconds. Because of the algorithm implemented it can take up to 120 seconds to register complete amount of precipitation fallen into the bucket, mainly depending on precipitation intensity and wind.

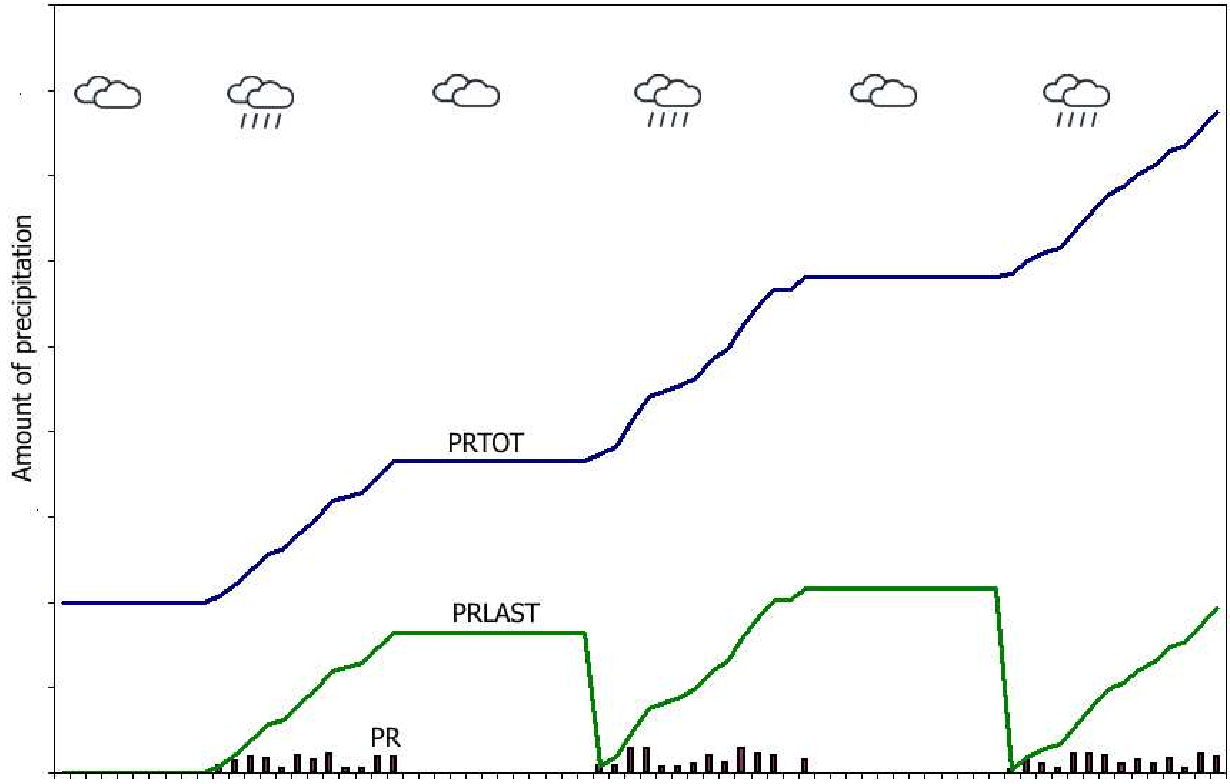
5.1 Measurement of precipitation amount

Three principal amounts of precipitation are calculated (10):

- <u>**PR** amount of precipitation registered since previous reading</u>
  At power-up he value of **PR** is set to zero. At the end of each 10-second measurement cycle the precipitation amount registered during that cycle is added to the **PR** value. After reading by *aM!/aD0!* command pair the value of **PR** is set to zero.

- <u>**PRTOT** total amount of precipitation</u>
  At power-up the value of **PRTOT** is set to zero. At the end of each 10-second measurement cycle the precipitation amount registered during that cycle is added to the **PRTOT** value. The value is never set to zero while the TRwS is running continuously.

- <u>**PRLAST** amount of precipitation registered during current or previous precipitation</u>
  At power-up the value of **PRLAST** is set to zero. At the end of each 10-second measurement cycle the precipitation amount registered during that cycle is added to the **PRLAST** value. The value is set to zero if after a period of ten or more minutes with no precipitation it begins to rain (or snow).
  In other words: while it is raining the **PRLAST** is equal to the precipitation fallen from the beginning of current rain. After it has stopped raining the **PRLAST** remains unchanged thus it's equal to the precipitation fallen during previous rain. At the beginning of the next rain **PRLAST** is set to zero.



5.2 Generating pulses on the contact output

At the end of each 10-second measurement cycle the TRwS begins generating a series of pulses. The count of the pulses corresponds to the precipitation amount registered during that cycle and depends on the value of **IMPRATIO** parameter (the amount of precipitation corresponding to one pulse). If there is not enough time to generate all pulses during one measurement cycle the remaining pulses will be accumulated and sent during following cycles. If **IMPRATIO** parameter is set to zero (default settings), pulse generating is disabled.

5.3 Measurement of rain intensity

A TRWS rain gauge provides two rain intensity values: **RIINST** and **RI**. The value of **RIINST** represents an estimate of the instantaneous rain intensity calculated from increase of the bucket content weight during one measurement cycle. The **RIINST** reacts quickly to the changes in real rain intensity. On the other hand the value of **RI** is an estimate of rain intensity calculated from one-minute data.

5.4 Measurement of bucket content

The value of **WAVG** represents a filtered weight of the bucket content including weight of the bucket itself.

5.5 Measurement of temperature

In the standard version a TRwS precipitation gauge the electronic thermometer is placed inside the electronic unit housing thus the **TA** represents the inside temperature. An external thermometer can be used instead of the internal one to measure the real ambient air temperature. The additional temperature values (**TAVG**, **TMIN**, **TMAX**) are one-minute running values.

5.6 Heating management

A TRwS can be equipped with a orifice rim heater (classical models) or an internal heater (E-series). The heating can operate in one of four modes depending on value of the **HEAT** parameter. Modes **0** (permanently off) and **1** (permanently on) are intended mainly for maintenance purposes, in modes **2** and **3** the heater is switched on or off automatically depending on the internal or ambient air temperature and the value of **THEAT** parameter.

Heating mode 2

The heater is switched on if the temperature falls below the value of **THEAT** parameter and switched off if the temperature rises above **THEAT** + 1°C. The factory preset value of **THEAT** is 4 °C.

Heating mode 3

This mode can be used to save the heating energy. It is the same as the mode 2 except for the heater is only switched on if precipitation is being detected.

Heating mode 4

The heater intensity is switched gradually,depending on temperature. There are four temperature ranges and intensities:

Temperature range	Default temperature range	Heater intensity
THEAT-4 .. THEAT	0 .. 4 °C	25%
THEAT-9 .. THEAT-4	-5 .. 0 °C	50%
THEAT-14 .. THEAT-9	-10 .. -5 °C	75%
< THEAT-14	< -10 °C	100%

5.7 Self-emptying (E-series rain gauges)

If the bucket of an E-series rain gauge is almost full, the bucket will tip and the water will flow out through the outlet in the base plate. The emptying occurs fully automatically thanks to the special shape of the bucket. The process is very quick (less than one second) and therefore it doesn't affect the measurement.

6 GETTING DATA

6.1 SDI-12 interface

Only the most important commands are described here. For more information on SDI-12 protocol please visit www.sdi-12.org. In all examples in this chapter ***a*** represents a sensor address and ***ccc*** the 3 character CRC code, appended if data was requested with the *aMC!*, *aRC!* etc. command.

6.1.1 General SDI-12 commands

Address query		
Command:	?!	
Response:	***a***<CR><LF>	
Explanation:	***a***	the sensor address
Example:	?!0<CR><LF>	

Change address		
Command:	***a***A***b***!	

Response:	***b***<CR><LF>	
Explanation:	***a***	the original address
	b	the new address
Example:	0A3!3<CR><LF>	

Send identification		
Command:	***a***I!	
Response:	***a*14MPSSYSTM11TRWS10200,SN=9007**<CR><LF>	
Explanation:	**MPSSYSTM**	company name
	11TRWS	sensor model
	10200	sensor version (1.02.00)
	SN=9007	serial number

6.1.2 SDI-12 measurement commands (metric units)

Basic data (amount of precipitation and weight)		
Start measurement		
Command:	***a***M! ***a***MC! ***a***C! ***a***CC!	
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>	
Send data		
Command:	***a***D0!	
Response:	***a***+***PR***±***WAVG***+***PRTOT***<CR><LF> ***a***+***PR***±***WAVG***+***PRTOTccc***<CR><LF>	
Explanation:	***PR***	amount of precipitation registered since previous reading [mm]
	WAVG	weight of the bucket content [g]
	PRTOT	total amount of precipitation [mm]
Example		
	0M!00003<CR><LF> 0D0!0+0.130+2893.481+116.443<CR><LF> 0MC!00003<CR><LF> 0D0!0+2.5+49.074+2.5Dsk<CR><LF> 1C!100003<CR><LF> 1D0!1+0+4365.316+222.598<CR><LF> 1CC!100003<CR><LF> 1D0!1+0+4365.21+222.598CqB<CR><LF>	

Precipitation intensity and last or current rain precipitation amount		
Start measurement		
Command:	***a***M1! ***a***MC1! ***a***C1! ***a***CC1!	
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>	
Send data		
Command:	***a***D0!	

Response:	***a***+***PRLAST***+***RIINST***+***RI***<CR><LF> ***a***+***PRLAST***+***RIINST***+***RIccc***<CR><LF>	
Explanation:	***PRLAST***	amount of precipitation registered during current or previous precipitation [mm]
	RIINST	instantaneous precipitation intensity [mm/h]
	RI	one-minute precipitation intensity [mm/h]
Example		
	0M1!00003<CR><LF> 0D0!0+3.794+2.5+1.3<CR><LF> 0MC1!00003<CR><LF> 0D0!0+2.5+0+0BrY<CR><LF> 1C1!100003<CR><LF> 1D0!1+0.992+0+0<CR><LF> 1CC1!100003<CR><LF> 1D0!1+0.992+0+0D_^<CR><LF>	

Temperature and service data		
Start measurement		
Command:	***a***M2! ***a***MC2! ***a***C2! ***a***CC2!	
Response:	***a***0006<CR><LF> ***a***00006<CR><LF>	
Send data		
Command:	***a***D0!	
Response:	***a***±***TA***±***TMIN***±***TAVG***±***TMAX***+***UPWR***+***STATUS***<CR><LF> ***a***±***TA***±***TMIN***±***TAVG***±***TMAX***+***UPWR***+***STATUSccc***<CR><LF>	
Explanation:	***TA***	temperature [°C]
	TMIN	one-minute temperature minimum value [°C]
	TAVG	one-minute temperature average value [°C]
	TMAX	one-minute temperature maximum value [°C]
	UPWR	internal power supply voltage [V]
	STATUS	various status data [-]
Example		
	0M2!00006<CR><LF> 0D0!0+10.80+10.80+10.80+10.81+3.327+1<CR><LF> 0MC2!00006<CR><LF> 0D0!0+21.85+21.84+21.85+21.85+3.306+1DmY<CR><LF> 1C2!100006<CR><LF> 1D0!1+6.85+6.84+6.85+6.85+3.300+1<CR><LF> 1CC2!100006<CR><LF> 1D0!1+6.88+6.87+6.87+6.88+3.300+1AGz<CR><LF>	

Corrected precipitation amount data	
Start measurement	
Command:	***a***M3! ***a***MC3! ***a***C3! ***a***CC3!
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>

Send data		
Command:	***a***D0!	
Response:	***a***+***PRcor***+***PRTOTcor***+***WS***<CR><LF> ***a***+***PRcor***+***PRTOTcor***+***WSccc***<CR><LF>	
Explanation:	***PRcor***	corrected amount of precipitation [mm]
	PRTOTcor	corrected total amount of precipitation [mm]
	WS	estimate of wind speed [dimensionless quantity]
Example		
	0M3!00003<CR><LF> 0D0!0+0.150+121.511+2.3<CR><LF> 0MC3!00003<CR><LF> 0D0!0+2.677+2.677+0.9KDC<CR><LF> 1C3!100003<CR><LF> 1D0!1+0+231.564+1.3<CR><LF> 1CC3!100003<CR><LF> 1D0!1+2.199+233.763+0.9IJG<CR><LF>	

Instantaneous precipitation amount		
Start measurement		
Command:	***a***M4! ***a***MC4! ***a***C4! ***a***CC4!	
Response:	***a***0001<CR><LF> ***a***00001<CR><LF>	
Send data		
Command:	***a***D0!	
Response:	***a***+***PRINST***<CR><LF> ***a***+***PRINSTccc***<CR><LF>	
Explanation:	***PRINST***	instantaneous precipitation [mm]
Example		
	0M4!00001<CR><LF> 0D0!0+0.251<CR><LF> 0MC4!00001<CR><LF> 0D0!0+2.5I`u<CR><LF> 1C4!100001<CR><LF> 1D0!1+0.001<CR><LF> 1CC4!100001<CR><LF> 1D0!1+0.001B~z<CR><LF>	

6.1.3 SDI-12 measurement commands (imperial units)

Basic data (amount of precipitation and weight), imperial units	
Start measurement	
Command:	***a***M5! ***a***MC5! ***a***C5! ***a***CC5!
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>

Send data		
Command:	***a***D0!	
Response:	***a***+***I_PR***±***I_WAVG***+***I_PRTOT***<CR><LF> ***a***+***I_PR***±***I_WAVG***+***I_PRTOTccc***<CR><LF>	
Explanation:	***I_PR***	amount of precipitation registered since previous reading [in]
	I_WAVG	weight of the bucket content [oz]
	I_PRTOT	total amount of precipitation [in]

Example

```
0M5!00003<CR><LF>
0D0!0+0.00512+102.06454+4.58437<CR><LF>
0MC5!00003<CR><LF>
0D0!0+0.09839+1.73082+0.19681AcI<CR><LF>
1C5!100003<CR><LF>
1D0!1+0.00000+153.9816+8.76370<CR><LF>
1CC5!100003<CR><LF>
1D0!1+0.00000+153.9784+8.76370@|R<CR><LF>
```

Precipitation intensity and last or current rain precipitation amount, imperial units

Start measurement		
Command:	***a***M6! ***a***MC6! ***a***C6! ***a***MCC6!	
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>	
Send data		
Command:	***a***D0!	
Response:	***a***+***I_PRLAST***+***I_RIINST***+***I_RI***<CR><LF> ***a***+***I_PRLAST***+***I_RIINST***+***I_RIccc***<CR><LF>	
Explanation:	***I_PRLAST***	amount of precipitation registered during current or previous precipitation [in]
	I_RIINST	instantaneous precipitation intensity [in/h]
	I_RI	one-minute precipitation intensity [in/h]

Example

```
0M6!00003<CR><LF>
0D0!0+0.14937+0.09843+0.05118<CR><LF>
0MC6!00003<CR><LF>
0D0!0+0.09839+0.000+0.000E}g<CR><LF>
1C6!100003<CR><LF>
1D0!1+0.03906+0.000+0.000<CR><LF>
1CC6!100003<CR><LF>
1D0!1+0.03906+0.000+0.000BTg<CR><LF>
```

Temperature and service data, imperial units

Start measurement	
Command:	***a***M7! ***a***MC7! ***a***C7! ***a***CC7!
Response:	***a***0006<CR><LF> ***a***00006<CR><LF>
Send data	
Command:	***a***D0!

Response:	***a***±***I_TA***±***I_TMIN***±***I_TAVG***±***I_TMAX***+***UPWR***+***STATUS***<CR><LF> ***a***±***I_TA***±***I_TMIN***±***I_TAVG***±***I_TMAX***+***UPWR***+***STATUSccc***<CR><LF>

Explanation:	***I_TA***	temperature [°F]
	I_TMIN	one-minute temperature minimum value [°F]
	I_TAVG	one-minute temperature average value [°F]
	I_TMAX	one-minute temperature maximum value [°F]
	UPWR	internal power supply voltage [V]
	STATUS	various status data [-]

Example	
	0M7!00006<CR><LF> 0D0!0+51.44+51.44+51.44+51.46+3.327+1<CR><LF> 0MC7!00006<CR><LF> 0D0!0+71.31+71.29+71.31+71.31+3.306+1BRQ<CR><LF> 1C7!100006<CR><LF> 1D0!1+44.35+44.33+44.35+44.35+3.300+1<CR><LF> 1CC7!100006<CR><LF> 1D0!1+44.40+44.38+44.40+44.40+3.301+1Iy{<CR><LF>

Corrected precipitation amount data, imperial units

Start measurement	
Command:	***a***M8! ***a***MC8! ***a***C8! ***a***CC8!
Response:	***a***0003<CR><LF> ***a***00003<CR><LF>

Send data	
Command:	***a***D0!
Response:	***a***+***I_PRcor***+***I_PRTOTcor***+***WS***<CR><LF> ***a***+***I_PRcor***+***I_PRTOTcor***+***WSccc***<CR><LF>

Explanation:	***I_PRcor***	corrected amount of precipitation [in]
	I_PRTOTcor	corrected total amount of precipitation [in]
	WS	estimate of wind speed [dimensionless quantity]

Example	
	0M8!00003<CR><LF> 0D0!0+0.00591+4.78390+2.3<CR><LF> 0MC8!00003<CR><LF> 0D0!0+0.09839+0.20378+0FYY<CR><LF> 1C8!100003<CR><LF> 1D0!1+0.00000+9.11669+1.3<CR><LF> 1CC8!100003<CR><LF> 1D0!1+0.00000+9.11669+1.4C^e<CR><LF>

Instantaneous precipitation amount, imperial units

Start measurement	
Command:	***a***M9! ***a***MC9! ***a***C9! ***a***CC9!
Response:	***a***0001<CR><LF> ***a***00001<CR><LF>

Send data		
Command:	***a***D0!	
Response:	***a***+***I_PRINST***<CR><LF> ***a***+***I_PRINSTccc***<CR><LF>	
Explanation:	***I_PRINST***	instantaneous precipitation amount [in]
Example		
	0M9!00001<CR><LF> 0D0!0+0.00988<CR><LF> 0MC9!00001<CR><LF> 0D0!0+0.09843F^z<CR><LF> 1C9!100001<CR><LF> 1D0!1+0.00008<CR><LF> 1CC9!100001<CR><LF> 1D0!1+0.00004Jmv<CR><LF>	

6.1.4 SDI-12 reading status commands

Reading status byte (bit-mapped)		
Command:	***a***R0! ***a***RC0!	
Response:	***a***+***STATUS***<CR><LF> ***a***+***STATUSccc***<CR><LF>	
Explanation:	***STATUS***	bit-mapped status register
Example:	0R0!0+1<CR><LF> 0RC0!0+1Bo_<CR><LF>	

Reading status bits		
Command:	***a***R1! ***a***RC1!	
Response:	***a***+***STATUS0***+***STATUS1***+***STATUS2***+***STATUS3***+***STATUS4***+***STATUS5***+***STATUS6***+***STATUS7***<CR><LF> ***a***+***STATUS0***+***STATUS1***+***STATUS2***+***STATUS3***+***STATUS4***+***STATUS5***+***STATUS6***+***STATUS7ccc***<CR><LF>	
Explanation:	***STATUS0***	1: activated
	STATUS1	1: 80% of bucket capacity reached
	STATUS2	1: unexpected restart detected
	STATUS3	(reserved)
	STATUS4	(reserved)
	STATUS5	(reserved)
	STATUS6	(reserved)
	STATUS7	(reserved)
Example:	0R1!0+1+0+0+0+0+0+0+0<CR><LF> 0RC1!0+1+0+0+0+0+0+0+0GuL<CR><LF>	

6.1.5 SDI-12 verification

Verification command can be used to quick verify accuracy of weight. After V-command immediately put a reference weight on the bottom of the bucket. Try to place it precisely in the centre. Wait 30 seconds. Then D0 command can be used to get measured weight.

Verification	
Start verification	
Command:	***a***V!

Response:	***a***0301<CR><LF>	
Send verification data		
Command:	***a***D0!	
Response:	***a***+***WDIF***<CR><LF>	
Explanation:	***WDIF***	weight difference registered during verification
Example		
	0V!00301<CR><LF> 0D0!0+19.985<CR><LF>	

For more information on the sensor verification procedure consult chapter 7

6.1.6 SDI-12 1.4 metadata commands

Identify measurement commands		
Command:	***a***IM! ***a***IM***i***! etc.	
Response:	***a***000***n***<CR><LF>	
Explanation:	***i***	the number of an additional measurement (1...9)
	n	the number of measurement values the sensor will make and return
Examples:	0IM!00003<CR><LF> 0IM2!00006<CR><LF> etc.	

Identify measurement parameter commands		
Command:	***a***IM_***ppp***! ***a***IM***i_ppp***! etc.	
Response:	***a***,***ID***,***UNIT***,***REGNO***,***TYPE***,***ATTR***,***DECIMAL***,***MIN***,***MAX***;<CR><LF>	
Explanation:	***i***	the number of an additional measurement (1...9)
	ppp	the order number of a measured parameter
	ID	concise identification of the parameter
	UNIT	unit of measurement
	REGNO	internal register number
	TYPE	internal data type (e.g. FLOAT, UINT8, UINT32, CHAR, BOOL etc.)
	ATTR	attribute (RO: read only, RW: read/write)
	DECIMAL	decimal places
	MIN	minimum possible value
	MAX	maximum possible value
Examples:	0IM_001!0,PR,mm,194,FLOAT,RO,3,0,9999, ;<CR><LF> 0IM_002!0,WAVG,g,193,FLOAT,RO,3,-60000,60000, ;<CR><LF> etc.	

6.2 RS-485 interface

Note: *To use the RS-485 interface the proper RS-485 wiring must be used (see Chapter 8, 5, 8) if the TRwS is equipped with the standard 8-wire cable. If the RS-485 interface is wired the pulse (contact) output is not available.*

Over RS-485 three main protocols are available: MODBUS (RTU, ASCII), SDI-12 and legacy MPS protocol (for compatibility with older TRwS sensors). Protocol is user-selectable by setting the **LINKPROT** parameter to desired value (see 7). To set the parameter use the mobile application.

6.2.1 MODBUS protocol

The default (factory preset) device address is **1**. Use function code **04** (read input registers) to read data from the sensor. For list of registers see the 6 below. Since all measurements are of type float, read two consecutive registers to get a value. *For more information on MODBUS protocol please visit www.modbus.org.*

Note: *1. To change the address use the MPS AiO mobile application (Chapter 9).*
2. Float values byte order depens on Modbus Format setting.

Table 6 MODBUS input registers

MODBUS input registers (function code 04)					
Measurement name	**Explanation**	**Register address**	**Register number**	**Register count**	**Data type**
PR	amount of precipitation registered since recent power-on or software restart of the instrument [mm]	388	389	2	float
WAVG	weight of the bucket content [g]	386	387	2	float
TAVG	one-minute temperature average value [°C]	400	401	2	float
PRLAST	amount of precipitation registered during current or previous precipitation [mm]	392	393	2	float
PRTOT	total amount of precipitation [mm]	390	391	2	float
I_PR	amount of precipitation registered since recent power-on or software restart of the instrument [in]	422	423	2	float
I_PRLAST	amount of precipitation registered during current or previous precipitation [in]	426	427	2	float
I_PRTOT	total amount of precipitation [in]	424	425	2	float
I_TAVG	one-minute temperature average value [°F]	434	435	2	float
I_WAVG	weight of the bucket content [oz]	420	421	2	float

Modbus example (in hexadecimal notation)		
Command:	010401900002701A	
Explanation:	**01**	modbus address (1)
	04	function code (04)
	0190	starting registers address (400=TAVG)
	0002	register count (2)
	701A	CRC
Response:	01040441CA8F5CAB8F	
Explanation:	**01**	modbus address (1)
	04	function code (04)
	04	byte count (4)
	41CA8F5C	response, decoded float is 25.32
	AB8F	CRC

6.2.2 SDI-12 protocol over RS-485

Commands and responses are the same as those on the SDI-12 interface. Initial BREAK is not required.

6.2.3 MPS protocol

Only *request basic set of data* command is implemented. Note, that unlike SDI-12 and MODBUS the MPS protocol provides integer values only and that's why precipitation amounts are in micrometres and the weight is in milligrams. The MPS protocol shares its address with the SDI-12 protocol.

Requesting basic data (amount of precipitation and weight)	
Command:	<ENQ>***a***<CR>

Response:	<SOH>***a***<STX>***PR***<TAB>***WAVG***<TAB>***PRTOT***<ETX><CR><LF>	
Explanation:	***PR***	amount of precipitation registered since previous reading [µm]
	WAVG	weight of the bucket content [mg]
	PRTOT	total amount of precipitation [µm]

6.3 All data summary

Configuration parameters, which are highlighted in the table below, can be changed by mobile application.

Table 7 All data summary

Internal register number	Register name	Description	Unit	Range	Resolution	Type
3	LINKPROT	Communication protocol	-	0: off 1:SDI-12 4: MODBUS RTU 5: MODBUS ASCII 6: MPS protocol	1	uint8
139	HEAT	Heating mode	-	0: permanently off 1: permanently on 2: on if T_a<THEAT 3: on if T_a<THEAT and is raining or snowing	1	uint8
140	THEAT	Temperature threshold for heating	°C	-70 ... 125	1	int8
4	BAUD	Baud rate (RS-485)	baud	300 ... 115200	N/A	uint32
5	DATABIT	Number of data bits (RS-485)	-	5 ... 9	1	uint8
6	PARITY	Parity (RS-485)	-	n,e,o	N/A	char
7	STOPBIT	Number of stop bits	-	1 ... 2	1	uint8
64	UPWR	Internal power supply voltage	V	0 ... 5	0.1	float
76	STATUS	Status data	-	0 ... 255	1	uint8
194	PR	Amount of precipitation	mm	0 ... 9999	0.001	float
193	WAVG	Weight of the bucket content	g	-3000 ... 33000	0.001	float
200	TAVG	One-minute temperature average	°C	-50 ... 70	0.01	float
196	PRLAST	Amount of precipitation registered during current or previous precipitation	mm	0 ... 9999	0.001	float
195	PRTOT	Total amount if precipitation	mm	0 ... 9999	0.001	float
198	RI	One-minute precipitation intensity	mm/h	0 ... 3600	0.1	float
202	PRcor	Corrected amount of precipitation	mm	0 ... 9999	0.001	float
203	PRTOTcor	Corrected total amount if precipitation	mm	0 ... 9999	0.001	float
197	RIINST	Instantaneous precipitation intensity	mm/h	0 ... 3600	0.1	float
199	TMIN	One-minute temperature minimum value	°C	-50 ... 70	0.01	float
201	TMAX	One-minute temperature maximum value	°C	-50 ... 70	0.01	float
205	PRINST	Instantaneous precipitation amount	mm	0 ... 9999	0.001	float
204	WS	Estimate of wind speed	-	0 ... 999	0.1	float
206	TA	Temperature	°C	-50 ... 70	0.01	float
132	IMPRATIO	Amount of precipitation corresponding to one pulse on contact output	mm	0 ... 1	0.01	float
8	UNITS	Measurement units	-	0: metric 1: imperial	1	uint8

Internal register number	Register name	Description	Unit	Range	Resolution	Type
222	I_TA	Temperature	°F	-58 ... 158	0.01	float
211	I_PR	Amount of precipitation	in	0 ... 393.662	0.00001	float
213	I_PRLAST	Amount of precipitation registered during current or previous precipitation	in	0 ... 39.331	0.00001	float
212	I_PRTOT	Total amount if precipitation	in	0 ... 393.662	0.00001	float
214	I_RIINST	Instantaneous precipitation intensity	in/h	0 ... 142	0.001	float
217	I_TAVG	One-minute temperature average	°F	-58 ... 158	0.01	float
216	I_TMIN	One-minute temperature minimum value	°F	-58 ... 158	0.01	float
218	I_TMAX	One-minute temperature maximum value	°F	-58 ... 158	0.01	float
221	I_PRINST	Instantaneous precipitation amount	in	0 ... 393.662	0.00001	float
219	I_PRcor	Corrected amount of precipitation	in	0 ... 393.662	0.00001	float
220	I_PRTOTcor	Corrected total amount if precipitation	in	0 ... 393.662	0.00001	float
210	I_WAVG	Weight of the bucket content	oz	-106 ... 1165	0.00001	float
215	I_RI	One-minute precipitation intensity	in/h	0 ... 142	0.001	float

7 MAINTENANCE

WARNING
A full bucket can be very heavy, it can weigh more than 25 kg! Be careful while emptying the bucket! Accidentally dropping the bucket on the load cell can damage the sensor.

WARNING
The internal heater of an E-series precipitation gauge can be hot! Be careful and don't touch it when handling the instrument or turn off the heating to prevent an injury.

Generally, thanks to its design and measurement principle, the TRwS precipitation gauge requires very few maintenance work. However to guarantee a long-term and a trouble-free operation it is recommended to perform some simple maintenance tasks on a regular basis (see the table below).

The periodical maintenance should be preferably performed at the beginning and at the end of the winter season and during a dry period to prevent loss in precipitation while maintenance work is performed.

At the beginning of any maintenance work it is recommended to switch the instrument to the maintenance mode in order to prevent it from registering fake precipitation during the work. If you forget to switch the maintenance mode off when finished the maintenance mode will be switched off after the period you entered while switching to the maintenance mode (see Chapter 26).

Table 8 Recommended maintenance tasks

Summary of recommended maintenance tasks	
Task	**Period**
Emptying the bucket*	if filled to more than 80% of full capacity
Visual check	twice a year
Cleaning	twice a year or as necessary
Checking heater	once a year, at the beginning of winter season

Adding antifreeze*	at the beginning of winter season or as necessary
Levelling	once a year, at the end of winter season
Checking accuracy of measurement	once a year, at the end of winter season

* Doesn't apply to E-series precipitation gauges

7.1 Emptying the bucket

Empty the bucket if it is filled to more than 80% of its full capacity or if you preform regular maintenance. Check the status register to determine if the bucked needs to be emptied. Use the *R0* or *R1* commands (*SDI*-12) or the MPS AiO application to do this.

Procedure:

1. Loosen three screws fixing the enclosure and detach if from the base plate by lifting it up.
2. Carefully lift the bucket up and drain it. As a full bucket can be very heavy you'd better use a small bucket or a mug to drain same water before lifting it up. If there is an antifreezing agent inside do not dispose the content into environment. Follow your local environmental regulations.
3. Clean the inside of the bucket and put it back to its place. Put back the enclosure and tighten three screws on its lower edge.
4. Use your finger to check if everything has been assembled correctly: the bucket must not touch the enclosure!

7.2 Visual check

Check if there is no visible damage, if the rain gauge is correctly assembled and if all screws are tightened. Always check if there is no contact between the bucket and the enclosure. Check if the bucket of an E-series precipitation gauge can be tipped freely.

7.3 Cleaning

Remove any dirt (dust, leaves, insects, insect nests, spider's webs etc.) from both inside and outside parts of the precipitation gauge. Use a brush and/or a soft cloth and clean water or mild detergent.

7.4 Heater check

Run the MPS AiO application, connect to the TRwS and on the *Settings* screen change the heating mode to 1: permanently on. Wait for about 5 minutes and check with your hand if the rim (or internal heater) has become warm. The heater can also be checked very comfortably with a compact thermographic camera. Don't forget to switch the heating mode back to automatic (2 or 3).

7.5 Adding antifreeze

If negative temperatures are expected it is recommended to add some antifreeze into the bucket to melt the solid precipitation and to prevent the content of the bucket from freezing completely. Empty the bucket before adding the antifreeze. Prefer some noncorrosive and environmentally friendly e.g. propylene glycol. As for the amount it depends on the lowest temperature awaited. Please consult the technical specification of the antifreeze.

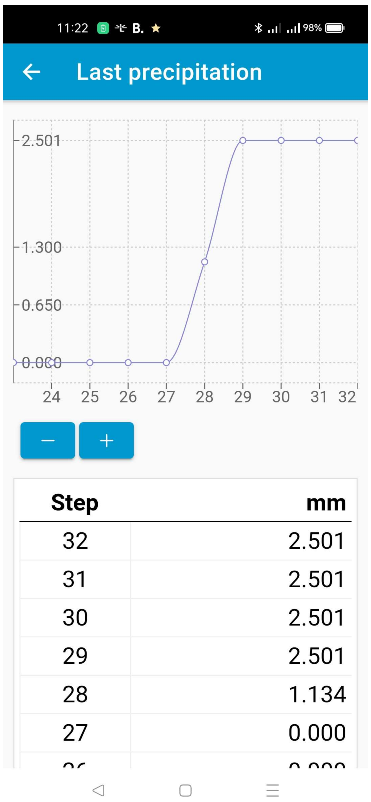
7.6 Levelling

Check if the precipitation gauge is level by placing a spirit level onto the rim in two directions perpendicular to each other. If not satisfactory repeat the initial procedure of levelling the base plate (see chapter 3).

7.7 Checking accuracy of measurement

The measurement accuracy check can be performed by the mobile application. The check should be performed at dry weather and no or a light wind (wind speed less than 2 m/s, no gusts) and the precipitation gauge must be perfectly levelled. To check accuracy you need a precise reference weight (20, 25, 50 or 100 g) and a mobile phone with the MPS AiO application installed (chapter 26). Alternatively, you can use an accurate amount of water (doesn't apply to E-series precipitation gauges which can only be checked by a weight).

Procedure using MPS AiO application:



1. If connected to a running data logger stop the measurement.
2. Empty the bucket.
3. Level the precipitation gauge (see chapter 22)
4. Run the MPS AiO application and connect to the rain gauge (chapter 26).
5. Perform the *Data reset* and wait for 2 minutes.
6. Display the *Short-term measurement history* of *Last precipitation*
7. Put a reference weight on the bottom of the bucket. Try to place it precisely in the centre.
8. Watch the value of *last precipitation* on the short-term history graph and table. Wait until the value has stopped increasing but at least 3 minutes (see the image on the right). The test has passed if the final value in millimetres lies within the interval *Minimum..Maximum* for given reference weight and orifice area (see table 9 below).
9. Remove the reference weight.
10. Perform the *Data reset* once again so that the precipitation measured during the test won't be read by the data logger.
11. Resume the measurement.

Table 9 Reference weights and corresponding precipitation amounts

	Orifice area [cm^2]								
	200			400			500		
Reference weight [g]	Minimum [mm]	Precise value [mm]	Maximum [mm]	Minimum [mm]	Precise value [mm]	Maximum [mm]	Minimum [mm]	Precise value [mm]	Maximum [mm]
20	0.99	1	1.01	0.495	0.5	0.505	0.396	0.4	0.404
25	1.238	1.25	1.263	0.619	0.625	0.631	0.495	0.5	0.505
50	2.475	2.5	2.525	1.238	1.25	1.263	0.99	1	1.01
100	4.95	5	5.05	2.475	2.5	2.525	1.98	2	2.02

Note: Above mentioned minimum/maximum values can only be used if accuracy check is performed under laboratory conditions. As it's usually not possible to meet such conditions when performing a field accuracy check a measurement error of 2 % is acceptable in such case.

8 TECHNICAL SPECIFICATION

8.1 Classical weighing precipitation gauges

Table 10 Technical specification of classical weighing precipitation gauges

	Model				
	TRwS_10.200	**TRwS_30.200**	**TRwS_30.400**	**TRwS_10.500**	**TRwS_30.314**
Orifice area	200 cm^2	200 cm^2	400 cm^2	500 cm^2	314 cm^2
Precipitation range	500 mm	1500 mm	750 mm	200 mm	955 mm
Absolute accuracy	±0.1 %				
Relative accuracy	±1 %				
Accuracy of precipitation amount	0.025 mm				
Accuracy of precipitation intensity	0.025 mm/min.				
Threshold	0.05 mm	0.05 mm	0.025 mm	0.02 mm	0.032 mm
Maximum precipitation intensity	3600 mm/hr.				
Resolution	0.001/0.01 mm				
Measuring element	load cell				
Supply voltage	5 ... 30 V_{DC} (reverse polarity protected)				
Power consumption	<25 mW; 4 mA (5 V) ... 0.5 mA (24 V)				
Heating voltage (heating power)	10 ... 30 V_{DC} / cca 0.8 ... 2.5 A (cca 8 ... 75 W)				
Pulse output	relay contact; 2 Hz (250:250 ms); 1/0.1/0.01 mm/pulse; 24 V/0.5 A max.				
Interfaces	SDI-12, RS-485 2W (300 ... 115200 bps), Bluetooth LE, USB (optional)				
Communication protocols	SDI-12 V1.4, MODBUS-RTU, MODBUS-ASCII, legacy MPS/ASCII				
Dimensions (without pedestal)	Ø360 x 540 mm	Ø385 x 650 mm	Ø385 x 610 mm	Ø360 x 380 mm	Ø385 x 610 mm
Weight	8 kg	9.5 kg	9.5 kg	8 kg	9.5 kg
Operation temperature	-40 ... +70 °C				
Storage temperature	-50…..+70 °C				
Operation humidity	0 ... 100 %				
Degree of protection • instrument • load cell	 IP65 IP68				
Surge protection	all inputs/outputs				

8.2 E-series self-emptying weighing precipitation gauges

Table 11 Technical specification of E-seriesl weighing precipitation gauges

	Model		
	TRwS_E.200	**TRwS_E.314**	**TRwS_E.400**
Orifice area	200 cm^2	314 cm^2	400 cm^2
Bucket capacity	180 ml		
Precipitation range	unlimited		
Absolute accuracy	±0.1 %		
Relative accuracy	±1 %		
Accuracy of precipitation amount	0.025 mm		
Accuracy of precipitation intensity	0.025 mm/min.		
Threshold	0.025 mm	0.016 mm	0.013 mm
Maximum precipitation intensity	3600 mm/hr.		
Resolution	0.001/0.01 mm		
Measuring element	load cell		
Supply voltage	5 ... 30 V_{DC} (reverse polarity protected)		
Power consumption	<25 mW; 4 mA (5 V) ... 0.5 mA (24 V)		
Heating voltage (heating power)	10 ... 30 $V_{AC/DC}$ / cca 0.4 ... 1.15 A (cca 4 ... 35 W)		
Pulse output	relay contact; 2 Hz (250:250 ms); 1/0.1/0.01 mm/pulse; 24 V/0.5 A max.		
Interfaces	SDI-12, RS-485 2W (300 ... 115200 bps), Bluetooth LE, USB (optional)		
Communication protocols	SDI-12 V1.4, MODBUS-RTU, MODBUS-ASCII, legacy MPS/ASCII		
Dimensions (without pedestal)	Ø253 x 320 mm	Ø253 x 355 mm	Ø253 x 380 mm
Weight	4.6 kg	5.2 kg	5.3 kg
Operation temperature	0 ... +70 °C (without heating) -10 ... +70 °C (with heating)		
Operation humidity	0 ... 100 %		
Degree of protection • instrument • load cell	 IP65 IP68		
Surge protection	all inputs/outputs		

9 MPS AiO MOBILE APPLICATION

There is an application for both Android an iOS available. Using this application you can connect to a TRwS via Bluetooth wireless interface and perform various tasks such as check measurements, change settings and update firmware of your sensor. You can download the application for free from Google Play Store or Apple App Store.

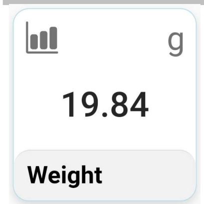
Scanning for nearby devices

Tap on the *Scan* button on and wait until a list of nearby devices appears below. Each list item contains identification of the device (e.g. TRwS), its serial number and set of basic measurements including content of *Status* register provided by Bluetooth advertising packets. Eventually you can tap on *Stop scanning*.

Connecting to a device

To perform more tasks you must connect to the device. Choose a desired one from the list and tap on the *Connect* button. Wait until panels with measurements are shown.

Displaying current measurements



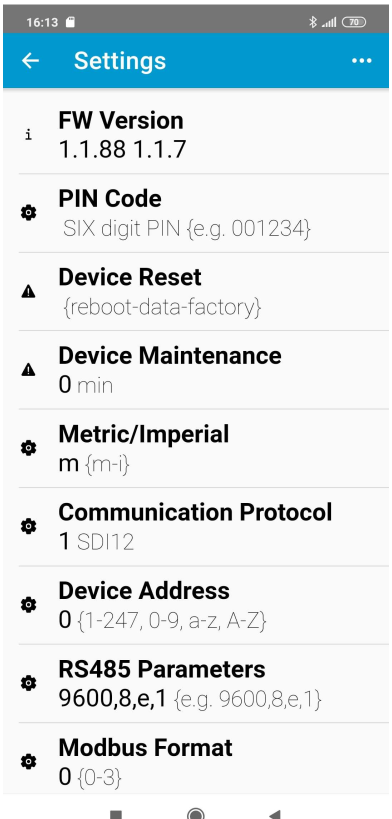
- After a device has been connected a set of panels with current measurements is shown. While connected the values are updated at regular intervals.
- You can tap on a panel to show a short-term history of the single measurement or touch-and-hold and then select two measurements to show a history of them.

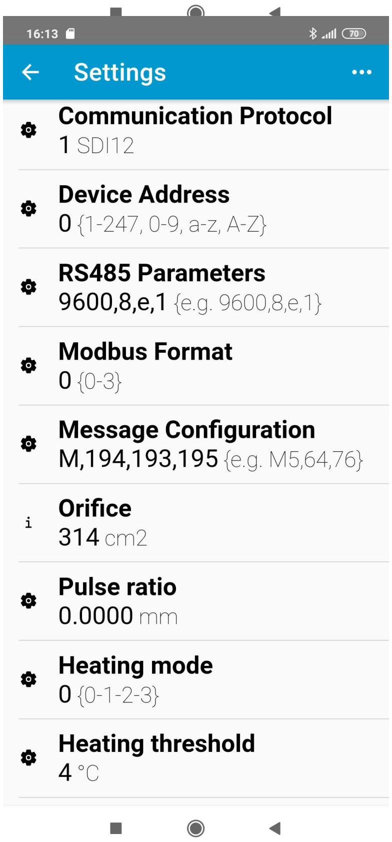
Displaying short-term measurement history

- To display a short-time history of measurement you can either tap on a measurement panel to show history of a single measurement or touch and hold on a panel and then select second measurement.
- You can display precise values of the displayed measurement(s) by tapping on a data point of the graph.
- By tapping the *Plus* and *Minus* buttons you can zoom and unzoom the vertical axis (axes).
- Tap on a row in the table below the graph to centre the horizontal axis around corresponding data point.
- Go back to the current measurements screen by tapping the arrow in the upper left corner.

Checking and changing precipitation gauge settings

- Tap on the *Settings* panel on the *Current measurements* screen. (Scroll down if the panel is not visible.) Now you can see the *Settings screen* with current instrument settings.
- If you intend to change any value or perform any action enter a PIN into the field labelled *PIN Code* and tap on *Save* button. The default value of the PIN is the six-digit zero-padded serial number of the instrument, e.g. 002549
- Tap on an item to change it. Enter a new value and tap on *Save* button.
- After changes sensor is automatically restarted.
- For list of all values which can be changed see 7 in the chapter 20 (highlighted rows).
- In addition to precipitation gauge settings there are some special items which do not represent settings but hold some information (**i**) or represent some action (⚠).





FW Version	Version of precipitation gauge firmware
Orifice	Orifice area
Device Address	Device address for current selected protocol. Allowed value: **1..247** for MODBUS protocol **0…9**, **A…Z**, **a…z** for other protocols.
Metric/Imperial	Selection of measurement units. Allowed values: **m**: metric, **i**: imperial
Pulse ratio	Amount of precipitation corresponding to one pulse on contact output in millimeters or inches, depending on measurement units. Set **0** to disable pulse generation.
Communication Protocol	Communication protocol on RS-485 or SDI-12 interface. Allowed values: **0**: off, **1:** SDI-12, **4**: MODBUS RTU, **5**: MODBUS ASCII, **6**: MPS protocol
RS485 Parameters	Baud rate,Data bits.Parity,Stop Bits separated by comma Baud rate on RS-485 interface. Allowed values: **300**, **600**, **1200**, **2400**, **4800**, **9600**, **19200**, **38400**, **57600**, **115200** Number of data bits on RS-485 interface. Allowed values: **7**, **8**, **9** Parity on RS-485 interfaces. Allowed values: **n**: no parity, **e**: even parity, **o**: odd parity Number of stop bits on RS-485 interface. Allowed values: **1**, **2**

Modbus Format

Order or bytes in float values in MODBUS protocol.
Allowed values: **0**: dcba **1:** cdab **2**: badc **3**: abcd
Example:
How float value 23.0625 is encoded is MODBUS protocol depending on Modbus Format.
0: 41B88000
1: B8410080
2: 800041B8
3: 0080B841

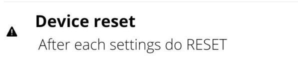
Heating mode

Heating mode.
Allowed values: **0**: permanently off, **1**: permanently on, **2**: on if T_a<THEAT, **3**: on if T_a<THEAT and is raining or snowing

Heating threshold

Temperature threshold for heating in Celsius or Fahrenheit depending on measurement units.

Device Reset



Device Reset performs one of the three possible oprerations depending on entered string value:
1) reboot
Performs software reset of the precipitation gauge. Depending on,there are three maintaining the values of ***PRTOT*** and ***PRLAST*** registers.
2) data
Resets the values of ***PRTOT*** and ***PRLAST*** registers (total precipitation amount and current/previous precipitation amount).
3) factory
Sometimes, if you get into trouble, it can be useful to reset all settings of your precipitation gauge to the original values. Use Factory reset in such case.

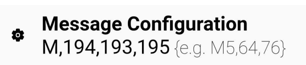
- Tap on the *Device reset* item on the *Settings* screen.
- Enter reboot/data/factory and tap on *Save.*

Device Maintenance

At the beginning of maintenance work it is recommended to switch the instrument to the maintenance mode to prevent it from registering fake precipitation.

- Tap on the *Device maintenance* item on the *Settings* screen.
- Enter the length of a period of time in minutes after which the maintenance mode should by terminated automatically and tap on *Save*.
- As you have finished the maintenance work switch off the maintenance mode by entering zero. Otherwise the maintenance mode will be switched off automatically as soon as the given time period has lapsed.

Message Configuration



Message Configuration can be used to display or change content of SDI-12 messages.

- Tap on the *Device maintenance* item on the *Settings* screen.

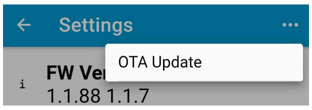
Read mode:

- Enter message name (M,M1,M2,…). Content of these message is displayed as list of register numbers separated by comma.

Write mode:

- Enter message name (M,M1,M2,…) followed by comma and list of register numbers separated by comma.

Updating the firmware



- On the *Settings* screen tap on "..." in the upper right corner and choose *OTA update* from the menu.
- Locate the *.gbl* file containing the new firmware for the instrument and tap on *Upload*.
- Wait for about 2 minutes and tap on *Finish & Disconnect*.
- Reconnect the precipitation gauge and on the *Settings* screen check if the firmware version reported by the instrument corresponds with the version of firmware just uploaded.