



/HydroMet

User Manual

PreciBal

 **KISTERS**
Empowering decisions of tomorrow

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I Disclaimer

The information provided in this manual was deemed accurate as of the publication date. However, updates to this information may have occurred.

This manual does not include all of the details of design, production, or variation of the equipment nor does it cover every possible situation which may arise during installation, operation or maintenance. KISTERS shall not be liable for any incidental, indirect, special or consequential damages whatsoever arising out of or related to this documentation and the information contained in it, even if KISTERS has been advised of the possibility of such damages.

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II Safety Instructions

-  Read the user manual including all operating instructions prior to installing, connecting and powering up the KISTERS PreciBal. The manual provides information on how to operate the product. The manual is intended to be used by qualified personnel, i.e. personnel that have been adequately trained, are sufficiently familiar with installation, mounting, wiring, powering up and operation of the product.
- Keep the user manual on hand for later reference!
- If you encounter problems understanding the information in the manual (or part thereof), please consult the manufacturer or its appointed reseller for further support.
- KISTERS PreciBal is intended to be used in hydrometeorological or environmental monitoring applications.
- Before starting to work, you have to check the functioning and integrity of the system.
 - Check for visible defects on the PreciBal, this may or may not include any or all of the following: mounting facilities, connectors and connections, mechanical parts, internal or external communication devices, power supplies or power supply lines, etc.
 - If defects are identified that could compromise operational safety, work must be stopped immediately. This applies to defects detected both before work begins and during operation.
- Do not use the KISTERS PreciBal in areas where there is a danger of explosion.
- The present user manual specifies environmental/climatic operating conditions as well as mechanical and electrical conditions. Installation, wiring, powering up and operating the KISTERS PreciBal must strictly comply with these specifications.
- Perform maintenance only when tools or machinery are not in operation.
- If guards are removed to perform maintenance, replace them immediately after servicing.
- Never make any electrical or mechanical diagnostics, inspections or repairs under any circumstances. Return the product to the manufacturer's named repair centre. You can find information on how to return items for repair in the relevant section of the KISTERS website.



Disposal instructions: After taking the KISTERS PreciBal out of service, it must be disposed of in compliance with local waste and environmental regulations. The KISTERS PreciBal is never to be disposed of in household waste!



Inputs and outputs of the device are protected against electric discharges and surges (so-called ESD). Do not touch any part of the electronic components! If you need to touch any part, please discharge yourself, i.e. by touching grounded metal parts.



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.



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 printed circuit boards of the electronic assemblies are manufactured in accordance with the IPC-A-610G standard.

1 Package Contents

Weighing Rain Gauge – model as ordered PreciBal or RainBal

For unheated rain gauges:

- 1 × 10 m signal cable with 8-pin M12 plug

For heated rain gauges:

- 1 × 10 m signal cable with 8-pin M12 plug
- 1 × 10 m power cable with 4-pin M12 plug

2 Introduction

Thank you for choosing our product. We hope you will enjoy using the device.

KISTERS manufactures, sells, installs and operates quality instrumentation, data loggers and communication technology. Products are designed with passion for environmental monitoring and with a deep understanding of the quality, accuracy and robustness needed to fulfil the requirements of measurement practitioners in the field.

The present User Manual will help you understand, install and deploy the device. If, however, you feel that a particular information is missing, incomplete or confusing, please do not hesitate to contact us for further support!

The KISTERS PreciBal is a rain gauge based on a weighing principle and the totaliser method. The amount and the intensity of rainfall is determined by collecting liquid, mixed and solid precipitation in a bucket and by the continuous measuring of weight increments. Sophisticated algorithms are implemented to suppress impact of temperature fluctuations, vibrations caused by wind, or evaporation.

The heated version is equipped with a rim heater to prevent snow on the rim and to avoid snow capping and/or ice accretion inside the rim which could result in the decrease of catching area.

An antifreeze such as propylene glycol is used to decrease the freezing point when collecting solid precipitation. Propylene glycol is a water-based, non-toxic Polymer to be used in precipitation gauges based on totalisator weighing principle that are especially used for collecting mixed and solid precipitation. The collected solid precipitation will turn from solid into liquid by the decreased freezing point instead of using electrical energy as usually required for heated tipping bucket gauges.

The use of an antifreeze allows for lower power consumption in locations where there is no mains power, but which are powered by batteries or solar panels. This combination of antifreeze and heating can be used, for example, in higher locations with moderately humid environmental conditions. With this intelligent power supply to heat the rim at low power consumption, the formation of ice build-up and snow caps is prevented.

Note: It is not required to add synthetic oil on top of the pre-filled mix of antifreeze and water.

In general, the model PreciBal 314 with its wider orifice is ideal for high mountain application with or without utilizing the rim heater.

- [Measurements and Data Processing](#) 
- [Interfaces](#) 
- [Models and Catching Areas](#) 
- [Measurement of Temperature](#) 

2.1 Measurements and Data Processing

The most important measurements provided by KISTERS PreciBal include:

- 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)

The measurement of the precipitation amount is based on continuously measuring the 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 using a communication protocol. 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 amounts of precipitation fallen into the bucket, mainly depending on precipitation intensity and wind.

2.2 Interfaces

PreciBal is equipped with the SDI-12 version 1.4 serial interface, RS 485 and a contact voltage-free pulse output for emulation of a tipping-bucket rain gauge. RS-485 various protocols can be used, e.g. MODBUS RTU, MODBUS ASCII. For comfortable maintenance work the Bluetooth LE and USB-over-Bluetooth interface is available.

2.3 Models and Catching Areas

Two different models with 200 and 314 cm² orifice area with optional rim heater are available for specific regions with standard orifices standardized upon by the National weather services.

PreciBal 200 and PreciBal 200-RH: EU, LATAM, Canada, Africa, Russia-CIS

PreciBal 314 and PreciBal 314-RH: US, China, Asia-Pacific, Australia and New Zealand

Model	PreciBal 200	PreciBal 200-RH	PreciBal 314	PreciBal 314-RH	PreciBal 400	PreciBal 400-RH
Orifice area [cm ²]	200	200	314	314	400	400
Diameter in mm/inches	160 / 6.4	160 / 6.4	200 / 7.9	200 / 7.9	226 / 8.9	226 / 8.9
Bucket capacity [l]	30	30	30	30	30	30
Approximate amount of precipitation for full bucket [mm]	1500	1500	955	955	750	750

2.4 Measurement of Temperature

Heated PreciBal versions: 200-RH, 314-RH and 400-RH.

Heated models are equipped with an orifice rim heater to prevent snow and frost from accumulating on the rim. The heater is powered by a separate power supply and switches on automatically when the temperature falls below a preset threshold. The heating supply voltage can range from 10 to 30 V DC. The heating output depends on the applied supply voltage. No power regulation is provided.

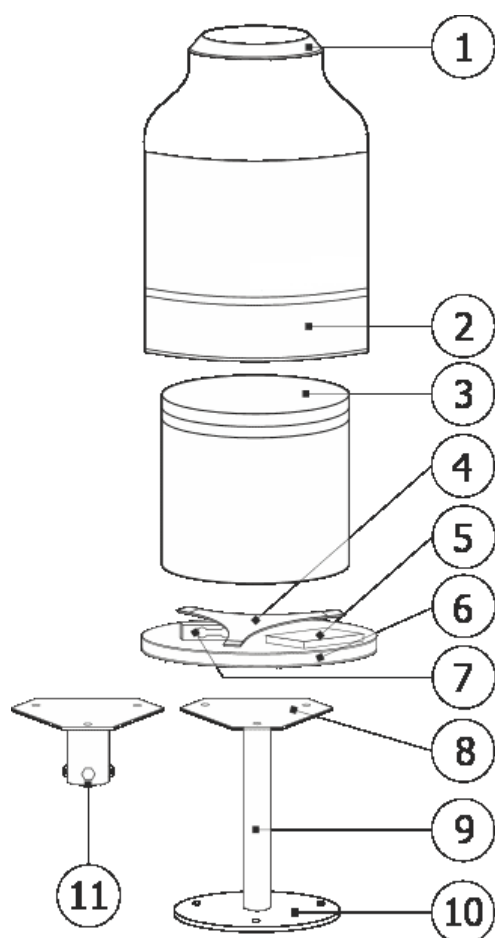
3 Installation

See the separate PreciBal installation instructions, which are included in the scope of delivery and can be downloaded from the website.

Installation for Measuring Heights of 1.0 and 1.5 m

PreciBal can be mounted on a 2" threaded pole with ground plate corresponding to the KISTERS TB series. In addition, a mechanical KISTERS 334 mounting bracket is required (3-point adapter on 2" pipe with internal thread).

See mounting Instructions: KISTERS 334 Multi Adapter for PreciBal.



- Pos 1: Rim
- Pos 2: Pipe house/enclosure
- Pos 3: Collecting bucket
- Pos 4: Triangular Support for bucket
- Pos 5: Electronic unit housing
- Pos 6: Base plate
- Pos 7: Load cell with transportation screws
- Pos 8: KISTERS 334 multi-adapter 3-point to 2" adapter (installation heights from 1 to 1.5 m)
- Pos 9: Threaded pipe 2"
- Pos 10: Ground plate
- Pos 11: 3-point to 4" adapter (installation heights from 1 to 3 m)
- Pos 12: Heater connector
- Pos 13: Funnel
- Pos 14: Balance weight
- Pos 15: Heater (optional)
- Pos 16: Spirit level

Top view of the measuring unit for PreciBal precipitation gauge:

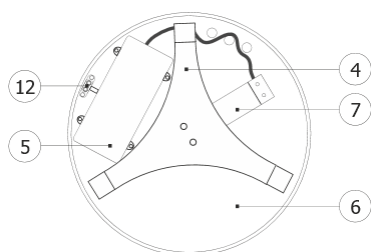


Figure 1 – Overview of sub-assemblies

Sub-assembly position 11: See Mounting instruction: 3-point to 4" pole adapter for PreciBal.

Measuring height PreciBal with KISTERS 334X adapter	Pos 9: Length 2" threaded pipe
1.0 m	300 mm
1.5 m	800 mm

Installation for Measuring Heights of 1.0 and 3 m

PreciBal can be mounted on a 4" threaded pole with ground plate. In addition, a mechanical mount bracket KISTERS 334X is required (3-point to inner threaded 4" pipe adapter).

Consult these chapters for installation instructions.

- [General Requirement](#) 
- [Mounting the Pedestal](#) 
- [Preparing the Precipitation Gauge for Mounting](#) 
- [Mounting the Precipitation Gauge on the Pedestal](#) 
- [Mounting the Precipitation Gauge on a Pole Using the Pole-Mounting Adapter](#) 
- [Finishing Installation](#) 

3.1 General Requirement

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 1.0 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 buildings.

3.2 Mounting the Pedestal

1. Prepare a concrete base and attach three M8 screws to it (e.g. with wall plugs and hanger bolts).
2. Screw three M8 nuts onto the bolts and place the ground plate (10) of the threaded pipe (9) on them (see figure [Overview of sub-assemblies](#) ). **Note:** The ground plate is round but the KISTERS 334 Multi-Adapter (8) is triangular.
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 three 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) loosening the screws at the bottom edge of the enclosure. Remove the bucket (3) from the base plate.

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

Set the mounting adapter (8 or 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) of the precipitation gauge. Finally tighten the fixing screws of the mounting adapter.

For more details, see the separate installation instructions on 3-point to 2"- and 3-point to 4" adapter with installation poles and ground plate for mounting onto concrete.

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 (see figure [Transportation bracket](#)). Loosen both screws so that there is a gap of at least 1 millimetre between the tip of the screw and the housing of the measuring device (or the load cell, depending on the PreciBal 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 heating connector has to be plugged into the female one located at the base plate of the rain gauge. Fix the enclosure tightening the screws around the lower edge.
3. Use your finger to check if the rain gauge has been assembled correctly: the rim of the enclosure must not touch the bucket!

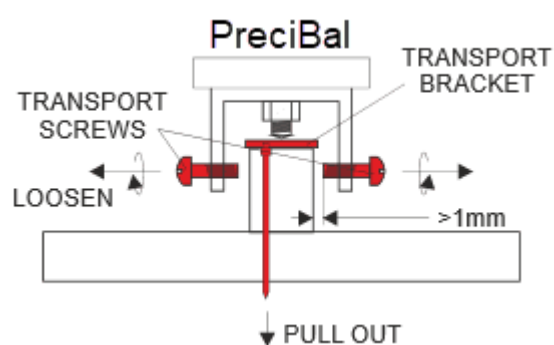


Figure 2 – Transportation bracket

4 Configuration

This chapter contains the following subsections:

- [Interfaces](#) ¹²
- [External Connection](#) ¹²
- [Internal Wiring](#) ¹³

4.1 Interfaces

PreciBal is equipped with the SDI-12 version 1.4 serial interface, RS 485 and a contact voltage-free pulse output for emulation of a tipping-bucket rain gauge. RS-485 various protocols can be used, e.g. MODBUS RTU, MODBUS ASCII. For comfortable maintenance work the Bluetooth LE and USB-over-Bluetooth interface is available. The serial interfaces are both fully equipped and can be selected with the implemented protocols. Both interfaces cannot be operated simultaneously.

By default the interface is set to SDI-12 V1.4.

Possible interface settings						
Protocol	SDI-12		MODBUS		ASCII	
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,N,1	0	9600,8,E,1	48	9600,8,N,1	0

The pulse output is available in metric and imperial units with different pulse factors. Here the behaviour of a reed contact is simulated, which is usually integrated in tipping bucket rain gauges.

The pulse output is working simultaneously to any selected interface and protocol and can also be used as redundant output to be connected to a second device.

For changing the interface or other parameters, please [use the app](#) ⁴⁵ available for iOS and Android smart phones.

More information see installation guide.

4.2 External Connection

See the separate PreciBal installation instructions, which are included in the scope of delivery and can be downloaded from the website.

On the bottom side of the base plate there are either M12-8pol or additionally M12-4pol (for the heated version) connectors with cap to utilize and connect the delivered cables. The cable ends or open wires must be connected to the corresponding terminals of the data logger, AWS or SCADA system. A standard length of the cables is 10 metres but a cable of customs and site specific length can be ordered upon request.

The maximum length for the cables is 15 m for M12 SAC-4pol (heater cable) and 50 m for M12-8pol (instrument supply and interfaces).

Terminal	Description	8 wire connection	M12 8-pin	M12 4-pin
GND	Operating Voltage, Ground	Blue	7 (Blue)	--
PWR	Operating Voltage, 5 to 30 V DC	Red	8 (Red)	--
HT-IN	Heating voltage	Violet		2+3 (White+Blue)

Terminal	Description	8 wire connection	cable	M12 8-pin	M12 4-pin
HT-IN	5 to 30 V DC	Orange			1+4 (Brown+Black)
GND	SDI-12 Ground	Green		3 (Green)	--
SDI-12	SDI-12 Data	Yellow		4 (Yellow)	--
RS485-B	RS485 negative	Brown		2 (Brown)	--
RS485-A	RS485 positive	Grey		5 (Grey)	--
CONT-B	Contact (pulse) Output			1 (White)	--
CONT-A				6 (Pink)	--
SHIELD	Cable Shield	SHIELD			

4.3 Internal Wiring

The cable and the M12 connectors are connected to a terminal block on the PCB inside the electronics unit. The terminal block can be accessed by removing the lid of the electronics unit housing.

If the standard 8-core cable is used, two wiring configurations are possible, depending on whether the RS-485 interface or the pulse output is used in addition to the SDI-12 interface.

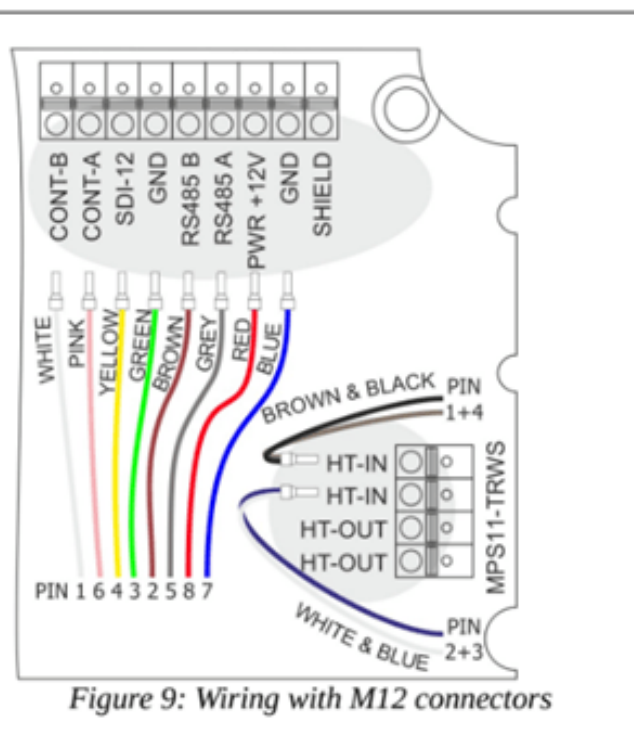
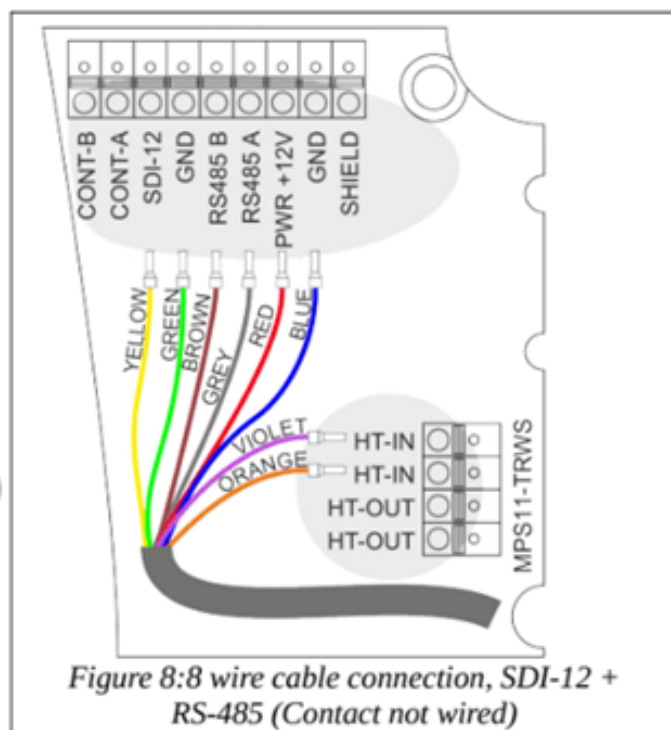


Figure 3 – Internal wiring

5 Operation

This chapter contains the following subsections:

- [Process for Measuring Precipitation](#) ¹⁴
- [Parameters for Precipitation Measurement](#) ¹⁴
- [Generating Pulses on the Contact Output](#) ¹⁵
- [Measurement of Rain Intensity](#) ¹⁵
- [Measurement of Bucket Content](#) ¹⁵
- [Measurement of Temperature](#) ¹⁵
- [Heating Management](#) ¹⁶
- [Data Communication](#) ¹⁶
- [Diagnosis](#) ³⁵

5.1 Process for Measuring Precipitation

The amount of precipitation is determined by continuously measuring the weight of the bucket's contents. Each measurement cycle lasts 10 seconds. At the end of each cycle, all recorded values are updated and prepared for transmission via the designated communication protocol. The measured values can be retrieved at any interval of at least 10 seconds. Due to the implemented algorithm, it can take up to 120 seconds for the entire amount of precipitation collected in the bucket to be fully registered. This delay depends primarily on factors such as precipitation intensity and wind conditions.

5.2 Parameters for Precipitation Measurement

Precipitation since last reading - PR (Precipitation Since Last Reading)

- Represents the amount of precipitation recorded since the last data retrieval.
- At start-up, **PR** is set to zero.
- Every 10 seconds, the precipitation measured during this cycle is added to **PR**.
- After reading out via the command pair `aM!` / `aD0!`, **PR** is reset to zero.

Total precipitation amount - PRTOT (Total Precipitation Amount)

- Represents the total amount of precipitation recorded.
- During start-up, **PRTOT** is set to zero.
- Every 10 seconds, the precipitation measured during this cycle is added to **PRTOT**.
- **PRTOT** is never reset as long as the system is running continuously.

Registered precipitation amount for the current or previous precipitation event - PRLAST (Precipitation During Current or Previous Rain Event)

- Represents the amount of precipitation recorded during the current or last precipitation event.
- At start-up, **PRLAST** is set to zero.
- Every 10 seconds, the precipitation measured during this cycle is added to **PRLAST**.
- If no precipitation is detected for 10 minutes and then precipitation starts again, **PRLAST** is reset to zero.
- As long as it is raining or snowing, **PRLAST** collects the precipitation since the beginning of the current event.
- When the precipitation stops, **PRLAST** retains its last value, which reflects the total amount of the last event.
- At the start of a new rain or sleet event, **PRLAST** is reset to zero.

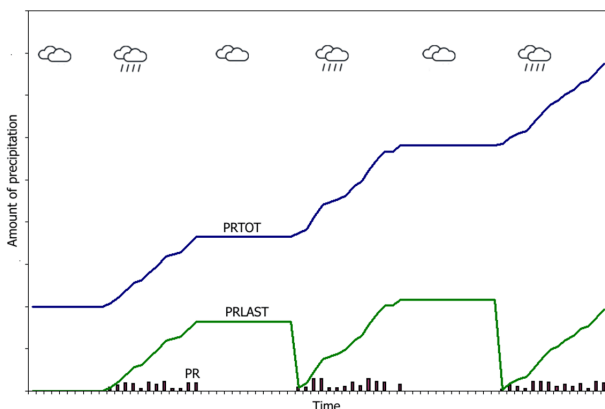


Figure 4 – PR, PRTOT and PRLAST

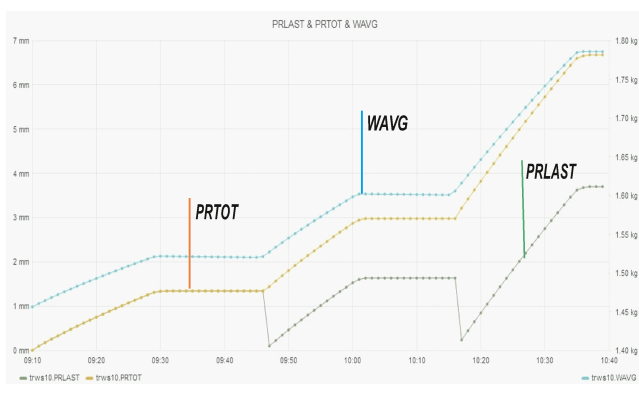


Figure 5 – PRTOT, PRLAST and WAVG – graphical view of variations in time

5.3 Generating Pulses on the Contact Output

At the end of each 10-second measurement cycle the PreciBal 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.

5.4 Measurement of Rain Intensity

A PreciBal total precipitation 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.

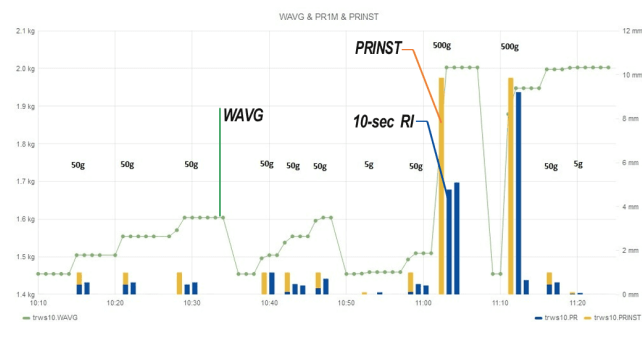


Figure 6 – RI and 1-minute precipitation – graphical view of variations in time

5.5 Measurement of Bucket Content

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

5.6 Measurement of Temperature

In the standard version a PreciBal total 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.

5.7 Heating Management

The following PreciBal models are heated: PreciBal 200-RH, 314-RH and 400-RH.

Heated models are equipped with an orifice rim heater to prevent snow and frost from accumulating on the rim. The heater is powered by a separate power supply and switches on automatically when the temperature falls below a preset threshold. The heating supply voltage can range from 10 to 30 V DC. The heating output depends on the applied supply voltage. No power regulation is provided.

A heated PreciBal is equipped with an orifice rim heater (classical models). 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 to 4 °C	25%
THEAT-9 .. THEAT-4	-5 to 0 °C	50%
THEAT-14 .. THEAT-9	-10 to -5 °C	75%
< THEAT-14	below -10 °C	100%

5.8 Data Communication

Communication modes:

- Standard: SDI-12, version 1.4, factory settings: 1200, 7, E, 1 and standard address is '0'.
- Optional: RS-485: MODBUS factory settings 9600 bits per second, 8 bits, no parity, 1 stop bit, default address is "1" - MODBUS RTU and MODBUS ASCII.

Protocols	PreciBal 200	PreciBal 314	PreciBal 400
SDI-12, Version 1.4	X	X	X
RS 485 Modbus	X	X	X

Table 1 – Protocols

The communication mode is preset to SDI-12.

Independent of the communication protocol in use, PreciBal stores all data in so-called "registers". All measured and status values and parameters are stored in the registers. The table [Protocols](#) describes the most important registers that you may need in order to work with the sensor.

Follow the links for further information.

- [SDI-12](#)¹⁷
- [RS-485](#)²⁶
- [Description of Registers](#)³⁰
- [Table of Output Data](#)³¹

5.8.1 SDI-12

In all examples in this chapter, **a** represents a sensor address and **ccc** represents the three-character CRC code. The CRC code is appended when data is requested using commands such as **aMC!** or **aRC!**.

Note: Only the most important commands are described in this chapter. For further information about the SDI-12 protocol, please visit sdi-12.org.

- [SDI-12 General Commands](#)¹⁷
- [SDI-12 Measurement Commands \(Metric Units\)](#)¹⁸
- [SDI-12 Measurement Commands \(Imperial Units\)](#)²⁰
- [SDI-12 Reading Status Commands](#)²²
- [SDI-12 Verification](#)²³
- [SDI-12 V1.4 Metadata Commands](#)²⁴
- [SDI-12 Sensor Extended Commands](#)²⁵

5.8.1.1 SDI-12 General Commands

Address query		
Command:	? !	
Response:	a<CR><LF>	
Explanation:	a	the sensor address
Example:	? ! 0<CR><LF>	
Change address		
Command:	aAb !	
Response:	b<CR><LF>	
Explanation:	a	the original address
	b	the new address
Example:	0A3 ! 3<CR><LF>	

Send identification		
Command:	aI !	
Response:	a14MPSSYSTM11TRWS10200 , SN=9007<CR><LF>	
Explanation:	MPSSYSTM	company name
	11TRWS	sensor model
	10200	sensor version (1.02.00)
	SN=9007	serial number

5.8.1.2 SDI-12 Measurement Commands (Metric Units)

Basic data (amount of precipitation and weight)		
Start measurement		
Command:	aM! aMC! aC! aCC!	
Response:	a0003<CR><LF> a00003<CR><LF>	
Send data		
Command:	aD0!	
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]

Basic data (amount of precipitation and weight)

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>
```

Last or current rain precipitation amount and duration, temperature and service data

Start measurement

Command:

```
aM1!
aMC1!
aC1!
aCC1!
```

Response:

```
a0004<CR><LF>
a00004<CR><LF>
```

Send data

Command:

```
aD0!
```

Response:

```
a+PRLAST+PRDUR±TAVG+STATUS<CR><LF>
a+PRLAST+PRDUR±TAVG+STATUSccc<CR><LF>
```

Explanation:	PRLAST	amount of precipitation registered during current or previous precipitation [mm]
	PRDUR	current or previous precipitation duration [s]
	TAVG	one-minute temperature average value [°C]
	STATUS	various status data [-]

Example

Last or current rain precipitation amount and duration, temperature and service data

```

0M1!00004<CR><LF>
0D0!0+1.598+2260+24.23+1<CR><LF>
0MC1!00004<CR><LF>
0D0!0+1.598+2260+24.23+1Eu] <CR><LF>
0C1!000004<CR><LF>
0D0!0+1.598+2260+24.23+1<CR><LF>
0CC1!000004<CR><LF>
0D0!0+1.598+2260+24.23+1Eu] <CR><LF>

```

5.8.1.3 SDI-12 Measurement Commands (Imperial Units)

Basic data (amount of precipitation and weight), imperial units

Start measurement

Command:

```

aM5!
aMC5!
aC5!
aCC5!

```

Response:

```

a0003<CR><LF>
a00003<CR><LF>

```

Send data

Command:

```

aD0!

```

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

Basic data (amount of precipitation and weight), imperial units

```

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>

```

Last or current rain precipitation amount and duration, temperature and service data, imperial units

Start measurement

Command:	aM6! aMC6! aC6! aMCC6!
Response:	a0004<CR><LF> a00004<CR><LF>

Send data

Command:	aD0!
Response:	a+I_PRLAST+PRDUR±I_TAVG+STATUS<CR><LF> a+I_PRLAST+PRDUR±I_TAVG+STATUSccc<CR><LF>

Explanation:	I_PRLAST	amount of precipitation registered during current or previous precipitation [in]
	PRDUR	current or previous precipitation duration [s]
	I_TAVG	one-minute temperature average value [°F]
	STATUS	various status data [-]

Example

```
0M6!00004<CR><LF>
```

Last or current rain precipitation amount and duration, temperature and service data, imperial units

```

0D0!0+0.06283+700+75.61+1<CR><LF>
0MC6!000004<CR><LF>
0D0!0+0.06283+700+75.61+1NkA<CR><LF>
0C6!000004<CR><LF>
0D0!0+0.06283+700+75.61+1<CR><LF>
0CC6!000004<CR><LF>
0D0!0+0.06283+700+75.61+1NkA<CR><LF>

```

5.8.1.4 SDI-12 Reading Status Commands

Reading status byte (bit-mapped)

Command:	aR0! aRC0!
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 byte (bit-mapped)

Command:	aR1! aRC1!
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	always 1
--------------	----------------	----------

	STATUS1	1: 80% of bucket capacity reached
--	----------------	-----------------------------------

	STATUS2	1: unexpected restart detected
--	----------------	--------------------------------

Reading status byte (bit-mapped)		
	STATUS3	1: maintenance mode is on
	STATUS4	1: heater is on
	STATUS5	(reserved)
	STATUS6	(reserved)
	STATUS7	(reserved)
Example:	<pre>0R1!0+1+0+0+0+0+0+0+0<CR><LF> 0RC1!0+1+0+0+0+0+0+0+0GuL<CR><LF></pre>	

5.8.1.5 SDI-12 Verification

The **verification command** can be used to quickly verify the accuracy of the weight measurement. Immediately after sending the **V command**, place a reference weight on the bottom of the bucket. Position the weight as close to the centre as possible.

Wait for 30 seconds, then use the **D0 command** to retrieve the measured weight.

Verification		
Start Verification		
Command:	aV!	
Response:	a0301<CR><LF>	
Send verification data		
Command:	aD0!	
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 ch. [Maintenance](#) ³⁷.

5.8.1.6 SDI-12 V1.4 Metadata Commands

Identify measurement commands		
Command:	aIM! aIMi! etc.	
Response:	a000n <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:	aIM_ppp! aIMi_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

Identify measurement parameter commands		
	MAX	maximum possible value
Examples:	<pre>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.</pre>	

5.8.1.7 SDI-12 Sensor Extended Commands

Extended commands can be used to perform special actions. The general command syntax is: **aXaction_value!**

Note: After changing the temperature threshold or heating mode, the new settings do not take effect until the device is restarted.

SDI12 actions (X-commands)		
Explanation	Action	Allowed values
Set heating mode	278	0 to 4
Set temperature threshold for heating [°C]	280	-70 to 125
Set maintenance mode for n minutes or turn it off by setting value 0	1000	0 to 255
1 - Perform software reset of the precipitation gauge 2 - Reset the values of PRTOT and PRLAST registers	1001	1 or 2
Example 1: Software reset		
Command:	aX1001,1!	
Response:	no response (TRWS is restarted)	
Example 2: Reset PRTOT and PRLAST registers		
Command:	aX1001,2!	
Response:	aOK	
Example 3: Set maintenance mode for 5 minutes		
Command:	aX1000,5!	
Response:	aOK	
Example 4: Set heating mode to 4		
Command:	aX278,4!	

SDI12 actions (X-commands)

Response:	aOK
-----------	-----

5.8.2 RS-485

Three main protocols are available over the RS-485 interface: MODBUS (RTU and ASCII), SDI-12, and the legacy MPS protocol for compatibility with older sensors.

The user can select the desired protocol by setting the parameter LINKPROT to the required value. The parameter can be set via the mobile application.

Note: If the sensor is equipped with a standard hard-wired 8-core cable, the correct wiring configuration is required to use the RS-485 interface. When the RS-485 interface is connected, the pulse output is not available.

- [MODBUS Protocol](#) 
- [SDI-12 Protocol over RS-485](#) 

5.8.2.1 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 table below. Since all measurements are of type 'float', two consecutive registers must be read to obtain a value. For more information on MODBUS protocol, please visit www.modbus.org.

Note:

- To change the address, use the MPS AiO app.
- The byte order of the float values depends on the MODBUS format setting.

MODBUS input registers (function code 04)

Measurement name	Explanation	Register address	Register number	Register count	Data type
PR	amount of precipitation registered since previous reading [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
PRDUR	current or previous precipitation duration [s]	450	451	2	float
I_PR	amount of precipitation registered since previous reading [in]	422	423	2	float

MODBUS input registers (function code 04)

Measurement name	Explanation	Register address	Register number	Register count	Data type
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
STATUS	bit-mapped status data bit 0: 1 if activated bit 1: 1 if 80% of bucket capacity reached bit 2: 1 if unexpected restart detected bit 3: 1 if maintenance mode is activated bit 4: 1 if heater is on	152	153	1	u16
HEAT	heating mode	278	279	1	u16
THEAT	temperature threshold for heating	280	281	1	s16

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)

MODBUS example (in hexadecimal notation)

	04	function code (04)
	04	byte count (4)
	41CA8F5C	response, decoded float is 25.32
	AB8F	CRC

Use function code **06** (Write Single Register) to perform special actions.

Note: After changing the temperature threshold or heating mode, the new settings do not take effect until the device is restarted.

MODBUS write single register (function code 06)

Explanation	Register address	Register number	Data type	Allowed values
Set heating mode	278	279	u16	0 to 4
Set temperature threshold for heating [°C]	280	281	s16	-70 to 125
Set maintenance mode for n minutes or turn it off by setting value 0	1000	1001	u16	0 to 255
1 - Perform software reset of the precipitation gauge 2 - Reset the values of PRTOT and PRLAST registers	1001	1002	u16	1 or 2

MODBUS example (in hexadecimal notation)

Example 1:	Software reset	
Command:	010603E9000199BA	
Explanation:	01	modbus address (1)
	06	function code (06)
	03E9	registers address (1001)
	0001	value (1)
	99BA	CRC
Response:	010603E9000199BA	

MODBUS example (in hexadecimal notation)		
Explanation:	Reponse is same as command	
Example 2:	Set maintenance mode for 5 minutes	
Command:	010603E80005C9B9	
Explanation:	01	modbus address (1)
	06	function code (06)
	03E8	registers address (1000)
	0005	value (5)
	C9B9	CRC
Response:	010603E80005C9B9	
Explanation:	Reponse is same as command	
Example 3:	Set heating mode to 4	
Command:	0106011600046831	
Explanation:	01	modbus address (1)
	06	function code (06)
	0116	registers address (278)
	0004	value (4)
	6831	CRC
Response:	0106011600046831	
Explanation:	Reponse is same as command	

5.8.2.2 SDI-12 Protocol over RS-485

Commands and responses are the same as those on the [SDI-12](#)  interface. Initial BREAK is not required.

5.8.3 Description of Registers

Register acronym	Description
PR	Precipitation amount between two readings (SDI 12) M" command), after reading value is reset
PRTOT*	Precipitation amount from power ON, or reset up to 999.99mm
PRLAST*	Precipitation amount of present or last precipitation event, used for validation with weight or with water and for APP and SDI12.
WAVG*	Total weight of bucket
PRINST**	Instant precipitation between two readings with "M" command, delay is max. 10 sec.
RI**	Instant 10-sec rain intensity express in mm/h
PRcor	Corrected PR value
PRTot	Corrected PRTOT value
T	Temperature
TMIN	1-minute temperature minimum
TMAX	1-minute temperature maximum
TAVG	1-minute temperature average
U	Power supply
WS	Wind speed estimation used for corrected data
HEAT	Heating mode: 0 ~ heating OFF, 1 ~ heating ON, 2 ~ heating ON when temperature ('T') is below THEAT, 3 ~ heating ON when temperature ('T') is below THEAT and it rains
THEAT	Parameter: heating temperature threshold
IMRATIO	Parameter: precipitation that equals one pulse

Table 2 – Description of Registers

Note:

* For more information on how these values vary in time, refer to figure PRTOT, PRLAST and WAVG – graphical view of variations in time .

5.8.4 Table of Output Data

Internal Address	Register Name	Description	Unit	Modbus Address	Modbus Register	Range	Resolution	Register Count	Data Type
3	LINKPROT	Communication Protocol	-	6	7	0: off 1:SDI-12 4: Modbus RTU 5: Modbus ASCII	1	1	uint8
4	BAUD	RS-485 Baudrate	baud	8	9	300 ... 115,200	N/A	1	uint32
5	DATABIT	Number of Data Bits	-	10	11	5 ... 9	1	1	uint8
6	PARITY	RS-485 Parity	-	12	13	n(0), e(1), o(2)	N/A	1	char
7	STOPBIT	Number of Stop Bits	-	14	15	1 ... 2	1	1	uint8
8	UNITS	Measurement Units	-	16	17	0: metric 1: imperial	1	1	uint8
64	UPWR	Internal Power Supply Voltage	V	128	129	0 ... 5	0.1	2	float
76	STATUS	Status data	-	152	153	0 ... 255	1	1	uint16
132	IMPRATIO	Amount of Precipitation corresponding to one pulse on Contact output	mm	264	265	0 ... 1	0.01	2	float
139	HEAT	Heating Mode	-	278	279	0: permanently off 1: permanently on 2: on if TA < THEAT 3: on if TA < THEAT and rain	1	1	uint16

Internal Address	Register Name	Description	Unit	Modbus Address	Modbus Register	Range	Resolution	Register Count	Data Type
						or snowfall			
140	THEAT	Temperature Threshold for Heating Mode	°C	280	281	-70 ... 125	1	1	s16
193	WAVG	Weight of the Bucket Content	g	386	387	-3000 ... 33,000	0.001	2	float
194	PR	Amount of Precipitation	mm	388	389	0 ... 9999	0.001	2	float
195	PRTOT	Total Amount of Precipitation	mm	390	391	0 ... 9999	0.001	2	float
196	PRLAST	Amount of Precipitation Registered During Current or Previous Precipitation	mm	392	393	0 ... 9999	0.001	2	float
197	RIINST	Instantaneous Precipitation Intensity	mm/h	394	395	0 ... 3600	0.1	2	float
198	RI	One-minute Precipitation Intensity	mm/h	396	397	0 ... 3600	0.1	2	float
199	TMIN	One-Minute Minimum Temperature	°C	398	399	-50 ... 70	0.01	2	float
200	TAVG	One-Minute Temperature Average	°C	400	401	-50 ... 70	0.01	2	float

Internal Address	Register Name	Description	Unit	Modbus Address	Modbus Register	Range	Resolution	Register Count	Data Type
201	TMAX	One-Minute Maximum Temperature	°C	402	403	-50 ... 70	0.01	2	float
202	PRcor	Corrected Amount of Precipitation	mm	404	405	0 ... 9999	0.001	2	float
203	PRTOTcor	Corrected Total Amount of Precipitation	mm	406	407	0 ... 9999	0.001	2	float
204	WS	Estimated Wind Speed	-	408	409	0 ... 999	0.1	2	float
205	PRINST	Instantaneous Precipitation Amount	mm	410	411	0 ... 9999	0.001	2	float
206	TA	Temperature	°C	412	413	-50 ... 70	0.01	2	float
210	I_WAVG	Weight of the Bucket Content	oz	420	421	-106 ... 1165	0.00001	2	float
211	I_PR	Amount of Precipitation	in	422	423	0 ... 393,662	0.00001	2	float
212	I_PRTOT	Total amount of Precipitation	in	424	425	0 ... 393,662	0.00001	2	float
213	I_PRLAST	Amount of Precipitation Registered During Current or Previous Precipitation	in	426	427	0 ... 39,331	0.00001	2	float
214	I_RIINST	Instantaneous Precipitation	in/h	428	429	0 ... 142	0.001	2	float

Internal Address	Register Name	Description	Unit	Modbus Address	Modbus Register	Range	Resolution	Register Count	Data Type
		on Intensity							
215	I_RI	One-minute Precipitation Intensity	in/h	430	431	0 ... 142	0.001	2	float
216	I_TMIN	One-Minute Minimum Temperature	°F	432	433	-58 ... 158	0.01	2	float
217	I_TAVG	One-Minute Temperature Average	°F	434	435	-58 ... 158	0.01	2	float
218	I_TMAX	One-Minute Maximum Temperature	°F	436	437	-58 ... 158	0.01	2	float
219	I_PRCOR	Corrected Amount of Precipitation	in	438	439	0 ... 393,662	0.00001	2	float
220	I_PRTOTCOR	Corrected Total Amount of Precipitation	in	440	441	0 ... 393,662	0.00001	2	float
221	I_PRINST	Instantaneous Precipitation Amount	in	442	443	0 ... 393,662	0.00001	2	float
222	I_TA	Temperature	°F	444	445	-58 ... 158	0.01	2	float
225	PRDUR	Current or Previous Precipitation Duration	s	450	451	0 ... 10,000,000	10	2	float

5.9 Diagnosis

Practice of diagnosis (mechanical items – see figure [Overview of sub-assemblies](#)^[35]):

1. Turn the PreciBal on and let it stabilise for about three minutes.
2. Put a weight or pour a known amount of water into the bucket. **Note:** Weights must be placed in the center of the bucket. The enclosure must be in place.
3. Check the output from the PreciBal impulse output and/or serial output (SDI-12 or RS-485). Follow the instructions in the following chapters for serial SDI-12 and serial RS-485 communication. Reference values for representative weights and areas can be found in the [Verification Procedure Reference Table](#)^[35].

Weight [g]	PreciBal 200: Pr [mm]			PreciBal 314: Pr [mm]			PreciBal 400: Pr [mm]		
	Min.	Nom.	Max.	Min.	Nom.	Max.	Min.	Nom.	Max.
20	0.990	1.000	1.010	0.634	0.640	0.646	0.495	0.500	0.505
25	1.238	1.250	1.263	0.788	0.796	0.804	0.619	0.625	0.631
50	2.475	2.500	2.525	1.576	1.592	1.608	1.238	1.250	1.263
100	4.950	5.000	5.050	3.152	3.184	3.216	2.475	2.500	2.525

Table 3 – Verification Procedure Reference Table, Relative Accuracy 1%

Follow the links for further information.

- [RS-485: Sensor Diagnosis](#)^[35]
- [SDI-12: Sensor Diagnosis](#)^[35]

5.9.1 RS-485: Sensor Diagnosis

For the sensor diagnosis the SDI-12 protocol is used on the RS-485 port. Subsequently, the entire diagnosis follows the same steps and uses the same commands as described in ch. [SDI-12: Sensor Diagnosis](#)^[35].

5.9.2 SDI-12: Sensor Diagnosis

This chapter contains the following subsections:

- [Step 1: Reset/Clear Cumulative Precipitation Counters](#)^[35]
- [Step 2: Put Known Weight and Wait](#)^[35]
- [Step 3: Read Data & Check Precipitation Value](#)^[36]

5.9.2.1 Step 1: Reset/Clear Cumulative Precipitation Counters

- Command: aXreset!
- Response: aOK<CR><LF>
 - resets the statistic calculation module,
 - rainfall counter {PRTOT} set to zero
- Example:
 - Command: 1Xreset!
 - Response: 1OK<CR><LF>

5.9.2.2 Step 2: Put Known Weight and Wait

- (A) Carefully deposit a known precision weight in the centre of the PreciBal bucket; reference weights are illustrated in the [Verification Procedure Reference Table](#)^[35]
- (B) Wait for at least three minutes for the accumulated precipitation calculation to complete.

5.9.2.3 Step 3: Read Data & Check Precipitation Value

- To start the diagnosis/verification process, send the following command:
 - Command: aV!
 - Response: atttn<CR><LF>
- To read data from the PreciBal, send the following command:
 - Command: aD0!
 - Response: a<Reg.Val.156><CR><LF>

Here <Reg.Val.156> corresponds to **PRLAST** and contains the precipitation equivalent in mm corresponding to the inserted weight.
- Compare measured value with the reference value and evaluate according to the validity range in the [Verification Procedure Reference Table](#)³⁵.
- Example:
 - Command: 1V!<CR>
 - Response: 10001<CR><LF>
 - Command: 1D0!<CR>
 - Response: 1+1.247<CR><LF>

Here, <Reg.Val.156> corresponds to **PRLAST** and 1.247 mm is the precipitation equivalent in mm for a PreciBal with an opening $\varnothing = 200 \text{ cm}^2$ and an inserted precision weight of 25 g.
- Test successfully passed because $1.238 \text{ mm} \leq 1.247 \text{ mm} \leq 1.263 \text{ mm}$.

6 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 heating element of an E-series rain gauge can be hot! Be careful and do not touch them when handling the device, or switch off the heating to avoid injury.

- Generally, thanks to its design and measurement principle, the precipitation gauge PreciBal requires very low maintenance. 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 switch the sensor 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 30 minutes automatically.

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
Checking Horizontal Position 	once a year, at the end of winter season
Checking Accuracy of Measurement 	once a year, at the end of winter season

6.1 Emptying the Bucket

Empty the bucket if it is filled to more than 80% of its full capacity or if you perform a regular maintenance. Check the status register to determine if the bucket needs to be emptied. Use the R0 or R1 commands (SDI-12) or the [KISTERS PreciBal \(RainBal\) App](#)  to do this.

Procedure:

1. Loosen the three screws fixing the enclosure and detach it 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, better use a small bucket or a mug to drain some water before lifting it up. If an antifreeze agent is present, do not dispose of the contents into the 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 the 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!

6.2 Visual Check

Check if there is any 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.

6.3 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.

6.4 Heater Check

Start the [KISTERS PreciBal \(RainBal\) app](#)⁴⁵⁾, connect to the PreciBal and change the heating mode to 1 (permanently switched on) on the **Settings** screen. Wait for about five minutes and check with your hand if the rim (or internal heater) has become warm. Don't forget to switch the heating mode back to automatic (2 or 3).

6.5 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 non corrosive and environmentally friendly antifreeze like propylene glycol. As for the amount it depends on the lowest temperature awaited. Please consult the technical specification of the antifreeze.

An antifreeze such as propylene glycol is utilised to decrease the freezing point of collecting solid precipitation. Propylene glycol is water-based, non-toxic and non-hygroscopic Polymer to be utilised in totalisator weighing precipitation gauges especially for collecting mixed and solid precipitation.

In general, it is not required to add synthetic oil on top of the pre-filled mix of antifreeze with water.

Please fill the antifreeze solution in the following mixing ratio into the bucket of the PreciBal:

Antifreeze	water	Antifreeze protection for filling level 50%	Antifreeze protection for filling level 80%
5.0 l	2.0 l	-15 °C	-8 °C
7.5 l	3.0 l	-34 °C	-4 °C

Attention: Never use the anti-freeze undiluted when you do not add oil on top of the surface! Always add 40 volume per cent water. The pure anti-freeze is hygroscopic and may adhere humid air onto the water surface.

Anti-freeze protection is ensured already when mixture of propylene glycol/water and precipitation is not completely frozen but started to thaw. The content of the container does not need to be completely unfrozen. The bucket will not be damaged even when deep frozen.

6.6 Checking Horizontal Position

PreciBal total precipitation gauges are equipped with a bullseye level. Ensure that the bubble is positioned exactly in the centre of the level, within the black rings.

6.7 Checking Accuracy of Measurement

To check the accuracy of measurement the SDI-12 verification command (aV!) is used. The accuracy check should be performed at dry weather and no or only light wind (wind speed less than 2 m/s, no gusts). To verify accuracy, you will need a precise reference weight (20, 25, 50, 100 or 200 g) and a data logger that supports SDI-12 transparent mode. 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:

1. If the device is connected to a running data logger, pause the measurement.
2. Empty the bucket.
3. Then level the rain gauge.
4. Start the KISTERS AiO application and connect it to the rain gauge.
5. Perform a data reset and wait two minutes.
6. Display the short-term measurement history of the last precipitation.
7. Put a reference weight on the bottom of the bucket. Try to place it precisely in the centre.
8. Observe the value of the last precipitation in the graph or in the table of the short-term measurement history. Wait until the value stops rising, but for at least three minutes (see illustration).



Figure 7 – KISTERS AiO application

The test is successful if the final value in millimetres is within the 'minimum...maximum' range for the specified reference weight and the specified opening area.

9. Remove the reference weight.
10. Perform the data reset again so that the precipitation values measured during the test cannot be read by the data logger.
11. Continue with the measurement.

Reference weight [g]	Orifice area [cm ²]											
	200			314			400			500		
	Min. [mm]	Nom. [mm]	Max. [mm]	Min. [mm]	Nom. [mm]	Max. [mm]	Min. [mm]	Nom. [mm]	Max. [mm]	Min. [mm]	Nom. [mm]	Max. [mm]
20	0.99	1.0	1.01	0.634	0.640	0.646	0.495	0.5	0.505	0.396	0.4	0.404
25	1.238	1.25	1.263	0.788	0.796	0.804	0.619	0.625	0.631	0.495	0.5	0.505
50	2.475	2.5	2.525	1.576	1.592	1.608	1.238	1.25	1.263	0.99	1.0	1.01
100	4.95	5	5.05	3.152	3.184	3.216	2.475	2.5	2.525	1.98	2.0	2.02

Note: The above minimum/maximum values can only be used if the accuracy test is carried out under laboratory conditions. As it is generally not possible to meet such conditions during an on-site accuracy test, a measurement error of 2% is acceptable in this case.

7 Repair

KISTERS precision instruments and data loggers are produced in quality-controlled processes. All KISTERS production and assembly sites in Australia, New Zealand and Europe are ISO 9001 certified. All equipment is factory tested and/or factory calibrated before it is shipped to the client. This ensures that KISTERS products perform to their fullest capacity when delivered.

Despite KISTERS most rigorous quality assurance (QA), malfunction may occur within or outside of the warranty period. In rare cases, a product may not be delivered in accordance with your order.

In such cases KISTERS' return and repair policy applies. For you as a customer, this means the following:

- Contact KISTERS using the Repair Request Form and the Declaration of Contamination made available online:

Region (Language)	Download Link
Asia-Pacific (English)	Repair Request Form (APAC) Declaration of Contamination (APAC)
Europe, the Middle East and Africa (English)	Repair Request Form (EMEA) Declaration of Contamination (EMEA)
Germany (German)	Repair Request Form (DE) Declaration of Contamination (DE)

In response you will receive a reference number that must be referenced on all further correspondence and on the freight documents accompanying your return shipment.

- Please provide as much information and/or clear instructions within the return paperwork. This will assist our test engineers with their diagnosis.
- Please do not ship the goods prior to obtaining the reference number. KISTERS will not reject any equipment that arrives without reference number; however, it may take us longer to process.

Custom requirements for items sent to KISTERS for warranty or non-warranty repairs: Check with your national customs/tax authorities for details, processes and paperwork regarding tax exempt return of products. Typically, special custom tariff codes are available (such as HS Code = 9802.00) that verify the item is being returned for repair and has no commercial value. Please note that the customs invoice / dispatch documents should also clearly state: "Goods being returned to manufacturer for repair – No Commercial value". It is mandatory to have any returned goods accompanied by a commercial invoice on headed paper. KISTERS reserves the right to charge the customer for time spent rectifying incorrect customs documents.

Note: Please ensure that your goods are packed carefully and securely. Damage that occurs during transit is not covered by our warranty and may be chargeable.

8 Technical Specifications

	Model		
	PreciBal 200	PreciBal 314	PreciBal 400
Orifice area	200 cm ²	314 cm ²	400 cm ²
Precipitation range	1500 mm	955 mm	750 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	0.032 mm	0.025 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 protection)		
Power consumption / Current consumption	<25 mW; 4 mA (5 V) ... 0.5 mA (24 V)		
Heating voltage (heating power)	10-30 V AC/DC; I ≈ 0.8-2.5 A; P ≈ 8-75 W		
Pulse output	Relay contact; 2 Hz (250/250 ms); 1/0.1/0.01 mm per pulse; max. 24 V / 0.5 A		
Interfaces	SDI-12, RS-485 (2-wire, 300-115,200 bit/s), Bluetooth Low Energy, USB (optional)		
Communication protocols	SDI-12 Version 1.4, Modbus RTU, Modbus ASCII, older MPS/ASCII protocol		
Dimensions (without base)	Ø 385 × 650 mm	Ø 385 × 610 mm	Ø 385 × 610 mm
Mass	9.5 kg	9.5 kg	9.5 kg
Operating temperature range	-40 ... +70 °C		
Storage temperature	-50 ... +70 °C		
Operating humidity	0 ... 100%		

9 Obligations of the Operator and Disposal

This chapter contains the following subsections:

- [Obligations of the Operator](#)⁴³
- [Dismantling / Disposal](#)⁴³

9.1 Obligations of the Operator

European Union

In the Single European Market it is the responsibility of the operator to ensure that the following legal regulations are observed and complied with: national implementation of the framework directive (89/391/EEC) and the associated individual directives, in particular 2009/104/EC, on minimum safety and health requirements for the use of work equipment by employees at work.

Worldwide

Regulations: If and where required, operating licences must be obtained by the operator. In addition, national or regional environmental protection requirements must be complied with, regardless of local legal provisions regarding the following topics:

- Occupational safety
- Product disposal

Connections: Local regulations for electrical installation and connections must be observed.

9.2 Dismantling / Disposal

When disposing of the units and their accessories, the applicable local regulations regarding environment, disposal and occupational safety must be observed.

Before dismantling

- Electrical Devices:
 - Switch off the units.
 - Disconnect electrical appliances from the power supply, regardless of whether the appliances are connected to the mains or to another power source.
- Mechanical devices:
 - Fix all loose components. Prevent the device from moving independently or unintentionally.
 - Loosen mechanical fastenings: Please note that appliances can be heavy and that loosening the fastenings may cause them to become mechanically unstable.

Disposal

Operators of old appliances must recycle them separately from unsorted municipal waste. This applies in particular to electrical waste and old electronic equipment.

Electrical waste and electronic equipment must not be disposed of as household waste!

Instead, these old appliances must be collected separately and disposed of via the local collection and return systems.

Integrated or provided batteries and accumulators must be separated from the appliances and disposed of at the designated

collection point. At the end of its service life, the lithium-ion battery must be disposed of according to legal provisions.

EU WEEE Directive

As players in the environmental market, KISTERS AG is committed to supporting efforts to avoid and recycle waste. Please consider:

- Avoidance before recycling!
- Recycling before disposal!



This symbol  indicates that the scrapping of the unit must be carried out in accordance with Directive 2012/19/EU. Please observe the local implementation of the directive and any accompanying or supplementary laws and regulations.

10 Appendices

This chapter contains the following subsections:

- [KISTERS PreciBal \(RainBal\) App](#)

10.1 KISTERS PreciBal (RainBal) App

The KISTERS PreciBal (RainBal) app changes the way you interact with the device. The PreciBal (RainBal) App provides a suite of innovative, easy to use features that put the power of the device right in the palm of your hand.

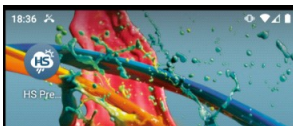
The KISTERS PreciBal (RainBal) app connects to the device via Bluetooth®.

The App is available for free for Android and iOS.

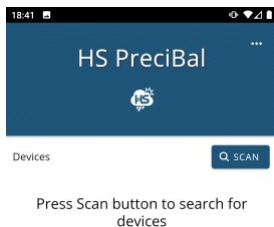
10.1.1 PreciBal/RainBal App Functionality in a Nutshell

- Pair with and connect to your device(s).
- Access measurement data from various registers with numerical and graphical visualisation.
- Display and edit selected parameter settings.
- Display and forward log data by email (device status information).
- Update the Firmware.

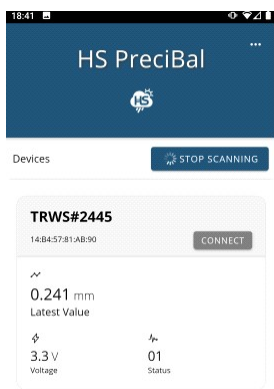
10.1.2 Precibal/RainBal App – User Interface



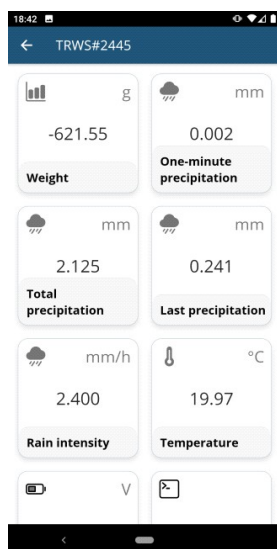
To start the PreciBal (RainBal) App: Click the KISTERS PreciBal (RainBal) icon on your smartphone and tablet.



The App opens. Press the **[SCAN]** button to start scanning for nearby devices.



The App starts searching for devices. When a device is found it is inserted in a list. The **[CONNECT]** button enables you to connect to a specific device. Once the device you want to connect to is found, you may want to "STOP SCANNING".



Once properly connected, the PreciBal (RainBal) App shows the latest readings from the device.

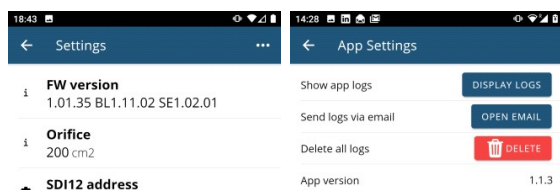
Each value is shown in a separate tile.

Depending on your device, the list of tiles may be too long to fit the screen. Use the usual touch display functions to scroll up and down to view all values or a desired specific data value.



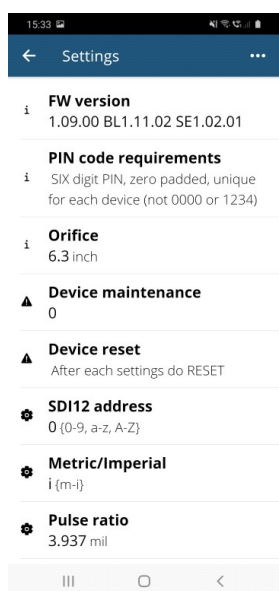
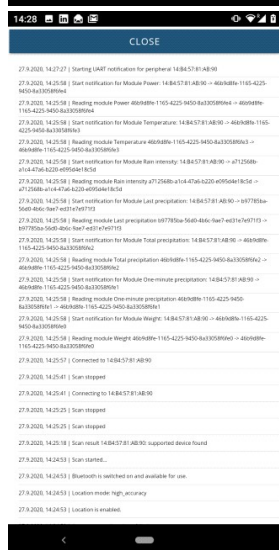
Tiles are active elements, just like a button. Clicking a tile gives access to a detailed view on the data.

The screenshot on the left-hand side visualises "Total precipitation" data with a line graph showing on top and a numeric table of individual values at the bottom.

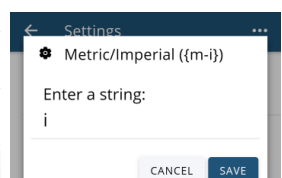


Other tiles provide access to device settings as illustrated in the screenshots.

Device status log information can be viewed on the mobile device and/or forwarded by email.



Changing physical units: The default setting is metric units. Use the **SETTINGS** menu of the App to switch to imperial units. The setting is performed manually: entering 'm' sets metric units, entering 'i' sets imperial units. To activate the settings, reset the device (also using the **SETTINGS** menu of the App).



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