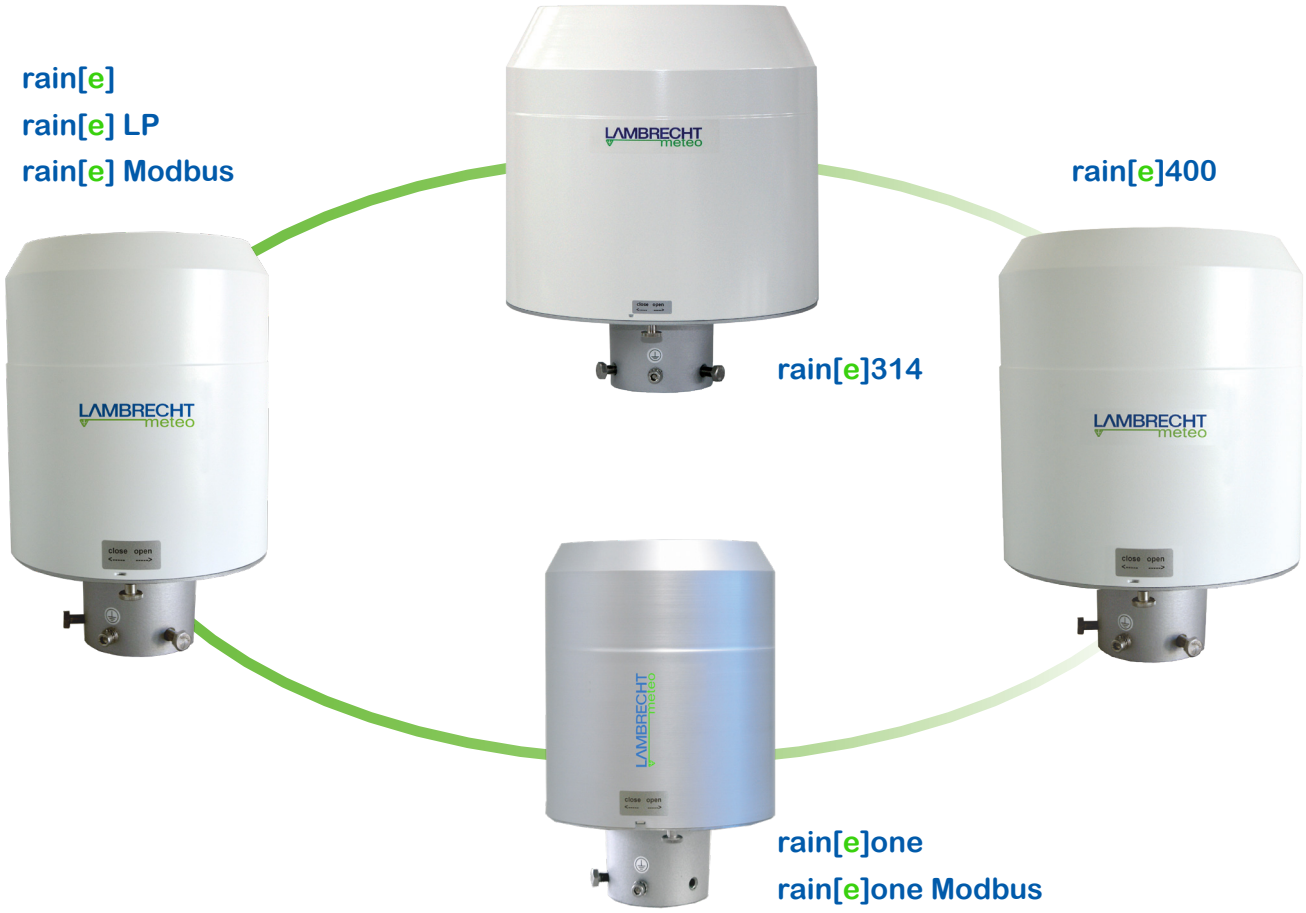


rain[e] Series

rain[e] is a new type of precipitation sensor that combines highest resolution with a very compact design. The unique, continuously self-emptying collection system enables the measurement of each single drop. The rain[e] series is compatible with a wide range of data loggers and ideal for setting up measurement networks.

- Latest weighing technology, compact design
- Fully automatic continuous emptying prevents over low and incorrect measurements
- DAkkS proof of non-impact of the measurement sensor by wind and solar radiation
- Wide range of signal outputs:
  - Two independently con igurable pulse outputs
  - SDI-12
  - RS485 (SDI-12 protocol, ASCII protocol, TALKER protocol)
  - Analogue output
  - Modbus
- Cold climate model with two electronically controlled heating circuits
- Environmentally friendly, as free of antifreeze agent
- Models with 200 cm^2, 314 cm^2 and 400 cm^2 collecting area
- WMO compliant

Table of Contents

1 Scope of Delivery

- **rain[e]** sensor
- Collecting vessel
- These operating instructions
- USB-to-mini-USB cable
- Software **rain[e]**-Commander (country-dependant on CD or as download)

Check the delivery for transport damage and document it extensively to lodge claims for damage against the shipper. Afterwards contact the LAMBRECHT service department on **+49-(0)551-4958-0.**

2 Order Codes

rain[e] (heated)	**00.15184.400 000**
rain[e] (unheated)	**00.15184.000 000**
rain[e] Modbus (heated)	**00.15184.400 100**
rain[e] Modbus (unheated)	**00.15184.000 100**
rain[e] 400 (heated)	**00.15184.404 000**
rain[e] 400 (unheated)	**00.15184.004 000**
rain[e] 314 (heated)	**00.15184.403 000**
rain[e] 314 (unheated)	**00.15184.003 000**
rain[e]one (heated)	**00.15184.400 001**
rain[e]one (unheated)	**00.15184.000 001**
rain[e]one Modbus (heated)	**00.15184.400 101**
rain[e]one Modbus (unheated)	**00.15184.000 101**
rain[e]LP (unheated)	**00.15184.010 000**

The order codes for accessories and spare parts can be found in chapter “Equipment and Spare Parts”.

3 Safety Instructions and Warranty

This system is designed according to the state-of-the-art accepted safety regulations. However, please note the following rules:

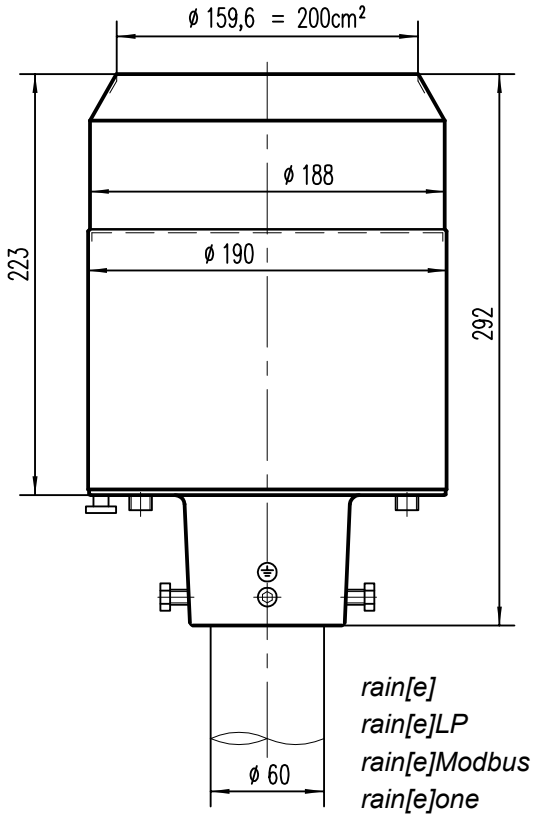
1. Before putting into operation please read all respective manuals!
2. Please observe all internal and state-specific guidelines and/or rules for the prevention of accidents. If necessary ask your responsible safety representative.
3. Use the system only as described in the manual.
4. Always have the manual at hand at the installation site.
5. Use the system within the specified operating condition. Eliminate influences, which might impair the safety.
6. Prevent the ingress of unwanted liquids into the devices.
7. Funnel heating and drain heating can be very hot if the heating is operated with the housing open. There is a risk of being burnt! It is therefore recommended that the connector of the heating supply be disconnected during cleaning and maintenance work.
8. The measuring edge of the upper part of the housing is quite sharp. There is a risk of cuts. It is therefore recommended that the measuring edge not to be pressed on and/or that gloves are worn!

Please note the loss that unauthorized manipulation of the system shall result in the loss of warranty and non-liability. Changes to system components require express written permission from LAMBRECHT meteo GmbH. These activities must be performed by a qualified technician.

The warranty does not cover:

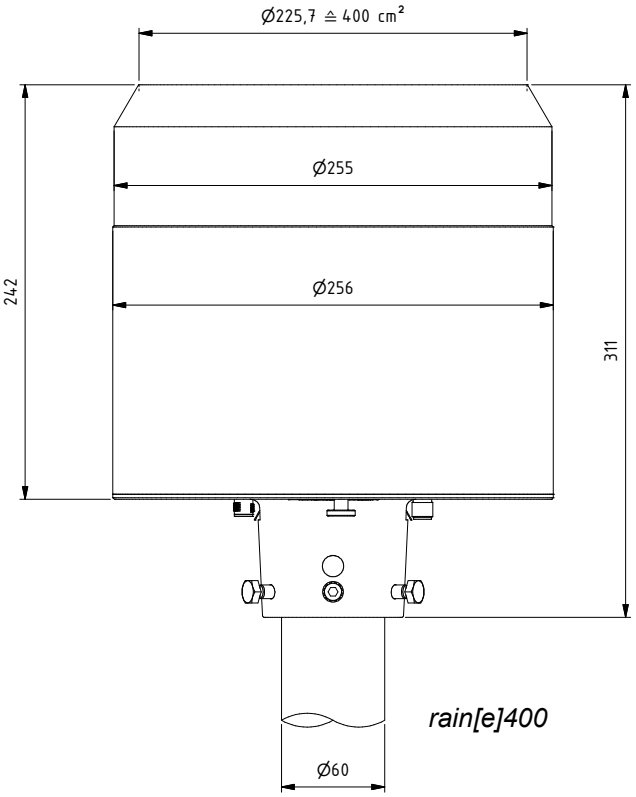
1. Mechanical damage caused by external impacts (e. g. icefall, rockfall, vandalism).
2. Impacts or damage caused by over-voltage or electromagnetic fields which are beyond the standards and specifications of the device.
3. Damage caused by improper handling, e. g. by using the wrong tools, incorrect installation, incorrect electrical installation (incorrect polarity) etc.
4. Damage caused by using the device outside the specified operation conditions.

4 Dimensional Drawings and Product Drawing



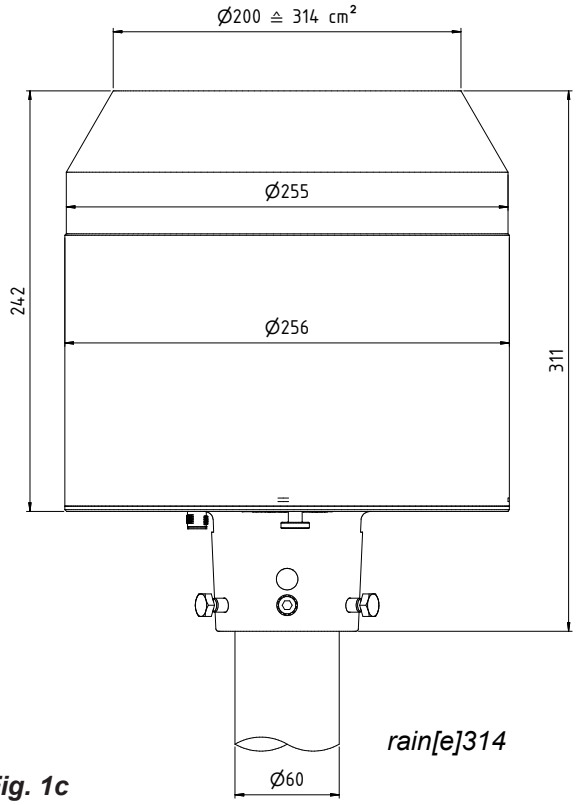
rain[e]
rain[e]LP
rain[e]Modbus
rain[e]one
rain[e]one Modbus

Fig. 1a



rain[e]400

Fig. 1b



rain[e]314

Fig. 1c

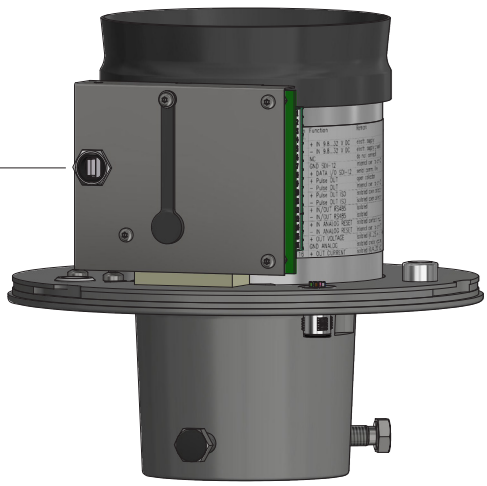


Fig. 1d

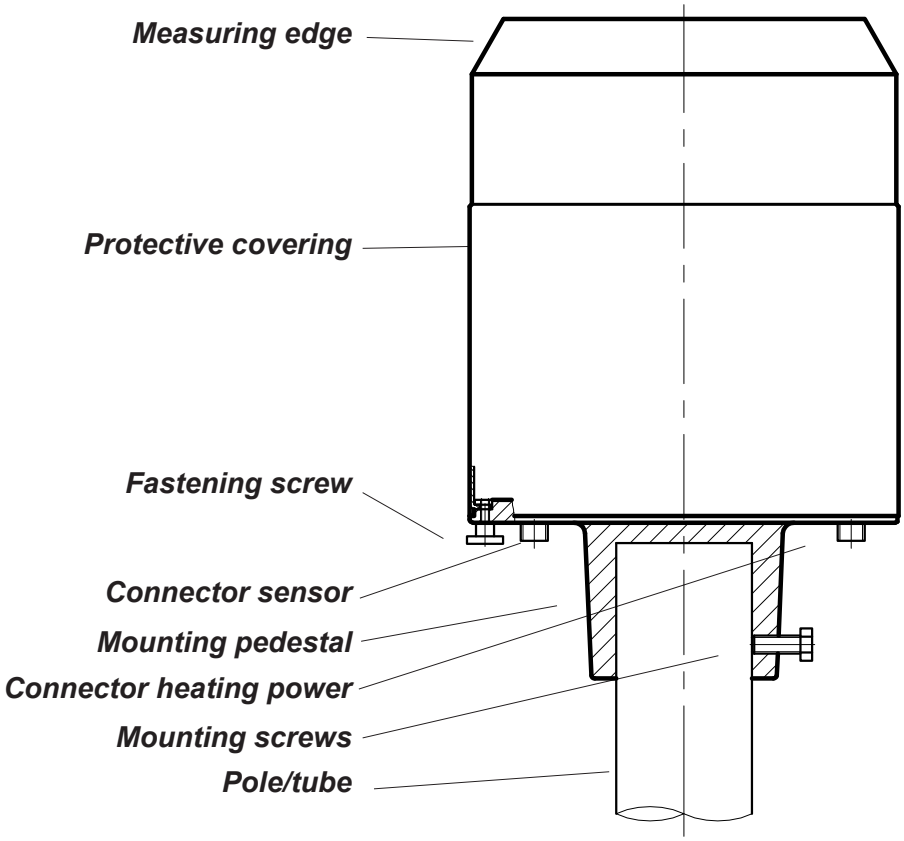


Fig. 2

5 Introduction

The precipitation sensor **rain[e]** measures precipitation amount and intensity. The **rain[e]** combines the advantages of the latest weighing technology and a self-emptying collecting vessel, allowing a high resolution and high precision at a very small total volume. Therefore the **rain[e]** has a higher resolution and precision than common tipping bucket sensors and at the same time is much smaller than common weighing sensors, since there is no need for a collecting container.

The main sensor is a highly precise load cell with overload protection. Its temperature coefficient can be determined using a temperature sensor in the interior space if necessary. The pulses from the reed contact generated by tipping the collecting vessel are used for error correction during periods of high intensity precipitation. Furthermore, the self-emptying system allows weighing without interruption.

The **rain[e]** calculates the following values:

- Amount of precipitation (Pulse or Analogue Output)
  The **rain[e]** outputs the amount of precipitation in real time via the pulse or analogue output with a maximum resolution of 0.01 mm.
- Intensity within the last minute (SDI-12 or RS485 interface)
  The **rain[e]** measures 6 times per minute and sums these values up in a moving sum - that is, every time a new value is measured, it is summed to the previous 5 values and thus generates the new value for the intensity within the last minute.

- Intensity since last retrieval (SDI-12 or RS485 interface)
  The difference in the amount of precipitation since the last retrieval is divided by the time since the last retrieval. If the time is smaller than 30 s, the **rain[e]** will use the “intensity within the last minute” value.

- Amount since last retrieval (SDI-12 or RS485 interface)
  The difference in the amount of precipitation between the current and the last retrieval.

- Minimum intensity within the last x minutes (SDI-12 or RS485 interface)
  Every minute the value of the intensity within the last minute is compared to the current minimum value. If the new value is smaller, it replaces the former minimum value.

- Maximum intensity within the last x minutes (SDI-12 or RS485 interface)
  Every minute the value of the intensity within the last minute is compared to the current maximum value. If the new value is bigger, it replaces the former maximum value.

- Average intensity within the last x minutes (SDI-12 or RS485 interface)
  Counts the amount of precipitation in steps of 0.01 mm for x minutes and divides the result by x minutes.

- Variance (SDI-12 or RS485 interface)
  Variance of measured values over 4 s

The two pulse outputs can be configured to return the amount of precipitation with resolutions between 0.01 and 1 mm and closing times between 10 and 500 ms (see ch. 7 and ch. 8.3). Alternatively they can be configured to return the status Heating ON/OFF or Rain YES/NO.

The analogue output can be used in the two modes 0/4...20 mA or 0...2.5/5 V DC to return the amount of precipitation. For further details on the functioning of the analogue output and the reset function see chapter 8.4 .

For further details on the way the values will be returned using SDI-12 protocol via SDI-12 or RS485 interface and the available commands see chapter 8.1 and 8.2.1. For further information regarding the configuration see chapter 7. In addition to SDI-12, the RS485 interface can be used in Talker or WL ASCII mode. For descriptions of these modes please see chapters 8.2.2 and 8.2.3.

5.1 Heating

For applications in regions with seasonal or permanent cold climate the **rain[e]** is available as a heated version. To melt solid precipitation in the funnel and prevent the outlets from complete icing the internal heating of the heated **rain[e]** is separated into two parts. An 80 W heating pad (resp. 150 W heating pad at rain[e]400) along the funnel surface and a 60 W heating plate below the protective wired grid and the collecting vessel. The targeted temperature of the inner funnel surface is 2 °C. The heated **rain[e]** is operational at -40...70 °C. The operational readiness is checked continuously and can be requested via SDI-12, RS485 or pulse output (see ch. 8.1 and 8.2 or ch. 7).
The heating can be switched off via the configuration software **rain[e]** Commander (see ch. 7). In the factory settings the heating is switched on. The heating uses a separate power cable.

Funnel heating and drain heating can be very hot if the heating is operated with the housing open. There is a risk of being burnt! It is therefore recommended that the connector of the heating supply be disconnected during cleaning and maintenance work.

6 Installation

6.1 Site Selection

To minimise the entry of splash water it is recommended that sites with hard ground like concrete are avoided. Place the precipitation sensor on grass or other soft ground instead. In general the sensor should not been placed on slopes or roofs. We recommend installation of the precipitation sensor at a distance of at least 2 m from any obstacle or the obstacle height (above the gauge's orifice), as defined by the German Meteorological Service DWD or twice the obstacle height as defined by the WMO and preferably at a distance of four times the obstacle height. Vegetation around the site have to be clipped regularly to the height of the sensor to prevent them from disturbing the measurement and at the same time reduce wind influence.

6.2 Mounting

Necessary tools

► Wrench (13 mm)
► Allen key (6 mm)
► Slotted screwdriver (approx. 2.5 blade width)

- Unpack the device.
- Take the box of the collecting vessel out of the funnel of the **rain[e]**.
- Check the collecting vessel for transport damage and put it back into its box for later installation.
- Place the sensor on a tube or pole with an outer diameter of 60 mm. A metallic extension tube with a minimum length of 100 mm is recommended if a wooden pole is used. Use a wrench (13 mm) to tighten the screws in the mounting pedestal evenly.

Do not damage the measuring edge.

- To improve the operating security in lightning-prone areas it is suggested that the sensor be earthed via the integrated earthing screw of the **rain[e]**. The illustration shows the steps of installation of an earthing connection with a cable clip and earthing screws onto the sensor. The other end of the cable should be connected to a ground nail.

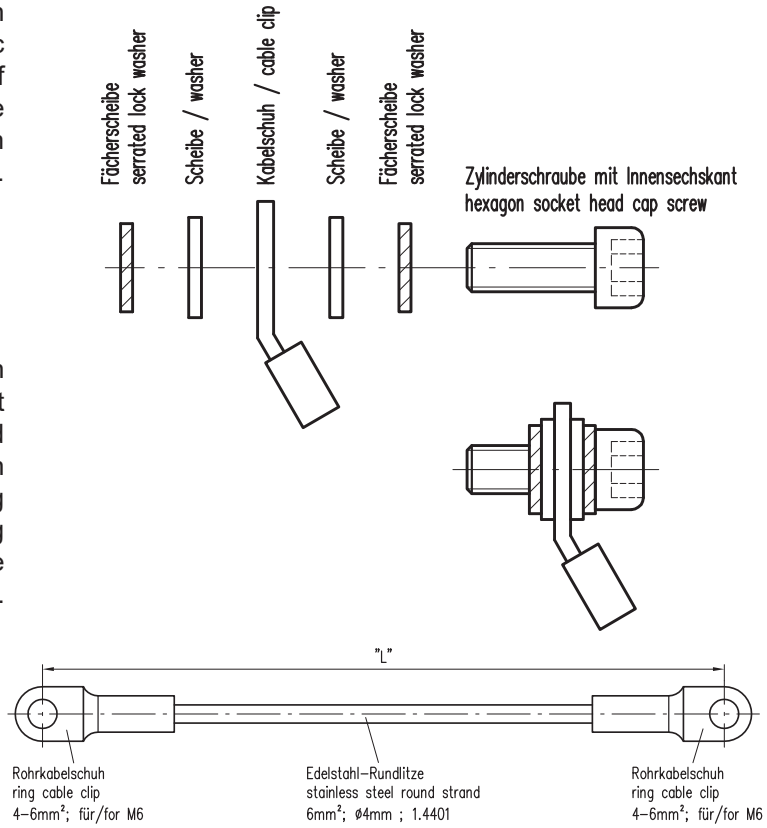


Fig 3

6.3 Integrated Collecting System

Illustrations using the example rain[e]

Fig. 4

- Open the device.
  - Unscrew the knurled screw at the bottom.
  - Take hold of the casing and base and turn the casing in the “open” direction (anti-clockwise).
  - Lift the casing with caution. Mind the heater’s terminal plug.

The measuring edge of the upper part of the housing is quite sharp. There is a risk of cuts. It is therefore recommended that the measuring edge not be pressed on and/or that gloves are worn!

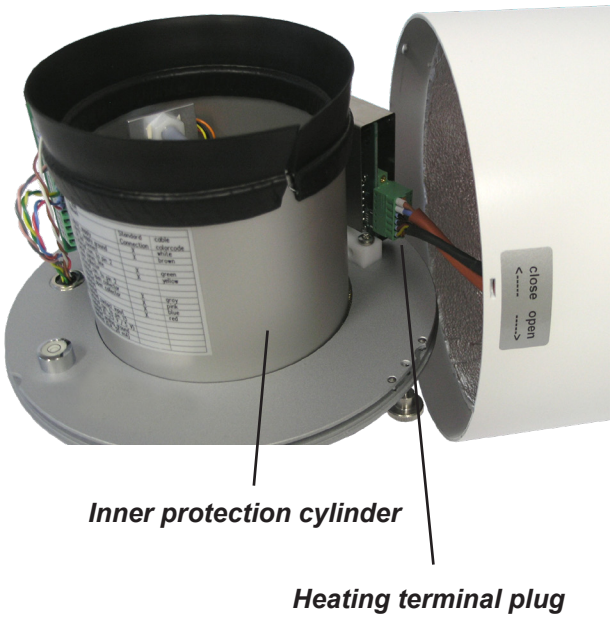
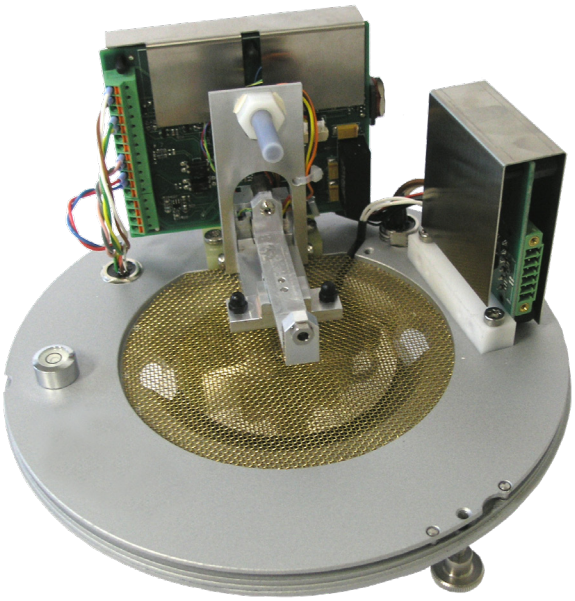


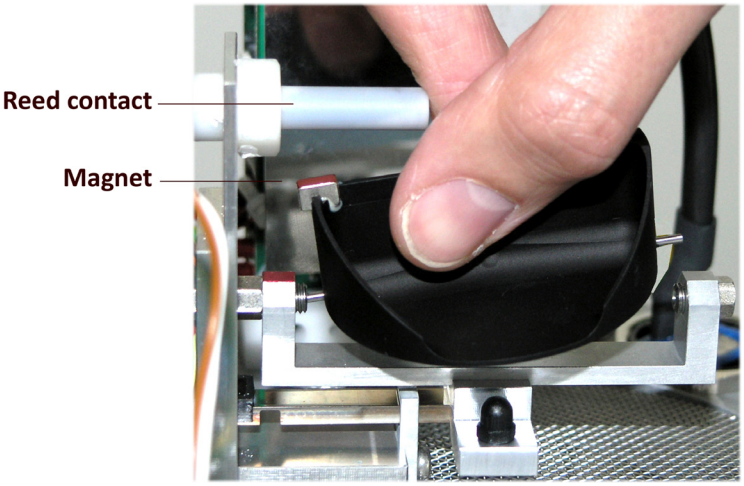
Fig. 5

- Remove terminal plug.
- Place the housing aside.
- Lift inner protection cylinder.



Inner workings of the **rain[e]** without collecting vessel.

Fig. 6



- Unpack the collecting vessel.
- Insert the collecting vessel.
  - Insert collecting vessel against the bearing spring with the site of the magnet facing towards the reed contact (Fig. 7)
  - Insert the other axis into the other bearing.
  - **Test for flawless tipping.**

Fig. 7

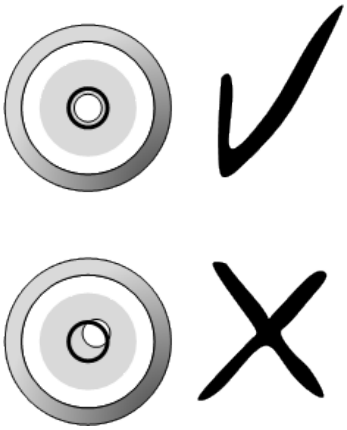


Fig. 8

Level the device with the assistance of the spirit level (Fig. 8) by tightening the hexagon head screws in the base evenly.

Fig. 9

- Reassembly
  - Cautiously put the inner protection cylinder back into place.
  - Plug in the terminal plug of the heating.
  - Put the casing onto the device – embossings into notches (Fig. 8).
  - Press down on the housing and turn it clockwise towards “close”.
  - Fasten the knurled screw.
  - Insert the enclosed dirt trap spiral into the funnel (Fig. 10).

The measuring edge of the upper part of the housing is quite sharp. There is a risk of cuts. It is therefore recommended that on the measuring edge not be pressed on and/or that gloves are worn!

In order to protect the collecting vessel the dirt trap spiral must be inserted into the collecting funnel.

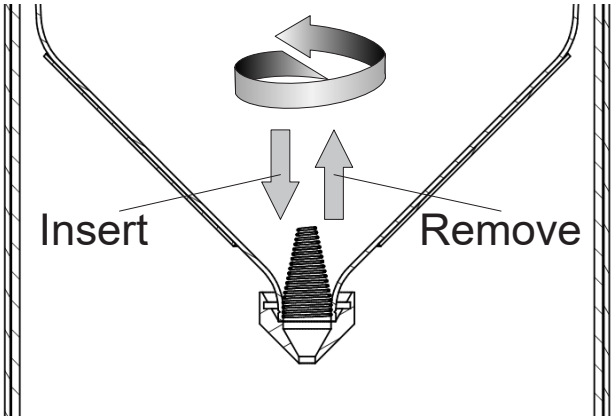


Fig. 10

- **Inserting of the dirt trap spiral**
  Insert the enclosed dirt trap spiral in the funnel. The spiral should be held in such a way that a complete turn in the anti-clockwise direction is possible. Push the dirt trap spiral in circular motion from above into the funnel opening.
- **Removing the dirt trap spiral**
  Grab the dirt trap spiral in such a way that a complete turn in the anti-clockwise direction is possible and pull it in a circular motion towards the funnel opening.

6.4 Power and Signal Connection

To connect the to a data acquisition system a M12 connecting cable e.g. 32.15184.060000 is required. Connect the cable according to the connecting diagram **rain[e]** without heating'. For the power supply of the heating, a power cable is required, which has to be connected to the power supply unit according to the connecting diagram **rain[e]** with heating'.

Connecting cable sensor, 8-pole, 10 m	32.15184.060000
Connecting cable Modbus sensor, 4-pole, 15 m	32.14567.060010
Connecting cable heating, 1 m	32.15184.061000

It is important to plug in the power plug of the heating first – before the terminal plug of the funnel heating and the sensor connector. Otherwise the automatic heating control will shut down the heating.

The maximum distance between the **rain[e]** and the data acquisition system depends on the interfaces being used. The values for SDI-12 and RS485 are obtained from the respective definitions of these standards.

- SDI-12 70 m, unshielded, low voltage cabling
- RS485 1000 m,
- Pulse output 1000 m.

If a power cable longer than our recommended 1 m power supply cable is be used for heating supply, this formula can be used to calculate the actual power P_a with the nominal voltage U_N = 24 V DC, the nominal power P_N = 140 W, the specific electrical resistance ρ = *0.017 Ωmm²/m for copper*, the length of the cable l and the cross section of the cable A.

$$P_a = \frac{U_N^4}{P_N\left(\frac{U_N^2}{P_N} + 2\rho\frac{l}{A}\right)^2}$$

The heating requires an actual power P_a of higher than 125 W to operate.

The USB cable for the service interface should not be longer than 3 m.

For **rain[e]H** applies: P_a > 125 W and P_N = 140 W;
for **rain[e]400H and rain[e]314H** applies: P_a > 187 W and P_N = 210 W

6.5 System Start

The system starts automatically after connecting all plugs. After ~15 s the system starts collecting data and sends them to the attached data logger according to the device configuration. T

Overview status LED (in the center of the main board, underneath the protection plate):	
System start	Permanent lighting of the LED for approx. 3 seconds
In operation	Fast flashing of the LED

6.6 Available In- and Outputs

The **rain[e]** provides the following outputs:

Pulse Output:
- 1 galvanically isolated open-collector and
- 1 non-isolated open-collector

selectable as
- Pulse Output
  - Resolution: 0.01...1 mm
  - Closing time: 10...500 ms (duty cycle of 1:1)
- Status Output (heating ON / OFF; rain YES / NO)

Analogue Output:
- 0 / 4…20 mA
- 0...2.5 / 5 V

Serial output:
- SDI-12
- RS485 (Talker protocol, WL ASCII protocol, SDI-12 protocol)
- Modbus RTU

6.7 Factory Settings (heated / unheated)

6.7.1 Factory Settings rain[e], rain[e]314, rain[e]400, rain[e]one

Id-No.:

00.15184.000000	**00.15184.004000**	**00.15184.000001**	**00.15184.400000**
00.15184.404000	**00.15184.400001**	**00.15184.403000**	**00.15184.003000**

The factory settings of the **rain[e]** according to the standard connecting diagram are:

- Galvanically isolated output as pulse output
  Resolution: 0.1 mm
  Closing time: 300 ms
  Duty cycle: 1:1

- Galvanically non-isolated output as pulse output
  Resolution: 0.01 mm
  Closing time: 300 ms
  Duty cycle: 1:1

- SDI-12 protocol activated (on SDI-12 Interface, 1200 Bd)
- Analogue output OFF
- Heating activated (if available)

6.7.2 Factory Settings rain[e]LP

Id-No.: 00.15184.010000

The factory settings of the **rain[e]** according to the standard connecting diagram are:

- Galvanically isolated output as pulse output
  Resolution: 0.1 mm
  Closing time: 300 ms
  Duty cycle: 1:1

- Galvanically non-isolated output as pulse output

  Resolution: 0.01 mm
  Closing time: 300 ms
  Duty cycle: 1:1

- SDI-12 protocol activated

6.7.3 Factory Settings Modbus Versions

Id-No.:
00.15184.400100 00.15184.400101 00.15184.000100 00.15184.000101

RS485 interface configured to Modbus RTU

Baud rate: 19200 Baud
Communication frame: 8E1 (1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit)

6.8 Terminal Assignment

All unused wires must be connected to unused pins or insulated to avoid malfunctions.

The following wiring diagrams illustrate the pin assignment of the rain[e] versions with 8-pin plug for the corresponding quick configurations in the rain[e] Commander configuration software.
To document your own assignment, we provide you with an empty connection diagram at the end of this operating manual.

Connecting diagram with heating

Id-No. 00.15184.400000, 00.15184.404000, 00.15184.400001 and 00.15184.403000

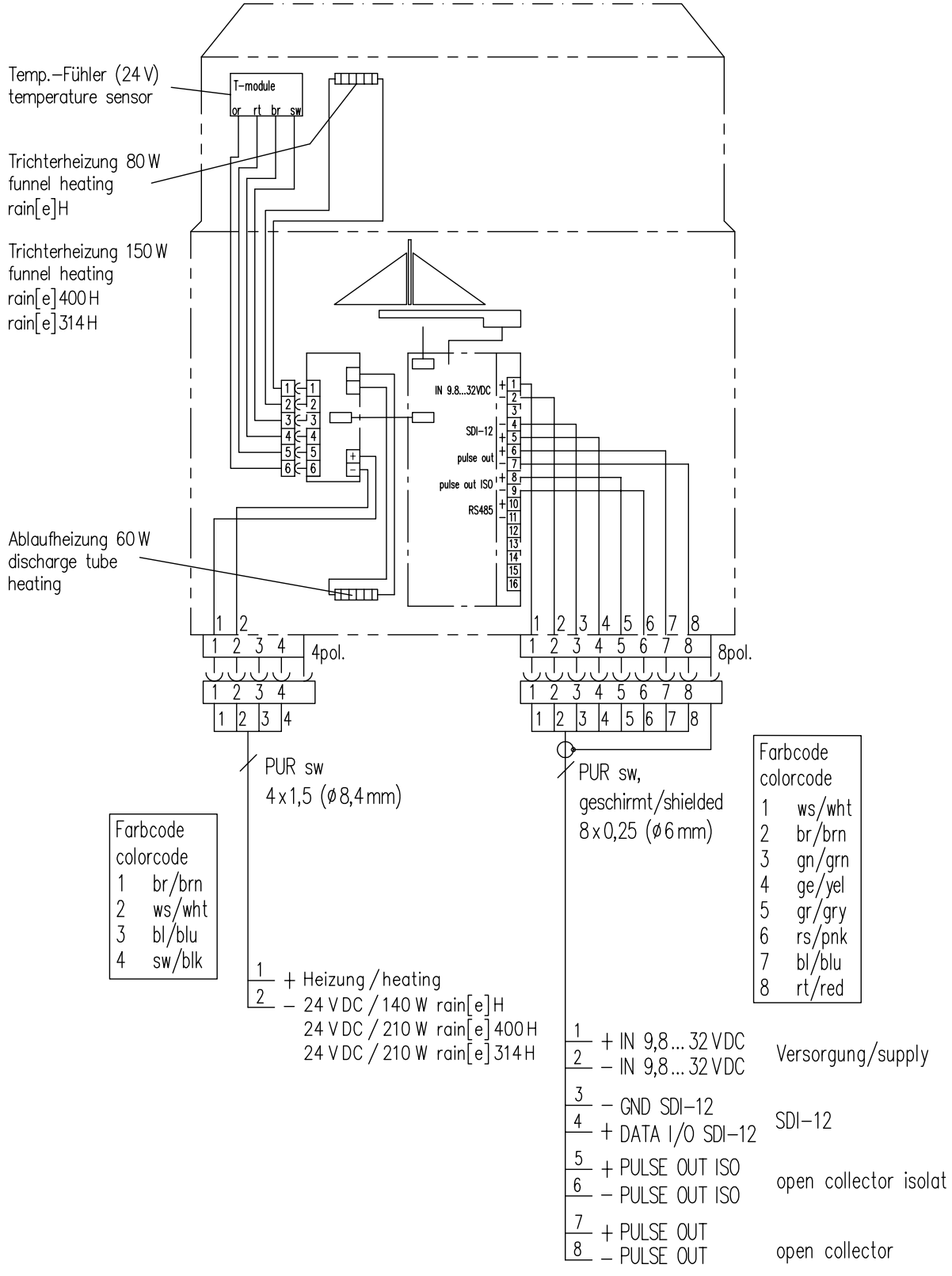


Fig. 11 a

Connecting diagram without heating

Id-No. 00.15184.000000, 00.15184.004000, 00.15184.000001 and 00.15184.003000

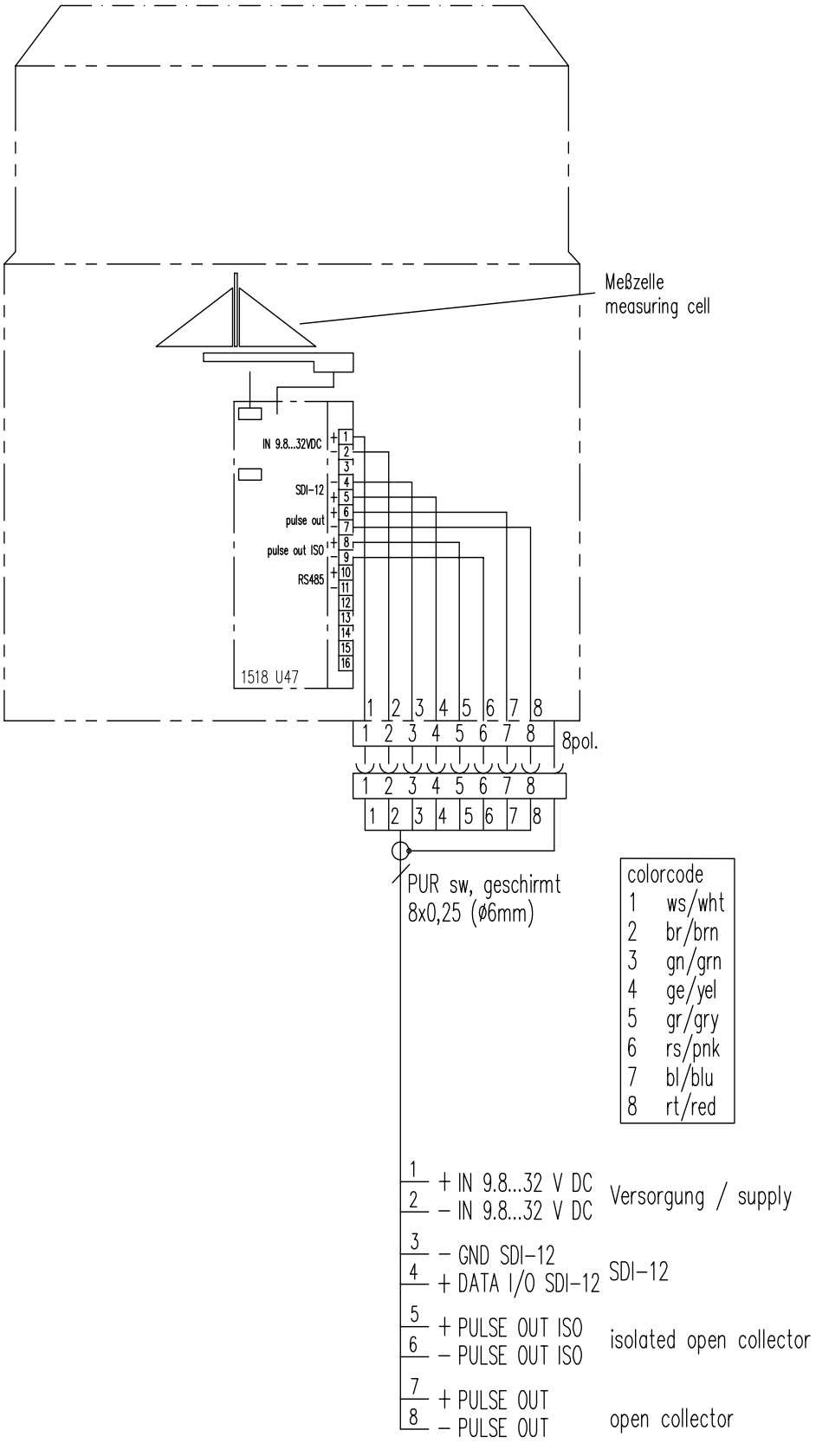


Fig. 11 b

Connecting diagram without heating / Modbus / 4-pin plug

Id-No. 00.15184.000100 and 00.15184.000101

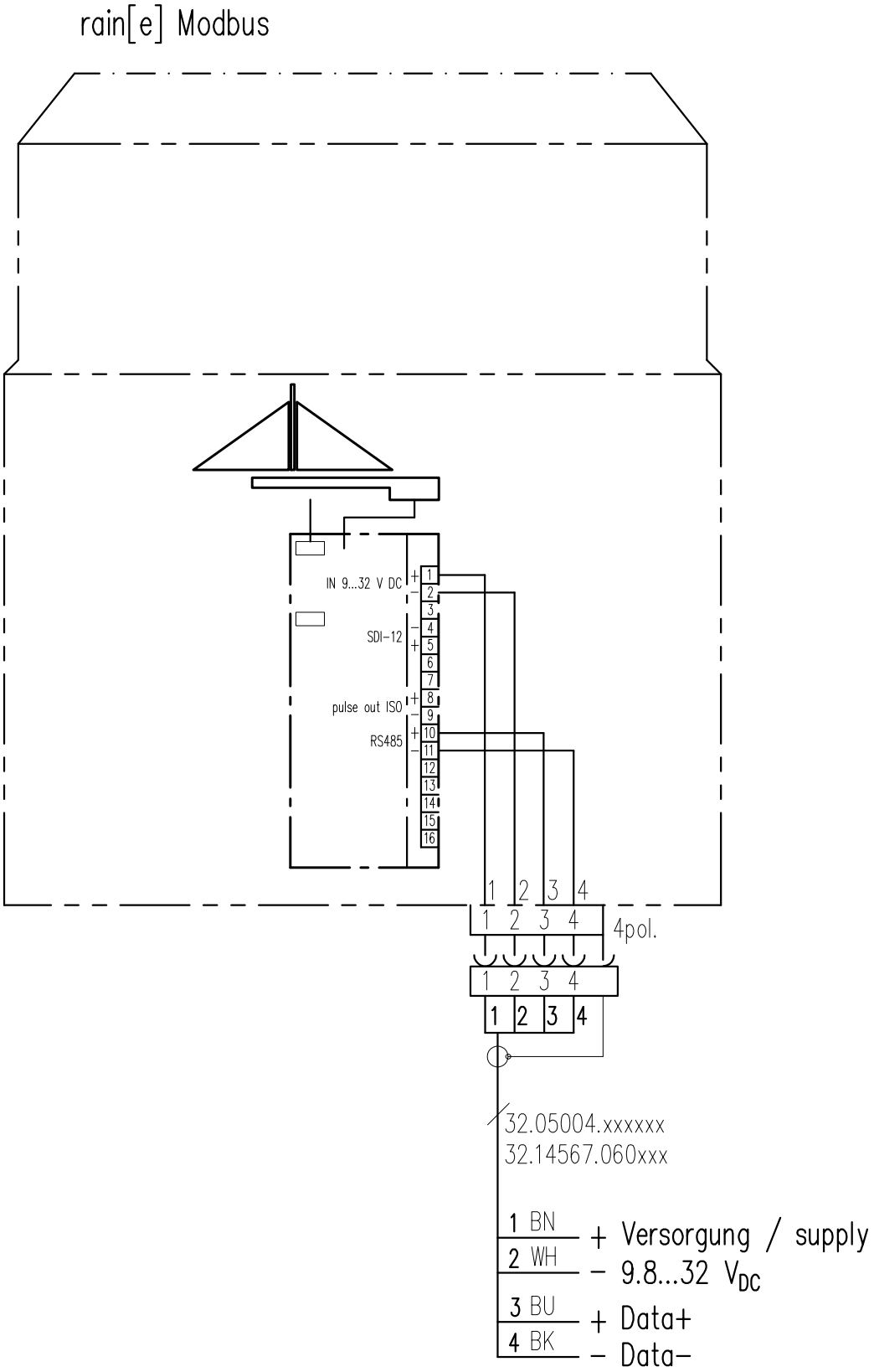


Fig. 12

Connecting diagram with heating / Modbus / 4-pin plug

Id-No. 00.15184.400100 and 00.15184.400101

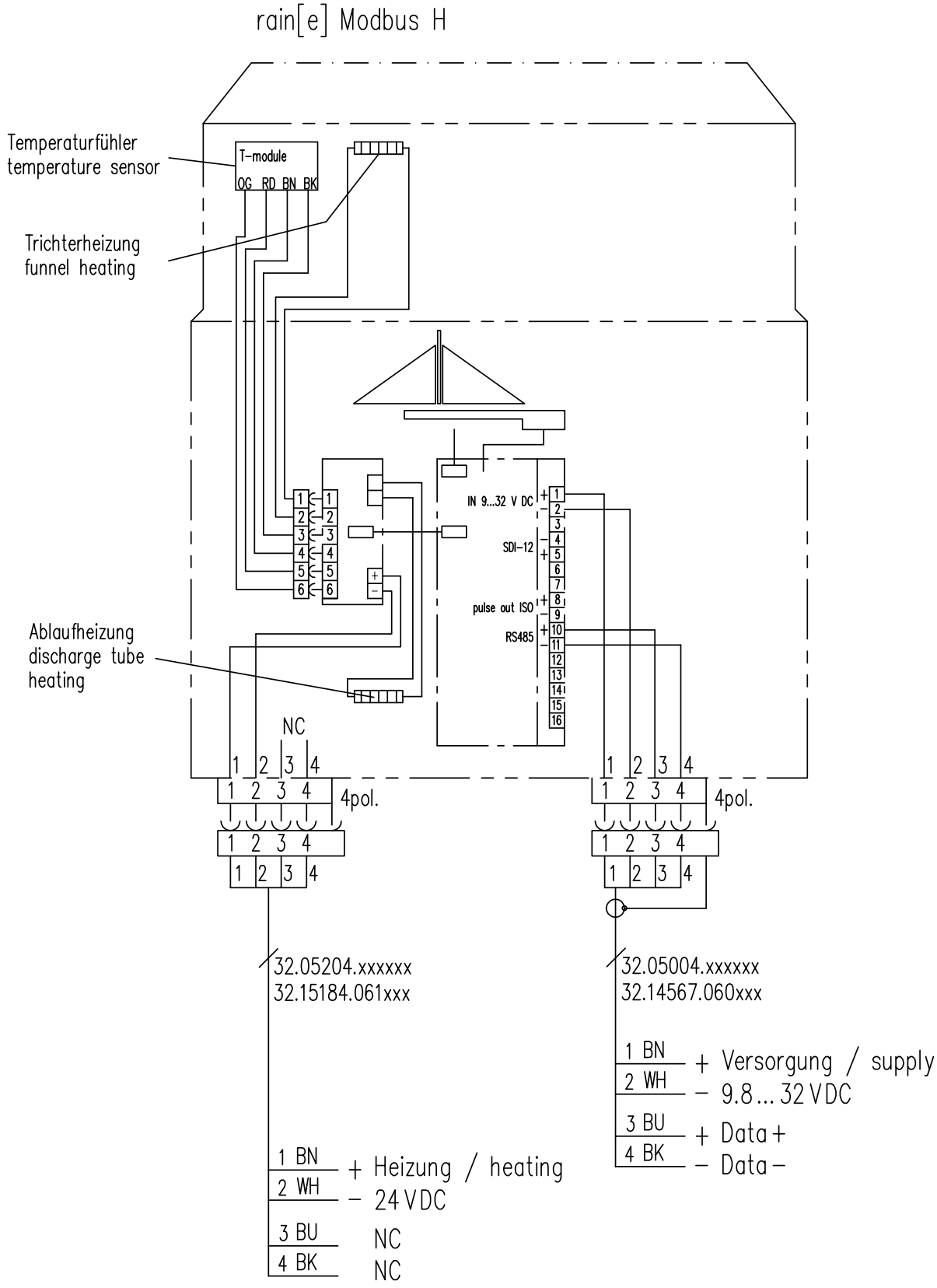


Fig. 13a

Connecting diagram without heating / 5-pin plug

Id-No. 00.15184.010000

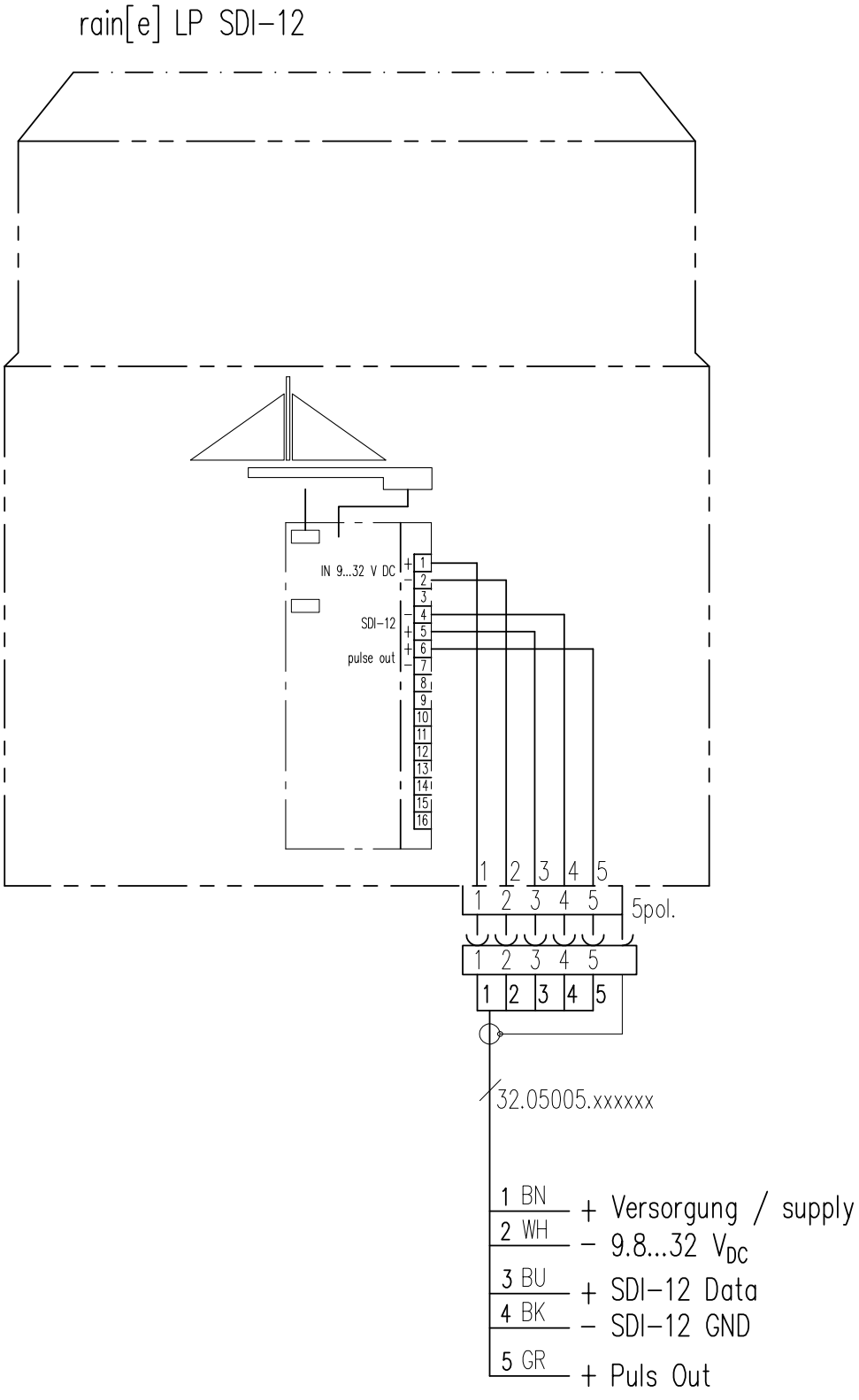


Fig. 14

Connecting Diagram for Quick Configuration ‘Analog Output 4...20 mA’

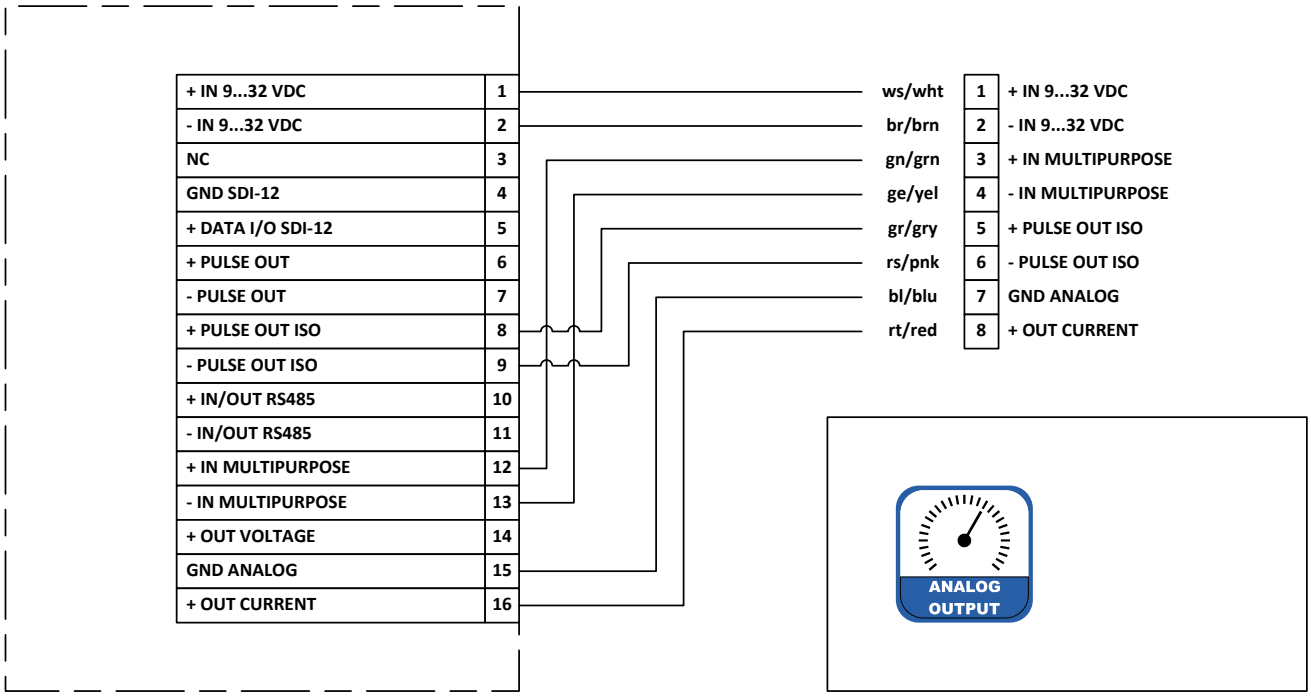


Fig. 15

Connecting Diagram for Quick Configuration ‘Analogue Output 0...2.5 V’

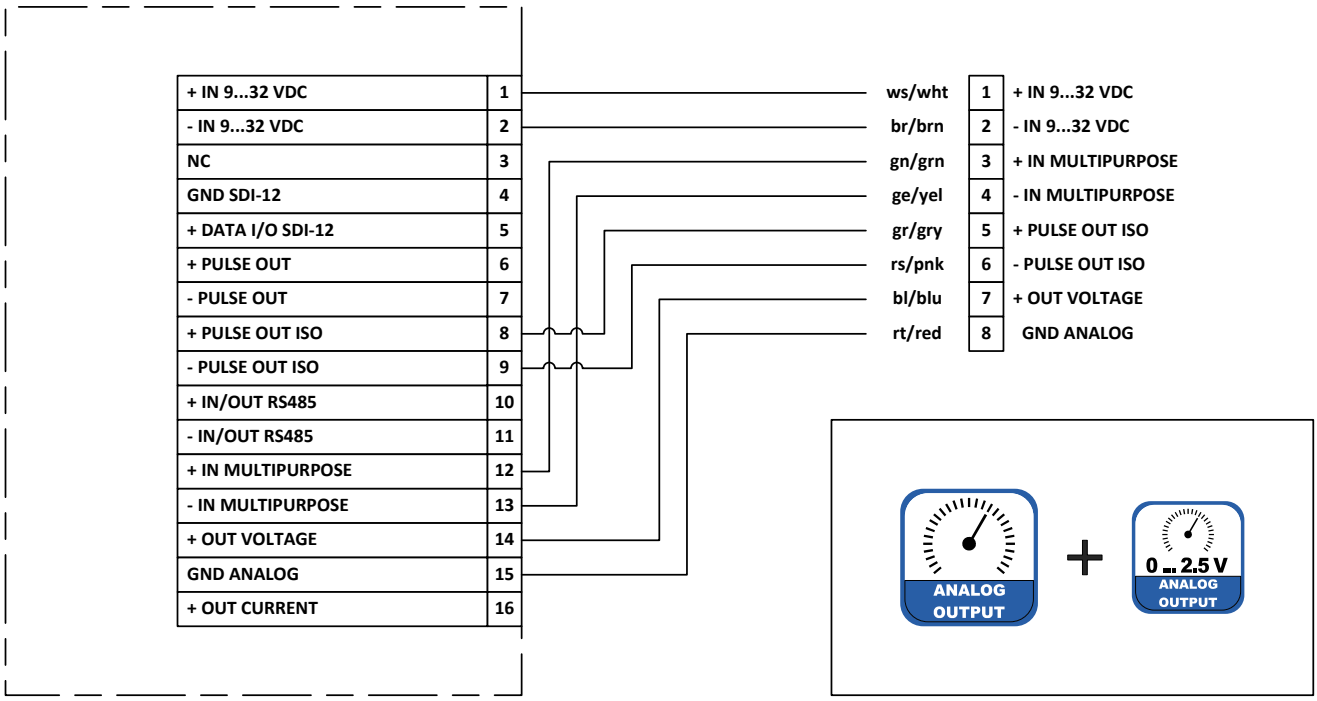


Fig. 16

Connecting Diagram for Quick Configuration ‘Analogue 4...20 mA / Digital Output +RS485’

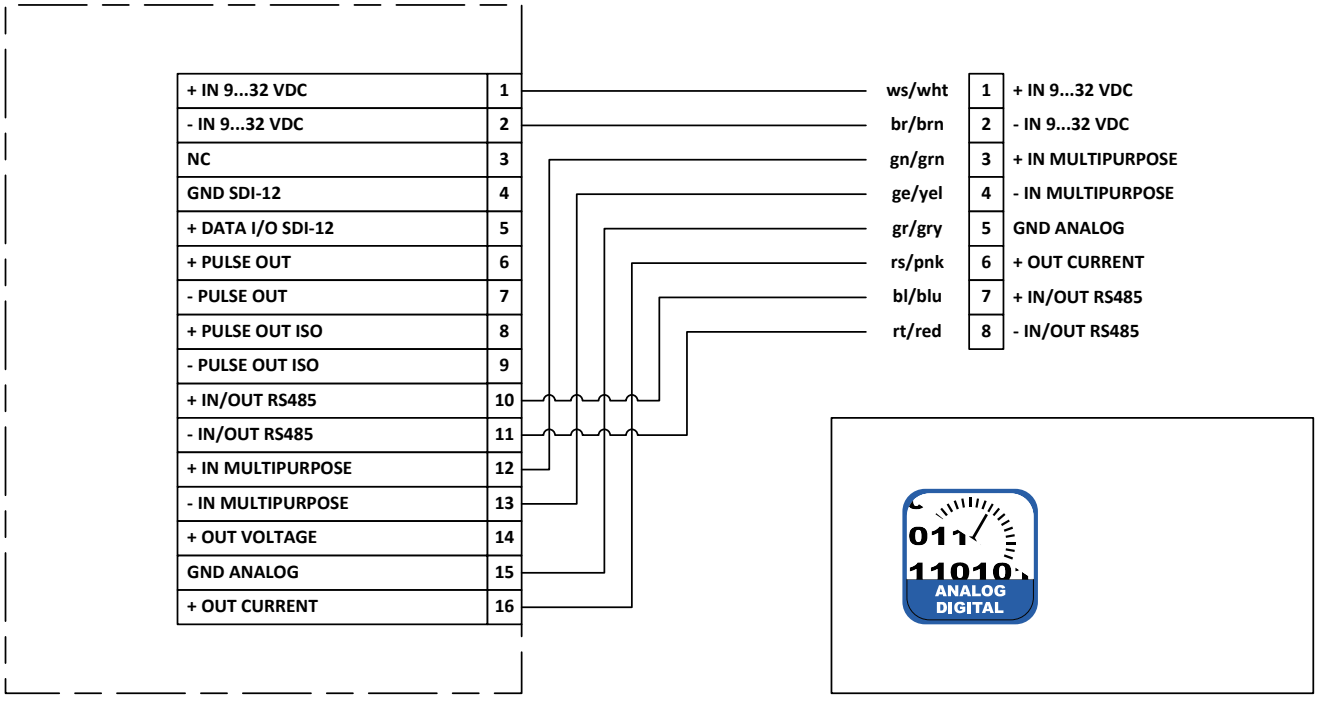


Fig. 17

Connecting Diagram for Quick Configuration ‘Analogue 0...2.5 V / Digital Output’

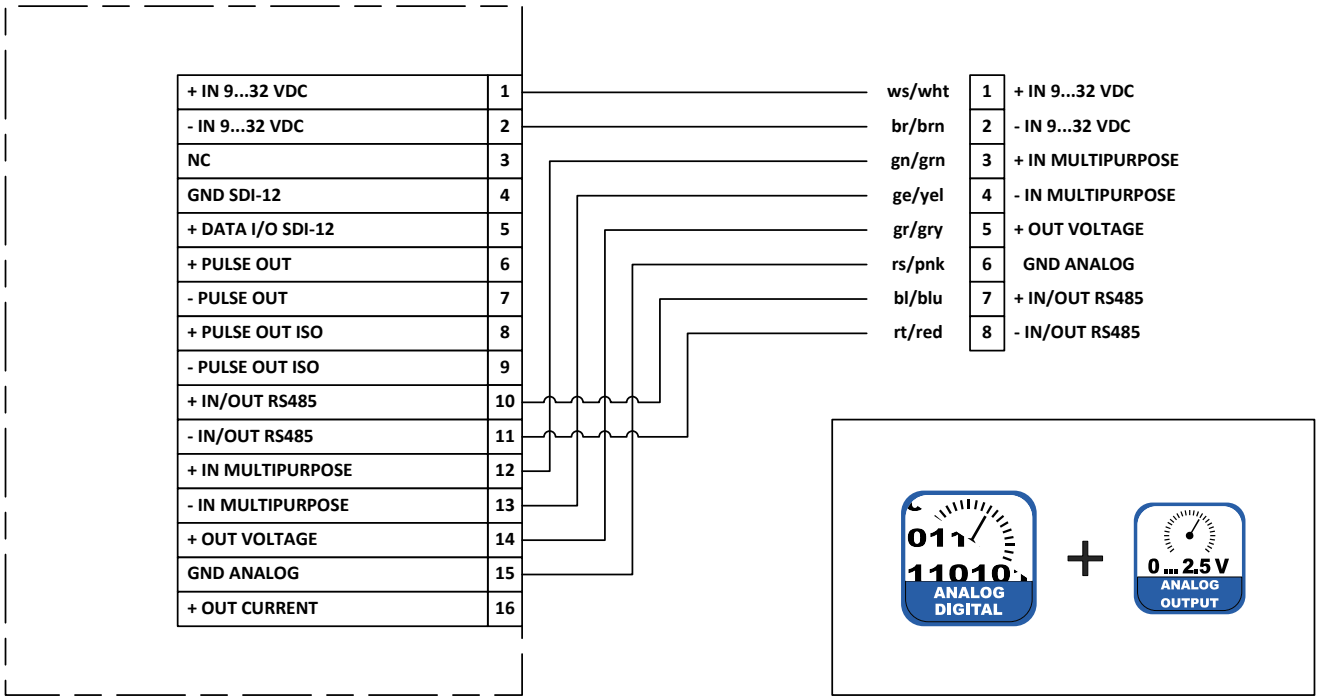


Fig. 18

Connecting Diagram for Quick Configuration ‘Pulse Output’

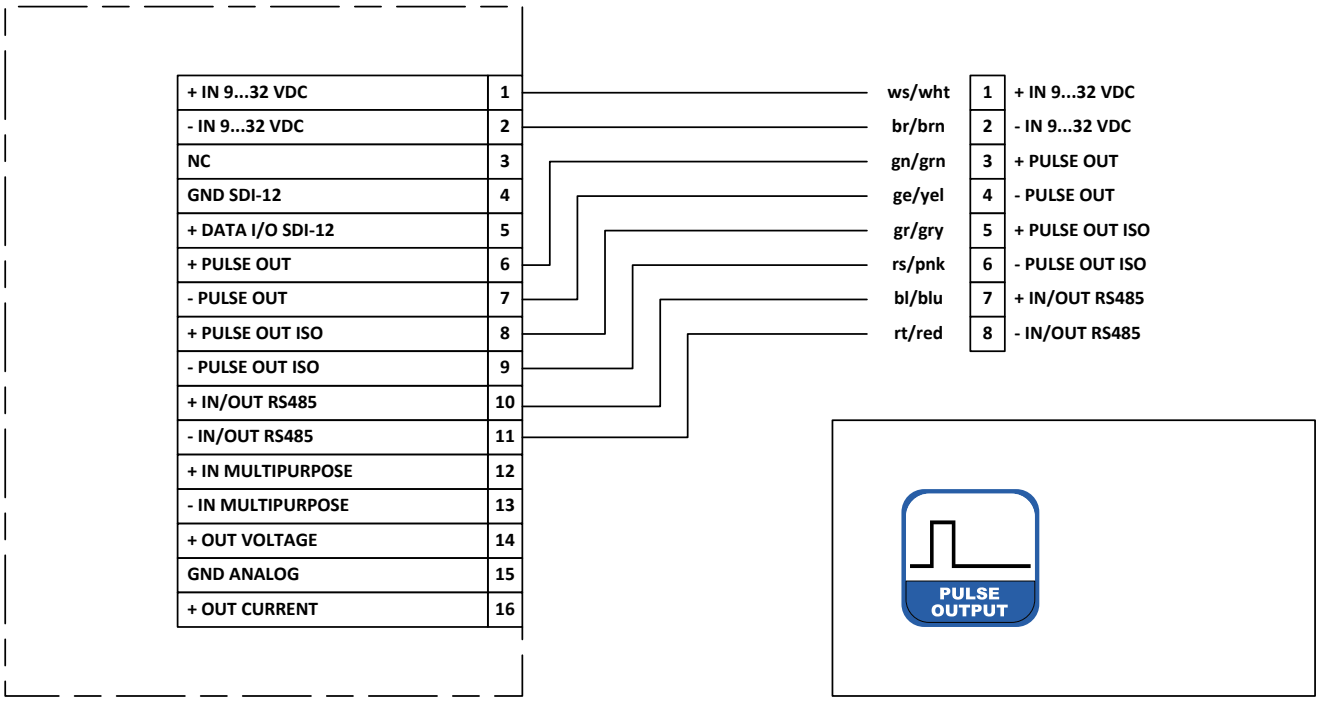


Fig. 19

7 Configuration Software - rain[e] Commander

Lambrecht.net

Setup

Adjust **rain[e]** *load cell*

Upload firmware to **rain[e]**

Diagnostics

Exit program

Fig. 20

The **rain[e]** Commander is the configuration tool of the **rain[e]**. It can be used to configure the output signals of the **rain[e]**. Furthermore the load cell can be adjusted with the help of a reference weight. The software also has an update function for the **rain[e]** firmware and a diagnosis function to control the readiness for use of the **rain[e]** (see Fig. 20).
To configure the **rain[e]** it has to be connected via the USB service interface in the device interior to a PC with installed **rain[e]** Commander.

It is recommended that the power plug and the sensor connector are unplugged before opening the rain[e] case to prevent it from mismeasuring. In addition, please use the 'service function', if your data logger has one.

rain[e] Setup

When entering the Setup area it requests that the user first select the COM port to which the **rain[e]** is connected (from the drop-down menu) and retrieve the settings from the **rain[e]** (gear wheel icon). After retrieving the data from the **rain[e]** the setup screen shows the product ID, serial number, hardware revision and firmware version of the device. In the 'Quick Configuration' section the program provides buttons for the most common combination to configure the **rain[e]** with a few clicks. The 'Expert Configuration' section allows to customise the output signals in any desired way.

Quick Configuration

To configure the **rain[e]** with the Quick Configuration screen click on the buttons representing the desired options and sub-options. After each selection the changes will be send to the **rain[e]**. The output field shows the current **rain[e]** settings. It will be updated automatically after sending new settings to the **rain[e]**.

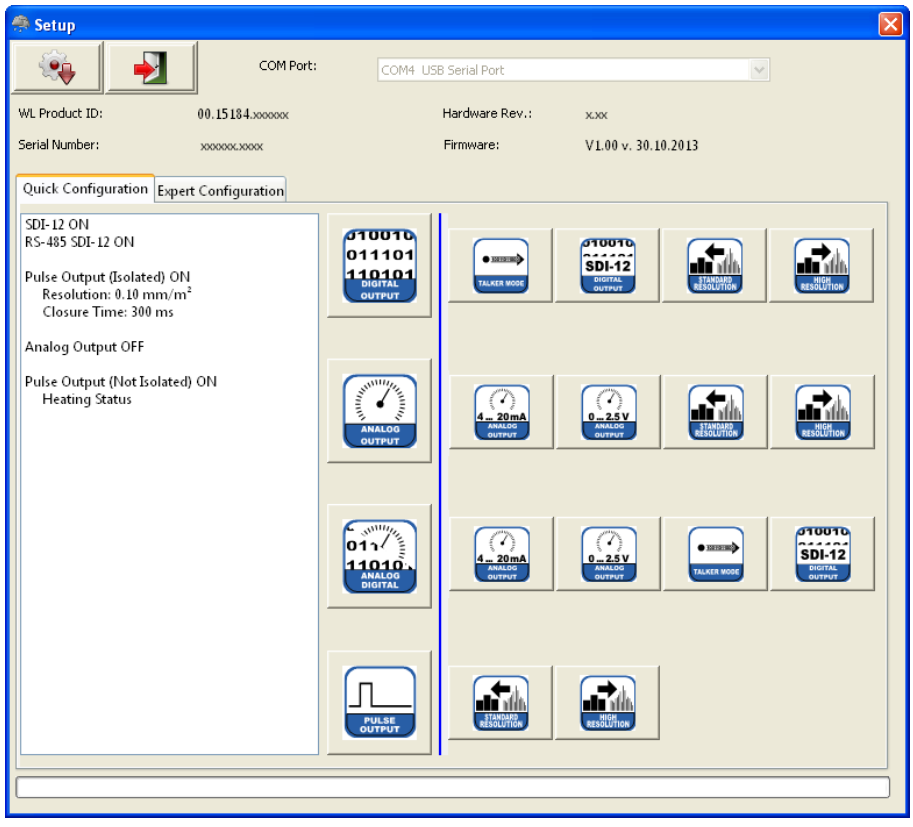


Fig. 21

Following are the respective settings listed which will be implemented by the quick configuration buttons. For the buttons of the sub-options only the changes are listed

Analogue Output

SDI-12	ON
RS485	SDI-12 ON
Pulse Output (isolated)	ON
Operating Mode	Pulse
Resolution	0.10 mm/m²
Closing Time	300 ms
Analogue Output	ON
Effective Range	4...20 mA
Scale	20 mm/m²
Pulse Output (not isolated)	ON
Operating Mode	Heating ON / OFF

- 4...20 mA

Analogue Output	ON
Effective Range	4...20 mA
Scale Maximum	200 mm/m²

0...2.5 V

Analogue Output	ON
Effective Range	0...2.5 V DC
Scale Maximum	200 mm/m²

- Standard resolution

Pulse Output (not isolated)	ON
Operating Mode	Pulse
Resolution	0.10 mm/m²
Closing Time	300 ms

- High Resolution

Pulse Output (not isolated)	ON
Operating Mode	Pulse
Resolution	0.01 mm/m²
Closing Time	10 ms

Analogue / Digital Output

SDI-12	ON
RS485	SDI-12 ON
Pulse Output (isolated)	ON
Operating Mode	Pulse
Resolution	0.10 mm/m²
Closing Time	300 ms
Analogue Output	ON
Effective Range	4...20 mA
Scale	20 mm/m²
Pulse Output (not isolated)	ON
Operating Mode	Heating ON / OFF

- 4...20 mA

Analogue Output	ON
Effective Range	4...20 mA
Scale Maximum	200 mm/m²

- 0...2.5 V

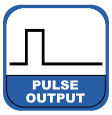
Analogue Output	ON
Effective Range	0...2.5 V DC
Scale Maximum	200 mm/m²

- Talker Mode

SDI-12	OFF
RS485	TALKER ON
Talker Interval	10 s .

- SDI-12 Digital Output

SDI-12	ON
RS485	SDI-12 ON



Pulse Output

SDI-12	OFF
RS485	ASCII ON
Pulse Output (isolated)	ON
Operating Mode	Pulse
Resolution	0.10 mm/m²
Closing Time	300 ms
Analogue Output	OFF
Pulse Output (not isolated)	ON
Operating Mode	Heating ON / OFF

- Standard Resolution

Pulse Output (isolated)	ON
Resolution	0.10 mm/m²
Closing Time	300 ms

- High Resolution

Pulse Output (isolated)	ON
Resolution	0.01 mm/m²
Closing Time	10 ms

Expert Configuration

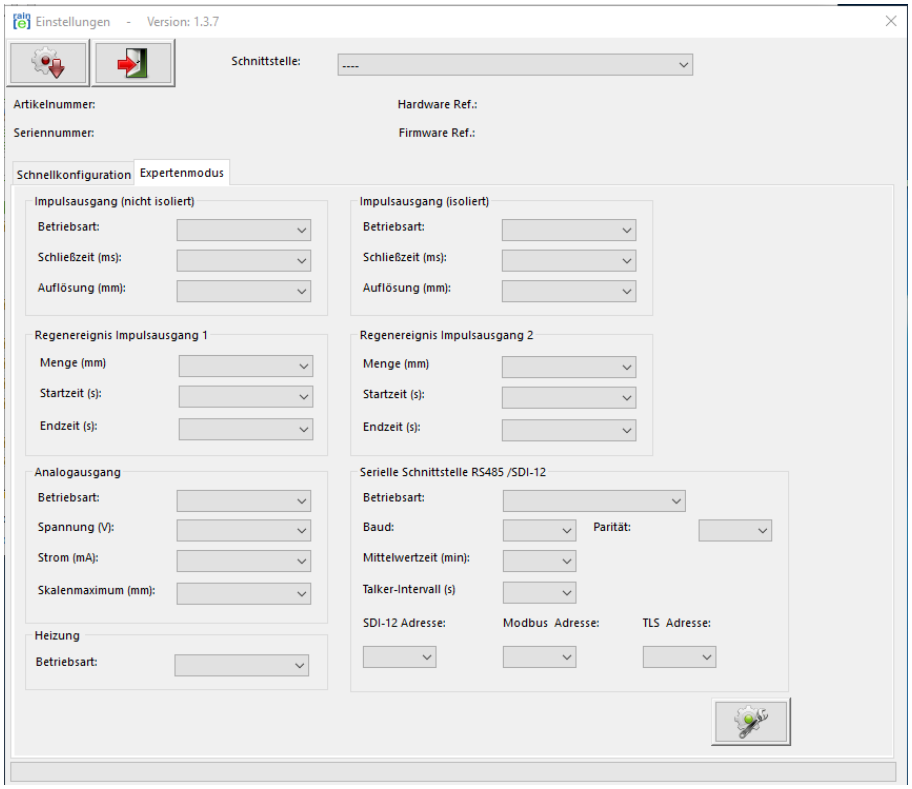


Fig. 22

The Expert Configuration screen (Fig. 22) is an easy to use tool to completely customise the configuration of the **rain[e]** output signals. Options are visible depending on the selected output modes. The following list shows the available options, sub-options and value ranges.

Pulse Output (non-isolated) / (isolated)
- Operating Mode
  - Pulse
    - ► Closing Time — 10...500 ms in steps of 5 ms
    - ► Resolution — 0.01...1 mm in steps of 0.01 mm
  - Rain YES / NO
    - ⇨ Precipitation Event (non-isolated) / (isolated)
      - ► Amount — 0.10...1 mm in steps of 0.10 mm
      - ► Start Time — 20...60 s in steps of 1 s
      - ► End Time — 20...600 s in steps of 1 s
  - Heating ON / OFF

Analogue Output
- Operating Mode
  - Voltage — 0...2.5 / 5 V
  - Current — 0 / 4...20 mA
  - Scale Maximum — 1...200 mm/m² in steps of 1 mm/m²

Heating - Operation Mode — ON / OFF

Serial Port (RS485)

- Operating Mode
  - WL ASCII
    - ► Average Time — 1...60 min in steps of 1 min
  - SDI-12
    - ► Average Time — 1...60 min in steps of 1 min
  - Talker
    - ► Average Time — 1...60 min in steps of 1 min
    - ► Talker Interval — 10...60 s in steps of 1 s
  - Modbus RTU

SDI-12 - Address — 0...9, A...Z, a...z
Modbus-Adresse — 0...247

Load Cell Adjustment

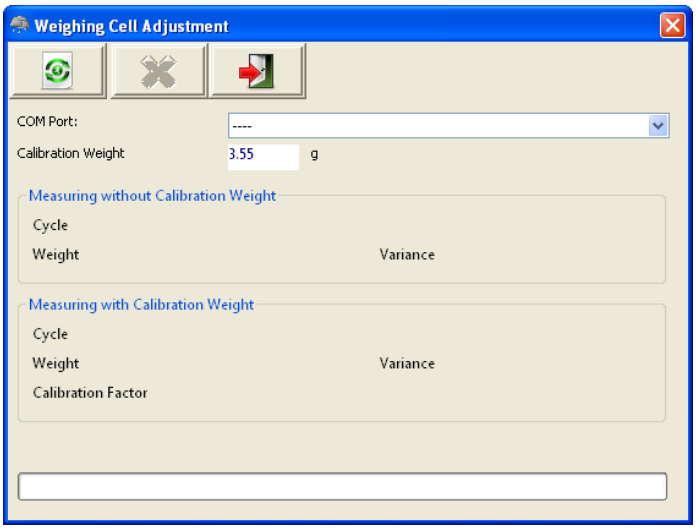


Fig. 23

The Load Cell Adjustment screen (Fig. 23) may be used to adjust the load cell. It will give the number of cycles the program has carried out, the mean value of the measured weight and the variance of the values. If a calibration weight is used, a calibration factor will be given.

To adjust the load cell first select the COM port of the **rain[e]** from the drop-down menu. If desired, put a calibration weight in the collecting vessel and enter the weight into the corresponding text box. To start the adjustment click the green Start Adjustment button.
Pressing the button with the red ‘X’ will stop the running adjustment.
Adjustment has to done again if the deviations in the diagnostics are higher than ± 30 mg.

Firmware Update

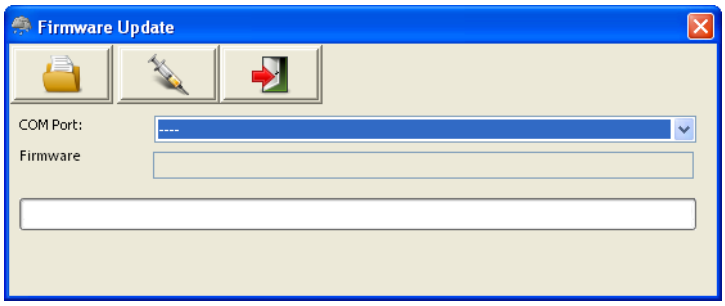


Fig. 24

If an update or modification of the firmware is needed e.g new features are available or the requirements of the output signals have changed, you shall receive a firmware file via email.
To update your **rain[e]** firmware use the Firmware Update screen (Fig. 24). Select the COM port of the connected **rain[e]** from the drop-down menu, click Browse for Firmware File (folder icon) and select the firmware file on your computer or tablet. Then click Load Firmware to **rain[e]** (syringe icon).

Diagnostics

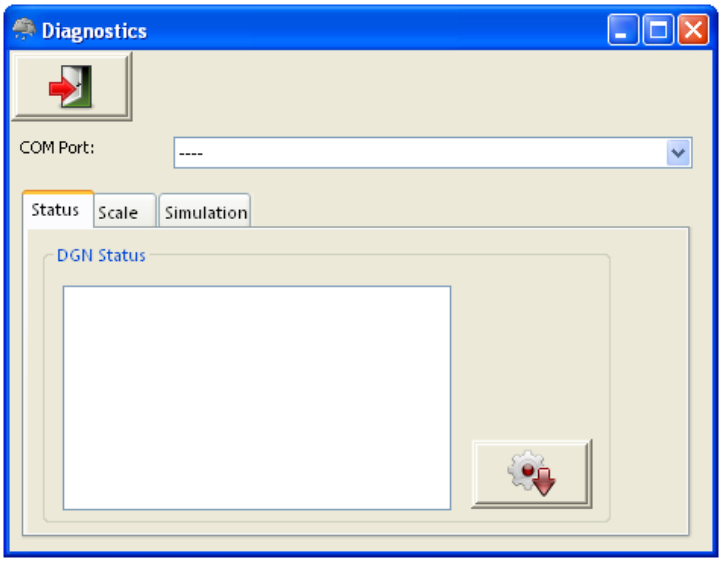


Fig. 25

The "**Diagnostics**" mask is divided into three tabs: "**Status**" - to check the system status, "**Scale**" - to test the load cell and "**Simulation**" - to simulate precipitation amounts to check the output signals of the impulse and analogue outputs (Fig. 25).

To use any of these functions the COM port of the connected **rain[e]** has to be selected from the drop-down menu.
To check the system status one has to click "**Retrieve rain[e] Status**" (gear wheel icon) in the tab "**Status**". The program will return the following status message:

Heating Temperature - OK / Malfunction	Not exceeding the heating temperature by 10 °C
Heating Test - OK / Malfunction	Working Heating
Temperature Sensor Bottom - OK / Malfunction	Working Temperature Sensor Bottom
Temperature Sensor Top - OK / Malfunction	Working Temperature Sensor Top
Status 6-9	Internal use only

To test the weighing scale one has to put a (known) weight into one pan of the collecting vessel and click “**Test Scale**” (blue gear wheel icon) in the tab “**Scale**”.
To simulate precipitation amounts to check the output signals of the pulse and analogue outputs, one has to select the desired amount from the drop-down menu in the tab “**Simulation**” and click “**Simulate Precipitation**” (cloud icon). The analogue and pulse outputs will return signals according to the applied settings in the **rain[e]** Setup.

8 In- and Output

The following chapter describes the available analog, digital and serial interfaces and their protocols. Depending on the sensor version different interfaces are available:

Id-No.	Description	RS485	SDI-12	Analog	Impuls (Digital)	Default Protocol
00.15184.000000	rain[e]	X	XX	X	XX	SDI-12
00.15184.400000	rain[e]H	X	XX	X	XX	SDI-12
00.15184.403000	rain[e]314H	X	XX	X	XX	SDI-12
00.15184.003000	rain[e]314	X	XX	X	XX	SDI-12
00.15184.404000	rain[e]400H	X	XX	X	XX	SDI-12
00.15184.004000	rain[e]400	X	XX	X	XX	SDI-12
00.15184.000100	rain[e] Modbus	XX	X	X	X	Modbus
00.15184.400100	rain[e]H Modbus	XX	X	X	X	Modbus
00.15184.400001	rain[e]one H	X	XX	X	XX	SDI-12
00.15184.400101	rain[e]one H Modbus	XX	X	X	X	Modbus
00.15184.000001	rain[e]one	X	XX	X	XX	SDI-12
00.15184.000101	rain[e]one Modbus	XX	X	X	X	Modbus
00.15184.010000	rain[e] LP	-	XX	-	XX	SDI-12

H = heated; XX = Default; X = available, requires rewiring and configuration; - = not available

8.1 SDI-12 Interface

The communication using SDI-12 protocol via SDI-12 interface is based on the ‘SDI-12 A Serial-Digital Interface Standard for Microprocessor-Based Sensors, Version 1.3, 2012’. The **rain[e]** can be used in bus mode parallel to other **rain[e]**s.

The following subset of SDI-12 commands were implemented into the **rain[e]**.
For further details to the SDI-12 protocol we recommend the afore-mentioned standard document or the website www.SDI-12.org.

Implemented SDI-12 commands:

Command	Function	Answer of the sensor
a!	Acknowledge Active	a<CR><LF>
?!	Address Query Command	a<CR><LF>
aI!	Send Identification	allccccccccmmmmmmvvvxx...xx<CR><LF>
aAb!	Change Address	b<CR><LF>
aM!	Start Measurement	atttn<CR><LF>
aMC!	Start Measurement and Request CRC	atttn<CR><LF>
aC!	Start Concurrent Measurement	atttnn<CR><LF>
aCC!	Start Concurrent Measurement and Request CRC checksum	atttnn<CR><LF>
aD0! **aD1!**	Send Data (Puffer 0) Send Data (Puffer 1)	a<values<CR><LF> a<values><CRC><CR><LF> resp. with CRC checksum
aM1!	Generate Variance	atttn<CR><LF>
aM2!	Generate Heating Data	atttn<CR><LF>
aM3!	Start Intensity Measurement Average Value, Maximum and Minimum	atttn<CR><LF>
aMC1!	Generate Variance and Request CRC	atttn<CR><LF>
aMC2!	Generate Heating Data and Request CRC	atttn<CR><LF>
aMC3!	Start Intensity Measurement Average Value, Maximum and Minimum and Request CRC	atttn<CR><LF>
aC1!	Generate Variance	atttnn<CR><LF>
aC2!	Generate Heating Data	atttnn<CR><LF>
aC3!	Start Intensity Measurement Average Value, Maximum and Minimum	atttnn<CR><LF>
aCC1!	Generate Variance and Request CRC	atttnn<CR><LF>
aCC2!	Generate Heating Data and Request CRC	atttnn<CR><LF>
aCC3!	Start Intensity Measurement Average Value, Maximum and Minimum and Request CRC	atttnn<CR><LF>
aV!	Start Verification	atttn<CR><LF>

a = address of the respective sensor; standard sensor address = 0
SDI-12 commands always start with the address of the appropriate sensor. Therefore all other sensors on the same bus will ignore these commands. SDI-12 commands end with '**!**'. All answers from sensors start with its address, too, but end with the ASCII characters 'Carriage Return' **<CR>** and 'Line Feed' **<LF>**.

The SDI-12 protocol is based on the ASCII character set. The baud rate of the SDI-12 protocol is 1200 Bd and has the byte frame format:

1 start bit
7 data bits (least significant bit transmitted first)
1 parity bit (even parity)
1 stop bit.

Acknowledge Active - a!

This command ensures that the sensor responds to requests from the master. Basically it asks the sensor to confirm it is connected to the bus.
The sensor returns its address and **<CR><LF>**.

Syntax

Command	Answer
a!	**a<CR><LF>**
a – Sensor address	**a** – Sensor address
! – End of command	**<CR><LF>** – End of answer

Example:

Command	Answer
0!	**0<CR><LF>**
1!	**1<CR><LF>**

Send Identification - aI!

The command **aI!** is used to ask the sensor for its model number and firmware version.

Syntax

Command	Answer
aI!	**a 13LMGmbH1515184x1.0781129.0001<CR><LF>**
a – Sensor address	**a** – Sensor address
I – Command 'Send Identification'	
	13LMGmbH1515184x1.0781129.0001
	13 – 2 characters SDI-12 version-No. 13 = version 1.3
	LMGmbH15 – 8 characters manufacturer's name (= Lambrecht meteo GmbH)
	15184x – 6 characters sensor type (= precipitation sensor **rain[e]**)
	1.0 – Sensor version (= version 1)
	781129.0001 – 11 characters serial No.
! – End of command	**<CR><LF>** – End of answer

Example:

Command	Answer
0I!	**013LMGmbH1515184x1.0781129.0001<CR><LF>**
1I!	**113LMGmbH1515184x1.0781129.0002<CR><LF>**

Change Address - aAb!

The factory setting of the address is '**0**'. If there are several sensors connected to one bus, the sensor address can be changed with the command **aAb!**. The address is always a single ASCII character. Standard for addresses are the ASCII characters '**0**' to '**9**' (decimal 48 to 57). If there are more than 10 sensors connected to one bus, using the characters '**A**' to '**Z**' (decimal 65 to 90) and '**a**' to '**z**' (decimal 97 to 122) is allowed. The sensor answers with its new address and **<CR><LF>**. After the address is changed, one should not send further commands to the sensor for a period of one second (see also 'SDI-12 Standard, Version 1.3, 2012').

Syntax

Command	Answer
aAb! **a** – Old sensor address **A** – Command 'Change Address' **b** – New sensor address **!** – End of command	**b<CR><LF>** **b** – New sensor address **<CR><LF>** – End of answer

Example:

Command	Answer
0A1!	**1<CR><LF>**

Start Measurement - aM!

The command **aM!** requests that the sensor process the returning string and provide the available measured data. In contrast to standard sensors described in the SDI-12 documentation the **rain[e]** measures continuously. Thus the measured values from the continuous measurement are stored in a buffer while the string is being processed. These values are processed after the string processing. Therefore the **rain[e]** always responds with 'a003x'. This is also the reason why the **rain[e]** does not send a Service Request and ignores signals to interrupt the measurement. Prior to the returned waiting time (3 s) the data logger must not send further commands. After expiration of the waiting time the data can be requested with the commands **aD0!** and **aD1!** (see **Send Data**). The data will not be overwritten until the next **C**, **M**, or **V** command and can be read several times until then.

Syntax

Command	Answer
aM! **a** – Sensor address **M** – Command 'Start Measurement' **!** – End of command	**a0036<CR><LF>** **a** – Sensor address **003** – Seconds the sensor needs until the measured data can be returned (= 3 s) **06** – Number of provided measured data **<CR><LF>** – End of answer

Example:

Command	Answer
1M!	**10036<CR><LF>**

The measured data can be requested with the commands **aD0!** and **aD1!**. (see **Send Data**).

Start Measurement and Request CRC - aMC!

Same command as **aM!** but in addition to the generated data the sensor returns a 3-digit CRC checksum. For information on how the CRC checksum is generated, please consult 'SDI-12 Standard, Version1.3, 2012, chapter 4.4.12'.

Syntax

Command	Answer
aMC! **a** – Sensor address **M** – Command 'Start Measurement and Request CRC' **C** – Request for transmission of the CRC checksum **!** – End of command	**a0036<CR><LF>** **a** – Sensor address **003** – Seconds the sensor needs until the measured data can be returned (= 3 s) **6** – Number of provided measured data **<CR><LF>** – end of answer

Example:

Command	Answer
2MC!	**20036<CR><LF>**

Start Concurrent Measurement - aC!

The **Concurrent Measurement** enables the data logger to measure simultaneously with multiple **rain[e]**s on the same bus.
The command **aC!** requests that the sensor process the returned string and to provide the available measured data.
In contrast to standard sensors described in the SDI-12 documentation, the **rain[e]** measures continuously. Thus the values during continuous measuring are stored in buffer while the string is being processed. These values are processed after the string processing. Prior to the return waiting time (3 s) the data logger must not send further commands. After expiration of the waiting time the data can be requested with the commands **aD0!** and **aD1!** (see **Send Data**).
The data will not be overwritten until the next **C**, **M**, or **V** command and can be read several times in the mean time.

Syntax

Command	Answer
aC! **a** – Sensor address **C** – Command 'Start Concurrent Measurement' **!** – End of command	**a00306<CR><LF>** **a** – Sensor address **003** – Seconds the sensor needs until the measured data can be returned (= 3 s) **6** – Number of provided measured data **<CR><LF>** – End of answer

Example:

Command	Answer
2C!	**200306<CR><LF>**

The measured data can be requested with the commands **aD0!** and **aD1!**. (see **Send Data**).

Start Concurrent Measurement and Request - CRC aCC!

Same command as **aC!** but in addition to the generated data the sensor returns a 3-digit checksum. For information on how the CRC checksum gets generated, please consult 'SDI-12 Standard Version1.3, 2012, chapter 4.4.12'.

Syntax

Command	Answer
aCC! **a** – Sensor address **C** – Command 'Start Concurrent Measurement' **C** – Request for transmission of the CRC checksum **!** – End of command	**a00306<CR><LF>** **a** – Sensor address **003** – Seconds the sensor needs until the measured data can be returned (= 3 s) **06** – Number of provided measured data **<CR><LF>** – End of answer

Example:

Command	Answer
2CC!	**200306<CR><LF>**

Send Data - aD0! and aD1!

Data generated by the commands **C**, **M**, or **V** are requested from the sensor with **aD0!** and **aD1!**. The sensor uses the respective arithmetic sign ('+' or '-') to separate the values. If the data was requested with a **CC** or **MC** command, it will be returned with the CRC checksum. For information on how the CRC checksum gets generated, please consult 'SDI-12 Standard Version1.3, 2012, chapter 4.4.12'.
The measured data is returned in metric units.

Measured data	**Unit**
Buffer 0	
Precipitation intensity within the last minute	mm/min
Precipitation intensity within the last minute in mm/h	mm/h
Precipitation intensity since last request	mm/min

Measured data	**Unit**
Buffer 1	
Precipitation intensity since last request in mm/h	mm/h
Precipitation amount since last request	mm/m²
Precipitation amount total *	mm/m²

* see also chapter 8.3 for the evaluation of the total precipitation quantity

Syntax for measurements with aC! or aM!

Command	Answer
aD0! **a** – Sensor address **D** – Command 'Send Data' **0** – Request for the data in buffer 0 or **1** = buffer 1 **!** – End of command	**a<values><CR><LF>** **a** – Sensor address **<values>** – Requested data separated by resp. sign ('+' or '-') **<CR><LF>** – End of answer

Example:

Command	Answer
0C!	**000306<CR><LF>**
0D0!	**0+0.100+6.000+0.100<CR><LF>**
0D1!	**0+6.000+12.000+25.231<CR><LF>**

Syntax for measurement with aCC! or aMC!

Command	Answer
aD0! **a** – Sensor address **D** – Command 'Send Data' 0 – Request for the data in buffer 0 or **1** = buffer 1 **!** – End of command	**a<values><CRC><CR><LF>** **a** – Sensor address **<values>** – Requested data separated by resp sign ('+' or '-') **<CRC>** – 3-digit CRC checksum **<CR><LF>** – End of answer

Additional Measurements

With the following commands additional information can be generated by the **rain[e]** and requested with **aD0!**.

The additional measurement commands **aMn!** and **aMCn!** have the same format as the commands **aM!** and **aMC!**. The same applies to the commands **aCn!** and **aCCn!** which have the same format as **aC!** and **aCC!**.

n	Function		Command	Answer
1	Generation of the variance (period 4 s)		**aM1!**	**a0031<CR><LF>**
			aC1!	**a00301<CR><LF>**
		with CRC checksum	**aMC1!**	**a0031<CR><LF>**
			aCC1!	**a00301<CR><LF>**
2	Generation of the heating data **Measured variable** / **Unit** Buffer 0 Temperature interior / °C Heating ON (1) / OFF (0) Heating power total / %		**aM2!**	**a0033<CR><LF>**
			aC2!	**a00303<CR><LF>**
		with CRC checksum	**aMC2!**	**a0033<CR><LF>**
			aCC2!	**a00303<CR><LF>**

3	Generation of the data: precipitation intensity, average value, max. / min. intensity of the last x minutes*. **Measured variables** / **Unit** Buffer 0 Average value over x minutes* — mm/min Max. intensity of the last x minutes* — mm/min Min. intensity of the last x minutes* — mm/min The default value for the period x is 10 min. The value can be changed with the **rain[e]** Commander (see ch. 7).		**aM3!**	**a0033<CR><LF>**
			aC3!	**a00303<CR><LF>**
		with CRC checksum	**aMC3!**	**a0033<CR><LF>**
			aCC3!	**a00303<CR><LF>**

* The acquisition of these values starts with the command and they have to be requested after exactly x minutes with the aD0! command.

Start Verification - aV! (Error string)

For service purposes the command **aV!** can be used to do a system analysis and generate an error string. The command **aV!** has the same format as the command **aM!** (see above). The **rain[e]** answers to the command **aV!** with 'a0039'.

Syntax

Command	Answer
aV!	**a0039<CR><LF>**
a – Sensor address	**a** – Sensor address
V – Command 'Start Verification'	**003** – Seconds the sensor needs until the measured data can be returned (= 3 s)
	9 – Number of provided data
! – End of command	**<CR><LF>** – End of answer

Example:

Command	Answer
1V!	**10039<CR><LF>**

The measured data can be requested with the command **aD0!**. (see **Send Data**).

Data output	**Value range**
Buffer 0	
For internal use	0...99
Error due to exceeding of the heating temperature by 10° C	0 or 1
Error heating	0 or 1
Error interior temperature sensor	0 or 1
Error funnel temperature sensor	0 or 1
For internal use	0 or 1
For internal use	0 or 1
For internal use	0 or 1
For internal use	0 or 1

+0 = ok; +1 = error

The data will not be overwritten until the next **C**, **M**, or **V** command and can be read several times until then.

Remark to SDI-12 ‘Break’ signal

Since the **rain[e]** does not have a sleeping mode it does not need to be ‘awakened’. This means that the **rain[e]** ignores the “Break“ command. Therefore all regulations associated to the ‘break’ command do not have to be considered.

8.2 RS485 Interface

These protocols are available on the RS485 interface: SDI-12 (on RS485) · WL ASCII · Talker.

The usual communication settings for the SDI-12 protocol are:

Baud rate: 1200 Baud
Data bits: 7
Parity: even
Stop bits: 1

The following communication settings apply to the other protocols:

Baud rate: 19200 Baud
Data bits: 8
Parity: none
Stop bits: 1

8.2.1 SDI-12 Protocol

This is exactly the same protocol with the same commands as the SDI-12 protocol via SDI-12 interface - described in ch. 8.1, pp. 23 ff.

8.2.2 WL ASCII Protocol

As an alternative to the SDI-12 protocol the **rain[e]** can also answer with a LAMBRECHT defined ASCII protocol via the RS485 interface, too. It may be addressed every 10 s. It is recommended to work with 60 s intervalls. Commands in the WL ASCII protocol start with **<STX>** ‘Start Text’ and end with ‘Carriage Return’ **<CR>** and ‘Line Feed’ **<LF>**. Since addressing is not possible with the WL ASCII protocol, it can only be used with a single **rain[e]** and not in a bus. The baud rate is 19200 Bd and has the byte frame format 8N1:

8 data bits · no parity bit (no parity) · 1 stop bit

Start Measuring <STX>m<CR><LF>

The command **<STX>m<CR><LF>** requests the sensor to process the returning string and to provide the available measured data. The **rain[e]** measures continuously. Thus measured values from the continuous measuring get stored into a buffer while the string is being processed. These values will be processed after the string processing. The answer is according to the syntax described below. The data fields are separated by a semicolon and the sign is always transmitted. The respective field lengths are fixed, leading non-significant digits are filled with blanks after the sign.

Syntax

Command	Answer		Number of digits (before point, after point)
<STX>m<CR><LF>	**int_{min};int_{h};int_{ret_min};int_{ret_h};am_{ret};am_{tot};s_{he};t_{in}<CR><LF>**		
<STX> – Start of command	**int_{min}** –	Intensity in mm/min	**2.3**
m – Command ‘Start Measuring’	**int_{h}** –	Intensity in mm/h	**4.3**
<CR><LF> – End of command	**int_{ret_min}** –	Average intensity since last retrieval in mm/min	**2.3**
	int_{ret_h} –	Average intensity since last retrieval in mm/h	**4.3**
	am_{ret} –	Amount since last retrieval in mm	**4.3**
	am_{tot} –	Total amount * since system start in mm	**4.3**
	s_{he} –	Heating Status (1 = ON, 0 = OFF)	**1.0**
	t_{in} –	Temperature in °C	**3.2**
	<CR><LF> –	End of answer	(* see also chapter 8.3)

Example: Retrieval after 10 min with constant intensity.

Command	Answer
<STX>m<CR><LF>	+ 1.059;+ 63.514;+ 1.059;+ 63.514;+ 0.164;+ 1.239;+0;+ 4.06;<CR><LF> (+12.123;+1234.123;+12.123;+1234.123;+1234.123;+1234.123;+1;+123.12;<CR><LF>)

Return Error String <STX>e<CR><LF>

For service purposes the command **<STX>e<CR><LF>** can be used to do a system analysis and generate an error string.

Syntax

Command	Answer
<STX>e<CR><LF> **<STX>** – Start of command **e** – Command 'Return Error String' **<CR><LF>** – End of command	**1;2;3;4;5;6;7;8;9;<CR><LF>** **1** – For internal use **2** – Error due to exceeding of the heating temperature by 10 °C **3** – Error heating **4** – Error interior temperature sensor **5** – Error funnel temperature sensor **6** – For internal use **7** – For internal use **8** – For internal use **9** – For internal use **<CR><LF>** – End of answer

+0 = ok; +1 = error

Example: Heating check failed

Command	Answer
<STX>e<CR><LF>	**3;0;1;0;0;0;0;0;0;<CR><LF>**

Return Device Information <STX>i<CR><LF>

For service purpose the command **<STX>i<CR><LF>** can be used to ask the sensor for its serial number, board version, software version and serial number of the load cell.

Syntax

Command	Answer
<STX>i<CR><LF> **<STX>** – Start of command **e** – Command 'Return Error String' **<CR><LF>** – End of command	**No;P;S;Serial;<CR><LF>** **No** – Serial No. of the device **P** – Board version **S** – Firmware version **Serial** – Serial No. of the load cell **<CR><LF>** – End of answer

Example:

Command	Answer
<STX>i<CR><LF>	**801456.0010;1.3v;V1.00 v. 12.11.2013;2C096/0420000000;<CR><LF>**

Start Measurement Intensity <STX>a<CR><LF>

The command **<STX>a<CR><LF>** can be used to ask the sensor for the average, maximum and minimum intensity over a selected time frame - this time frame has to be selected in the "**Expert Configuration**" in the **rain[e]** Commander.

Syntax

Command	Answer
<STX>a<CR><LF> **<STX>** – Start of command **a** – Command 'Measurement Intensity' **<CR><LF>** – End of command	$\mathbf{int_{avr}}$;$\mathbf{int_{max}}$;$\mathbf{int_{mini}}$;**<CR><LF>** $\mathbf{int_{avr}}$ – Average intensity in mm/min $\mathbf{int_{max}}$ – Maximum intensity in mm/min $\mathbf{int_{mini}}$ – Minimum intensity in mm/min **<CR><LF>** – End of answer

Example:

Command	Answer
<STX>a<CR><LF>	**0.059;0.073;0.031;<CR><LF>**

8.2.3 Talker Protocol

The Talker protocol is the third available mode of the RS485 interface. It sends an ASCII string in a defined interval. The interval can be adjusted between 10...60 s using the **rain[e]** Commander.

The baud rate is 19200 Bd and has the byte frame format 8N1:
8 data bits
no parity bit (no parity)
1 stop bit

Syntax

+$\mathbf{int_{min}}$;+$\mathbf{int_{h}}$;+$\mathbf{am_{tot}}$;+$\mathbf{s_{he}}$;+$\mathbf{t_{in}}$;+$\mathbf{s_{sys}}$<CR><LF>

- $\mathbf{int_{min}}$ – Intensity in mm/min
- $\mathbf{int_{h}}$ – Intensity in mm/h
- $\mathbf{am_{tot}}$ – Total amount * in mm
- $\mathbf{s_{he}}$ – Status heating (1 = ON, 0 = OFF)
- $\mathbf{t_{in}}$ – Temperature in °C
- $\mathbf{s_{sys}}$ – Status System
- **<CR><LF>** – End of answer

Temperature sensor **indoor** in °C

Output e.g. +21.06 acc. 21.06 °C
At heated sensors the heating test has to be successful in order to assure that the temperature sensor will be initialised. If not, 0.00 will be shown.

The returned value of $\mathbf{s_{sys}}$ is a decimal representation of a binary number. In binary representation the positions correspond to the following status messages.

(* see also chapter 8.3)

Bit position	Status message
0	1 = Error due to exceeding of the heating temperature by 10 °C
1	1 = Error heating
2	1 = Error interior temperature sensor
3	1 = Error funnel temperature sensor

Example: 15 °C ambient temperature, but heating is ON and defect interior temperature sensor

+0.059;+3.545;+7.701;+1;+15;+1<CR><LF>

8.2.4 Modbus Protocol

The Lambrecht meteo Modbus sensors and the met[LOG] follow the specification of the Modbus organization: “MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3” (see www.modbus.org).

8.2.4.1 Data Encoding

MODBUS uses the „big-endian“ format for addresses and data. This means that if a value is transmitted with a number format that is larger than a single byte, the „most significant byte“ is sent first. For values that go beyond one register (e.g. 32 bit) this is not clearly specified for the Modbus. In these cases (32 bit or 64 bit) the LAMBRECHT Modbus sensors follow the big-endian number format.

Example Big-Endian (1 register value):
16 - bit value
0x1234 is transmitted in the sequence: 0x12 0x34.

Beispiel Big-Endian (2 register value):
32 - bit value
0x12345678 is transmitted in the sequence: 0x12 0x34 0x56 0x78.

To obtain the real measuring value, divide the received register value by the divisor.
Values of -9999 (16 bit value) or -9999999 (32 bit value) indicate an internal sensor error.

8.2.4.2 Device Address

The addresses 1...247 are permitted for Modbus.

8.2.4.3 Standard Configuration - Default

Baud rate: 19200 Baud
Address: Each sensor type (or family) has its own default address.

Default addresses of the LAMBRECHT sensors:

Address	Sensor
1	Wind speed
2	Wind direction
3	Precipitation rain[e]
4	THP
5	EOLOS IND · u[sonic]WS6
6	com[b]
7	PREOS
8	ARCO
9	u[sonic]
10	Pyranometer 2nd Class
11	Secondary standard Pyranometer
12	PT100 to Modbus converter (temperature)
13	u[sonic]WS7

Byte frame according to MODBUS standard for RTU mode:
8E1 (1 start bit, 8 data bits, 1 parity bit (even parity), 1 stop bit)

8.2.4.4 Modbus Command Set

The LAMBRECHT Modbus sensors support the following commands:

- "Read Holding Register" command: 0x03 (descriptive sensor data registers)
- "Read Input Register" command: 0x04 (measured values registers, every measured value is to be requested individually)
- "Write Multiple Register" command: 0x10 (write to configuration registers)

8.2.4.5 Measured Value and Parameter Register Lambrecht Sensors

The register range 30001 to 35000 of the Lambrecht sensors is intended for measured values.
The following measured values are provided by the rain[e] precipitation sensors.

Register	Parameter name	Unit	Divisor	Quantity of registers	Access type	
31001	Precipitation amount total (standard resolution)	mm	10	1	Read only	INT
31101	Precipitation amount total (high resolution)	mm	1000	2	Read only	LONG
31103	Precipitation amount since last retrieval (high resolution)	mm	1000	2	Read only	LONG
31201	Precipitation intensity 1-minute sliding	mm/min	1000	1	Read only	INT
34901	Status of sensor	-	1	1	Read only	INT
34921	Status of heater	-	1	1	Read only	INT
34922	Internal temperature	°C	10	1	Read only	INT
34931	Total heating power in %	%	1	1	Read only	INT

The registers addresses 30001 to 35000 apply to all LAMBRECHT meteo Modbus sensors, but are only available or valid if the respective sensor supports the corresponding values. (e.g. a pure wind sensor does not provide any air humidity).
The LAMBRECHT sensors give 0xD8F1=-9999(16 bit) or 0xFF676981=-9999999 (32 bit) as error code or invalid value.

Example: Precipitation amount total (standard resolution)

03	04	79	19	00	01	F8	B3	03	04	02	00	01	01	30

LEN 6	Transmission Query =>	Source Master	Dest Slave 3	Function Read Input Register (4)	Func Desk Address=31001, Quantity of Register=1	Checksum OK:B3F8

LEN 5	Transmission Response <=	Source Slave 3	Dest Master	Function Read Input Register (4)	Func Desk Byte count=2	Data 00 01	Checksum OK:3001

Example: Precipitation amount total (high resolution)

03	04	79	7D	00	02	F9	6D	03	04	04	00	00	00	91	19	E8

LEN 6	Transmission Query =>	Source Master	Dest Slave 3	Function Read Input Register (4)	Func Desk Address=31101, Quantity of Register=2	Checksum OK:6DF9

LEN 7	Transmission Response <=	Source Slave 3	Dest Master	Function Read Input Register (4)	Func Desk Byte count=4	Data 00 00 00 91	Checksum OK:E819

8.2.4.5.1 Special Case of Precipitation

Except for the amount of precipitation, all measured values are to be read in as instantaneous values. The amount of precipitation must be read in as a total amount. And the difference to the previous call must be formed for the displayed and the precipitation quantity to be stored.

Note: The value overflow of the precipitation sum must be considered when calculating the difference. The value overflow occurs at 60,000 g of collected liquid. This results in a value overflow at 3,000 mm for sensors with a collecting surface of 200 cm² and a value overflow at 1,500 mm for sensors with a collecting surface of 400 cm².

8.2.4.5.2 Sensor Status

The sensor status can be retrieved by using register 34901. The returned numerical value must be interpreted in binary form as follows.

Bit position	Status message
0	1 = error maximum heating temperature threshold exceeded
1	1 = error heating
2	1 = error temperature sensor interior
3	1 = error temperature sensor at the funnel
4	1 = error initialization RTC
5	1 = error external temperature sensor (only rain[e]H3)
6	1 = poor quality of supply voltage (only rain[e]H3)

8.2.4.6 Descriptive Sensor Parameter Registers (Holding Register)

Register	Parameter name	Quantity of registers	Remark	Access type
40050	Device identification number (15 characters)	8 (2 characters in each register)	The returned data are in form of a 16 byte null terminated string	Read only
40100	Serial number (11 characters)	6 (2 characters in each register)	The returned data are in form of a 12 byte null terminated string	Read only
40150	Firmware e version (up to 25 characters)	13 (2 characters in each register)	The returned data are in form of a 26 byte null terminated string	Read only

Example: Retrieve the device identification number
(The identification number shown in the example is sensor-dependent. It is only used here for demonstration purposes).

															ASCII
05	03	9C	72	00	08	CB	C3	05	03	10	30	30	2E	31	36	□□□□□□□□□□□□□□□□
34	38	30	2E	30	30	30	31	33	30	00	37	CA				00.16480.000130.□□

LEN 6	Transmission Query =>	Source Master	Dest Slave 5	Function Read Holding Register (3)	Func Desk Address=40050, Quantity of Register=8	Checksum OK:C3CB

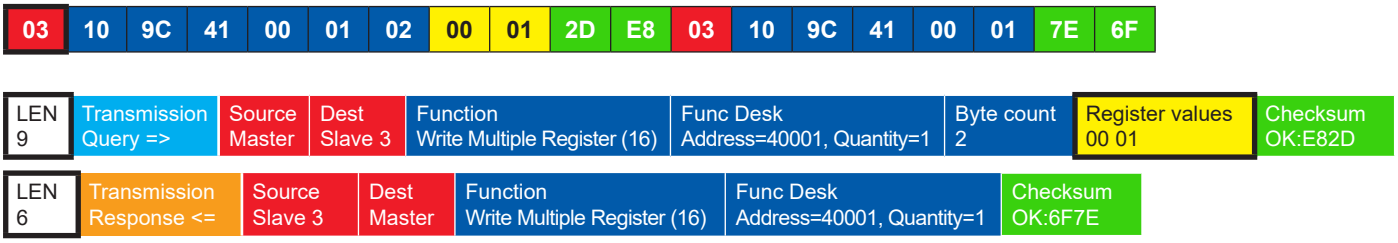
LEN 19	Transmission Response <=	Source Slave 5	Dest Master	Function Read Holding Register (3)	Func Desk Byte count=16	Data 30 30 2E 31 36 34 38 30 2E 30 30 30 31 33 30 00	Checksum OK:CA37

8.2.4.7 Sensor Parameters / Configuration Parameters

Register	Parameter name	Allowed values	Quantity of registers	Access type
40001	Modbus device address		1	Write only
40200	Baud rate	96 = 9600 192 = 19200 384 = 38400	1	Write only
40201	Parity	1 = even 0 = none	1	Write only

The device must be restarted after each change of a setting!

Example: Change the RTU address from 3 to 1



8.2.4.8 Autoconfiguration

All Lambrecht Modbus sensors offer the experienced user the possibility to implement an auto-configuration in his Modbus master based on additional information stored in the sensor. The necessary information can be found in the document “General Manual for LAMBRECHT meteo Modbus Sensors”.

8.3 Total Precipitation

For the measurement of the precipitation amount from data set to data set via the serial protocols (e.g. SDI 12, Talker, Modbus) the difference of the total precipitation amount to the previous value must be calculated.

Note: The value overflow of the precipitation total must be taken into account in the calculation of the difference. The value overflow occurs at 60000 g of collected liquid. This results in a value overflow at 3000 mm for sensors with a collecting surface of 200 cm² and a value overflow at 1500 mm for sensors with a collecting surface of 400 cm².

8.4 Pulse Output

Each pulse corresponds to a predefined amount of measured precipitation. The rocker factor value range is 0.01...200 mm/pulse. The rocker factor can be set with the rain[e] Commander together with the closing time / pulse width. The duty cycle is 1:1 - so the closing time is as long as the pause time. If more pulses have to be output than is possible with the set rocker factor and closing time, the excess impulse are queued and output as soon as no more pulses are added.
Assuming now the scenario that e.g. with a closing time of 100 ms (corresponding to a maximum of 300 pulses per minute) and a rocking factor of 0.01 mm/pulse [order changed] precipitation is collected with an intensity of a constant 4 mm/min (corresponding to 400 pulses/min) over the duration of 2 min followed by a sustained precipitation intensity of 1.9 mm/min (corresponding to 190 pulses per minute), then the pulse output will output the maximum 300 pulses in each of the first 2 minutes and 200 pulses will go into the queue. In the third minute, 300 pulses are output again - 190 because of the current precipitation and 110 from the queue. Correspondingly, 280 pulses are output in the fourth minute and 190 pulses are output in all subsequent minutes. In this case, therefore, the pulses in the queue are only processed after the fourth minute.

8.5 Analog Output

Absolute sum of precipitation

In this operating mode the accumulated amount of precipitation is returned as an increasing analogue signal corresponding to the amount of precipitation. The output can be configured to return the amount as an increasing current or an increasing voltage. If the maximum value of the selected range, e. g. 20 mA for a range of 4...20 mA is exceeded, a new summation starts, i. e. the analogue signal starts again on the lower end of the scale - resulting in a sawtooth diagram. The resolution is defined by the chosen scale maximum corresponding to the maximum of the output signal. The scale maximum as well as the output mode and output signal range can be configured with the **rain[e]** Commander (see chapter 7).

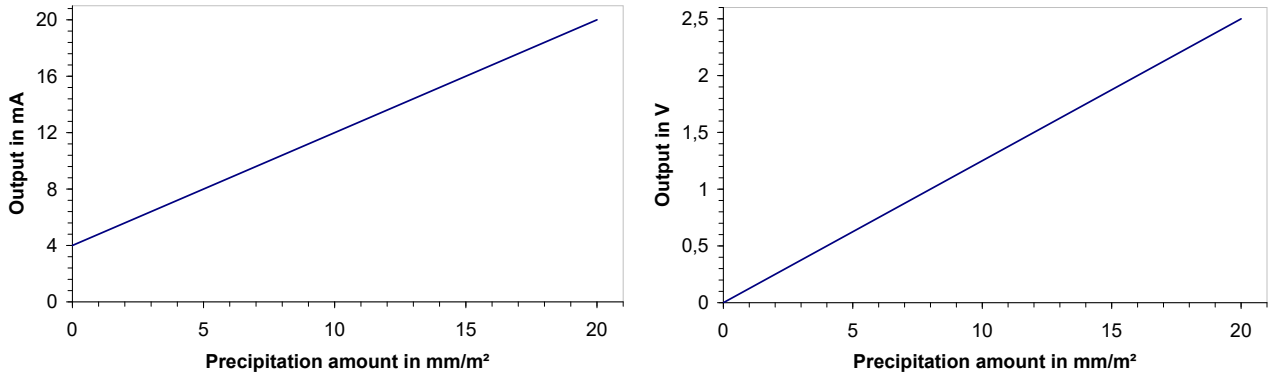


Fig. 26

Reset of analog output signal

By an external switch at the pins "**IN MULTIPURPOSE**" the analogue output can be reset to the lower end (starting value) of the output range.
This means that e. g. at the range of 4...20 mA the output will be reset to 4 mA. The summation of precipitation amount starts at zero again.

9 Inspection and Troubleshooting

- Visual checks for contamination should be done on a regular basis - depending on the environment and seasonal situation (spider and bird population, pollen, leaf fall). According to chapter 6 of the "VDI Guidelines - Environmental meteorology - Meteorological measurements - Precipitation, VDI 3786 Part 7 (December 2010)" we recommend monthly checks. In areas with high air pollution weekly checks might be necessary to ensure correct measuring results.

⚠ **Pull the power plug and sensor connector before cleaning the device interior to prevent it from erroneous measurements. Funnel heating and drain heating can be very hot if the heating is operated with the opened housing. There is a risk of being burnt! It is therefore recommended to disconnect the connector of the heating supply during cleaning and maintenance work.**

- All water-bearing parts should be cleaned regularly. Rinsing should be sufficient to clean the sensor from most contamination. Dirt clinging to the collecting funnel or outlet pipe has to be removed carefully. Slight pollution of the collecting vessel is not critical. The collecting vessel can be cleaned with water and a mild cleaning agent.
- Make sure the instrument is in a stable and perpendicular position and check the ring, the funnel surface and the sensor for damages.
- Keep the measurement site free from overgrowing vegetation.
- The bird protection has to be removed before the frost period.

⚠ **Please be careful while cleaning the collecting vessel to prevent it from taking damage. The rain[e] and the collecting vessel must not be cleaned with steel brushes or similar tools or aggressive detergents.**

Troubleshooting

<u>The heating got shut down after installing the device (error string: 'error heating' = 1):</u>

- Unplug the power plug of the sensor
- Control the power plug of the heating and the clamp plug of the funnel heating to be plugged in
- Plug in the power plug of the sensor

If this does not fix the problem, there are the following reasons

- Floor heating does not work, is not internally connected
- Funnel heating does not work
- Power cable of the heating is too long or defective

⇨ Please contact the LAMBRECHT-Service.

<u>Error message, when trying to retrieve data from the rain[e] with the rain[e] Commander:</u>

Please reconnect the USB cable and restart the **rain[e]** Commander.

<u>rain[e] Commander returns 'COM port not found' or 'rain[e] does not respond!':</u>

- Check if the **rain[e]** is correctly connected to the Laptop/Tablet and the correct COM port is selected.
- Restart the **rain[e]** Commander.

10 Maintenance and Repair

In case you should be faced with any specific problems please contact the Lambrecht service on:

Tel.: **+49-(0)551-4958-0**
E-mail: **support@lambrecht.net**

11 Equipment and Spare Parts

General Accessories:

32.15184.060 000	Connecting cable with M12 plug for connection sensor/ data logger; L = 10 m (8-core)
65.53090.160 100	USB cable for sensor configuration
36.15184.000 000	**rain[e]** Commander
00.15180.400 000	Stainless steel mast for concrete foundation
00.15180.800 050	Stainless steel mast for concrete foundation with base plate
32.15180.022 040	Bird defense ring for **rain[e]400 and rain[e]314**
32.15180.023 020	Bird defense ring for: **rain[e], rain[e] Modbus, rain[e]one, rain[e]one Modbus, rain[e]LP**
33.15180.049 010	Dirt spiral (spare part)
32.15184.080 000	Maintenance set (2 calibration balls, cleaning spray, cleaning brush, CD with **rain[e]** Commander, MiniUSB-USB cable, case, calibration manual)

For rain[e] Modbus Versions:

32.14567.060 010	Connecting cable with M12 plug (sensor) L ≈ 15 m (4-core), A-coded
32.14567.060 000	Connecting cable with M12 plug (sensor) L ≈ 12 m (4-core), A-coded

For Heated Versions:

00.14966.200 000	Power supply unit 150 W · **not** for rain[e]400H and rain[e]314H
00.14966.500 000	Power supply unit 240 W · for rain[e]400 and rain[e]314H
32.15184.061 000	Connecting cable (heating) for mounting at the mast; L ≈ 1 m (4-core)
32.15184.061 010	Connecting cable (heating) for mounting at the mast; L ≈ 10 m (4-core), T-coded
32.14622.220 000	Holder for power supply unit on the mast

Services:

97.15180.000 000	User-specific configuration

Connecting Diagram for Customized Configuration

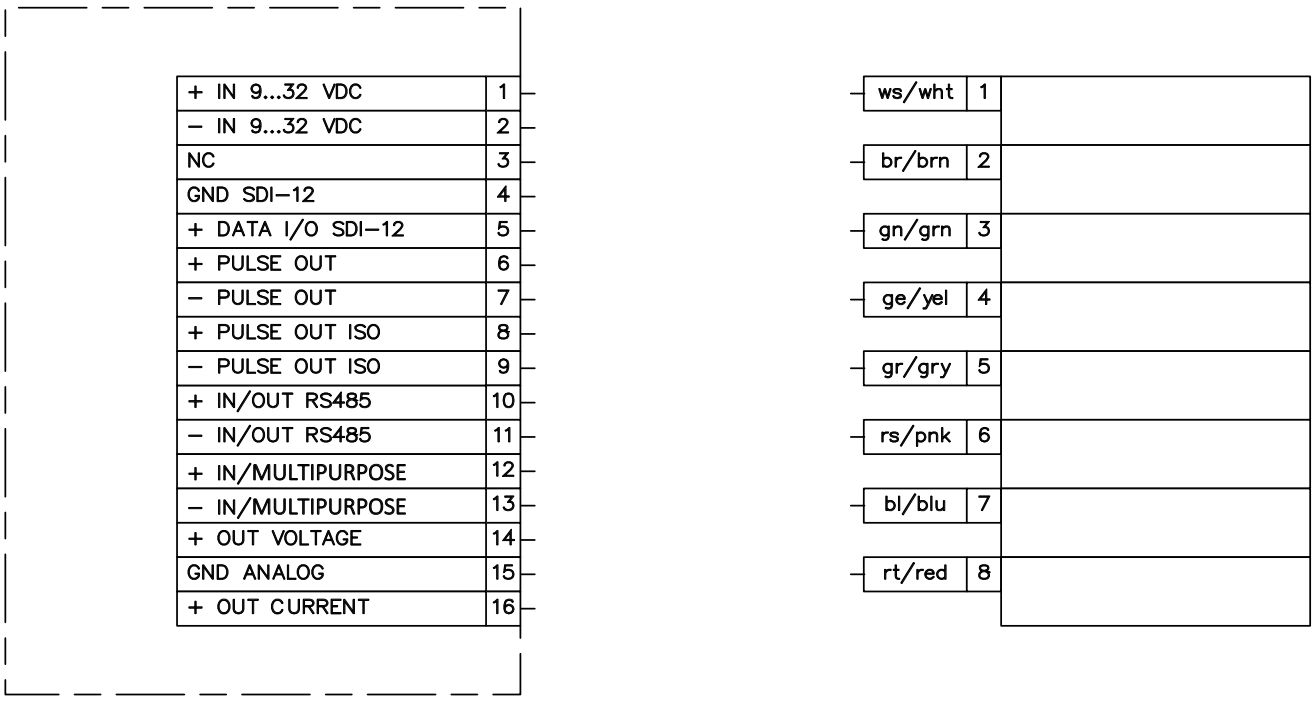


Fig. 27

Note: The SDI-12 interface and the RS485 interface cannot be used simultaneously. Furthermore, it is recommended to apply only one of the two interfaces to the cable used at the same time.

12 Download of Updates

On our homepage (https://www.lambrecht.net) you will find free firmware and the configuration software “Commander” for your product under “Support” in the “Software Portal” in the section “Free Software Tools & Firmware”. Select the appropriate software for your product and benefit after the download from new functions and product enhancements by Lambrecht meteo development.

12 Technical Data I

	rain[e], unheated Id-No. 00.15184.000000	**rain[e], heated** Id-No. 00.15184.400000	**rain[e]400H, heated** Id-No. 00.15184.404000	**rain[e]400, unheated** Id-No. 00.15184.004000
Measurable precipitation types:	liquid (solid, mixed – with heated sensor)			
Measurement principle:	weighing with automatic self emptying			
Operating temperature:	0...+70 °C	-40...+70 °C (no icing, no snowdrift)		0...+70 °C
Storage temperature:	-40..+70 °C			
Collecting area:	200 cm²		400 cm²	
Amount measurement range:	without limitation (0.005…∞ mm)		without limitation (0.0025…∞ mm)	
Amount resolution:	0.001 mm (pulse output: 0.01 mm)			
Amount accuracy:	0.1 mm or 1 % at < 6 mm/min and 2 % at ≥ 6 mm/min		0.1 mm or 1 % at < 3 mm/min and 2 % at ≥ 3 mm/min	
Intensity range:	0…20 mm/min resp. 0…1200 mm/h		0…10 mm/min resp. 0…600 mm/h	
Intensity resolution:	0.001 mm/min resp. 0.001 mm/h			
Intensity accuracy:	0.1 mm/min resp. ± 6 mm/h			
Dimensions:	292 mm x 190 mm (h x d), see dimensional drawing		311 mm x 256 mm (h x d), see dimensional drawing	
Suitable for mounting:	Ø 60 mm			
Weight:	approx. 2.5 kg		approx. 4 kg	
Standards:	WMO-No. 8 • VDI 3786 Bl. 7 • EN 61000-2, -4 EN 61000-4-2, -3, -4, -5, -6, -11 • NAMUR NE-21			
Protection class load cell:	IP67			
Current consumption:	max. 45 mA at 24 V power supply and analogue output • typ. 6.5 mA at 24 V power supply and pulse output • typ. 12.5 mA at 12 V			
Supply voltage:	9.8...32 V DC			
Heating data:	---	electronically controlled, dual-circuit-heating		---
Target temperature:	---	+2 °C funnel surface temperature		---
Accuracy:	---	± 1 °C		---
Heating power:	---	80 W (funnel)	150 W (funnel)	---
		60 W (outlet/ collecting vessel)		
Supply voltage:	---	24 V DC / 140 W	24 V DC / 210 W	---

Signal outputs:

- SDI-12
- RS485 (SDI-12 protocol, ASCII protocol, TALKER protocol and Modbus RTU)
- linearised, bounce-free pulse output signal **or** status output (configurable, e.g. ‘Rain YES/NO’ or ‘Heating ON/OFF’)
  - Pulse 1 (galvanically isolated, open collector): Max. 24 V DC / max. 0.05 A / max. 0.5 W
  - Pulse 2 (open collector): Max. 24 V DC / max. 0.1 A / max. 0.5 W
- Analogue output
  - 0/4…20 mA - max. load 500 Ω at 24 V DC • or 0…2.5/5 V with reset output function

13 Technical Data II

	rain[e]314, unheated Id-No. 00.15184.003000	rain[e]314, heated Id-No. 00.15184.403000
Measurable precipitation types:	liquid (solid, mixed – with heated sensor)	
Measurement principle:	weighing with automatic self emptying	
Operating temperature:	0...+70 °C	-40...+70 °C (no icing, no snowdrift)
Storage temperature:	-40..+70 °C	
Collecting area:	314 cm²	
Amount measurement range:	without limitation (0.0032…∞ mm)	
Amount resolution:	0.001 mm (pulse output: 0.01 mm)	
Amount accuracy:	0.1 mm or 1 % at < 3.82 mm/min and 2 % at ≥ 3.82 mm/min	
Intensity range:	0…12 mm/min resp. 0…720 mm/h	
Intensity resolution:	0.001 mm/min resp. 0.001 mm/h	
Intensity accuracy:	0.1 mm/min resp. ± 6 mm/h	
Dimensions:	311 mm x 256 mm (h x d), see dimensional drawing	
Suitable for mounting:	Ø 60 mm	
Weight:	approx. 4 kg	
Standards:	WMO-No. 8 • VDI 3786 Bl. 7 • EN 61000-2, -4 EN 61000-4-2, -3, -4, -5, -6, -11 • NAMUR NE-21	
Protection class load cell:	IP67	
Current consumption:	max. 45 mA at 24 V power supply and analogue output • typ. 6.5 mA at 24 V power supply and pulse output • typ. 12.5 mA at 12 V	
Supply voltage:	9.8...32 V DC	
Heating data:		electronically controlled, dual-circuit-heating
Target temperature:		+2 °C funnel surface temperature
Accuracy:		± 1 °C
Heating power:		150 W (funnel)
		60 W (outlet/ collecting vessel)
Supply voltage:		24 V DC / 210 W

Signal outputs:

- SDI-12
- RS485 (SDI-12 protocol, ASCII protocol, TALKER protocol and Modbus RTU)
- linearised, bounce-free pulse output signal **or** status output (configurable, e.g. ‘Rain YES/NO’ or ‘Heating ON/OFF’)
  - Pulse 1 (galvanically isolated, open collector): Max. 24 V DC / max. 0.05 A / max. 0.5 W
  - Pulse 2 (open collector): Max. 24 V DC / max. 0.1 A / max. 0.5 W
- Analogue output
  - 0/4…20 mA - max. load 500 Ω at 24 V DC • or 0…2.5/5 V
    with reset output function

14 Technical Data III

	rain[e] Modbus, unheated Id-No. 00.15184.000100	**rain[e] Modbus, heated** Id-No. 00.15184.400100	**rain[e]one, heated** Id-No. 00.15184.400001 **rain[e]one Modbus, heated** Id-No. 00.15184.400101	**rain[e]one, unheated** Id-No. 00.15184.000001 **rain[e]one Modbus, unheated** Id-No. 00.15184.00101
Measurable precipitation types:	liquid (solid, mixed – with heated sensor)			
Measurement principle:	weighing with automatic self emptying			
Operating temperature:	0...+70 °C	-40...+70 °C (no icing, no snowdrift)		0...+70 °C
Storage temperature:	-40..+70 °C			
Collecting area:	200 cm²			
Amount measurement range:	without limitation (0.005…∞ mm)		without limitation (0.005…∞ mm)	
Amount resolution:	0.001 mm (pulse output: 0.01 mm)			
Amount accuracy:	0.1 mm or 1 % at < 6 mm/min and 2 % at ≥ 6 mm/min		0.1 mm or 2 %	
Intensity range:	0…20 mm/min resp. 0…1200 mm/h		0…10 mm/min resp. 0…600 mm/h	
Intensity resolution:	0.001 mm/min resp. 0.001 mm/h			
Intensity accuracy:	0.1 mm/min resp. 6 mm/h-			
Dimensions:	292 mm x 190 mm (h x d), see dimensional drawing			
Suitable for mounting:	Ø 60 mm			
Weight:	approx. 2.5 kg			
Standards:	WMO-No. 8 • VDI 3786 Bl. 7 • EN 61000-2, -4 • EN 61000-4-2, -3, -4, -5, -6, -11 • NAMUR NE-21			
Protection class load cell:	IP67			
Current consumption:	max. 45 mA at 24 V power supply and analogue output • typ. 6.5 mA at 24 V power supply and pulse output • typ. 12.5 mA at 12 V			
Supply voltage:	9.8...32 V DC			
Heating data:	---	electronically controlled, dual-circuit-heating		---
Target temperature:	---	+2 °C funnel surface temperature		---
Accuracy:	---	± 1 °C		---
Heating power:	---	80 W (funnel)		---
		60 W (outlet/ collecting vessel)		
Supply voltage:	---	24 V DC / 140 W		---

Signal outputs:

- SDI-12
- RS485 (SDI-12 protocol, ASCII protocol, TALKER protocol and Modbus RTU)
- linearised, bounce-free pulse output signal **or** status output (configurable, e.g. ‘Rain YES/NO’ or ‘Heating ON/OFF’)
  - Pulse 1 (galvanically isolated, open collector): Max. 24 V DC / max. 0.05 A / max. 0.5 W
  - Pulse 2 (open collector): Max. 24 V DC / max. 0.1 A / max. 0.5 W
- Analogue output
  - 0/4…20 mA - max. load 500 Ω at 24 V DC • or 0…2.5/5 V with reset output function

15 Technical Data IV

	rain[e] LP Id-No. 00.15184.010000
Measurable precipitation types:	liquid
Measurement principle:	weighing with automatic self emptying
Operating temperature:	0...+70 °C
Storage temperature:	-40..+70 °C
Collecting area:	200 cm²
Amount measurement range:	without limitation (0.005…∞ mm)
Amount resolution:	0.001 mm (pulse output: 0.01 mm)
Amount accuracy:	0.1 mm or 1 % at < 6 mm/min and 2 % at ≥ 6 mm/min
Intensity range:	0…20 mm/min resp. 0…1200 mm/h
Intensity resolution:	0.001 mm/min resp. 0.001 mm/h
Intensity accuracy:	0.1 mm/min resp. 6 mm/h-
Dimensions:	292 mm x 190 mm (h x d), see dimensional drawing
Suitable for mounting:	Ø 60 mm
Weight:	approx. 2.5 kg
Standards:	WMO-No. 8 • VDI 3786 Bl. 7 • EN 61000-2, -4 • EN 61000-4-2, -3, -4, -5, -6, -11 • NAMUR NE-21
Protection class load cell:	IP67
Current consumption:	typ. 6.9 mA at 12 V power supply
Supply voltage:	9.8...12 V DC
Heating data:	---
Target temperature:	---
Accuracy:	---
Heating power:	---
Supply voltage:	---

Signal outputs:

- SDI-12
- linearised, bounce-free pulse output signal **or** status output (configurable, e.g. ‘Rain YES/NO’ or ‘Heating ON/OFF’)
  - Pulse 1 (galvanically isolated, open collector): Max. 24 V DC / max. 0.05 A / max. 0.5 W
  - Pulse 2 (open collector): Max. 24 V DC / max. 0.1 A / max. 0.5 W

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