



# Instruction Manual

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RT1 • Rooftop Monitoring System

# Important User Information

Dear customer, thank you for purchasing a Kipp & Zonen instrument. Completely reading this manual is essential for understanding the proper use and safe operation of this product.

Should you have any comments on this manual please send them to:

**Kipp & Zonen B.V.**

Delftechpark 36, 2628 XH Delft, - or  
P.O. Box 507, 2600 AM Delft,  
The Netherlands

+31 15 2755 210  
support@kippzonen.com  
www.kippzonen.com

Kipp & Zonen reserves the right to make changes to the specifications without prior notice.

**Warranty and liability**

Kipp & Zonen guarantees that the product delivered has been thoroughly tested to ensure that it meets its published specifications. The warranty included in the conditions of delivery is valid only if the product has been installed and used according to the instructions supplied by Kipp & Zonen.

Kipp & Zonen shall in no event be liable for incidental or consequential damages, including without limitation, lost profits, loss of income, loss of business opportunities, loss of use and other related exposures, however incurred, arising from the incorrect use of the product.

Modifications made by the user may affect the instrument performance, void the warranty, or affect the validity of the CE declaration or other approvals and compliances to applicable International Standards.

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## Declaration of Conformity



### **Kipp & Zonen B.V.**

Delftechpark 36, 2628 XH Delft  
P.O. Box 507, 2600 AM Delft  
The Netherlands

declares under our sole responsibility that the product

### **RT1 • Rooftop Monitoring System**

to which this declaration relates, is in conformity with European Harmonised Standards  
as published in the Official Journal of the EU, based on the following standard

[EMC - Emissions] **EN 61326-2-1:2013** and **EN 61326-2-3:2013**

[EMC - Immunity] **EN 61326-2-1:2013** and **EN 61326-2-3:2013**

[Environmental Affairs] **EN 50581:2012**

following the provisions  
EMC-directive **2014/30/EU**  
RoHS Directive **2011/65/EU**

**also, this device complies to**  
[EMC - FCC] **Title 47CFR part 15**

Delft, 1 September 2017

A handwritten signature in blue ink, appearing to read "E. Valks".

E. Valks - CEO  
Kipp & Zonen B.V.

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## Using this table

Click on any item in the table of contents to be taken directly to the relevant page.

Click on the bottom of any page to be taken back to the table of contents.

Reading this entire manual is recommended for a full understanding of this product.



The triangle with exclamation mark is intended to alert the user to the presence of important operating and maintenance instructions in the literature accompanying the instrument.

Kipp & Zonen reserve the right to make changes in the specifications without prior notice.



Many types of equipment should only be serviced by authorized personnel, meaning people who have been trained and designated as 'authorized' by their employers.

## Note

Useful information for the user

### 1.1 Safety Precautions

Many hazards are associated with installing and maintaining instruments on towers or elevated structures. It is advised to use qualified personnel for installation and maintenance. The client is responsible for following the local safety regulations. The use of appropriate equipment and safety practices is mandatory. Check your company's safety procedure and protective equipment prior to performing any work. If the RT1 is mounted at a high position, special care must be taken to secure both the person installing it and the instrument from falling during installation and maintenance.

While every attempt is made to get the highest degree of safety in our products, the client assumes all risk from injuries resulting from improper installation, use or maintenance of the RT1.

### 1.2 Waste disposal



The pictogram showing a waste bin with a cross means that the product is subject to European Union regulations covering segregated waste disposal. This applies both to the product itself and to any accessories marked with the same symbol. Disposal of any such item as unsorted domestic waste is not allowed.

- Please dispose of all packaging materials in accordance with the applicable national waste management regulations.
- Please dispose of cardboard boxes, protective plastic packaging materials and all preservative substances separately and in the proper manner.
- The disposal of the device itself as well as device parts, accessories and consumables, is subject to the applicable national and local waste management regulations and to the environmental protection legislation in force in the country of use.

### 1.3 Product overview

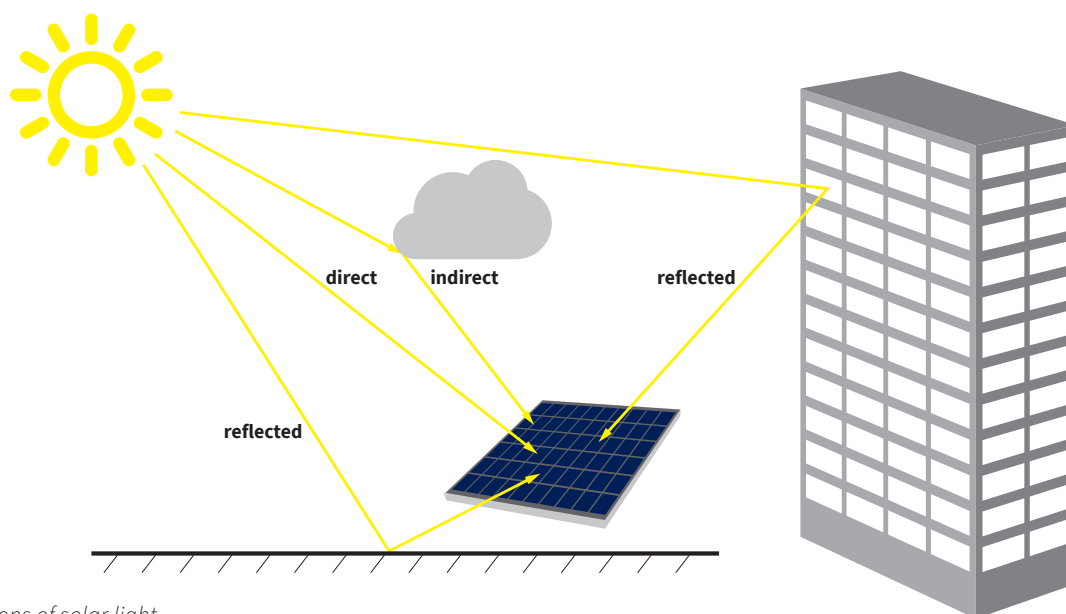
This manual, together with the SmartExplorer v1.4 manual and instruction sheet, provides information related to the installation, maintenance, calibration, product specifications and applications of the RT1 Rooftop Monitoring Solution.

If any questions should remain, please contact your local Kipp & Zonen representative or e-mail the Kipp & Zonen customer and product support department at: [support@kippzonen.com](mailto:support@kippzonen.com)

Please go to [www.kippzonen.com](http://www.kippzonen.com) for information about other Kipp & Zonen products, or to check for any updates to this manual or software.

## 1.4 The RT1 Rooftop Monitoring System

The RT1 instrument is a high quality radiometer designed for measuring solar irradiance on a plane surface (radiant flux,  $W/m^2$ ), which results from the sum of the direct solar radiation and the diffuse sky radiation above the instrument.



*Combinations of solar light*

The RT1 features internal digital signal processing and interfaces optimised for industrial data acquisition and control systems. Kipp & Zonen has developed a smart interface that features RS-485 Modbus<sup>®</sup> data communication for connection to programmable logic controllers (PLC's), inverters, digital control equipment and the latest generation of data loggers.

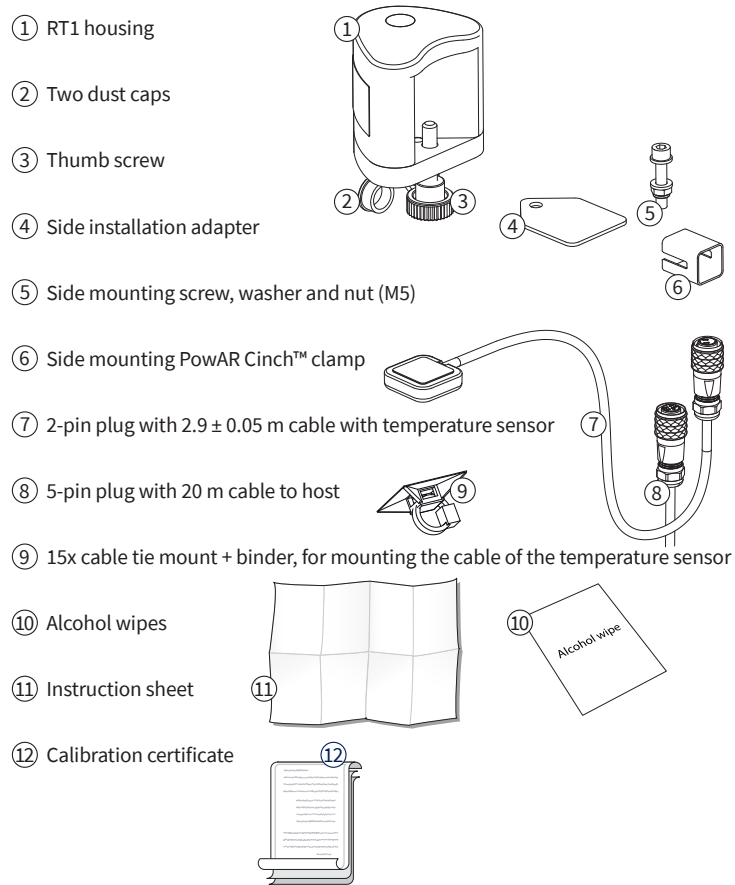
Digital signal processing provides faster response times and, with an integrated temperature sensor, corrects for the temperature dependence of the detector sensitivity.

To achieve the required low directional error when the sun is low at the horizon the RT1 uses a special diffuser that also improves the RT1's resistance to soiling as much of the dust and dirt simply blows or flows off.

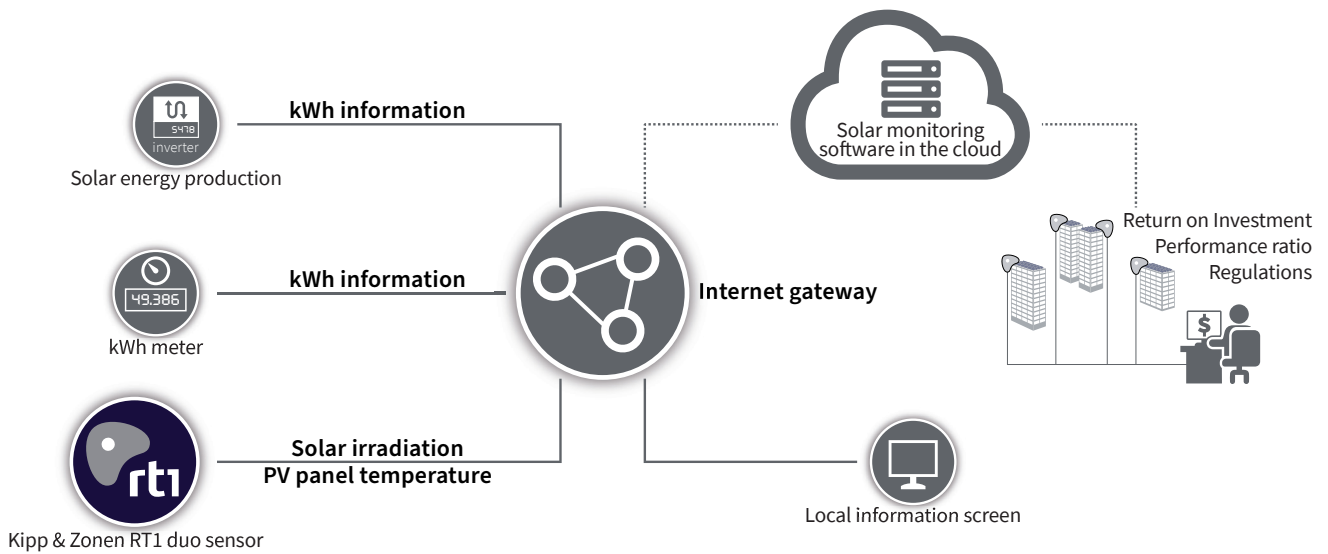
The RT1 is delivered with a waterproof plug pre-wired to a 20 m long, high quality signal cable plus a PV panel temperature sensor with  $2.9\text{ m} \pm 0.05\text{ m}$  cable.

The RT1 Rooftop Monitoring Systems are calibrated using a pyranometer that has been calibrated in accordance with Annex A.3 of ISO 9847 'Calibration of Field Pyranometers by Comparison to a Reference Pyranometer'. Calibrations are traceable to the World Radiometric Reference (WRR) in Davos, Switzerland. Full details can be found on the calibration certificate that comes with each instrument.

## 1.5 Key parts of the RT1 Rooftop Monitoring System



## 1.6 Key parts of a solution around the RT1 Rooftop Monitoring System



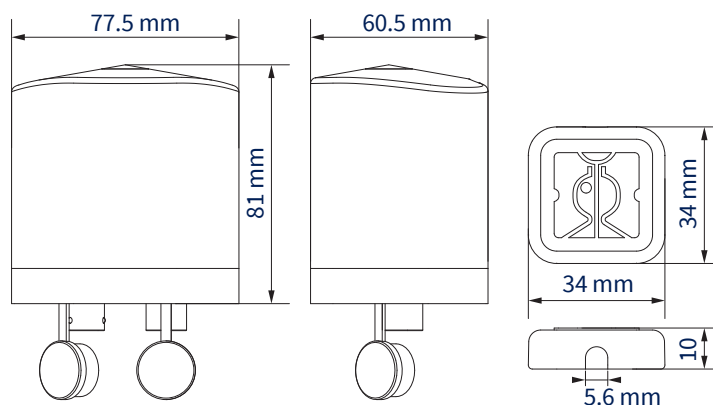
## 2 Specifications

Kipp & Zonen reserves the right to make changes to specifications and other product documentation without prior notice.

### 2.1 Optical and electrical

Irradiance	0 to 2000 W/m <sup>2</sup>
Spectral range	400 to 1100 nm
Non-stability (change/year)	< 1 %
Non-linearity (0 to 1000 W/m <sup>2</sup> )	< 1 %
Directional response (up to 55 ° with 1000 W/m <sup>2</sup> beam)	< 1.7 %
Uncertainty in daily total	< 7 %
The combined calibration uncertainty	±3 % against traceable reference pyranometer
PV panel temperature	-40 to +100 °C, ± 1 °C, using a 10 k NTC
Calibration	Against traceable reference pyranometer
Signal connections	1 - RS-485 connection to host 2 - PV panel temperature sensor
Voltage and current range	5 to 30 VDC, 2.5 to 10 mA
Power consumption maximum	60 mW
Ambient operating temperature	-40 to +80 °C
Recommended calibration interval	2 years
Standard Warranty	2 years
Ingress Protection (IP) rating	IP67 with both plugs securely attached
Supported PV panel heights when mounted on corner	30 to 50 mm
Communication to host	Modbus® Slave RTU over 2-wire EIA RS-485 connection 1200 to 38400 baud
Connections on instrument	Two connectors, 5 pin to host and 2 pin to temperature sensor
Cable to host	20 m
Cable to temperature sensor	2.9 m ±0.05 m

### 2.2 Dimensions and weight



Weight	
RT1 main body	514 g
Complete boxed unit with cables, adapter and instruction sheet	1710 g

### 2.3 Communication

RS-485 specifications	
Baud rates	38400, 19200, 9600, 4800, 2400 and 1200
Data bits	8
Parity	Non, even, odd
Stop bits	1, 2

Settings can be changed from the factory default 19200, 8, even, 1 using the downloadable Smart Sensor Explorer.



# 3

## Installation

Please follow the instructions in this section carefully for the mechanical and electrical installation of the RT1 Rooftop Monitoring System.



Do not turn on power to the instrument until instructed to do so.

Do not connect the instrument to a computer, data logger or SCADA system until instructed to do so.

### 3.1 Included with the product

Check the contents of the shipment for completeness (see below) and note whether any damage has occurred during transport. If there is damage, a claim should be filed with the carrier immediately. In the case of damage and/or the incomplete contents, contact your local Kipp & Zonen representative or e-mail the Kipp & Zonen customer and product support department at: [support@kippzonen.com](mailto:support@kippzonen.com)

Although the RT1 Rooftop Monitoring System is weatherproof and suitable for use in harsh environmental conditions, they have some delicate mechanical parts. Please keep the original packaging for safe transport of the radiometer to the measurement site, or for use when returning the radiometer for calibration.

The following parts come with the RT1 Rooftop Monitoring System:

1. RT1 housing
2. Two dust caps
3. Thumb screw
4. Side installation adapter
5. Side mounting nut, ring and M6x30 screw
6. Side mounting PowAR Cinch™ clamp
7. 2-pin plug with 2.9 m ±0.05 m cable with temperature sensor
8. 5-pin plug with 20 m cable to host
9. 15x cable tie mount + binder, for mounting the cable of the temperature sensor
10. Alcohol wipes
11. Instruction sheet
12. Warranty & manual download card
13. Calibration certificate

### 3.2 Tools required

No tools are required to fit a RT1 to a corner of a PV panel. Securing the thumbscrew hand tight is enough.

In case the corner mounting is no option use a 5 mm Allen key and 10 mm spanner to secure the adapter plate to the RT1.

### 3.3 Preparation

It might be convenient to adjust the RS-485 settings and change e.g. the Modbus® address prior to visiting the site, otherwise a computer and RS-485 / USB converter may be required during installation. Standard factory settings are: Modbus® address 1 and 19200 baud, 8 bits, even parity, 1 stopbit, which is also known as 19200 - 8E1.

### 3.4 Installation for measurement of tilted (POA) irradiance

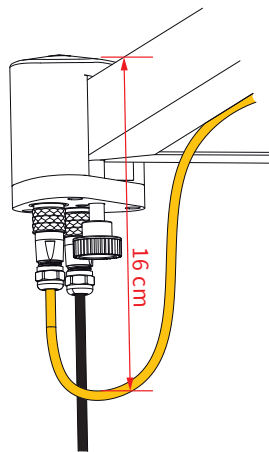
For optimal performance of the instrument the following steps must be taken carefully.

Ideally, the site for the RT1 should be free from any obstructions to the sky. Ideally the RT1 should have the same combination of direct, indirect and reflected light as the PV panels. Typically a place that has shade and reflections like most of the installed PV panels. The top corner of a PV panel is the best place to put the RT1 as its field of view will be the same as that of the actual PV panel.

The most common method of installing the RT1 is on a corner of one the PV panels. Screw out the thumbscrew just enough for the RT1 to fit over the corner of the PV panel.

Position the RT1 in such a way that it fits well and snugly to both sides of the PV panel, then turn in the thumb screw until it is hand tight and feels well secured.

The RT1 is very sturdy and will not bend or flex and overtightening the thumbscrew could damage the PV panel frame. Do not plug in the cable to the host or Modbus® gateway unless the cable is properly installed.

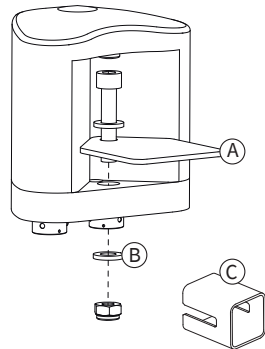


*RT1 mounting on a corner*



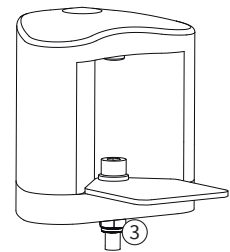
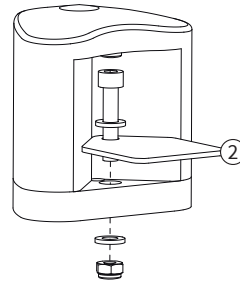
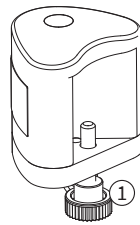
It is also possible to mount the RT1 at the side of a PV panel by using the adapter plate (A), the screw, nut and washers (B) and PowAR Cinch™ clamp (C).

Adapter plate and clamp



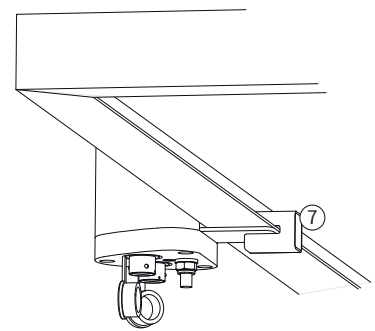
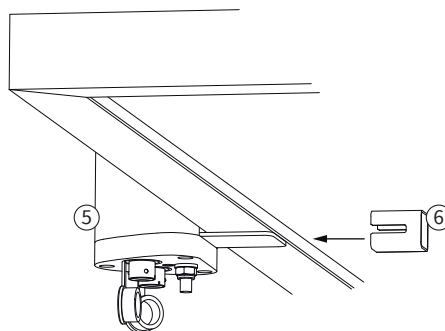
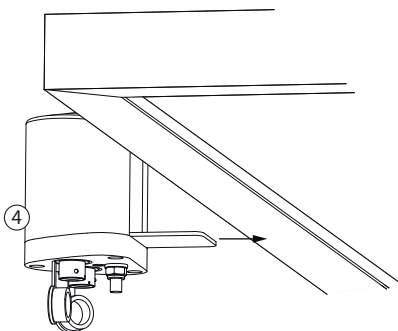
- PowAR Cinch™ is for single use
- Safety gloves recommended
- No tools required
- Please go to [www.araymond-energies.com](http://www.araymond-energies.com) for more detailed information

- ① Remove and store the thumb screw
- ② Put the adapter plate in the RT1
- ③ Secure with the nut and screw



The RT1 is now ready to be installed on the side of a PV panel.

- ④ Align the RT1 with the side of the PV panel
- ⑤ Keep the RT1 securely in place
- ⑥ Position the PowAR Cinch™ in front of the adapter plate and make sure that the claws are on the upper side to be in contact with the module aluminum frame.
- ⑦ Insert the PowAR Cinch™ and make sure that it is fully engaged. This will require some force or potentially a small hamer.



### 3.5 PowAR Cinch™ grounding details

Bonding path from the module frame to its supporting structure is ensured by the part itself as it maintains a stable electrical contact between the module frame and the stainless steel adapter plate at several contact points.

### 3.6 PowAR Cinch™ dismantling

Insert a flatblade screwdriver without sheathed insulation under the tab in order to move up the two claws. Pull back the PowAR Cinch™ until it is disengaged. Please note that PowAR Cinch™ is for single use.

### 3.7 Installing the PV panel temperature sensor

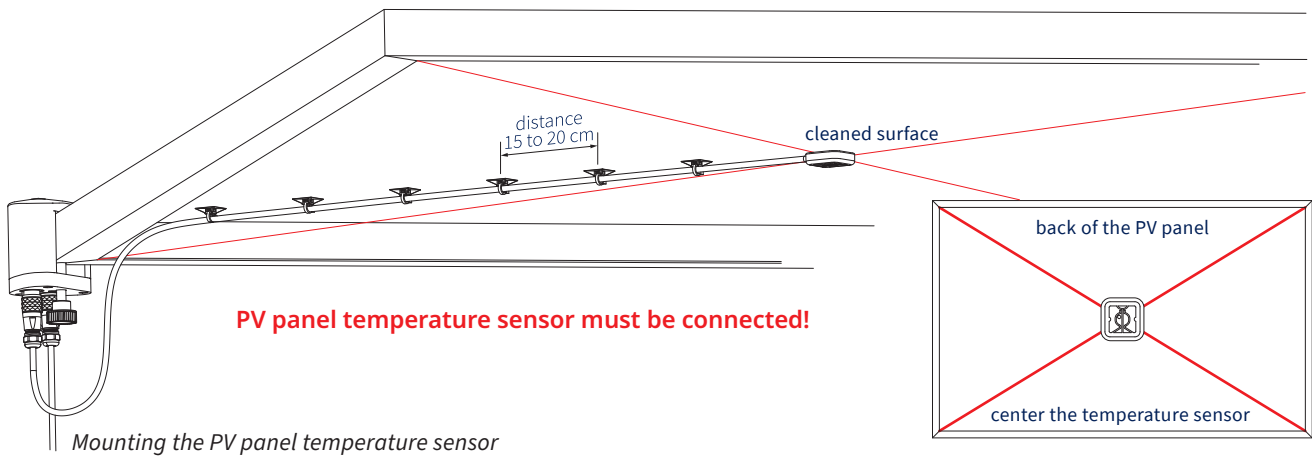
Install the PV panel temperature sensor by the following steps:

- a - From the RT1 sensor, pull off the black dust cap of the 2-pin connector
- b - Insert the 2-pin plug in the 2-pin connector of the RT1 sensor
- c - Clean the surfaces of the locations for the cable supports and for the PV panel temperature sensor<sup>(2)</sup> at the back of the PV panel

- <sup>(2)</sup> The best location for the temperature sensor is the center of the PV panel
- d - Stick the temperature sensor to the cleaned surface at back of the PV panel

**Place with care as the temperature sensor can not be removed once stuck**

- e - Stick the cable tie mounts to the cleaned surfaces at the back of the PV panel
- f - Secure the cable to the cable supports by using tie wraps



### 3.8 Electrical connections

As standard, the RT1 is supplied with a waterproof connector pre-wired to 20 m of high quality cable with 5 wires and a shield covered with a black sleeve. The first production runs will have a 20 m yellow cable with the green, brown and red wires cut off. The colour code of the wires are shown below.

Wire	Function	Connect with
Yellow	Modbus® RS-485	B/B'+
Grey	Modbus® RS-485	A/A'-
Green	Modbus® common / Ground	
Red	Power 5 to 30 VDC (12 V recommended) 60 mW max.	
Blue	Power ground	
Shield	Housing	Ground *

\* Connect to ground if radiometer not grounded

Table 1 RT1 connection



Special attention is needed to prevent power or ground loops when connecting the RT1 to multiple readout devices. The maximum differential voltage between either of the Modbus® RS-485 lines (yellow and grey) and the power ground / RS-485 common line (black) is 70 VDC.

**Note** First connect all wires at the data logger or Modbus® gateway before putting the plug into the RT1.

The shield of the cable is connected to the aluminum RT1 housing through the connector body. Preferably, secure the RT1 on the metal PV panel frame with a good connection to ground (e.g. by using a lightning conductor) and do not connect the cable shield at the data logger or Modbus® gateway.

If there is no good ground connection at the RT1, the shield at the cable end should be connected to ground at the data logger or gateway. Lightning can induce high voltages in the shield but these will be led off at the RT1 or data logger or gateway.

**Note** Long cables may be used, but may affect the maximum baud rate of the RS-485 digital connection.

### 3.9 Power connection

The minimum power supply voltage for RT1 is 5 VDC. However, for optimal performance it is advised to use 12 VDC, especially when long cables are used. 5-volt power can only be used in combination with a short cable with a maximum length of 10 m.

It is advised to protect the output of the power supply with a fast blowing fuse of maximum 250 mA rating.

5 VDC	50 mW	approximately 10.0 mA
12 VDC	55 mW	approximately 4.5 mA
24 VDC	60 mW	approximately 2.5 mA

Table 2 RT1 typical power consumption

Maximum power consumption is 65 mW at the highest input voltage. Maximum input current is 12.5 mA at the lowest input voltage. Maximum inrush current 200 mA.

### 3.10 Fitting the host connector cable

Connect the 5-pin plug in the RT1 socket by placing the red dot on the plug opposite the red dot on the chassis part. It will only fit in this way. To secure the plug, push it in by holding the plug at the end and not by the grooved ring.



To unplug, pull the grooved ring towards the cable and then pull out the plug. Do not try to rotate the grooved ring!

**Note** The cable must be arranged with a curve below the instrument so water drips off and does not run along the cable up to the connector.

### 3.11 Fitting the temperature sensor cable

Connect the 2-pin plug in the RT1 socket by placing the red dot on the plug opposite the red dot on the chassis part. It will only fit in this way. To secure the plug, push it in by holding the plug at the end and not by the grooved ring.



To unplug, pull the grooved ring towards the cable and then pull out the plug. Do not try to rotate the grooved ring!

**Note** The cable must be arranged with a curve below the instrument so water drips off and does not run along the cable up to the connector.

### 3.12 Data connection to a PC for setup

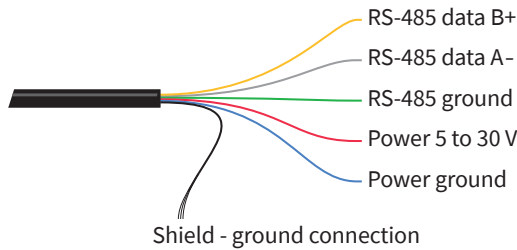
Connection to a computer by USB. The connection depends on the use of a RS-485 to USB converter.



The converter must have galvanic isolation between the inputs and outputs to prevent possible damage to the RT1 digital interface. This is particularly an issue with portable computers (laptops, etc.) in which the power supplies can generate large voltage spikes.

A suitable converter is the model USOPTL4 from B & B Electronics. One end has the USB connector to the PC the other end has a connector with screw terminals for the instrument wires. This RS-485 converter is powered from the USB interface, so no additional power adaptor is necessary.

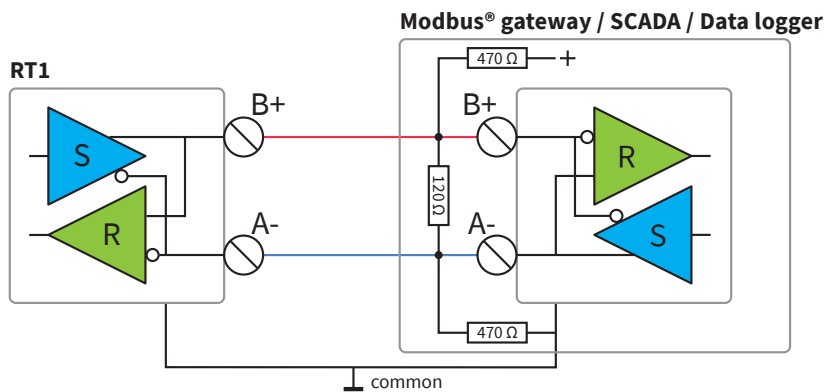
### RT1 connections to USB



\* Switches on the converter should be set for RS-485, 2-wire operation and Echo off

### 3.13 Connection to a RS-485 Network

The RT1 can be connected to a 2-wire RS-485 network as shown.



The slaves may be an RT1 or other Kipp & Zonen Smart device or other Modbus® devices. If a RT1 is the last device in the network a line terminator (LT), consisting of a 120 Ω or 150 Ω resistor, must be connected between the terminals A/- and B/+. It is also required to install the pull up and pull down resistors as shown. The value of these resistors must be between 470 Ω and 850 Ω.

### 3.14 Recommended cable types

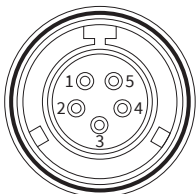
Where cables need to be extended, or the customer prefers to provide their own cables, they should be suitable for outdoor used, UV resistant, use twisted pair wires and proper shielding.

Recommended cable	
Ethernet CAT 5 shielded twisted pair (STP)	

### 3.15 Connector type

The connector used is Weipu SF1210/P5

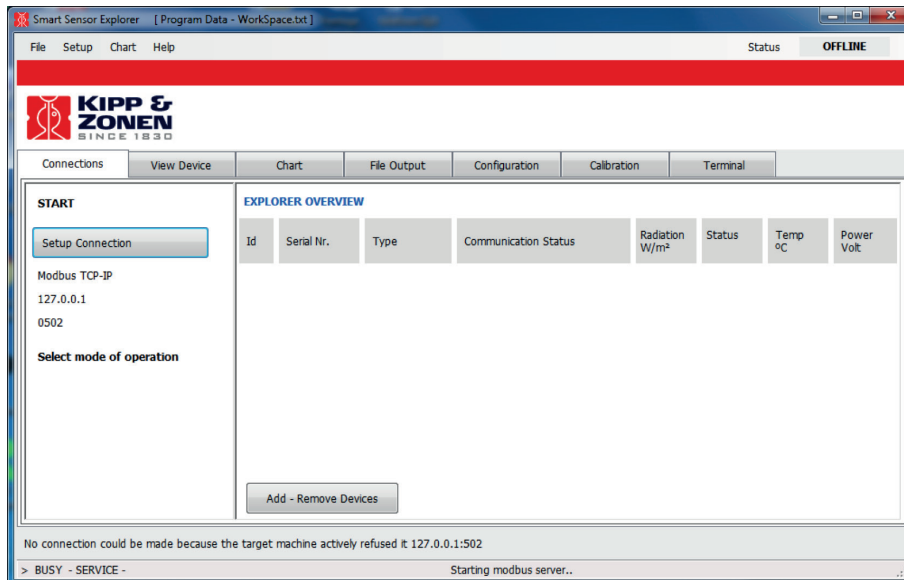
Pin	Signal
1	Power ground
2	Power +
3	Modbus® RS-485 A/A'-
4	Modbus® RS-485 B/B'+
5	Modbus® common / Ground



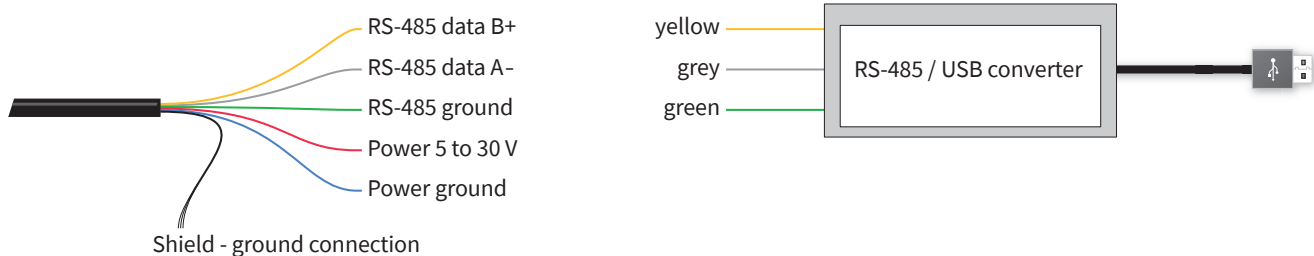
## SmartExplorer software and Modbus® communication

The SmartExplorer software allows you to configure a smart sensor and to collect real-time data. SmartExplorer runs on a PC with Windows Vista, 7 or 8 and when installing downloads the .NET 4.5 framework from the Microsoft Server when needed. When using the software on site, make sure the software is already installed on your laptop.

To connect a smart radiometer like the RT1 to a PC, a RS-485 to USB converter is required. An isolated version like the 'USOPTL4' from B&B is recommended for safety and protection of the PC.



### RT1 connections to USB



- Configuration makes it possible to configure the RT1 'out of the box' and test the RT1 before the sensor use.
- The SmartExplorer software can use a RS-485 to USB or Ethernet interface to connect to a PC.
- Collecting data makes it possible to store data from the RT1 in a comma-separated file. The comma separated file is created at the beginning of every new day or at the beginning of the first day of the week.
- The SmartExplorer software can also be used to monitor and/or log up to 10 instruments simultaneously and works with all smart radiometers (RT1, SMP, SHP, SGR, SUV).

Please check the separate SmartExplorer manual for detailed information about the set-up, monitoring and data logging of the smart sensors. The latest version of the manual can be downloaded from the relevant product page under the tab 'Download' from our website.

The factory default communication parameters for all Smart instruments are:

- 19200 baud
- 8 bits - even parity - 1 stopbit (8E1)
- Modbus® address 1



# 5 Operation and measurement

Smart instruments like the RT1 only require suitable sources of power and radiation (light) to operate and make measurements. However, it is necessary to connect them to some sort of readout or data storage device in order to save the measurements, there is no internal data memory.

## 5.1 Data collection

An optimal setting for the data interval is to sample every second and store one minute averages. For setting up the combination of pyranometer and data storage, please refer to the manual of the data collection device.

## 5.2 Maintenance and re-calibration

The RT1 is simple to maintain and does not require any special tools or training. There are no service items requiring scheduled replacement.

## 5.3 Monthly maintenance

The frequency of cleaning is highly dependent upon the local weather and environmental conditions, such as dust, airborne pollutants or salt spray in marine environments. Ideally, the dome of the RT1 should be cleaned every month.

Note Clean the dome using pure alcohol or distilled water and a lint-free cloth. Ensure that no smears or deposits are left on the dome.

## 5.4 Yearly maintenance

Check all the electrical connections. Check cables for damage caused by accident or by rodents.  
Check if the instrument mountings and the PV panel temperature sensor are still securely installed.

## 5.5 Calibration

RT1 rooftop sensors are very stable instruments, but they do change very slightly with time. This is largely due to exposure of the sensor to UV solar radiation. Re-calibration is recommended every five years. Normally this is carried out at the Kipp & Zonen factory or at an authorised calibration facility.

### 5.5.1 Calibration principle

At the Kipp & Zonen factory pyranometers are calibrated, or re-calibrated, according to ISO 9847:1992 'Solar energy - Calibration of field pyranometers by comparison to a reference pyranometer', Annex A 'Calibration devices using artificial sources'. The calibration is based on a side-by-side comparison of the test pyranometer with a reference pyranometer of the same type under a stable artificial sun. The reference pyranometers are regularly calibrated outdoors at the World Radiation Centre (WRC) in Davos, Switzerland.

The sensitivity of the test pyranometer is calculated by comparison to the reference pyranometer readings and the calibration certificate is produced. At Kipp & Zonen the complete process is automated under computer control, including programming the RT1 pyranometer with the correct calibration factors.

### 5.5.2 Calibration traceability to the WRR

Our reference pyranometers are calibrated at the World Radiation Centre (WRC) in Davos, Switzerland by comparison to the World Radiometric Reference (WRR). They are also fully characterized for linearity, temperature dependence and directional response to enable transfer of the sensitivity under the measurement conditions in Davos to our calibration laboratory conditions.

Kipp & Zonen keeps at least two reference instruments for each pyranometer model. These reference instruments are sent alternate years to the WRC for calibration, so that production and calibration in Delft can carry on without interruption.

Kipp & Zonen calibration certificates include an overview of the calibration method, details of the reference pyranometer used, traceability to the WRR, and the uncertainty in the full calibration chain from the WRR to the pyranometer being calibrated.

There are no user-serviceable parts within the RT1 and it must not be opened.

### 6.1 Output signal not present or incorrect

The following contains a procedure for checking the instrument in case it appears that it does not function correctly:

1. Check the RT1 cable is properly connected to the data logger or gateway.
2. Check the power supply (12 VDC recommended).
3. Check that the instrument has a unique Modbus® address.
4. Check the instrument location. Are there any obstructions that cast a shadow on the instrument by blocking the direct sun during some part of the day?
5. Check the cable to the temperature sensor
6. Check the dome, it should be clear and clean.

Any malfunction or visible damage should be reported to your Kipp & Zonen representative, who will suggest the appropriate action.

### 6.2 Frequently Asked Questions

The most frequently asked questions are listed below. For an update or further information refer to our website at [www.kipp-zonen.com](http://www.kipp-zonen.com).

**Q: Maximum and minimum irradiation quantities?**

A: Due to reflection from certain types of clouds the global irradiance at sea level can rise above the extra-terrestrial direct irradiance (the Solar Constant) of  $1367 \text{ W/m}^2$  at the top of the atmosphere (WMO 1982). Values up to  $1500 \text{ W/m}^2$  have been reported. Because the clouds move, this irradiance value mostly appears as short events of a few minutes duration.

**Q: Is the pyranometer calibration affected by the length of the signal cable?**

A: The digital RS-485 output can operate over cable lengths up to 1000 m, depending on the baud-rate used.

## Customer support

If you require any support for your Kipp & Zonen product please contact your local representative in the first instance. The information can be found in the 'Contact' section (home tab) of our website at [www.kippzonen.com](http://www.kippzonen.com).

Alternatively, you can contact us directly at [www.kippzonen.com/support](http://www.kippzonen.com/support)

Please include the following information:

- Instrument model
- Instrument serial number
- Details of the fault or problem
- Examples of data files
- Readout device, data acquisition system and operating system
- Interfaces and power supplies
- History of any previous repairs or modifications
- Pictures of the installation
- Overview of the local environment conditions

Kipp & Zonen guarantees that your information will not be shared with other organisations.

## 8.1 Modbus® commands

The commands are all according to the Modbus RTU protocols described in the document: 'Modbus® over serial line V1.02' and 'MODBUS application protocol V1.1b' available from the Modbus® organization ([www.modbus.org](http://www.modbus.org)). The commands can be tested using software tools, such as the program 'Modbus Poll' from [www.modbustools.com](http://www.modbustools.com) or QmodMaster from [sourceforge.net](http://sourceforge.net).

The following commands are implemented:

Function	Description
0x01	Read Coils
0x02	Read Discrete Inputs
0x03	Read Holding Registers
0x04	Read Input Register
0x05	Write Single Coil
0x06	Write Holding Register
0x10	Write multiple Registers

- The RT1 does not make a difference between a 'coil' and a discrete input. The only difference is that a discrete input is read only.
- The RT1 does not make a difference between a holding register and an input register. The only difference is that an input register is read only.

## 8.2 Input registers

Input registers are read only and detail descriptions to be found in paragraph 9.3

**Note** PDU address + 1 = Modbus® register number

Real-time Processed Data						
PDU address	Parameter	Name	R/W	Type	Mode	Description
0	IO_DEVICE_TYPE	DevType	R	U	All	Device type of the sensor
1	IO_DATAMODEL_VERSION	DataSet	R	U	All	Version of the object data model
2	IO_OPERATIONAL_MODE	DevMode	R	U	All	Operational mode: normal, service, calibration, factory and error (1-5)
3	IO_STATUS_FLAGS	Status	R	U	All	Device Status flags
5	IO_SENSOR1_DATA	Sensor1	R	S	N,S	Radiation, temperature compensated radiation in W/m <sup>2</sup>
8	IO_PANEL_TEMPERATURE	PanelTemp	R	S	N,S	PV panel temperature in 0.1 °C
9	IO_EXT_POWER_SENSOR	VSupply	R	S	N,S	External power voltage in 0.1 V
332 & 333	IO_CALIBRATION_DATE	Calibration	R	FP32	N,S	Floating Point ABCD number that represents the calibration date as yymmdd

Example:

Register 332 18470

Register 333 52480

Form 0x4826cd00 in hex

These two registers treated as a Floating Point ABCD form 170804 representing 4 August 2017.

**Note** Panel temperature and Power sensor need to be divided by 10.

Error reports and version information					
PDU address	Parameter	R/W <sup>(2)</sup>	Type	Mode	Description
26	IO_ERROR_CODE	R	U16	All	Most recent/ actual error code
27	IO_PROTOCOL_ERROR	R	U16	All	Protocol error/communication error
41	IO_BATCH_NUMBER	R	U16	All	The year of production e.g. 17 for the year 2017
42	IO_SERIAL_NUMBER	R	U16	All	Serial number 0 - 9999. Batch + serial number form the instrument serial number e.g. 17 & 3098 form 173098 as on the instrument label
43	IO_SOFTWARE_VERSION	R	U16	All	Software version
44	IO_HARDWARE_VERSION	R	U16	All	Hardware version
45	IO_NODE_ID	R	U16	All	(Modbus <sup>®</sup> /SMA) device address RS-485

<sup>(2)</sup> Writing any value to input registers 26 to 33 will reset the contents of the registers

Legend			
R/W	Read or write	R	Read only
		R/W	Read/write
Type	Type and size	U16	16 bit unsigned integer
		S16	16 bit signed integer
		S32	32 bit signed integer (MSB first, LSB last)
		FP	32 bit floating point
Mode	Operation mode	N	available in normal mode
		S	available in service mode
		C	available in calibration mode (not for users)
		F	available in factory mode (not for users)
		All	available in all modes

## 8.3 Read input register

In this chapter only the most important registers and controls are described.

### Register 0 IO\_DEVICE\_TYPE

The device type defines which device is connected.

Parameter name	Register	R/W	Initial Val	Mode	Description
IO_DEVICE_TYPE	R0	R	631 or 632	All	RT1

### Register 1 IO\_DATAMODEL\_VERSION

The data-model describes the functions supported by the smart sensor. This document is valid for data-model version 3.01 or higher.

Parameter name	Register	R/W	Initial Val	Mode	Description
IO_DATAMODEL_VERSION	R0	R	3.01 or higher	All	Data model

### Register 2 IO\_OPERATIONAL\_MODE

The operation mode defines the state of the smart sensor. The operational modes are 1 = Normal Mode; 2 = Service Mode; 3 = Calibration Mode; 4 = Factory Mode and 5 = Error mode. The standby mode (mode 0) is not supported.

Parameter name	Register	R/W	Initial Val	Mode	Description
IO_OPERATIONAL_MODE	R0	R	1, 2, 3, 4, 5	All	instrument mode

After power on the operation mode (1) is set by the RT1. When the Error mode (5) is set, then there is a fatal error.

**Register 3** **IO\_STATUS\_FLAGS**

This register defines the status of the smart sensor and the validity of the data. Each bit has a special meaning. Bit 0 is the first (least significant) bit.

Bit 0	Quality of the signal	1 = unstable signal
Bit 1	Overflow	1 = error reported
Bit 2	Underflow	1 = error reported
Bit 3	Error flag	1 = error reported
Bit 4	ADC Error	1 = error reported
Bit 5	DAC Error	1 = error reported
Bit 6	Calibration Error	Not a normal usage error
Bit 7	Update EEPROM error	Not a normal usage error

**Register 5** **IO\_SENSOR1\_DATA**

This register holds the actual data (solar radiation) measured by the sensor. The solar radiation is measured in W/m<sup>2</sup>.

**Register 8** **IO\_BODY\_TEMPERATURE**

This register holds the PV panel temperature as measured by the external sensor. The temperature is measured in 0.1 degrees Celcius.

**Register 9** **IO\_EXT\_POWER\_SENSOR**

The Ext power sensor measured the external voltage applied to the sensor in 0.1 Volt. To convert the data to a floating point number, make the following calculation: (floating point) result = (integer) register (IO\_EXT\_POWER\_SENSOR) / 10.0



# Customer Services

Kipp & Zonen stands for quality and our instruments are known around the world for their accuracy, reliability and durability. We invest a lot of care and effort into providing you with the best products available on the market, at a range of price and performance points.

Our instruments have an impressively long operating life when properly maintained. We offer a variety of services to support and assist you in optimising the use of our instruments.

Resources include our Customer Support System, Download Center and Knowledge Center with FAQ's.

Please go to [www.kippzonen.com](http://www.kippzonen.com) to find your preferred customer support resource.

Go to [www.kippzonen.com](http://www.kippzonen.com) for your local distributor or contact your local sales office.



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