OTT HydroMet

KIPP & ZONEN
an OTT HydroMet brand

SMP Series Smart Pyranometers

Operational Manual

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Subject to technical change.

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1 Scope of supply

The following items are included with SMP series pyranometers:

- Smart pyranometer
- Sun shield
- Optional cable, pre-wired with 8-pins connector or connector only for customer cable
- Calibration certificate
- Instruction sheet
- Pyranometer fixing kit SMP3:
  - 2 stainless steel screws each: M5 x 30 mm, M5 X 40 mm and M5 x 50 mm
  - Nuts and flat washers
- Pyranometer fixing kit SMP6, SMP10 and SMP22:
  - 2 stainless steel screws M5 x 80 mm
  - Nuts and flat washers
  - Nylon insulation ring

2 Order numbers and variant code

2.1 Product variants

Variant	Order number
SMP3	0374900
SMP6	0374920
SMP10	0374905
SMP22	0374940

2.2 Accessories and spare parts

Accessories

Item	Order number
CVF 4 Ventilation Unit	0378910
CMF1 - Albedometer mount	0362700
CMF4 - Albedometer mount	0362703
Unventilated glare screen kit	0305722
Ventilated glare screen kit	0305725
AMPBOX	0365900
METEON Data Logger	0365910
METEON 2.0 Data Logger	0388900
LogBoxSE Data Logger	3303096
Fixed Feet	0362705
CMP3 Albedometer Rod	0338720
CM121B/C Shadow Ring - Unventilated	0346900
CM121B/C Shadow Ring - Ventilated	0346901
Smart Powered Hub	0382440
Smart Hub	0382445
PMU485 Smart Set Hub	0382460

For SMP3, SMP6, SMP10, SMP22

Item	Order number
Waterproof 8-pin plug	2523146
10 m cable, pre-wired with waterproof 8-pin plug	0362621
25 m cable, pre-wired with waterproof 8-pin plug	0362623
50 m cable, pre-wired with waterproof 8-pin plug	0362624
100 m cable, pre-wired with waterproof 8-pin plug	0362625

3 About this manual

3.1 Other applicable documents

The following documents contain further information on installation, maintenance and calibration:

- Smart Pyranometer Communication Manual
- Smart Explorer Software Manual

3.2 General signs and symbols

The signs and symbols used in the operating manual have the following meaning:

Practical tip

This symbol indicates important and useful information.

Action

✓ Prerequisite that must be met before performing an action.

▸ Step 1

⇨ Intermediate result of an action

▸ Step 2

⇨ Result of a completed action

List

- List item, 1st level
  - List item, 2nd level

3.3 Explanation of warnings

To avoid personal injury and material damage, you must observe the safety information and warnings in the operating manual. The warnings use the following danger levels:

WARNING

WARNING

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in death or serious injuries.

CAUTION

CAUTION

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in moderately serious or minor injuries.

NOTICE

NOTE

This indicates a situation from which damage may arise. If the situation is not avoided, products may be damaged.

4 General safety instructions

4.1 Intended use
The pyranometer is used to measure and report the solar radiation.

4.2 Potential misuse
Any use of the product that does not comply with the intended use, be this intentional or negligent, is forbidden by the manufacturer.

- Use the product only as described in the operational manual.

4.3 Personnel qualification
The equipment described in this manual must be installed, operated, maintained and repaired by qualified personnel only.

- Obtain training from OTT HydroMet if necessary.

4.4 Personnel obligations
To avoid equipment damage and injury when handling the product, personnel are obliged to the following:

- Read the operational manual carefully before using the product for the first time.
- Pay attention to all safety information and warnings.
- If you do not understand the information and procedure explanations in this manual, stop the action and contact the service provider for assistance.
- Wear the necessary personal protective equipment.

4.5 Danger of burns due to hot surfaces
The metal parts of the housing may get very hot when subject to a high ambient temperature (> 60 °C). If someone touches the housing, these metal parts may cause burns.

- Wear protective gloves during installation and maintenance.

4.6 Correct handling
If the product is not installed, used and maintained correctly, there is a risk of injury. The manufacturer does not accept any liability for personal injury or material damage resulting from incorrect handling.

- Install and operate the product under the technical conditions described in the operational manual.
- Do not change or convert the product in any way.
- Do not perform any repairs yourself.
- Get OTT HydroMet to examine and repair any defects.
- Ensure that the product is correctly disposed of. Do not dispose of it in household waste.

4.7 Certification

CE (EU)
The equipment meets the essential requirements of EMC Directive 2014/30/EU.

FCC (US)
FCC Part 15, Class "B" Limits

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

IC (CA)
Canadian Radio Interference-Causing Equipment Regulation, ICES-003, "Class B"

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

5 Product description

5.1 Design and function

The SMP series instruments are radiometers designed for measuring short-wave 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 incident from the hemisphere above the instrument.

Two pyranometers can be used as albedometers. The upper measures incoming global solar radiation and the lower measures solar radiation reflected from the surface below, when the two signal outputs have been converted to irradiance in W/m^3, the albedo can be simply calculated.

SMP pyranometers feature a 2-wire smart interface with RS-485 Modbus® (RTU) protocol for connection to programmable logic controllers (PLC's), inverters, digital control equipment and data loggers. All models are available in two versions. One has an analog voltage output of 0 to 1 V, the other has an analog current output of 4 to 20 mA. 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 spectral and directional characteristics SMP pyranometers use thermopile detectors and glass domes. The thermopile responds to the total energy absorbed by black surface coating, which is spectrally non-selective. The thermopile warms up and the heat generated flows through a thermal resistance to a heat-sink, the pyranometer housing.

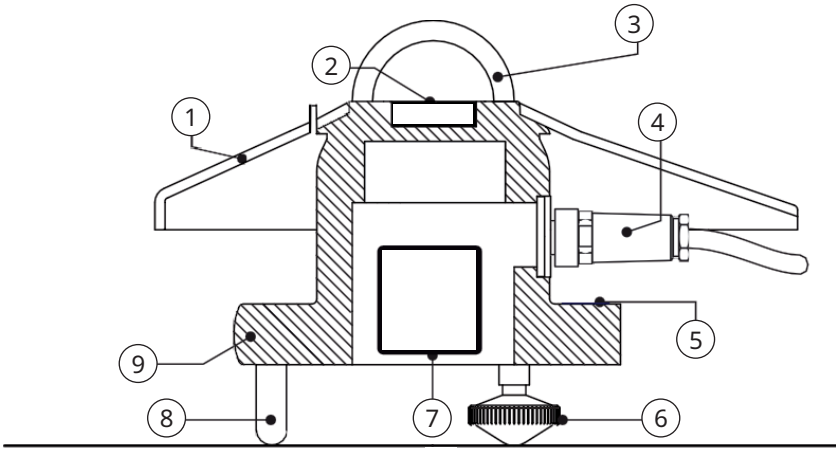
The rise of temperature in the thermopile is easily affected by wind, rain and thermal radiation losses to the environment and the delicate black coating must be protected. Therefore the detector is shielded by one or two domes. These domes allow equal transmittance of the direct solar radiation component for every position of the sun in the hemisphere above the detector. The internal desiccant prevents condensation on the inner sides of the domes, which can cool down considerably on clear windless nights.

The pyranometers have built-in bubble levels and adjustable leveling feet. Snap-on sun shields reduce solar heating of the housings. The waterproof connectors have gold-plated contacts.

Albedometers are constructed using two pyranometers, an albedometer mounting rod, and a glare screen to prevent direct sunlight from below the horizon entering the lower pyranometer.

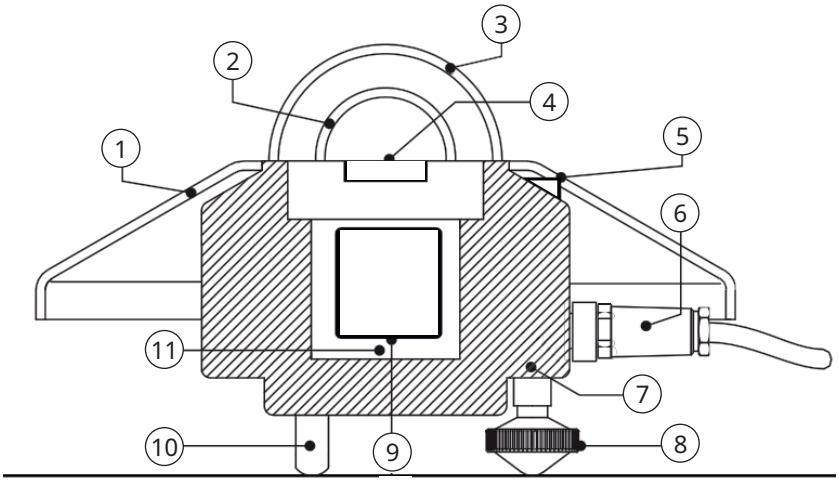
The pyranometers are delivered with a waterproof plug pre-wired to a signal cable. The cable is 10 m long but other lengths are available. The instruments can also be ordered with a plug only, for the user to fit their own cable.

5.2 Product overview



SMP3 pyranometer

1	Sun shield	6	Adjustable leveling feet
2	Thermopile detector	7	Smart interface
3	Glass dome	8	Fixed foot
4	Connector	9	Housing
5	Bubble level		



SMP6, SMP10, SMP22 pyranometers

1	Sun shield	7	Housing
2	Inner glass dome	8	Adjustable leveling feet
3	Outer glass dome	9	Smart interface
4	Thermopile detector	10	Fixed foot
5	Bubble level	11	Internal desiccant
6	Connector		

6 Transport, storage, and unpacking

6.1 Unpacking

- Carefully remove the product from the packaging.
- Check that the delivery is complete and undamaged.
- If you find any damage or if the delivery is incomplete, then immediately contact the supplier and manufacturer.
- Keep the original packaging for any further transportation.

6.2 Storage

- Store within specified temperature ranges.
- Store in dry area.
- Store in original box where possible.

7 Installation

7.1 Planning installation

For the solar irradiation to be measured in the entire photovoltaic system, it is necessary to position several pyranometers in the system. The number of pyranometers required depends on the system's performance and ambient conditions.

The minimum number of sensors required for a Class A system is defined as follows:

- 1 sensor for each monitoring point to measure the following values:
  - In-plane irradiance (POA)
  - Global horizontal irradiance
- In addition, the following sensors are used:
  - 1 horizontal albedo sensor
    or
  - 3 in-plane rear-side irradiance sensors

The number of monitoring points depends on the system size, as seen in the table below:

System size (AC) in MW	Number of monitoring points	Number of pyranometers
< 40	2	6 to 10
≥ 40 to < 100	3	9 to 15
≥ 100 to < 300	4	12 to 20
≥ 300 to < 500	5	15 to 25
≥ 500 to < 700	6	18 to 30
≥ 700	7, plus 1 for every further 200 MW	21+ to 35+

7.2 Mechanical installation

7.2.1 Preparatory work

- If using the digital output, then set the Modbus® address before visiting the site. Otherwise a computer and RS-485 / USB converter is required during installation.

7.2.2 Required tools and aids

The following tools and aids are required:

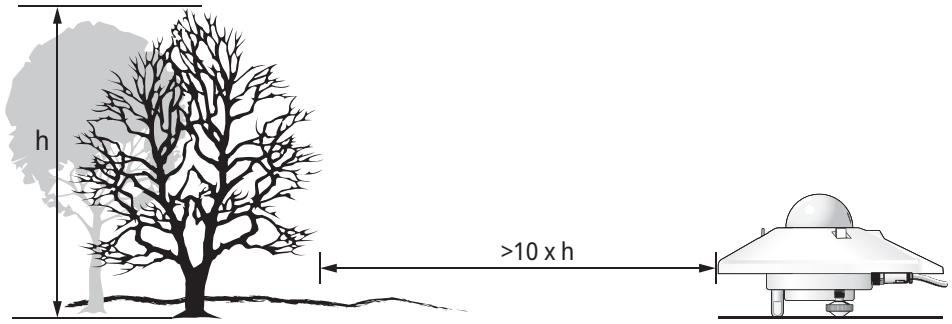
- Allen key, 4 mm
- wrench, 8 mm
- open-ended wrench, 16 mm or ⅝"

7.2.3 Installation for measuring global radiation

7.2.3.1 Choosing a site

There should be no obstructions to the field of vision above the instrument's sensor element. If this is not possible, the location of the instrument must be chosen to ensure that obstacles do not rise by more than 5 degrees above the azimuth range between sunrise after the shortest night and sunset on the longest day.

The 5 degrees correspond to a minimum distance from the instrument to the obstacle of 10 times the height of the obstacle:

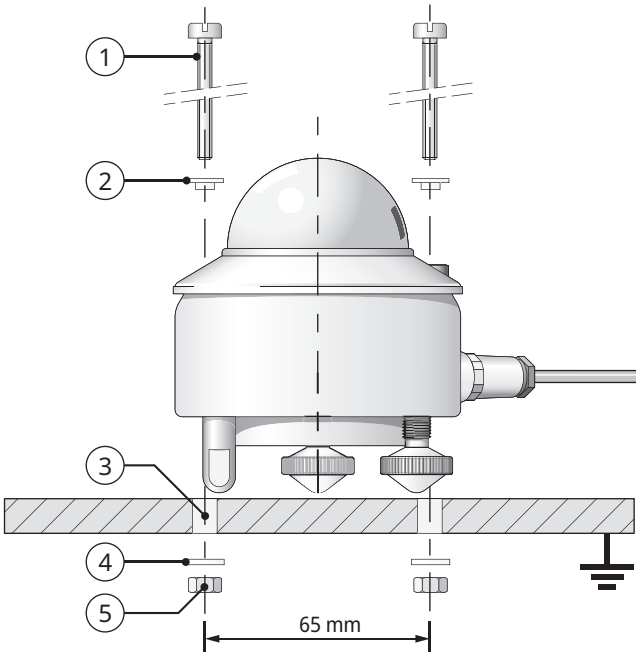


Minimum distance from instrument to obstacle

The minimum distance is important for measuring the direct radiation. The diffuse solar radiation is not so affected by obstacles near the horizon. An obstacle to the field of vision that rises 5 degrees over the entire azimuth range of 360 degrees reduces the diffuse radiation directed downwards by only 0.8%.

- Position the instrument in such a way that no shadows fall on it, for instance from masts.
- Avoid hot exhaust gases with a temperature of over 100 °C in the proximity of the instrument. The radiation can cause measurement deviations.
- Do not position the instrument in front of light-colored walls or any other objects that reflect the sunlight or emit short-wave radiation.

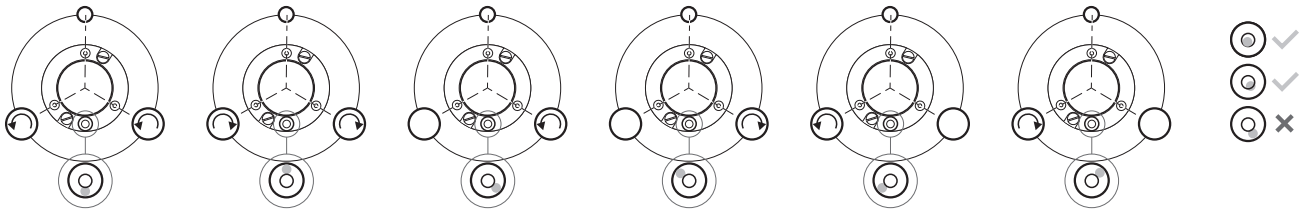
7.2.3.2 Mounting



1	2x M5 x 80 mm screws	4	2x flat washers
2	2x nylon insulating rings	5	2x nuts
3	2x Ø 5.2 mm		

- To insulate the instrument against the temperature of the mounting device, place the instrument on the adjustable foot and the two leveling feet.

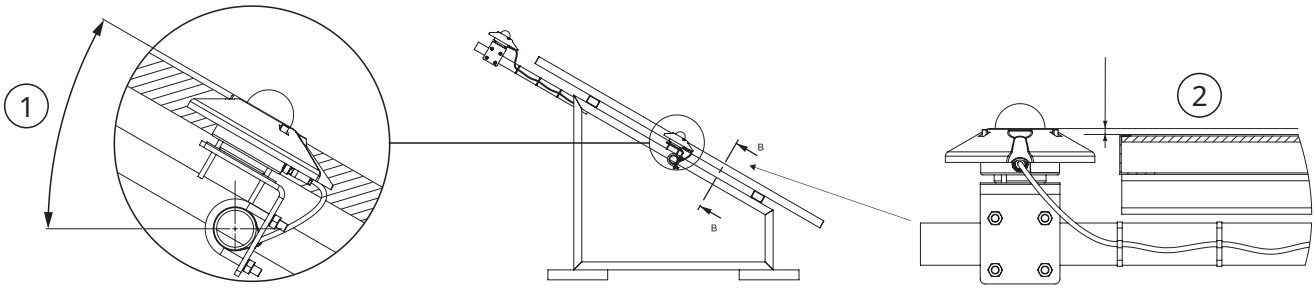
- Position the instrument in such a way that the nuts are located at a distance of 2 to 3 mm from the mounting device.
- Ensure that the instrument is grounded.
- Ensure that the instrument is not in the shade.
- When installed horizontally, point the cable connector towards the nearest pole to reduce the UV exposure on the cable.
- In order to align the instrument horizontally, rotate the leveling feet until at least half the spirit level bubble is in the inner ring.



- Fix the instrument with the screws, ensure that the instrument retains the correct alignment.
- To prevent corrosion between the screws and the instrument housing, ensure that the nylon insulating rings are fixed.
- Insert the connector with the cable into the instrument's connection socket.
- Tighten the locking ring hand tight.
  NOTICE! The seal may be damaged by overtightening!
- Fix the cable in such a way that the cable doesn't move or cast a shadow on the instrument.
- Fix the sun shield.

7.2.4 Installation for measuring global radiation on sloping surfaces

In a photovoltaic system, the pyranometer must be installed at the same zenith angle and azimuth angle as the modules. The pyranometer can be mounted using the adjustable leveling feet or using a set of fixed feet that are suitable for mounting on sloping surfaces.

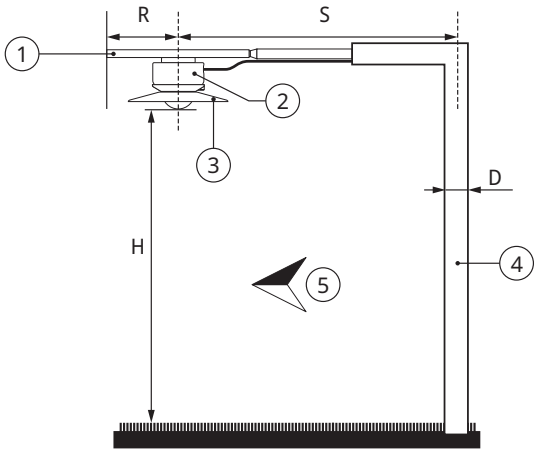


1 Zenith angle ± 1° 2 Azimuth angle ± 2°

- Place the pyranometer on a horizontal surface.
- Ensure that the leveling feet protrude as far as the adjustable foot.
- Level the pyranometer.
- Label the pyranometer with a note stating that the feet have been set.
- Alternatively, remove the leveling feet and mount the fixed feet.
- Label the pyranometer with a note stating that the fixed feet are suitable for sloping installation.
- Fix the pyranometer on the sloping surface.
- Point the cable connector downwards to reduce moisture exposure around the connector.

7.2.5 Installation for measuring reflected radiation

In inverted position the pyranometer measures the reflected global radiation.



1 Mounting plate
2 Pyranometer
3 Glare screen
4 Mast
5 Equator

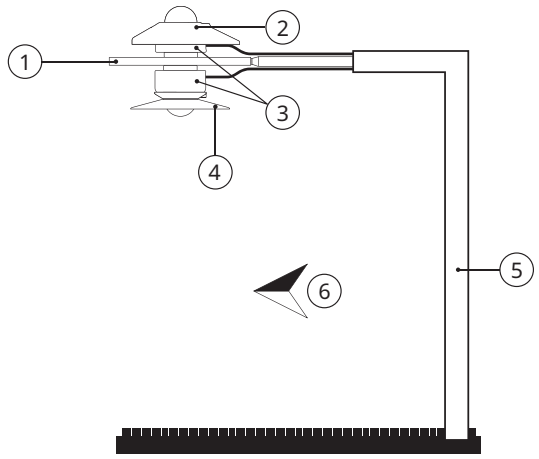
The mounting plate prevents the pyranometer from being heated by solar radiation. The optional glare screen has an angle of 5 degrees and prevents direct radiation on the glass dome during sunrise and sunset.

The mounting device must not excessively disrupt the pyranometer's field of vision. The mast in the illustration absorbs the radiation reflected by the earth's surface with a fraction of D/2πS. In the worst case (sun at its zenith), the pyranometer shadow reduces the signal by a factor of R^2/H^2. As a rule of thumb, a black shadow under the pyranometer with a radius of 0.1 x H reduces the signal by 1%. 99% of the signal comes from a range with a radius of 10 x H.

- Level the mounting plate well, as the pyranometer will be mounted without feet.
- Fix the pyranometer to the mounting plate at a height of between 1 and 2 meters above an even surface such as short grass.

7.2.6 Installation for measuring albedo

An albedometer consists of two identical pyranometers that measure the incident radiation and the radiation reflected by the surface below. Albedo is the ratio of the two radiation measurements and varies from 0 (dark) to 1 (bright).

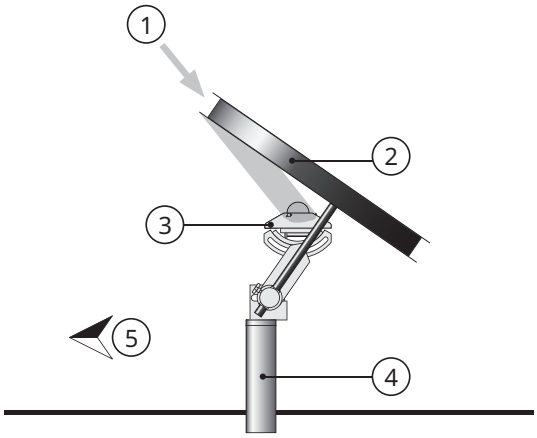


1 Albedo mounting plate
2 Sun shield
3 Pyranometer
4 Glare screen
5 Mast
6 Equator

- Mount the upper pyranometer.
- Mount the lower pyranometer.

7.2.7 Installation for measuring diffuse radiation

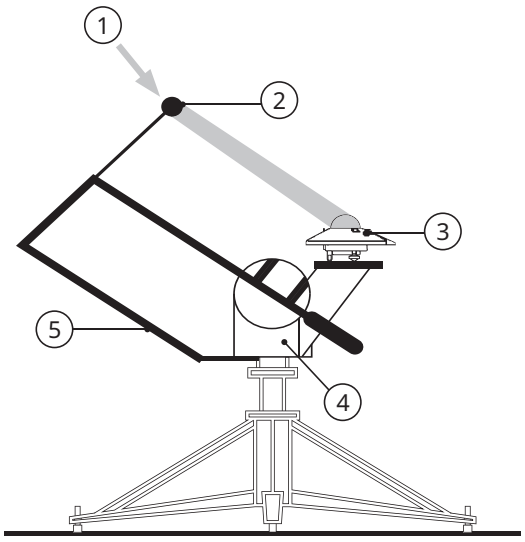
For the diffuse radiation to be measured, the direct radiation on the pyranometer's glass dome must be blocked. The direct radiation can be blocked using a static shadow ring or a two-axis automatic sun tracker.



1 Sun
2 Shadow ring
3 Pyranometer
4 Mounting bracket
5 Equator

Mounting static shadow ring

Because the sun moves across the sky, the static shadow ring interrupts part of the diffuse radiation and needs to be regularly adjusted. At times the shadow ring intercepts a significant proportion of the diffuse sky radiation. Therefore, the recorded data must be revised.



1 Sun
2 Shadow ball
3 Pyranometer
4 Sun tracker
5 Shading assembly

Mounting automatic sun tracker

The automatic sun tracker uses the information regarding its location and the time to calculate the position of the sun. This allows the tracker to be oriented exactly towards the sun whatever the weather. Using a shadowing fixture on the tracker, the pyranometer's glass dome can be shaded all year round without any need for adjustment.

7.3 Electrical installation

7.3.1 Electrical connections

SMP pyranometers are supplied with a waterproof connector pre-wired to 10 m of high quality yellow cable with 8 wires and a shield covered with a black sleeve.

i Long cables may be used if the cable resistance is less than 0.1 % of the impedance of the readout equipment for the analog outputs. This may affect the baud rate of the RS-485 digital connection.

7.3.2 Grounding pyranometer

NOTICE

Damage due to power or ground loops!

Connecting the RS-485 to a grounded circuit and the analog output to a floating circuit can cause ground loops. This may cause differential voltages that will damage the instrument.

- Use either the analog or the digital output.
- Observe the maximum differential voltage of 70 V DC between one of the two Modbus® RS-485 lines (yellow and gray) and the power ground (black) or RS-485 common line (blue).

Lightning can induce high voltages in the shield but these will be led off at the pyranometer or readout equipment. The shield of the cable is connected to the aluminium pyranometer housing through the connector body.

- Secure the pyranometer with the leveling screws to a metal support with a good connection to ground, e.g. to a lightning coductor.
- Do not connect the cable shield.
- If there is no good ground connection at the pyranometer, then connect the shield at the cable end to ground at the readout equipment.

7.3.3 Power connection

The minimum supply voltage for the pyranometer is 5 V DC. 5-volt-power can only be used with a short cable, maximum 10 m. To ensure reliable performance, a voltage of 12 V DC is recommended. For the output of the power supply, it is recommended to protect it with a fast blowing fuse of maximum 250 mA rating.

7.3.4 Power consumption

Typical power consumption SMP-V for maximum output (1 V)

Voltage on the pyranometer (V DC)	Current (mA)	Power (mW)
5	10.0	50
12	4.5	55
24	2.5	60

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

Typical power consumption SMP-A for max output (20 mA)

Voltage on the pyranometer (V DC)	Current (mA with 100 Ω load resistor)	Power (mW)
5	28	77
12	24	83
24	6	100

The above Megawatt values represent the dissipation within the SMP-A. For the total power the energy in the load resistor has to be added.

For supply voltages below 12 Volts or above 20 Volts use a load resistor of less than 500 Ω to keep the power consumption as low as possible.

7.3.5 Analog voltage output

The SMP-V (voltage output versions) have been factory set such that an output of 0 Volts represents -200 W/m^2 (this will never be reached in practice), and the full-scale output of 1 Volt represents 2000 W/m^2. The voltage output range in W/m^2 can be changed with the supplied PC software.

The measurement range must start from a negative value in order to show (small) negative readings, for example night-time offsets, because the analog output itself cannot go negative. For the default setting of 0 to 1 Volt representing -200 to 2000 W/m^2 the range is actually 2200 W/m^2 with a zero offset of 200 W/m^2.

The irradiance value ($E_{\downarrow solar}$) for the default setting can be calculated as shown below:

$E_{\downarrow solar}$= (V x 2200) - 200

$E_{\downarrow solar}$= Solar radiation

[W/m^2] V = Output of radiometer [Volt]

If the pyranometer is used in atmospheric conditions it is advised to keep the range as factory set.

7.3.6 Analog current output

The SMP-A (current output versions) have been factory set such that an output of 4 mA represents 0 W/m^2 and the full-scale output of 20 mA represents 1600 W/m^2. The current output range in W/m^2 can be changed with the supplied PC software. The maximum recommended irradiance for the SMP3 and SMP6 are 2000 W/m^2 and for the SMP10 and SMP22 are 4000 W/m^2.

Negative inputs will make the output go below 4 mA and no zero offset is needed. For the default setting of 4 to 20 mA representing 0 to 1600 W/m^2, each mA represents 100 W/m^2.

The irradiance value ($E_{\downarrow solar}$) for the default setting can be calculated as shown below:

$E_{\downarrow solar}$= (mA - 4) x 100

$E_{\downarrow solar}$= Solar radiation

[W/m^2] mA = Output of radiometer [mA]

7.3.7 Connecting to computer

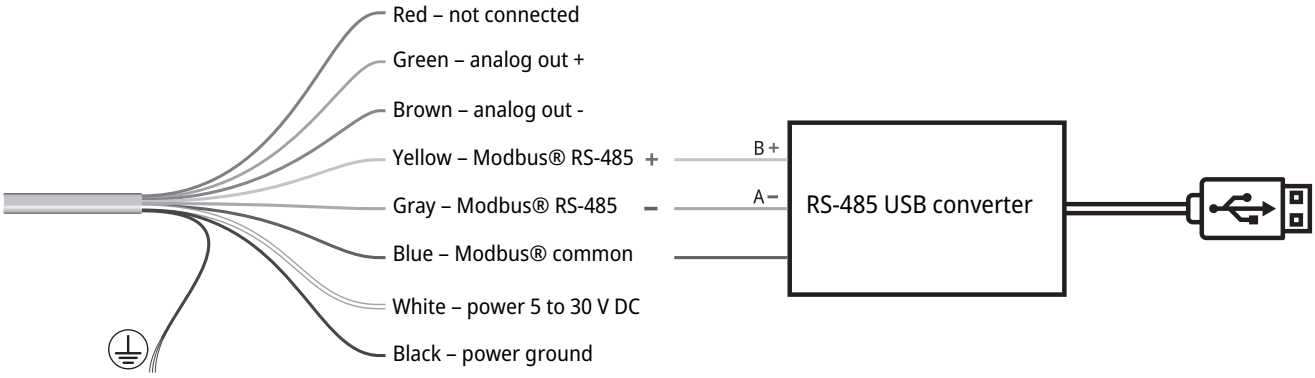
NOTICE

Damage due to lack of insulation!

The power supply units of portable computers such as laptops can generate large voltage peaks. This may cause damage to the instrument's digital interface.

- Ensure that the converter has galvanic separation between the inputs and outputs.

The instrument must be connected to a computer via an RS-485 converter with a USB port.



Connection to RS-485 converter

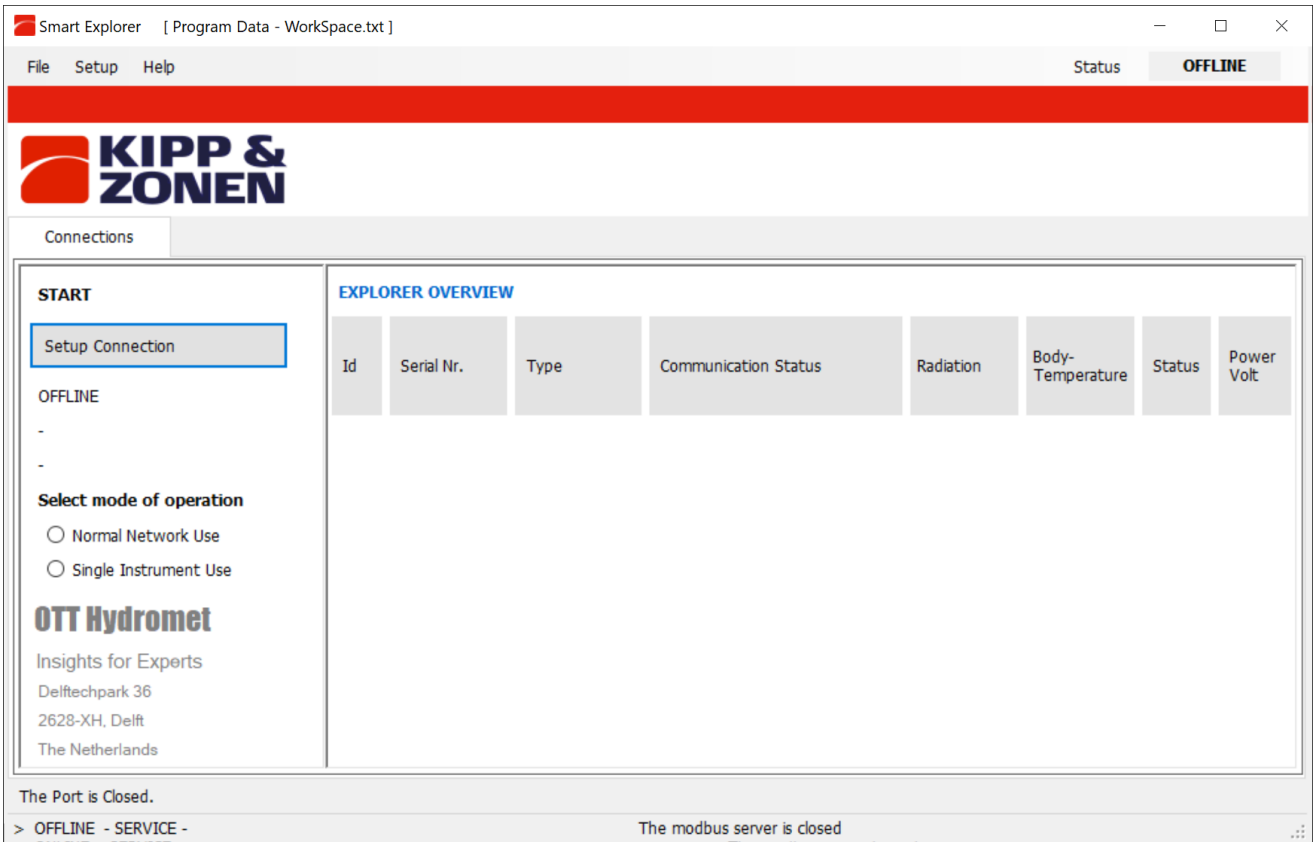
- Ensure that the power supply is switched off.
- Connect the white wire to the black wire on the power supply unit.
- Connect the yellow, gray and blue wires to the RS-485 converter.
- Isolate and seal the red wire and any other wires when they are not in use.
- Align the indentation on the connector with the indentation on the instruments's connection socket.
- Plug the connector into the connection socket.
- Turn the locking ring clockwise and tighten it hand tight to secure the connector.
  NOTICE! The seal may be damaged by overtightening!
- Switch on the power supply.
- Switch on the computer.

i It may take three hours for the pyranometer to reach a stable temperature. During this time, the irradiation measurements may deviate from the final measurements.

8 Commissioning

8.1 Set up instrument

The Smart Explorer software allows to configure a smart sensor and to collect real-time data.



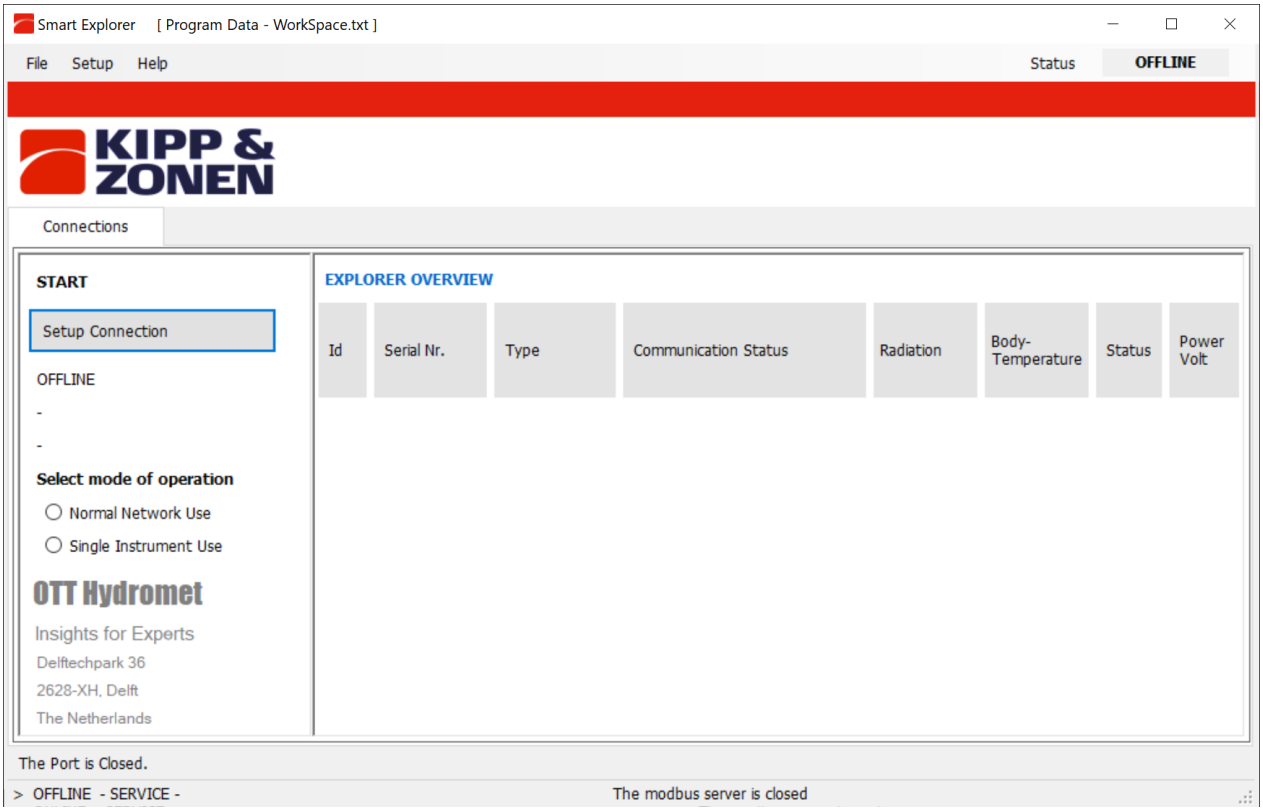
The factory default communication parameters are as follows:

- Modbus® baud rate: 19200
- Parity: even
- Data bits: 8
- Stop bits: 1
- Address: 1

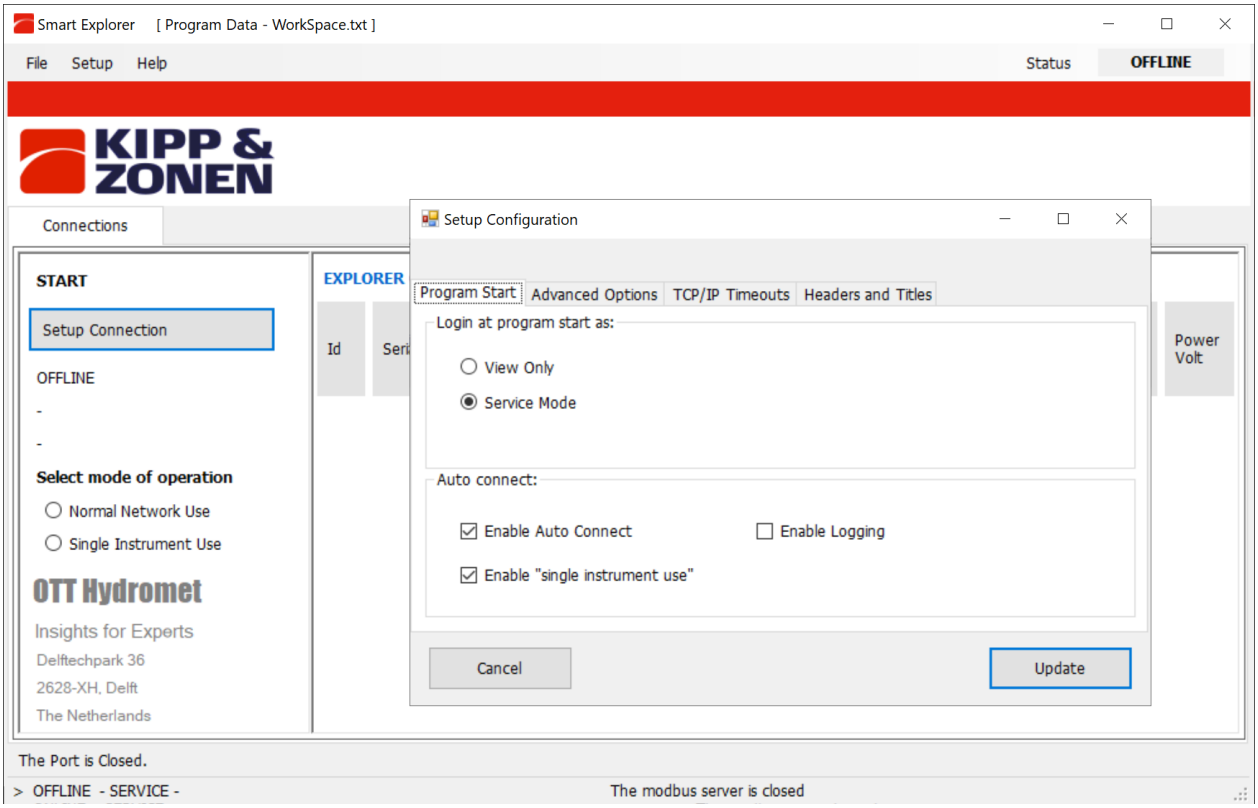
- If using the software on-site, ensure that the software is already installed on the laptop.
- For detailed information about setup, monitoring, and data logging, see the Smart Explore software manual.
- Download the Smart Explorer software and the manual at the following address: www.kippzonen.com

8.1.1 Starting the Smart Explorer Software

- Start the Smart Explorer Software:



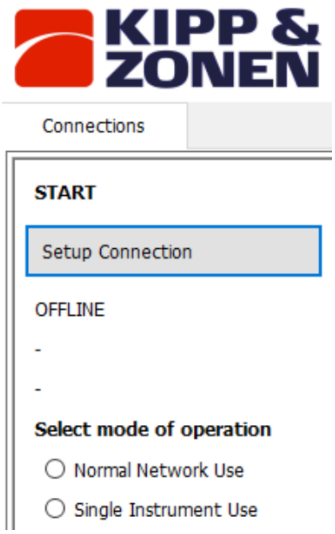
- Click on the *Setup* menu and check whether the following settings are activated:



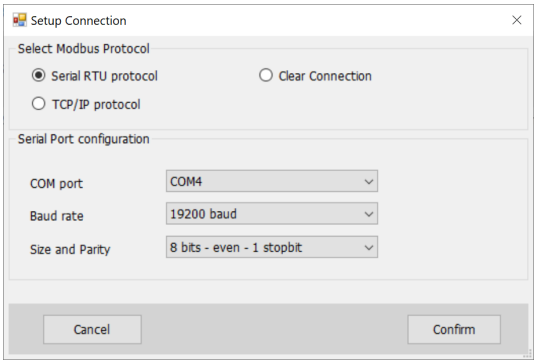
- Adjust the settings if necessary.
- Click on the **Update** button to save the settings.

8.1.2 Establishing connections

- To establish a connection to the instrument, click on the **Setup Connection** button.



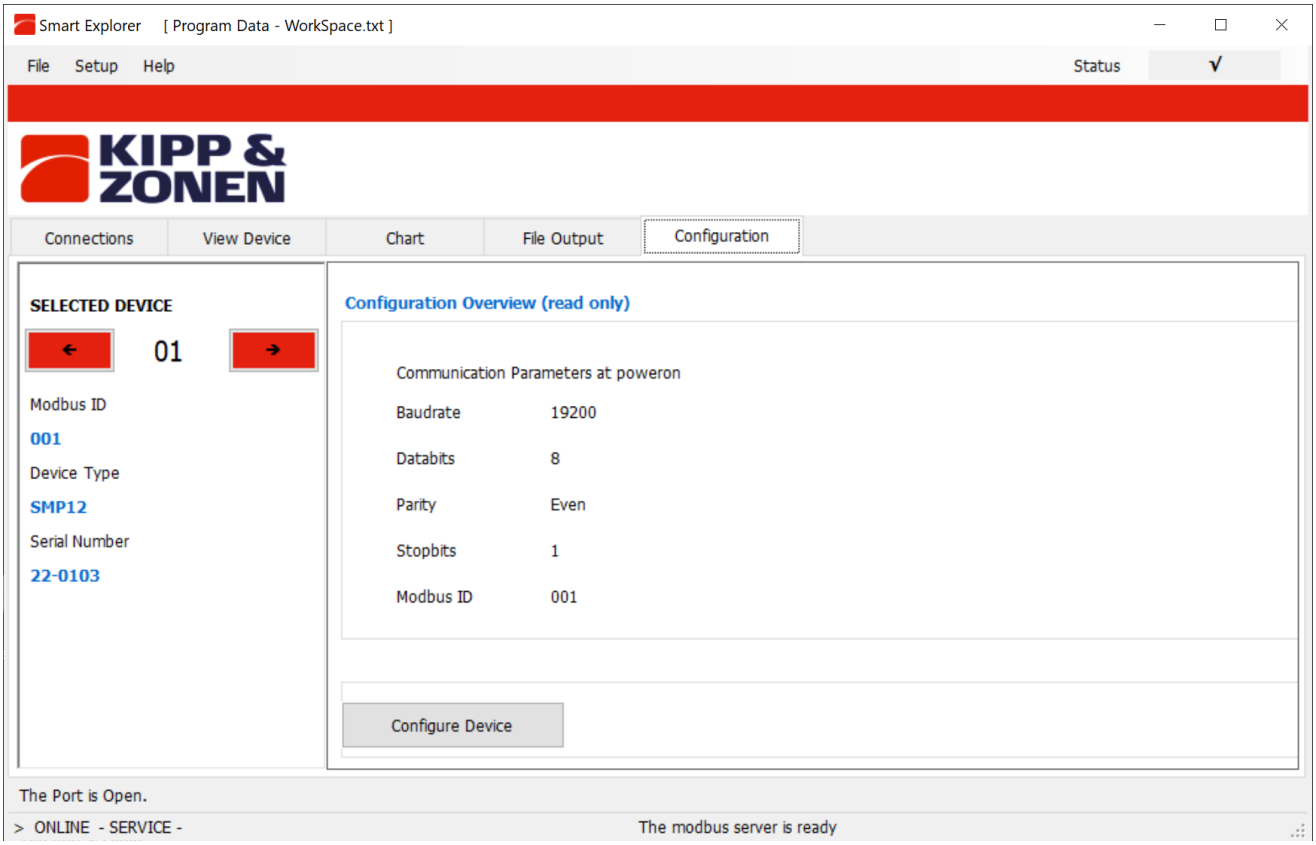
- Activate the *Serial RTU protocol* to establish the direct RS-485 connection.



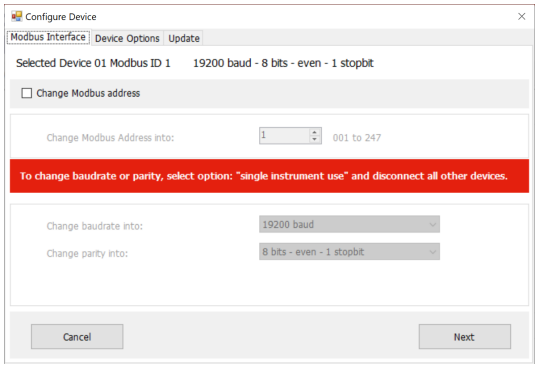
- Select the COM port (see Windows Device Manager).
- Leave the other factory settings unchanged.
- Click on the **Confirm** button to save the settings.

8.1.3 Adjusting the communication parameters

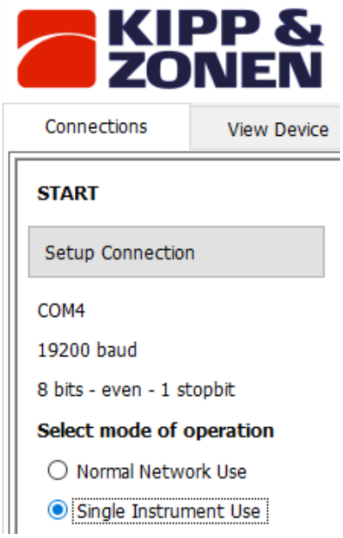
- Click on the *Configuration* tab to access the current communication parameters.



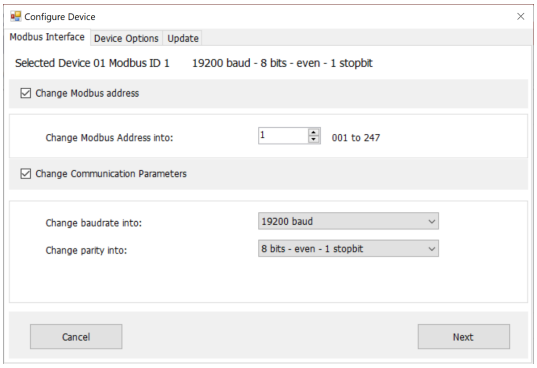
- To change the parameters, click on the **Configure Device** button.
  - ⇨ The following warning appears:



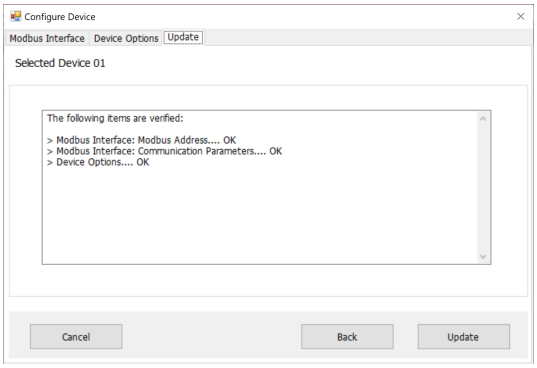
- To change the Modbus address, the baud rate and the parity, close the window and activate the *Single Instrument Use* operating mode on the *Connections* tab. The Modbus address can also be changed in the *Normal Network Use* operating mode.



- Go to the *Configuration* tab and click on the **Configure Device** button again.
- Activate the *Change Modbus address* checkbox and set the new address.



- Activate the *Change Communication Parameters* checkbox and select the baud rate and parity.
- Click on the **Next** button.
  - ⇨ The *Update* tab appears:



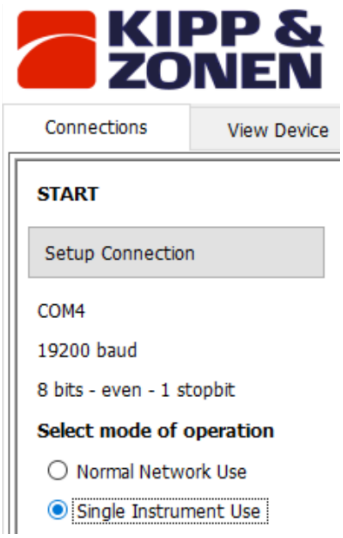
- Click on the **Update** button to save the settings.

⇨ Following the update, the pyranometer is reset and is ready for operation again after approximately 1 minute.

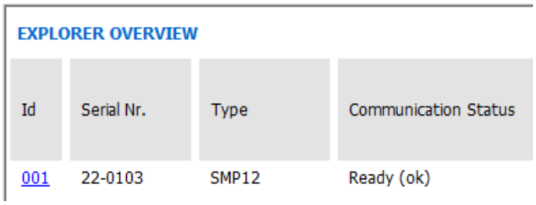
⇨ The communication parameters are changed and the *Connections* tab appears.

8.1.4 Finding an instrument with unknown communication parameters

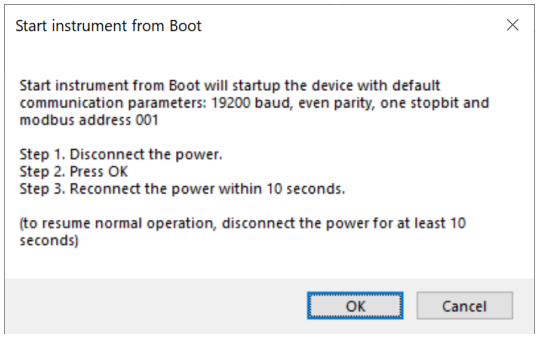
- Activate the *Single Instrument Use* operating mode on the *Connections* tab.



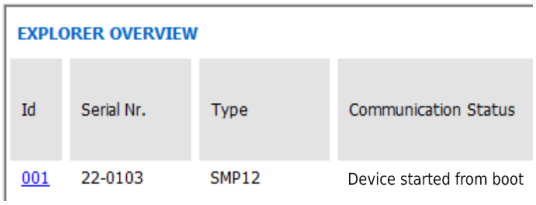
- If only the Modbus address is unknown, click on the **Send Broadcast** button.
  - ⇨ The connected pyranometer is displayed:



- If no instrument is found, click on the **Start From Boot** button.
  - ⇨ The following window appears:



- Follow the instructions in the window.
  - ⇨ The connected instrument is displayed:



  - ⇨ After approximately 1 minute, reliable measurement results appear on the *Connections* tab.
- Check the communication parameters on the *Configuration* tab.
- Switch off the instrument and switch it back on after 10 seconds to restore normal operation.

9 Operation

9.1 Making and saving measurements

The instruments require suitable sources of power and radiation (light) to operate and make measurements.

- To save the measurements, connect the instrument to a readout or data storage device. The instrument has no internal data memory.

9.2 Collecting data

An optimal setting for the data interval is to sample every second and store one minute averages.

- For setting up the combination of the instrument and data storage read the manual of the data collection device.
- Take care when using the analog output to match the output range of the instrument closely to the input range of the data collection device to maximise the available resolution and minimise noise.
- To do this, determine the maximum analog output of the instrument and the minimum input range of the data collection device.

10 Maintenance

10.1 Maintenance schedule

The frequency of cleaning is dependent upon the local weather and environmental conditions. Ideally, the dome of the instrument should be cleaned every morning before sunrise. The frequency of cleaning can be reduced by the use of a ventilation unit (not available for the SMP3), with the heaters switched on when necessary.

The following maintenance intervals are recommended:

Interval	Activity	Performed by
Twice a week	▸ Clean the dome using a dry and lint-free cloth. ▸ For persistent soiling, use additional distilled water. If the soiling is servere, pure alcohol can be used. ▸ Ensure that no streaks or deposits are left on the dome.	Operator
Monthly	▸ Check that the instrument is standing horizontally or at the correct angle. Adjust the instrument if required. ▸ Check that the sun shield is fixed tightly.	Operator
Annually	▸ Check all electrical connections: Unscrew the plugs, clean the plugs if necessary and reconnect. ▸ Check all cables for damage. ▸ Check fastenings and basic supports. ▸ Clean the sun shield if dirty.	Operator
2 years	▸ Check sensitivity or have a recalibration performed.	OTT HydroMet
10 years	▸ Replace the desiccant in the pyranometer.	OTT HydroMet

11 Troubleshooting

11.1 Fault elimination

Fault	Possible cause	Measures
Output signal not available or incorrect	Pyranometer does not work properly	▸ Check that the cables are correctly connected to the readout equipment. ▸ Check the power supply (12 V DC recommended). ▸ Check that the instrument has a unique Modbus® address. ▸ Compare the digital and analog outputs to see if the problem is only on one output. ▸ Check the location for obstacles that block the direct solar radiation. ▸ Check the glass dome for contamination. Carry out maintenance work as required. ▸ For analog outputs, check the data logger or integrator input offset so that a signal of 0 V or 4 mA gives a "zero" reading. ▸ Check that the leveling is correct. ▸ Report any malfunctions or damage to the representative of OTT HydroMet.

12 Repair

12.1 Customer support

- Have repairs carried out by OTT HydroMet service personnel.
- Only carry out repairs yourself if you have first consulted OTT HydroMet.
- Contact your local representative: www.otthydromet.com/en/contact-us
- Include the following information:

– instrument model
– instrument serial number
– details of the fault or problem
– examples of data files
– readout device or data acquistion system
– interfaces and power supplies
– history of any previous repairs or modifications
– pictures of the installation
– overview of the local environment conditions

13 Notes on disposing of old devices

Member States of the European Union

In accordance with the German Electrical and Electronic Equipment Act (ElektroG; national implementation of EU Directive 2012/19/EU), OTT HydroMet takes back old devices in the Member States of the European Union and disposes of them in the proper manner. The devices that this concerns are labeled with the following symbol:

- For further information on the take-back procedure contact OTT HydroMet:

OTT HydroMet B.V.
Service & Technical Support
Delftechpark 36
2628 XH Delft
The Netherlands
Fon: +31 15 2755 210
email: solar-info@otthydromet.com

All other countries

- Dispose of the product in the proper manner following decommissioning.
- Observe the country-specific regulations on disposing of electronic equipment.
- Do NOT dispose of the product in household waste.

14 Technical data

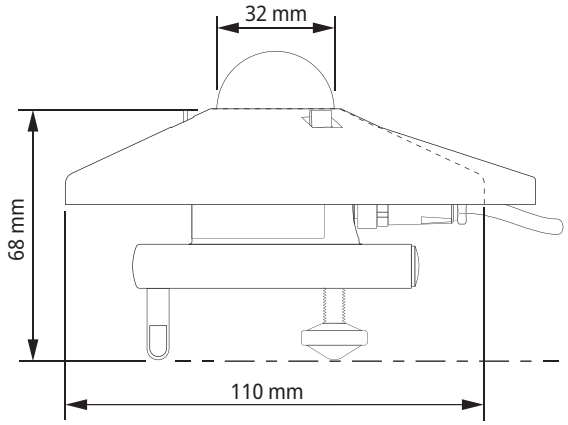
14.1 Optical and electrical data

Specification	SMP3	SMP6	SMP10	SMP22
Classification to ISO 9060:2018	Spectrally flat Class C	Spectrally Flat Class B	Spectrally Flat Class A	Spectrally Flat Class A
Analog output , V-version	0 to 1 V	0 to 1 V	0 to 1 V	0 to 1 V
Analog output range, V-version	-200 to 2000 W/m^2	-200 to 2000 W/m^2	-200 to 2000 W/m^2	-200 to 2000 W/m^2
Analog output , A-version	4 to 20 mA	4 to 20 mA	4 to 20 mA	4 to 20 mA
Analog output range, A-version	0 to 1600 W/m^2	0 to 1600 W/m^2	0 to 1600 W/m^2	0 to 1600 W/m^2
Serial output	RS-485 Modbus®	RS-485 Modbus®	RS-485 Modbus®	RS-485 Modbus®
Serial output range	-400 to 2000 W/m^2	-400 to 2000 W/m^2	-400 to 4000 W/m^2	-400 to 4000 W/m^2
Response time (63 %)	< 1.5 s	< 1.5 s	< 0.7 s	< 0.7 s
Response time (95 %)	< 12 s	< 12 s	< 2 s	< 2 s
Spectral range (20 % points)	285 to 3000 nm	270 to 3000 nm	270 to 3000 nm	210 to 3600 nm
Spectral range (50 % points)	300 to 2800 nm	285 to 2800 nm	285 to 2800 nm	250 to 3500 nm
Zero offset:				
a) thermal radiation (at 200 W/m^2)	< 15 W/m^2	< 8 W/m^2	< 7 W/m^2	< 3 W/m^2
b) temperature change (5 K/h)	< 5 W/m^2	< 2 W/m^2	< 2 W/m^2	< 1 W/m^2
c) total zero offset (a, b and other sources)	< 20 W/m^2	< 10 W/m^2	< 9 W/m^2	< 4 W/m^2
Additional signal processing errors	< 3 W/m^2	< 2 W/m^2	< 2 W/m^2	< 1 W/m^2
Non-stability (change/year)	< 1 %	< 1 %	< 0.5 %	< 0.5 %
Non-linearity (100 to 1000 W/m^2)	< 3 %	< 1 %	< 0.2 %	< 0.2 %

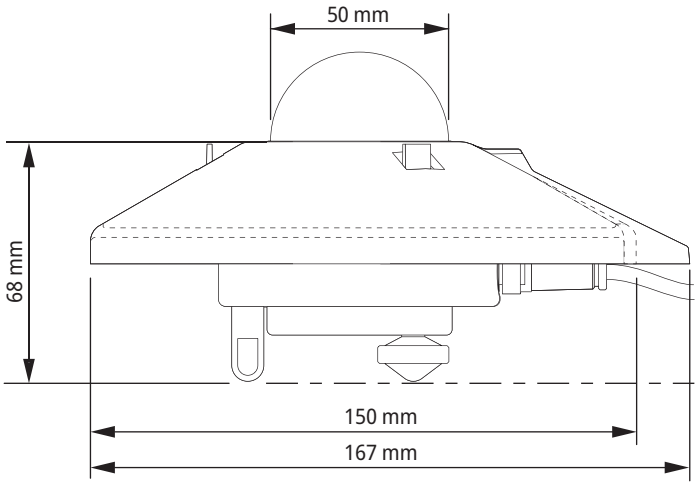
Specification	SMP3	SMP6	SMP10	SMP22
Directional response (up to 80° with 1000 W/m^2 beam)	< 20 W/m^2	< 15 W/m^2	< 10 W/m^2	< 5 W/m^2
Temperature response	< 3 % (-20 °C to +50 °C) < 4 % (-40 °C to +70	< 2 % (-10 °C to +40 °C) < 4 % (-40 °C to +70	< 1 % (-20 °C to +50 °C) < 2 % (-40 °C to +70	< 0.3 % (-20 °C to +50 °C) < 0.3 % (-40 °C to +70
Clear sky GHI spectral error	< 0.2 %	< 0.1 %	< 0.1 %	< 0.04 %
Spectral selectivity (350 to 1500 nm)	< 3 %	< 3 %	< 3 %	< 3 %
Tilt response (0° to 180° at 1000 W/m^2)	< 1.5 %	< 1 %	< 0.2 %	< 0.2 %
Field of view	180°	180°	180°	180°
Accuracy of bubble level	< 0.2°	< 0.1°	< 0.1°	< 0.1°
Power consumption (at 12 V DC)	V-version: 55 mW A-version: 100 mW	V-version: 55 mW A-version: 100 mW	V-version: 55 mW A-version: 100 mW	V-version: 55 mW A-version: 100 mW
Software, Windows™	SmartExplorer software, for configuration, test and data logging	SmartExplorer software, for configuration, test and data logging	SmartExplorer software, for configuration, test and data logging	SmartExplorer software, for configuration, test and data logging
Supply voltage	5 to 30 V DC	5 to 30 V DC	5 to 30 V DC	5 to 30 V DC
Detector type	Thermopile	Thermopile	Thermopile	Thermopile
Operating temperature range	-40 °C to +70 °C	-40 °C to +70 °C	-40 °C to +70 °C	-40 °C to +70 °C
Storage temperature range	-40 °C to +80 °C	-40 °C to +80 °C	-40 °C to +80 °C	-40 °C to +80 °C
Humidity range (non-condensing)	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %
MTBF (Mean Time Between Failures)	> 10 years	> 10 years	> 10 years	> 10 years
Ingress Protection (IP) rating	67	67	67	67

Specification	SMP3	SMP6	SMP10	SMP22
Recommended applications	Economical solution for efficiency and maintenance monitoring of PV power installations, routine measurements in weather stations, agriculture, horticulture and hydrology	Good quality measurements for Solar Monitoring, hydrology networks, greenhouse climate control	High performance for PV panel and thermal collector testing, solar energy research, solar prospecting, materials testing, advanced meteorology and climate networks	Scientific research requiring the highest level of measurement accuracy and reliability under all conditions

14.2 Dimensions and weight



SMP3



SMP6, SMP10, SMP22

Specification	SMP3	SMP6, SMP10, SMP22
Instrument weight	300 g	600 g
Dimensions unpacked (diameter x height)	11 x 8.4 cm	15 x 9.3 cm
Packaging dimensions	29 x 21 x 10 cm	22,5 x 19 x 15 cm
Weight of 10 m cable	400 g	

OTT HydroMet

Contact Information