OTT HydroMet

KIPP & ZONEN
an OTT HydroMet brand

CUV5 and SUV Series
Ultraviolet Radiometers

Operational Manual

0377201 | 01-1123

Copyright © OTT HydroMet B.V.

OTT HydroMet B.V.
Delftechpark 36
2628 XH Delft
The Netherlands

+31 15 2755 210
solar-info@otthydromet.com
www.otthydromet.com

All rights reserved.

All content is the intellectual property of OTT HydroMet. Reprinting, duplication and translation (even as excerpts) are only permitted with the prior written consent of OTT HydroMet.

Subject to technical change.

Table of contents

1 Scope of supply

The following items are included with the radiometers:

- UV Radiometer
- Sun shield
- Cable and plug
- Calibration certificate
- Instruction sheet
- Fixing kit:
  - 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
CUV5	0364910
SUV5	0377900
SUV-A	0387910
SUV-B	0387920
SUV-E	0387930

2.2 Accessories and spare parts

2.2.1 Accessories

For CUV5, SUV-A, SUV-B, SUV-E

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
CM121B/C Shadow Ring - Unventilated	0346900
CM121B/C Shadow Ring - Ventilated	0346901

For SUV5

Item	Order number
Smart Powered Hub	0382440
Smart Hub	0382445
PMU485 Smart Set Hub	0382460

2.2.2 Cables and plugs

For CUV5

Item	Order number
Waterproof 2-pin plug	2523144
10 m cable, pre-wired with waterproof 2-pin plug	0362601
25 m cable, pre-wired with waterproof 2-pin plug	0362603
50 m cable, pre-wired with waterproof 2-pin plug	0362604
100 m cable, pre-wired with waterproof 2-pin plug	0362605

For SUV5, SUV-A, SUV-B, SUV-E

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

i 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 radiometer is used to measure and report the global ultraviolet (UV) solar irradiance.

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

CUV5 and SUV radiometers are designed and calibrated to measure global ultraviolet (UV) solar irradiance.

There are models for the specific UV bands and they provide measurements in units of W/m^2:

- CUV5 and SUV5 cover the total UV range.
- SUV-A covers the UVA band.
- SUV-B covers the UVB band.
- SUV-E measures with the standard "Erythemal" response of human skin.

The CUV5 radiometer has a low-level analog output signal directly from the detector.

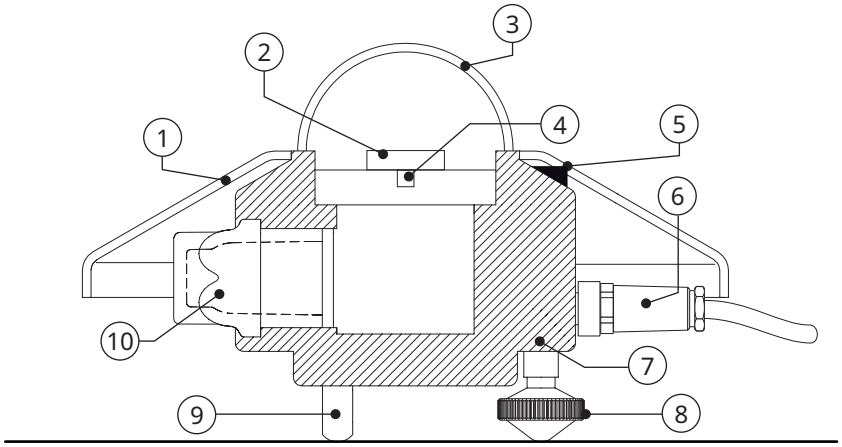
SUV radiometers feature internal digital signal processing and outputs for industrial data acquistion and control systems. In addition to the 2-wire RS-485 interface with Modbus® (RTU) protocol the SUV radiometers provide an analog output of 0 to 1 V. Digital signal processing and an integrated temperature sensor correct for the temperature dependency of the detector sensitivity.

To achieve the required spectral and directional reponse characteristics the radiometers use a photodiode detector, an optical filter, a diffusor and a glass or quartz dome. The instruments 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.

The radiometers 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.

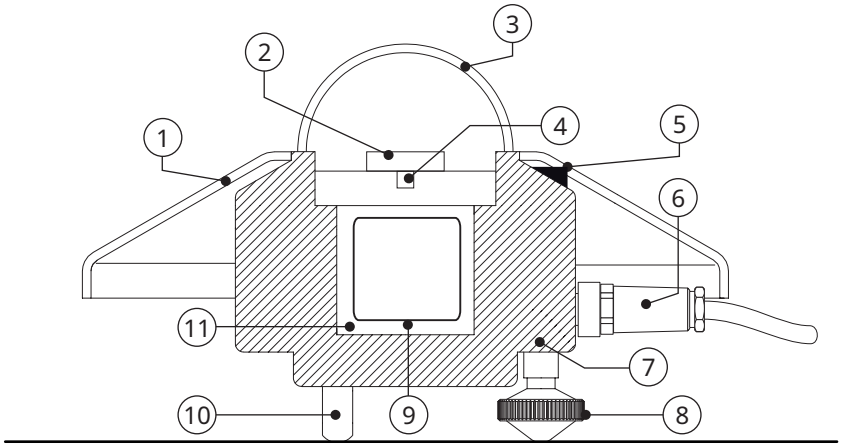
To prevent condensation on the inner side of the dome, the SUV radiometers have an internal desiccant that last up to 10 years. The desiccant of the CUV5 radiometer is located in a drying cartridge and must be replaced regularly.

5.2 Product overview



CUV5 radiometer

1	Sun shield	6	Connector
2	Diffusor	7	Housing
3	Glass dome	8	Adjustable leveling feet
4	Photodiode detector	9	Fixed foot
5	Bubble level	10	Drying cartridge



SUV radiometers

1	Sun shield	7	Housing
2	Diffusor	8	Adjustable leveling feet
3	Glass or quartz dome	9	Smart interface
4	Photodiode 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 Mechanical installation

7.1.1 Preparatory work

- Check the desiccant of the CUV5 radiometer and replace the desiccant if necessary.
- If using the digital output of the SUV radiometer, set the Modbus® address before visiting the site. Otherwise a computer and RS-485 / USB converter is required during installation.

7.1.2 Required tools and aids

The following tools and aids are required:

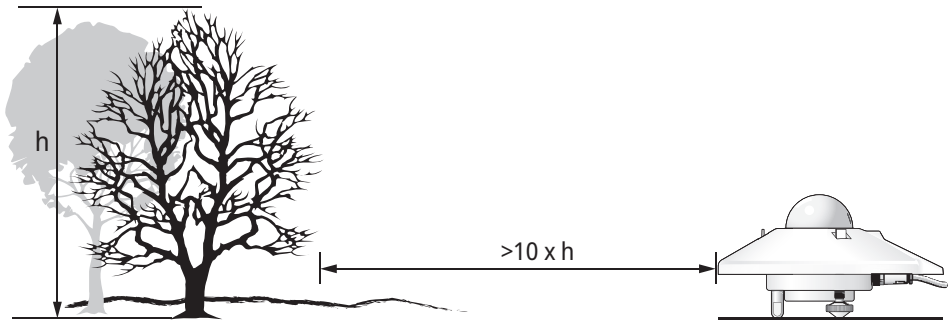
– Allen key, 4 mm
– wrench, 8 mm
– open-ended wrench, 16 mm or ⅝"

7.1.3 Installation for measurement on a horizontal plane

7.1.3.1 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:

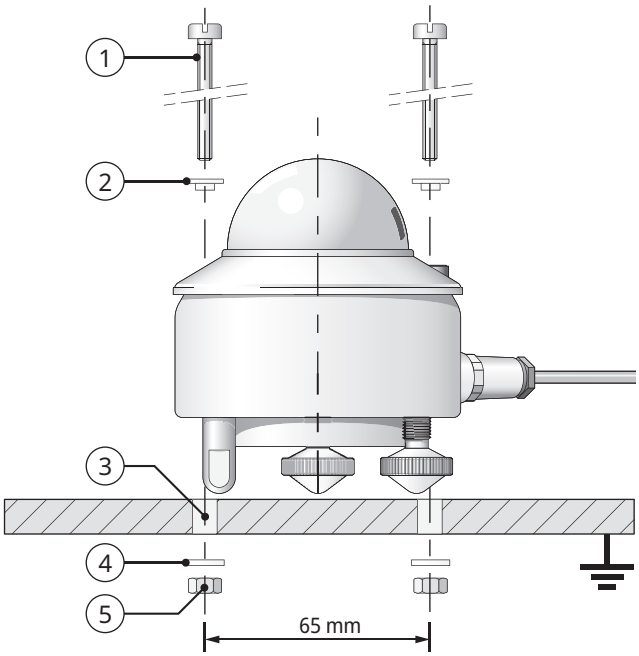


Minimum distance from instrument to obstacle

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%.

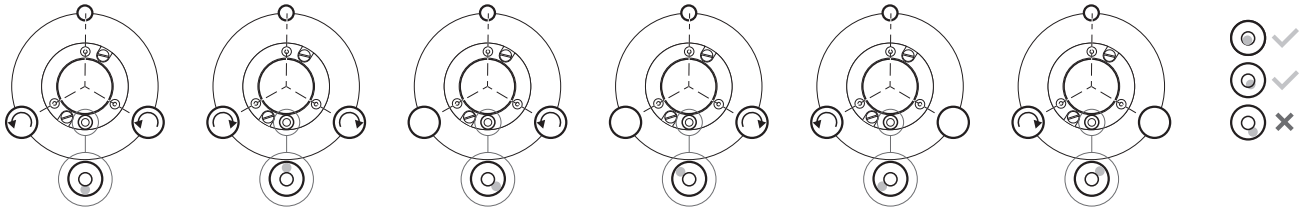
- Position the instrument in such a way that no shadows fall on it, for instance from masts.
- Avoid hot exhaust gases with a temperature of over 100 °C in the proximity of the instrument. The radiation can cause measurement deviations.
- Do not position the instrument in front of light-colored walls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

7.1.3.2 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 Electrical installation

7.2.1 Electrical connections of CUV5 radiometer

NOTICE

Damage due to power supply!

The instrument does not require power. Connecting power causes damage to the instrument.

- Do not connect the instrument to power supply.

The CUV5 radiometer has a 2-wire cable and 2-pin connector. The maximum recommended cable length is 100 m of good quality shielded 2-core signal cable.

7.2.2 Electrical connections of SUV radiometers

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).

The SUV radiometers use an 8-wire cable and 8-pin connector.

- Connect all the required wires.
- Plug the cable into the radiometer.
- Turn the power on.

7.2.2.1 Power connection

The minimum supply voltage for SUV radiometers is 5 V DC and the maximum is 30 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.

7.2.2.2 Power consumption

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

Typical power consumption SUV for maximum analog output (1 V)

- 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.

7.2.2.3 Connecting to computer

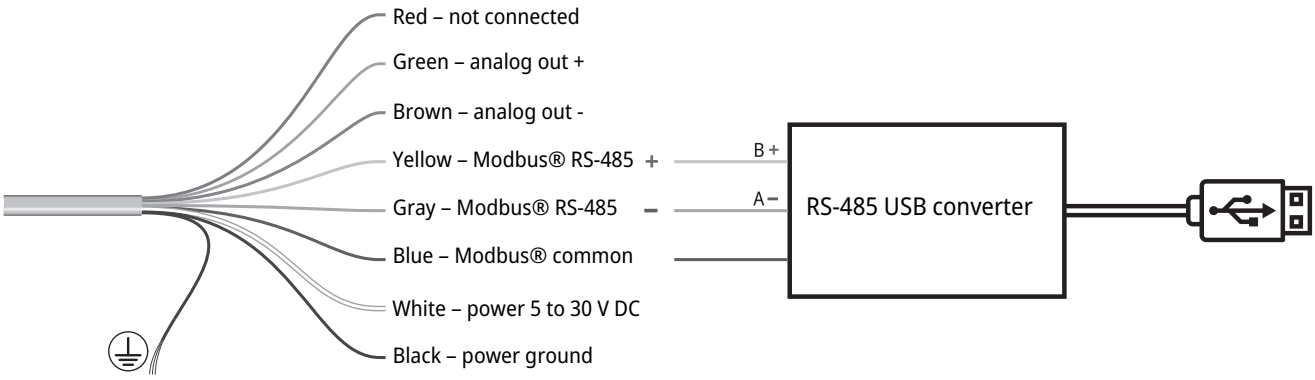
NOTICE

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.

7.2.3 Grounding radiometer

Good electrical contact to ground must be maintained to conduct away currents induced in the cable shield by lightning or other electrostatic discharge (ESD). The fixing screws are isolated and the anodizing of the radiometer housing and feet is non-conductive. The shield of the cable is connected to the aluminum radiometer housing through the connector body.

- Set up the grounding via the cable shield close to the radiometer. The shield connection is the thick black wire.
- Do not ground through the radiometer mounting.

7.2.4 Analog voltage output

CUV5 radiometer

The analog voltage output is generated directly by the photodiode detector in response to received radiation. The individual sensitivity is used to convert the output signal in in µV to W/m^2 of irradiance when recorded by a data logger. Total UV radiation is unlikely to exceed 100 W/m^2 from natural sunlight and the maximum signal is unlikely to exceed 75 mV.

SUV radiometers

The analog voltage output is derived from the digital value and has a fixed range of 0 – 1 V (1000 mV). The irradiance range that this represents is set in the Smart Interface firmware scale length and the factory settings are appropriate for use under natural sunlight. An extended range enables use in test chambers with high-intensity UV simulation lamps.

i The zero (0 W/m^2) point is raised to allow for possible electrical offsets in the output amplifier.

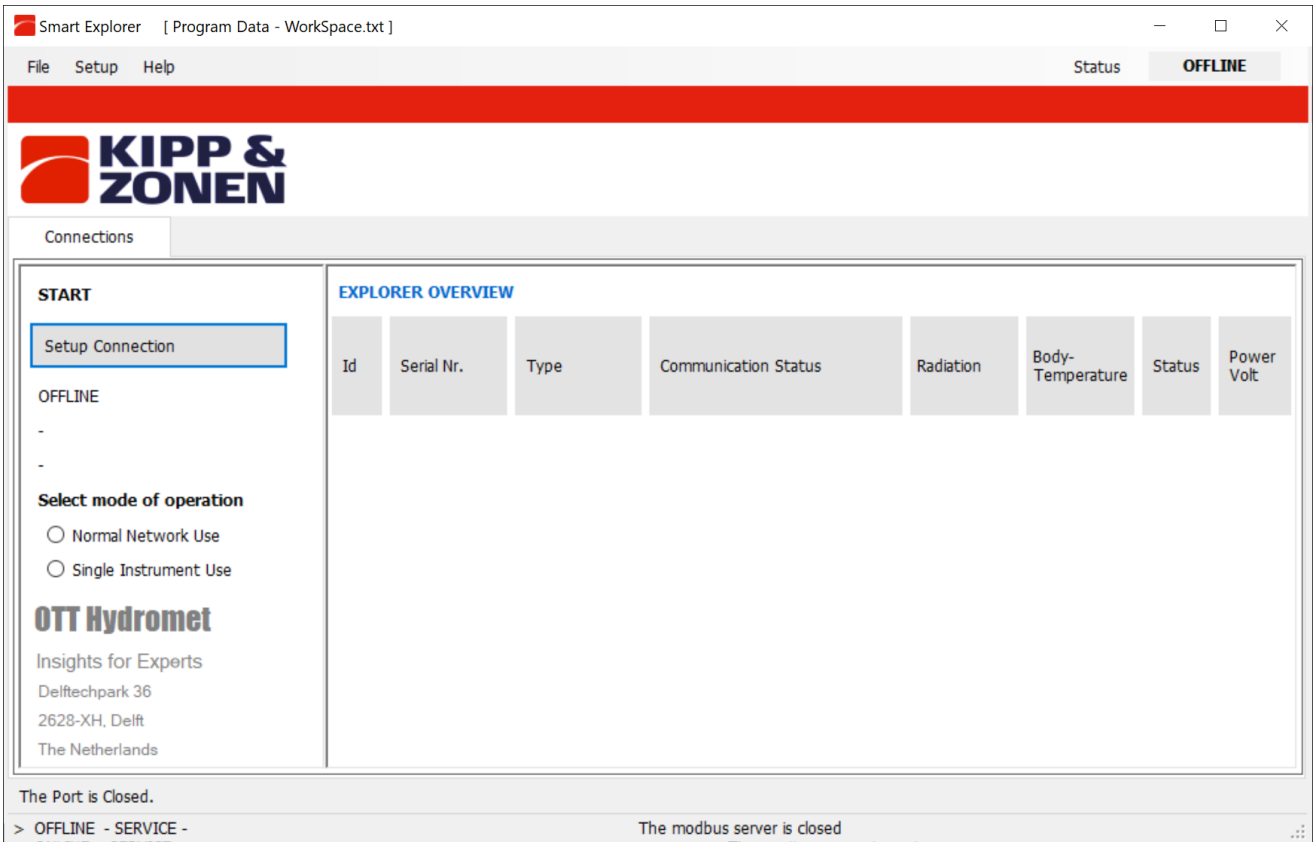
Specification	SUV5	SUV-A	SUV-B	SUV-E
Irradiance (W/m^2)	0 to 400	0 to 90	0 to 9	0 to 0.9
Output (mV)	100 to 1000	100 to 1000	100 to 1000	200 to 1000

The voltage output range in W/m^2 can be changed with the supplied PC software.

8 Commissioning

8.1 Set up instrument

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



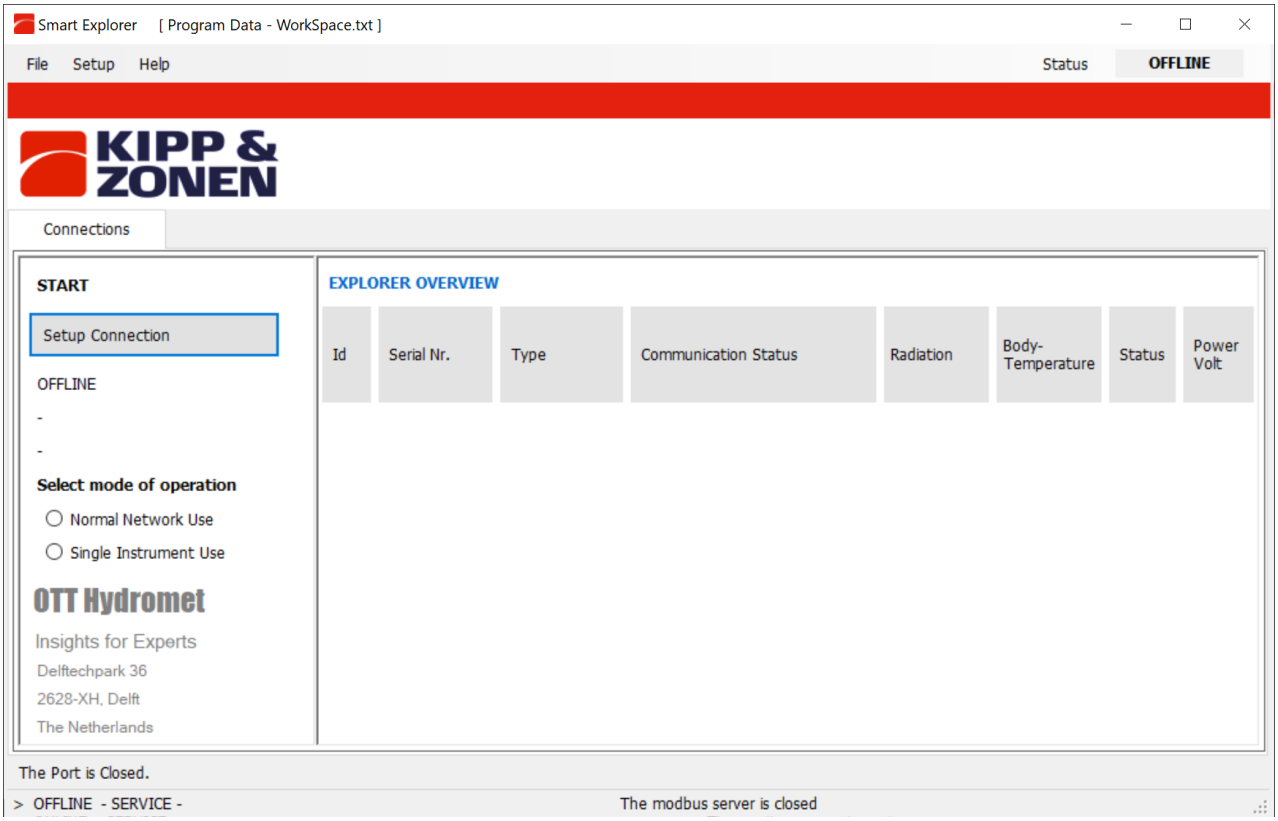
The factory default communication parameters are as follows:

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

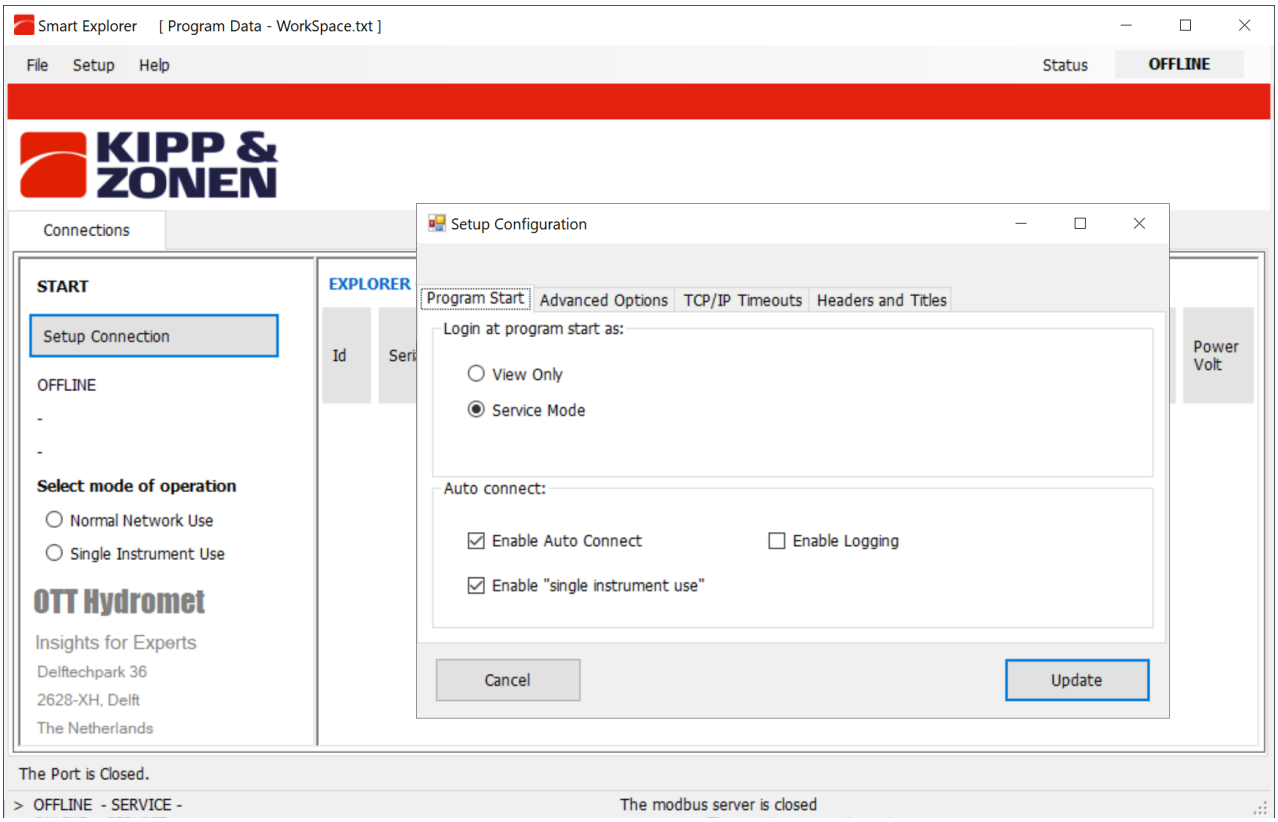
- If using the software on-site, ensure that the software is already installed on the laptop.
- For detailed information about setup, monitoring, and data logging, see the Smart Explore software manual.
- Download the Smart Explorer software and the manual at the following address: www.kippzonen.com

8.1.1 Starting the Smart Explorer Software

- Start the Smart Explorer Software:



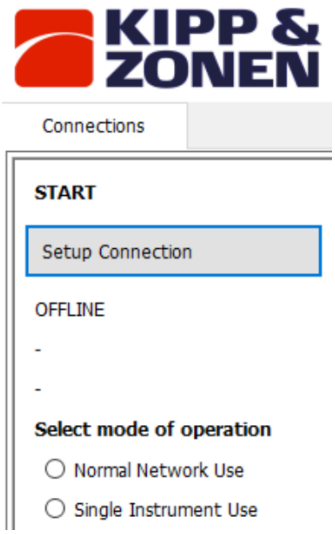
- Click on the *Setup* menu and check whether the following settings are activated:



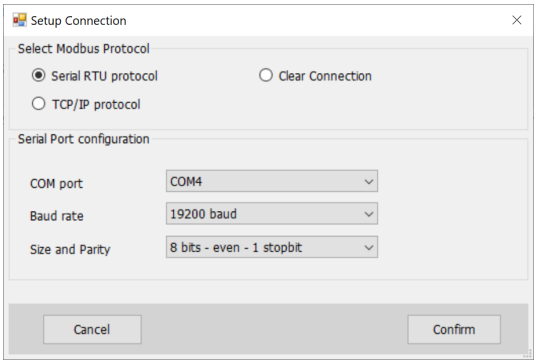
- Adjust the settings if necessary.
- Click on the **Update** button to save the settings.

8.1.2 Establishing connections

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



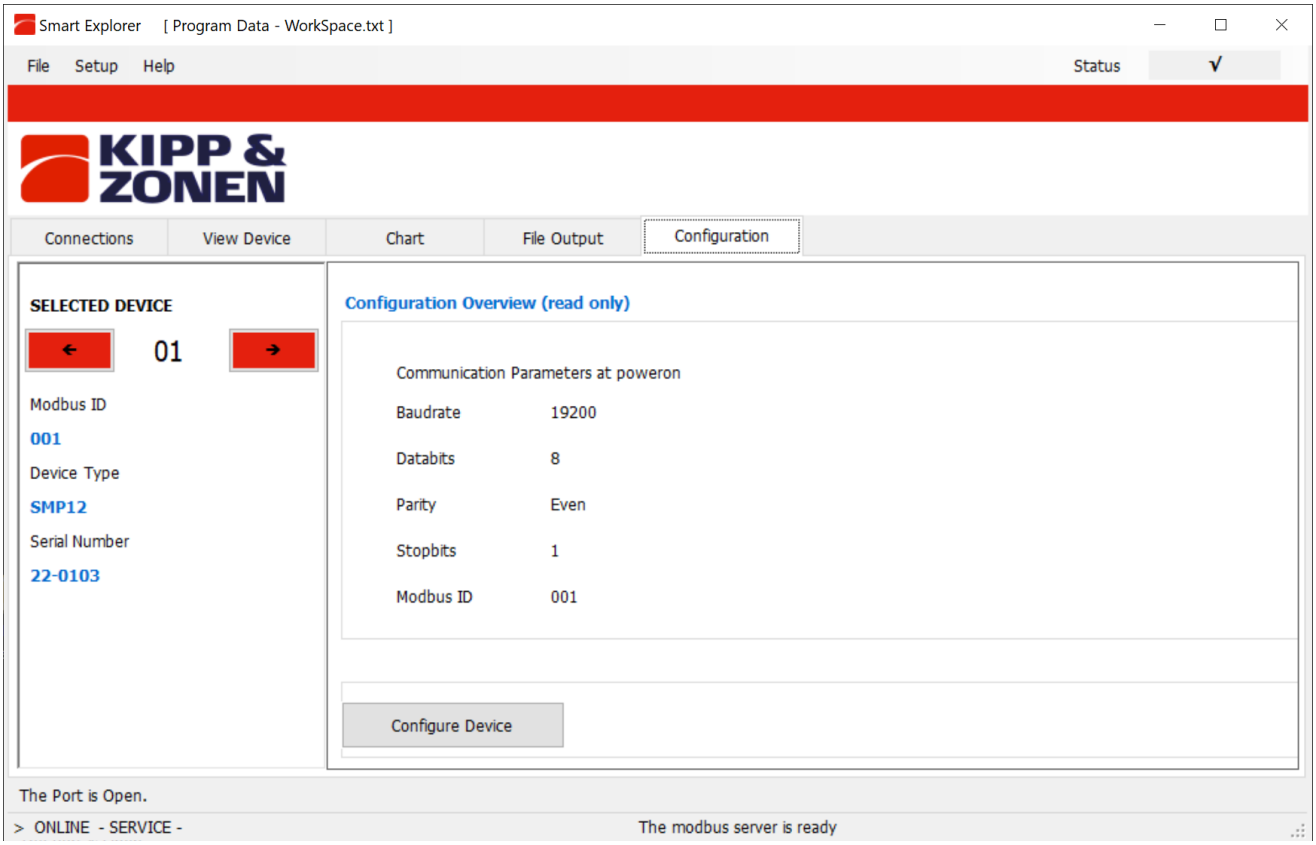
- Activate the *Serial RTU protocol* to establish the direct RS-485 connection.



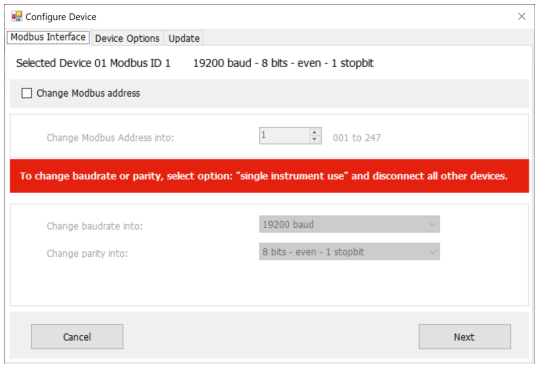
- Select the COM port (see Windows Device Manager).
- Leave the other factory settings unchanged.
- Click on the **Confirm** button to save the settings.

8.1.3 Adjusting the communication parameters

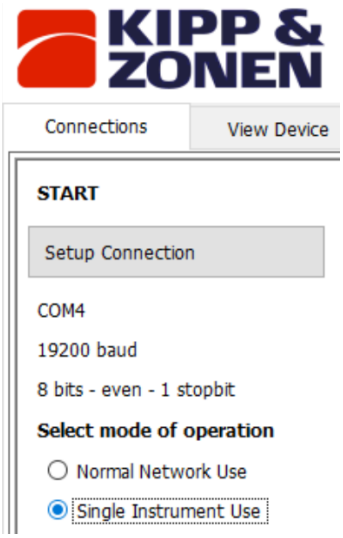
- Click on the *Configuration* tab to access the current communication parameters.



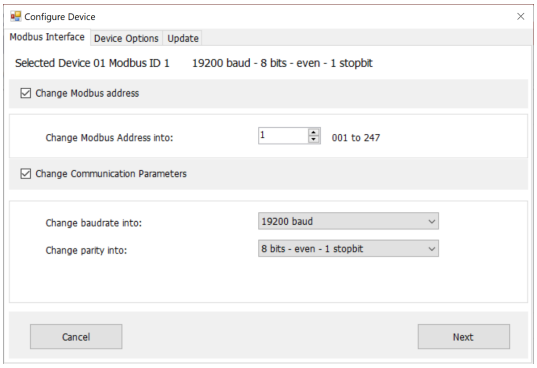
- To change the parameters, click on the **Configure Device** button.
  - ⇨ The following warning appears:



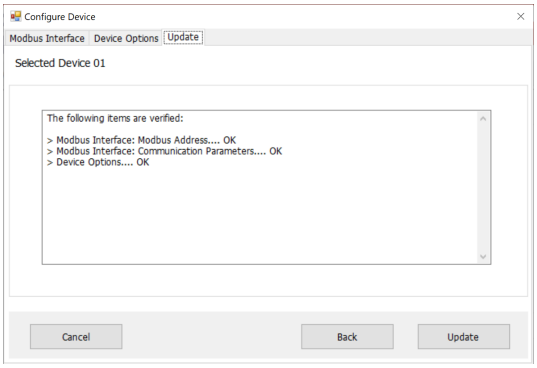
- To change the Modbus address, the baud rate and the parity, close the window and activate the *Single Instrument Use* operating mode on the *Connections* tab. The Modbus address can also be changed in the *Normal Network Use* operating mode.



- 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:



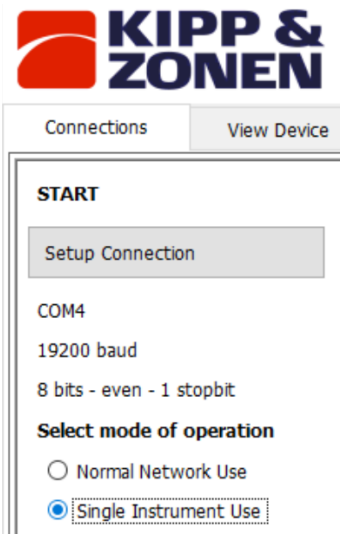
- Click on the **Update** button to save the settings.

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

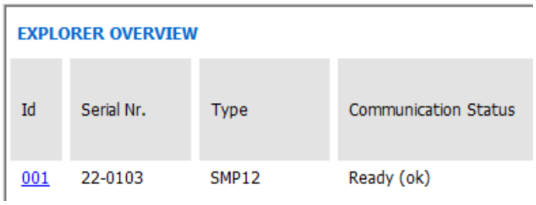
⇨ The communication parameters are changed and the *Connections* tab appears.

8.1.4 Finding an instrument with unknown communication parameters

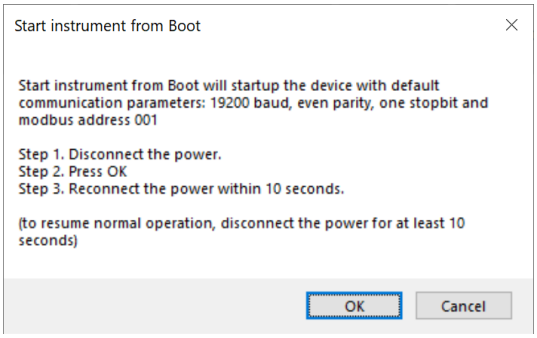
- Activate the *Single Instrument Use* operating mode on the *Connections* tab.



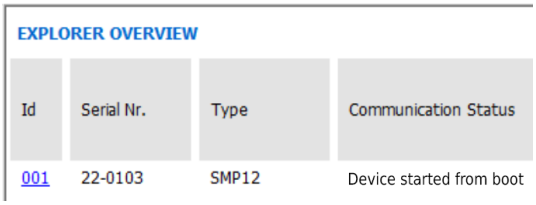
- If only the Modbus address is unknown, click on the **Send Broadcast** button.
  - ⇨ The connected pyranometer is displayed:



- 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, 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 bubble is level. Adjust the instrument if required. ▸ Check that the sun shield is fixed tightly. ▸ For CUV5, check the desiccant in the drying cartridge. ▸ Replace the desiccant when the color changes from orange to yellow to clear (transparent) and some yellow balls are still left.	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 SUV radiometers.	OTT HydroMet

10.2 Replacing desiccant

The SUV radiometers have an internal desiccant that need replacement after 10 years. This is done with every factory re-calibration.

The desiccant of the CUV5 radiometer can be replaced with the following steps:

- Unscrew the drying cartridge from the radiometer housing. If the cartridge is tight, then use a 16 mm or ⅝" open-ended wrench.
- Remove the cap from the end of the cartridge and dispose the used desiccant.
- Refill the cartridge with fresh desiccant.
- Place the cap on the cartridge.
- Ensure that the o-ring seal and its seat in the housing are clean.
- Grease the seal with Vaseline if it is dry.
- Screw in the cartridge hand tight in the radiometer housing.
- Check that the radiometer is level and adjust the radiometer if necessary.
- Check that the sun shield is firmly clipped on.

11 Troubleshooting

11.1 Fault elimination

Fault	Possible cause	Measures
Output signal not available or incorrect	Radiometer does not work properly	▸ Check that the cables are correctly connected to the readout equipment. ▸ Check the power supply of the SUV radiometer. 12 V DC are recommended. ▸ Check that the SUV radiometer has a unique Modbus® address. ▸ Compare the digital and analog outputs of the SUV radiometer to see if the problem is only on one output. ▸ For CUV5 radiometer, measure the resistance at the end of the cables. The typical instrument impedance is given on the instrument certificate. ▸ Check the location for obstacles that block the direct solar radiation. ▸ Check the dome for contamination. Carry out maintenance work as required. ▸ For analog outputs, check the data logger input offset so that a signal of 0 V 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.

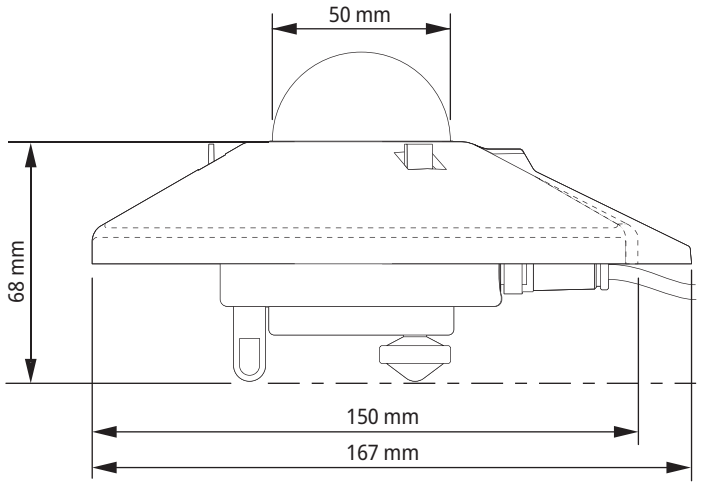
14 Technical data

14.1 Optical and electrical data

Specification	CUV5	SUV5	SUV-A	SUV-B	SUV-E
Spectral range (overall)	280 to 400 nm	280 to 400 nm	315 to 400 nm	280 to 315 nm	280 to 400 nm according to ISO/IEC 17166:2019
Measurement range	0 to 100 W/m^2	0 to 400 W/m^2	0 to 90 W/m^2	0 to 9 W/m^2	0 to 0.9 W/m^2
Non-stability (change/ year)	< 2 %	< 2 %	< 2 %	< 2 %	< 2 %
Response time (95 %)	< 1 s	< 1 s	< 1 s	< 1 s	< 1 s
Non-linearity (0 to max W/ m^2)	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %
Directional response (up to 70°)	< 5 %	< 5 %	< 5 %	< 5 %	< 5 %
Temperature response (-40 °C to +70 °C)	< 3 %	< 2 %	< 2 %	< 2 %	< 2 %
Spectral selectivity	< 20 %	< 20 %	< 20 %	< 20 %	< 20 %
Field of view	180°	180°	180°	180°	180°
Accuracy of bubble level	0.1°	0.1°	0.1°	0.1°	0.1°
Power consumption (at 12 V DC)	–	55 mW	55 mW	55 mW	55 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	Photodiode	Photodiode	Photodiode	Photodiode	Photodiode
Operating temperature range	-40 °C to +80 °C	-40 °C to +70 °C	-40 °C to +70 °C	-40 °C to +70 °C	-40 °C to +70 °C

Specification	CUV5	SUV5	SUV-A	SUV-B	SUV-E
Storage temperature range	-40 °C to +80 °C	-40 °C to +80 °C	-40 °C to +80 °C	-40 °C to +80 °C	-40 °C to +80 °C
Humidity range	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %	0 to 100 %
Ingress Protection (IP) rating	67	67	67	67	67
Analog output	Sensitivity 175 to 300 µV/ W/m^2	0 to 1 V	0 to 1 V	0 to 1 V	0 to 1 V
Analog output range W/m^2	–	-100 to 400	-10 to 90	-1 to 9	-0.1 to 0.9
Serial output	–	RS-485 Modbus®	RS-485 Modbus®	RS-485 Modbus®	RS-485 Modbus®
Serial output range	–	0 to 400 W/m^2	0 to 400 W/m^2	0 to 400 W/m^2	0 to 400 W/m^2

14.2 Dimensions and weight



Specification	CUV5	SUV5, SUV-A, SUV-B, SUV-E
Instrument weight	600 g	600 g
Dimensions unpacked (diameter x height)	15 x 9.3 cm	15 x 9.3 cm
Packaging dimensions	23 x 20 x 16 cm	23 x 20 x 16 cm
Weight of 10 m cable	400 g	

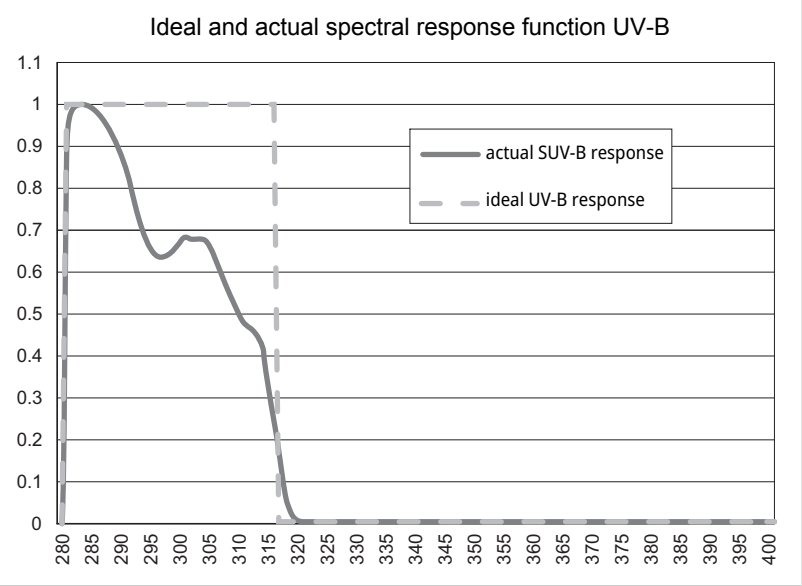
15 Appendix

15.1 UV broadband radiometers

CUV5 and SUV radiometers are designed for continuous outdoor use in routine monitoring applications with the sun as the source. However, they can also be used in indoors in test chambers and laboratories; bearing in mind the specifications of the UV source (lamp) and of the radiometer used.

The instruments are so-called "broadband radiometers". They each have a spectral response determined by the properties of the photodiode detector, the bandpass optical filter, the diffusor and the dome. The signal output represents all the radiant energy within the radiometer response band. They do not measure each wavelength individually, as a spectroradiometer does.

The standardized UVA and UVB bands (and, therefore, total UV) have 'ideal' rectangular instrument response curves, however, in practice such a response cannot be realized with a broadband radiometer. This means that there is always a mismatch between the two responses as shown for UVB in the following figure:



Example of an ideal UVB response and a SUV-B instrument response curve

However, the effects of this can be reduced by careful calibration.

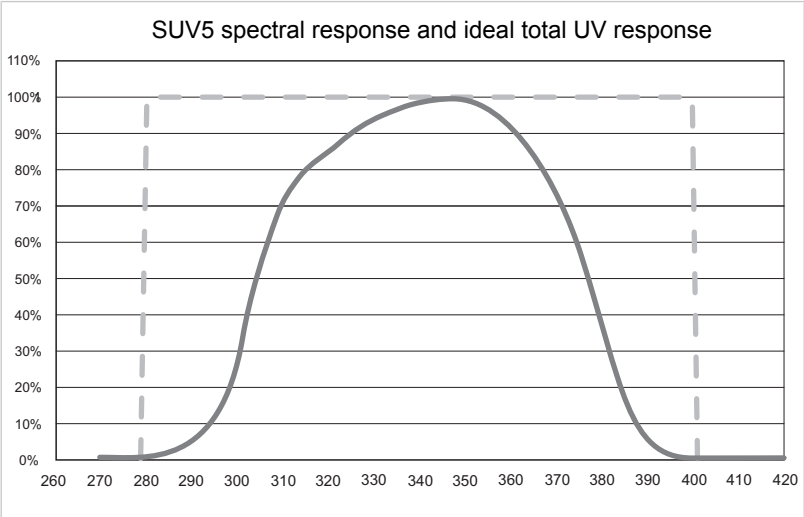
15.2 Instrument spectral response and ideal UV response

Due to the non-rectangular spectral response curve of the CUV5, SUV5, SUV-A and SUV-B, the instrument will not weigh all the radiation of different wavelengths equally in this band. However, when the instrument is calibrated, its detector output is set to represent the amount of UV according to the ideal response. The detector output represents the enclosed irradiance; the integrated product of the instrument spectral response and the applied radiation spectrum.

So, for a typical clear-sky, sea-level, solar spectrum at airmass 1.5 (48 solar zenith angle) and with a total ozone column of 325 Dobson Units, the instrument sensitivity is determined by the ratio of the detector output and the amount of UV expected according to the ideal response. When the radiometer is used in exactly those same conditions, e.g. AM 1.5, 325 DU, the instrument will give the correct output of UVA or UVB as if it has an ideal spectral response.

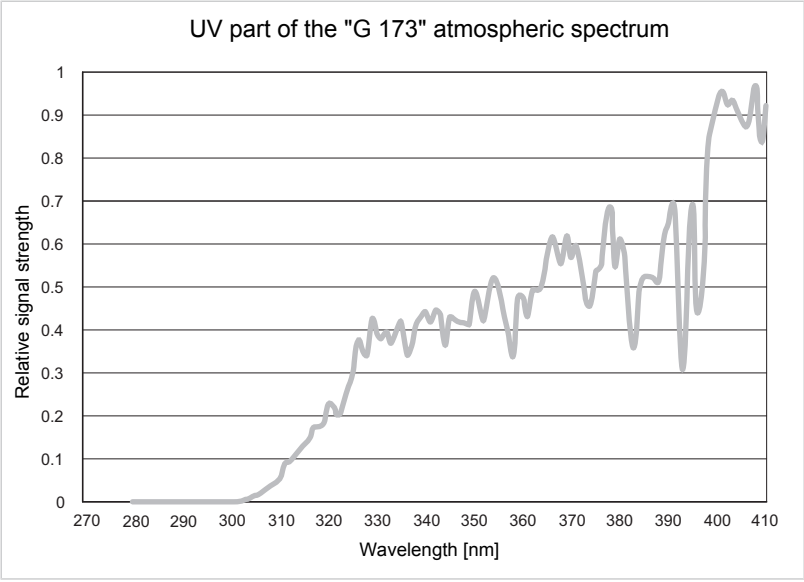
However, when the received solar spectrum changes due to atmospheric conditions, or when a different light source such as a lamp is used, the ratio between the instrument's enclosed irradiance and the ideal enclosed irradiance can vary and "spectral errors" will occur.

The figure below shows the ideal spectral response for "total UV" as well as the instrument response of a typical SUV5.



Example of a CUV/SUV5 instrument response curve and the ideal total UV response

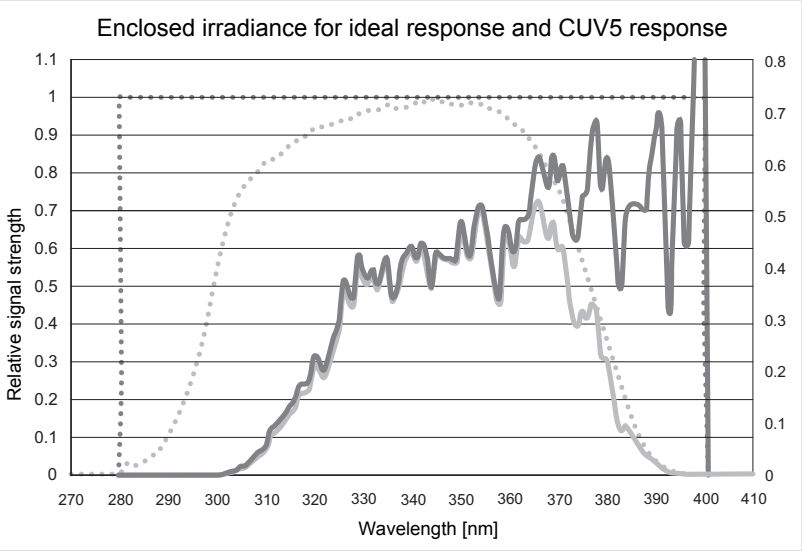
The following figure shows the G 173 solar spectrum, a typical atmospheric spectrum at airmass 1.5.



The G 173 atmospheric spectrum at airmass 1.5

It can be seen that the SUV5 responds mainly to wavelengths in the range of 300 – 380 nm. "Total-UV" is defined as all radiation between 280 nm and 400 nm. When it is calibrated, its detector output is set to represent the amount of UV according to the ideal response. In effect, the spectral response of the instrument is extrapolated.

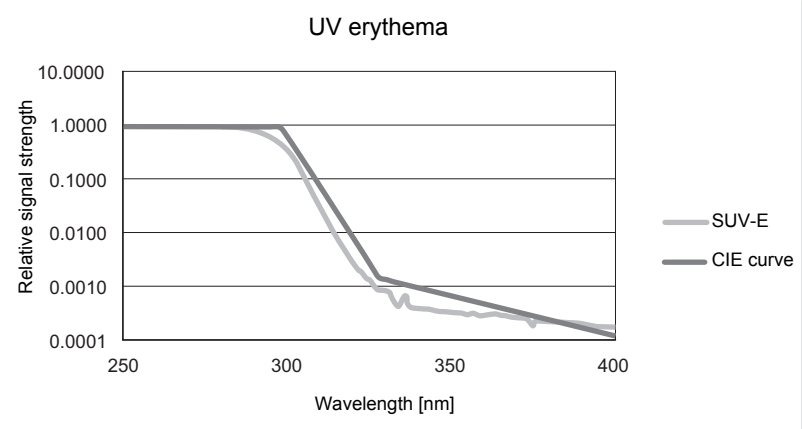
The next figure shows the "enclosed radiation". This is per wavelength the product of the instrument's response and the irradiance level at that wavelength. The instrument's detector signal represents the enclosed radiation; the sum over the whole range of wavelengths, represented by the area under the curve (the integral).



The enclosed radiation of the G 173 spectrum as measured by the CUV/SUV5 (light gray solid line) as well as when measured by an instrument with "ideal response" (dark gray solid line)

The instrument's sensitivity is the ratio between the integrated curve of the ideal enclosed radiation and the actual enclosed radiation. For a given spectrum this ratio will be constant, however, as the atmospheric spectrum varies with environmental conditions, also the ratio of the ideal enclosed radiation and the actual enclosed radiation might change, giving rise to "spectral errors".

The SUV-E is slightly different, in that the ideal response is not rectangular. To provide a Global Solar UV Index (UVI) value you must measure the solar UV radiation with the spectrally-weighted (Erythemal) response of a 'standard' human skin. This is internationally defined in ISO/CIE 17166:2019. Also for this instrument, the effect of the spectral mismatch is minimized during calibration, as for CUV5, SUV-A and SUV-B.



Example of ideal erythemal UVE response and a SUV-E instrument response curve

Typical spectral errors that can occur for solar irradiance measurement due to spectral changes over solar zenith angles 0° – 70° and total ozone columns 260 – 400 DU are shown in the following table:

CUV5 and SUV5	SUV-A	SUV-B	SUV-E
+2 %	+2 %	+5 %	+2 %
-2 %	-2 %	-15 %	-15 %

Typical range of errors expected due to change in AM (SZA) and TOC (DU)

15.3 Indoor measurement with lamps

When a UV radiometer calibrated for natural solar UV radiation is used to measure other light sources deviations in the irradiance readings are likely to occur; due to differences in the emission spectrum of the lamp. In the table below typical errors for halogen, xenon and metal halide lamps are given for CUV5 /SUV5 and SUV-A instruments. However, there are several types of metal halide lamp available and the error could be better or worse.

Lamp type	CUV5 and SUV5	SUV-A
Halogen (5000K)	10 %	10 %
Xenon	3 %	2 %
Metal halide	>15 %	>15 %

Typical range of errors expected due to lamp spectrum differing from solar radiation

In general, the instruments will overestimate read a bit higher irradiance than the lamps are giving, because the instruments are calibrated for a solar spectrum, not for a lamp.

If a lamp is used that emits largely radiation between 390 nm and 400 nm, the CUV5 and SUV5 radiometers will have a larger spectral error.

The SUV-B and SUV-E are not in this table since these instruments are not intended for indoor use with lamps; medical UVB lamps have narrow emission band-widths and are too different from the UVB solar spectrum to be useful with the SUV-B. SUV-E is specifically designed to measure the response of the human skin to natural solar UV radiation.

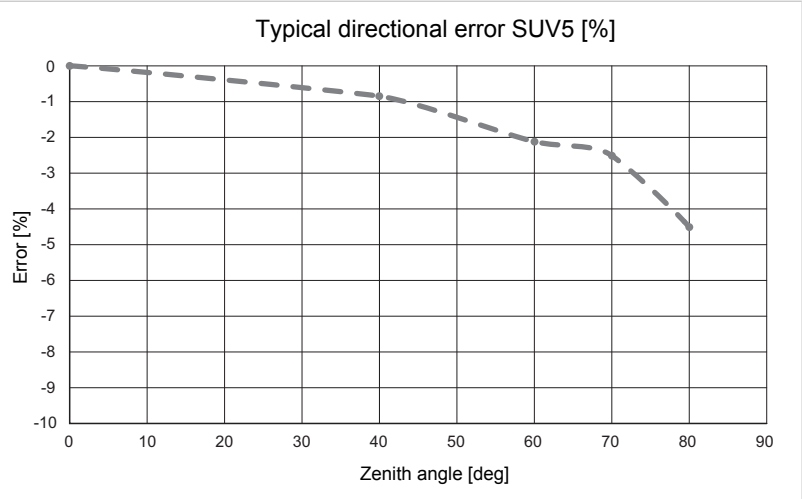
15.4 Directional response and its impact on UV measurement

Global Horizontal Irradiance (GHI) is the radiant flux , incident upon a horizontal plane surface and is measured by a horizontal radiometer in units of W/m^2. This flux comprises energy in the beam of direct radiation from the sun and in diffuse (scattered and reflected) radiation for the sky.

As the sun changes position in the sky, the direct beam is incident at a changing solar zenith angle and the flux density on the horizontal surface changes. This is proportional to the cosine of the solar zenith angle and the radiometer ‘directional response’ should follow this.

CUV5 and SUV radiometers are equipped with photoelectric detectors (photodiodes) sensitive to UV radiation and have optical filters to obtain a response that corresponds to a specific UV band. Unfortunately, photodiodes and optical filters cannot accept radiation coming in with large incident angles. Therefore, a diffusor is necessary which accepts radiation up to an enclosed angle of 180° and provides a hemispherical view of the sky.

To ensure the response at 90° angle of incidence is zero (cos. 90° = 0) a rim shades the diffuser side at SZA >85°. The shape of the diffuser ensures a good cosine response. Due to tolerances of the components and in assembly, there is a slight variation in directional response between radiometers. This response characteristic is measured with a lamp, which simulates a direct sun beam. For the different angles of incidence the instrument's output is measured and compared to the ideal response; the perpendicular output signal is multiplied by the cosine of the given angle. The deviation from the ideal cosine response is the termed the directional error (or cosine) error. The typical response error of a SUV5 is shown in the following figure:



Due to sunlight being scattered and reflected in the earth's atmosphere, we have diffuse solar radiation. Scattering is wavelength dependent and is strongest in the UV and blue wavelengths (hence the sky is blue). In practice, about 50 % of all atmospheric UV arrives at the surface as diffuse radiation, the other half is in the direct solar beam.

Therefore, the directional response of a UV radiometer is less critical than for a pyranometer as, effectively, only half of the incoming UV light is affected by the instrument's cosine error for clear sky conditions. When the sky is clouded there is no direct sun beam and only diffuse radiation.

So, in practice, the directional errors that actually occur during measurements with CUV or SUV radiometers will be at least 2 times smaller than given in the graph.

OTT HydroMet

Contact Information