OTT HydroMet

KIPP & ZONEN
an OTT HydroMet brand

CHP1 and SHP1 Pyrheliometer

Operational Manual

0368201 | 01-1124

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Table of contents

1 Scope of supply

The following items are included with delivery:

- Pyrheliometer
- Rain shield
- Test reports
- Instruction sheet
- 2 desiccant bags

2 Order numbers and variant code

2.1 Product variants

Variant	Order number
CHP1 Pyrheliometer, 10 K + Pt-100, no plug, no cable	0368900-030
SHP1-V Smart Pyrheliometer, 0 to 1 V version, no plug, no cable	0375900-100
SHP1-A Smart Pyrheliometer, 4 to 20 mA version, no plug, no cable	0375900-200

2.2 Accessories and spare parts

Data logging

Item	Order number
LogBox SE Data Logger	3303096
METEON Irradiance Meter and Data Logger	0365910
METEON 2.0 Smart Irradiance Meter	0388900

Cables

Item	Order number
Waterproof 8-pin plug only	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:

3.2 General signs and symbols

The signs and symbols used in the operational 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 pyrheliometer is used to measure direct short-wave 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 Operator obligations
The installer is responsible for observing the safety regulations. Unqualified personnel working on the product can cause risks that could lead to serious injury.

- Have all activities carried out by qualified personnel.
- Ensure that everybody who works on or with the product has read and understood the operational manual.
- Ensure that safety information is observed.
- File the operational manual together with the documentation of the entire system and ensure that it is accessible at all times.
- The operational manual is part of the product, forward the operational manual together with the product.

4.5 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.

4.6 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 pyrheliometer is designed to measure the direct short-wave irradiance (radiant flux, W/m^2) which results from the radiant flux from a solid angle of 5 degrees.

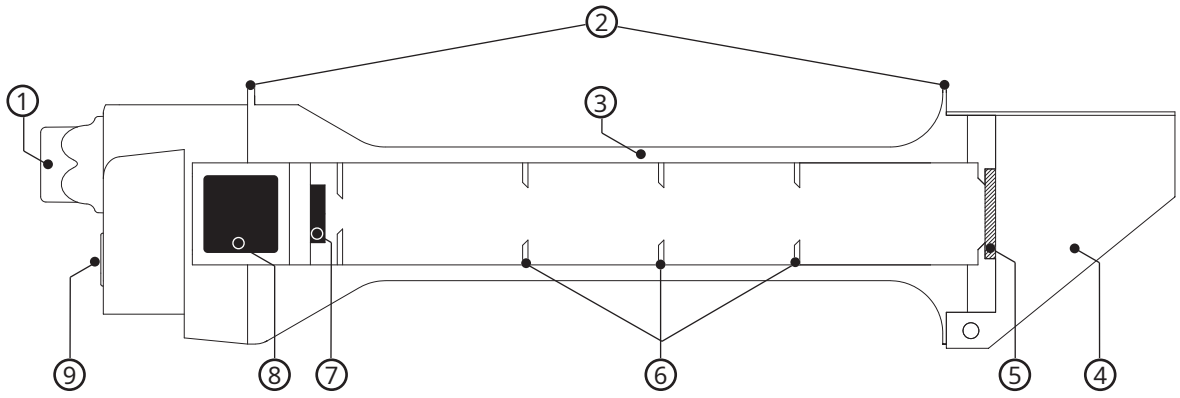
As standard CHP1 comes fitted with 10 kΩ thermistor and Pt-100 and temperature sensors; so that the small temperature dependency of sensitivity can be corrected in post-processing using the supplied test data.

The SHP1 features 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. The SHP1 is available in two versions. The SHP1-V has an analog voltage output of 0 to 1 V, the SHP1-A has an analog current output of 4 to 20 mA. The 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 characteristics the instrument uses a quartz window and a thermopile detector. The desiccant in the drying cartridge prevents condensation on the internal side of the instrument.

The instrument is typically mounted on a sun tracker.

5.2 Product overview



1	Drying cartridge	6	Aperture rings
2	Alignment aids	7	Detector
3	Housing	8	Smart interface (SHP1 only)
4	Rain shield	9	Cable connection
5	Quartz window		

6 Transport, storage, and unpacking

6.1 Transport

- Transport the product always in its original packaging.
- Ensure that the product is not mechanically stressed during transport.

6.2 Storage

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

6.3 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 your supplier or manufacturer.
- Keep the original packaging for any further transportation.

7 Installation

7.1 Mechanical installation

7.1.1 Preparatory work

- Check the desiccant and replace if necessary.
- If using the digital output of the SHP1 pyrheliometer, 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, 3 mm

7.1.3 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.

> Further details for installation of the sun tracker can be found in the manual of the used tracker.

- 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. It can cause measurement deviations.
- Ensure that the instrumet is readily accessible for cleaning and maintenance.

7.1.4 Mounting instrument

The mounting of the instrument is related to the used sun tracker.

- Refer to the sun tracker manual for further instructions on how to mount the instrument.

7.2 Electrical installation

7.2.1 Electrical connections of CHP pyrheliometer

> 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.

The CHP pyrheliometers can be supplied with a waterproof plug pre-wired to 10 m of high quality yellow cable with 8 wires and a shield covered with a black sleeve. Longer cables are available as options. The number of plug pins and cable leads depends upon the model and whether a temperature sensor is fitted. The color code of the wires and the connector pin numbers are shown below and on the instruction sheet.

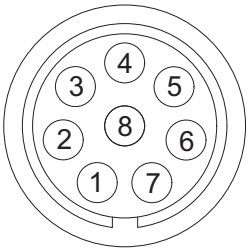
The impedance of the readout equipment loads the temperature compensation circuit and the thermopile. It can increase the temperature dependency of the instrument. The sensitivity is affected more than 0.1 % when the load resistance is less than 100 kΩ. For this reason, the use of readout equipment with an input impedance of 1 MΩ or more is recommended. The solar integrators, data loggers and chart recorders from Kipp & Zonen meet these requirements.

The use of attenuator circuits to modify the calibration factor is not recommended because the temperature response will also be affected.

A high input bias current at the readout equipment can produce several micro-Volts across the impedance of the instrument and cable. The zero offset can be verified by replacing the instrument impedance at the readout equipment input terminals with a resistor.

The instrument can also be connected to a computer or data acquisition system. A low voltage analog input must be available. The resolution of the Analog-to-Digital Converter (ADC) must allow a system sensitivity of about 1 bit per W/m^2. More resolution is not necessary during outdoor measurements, because the instrument exhibits offsets up to ±2 W/m^2 due to lack of thermal equilibrium.

7.2.1.1 Pyrheliometer connection



8-pin plug

Pin assignment

Wire			
Number	Color	Function	Connect to
1	Red	+	+ (Hi)
2	Blue	–	- (Lo)
4	Yellow	Combined	Pt-100
6	Brown		
3	Green	Combined	Pt-100
5	Gray		
7	Black	Combined	Thermistor
8	White		
Shield		Housing	Ground

7.2.2 Electrical connections of SHP pyrheliometer

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.

The SHP pyrheliometers can be supplied with a waterproof plug pre-wired to 10 m of high quality yellow cable with 8 wires and a shield covered with a black sleeve. Longer cables are available as options. The color code of the wires and the connector pin numbers are shown in chapter Connecting to computer [▶ 15] and on the instruction sheet.

7.2.2.1 Power connection

The minimum power supply voltage for the instrument 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.

7.2.2.2 Power consumption

Typical power consumption SHP1-V for maximum output (1 V)

Voltage (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 SHP1-A for max output (20 mA)

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

The above mW values represent the dissipation within the SGR-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.

7.2.2.3 Analog voltage output

The SHP1-V (Volt version) has been factory set for an output of -200 to 2000 W/m^2. This only applies to the analog output and means that an output of 0 Volt corresponds to -200 W/m^2 (this will never be reached) and 1 Volt corresponds to 2000 W/m^2.

The digital output range can be modified with Modbus® commands. For the SHP1 the output range can be set to -200 to 4000 W/m^2 for 0 to 1 Volt.

The range has to start negative in order to show (small) negative readings also the analog output itself cannot go negative. If used in atmospheric conditions it is advised to keep the range as factory set.

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]

7.2.2.4 Analog current output

The SHP1-A (current version) is factory set to 0 to 1600 W/m^2 for 4 to 20 mA.

Negative inputs will make the output go below 4 mA.

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]

7.2.2.5 Connecting to computer

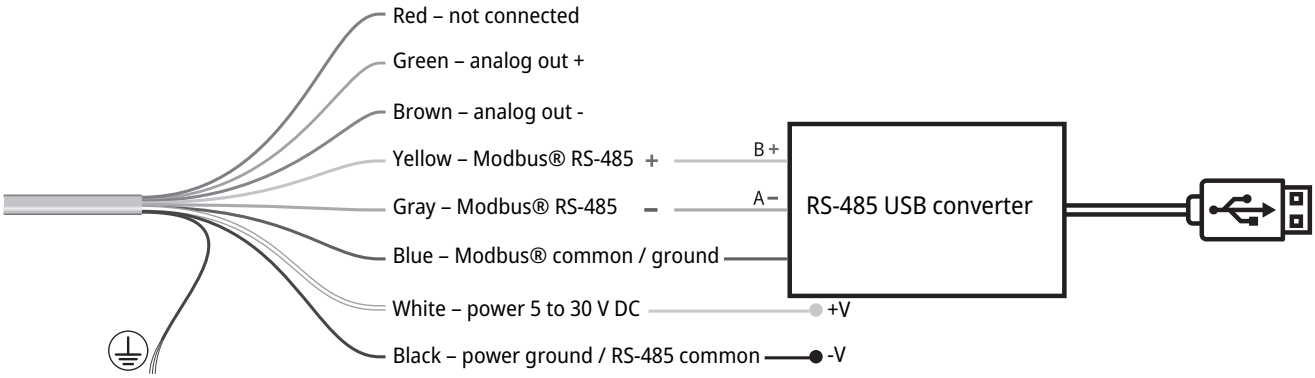
NOTICE

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 isolation 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 any other wires when they are not in use.
- Align the indentation on the plug with the indentation on the instruments's connection socket.
- Connect the plug to the instrument.
- Turn the locking ring clockwise and tighten it hand tight to secure the plug.
  NOTICE! The seal may be damaged by overtightening!
- Switch on the power supply.
- Switch on the computer.

7.2.3 Grounding instrument

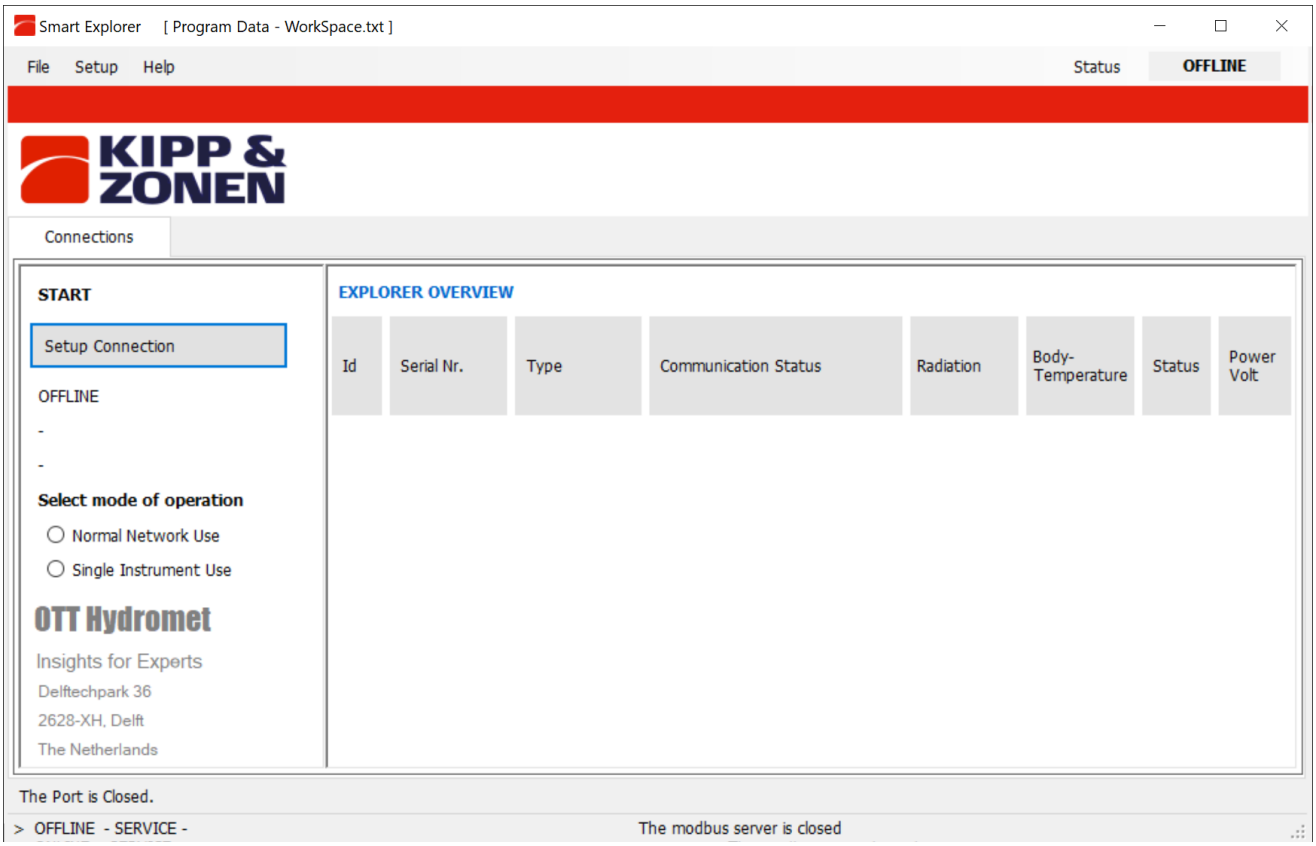
Lightning can induce high voltages in the shield but these will be led off at the instrument or readout equipment. The shield of the cable is connected to the aluminum housing of the instrument through the plug body.

- If there is no good ground connection at the instrument, connect the shield at the cable end to the ground at the readout equipment.

8 Commissioning

8.1 Instrument set-up

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.otthydromet.com

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 window of the instrument should be cleaned at regular intervals.

The following maintenance intervals are recommended:

Interval	Activity	Performed by
Twice a week	▸ Clean the window 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 the desiccant in the drying cartridge. ▸ Replace the desiccant when the color changes from orange to clear (transparent).	Operator
Annually	▸ Check all electrical connections. ▸ Check all cables for damage. ▸ Check the instrument mounting.	Operator
2 years	▸ Check sensitivity or have a recalibration performed.	OTT HydroMet

10.2 Replacing desiccant

The desiccant can be replaced with the following steps:

- Unscrew the drying cartridge from the instrument 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 instrument housing.

11 Troubleshooting

11.1 Error elimination

Error	Possible cause	Corrective action
Output signal not available or incorrect	Instrument does not work properly	▸ Check that the cables are correctly connected to the readout equipment. ▸ Check the location for obstacles that block the direct solar radiation ▸ Check the window for contamination. Carry out maintenance work as required. ▸ Replace the desiccant, if water is deposited on the inside of the window. ▸ Report any malfunctions or damage to the representative of OTT HydroMet. For CHP1 pyrheliometer: ▸ Check the impedance. See specifications for expected values. ▸ Check the data logger or integrator offset by connecting a dummy load (100 Ohm resistor). This should give a "zero" reading. For SHP1 pyrheliometer: ▸ Check the power supply; 12 V DC is 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. ▸ 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.

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 acquisition system
– interfaces and power supplies
– history of any previous repairs or modifications
– pictures of the installation
– overview of the local environment conditions

OTT HydroMet repair service

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
phone: +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.

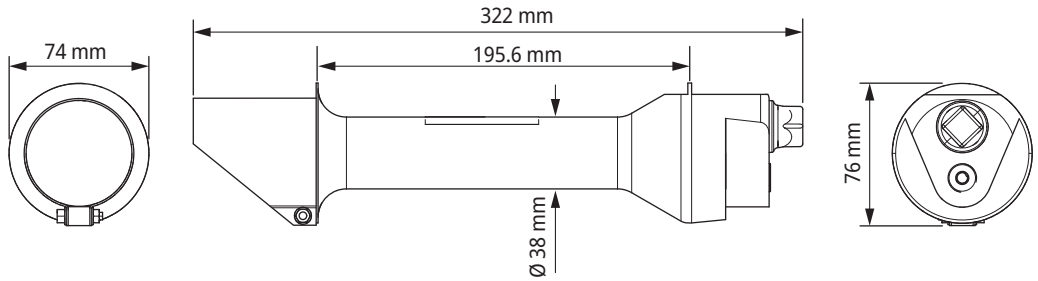
14 Technical data

14.1 Optical and electrical data

Specification	CHP1	SHP1
Response time (63 %)	< 1.7 s	< 0.7 s
Response time (95 %)	< 5 s	< 2 s
Zero offset, temperature change (5 K/h)	< 1 W/m^2	< 1 W/m^2
Non-stability (change/year)	< 0.5 %	< 0.5 %
Non-linearity (0 to 1000 W/m^2)	< 0.2 %	< 0.2 %
Temperature dependence of sensitivity	< 0.5 % (-20 °C to +50 °C)	< 0.5 % (-30 °C to +60 °C) 1 % (-40 °C to +70 °C)
Sensitivity	7 to 14 µV/W/m^2	–
Full viewing angle	5° ±0.2°	5° ±0.2°
Slope angle	1° ±0.2°	1° ±0.2°
Maximum irradiance	4000 W/m^2	4000 W/m^2
Expected daily uncertainty	< 1 %	< 1 %
Spectral range (50 % points)	200 to 4000 nm	200 to 4000 nm
Required sun tracker accuracy	< 0.5° from ideal	< 0.5° from ideal
Impedance	10 to 100 Ω	–
Analog output	10 to 20 mV for 1400 W/m^2	-V version: 0 to 1 V -A version: 4 to 20 mA
Analog output range	0 to 4000 W/m^2	-V version: -200 to 2000 W/m^2 * -A version: 0 to 1600 W/m^2
Digital output	–	2-wire RS-485
Digital output maximum range	–	-400 to 4000 W/m^2
Digital communication protocol	–	Modbus®
Supply voltage	–	5 to 30 V DC
Power consumption (at 12 V DC)	–	V-version: 55 mW A-version: 100 mW
Software, Windows™	–	Smart Explorer Software, for configuration, test and data logging
Temperature sensor	Both Pt-100 and 10k thermistor as standard	Internal
Operating temperature range	-40 °C to +80 °C	-40 °C to +80 °C
Storage temperature range	-40 °C to +80 °C	-40 °C to +80 °C
Humidity range (non-condensing)	0 to 100 %	0 to 100 %
Protection rating	IP67	IP67

*The analog output range of SHP1 can be rescaled by the user to a maximum of -200 to 4000 W/m^2.

14.2 Dimensions and weight



CHP1 and SHP1, 900 g

OTT HydroMet

Contact Information