OTT HydroMet

KIPP & ZONEN
an OTT HydroMet brand

CNR4 Net Radiometer

Operational Manual

0369211 | 01-0824

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

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

Table of contents

1 Scope of supply

The following items are included with delivery:

- CNR4 net radiometer
- Mounting rod
- 2 drying cartridges
- Instruction sheet
- Test reports
- CNF4 ventilation unit (optional)

2 Order numbers and variant code

2.1 Product variants

Variant	Order number
CNR4 Net Radiometer, four-component, no plug, no cable	0369900-030

Optional

Variant	Order number
CNF4 Ventilation Unit 8 wire, no plug, no cable	0369710-000

2.2 Accessories and spare parts

Item	Order number
AMPBOX signal amplifier, standard gain setting	0365900
CMB1 Mounting Bracket	0369701
50 m cable, pre-wired with waterproof 8-pin plug	0362624

3 About this manual

3.1 Other applicable documents

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

– Instruction Sheet

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 CNR4 net radiometer is used to measure the energy balance between incoming short-wave and long-wave Far Infrared (FIR) radiation versus surface-reflected short-wave and outgoing long-wave radiation. The CNR4 is intended for continuous outdoor use.

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 CNR 4 is a 4 component net radiometer that measures the energy balance between incoming short-wave and long-wave Far Infrared (FIR) radiation versus surface-reflected short-wave and outgoing long-wave radiation.

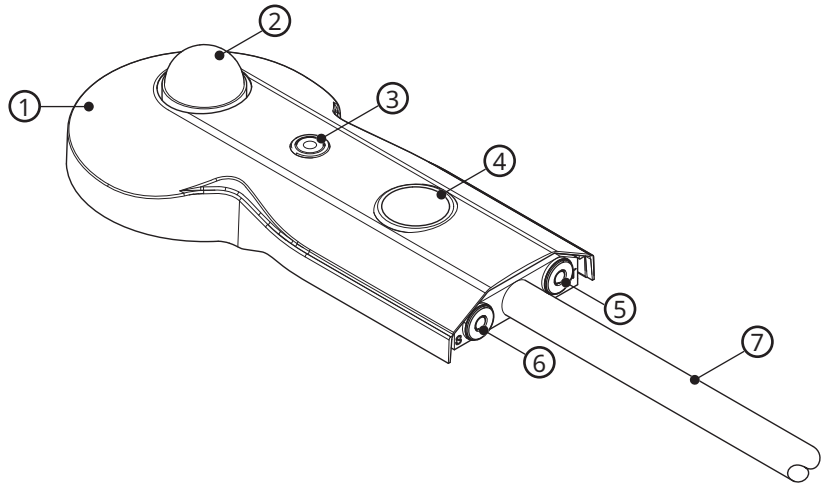
The CNR 4 net radiometer consists of a pyranometer pair, one facing upward, the other facing downward, and a pyrgeometer pair in a similar configuration. The pyranometer pair measures the short-wave radiation. And the pyrgeometer pair measures long-wave radiation. From a spectral point of view, the pyranometer and pyrgeometer are complementary. Together they cover the full spectral range. The upper long-wave detector of CNR4 has a meniscus dome with a view to nearly 180°. All 4 sensors are integrated directly into the instrument body. Each sensor is calibrated individually.

Two temperature sensors, a Pt-100 and Thermistor, are integrated for compatibility with every data logger. The temperature sensor is used to provide information to correct the infrared readings for the temperature of the instrument housing. The long-wave sensors are placed close to each other and close to the temperature sensors. This assures that the temperatures of the measurement surfaces are the same and accurately known.

The radiometer has an integrated sun shield that reduces thermal effects on both long-wave and short-wave measurements. The mounting rod can be unscrewed for transport.

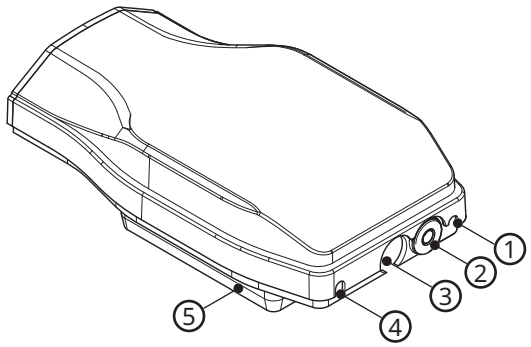
An optional CNF4 ventilation unit with heater is designed as an extension of the sunshield and can be fitted new to the CNR4 or retrofitted later. This unit provides efficient air-flow over the domes and windows to minimize the formation of dew and reduce the frequency of cleaning. The integrated heater can be used to melt frost.

5.2 Product overview



CNR4 net radiometer

1	Cover	5	Temperature connector (T)
2	Glass dome of upper pyranometer	6	Sensor connector (S)
3	Bubble level	7	Mounting rod
4	Silicon meniscus dome of upper pyrgeometer		



CNF4 ventilation unit (optional)

1 Cable feed-through for temperature connection
2 Ventilation unit connector
3 Mounting rod feed-through
4 Cable feed-through for sensor connection
5 Filter

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 Required tools and aids

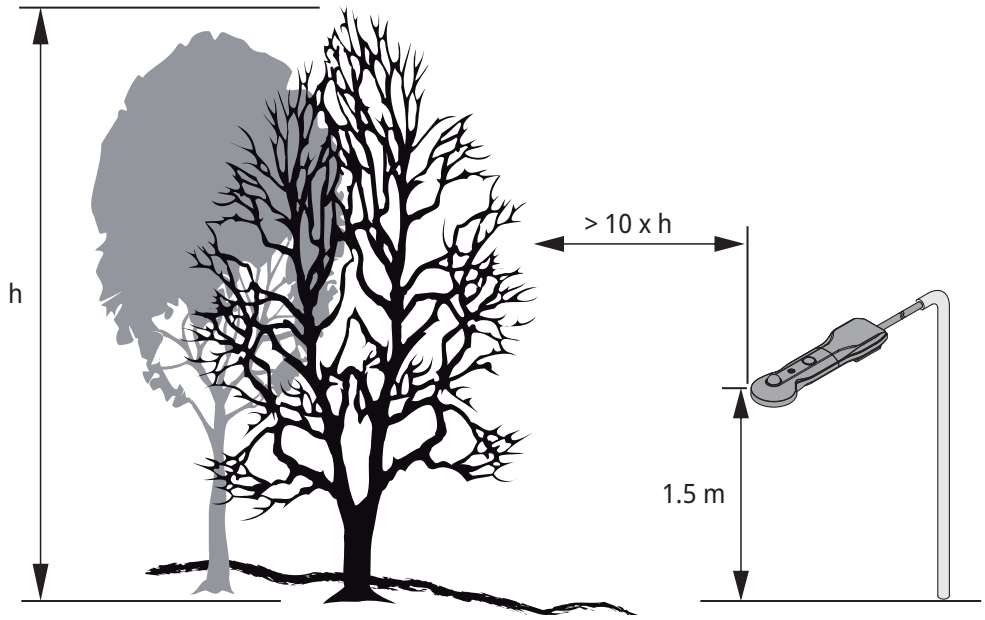
The following tools and aids are required:

- adjustable wrench, 6" to 12"
- torque wrench
- spanner wrench, M6 and M8

7.1.2 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:



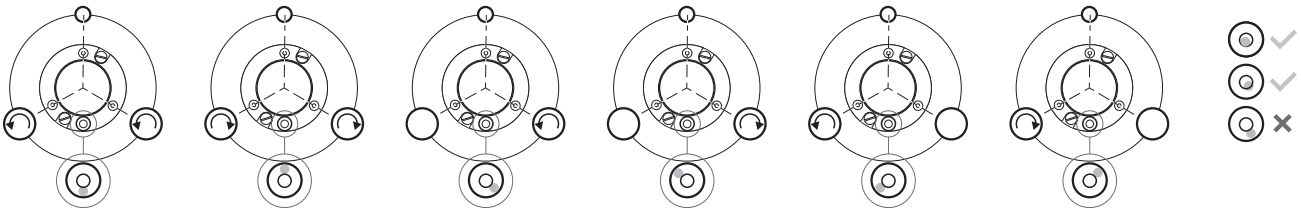
Minmum distance from instrument to obstacle

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 Mounting instrument

- Screw in the mounting rod.
- Attach the mounting rod at the chosen installation site or use the CMB1 mounting bracket to fix the mounting rod to a mast, pole or wall.
- Ensure that the instrument is approximately 1.5 m above the ground
- Align the mounting rod with the next pole.
- To align the instrument horizontally, rotate and tilt the instrument until at least half of the spirit level bubble is in the inner ring.



If the radiometer is mounted in a rotated or vertical position, the tilt effect occurs and changes the sensitivity of the instrument. For the instrument, the tilt effect remains in1 %.

7.1.4 Mounting ventilation unit (optional)

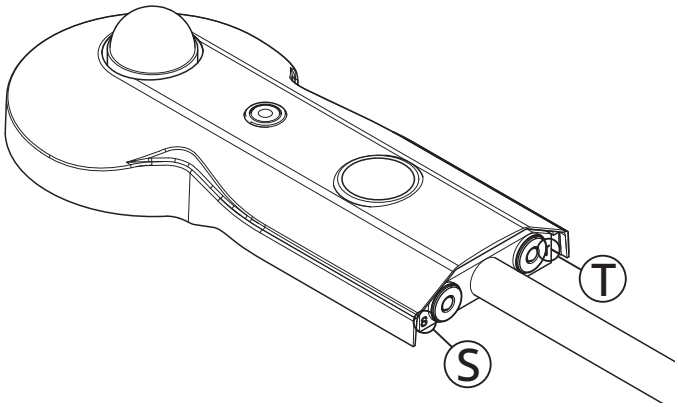
The CNF4 ventilation unit can be retrofitted.

- Mount the extra bottom plate to the bottom of the instrument.
- Ensure that the (S) and (T) cables run on both sides of the ventilator to the back of the instrument housing.
- Slide the ventilation unit cover under the instrument cover.

7.2 Electrical installation

7.2.1 Electrical connections

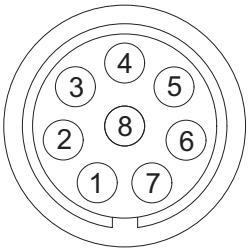
The instrument has 2 voltages for the pyranometers, 2 voltages for the pyrgeometers, and two temperature sensors as standard. The connector with the 4 sensor outputs is indicated with an S on the back of the instrument, the temperature connector is indicated with a T.



The sensor connector has 8 pins and needs an 8-wire cable. The temperature connector has also 8 pins, but 2 pins are not used. This requires a 6-wire cable. To prevent mix up of the cables after installation it is advised to mark the cables with a permanent marker or tape showing also S and T.

7.2.2 Sensor connection

The sensor connector carries the signals for the pyranometers and pyrgeometers.



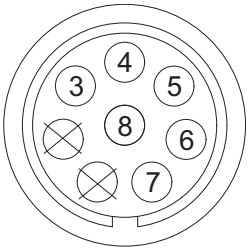
8-pin sensor connector

Pin assignment

Wire				
Number	Color	Function		Connect to
1	Red	+	Pyranometer upper	+ Hi
2	Blue	–		– Lo
7	White	+	Pyranometer lower	+ Hi
8	Black	–		– Lo
5	Gray	+	Pyrgeometer upper	+ Hi
4	Yellow	–		– Lo
6	Brown	+	Pyrgeometer lower	+ Hi
3	Green	–		– Lo
Shield			Housing	Ground

7.2.3 Temperature connection

The temperature connector carries the signals for the PT-100 (4 wires) and Thermistor (2 wires). The selected connection depends on the data logger.



6-pin temperature connector

Pin assignment

Wire			
Number	Color	Assignment	
7	White	Thermistor standard	
8	Black		
5	Gray	Combined	Pt-100 standard
3	Green		

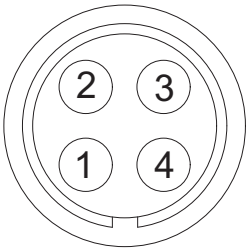
Wire			
Number	Color	Assignment	
4	Yellow	Combined	Pt-100 standard
6	Brown		
Shield	Housing		Ground

7.2.4 Grounding instrument

- If the instrument has not been grounded, connect the black shield cable to the ground.
- To avoid ground loops and signal offsets, do not connect the shield to the data logger if the instrument is grounded to the mast.

7.2.5 Ventilation unit connection

The ventilation unit connector has separate wires for heating and ventilation. In case the heater is used also the ventilator must be active. The other way around the ventilator can be used without heating.



4-pin ventilation unit connector

Pin assignment

Wire				
Number	Color	Function		Connect to
1	Red	+	5 Watt ventilator	12 V DC
2	Blue	–		
3	Green	+	10 Watt heater	12 V DC
4	Yellow	–		
Shield			Housing	Ground

8 Maintenance

8.1 Maintenance schedule

The regular maintenance of all four sensors and connections ensures accurate and reliable measurements. The frequency of cleaning is dependent upon the local weather and environmental conditions and can be reduced by the use of a ventilation unit, with the heater switched on when necessary.

The following maintenance intervals are recommended:

CNR4 net radiometer

Interval	Activity	Performed by
Twice a week	▸ Clean the pyranometers domes using a dry and lint-free cloth. ▸ Clean the surfaces of the pyrgeometer. ▸ For persistent soiling, use additional distilled water or pure alcohol. ▸ Remove frost and ice by hand if necessary. ▸ Ensure that no scratches are made on the surfaces. ▸ Ensure that no streaks or deposits are left on the surfaces.	Operator
Monthly	▸ Check that the instrument is level. Adjust the instrument if required. ▸ Check that the cover is fixed tightly. ▸ Check if the drying cartridge 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 cover if dirty.	Operator
2 years	▸ Replace the drying cartridge.	Operator
2 years	▸ Have a recalibration performed.	OTT HydroMet

CNF4 ventilation unit

Interval	Activity	Performed by
6 to 12 months	▸ Check the filter for dust and particles. ▸ Clean the filter by washing it in clean water. ▸ If necessary, replace the filter.	Operator

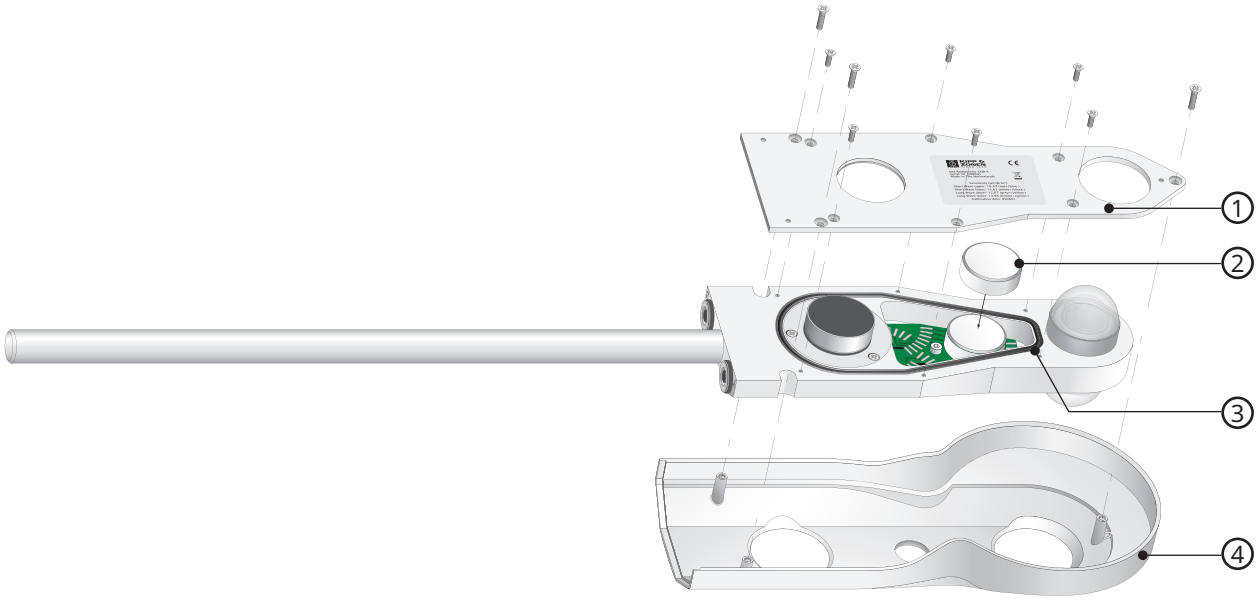
8.2 Replacing drying cartridge of CNR4

CAUTION

Risk of slight burns due to warm surface!

As soon as the device is connected to the power supply, the device starts to heat up. Touching the warm surface can be painful and can cause fright.

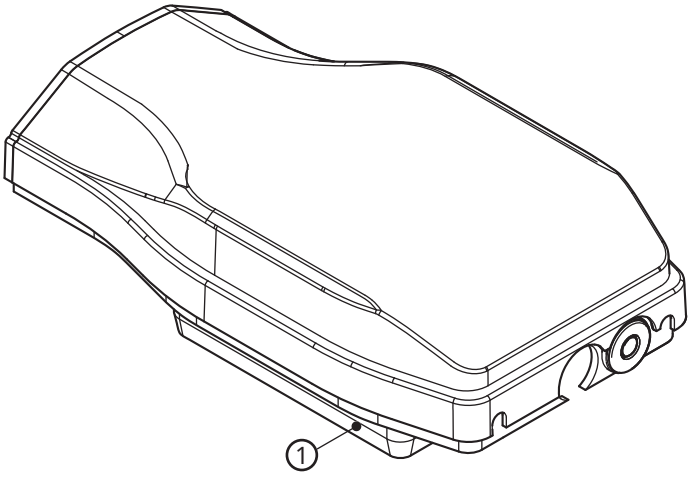
- Disconnect the device from the power supply and allow it to cool down.
- Wear protective gloves.



1	Base plate	3	Sealing ring
2	Drying cartridge	4	Cover

- Remove the 3 screws holding the white cover with a Phillips Screwdriver (PH1 tip).
- Remove the 6 screws holding the aluminum base plate.
- Replace the used drying cartridge with a new one using a wrench 13 mm (½").
- Ensure that the black rubber gasket is properly in place.
- Fasten the cover and the base plate with the screws.

8.3 Replacing filter of CNF4



1 Filter

- Pull the filter with the cover from the ventilation unit.
- Replace the filter.
- Click the cover back on the ventilation unit.

9 Troubleshooting

9.1 Error elimination

If the instrument does not work properly and the problem is not clear, perform an "upside-down test" as follows:

- ✓ Indoor:
  A lamp is available as a source of solar and far infrared radiation.
- ✓ Outdoor:
  - The elevation of the sun is more than 45 degrees above the horizon.
  - Weather conditions are stable and cloudless.
- ▸ Measure the output in the normal position.
- ▸ Record the measured values when the signals have stabilized, i.e. after about 3 minutes.
- ▸ Rotate the instrument 180 degrees, so that the upper and the lower sensors are now in the reverse orientation as to the previous position.
- ▸ Measure the output again.
- ▸ Record the measured values when the instrument has stabilized.
- ⇨ The calculated radiation for the sensors in the rotated position must be equal in magnitude, differing only in sign. In a rough test such as this, deviations of ±10 % can be tolerated.

9.2 Testing the pyranometer

1st test

- ▸ Check the sensor impedance.
- ⇨ The sensor impedance has a nominal value between 20 and 200 Ohm. Zero, or infinite resistance indicates a failure in hardware connection.

2nd test

- ▸ Let the pyranometer rest for at least 5 minutes to let it regain its thermal equilibrium.
- ▸ Set a voltmeter to its most sensitive range setting.
- ▸ Darken the sensor.
- ⇨ After about 1 minute, the signal reads zero.

Small deviations from zero are possible; this is caused by thermal effects like touching the pyranometer with hand. Another cause might be the zero offset of the data logger. When this is the case, the same offset will also be present when the data logger is short-circuited with a 200 Ohm resistor. This is an amplifier error from the data logger. This amplifier error should not be largerthan 5 Watts per square meter. If the amplifier error is within specifications, proceed with the third test.

3rd test

- ▸ Expose the sensor to light.
  - ⇨ The signal is a positive reading.
- ▸ Set the voltmeter range in such a way that the expected full-scale output of the pyranometer is within the full-scale input range of the voltmeter.

The range can be estimated on theoretical considerations. When the maximum expected radiation is 1500 Watts per square metre, which is roughly equal to normal outdoor daylight conditions, and the sensitivity of the pyranometer is 15 µV per Watt per square metre, the expected output range of the pyranometer is 1500 times 15 which is equal to 22 500 µV, or 0.0225 Volts. The radiation intensity can be calculated by dividing the pyranometer output (0.0225 Volts) by the calibration factor (0.000015 Volt per watt per square metre).

9.3 Testing the pyrgeometer

It is assumed that the data logger (amplifier) circuit is the same as the one used for pyranometer, and that its zerooffset is no more than a few watts per square metre, e.g. 5 Watts per square metre. The CNR 4 body and ambient air should be at the same temperature as much as possible.

- Let the pyrgeometer rest for at least 5 minutes to regain its thermal equilibrium.
- Set the voltmeter to its most sensitive range.
- To test if the pyrgeometer is working properly, put a hand in front of the pyrgeometer.

⇨ The pyrgeometer generates a positive voltage when the hand's surface temperature is higher than the pyrgeometer temperature.

⇨ The pyrgeometer generates a negative voltage if the hand is colder.

The signal is proportional to the temperature difference. The radiation that is emitted by the hand can be calculated by dividing the pyrgeometer output by the calibration factor, and subsequently correcting for the temperature. For the equation refer to the Instruction Sheet.

9.4 Testing the Pt-100

- Check the operation of the Pt-100 with a resistance meter.
- Measure the resistance on two opposite wires of the Pt-100.
  - ⇨ The value should be above 100 Ohms. The cable resistance should measure about 0.1 Ohms per metre cable.
- When in doubt, check the thermistor resistance (temperature) for reference.

9.5 Testing the thermistor

- Check the operation of the thermistor with a resistance meter.
- Measure the resistance on two opposite wires of the thermistor.
  - ⇨ The value should be around 10 000 Ohms for 25 °C. The cable resistance should measure about 0.1 Ohms per metre cable.
- When in doubt, check the Pt-100 resistance (temperature) for reference.

9.6 Testing the heater

Test the heater of the optional CNF4 ventilation as follows:

- Check the operation of the heating resistor with a resistance meter.
  - ⇨ The value should be around 15 Ohm. The cable resistance should measure about 0.1 Ohms per metre cable.
- Check the operation of the heater with a resistance meter.
- Measure the resistance on two opposite wires of the heater. This includes the cable resistance for the standard 10-meter cable.

⇨ The cable resistance should measure about 0.1 Ohms per metre cable.

⇨ An infinite resistance reading indicates the likelihood of a broken wire, or cable.

9.7 Testing the ventilator

Test the ventilator of the optional CNF4 ventilation unit as follows:

- ▸ Check the impedance of the ventilator motor.

⇨ The value should be around 30 Ohms. The cable resistance should measure about 0.1 Ohms per metre cable.

In this case a correct value is measured this does not guarantee proper operation. It is possible the ventilation unit is stalled by an object blocking the ventilator.

- ▸ To check for blockages, remove the cover and filter and inspect the ventilator rotation by hand.

10 Repair

10.1 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

11 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.

12 Technical data

12.1 Optical and electrical data

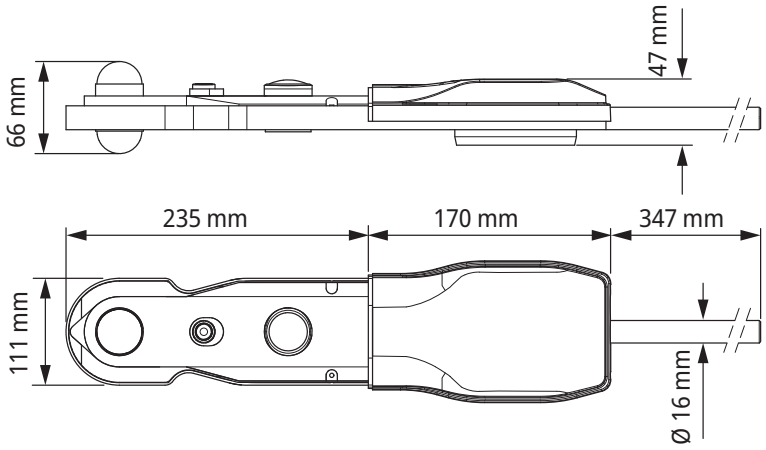
CNR4 net radiometer

Specification	Value
Number of signal outputs	4 - incoming and reflected short-wave radiation downward and upward long-wave radiation
Pyrgeometer temperature sensors	10 K thermistor and Pt-100
Response time (95 %)	< 18 s
Non-linearity (over full range)	< 1 %
Temperature dependence of sensitivity (-10 °C to +40 °C)	< 4 %
Sensitivity	7 to 20 µV/W/m^2 short-wave 5 to 10 µV/W/m^2 long-wave
Tilt error	< 1 %
Bubble level sensitivity	< 0.5° (bubble half inside ring)
Operating temperature	-40 °C to +80 °C
Humidity range	0 to 100 %
Spectral range (50 % points)	0.3 to 2.8 µm (300 to 2800 nm) short-wave 4.5 to 42 µm (4500 to 42000 nm) long-wave
Field of view	180° short-wave upper sensor 170° short-wave lower sensor 180° long-wave upper sensor 150° long-wave lower sensor
Protection rating	IP67

CNF4 ventilation unit

Specification	Value
Power supply	12 V DC, 1.25 A (with heater on)
Ventilation power	5 W continuously
Heating power	10 W externally switched
Voltage	8 to 13.5 V DC
Operating temperature	-40 °C to +80 °C

12.2 Dimensions and weight



CNR4 net radiometer with CNF4 ventilation unit

Specification	CNR4	CNF4
Mounting rod	Screw-in, 350 mm long x 16 mm Ø	–
Weight	850 g (with rod)	500 g

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Contact Information