INSTRUCTION MANUAL

CNR2 Net Radiometer

Revision: 5/10

Warranty and Assistance

The **CNR2 NET RADIOMETER** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

For all returns, the customer must fill out a "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from our website at www.campbellsci.com/repair. A completed form must be either emailed to repair@campbellsci.com or faxed to 435-750-9579. Campbell Scientific will not process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

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CNR2 Net Radiometer

1. General Description

The CNR2 Net Radiometer is intended for the analysis of the radiation balance of short-wave and long-wave infrared radiation. The most common application is the measurement of total net radiation at the earth's surface.

The CNR2 design is such that both the upward facing and the downward-facing instruments measure the energy that is received from the hemisphere. The short-wave sensor, or pyranometer, has a field of view of 180 degrees on the upper and 150 degrees on the lower detector. The long wave sensor, or pyrgeometer, has a field of view of 150 degrees on the upper and the lower detector. The output is expressed in Watts per square meter. The total spectral range that is measured is roughly from 0.3 to 40 micrometers. This spectral range covers both the solar radiation, 0.3 to 2.8 micrometers, and the far infrared radiation, 4.5 to 42 micrometers.

The design of the CNR2 is such that short-wave radiation and long-wave radiation are measured separately. Short-wave radiation is measured by two pyranometers, one for measuring incoming short-wave radiation from the sky, and the other, which faces downward, for measuring the reflected short-wave radiation. The final result from these two pyranometers is net short-wave radiation.

Long-waveradiation is measured by two pyrgeometers, one for measuring the long-wave radiation from the sky, the other from the soil surface. Net long-wave radiation is a final result of measurements from those two detectors.

Additional information on the CNR2 sensor can be found in the Kipp & Zonen CNR2 Manual. The primary intent of this manual is to provide information on interfacing the CNR2 to Campbell Scientific dataloggers.

2. Sensor Specifications

2.1 CNR2 Specifications

Response time:	<10s
Temperature dependence of sensitivity (-10°C to +40°C):	<5%
Sensor asymmetry:	<5%
Sensitivities:	10 to 20 $\mu V/W/m^2$
Sensitivity change per year:	<1%
Tilt error:	<1%
Uncertainty in daily total:	<10%
Cable length:	Customer’s choice from 3 to 100 ft. (Recommended are 50, 75, and 100 ft)
Weight:	250 g (add about 300g for each 30ft of cable)

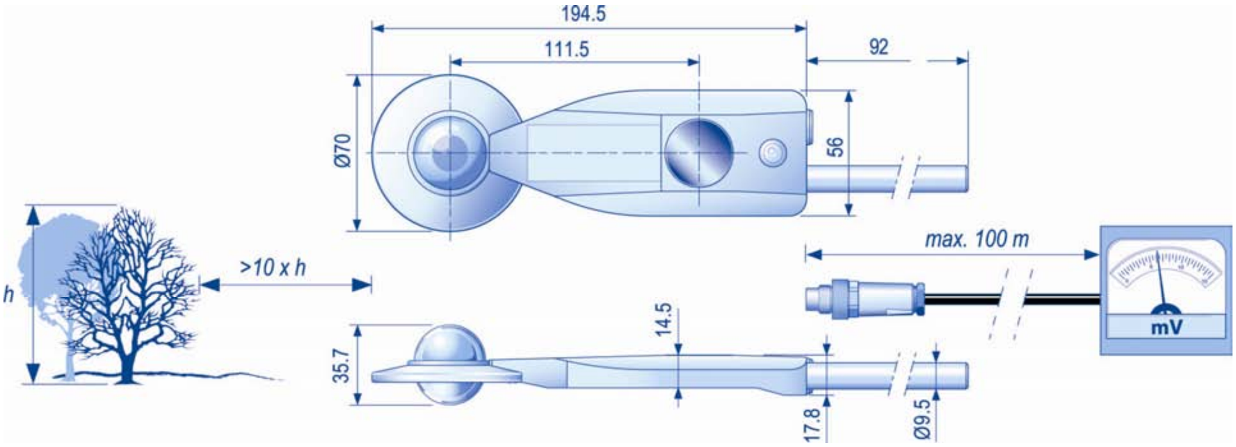

FIGURE 2-1. The Dimensions of the CNR2

2.2 Pyranometer Specifications

Spectral range:	310 to 2800 nm
Zero offset: Type A; 200 W/m^2 FIR	<15 W/m^2
Field of view for upper detector:	180°
Field of view for lower detector:	150°
Directional error:	<20 W m^{-2}
Non-linearity (0-1000 W m^{-2}) net irradiance:	<2.0%

2.3 Pyrgeometer Specifications

Spectral range:	4.5 to 42 µm
Field of view of upper detector:	150°
Field of view of lower detector:	150°
Non-linearity (-250 to +250 W m^{-2}) net irradiance:	<1%

3. Installation

For measurement of the net radiation, it is important that the instrument is located in a place that is representative of the entire study region.

Install the CNR2 such that no shadow is cast on the net radiometer at any time during the day. In the Northern Hemisphere, mount the CNR2 south of the mast. In the Southern Hemisphere, mount the CNR2 north of the mast (see Figure 3-1).

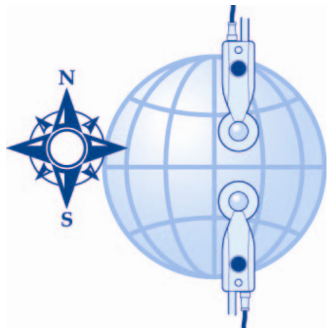

FIGURE 3-1. Mounting According to Hemisphere

Mount the CNR2 at a height of at least 1.5 meters above the surface to avoid the shading effects of the instruments on the soil and to promote spatial averaging of the measurement. If the instrument is H meters above the surface, 99% of the input of the lower sensors comes from a circular area with a radius of 10 H. Shadows or surface disturbances with radius <0.1 H will affect the measurement by less than 1%.

The 26120 mounting bracket kit is used to attach the CNR2 directly to a vertical pole or to a CM202, CM204, or CM206 crossarm.

NOTE A 26127 mounting rod is required to attach the CNR2 to a pole or crossarm via the 26120 mounting kit. The 26127 mounting rod began shipping with the CNR2 in February 2010. This mounting rod will need to be purchased if the CNR2 was shipped prior to February 2010.

Mount the sensor as follows:

1. Screw the 26127 mounting rod into the base of the CNR2.

2. Attach the 26120 mounting bracket to the pole or crossarm, using the kit's U-bolts (see Figure 3-2).

3. Insert the 26127 mounting rod into the mounting block of the 26120 mounting bracket kit. Make sure the sensor points in the direction of the arrows that appear after the word "SENSOR" on top of the bracket (see Figure 3-2). Perform a coarse leveling of the sensor using the bubble level on the top of the CNR2, and tighten the four screws on top of the mounting bracket to properly secure the mounting rod so that it does not rotate.

NOTE Do not attempt to rotate the instrument using the sensor heads, or you may damage the sensor; use the mounting rod only.

4. Perform the fine leveling using the two spring-loaded leveling screws: one on the front and the other on the back of the bracket.

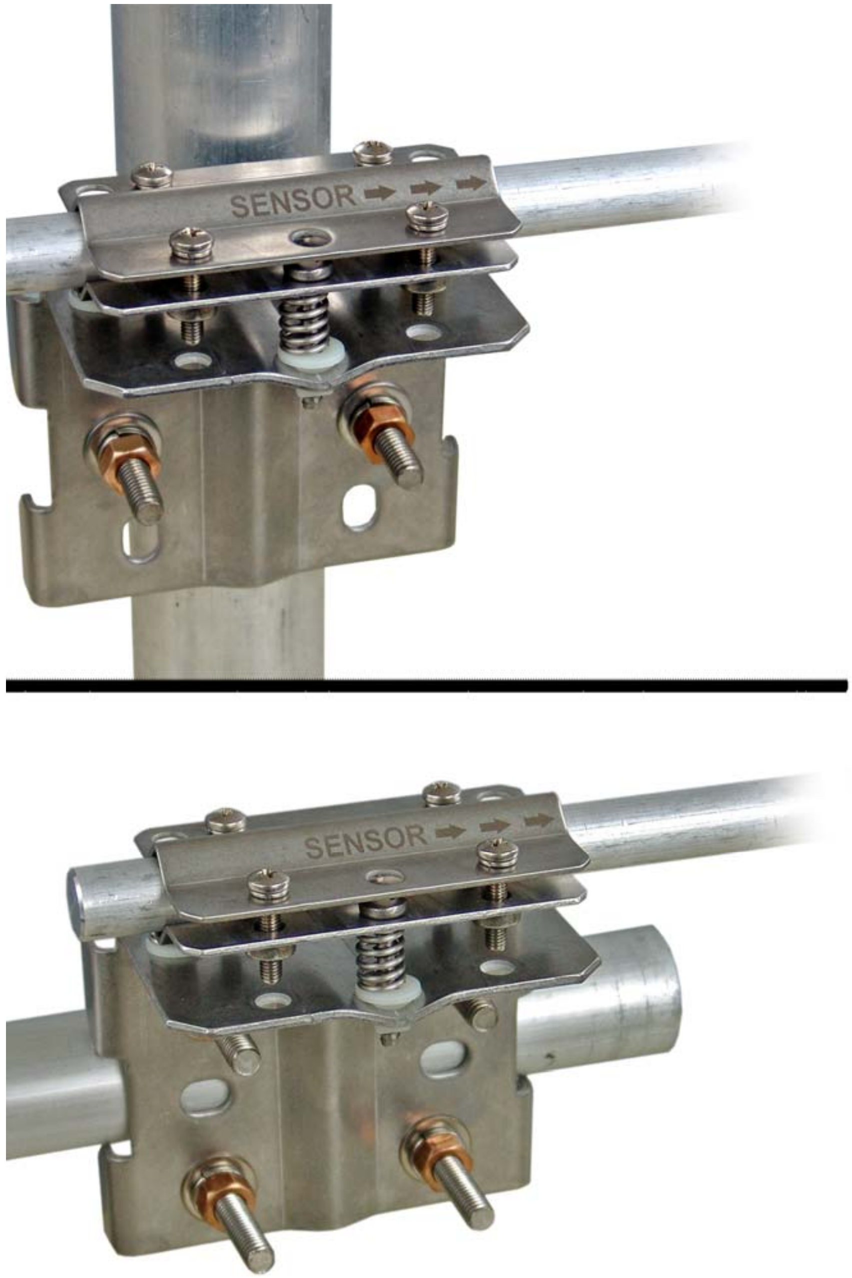

FIGURE 3-2. The CNR2 mounted to a pole (top) and crossarm (bottom) via the 26120 Mounting Bracket Kit.

For installation in buildings or in solar energy applications, users will often have to mount the CNR2 parallel to the surface that is being studied. This may be in a tilted or a vertical position. The sensitivity of the radiometers will be affected, but only in a minor way. This is specified as the so-called tilt effect. From the specifications, notice that the tilt effect (this is change in sensitivity) remains within 1%.

4. Using the CNR2 in the Two Separate Components Mode (2SCM)

The two pyranometers will measure the short-wave radiation (incoming from the sky and reflected from the soil surface); the two pyrgeometers will measure the long-wave radiation (incoming from the sky and reflected from the soil surface). However, only one output for short-wave radiation (net short-wave) and one output for long-wave radiation (net long-wave) will be given as a result of the CNR2 measurements.

4.1 Measuring Solar Radiation with the Pyranometers

The upward-facing pyranometer measures incoming short-wave (global or solar) radiation. The downward-facing pyranometer measures the reflected short-wave (solar) radiation. When the final output of the net solar radiation is made by the sensor, the reflected radiation is subtracted from the global radiation.

To find the net short-wave radiation, divide the measured short-wave output from the sensor by its sensitivity.

$$E_{NETSW} = \frac{U_{SW}}{S_{SW}} \qquad (4.1)$$

Where, E_{NETSW} is the net short-wave radiation in W m^{-2}
U_{SW} is output voltage in μV

S_{SW} is sensitivity in $\frac{\mu V}{W/m^2}$

4.2 Measuring Far Infrared Radiation with the Pyrgeometers

The upward-facing pyrgeometer measures the far infrared radiation from the sky. The downward-facing pyrgeometer measures the far infrared radiation that is emitted by the ground.

The long-wave infrared signal output is the difference between incoming and outgoing infrared radiation.

To find the net long-wave radiation, divide the measured long-wave output from the sensor by its sensitivity.

$$E_{NETLW} = \frac{U_{LW}}{S_{LW}} W/m^2 \qquad (4.2)$$

Where, E_{NETLW} is the net long-wave radiation in W m^{-2}
U_{LW} is output voltage in μV

S_{LW} is sensitivity in $\frac{\mu V}{W/m^2}$