NR-LITE2

Net Radiometer

RELIABLE
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MONITORING

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1. Introduction

The NR-LITE2 is a high-output thermopile sensor that measures the algebraic sum of incoming and outgoing all-wave radiation (both short-wave and long-wave components). Incoming radiation consists of direct (beam) and diffuse solar radiation plus long-wave irradiance from the sky. Outgoing radiation consists of reflected solar radiation plus the terrestrial long-wave component.

The NR-LITE2 is equipped with PTFE-coated (polytetrafluoroethylene) sensor surfaces. This results in a robust design which provides easy maintenance and good sensor stability. However, this design is slightly less accurate than the more traditional radiometers which use plastic domes.

> **NOTE:**
> This manual provides information only for CRBasic data loggers. For retired Edlog data logger support, see an older manual at www.campbellsci.com/old-manuals☑.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Although the NR-LITE2 is rugged, it is also a highly precise scientific instrument and should be handled as such.
- Care should be taken when opening the shipping package to not damage or cut the cable jacket. If damage to the cable is suspected, contact Campbell Scientific.
- When installing the NR-LITE2, use only the support arm to rotate the NR-LITE2. Using the sensor head to rotate the instrument may damage it.

3. Initial inspection

- Upon receipt of the NR-LITE2, inspect the packaging and contents for damage. File damage claims with the shipping company.

- The model number and cable length are printed on a label at the connection end of the cable. Check this information against the shipping documents to ensure the correct product and cable length are received.
- Refer to the Ships with list to ensure that parts are included (see Ships with (p. 2)).

3.1 Ships with

(1) WRR traceable calibration certificate

(1) Mounting arm from original manufacturer

(1) Bird stick from original manufacturer

4. QuickStart

> **NOTE:**
> The *Short Cut* example provided here is for no wind speed correction. *Short Cut* also supports dynamic wind speed correction; refer to the *Short Cut Help* for more information.

A video that describes data logger programming using *Short Cut* is available at: www.campbellsci.com/videos/cr1000x-datalogger-getting-started-program-part-3 ▶. *Short Cut* is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. *Short Cut* is available as a download on www.campbellsci.com ↗. It is included in installations of *LoggerNet*, *RTDAQ*, or *PC400*.

The following procedure also shows using *Short Cut* to program the NR-LITE2.

1. Open *Short Cut* and click **Create New Program**.
2. Double-click the data logger model.

3. In the **Available Sensors and Devices** box, type NR-LITE2 or find the sensor in the **Sensors** > **Meteorological** > **Solar Radiation** folder. Double-click **NR-LITE2 Net Radiometer (no wind correction)**. Enter the calibration factor supplied on the manufacturer certificate of calibration; this calibration factor is unique to each sensor.
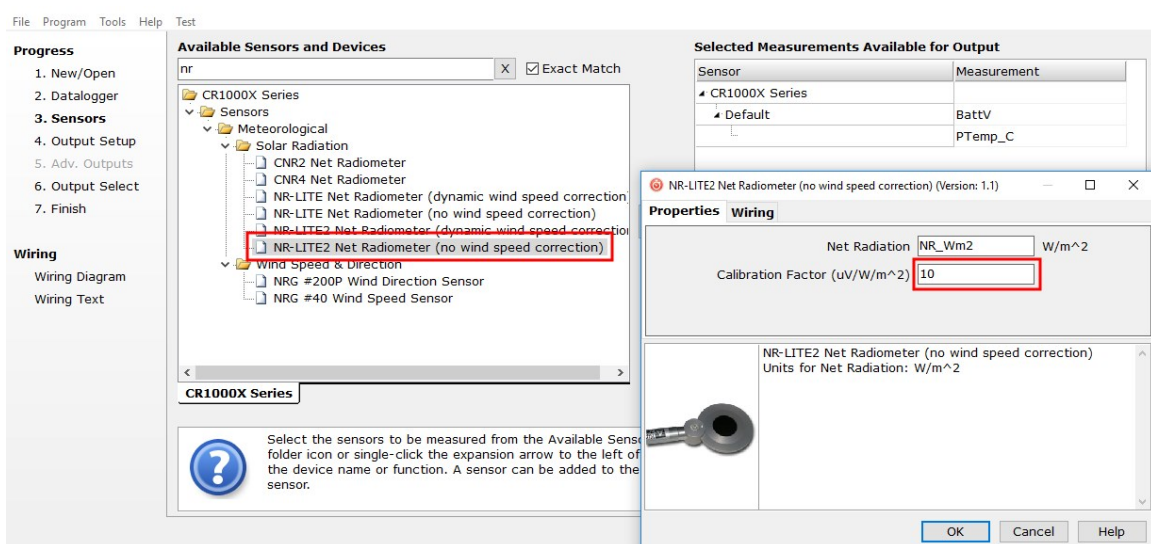
4. Click the **Wiring** tab. Click **OK** after wiring the sensor.
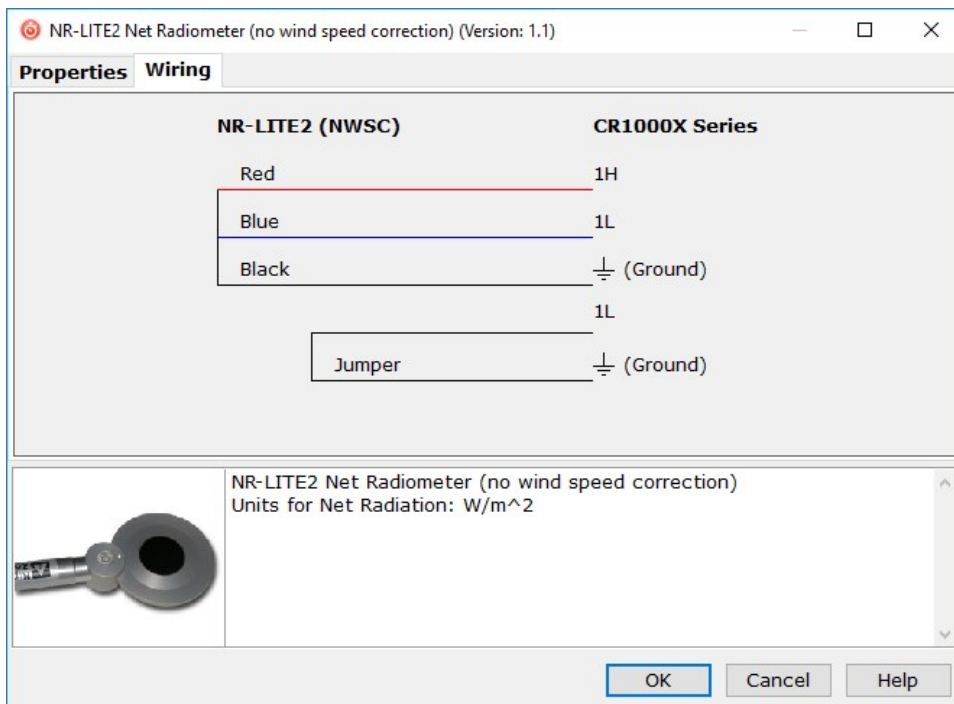
5. Repeat steps three and four for other sensors you want to measure. Click **Next**.

6. In **Output Setup**, type the scan rate, a meaningful **Table Name**, and **Data Output Storage Interval**. Click **Next**.
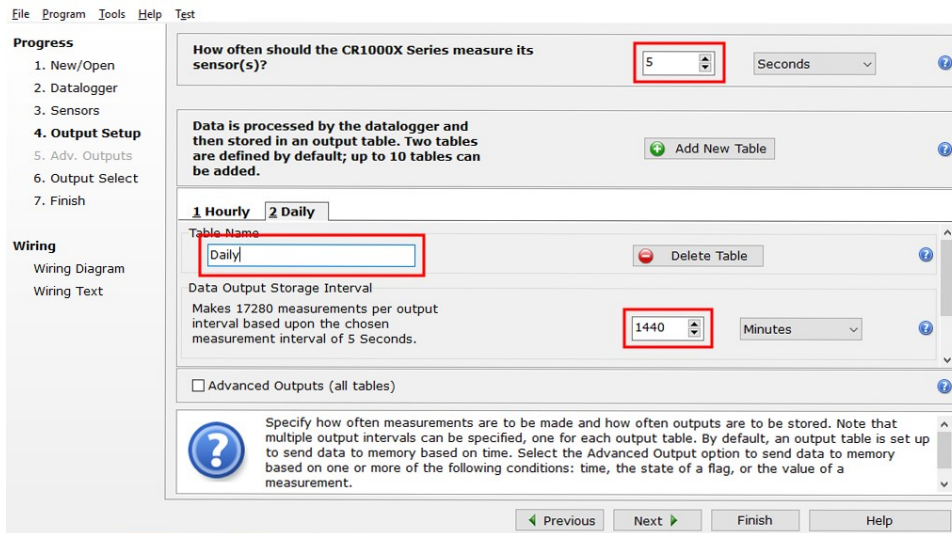
7. Select the output options.
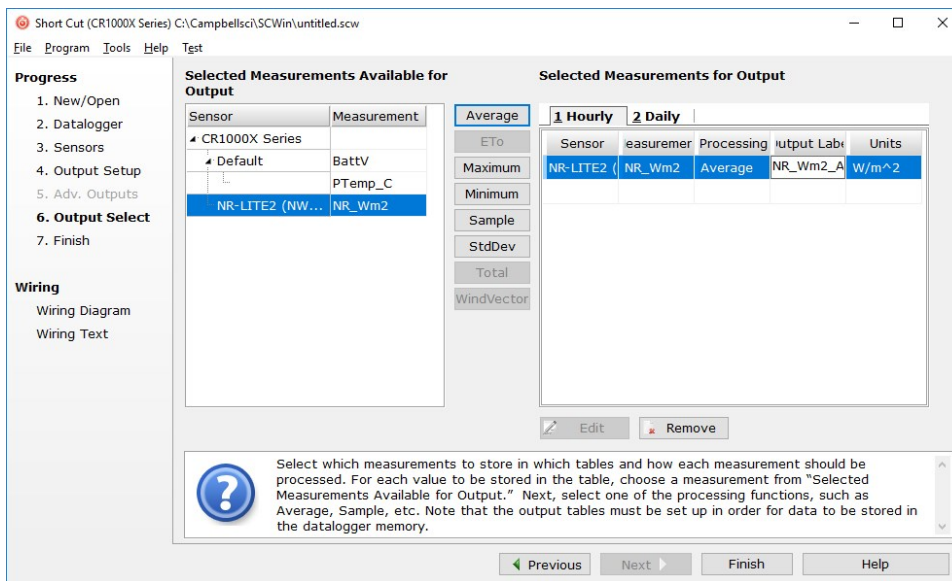
8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.

9. If the sensor is connected to the data logger, check the output of the sensor in the data logger support software data display in *LoggerNet*, *RTDAQ*, or *PC400* to make sure it is making reasonable measurements.

5. Overview

The NR-LITE2 is used for measuring solar and far infrared radiation balance. This balance is known as the net (total) radiation. Its upwards facing sensor measures the solar energy and far infrared energy that is received from the entire hemisphere (180° field of view). Its downwards facing sensor measures the energy received from the surface of the soil. The two readings are automatically subtracted and the result converted to a single output signal. This output represents the net radiation (which can be interpreted as meaning the radiative energy that is seen at the surface) and is expressed in Watts per square meter (W/m^2).

The NR-LITE2 is designed for continuous outside use. The sensor surfaces are coated with PTFE. This ensures sensor stability, long life, and easy maintenance compared to the more usual radiometers fitted with plastic domes. However, it does have some disadvantages, particularly a higher sensitivity to wind speed with a subsequent lessening of accuracy. It is, though, possible to correct for the wind speed sensitivity if the sensor is installed in a system where wind speed is also being measured.

Although net radiometers are usually used in meteorology to measure radiation balance, the NR-LITE2 can also be used to measure indoor climate radiative stress.

The NR-LITE2 is manufactured by Kipp & Zonen, but cabled for use with Campbell Scientific data loggers.

Features:

- Integrated bubble level ensures proper installation
- Includes rod that deters birds from roosting on the radiometer
- PTFE-coated absorbers are weather resistant without using a fragile plastic dome
- Compatible with the following CRBasic data loggers: CR6 series, CR3000, CR1000X, CR800 series, CR300 series, and CR1000

6. Specifications

6.1 Spectral

Spectral range:	0.2 to 100 μm
Detector type:	Thermopile
Detector protection:	PTFE coating
Detector profile:	Conical

6.2 Directional

Directional error (0 to 60 °C at 1000 W/m^2):	< 30 W/m^2
Sensor asymmetry:	±5% typical, (±10% worst case)

6.3 Mechanical

Housing material:	Anodized aluminum
Cable material:	Polyurethane
Sensor weight:	200 g (7 oz)

Physical dimensions (FIGURE 6-1 (p. 7)

Sensor:	8.0 cm (3.1 in) diameter
Support arm:	1.6 cm (0.6 in) diameter x 80 cm (31.5 in) L
Support arm weight:	635 g (23 oz)
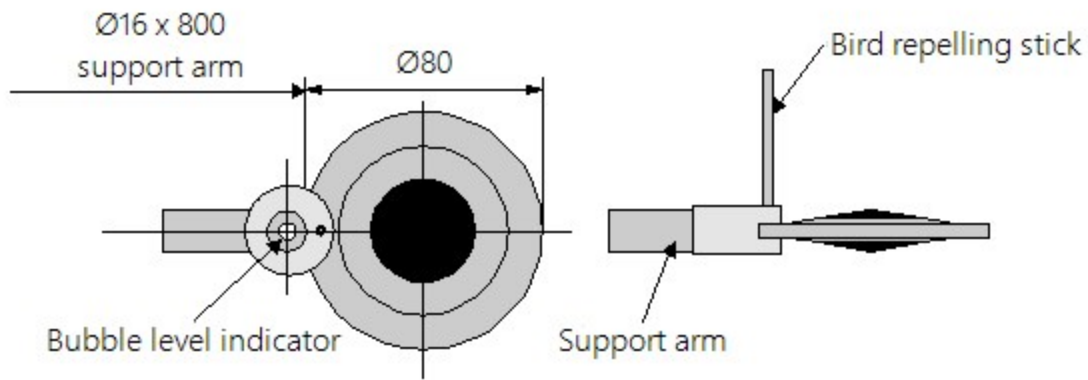
FIGURE 6-1. NR-LITE2 components and dimensions (in millimeters)

6.4 Environmental

Operating temperature: –40 to 80 °C

Temperature dependence: 0.12% per °C

7. Installation

If you are programming your data logger with *Short Cut*, skip Wiring (p. 10) and Data logger programming (p. 11). *Short Cut* does this work for you. See QuickStart (p. 2) for a *Short Cut* tutorial.

7.1 Siting considerations

1. Mount the sensor so no shadows or reflections will be cast on it at any time of day from obstructions such as trees, buildings, or the mast or structure on which it is mounted (1 in FIGURE 7-1 (p. 8)).

2. To avoid shading or reflection effects and to promote spatial averaging, the NR-LITE2 should be mounted at least 1.5 m above the ground or crop surface. It is recommended that the NR-LITE2 be mounted to a separate vertical pipe at least 25 ft from any other mounting structures (2 in FIGURE 7-1 (p. 8)).

3. Orient the sensor towards the nearest pole to avoid potential problems from shading (3 in FIGURE 7-1 (p. 8)).
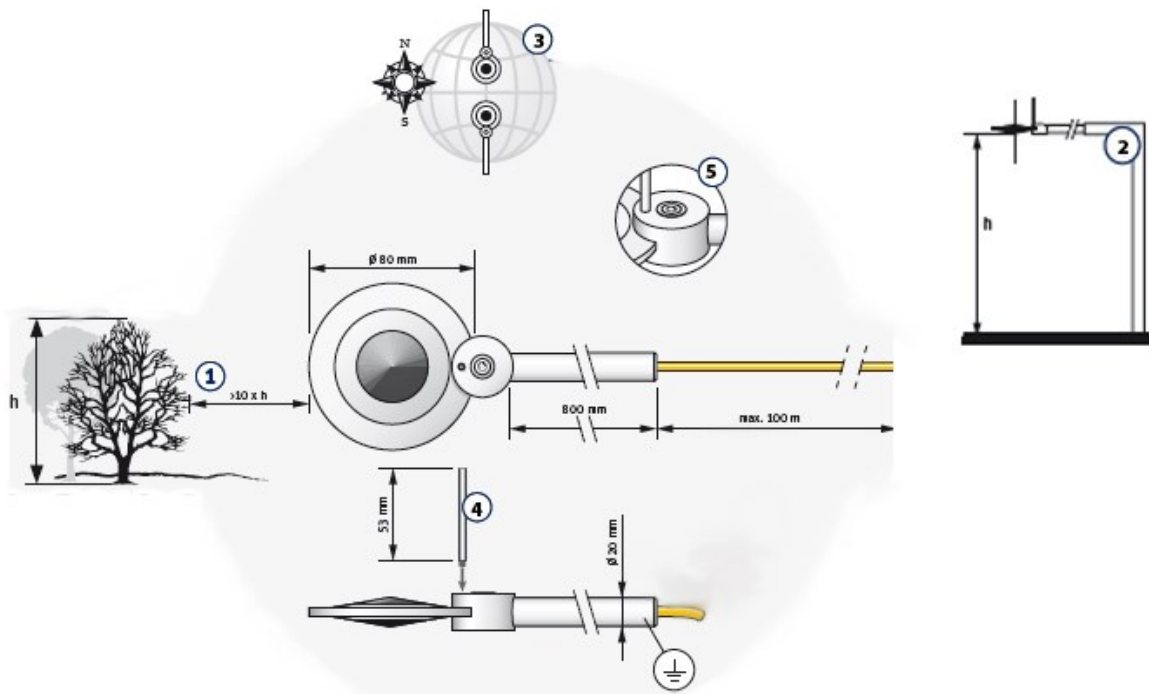
FIGURE 7-1. Siting and mounting diagram for the NR-LITE2

7.2 Mounting

The Net Radiation Sensor Mounting Kit is used to mount the NR-LITE2 directly to a vertical pipe, or to a CM200-series crossarm. If mounting the sensor to a vertical pipe, ensure that no reflections from the pipe are cast on to the sensor. Mount the sensor as follows:

1. Screw in the bird repellent stick, which is shipped with the calibration documentation (4 in FIGURE 7-1 (p. 8)).

2. Attach the mounting bracket to the vertical mounting pipe, or CM200-series crossarm using the provided U-bolt (see FIGURE 7-2 (p. 9)).
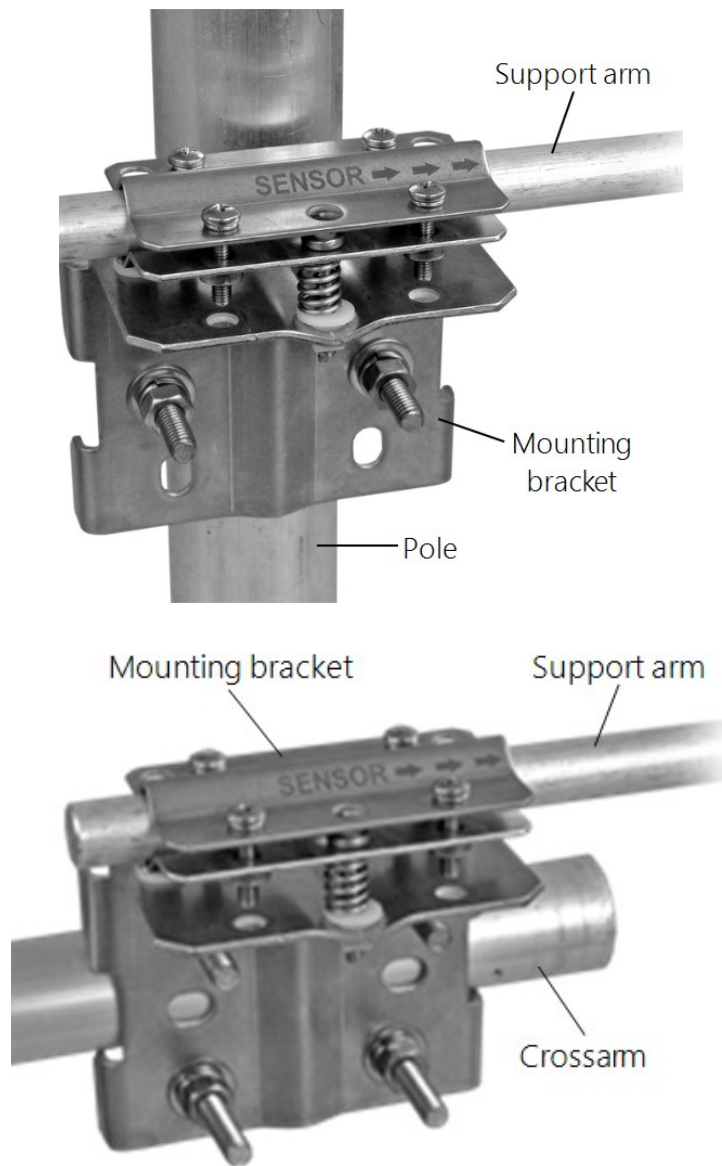
FIGURE 7-2. Mounting the NR-LITE2 onto a pole (top) and crossarm (bottom) via the Net Radiation Sensor Mounting Kit

3. Insert the sensor support arm into the mounting block of the 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 7-2 (p. 9)).

4. Perform a coarse leveling of the sensor using the sensor bubble level (FIGURE 7-1 (p. 8)).

5. Tighten the four screws on top of the mounting bracket to properly secure the support arm so that it does not rotate (see FIGURE 7-2 (p. 9)).

> **CAUTION:**
> Do not attempt to rotate the instrument using the sensor head or you may damage the sensor — use the support arm only.

6. 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 7-2 (p. 9)).

7. Route the sensor cable to the instrument enclosure.

8. Use cable ties to secure the cable to the vertical pipe or crossarm and tripod/tower.

7.3 Wiring

The NR-LITE2 can be measured with a differential or single-ended terminal on the data logger; a differential terminal is recommended.

FIGURE 7-3 (p. 10) provides the NR-LITE2 wiring. Data logger connections are shown in Table 7-1 (p. 11).

Red	Radiation signal
Blue	Signal reference
	(User-supplied jumper wire for differential measurement only)
Black	Shield
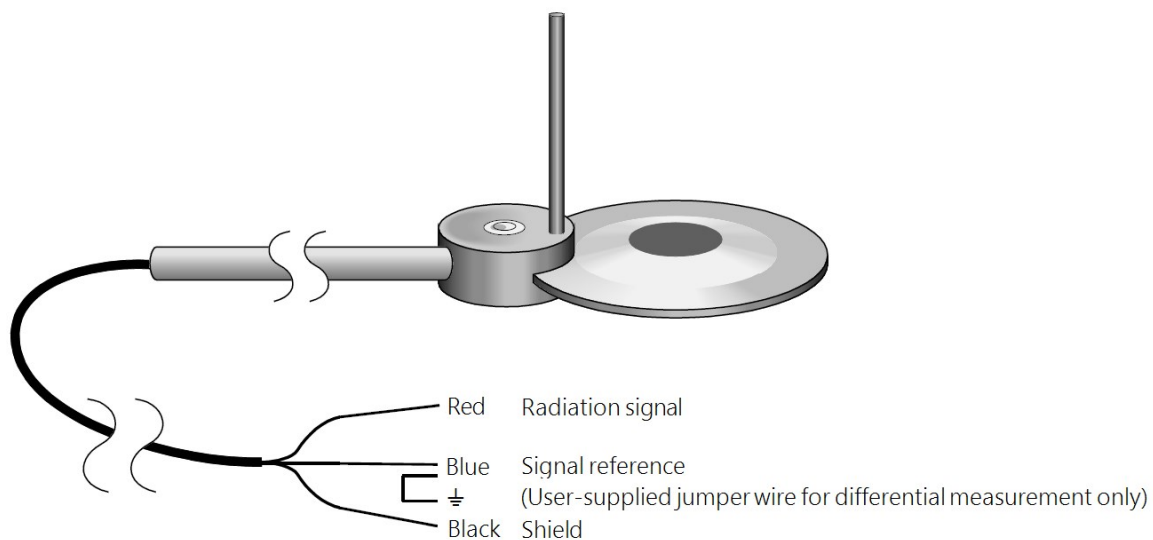
FIGURE 7-3. NR-LITE2 to data logger connections

Table 7-1: Wire color, function, and connections to the data logger			
Wire color	Function	Differential data logger terminal	Single-ended data logger terminal
Red	Radiation signal	**U** configured for differential high[1], **DIFF H** (differential high, analog-voltage input)	**U** configured for single-ended[1], **SE** (single-ended, analog-voltage input)
Blue	Signal reference	**U** configured for differential low[1,2], **DIFF L** (differential low, analog-voltage input)[2]	⏚ (analog ground)
Black	Shield	⏚ (analog ground)	⏚ (analog ground)
[1] U and C terminals are automatically configured by the measurement instruction.			
[2] Jumper to ⏚ with user-supplied wire.			

7.4 Data logger programming

Short Cut is the best source for up-to-date programming code for Campbell Scientific data loggers. If your data acquisition requirements are simple, you can probably create and maintain a data logger program exclusively with *Short Cut*. If your data acquisition needs are more complex, the files that *Short Cut* creates are a great source for programming code to start a new program or add to an existing custom program.

> NOTE:
> *Short Cut* cannot edit programs after they are imported and edited in *CRBasic Editor*.

A *Short Cut* tutorial is available in QuickStart (p. 2). If you wish to import *Short Cut* code into *CRBasic Editor* to create or add to a customized program, follow the procedure in Importing Short Cut code into CRBasic Editor (p. 18). Programming basics for CRBasic data loggers are provided in the following section. Complete program examples for select CRBasic data loggers can be found in Example programs (p. 19).

The NR-LITE2 outputs a low-level voltage ranging from 0 to a maximum of about 15 mV. A differential voltage measurement (`VoltDiff()` in CRBasic) is recommended because it has better noise rejection than a single-ended measurement. If a differential terminal is not available, a single-ended measurement can be used. The acceptability of a single-ended measurement can be determined by comparing the results of single-ended and differential measurements made under the same conditions.

7.4.1 Input range integration

Normally, the 200 mV range for the CR300-series and CR1000X, the 25 mV range for the CR800, CR850, or CR1000, and the 50 mV range for the CR3000 are suitable.

The slow or 60 Hz rejection integration or f_{N1} gives a more noise-free reading. A fast integration or f_{N1} takes less power and allows for faster throughput.

7.4.2 Calibration factor

The manufacturer provides a Certificate of Calibration with each NR-LITE2. This shows the sensor serial number and a sensitivity, or calibration factor. This calibration factor is used in the data logger program. Always cross-check to ensure that the serial number of the NR-LITE2 and the number on the calibration certificate are identical. The serial number and sensitivity are also shown on a small label attached to the connecting arm near the head of the sensor itself.

When using **Short Cut** to generate a program, you are prompted for the calibration factor. Input the factor listed on the calibration certificate directly.

Programming the data logger in the **CRBasic Editor** requires converting the calibration factor included on the Certificate of Calibration from units of µV/(W/m^2) to (W/m^2)/mV. Enter the converted number as the multiplier parameter, `Mult`, in the `VoltDiff()` or `VoltSE()` instruction (see CRBasic Example 1 (p. 20)). To convert the units, divide the calibration factor into 1000. For example, if the calibration factor is 15.8, the multiplier is:

$$\frac{1000 \; \mu V/mV}{15.8 \; \mu V/(W/m^2)} = 63.29 \; (W/m^2)/mV$$

8. Operation

8.1 Electrical properties

The thermopile consists of a number of thermocouples connected in series, essentially providing a highly sensitive differential temperature sensor. The thermopile generates a voltage output — the sensor itself is passive, and so no power supply is required.

The upwards and downwards facing sensor surfaces are connected to the upper and lower thermopile junctions respectively, allowing the sensor to measure the differential temperature (FIGURE 8-1 (p. 13)). This temperature differential can be measured to a high accuracy (on the order of 0.001 degrees), and is proportional to the net radiation.

The thermopile determines the electrical characteristics of the instrument. Both upward and downward facing sensors have a field of view of 180 degrees, and their angular characteristics conform closely to the cosine response (see following sections).

The electrical sensitivity for the thermopile changes with temperature, and no nominal sensitivity value is available.
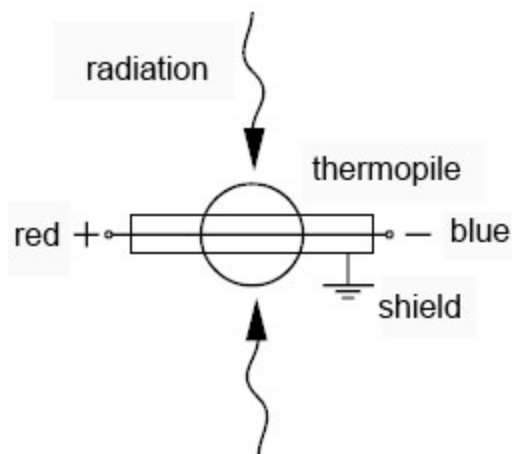
FIGURE 8-1. Electrical circuit for the NR-LITE2 Net Radiometer

8.2 Spectral properties

The upward facing sensor is calibrated for solar radiation wavelengths. The following assumptions are made:

- The downward facing sensor has the same sensitivity. However, since the two sensors may not be perfectly symmetrical, this assumption may not always be true, but differences are small.
- The NR-LITE2 sensitivity is the same for both solar and infrared radiation.

8.3 Directional/cosine response

The measurement of the radiation falling on a surface (also known as irradiance or radiative flux) is based on two assumptions:

1. The sensor surface is spectrally black — that it absorbs all radiation from all wavelengths (Spectral properties (p. 13)).
2. That it has a true field of view of 180°.

These two properties, taken together, with which the net radiometer needs to comply, are generally known as the cosine response.

A perfect cosine response will show maximum sensitivity at an angle of incidence of zero degrees (perpendicular to the sensor surface) and zero sensitivity at an angle of incidence of 90 degrees (radiation passing over the sensor surface). At any angle between 0 and 90 degrees the sensitivity should be proportional to the cosine of the angle of incidence.

FIGURE 8-2 (p. 14) shows the behavior of a typical net radiometer. The vertical axis shows the deviation from ideal behavior, expressed in percentage deviation from the ideal value.
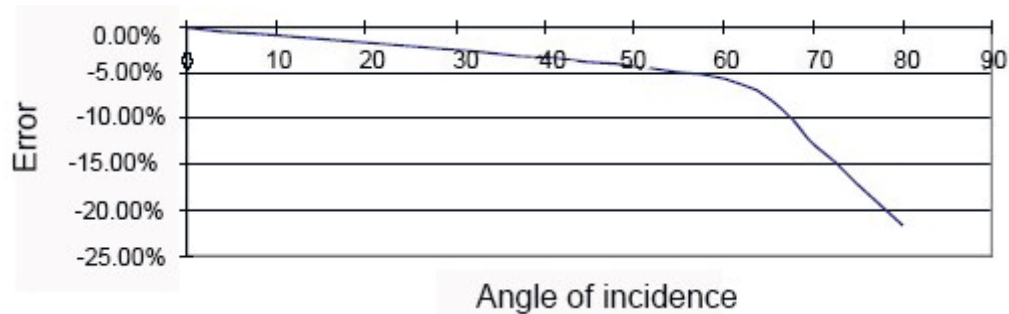
FIGURE 8-2. Cosine response of a typical net radiometer

8.4 Sensitivity to wind speed

The calibration of the NR-LITE2 is carried out at zero wind speed. At any other wind speed, the sensitivity will decrease. It has been shown that this decrease in sensitivity is less than 1% of reading per meter per second wind speed, and the effect is essentially independent of the radiation level.

Net radiation readings can be corrected for wind speed sensitivity using the following equation, which was developed by Jerry Brotzge at the Oklahoma Climate Survey:

Wind Sensitivity equation for the NR-LITE2:

$$Rn,cor = Rn,obs \qquad\qquad U < 5 \text{ m s}^{-1}$$

$$Rn,cor = Rn,obs * (1.0 + A \times (U - 5.0)) \qquad U > 5 \text{ m s}^{-1}$$

Where,

Rn,cor = Net radiation corrected for wind speed

Rn,obs = Net radiation not corrected for wind speed

U = Horizontal wind speed in m s^{-1}

A = empirical constant derived from data = 0.021286

9. Maintenance and troubleshooting

> **NOTE:**
> For all factory repairs, customers must get an RMA number. Customers must also properly fill out a "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. Refer to the Assistance page at the back of this manual for more information.

9.1 Maintenance

The radiometer requires little periodic maintenance, apart from cleaning the sensor surfaces carefully with a soft cloth using water or alcohol.

The NR-LITE2 should be recalibrated every two years (see Assistance page).

9.2 Troubleshooting

To check the instrument operation, you will need:

- NR-LITE2
- Voltmeter, range 0 to 50 mV, with an input impedance greater than 5000 Ohms
- Light source
- Table or bench

Position the radiometer so that its downward facing sensor is about 10 mm (0.4 in) above a flat surface (table or bench), and the upwards facing sensor is facing the light source (lamp). Do not touch the sensor head itself, as this will introduce thermal shocks. Hold the instrument only by its mounting arm at all times.

Do the following:

1. Connect the NR-LITE2 wires to the voltmeter. Connect the red wire to the positive terminal and the blue wire to the negative terminal.
2. Select the most sensitive range on the voltmeter.

3. With the lamp switched off, read the sensor output signal — allow a minute or so for the signal to fully stabilize.

4. Switch on the lamp. The sensor should now produce a higher positive reading.

5. Turn the lamp off again, the signal should slowly return to its original level, proving the sensor sensitivity to light.

6. Turn the sensor upside down. The signal value should reverse in sign; a +10 mV signal should become a –10 mV signal. Don't worry if the two values are not exactly the same (up to 10% difference) as the sensor profiles can vary. After completing this test, return the sensor to its original orientation and let it stabilize.

7. Put your hand over the upper sensor. Assuming that your hand is at a higher temperature than the sensor, the positive reading should increase. Conversely, if the sensor is warmer than your hand, the reading will decrease.

8. Check the radiometer's sensitivity to thermal shocks by touching the edge of the sensor (the blank metal) with your hand for several seconds. The resultant shock will result in a signal drift, or a zero offset that will take some time to settle back to zero.

9. Adjust the range of the voltmeter so that the expected full-scale output of the radiometer is about the same as the range of the voltmeter. The following calculates the maximum expected output for normal meteorological applications:

   Max. expected radiation +1500 W/m^2

   Min. radiation –200 W/m^2

   Sensitivity of the net radiometer 10 μV/(W/m^2)

   Expected output range of the radiometer is (1500 + 200) × 10 =
       1700 × 10 = 17.0 mV or 0.017 V.

If your net radiometer does not appear to be working, do the following:

1. Check the instrument sensitivity to radiation by following the procedure shown in the beginning of this section.

2. If this appears to produce no results, measure the impedance of the sensor across the red and blue wires. The impedance reading should be close to 2.3Ω. If it is virtually zero, a short circuit is indicated. If it is 'infinite', the thermopile is damaged.

If your readings are not as expected, check the following:

1. Under full sunlight, the expected radiation value is about 1000 W/m^2. Under lamps it may be greater. For indoor climate studies, smaller values are to be expected unless solar

radiation is present. A typical value for a room when facing a wall and a relatively cold window is 50 W/m^2.

2. Are you using the correct calibration factor? Note that this factor is unique for each individual sensor as noted on the calibration certificate provided with that sensor. Did you convert the factor to the correct value for the data logger program? (Data logger programming (p. 11).)

3. Check the data logger program for errors.

If you cannot resolve your problems, please contact Campbell Scientific for further advice.

Appendix A. Importing *Short Cut* code into *CRBasic Editor*

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the *CRBasic Editor*. By default, these files reside in the C:\campbellsci\SCWin folder.

Import *Short Cut* program file and wiring information into *CRBasic Editor*:

1. Create the *Short Cut* program. After saving the *Short Cut* program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > **NOTE:**
   > Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the program it created.

2. To add the *Short Cut* wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.

3. Go into the CRBasic program and paste the wiring information into it.

4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video ▶.

Appendix B. Example programs

B.1 CR3000 example program without wind speed correction

provides the wiring for the example program. In this example, the CR3000 measures the output from the sensor every 5 seconds and outputs the average net radiation every hour. The calibration factor used will only apply for one specific sensor. A new value will need to be calculated for every different sensor based on the Certificate of Calibration for that sensor ().

Table B-1: Wiring for CR3000 example		
Color	Function	CR3000 terminals
Red	Radiation signal	1H
Blue	Signal reference	1L
Jumpered to		⏚
Black	Shield	⏚

CRBasic Example 1: CR3000 example program without wind speed correction

```
'CR3000

'Declare Variables and Units
Public BattV
Public NR_Wm2

Units BattV=Volts
Units NR_Wm2=W/meter^2

'Define Data Tables
DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,NR_Wm2,FP2,False)
EndTable

DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program
BeginProg
  Scan(5,Sec,1,0)
    'Default Data Logger Battery Voltage measurement BattV
    Battery(BattV)
    'NR-LITE2 Net Radiometer (no wind speed correction) measurement NR_Wm2
    'Note that the calibration factor in the Volt_Diff instruction is
    'specific to each sensor. See Calibration factor section for details.
    VoltDiff(NR_Wm2,1,mV50,1,True,0,_60Hz,63.29,0)
    'Call Data Tables and Store Data
    CallTable(Hourly)
    CallTable(Daily)
  NextScan
EndProg
```

B.2 CR1000X example program with wind speed correction

Table B-2 (p. 21) provides the wiring for this CR1000X example program. Besides measuring the NR-LITE2, the program also measures wind speed and applies the correction factor as described in Sensitivity to wind speed (p. 14). Average net radiation and wind speed are output every hour.

Table B-2: Wiring for CR1000X example		
Color	Function	CR1000X terminals
Red	Radiation signal	2H
Blue	Signal reference	2L
Jumpered to		⏚
Black	Shield	⏚

CRBasic Example 2: CR1000X example program with wind speed correction

```
'CR1000X

'Declare Variables and Units
Public BattV
Public WS_ms
Public WindDir
Public NR_Wm2
Public CNR_Wm2

Units BattV=Volts
Units WS_ms=meters/second
Units WindDir=Degrees
Units NR_Wm2=W/m^2
Units CNR_Wm2=Watts/meter^2

'Define Data Tables
DataTable(Hourly,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,WS_ms,FP2,False)
  Sample(1,WindDir,FP2)
  Average(1,NR_Wm2,FP2,False)
  Average(1,CNR_Wm2,FP2,False)
EndTable

DataTable(Daily,True,-1)
```

```
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program
BeginProg
  Scan(5,Sec,1,0)
    'Default Data Logger Battery Voltage measurement BattV
    Battery(BattV)

    '05103 Wind Speed & Direction Sensor measurements WS_ms and WindDir
    PulseCount(WS_ms,1,P1,5,1,0.098,0)
    BrHalf(WindDir,1,mV5000,1, Vx1,1,2500,True,20000,60,355,0)
    If WindDir>=360 Then WindDir=0

    'NR-LITE2 Net Radiometer (dynamic wind speed correction)
    'measurement NR_Wm2 and CNR_Wm2

    'Note that the calibration factor in the Volt_Diff instruction is
    'specific to each sensor.
    VoltDiff(NR_Wm2,1,mv200,2,True,0,60,63.29,0
    If WS_ms>=5 Then
      CNR_Wm2=NR_Wm2*(1+0.021286*(WS_ms-5))
    Else
      CNR_Wm2=NR_Wm2
    EndIf
      'Call Data Tables and Store Data
    CallTable(Hourly)
    CallTable(Daily)
  NextScan
EndProg
```

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To obtain a Returned Materials Authorization or Repair Reference number, contact your CAMPBELL SCIENTIFIC regional office. Please write the issued number clearly on the outside of the shipping container and ship as directed.

For all returns, the customer must provide a "Statement of Product Cleanliness and Decontamination" or "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from your CAMPBELL SCIENTIFIC regional office. Campbell Scientific is unable to process any returns until we receive this statement. If the statement 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.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.** FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General
- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical
- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather
- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance
- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery
- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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A worldwide network to help meet your needs

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