

INSTRUCTION MANUAL



NR-LITE2 Net Radiometer

Revision: 5/16



Copyright © 1998-2016
Campbell Scientific, Inc.

Limited Warranty

“Products manufactured by CSI are warranted by CSI to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified in the corresponding product manual. (Product manuals are available for review online at www.campbellsci.com.) Products not manufactured by CSI, but that are resold by CSI, are warranted only to the limits extended by the original manufacturer. Batteries, fine-wire thermocouples, desiccant, and other consumables have no warranty. CSI’s obligation under this warranty is limited to repairing or replacing (at CSI’s option) defective Products, which shall be the sole and exclusive remedy under this warranty. The Customer assumes all costs of removing, reinstalling, and shipping defective Products to CSI. CSI will return such Products by surface carrier prepaid within the continental United States of America. To all other locations, CSI will return such Products best way CIP (port of entry) per Incoterms ® 2010. This warranty shall not apply to any Products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for installation services performed by CSI such as programming to customer specifications, electrical connections to Products manufactured by CSI, and Product specific training, is part of CSI’s product warranty. **CSI EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CSI hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.”**

Assistance

Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit www.campbellsci.com to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. After an application 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 "Statement of Product Cleanliness 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) 227-9106. Campbell Scientific is unable to 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.

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 or by telephoning (435) 227-9000 (USA). 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

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- 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, 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.

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.

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.

Table of Contents

PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.

1. Introduction	1
2. Precautions	1
3. Initial Inspection.....	1
3.1 Ships With.....	2
4. QuickStart.....	2
4.1 Siting Considerations	2
4.2 Mounting.....	3
4.3 Short Cut Programming	4
5. Overview	7
6. Specifications.....	7
6.1 Spectral	8
6.2 Directional.....	8
6.3 Mechanical.....	8
6.4 Environmental.....	8
7. Installation.....	9
7.1 Wiring	9
7.2 Datalogger Programming	10
7.2.1 Input Range and Integration.....	10
7.2.2 Calibration Factor	11
8. Operation	11
8.1 Electrical Properties	11
8.2 Spectral Properties	12
8.3 Directional/Cosine Response	12
8.4 Sensitivity to Wind Speed.....	13
9. Maintenance	14
10. Troubleshooting.....	14
10.1 Checking Sensor Operation.....	14
10.2 Radiometer Produces No Apparent Output.....	16
10.3 Readings Are Not As Expected.....	16

Appendices

A. Importing *Short Cut Code* Into *CRBasic Editor* ... A-1

B. Example Programs B-1

- B.1 CR3000 Example Program without Wind Speed Correction B-1
- B.2 CR1000 Example Program with Wind Speed Correction B-2

Figures

- 4-1. Siting and mounting diagram for the NR-LITE2 2
- 4-2. Mounting the NR-LITE2 onto a pole (top) and crossarm (bottom) via the 26120 Mounting Kit 4
- 6-1. NR-LITE2's components and dimensions (in millimeters) 8
- 7-1. NR-LITE2 to datalogger connections 9
- 8-1. Electrical circuit for the NR-LITE2 Net Radiometer 12
- 8-2. Cosine response of a typical net radiometer 13
- 8-3. NR-LITE2 wind sensitivity 14

Tables

- 7-1. Datalogger Connections for Differential Measurement 9
- 7-2. Datalogger Connections for Single-Ended Measurement 10
- B-1. Wiring for CR3000 Example B-1
- B-2. Wiring for CR1000 Example B-2

CRBasic Examples

- B-1. CR3000 Example Program without Wind Speed Correction B-1
- B-2. CR1000 Example Program with Wind Speed Correction B-2

NR-LITE2 Net Radiometer

1. Introduction

The NR-LITE2 is a high-output thermopile sensor which 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.

Before using the NR-LITE2, please study:

- Section 2, *Precautions* (p. 1)
- Section 3, *Initial Inspection* (p. 1)
- Section 4, *QuickStart* (p. 2)

For Edlog datalogger support, check the availability of an older manual at www.campbellsci.com/old-manuals, or contact a Campbell Scientific application engineer for assistance.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front 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, consult with a Campbell Scientific applications engineer.
- 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 Section 3.1, *Ships With* (p. 2), to ensure that parts are included.

3.1 Ships With

- (1) WRR traceable calibration certificate
- (1) Mounting arm from original manufacturer
- (1) Bird stick from original manufacturer
- (1) ResourceDVD

4. QuickStart

Please review Section 7, *Installation* (p. 9), for wiring and CRBasic programming.

4.1 Siting Considerations

1. Mount the sensor so that no shadows or reflections will be cast on it at any time of day from obstructions such as trees, buildings, the mast, or structure on which it is mounted (1 in FIGURE 4-1).
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 4-1).
3. Orient the sensor towards the nearest pole to avoid potential problems from shading (3 in FIGURE 4-1).

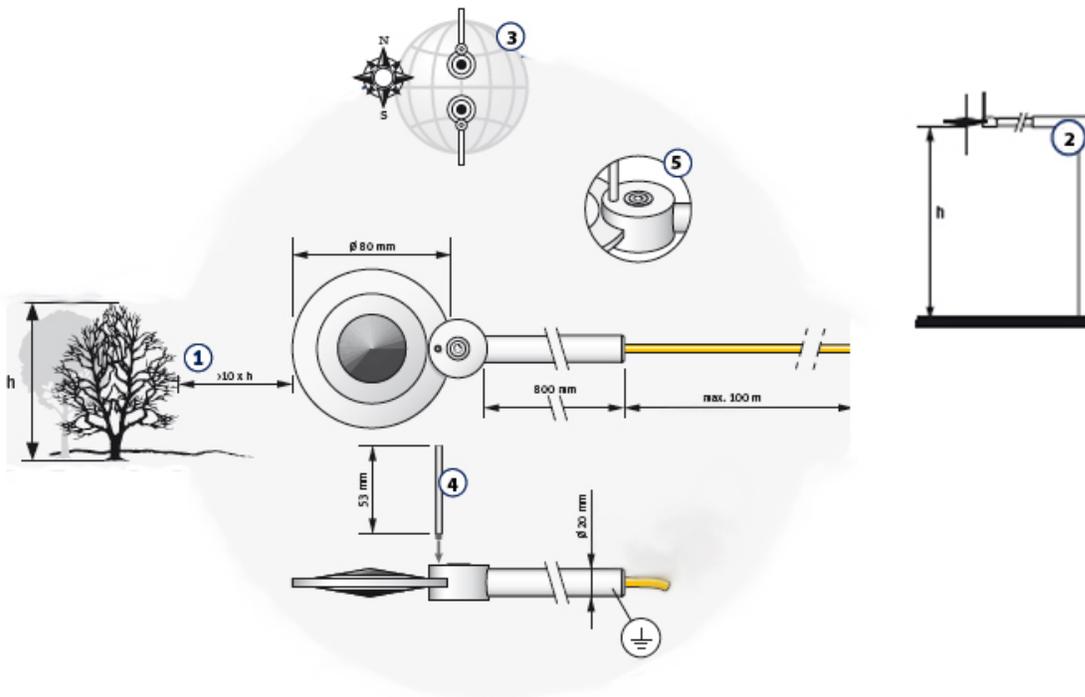


FIGURE 4-1. Siting and mounting diagram for the NR-LITE2

4.2 Mounting

The mounting bracket kit, pn 26120, 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 4-1).
2. Attach the 26120 mounting bracket to the vertical mounting pipe, or CM200-series crossarm using the provided U-bolt (FIGURE 4-2).
3. Insert the sensor's 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 (FIGURE 4-2).
4. Perform a coarse leveling of the sensor using the sensor's bubble level (5 in FIGURE 4-1).
5. Tighten the four screws on top of the mounting bracket to properly secure the support arm so that it does not rotate (FIGURE 4-2).

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 4-2).
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.

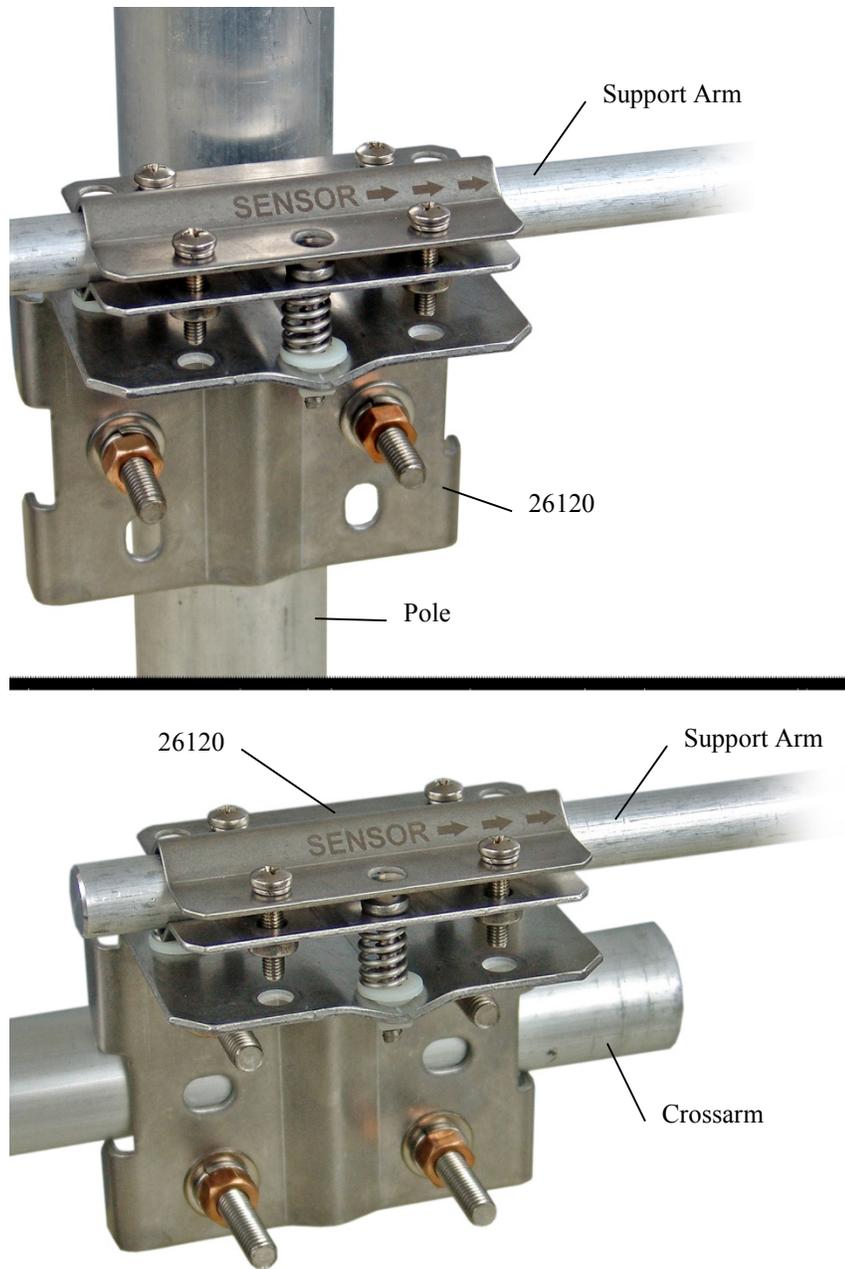


FIGURE 4-2. Mounting the NR-LITE2 onto a pole (top) and crossarm (bottom) via the 26120 Mounting Kit

4.3 Short Cut Programming

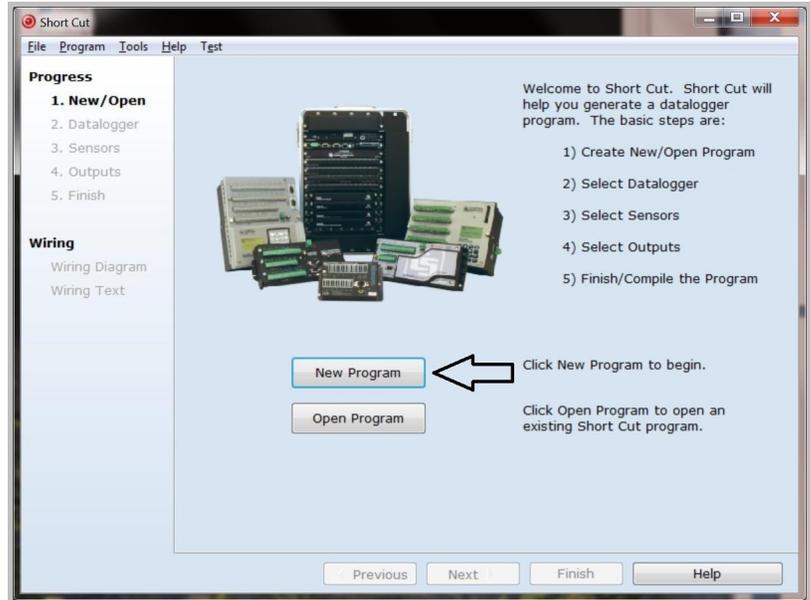
NOTE The *Short Cut* example provided here is for no wind speed correction. *Short Cut* also supports dynamic wind speed correction; refer to the *Short Cut Help* for more information.

Short Cut is an easy way to program your datalogger to measure the pyranometer and assign wiring terminals. *Short Cut* is available as a download

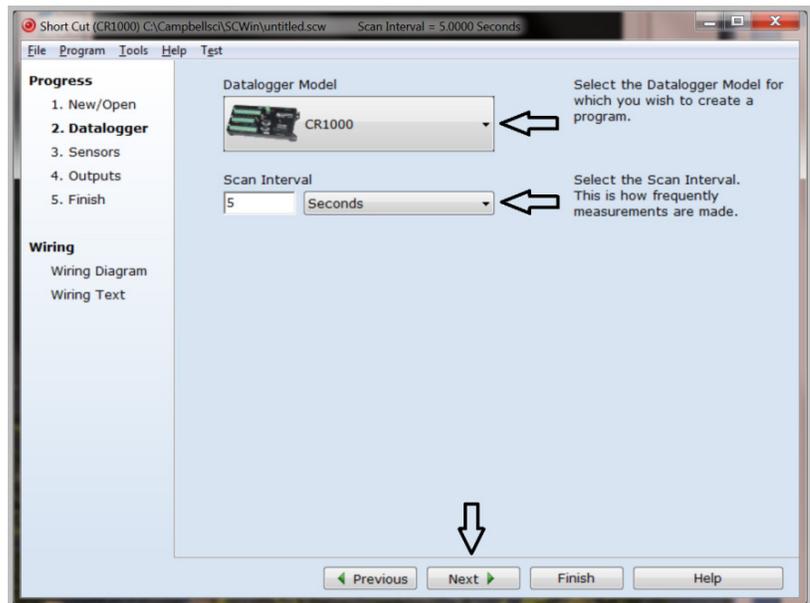
on www.campbellsci.com and the *ResourceDVD*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

Use the following procedure to get started.

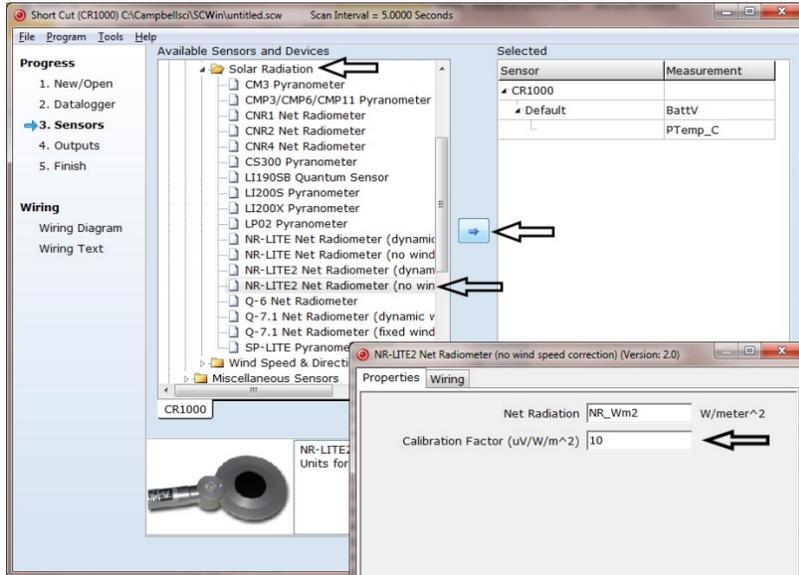
1. Open *Short Cut*. Click **New Program**.



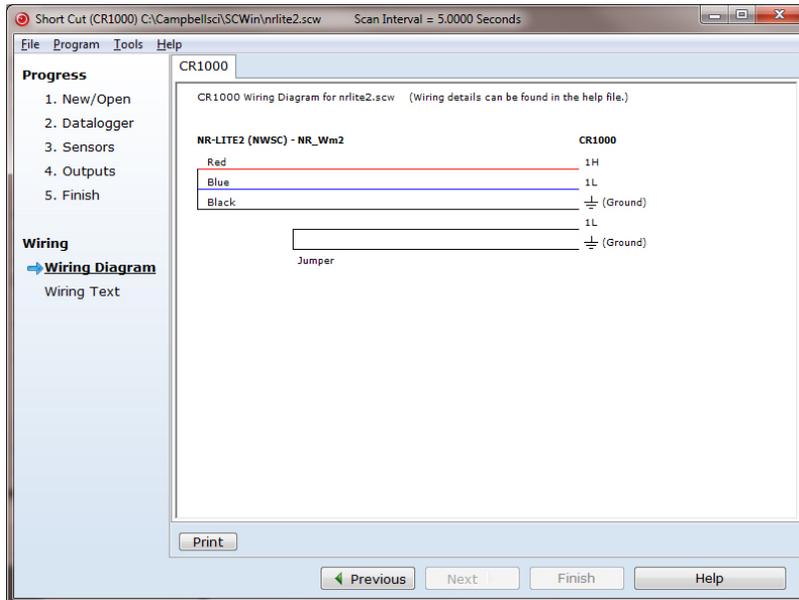
2. Select **Datalogger Model** and **Scan Interval** (default of 5 seconds is OK for most applications). Click **Next**.



- Under the **Available Sensors and Devices** list, select **Sensors | Meteorological | Solar Radiation** folder. Select **NR-LITE2 Net Radiometer (no wind correction)**. Click  to move the selection to the **Selected** device window. Enter the calibration factor supplied on the manufacturer's certificate of calibration; this calibration factor is unique to each sensor. The public variable defaults to **NR_Wm2**. After entering the information, click on **OK**, and then select **Next**.



- After selecting the sensitivity values, click **Wiring Diagram** to see how the sensor is to be wired to the datalogger. The wiring diagram can be printed out now or after more sensors are added.



5. Select any other sensors you have, then finish the remaining *Short Cut* steps to complete the program. The remaining steps are outlined in *Short Cut Help*, which is accessed by clicking on **Help | Contents | Programming Steps**.
6. If *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* is running on your PC, and the PC to datalogger connection is active, you can click **Finish** in *Short Cut* and you will be prompted to send the program just created to the datalogger.
7. If the sensor is connected to the datalogger, as shown in the wiring diagram in step 4, check the output of the sensor in the datalogger support software data display 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 dataloggers. Its cable can terminate in:

- Pigtails that connect directly to a Campbell Scientific datalogger (cable termination option –PT).
- Connector that attaches to a prewired enclosure (cable termination option –PW).

6. Specifications

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 dataloggers: CR300 series, CR6 series, CR800 series, CR1000, CR3000, CR5000, and CR9000(X)

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
Weight:	200 g
Cable length:	15 m (can be extended up to 100 m)
Physical dimensions (FIGURE 6-1)	
Sensor:	8.0 cm (3.1 in) diameter
Support arm:	1.6 cm (0.6 in) diameter x 80 cm (31.5 in) L
Weight:	635 g (23 oz)

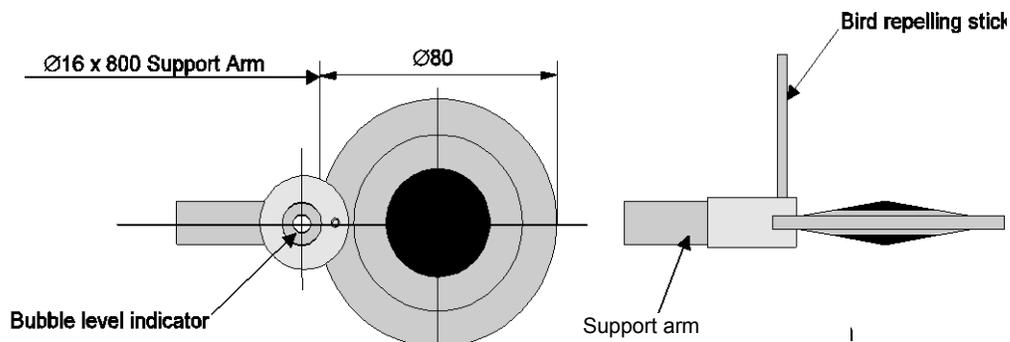


FIGURE 6-1. NR-LITE2's components and dimensions (in millimeters)

6.4 Environmental

Working temperature:	-30 to 70 °C
Temperature dependence:	0.12% per °C

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.1, *Wiring* (p. 9), and Section 7.2, *Datalogger Programming* (p. 10). *Short Cut* does this work for you. See Section 4, *QuickStart* (p. 2), for a *Short Cut* tutorial.

7.1 Wiring

The NR-LITE2 can be measured with a differential or single-ended channel on the datalogger; a differential channel is recommended.

FIGURE 7-1 provides the NR-LITE2 wiring. Datalogger connections are shown in TABLE 7-1 for differential measurements and TABLE 7-2 for single-ended measurements.

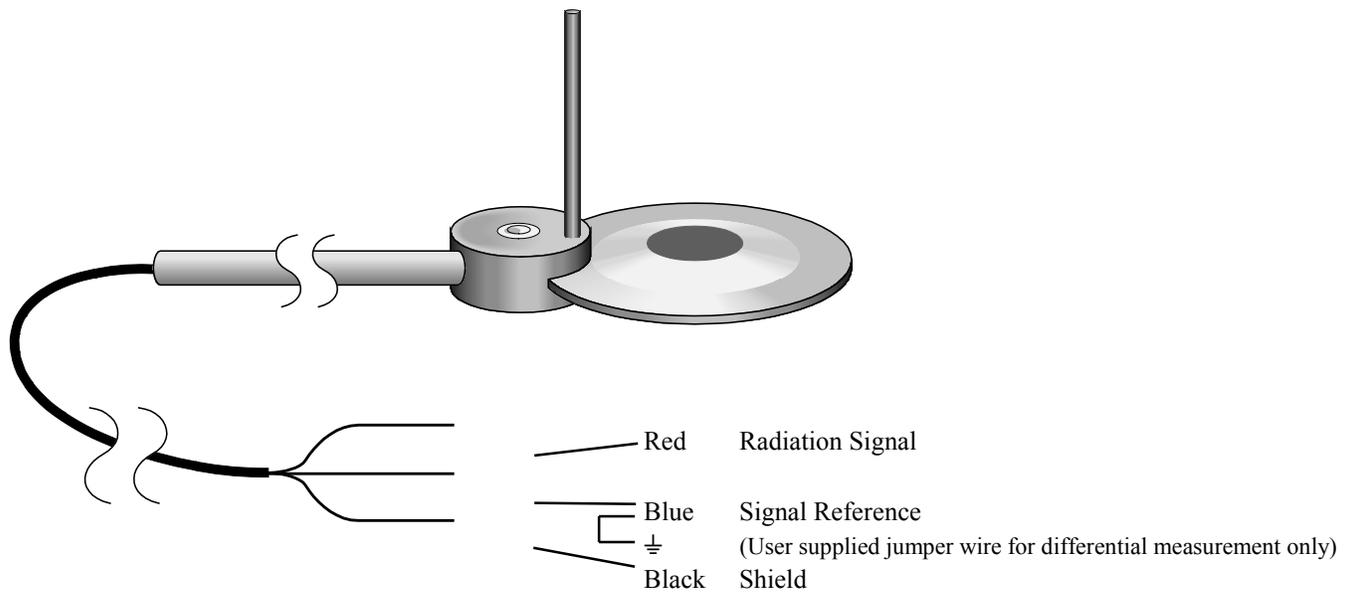


FIGURE 7-1. NR-LITE2 to datalogger connections

TABLE 7-1. Datalogger Connections for Differential Measurement		
Function	Color	CR6, CR800, CR850, CR1000, CR3000, CR5000, CR9000(X)
Radiation Signal	Red	Differential H
Signal Reference	Blue	Differential L
	Jumper to	⊥
Shield	Black	⊥

TABLE 7-2. Datalogger Connections for Single-Ended Measurement

Function	Color	CR6, CR800, CR850, CR1000, CR3000, CR5000, CR9000(X)
Radiation Signal	Red	S.E. Channel
Signal Reference	Blue	⊥
Shield	Black	⊥

7.2 Datalogger Programming

Short Cut is the best source for up-to-date datalogger programming code. Programming code is needed when,

- Creating a program for a new datalogger installation
- Adding sensors to an existing datalogger program

If your data acquisition requirements are simple, you can probably create and maintain a datalogger 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 Section 4, *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 Appendix A, *Importing Short Cut Code Into CRBasic Editor* (p. A-1). Programming basics are provided in the following section. A complete program example can be found in Appendix B, *Example Programs* (B-1).

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 channel is not available, a single-ended measurement (**VoltSE**) in *CRBasic* can be used. The acceptability of a single-ended measurement can be determined by simply comparing the results of single-ended and differential measurements made under the same conditions.

7.2.1 Input Range and Integration

Normally the 25 mV range for the CR800, CR850, or CR1000, and the 50 mV range for the CR3000, CR5000, or CR9000X are suitable.

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

7.2.2 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 datalogger 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 datalogger in the *CRBasic Editor* requires converting the calibration factor included on the Certificate of Calibration from units of $\mu\text{V}/(\text{W m}^{-2})$ to $(\text{W m}^{-2})/\text{mV}$. Enter the converted number as the multiplier parameter, **Mult**, in the **VoltDiff()** or **VoltSE()** instruction (see CRBasic Example B-1 (p. B-1)). To convert the units, divide the calibration factor into 1000. For example, if the calibration factor is 15.8, the multiplier is:

$$\frac{1000 \mu\text{V}/\text{mV}}{15.8 \mu\text{V}/(\text{Wm}^{-2})} = 63.29 (\text{Wm}^{-2})/\text{mV}$$

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). This temperature differential can be measured to a high accuracy (in the order of 0.001 degrees), and is proportional to the net radiation.

The thermopile determines the electrical characteristics of the instrument. Both upper and lower 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.

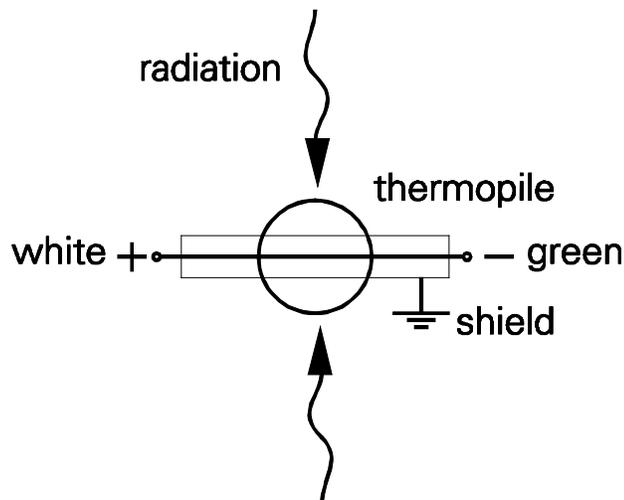


FIGURE 8-1. Electrical circuit for the NR-LITE2 Net Radiometer

8.2 Spectral Properties

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

- The downwards 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's 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 (Section 8.2, *Spectral Properties* (p. 12)).
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 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:

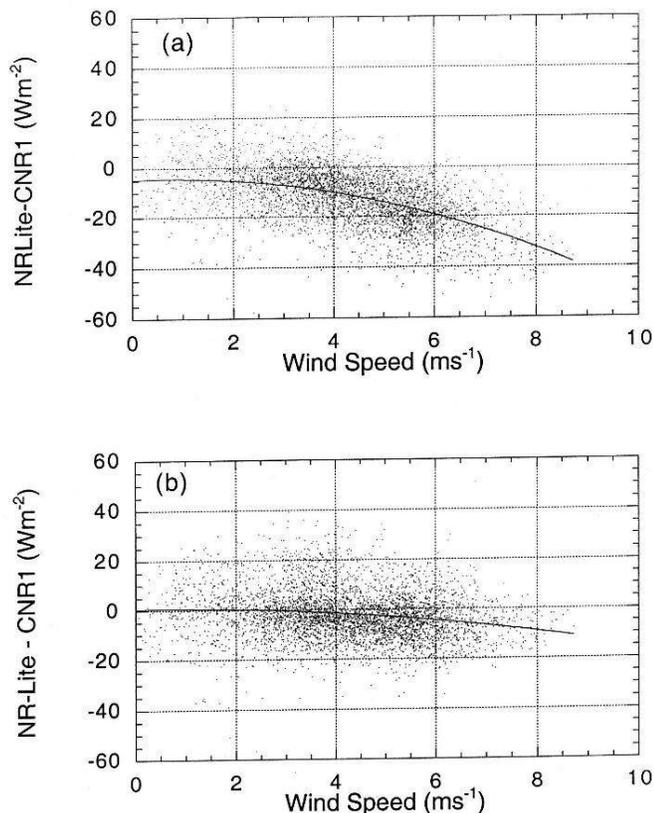
Wind Sensitivity equation for the NR-LITE2:

$$\begin{aligned} R_{n,cor} &= R_{n,obs} & U < 5 \text{ m s}^{-1} \\ R_{n,cor} &= R_{n,obs} * (1.0 + A * (U - 5.0)) & U > 5 \text{ m s}^{-1} \end{aligned}$$

Where,

$R_{n,cor}$ = Net radiation corrected for wind speed
 $R_{n,obs}$ = Net radiation not corrected for wind speed
 U = Horizontal wind speed in m s^{-1}
 A = empirical constant derived from data = 0.021286

FIGURE 8-3 provides scatter plots showing the wind sensitivity for both the NR-LITE2 and CNR1 net radiometer models.



Differences between the NR-Lite and CNR1 as a function of wind speed for daytime conditions during 7 May – 6 June, 1998. (a) No correction. (b) Eq. (4) applied as a correction.

FIGURE 8-3. NR-LITE2 wind sensitivity

9. Maintenance

The radiometer is an ‘all weather’ instrument and is very stable, but should be handled with care. It 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. An RMA number is required before returning the sensor for recalibration; refer to the [Assistance](#) section in the beginning of this manual for more information.

10. Troubleshooting

10.1 Checking Sensor Operation

To effectively check the instrument’s 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.

Follow the procedure outlined below:

1. Connect the NR-LITE2 wires to the voltmeter. Connect the red wire to the positive lead and the blue wire to the negative lead.
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, when the signal should slowly return to its original level, proving the sensor's 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 some 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. A (theoretical) way to calculate the maximum expected output for normal meteorological applications is shown below:

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.

10.2 Radiometer Produces No Apparent Output

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

1. Check the instrument's sensitivity to radiation, following the procedure shown in Section 10.1, *Checking Sensor Operation* (p. 14).
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 blown.

10.3 Readings Are Not As Expected

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 datalogger program? (Section 7.2, *Datalogger Programming* (p. 10).)
3. Check the datalogger 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

This tutorial shows the following:

- How to import a *Short Cut* program into a program editor for additional refinement
- How to import a wiring diagram from *Short Cut* into the comments of a custom program

Short Cut creates files, which can be imported into *CRBasic Editor*. Assuming defaults were used when *Short Cut* was installed, these files reside in the C:\campbellsci\SCWin folder:

- .DEF (wiring and memory usage information)
- .CR300 (CR300-series datalogger code)
- .CR6 (CR6-series datalogger code)
- .CR8 (CR800-series datalogger code)
- .CR1 (CR1000 datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)
- .CR9 (CR9000(X) datalogger code)

Use the following procedure to import *Short Cut* code and wiring diagram into *CRBasic Editor*.

1. Create the *Short Cut* program following the procedure in Section 4, *QuickStart* (p. 2). Finish the program and exit *Short Cut*. Make note of the file name used when saving the *Short Cut* program.
2. Open *CRBasic Editor*.
3. Click **File** | **Open**. Assuming the default paths were used when *Short Cut* was installed, navigate to C:\CampbellSci\SCWin folder. The file of interest has the .CR300, .CR6, .CR8, .CR1, .CR3, .CR5, or .CR9 extension. Select the file and click **Open**.
4. Immediately save the file in a folder different from C:\Campbellsci\SCWin, or save the file with a different file name.

NOTE

Once the file is edited with *CRBasic Editor*, *Short Cut* can no longer be used to edit the datalogger program. Change the name of the program file or move it, or *Short Cut* may overwrite it next time it is used.

5. The program can now be edited, saved, and sent to the datalogger.
6. Import wiring information to the program by opening the associated .DEF file. Copy and paste the section beginning with heading “-Wiring for CRXXX-” into the CRBasic program, usually at the head of the file. After pasting, edit the information such that an apostrophe (') begins each line. This character instructs the datalogger compiler to ignore the line when compiling.

Appendix B. Example Programs

B.1 CR3000 Example Program without Wind Speed Correction

Shown below is an example program written for the CR3000 datalogger. TABLE B-1 provides the wiring for the example program. In this example, the datalogger 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 (Section 7.2.2, *Calibration Factor* (p. 11)).

Color	Function	CR3000 Channels
Red	Radiation Signal	1H
Blue	Signal Reference	1L
Jumpered to		⊥
Black	Shield	⊥

```

CRBasic Example B-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(Table1,True,-1)
  DataInterval(0,60,Min,10)
  Average(1,NR_Wm2,FP2,False)
EndTable

DataTable(Table2,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program
BeginProg
Scan(5,Sec,1,0)
  'Default Datalogger 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 Section 7.2.2 (p. 11) for details.
  VoltDiff(NR_Wm2,1,mV50,1,True,0,_,60Hz,63.29,0)
  'Call Data Tables and Store Data
  CallTable(Table1)
  
```

```

CallTable(Table2)
NextScan
EndProg
    
```

B.2 CR1000 Example Program with Wind Speed Correction

Shown below is an example program written for the CR1000 datalogger. TABLE B-2 provides the wiring for the example program. Besides measuring the NR-LITE2, the program also measures wind speed and applies the correction factor as described in Section 8.4, *Sensitivity to Wind Speed* (p. 13). Average net radiation and wind speed are output every hour.

Color	Function	CR1000 Channels
Red	Radiation Signal	2H
Blue	Signal Reference	2L
Jumpered to		⊥
Black	Shield	⊥

CRBasic Example B-2. CR1000 Example Program with Wind Speed Correction

```

'CR1000

'Declare Variables and Units
Dim WindCor_7
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(Table1,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(Table2,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
EndTable

'Main Program
BeginProg
Scan(5,Sec,1,0)
    
```

```
'Default Datalogger Battery Voltage measurement BattV
Battery(BattV)

'05103 Wind Speed & Direction Sensor measurements WS_ms and WindDir
PulseCount(WS_ms,1,1,1,1,0.098,0)
BrHalf(WindDir,1,mV2500,1,1,1,2500,True,0,_60Hz,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. See Section 7.2.2 (p. 11) for details.
VoltDiff(NR_Wm2,1,mv25,2,True,0,_60Hz,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(Table1)
CallTable(Table2)
NextScan
EndProg
```


Campbell Scientific Companies

Campbell Scientific, Inc.

815 West 1800 North
Logan, Utah 84321
UNITED STATES

www.campbellsci.com • info@campbellsci.com

Campbell Scientific Canada Corp.

14532 – 131 Avenue NW
Edmonton AB T5L 4X4
CANADA

www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Africa Pty. Ltd.

PO Box 2450
Somerset West 7129
SOUTH AFRICA

www.campbellsci.co.za • cleroux@csafrica.co.za

Campbell Scientific Centro Caribe S.A.

300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA

www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Southeast Asia Co., Ltd.

877/22 Nirvana@Work, Rama 9 Road
Suan Luang Subdistrict, Suan Luang District
Bangkok 10250
THAILAND

www.campbellsci.asia • info@campbellsci.asia

Campbell Scientific Ltd.

Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM

www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Australia Pty. Ltd.

PO Box 8108
Garbutt Post Shop QLD 4814
AUSTRALIA

www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific Ltd.

3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE

www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific (Beijing) Co., Ltd.

8B16, Floor 8 Tower B, Hanwei Plaza
7 Guanghua Road
Chaoyang, Beijing 100004
P.R. CHINA

www.campbellsci.com • info@campbellsci.com.cn

Campbell Scientific Ltd.

Fahrenheitstraße 13
28359 Bremen
GERMANY

www.campbellsci.de • info@campbellsci.de

Campbell Scientific do Brasil Ltda.

Rua Apinagés, nbr. 2018 – Perdizes
CEP: 01258-00 – São Paulo – SP
BRASIL

www.campbellsci.com.br • vendas@campbellsci.com.br

Campbell Scientific Spain, S. L.

Avda. Pompeu Fabra 7-9, local 1
08024 Barcelona
SPAIN

www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or international representative.