INSTRUCTION MANUAL

LI200R Pyranometer

Revision: 4/18

Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. Quotations for repairs can be given on request. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.

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PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2	**Mass:**	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km	**Pressure:**	1 psi (lb/in^2) = 68.95 mb
		Volume:	1 UK pint = 568.3 ml 1 UK gallon = 4.546 litres 1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

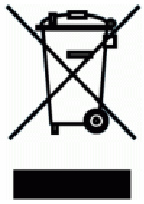
Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a "#" symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.

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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.eu or by telephoning +44(0) 1509 828 888 (UK). 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, or 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.

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CRBasic Examples

LI200R Pyranometer

1. Introduction

The LI200R pyranometer measures sun plus sky radiation. It connects directly to our dataloggers and is used extensively in solar, agricultural, and meteorological applications. The input range and multipliers vary from one pyranometer to another.

NOTE This manual provides information only for CRBasic dataloggers. For retired Edlog datalogger support, you can access a retired manual at *www.campbellsci.com/old-manuals*.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- 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.
- Although the LI200R is rugged, it should be handled as a precision scientific instrument.
- Keep the sensor clean. The vertical edge of the diffuser must be kept clean to maintain appropriate cosine correction.
- Clean the sensor only with water, mild detergent, or vinegar. Alcohol, organic solvents, abrasives, or strong detergents harm the acrylic materials, which adversely affects the cosine response of the sensor.
- The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket supports combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

3. Initial Inspection

- Upon receipt of the LI200R, 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.

3.1 Ships With

- (1) Calibration Sheet

The LI200R is also shipped with a red cap on it. Ensure that this red cap is removed after installing the sensor. Save the cap for shipping or storing the sensor.

NOTE The calibration sheet shipped with each sensor includes a serial number and calibration constant. The calibration constant is unique for each sensor, and is used to compute the multiplier for the measurement instruction in the datalogger program.

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4. QuickStart

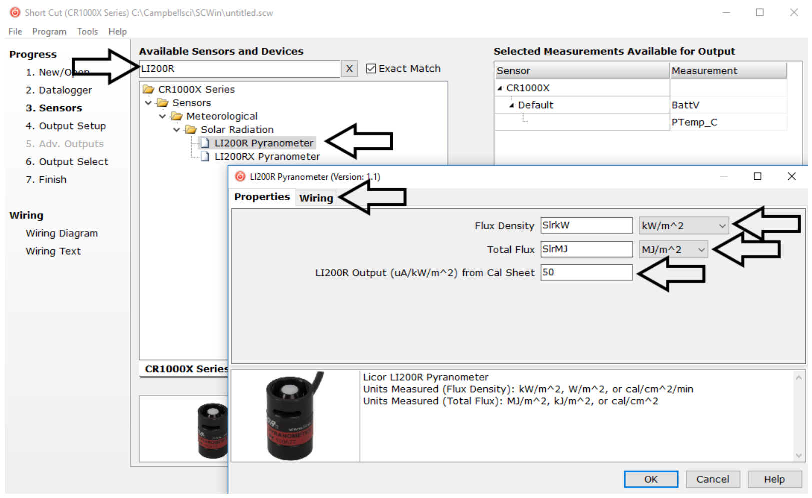
Short Cut is an easy way to program your datalogger to measure the LI200R and assign datalogger wiring terminals. *Short Cut* is available as a download on *www.campbellsci.eu*. It is included in installations of *LoggerNet*, *PC200W*, *PC400*, or *RTDAQ*.

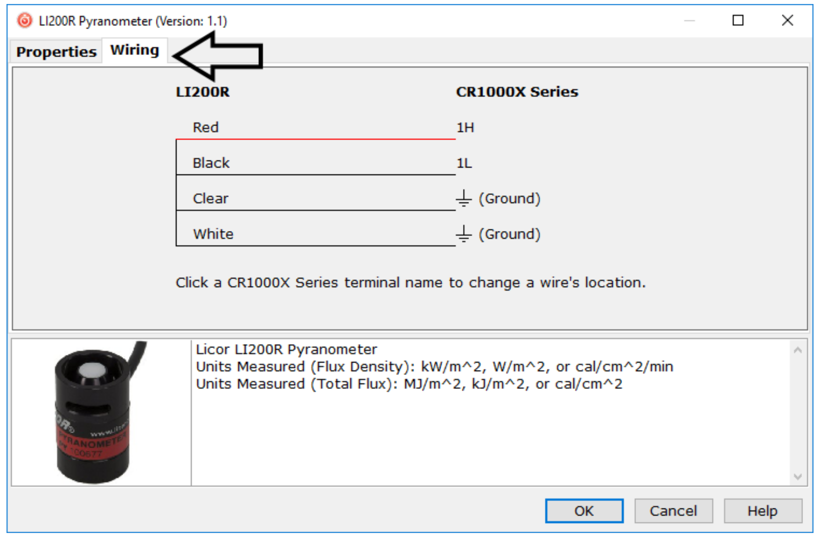
The following procedure shows using *Short Cut* to program the LI200R.

1. Open *Short Cut* and create a new program.

2. Double-click the datalogger model.

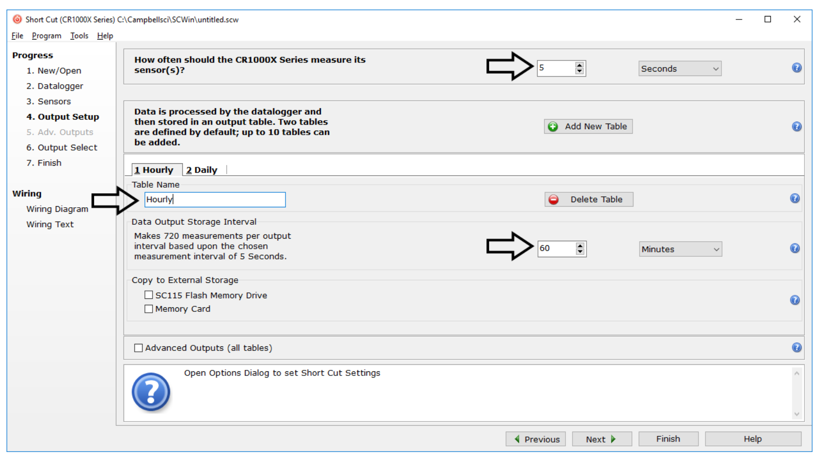
3. In the **Available Sensors and Devices** box, type **LI200R**. You can also find the sensor in the **Sensors** | **Meteorological** | **Solar Radiation** folder, and then double-click **LI200R Pyranometer**. Enter the **LI200R Output** that is provided on the calibration sheet shipped with the sensor. This value is unique to the individual sensor. The flux density defaults to kW/m^2 and the total flux defaults to MJ/m^2. To change this, click the **Flux Density** or **Total Flux** box and select another option. After entering the **Properties**, click the **Wiring** tab to see how the sensor is to be wired to the datalogger.



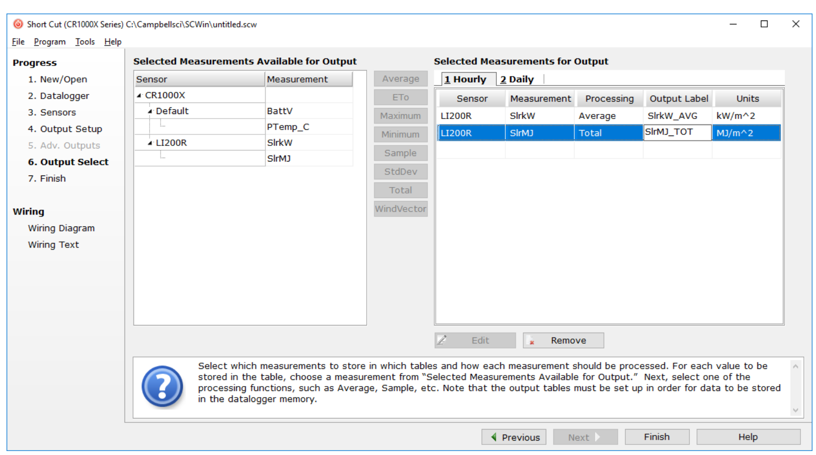


4. Repeat step three for other sensors you want to measure.

5. In **Output Setup**, type the scan rate, a meaningful table name, and the **Data Output Storage Interval**.



6. Select measurement and its associated output options.



7. Click **Finish** and save the program.

8. Send the program to the datalogger if the datalogger is connected to the computer.

9. If the sensor is connected to the datalogger, as shown in the wiring diagram, check the output of the sensor in the data display of *LoggerNet*, *PC400*, *RTDAQ*, or *PC200W* to make sure it is making reasonable measurements.

NOTE *Short Cut* uses the execution interval to make total flux calculations (Section 7.4.2, *Multiplier* (p. 11)). You need to take this into account while editing the *Short Cut* program.

5. Overview

The LI200R measures incoming solar radiation with a silicon photovoltaic detector mounted in cosine-corrected head. The detector outputs current; a shunt resistor in the sensor cable converts the signal from current to voltage, allowing the LI200R to be measured directly by Campbell Scientific dataloggers.

The LI200R is calibrated against an Eppley Precision Spectral Pyranometer to accurately measure sun plus sky radiation. Do not use the LI200R under vegetation or artificial lights because it is calibrated for the daylight spectrum (400 to 1100 nm). FIGURE 5-1 shows the pyranometer spectral response.

During the night, the LI200R may read slightly negative incoming solar radiation. This negative signal is caused by electrical noise. The datalogger program can set the negative values to zero.

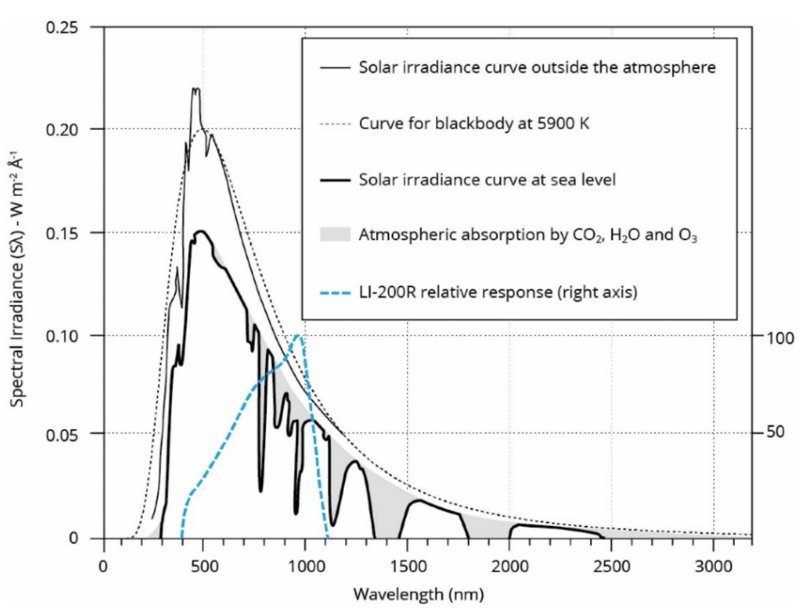


FIGURE 5-1. LI200R spectral response

The –L portion of the model number indicates that the LI200R has a user-specified cable length. Its cables can terminate in:

- Pigtails that connect directly to a Campbell Scientific datalogger (cable termination option –PT).
- Connector that attaches to a CWS900-series interface (cable termination option –CWS). Connection to a CWS900-series interface allows this sensor to be used in a wireless sensor network.

For more theoretical information on the silicon photovoltaic detector, see Kerr, J. P., G. W. Thurtell, and C. B. Tanner: 1967, "An integrating pyranometer for climatological observer stations and mesoscale networks", *J. Appl. Meteor.*, **6**, 688-694.

6. Specifications

Features:
- Calibrated for the daylight spectrum (400 to 1100 nm)
- Compatible with Campbell Scientific CRBasic dataloggers: CR300 series, CR6 series, CR800 series, CR1000, CR1000X, CR3000, CR5000, and CR9000(X)

Stability:	< ±2% change over a 1-year period
Response Time:	< 1 µs
Cosine Correction:	Cosine corrected up to 82° angle of incidence
Operating Temperature:	–40 to 65 °C
Temperature Dependence:	±0.15% per °C maximum
Relative Humidity:	0 to 100%
Detector:	High stability silicon photovoltaic detector (blue enhanced)
Sensor Housing:	Weatherproof anodized aluminium case with acrylic diffuser and stainless steel hardware; O-ring seal on the removable base and cable assembly
Diameter:	2.36 cm (0.93 in)
Height:	3.63 cm (1.43 in)
Weight:	84 g (2.96 oz)
Accuracy:	Absolute error in natural daylight is ±5% maximum; ±3% typical
Sensitivity:	Typically 0.13 kW m^{-2} mV^{-1}
Linearity:	Maximum deviation of 1% up to 3000 W m^{-2}

Shunt Resistor: 100 Ω, 1%, 50 PPM

Light Spectrum Waveband: 400 to 1100 nm

7. Installation

If you are programming your datalogger with *Short Cut*, skip Section 7.3, *Wiring* *(p. 9)*, and Section 7.4, *Programming* *(p. 10)*. *Short Cut* does this work for you. See Section 4, *QuickStart* *(p. 2)*, for a *Short Cut* tutorial.

7.1 Siting

Mount the LI200R so that no shadows or reflections are cast on it by the tripod/tower or other sensors. Mount the sensor with the cable pointing towards the nearest magnetic pole. For example, in the Northern Hemisphere, point the cable toward the North Pole.

Mounting height is not critical for the accuracy of the measurement. However, pyranometers mounted at heights of 3 m or less are easier to level and clean.

7.2 Mounting to an Instrument Mount

7.2.1 Required Tools

Tools required for installation on a tripod or tower:

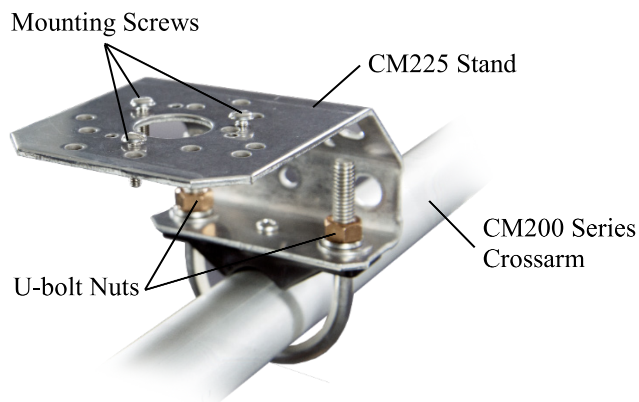
- Small and medium Phillips screwdrivers
- 1/2-inch open-end wrench for CM225 or 015ARM
- Tape measure
- UV-resistant cable ties
- Side-cut pliers
- Compass
- Step ladder

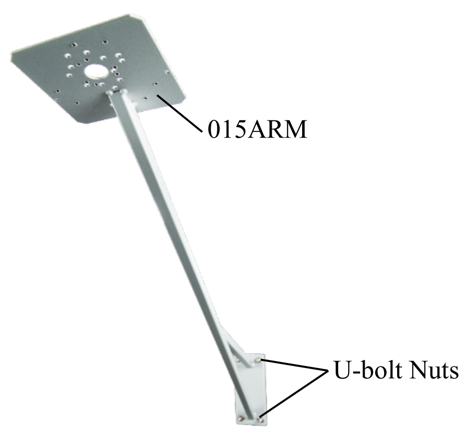
7.2.2 Mounting Procedure

CAUTION	Avoid mounting the CM225 directly to a vertical pipe. Instead, mount the CM225 to a crossarm. This avoids reflections from the vertical pipe onto the sensor.

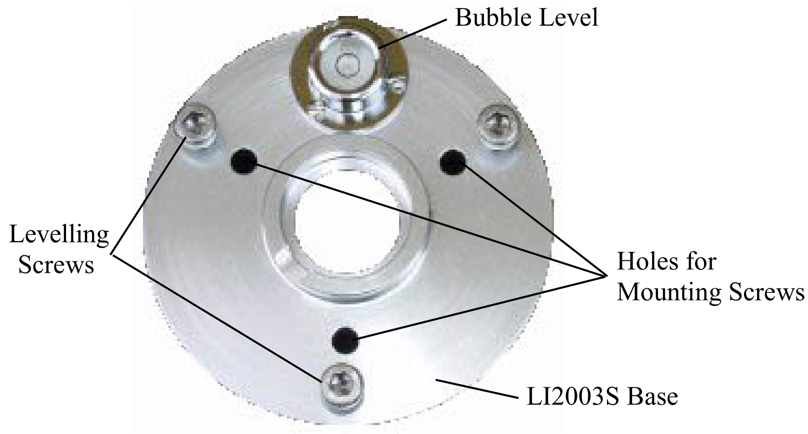
1. Mount the crossarm to the tripod or the tower if using a CM225.

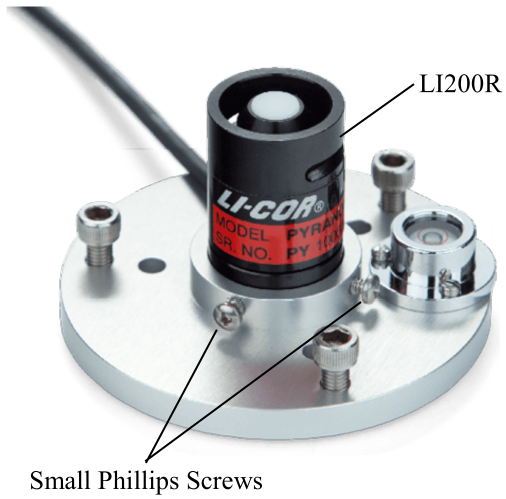
2. Secure the CM225 to the crossarm by placing the CM225 U-bolt in the bottom holes and tightening the nuts. Secure the 015ARM to the mast by tightening the U-bolt nuts.



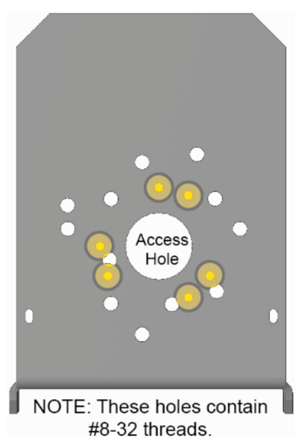


3. Place the LI200R in the centre of the LI2003S base/levelling fixture. Secure the LI200R to the LI2003S by tightening the small Phillips screws.





4. Loosely mount the LI2003S and LI200R on the CM225 or 015ARM. Do not fully tighten the three mounting screws.



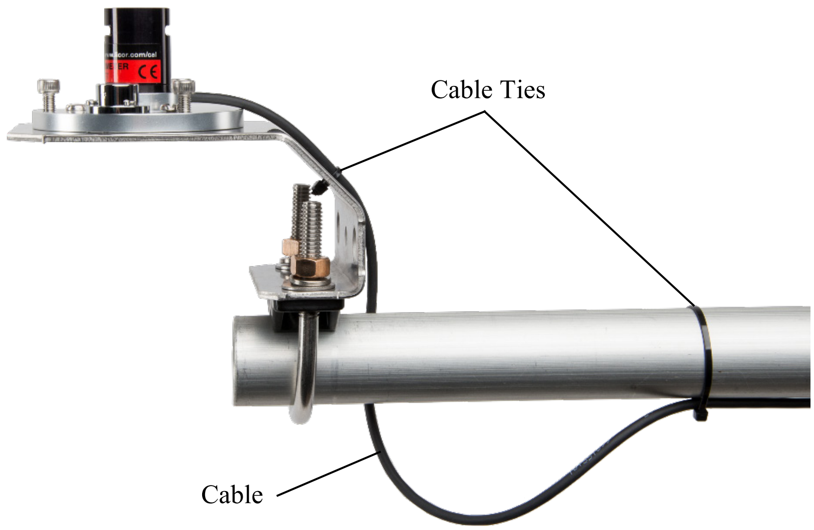
Mounting holes used for the LI200R are indicated in yellow.

5. Turn the levelling screws as required to bring the bubble of the bubble level within the ring.

6. Tighten the mounting screws to secure the assembly in its final position. Check that the pyranometer is still correctly levelled and adjust as necessary.

7. Route the sensor cable along the underside of the crossarm or 015ARM mounting arm to the tripod/tower, and to the instrument enclosure.

8. Secure the cable to the crossarm or 015ARM mounting arm and mast by using cable ties.



9. Remove the red cap after installing the sensor. Save this cap for shipping or storing the sensor.

7.3 Wiring

A schematic diagram of the LI200R is shown in FIGURE 7-1.

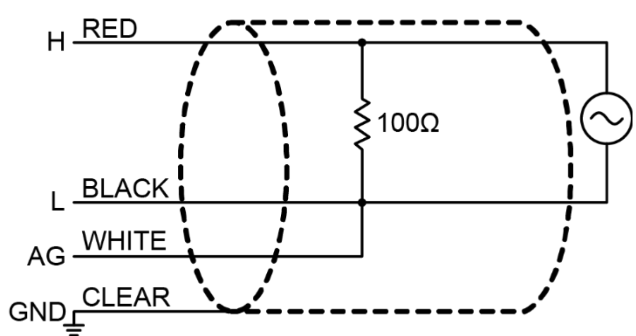


FIGURE 7-1. LI200R schematic

Connections to Campbell Scientific dataloggers are given in TABLE 7-1. When *Short Cut* is used to create the datalogger program, connect the sensor to the terminals shown in the wiring diagram created by *Short Cut*.

TABLE 7-1. Datalogger Connections for Differential Measurements		
Wire Colour	**Wire Function**	**Datalogger Connection Terminal**
Red	Signal	**U** configured for differential high input[1], **DIFF H** (differential high, analogue-voltage input)
Black	Signal Reference	**U** configured for differential input low[1], **DIFF L** (differential low, analogue-voltage input)
White	Analogue Ground	⏚ (analogue ground)
Clear	Shield	⏚ (analogue ground)
[1]**U** terminals are automatically configured by the measurement instruction.		

7.4 Programming

Short Cut is the best source for up-to-date datalogger programming code.

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 for CRBasic dataloggers are provided in the following sections. Complete program examples for CRBasic dataloggers can be found in Appendix B, *Example Programs (p. B-1)*. Programming basics and programming examples for Edlog dataloggers are provided at *www.campbellsci.com/old-manuals*.

The LI200R output is measured by the datalogger by using the **VoltDiff()** CRBasic instruction. CRBasic is included in *PC400* and *LoggerNet* datalogger support software. The **VoltDiff()** instruction has the following structure:

```
VoltDiff(Dest, Reps, Range, DiffChan, RevDiff, SettlingTime,
Integ/FNotch, Mult, Offset)
```

Section 7.4.1, *Input Range (p. 11)*, provides information about choosing the ***Range***. Nearby ac power lines, electric pumps, or motors can be a source of electrical noise. If the sensor or datalogger is located in an electrically noisy environment, use the 60 or 50 Hz rejection integration option as shown in CRBasic Example B-1, *CR1000X Program for Measuring the LI200R (p. B-1)*. The ***Multiplier*** parameter converts the millivolt reading to engineering units (Section 7.4.2, *Multiplier (p. 11)*).

7.4.1 Input Range

The following is an example of how to determine the optimum input range for a given sensor calibration and maximum expected irradiance. This is an example only. Your values will be different.

This example uses the calibration provided by LI-COR®, Inc. Assume that the sensor calibration is 87 µA kW^{-1} m^2. The pyranometer outputs current that is converted to voltage by the 100 Ω shunt resistor in the cable or on the wiring panel. To convert the calibration from current to voltage, multiply the LI-COR® calibration by 0.1 kΩ (shunt resistor). The example calibration changes to 8.7 mV kW^{-1} m^2.

A reasonable estimate of maximum of irradiance at the earth's surface is 1 kW m^{-2}. Thus, an estimate of the maximum input voltage is obtained by multiplying the calibration by the maximum expected irradiance. In this example that product is 8.7 mV. Now, select the smallest input range that is greater than the maximum expected input voltage.

7.4.2 Multiplier

The multiplier converts the millivolt reading to engineering units. The most common units and equations to calculate the multiplier are listed in TABLE 7-2.

TABLE 7-2. Multipliers Required for Average Flux and Total Flux Density for SI and English Units

Units	Multiplier	Process
W m^{-2}	(1/C) • 1000	Average
MJ m^{-2}	t • (1/C) • 0.001	Total
kJ m^{-2}	t • (1/C)	Total
cal cm^{-2} min^{-1}	(1/C) • (1.4333)	Average
cal cm^{-2}	t • (1/C) • (0.02389)	Total
C = (LI-COR® calibration) • 0.1 t = datalogger execution interval in seconds		

7.4.3 Total Solar Radiation

Solar measurements are often totalized, which has the following structure:

```
Totalize(Reps,Source,Data Type,Disable Variable)
```

If the solar radiation is totalized in units of kJ m^{-2}, there is a possibility of overranging the output limits. CRBasic dataloggers avoid this by using the IEEE4 or long data type. For example, the following **Totalize()** instruction uses the IEEE4 data type to prevent overranging:

```
Totalize(1,SlrMJ,IEEE4,False)
```

8. Troubleshooting, Maintenance, and Calibration

NOTE All factory repairs and recalibrations require a returned material authorization (RMA) and completion of the "Declaration of Hazardous Material and Decontamination" form. Refer to the *Assistance* page at the beginning of this document for more information.

8.1 Troubleshooting

Symptom: –9999 or radiation values around 0

1. Check that the sensor is wired to the differential terminal specified by the measurement instruction.

2. Verify that the range code is correct for the datalogger type.

3. Disconnect the sensor wire from the datalogger and use a digital voltmeter to check the voltage between the red (+) and the black (–) wires. No voltage indicates a problem with the photodiode, the cable, or the variable shunt resistor.

Symptom: Incorrect solar radiation

1. Make sure the top surface of the sensor head is clean and that the sensor is properly levelled.

2. Verify that the range code, multiplier, and offset parameters are correct for the desired engineering units and datalogger type.

8.2 Maintenance

On a monthly basis, check the levelling of the pyranometer. Keep the sensor clean and treat it as a scientific instrument to maintain the accuracy of the calibration. Keep the vertical edge of the diffuser clean to maintain appropriate cosine correction.

Clean the sensor only with water and/or a mild detergent such as dishwashing soap. Vinegar can remove hard water deposits from the diffuser element if necessary.

CAUTION Do not use alcohol, organic solvents, abrasives, or strong detergents to clean the diffuser element. Exposure to alcohol or organic solvents harm the acrylic materials of the sensor, which adversely affects the cosine response of the sensor.

8.3 Calibration

Recalibrate the LI200R every two years.

The LI200R can be separated into two parts. The sensor head containing the photodiode disconnects from the base and cabling. Calibration values follow the sensor head. Each sensor head has a unique calibration value. When the sensor is cabled at the factory, the sensor calibration value, as received from LI-COR®, is put on a heat shrink label close to the end of the cable. We recommend sending the entire sensor and cable to Campbell Scientific for recalibration. Along with a calibration certificate, a new heat shrink label is included on the cable with the new calibration value.

When it's problematic to send in the sensor and the cable, you can send only the sensor head for recalibration. A new calibrated LI200R head can be used with the base or a protective cover put over it. Never leave the base part of the sensor exposed to the environment while the sensor head is being calibrated.

NOTE The cable will no longer have the correct calibration information on the label when calibration is done in this manner.

The datalogger program will need to be updated with the new calibration value regardless of which method is used.

8.3.1 Taking the Sensor Apart

Replace the O-ring gasket on the base each time a sensor head is sent in for calibration. You will need the parts listed in TABLE 8-1; part numbers and pricing are available from our website.

TABLE 8-1. Replacement Parts

Description	Notes
LI-COR® Replacement LI190R and LI200R O-ring	Replace this O-ring every time a sensor is separated.
LI-COR® LI190R and LI200R Sensor Base Cover	Cover comes with three small Phillips screws. Cap and screws can be reused.
LI-COR® LI200R Replacement Head	When replacing the sensor head, the sensor base cover is only required if the sensor head cannot be immediately swapped out.

Tools needed:

- Small Phillips screwdriver
- Small slotted screwdriver

NOTE Collect all data from the datalogger before working on sensors. Power the datalogger down while removing the sensor. Power can be applied to the datalogger after work is completed. The datalogger program can be run without a sensor attached but the values will be erroneous. Write down the time and date that the station was worked on to keep track of when bad data occurs in the data file for these readings and when a calibrated sensor is put back in place.

8.3.2 Remove the Sensor

1. Remove the sensor from the LI2003S levelling fixture.

2. Remove the three small Phillips screws from the underside of the sensor. Don’t lose them.

3. Gently pull the sensor apart. Notice the two wires coming up from the base into a small printed circuit board. This printed circuit board has two gold-plated sockets that mate with two gold plated pins from the sensor head.

4. With a small screwdriver, gently pry the printed circuit board away from the pins. Avoid twisting the wires.

5. Put the sensor head in a safe place.

8.3.2.1 If Using a Cover

1. Place the sensor cover over the base and screw it into place by using the three Phillips screws. Screw it down tight, but be careful not to strip the screw heads.

2. Secure the base and cover to the LI2003S levelling fixture.

8.3.2.2 Putting On a Calibrated Sensor Head

1. If using a cover:

    a. Remove the base and cover from the LI2003S levelling fixture.

    b. Turn the base over and remove the three small Phillips screws holding the cover in place. Don’t lose the screws.

    c. Remove the protective cover. Put the cover in a safe place.

2. Replace the O-ring on the base with a new one. You might need to use the small slotted screwdriver to gently pry off the old O-ring.

3. The printed circuit board will only fit inside the sensor head one way. Line up the sensor head pins with the printed circuit board sockets and gently push them together. You might need to use the small slotted screwdriver to make sure the printed circuit board is completely seated into the mating sensor head.

4. Seat the sensor head on to the base and use the three small Phillips screws to secure the assembly. Screw it down tight, but be careful not to strip the screw heads.

5. Remember to update the datalogger program with the new sensor head calibration value.

6. Pack the head for shipment and send it to Campbell Scientific. Refer to the *Assistance* page at the beginning of this document for the required procedure for sending equipment to Campbell Scientific.

9. Acknowledgements

Campbell Scientific, gratefully acknowledges the contribution of LI-COR® to concepts, text, and images used in this manual.

Appendix A. Importing Short Cut Code Into CRBasic Editor

This tutorial shows:

- Importing a *Short Cut* program into a program editor for additional refinement
- Importing 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)
- .CR1X (CR1000X-series datalogger code)
- .CR3 (CR3000 datalogger code)
- .CR5 (CR5000 datalogger code)
- .CR9 (CR9000(X) datalogger code)

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. On the **Advanced** tab, click the **CRBasic Editor** button. The program opens in CRBasic with the name **noname.CR_**. Provide a name and save the program.

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

2. The program can now be edited, saved, and sent to the datalogger.

3. Import wiring information to the program by opening the associated .DEF file. By default, it is saved in the c:\campbellsci\SCWin folder. 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. You can highlight several lines of CRBasic code then right-click and select **Comment Block**. (This feature is demonstrated at about 5:10 in the *CRBasic | Features* video.)

Appendix B. Example Programs

The following programs measure the LI200R every second, and converts the mV output to Wm^{-2} and MJ m^{-2}. The scan interval is entered as a constant at the beginning of the program. This way the user changes the constant when they want to change their scan rate and it ripples through the program. The programs output an hourly average flux (Wm^{-2}) and a daily total flux density (MJm^{-2}). Negative values are set to zero before being processed. Wiring for the examples is given in TABLE B-1. These examples assume the LI-COR calibration value is 71.37. This value is unique to the sensor; therefore, your program will be different.

TABLE B-1. Wiring for Example Programs

Colour	Description	CR1000X	CR6
Red	Signal	1H	U1
Black	Signal Reference	1L	U2
White	Analogue Ground	⏚	⏚
Clear	Shield	⏚	⏚

CRBasic Example B-1. CR1000X Program for Measuring the LI200R

```
'CR1000X

'Declare Constants
't=scan rate in seconds
Constant t = 1

'Declare Variables and Units
Public BattV
Public PTemp_C
Public SlrW
Public SlrMJ

Units BattV=Volts
Units PTemp_C=Deg C
Units SlrW=W/m^2
Units SlrMJ=MJ/m^2

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

'The Totalize instruction uses the IEEE4 data type to prevent overranging.
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
  Totalize(1,SlrMJ,IEEE4,False)
EndTable

'Main Program
BeginProg
  'Main Scan
```

```
  Scan(t,Sec,1,0)
    'Default Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)

    'Default Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,_60Hz)

    'LI200R Pyranometer measurements 'SlrMJ' and 'SlrW'
    'Measurement returns SlrW in millivolts.
    VoltDiff(SlrW,1,mV200,1,True,0,_60Hz,1,0)

    'Set negative value to zero.
    If SlrW<0 Then SlrW=0
    'Convert millivolts to Megajoules/m² by using equation from TABLE 7-2.
    'Multiplier = t*(1/C)*0.001
    'Where t = execution interval in seconds
    'Where C = (LI-COR calibration) * 0.1 = 71.37 * 0.1 = 7.137
    SlrMJ=SlrW*t*(1/7.137)*0.001

    'Convert millivolts to Watts/m² by using equation from TABLE 7-2.
    'Multiplier = (1/C) * 1000
    'Where C = (LI-COR calibration) * 0.1 = 71.37 * 0.1 = 7.137
    'Therefore, Multiplier = (1/7.137)*1000 = 140.1149
    SlrW=SlrW*140.1149

    'Call Data Tables and Store Data
    CallTable Hourly
    CallTable Daily
  NextScan
EndProg
```

CRBasic Example B-2. CR6 Program for Measuring the LI200R

```
'CR6 Series

'Declare Constants
't=scan rate in seconds
Constant t = 1

'Declare Variables and Units
Public BattV
Public PTemp_C
Public SlrW
Public SlrMJ

Units BattV=Volts
Units PTemp_C=Deg C
Units SlrW=W/m^2
Units SlrMJ=MJ/m^2

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

'The Totalize instruction uses the IEEE4 data type to prevent overranging.
DataTable(Daily,True,-1)
  DataInterval(0,1440,Min,10)
  Minimum(1,BattV,FP2,False,False)
  Totalize(1,SlrMJ,IEEE4,False)
EndTable

'Main Program
BeginProg
  'Main Scan
```

```
  Scan(t,Sec,1,0)
    'Default Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)

    'Default Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,60)

    'LI200R Pyranometer measurements 'SlrMJ' and 'SlrW'
    'Measurement returns SlrW in millivolts.
    VoltDiff(SlrW,1,mV200,U1,True,0,60,1,0)

    'Set negative value to zero.
    If SlrW<0 Then SlrW=0

    'Convert millivolts to Megajoules/m² by using equation from TABLE 7-2.
    'Multiplier = t*(1/C)*0.001
    'Where t = execution interval in seconds
    'Where C = (LI-COR calibration) * 0.1 = 71.37 * 0.1 = 7.137
    SlrMJ=SlrW*t*(1/7.137)*0.001

    'Convert millivolts to Watts/m² by using equation from TABLE 7-2.
    'Multiplier = (1/C) * 1000
    'Where C = (LI-COR calibration) * 0.1 = 71.37 * 0.1 = 7.137
    'Therefore, Multiplier = (1/7.137)*1000 = 140.1149
    SlrW=SlrW*140.1149

    'Call Data Tables and Store Data
    CallTable Hourly
    CallTable Daily
  NextScan
EndProg
```

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