Rotating Shadowband Radiometer Model 2 (RSR2)

Installation and Operation Manual

Guidelines for solar energy professionals

This manual provides guidance to solar energy professionals regarding the application, installation and operation of Irradiance, Inc.'s solar energy resource instrumentation, specifically its second-generation rotating shadowband radiometer (RSR2). Ascension Technology developed the first generation instrument in the early 1990's.

Additional Services

Companies lacking staff experienced with solar resource assessment, instrumentation and computer-based data acquisition, but desire to acquire and apply solar resource data are invited to discuss their requirements with Irradiance and its partners in the manufacture and application of solar energy resource instrumentation. Our mission is to support the development and use of solar energy, and we welcome the opportunity to share our knowledge and experience with others entering the field.

Application of RSR2

Measurement of solar energy resources

The RSR2 measures the radiant power per unit area received from the sun at a point on the surface of earth. Power is an instantaneous measurement of the rate of energy flow; solar power is usually expressed in metric units of Watts per square meter and solar energy in terms of kilowatt-hours per square meter (per hour, day, or year).

Types of solar radiation

Sunlight reaching the ground must first pass through the earth's atmosphere. It reaches the outer atmosphere at an average rate of 1,367 W/m^2, on a plane perpendicular to the path from the sun. On clear days, the majority of solar energy reaching the earth comes on a path directly from the sun. The intensity of the sun's power on the earth's surface is reduced to 800 to 1,100 W/m^2, depending on the clearness of the atmosphere and the altitude of the location. (At high altitudes, there are reduced atmospheric gases to scatter and absorb solar radiation.)

Sunlight that follows a path directly from the sun's disk and strikes a surface perpendicular to the path is called **direct normal irradiance,** "**direct normal**", **"direct beam"** or simply "**direct**", and is abbreviated as **DNI**. Sunlight that is scattered in the atmosphere and reaches the earth indirectly is called **diffuse irradiance.** The standard measurement of diffuse irradiance is taken on a horizontal surface, and this measurement is called **diffuse horizontal irradiance**, or simply "**diffuse**" and is abbreviated as **DHI**. The sum of DHI and DNI striking a horizontal surface is the **total horizontal irradiance**, **"global horizontal irradiance"** or often simply "**global irradiance**" and abbreviated as **GHI**. The angle at which DNI strikes a horizontal surface is called the sun's **zenith angle**, or the angle measured downward from directly overhead of a point on the earth's surface to the center of the sun's disk. At sunrise and sunset the zenith angle is 90 degrees and no portion of the direct normal irradiance reaches a horizontal surface. (A further complication is that direct sunlight is refracted downward into the atmosphere, with the refraction angle greatest at sunrise and sunset such that when the sun appears visible on the horizon it is geometrically below the horizon. The equation relating these three solar irradiance parameters:

GHI = DHI + DNI cosine (zenith)

This relationship is fundamental to the operation of the Irradiance RSR2 rotating shadowband radiometer. The RSR2 measures GHI and DHI, computes the cosine of the sun's zenith angle (both the geometrical and apparent zenith angles) based on the time, date and RSR2 location (latitude and longitude), and then computes the DNI as a function of these known quantities using the above equation.

Types of solar radiation instruments

There are two conventional solar radiation-monitoring instruments, the **pyrheliometer** and the **pyranometer**. A pyrheliometer is a telescope-like instrument that measures direct normal irradiance by tracking the sun such that only rays coming directly from the sun are incident upon its sensor. It is used in conjunction with a solar tracker that keeps the unit pointed toward the sun from sunrise to sunset. Most trackers require checking and minor realignment to the sun by a technician on a daily or weekly basis.

A pyranometer is used to measure global horizontal irradiance. In this case the instrument is fixed in a horizontal position and one or two glass hemispheres typically cover the sensor. The sensor is exposed to the entire sky as well as the solar disk and responds to both DHI and DNI cosine (zenith). Pyranometers and pyrheliometers have glass windows that require frequent cleaning.

The Irradiance RSR2 is a "smart" instrument that uses a programmable rotating shading band to intermittently block the direct irradiance from reaching its sensor. By alternately operating as a simple pyranometer to measure GHI and a shadowband radiometer to measure DHI, the RSR2 produces data equivalent to both a pyrheliometer and pyranometer. A drawback of the RSR2 is that it uses a silicon photodiode, rather than a black body absorber coupled with a thermopile, and therefore has temperature and solar spectral sensitivities that are not desirable in a broadband radiometer. Fortunately the RSR2 sensor has been extensively studied and correction factors have been developed that make this instrument almost as accurate as conventional black body absorber, thermopile-based instruments

Basis for RSR2 operation

The RSR2 is programmed to measure GHI once each three seconds and to average the value over a one-minute interval then store the value. The RSR2's data logger has a very accurate internal clock that is synchronized with Universal Coordinated Time (also know as Greenwich Mean Time), typically maintained to within one second of an internet-based timeserver such as that at the U.S. National Bureau of Standards. At leaser every 30 seconds the RSR2's band is rotated such as to briefly cast a shadow on its sensor. Rotations are made more often during partly cloudy periods when the irradiance is rapidly varying. Irradiance's proprietary program code parses a series of rapid measurements taken during a rotation to identify the shadow passage and compute DNI and DHI. Measurements (one on the minute, one 30 seconds into each minute, and additional ones when sunlight is changing rapidly) are averaged and stored with the GHI in a data logger output tables. The standard RSR2 code includes 1-minute, 1-hour and 1-day output tables, but these are easily configured to other intervals.

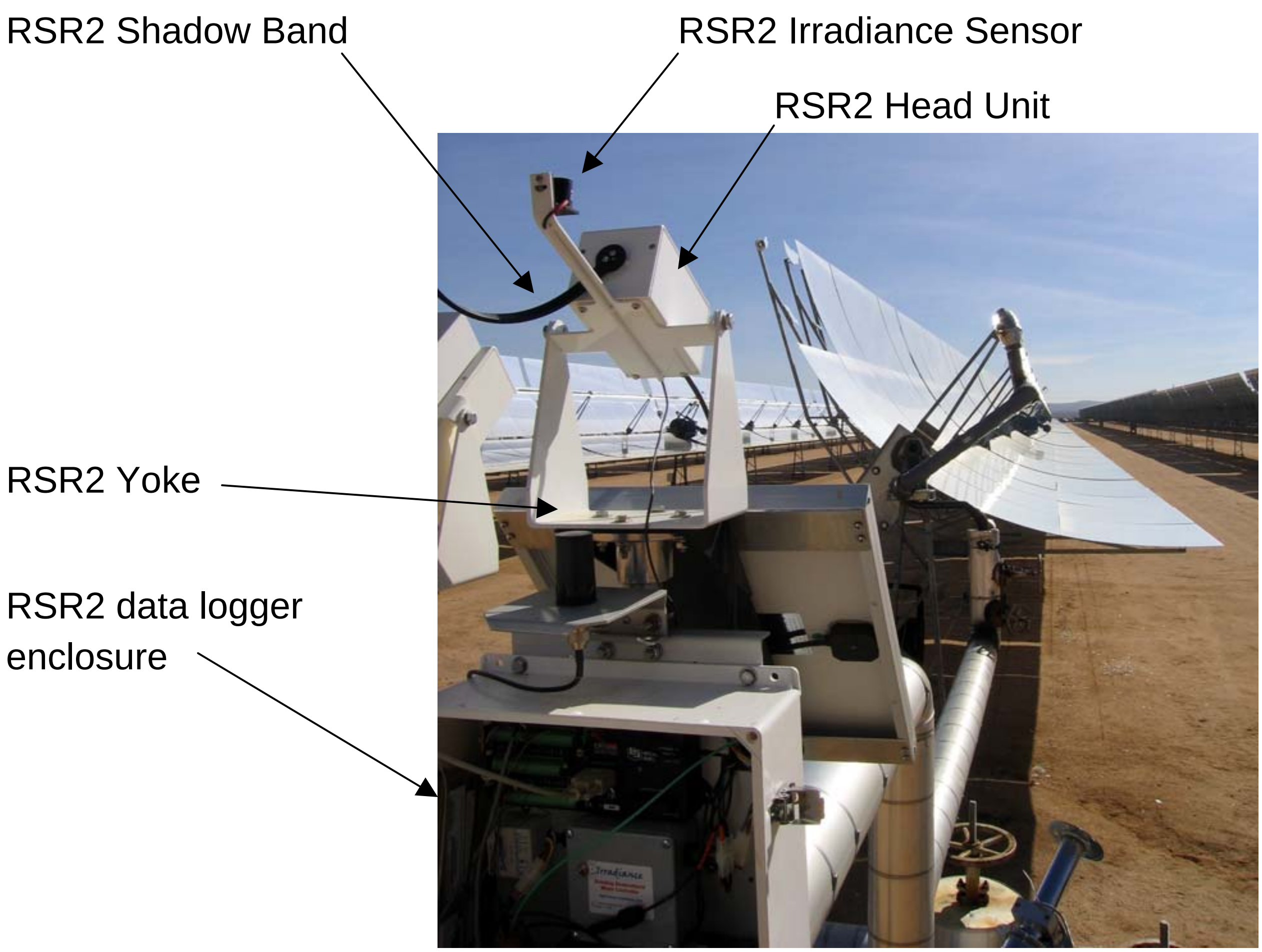
Base RSR2 instruments use the data logger's wiring panel temperature and sunlight levels to estimate ambient air temperature and barometric pressure. Both are used for second and third order adjustments ("corrections") to compensate for the irradiance sensor's sensitivity to its operating temperature and for estimating refraction of the beam irradiance.

The RSR2 uses a commercial data logger and can be programmed to measure additional instruments, such as air temperature, relative humidity, barometric pressure, wind speed and direction, rainfall, barometric pressure, etc. It can also be programmed to measure instruments that output any electronic signal, including power and flow meters, additional temperatures, etc. Readers are directed to the Campbell Scientific web site, http://www.campbellsci.com/sensors to see the range of sensors that are frequently used with Campbell Scientific instruments.

Components of the RSR2

The standard RSR2 is a self-contained data logging system that includes an Irradiance RSR2 head unit, motor controller, mounting pole and yoke and a data logger enclosure. Figure 1 shows an RSR2 at a CSP facility. The head unit and yoke are at the top-left of the image; the RSR2 sensor is a black cylinder with a red wire exiting its base. It is mounted on a small black bracket that allows for one axis of level adjustment for the RSR2 sensor. The curved black band below and to the left of the sensor is the rotating shadow band. A U-shaped yoke supports the head unit. Directly below the yoke is an optional cellular modem antenna, as this location uses a cellular modem to communicate (for programming and data capture) with a base station and the remote RSR2 stations. Also below the yoke a NEMA rated enclosure can be seen. Inside the enclosure is the Campbell Scientific data logger, the RSR2 motor controller, an 18 Amp-hour sealed lead acid gel-type battery and battery charge controller. In this particular installation a cellular modem and barometric pressure sensor were also mounted in the enclosure. To the south (on the far side, not in view) of the enclosure there is a gill shield covering a temperature (or optional temperature/humidity) sensor and a solar panel that is used to maintain the battery charge and operate the system.

Alternate Sensor Brackets: The standard RSR2 is designed for use in mid-latitudes with the axis or rotation set at 45 degrees from horizontal. If the location of the RSR2 is either in the **tropics** (between 23 S and 23 N latitude) or close to or beyond the Arctic or Antarctic Circles (**high latitudes,** greater than 60 N or 60 S) a different sensor bracket is used. Contact Irradiance for details.



Campbell Scientific equipment

The RSR2 operates with either of two similar Campbell Scientific data loggers. The CR800 or the CR1000 data loggers are similar in size and processing capabilities. The main difference is that the CR1000 has more built-in analog input channels (8 double ended or 16 single ended inputs) than the CR800 that has three double ended or six single-ended analog inputs. The CR1000 also has twice the number of control ports (8 versus 4). For applications where there is no need for additional data logging capabilities the CR800 is perfectly adequate for solar resource measurements. (The optional CR1000 adds to the cost of an RSR2 system.) Either data logger can accept an expansion multiplexer to further increase the number of measurement channels.

Irradiance Standard RSR2 Program Code;

All software for the RSR2 operates as a program within the Campbell Scientific Data Logger. It is written in Campbell Scientific's CR Basic language and is compiled in both LoggerNet and in the Campbell CR800 and CR1000 data loggers. All parameters for setup and operation of the RSR2 are contained within this program. The main parts of this code are listing in the box below.

1. Program name and grant of license for use with Irradiance RSR2 head units
2. Version comments and changes (any user modifications should be added)
3. Declaration of variables and constants used in the code
4. Definition of the units of the variables
5. Declaration of the output data tables that will be created from the measurements
6. The "Constants Definitions" at the head of each data loggers program code that must be configured specially for each RSR2 site; it includes the specification of the site location (latitude and longitude), the altitude of the site in meters, and types of sensors, their calibration values and serial numbers used at the site.
7. The "SolPos" subroutine that computes the sun's azimuth and elevation angle.
8. The "Rotation" subroutine that controls the rotations of the band and determines a value for DHI.
9. The "Corrections" subroutine that makes corrections to the raw sensor readings for GHI, DHI, and DNI based on extensive studies of the RSR2 sensor.
10. The "BirdClearSky" subroutine that calculates a theoretical value of DNI for comparison purposes.
11. The "Main Program" which provides the high level control of the data logger, includes a one-time "initialization" section of code and a multiple "looping" section of code that, over time, populates output data tables with solar energy resource data records.

With each RSR2 system, Irradiance provides a copy of its RSR2 code and a license to use it in a single RSR2 system. Generally Irradiance will customize the code, in particular the "Constants Definition" header, for first time RSR2 customers or clients that hire Irradiance or its partners to install stations. All the user needs to provide is the location or address of the site. (Goggle Earth is often used to provide the site latitude, longitude and altitude.)

Additional sensors

A wide range of additional sensors is available to integration with the standard RSR2 system. Typically these include sensors for measurement of parameters that are used for solar power system modeling and performance monitoring. They include:

- Air temperature
- Air temperature and relative humidity
- Barometric pressure
- Wind speed and direction
- Rainfall

Application purpose and data format

Typical solar energy resource records are archived and distributed on an hourly or daily level. The storage capabilities of the CR800 and CR1000 loggers are very large, however, and can easily accommodate measurement and recording of solar energy resource records at 1-minute intervals. As the integration of solar power generating systems with other power transmission and distribution systems becomes more widespread and detailed, 1-minute resource data will become more and more useful in system integration studies and is now recommended by Irradiance for most solar energy resource measurement operations. At 1-minute intervals the CR800 can store GHI, DHI, DNI and air temperature for over a month without writing over data. (Data is usually retrieved far more frequently, ranging from intervals of ten minutes to one day.)

Planning for data retrieval, achieving and reporting

When a CR800 or CR1000 data logger has been programmed, LoggerNet can connect to the station and monitor its status, including the estimated time to fill the various data tables. LoggerNet is usually programmed to periodically download data from each station using a wired or wireless modem or Internet connection. During communication between the data logger and LoggerNet, new records are transferred to the base station, but are not deleted from the data logger until they are overwritten. (In this way a station can be monitored independently from two locations.)

Campbell Scientific's LoggerNet software is used for communications with RSR2 sites. A number of options are available for communicating with remote data loggers. (On site communications are made using a serial cable and an RS-232 serial port on a computer.)

- Telephone modem (wired)
- Cellular GPRS/Edge modem (uses fixed or dynamic domain name server addressing)
- Wired (Ethernet) Internet protocol (requires a fixed IP address)
- Satellite up/down link (these are expensive and relatively slow)

Users should become familiar with the operation of Campbell Scientific data logger network operation software and data file structure. In situations where users do not have staff available to learn and operate these systems, Irradiance and its partners are available to assist on a retainer basis.

Application Check List

- How will the data be used?
- What time interval is needed for this use?
- What extra sensors, if any, are needed for the application?
- Are averages, maximums or totals required for the various sensors? (e.g., for wind the average might be appropriate for convective cooling calculations and the maximum for wind force calculations.)
- How often should the logger be checked to be sure it is operating properly?

Site Selection for Solar Energy Resource Instruments

There are numerous factors involved in identifying a suitable location to establish a solar energy resources monitoring station. In tropical and in high latitude locations special RSR2 shading bands need to be attached to the instrument (see details in the next section)..

Solar access and Shading

First and fore most, the site should have clear access to the sky from sunrise to sunset year round. The sun's compass angle at sunrise is generally in the east, but moves northward (toward the northeast) in the northern hemisphere summer and southward (to the southeast) in the northern hemisphere winter. (In the southern hemisphere the angles are reversed.) There are five critical latitudes that must be considered when installing RSR2 radiometers.

- the Arctic Circle (66° 33′ 38″ N)
- the Tropic of Cancer (23° 26′ 22″ N)
- the Equator (0° N/S)
- the Tropic of Capricorn (23° 26′ 22″ S)
- the Antarctic Circle (66° 33′ 38″ S)

The RSR2 alignment (see Instrument Orientation below) is determined by whether it is north or south of the equator. If it is on the equator either alignment will work.

For installation in the tropics (between the Tropics of Cancer and Capricorn) sunrise and sunset is within +/- 30 degrees of east and west respective and an unobstructed horizon north and south of these sectors is not critical. In tropical locations a different sensor bracket is needed to make certain that a shadow is cast on the sensor when the sun's position is closer to a pole than the location of the instrument.

For installation in the northern and southern temperate zones at 45 degrees latitude (N and S) the horizon should be clear from 30 degrees from east toward the north or south poles and 35 degrees toward the equator. At 60 degrees latitude (N and S) the horizon should be clear from 55 degrees toward the poles to 50 degrees toward the equator.

In the Arctic or Antarctic there are days during the year when the sun never rises and when the sun never sets. For summers near the poles therefore, the horizon must be clear of obstructions in all directions. In such locations a different sensor bracket is needed to make certain a shadow is cast on the sensor as the sun follows a full 360-degree path above the horizon.

Generally solar radiation measurements (particularly for DNI) are subject to significant uncertainty when the sun is within 15 degrees of the horizon, so some compromise on site selection is possible to allow for locations where some shading occurs either immediately following sunrise or before sun set.

Unwanted Diffuse and Specular Reflections

Although less common than shading problems, unwanted reflections of solar energy into the sensor can also render RSR2 measurements inaccurate. Objects below the plane of the sensor (these are also effectively below the horizon) are of no concern and need not be considered. Ideally there would be no white painted or shinny, “mirror-like” surfaces “near” the sensor that could cause diffuse or specular reflections into the sensor. Generally any such reflections would register higher global and diffuse irradiance measurements by the RSR2 instrument. Only general guidelines on what constitutes “near” are possible owing the number of different situations possible. For diffuse reflections any object that subtends 10 degree or more azimuth and elevation angles should be avoided. (This would be, for example a 1-meter sided square about 10 meters from the sensor, or a 2-meter sided square about 20 meters distant.) The higher the reflecting object the more it will effect the measurements. A 1 meter square reflecting surface 20 degrees above the horizon seen by the sensor will cause twice the error as one 10 degrees up.

Specular reflections from shiny surfaces will less uniformly cause problems, but when they do they will be far more significant. Sites near buildings with glass curtain walls (either reflective glass or clear) and even solar PV arrays should be avoided if the sensor cannot be placed higher than the potential sources of reflection.

Sensor maintenance

A good site will enable periodic maintenance of the RSR2 sensor, which includes cleaning the sensor and checking to make certain that it is level. Once should be able to easily look down on the sensor without applying any force to the head unit or mounting pole. (Applying such a force will likely make it impossible to level the sensor, and it is critical the sensor be level for accurate DNI measurements.)

The maximum time interval between sensor cleaning and leveling is very site and application specific. Frequent (daily) cleaning would be ideal, but is not realistic for most RSR2 applications. Where possible, weekly sensor cleaning with distilled water has been recommended by staff at the U.S. National Renewable Energy Laboratory in Golden, Colorado. Realistically, however, sensor cleaning can range from monthly to annually. Cleaning should be done while the global irradiance is a steady as possible, at solar noon on a cloudless or totally overcast day. The date and time of cleaning should be logged so that the sensor response before and after cleaning can be compared to determine any change in responsivity due to the cleaning.

The inspection should include listening to the motor to make sure there is no unusual bearing noise and opening the enclosure to be sure the plug around the wires pass-thru in intact and the enclosure has not become a home for insects, reptiles or rodents, and that all the connections to the battery and data logger are free of contamination.

Security

Obviously a good site is one that will not attract thieves or vandals. Often a rooftop with access via a stairway or internal ladder makes and excellent location since the roof height also makes an unobstructed horizon easier to attain.

Data retrieval

Data should be retrieved and reviewed sufficiently often so as to catch potential failures in the data logging system, sensor failure, or vandalism. While the logger can store a month or more of data, it is simply not prudent to wait that long. The method of data retrieval is mostly a matter of expense, both fixed costs for equipment and operating costs for leasing phone lines or paying for wireless services.

Installation

Once a site it selected, installation with Irradiance's optional mounting systems are straightforward. For customers that provide their own mounting, all that is needed is to assure that a relatively level surface or mounting pole (for the mounting pole 1- to 2-degrees is sufficient, fine tuning for the sensor is done at the head unit) and remains vertical during measurements. Fine adjustment of the sensor to make it perfectly level is accomplished by rotating the head unit in its mounting yoke and also the pyranometer sensor in its small black sensor bracket.

Instrument orientation

The instrument should be mounted with the top surface of the RSR2 head unit (and optional the solar panel) and facing toward the equator.

Foundation

An Irradiance RSR2 ground-mounted tripod mount, flat roof mounting ballasted base plate mount or simple pole mount can be used to support a mounting pole. Alternatively, any ANSI standard 1 ¼" pipe may be used. (ANSI standard pipe dimensions are nominal ***inside*** diameters, the ***outside*** diameter of 1.25" pipe is about 1.66" or 42.2 mm; our apologies to our friends in the metric world). If a user supplied pole mount is used, the user should be certain that its vertical orientation will not shift.

Mechanical assembly

The assembly of the RSR2 requires setting the mounting pole. The data logger enclosure attaches to the mounting pole along with the optional temperature or temperature/humidity sensor. A mounting flange, a solar panel mounted on a bracket, and the RSR2 yoke and head unit are then placed on top of the mounting pole and again secured with two set screws. In systems with optional cellular modems the antenna may is attached to the RSR2 yoke. In most cases the temperature or temperature/humidity probe will be shipped inside the enclosure and must be fed out thorough the hole in the bottom of the enclosure and inserted into the gill shield. The pre-wired head unit control and power plugs and conductors should then be feed into the enclosure through the bottom hole and plugged into the mating connectors. Finally the same should be done for the PV power panel. The bottom hole in the enclosure should be plugged with the electricians putty provided to keep insects, rodents, and snakes from getting into the enclosure.

Figure 2 RSR2 configured for ground mounting

Sensors and Data Logger Wiring

The data logger measures analog signals, counts pulses and accepts digital inputs. For the RSR2 irradiance is measured as analog signals. The irradiance is a simple voltage measurement, as detailed in the next paragraph. The air temperature is estimated or measured via the internal wiring panel or (optionally) to the response to a precision excitation of a temperature probe. Optional combined temperature and humidity measurements are made using digital inputs through the data loggers control ports and optional wind speed measurements are made with pulse counting inputs and

Campbell datalogger analog measurements are precisely defined and have various options for sampling to avoid 50 Hz or 60 Hz noise, for averaging over time (micro seconds), and for allowing sensors to settle before measurement. The RSR2 uses these options as needed for its operation, but DOES NOT and CAN NOT use 50 or 60 Hz noise rejection. Since a solar panel and a 12 V DC battery power the RSR2, rejecting nearby AC power is generally not a problem. Users should use care to avoid locations where high AC power interference might be present.

The most important sensor, the Licor pyranometer, is connected to input SE1 on either the CR800 or CR1000 logger. The coax shield in the SE1 input location and the coax center in the adjacent analog ground location. Since the Licor sensor outputs a current signal proportional to irradiance and the data logger measures voltages, a precision resistor (100 Ohm 1/8th Watt) is placed across the logger input to act as a shunt to create a voltage signal in proportion to the irradiance. (In units build after October 2008 these resistors will be buried inside a heat shrink cover assembly with a yellow lead for the SE1 location and a clear lead to the analog ground location.) If used, a secondary Licor pyranometer sensor will be similarly connected with the yellow lead to the SE2 location and clear lead to the adjacent analog ground..

The simple CS107 temperature probe signal is measured in SE 4. Depending on additional sensors and special configurations the wiring panels can be significantly different. Reference the attached sample wiring panels, any additional wiring panel configurations supplied with the instrument for additional information about the specific instrument.

	1H	**1L**	**AG**	**2H**	**2L**	**AG**	**3H**	**3L**	**AG**	**EX 1**	**AG**	**EX 2**	**AG**	**P 1**	**AG**	**P 2**	**G**	**5V**
	SE 1	**SE 2**		**SE 3**	**SE 4**		**SE 5**	**SE 6**										
Sensor	LICORP	LICORS	LICOR(2)	NIP	T107	BARO	BARO	034B	T107	034B	RAIN	T107	034B	034B	034B	RAIN		MTRCTR
Color	shield	shield	cores (2)	(+)	red	yellow/clr	blue	green	purple/clr	blue	white/clr	black	white/clr	red	black	black		red
Sensor			NIP			ATRH		03301					03301	03101	03102			
Color			(-)			clr		red					white/clr	black	white/clr			

	SW 12	**G**	**12V**	**G**	**C1**	**C2**	**C3**	**C4**	**G**
Sensor	MODEM	MODEM	ATRH	ATRH	MTRCTR	MTRCTR	ATRH	BARO	MTRCTR
Color	red	black	red	white/blac	grey	blue	green	green	black
Sensor			BARO	BARO					
Color			red	black					

LICORP	Licor 200	Primary RSR Licor (shade/unshade)
LICORS	Licor 200	Secondary Licor (horizontal, tilt, or
T107	CS 107	Air temperature sensor (optonal)
ATRH	CS 215	Temperature and relative humidity probe
NIP	NIP	Eppley NIP (field calibration)
BARO	CS106	Vaisala barometric pressure (optional)
034B	MET1	MET ONE 034B Wind Set (optional)
03101	RMYWS	RM Young Wind Sentry 03002 set; wind speed sensor
03301	RMYWS	RM Young Wind Sentry 03002 set; wind direction sensor
RAIN	TE525	Rain gauge (optional)
MODEM	Raven XT	Sierra Wireless AirLink GPRS cellular modem
MTRCTR	Rev B	Irradiance RSR2 motor controller

Figure 3 Typical CR800 wiring diagram (October 2008 and after)

Electric power system

The RSR2 power system includes a 10-Watt solar panel; an 18 Amp-hour sealed lead acid battery; and a charge controller. The panel should be mounted facing the equator and the battery placed in the lower right hand side of the enclosure. Care should be taken installing the battery to make certain the positive terminal is always protected from physical contact with any conductive materials.

Commissioning

Once the equipment is physically in place, the instrument can be commissioned with the following steps.

Campbell Scientific LoggerNet

Before commissioning the user should become familiar with CSI LoggerNet software. In particular the user should learn how to "set up" and "connect" to a data logger. The code used in the logger is provided by Irradiance.

Initial 12-volt power supply

Connect the solar panel to the battery and verify that the PV panel is charging the battery by observing the change in voltage when the battery is charging. While charging the battery voltage should increase 0.1 or more volts when the panel is connected and the sun is shinning. Fully charged the battery should reach about 13.9 V.

Initial data logger programming

With a PC connected to LoggerNet and the Data Logger (if they are close to one another this can be done with an RS232 cable) the program code provided by Irradiance can be downloaded into and compiled by the data logger.

Time zone setting

The program code in the Data Logger calculates sun's azimuth and elevation angles using the precise time (typically within +/- 3 seconds) and the station's latitude and longitude, typically accurate to within 50-meter radius. If any of these three values is set incorrectly, the calculation of direct normal and diffuse irradiance will be compromised. Time on the RSR is ALWAYS maintained at Universal Coordinated Time (UCT, sometimes called Greenwich Mean Time) and all data records are time stamped with UCT values. A provision in the Data Logger is made to write a daily summary record at the station's local midnight by entering the difference in hours between UCT and local STANDARD time. The use of Day Light Savings time, or "Summer Time" is NEVER made in the Data Logger and if desired should be done by post processing the Data Logger output files.

Onsite communications

The Data Logger can communicate with an onsite computer running Campbell Scientific Device Configuration Utility, LoggerNet server or PC200W via the Data Logger's RS232 port for setup and/or programming.

Onsite data verification

The Data Logger can communicate with an onsite computer running Campbell Scientific LoggerNet server or PC200W via the Data Logger's RS232 port for programming and initial onsite verification of proper operation and making sure that the sensors are reporting reasonable values.

Remote communication verification

If off site communications is planned this should also be done while the installation team is on site. This will verify the correct setup and programming of the peripheral communications equipment.

Operations

Data retrieval and verification

We recommend that data be retrieved and checked at least weekly. In addition to the data output tables (IRRAD, MEASURE were used before October 2008, 1_minute, 15_minute, 1_hour are used subsequently), the "RSR_Stat" daily output table (now called 1_day) should be checked to make certain that battery voltages and average well widths are tracking within consistent bounds. The average well width should be in the range from 10 to 25 and the voltages should track between minimums of 12 V to maximums of 14 V.

Care needs to be taken in selecting download options to avoid the loss of data. It is recommended that the standard LoggerNet options be selected for this application. We recommend that all LoggerNet-created files be copied and all post processing be applied to the copies to maintain the raw data file records.

Viewing Data

Data can be viewed using the LoggerNet, View option, or via other application programs such as Microsoft Excel.

Instrument maintenance

We recommend that the Licor pyranometer sensor be cleaned weekly and that the sensor levelness be verified monthly.

Calibration (Work in progress, currently we use the initial LICOR calibration and apply a set of corrections based on studies at NREL, Sandia and the University of Oregon …)

We recommend that the sensor calibration be checked………….

The software has a calibration facility……..