CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

CRSI2
Soiling Index Datalogger

Soiling Index Measurement Solution

Featuring advanced datalogger technology

Overview

Soiling, the loss of PV module power output due to accumulation of dirt and/or snow on the panel surface, has become one of the most important operational issues of solar energy power plant performance. The CRSI2 Soiling Index Datalogger, provides solar energy professionals who are responsible for managing the performance of a PV power plant with the information needed to evaluate and manage the impact of soiling. Soiling loss indices and soiling rate are calculated using industry standard methodologies. Raw data is stored and available for additional post-processing.

Benefits and Features

- Purpose built Campbell Scientific datalogger
- Complete system easily integrates into any SCADA network or existing MET station
- Supports Modbus, DNP3, PakBus, data encryption, and Internet protocols
- No programming required
- Web interface for data viewing and simple configuration
- Soiling loss indices and soiling rate calculated using industry standard methodologies.
- Measurements of reference and test modules: short-circuit current, back of module temperature, and open-circuit voltage

Technical Description

The CRSI2 Soiling Index Datalogger is designed to be at the heart of an independent soiling measurement station or as an add-on peripheral to any new or existing MET station. It supports many communication protocols such as Modbus, DNP3, PakBus, PakBus encryption and several internet protocols. Deployment/configuration is simple and easy through a built-in web configuration page. The CRSI2 is delivered field ready and requires no programming. It will work with any user-supplied solar module up to 300 W or can be ordered with mini 20 W modules. Two highly accurate and rugged back-of-temperature sensors are included.

The CRSI2 measures short-circuit current (Isc), open-circuit voltage (Voc), and back of module temperature of two solar modules every 30 s by default (configurable) ±60 min. of local solar noon. The CRSI2 evaluates (1) if the module power output is appropriate for calculating soiling index and (2) the stability of the atmospheric conditions. If the criteria are met, then effective irradiance is calculated, flagged and used for determining the soiling index. If all necessary and appropriate criteria are met, the soiling index is updated once daily.

Taking advantage of the extremely flexible Campbell Scientific datalogger platform, the CRSI2 offers additional soiling management solutions. Because many of our users want immediate feedback, the CRSI2 also provides a real-time index based on the typically very stable short-circuit current ratio. Additionally, raw measured data are stored and available for analyst and researchers who are looking to perform independent post-processing.

Example Plot

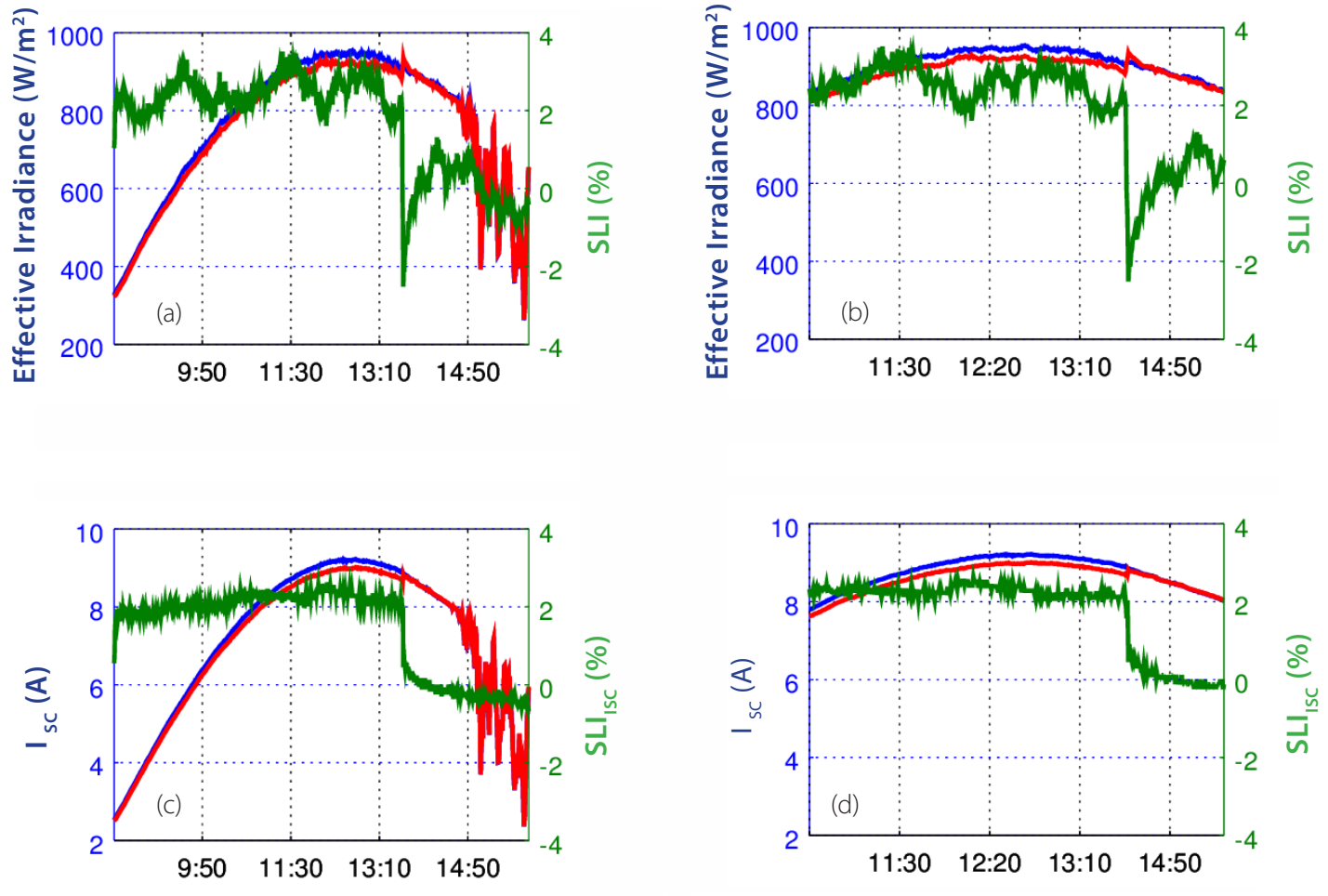

Figure 1: Example data file shows a cleaning event at ~ 1:30 p.m. The tables on the right show stable subsets of data ±1 hr of local solar noon. This data is used for long-term soiling index analysis. (a) and (b): Curve in blue is effective irradiance from the reference panel and the curve in red is the effective irradiance from the test panel. The green curve is the soiling index calculated from the ratio of these two. Higher value of SLI before 1:30 p.m. indicates loss due to soiling. (c) and (d): Curve in blue is short circuit current from the reference panel and the curve in red is the same quantity from the test panel. The green curve is the soiling index calculated from the ratio of these two. Higher value of SLI before 1:30 p.m. indicates loss due to soiling.

Application Overview

Figure 2(a)

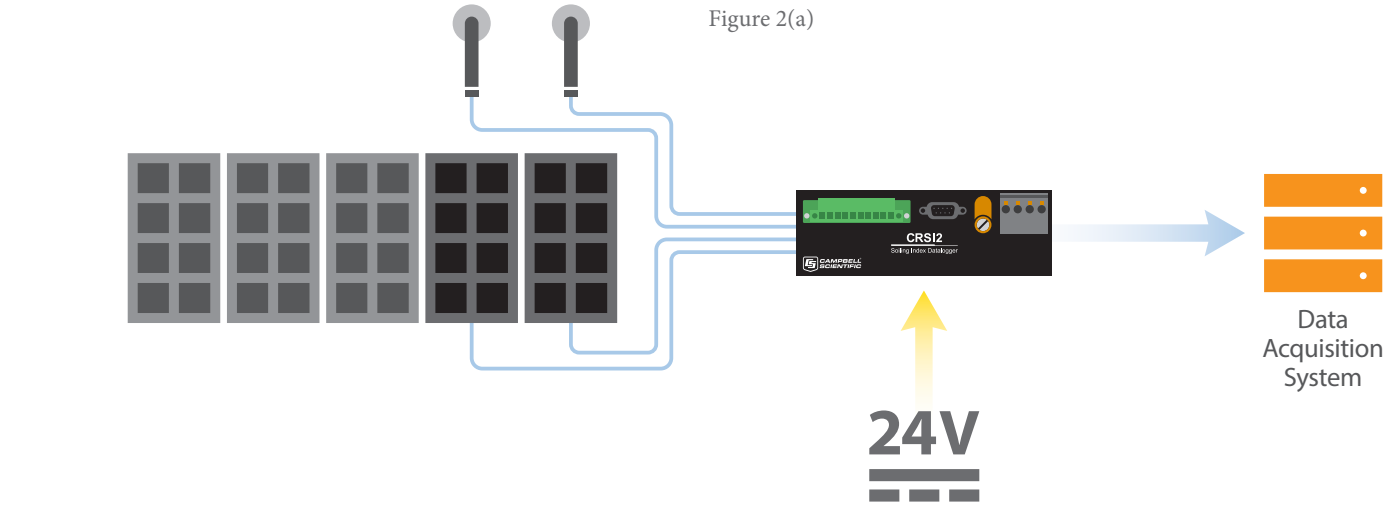

Figure 2(b)

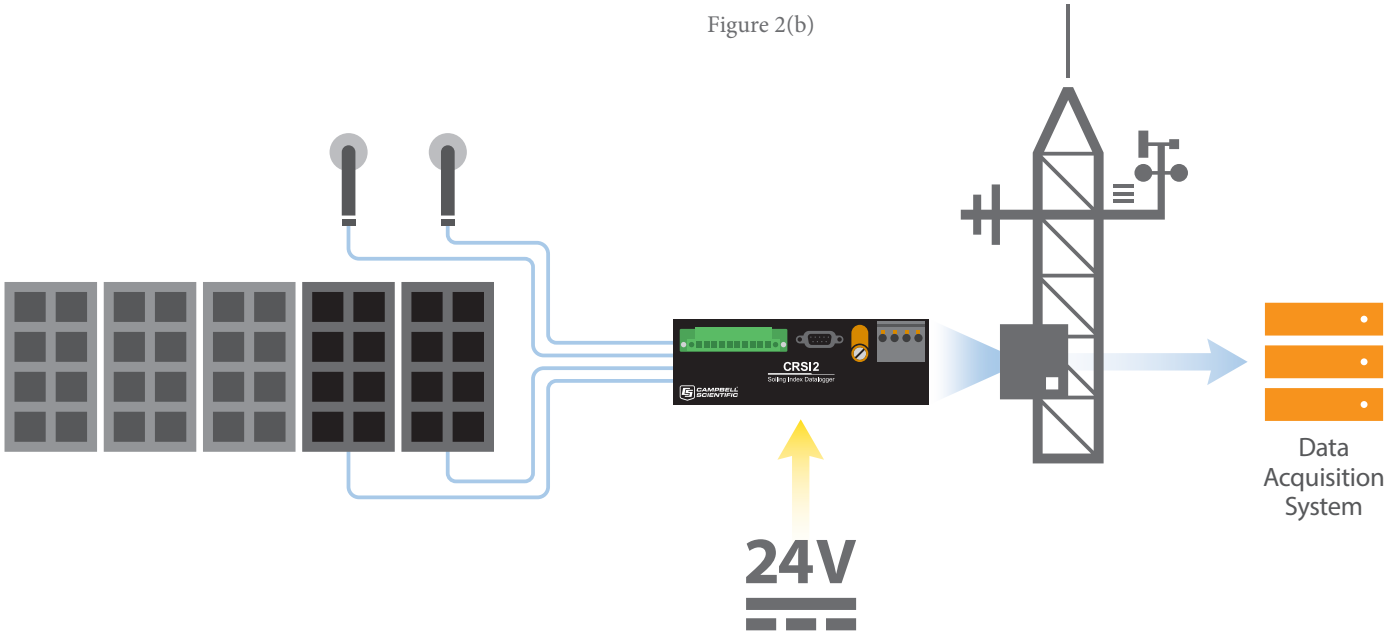

Figure 2: The CRSI2 can act as the system's central measurement and control unit (a) or as a peripheral unit that is added to any new or existing solar meteorological monitoring system (b). Data transfer from the CRSI2 is simple. The CRSI2 supports many communication options, including; Internet protocols, Modbus, DNP3, SDI-12, PakBus, and PakBus encryption. (See Communications on the Specifications page for a complete list.) Data files (many file formats are available) are sent directly to the cloud via email or FTP, for example.

Specifications

All CRSI2 dataloggers are tested and guaranteed to meet electrical specifications in a standard -40° to +70°C non-condensing environment. Datalogger recalibration is recommended every three years. System configuration and critical specifications should be confirmed with Campbell Scientific before purchase.

SOILING LOSS INDEX: can detect ~1%

SOLAR MODULES: up to 300 w crystalline or thin-film

MAXIMUM VOLTAGE: 50 V

MAXIMUM CURRENT: 20 A

24-BIT ADC MEASUREMENT ACCURACY: ~ 2 µV

VOLTAGE MEASUREMENTS

INPUT RESISTANCE: 5 GΩ (f_{N1} = 50/60), 300 MΩ (f_{N1} = 4000)

DC COMMON MODE REJECTION:
>120 dB with input reversal (≥90 dB without input reversal)

NORMAL MODE REJECTION: >71 dB @ 50 Hz, >74 dB @ 60 Hz

RANGE AND RESOLUTION:

Notch Frequency (f_{N1}) (Hz)	Range[1] (mV)	Typical Resolution[2] (Differential w/Input Reversal)		Typical Resolution[2] (Differential w/o Input Reversal)	
		Effective Resolution		Effective Resolution	
		RMS µV	bits	RMS µV	bits
4000	-100 to +2500	23	16.8	33	16.3
	-34 to +34	3.0	14.5	4.2	14.0
400	-100 to +2500	3.8	19.4	5.4	18.9
	-34 to +34	0.58	16.8	0.82	16.3
50/60	-100 to +2500	1.6	20.6	2.3	20.1
	-34 to +34	0.23	18.2	0.33	17.7

ACCURACY:

0° to 40°C	-40° to 70°C
±(0.04% of reading + offset)	±(0.1% of reading + offset)

OFFSETS:

Range (mV)	Differential with Input Reversal (µV)	Differential without Input Reversal (µV)	Single-Ended (µV)
-100 to +2500	±20	±40	±60
-34 to +34	±3	±7	±10

MEASUREMENT SPEED:
*(multiplexed measurement time (ms) * reps + 0.8 ms)*

f_{N1} (Hz)	Multiplexed Measurement Time (ms)	
	w/Input Reversal	SE or w/o Input Reversal
4000	2.9	1.4
400	14.6	7.3
50/60	103	51.5

DEFAULT SETTLING TIME: 500 µs

COMMUNICATIONS

INTERNET PROTOCOLS: PPP, ICMP/Ping, Auto-IP(APIPA), IPv6, UDP, TCP, TLS, DHCP Client, SLAAC, DNS Client, Telnet

ADDITIONAL PROTOCOLS SUPPORTED: PakBus, SDI-12, Modbus RTU, Modbus ASCII, Modbus TCP/IP, DNP3. Custom user-definable over serial

DATA FILE FORMATS: CSV, XML, JSON, binary, encrypted

USB: USB micro-B device only, 2.0 full-speed 12 Mbps, for computer connection.

RS-232: female RS-232, 9-pin interface

SERIAL (C1, C2): 0 to 5 V output, 3.3 V input, 1200 to 115.2k bps

SDI-12 (C1, C2): Two independent SDI-12 V1.3 compliant terminals configurable as sensor or recorder

SYSTEM

CLOCK ACCURACY: ±1 min. per month

CLOCK RESOLUTION: 1 ms

PROGRAM EXECUTION: 100 ms to one day

POWER REQUIREMENTS

CHARGER INPUT (CHG): 16 to 32 Vdc, current limited at 0.9 A. Power converter or solar panel input.

EXTERNAL BATTERIES (BAT): 12 Vdc, lead-acid 7 Ah battery, typical

INTERNAL LITHIUM BATTERY: 3 V coin cell CR2016 (Energizer) for battery-backed clock. 6 year life with no external power source.

TYPICAL POWER REQUIREMENTS

SLEEP: 1.5 mA

ACTIVE 1 HZ SCAN WITH ANALOG MEASUREMENTS: 5 mA

USB POWER (USB): For programming and limited functionality.

COMPLIANCE

CE: All terminals tested to Class 4 levels (IEC 61000-4-5: 2013) for surge and (IEC 61000-4-2:2008) for ESD

SHOCK AND VIBRATION: ASTM D4169-09

PROTECTION: IP30

WARRANTY

Three years against defects in materials and workmanship.