



## Soiling Index Measurement Solution

Providing on-board data filtering and real-time soiling loss index

### 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 CR-PVS1 Soiling Index RTU 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 are calculated using industry standard methodologies. Raw data is stored and available for additional post-processing.

### Benefits and Features

- ▶ Real-time soiling loss index (SLI) measurement and control system
- ▶ On-board data filtering that assures quality data
- ▶ Daily average soiling loss index calculated
- ▶ Modbus, DNP3, PakBus, data encryption, and Internet protocols supported
- ▶ No programming necessary
- ▶ Quick-deploy guide that simplifies installation

### Technical Description

The CR-PVS1 Soiling Index RTU 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. The CR-PVS1 is delivered field ready and requires no programming. It will work with any user-supplied solar module up to 300 W, or it can be ordered with mini 20 W modules. Two highly accurate and rugged back-of-temperature sensors are included.

Soiling loss index is calculated from short-circuit and back-of-module temperature measurements of a reference module that is kept clean and a test module that is kept dirty. Measurements are made only when certain characteristics of

global solar irradiance and temperature are met, avoiding any difference in soiling due to environmental instability, cloud influence, zenith angle of the sun, module current dependence on irradiance level, and to an extent, spectral effects. A quality factor is calculated to give the user some feedback on the number of qualified measurements.

From short-circuit current and back-of-module temperature, the effective irradiance of each module is calculated in accordance with IEC 60904 and a soiling loss index is calculated. A daily average soiling loss index is calculated, available for SCADA, and stored in on-board memory. For immediate feedback, a real-time soiling loss index and quality factor are available. Raw measured data are stored and available for the analyst or researcher looking to perform independent post-processing.



The procedure is straight forward and easily implemented with manual washing of the reference module, usually

cleaned at the same time as the on-site pyranometer(s).

## Specifications

*-NOTE- All CR-PVS1 RTUs are tested and guaranteed to meet electrical specifications in a standard -40° to +70°C non-condensing environment. 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
Measurement Accuracy	~ 2 $\mu$ V
Warranty	One year against defects in materials and workmanship
Dimensions	<ul style="list-style-type: none"> <li>› 20.3 x 14 x 6.3 cm (8.0 x 5.5 x 2.5 in.) without mounts</li> <li>› 21.6 x 14 x 6.3 cm (8.5 x 5.5 x 2.5 in.) with mounts</li> </ul>

### Back-of-Module Temperature Measurements

Measurement Range	-40° to +135°C
Temperature Uncertainty for -40° to +70°C	$\pm$ 0.2°C tolerance
Temperature Uncertainty for 71° to 105°C	$\pm$ 0.5°C tolerance
Temperature Uncertainty for 106° to 135°C	$\pm$ 1°C tolerance
Time Constant in Air	<ul style="list-style-type: none"> <li>› 252 s (still air)</li> <li>› 25 s (surface)</li> </ul>
Steinhart-Hart Linearization Equation Error	0.0024°C (at -40°C) maximum

### Short-Circuit Current Measurements

Maximum Operating Temperature	+80°C
Shunt Accuracy	$\pm$ 0.25%

### Communications

Default Configuration	Modbus RTU
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	$\pm$ 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	<ul style="list-style-type: none"> <li>› 1.5 mA (sleep)</li> <li>› 5 mA (active 1-Hz scan with analog measurements)</li> </ul>
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 & Vibration	ASTM D4169-09
Protection	IP30

For comprehensive details, visit: [www.campbellsci.eu/cr-pvs1](http://www.campbellsci.eu/cr-pvs1) 



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