NRG Systems

NRG INSTRUCTIONS

# Soiling Measurement Kit

## NRG SRA System | Kit #11174

**Authors:**

Technical Services

## TABLE OF CONTENTS

## INTRODUCTION

This document explains how to integrate the Soiling Measurement Kit onto NRG Systems' SRA tower. The process includes assembling and installing hardware to the tower and shelter box, wiring the system to the logger, and configuring the logger channels to read the signals. The Soiling Measurement Kit can be installed on any NRG Systems Solar Resource Assessment (SRA) tower equipped with a SymphoniePRO logger.

It is recommended that two people perform this installation.

## MATERIALS & TOOLS

### Inside the Kit

- PV panel assembly
- Angle adjustment boom
- U-bolts & mounting brackets
- Interface Module, DIN rail, & wiring cable

### Required Tools

- 3/16" hex key
- 5/32" hex key
- 7/16" combination wrench
- 3/4" combination wrench
- Small flathead screwdriver
- Small diagonal cutters or snips
- 6ft stepladder
- Elevation angle meter
- Compass or GPS (Required for initial SRA tower orientation, optional for panel orientation)
- Electrical tape
- Documentation equipment (Camera, pen, & paper)
- Windows PC with SymphoniePRO Desktop Software loaded, USB cable type-A to type-B
- Gloves
- Loctite 242 (optional)
- Digital Voltmeter (optional)
- Wire strippers (optional)

## SECTION 1: ASSEMBLING THE SOILING MEASUREMENT KIT

### 1.1 Open and unpack all items.

Verify that all contents are present and undamaged. Leave PV panel assembly inside the box for now to prevent the panels from getting scratched.

*Figure 1-1: Packaged Soiling Measurement Kit*

### 1.2: Mount upper U-bolt to tower,

Mount upper U-bolt (Figure 1-2, right) and bracket near the top of the NRG SRA tower using the 3/4" wrench (Figure 1-3). Make sure that the 7/16" bolt heads are facing down and the slide nuts are facing upwards. Do not overtighten the U-bolt nuts.

**Note**: The lower U-bolt will be mounted to the tower approximately 15" below the upper U-bolt later. Verify that there is space on the tower tube at this location for the lower U-bolt.

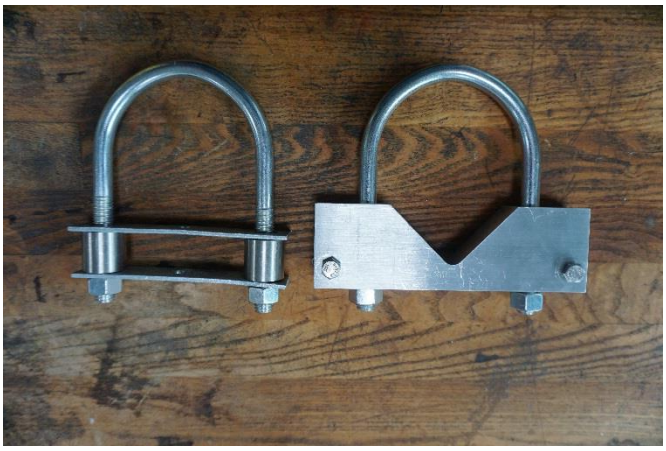


*Figure 1-2: U-bolts and brackets, lower (left) & upper (right)*

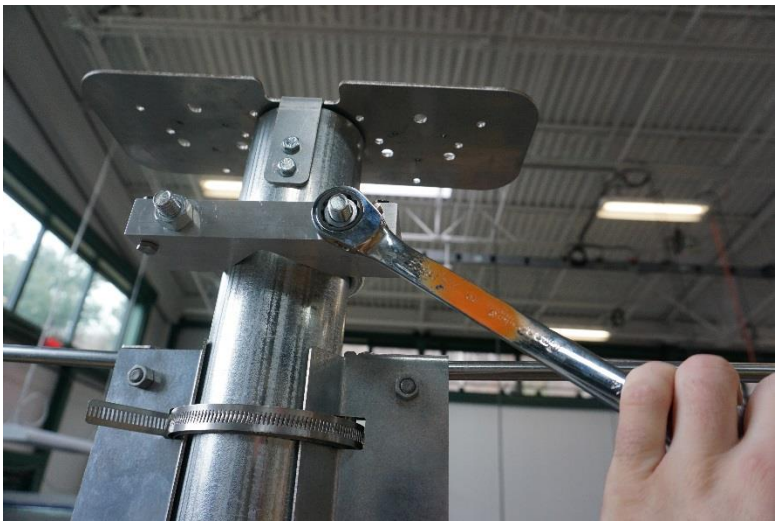


*Figure 1-3: Mounting the upper U-bolt*

### 1.3: Mount PV panel assembly to upper U-bolt.

If desired, remove the slide nuts and add Loctite to the threads. Allow to dry slightly, then reattach slide nuts to the bolts, leaving them loose.

Otherwise, loosen the slide nuts on the upper U-bolt bracket so they are flush with the end of the bolts (Figure 1-4).

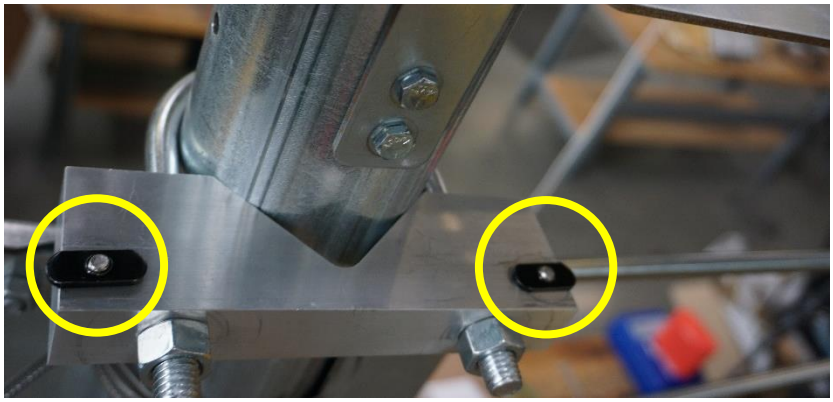


*Figure 1-4: Slide nuts (circled) on the upper U-bolt bracket.*

Remove the PV panel assembly from the box and slide the short, hinged section of mounting rail onto the slide nuts (Figure 1-5). Use 2 people if possible.

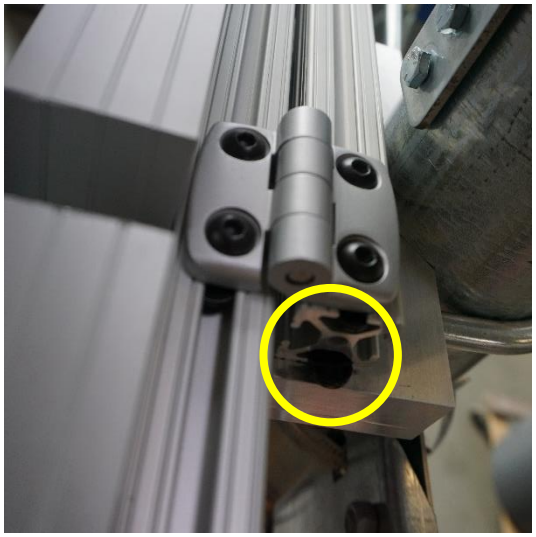


*Figure 1-5: Mounting PV panel assembly to bracket using slide nuts.*

Center PV panel assembly and tighten mounting bolts with the 7/16” wrench (Figure 1-6). Do not overtighten bolts.

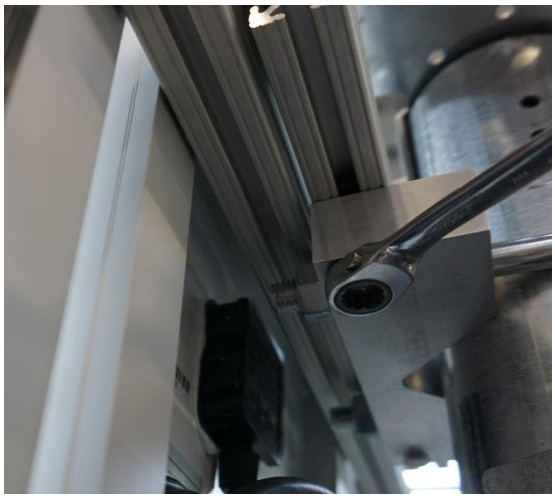


*Figure 1-6*

### 1.4: Attach the angle adjustment boom to PV assembly.

Attach angle boom to the lower mounting rail of PV assembly approximately 4.5” from the left side of the rail (Figure 1-7).

The bolts holding the hinge to the end of the angle boom must be loosened slightly in order to pivot the hinge. Loosen the slide nut on the end of the hinge enough to mount it to the rail. The slide nut is inserted into the channel opposite of the PV panels. Once in position, tighten the bolt inside the hinge with a 3/16” hex key. Allow the angle boom to pivot freely for the time being.


*Figure 1-7*

### 1.5: Mount the angle boom to the tower.

Disassemble the lower U-bolt assembly but leave slide nut/bolt attched through the outer bracket (Figure 1-8).

*Figure 1-8*

Remove the rubber angle boom end cap and insert slide nut/bolt/bracket into channel opposite the SRA tower. Tighten bolt slightly to keep bracket at approximately 3” from the end of the hinge (Figure 1-9).


*Figure 1-9*

Measure 15” down the tower from the upper U-bolt. Mark measurement with permanent marker if desired (Figure 1-10).

Attach lower U-bolt to the tower at this location and 90 degrees clockwise of the upper U-bolt. Insert inner bracket and spacers onto the ends of the U-bolt. Place outer bracket and angle boom through the ends of the U-bolt (Figure 1-9). Tighten nuts with 3/4" wrench. Do not overtighten.

*Figure 1-10: Location of lower U-bolt measured from the upper U-bolt.*

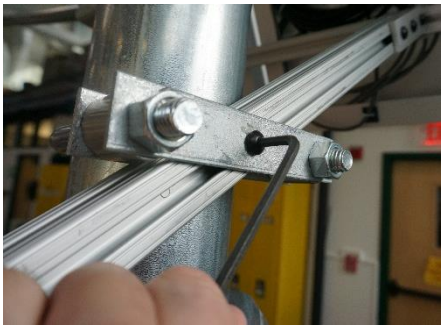
## 1.6: Adjust the PV panel angle.

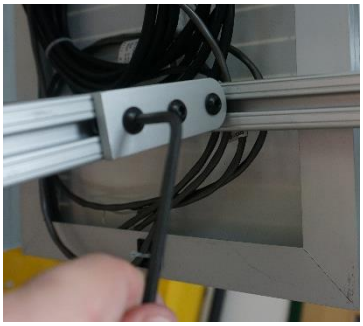
Adjust the panels to your desired angle using the angle boom and verify with angle finder (Figure 1-11). If the boom does not slide freely, then bolts in the system may be too tight. Ensure that the bolts are loose enough to allow movement.


*Figure 1-11*

### 1.7: Secure & tighten all hardware.

Tighten down all hardware sufficiently enough to prevent any unwanted movement (Figures 1-12, 1-13, 1-14).





*Figures 1-12, 1-13, 1-14: Tighten the bolts in the system.*

The system is now ready to be wired to your SymphoniePRO data logger.

## SECTION 2: WIRING AND MOUNTING THE INTERFACE MODULE

The Soiling Measurment Kit comes with an Interface Module used to create usable data for your SymphoniePRO data logger and mounts inside the FRP shelter box on the included DIN rail section.

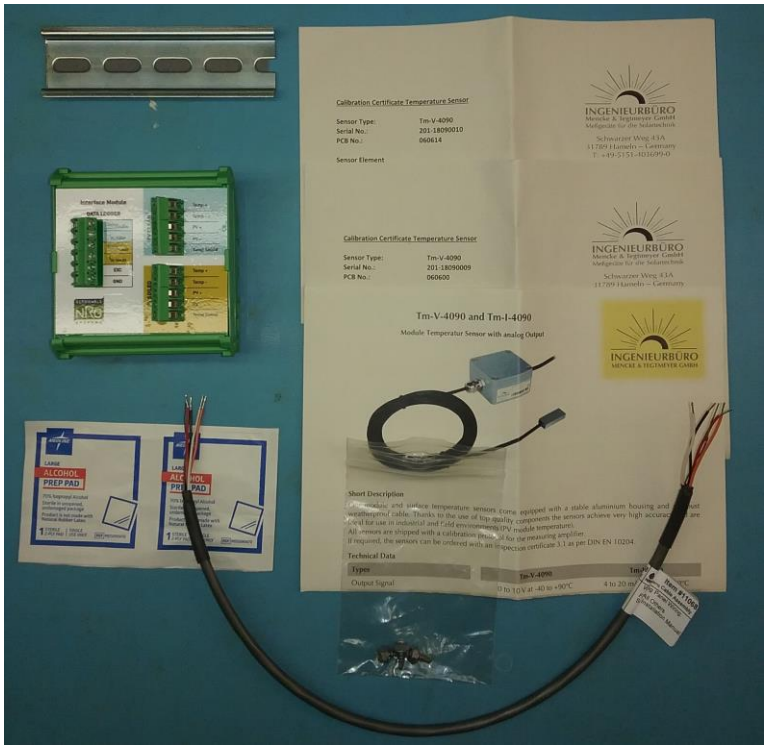



*Figure 2-1: Interface Module, cabling, DIN rail, mounting bolts & IMT Temp Sensor Instructions*

### 2.1: Connect the 4C cable.

Attach the 4C cable to the Interface Module according to Table 2-1. The cable ends are labeled for guidance.

| Wire Color | Interface Module Location | 26-Channel Wiring Panel | 16-Channel Wiring Panel |
|---|---|---|---|
| **Black** | GND | 16-26 | 16, 17, 20-22 |
| **Red** | EXC | 16-19, 20-26 | 16, 17, 20-22 |
| **Orange** | $I_{SC}$ CLEAN | 16-19, 20-26 | 16, 17, 20-22 |
| **White** | $I_{SC}$ SOILED | 16-19, 20-26 | 16, 17, 20-22 |

*Table 2-1*

## 2.2: Mount DIN rail to shelter box back plate.

Unplug and remove the SymphoniePRO wiring panel cable.

Attach DIN rail to the interior of the FRP shelter box approximately 6” from the top using the 3M VHB tape (Figure 2-2).

*Figure 2-2: DIN rail mounted to shelter box backing plate.*

If desired, the DIN rail can be affixed to the back plate using the supplied self-tapping screws.

## 2.3: Wire the PV panels to the interface modules.

Unroll the PV panel and route them down the SRA tower as desired and into the holes on the bottom of the FRP shelter box.

Route through the interior of the shelter box as desired, then attach the ends to the appropriate terminals on the Interface Module (Figure 2-3).

***Note: The [Temp +] and [Temp –] terminals in the PV Clean and PV Soiled sections are left empty.***

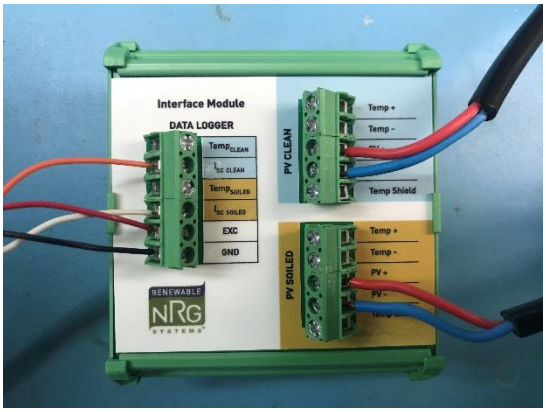



*Figure 2-3: Completed Interface Module wiring.*

## 2.4: Mount the IMT Tm-V-4090 Temperature Amplifier Boxes.

The Clean and Dirty PV panels have IMT Tm-V-4090 temperature sensors mounted on them. The amplifier boxes need to be mounted to the back side of the shelter box with adhesive tape.

1. Double sided tape is adhered to the back of the measuring amplifier box.
2. Unpeel the backing and mount the boxes to back right of the shelter box (if looking at it straight on), as shown in Figure 2-4 below.
3. Hold the box in place for at least a minute to properly bond the box to the shelter box. **Note: the amplifier boxes should be mounted horizontally with a drip loop on either end of the cable to avoid water ingress.**

*Figure 2-4: IMT Amplifier Box Installation*

## 2.5: Connect PV panel to the SymphoniePRO logger & iPack.

Wire the PV panel labeled “Logger Power” to the PV terminals on the NRG iPack (Figure 2-5). The cable can be routed as desired from the panel, down the tower, and into the FRP shelter box.

*Figure 2-5: iPack charging circuit wiring.*

## 2.6: Affix Interface Module to DIN rail & wire snesor signals to the logger wiring panel.

Attach the wired Interface Module onto the DIN rail and connect the other end of the 4C cable to the wiring panel. Connect the two IMT back of the panel temprature sensors to the wiring panel.

The Soiling Measurement Kit consists of four inputs:

- Two 0-30 V temperatures inputs - Temperature 'CLEAN' & Temperature 'SOILED':
  - Each input requires a #9135 P-SCM cards.
  - The sensor signals come from the IMT amplifier boxes.
  - Both sensors require 12v DC excitation voltage.

- Two 0-5 V inputs PV inputs - $I_{sc}$CLEAN and $I_{sc}$SOILED:
  - Each input requires a #9132 P-SCM cards.
  - The sensor signals come from the Interface Module.
  - The $I_{sc}$ outputs require a single 12V excitation (EXC) and ground connection (GND).

Table 2-2 provides an example of how the sensor wires can be connected to the wirng panel (any combination of P-SCM channels can be used ~ 20-26).

| Channel | Sensor Output | Wire Color | Terminal |
|---|---|---|---|
| **21 Temprature 'CLEAN'** | Power + | Red | EXC |
| | Power/Signal – | Thin Black | GND |
| | Signal Output | Brown | SIG + |
| | Sheild | Thick Black | SHD |
| **22 Temprature 'SOILED'** | Power + | Red | EXC |
| | Power/Signal – | Thin Black | GND |
| | Signal Output | Brown | SIG + |
| | Sheild | Thick Black | SHD |
| **24 $I_{sc}$CLEAN** | Interface Module Power* | Red | EXC |
| | Interface Module Ground* | Black | GND |
| | IscCLEAN PV Signal | Orange | SIG + |
| **26 $I_{sc}$SOILED** | IscSOILED PV Signal | White | SIG+ |

***Interface Module Power and Ground can be placed on either IscClean or IscSoiled channel***

*Table 2-2: Example Configuration*

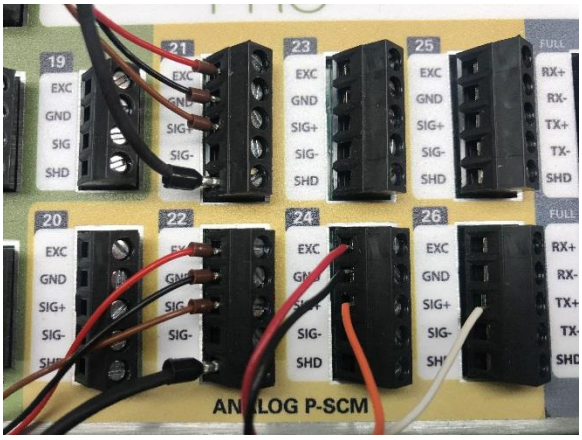



*Figure 2-6*

### 2.7: Reconnect wiring panel to the logger.

Reattach your SymphoniePRO wiring panel cable. The Soiling Measurement Kit is now completely wired and ready to be programed into your SymphoniePRO logger.

## SECTION 3: LOGGER PROGRAMMING & CONFIGURATION

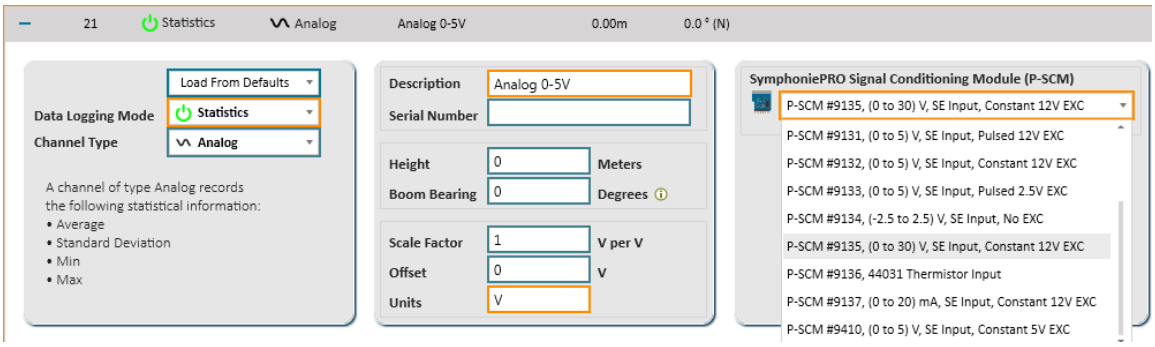
Open SymphoniePRO Desktop Application, connect to the logger and navigate to the **Channels** tab in the sidebar. Expand the desired channels for the Soiling Measurement Kit.

For the purposes of these instructions, channels 21, 22, 24, 26 are used.

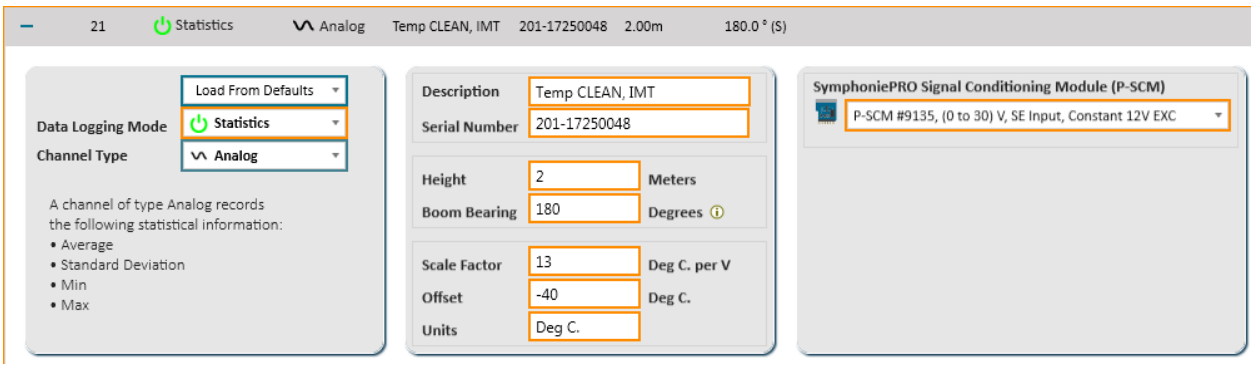
### 3.1: Programming the SymphoniePRO logger.

***Temperature Clean:***

- Expand Channel 21 and choose “Custom Analog 0-1V” from the “Load From Defaults” drop-down menu.
- Choose “P-SCM #9135, (0 to 30) V, SE Input, Constant 12V EXC” from the SymphoniePRO Signal Conditioning Module (P-SCM)” drop-down menu.

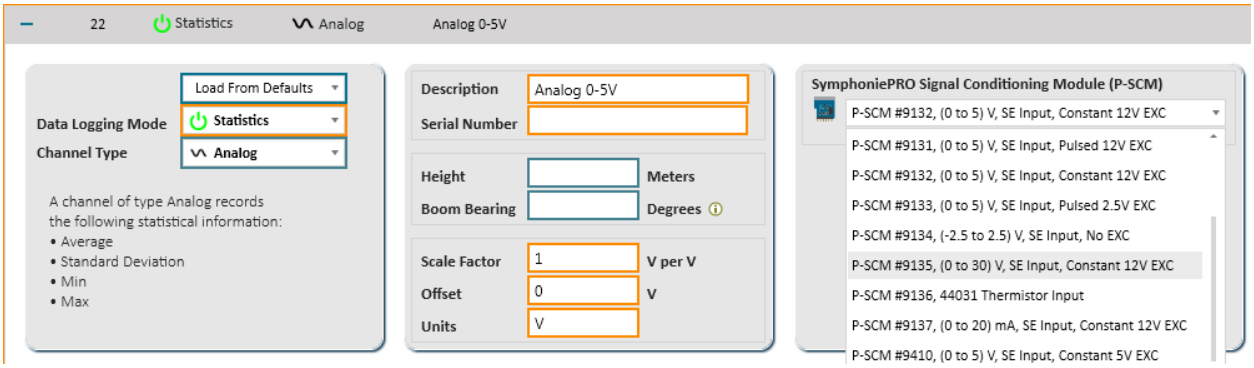



- Edit the **Description**, **Scale Factor**, **Offset** and **Units** as show in the image below:

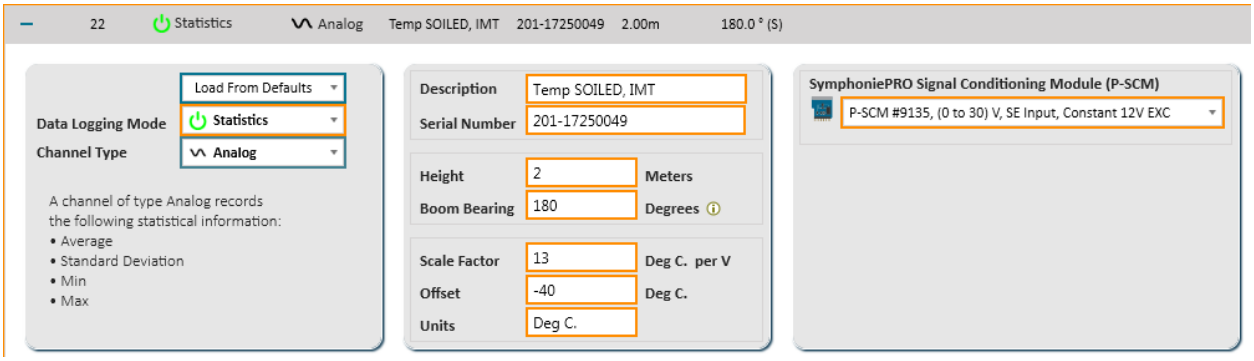


### *Temperature Soiled:*

- Expand Channel 22 and choose “Custom Analog 0-1V” from the “Load From Defaults” drop-down menu.
- Choose “P-SCM #9135, (0 to 30) V, SE Input, Constant 12V EXC” from the SymphoniePRO Signal Conditioning Module (P-SCM)” drop-down menu.

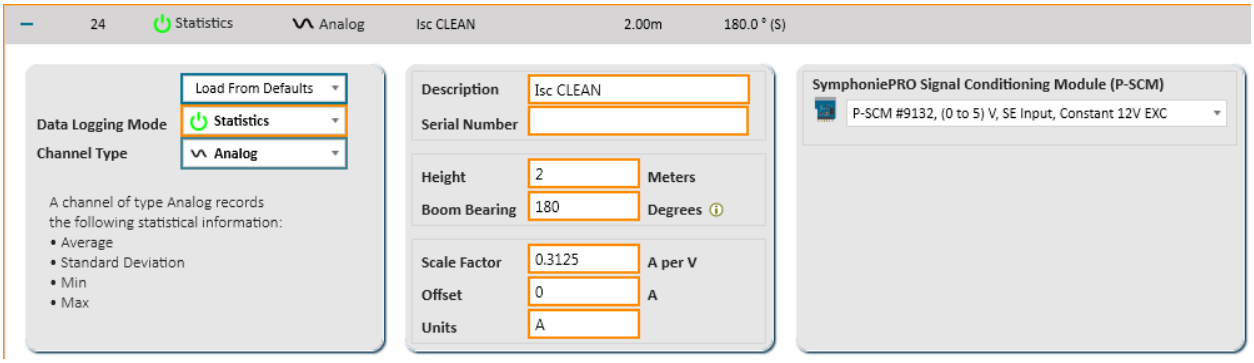



- Edit the **Description**, **Scale Factor**, **Offset** and **Units** as show in the image below:



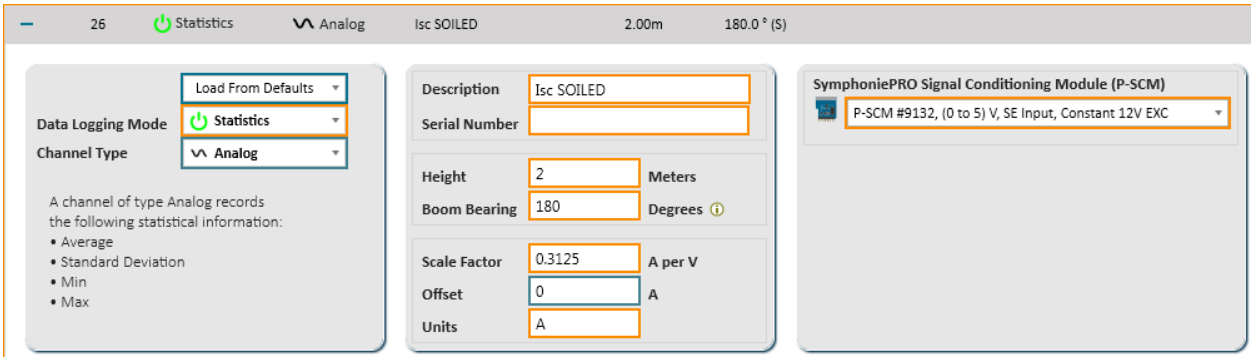

### *$I_{SC}$Clean:*

- Expand Channel 24 and choose “Custom Analog 0-5V” from the “Load From Defaults” drop-down menu.
- This will auto select “P-SCM #9132, (0 to 5) V, SE Input, Constant 12V EXC” from the SymphoniePRO Signal Conditioning Module (P-SCM)” drop-down menu.
- Edit the **Description**, **Scale Factor**, **Offset** and **Units** as show in the image below:




### *$I_{sc}$Soiled:*

- Expand Channel 26 and choose "Custom Analog 0-5V" from the "Load From Defaults" drop-down menu.
- This will auto select "P-SCM #9132, (0 to 5) V, SE Input, Constant 12V EXC" from the SymphoniePRO Signal Conditioning Module (P-SCM)" drop-down menu.
- Edit the **Description**, **Scale Factor**, **Offset** and **Units** as show in the image below:



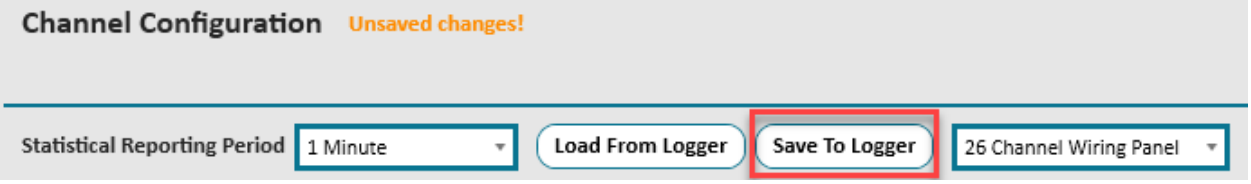

### *3.1.2 Scale Factors and Offsets Summary*

| Signal Input | Channel | Input Type | Scale Factor | Offset | Units |
|---|---|---|---|---|---|
| **TempCLEAN** | 21 | Analog 0-30 V | 13 | -40 | Deg. C |
| **$I_{sc}$CLEAN** | 24 | Analog 0-5 V | 0.3125 | 0 | A |
| **TempSOILED** | 22 | Analog 0-30 V | 13 | -40 | Deg. C |
| **$I_{sc}$SOILED** | 26 | Analog 0-5 V | 0.3125 | 0 | A |

Table 3-1

### *3.1.3 Saving the Channel Configuration*

When all the channel configurations have been edited and are ready, click the "Save To Logger" button at the top of the Channel Configuration page.




***Note: It is a good idea to save the .LGR configuration file on your computer as well as to the logger. Go to the Logger drop down menu in the upper right hand corner of the application screen and select "Save Instrument Configuration File."***

## SITE MAINTENANCE

Back-of-panel temperature and short-circuit current for each panel are continuously measured by the system, and (typically) averaged every one minute.

The clean panel should be regularly cleaned thoroughly with deionized water and a soft non-abrasive cloth (about once a week or as recommended by your analyst). Deionized water is free from calcium and salt so it will not leave deposits on your PV panels.

Certain sites may have very abrasive mineral deposits, so be mindful of abrasion when cleaning the PV panels.

Rainfall also has a natural cleaning effect and should also be recorded at the site with an instrument such as a tipping rain bucket connected to the same data logger.

## DATA PROCESSING

The measured values (Temp CLEAN, Isc CLEAN, Temp SOILED, Isc SOILED) can be used to determine a Soiling Ratio which compares the soiled PV output to the clean PV output. By monitoring the soiling ratio over time and using additional analysis techniques, the potential impact of soiling losses on a PV farm's energy production can be characterized.

For a quick check, the simplest of methods is to divide the soiled PV Isc by the clean PV Isc. Note that other, more complex methods are often utilized.

One good reference paper which defines a soiling ratio is called *"Accurately Measuring PV Soiling Losses with Soiling Station Employing Module Power Measurements"*. If you are unsure how to process the data, please consult with your analyst, as there are various ways to handle the data.