

## Introduction

These instructions explain how to use the NRG Systems 35W Soiling Measurement Kit with a SymphoniePRO Data Logger. The physical installation of kit #15152, the complete 35W tower-mounted kit is covered first, followed by wiring and SymphoniePRO logger configuration for all NRG Soiling Measurement Kit designs.

Kit #15152 utilizes the NRG PVT1 PV Temperature Sensor to measure back-of-module (BoM) temperature. The previous version of the Soiling Measurement Kit (#14586) utilized IMT BoM temperature sensors. Please contact NRG Technical Services for Rev 4.0 of this document, which contains information about kit #14586.

The standard Soiling Measurement Kit (#15152) is designed to use the NRG Pipe Boom mounting system. The procedure for mounting that system to an NRG Solar Tower is in the section below.

### *Using Alternative Mounting Methods*

When using the Soiling Measurement Kit with a different mounting design, skip this section and use the mounting instructions that pertain to your specific design instead. The wiring & configuration procedures remain the same though and are covered in these instructions in subsequent sections.

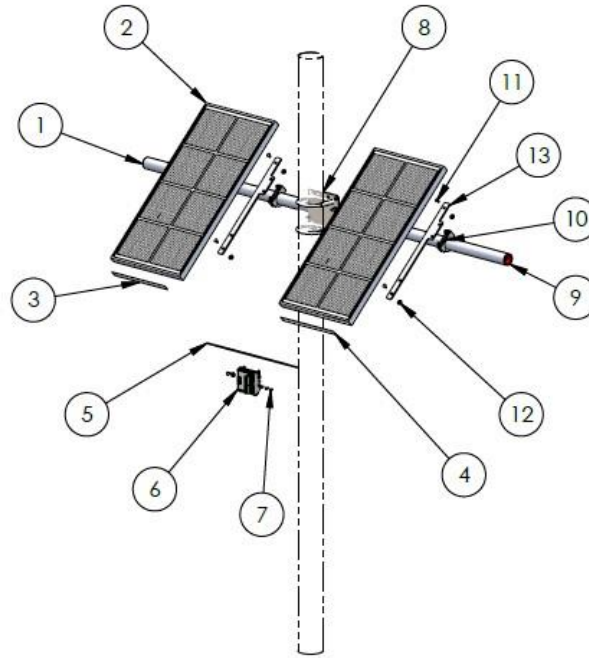


## #15152: Parts/BOM

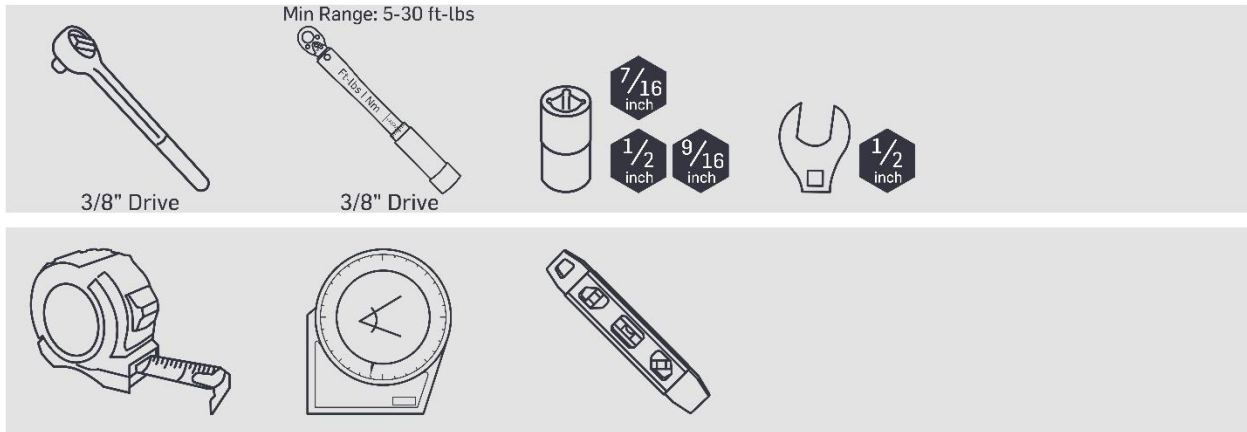
NRG Part Number	Part Description	Part Specification	Qty	Diagram Key
14593	Mounting Boom	6061 Aluminum   Sch. 40   1.65" nominal OD   72" length	1	1
15151	(2) 35 W PV Panels	Matched pair for soiling w/ PVT1 Back of Module Temperature Sensors attached.	1	2
11044	Clean label	Outdoor label - "Clean"	1	3
11046	Dirty label	Outdoor label - "Dirty"	1	4
11068	6C cable	6C   18" long	1	5
15210	Interface Module	Soiling Station Interface Module	1	6
11233	Self-tapping Screw	#8x.375" Self-Tapping Hex Screw	3	7
14092	Mounting Bracket	0.17" Thickness   Stainless	1	8
14232	Clamping U-bolt	3.625" ID   Zinc-plated steel   With nuts	2	8
14099	Clamping U-bolt	1.75" ID   Galvanized steel   With nuts	2	8
14391	Pipe Cap	Pipe Cap   1.25" ID nominal	2	9
14223	Clamping U-Bolt	1.75" ID   5/16-18 thread   w/ Clamp	5	10
15870	Carriage Bolt	1/4-20 thread   .75" length   Stainless	9	11
15869	Locknut	Serrated flange   1/4-20 thread   Stainless	9	12
15651	Mounting Plate	.19" thickness   Aluminum	4	13



**Exploded Diagram**



**#15152: Assembly Tools**

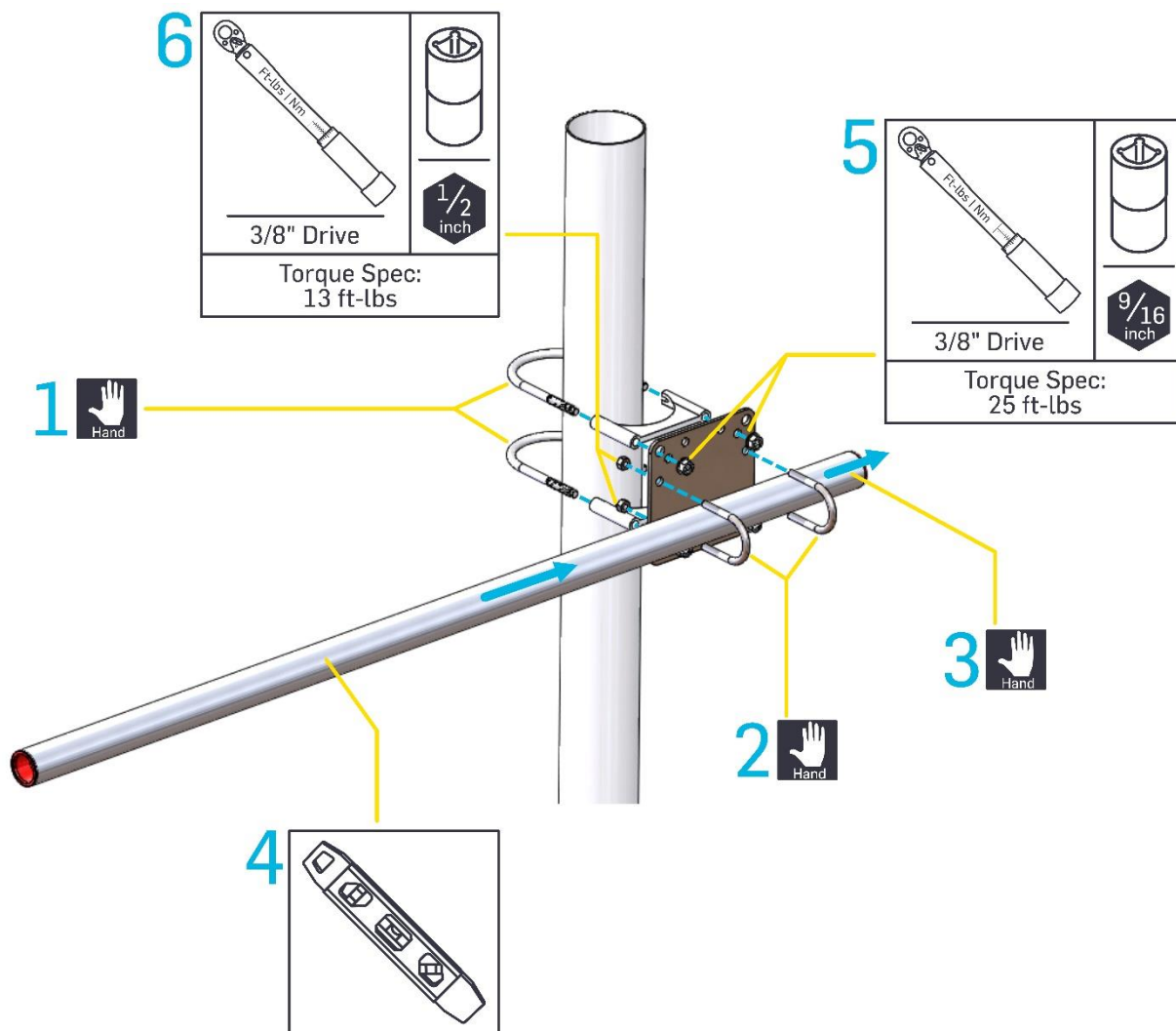




## Procedures

### Boom Mounting & Assembly

1. Place the bracket against the tower tube and feed two 3.625" U-bolts around the tower, through the clamping piece, and through the appropriate holes in the bracket.
2. Feed the 1.75" galvanized U-bolts through the appropriate holes in the bracket, from the side opposite of the tower. Thread the galvanized nuts onto the end threads of each U-bolt.
3. Feed the Sch. 40 aluminum pipe through the galvanized U-bolts to the desired location, depending on the intended length of boom on each side of the tower.
4. Orient the boom to your desired heading and level.
5. Torque the 3.625" U-bolt nuts to spec.
6. Torque the 1.75" U-bolt nuts to spec.

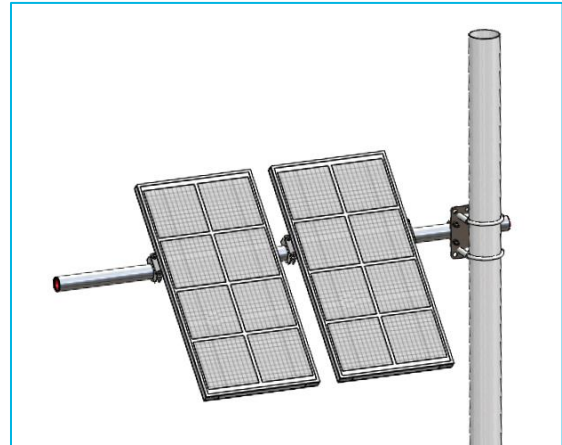
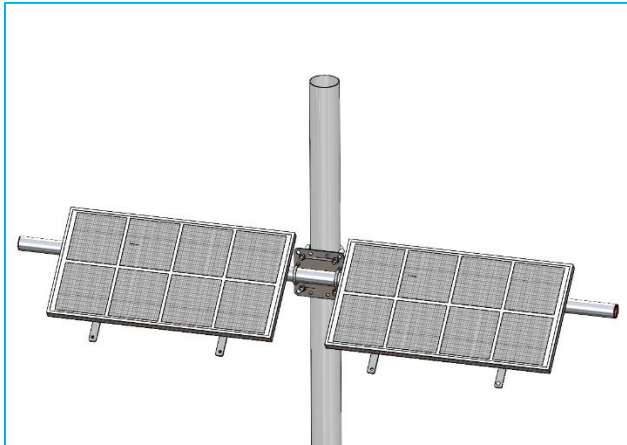




## 35W PV Panel Pair Mounting

### *PV Panel Orientation*

The PV Mounting Plates (#15869) are designed to accommodate horizontal layout (“landscape”) or vertical (“portrait”) of the 35W PV panels.



The procedure below shows the panels being mounted in portrait orientation. Where appropriate, notes have been added for mounting the panels in the landscape orientation.

### *Procedure*

- 1 Determine if the panels will be installed in a horizontal layout (“landscape”) or vertical (“portrait”).

Horizontal is the ideal orientation but may not be possible due to the layout of the tower or the amount of boom available on one side of the mounting bracket.



*Ensure that no shadowing of the PV panels by other booms and sensors occurs at the desired mounting location. This is important for the collection of accurate data by the panels.*



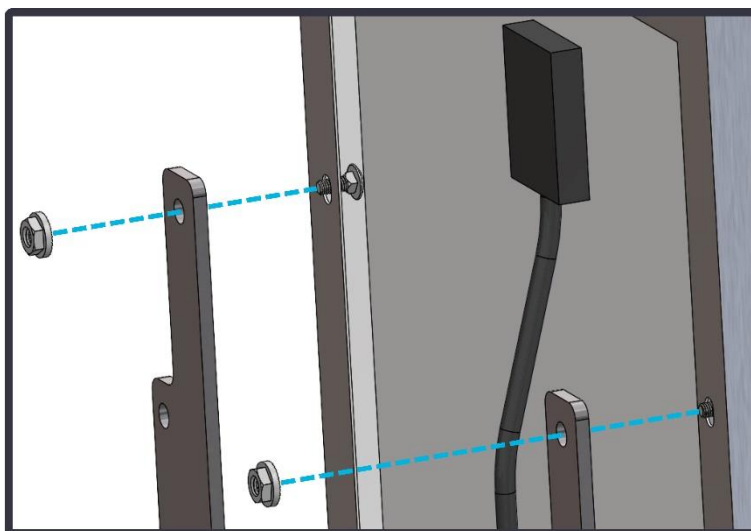
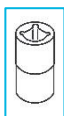
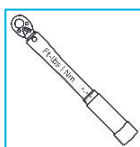
**When installing PV panels in the horizontal layout**, complete Step 3 (Attach the PV Mounting Plates to the pipe boom) prior to Step 2 (Attach the PV panels to the PV Mounting Plates).

The clamping U-bolts are covered by the PV panels in the horizontal layout, making it more difficult to thread nuts onto the U-bolts.

## 2 Attach the 35W PV panels to the PV Mounting Plates.

Use the 1/4-20 carriage bolts (#15870) & serrated flange locknuts (#15869) to attach the PV Mounting Plates (#15651) to the 35W PV panels.

**Torque locknuts to 8 ft-lbs.**

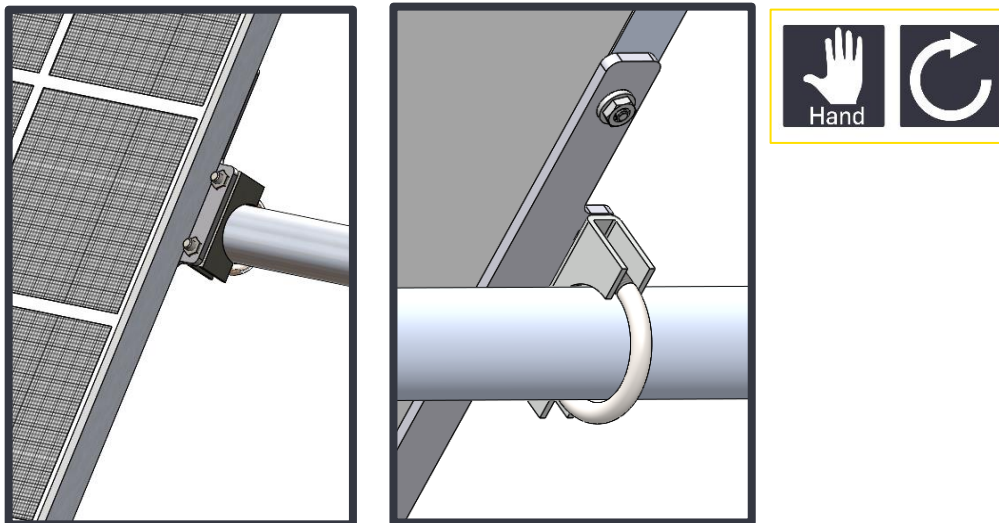


The PV Mounting Plates can be attached to the 35W PV panels in either portrait or landscape orientation.



### 3 Attach the PV Mounting Plates to the pipe boom.

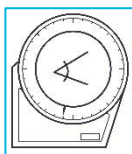
Install two clamping U-bolts (#14223) on each PV Mounting Plate in the holes located outside the PV panel frame.



Keep the U-bolts loose so the PV panel can slide on the boom.

### 4 Install panels on mounting boom and set to desired angle.

- Slide the panels onto the mounting boom
- Tighten slightly so they stay in place but can be adjusted by hand.
- Use an angle finder to set the angle of the panels to the same angle as the Production PV panels on the solar farm.
- Once at the correct angle, tighten the U-bolts until they are locked in place.
- Clean the bottom edge of the PV panels with an alcohol wipe to remove dirt.



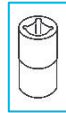


## Solar | 35W Soiling Measurement Kit #15152

### 5 Fix the panels in place on the boom.

Once the panels are at the desired location and correct angle, torque the U-bolt nuts in place to secure them.

- Torque specifications: **13 ft-lbs (17.6 Nm)**



Portrait



Landscape



### 6 Label the panels using the “CLEAN” and “DIRTY” stickers supplied with the kit.



The panels are now mounted, secured, and ready to be connected to the Interface Module.

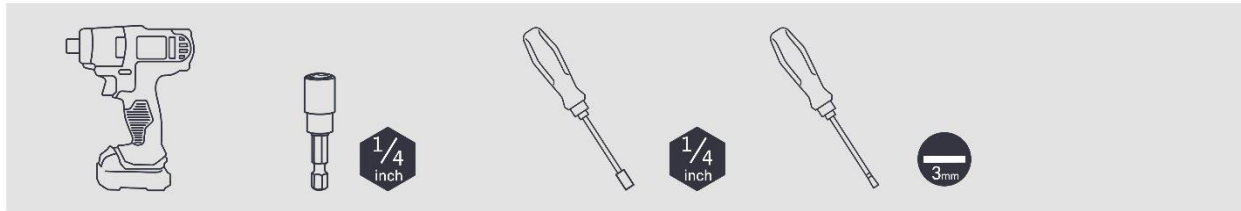






## Logger Wiring & Configuration

### Wiring Tools

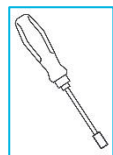
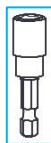
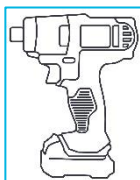


### SymphoniePRO Wiring Procedure

- 1 Install the DIN rail section in the shelter box.
  - Unplug and remove the SymphoniePRO wiring panel cable.
  - Attach DIN rail to the back plate of the FRP shelter box approximately 9" from the bottom of the shelter box, using the 3M VHB tape affixed to the back of the rail.



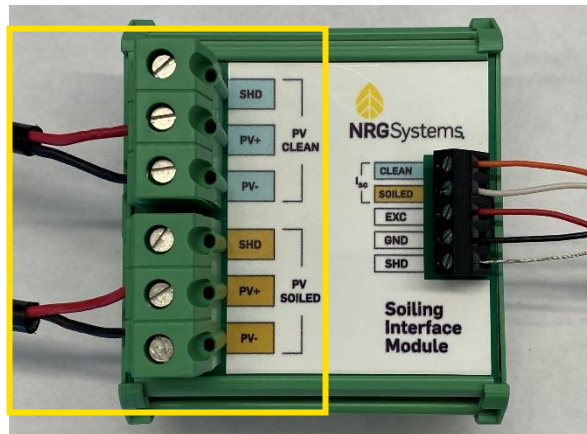
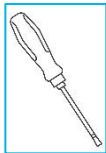
If desired, the DIN rail can be affixed to the back plate using the supplied self-tapping screws.



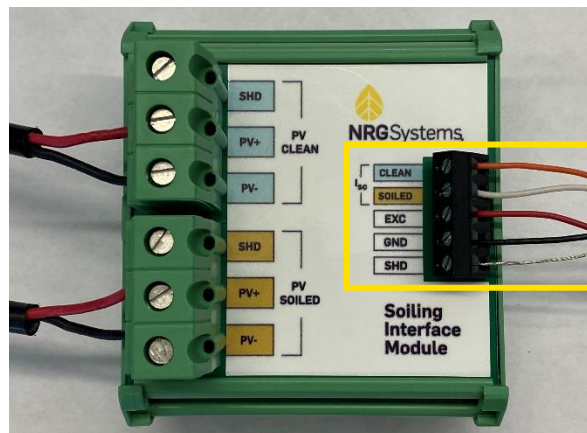
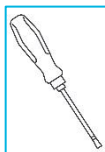


**2 Wire PV panels into Interface Module.**

- Feed the PV panel wires down the tower and into the shelter box.
- Wire the leads from the “Clean” PV panel into the ‘PV Clean’ terminals.
- Wire the leads from the “Dirty” PV panel into the ‘PV Soiled’ terminals.



**3 Wire the 4C cable to the Interface Module outputs.**



**4 Attach the Interface Module to the DIN rail.**

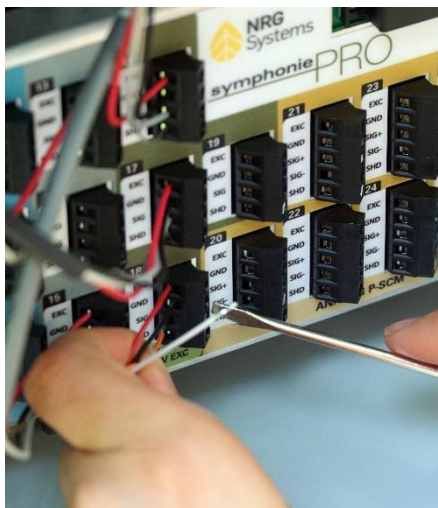
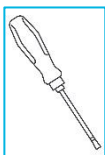
The Interface Module snaps into place on the DIN rail. The electronics enclosure is a standard piece designed for this purpose.

After mounting to the DIN rail, feed the short 4C cable down under the 26-Channel Wiring Panel and to the terminals they will be connected to.



**5 Wire Interface Module into logger wiring panel.**

Wire the short 4C cable from the Interface Module into the data logger wiring panel.



The following channels may be used:

- Channels: 16-19 | No P-SCM
- Channels 20-26 | P-SCM #9132

Interface Module Wiring Key:

Interface Module	Wire Color	Channel Input
Isc Clean	Orange	CH 18 SIG
Isc Soiled	White	CH 19 SIG
EXC	Red	CH 18 EXC
GND	Black	CH 18 GND

**Note:** When using a different set of channels than those shown above, connect the EXC & GND wires to the same channel as the Isc Clean wire.



**6 Wire PVT1 into the wiring panel.**

Feed the wires from the PVT1 Back-of-Module temperature sensors into the shelter box and to the wiring panel.



- Channels: 20-26
- P-SCM: #9420



PVT1 wiring key:

PVT1 Wire Color	Logger Terminal
Red	EXC
Black	GND
Green	SIG+
White	SIG-
Bare Wire	SHD

**7 Install P-SCM cards into the PRO logger.**

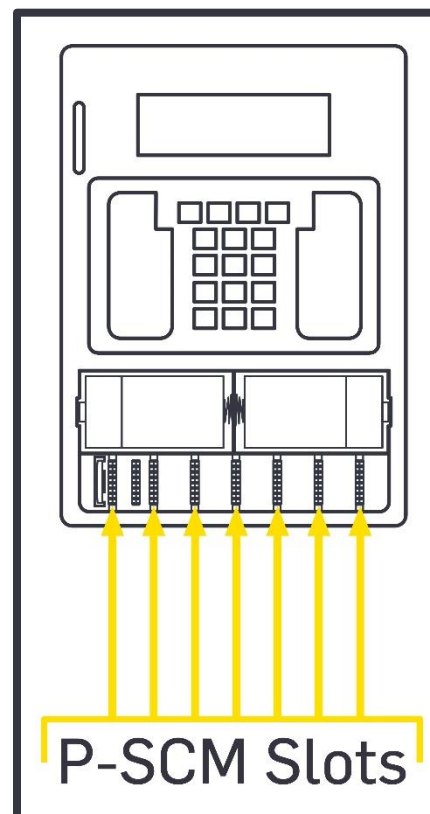
- Install each P-SCM in the channels corresponding to each sensor wire connection on the wiring panel.
- The P-SCM slots are labeled with their channel.

Isc Clean and Dirty:

- Channels: 16-19 | No P-SCM
- Channels 20-26 | P-SCM #9132

NRG PVT1 Back-of-Module Temperature:

- Channels 20-26 | P-SCM #9420





## SymphoniePRO Configuration

Use the SymphoniePRO Desktop App to do the following configuration steps.

### 1 Configure the Isc Channels:

Isc Clean:

- **If using Ch. 16-19**, click **Load from Defaults** and choose “NRG RH5X Humidity” from the drop-down
- **If using Ch. 20-26**, click **Load from Defaults** and choose “Custom Analog (0-5V)” from the drop-down
- Change the **Description** to “Isc Clean”
- Enter **Height** and **Boom Bearing** (the direction the panels are facing)
- Enter a **Scale Factor** of “3.125”, an **Offset** of “0” and **Units** “A” (for Amps)

The screenshot shows the configuration interface for channel 18, named 'Isc Clean'. The top bar displays '18', 'Statistics', 'Analog', 'Isc Clean', '0.00m', '0.0° (N)', '3.125', '0', and 'A'. The main configuration area is divided into three sections:

- Data Logging Mode:** 'Load From Defaults' (dropdown), 'Statistics' (selected), and 'Channel Type' 'Analog' (selected).
- Description:** 'Isc Clean' (text input), 'Serial Number' (empty text input), 'Height' '0' (text input) 'Meters', and 'Boom Bearing' '0' (text input) 'Degrees'.
- Sensor Transfer Function:** 'Scale Factor' '3.125' (text input) 'A per V', 'Offset' '0' (text input) 'A', and 'Units' 'A' (text input).
- Excitation:** 'Mode' 'Pulsed On' (dropdown) and 'Voltage' '5 V' (dropdown).

A note on the left states: 'A channel of type Analog records the following statistical information: Average, Standard Deviation, Min, Max.'

Repeat the configuration steps for the channel being used for Isc Dirty:

The screenshot shows the configuration interface for channel 19, named 'Isc Soiled'. The top bar displays '19', 'Statistics', 'Analog', 'Isc Soiled', '2.00m', '180.0° (S)', '3.125', '0', and 'A'. The main configuration area is divided into three sections:

- Data Logging Mode:** 'Load From Defaults' (dropdown), 'Statistics' (selected), and 'Channel Type' 'Analog' (selected).
- Description:** 'Isc Soiled' (text input), 'Serial Number' (empty text input), 'Height' '2' (text input) 'Meters', and 'Boom Bearing' '180' (text input) 'Degrees'.
- Sensor Transfer Function:** 'Scale Factor' '3.125' (text input) 'A per V', 'Offset' '0' (text input) 'A', and 'Units' 'A' (text input).
- Excitation:** 'Mode' 'Constant On' (dropdown) and 'Voltage' '12 V' (dropdown).

A note on the left states: 'A channel of type Analog records the following statistical information: Average, Standard Deviation, Min, Max.'

**Configure the PVT1 Channels:**

2

## PV Temp Clean:

- The NRG PVT1 sensors must go on channels 20-26
- Click **Load from Defaults** and choose “NRG PVT1 PV Temperature Sensor” from the drop-down
- Change the **Description** to “PV Temp Clean”
- Enter the **Serial Number** from the end of the sensor cable.
- Enter **Height** and **Boom Bearing** (the direction the panels are facing)
- Leave the **Scale Factor** and **Offset** as they are.
- Make sure there is a P-SCM #9420 is installed in the P-SCM compartment.

The screenshot shows the configuration interface for channel 20, titled 'Analog (P-SCM)'. The channel is configured for 'PV Temp Clean' with a 'Thermistor' channel type. The 'Data Logging Mode' is set to 'Statistics'. The 'Description' is 'PV Temp Clean', and the 'Serial Number' is empty. The 'Height' is 2 Meters and the 'Boom Bearing' is 180 Degrees. The 'Sensor Transfer Function' has a 'Scale Factor' of 1, an 'Offset' of -273.15, and 'Units' set to 'C'. The 'SymphoniePRO Signal Conditioning Module (P-SCM)' is set to 'P-SCM #9420 (0-5)V, Diff Input, Const 15uA No Exc, 2/4w'. The 'Calculation Type' is 'Thermistor: Steinhart-Hart', with coefficients A: 0.001032, B: 0.0002387, and C: 0.000000158.

Repeat the configuration steps for the channel being used for PV Temp Dirty:

The screenshot shows the configuration interface for channel 21, titled 'Analog (P-SCM)'. The channel is configured for 'PV Temp Soiled' with a 'Thermistor' channel type. The 'Data Logging Mode' is set to 'Statistics'. The 'Description' is 'PV Temp Soiled', and the 'Serial Number' is empty. The 'Height' is 2 Meters and the 'Boom Bearing' is 180 Degrees. The 'Sensor Transfer Function' has a 'Scale Factor' of 1, an 'Offset' of -273.15, and 'Units' set to 'C'. The 'SymphoniePRO Signal Conditioning Module (P-SCM)' is set to 'P-SCM #9420 (0-5)V, Diff Input, Const 15uA No Exc, 2/4w'. The 'Calculation Type' is 'Thermistor: Steinhart-Hart', with coefficients A: 0.001032, B: 0.0002387, and C: 0.000000158.



### 3 Configure Soiling Ratio on a Calculated Channel.

The SymphoniePRO can calculate the soiling ratio from the Isc Clean and Isc Soiled inputs. To activate this feature, scroll down to channel 100.

- Choose “Ratio” from the **Calculation Type** drop down menu
- Edit the **Description** to say “Soiling Ratio”
- Edit the **Units** to say “Ratio”
- Choose the **Isc Soiled** channel as the **Numerator Source**
- Chose the **Isc Clean** channel as the **Denominator Source**

The screenshot shows the configuration page for a calculated channel in the SymphoniePRO software. The channel is named 'Soiling Ratio' and is located at channel 100. The configuration is as follows:

Field	Value
Calculation Type	Ratio
Data Logging Mode	Statistics
Channel Type	Calculated
Description	Soiling Ratio
Units	Ratio
Numerator Source	Channel: 19 - Isc Soiled
Denominator Source	Channel: 18 - Isc Clean

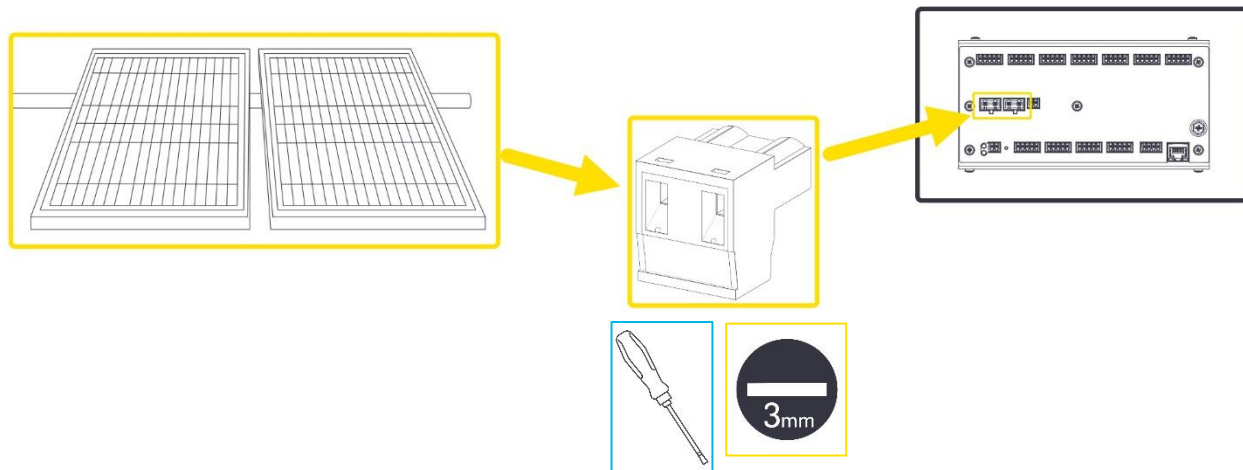
Ratio is the result of dividing two values. To create a ratio, two channels of the same type (i.e., analog or RS485) need to be selected – one channel for the numerator and another channel for the denominator.





**LOGR-S Wiring**

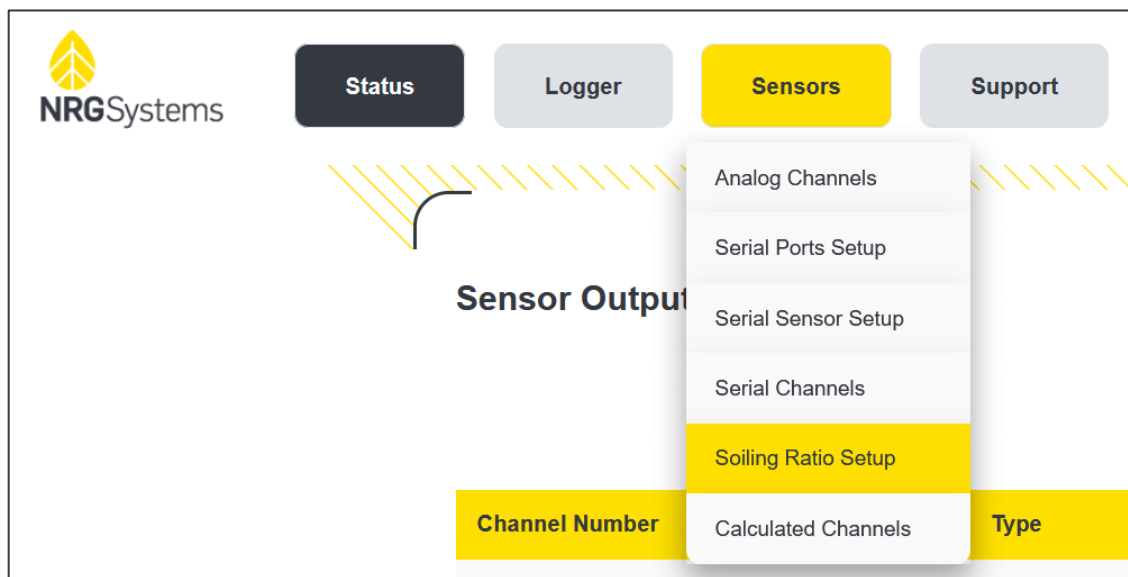
Connect the leads from the “Clean” & “Dirty” PV panels to the dedicated terminals on the front of the LOGR-S enclosure. They are labeled “PV SOIL” & “PV CLEAN” above each removable terminal block.



**LOGR-S Configuration**

Use the LOGR-S Web Interface to complete the following steps.

- 1 Select **Soiling Ratio Setup** from the Sensors dropdown menu on the web server.







- 2 Check the **Compute** checkbox in the **Soiling Ratio Setup** section and select the channel that matches a POA Irradiance measurement with the dropdown menu. Click the yellow **Save** button.

The screenshot shows the 'Soiling Ratio Setup' interface. It includes a 'Compute Soiling Ratio' section with a checked 'Compute' checkbox. Below this is a 'POA Irradiance Channel' dropdown menu set to '101-Hukseflux SR30-Irradiance'. There are two input fields: 'POA Irradiance' with the value '1009.3 W/m^2' and 'Soiling Ratio' with the value '1.000'. At the bottom right, there are three buttons: 'Back', 'Cancel', and a yellow 'Save' button.

### ***LOGR-S Panel Cleaning***

When the “Clean” panel has been cleaned, access this page and click the yellow **Clean Panel** button to record the event in the log.

The screenshot shows the 'Panel Cleaning' interface. It features a 'Last Cleaning Time' input field containing the timestamp '2022-01-04T20:32:55Z'. To the right of this field is a yellow 'Clean Panel' button.



### Site Maintenance

- Back-of-panel temperature and short-circuit current for each panel are continuously measured by the system, and (typically) averaged each 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 bucket rain gauge 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.
- The simplest of methods is to divide the soiled PV Isc by the clean PV Isc, which can be recorded by the data logger by activating a Calculated Channel.
- 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.