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’s technical support team for Rev 4.0 of this document, which contains information about kit #14586.

NRG Kit #15152 | 35W Tower-Mounted Soiling Measurement Kit

Mounting Procedures

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.

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.

Parts/BOM

<table>
<thead>
<tr>
<th>NRG Part Number</th>
<th>Part Description</th>
<th>Part Specification</th>
<th>Quantity</th>
<th>Diagram Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>14394</td>
<td>Mounting Boom</td>
<td>Boom, Schedule 40, 72”</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>15151</td>
<td>(2) 35 W PV Panels</td>
<td>Matched pair for soiling w/ PVT1 Back of Module Temperature Sensors attached.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>11044</td>
<td>Clean label</td>
<td>Outdoor label, “Clean”</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>11046</td>
<td>Dirty label</td>
<td>Outdoor label, “Dirty”</td>
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<td>4</td>
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<tr>
<td>11068</td>
<td>6C cable</td>
<td>Cable, 6C, 18” long</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>15210</td>
<td>Interface Module</td>
<td>Soiling Station Interface Module</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>11233</td>
<td>Self-tapping Screw</td>
<td>#8x.375” Self-Tapping Hex Screw</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>14488</td>
<td>Mounting Bracket</td>
<td>Includes 2 x 3.625” ID U-bolt and 2 x 1.75” OD U-bolt mounting hardware</td>
<td>1</td>
<td>8</td>
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<tr>
<td>14391</td>
<td>Pipe Cap</td>
<td>Cap, Pipe, 1.25” Nominal</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>14223</td>
<td>Clamping U-Bolt</td>
<td>1.75” ID, 0.3125 Thread, w/ Clamp</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>14622</td>
<td>U-Bolt Plate</td>
<td>Plate, U-bolt, 0.3125” Zinc</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>
Exploded Diagram

Assembly Tools

3/8" Drive

Min Range: 10-30 ft-lbs
Pipe Boom Assembly & Mounting

1. Place the bracket against the tower tube and feed a 3.625” U-bolt (the larger-sized of the two types) around the tower, through the clamping piece, and through the appropriate holes in the bracket.
   - The bracket is symmetrical, so exact orientation does not matter.
   - Thread on the nuts and hand-tighten.
   - Repeat with the second 3.625” U-bolt.

2. With both U-bolts in place around the tower and through the bracket, slide the assembly to the desired location on the tower.
   Tighten with a ratchet & socket just enough to keep the bracket in place.

3. 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.
4 Feed the 1.25” aluminum pipe through the galvanized U-bolts to the desired location, depending on the intended length of boom on each side of the tower. Once in place, tighten with a ratchet & socket just enough to prevent it from moving.

5 Confirm that the bracket and boom are level and adjust as needed. While the boom is the most important piece to be level, confirming that the bracket is also level and square to the boom & tower will make the process easier.

Once satisfied, tighten the U-bolt nuts to the following specifications:

- NRG #14232 | 3.625” ID U-bolt | 25 ft-lbs (33.9 Nm)
- NRG #14099 | 1.75” Galvanized U-bolt | 13 ft-lbs (17.6 Nm)

The boom can now be used to mount PV panels, pyranometers, and other sensors to the tower.
35W PV Panel Pair Mounting

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.

**NOTICE** 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.

2 Assemble 35W PV panel mounting hardware – Items #15151, #14223 & #14622.

Install two U-bolts (#14223) on each panel in the holes that correspond to the desired orientation. Use the U-bolt plate (#14622) on the inside face of the panel frame, in between the frame and the nuts, to reduce stress on the frame.

Keep the U-bolts loose so they will slide onto the mounting boom.

3 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.
4 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)**

5 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.
**Wiring**

**Wiring Tools**

![Wiring Tools Image](image)

**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.

![Wiring Procedure Image](image)

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

![Affixing DIN Rail Image](image)
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:**

<table>
<thead>
<tr>
<th>Interface Module</th>
<th>Wire Color</th>
<th>Channel Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isc Clean</td>
<td>Orange</td>
<td>CH 18 SIG</td>
</tr>
<tr>
<td>Isc Soiled</td>
<td>White</td>
<td>CH 19 SIG</td>
</tr>
<tr>
<td>EXC</td>
<td>Red</td>
<td>CH 18 EXC</td>
</tr>
<tr>
<td>GND</td>
<td>Black</td>
<td>CH 18 GND</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>PVT1 Wire Color</th>
<th>Logger Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>EXC</td>
</tr>
<tr>
<td>Black</td>
<td>GND</td>
</tr>
<tr>
<td>Green</td>
<td>SIG+</td>
</tr>
<tr>
<td>White</td>
<td>SIG-</td>
</tr>
<tr>
<td>Bare Wire</td>
<td>SHD</td>
</tr>
</tbody>
</table>

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
Programming the PRO Logger

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

1. Program 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)

Repeat the programming steps for the channel being used for Isc Dirty:
Program 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.

Repeat the programming steps for the channel being used for PV Temp Dirty:
3 Program 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
- Choose the Isc Clean channel as the Denominator Source

Calculation Type: Ratio

Data Logging Mode: Statistics

Channel Type: Calculated

Soiling Ratio:

<table>
<thead>
<tr>
<th>Description</th>
<th>Soiling Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>Ratio</td>
</tr>
</tbody>
</table>

Calculation Sources:

- Numerator Source: Channel 19 - Isc Soiled
- Denominator Source: Channel 18 - Isc Clean
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.