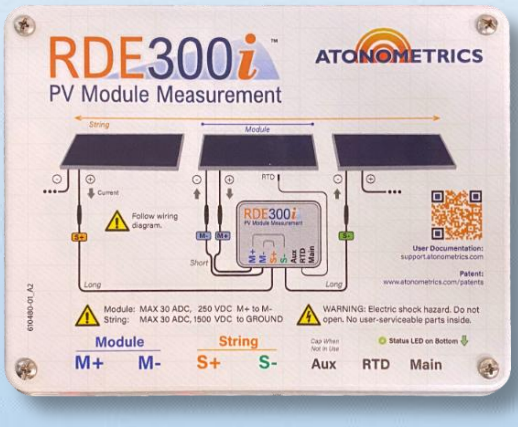
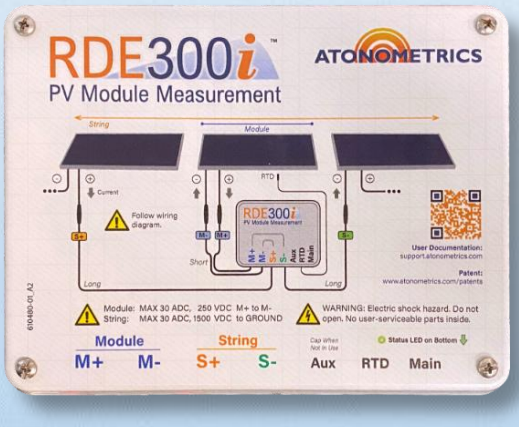
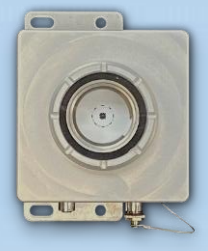
Configuration and Normalization Guide

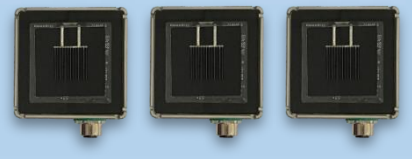
for RDE300i Systems











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1 Overview

This document will guide you through the configuration and normalization of RDE300i systems where module IV data is compared against reference data from either a second RDE300i unit (Module-Module) or a system of RC22 Reference Cells (Module-Cell).

Optionally, the integration of a Mars Sensor (Module-Cell-Optical) or Cell Wash unit (Module-Cell-Washer) can eliminate or automate the regular washing of the RC22 Reference Cells.

Normalization is required for soiling, bifacial gain, or other reference-based applications.

One RDE300i unit will always be configured as a Leader. Power and communication connections to your datalogger or SCADA system will be made only to the Leader, and reference data is aggregated through the Leader's private Aux network.

For Module-Module soiling applications:

- The PV module(s) on the Follower units(s) should be allowed to soil in the same way as other modules in the PV array.
- The PV module connected to the Leader unit should be routinely cleaned. It will be a clean reference for the modules connected to the Follower(s).

For Module-Cell soiling applications:

- The PV module connected to the Leader unit should be allowed to soil in the same way as other modules in the PV array.
- The RC22 Reference Cell(s) should be routinely cleaned. It will be a clean reference for the module connected to the Leader.
- Optionally, the integration of a Mars Sensor (Module-Cell-Optical) or Cell Wash unit (Module-Cell-Washer) can eliminate or automate the regular washing of the RC22 Reference Cells.

Note: For more information on RDE300i system configurations and cabling, see the Soiling Products Ordering Guide (880100), available from the Atonometrics website. For reference to system kit part numbers, see the RDE300i User Guide (880093).

Section 3 Configuration may be completed in an office environment prior to field deployment.

Following the steps in this document, you will normalize the Performance Index (PI) values. This is equivalent to the initial calibration of the soiling ratio for soiling applications or bifacial gain for bifacial gain applications.

To successfully normalize the Performance Index, the normalization procedure must be completed on a clear sunny day. Additionally, the plane of array (POA) irradiance must be greater than 500 W/m2.

The normalization procedure takes approximately 30 minutes to complete.

For more information on **RDE300i**, consult the RDE300i User Guide (880093), available from the Atonometrics website.

Note: Please read the entire RDE300i User Guide (880093) before undertaking the instructions in this guide.

2 Equipment and Software Required

Obtain the following equipment and software before performing the steps in this guide, according to the system configuration that you have:

- For Module-Module configurations:
    - 2 or more RDE300i units
        - Latest RDE300i firmware from RDE300i Software Updates
        - RDE300i User Guide (880093)
- For Module-Cell configurations:
    - 1 RDE300i unit
        - Latest RDE300i firmware from RDE300i Software Updates
        - RDE300i User Guide (880093)
    - 1 (Monofacial) or 3 (Bifacial) RC22 units
        - Latest RC22 firmware version from RC22 Software Updates
        - RC22 User Guide (880095)
    - 1 Mars unit if deploying Module-Cell-Optical configuration
        - Latest Mars firmware version from Mars Firmware Updates
        - Mars User Guide (880060-20)
    - 1 Cell Wash unit if deploying Module-Cell-Washer configuration
        - Latest Cell Wash firmware version from Cell Wash Firmware Updates
        - Cell Wash User Guide (880104)
- PV Modules for RDE300i unit(s)
- Power and Communication Cables (830284 and 830303)
- Other required equipment specified for your configuration
    - Refer to the Soiling Products Ordering Guide (880100) for the required equipment
- Configuration Kit (810276)
- Latest RDE300i Configuration Manager Software from RDE300i Software Updates
- Laptop or PC (Windows 7 or Higher)

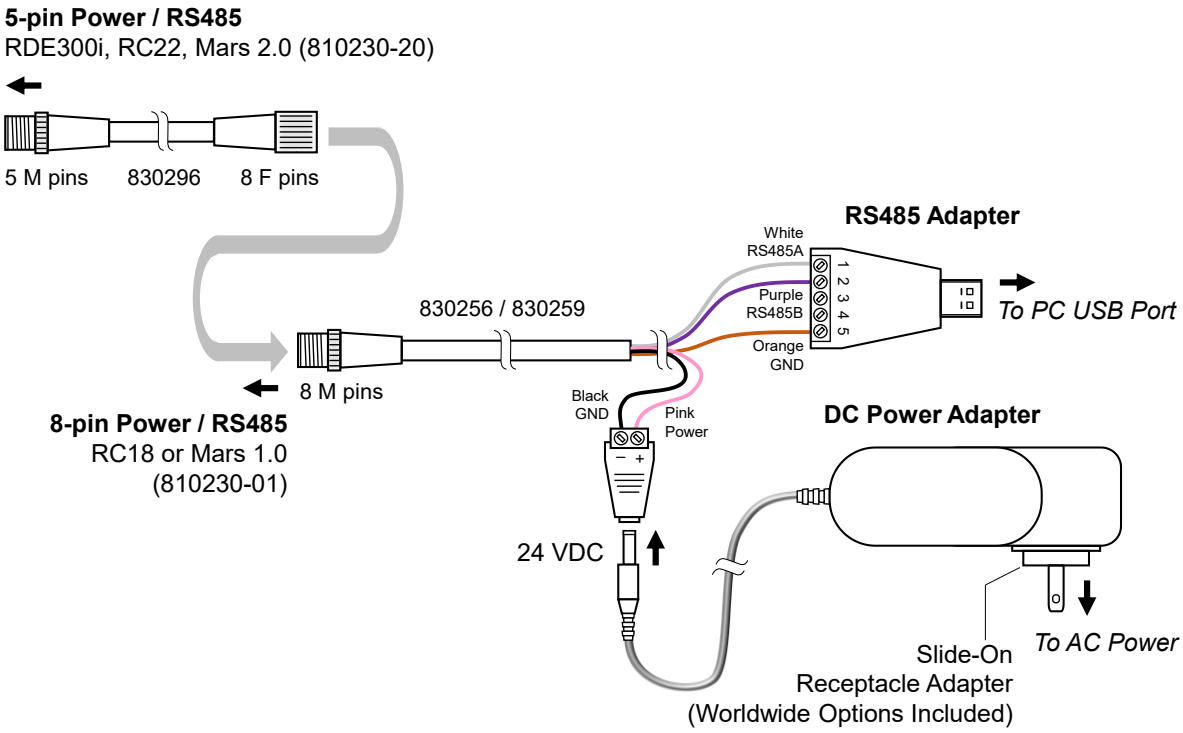


Figure 2-1: Configuration Kit 810276 for connecting your PC to RDE300i, RC22, Mars, and Cell Wash

Note: For more information on Configuration Kit 810276, or to find software drivers, visit support.atonometrics.com.

3 Configuration

3.1 Module-Module Configurations

3.1.1 Designating Leader and Follower(s)

This guide presents instructions for applications where one RDE300i™ unit will be designated and configured as a Leader and the other unit(s) will be designated and configured as Follower(s).

Power and data logger or SCADA communication connections will be made only to the Leader, while the Followers will connect to the Leader over the Leader's private Aux network.

The user's data logger or SCADA system will read all data from the Leader.

Prior to continuing with these instructions, designate one of your system's RDE300i units as Leader and the other units as Followers. Then, proceed.

Refer to **Figure 3-1** for proper cabling set up during **Section 3 Configuration**.

Note: For more information on RDE300i configuration options, including Solo, Leader, and Follower configurations, see the RDE300i User Guide (880093).

Note: For more information on RDE300i system configurations and cabling, see the Soiling Products Ordering Guide (880100), available from the Atonometrics website.

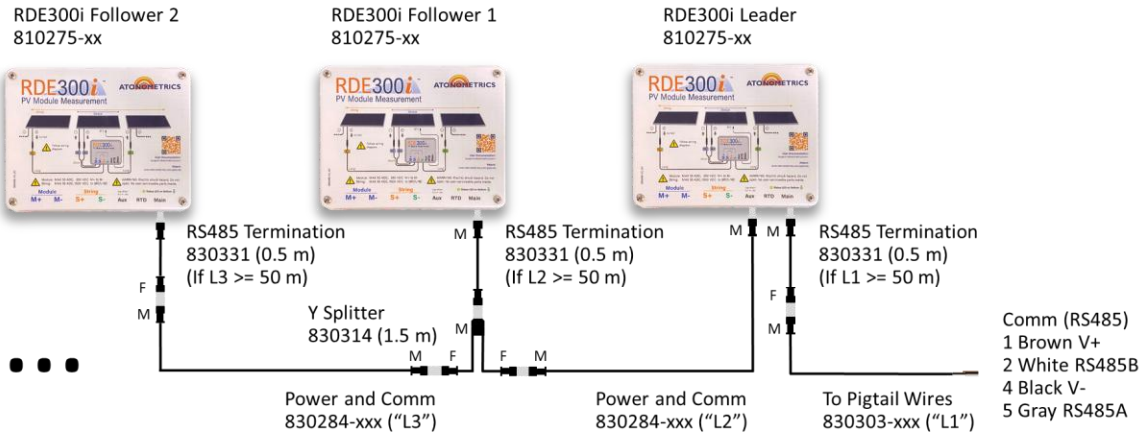


Figure 3-1: Multi-RDE300i system cabling diagram (example)

3.1.2 RDE300i Follower Configuration

3.1.2.1 Connect to the Follower

Connect the Configuration Kit (or equivalent equipment) to the RDE300i unit you have designated as the first Follower and ensure the kit is powered.

Launch the RDE300i Configuration Manager Software on your PC.

From the RDE300i Configuration Manager, select the Connect tab and connect to your RDE300i Follower unit.

Select your PC's COM port corresponding to the USB/RS485 adapter of the Configuration Kit.

If the Modbus communication settings of your RDE300i are unknown, Scan for the RDE300i using the Find button. The software will attempt to discover your RDE300i address, baud rate, and data format.

If your Modbus communication settings are known, you may enter these in the Connect Manually box and press the Connect button.

Once your RDE300i unit is connected, the software will display the Connected status as shown in **Figure 3-2**.

Note: To determine the COM port of your RS485 adapter, check the COM ports drop down box with and without the adapter connected to your PC, using the Refresh button to update the list after connecting/disconnecting the adapter from the PC.

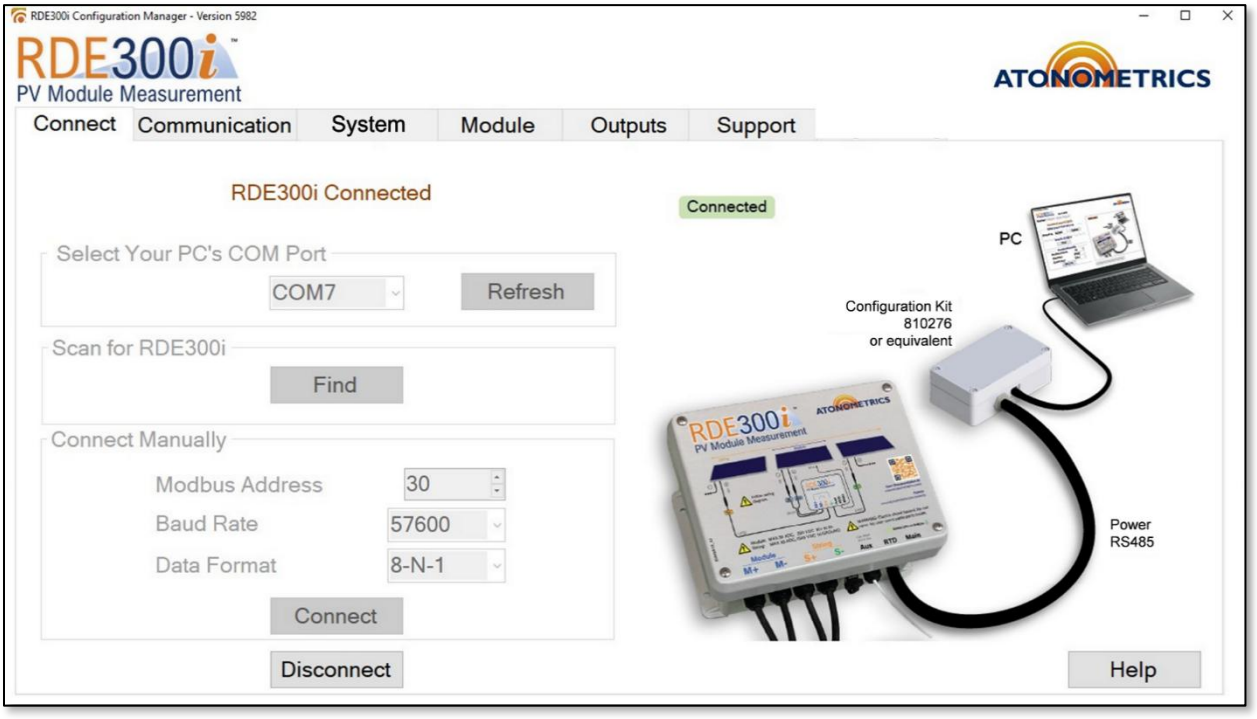


Figure 3-2: RDE300i connected

3.1.2.2 Configure as Follower

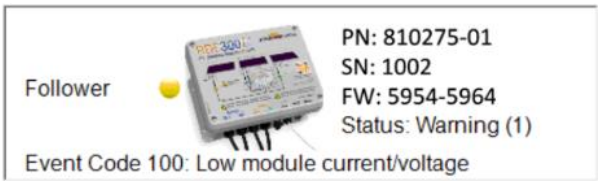
To set RDE300i to the Follower configuration, select the System tab, and select Follower from the Choose Device Configuration drop-down menu. Then, select 1st from the Follower drop-down menu corresponding to the first Follower unit, as shown in **Figure 3-3**, and press Apply.

The diagram displayed on the tab provides visual confirmation of the Follower operation and illustrates how the Follower works with a Leader.

The System Status box displays the operation status of the connected RDE300i as well as its part number, serial number, and installed firmware version.

Note: When RDE300i is set to the Follower configuration, the unit will operate using default Modbus communication parameters as shown in the diagram below. These parameters are not user settable. The Follower operates on the Leader's private Aux network, and user data acquisition is from the Leader only.

Note: If you are not connected to a PV module, you will see a yellow indicator, Status: Warning (1), and Event Code 100: Low module current/voltage in the system status box. This is okay for all of Section 3 Configuration.



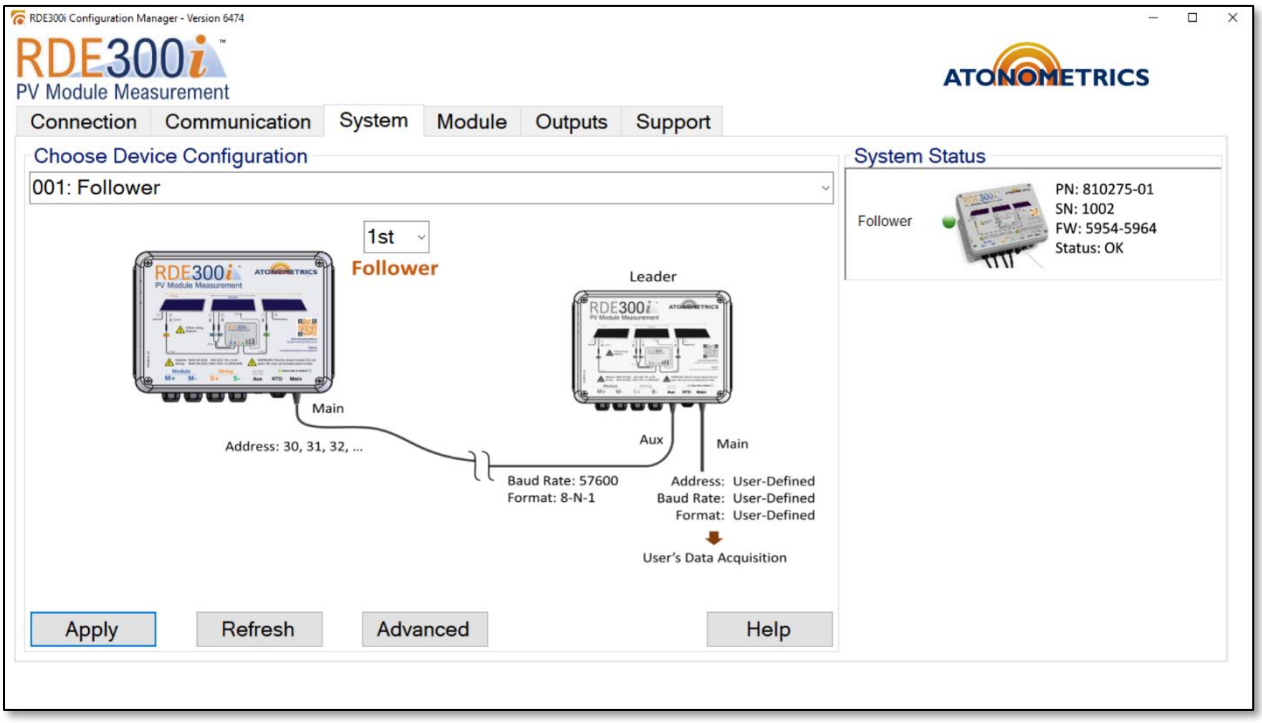


Figure 3-3: Setting Follower configuration

3.1.2.3 Set Module Parameters

RDE300i™ needs calibration data on its connected PV module to calculate performance metrics.

Calibration parameters include the modules short-circuit current (Isc) and maximum power (Pmax) at reference conditions of irradiance and temperature.

Typically reference irradiance and temperature are standard test conditions (STC) of 1000 W/m^2 and 25 °C, but other conditions may be used. Isc and Pmax temperature coefficients must also be provided.

You may use datasheet information for the Module parameters or obtain these parameters from a calibration report, if available.

Select the Module tab to set these values, as shown in **Figure 3-4**. Enter the module parameters and press Apply.

Note: The configuration manager software accepts period and comma decimal formatting only and automatically adjusts inputs to be consistent with your PC's regional settings. Only 1 decimal point is allowed per entry.

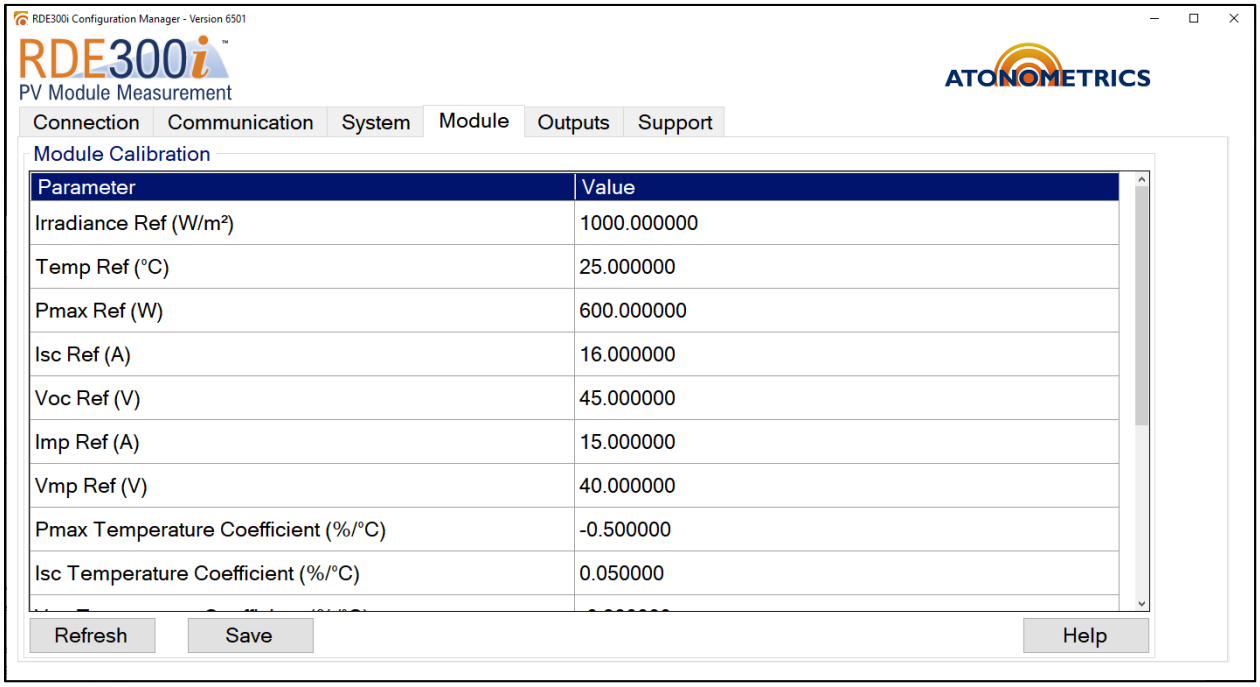


Figure 3-4: Setting Module parameters

3.1.2.4 Configure Remaining Followers

Repeat Section 3.1.2 to configure each of the remaining RDE300i Follower units, if applicable.

3.1.3 RDE300i Leader Configuration

3.1.3.1 Connect to the Leader

Disconnect the configuration kit from the Follower. Then, connect or daisy chain 830284 power and communication cables from the Followers' Main ports to the Leader's Aux port as shown in example **Figure 3-5**.

To daisy chain multiple Follower units, use the 830314 Y-splitter cable at the Followers' Main ports. Use 830331 RS485 termination cables where necessary, per the Soiling Measurement Ordering Guide (880100), available from the Atonometrics website.

Connect to the Leader with the configuration kit and software following the steps in Section 3.1.2.1.

Note: Your system may have two or more RDE300i units. For more information on RDE300i system configurations and cabling, see the Soiling Products Ordering Guide (880100).

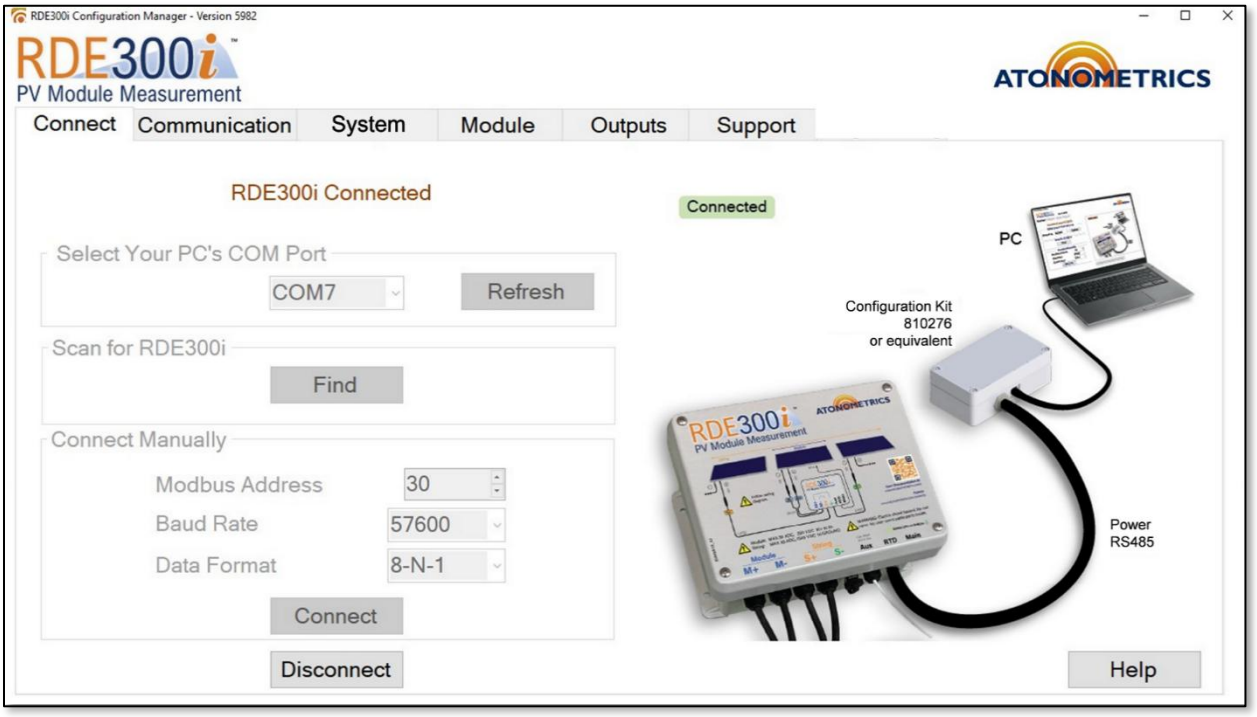


Figure 3-5: RDE300i connected

3.1.3.2 Configure as Leader

To set the RDE300i to the Leader configuration, select the System tab, and select Leader from the Choose Device Configuration drop-down menu. Then, select the number of Follower units from the Followers drop-down menu, as shown in **Figure 3-6**. Press Apply.

The diagram displayed on the tab illustrates how the Leader works with the Followers.

The System Status box displays the operation status of the connected RDE300i Leader and Followers as well as their part numbers, serial numbers, and installed firmware versions.

Note: When RDE300i is set to the Leader configuration, its Modbus communication parameters may be set by the user, but the Follower must be operating at default parameters as shown in the diagram below.

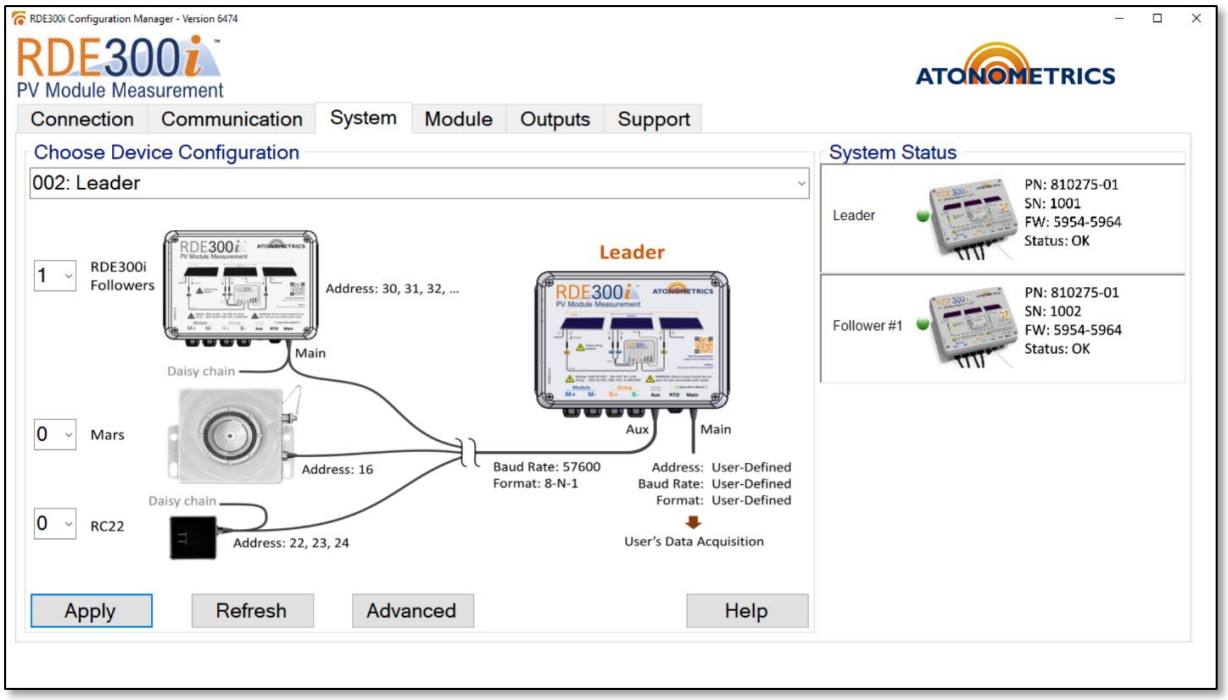


Figure 3-6: Setting Leader configuration

3.1.3.3 Verify System Communication

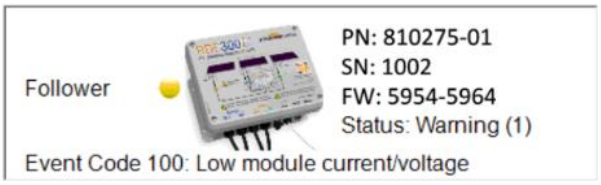
Remain connected to the Leader unit. Confirm that the Status LED on each of the Followers lights up.

Select the System tab and verify that the Status is OK for both the Leader and all the Follower units as shown in **Figure 3-7**.

The System Status box displays whether communication from the Leader to the Follower units is working properly and displays the operation status of the Leader and Follower units as well as their part numbers, serial numbers, and installed firmware versions.

Note: If a Follower unit is not properly configured or connected, its status may be displayed with an error in the System Status box. To resolve this condition, ensure that the Leader and Follower units are connected, and that the Leader unit is properly configured.

Note: If you are not connected to a PV module, you will see a yellow indicator, Status: Warning (1), and Event Code 100: Low module current/voltage in the system status box. This is okay for all of Section 3 Configuration.



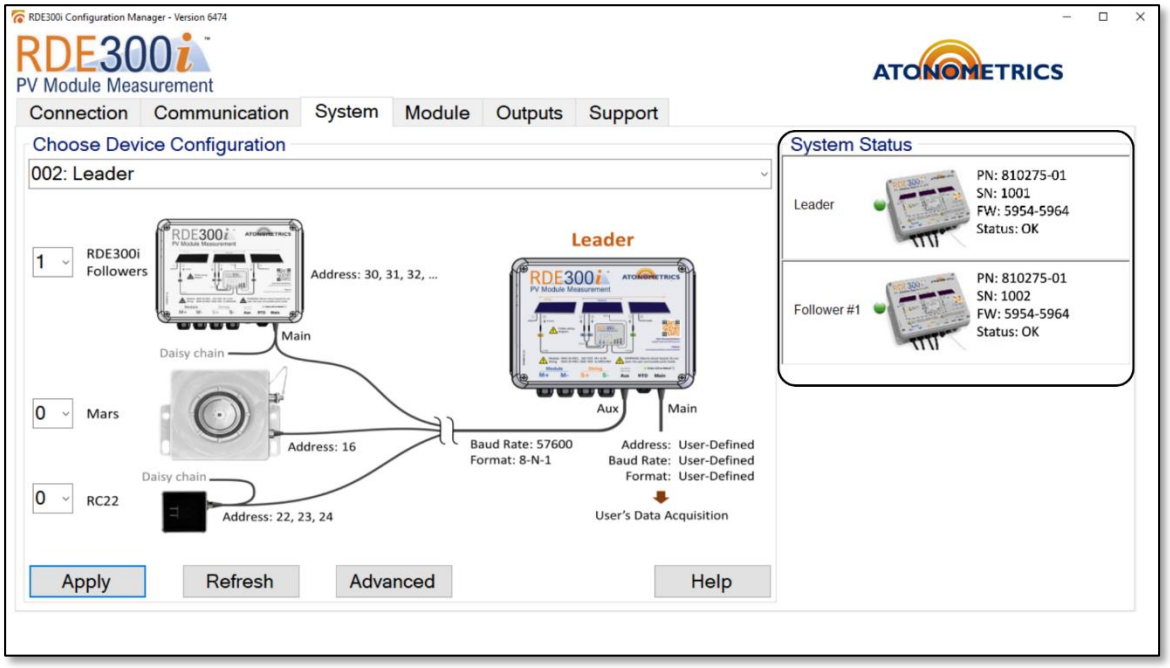


Figure 3-7: Verifying communication between Leader and Followers

3.1.3.4 Set Module Parameters

Enter the module parameters for the Leader's PV module, following the steps in Section 3.1.2.3.

3.1.3.5 Set Leader Communication Options

Your RDE300i™ unit's default Modbus serial communication parameters for its Main communication port are Address = 30, Baud Rate = 57600, and Data Format = 8-N-1 (8 data bits, no parity, 1 stop bit).

To update the communication parameters, use the Communication tab of RDE300i Configuration Manager, shown in **Figure 3-8**.

Enter your new parameters in the Update Modbus Settings box and press Apply to transmit these to the unit. These are the communication parameters that you will use with your data logger or SCADA system to communicate with the Leader unit.

Addresses from 1 to 247 are allowed.

Supported baud rates are 9600, 19200, 38400, 57600, and 115200.

Supported data formats are 8-N-1, 8-N-2, 8-E-1, and 8-O-1.

Note: If performing configuration in an office environment, this is your last step. Remove the Aux cables and Configuration Kit. The following sections must be completed in the field.

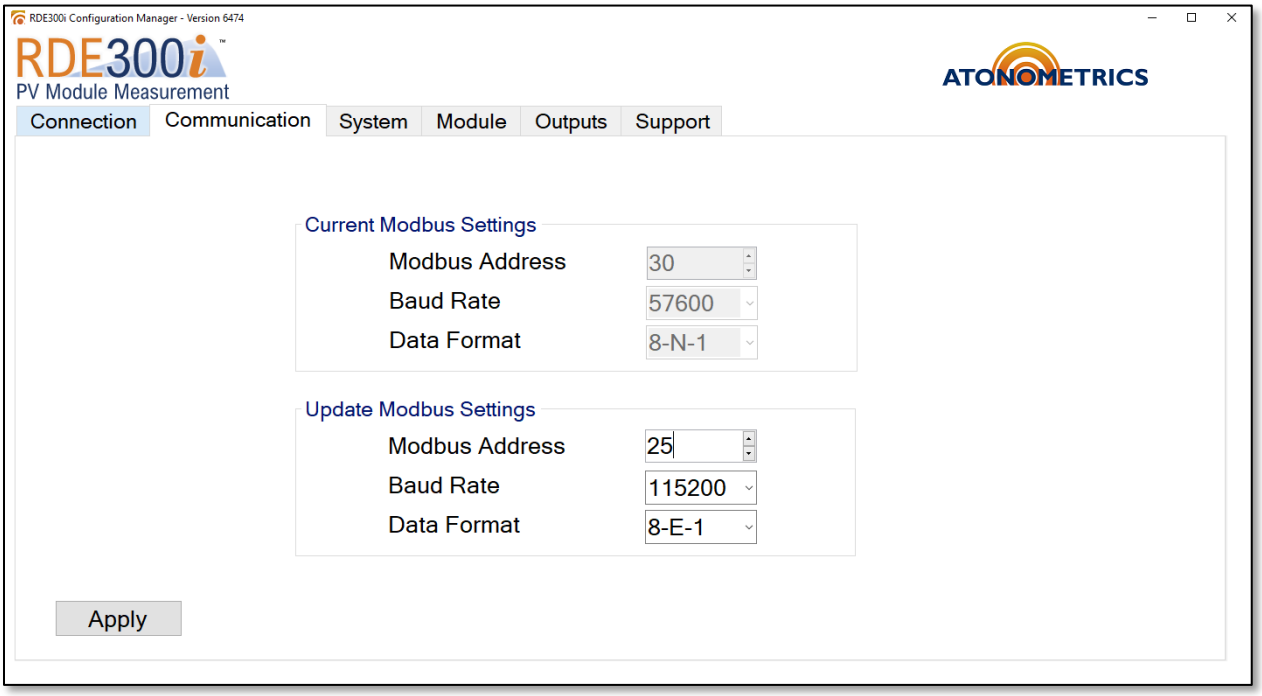


Figure 3-8: Setting Leader communication parameters

3.1.4 Equipment Installation

Refer to the RDE300i User Guide (880093) for the installation procedure and wiring instructions to install the RDE300i Leader and Follower units.

See **Figure 3-9** below for our recommended field layout for the RDE300i Leader and Followers for module-module soiling measurement applications. Additional examples are shown in the Soiling Products Ordering Guide (880100).

Ensure all modules connected to RDE300i units are at the same tilt angles, preferably within 0.5 degrees. Use a handheld inclinometer to confirm. Check the tilt in both directions across each module. If necessary, use shims to adjust the modules to be at the same tilt angle.

WARNING: Follow all installation and wiring instructions per the RDE300i User Guide (880093). Failure to follow instructions properly may result in serious damage to the product or connected equipment and/or hazards to human health and safety.

WARNING: **FOR PV STRINGS OF LESS THAN TEN MODULES (E.G., HIGH-VOLTAGE, THIN-FILM MODULES),** use at most one RDE300i unit per string. (E.g., RDE300i Leader and Follower units should be installed on separate strings.)

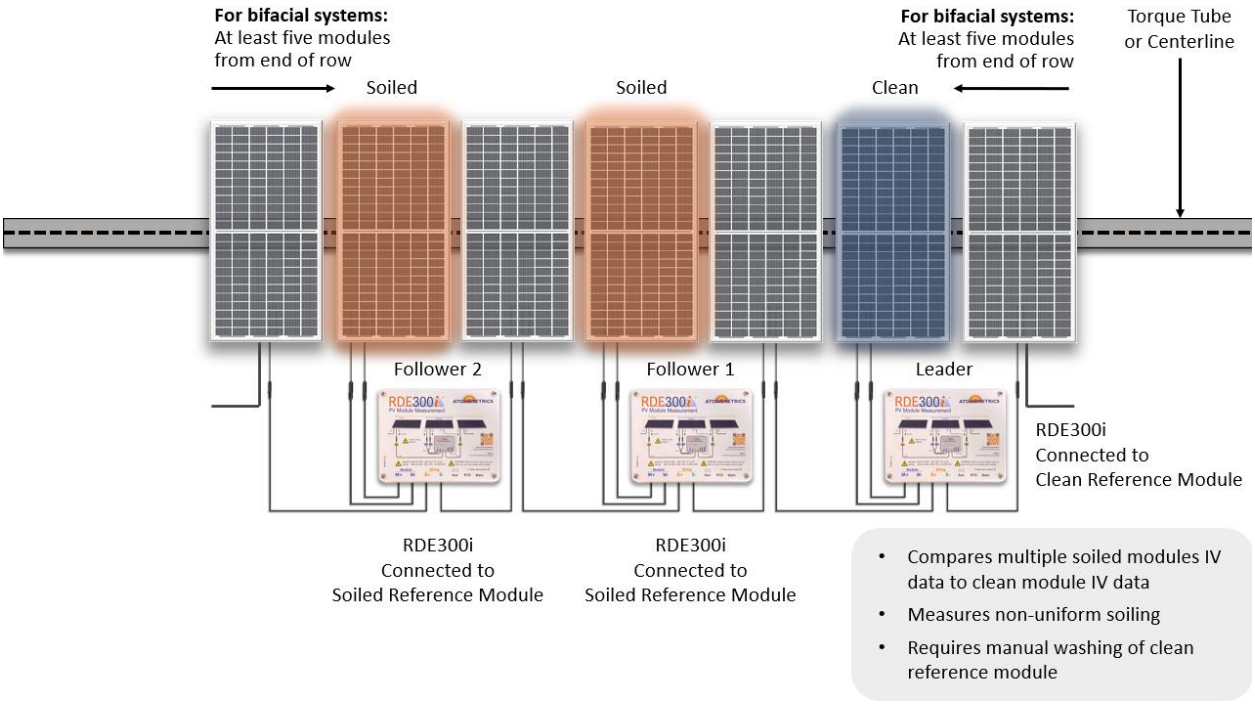


Figure 3-9: Recommended field layout for soiling application example

3.1.5 Verify System Operation

If not already connected, repeat the steps in Section 3.1.3.1 to connect to the RDE300i Leader unit. Select the System tab and ensure that the Status is OK for both the Leader and the Follower units, as shown in **Figure 3-10**.

Note: If the Follower units are not properly configured or connected, status may be displayed with an error in the System Status box. To resolve this condition, ensure that the Leader and Follower units are connected and properly configured.

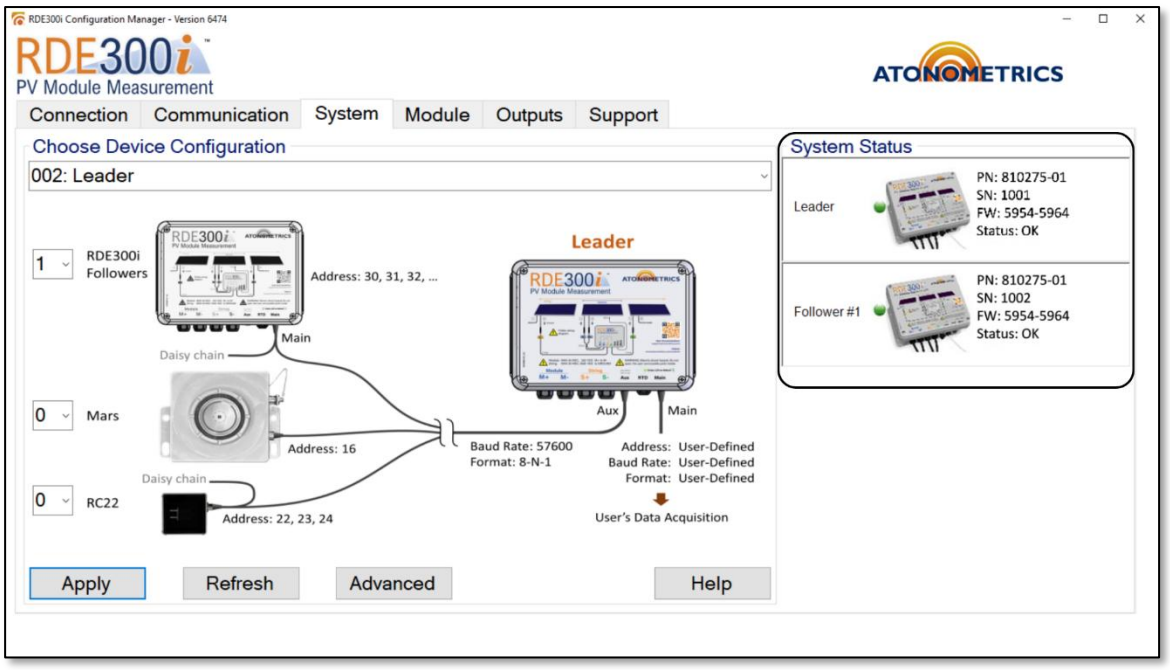


Figure 3-10: Verifying system operation between Leader and Followers

Select the Outputs tab to check the measurement results from your system, as shown in **Figure 3-11** and **Figure 3-12**.

The tab displays the most recently measured IV curve and the most recent readings of all the measured and calculated parameters, including Pmax, Isc, module voltages and currents, string data, performance indices, and more. Scroll through the tab to examine all the parameters.

The Leader's data are displayed as Module 1 and the Followers' data are displayed below that as Module 2, Module 3, etc.

All the data displayed on the Outputs tab are available for data acquisition via the Modbus interface.

In the Outputs tab, check that the module Isc and Pmax values are periodically updated (every 5-60 seconds, depending on configuration options) for the Leader and Follower units, and that reasonable values are being recorded, as shown in **Figure 3-11** and **Figure 3-12**.

Your Module-Module system is configured for normalization. Continue to Section 4 Normalization.

Note: If values are not being updated, ensure that all RDE300i units are connected to each other **AND** connected to their respective reference modules.

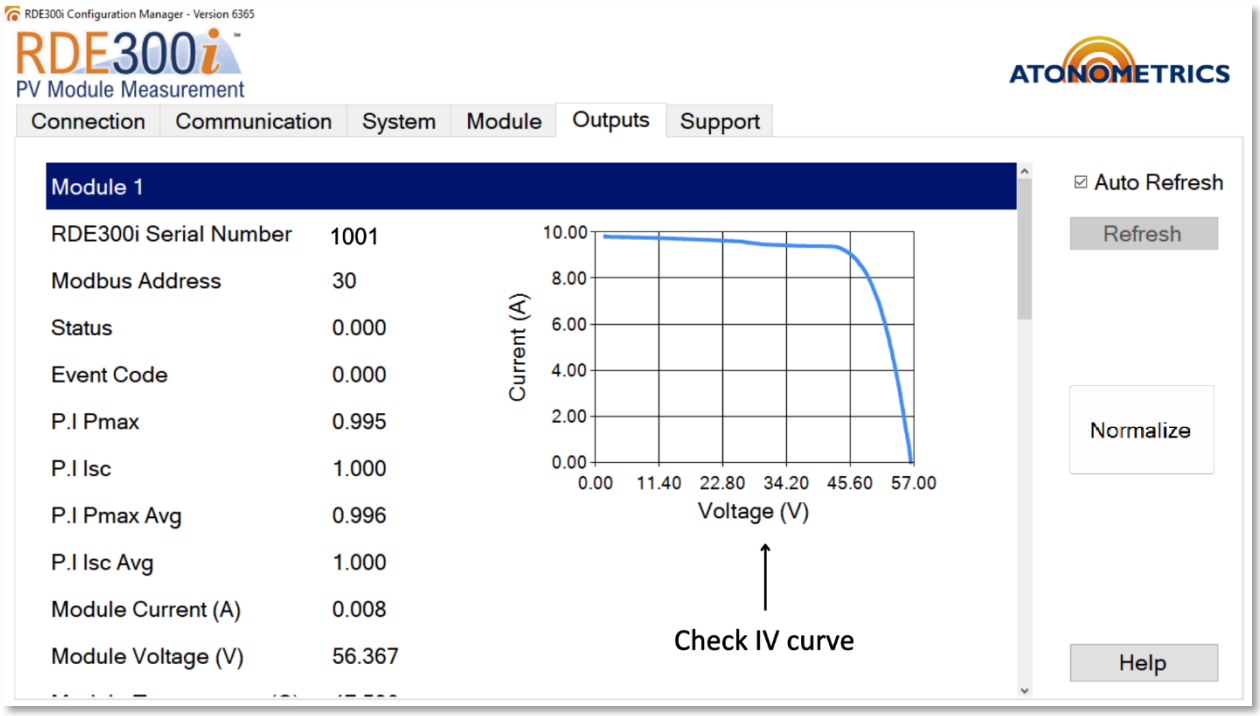


Figure 3-11: Checking output data and IV curves

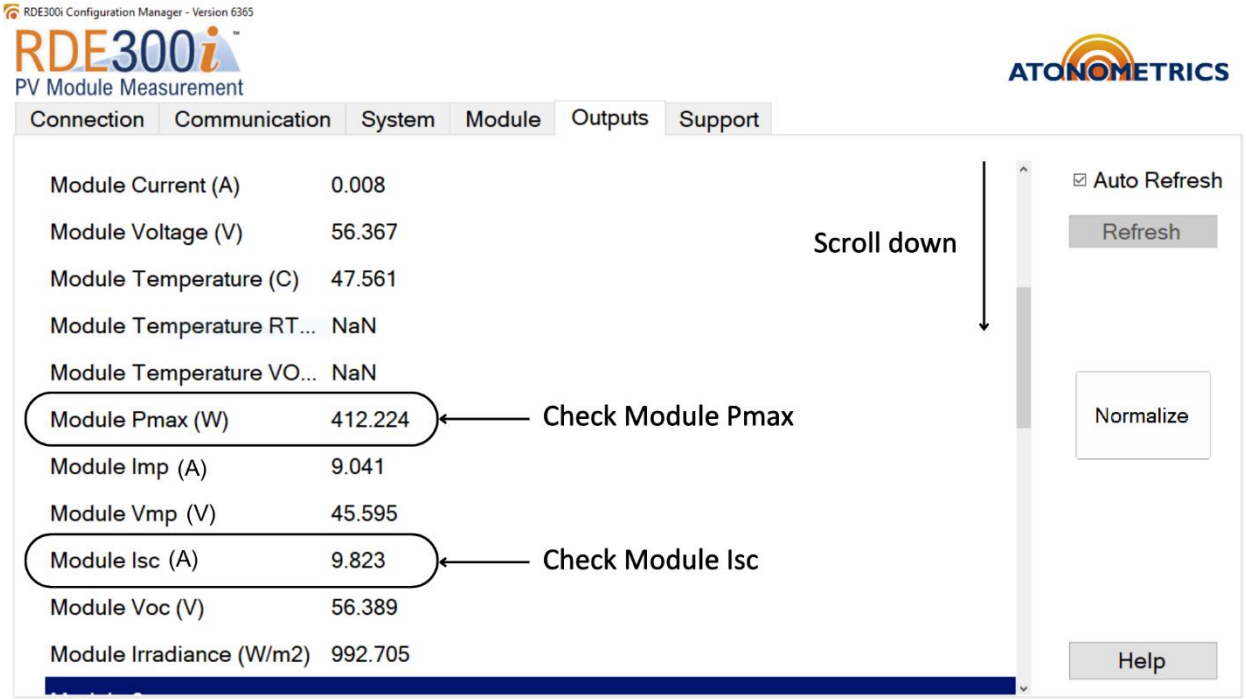


Figure 3-12: Check module outputs

3.2 Module-Cell Configurations

3.2.1 RC22 Configuration

3.2.1.1 Designating RC22 units for the Aux Network

Refer to **Table 3-1** to view the necessary mounting position and Modbus settings for RC22(s) on your Aux Network.

Table 3-1: RC22 Modbus Communication Settings for Aux Network

Line	RC22 Mounting Position	Modbus Address	Baud Rate	Data Format
1	Front Facing	22	57600	8-N-1
2	Rear Facing East (Single-Axis Tracker Installations) Or Rear-Facing Lower (Fixed-Tilt Installations)	23	57600	8-N-1
3	Rear Facing West (Single-Axis Tracker Installations) Or Rear-Facing Upper (Fixed-Tilt Installations)	24	57600	8-N-1

For monofacial systems, the mounting position and Modbus settings from only Line 1 will be needed for your RC22 unit. Atonometrics recommends creating a label with the information displayed in Line 1 and attaching it to the RC22 unit.

For bifacial systems, three RC22 units are required. Atonometrics recommends designating each RC22 unit by creating three labels. Write the information from Line 1 on one label, Line 2 on the next label, and Line 3 on the last label. Then attach one label to each RC22 unit.

Note: For bifacial systems, one line in **Table 3-1** must be assigned to each RC22 unit. Do not assign multiple RC22 units to the same settings within the same Aux Network.

3.2.1.2 Configuring RC22 units for the Aux Network

To apply the Modbus settings displayed in **Table 3-1**, you will need to use the RC22 Configuration Manager Software and the Configuration Kit as shown in **Figure 2-1**.

Use the Configuration Kit to connect to one RC22 unit at a time. Ensure the Configuration Kit is powered and connected to RC22. Plug the USB-RS485 converter into your PC. Open the RC22 Configuration Manager.

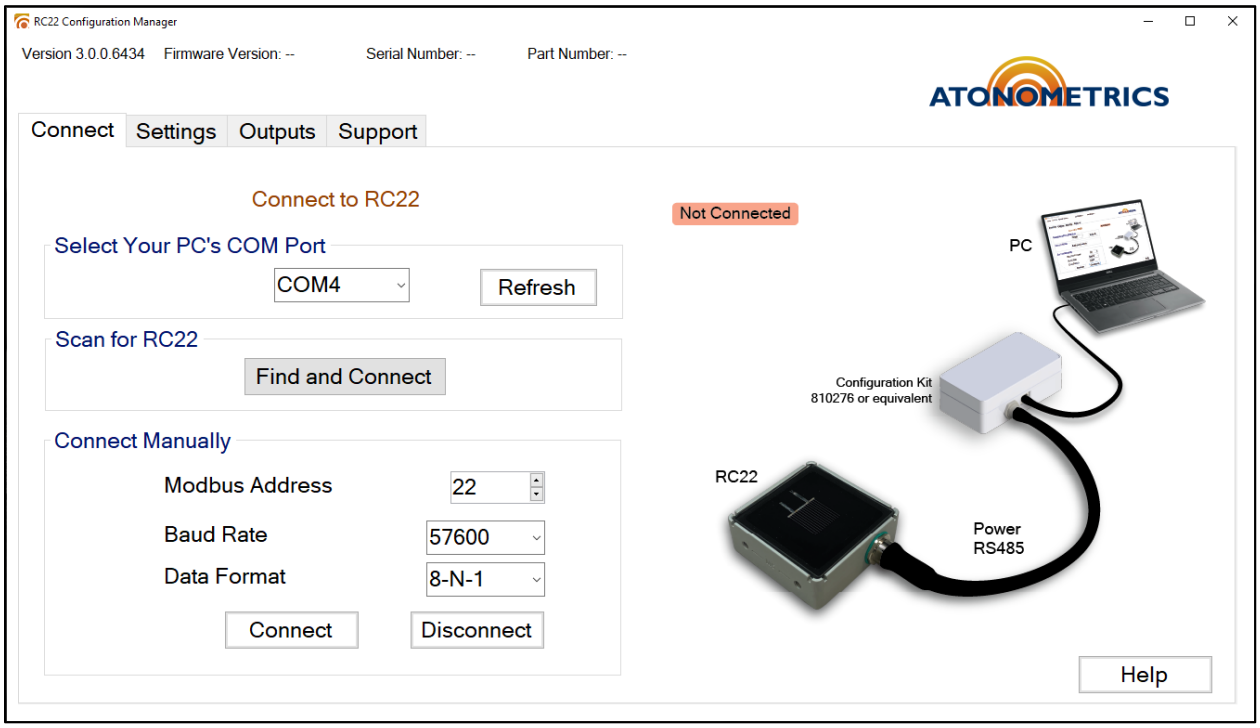


Figure 3-13: RC22 Configuration Manager – Disconnected

Determine the COM port to which the Configuration Kit is connected. If you are not sure which COM to select, then unplug the USB-RS485 converter from your PC and press the “Refresh” button. Note which COM ports are displayed in the “COM Port” dropdown. Then, plug the converter back in and hit the “Refresh” button again. The newly added COM port will map to the Configuration Kit connection.

Select the correct COM port for the Configuration Kit. Then press the “Find” button to establish a connection with RC22.

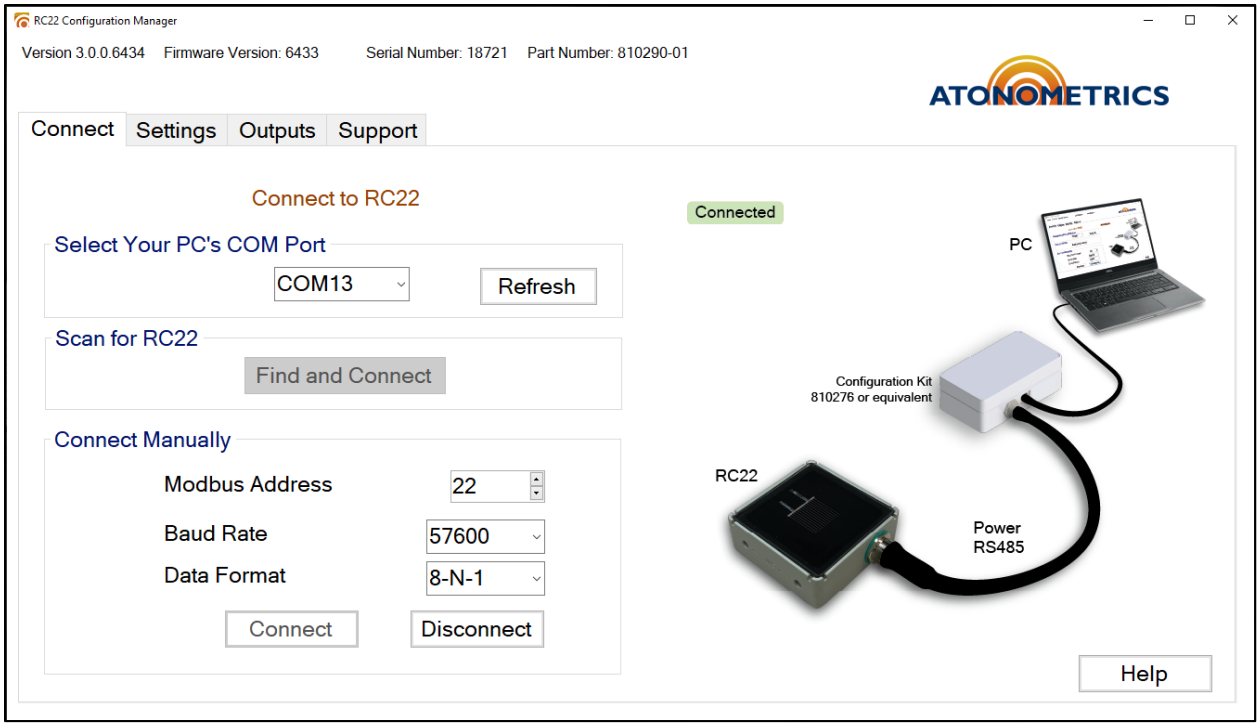


Figure 3-14: RC22 Configuration Manager – Connected

Navigate to the “Settings” Tab of the RC22 Configuration Manager. Refer to **Table 3-1** to apply the Modbus settings that you designated for the RC22 unit. Enter the corresponding Modbus address, baud rate, and data format to the RC22 Configuration Manager and press the “Apply” button.

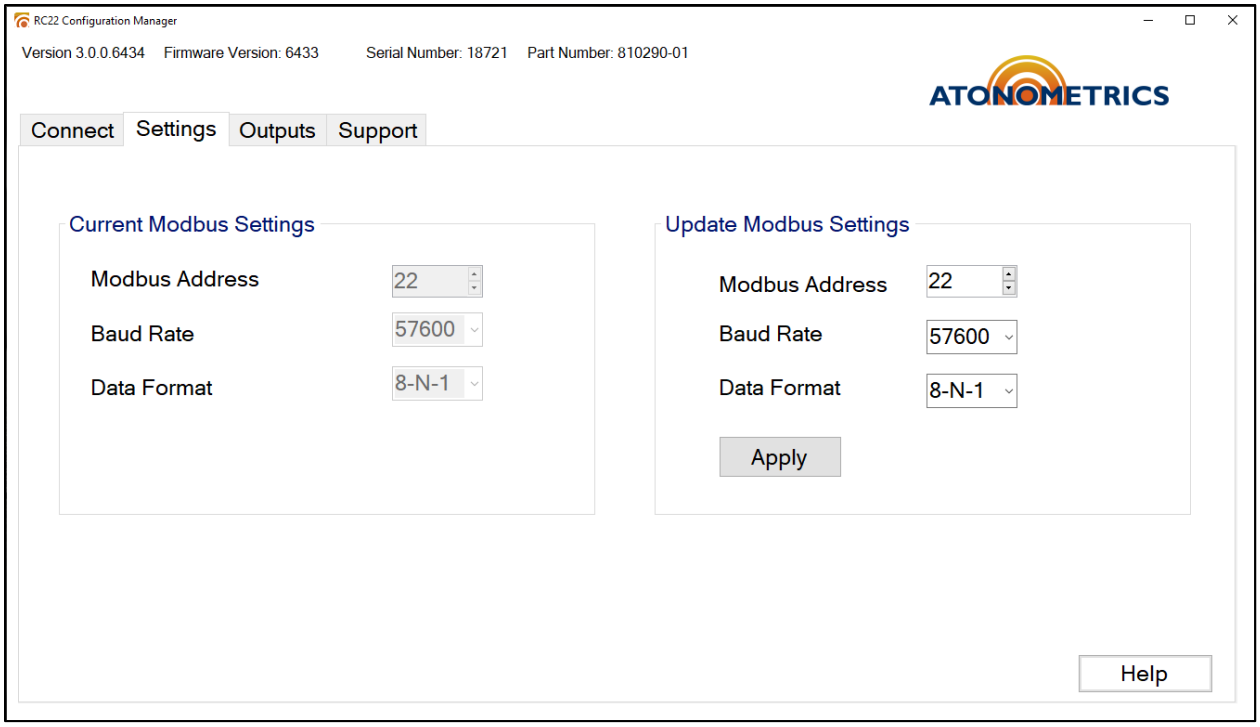


Figure 3-15: Communication Settings Entry (example for Front Facing RC22 unit)

Return to the “Connection” tab of the RC22 Configuration Manager. Press “Disconnect” and then “Find” to confirm that the correct Modbus settings were applied to the unit as shown in **Figure 3-16**.

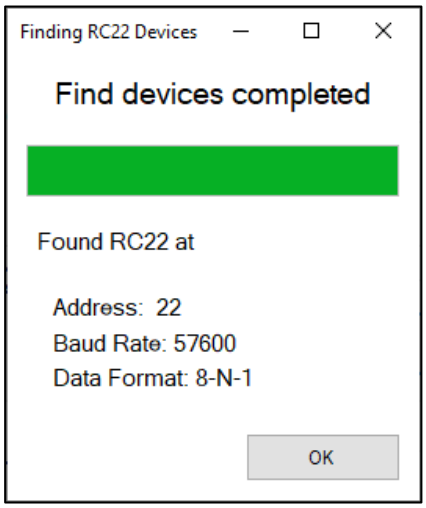


Figure 3-16: Verify settings (example for Front Facing RC22 unit)

If you are using RC22 for bifacial reference modules, follow these steps for the other RC22 units. Ensure that you refer to the row in **Table 3-1** that you assigned to the RC22 unit.

3.2.2 Mars Configuration

Consult this section if you are integrating a Mars unit into your Aux Network for Module-Cell-Optical configurations. Otherwise, continue to **Section 4 Normalization**.

Communication to Mars on the Aux Network will be established via Modbus RTU over RS485.

New Mars unit will be shipped with default settings as shown in **Table 3-2**. If you are retrofitting a previously configured Mars unit, or troubleshooting, consult the Mars User Guide (880060-20) for instructions to update Modbus settings via the web-based user interface.

3.2.2.1 Configuring Mars

The Mars Modbus settings must be configured to the Mars default values, matching **Table 3-2**.

Table 3-2: Mars Modbus Settings for Aux Network

Modbus Address	Baud Rate	Data Format
16	57600	8-N-1

3.2.3 Cell Wash Configuration

Consult this section if you are integrating a Cell Wash unit into your Aux Network for Module-Cell-Washer configurations. Otherwise, continue to **Section 4 Normalization**.

Communication to Cell Wash on the Aux Network will be established via Modbus RTU over RS485.

New Cell Wash units will be shipped with default settings as shown in **Table 3-3**. If you are retrofitting a previously installed Cell Wash unit, troubleshooting, or would like to adjust spray setting, consult the Cell Wash User Guide (880104) for instructions to update Modbus settings via the Cell Wash Configuration Manager Software.

Table 3-3: Cell Wash Modbus Settings for Aux Network

Modbus Address	Baud Rate	Data Format
10	57600	8-N-1

3.2.4 RDE300i Leader Configuration

3.2.4.1 Connect to the Leader

Connect your Aux Devices to the Aux port of your RDE300i Leader unit per your configuration-specific wiring diagram found in the Soiling Products Ordering Guide (880100), available from the Atonometrics website.

To daisy chain multiple Aux Devices, use the 830314 Y-splitter cables and 830284 Power and Comm cables as shown in **Figure 3-17**. Use 830331 RS485 termination cables where necessary.

The wiring diagram for a Module-Cell-Optical (Bifacial) system configuration is shown below as an example in **Figure 3-17**.

Note: Cable wiring is unique for each RDE300i system configuration. Review the Soiling Products Ordering Guide (880100) for the wiring diagram specific to your system configuration.

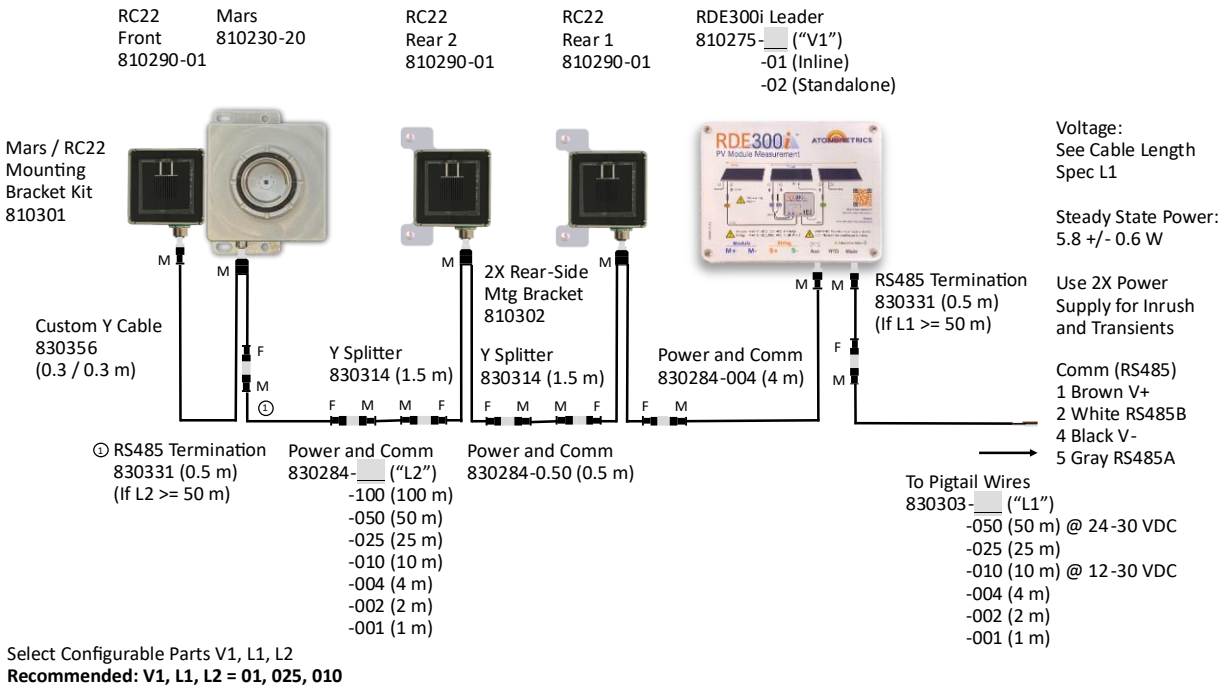


Figure 3-17: Module-Cell (Bifacial) system cabling diagram (example)

Connect the Configuration Kit (or equivalent equipment) to the RDE300i unit.

Launch the RDE300i Configuration Manager Software on your PC.

From the RDE300i Configuration Manager, select the Connect tab and connect to your RDE300i Follower unit.

Select your PC's COM port corresponding to the USB/RS485 adapter of the Configuration Kit.

If the Modbus communication settings of your RDE300i are unknown, Scan for the RDE300i using the Find button. The software will attempt to discover your RDE300i address, baud rate, and data format.

If your Modbus communication settings are known, you may enter these in the Connect Manually box and press the Connect button.

Once your RDE300i unit is connected, the software will display the Connected status as shown in **Figure 3-18**.

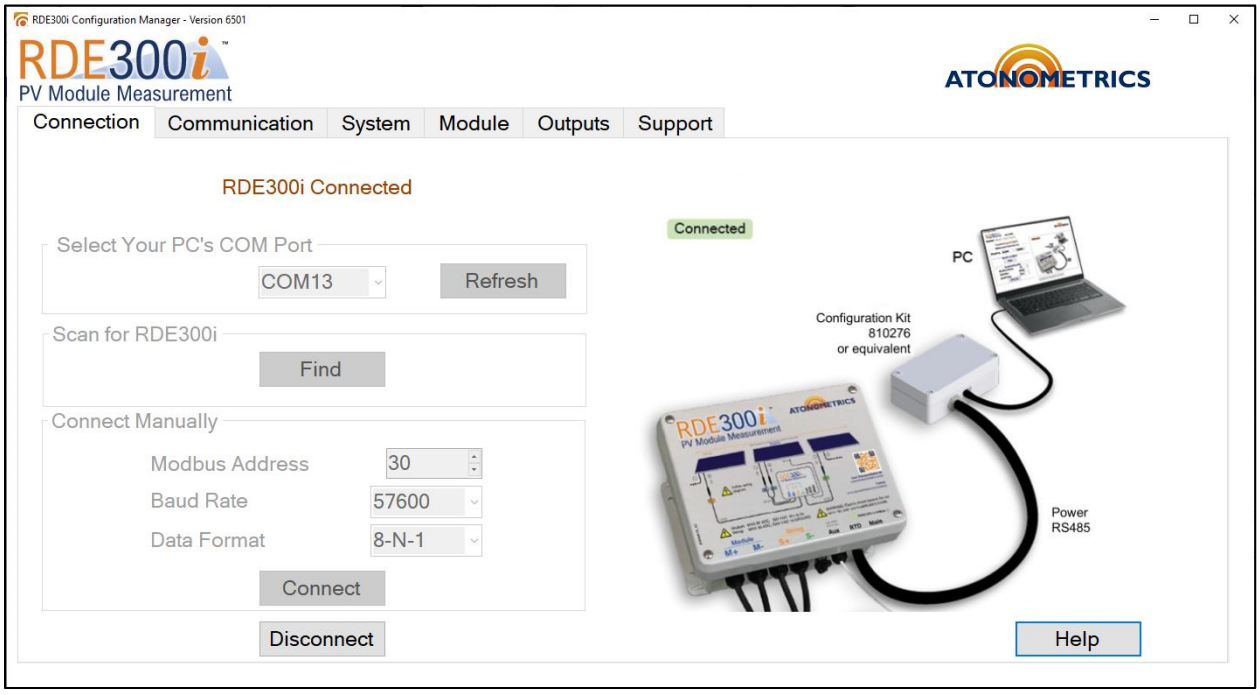


Figure 3-18: RDE300i Connected

3.2.4.2 Configure as Leader

To set the RDE300i to the Leader configuration, select the System tab, and select Leader from the Choose Device Configuration drop-down menu.

Then, select the number of Aux Devices from their respective drop-down menus, as shown in **Figure 3-19**. Press Apply.

For Module-Cell-Washer configurations, check the box for Is Automatically Washed.

The diagram displayed on the tab illustrates how the Leader connects to the Aux devices.

The System Status box displays the operation status of the connected RDE300i Leader and Aux Devices as well as their part numbers, serial numbers, and installed firmware versions.

The Configuration Manager screen for a Module-Cell-Optical (Bifacial) system configuration is shown below as an example in **Figure 3-19**.

Note: RDE300i Leader configuration is unique for each RDE300i system configuration. Review the Soiling Products Ordering Guide (880100) for the number of Aux Devices specific to your system configuration

Note: When RDE300i is set to the Leader configuration, its Modbus communication parameters may be set by the user, but the Aux Devices must be operating at default parameters as shown in the diagram below.

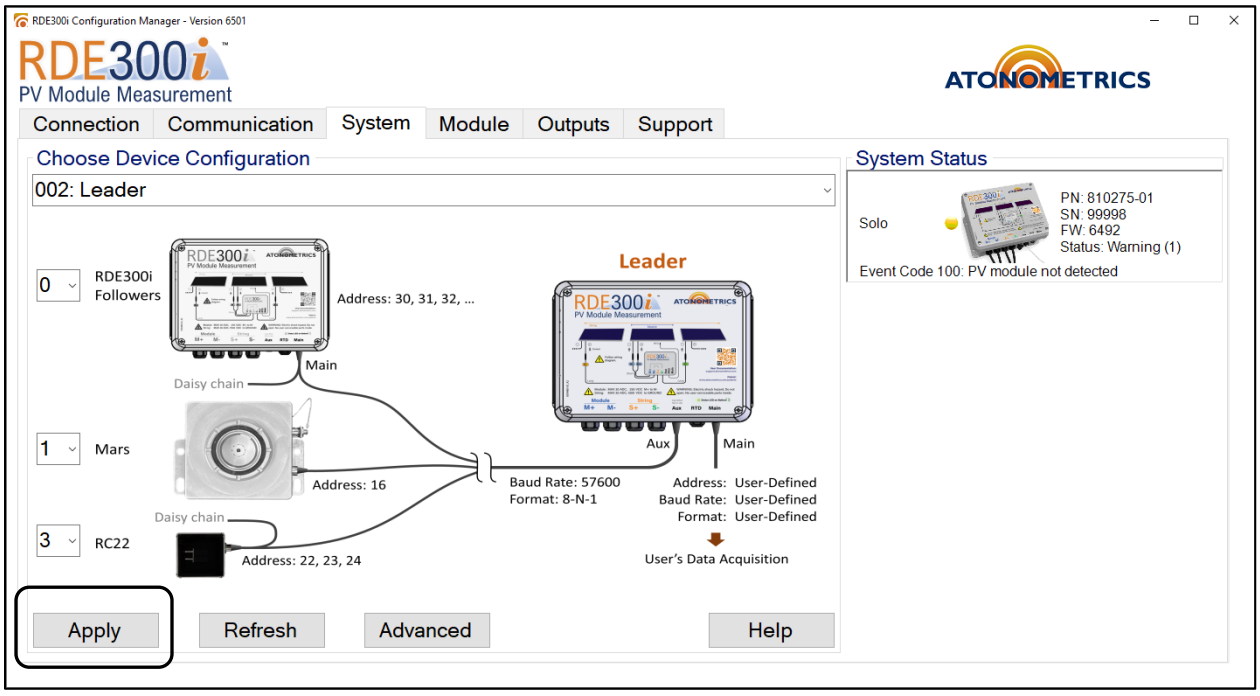


Figure 3-19: Setting Leader configuration

(Example for Module-Cell-Optical (Bifacial) Application)

3.2.4.3 Verify System Communication

Remain connected to the Leader unit.

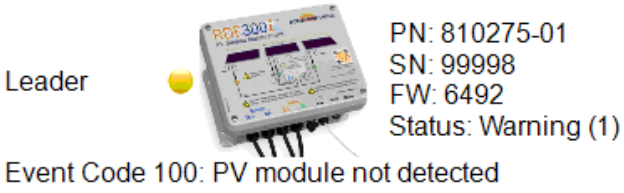
Select the System tab and verify that the Status is OK for the Leader and all Aux Devices as shown in **Figure 3-20**. (Status = Warning is also valid if not connected to a PV module.)

If Mars is included in your Aux Network, you may need to wait 2-5 minutes for communication to establish. A notification will be shown in the System Status panel as displayed in **Figure 3-21.**

The System Status box displays whether communication from the Leader to the Aux Devices is working properly and displays the operation status of the Leader and Aux Devices as well as their part numbers, serial numbers, and installed firmware versions.

Note: If an Aux Device is not properly configured or connected, its status may be displayed with an error in the System Status box. To resolve this condition, ensure that the Leader and Aux Devices are connected, and that the Leader unit is properly configured.

If you are not connected to a PV module, you will see a yellow indicator, "Status: Warning (1)", and "Event Code 100: PV module not detected" in the system status box. This is okay for all of Section 3 Configuration.



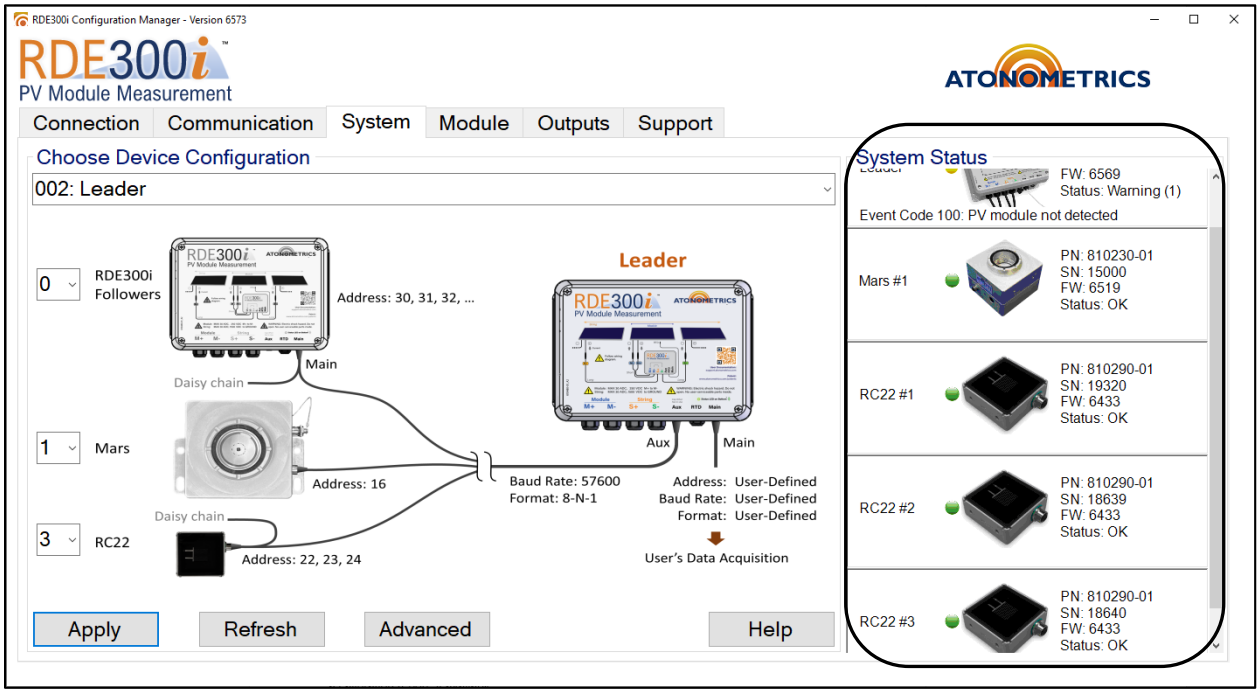


Figure 3-20: Verifying communication between Leader and Aux Devices (Example for Module-Cell-Optical (Bifacial) Application)

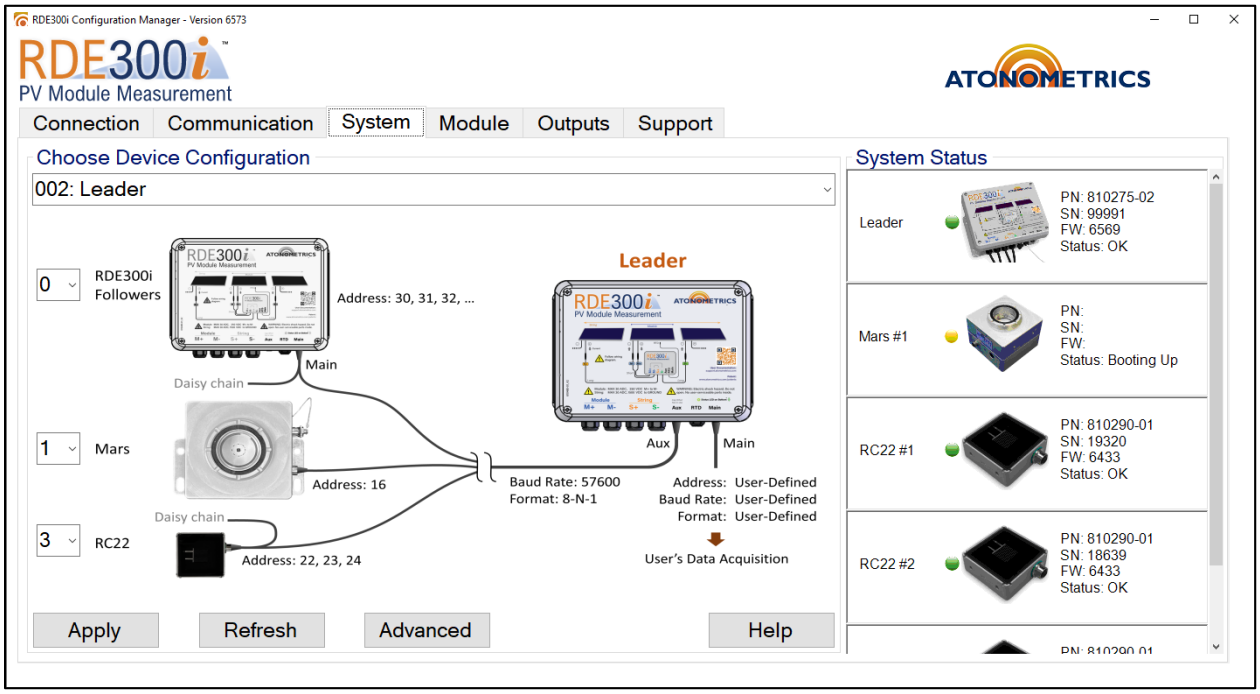


Figure 3-21: Mars bootup notification shown in the System Status panel.

3.2.4.4 Set Module Parameters

RDE300i™ needs calibration data on its connected PV module to calculate performance metrics.

Calibration parameters include the modules short-circuit current (Isc) and maximum power (Pmax) at reference conditions of irradiance and temperature.

Typically reference irradiance and temperature are standard test conditions (STC) of 1000 W/m^2 and 25 °C, but other conditions may be used. Isc and Pmax temperature coefficients must also be provided.

You may use datasheet information for the Module parameters or obtain these parameters from a calibration report, if available.

Select the Module tab to set these values, as shown in **Figure 3-22**. Enter the module parameters and press Apply.

Note: The configuration manager software accepts period and comma decimal formatting only and automatically adjusts inputs to be consistent with your PC's regional settings. Only 1 decimal point is allowed per entry.

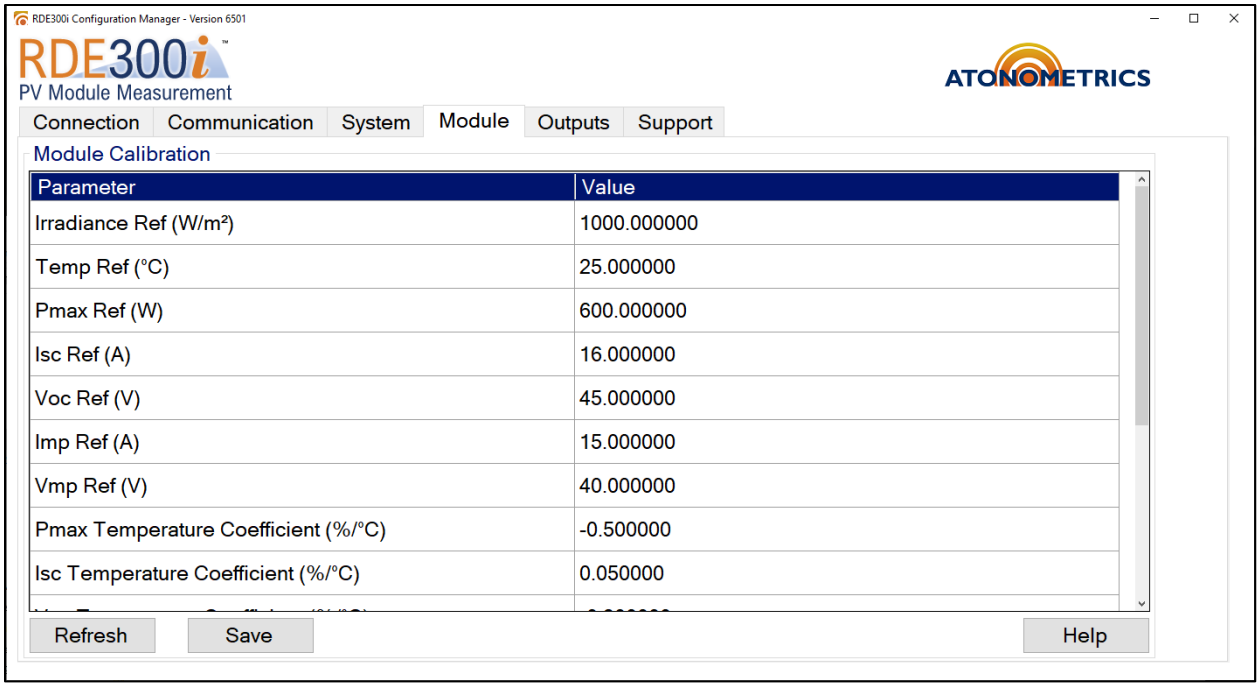


Figure 3-22: Setting Module Parameters

3.2.4.5 Set Leader Communication Options

Your RDE300i unit's default Modbus serial communication parameters for its Main communication port are Address = 30, Baud Rate = 57600, and Data Format = 8-N-1 (8 data bits, no parity, 1 stop bit).

To update the communication parameters, use the Communication tab of RDE300i Configuration Manager, shown in **Figure 3-23**.

Enter your new parameters in the Update Modbus Settings box and press Apply to transmit these to the unit. These are the communication parameters that you will use with your data logger or SCADA system to communicate with the Leader unit.

Addresses from 1 to 247 are allowed.

Supported baud rates are 9600, 19200, 38400, 57600, and 115200.

Supported data formats are 8-N-1, 8-N-2, 8-E-1, and 8-O-1.

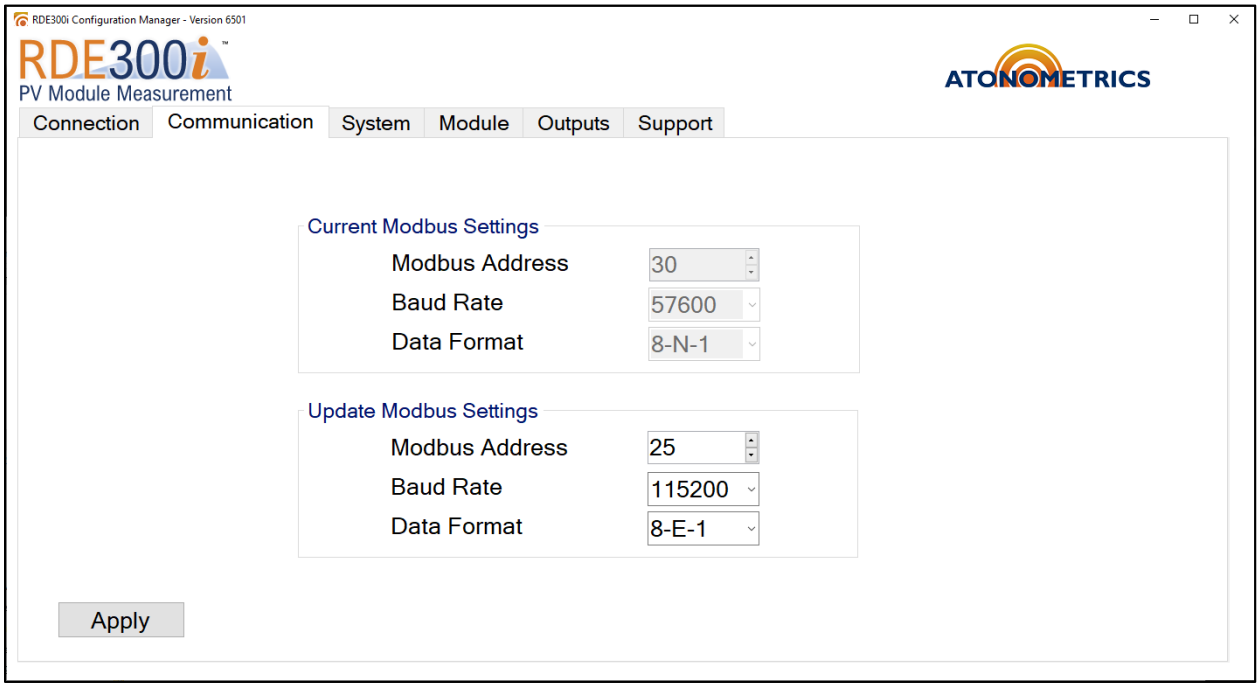


Figure 3-23: Setting Leader communication parameters

Note: If performing configuration in an office environment, this is your last step. Remove the Aux cables and Configuration Kit. The following sections must be completed in the field.

3.2.5 Equipment Installation

Refer to the RDE300i User Guide (880093) for the installation procedure and wiring instructions to install your RDE300i Leader unit.

WARNING: Follow all installation and wiring instructions per the RDE300i User Guide (880093). Failure to follow instructions properly may result in serious damage to the product or connected equipment and/or hazards to human health and safety.

Ensure the RC22 unit(s) and Mars unit, if applicable, are at the same tilt angles as the PV module to which the Leader is connected, preferably within 0.5 degrees. Use a handheld inclinometer to confirm. Check the tilt in both directions across each device. If necessary, remount the device.

For bifacial configurations, it is critical to locate your rear-side RC22 units exactly as shown in the Soiling Products Ordering Guide (880100). Use the 810302 RC22 Rear-Side Mounting Clamp Brackets to clip the RC22 units to the frame of the module, 25% from the top and bottom edges.

The system installation diagram for a Module-Cell-Optical (Bifacial) system configuration is shown below as an example in **Figure 3-24**.

Note: System installation is unique for each RDE300i system configuration. Review the Soiling Products Ordering Guide (880100) for the system installation diagram specific to your system configuration.

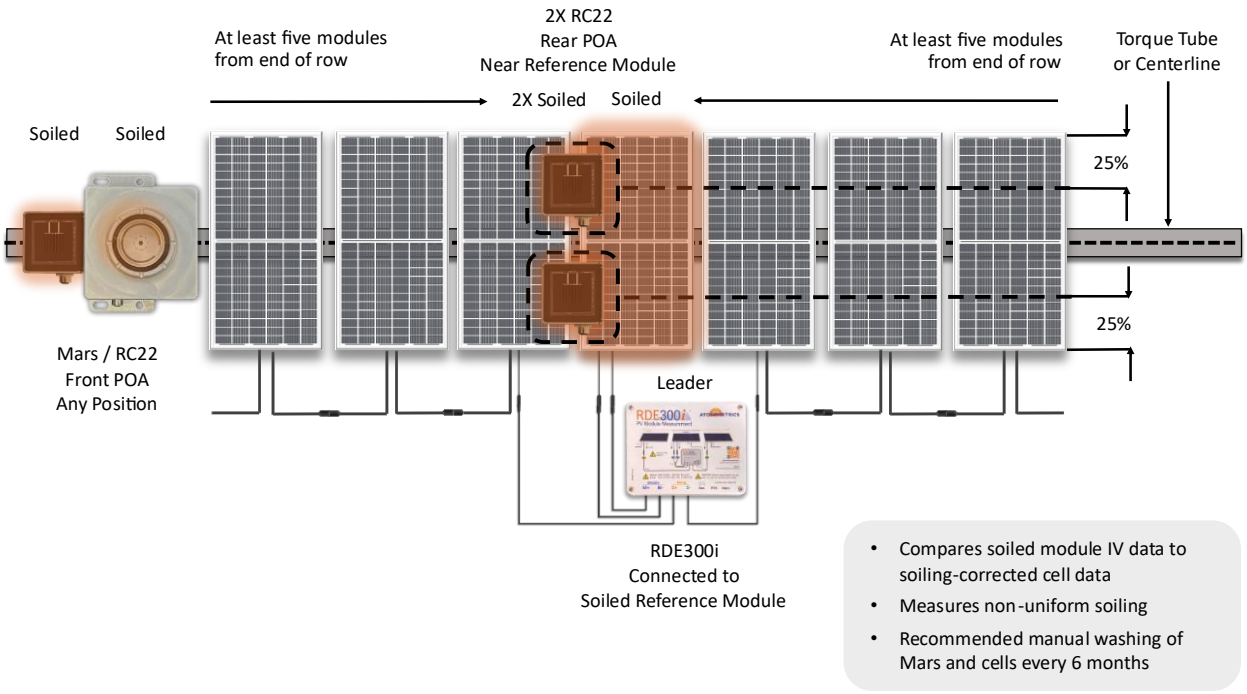


Figure 3-24: Module-Cell-Optical (Bifacial) System

3.2.6 Verify System Operation

If not already connected, repeat the steps in **Section 3.2.4.1** to connect to the RDE300i Leader unit. Select the System tab and ensure that the Status is OK for the Leader and your Aux Devices, as shown in **Figure 3-25**.

Note: If an Aux Device is not properly configured or connected, its status may be displayed with an error in the System Status box. To resolve this condition, ensure that the Leader and Aux Devices are connected and properly configured.

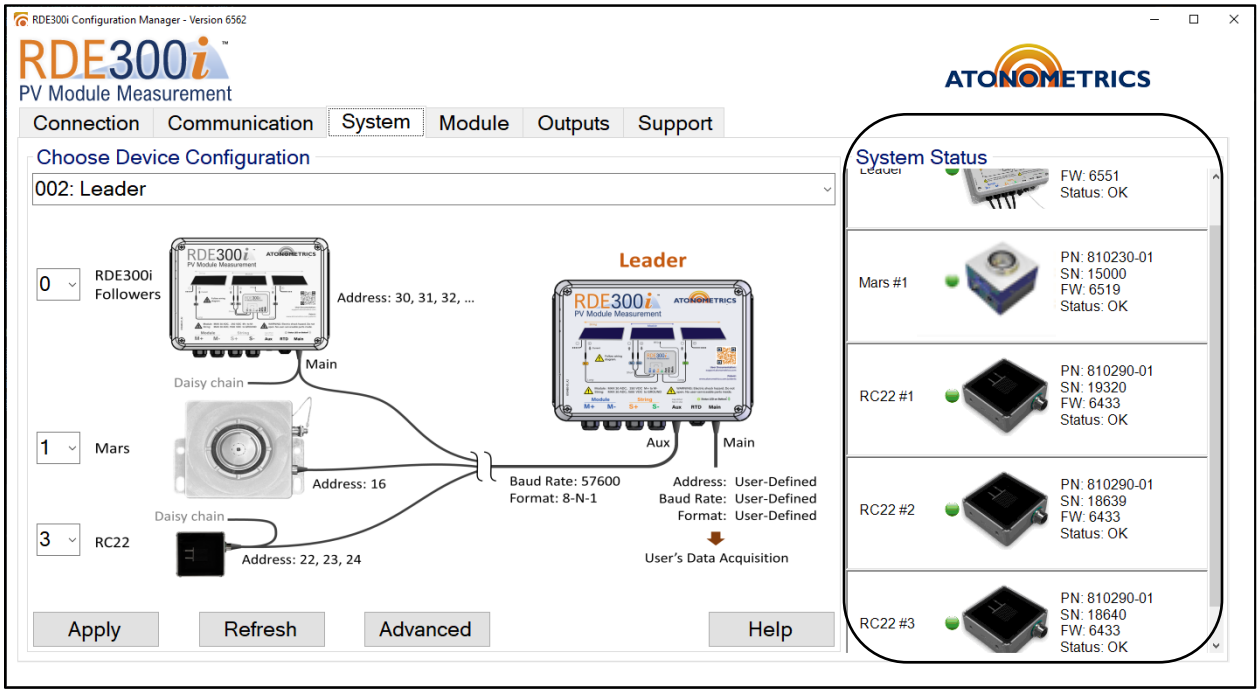


Figure 3-25: Verifying system operation between Leader and Aux Devices

Select the Outputs tab to check the measurement results from your system, as shown in **Figure 3-26**, **Figure 3-27**, and **Figure 3-28**.

The tab displays the most recently measured IV curve and the most recent readings of all the measured and calculated parameters, including Pmax, Isc, module voltages and currents, string data, irradiance, performance indices, and more. Scroll through the tab to examine all the parameters.

The Leader's data are displayed as Module 1 and the Aux Device's data are displayed below that as RC22 1, Mars 1, Cell Wash 1, etc. Ensure data are updating for each Aux Device.

All the data displayed on the Outputs tab are available for data acquisition via the Modbus interface.

Your Module-Cell system is configured for normalization. Continue to Section 4 Normalization.

Note: If values are not being updated, ensure that all Aux Devices are connected to the Leader, and the Leader is connected to its respective PV module.

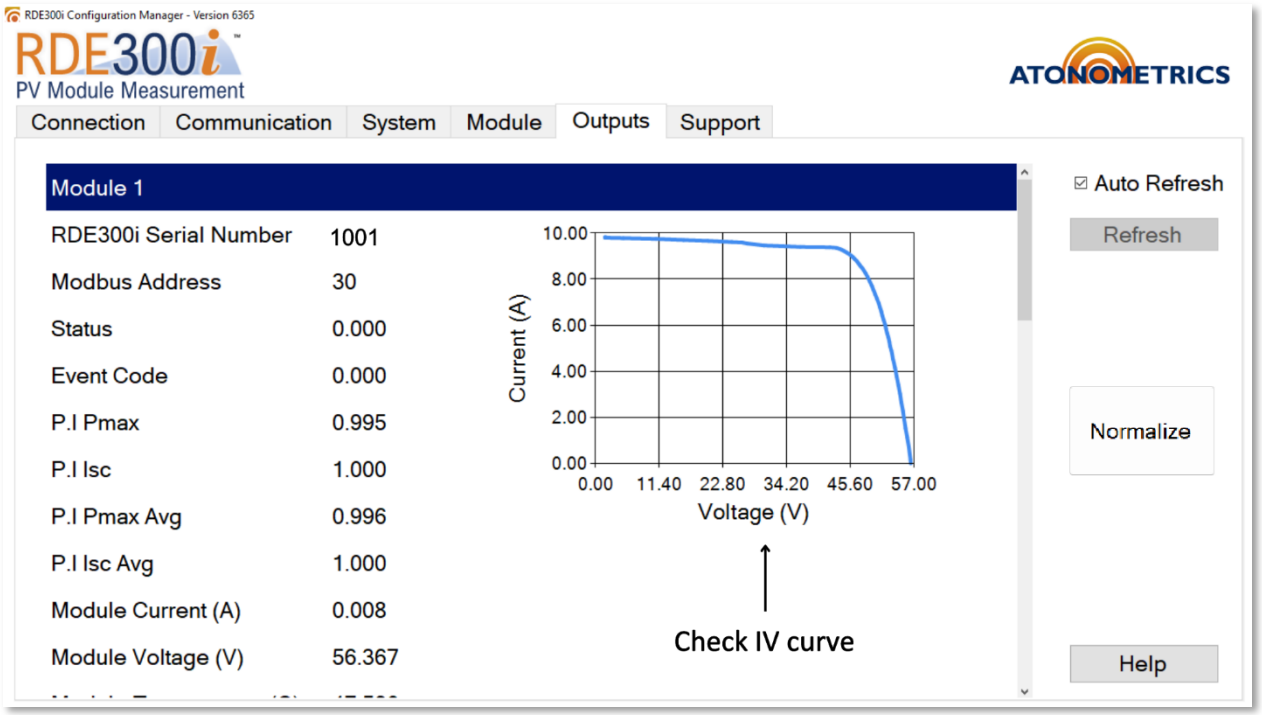


Figure 3-26: Checking output data and IV curves

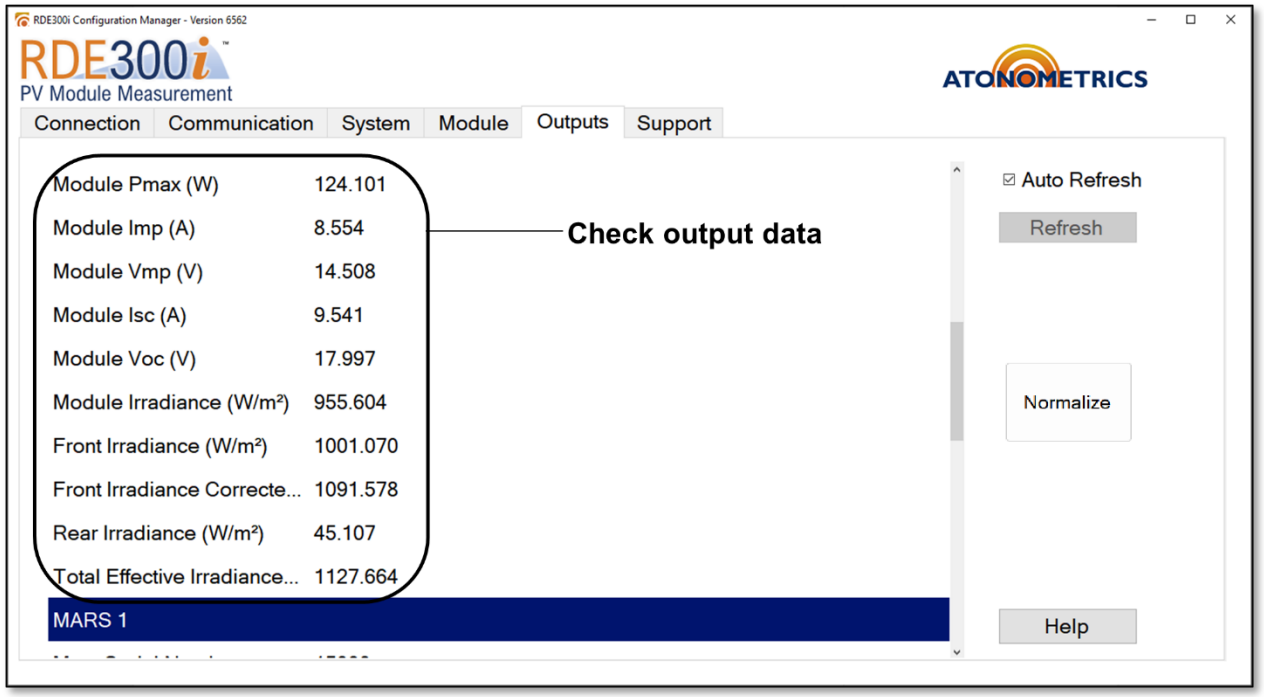


Figure 3-27: Check output data gathered from the module and Aux Devices

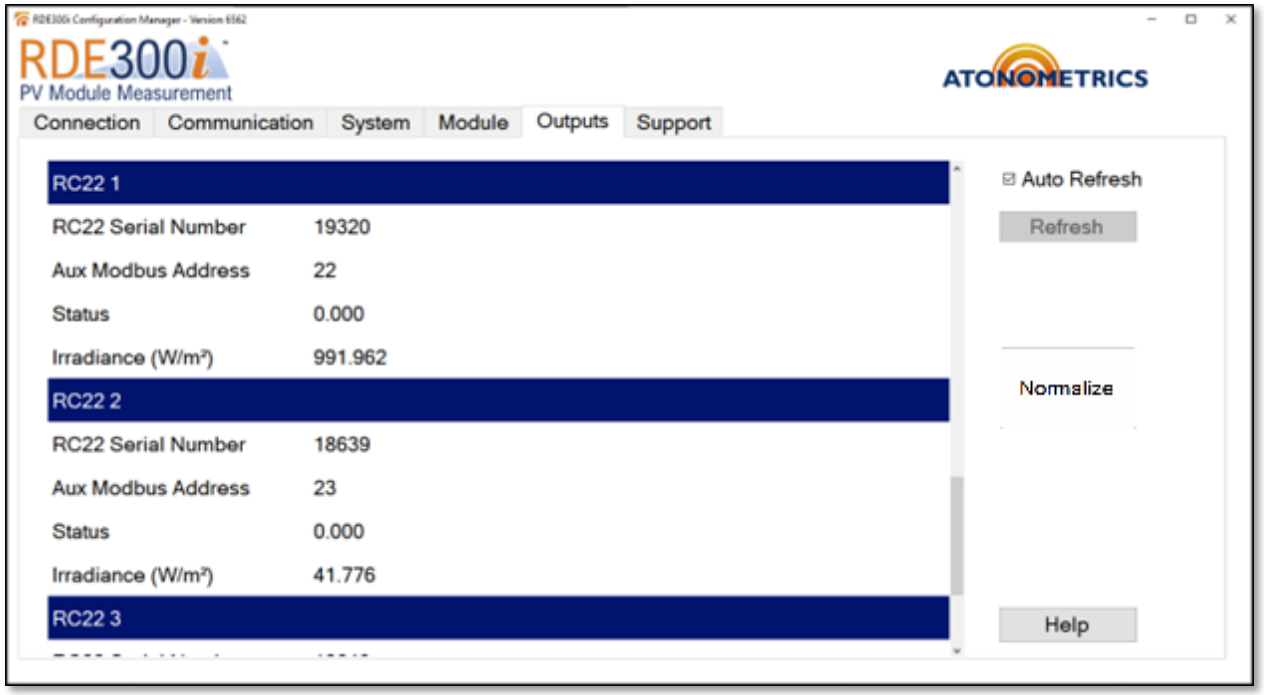


Figure 3-28: Check data gathered from Aux Devices

4 Normalization

4.1 Objective

The purpose of normalization is to support measurement of performance indices by comparing modules with a reference.

Normalization can be done through the configuration manager locally (**Section 4.3**) or remotely (**Section 4.4**).

Note: Performance indices represent the measured output of each module compared to expectations from the rated module parameters normalized for irradiance. For more information on Performance Index calculations, see the RDE300i User Guide.

4.2 Wash All Modules and Reference Devices

Before normalizing your soiling system, **thoroughly clean all modules and reference devices connected to RDE300i, including all reference cells and the Mars unit**. This will directly affect the normalization process.

Washing can be done the day you plan to normalize or the day before you plan to normalize, as long as the modules remain clean when you start the normalization process.

4.3 Perform Normalization Locally

In this section, we give directions on performing normalization in the field with RDE300i Configuration Manager.

Before initiating the normalization process, **ensure that it is a clear sunny day, ensure the plane of array (POA) irradiance is higher than 500 W/m2, and ensure the modules are clean (refer to Section 4.2).** Additionally, the angle of incidence to the sun should be small, preferably less than 35 degrees.

Connect to the leader RDE300i and verify the firmware on all units is up to date. If not, it is recommended that all units in your soiling system be updated with latest revision of firmware.

The normalization process takes about 20 minutes in total (two 10-minute stages).

In the Outputs tab, click the “Normalize” button, as shown in **Figure 4-1**. This initiates an automated normalization process. A progress bar will appear with a 10 minute timer countdown.

Note: If there is an active RDE300i event code, or certain conditions are not met, such as low irradiance or high rear irradiance non-uniformity, then the configuration manager software will automatically prevent normalization from initiating. For more information on normalization codes and recommended user action, see **Table 5-1**.

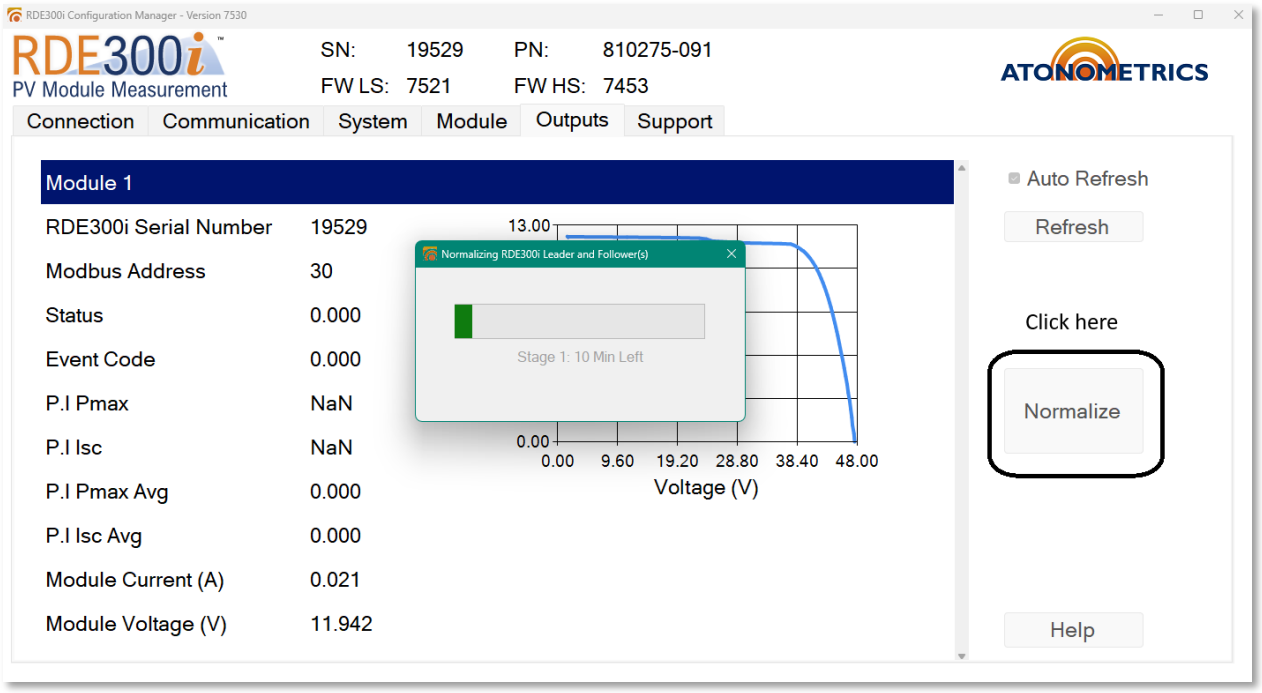


Figure 4-1: Initiate normalization

Stage one resets normalization data and then collects baseline data. After the ten minutes in stage 1, stage 2 will begin as shown in **Figure 4-2**.

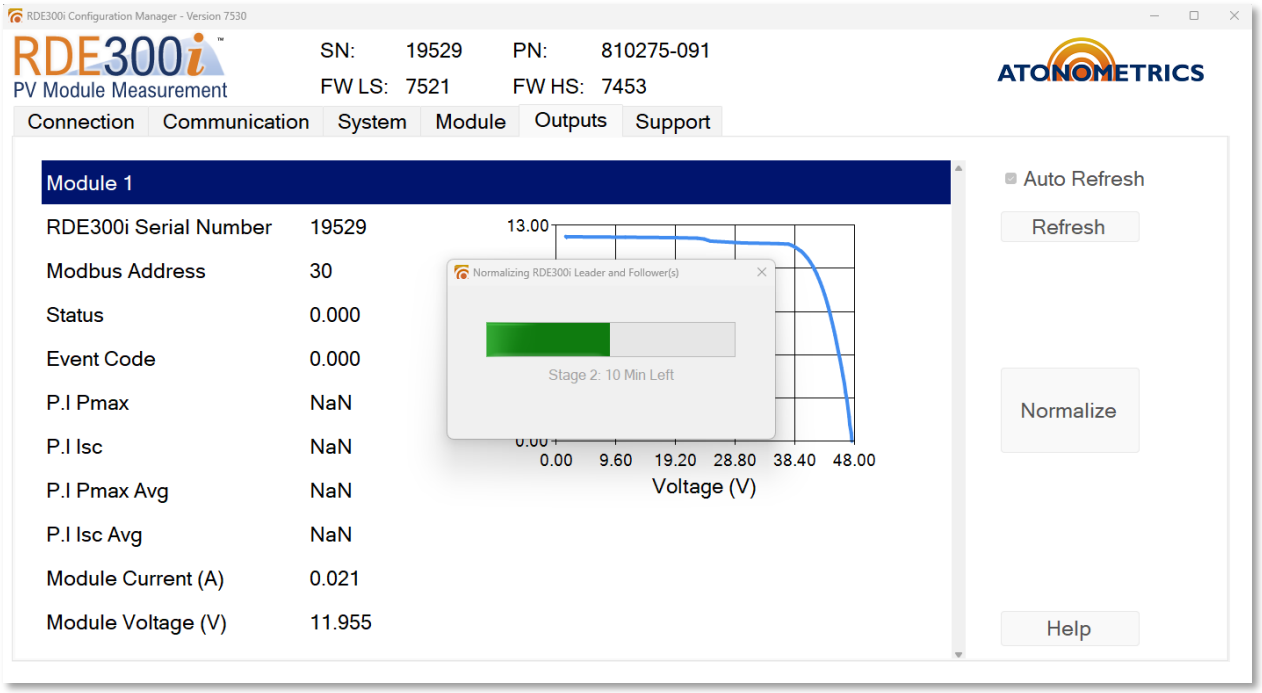


Figure 4-2: Stage 2 Normalization progress bar

Stage 2 sets new normalization constants and collects test data to evaluate normalization. At the end of stage two, a success message will show if there were no issues with the normalization process as shown in **Figure 4-3**. An error message will show if the normalization process fails at any point. If normalization factors or performance indices are not within limits, a warning message will show at the end of the 20 minute normalization period.

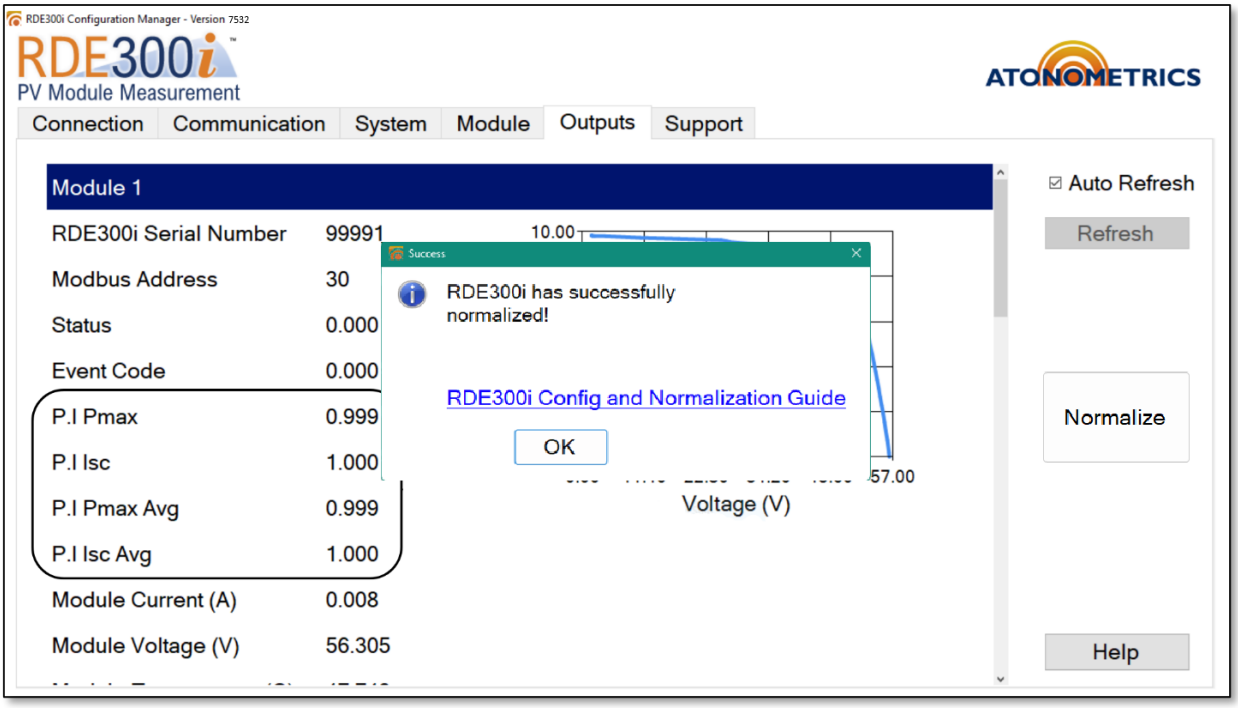


Figure 4-3: Normalization success

Note: Unstable irradiance conditions negatively affect the normalization process.

Note: The normalization process must be completed on a clear sunny day, plane of array (POA) irradiance should be higher than 500W/m2, and solar angle of incidence to the modules should be less than 35 degrees.

The configuration and normalization of your RDE300i Leader and Follower system is complete. The system is ready to go!

4.4 Perform Normalization Remotely

In this section, we explain how to perform a normalization remotely. With this feature, multiple different soiling stations can be normalized in parallel without having technicians present at each station.

Before initiating the normalization process, **ensure that it is a clear sunny day, ensure the plane of array (POA) irradiance is higher than 500W/m2, and ensure the modules are clean (refer to Section 4.2).** Additionally, the angle of incidence to the sun should be small, preferably less than 35 degrees.

Remote normalization is supported using RDE300i firmware **R7521 and higher**. Writing the password, 6.566, to Modbus register 103 will initiate an automated normalization process within RDE300i firmware. Refer to **Table 4-1** for additional normalization related registers. The normalization process takes 20 minutes.

The normalization trigger command can be sent directly by a SCADA system (**Figure 4-4**) or through a datalogger (**Figure 4-5**). **Section 4.4.1** demonstrates how to remotely normalize your soiling system using a the CR1000x data logger from Campbell Scientific.

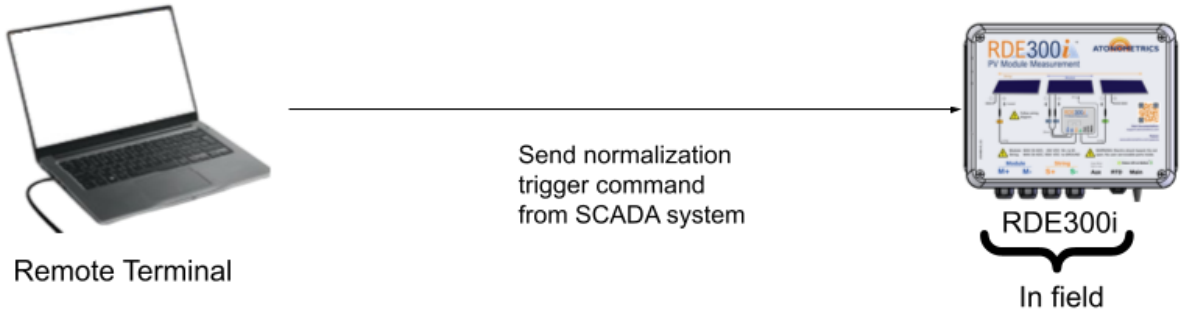


Figure 4-4: Performing Normalization remotely via direct access

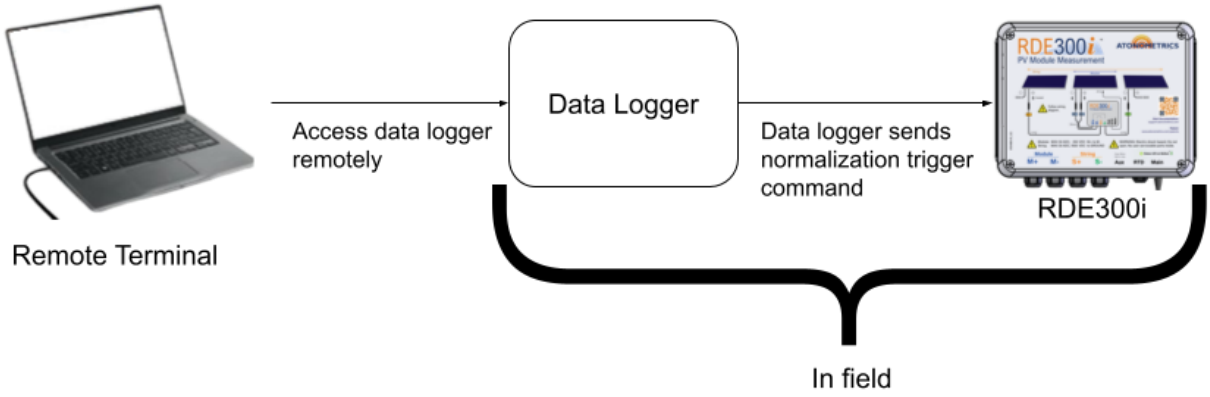


Figure 4-5: Performing Normalization with a data logger

Table 4-1: Normalization Modbus Registers

Parameter	Reg. Start	Count	Data Type	Read/ Write	Notes
Normalization Trigger	103	2	Float	Write	Write 6.566 to trigger remote normalization
Normalization Status	1701	2	Float	Read/ Write	-1 = Normalization Error 0 = Normalization Inactive 1 = Normalization In Progress 2 = Normalization Success 3 = Normalization Warning Writing anything to this register resets the returned value to 0.
Normalization Code	1703	2	Float	Read/ Write	If normalization status = 3 or -1, refer to **Table 5-1** for the recommended actions for a normalization code. Writing anything to this register resets the returned value to 0.

4.4.1 Remote Normalization Example

Below is an example of a simple method of remotely normalizing an RDE300i via a CR1000x datalogger. Our example data logger code contains the commands for initiating remote normalization for this model of datalogger. You will need PC400 software from Campbell Scientific as well as a CR1000x datalogger to follow this example.

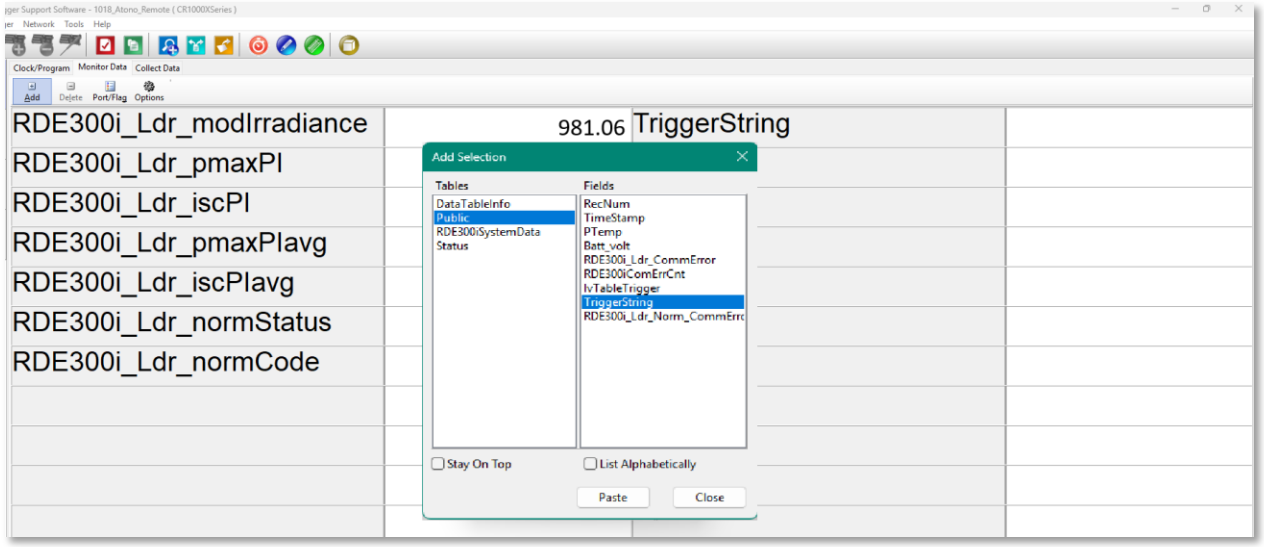


Figure 4-6: Adding a public variable to the outputs table

The example code has a public variable that can asynchronously control when the remote normalization command is sent to your RDE300i called “TriggerString”.

Figure 4-6 shows how to add this public variable to the “Monitor Data” page of your PC400 application. Typing an “N” in the column next to the “TriggerString” (same row) public variable and pressing enter will send the normalization command to your RDE300i. The cell will turn yellow as shown in **Figure 4-7**.

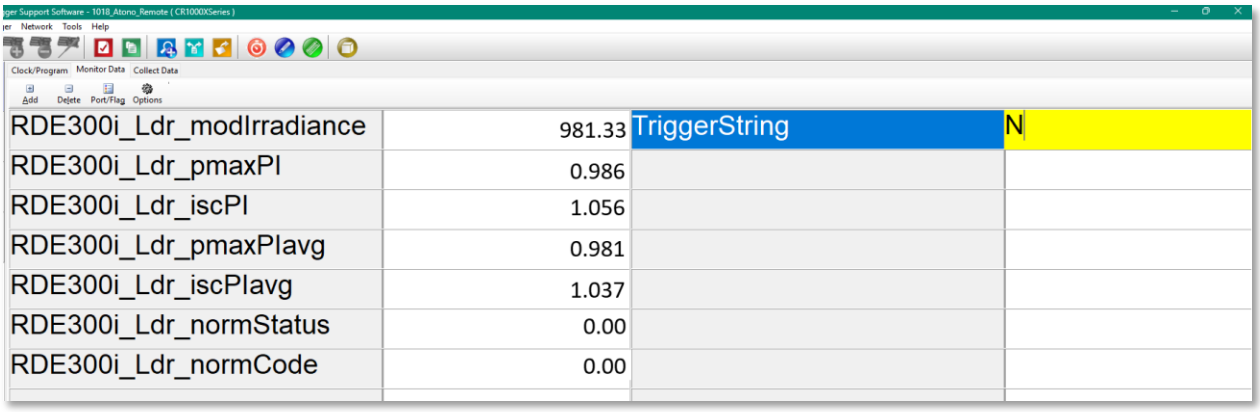


Figure 4-7: Triggering Normalization

After pressing enter, the letter you typed in will disappear, performance indices will show “NAN”, and norm status will change to 1 as shown in **Figure 4-8**.

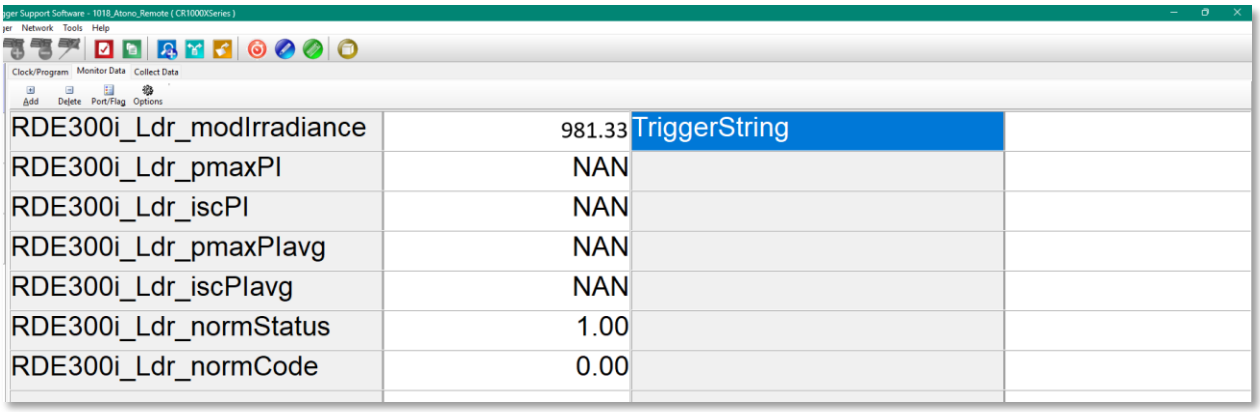


Figure 4-8: Outputs after triggering Normalization

Note: After ten minutes, warnings can appear, but normalization cannot be restarted until the full twenty-minute normalization period has passed. Normalization can be restarted any time after an error appears.

After approximately 20 minutes, normalization will be completed. If your RDE300i normalized without any issue your normalization status register will show a 2, the normalization code will stay 0, and the performance indices of the leader and all followers should read **1.000 +/- 0.010** as shown in **Figure 4-9**.

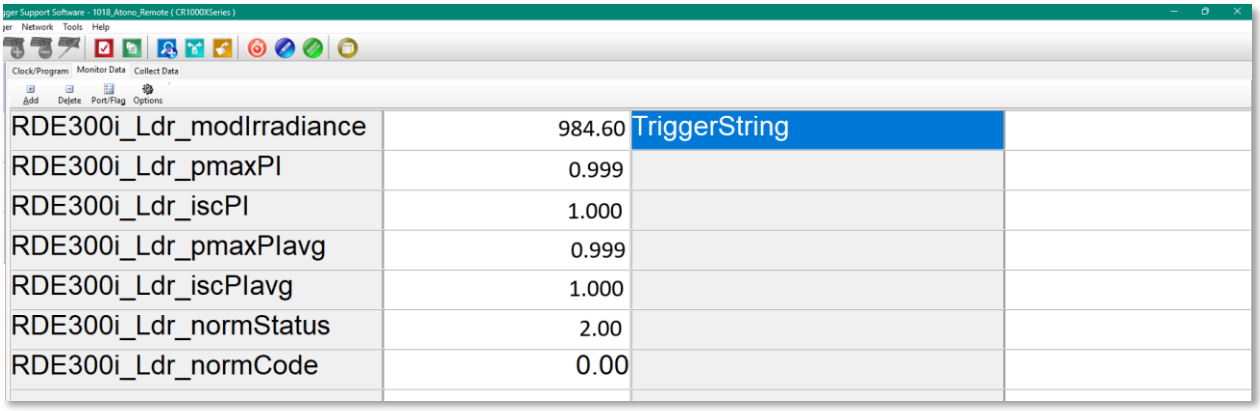


Figure 4-9: Successful Normalization example

If the normalization failed, normalization status will show a -1 and normalization can be reattempted. If normalization status is 3 (warning) or -1, check the normalization code and refer to **Table 5-1** for the meaning of the normalization code and the recommended action. Depending on the warning code, a normalization status of 3 could appear even if the performance indices are within limits. The normalization status and code registers can be reset back to 0 by writing an "R" instead of an "N" in the "TriggerString" variable.

Note: Unstable irradiance conditions negatively affect the normalization process.

Note: The normalization process must be completed on a clear sunny day, plane of array (POA) irradiance should be higher than 500W/m2, and solar angle of incidence to the modules should be less than 35 degrees.

The configuration and normalization of your RDE300i Leader and Follower system is complete. The system is ready to go!

5 Troubleshooting

Table 5-1: Normalization code meanings (warnings and errors)

Normalization Code	Name	User Action
0	No Issue	Normalization is complete! No user action is needed.
1, 2	Norm Factors Reset Error	Error. Normalization factors could not be reset at the beginning of the first phase of the normalization process. Issue with flash. Try again and then contact support.
3	Mars Transmission Loss Reset Error	Error. Check connection and functionality of Mars unit and try again.
4, 5	Norm Factors Set Error	Error. Normalization factors could not be programmed at the beginning of the second phase of the normalization process. Issue with flash. Try again and then contact support.
6, 7	PI Values Not Generated During Normalization.	Error. Performance Index values could not be generated during the first or second phase of the normalization process. Verify that irradiance is above 500 W/m2, verify connection, and verify that your reference module is measuring IV curve parameters. If everything looks good, attempt normalization again.
8. 9	Norm Factors Out of Limits	Warning only. Normalization is successful, but reference devices show significant output variation. This could be due to using 2 unique reference modules or improper module parameter input values. No user action is needed.
10, 11	PI Values Out of Limits	Warning only. Normalization is successful, but Follower PI values are outside the recommended range (1.00 +/- 0.01). No user action is needed.
20	Rear Irradiance Non-Uniformity	Error. Reposition the rear-side RC22 sensors to be 25% from the top and bottom edges of the reference module or increase the Rear-Side Irradiance Uniformity Threshold in the Advanced Configuration Options menu. Ensure that the RC22 measurements represent the average of the rear-side irradiance of your module.
21	Low Irradiance	Error. Ensure module parameters are inputted for your specific module. Perform normalization when irradiance is above 500 W/m2 or adjust Irradiance Threshold in the Advanced Configuration Options menu