

Configuration and Normalization Guide for Multi-RDE300i Systems



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1 Overview

This document will guide you through the configuration and normalization of a system with two or more RDE300i units for soiling, bifacial gain, or other module-module comparison applications.

This guide presents instructions for applications where one RDE300i™ unit will be designated and configured as a Leader and the other units will be designated and configured as Followers.

The PV module on the Leader unit will serve as a reference for the PV modules on the Followers.

For soiling measurement applications:

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

For bifacial gain applications:

- The PV module on the Leader unit should be monofacial.
- The PV modules on the Follower units should be bifacial.

Section 3 (Configuration) may be completed in an office environment prior to field deployment. During configuration, one unit will be configured as the Leader and the remaining units will be configured as Followers.

Following the steps in this document, you will normalize the Performance Index (P.I). 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 higher than 500W/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:

- Two or more RDE300i units
- Latest RDE300i firmware
 - Acquire the latest firmware version from support.atonometrics.com.
- PV Modules for RDE300i units
- Power and Communication Cables (830284 and 830303)
- Configuration Kit (810235-01 or 810276)
- Latest RDE300i Configuration Manager Software (500092)
 - Acquire the latest version from support.atonometrics.com
- RDE300i User Guide (880093)
- Laptop or PC (Windows 7 or Higher)



Figure 2-1: Connecting your laptop PC to the RDE300i

Note: For more information on RDE300i Configuration Manager Software (500092), configuration kits (810235-01 or 810276), or to find software drivers, visit support.atonometrics.com.

3 Configuration

3.1 Designating Leader and Follower

This guide presents instructions for applications where one RDE300i™ unit will be designated and configured as a Leader and the other units will be designated and configured as Followers.

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.

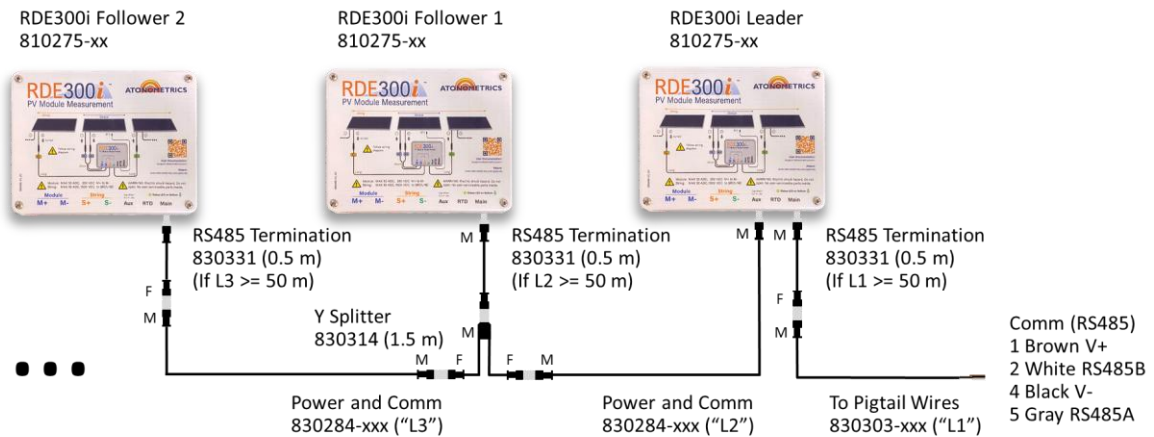


Figure 3-1: Multi-RDE300i system cabling diagram (example)

3.2 Configure the Follower

3.2.1 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.

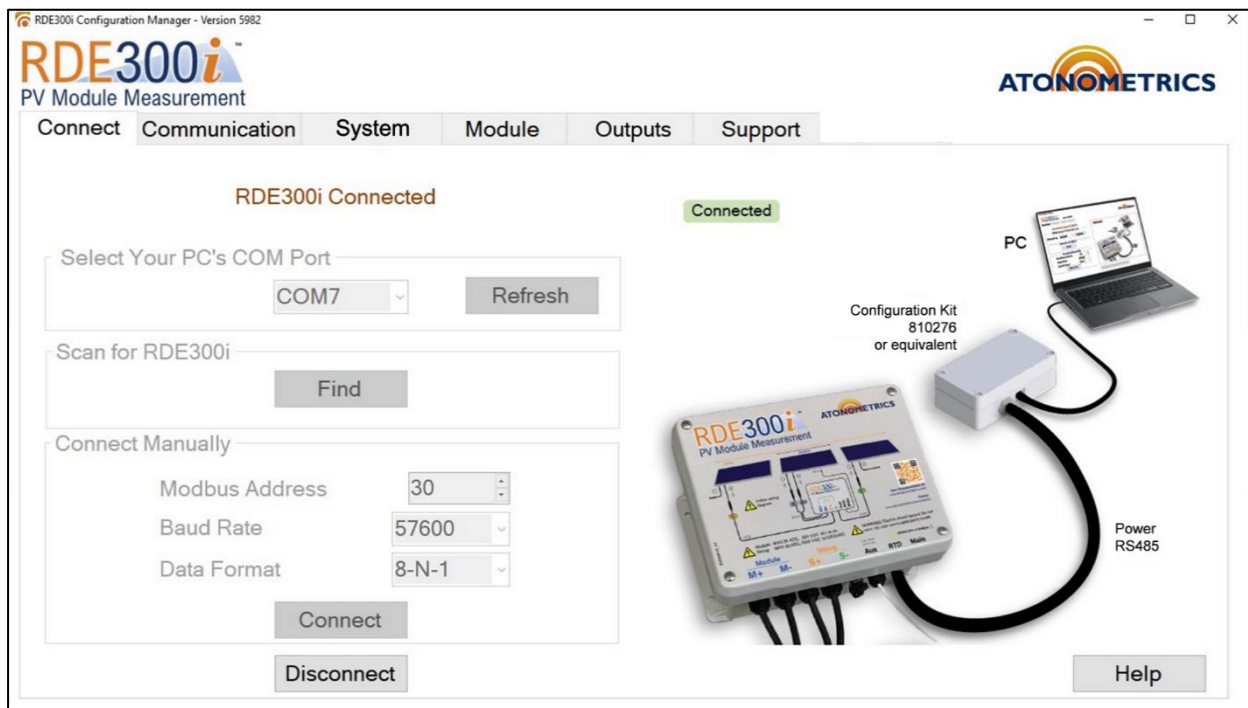


Figure 3-2: RDE300i connected

3.2.2 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.

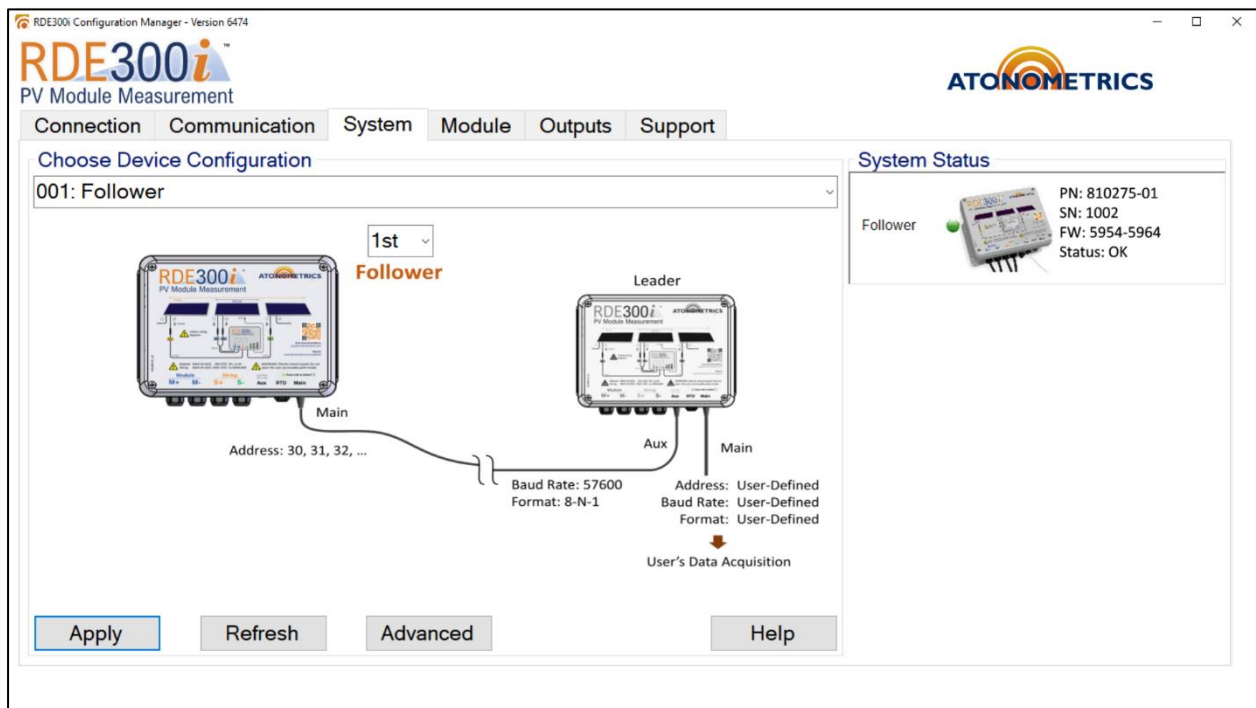
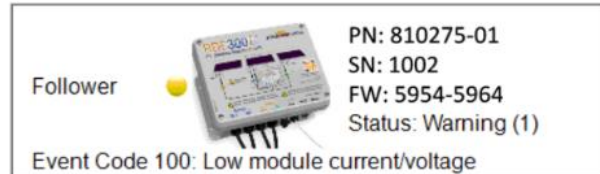


Figure 3-3: Setting Follower configuration

3.2.3 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/m² 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.

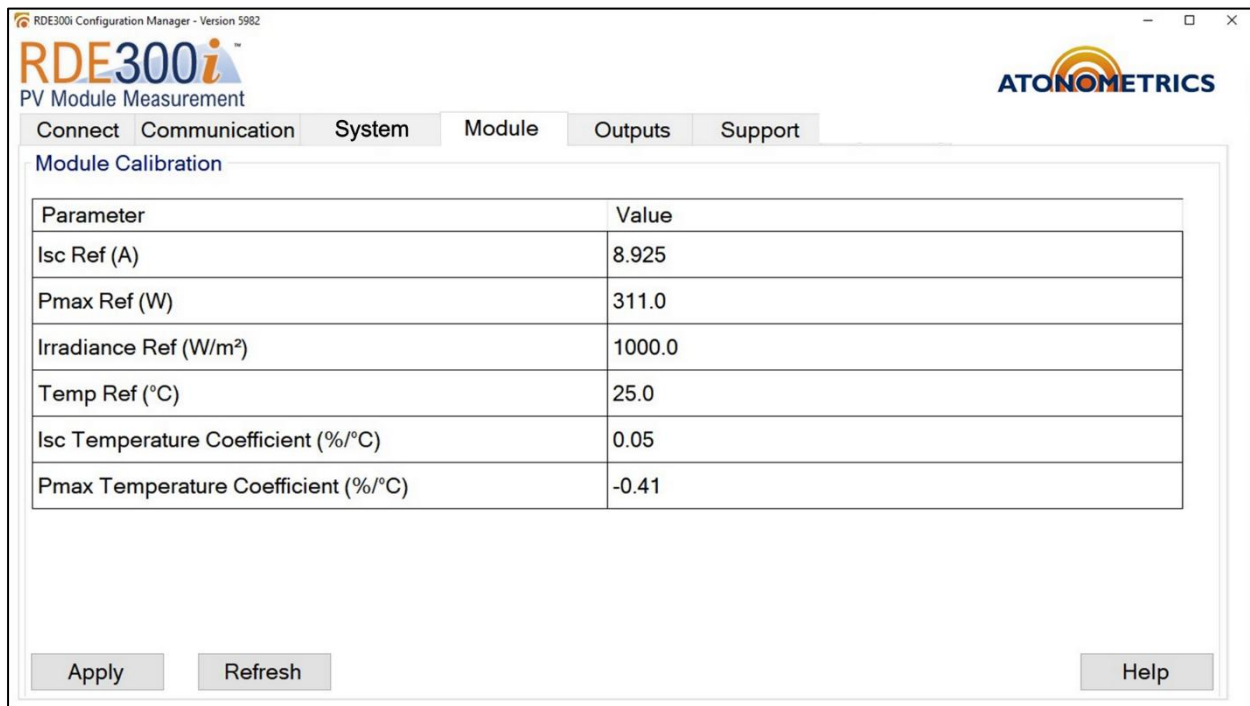


Figure 3-4: Setting Module parameters

3.2.4 Configure Remaining Followers

Repeat Section 3.2 to configure each of the remaining RDE300i Follower units.

3.3 Configure the Leader

3.3.1 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 3-1**.

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 3.2.1.

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).

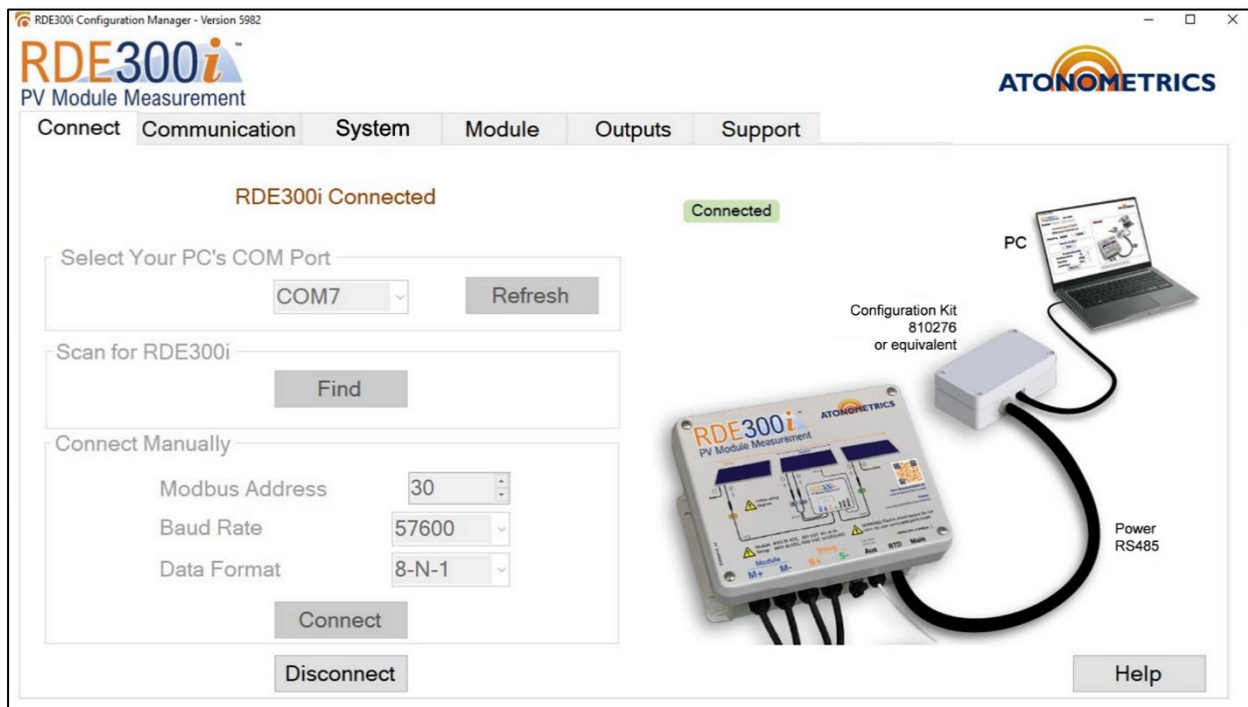


Figure 3-5: RDE300i connected

3.3.2 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.

Note: If using Mars and / or RC22 in combination with RDE300i, see the Configuration and Normalization Guides for RDE300i, Mars, and RC22 Systems (880096-03) or RDE300i and RC22 Systems (880096-02).

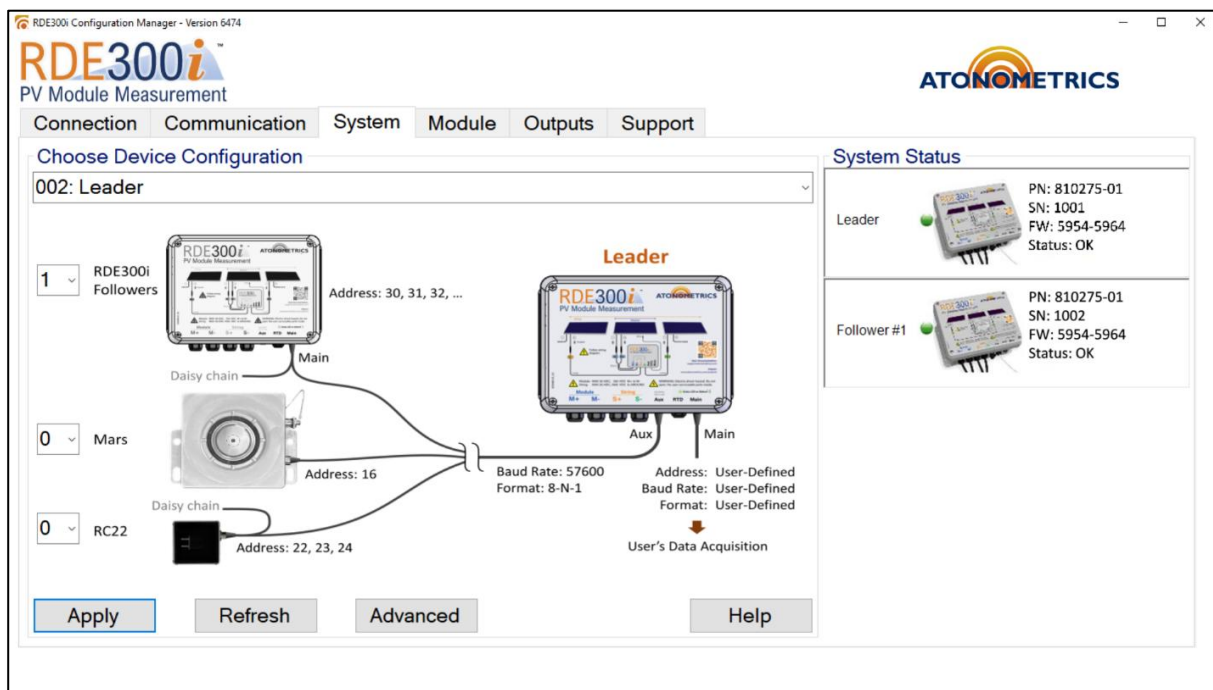


Figure 3-6: Setting Leader configuration

3.4 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.

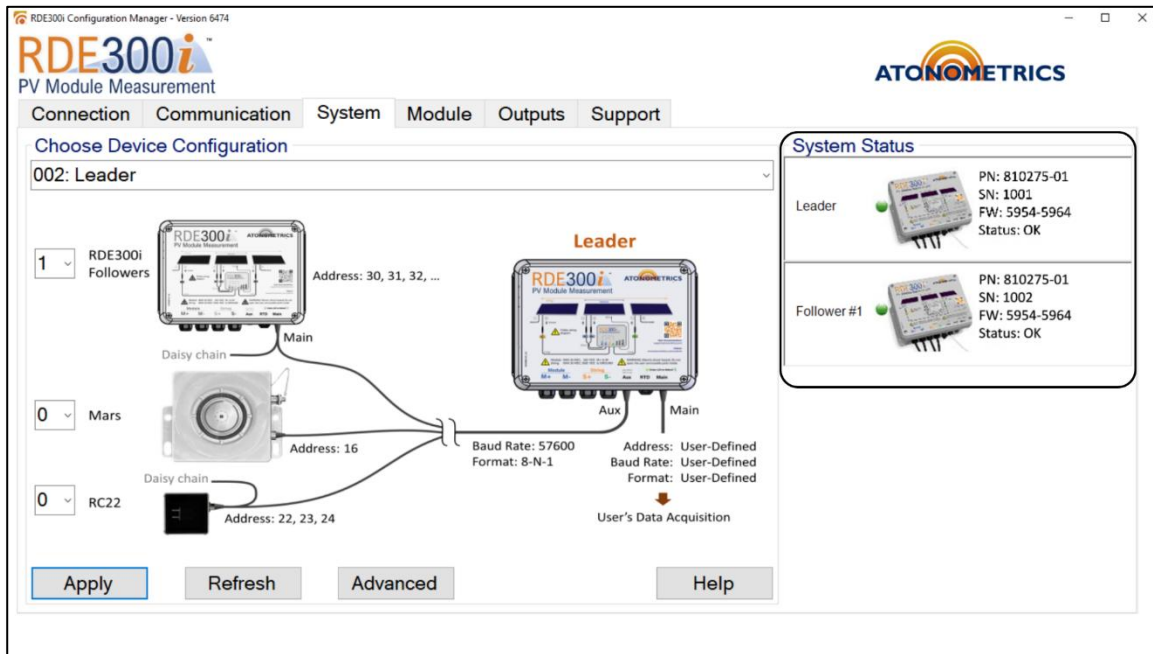
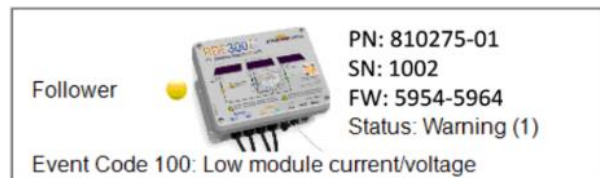


Figure 3-7: Verifying communication between Leader and Followers

3.4.1 Set Module Parameters

Enter the module parameters for the Leader's PV module, following the steps in Section 3.2.3.

3.4.2 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.

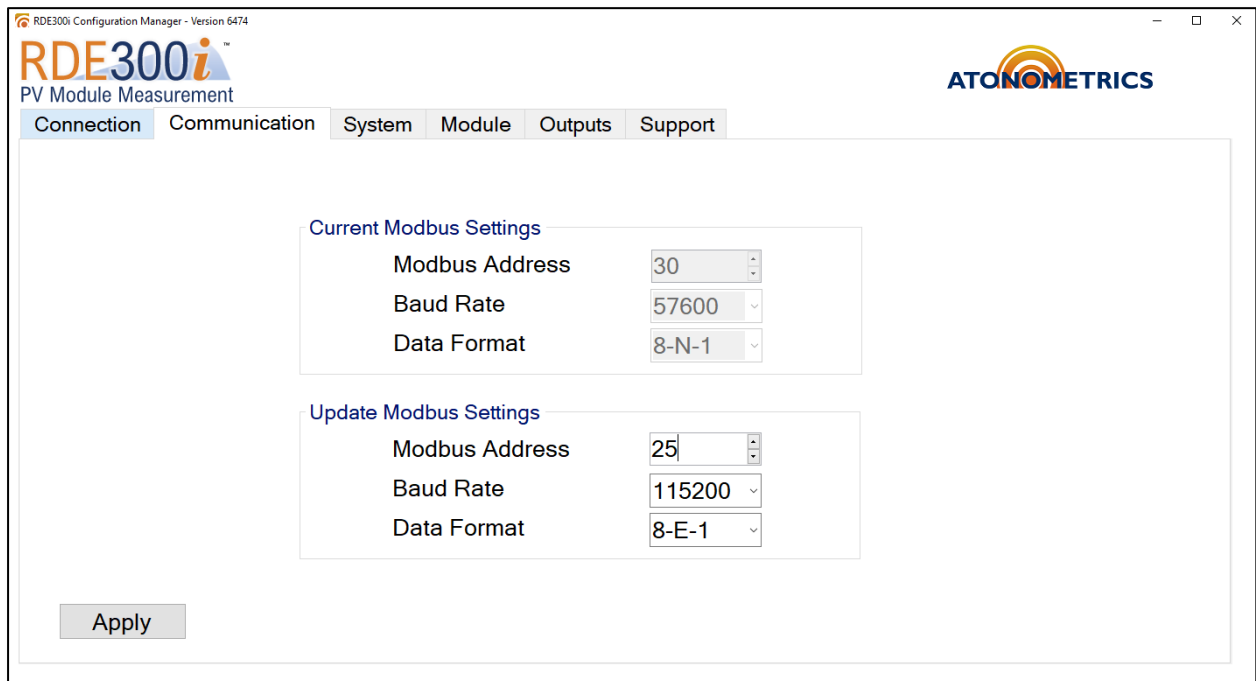


Figure 3-8: Setting Leader communication parameters

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 4-1** below for our recommended field layout for the RDE300i Leader and Followers for module-module soiling measurement application. Additional examples are shown in the Soiling Products Ordering Guide (880100).

Ensure all modules connected to RDE300is 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.

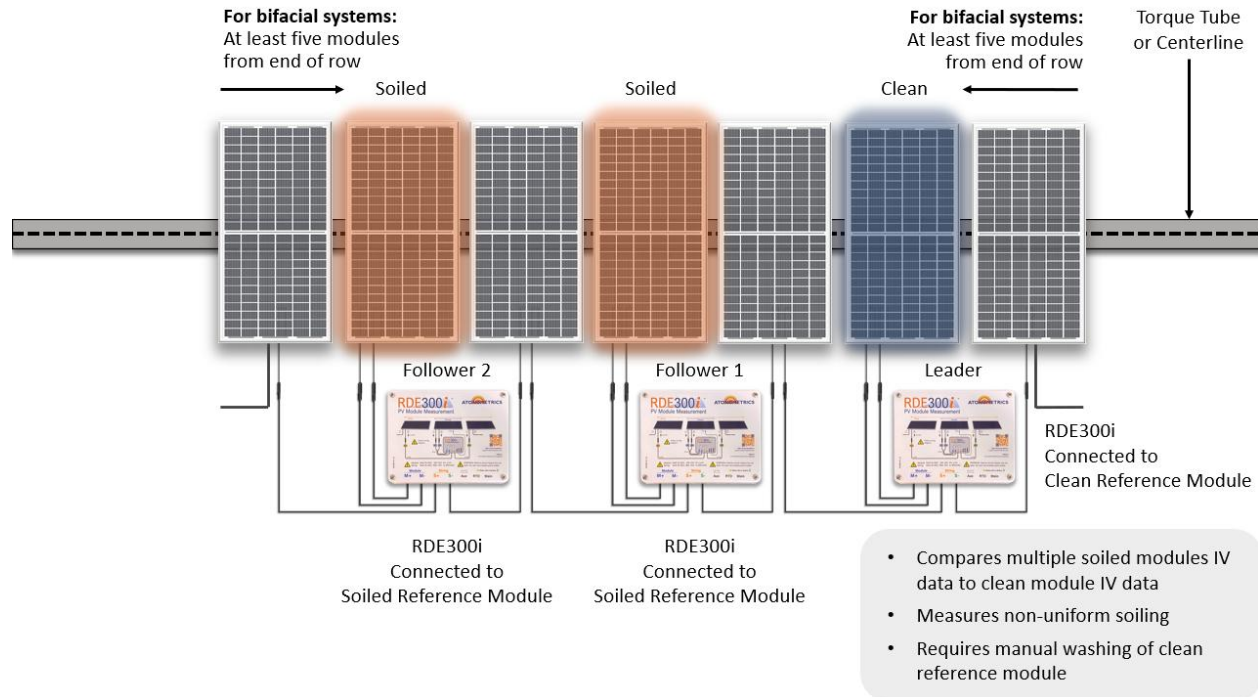


Figure 4-1: Recommended field layout for soiling application example

5 Verify System Operation

If not already connected, repeat the steps in Section 3.3.1 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 5-1**.

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.

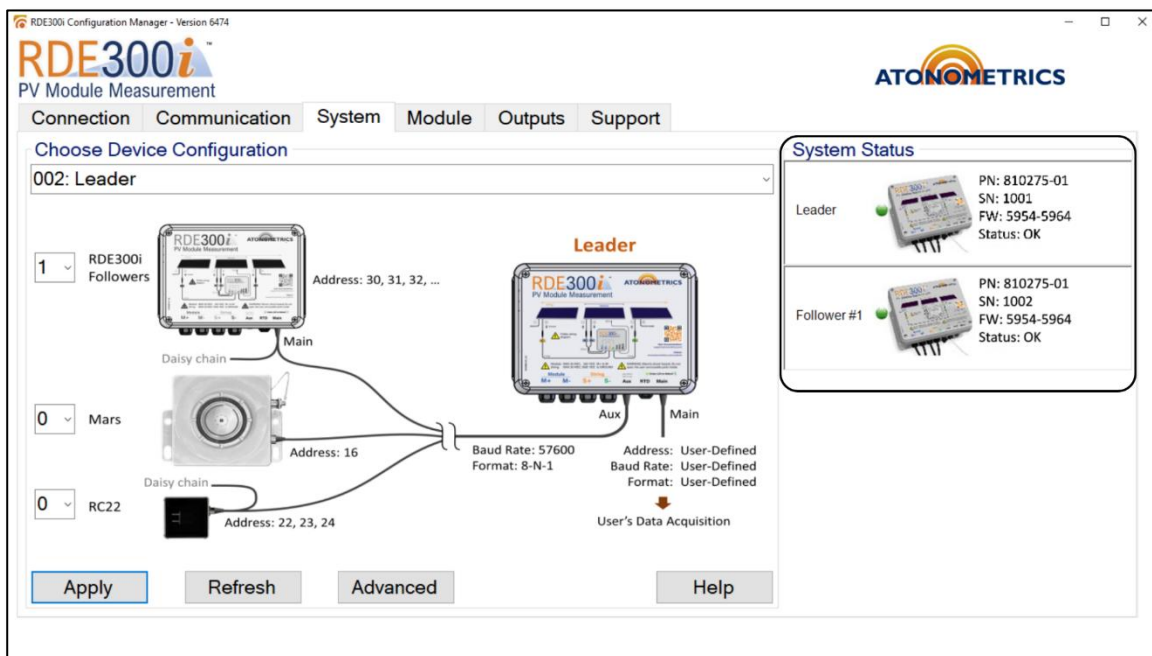


Figure 5-1: Verifying system operation between Leader and Followers

Select the Outputs tab to check the measurement results from your system, as shown in **Figure 5-2** and **Figure 5-3**.

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 2-60 seconds, depending on configuration options) for the Leader and Follower units, and that reasonable values are being recorded, as shown in **Figure 5-2** and **Figure 5-3**.

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

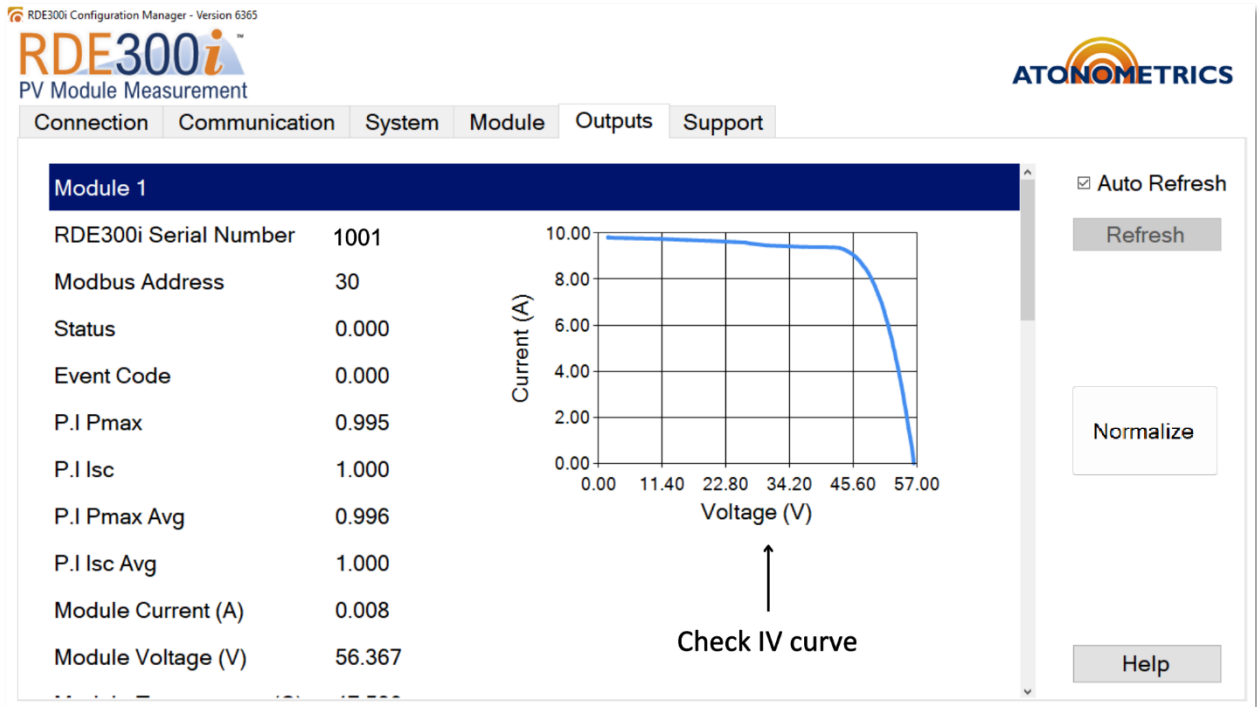


Figure 5-2: Checking output data and IV curves

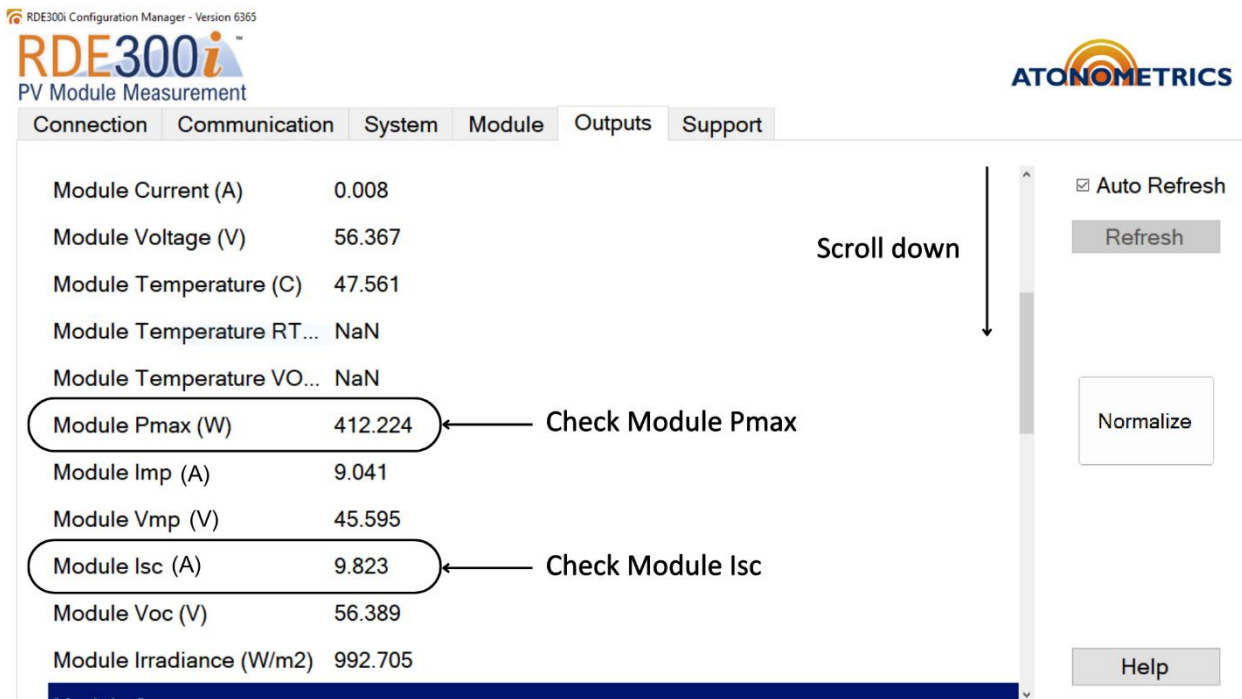


Figure 5-3: Check module outputs

6 Normalization

6.1 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 6.3**) or remotely (**Section 6.4**).

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.

6.2 Wash Modules

Before normalizing your soiling system, thoroughly clean all modules connected to RDE300is, i.e. the “soiled” and “clean” modules of soiling pairs. This will directly affect the normalization process. For bifacial gain applications, cover the rear side of the Leader’s PV module.

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.

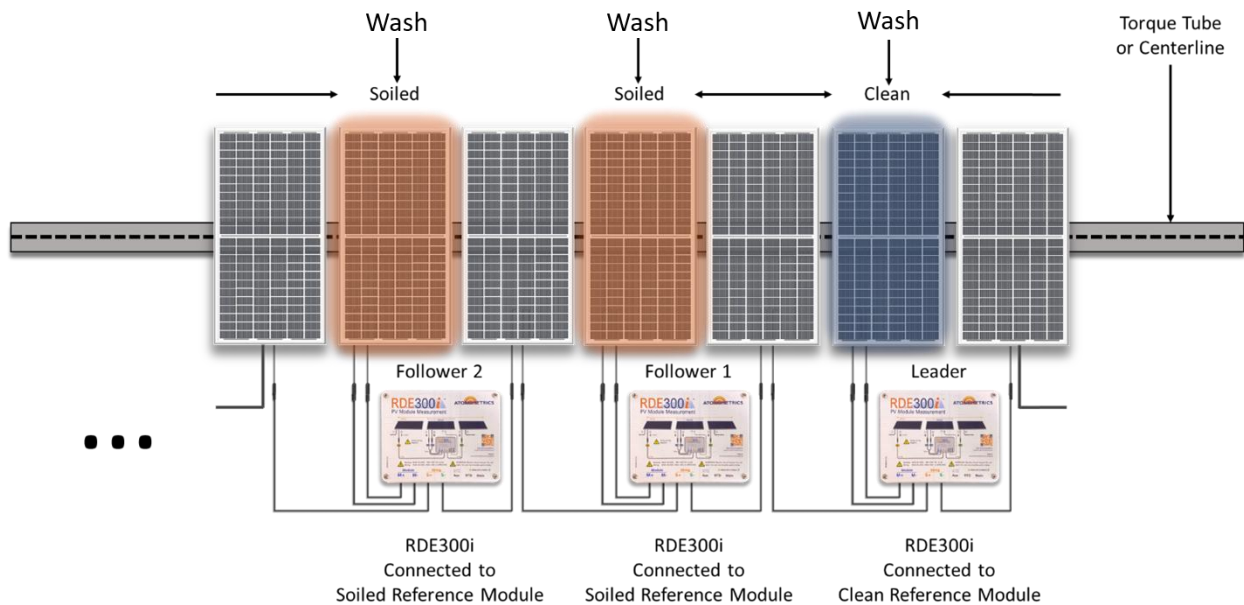


Figure 6-1: Modules that require washing before Normalization

6.3 Perform Normalization Locally

In this section, we give directions on performing a 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 500W/m2, and ensure the modules are clean (refer to Section 6.2)**. 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 6-2**. This initiates an automated normalization process. A progress bar will appear with a 10 minute timer countdown.

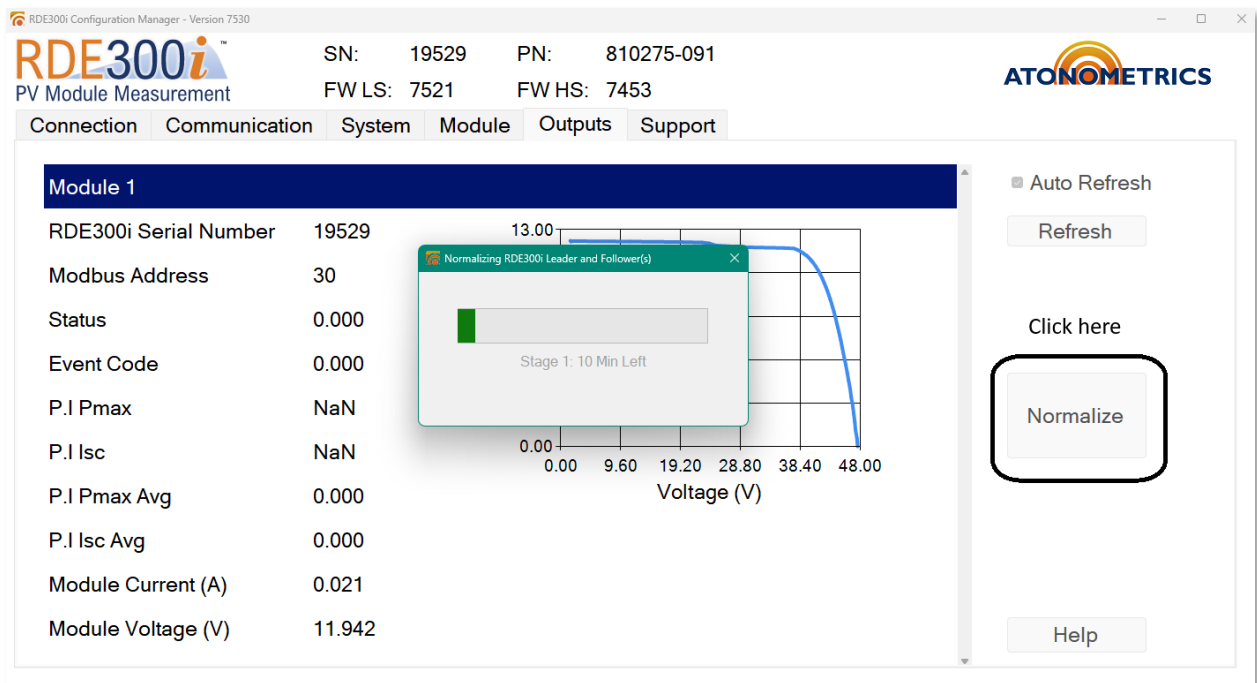


Figure 6-2: Initiate normalization

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 6-3**.

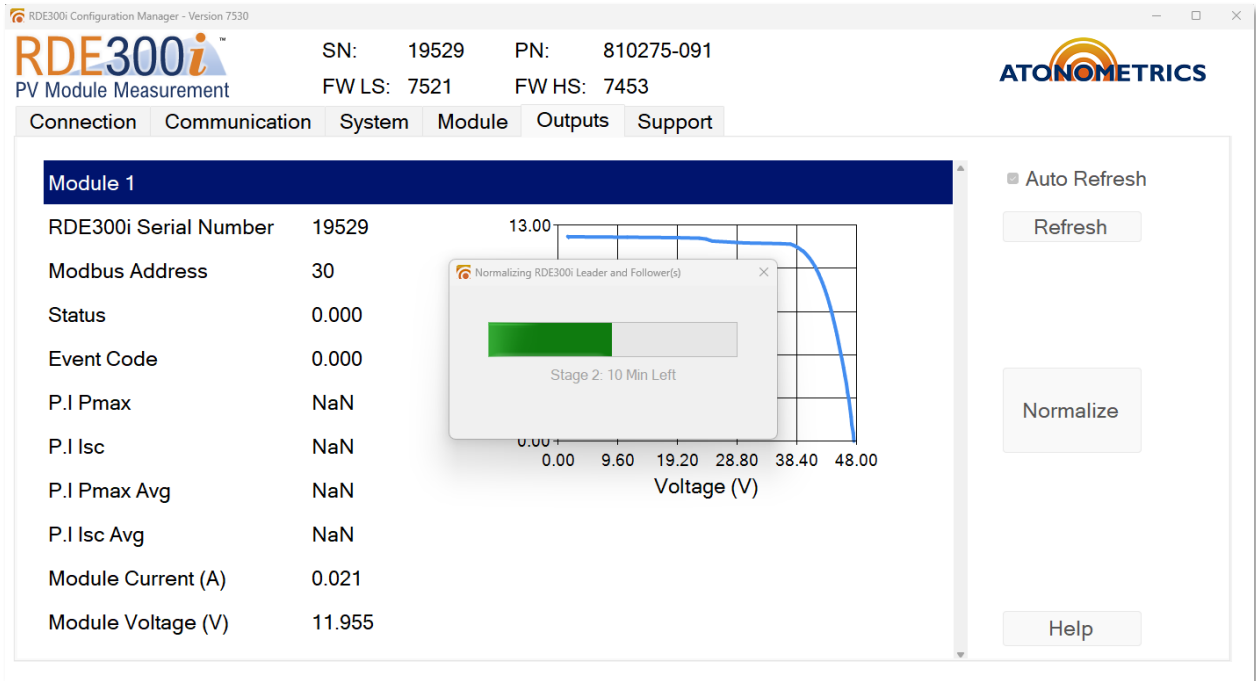


Figure 6-3: Stage 2 Normalization progress bar

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 6-4**. 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.

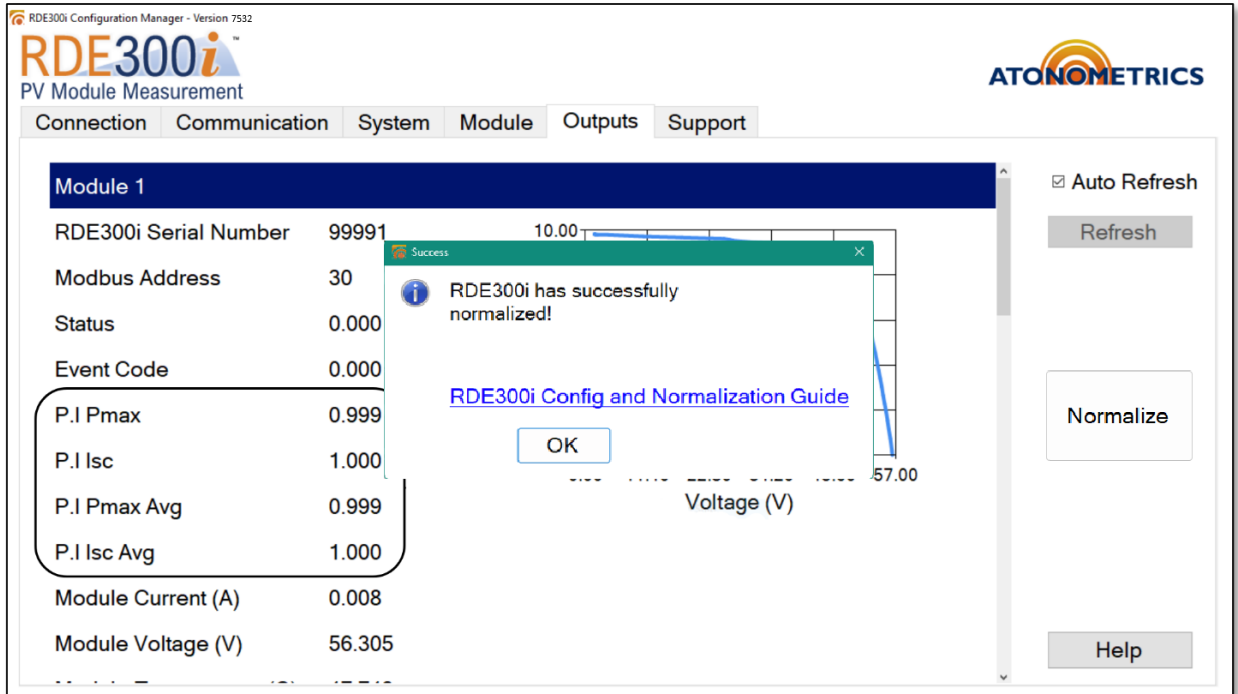


Figure 6-4: Normalization success

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!

6.4 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 6.2).** 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 6-1** for additional normalization related registers. The normalization process takes 20 minutes.

The normalization trigger command can be sent directly by a SCADA system (**Figure 6-5**) or through a datalogger (**Figure 6-6**). **Section 6.4.1** demonstrates how to remotely normalize your soiling system using a the CR1000x data logger from Campbell Scientific.

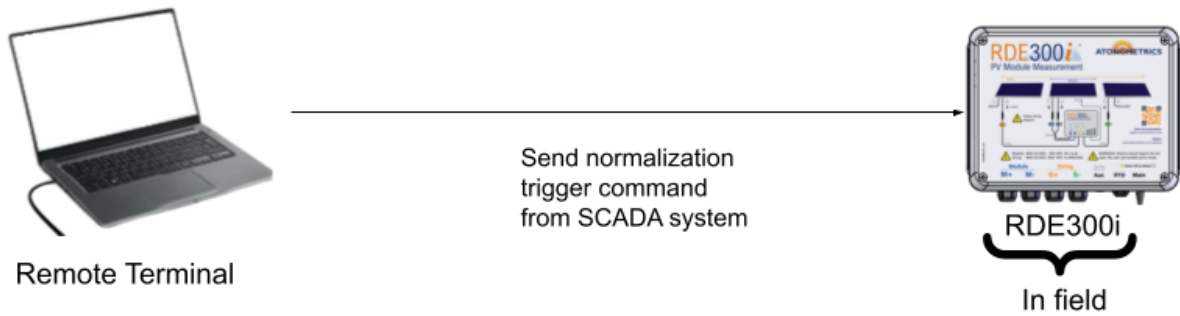


Figure 6-5: Performing Normalization remotely via direct access

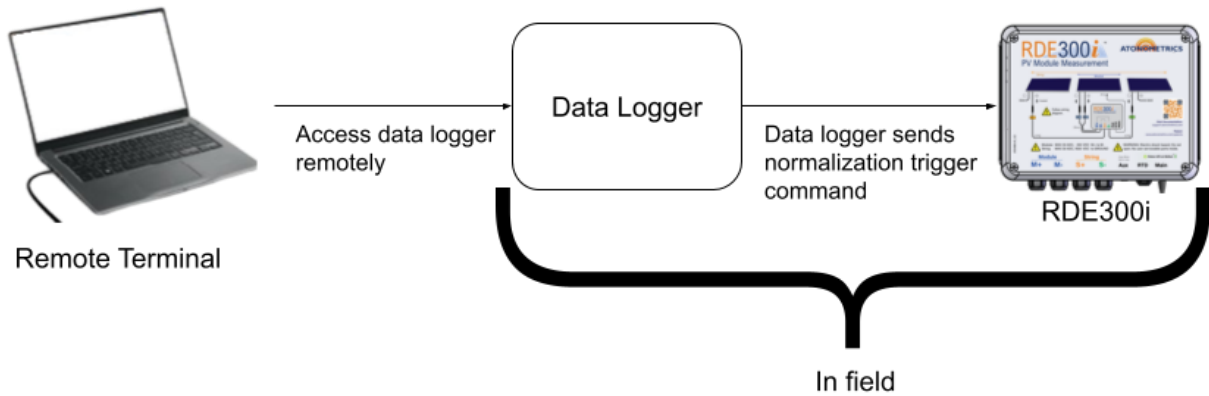


Figure 6-6: Performing Normalization with a data logger

Table 6-1: 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 6-2 for the recommended actions for a normalization code. Writing anything to this register resets the returned value to 0.

Table 6-2: Normalization code meanings (warnings and errors)

Normalization Code	User Action
0	Success. If normalization was just completed, then the unit is normalized and no further action is required.
1	Error. Issue with flash. Try again and then contact support.
2, 3, 5	Error. Verify connection with follower(s) or other auxiliary units. Try again and then contact support.
4, 6, 7	Error. Verify module parameters were set correctly, verify irradiance is above the threshold set in the advanced configuration options found in the "System" tab of RDE300i Configuration Manager, and verify connection to follower(s) or other auxiliary devices. Try again and then contact support.
8-11	Normalization completed with a warning. Verify module parameters were set correctly, verify the weather is good for normalization, and verify the modules were washed properly. If everything looks good and this warning still appears, module current and power may be out of tolerance with set module parameters.

6.4.1 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.

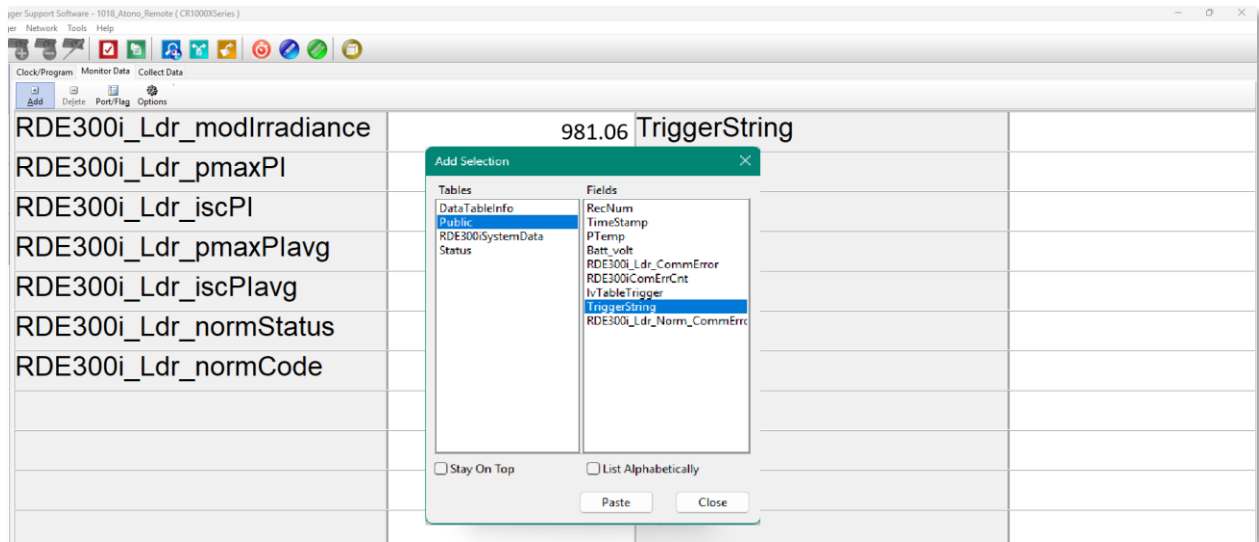


Figure 6-7: Adding a public variable to the outputs table

The example code has a public variable that can asynchronously control when the remote normalization command is sent to your RDE300i called “TriggerString”. **Figure 6-7** 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 6-8**.

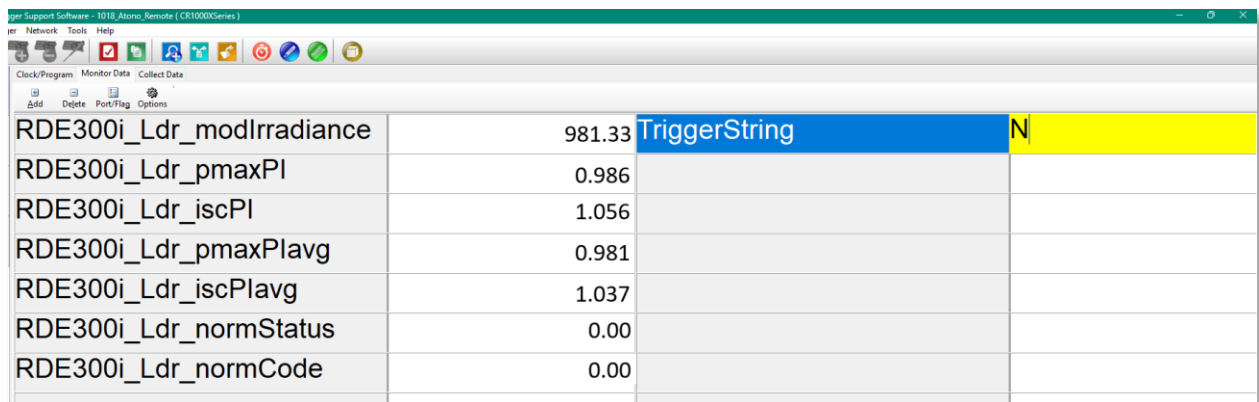


Figure 6-8: Triggering Normalization

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 6-9**.

Clock/Program	Monitor Data	Collect Data
RDE300i_Ldr_modIrradiance	981.33	TriggerString
RDE300i_Ldr_pmaxPI	NAN	
RDE300i_Ldr_iscPI	NAN	
RDE300i_Ldr_pmaxPIavg	NAN	
RDE300i_Ldr_iscPIavg	NAN	
RDE300i_Ldr_normStatus	1.00	
RDE300i_Ldr_normCode	0.00	

Figure 6-9: 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 6-10**.

Clock/Program	Monitor Data	Collect Data
RDE300i_Ldr_modIrradiance	984.60	TriggerString
RDE300i_Ldr_pmaxPI	0.999	
RDE300i_Ldr_iscPI	1.000	
RDE300i_Ldr_pmaxPIavg	0.999	
RDE300i_Ldr_iscPIavg	1.000	
RDE300i_Ldr_normStatus	2.00	
RDE300i_Ldr_normCode	0.00	

Figure 6-10: 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 6-2** 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!