



Advanced Test Equipment Corp.
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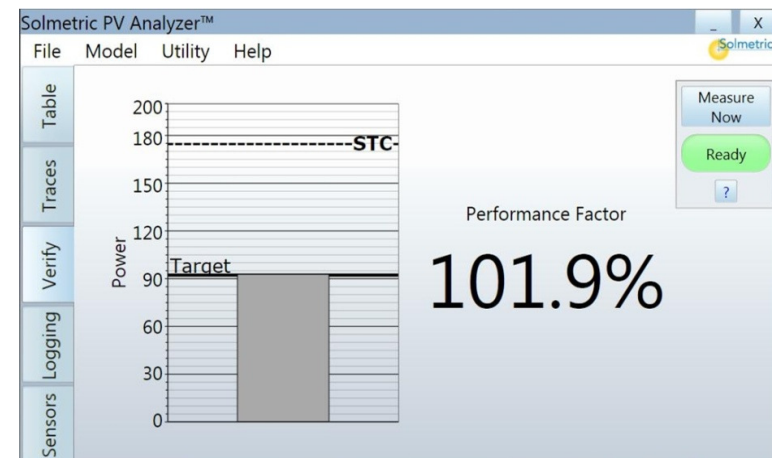


NOTE: When using the wireless PVA Sensor Kit or manual sensors, the end points may not match the predicted points when using the Sandia or 5 Parameter Performance Models.

To save the data to a csv file, click on the **Save Trace...** button then enter a filename in the **Save As** dialog box. The trace data file will be saved in the **Traces** folder. To save time in the field, create in advance a Windows® directory tree with the same architecture as the PV system under test.

Verify

Click on the **Verify** tab to view the numeric **Performance Factor** value as shown in the following screen. The **Performance Factor** is the ratio of actual to predicted maximum power, expressed in percent.



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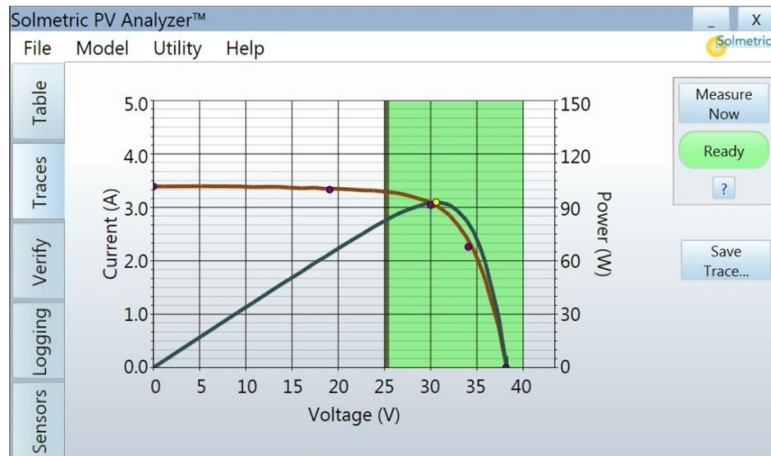
90Solmetric Corporation, 117 Morris Street, Suite 100, Sebastopol, CA 95472, USA Printed in the USA

More information about the analysis of the data is available in the PVA-600 User's Guide, which is accessible from the DVD, via the Help menu in the PVA-600 Software interface, and on the Solmetric website.

Traces

Click on the **Traces** tab to view the I-V and P-V graphs as shown in the following screen.

NOTE The first time a measurement is made, the trace may appear rough because the PVA-600 uses special internal settings to check the voltage and current of the circuit under test before choosing the most appropriate internal settings for the second and subsequent sweeps. In the second measurement, the data will scale properly and should be similar to the graph shown in the following screen.



NOTE If the Sandia Model is selected and the array itself is being used as the sensor, the end points of the measured I-V trace typically will match the predicted model points for I_{sc} and V_{oc} . If the 5 Parameter Model is selected and the array itself is being used as the sensor, the end points may not match the predicted points.

Welcome!

Thank you for purchasing the Solmetric PVA-600 PV Analyzer, the tool that measures the performance of PV modules and strings. We are confident you will find it easy to use and the right tool for the job.

Please verify that you have received all of the following items:

- I-V Measurement Unit
- Soft Case
- Wireless USB Adapter
- PVA-600 Software Application
- Battery Charger
- MC-4 to MC-4 Connector-Saver Cable (1 pair)
- MC-4 to MC-3 Adaptor Cables (1 set)

The User's Guide is in electronic form only and is accessible from the DVD, via the Help menu in the PVA-600 Software interface, and on the Solmetric website.

Be sure to visit our web site at:

www.solmetric.com for software updates and new products.

All Solmetric packaging and paperwork are made from recycled or reused materials.

The Solmetric PVA-600 PV Analyzer

The PVA-600 PV Analyzer is a portable test instrument designed to measure the current-voltage (I-V) curves of PV modules and strings and immediately compare the results to the predictions of on-board PV models. Measurement results are easily saved for future reference and analysis.

Safety and Regulatory

Before operating the PVA-600, familiarize yourself with the following notations.

WARNING A *Warning* calls attention to a procedure which, if not performed correctly, could result in personal injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.

CAUTION A *Caution* calls attention to a procedure that, if not performed correctly, could result in damage to, or destruction of, the instrument. Do not proceed beyond a caution note until the indicated conditions are fully understood and met.

NOTE A *Note* provides important or special information.



The IEC HV symbol indicates the presence of hazardous voltages. Danger exists of electrical shock that can cause severe injury or death.

8. Viewing and Analyzing the Data

Once an I-V measurement has been taken, the data is presented in several forms.

Table

Click the **Table** tab to observe **Predicted** and **Measured** parameter values.

	Predicted	Measured
Pmax (W)	62.00	62.42
Vmp (V)	30.89	31.03
Imp (A)	2.01	2.01
Voc (V)	38.37	38.37
Isc (A)	2.22	2.22
Tpv (C)	49.3	
Epoa (W/m ²)	408	
Rseries (Ohms)		0.03

Press the **Snapshot** button to temporarily store measured values for comparison with subsequent measurements. Temperature and irradiance values appear in the Predicted column if they are being derived from the measured I-V curve.

Operating Under High-Temperature Conditions

The most demanding thermal conditions for the measurement unit are:

- Hot day
- No wind
- No shade
- High open circuit voltage
- I-V sweeps taken in rapid sequence

If you expect these conditions, plan ahead to minimize the temperature rise in the I-V Measurement Unit. Shade the unit from direct sunlight, elevate it above hot surfaces, and allow more time between I-V sweeps.

The I-V Measurement Unit is also equipped with a thermal fuse that will open permanently when the temperature inside the unit reaches 85°C. This condition requires returning the unit to Solmetric for repair.

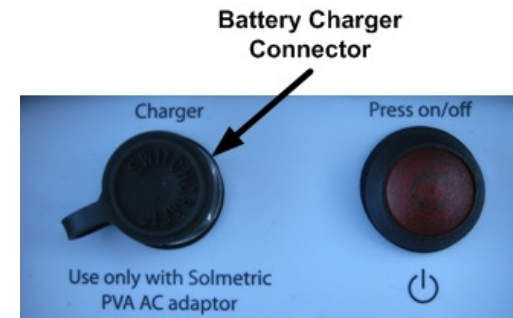
Over-Voltage, Over-Current, and Reverse Polarity Protection

If greater than 600 V dc and/or 20 A dc is applied to the I-V Measurement Unit, or the I-V Measurement Unit is connected with the wrong polarity across a string, the PVA-600 detects the condition and switches into disabled mode automatically, and an I-V measurement does not take place. The unit also has limited protection against the fast, high-current transients that can be produced by high-efficiency PV modules.

NOTE Conventional PV modules and strings may be measured in parallel up to the specified maximum current of the PVA-600. High-efficiency modules should NOT be measured in parallel.

Charging the Battery

The battery in the PVA-600 is not removable. It may be recharged by attaching the battery charger to the connector on the PVA-600 shown below and plugging the charger into an AC wall-plug.



Charging the battery can take up to 6 hours. Once the battery has been charged, the PVA-600 will operate for approximately 2 days of normal use. During heavy use, nightly charging is suggested.

The PVA-600 Software interface will warn the user when approximately one hour of battery life remains.

The software user interface displays the Disabled alert (below the **Measure Now** button) when the battery is nearing the end of its charge. In this state, no measurements can be taken.

CAUTION Do not operate the PVA-600 while charging.

WARNING To prevent electrical shock, disconnect the PVA-600 from the PV system and/or battery charger before cleaning. Use only a dry cloth or cloth slightly dampened with water to clean the external case and hard enclosure parts. Do not attempt to clean internally.

Computer Minimum Requirements

- Tested and Supported Operating System: Windows 7® (32 and 64 bit versions), Windows Vista® (32 bit versions only), Windows XP® SP3
- Two USB Ports (or one USB port if wireless sensors will not be used)
- Display Resolution: 1024 X 600 (minimum)
- Processor Speed: >700 MHz
- RAM: >500 Mbytes
- Available Disc Space: 100 Mbytes or more

Systems that do not meet these requirements may not operate correctly.

PVA-600 Operational States

The PVA-600 can be in any of the following operational states:

- Power off – LED off (I-V Measurement Unit is turned off)
- Network search – LED blinking (press the power button once to turn the Unit on and start it searching for the PC)
- Sweep enabled – LED on (I-V network exists and sweep is enabled)
- Sweeping – LED blinks once at start of each sweep when the I-V Measurement Unit receives a sweep trigger from the PC.
- Sweep disabled – LED off (press the power button once to disable the I-V sweep)
- Reset – LED blinking (press and hold the power button for more than 5 seconds to force a power-up type reset)

- Ensure that the **Irradiance** box blinks green every two seconds. If the box is not blinking, you may need to shorten the distance between transmitter and PC or clear the line-of-sight to the transmitter.
 - Ensure that the **Temperature** box blinks green every ten seconds. If the box is not blinking, you may need to shorten the distance between transmitter and PC or clear the line-of-sight to the transmitter.
 - If the **Wireless Interface: Not Found** message appears, select **Settings** from the **Utility** menu and set up the wireless sensor USB interface manually. Select the communications port with the “+” sign.
8. Click on the **Measure Now** button to start a measurement. The **Ready** button will change to **Measuring** and blink during the measurement. The red pushbutton on the I-V Measurement Unit will blink once.

Sweep Disabled

PV current is stopped automatically at the end of each I-V measurement. To ensure that another sweep cannot accidentally be started, press the power button to disable the measurement sequence. Pressing the power button again re-enables the measurement unit.

NOTE If no measurements are taken for 15 minutes, the I-V Measurement Unit will turn itself off to conserve battery. Press the power button to turn it back on.

Over-Temperature Protection

Built-in safeguards prevent the I-V Measurement Unit from operating at potentially damaging internal temperatures.

Thermal Shutdown

When the internal temperature approaches the battery's high-temperature limit, the measurement unit automatically shuts down (disables itself). To recover from thermal shutdown, wait for the measurement unit to cool. Placing it in the shade or a cool place will speed the recovery.

- Repeat the process until all strings have been measured.

WARNING PV circuits continue to present danger of electrical shock while system is paused. FAILURE TO TAKE APPROPRIATE SAFETY PRECAUTIONS COULD LEAD TO PERSONAL INJURY OR LOSS OF LIFE.

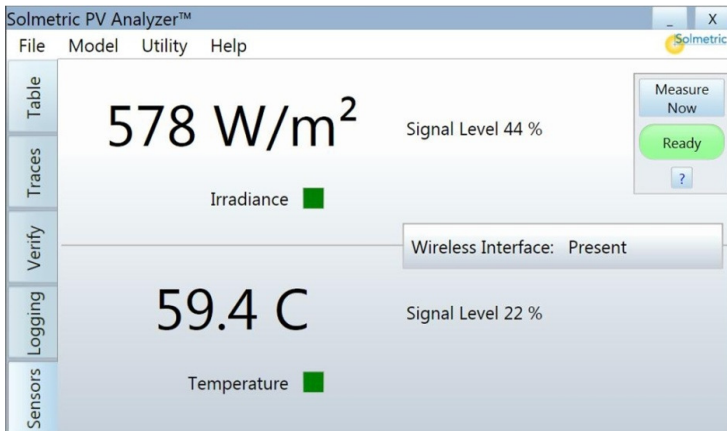
- If you are using the PVA Sensor Kit, perform the following:
 - Insert the Wireless Sensor USB Adapter into a second USB port.
 - Ensure that the PVA Sensor Kit is set up correctly.
 - Turn on the sensor transmitters by pressing the I/O button once.

NOTE Always turn on the wireless transmitters AFTER starting the PVA-600 application.

NOTE If communications are not established within one minute:

- Move the PC closer to the I-V Measurement Unit.
- Reset the I-V Measurement Unit.
- Remove and replace the Wireless USB Adapter.

- Click on the **Sensors** tab to access the screen shown in the following screen.



Specifications

- Current Measurement Range: 0 to 20 A dc
- Voltage Measurement Range: 0 to 600 V dc
- Operating Temperature: +0°C to +50° C
- Storage Temperature: -20°C to +60° C
- Operating Humidity: 10 to 80%

See the User’s Guide for complete specifications.

NOTE Conventional PV modules and strings may be measured in parallel up to the current limit specified above. High-efficiency modules should NOT be measured in parallel.

Precautions

PV Connectors

Always keep Connector-Saver jumpers attached to the primary test leads to extend the life of the primary PV connectors. To prevent damage to mating connectors, replace the Connector-Saver jumpers when they have been connected 100 times. **Cut off the used-up connectors to prevent re-use.**

PV/Electrical Safety Precautions

PV systems differ widely in design and construction. Therefore the guidance provided in this section is general in nature.

WARNING The operator must assess the potential dangers of each PV system, and take appropriate precautions. FAILURE TO TAKE APPROPRIATE SAFETY PRECAUTIONS COULD LEAD TO PERSONAL INJURY OR LOSS OF LIFE.

WARNING Do not remove instrument covers. There are no user serviceable parts within. Operation of the instrument in a manner not specified by Solmetric may result in personal injury or loss of life.

- Do not use the PVA-600 in wet environments.
- Wear electrical safety gloves and eye protection.
- Assume that metal surfaces are energized unless proven otherwise.
- Isolate the PV source circuit to be tested from the inverter and from other PV source circuits before making any electrical connections to the test device (PV module or string).
- Always disable the measurement sequence using the LED-illuminated pushbutton switch on the I-V unit before connecting or disconnecting the test leads of the PVA-600.
- Connect the test leads to the test device (PV module, string, or array) with the correct polarity.
- Do not use the PVA-600 to test devices that produce more than the instrument's specified maximum current and voltage.
- Do not operate at or subject the PVA-600 to temperatures beyond the published operating and storage temperature specifications.
- Inspect cables and connectors for damage before using. Do not use if damaged.
- Do not use the I-V Measurement Unit if it is damaged. Always inspect for damage before using.
- Do not use the I-V Measurement Unit if it is performing abnormally. Contact Solmetric for guidance or return the I-V Measurement Unit to the factory for service.

7. Making I-V Measurements

Ensure that the PC is running the Solmetric PV Analyzer software, that the wireless USB adapter is connected to the PC, that the PVA-600 is properly connected to the PV equipment, and that the I-V Measurement Unit is wirelessly connected to the PC (the “Measure Now” button will be colored green).

NOTE If the Wireless USB Adapter used for PVA-600 or wireless sensor communication is installed before starting the software, the USB port will be found automatically. If you install the Wireless USB Adapter(s) after starting the software, you must select the proper USB ports on your PC manually using the **Utility/Settings** menu.

1. Click on the **Measure Now** button to start a measurement.
 - The **Ready** button will change to **Measuring** and blink during the measurement. The red pushbutton on the I-V Measurement Unit will blink once.
 - The I-V Measurement Unit measures a single I-V curve each time the user clicks on the **Measure Now** button. I-V data is transmitted to the PC shortly after each I-V sweep is taken.
2. Save the trace by pressing “Save Trace...” in the **Traces** tab. Saved trace data can be viewed by a program that can read a csv file, such as Excel®. See the User’s Guide for further instructions.
3. Pause the measurement sequence of the PVA-600 by pressing the power button.

WARNING Do not disconnect from the tested string unless the red power button is turned off.

4. Disconnect from the tested string and connect to the next string to be measured.

4. If one or both of the terminals of the test device must be some distance from the I-V Measurement Unit, use extension cables made of UL (or equivalent) listed PV wire, with correctly installed connectors. Select a wire gauge that will introduce minimal voltage drop.
5. When extension cables are longer than 10 feet (one-way), lay the cables close to one another to minimize added cable inductance.
6. If connecting at a fused combiner box, insert one fuse to select the string to be measured.

6. Powering-Up the I-V Measurement Unit



Press the power button once on the I-V Measurement Unit.

The LED will begin to blink indicating that the I-V Measurement Unit is attempting to establish communication with the wireless USB adapter connected to the PC. If the wireless USB adapter is inserted into an operating PC, a network will be established and the LED will become continuously lit (no blinking). If a network is not established within 15 minutes, the I-V Measurement Unit will turn off to conserve the battery.

Overview

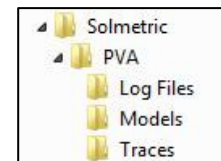
Proper operation of the Solmetric PVA-600 includes the following steps:

1. **Installing the Software**
2. **Setting up the PVA-600**
3. **Setting up the Wireless Sensor Kit (Optional)**
4. **Setting up a Performance Model**
5. **Connecting to the PV Equipment**
6. **Powering up the I-V Measurement Unit**
7. **Making I-V Measurements**
8. **Viewing and Analyzing the Data**

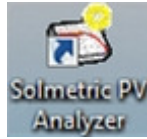
Each step is explained in this guide.

1. Installing the Software

1. Start the installer by inserting the PVA-600 DVD into the DVD drive on your Windows® computer. Alternatively, the installation file is available at www.solmetric.com.
 - a. If the welcome screen does not automatically open, either double-click on the **setup.exe** file on the DVD or run **setup.exe** from the **Run** dialog.
2. Follow the instructions in the welcome screen to install the PVA-600 software. The drivers for the wireless USB adapter will also be installed. The directory structure shown here is created in the Documents directory.



3. When the installation process is finished, start the PVA-600 software by double-clicking on the shortcut icon on your desktop as shown below.



Or, in the **Start** menu, select **Programs>Solmetric>PV Analyzer>Solmetric PV Analyzer**.

Special XP Operating System Instructions

This section applies to computers running the XP operating system only.

Older computers running the XP operating system require special steps during the installation of the wireless USB driver. Please pay close attention to onscreen prompts.

In addition, please be aware that XP will require the re-installation of the driver if you insert the wireless USB adapter in a different USB port. Therefore, we recommend one of the following when using the XP operating system:

- a. Select a single convenient USB port for the wireless interface and always use that port.
- b. Sequentially insert the wireless USB adapter into each USB port in your computer and follow the same installation process (as instructed on screen) for each port.

- d. If you choose to enter temperature manually, enter a cell temperature in the **PV Temperature** text box. Adjust your value to account for the offset described in the previous step.
8. In the **Array Plane** tab, enter the slope and azimuth of the PV modules under test. Always perform this step if you are using the Sandia Performance Model and a wireless or manual irradiance sensor.

5. Connecting to the PV Equipment

WARNING PV systems differ widely in design and construction. Therefore the procedure described below is general in nature. The operator must assess the potential dangers of each particular PV system, and take appropriate safety precautions. **FAILURE TO TAKE APPROPRIATE SAFETY PRECAUTIONS COULD LEAD TO PERSONAL INJURY OR LOSS OF LIFE.**

1. Isolate the PV module string to be tested (test string) from the inverter and from other strings in the array. If the measurement is being made at a fused DC combiner box, isolate the combiner box by means of the DC disconnect switch, then isolate the PV strings from one another by pulling their fuses.
2. Press the button on the I-V Measurement Unit to disable the I-V sweep.

WARNING PV circuits continue to present danger of electrical shock when fuses are pulled and the PVA-600 system is paused.

3. Following safe operating procedures, connect the PVA-600 to the test string. The connection may be made at PV connectors at the ends of the test string, or by clipping to the de-energized buss bars in a DC combiner box, using suitable test leads with MC-4 connectors at one end and insulated alligator clips at the other end.

4. In the **Modules / String** tab, enter string information. Select the Detailed or Simple performance model.
 - a. If you chose the Detailed Performance Model, click on **Change...** and select the PV module manufacturer and model number from the drop down lists.
 - b. If you will be entering performance model parameters from the manufacturer's published specifications, select **Simple Performance Model** and edit the default values to match your module's datasheet.

NOTE Enter temperature coefficients in units of % / C. If the manufacturer supplies coefficients for Voc (STC) in units of V / C, this value can be converted to % / C by dividing the supplied number by Voc and multiplying by 100.

- c. Enter the number of modules in each string and the number of strings in parallel that are being tested.
5. In the **Inverter** tab, select your inverter (optional step).
 6. In the **Wiring** tab, enter the wire gauge and the wire length
 - **Wire Length is** the one-way length of the PV output conductors from the ends of the module/string under test to the point where the PVA-600 is connected. (For two 50 foot leads running between the I-V unit and the string, enter "50" not "100".)
 7. In the **Sensor Methods** tab, select irradiance and temperature sensor methods. See the PVA-600 User's Guide for more details.
 - a. If you choose the wireless irradiance sensor, in the **Cal Factor** box, enter the cal factor from the sensor label.
 - b. If you choose to enter the irradiance manually, enter the irradiance in the **Irradiance (POA)** text box.
 - c. If you choose to use a wireless temperature sensor, enter a temperature **Offset** number that represents the rise in PV cell temperature compared with the measured temperature.

2. Setting Up the PVA-600

1. Place the I-V Measurement Unit close to the PV device to be measured.

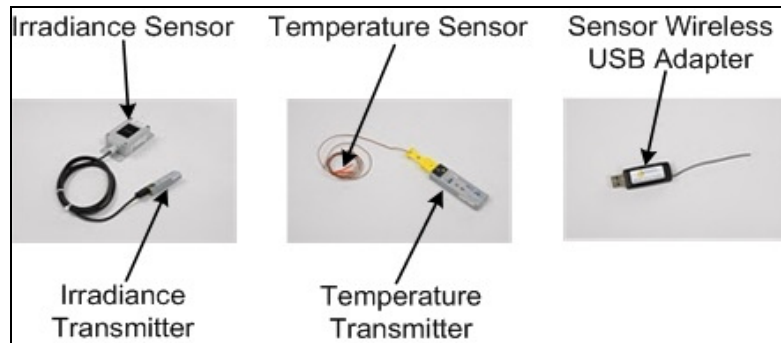
CAUTION In hot weather, place the PVA-600 in the shade to reduce the likelihood of thermal shutdown. Don't place the PVA-600 on hot asphalt or the roof in direct sun.

NOTE The PVA-600 will automatically shut down if its internal temperature reaches a preset limit. Internal temperature is increased by PV energy collected during I-V sweeps, and also by heat absorbed from the environment, including high ambient air temperature, hot surfaces on which the PVA-600 is placed, and exposure to direct sunlight.

2. Ensure that the Connector-Saver jumpers are installed on the primary test leads.
3. If using alligator clip leads or extension cables, connect them to the connector-saver jumpers. Be sure these leads are rated for the maximum current and voltage of the I-V Measurement Unit.
4. If long extension cables are used, lay the cables alongside one another to minimize the inductance they add to the measurement circuit path.
5. Connect the Wireless USB Adapter to a USB port in your computer.
6. If you will be using the PVA Sensor Kit, refer to the following section for setup information.

3. Setting Up the Wireless Sensor Kit

The PVA Sensor Kit (shown below) includes an irradiance sensor and a temperature sensor. Each sensor is connected to a transmitter that communicates wirelessly with the Sensor Wireless USB Adapter.



1. Before starting the PVA software, connect the Sensor Wireless USB Adapter to a USB port in your computer.

NOTE If a second USB position is not available, a USB hub with short connecting cable (<6”) may be used.

2. Ensure that the transmitter with the “I” label is connected to the irradiance sensor, and that that the transmitter with the “T” label is connected to the temperature sensor. Observe polarity markings.
3. Position the irradiance sensor in the same plane as the modules under test. For example, on the surface of a neighboring module that is not in the string of modules being tested.
4. Tape the temperature sensor and at least 1 inch of its lead to the backside of a PV module near the center of the module (away from the cooler outer edges). If the sensor is the self-stick type, use the sticky pad AND tape.
5. Start the PVA software, then turn on the sensor transmitters by pressing the **I/O** button on each transmitter.

OTHER SENSOR KIT NOTES

The temperature sensor may have an adhesive pad for securing it to the PV module. If so, use the pad, but also cover the sensor and at least 1 inch of its lead with tape to assure intimate contact with the backside of the PV module.

Ensure that the transmitters are not resting on the ground or on the roof, and are not placed against a metal surface. Elevating the transmitters improves the transmission range.

When turned on, each transmitter has a TX LED that will flash green periodically, but it is difficult to see the green LED in direct sunlight. Pressing the I/O button again will cause the transmitter to turn off, indicated by the TX LED flashing red three times.

When not in use, turn the transmitter power off to conserve battery life. The lithium batteries in the transmitters are not rechargeable. The typical battery life of the irradiance transmitter is 300 hours. The typical battery life of the temperature transmitter is 1500 hours.

If the LOW BAT LED on either transmitter is on, replace the battery with Lithium AAA batteries. You can substitute Alkaline AAA batteries but battery life will be much shorter.

4. Setting Up a Performance Model

The following procedure shows how to set up a performance model in the PV Analyzer software to compare with the I-V measurements.

1. In the PVA-600 Software, drop down the **Model** menu and select **Properties...**
2. In the **Name** tab, enter a model name.
3. In the **Location** tab, enter Latitude, Longitude and Time Zone.