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## 8155-1 Solar Tester User Manual

Firmware Version 1.3.0 and Up

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# 1 Table of Contents

|      |   |    |
|------|---|----|
| 2    | Overview .....  | 3  |
| 3    | Solar Tester .....  | 4  |
| 4    | Display Contrast Adjustment .....   | 5  |
| 5    | Battery Indicator .....   | 6  |
| 6    | Battery Replacement .....   | 7  |
| 7    | Supported Tests .....   | 7  |
| 8    | Basic Solar Panel Test.....   | 8  |
| 9    | Smart 12V Test .....  | 9  |
| 10   | Smart 6V Test .....   | 11 |
| 11   | Paint Test (Requires Optional Solar Paint Adapter Kit (P/N: 8156-1))..... | 11 |
| 11.1 | Paint Procedure.....  | 12 |
| 11.2 | Standard Solar Paint Test (Paint Test AUX Port) Connection.....           | 14 |
| 11.3 | Smart Solar Paint Test (Paint Test TEST Port) Connection .....            | 15 |
| 11.4 | Paint Test Adapters .....   | 15 |
| 12   | Reference Panel Test .....  | 15 |
| 13   | Test Adapters .....   | 17 |
| 14   | Specifications .....  | 17 |

## 2 Overview

The WilliamsRDM Solar Tester (Figure 1) is built to test the voltage, current and power output of the WilliamsRDM covert solar devices and other equivalent solar systems. The tester can be used to verify proper operation and wiring of repaired cables and solar panels. It can also be used to measure the performance of the solar panels in a deployed location to verify operation and power output. Using the optional paint adapter kit, the solar tester can be used as a guide to apply WilliamsRDM's custom formulated paint to the covert solar devices in the field without the fear of over painting and thus degrading the solar devices.



**Figure 1: WilliamsRDM 8155-1 Solar Tester**

### Key Features

- Interfaces with WilliamsRDM covert solar devices and equivalent solar products.
- Intuitive user Interface
- Measures standard solar panel parameters
  - Open circuit voltage
  - Short circuit current
  - Maximum power point voltage, current and power
- Allows testing of field repaired solar devices
  - Adjustable Panel Factor to Support New Covert Solar Devices
- Max voltage: 50V
- Max current: 2.4A
- Max power: 33.0W
- Built in overload protection
- Uses standard AA alkaline batteries
- Easy to read backlit LCD display
- 15-minute auto power off

### 3 Solar Tester

The Solar Tester is shown in Figure 2. The tester has three buttons for the user interface and a backlit LCD for easy readability in all lighting conditions. The device has two connectors for testing various solar products, the “TEST” port and the “AUX” port. The “TEST” port is typically used to test WilliamsRDM Smart solar devices while the “AUX” port is typically used to test WilliamsRDM and equivalent standard solar devices and solar panels. The unit is powered on by pressing the “SELECT” button and powered off by pressing and holding the “SELECT” button for about 2 seconds. The Up/Down arrows are used to navigate the menu system and the “SELECT” button is used to select a test as well as to exit from a test back to the main menu.



Figure 2: Solar Tester

Once powered on the version screen is displayed for several seconds then the tester displays the menu system as shown in Figure 3. The up and down arrows control the cursor and are used to select the desired test. The scroll indicator tells the user that there are additional tests above or below the displayed menu items. The display will scroll up or down as needed to allow the user to reach the desired test. Once the cursor is pointing to the desired test the “SELECT” button is used to start the test. The test port indicator identifies which port the test will be performed on. The [T] indicates the TEST port will be used while the [A] indicates that the AUX port will be used. The user will select the test with the connector that mates with the solar product they are trying to test. Once

the test is complete the “SELECT” button is then used to exit from the test back to the main menu to select a different test.

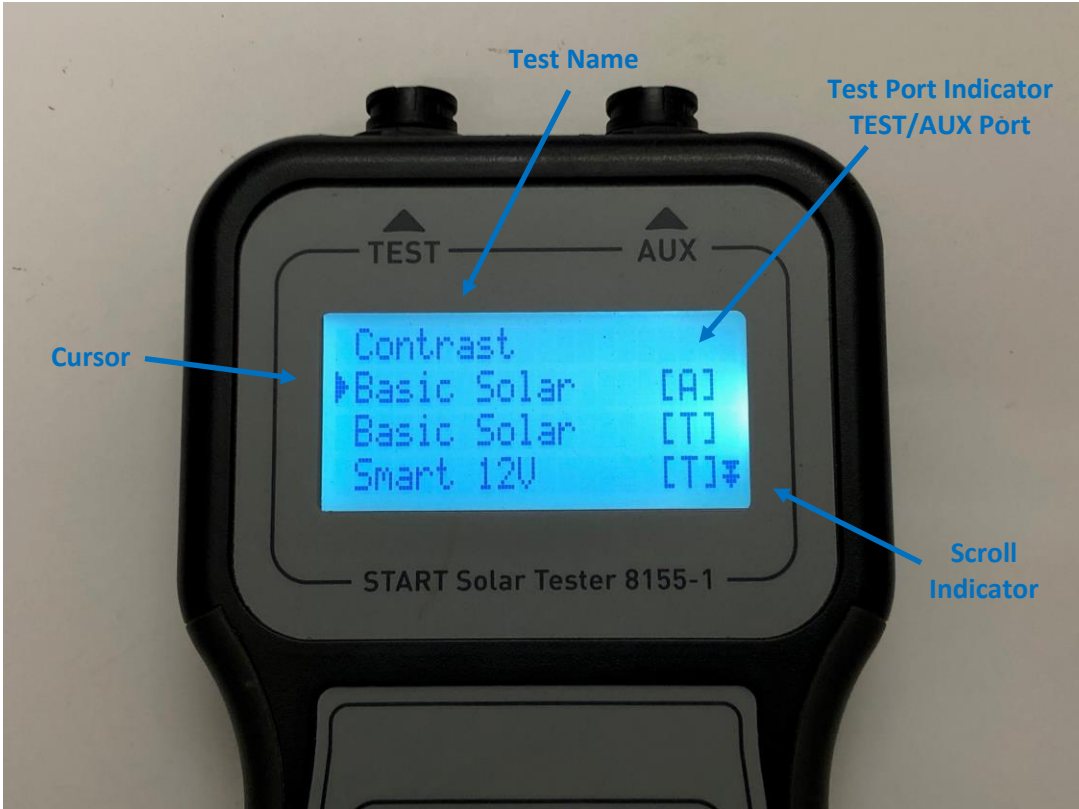


Figure 3: Main Menu Screen

#### 4 Display Contrast Adjustment

If the Solar Tester Display is too light or dark the contrast can be adjusted by selecting the “Contrast” option on the menu screen. Once the Contrast option is selected the contrast adjustment screen is displayed as shown in Figure 4. The screen contrast can then be adjusted using the up and down arrows. Once the desired display contrast is reached press the “SELECT” button to exit back to the main menu. The contrast setting will be saved once it is set.



Figure 4: Contrast Adjustment Screen

## 5 Battery Indicator

The Battery indicator is shown in the upper right corner of the display on any test screen (see Figure 5). The battery indicator provides a visual indication of the remaining battery capacity so that the user can replace the batteries before they are exhausted. The batteries should provide several hours of operation. Additionally, If the tester is left on it will automatically power off after 15 minutes of inactivity to conserve power.



Figure 5: Battery Indicator

When the batteries are exhausted the low battery screen will be displayed as shown in Figure 6 and the solar tester will automatically power off. At this time the batteries must be replaced to use the tester again.



Figure 6: Low Battery Screen

## 6 Battery Replacement

The solar tester is powered from 4 standard AA alkaline batteries which can be easily replaced by the user. Always use new AA alkaline batteries of the same brand in the solar tester. When replacing batteries don't mix and match batteries of different brands or new and old batteries. To replace the batteries, remove the battery cover from the back of the solar tester and replace the batteries. Figure 7 shows the orientation of the batteries within in the battery holder.



Figure 7: Battery Installation

## 7 Supported Tests

The solar tester is designed to test solar panels in sunlight. The tester will not work indoors with solar panels illuminated with fluorescent or LED lighting. The following tests are supported by the Solar Tester:

- 1) Contrast Adjustment
- 2) Basic Solar Panel [A] (Aux Port)
  - a. Tests Standard Covert Solar Devices via the AUX port
- 3) Basic Solar Panel [T] (Test Port)
  - a. Tests Standard Covert Solar Devices using the AUX port
  - b. Tests Smart Solar Devices in Basic Mode
- 4) Smart 12V Solar Panel [A] (Aux Port)
  - a. Tests Smart Solar Devices with integrated 12V solar charger
  - b. Test Smart Solar Devices with battery
- 5) Smart 12V Solar Panel [T] (Test Port)
  - a. Tests Smart Solar Devices with integrated 12V solar charger
  - b. Test Smart Solar Devices with battery
- 6) Smart 6V Solar Panel [T] (Test Port)
  - a. Tests Smart Solar Devices with integrated 6V solar charger
  - b. Test Smart Solar Devices with battery



- 7) Paint Test [A] (Aux Port) – Requires Paint Test Adapter Kit
  - a. For Painting WilliamsRDM Standard Solar Devices
- 8) Paint Test [T] (Test Port) – Requires Paint Test Adapter Kit
  - a. For Painting WilliamsRDM Smart Solar Devices
- 9) Reference Panel [A] (Aux Port) – Requires Paint Test Adapter Kit
  - a. Tests the Reference Panel and Aux Port Adapter
- 10) Reference Panel [T] (Test Port) – Requires Paint Test Adapter Kit
  - a. Tests the Reference Panel

## 8 Basic Solar Panel Test

The basic solar panel test is used to test the WilliamsRDM Standard Covert Solar devices as well as other equivalent solar panels. Additionally, WilliamsRDM Smart solar rocks can be tested in basic solar mode using the “TEST” port. This is done for applications where the smart solar rock is being used with an external battery charger and bypassing its internal charger. The basic solar panel test should be performed outside on a sunny day to measure the maximum output power of the solar device. The tester can also be used to test the output of a deployed solar device to measure the actual power output in the deployed location with the actual lighting conditions.

Figure 8 shows an example test screen for the basic solar test on the “AUX” port which is used for the WilliamsRDM standard solar devices. The solar tester reports several solar panel test parameters to ensure the solar panel is working properly. Table 1 shows an example of the test parameters provided by the solar tester for the basic solar test as well as their definitions and a brief description of their meaning. Additionally, the Testing Indicator turns on whenever the solar panel is actively being tested. To support testing of solar panels with higher power levels the solar panel sampling rate slows down as power increases to minimize power dissipation in the solar tester. For example, when measuring a 10W solar panel the test will be performed about once every 10s and with a 1W panel the measurement rate is about 1s. The testing indicator is used to inform the user when the test is performed. This indicator is only used on the Basic Solar Panel Test.



Figure 8: Basic Solar Test Screen



Table 1: Basic Solar Test Parameters

| Symbol | Definition                  | Description  | Value |
|--------|-----------------------------|--|-------|
| $V_o$  | Open Circuit Voltage        | Open Circuit Voltage that would be measured from solar panel with a multimeter                         | 19.5V |
| $I_s$  | Short Circuit Current       | Short Circuit Current that would be measured from a solar panel with a multimeter                      | 136mA |
| $V_m$  | Maximum Power Point Voltage | The voltage at which the solar panel produces its maximum output power                                 | 17.4V |
| $I_m$  | Maximum Power Point Current | The current at which the solar panel produces its maximum output power                                 | 96mA  |
| $P_m$  | Maximum Power Point power   | The maximum power the solar panel can produce if loaded at its maximum power point voltage and current | 1.7W  |

From a user perspective the most important parameter to consider is the  $P_m$  (Maximum Power) parameter which measures the maximum power that the solar panel can output when properly loaded in a particular lighting condition. The output power in full sun with the sun directly overhead should be close to the rating of the solar panel that is being tested otherwise the panel may not be working properly. For example, if a 5W solar rock is being tested in full sun and only producing 0.2W then the solar panel may not be working properly.

If multiple solar devices are connected in parallel with a Y-Adapter, then the measured output power should be approximately the sum of each individual solar device. Only devices of similar voltage should be connected with the Y-Adapter.

## 9 Smart 12V Test

The Smart 12V Test is used to test the WilliamsRDM Covert Smart Solar Devices which incorporate a Maximum Power Point Tracking (MPPT) Solar Charger, Partial Shading technology and are designed to charge 12V lead acid batteries. This test should be performed outside on a sunny day to measure the maximum power from the Smart Solar Device. The Smart 12V Test provides information on the battery charging voltage, current, power as well as a pass/fail indicator for the smart solar device. Table 2 shows an example of the test parameters provided by the solar tester for the Smart 12V Test as well as their definitions and a brief description of their meaning.

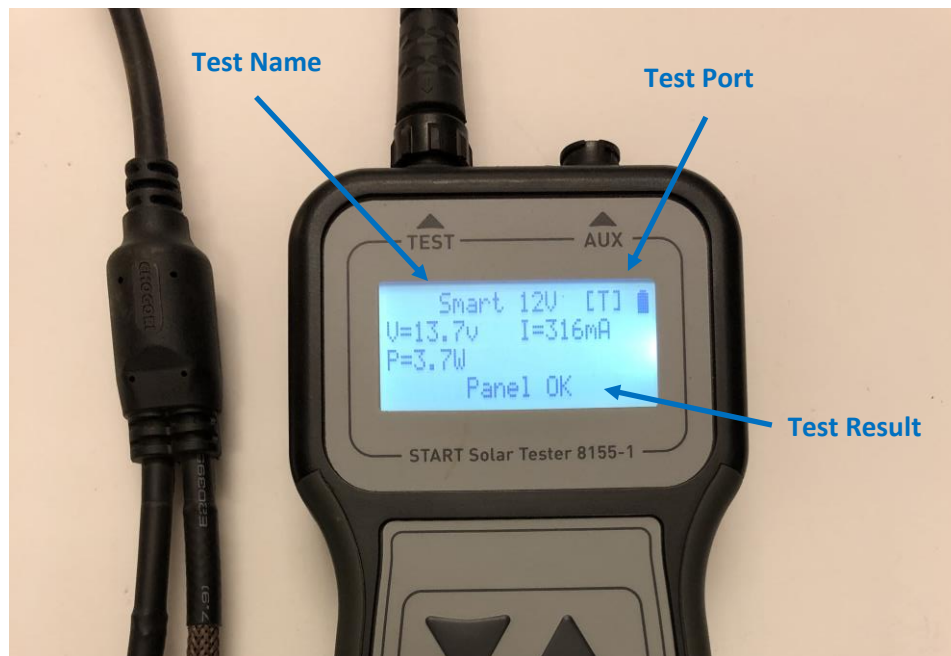


Figure 9: Smart 12V Solar Test Screen

Table 2: Smart 12V Solar Test Parameters

| Symbol      | Definition                    | Description  | Value           |
|-------------|-------------------------------|--|-----------------|
| V           | Battery Charge Voltage        | The is the maximum charging voltage (float voltage) for the battery.   | 13.7V           |
| I           | Battery Charging Current      | The current that the solar panel is providing to charge the battery  | 316mA           |
| P           | Battery Charging Power        | The power the solar panel is providing to charge the battery   | 3.7W            |
| Test Result | Smart Solar Panel Test Result | Panel OK – Smart Solar Panel OK<br>Fail: Low Voltage – Low Charging Voltage<br>Fail: High Voltage – High Charging Voltage<br>Battery Connected – A Battery is Connected<br>Incorrect Battery – An Incorrect Battery is Connected<br>Increase Sunlight – Test Requires More Light | See Description |

From a user perspective the main things to check for is that the Panel OK message is displayed, and the power output is in an acceptable range for the given lighting conditions and rated output power. If multiple solar

devices are connected in parallel with either Y-Adapter or daisy chained together then the measured output power should be approximately the sum of each individual solar device and the status should read Panel OK.

If running the test with a Smart Solar Device with a battery installed the tester will only be able to check that a battery is present and that it is able to provide around 1A of power which is enough for most applications. If the smart solar device solar charging functionality need to be checked then the battery must be disconnected from the smart solar device so that the tester can measure those parameters.

This test can be performed on either the TEST port or the AUX port as needed. When using the Smart Solar rocks with integrated for the Y-adapter for the buckeye cameras the TEST port is used to test the rocks directly. If it is desired to test the other output of the Y-adapter, then an adapter cable can be purchased and the AUX port output is used to perform the test.

## **10 Smart 6V Test**

The Smart 6V test is the same as the Smart 12V test except is intended to test Smart Solar rocks that are set up for 6V SLA battery charging. Just as with the Smart 12V test the Smart 6V test can be used to test Smart Solar Devices with a 6V battery installed in which case the tester reports that a battery is connected. See section 9 for the detailed test parameters.

## **11 Paint Test (Requires Optional Solar Paint Adapter Kit (P/N: 8156-1))**

To provide the ability for a user to field paint the WilliamsRDM Covert Solar Devices an optional Solar Paint Adapter Kit (P/N: 8156-1) is available for the Solar Tester to assist in the painting process. While it is desirable to be able to custom paint the WilliamsRDM solar devices in the field there is a danger of over painting the solar panels. The Solar Paint Test of the Solar Tester provides a guide while painting to show the user how much paint to apply to the solar panel. (NOTE: WilliamsRDM custom formulated paint is required to paint the covert solar devices)

The Solar Paint Adapter Kit shown in Figure 10 includes the Reference Panel and the AUX Port Adapter. The reference panel is used as a light reference for the paint test. It compensates for different lighting conditions, time of day, light cloud cover, slight orientation differences etc. to allow for a consistent paint application across various lighting conditions. The AUX Port Adapter is used to connect the Reference Panel to the AUX port when painting WilliamsRDM Smart Solar Devices.



Figure 10: Optional 8156-1 Solar Paint Adapter Kit

## 11.1 Paint Procedure

Specially formulated WilliamsRDM paint is required to paint the Covert Solar Devices. The paint is formulated to add camouflage while still allowing the wavelengths of light required for solar panel operation. Painting should be performed outside on a sunny day with no clouds. The reference panel will compensate for changing lighting conditions and light cloud cover but, for best results painting should be performed on a clear sunny day. The paint test needs to be done outdoors, the test will not work indoors with fluorescent or LED lighting since these lights do not emit the correct wavelength of light for solar panel operation. The covert solar devices to be painted should be connected to the appropriate port on the solar tester and the reference panel connected to the opposite port using the AUX port adapter if needed. Sections 11.2 and 11.3 depict connections for the WilliamsRDM Standard and Smart Solar devices.

Figure 11 shows the Paint Test AUX port test screen used when painting WilliamsRDM standard solar devices which connect to the AUX port. The paint test provides a guide as the covert solar device is painted. A simple bar graph is used to indicate the relative output of the solar panel as it is painted. A new unpainted solar device starts with the bar graph on the right side of the display in the OK region. As the device is painted the bar graph slowly moves down toward the left side. The goal is to minimize the applied paint by applying just enough paint to blend into the environment while maximizing the power output of the solar device. The line between the Low and OK indicators on the bar graph is the level where the maximum recommended level of paint is applied. Adding additional paint will result in a lower power output from the solar panel. A low power output may still work for some applications but, may not provide as much power as desired. The goal is not to paint the solar device until the low indicator is reached but, to use the tester as a guide and apply as little paint as possible while keeping the output above the low indicator on the bar graph.



Figure 11: Paint Test Aux Port (Covert Solar Paint Test)

The Panel Factor Setting can be adjusted by the user and is used to allow the tester to support painting of various models and configurations of covert solar devices. The setting is adjusted using the up and down arrows and is stored in memory between power cycles for convenience. The default setting of 1.0 is used for most WilliamsRDM covert solar devices but, some models require a change to this setting. For example, the 8203-1 requires a panel factor setting of 2.0. The power factor is essentially a scaling factor to allow painting of various solar devices with different solar panel configurations. For convenience, the Panel Factor can be obtained from the WilliamsRDM website for a particular solar panel model.

When painting the covert solar device apply light even coats of paint and avoid painting one section too heavily as this can greatly skew results. Add light coats of paint while watching the bar graph display with the goal of applying as little paint as needed to blend in with the environment but, keeping the bar graph above the low indicator. The sides and edges of the solar devices can be painted more heavily since they do not transmit much light and don't affect the output much. The Reference Panel and Solar device being painted need to be in the same lighting conditions for proper paint application. While painting ensure that when reading the bar graph no shadows fall across the reference panel or device being painted otherwise the bar graph reading will be incorrect. If needed move the object causing the shadow or move the equipment to a location without shadows. Additionally, the Reference panel and covert solar device should be placed on a level surface for best results. While painting ensure the reference panel does not get dirty or painted it needs to stay clean to ensure proper operation.

In addition to the bar graph indicator, additional information can be displayed during the test as shown in Figure 12. The "Attach Ref Panel message" indicates that either the reference panel is not connected, is too shaded, or it is not functioning. If it is suspected that the reference panel is not working, then it can be tested as shown in section 11.4. The "Increase Sunlight" message indicates that the light level needs to be brighter to perform the paint test.



Figure 12: Paint Test Messages

## 11.2 Standard Solar Paint Test (Paint Test AUX Port) Connection

When painting a standard WilliamsRDM Solar Device (or other device that connects to the AUX port) the solar device is connected to the AUX port while the reference panel is connected to the TEST port. Figure 13 shows the connection of a standard unpainted WilliamsRDM solar rock and the reference panel. Note that the AUX Port Adapter is not used for this test.



Figure 13: Standard Solar Device Paint Test Connection



### 11.3 Smart Solar Paint Test (Paint Test TEST Port) Connection

When painting a WilliamsRDM Smart Solar Device (or other devices that connect to the test port) the solar device is connected to the TEST port while the reference panel is connected to the AUX port using the AUX Port Adapter. Figure 14 shows the connection of an unpainted WilliamsRDM Smart Solar Rock and the reference panel. Notice that only one connector of the smart solar rock is used since there is only one connector that can interface with the solar tester. The other connector can be tested with the 8155-1-51 test adapter if desired.

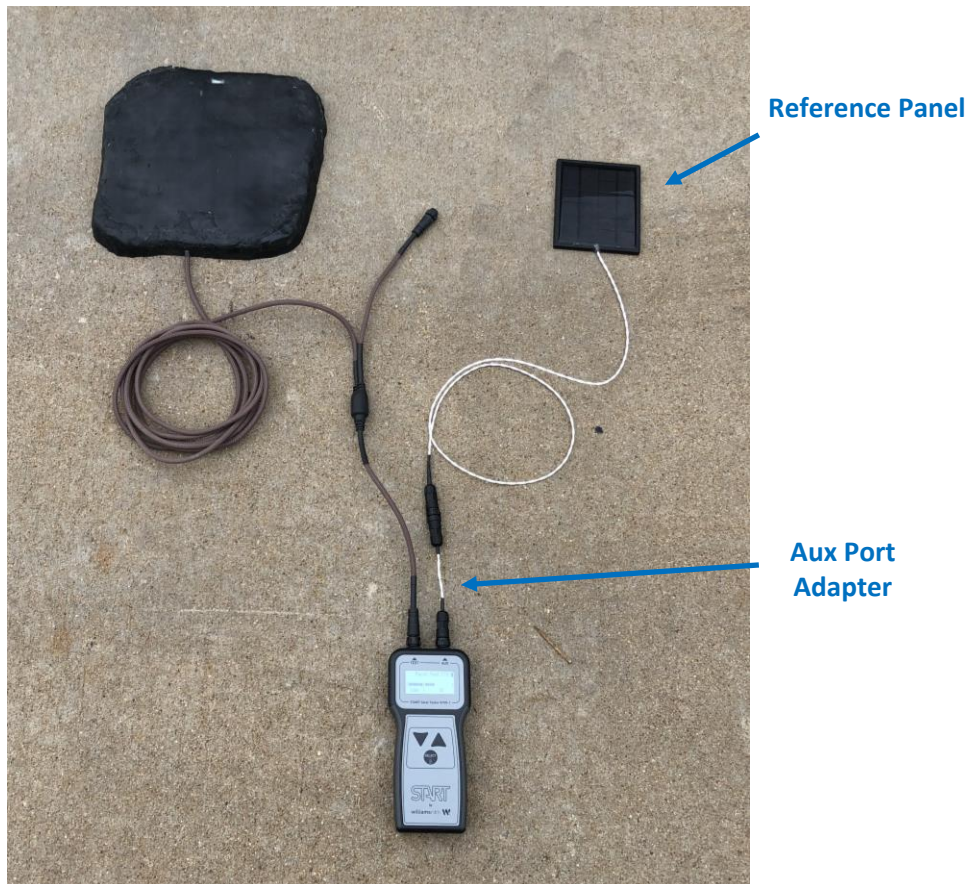


Figure 14: Smart Solar Device Paint Test Connection

### 11.4 Paint Test Adapters

For devices that don't directly connect with the solar tester WilliamsRDM has a line of test adapters to interface various models of covert devices to the solar tester to facilitate painting. When using the adapters connect the covert solar device to the solar tester using the adapter, set the panel factor to the appropriate setting, then connect the reference panel to the other input port using the Aux Port Adapter is needed.

## 12 Reference Panel Test

The Reference panel test is used to test the functionality of the reference panel to ensure it is functioning properly. Figure 15 shows the Reference Panel Test Screen. In this example the reference panel is connected to the AUX port using the AUX Port Adapter. The test displays the Open circuit voltage and the short circuit current



of the solar panel as well as an indication that the reference panel is OK. If there is not enough sunlight for the test the “Increase Sunlight” message is displayed.



Figure 15: Reference Panel Test Screen

There are two Reference Panel Tests. The Reference Panel [T] (TEST Port) Test is used to test the reference panel when connected to the TEST port. The Reference Panel [A] (AUX Port) Test is used to test the reference panel and AUX Port Adapter when connected to the AUX port. This test is primarily used to test the functionality of the Reference Panel and AUX Port Adapter to ensure they aren't damaged. Figure 16 shows how the reference panel and AUX port adapter are connected for the two reference panel tests.



Figure 16: Reference Panel Test (TEST Port Left, AUX Port Right)

## 13 Test Adapters

WilliamsRDM offers an assortment of various test adapters to interface covert solar devices that don't directly connect with the solar tester to allow them to be painted and tested. The following list of adapters may not be complete as new adapters are added over time. Please contact Williams RDM for test adapters you may require.

| Part Number | Usage  |
|-------------|--|
| 8155-1-51   | 1) For testing second connector of smart solar rocks for buckeye<br>2) For testing output of 6V battery box for spartan GoCam<br>3) For testing second connector of 8203-1 rocks |
| 8155-1-52   | 1) For testing output of Spartan GoCam battery box with barrel jack  |
| 8155-1-53   | 1) For testing output of basic solar rocks for Spartan Ghost, GoLive and GoLive2<br>2) For testing output of Spartan Ghost, GoLive and GoLive2 rocks with battery box.           |
| 8155-1-54   | 1) For testing solar rocks that connect to spartan battery boxes.  |
| 8155-1-55   | 1) For testing bare wires uses alligator clips   |
| 8214-1      | 1) For testing solar devices that connect with the Qual Tron solar charger.  |

## 14 Specifications

Below are the specifications for the solar tester

- 1) Tester Weight with batteries: 0.94 lbs.
- 2) Solar Tester Dimensions: 8¾" x 4" x 1¼"