Ossila T2002 Solar Cell I-V Test System User Manual

Contents

Ossila T2002 Solar Cell I-V Test System

Safety

Use of Equipment

The Ossila Solar Cell I-V Test System is designed to be used as instructed. It is intended for use under the following conditions:

- Indoors in a laboratory environment (Pollution Degree 2).
- Altitudes up to 2000m.
- Temperatures of 5°C to 40°C; maximum relative humidity of 80% up to 31°C.

The unit is supplied with a 24 VDC power adapter with a power cord for the country of purchase, in accordance with European Commission regulations and British Standards. Use of any other electrical power cables, adaptors, or transformers is not recommended

Hazard Icons

The following symbols can be found at points throughout the rest of the manual. Note and read each warning before attempting any associated operations associated with it:
Hazard warning labels used in this manual.

Associated Hazard

Electrical shock

General Hazards

Before installing or operating the Ossila Solar Cell I-V Test System there are several health and safety precautions which must be followed and executed to ensure safe installation and operation.

Power Cord Safety

Emergency power disconnect options: use the power cord as a disconnecting method and remove from wall. To facilitate disconnect, make sure the power outlet for this cord is readily accessible to the operator.

Servicing

If servicing is required, please return the unit to Ossila Ltd. The warranty will be invalidated if:

- Modification or service has taken place by anyone other than an Ossila engineer.
- The Unit has been subjected to chemical damage through improper use.
- The Unit has been operated outside the usage parameters stated in the user documentation associated with the Unit.

- The Unit has been rendered inoperable through accident, misuse, contamination, improper maintenance, modification, or other external causes.

Health and Safety – Servicing

Servicing should only be performed by an Ossila engineer. Any modification or alteration may damage the equipment, cause injury, or death. It will also void your equipment's warranty.

Requirements
details the power requirements for the Solar Cell I-V Test System, and the minimum computer specifications for the Ossila Solar Cell I-V software.
Solar Cell I-V Test System requirements.

Power	24 VDC
Operating System	Windows 10 or 11 (32-bit or 64-bit)
CPU	Dual Core 2 GHz
RAM	2 GB
Available Hard Drive Space	192 MB
Monitor Resolution	1680 x 1050
Connectivity	USB 2.0 Ethernet (requires DHCP)

Unpacking

Packing List

The standard items included with the Ossila Solar Cell I-V Test System are:

- Ossila Solar Cell I-V Test System.
- 24 VDC power adapter.
- USB-B cable.
- USB memory stick pre-loaded with the user manual, USB drivers, quality control data, and software installer.
- Resistor test device.

Damage Inspection

Examine the components for evidence of shipping damage. If damage has occurred, please contact Ossila directly for further action. The shipping packaging will come with a shock indicator to show if there has been any mishandling of the package during transportation.

Specifications

The Solar Cell I-V Test System specifications

Ossila Solar Cell I-V Test System specifications.

Voltage range	±10 mV to ±10 V
Voltage accuracy	±10 mV offset
Voltage resolution	170 µV
Current range	±10 nA to ±200 mA (5 ranges)
Current accuracy	±10 nA (at 20 µA range)
Current resolution	0.1 nA (at 20 µA range)
Substrate Size	20 mm x 15 mm 25 mm x 25 mm 75 mm x 25 mm
Substrate Compatibility	T2002B, T2003B – S211 T2002E, T2003E – S2006 T2002F, T2003F – S241, S251
Overall Dimensions (Automated)	Width: 150 mm Height: 55 mm Depth: 300 mm
Overall Dimensions (Manual)	Source Measure Unit Width: 125 mm; Height: 55 mm; Depth: 185 mm Test Board Width: 105 mm; Height: 40 mm; Depth: 125 mm (T2002F – Width: 100 mm; Height: 40 mm; Depth: 150 mm)

System Components
The Solar Cell I-V Test System is comprised of 2 items: the Solar Cell I-V Test System (Figure 7.1 or Figure 7.2) and the Ossila I-V Curve software

Figure 7.1. Solar Cell I-V Test System (Automated).

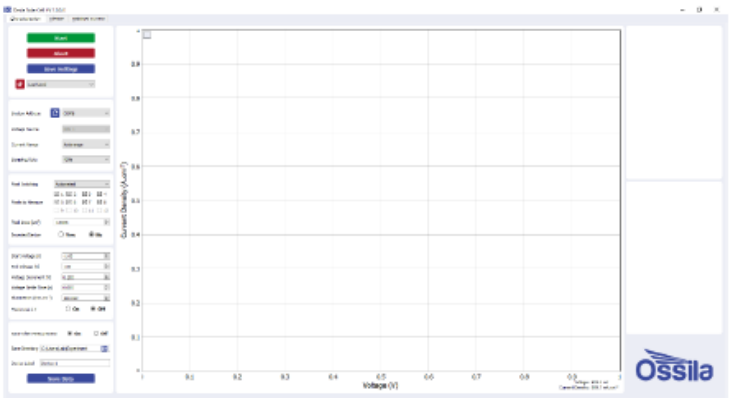


Figure 7.3. Solar Cell I-V Test System software.

Installation

- Install the Ossila Solar Cell I-V software on your PC.
- Run the file ‘Ossila-Solar-Cell-IV-Installer-vX-X-X-X.exe’ on the USB memory stick provided.
- Follow the on-screen instructions to install the software.
- Connect the 24 VDC power adaptor to the power socket on the rear of the unit.
- Connect the unit to your PC using the provided USB-B cable, or an Ethernet cable if preferred.

Note: The Ossila Solar Cell I-V software can also be downloaded from ossila.com/pages/software-drivers

Measurement Types
The Solar Cell I-V software can perform 3 different types of measurements. Each measurement type can be selected using the tabs at the top of the window. The available measurements are:

1. Characterisation (Section 9.1.1).
2. Lifetime (Section 9.1.2).
3. Stabilised Current (Section 9.1.3).

Each measurement type requires several settings to be selected before it can be performed. Settings that are shared between all measurements are detailed in Section 9.3. Measurement-specific settings are detailed in Sections 9.4, 9.5, and 9.6.

Characterisation

The Characterisation tab performs current-voltage (I-V) measurement and analysis of solar cells. The analysis calculates the following properties:

- Power conversion efficiency (PCE)
- Fill factor (FF)
- Short-circuit current density (Jsc)
- Open-circuit voltage (Voc)
- Shunt resistance (Rsh)
- Series resistance (Rs)
- Maximum power (Pmax)

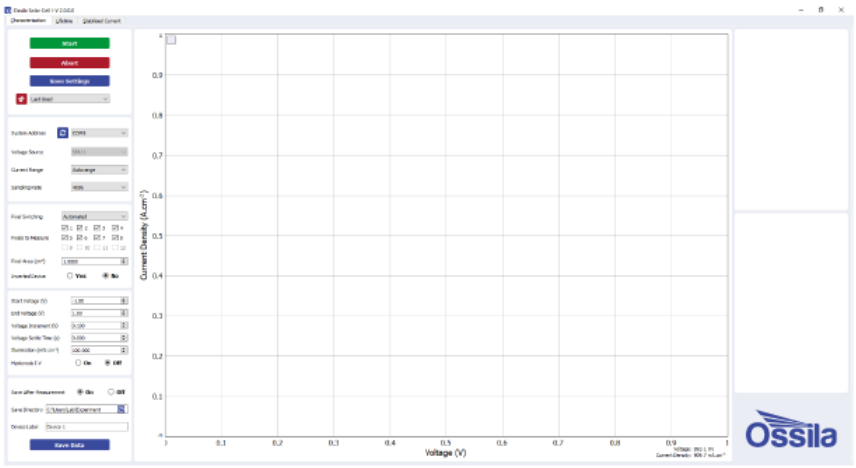


Figure 9.1. Solar Cell I-V software: The Characterisation tab.

Lifetime

The Lifetime tab tracks PCE, FF, Jsc, and Voc over time by performing periodic I-V measurements and analysis. Between I-V measurements, the solar cell can be held at short-circuit, open-circuit, or maximum power.

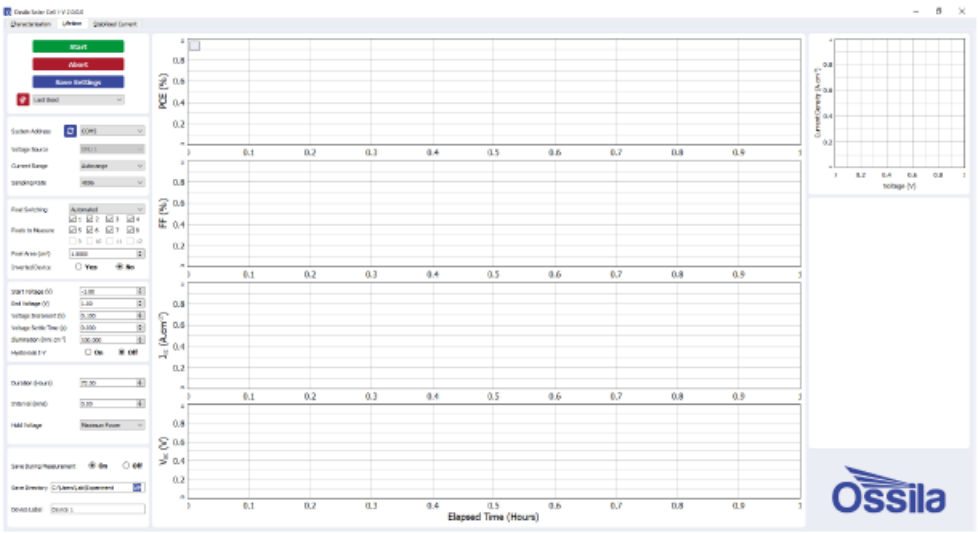


Figure 9.2. Ossila Solar Cell I-V software: The Lifetime tab.

Stabilised Current

The Stabilised Current tab lets you measure the evolution of the photogenerated current at specific voltages.

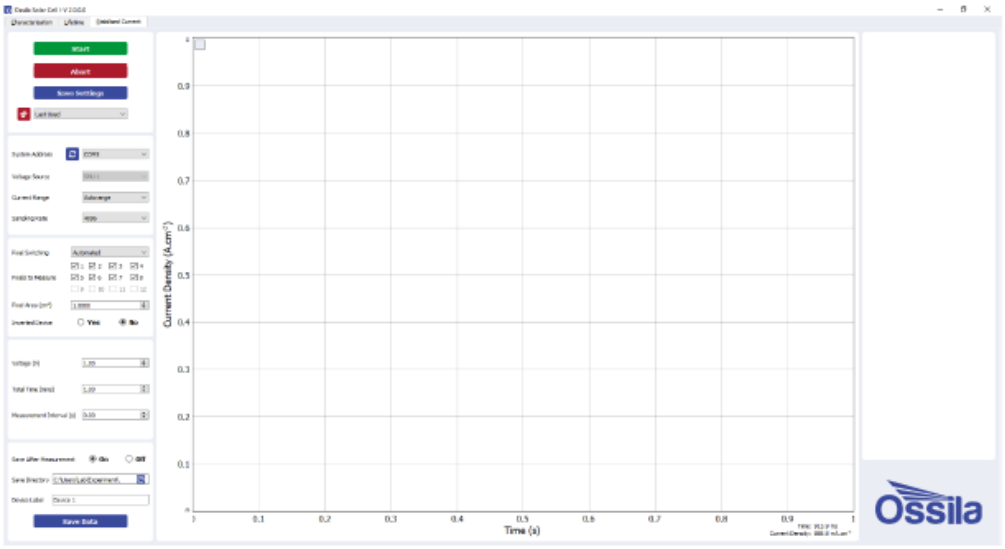


Figure 9.3. Ossila Solar Cell I-V software: The Stabilised Current tab.

Quick Start Guide

1. Start the Ossila Solar Cell I-V software. The window shown in Figure 9.1 will open.
2. Choose a measurement type as described in Section 9.1.
3. Place your sample in the device holder.
4. Place the device holder beneath your solar simulator.
5. Set the appropriate settings in the software (explained in more detail in Sections 9.4 – 9.8).
6. Open the shutter of your solar simulator.
7. Click the ‘Measure’ button.
   I. For each pixel, measurements are performed using the chosen measurement settings.
   II. This process is repeated until all pixels have been measured.
8. If automatic saving is turned on, the measurement data and settings will then be saved.

Shared Software Settings

The settings in these sections are shared between all measurement types.

System Settings

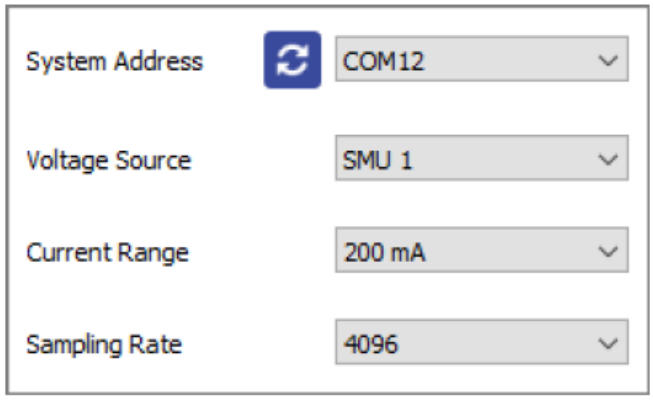


Figure 9.4. System settings.

System Address

- Select the COM port or IP address of the connected unit you intend to use (USB and Ethernet connection respectively).
- This box will be populated automatically with the addresses of any units connected to the computer.

Voltage Source

- Select which SMU channel of the Source Measure Unit the test board is connected to.
- 'SMU 1' will be automatically selected when pixel switching is set to 'Automated'.

Current Range

- Select the range of currents to be used for the measurement.
- This defines the upper limit and accuracy of current measurements that can be performed by the unit. The values for each range are given in Table
- Automatic range selection will start on the lowest current range and automatically switch to higher ranges if the current increases above the maximum for a range.

Maximum Current	Accuracy	Precision	Resolution
±200 mA	±500 µA	10 µA	1 µA
±20 mA	±10 µA	1 µA	100 nA
±2000 µA	±1 µA	100 nA	10 nA
±200 µA	±100 nA	10 nA	1 nA
±20 µA	±10 nA	1 nA	100 pA

Sampling Rate

- Select the number of samples to be taken for each data point.
  I. A higher number of samples per point will improve the accuracy and precision of the measurement. However, this will increase the time taken for the measurement to be performed.

Device Details

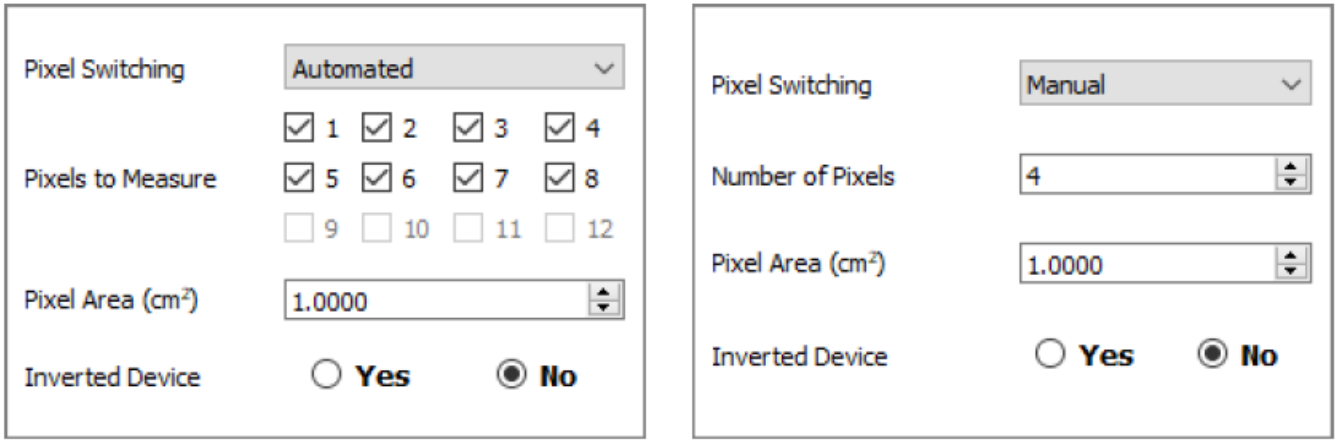


Figure 9.5. Device Details settings for automated (left) and manual (right) switching.

Pixel Switching

- Select whether changing the connected pixel is done manually or automatically by the system.
  Pixels to Test (Automated Switching)
- Select which pixels to measure.
  I. The pixel numbers are labelled on the device holder.

Number of Pixels (Manual Switching)

- Set the number of individual solar cell pixels in the device being measured.

Pixel Area

- Set the area in cm2 of each pixel in the device.

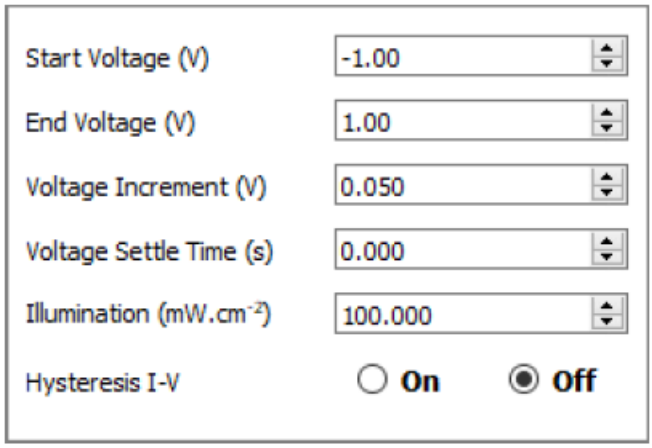
Inverted Device

- Set whether the device to be measured is inverted.

I. This option should be on if the anode of your device connects to the ‘cathode’ pins in the device holder.

Characterisation Settings

Measurement Settings



. Measurement Settings for the characterisation and lifetime measurements.

Start Voltage

- Set the voltage in volts at which to start the current-voltage measurement.
- This can be set between -10 V and +10 V.

End Voltage

- Set the voltage in volts at which to end the current-voltage measurement.
- This can be set between -10 V and +10 V.

Voltage Increment

- Set the step size in volts for changing the voltage during current-voltage measurement.

Voltage Settle Time

- Set the time in seconds between applying a voltage and measuring the current.
- This has a maximum of 10 seconds.

Illumination

- Set the illumination intensity (in mW.cm-2) being used during the measurement.

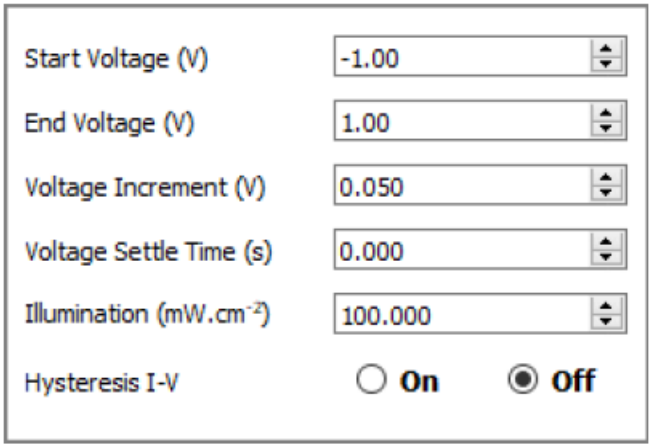
Hysteresis I-V

- This option performs a reverse current-voltage measurement after the forward current-voltage measurement has completed.
- This reverses the set start and end voltages and uses the same voltage increment and settle time as the

forward measurement.

Lifetime Settings

Measurement Settings



Measurement Settings for the characterisation and lifetime measurements.

Start Voltage

- Set the voltage in volts at which to start the current-voltage measurement.
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End Voltage

- Set the voltage in volts at which to end the current-voltage measurement.
- This can be set between -10 V and +10 V.

Voltage Increment

- Set the step size in volts for changing the voltage during current-voltage measurement.

Voltage Settle Time

- Set the time in seconds between applying a voltage and measuring the current.
- This has a maximum of 10 seconds.

Illumination

- Set the illumination intensity in mW.cm-2 being used during the measurement.

Hysteresis I-V

- Set whether to perform a reverse current-voltage measurement after the forward current-voltage measurement has completed.
- This reverses the set ‘start’ and ‘end’ voltages and uses the same voltage increment and settle time as the forward measurement.

Lifetime Parameters

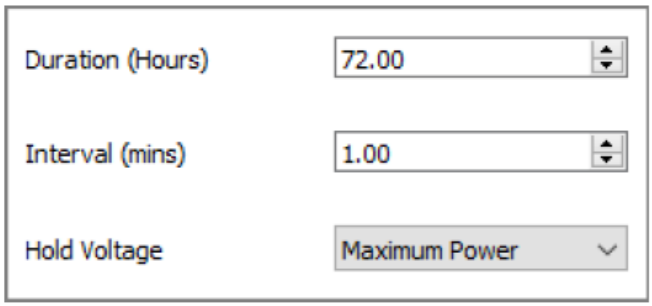


Figure 9.8. Lifetime Parameters settings.

Duration

- Set the total duration in hours of the lifetime measurement.

Interval

- Set the time interval in minutes between performing repeat current-voltage measurements of the device.

Hold Voltage

- Set the voltage that all pixels will be held at between measurements.
- This can be set as:

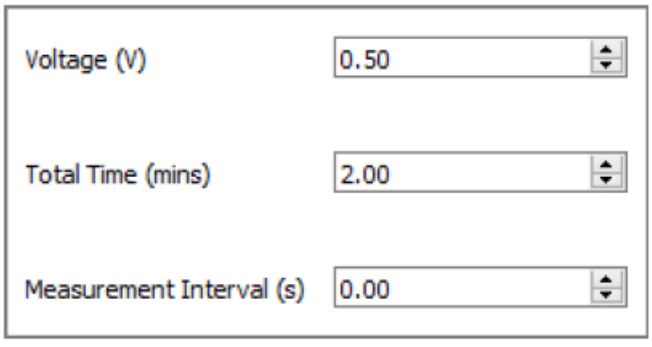
Short-Circuit – hold at 0 V.

- Maximum Power – hold at the average maximum power point determined from most recent current-voltage curve.
- Open-Circuit – hold at the average open-circuit voltage determined from the most recent current-voltage curve.

Note: As the voltage source is a single channel, the hold voltage will be the same for all pixels being tested.

Stabilised Current Settings

Measurement Settings



). Experimental Parameters settings for the Stabilised Current Output.

Voltage

- Set the voltage to apply to the sample for the measurement.
- This can be set between -10 V and +10 V.

Total Time

- Set the total length of the measurement in minutes.

Measurement Interval

- Set the time between each current measurement in seconds.

Saving and Loading Settings

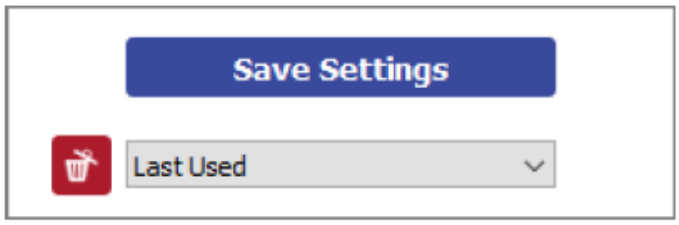


Figure 9.10. Controls for saving and loading settings profiles.

Save Settings

- Saves the current settings as a profile that can be loaded quickly for use at another time.
- When clicked, you will be prompted to name the settings profile.
- If the name is already in use, you will be asked if you wish to overwrite the previous profile.
- The name cannot contain the characters: \ / : * ? “ < > |
- The settings profile will be added to the drop-down box using the given name.

Settings Profiles

- Select a saved settings profile from the drop-down box.
- The settings fields will be populated with the saved values.
- Settings profiles can be deleted by selecting the profile, and then clicking the red ‘delete’ button next to the drop-down box.\

Saving Results

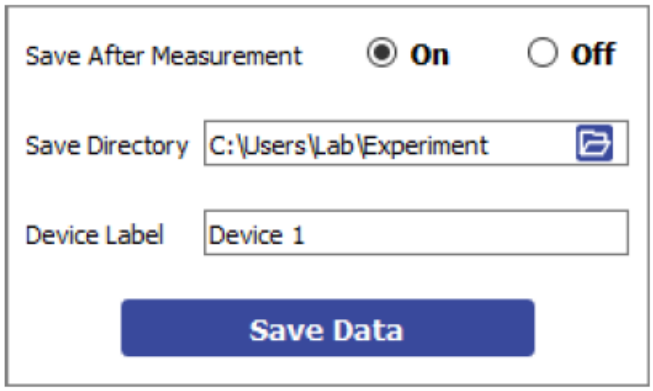


Figure 9.11. Saving measurement data settings.

Save After Measurement

- Set whether the measurement data will be saved after the measurement has completed.

Warning: Automatic saving can be turned off for lifetime measurements. However, manual saving is unavailable for lifetime measurements, so you will not be able to save your data if it is turned off.

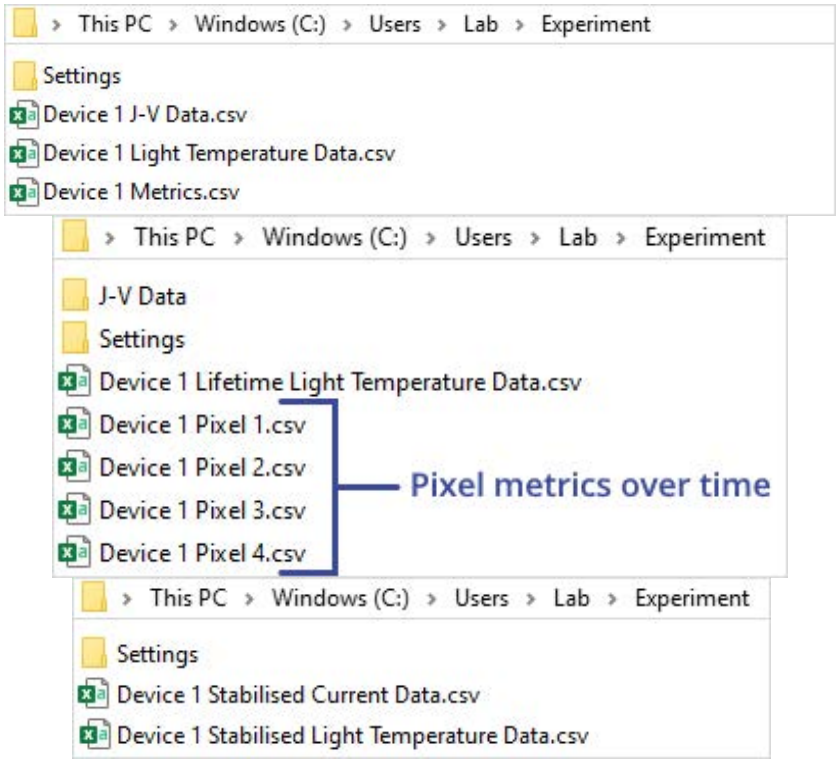
- The program allows for data to be saved automatically and manually once the measurement is complete.
- For automatic saving, the ‘Saving’ fields must be filled in before the measurement can start, these are detailed below.
- For all measurements, a save directory must be specified. This can be done either by:
- Manually typing the directory into the ‘Save Directory’ field,
- Copy and pasting from your file explorer,
- Clicking the file icon button, which will open a dialog box to allow the selection of a folder to save to.
- All output files are comma separated variable (.csv) files.

Save Directory

- Set the directory in which to create the data files.
- This can be filled in by:
- Manually typing the directory into the ‘Save Directory’ field,
- Copy and pasting from your file explorer,
- Clicking the ‘Select Directory’ button, which will open a dialog box to allow the selection of a folder to save to.
- Device Label
- Set the name of the device being tested.
- This is used to label the files for I-V data and measurement settings.
- This field cannot contain the following characters: I. \ / : * ? “ < > |

Save Data Format

- All data is saved as .csv (comma separated value) files.
- The figures below show the files that are created when saving data for each of the measurements.



Controls

Figure 9.15. Controls for the measurements.

Measure

- Clicking this button will start the measurement using the chosen settings.
- This button cannot be clicked if the software has not detected the test system.

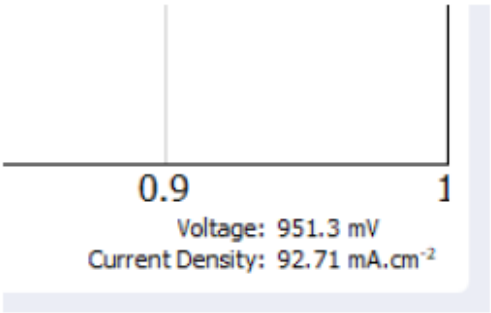
Abort

- Stops a measurement that is currently in progress.

Plot Controls

Position Readout

Whilst the mouse cursor is over the plot in the Characterisation and Stabilised Current tabs, the x and y position of its location are displayed in the bottom-right of the plot,



Plot Display Controls

By default, the axes of the plot will automatically scale to display all the data within it. The view can be controlled manually using the following mouse controls:

- Left/Middle click and drag – pan the axes.
- Right click and drag – scale the axes (left-right for x-axis, up-down for y-axis).
- Scroll wheel – scale the axes centred on the cursor location.

A specific axis can be controlled by using these controls on the axis labels. The axes can be reset by clicking the ‘A’ button in the bottom-left of the plot

Figure 9.17. Button to reset the plot axes.

Test Devices

The system is shipped with a test device that can be used to check the calibration of the system. They have resistors arranged in the geometry of the substrate pixels, and the appearance of the test device will depend on the substrate system being used

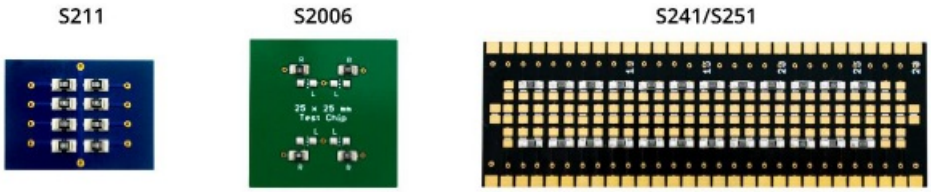


Figure 10.1. Test device configurations.

Taking a Measurement

1. Plug in and switch on the system.
2. Allow at least 30 minutes for the system to warm up.
3. Place the test device in the device holder with the resistors facing up for S211 and S2006 and facing down for S241/S251.
4. Start the Solar Cell I-V software and enter the following settings

- These settings can be used with any current range except for the 20 µA range. For this range the start and end voltages must be lowered to -2 V and 2 V respectively.
- The ‘Pixels to Measure’ checkboxes (Automated systems) or ‘Number of Pixels’ (Manual systems) should match the device configuration you have.

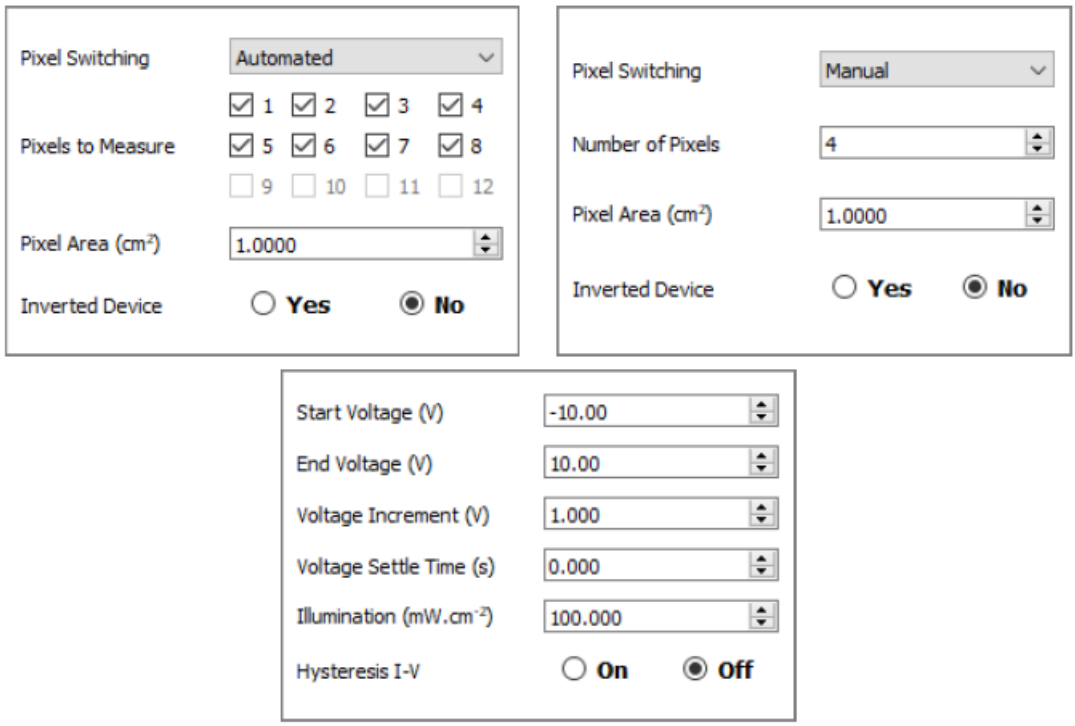


Figure 10.2. Measurement settings for the resistor test device.

- Click the ‘Measure’ button.
- The system should measure straight line resistor responses from -100 µA.cm-2 to 100 µA.cm-2 (or -20 µA.cm-2 to 20 µA.cm-2 for the 20 µA current range) as shown in Figure 10.3.
- To check the calibration of the system, use the I-V data to calculate the measured resistance at -10 and 10 V (-2 and 2 V for the 20 µA current range).
- Resistance can be calculated using: R = V / I
- For the 200 mA current range the calculated resistance should be between 98 and 102 kΩ (within 2% of the resistor value).
- For all other ranges the calculated resistance should be between 99 and 101 kΩ (within 1% of the resistor value).

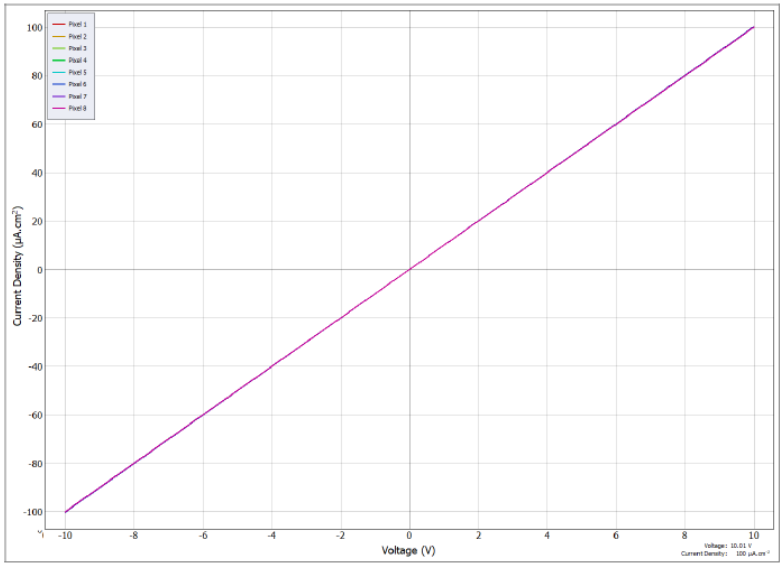


Figure 10.3. Example measurement of resistor test device using the 200 µA current range.

Troubleshooting

Most of the issues that may arise will be detailed here. However, if you encounter any issues that aren't in this list, please contact us by email at info@ossila.com, and we will respond as soon as possible.

Installation and Setup

Problem	Possible Cause	Action
No power	The power supply may not be connected properly.	Ensure the system is firmly plugged into the power supply, and that the plug is connected to both the adaptor and a working power socket.
	The power supply adaptor has a fault.	Contact Ossila for a replacement power supply adaptor.
Software does not start	The wrong version of Windows is installed on the computer.	Install the software on a computer with Windows Vista or newer.
	The software has not installed properly.	Try reinstalling the software.
Cannot connect to the system via USB	The USB cable may not be connected properly.	Ensure the USB cable is firmly plugged in at both ends.
	The USB cable may not be connected to a working USB port.	Try connecting the unit to a different USB port on the computer.
	The USB cable is defective.	Try using a different USB-B cable, and contact Ossila if necessary.
Cannot connect to the system via network	The MAC address of the unit is not registered with the internal network.	Register the system on the network using the MAC address obtained via a USB connection (see Source Measure Unit manual).
	The Ethernet cable may not be connected properly.	Ensure the Ethernet cable is firmly plugged in at both ends.
	The Ethernet cable is defective.	Try using a different Ethernet cable.

Error Messages and Warnings

Message	Description
Current compliance reached	The measured current is greater than the set current limit.
Error communicating with system	The software is unable to connect to the system.
No device holder detected	The device holder is not connected to the system properly.
Voltage increment cannot be zero	The voltage increment is set to 0 V.
Start and end voltage cannot be equal	The start and end voltages of are set to the same voltage.
No save directory or device label en tered	The save directory and/or the device label fields are empty.
Settings profile not found	The given settings profile does not exist or is open in other software.
Error loading settings	There is a problem with the settings profile preventing it from being loade d.
Error deleting profile	The given settings profile does not exist, the software does not have the necessary permissions to delete it, or it is open in other software.
No data to save	There is no measurement data in memory to save to file.
Error saving data	The software does not have the necessary permissions to access the giv en file path, or the file is already open in other software.
Error saving settings	The software does not have the necessary permissions to access the giv en file path, or the file is already open in other software.
Error creating data directories	The software could not create the directories for save data files.
Error creating data files	The software could not create the files for saving measurement data.

Related Products

Related Consumables

ITO Coated Substrates

Our range of ITO substrates for OPV, OLED, and sensing applications.
Product codes: S111 / S101 / S211 / S281 / S171

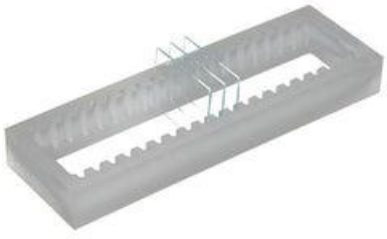
FTO Coated Substrates

Designed to be used as transparent electrodes for thin-film photovoltaics.
Product codes: S301 / S302 / S303 / S304

Flat Tip Tweezers

Provides a good substrate grip without scratching.
Product code: C121

Substrate Cleaning Rack



Holds 20 substrates for a variety of processing techniques.

Related Equipment

Spin Coater

Product high-quality coatings without any substrate warping. Perfect for busy labs with limited space.
Product code: L2001A3

UV Ozone Cleaner

For removing contamination on the surface of samples, providing you with ultraclean surfaces within minutes.
Product code: L2002A2

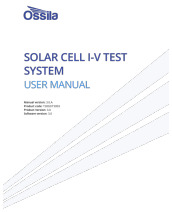
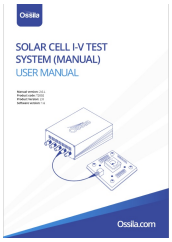
Syringe Pump

High-precision, programmable single and dual syringe pumps for automatic dispensing of solutions.
Product codes: L2003S1 / L2003D1

Source Measure Unit

Source voltage, measure current, get data. Simplify and accelerate your data collection!

Documents / Resources

	Ossila T2002 Solar Cell I-V Test System [pdf] User Manual T2002, Solar Cell I-V Test System, T2002 Solar Cell I-V Test System, T2003
	Ossila T2002 Solar Cell I-V Test System [pdf] User Manual T2002, Solar Cell I-V Test System, T2002 Solar Cell I-V Test System, I-V Test System