



## CC Series: I-V Curve Data Acquisition System Description and features

### **General System Description**

The Solar Cell I-V Curve Data Acquisition System characterizes the current-voltage (I-V) characteristics of photovoltaic devices with currents up to 20.0 amperes. It calculates the solar cell parameters, generates printable test reports and saves test data in text files. Curves are measured using classic four probes (Kelvin) technique. The system includes electronics, software, rack-mount computer, chuck and cell testing fixture with irradiance monitoring and optional temperature control. It interfaces with the customers' Solar Simulator or a Solar Simulator can be supplied.

### **System Details**

#### ***Test Fixture***

The I-V Curve Data Acquisition includes a fixture for holding test devices. This fixtures range in size from 50mm x 50mm, 80mm x 80mm, 100mm x 100mm, 150mm x 150mm, 200mm x 200mm and 300 mm x 300 mm, larger sizes are available. Two bus bars with multiple spring loaded contacting probes (20 per bus bar) are mounted on a frame. The frame can be manually raised to place the cell on the platen for testing. The cell is held down with vacuum during testing (customer needs to supply the vacuum source). After placing the cell in position, the frame can be manually lowered to make probe contact with the cell. Once in the down position, the frame is held down by clasps to maintain contact with the cell. Optional automatic cell contacting is available upon request.

Two back-side voltage probes are located inside the platen (electrically isolated from the platen) and make good electrical contact when the cell is held down by vacuum to the platen. Both of the bottom voltage and current probes are soft-touch, spring loaded and gold-plated. Platen can be either cooled or heated in the temperature range of 0-60° C using Peltier cells. Temperature of the platen is measured automatically with accuracy of  $<\pm 1^{\circ}$  C and is monitored during cell measurement.



## CC Series: I-V Curve Data Acquisition System Description and features

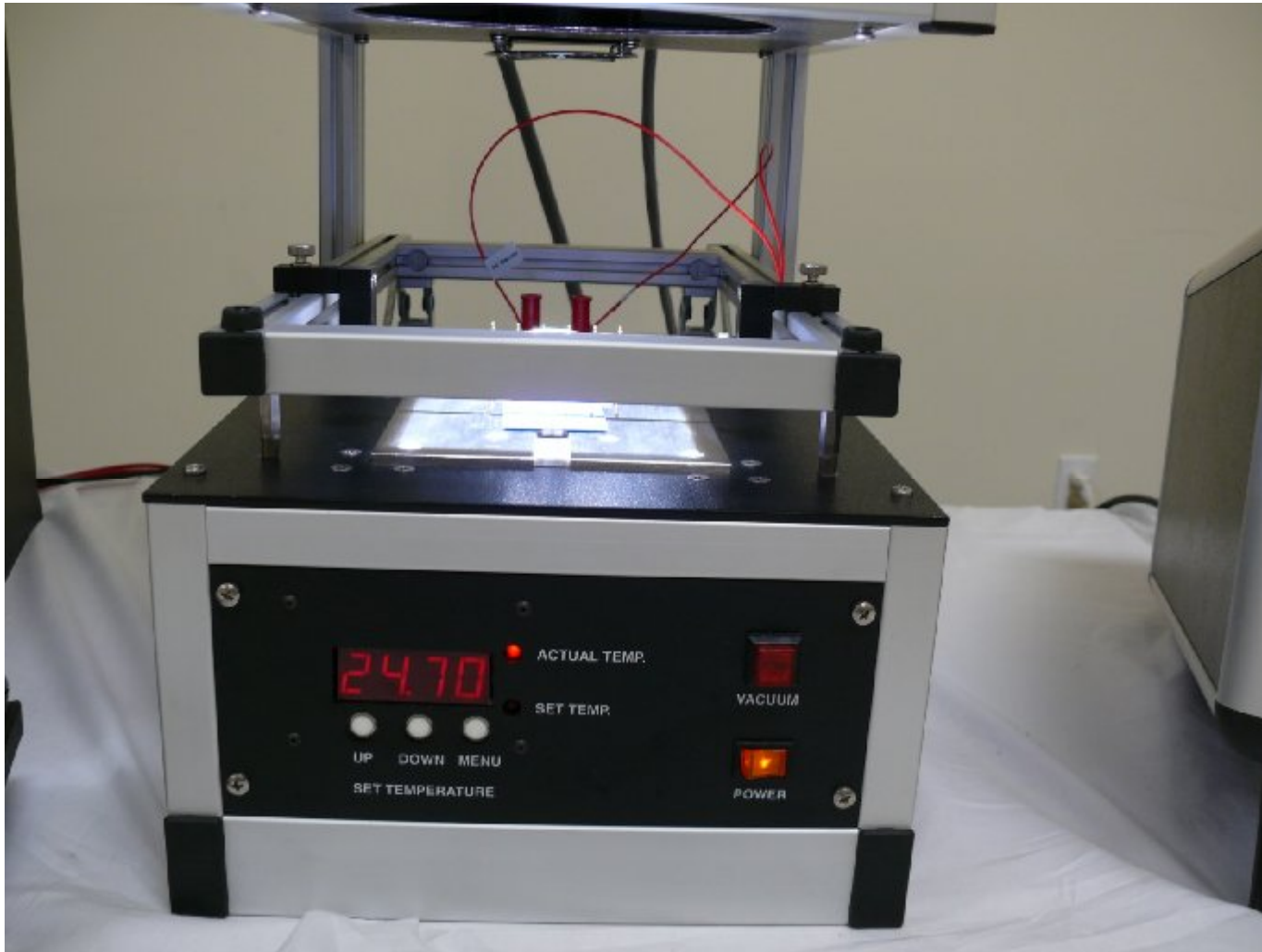


Figure 1: View of a typical cell measuring table with multiple probes solar cell contacting



## CC Series: I-V Curve Data Acquisition System Description and features



Figure 2: View of a Typical I-V System Console  
(Left view Model #'s CC1/CC3/CC5 : Right View Model #'s CC10/CC15/CC20)



## CC Series: I-V Curve Data Acquisition System Description and features

### Software Features

- ❖ Easy to use MS Windows environment and user friendly software.
- ❖ Software handles measurement of both P type and N type cells without any cell connection changes.
- ❖ Advanced noise filtering feature to enable measurement of good quality I-V curves even under fluctuating intensity conditions.
- ❖ Light Intensity & Temperature monitoring and control, 0-60°C Standard. Other ranges optional.
- ❖ Calculation of cell series resistance according to IEC 60891 standard.
- ❖ Procedures for fitting of measured I-V Curve to either equivalent diode models, i.e. SEM-Single Exponential, DEM-Double Exponential and VDEM-Variable Double Exponential with seventeen (17) weight functions.
- ❖ Procedures for curve correction to Standard Test Conditions (STC) to IEC60891, Anderson's and Blaessar's or user defined conditions.
- ❖ Computes solar cell parameters including  $I_{SC}$ ,  $V_{OC}$ ,  $F_F$ ,  $I_{MAX}$ ,  $V_{MAX}$ ,  $P_{MAX}$ ,  $E_{ff}$ ,  $R_s$  and  $R_{sh}$  and saves them automatically on hard disk drive. In addition cell's temperature and irradiance level is measured and stored for future analysis. User has the ability to perform automatic correction of measured I-V curve to STC (Standard Test Conditions), i.e. light intensity and temperature or other conditions specified by the user.
- ❖ Thermal Coefficients of  $V_{oc}$  &  $P_m$
- ❖ Dark saturation current,  $R_s$  and  $R_{SH}$  determination
- ❖ Provides printable test reports and test data in text files for easy exchange between programs
- ❖ Software features include cell sorting in various categories. This cell sorting can be performed in production or in virtual binning modes specified by the user.
- ❖ Solar Simulator shutter control (Solar Simulator sold separately)



## CC Series: I-V Curve Data Acquisition System Description and features

### **Options**

#### ***Temperature Control***

Temperature control of the platen that holds the cell during measurement is available. The standard temperature control range is 0-60°C. Other temperature control ranges are available. Temperature control accuracy is  $< \pm 1^\circ\text{C}$ .

#### ***Setup and Training***

System setup is easy when using the instructions provided in the manual. If desired, PET will provide system setup and training at the customer's facility.

*The above specifications provide general information about this product. Actual product can be customized to meet the needs of individual customers.*



# CC Series: I-V Curve Data Acquisition System Description and features

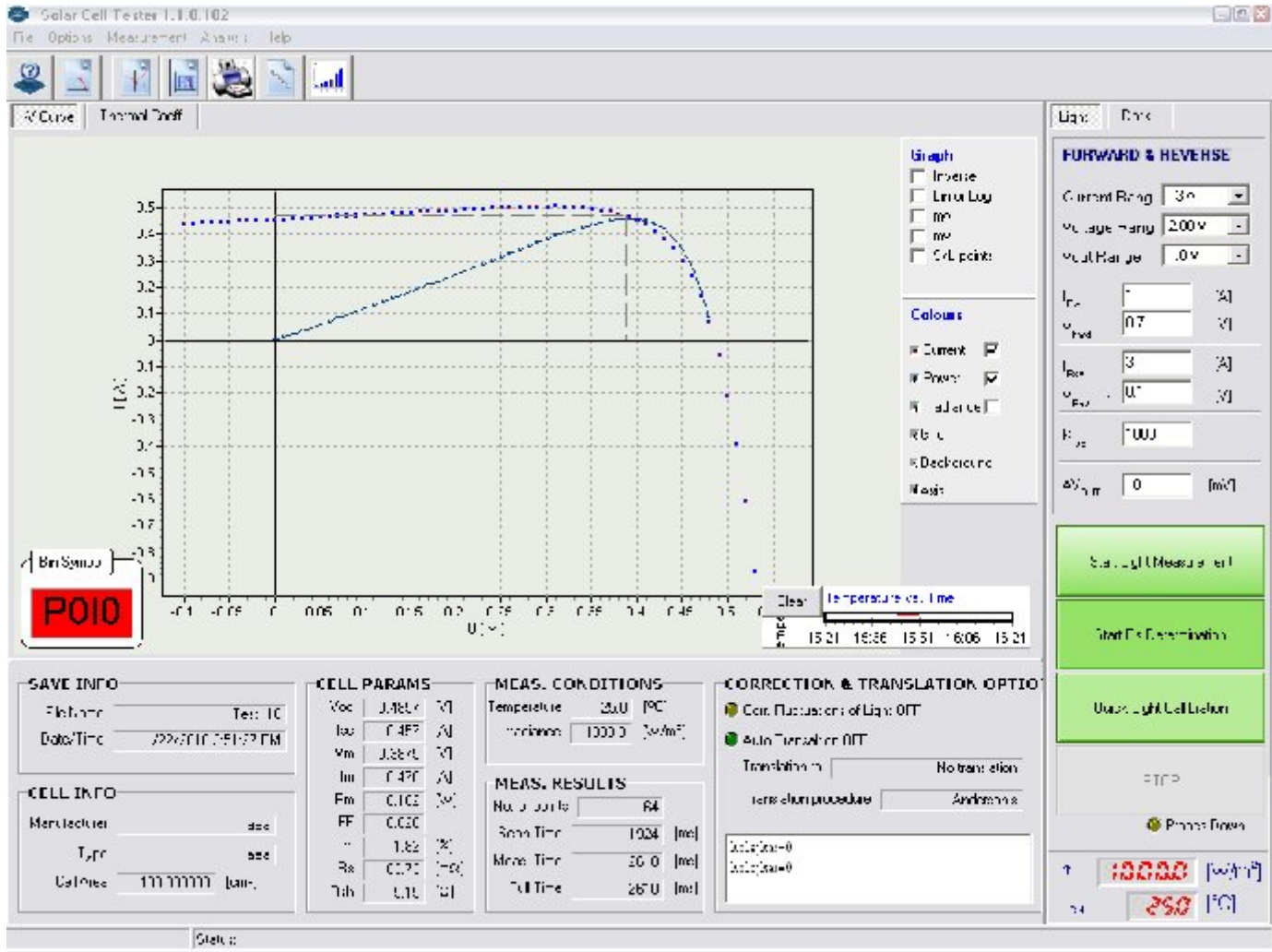


Figure 3: Example of “light” measurement



# CC Series: I-V Curve Data Acquisition System Description and Features

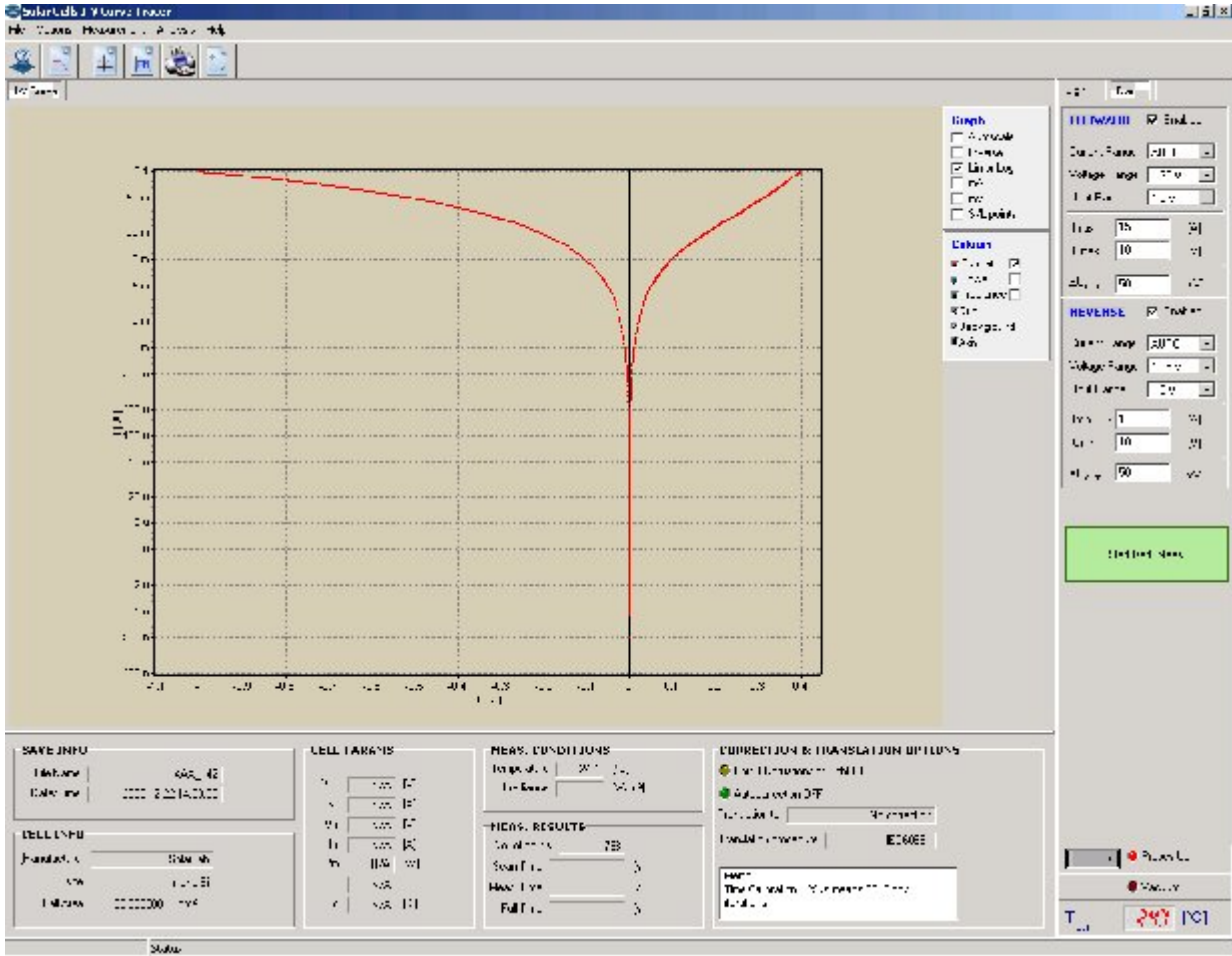


Figure 4: Example of “dark” measurement



# CC Series: I-V Curve Data Acquisition System Description and features

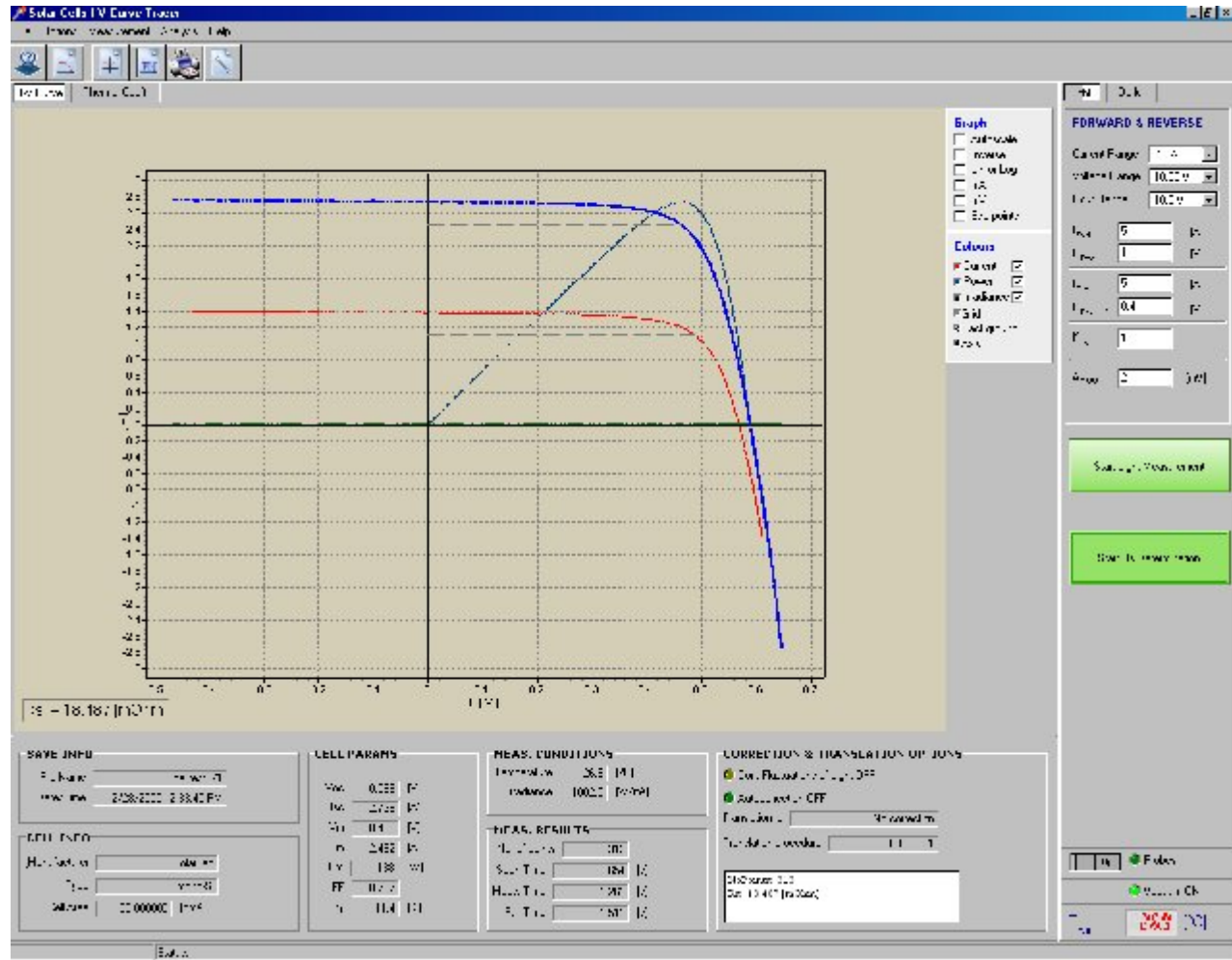


Figure 5: Example of cell's series resistance determination according to IEC 60891 Standard



# CC Series: I-V Curve Data Acquisition System Description and features

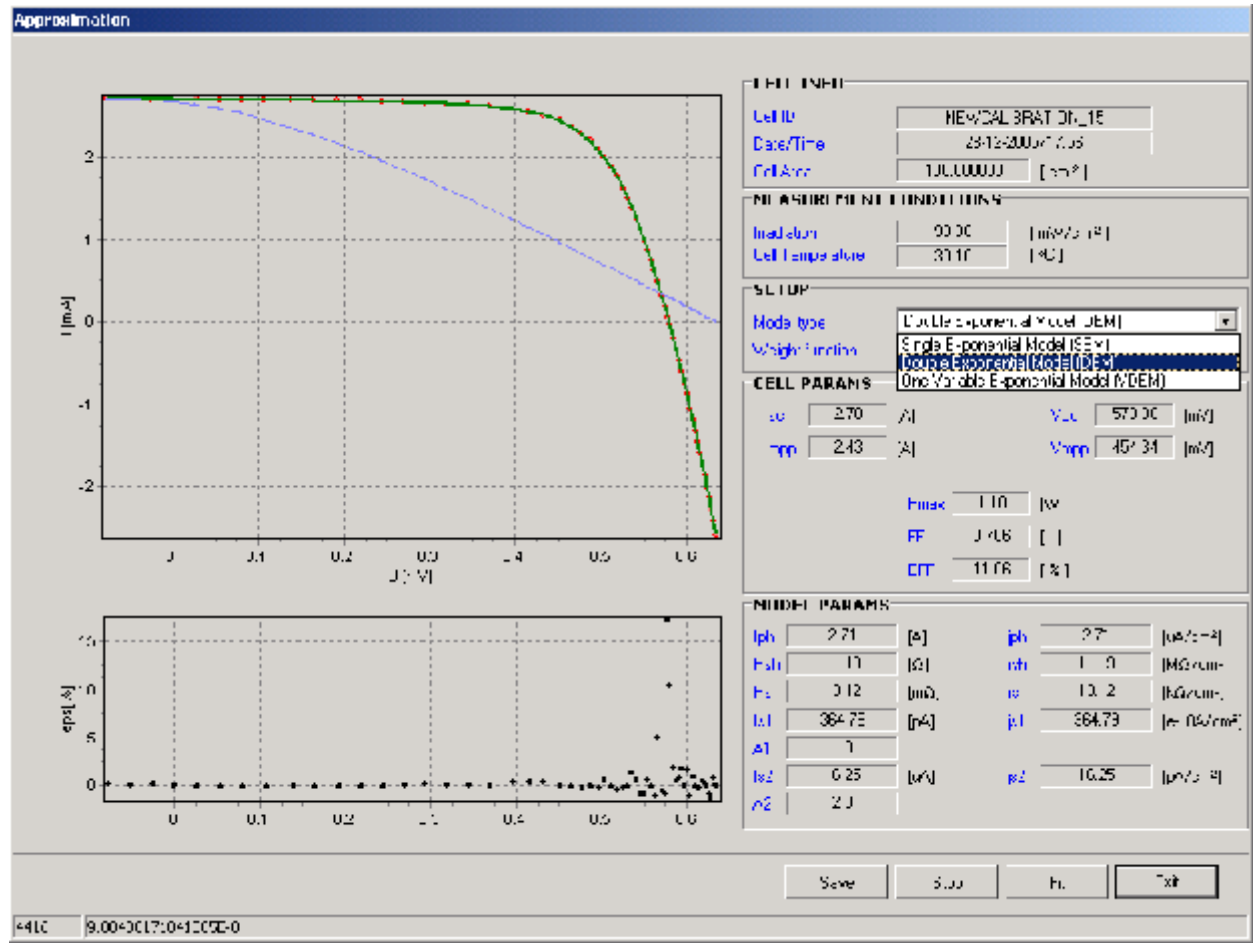


Figure 6: Example of cell's I-V curve fitting to Double Diode equivalent electrical model



# CC Series: I-V Curve Data Acquisition System Description and features

## Technical Specifications

<u>Model</u>	<u>CC-1</u>	<u>CC-3</u>	<u>CC-5</u>	<u>CC-15</u>	<u>CC-20</u>
Max. Current Range (A)	±1	±3	±5	±15	±20
Max. Voltage Range (V)	±40	±40	±40	±10	±10
Measurement Resolution	16 Bit				
Measurement Accuracy	Better than 0.5%				
Measurement Mode	Fixed or Auto				
Measurement Time (Light)	<500ms for stable light (Up to 4s if filtering for light fluctuations required)				
Measurement Time (Dark)	100-1,000ms				
Maximum Points per Curve	4,096				
Maximum Data Acquisition Speed	100kHz				
Maximum Cell Throughput	1,200/Hour (With optional Robotics)				
Phase (Power)	Single Phase				
Voltage (Volts)/Frequency (Hz)	220VAC (115VAC Optional)/50-60Hz				
Max. Power Consumption (W)	40 W (Up to 600W With Peltier Cells)				
Curve Correction to STC	IEC 80891, JRC or Anderson				
Advance Fitting of I-V Curves	SEM, DEM and VDEM Models (17 Different Weight Functions)				
Thermal Coefficients of Voc and Pm	Standard on All Systems (With Optional Temperature Control)				
Irradiance Monitoring & Correction	Standard on All Systems				