Photo Emission Tech., Inc.

760 Calle Plano, Camarillo, CA 93012 USA
Tel: (805) 482-5200 Fax: (805) 482-5252
Email: pet@photoemission.com

CELL TESTER MODEL # CT200AAA

SS200AAA-TP TOUCH PANEL SYSTEM FEATURES

- **Light intensity feedback for stable output intensity**
- **Computer based Controller**
- **Manual / automatic shutter control**
- **External lamp alignment with lamp on**
- **Manual/Automatic/External/ Remote shutter control**
- **Forced air cooling**
- **Lamp life display**

- **Selectable and adjustable constant intensity or constant lamp current**
- **Safety Interlock override warning**
- **Shutter Status Indicator**
- **Lamp status indicator**
- **Remote Trouble Shooting via Internet**
- **Two (2) year factory warranty**

STANDARD TOUCH PANEL (TP) SYSTEM
Specifications are subject to change without notice.

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CELL TESTER MODEL # CT200AAA

SS200AAA-EM ELECTRO-MECHANICAL SYSTEM FEATURES

- **Light intensity feedback for stable output intensity**
- **Electro-Mechanical Controller**
- **Lamp life display**
- **External lamp alignment with lamp on**
- **Manual/Automatic/External/ Remote shutter control**
- **Forced air cooling**
- **Lamp Life Meter**

- **Lamp Current Meter**
- **Selectable and adjustable constant intensity or constant power mode**
- **Safety Interlock override LED**
- **Over Temperature Warning LED**
- **Shutter Status Indicator**
- **Lamp status indicator**
- **Two (2) year factory warranty**

OPTIONAL ELCTRO-MECHNICAL SYSTEM (LOWER PRICE)
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CELL TESTER MODEL # CT200AAA

SS200AAA-TP & SS200AAA-EM TECHNICAL SPECIFICATIONS

FEATURE DESCRIPTION	SPECIFICATION
Type of lamp	Xenon Short Arc
Lamp Power	1,430 W
Max. Illuminated area	7.87" (200mm) X 7.87" (200mm)
Light Source	Steady State
Air Mass	AM1.5G Standard: AM1.5D or AM1 optional
Lamp lifetime	1,000 Hours
Adjustment Range of light intensity	100 mW/cm^2 +/- 15%
Simulator Class*	AAA
Spectral Match to all intervals*	±25% or better
Spatial Non-uniformity of irradiance*	≤ 2% or better
Short Term Temporal Instability (STI)*	≤ 0.5% or better
Long Term Temporal Instability (LTI)*	≤ 2% or better
Dimensions (Height x Width x Depth)	81.7" (2,075mm) x 16.4" (417mm) x 24.4" (620mm)
Weight	275 Lbs. (125 Kg)
Optimum Working Distance	22.7" (577mm)
Phase/Voltage/Frequency	Single Phase/220VAC/50-60Hz
Max. Power Consumption (W)	2.0 KVA

*MEETS CLASS A REQUIREMENTS OF ASTM E927-2010, IEC60904-9 Edition 2.0 2007-10 and JIS C 8912-1998: amendment 1-2005 & Amendment 2-2011

CC SERIES I-V CURVE DATA ACQUISITION SYSTEM DESCRIPTION & 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. IV 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 fixture can accommodate cells from small to up to 200 mm x 200 mm. Adjustable cell stops, in the X & Y-axis, are provided to consistently locate the cells for testing. For top cell contacting, 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 plate for testing. The cell is held down with vacuum (built-in) during testing. 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 third bus bar and automatic cell contacting is available upon request.

Two back-side voltage contacts are embedded in the platen (galvanically isolated from the platen) and make good electrical contact when the cell is held down by vacuum to the platen. All of the voltage and current probes are gold-plated. Alternative cell contacting meechanisms are available upon request.

With the optional Temperature Control, Cell Holding Plate can be either cooled or heated in the temperature range of 5-60°C using Peltier cells. Temperature of the platen is measured automatically with accuracy of <±0.5^{o}C and is monitored during cell measurement.

Figure 1: View of a typical cell measuring table with bottom current & voltage contacts and two (2) micro-manipulators for top cell contacts. Each Micro-Manipulator has one current & one voltage contact

Options

Temperature Control

Temperature control of the Cell Holding Plate is available. The standard temperature control range is 5-60°C. Other temperature control ranges are available. Temperature control accuracy is < ±1^{O}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.

Figure 2: Typical I-V System Console - ≤5A Current

Figure 3: Typical I-V System Console – 15A/20A Current

The IV Systems come with a choice of two different IV Measurement Software: Standard Software & Advance Software. The configuration of Console depends on the maximum current measurement capability.

Standard Software Features

- ❖ MS Windows environment and user friendly software.
- ❖ Computes solar cell parameters including: I_{SC}, V_{OC}, V_{MAX}, I_{MAX}, P_{MAX}, FF, $E_{fficiency}$, Rs, Rsh, J_{SC}, R_S Density, R_{SH} Density.
- ❖ Measures Light & Dark IV Curves.
- ❖ Scan data can be saved manually or automatically.
- ❖ In automatic file save mode, the user defines a file name series. In this mode, the software creates a summary file of all the major measured parameters for all the cells tested in that series. This helps in analyzing the data for a series of cells tested for trends etc.
- ❖ Provides printable test reports and test data in text files for easy exchange between programs
- ❖ Solar Simulator shutter control (Solar Simulator sold separately)

STANDARD SOFTWARE - SCREENS
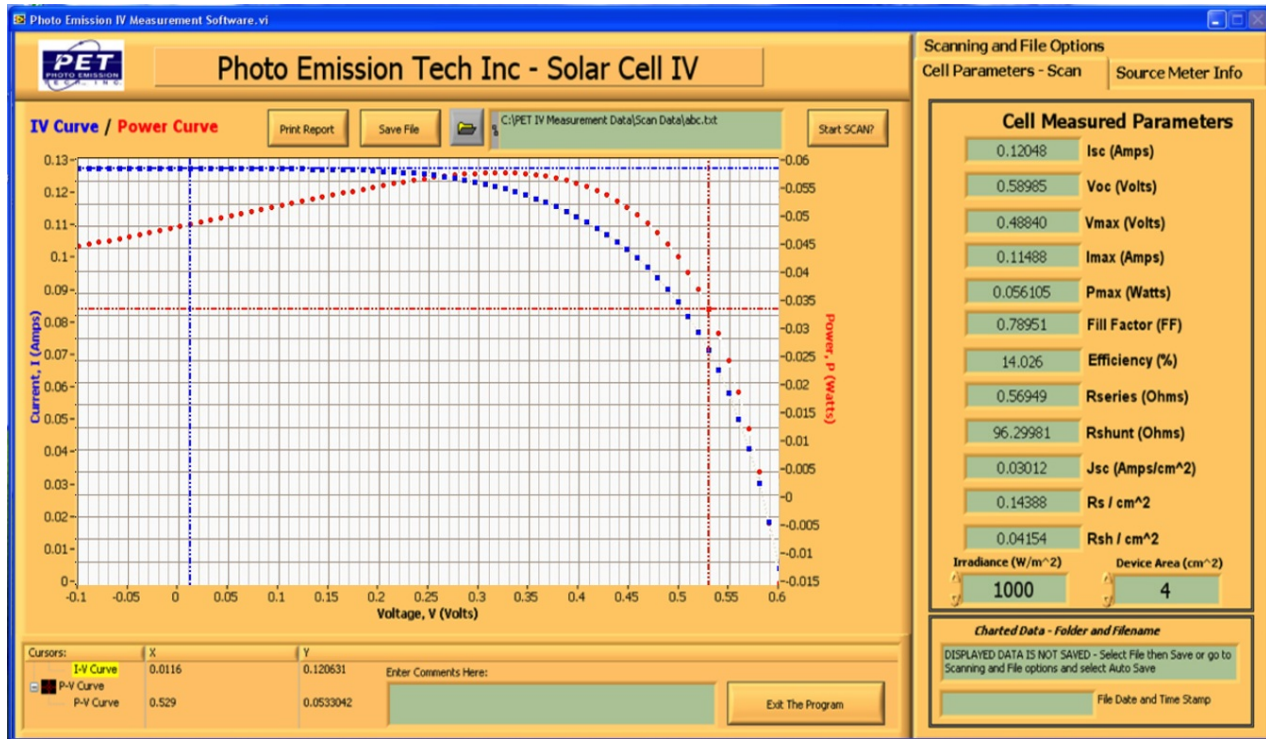
Figure 4: Cell Parameter Scan Screen
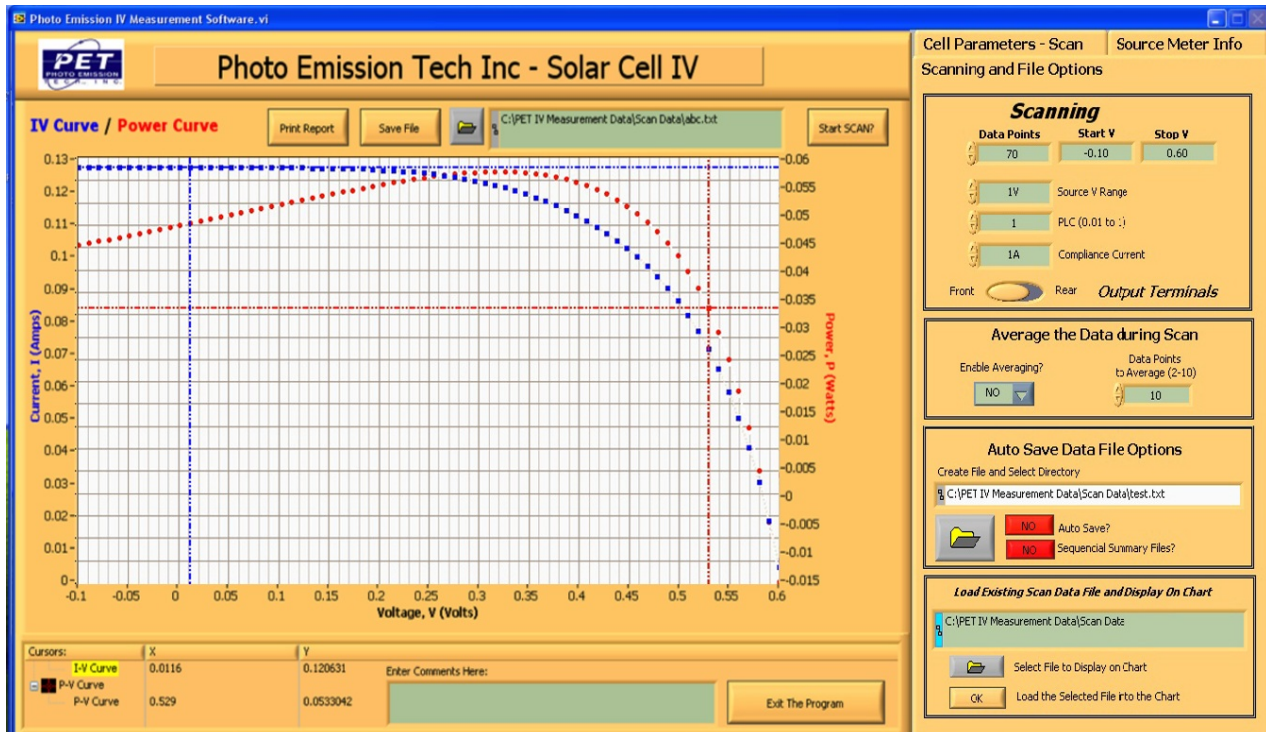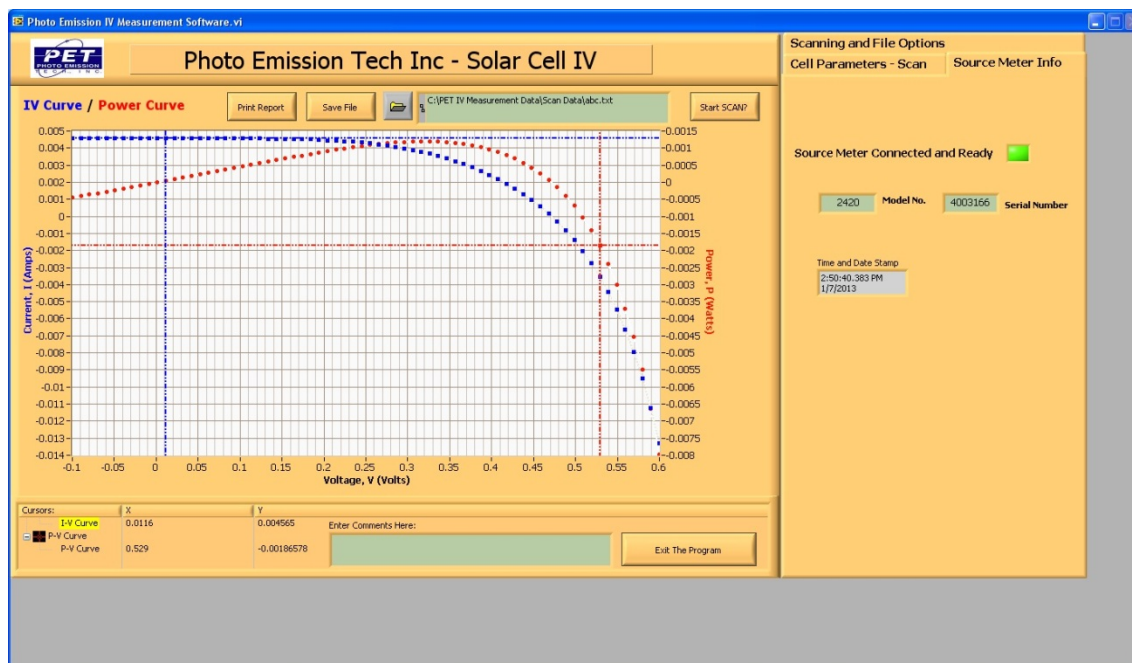

Figure 5: Scanning and File Options Screen

Figure 6: Source Meter Information Screen

IV SYSTEM TECHNICAL SPECIFICATIONS (WITH STANDARD SOFTWARE)

Model	CC-1	CC-3	CC-5	CC-20
Max. Current Range (A)	±1	±3	±5	±20
Keithley Source Meter Model #	2400	2420	2440	2651
Available Current Ranges	±1A, ±100mA, ±10mA, ±1mA, ±100µA, 10µA, ±1µA	±3A, ±1A, ±100mA, ±10mA, ±1mA, ±100µA, 10µA,	±5A, ±1A, ±100mA, ±10mA, ±1mA, ±100µA, 10µA,	±20A, ±10A, ±5A, ±1A, ±100mA, ±10mA, ±1mA, ±100µA, ±10µA, ±1µA, ±100nA
Max. Voltage Range (V)	±20	±60	±40	±40
Available Voltage Ranges	±20V, ±2V, ±200mV	±60v, ±20V, ±2V, ±200mV	±40V, ±10V, ±2V, ±200mV	±40V, ±20V, ±10V, ±1V, ±100mV
Max. Power (W)	20	60	50	200
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	275			
Maximum Data Acquisition	100kHz			
Maximum Cell Throughput	1,200/Hour (With optional Robotics)			
Phase (Power)	Single Phase			
Voltage (Volts)/Frequency (Hz)	115/220VAC: 50-60Hz			
Max. Power Consumption (W)	40 W (Up to 600W With Peltier Cells)			

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Advance 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, 5-60°C Standard. Other ranges optional.
- ❖ Calculation of cell series resistance according to IEC 60891 standard and ASTM E948-09 Annex A1.
- ❖ 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. 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.
- ❖ Computes solar cell parameters including I_{SC}, V_{OC}, F_F, I_{MAX}, V_{MAX}, P_{MAX}, E_{ff} , Rs and Rsh and saves them automatically on hard disk drive. In addition cell's temperature and irradiance level is measured and stored for future analysis.
- ❖ Calculate Thermal Coefficients of I_{SC} (α), V_{OC} (β) & P_M (γ).
- ❖ Ability to see relationship between different parameters, such as temperature over time, irradiance over time etc.
- ❖ 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)

Majority of the features highlighted in yellow are usually not found in competitors' software

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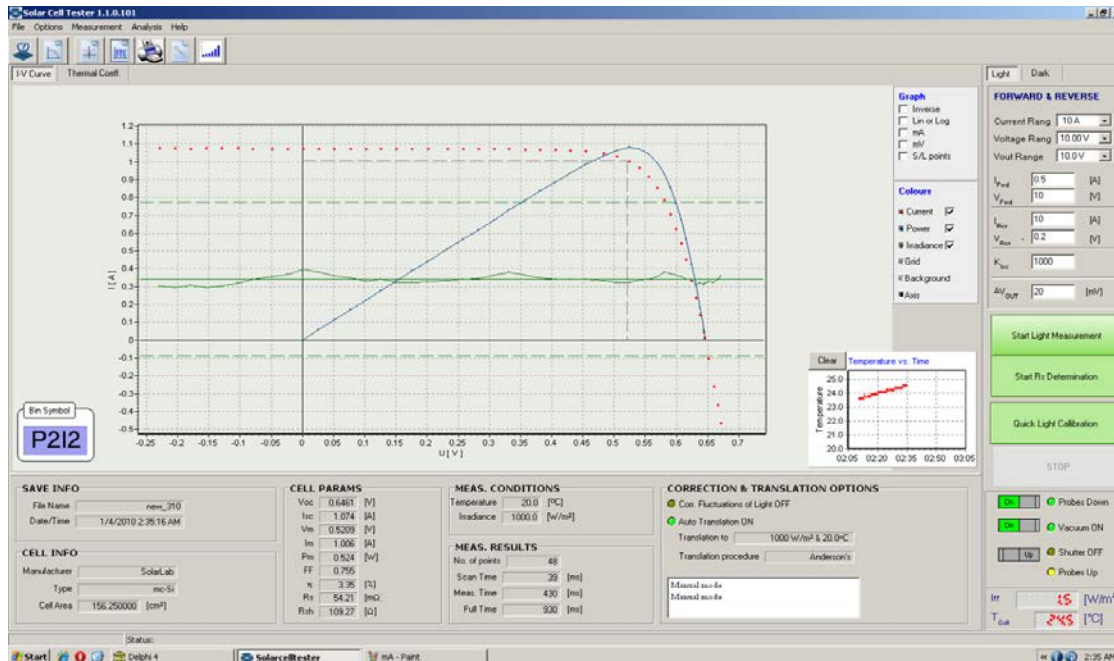
ADVANCE SOFTWARE - SCREENS

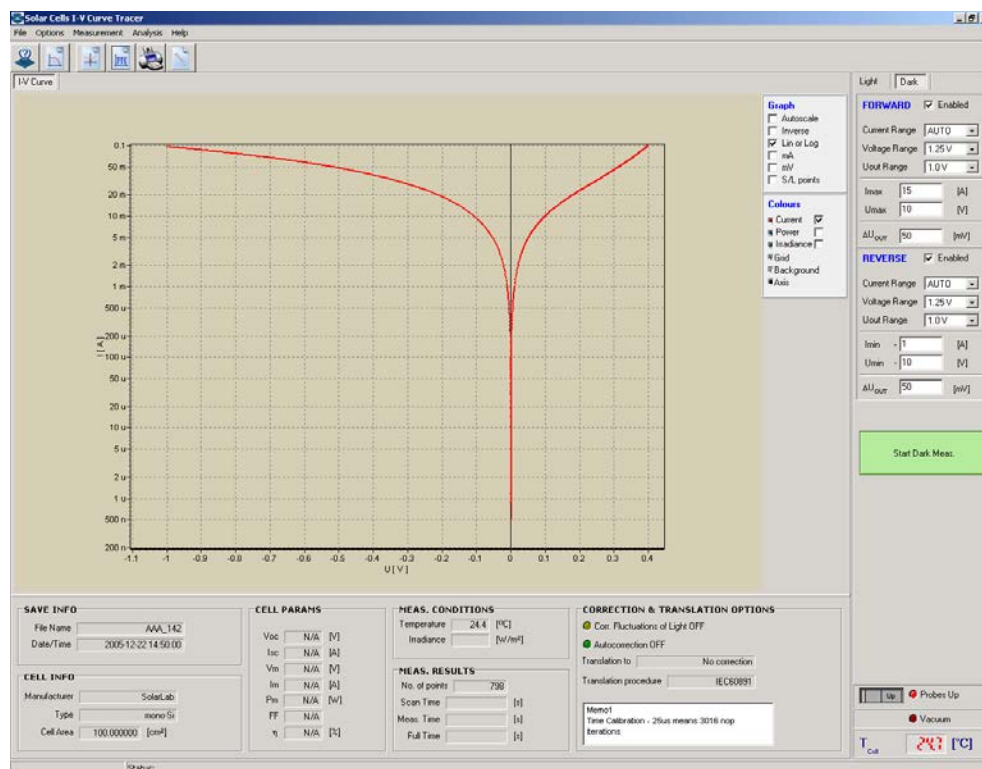Figure 7: Example of "light" measurement – Advance Software

Figure 8 : Example of "dark" measurement – Advance Software

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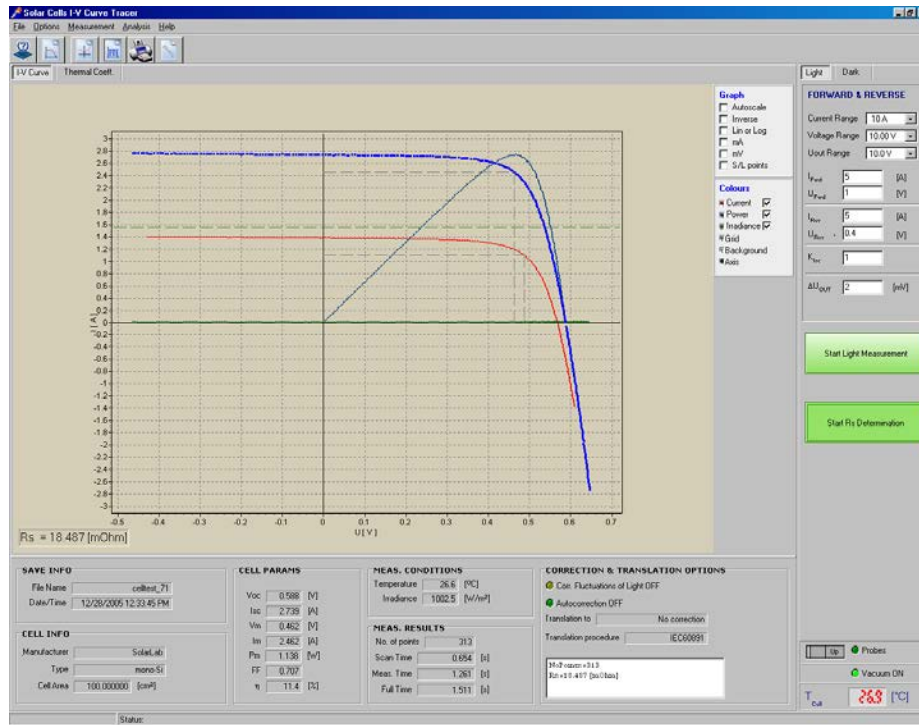**Email:** pet@photoemission.com

Figure 9: Example of cell's series resistance determination according to IEC 60891 & ASTM E948-09 Annex A1 Standard
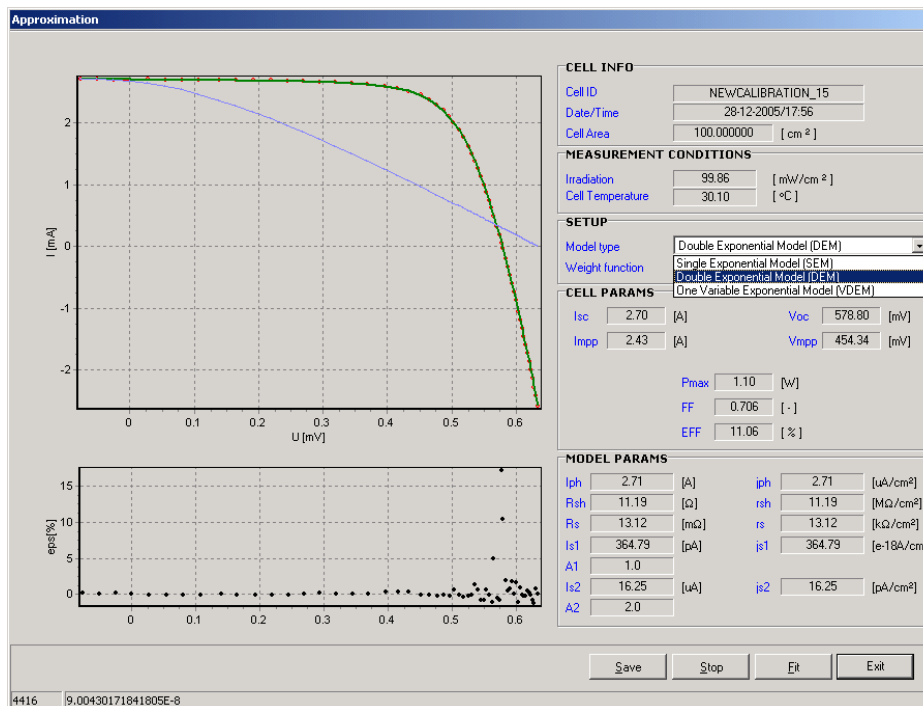

Figure 10: Example of cell's I-V curve fitting to Double Diode equivalent electrical model

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Model	CC-1	CC-3	CC-5	CC-15	CC-20
Max. Current Range (A)	±1	±3	±5	±15	±20
Available Current Ranges	±1A, ±100mA, ±10mA, ±1mA,	±3A, ±1A, ±100mA,	±5A, ±1A, ±100mA,	±15A, ±10A, ±1A, ±100mA,	±20A, ±10A, ±1A, ±100mA,
Max. Voltage Range (V)	±20	±60	±40	±10	±10
Available Voltage Ranges	±20V, ±2V, ±200mV	±60v, ±20V, ±2V, ±200mV	±60v, ±20V, ±2V, ±200mV	±10V, ±5V, ±2.5V, ±1.25V,	±10V, ±5V, ±2.5V, ±1.25V,
Max. Power (W)	20	60	50	150	200
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	100-1,000 (model specific)				
Maximum Data Acquisition Speed	100kHz		4,096		
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 60891, Anderson or Blaessar				
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				