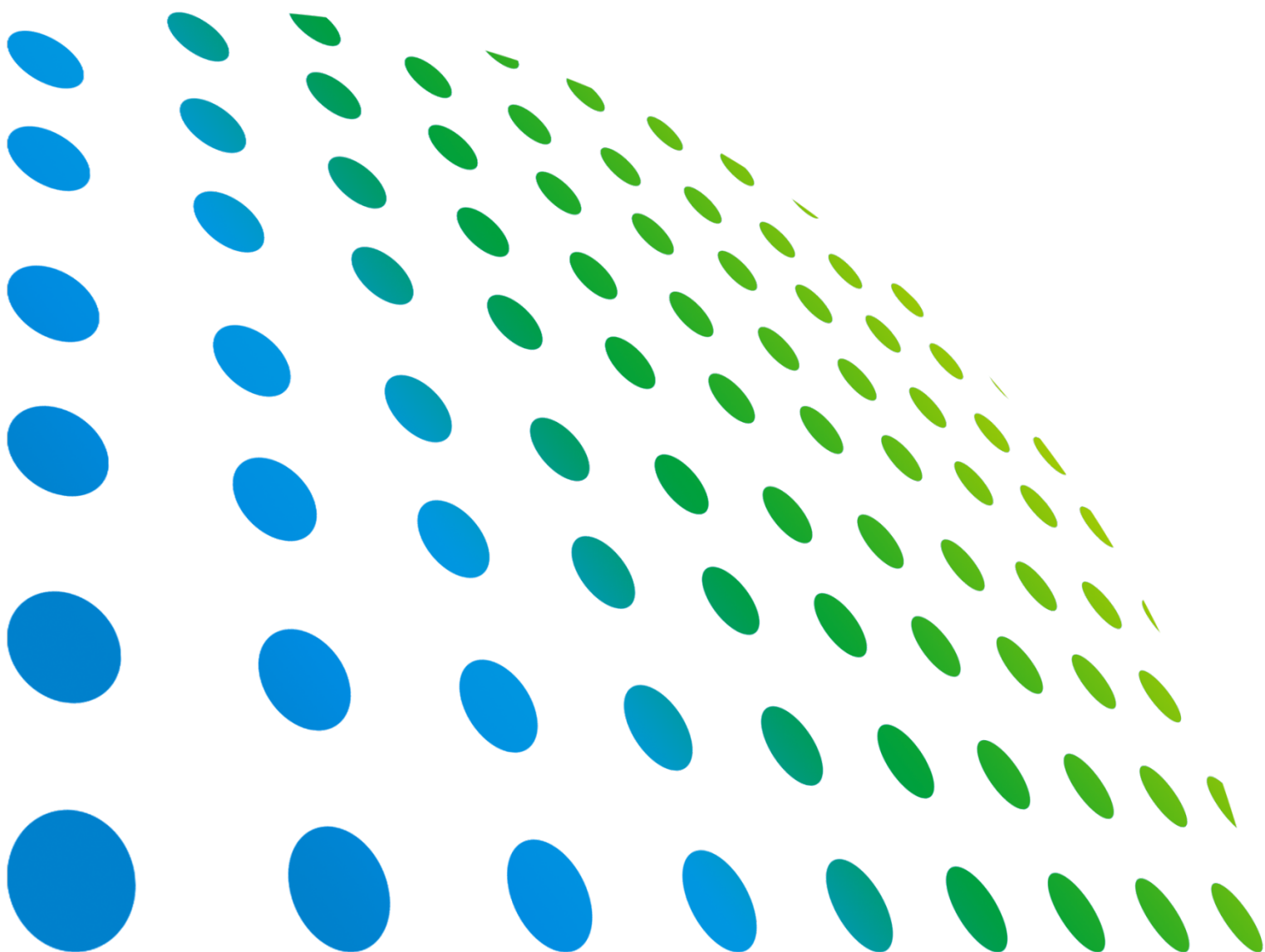




Solar Array Simulation
Soft Panel
62000H Series
User's Manual



Solar Array Simulation Soft Panel 62000H Series User's Manual



Version 1.8
April 2016

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Revision History

The following lists the additions, deletions and modifications in this manual at each revision.

Date	Version	Revised Sections
Apr. 2010	1.0	Complete this manual.
Sep. 2010	1.1	Update the contents and figures in the chapter of <i>"Main Panel."</i> Add IV/PV and Parameter two sections in the chapter of <i>"Main Panel."</i>
Jun 2011	1.2	Modify the following: <ul style="list-style-type: none"> – <i>"System Structure"</i> chapter – <i>"Curve and Reading Chart"</i>, <i>"I-V Curve Edit (SAS Modeling)"</i> and <i>"I-V File Management"</i> in the chapter of <i>"Main Panel"</i> – <i>"Recording the Set Parameter"</i> and <i>"Report Example"</i> in the chapter of <i>"Report"</i>. Add the chapter of <i>"Advanced Dynamic MPPT Test Functions"</i> .
Mar. 2012	1.3	Modify the description of following chapters: <ul style="list-style-type: none"> – <i>"Installing the Soft Panel"</i>. – <i>"Main Panel"</i> – <i>"Report"</i> Add the following: <ul style="list-style-type: none"> – <i>"Disclaimer and Intellectual Property Rights Statements"</i> – <i>"Auto Run"</i> chapter – <i>"Real World Weather"</i> in the chapter of <i>"Advanced Dynamic MPPT Test Functions"</i> – <i>"Regulations for Parameter and I-V Curve Mathematical Models"</i> chapter
Jun. 2012	1.4	Modify the following: <ul style="list-style-type: none"> – Screens and parameters description of Sandia and EN50530 in the chapter of <i>"Main Panel"</i> – Screens and parameters of User Define page in the chapter of <i>"Advanced Dynamic MPPT Test Functions"</i>
Mar. 2013	1.5	Modify the following: <ul style="list-style-type: none"> – Description of introduction in the chapter of <i>"System Structure"</i> – Figure of Advance Setting in the chapter of <i>"Main Panel"</i> – Figure of Auto Run and its description in the chapter of <i>"Auto Run"</i>
Oct. 2013	1.6	Modify the following: <ul style="list-style-type: none"> – <i>"Introduction"</i>, <i>"Supported Hardware"</i> and <i>"Software and Hardware Requirements"</i> in the chapter of <i>"System Structure"</i> – <i>"Installation Procedure"</i> in the chapter of <i>"Installing the Soft Panel"</i> – <i>"Startup"</i> in the chapter of <i>"Starting Up Solar Array Simulation Soft Panel"</i> – <i>"Function Bar"</i> and <i>"Back"</i> in the chapter of <i>"Main Panel"</i> – <i>"Auto Run"</i> chapter Add the following: <ul style="list-style-type: none"> – <i>"Setting Channel Active and Sync. Trigger"</i> section in the chapter of <i>"Main Panel"</i> – <i>"Shadowed I-V Curve Simulation Panel"</i> chapter
Aug. 2014	1.7	Update the Time Interval setting in the section of <i>"Real World Weather."</i>
Apr. 2016	1.8	Modify the following sections:

- *“Introduction” and “Software and Hardware Requirements” in the chapter of “System Structure”.*
- *“Startup” in the chapter of “Starting Up Solar Array Simulation Soft Panel”.*
- *“Setting Channel Active and Sync. Trigger” and “MPPT Test” in the chapter of “Main Panel”.*
- *“MPPT Testing” in the chapter of “Advanced Dynamic MPPT Test Functions”.*
- *“Setting Shadow Moving” and “Other Measurement Parameters” in the chapter of “Shadowed I-V Curve Simulation Panel”.*

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1. System Structure

This chapter describes the Soft Panel application for Solar Array I-V Simulation and the applicable devices as well as their functions. The supported hardware and communication protocols when linked with PC are listed in this chapter for the user to check the environment required rapidly.

1.1 Introduction

This soft panel is applicable for CHROMA A620029 Control and Supervisor Unit (CSU) ^{Note 1} for DC Power Supply and CHROMA 62000H Series Programmable DC Power Supply with Solar Array I-V Simulation. Chroma Solar Array Soft Panel is able to control 10 devices at the same time. When using the software, the programmable DC Power Supply and PC must be connected remotely for commands transmission.

The soft panel is able to do the settings of hardware's internal parameters, also can monitor the output measurement. In addition the feature pre-simulation output I-V curve is also equipped for use. When the parameters are set, the screen will show the output waveform to preview the I-V curve for output before the DC Power Supply sending out the set voltage and current. The voltage will send out once the I-V curve is confirmed OK. Moreover, the software has parameter storage function so that the user can open an existing file easily from the hard disk for execution.

- Note 1**
1. This soft panel has new Shadow I-V function and is able to control multiple devices at the same time at version 1.3 or later.
 2. This soft panel supports Chroma A620029 Control and Supervisor Unit (CSU) at version 1.2 or later. However, only one CSU is supported without supporting the new Shadow I-V function.

1.2 Supported Hardware

The programmable DC Power Supply of Chroma 62000H Series includes the following model numbers:

- Model 62020H-150S Programmable DC Power Supply with Solar Array I-V Simulation
- Model 62050H -600S Programmable DC Power Supply with Solar Array I-V Simulation
- Model 62100H-600S Programmable DC Power Supply with Solar Array I-V Simulation
- Model 62150H-600S Programmable DC Power Supply with Solar Array I-V Simulation
- Model 62150H-1000S Programmable DC Power Supply with Solar Array I-V Simulation
- Model A620029 Control and Supervisor Unit (CSU), (only one is supported)

Supported firmware version:

- Version 2.1 or later for 62000H Series DC Power Supply (Shadow Test function is supported after this version.)
- Version 1.0 or later for Model A620029 Control and Supervisor Unit (CSU).

1.3 Communication Interface

There are 4 types of communication interfaces between the PC and DC Power Supply:

- GPIB
- RS232 (applicable for controlling one DC Power Supply only)
- USB
- LAN

1.4 Software and Hardware Requirements

The execution program of Soft Panel is quite large; therefore, the following PC software and hardware environments are suggested.

- Intel CPU 3.2GHz dual-core or above
- Windows XP/Vista/7/8 Operating System
- NI VISA driver
- Suggested hard disk with 2GB storage or above remaining.
- 4GB or above memory available at least when 6 or less DC Power Supplies are in control. When controlling more than 6 DC Power Supplies, it is suggested to use Windows 7 or above with 64Bit or higher version OS and add to 8GB computer memory to smooth the operation.
- Microsoft Office Excel 2003 to or before 2014.
- VGA or SVGA color monitor
- PS2 mouse

2. Installing the Soft Panel

First install the Chroma Solar Array Simulation Soft Panel to the hard disk on PC before using it. This chapter describes how to install the Soft Panel on Windows step by step.

- Different NI VISA driver needs to be installed for different OS, for instance Windows XP needs to install VISA RTE 3.0 or above. Please go to <http://www.ni.com/support/zht/> website to download the mapping driver.
- Ensure there is at least 1GB or above hard disk space on PC.
- Insert the Chroma Solar Array Simulation Soft Panel CD into the CD drive.

2.1 Files in CD

The CD contains the files shown in Figure 2-1.

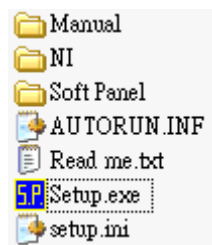


Figure 2-1 Files in the CD

2.2 Installation Procedure

Place the CD into the CD drive and the `Setup.exe` file will run automatically. An installation menu will prompt as Figure 2-2 shows.

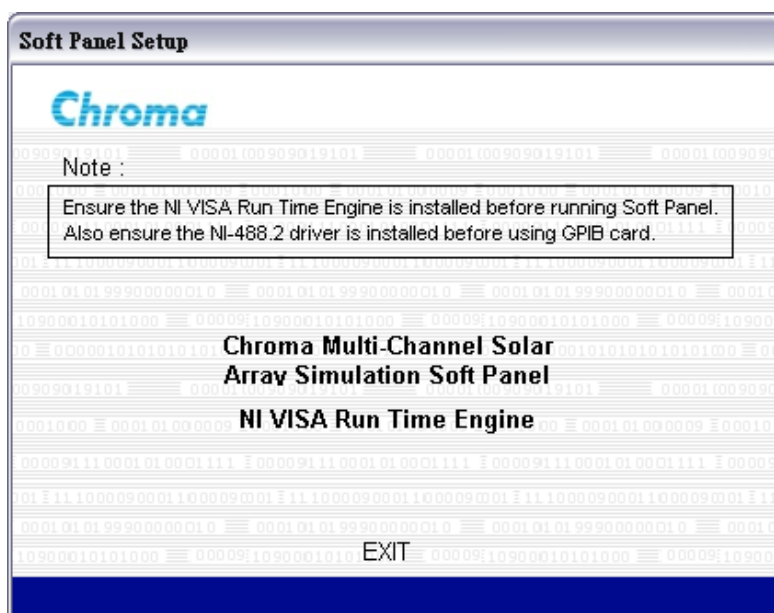


Figure 2-2 Soft Panel Installation Menu

Double click **Chroma Multi-Channel Solar Array Simulation Soft Panel** will prompt the following to start installing the program.

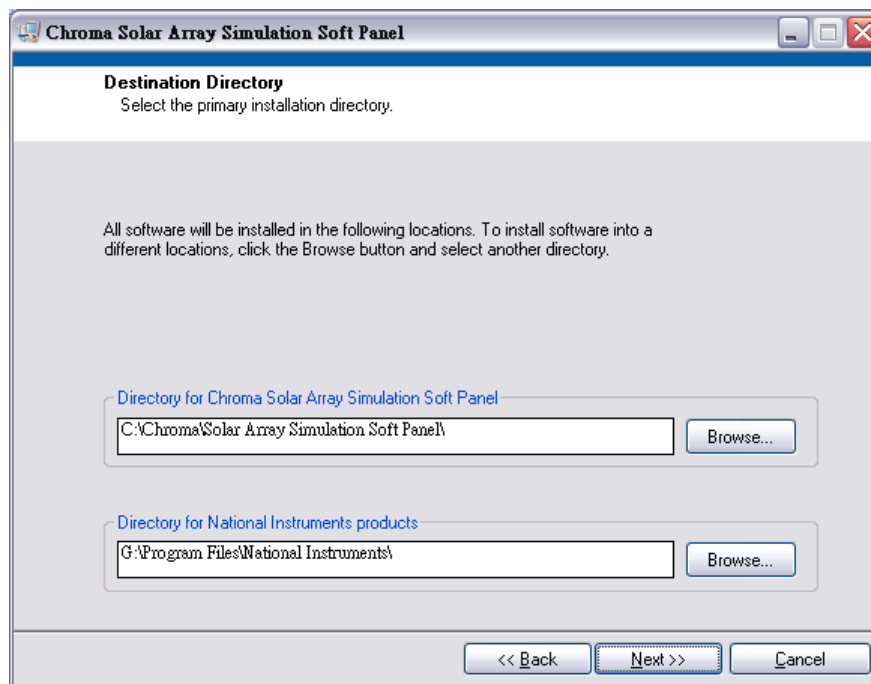


Figure 2-3 Installing Solar Array Simulation Soft Panel

Follow the message prompted to proceed with the installation by clicking **Next**.

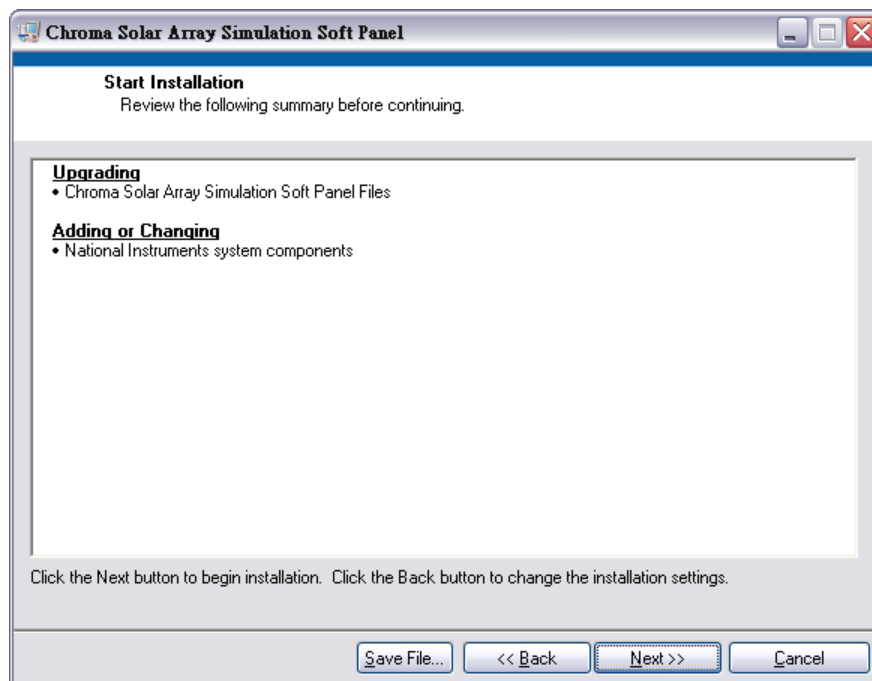


Figure 2-4 Upgrading Message

When the installation procedure is done after waited a period of time, a window as Figure 2-5 shows will prompt. Click **Finish** to end the installation.



Figure 2-5 Installation Complete

2.2.1 Installing Required NI VISA Driver

The NI directory in the Soft Panel CD has NI VISA Run Time Engine 3.0 and 4.1 version (default for installation). These two versions have been tested by Chroma as applicable for use; however, the user can still follow the OS to install the applicable VISA version for use. For other associated information, please refer to <http://www.ni.com/support/zht/> website.

Ignore this section if NI VISA Run Time Engine driver has been installed before.

1. Install the NI VISA 4.1 version driver by double-clicking the **NI VISA Run Time Engine** appeared in Figure 2-2. When the program is initialized, it enters into the installation window as Figure 2-6 shows.

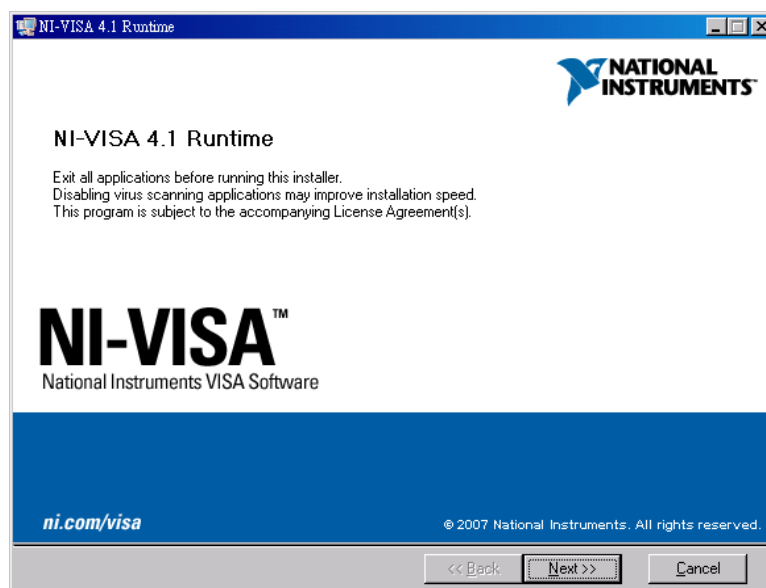


Figure 2-6 Installing NI VISA 4.1 Version Driver

2. It is suggested to end other executing applications before clicking **Next** to start installation. The next step asks the user to determine the installation path as Figure 2-7 shows.

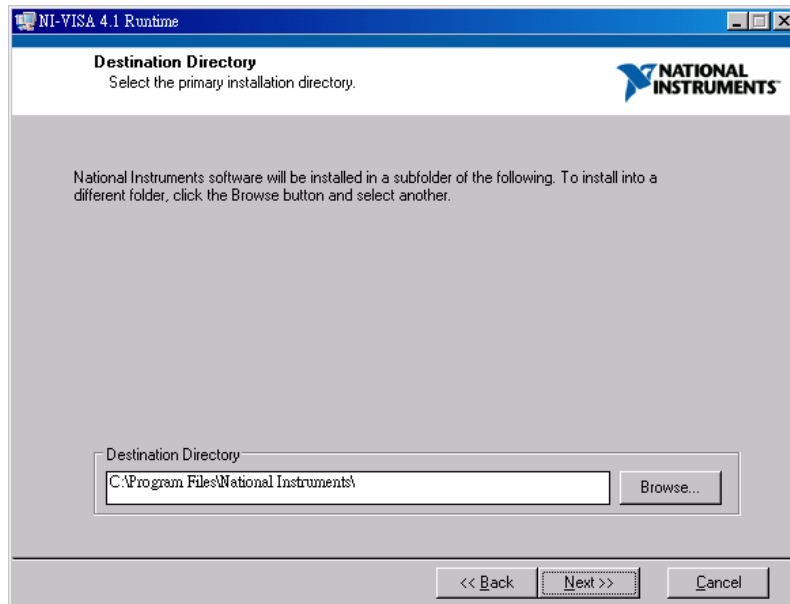


Figure 2-7 Determining the Installation Path

3. Click **Next** following the installation prompt message to complete the installation procedure. A complete window will prompt as Figure 2-8 when the installation is done.

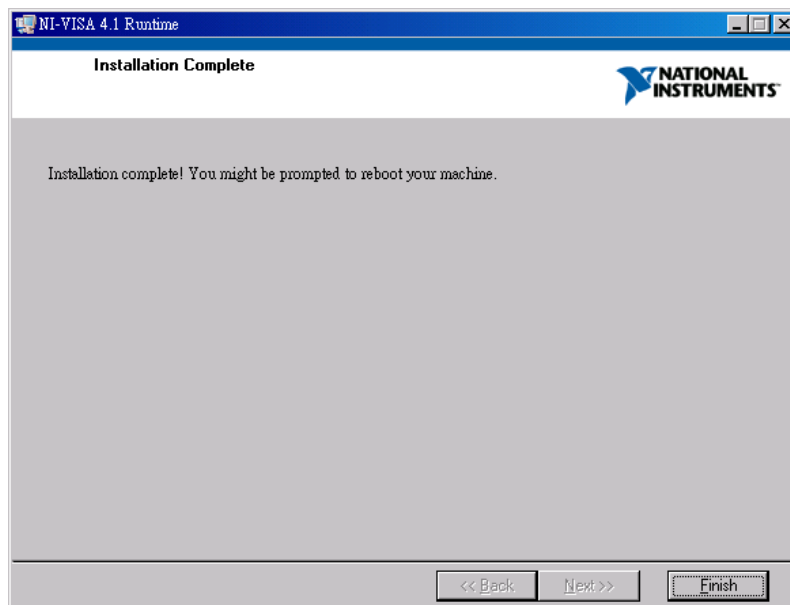


Figure 2-8 Installation Complete Window

4. For the OS upgraded in the future, the NI VISA supports it should also be installed. Please refer to <http://www.ni.com/support/zht/> website for new version download.

2.3 Installing GPIB Interface

Follow the procedures described in the GPIB Installation Manual to install the GPIB interface.

2.4 Uninstalling Solar Array Simulation Soft Panel

To remove the **Solar Array Simulation Soft Panel** from PC, it is suggested to click **[Start]** → **[Settings]** → **[Control Panel]** and use **[Add/Remove Programs]** to uninstall the software related items.

3. Starting Up Solar Array Simulation Soft Panel

3.1 Startup

Once the installation is done, click **[Start]→[Program]→[Chroma Solar Array Simulation Soft Panel]** and the startup screen will appear as Figure 3-1.

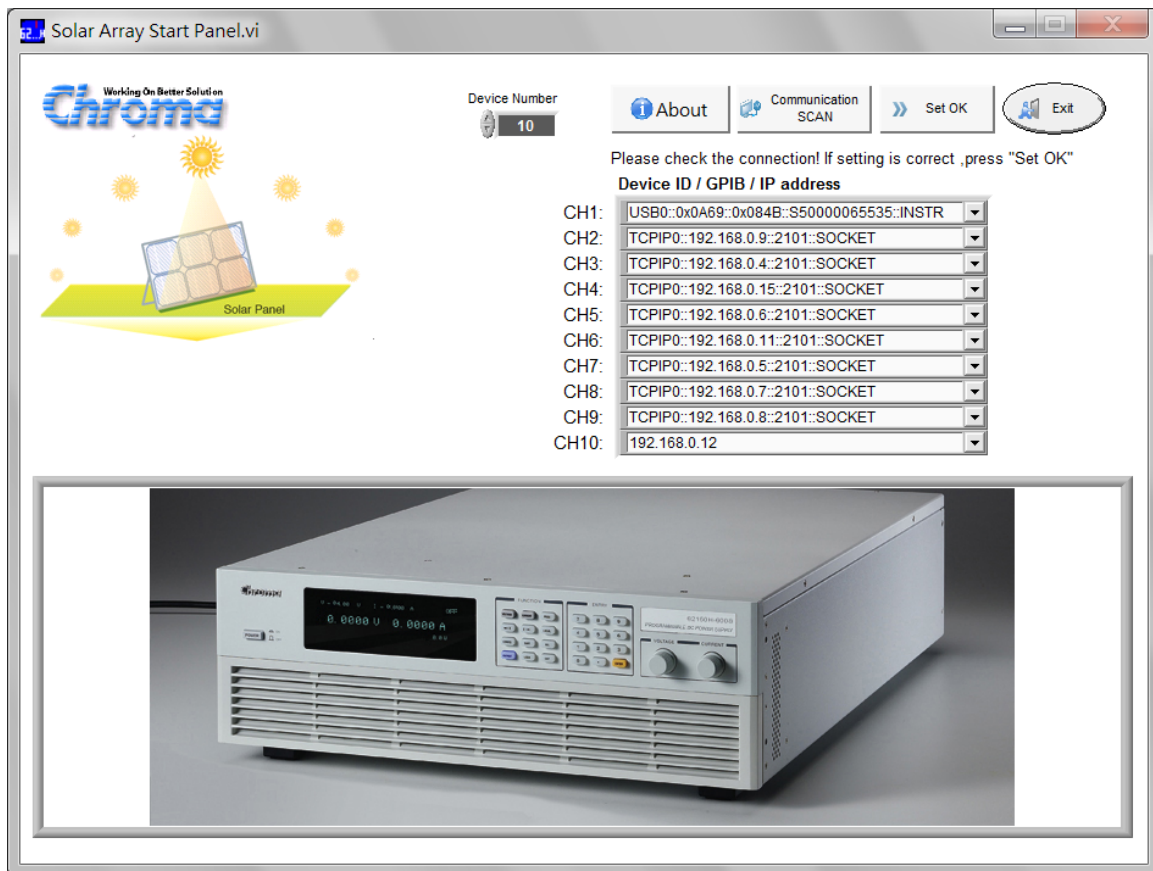


Figure 3-1 Startup Screen

Description: The startup screen is composed of 2 modules - a. Communication Selection and b. Product Presentation.

- a. Communication Selection: It sets the communication protocol of PC and the 62000H Series DC Power Supply. Chroma Solar Array Simulation Soft Panel has GPIB, RS232, LAN and USB for communication protocol selection. The PC site must have a GPIB card when using it as the communication protocol.

When GPIB is selected, the GPIB Address should be set same as the one on the 62000H DC Series Power Supply. When RS232 is selected, it needs to set the COM Port, Baud rate and Parity the same as the one on the device. When USB is selected, it needs to set the Produce ID and Vendor ID. When LAN is selected, it needs to set the TCP/IP on PC which includes IP address, subnet mask as well as default gateway to be the same as the one on the device, or to use auto detection. When the communication protocol is

confirmed ok, click **Set OK** on the soft panel will enter into the next screen for relative position check.

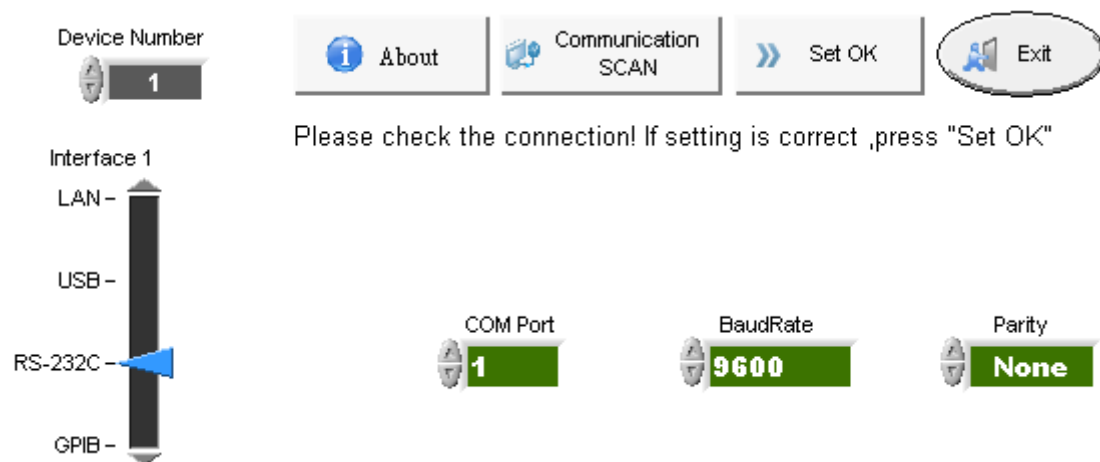
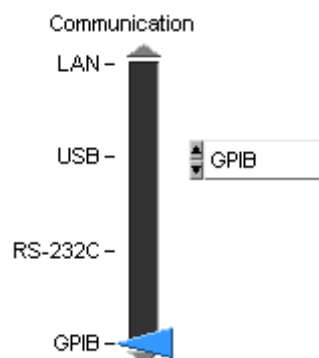


Figure 3-2 Communication Selection

Communication:

It sets the communication currently in use. The selections available are GPIB, RS232 (for one DC Power Supply control only), LAN and USB. If GPIB is set, the PC site must have a GPIB Card. It is suggested to use the GPIB card of NI or AD Link. If RS232C is used to control the device, the PC site must have a COM Port. The PIN definition of cable, please refer to the user's manual of the device or use Chroma's standard cable. The USB and LAN cables are standard except for definition. Different communication maps to different setting parameters. The GPIB Address needs to be set when GPIB is selected and the COM Port, Baud Rate and Parity need to be set when RS232C is selected. When USB is selected, the Produce ID and Vendor ID will show in a drop-down menu and click Communication Scan can scan the USB Device for use. When LAN is selected, the IP Address must be set.



RS232C Pin definition: "N.C." indicates "No Connection".

Pin No.	IBM PC	62000H
1	DCD	"N.C."
2	RX	RX
3	TX	TX
4	DTR	"N.C."
5	GND	DGND
6	DSR	"N.C."
7	RTS	"N.C."
8	CTS	"N.C."
9	"N.C."	"N.C."

Set OK:

Once the settings are done, check if the cables are well connected. When ready, click this button to check if the communication is successful. If yes, a screen with the FW version will prompt, or it will show Connection Error when fail.

» Set OK

- b. Product Presentation: It shows the appearance of the device.



Figure 3-3 Product Presentation

Communication SCAN:

Since the USB, GPIB and LAN interfaces can be mixed for use, the soft panel will detect the communication protocol that is linked successfully when clicked. The sequence is LAN, GPIB and then USB. If none of them is detected, it will stop at RS232 that is the default set by software. The users can set the Communication interface by themselves. However, it is suggested to click this button to scan for the USB interface as the ID is too long and may be entered mistakenly if USB is in use.



USB:

If USB is selected, a mapping drop-down menu will appear. Be sure to select the correct Produce ID and Vendor ID as shown below if many USB devices are connected.

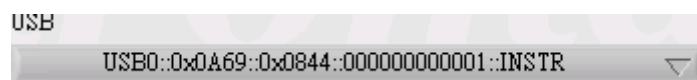


Figure 3-4 USB Produce ID Vendor ID Selection

LAN:

If LAN is selected, it will appear a mapping IP address. If manual setting is selected, it needs to input the IP address, other subnet masks, default gateway mapping to the 62000H Series DC Power Supply.

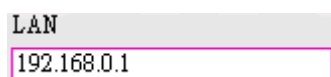


Figure 3-5 Setting LAN Address

Enter the TCP/IP settings of LAN:

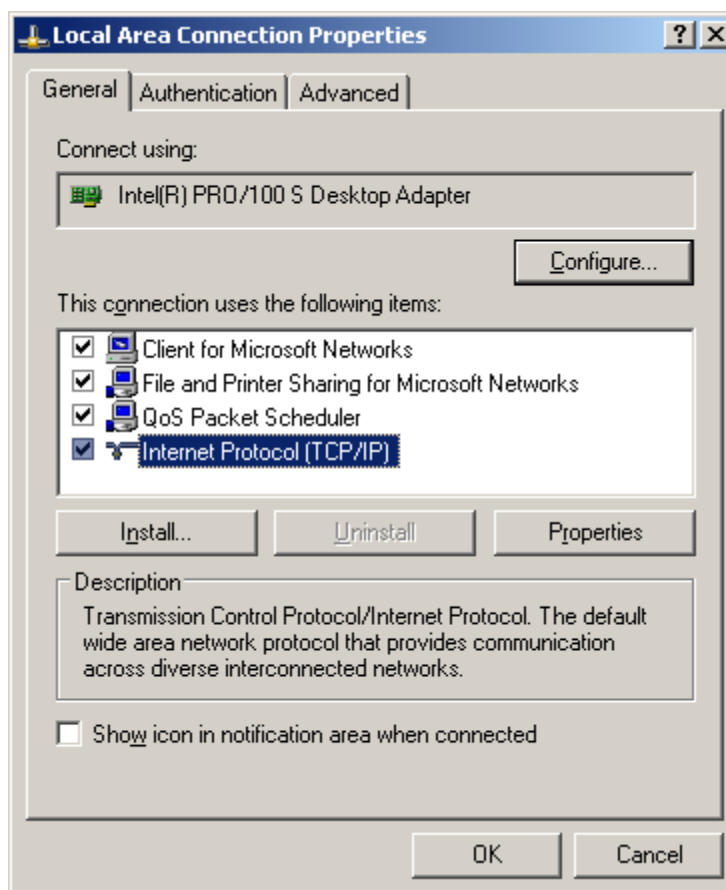


Figure 3-6 Setting Internet Protocol (TCP/IP) on PC

Set the correct IP address on PC:

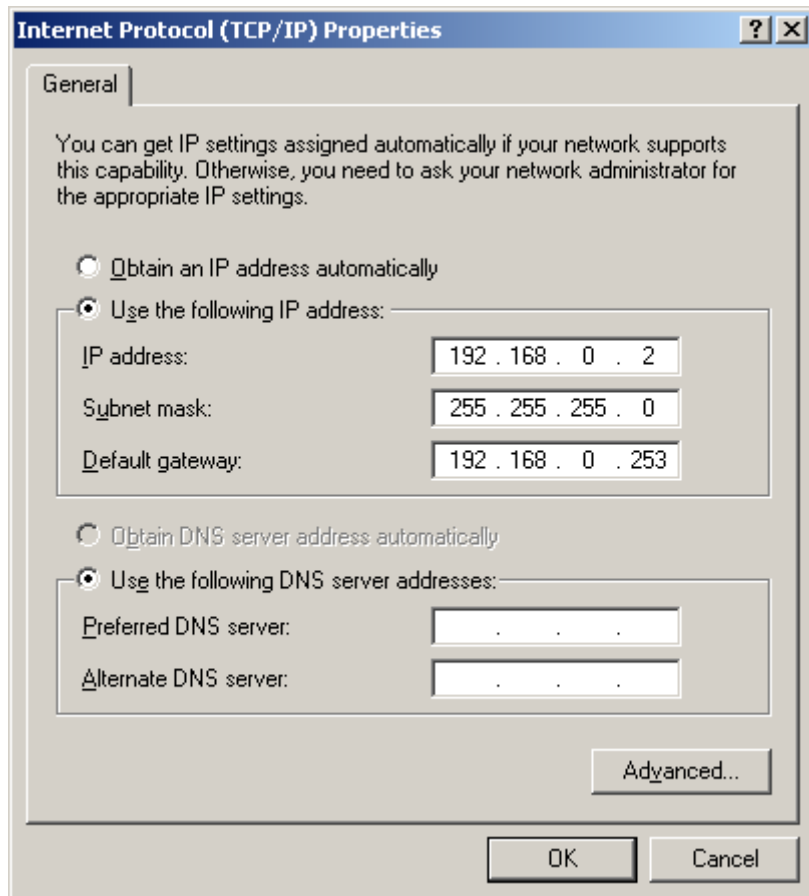


Figure 3-7 Setting Internet Protocol (TCP/IP PC) Parameters



: Click this button to exit the program.

4. Main Panel

Assuming two DC Power Supplies are selected, it will enter into the main panel as Figure 4-1 shows when the communication protocol is set.

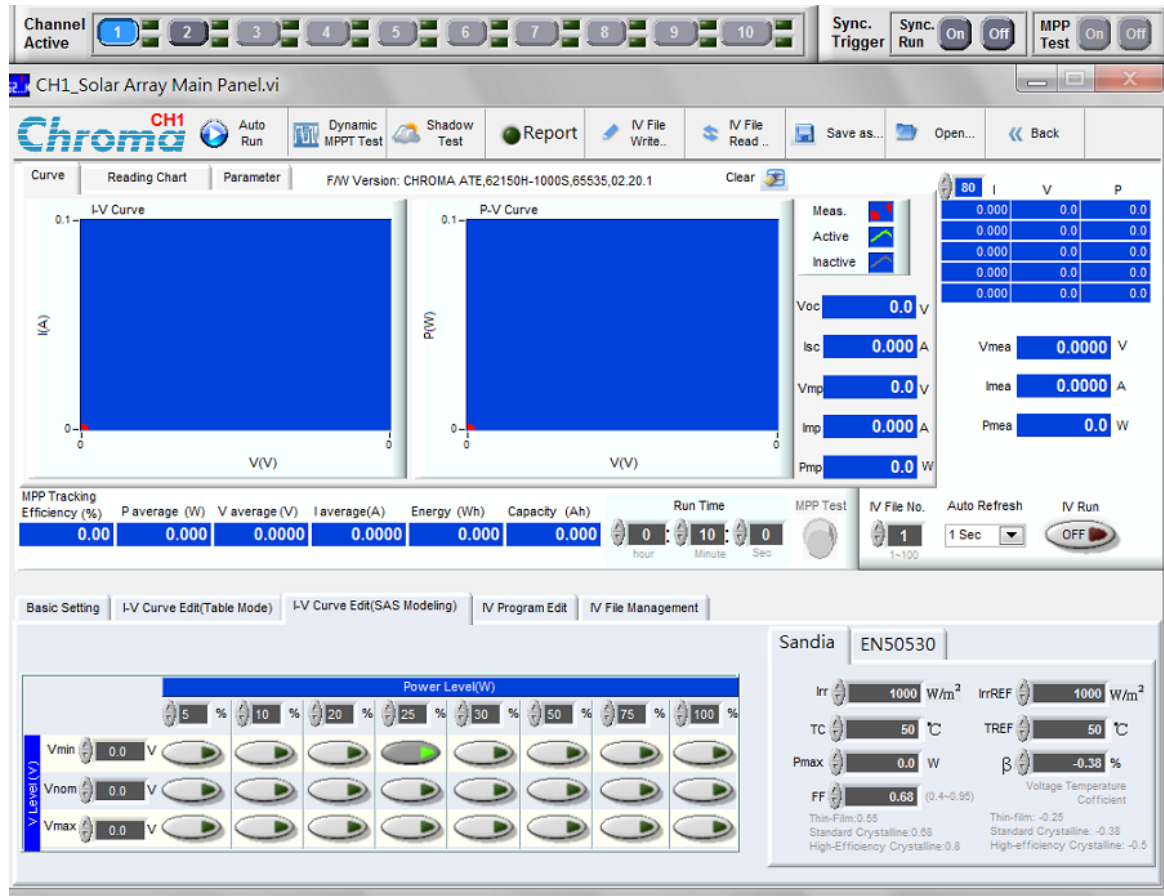


Figure 4-1 Main Panel and Channel Active Selection

Be sure the 62000H Series DC Power Supply is connected when entering the main panel. If the hardware is connected, the Firmware Version will appear as shown below.

F/W Version: CHROMA ATE,62150H-1000S,00072,02.00 BETA xx

If the hardware is not connected, it will show Connection Error as shown below.

Communication: Connection Error!

When **CH1** appears on the main panel above the Chroma logo, it indicates it is Channel 1 on the test screen. The channel is selected by the Channel Active block while sync output is set by the Sync. Trigger block on the top.

There are three blocks in the main panel: function bar, simulation and reading display area and control area for condition settings.

Simulation display area includes: I -V Curve, P- V Curve simulation diagram and reading display elements.

Control area includes: Basic Setting, I-V Curve Editor (Table Mode), I-V Curve Edit (SAS Modeling), I-V Program Edit and I-V File Management function.

The following sections explain the functions and their operations.

4.1 Setting Channel Active and Sync. Trigger

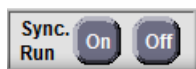


Figure 4-2 Channel Active and Sync. Trigger

This panel is fixed on the top of the screen showing the status of Channel IV Run (in red) and MPP Test Run (in green) as described below.



: It sets the channel number (1~10) to be displayed on the screen. The CH pattern with blue background indicates it is in displaying state while grayscale means not in displaying state. If it blinks in red and yellow, it means a warning is occurred to this channel and a message window will prompt to warn the user. Each channel has two lights on the right side and when the red light on the top is ON, it means the IV Run channel is running. When the green light at the bottom is ON, it means the MPP Test is running.



: These buttons set the IV Run (I-V curve output) status of all channels to On or Off. It can be programmed with channel to set for dynamic and shadow testing in order to run synchronously.



: These buttons set the MPP Test (Maximum Power Point) status of all channels to On or Off. If the above IV Run is not enabled, this button will turn to grayscale automatically that cannot be activated for the MPP Test.

4.2 Function Bar

The function bar contains Auto Run, Dynamic MPPT Test, Shadow Test, I-V File Write, I-V File Read, Save as..., Open, Back and Report. The detail descriptions of Auto Run, Dynamic MPPT Test and Shadow Test functions are described in Chapter 6, 7 and 9.

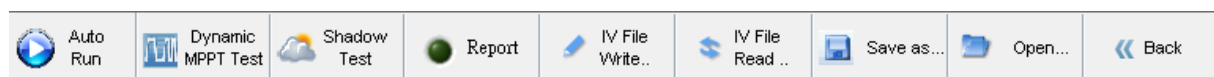


Figure 4-3 Chroma Solar Array Main Panel Function Bar

4.2.1 I-V File Write

The main function of this button is to send the I-V curve data to the memory of 62000H Series DC Power Supply that can substitute the data inputted manually. Before clicking the button, it needs to specify the I-V File No. to be written. The valid index range is 1-100.

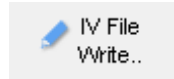


Figure 4-4 IV File Write to the DC Power Supply

4.2.2 I-V File Read

The main purpose of this button is to read the set parameters stored in the I-V File of DC Power Supply memory to check if the settings are correct in I-V curve display area. Before clicking the button, it needs to specify the I-V File No. to be read. The valid index range is 1-100.

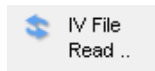


Figure 4-5 IV File Read from the DC Power Supply

4.2.3 Report

Click the button will enter into the Report editing window. See next chapter for detail description. The light at the left indicates if the Report starts recording. On means the recording has begun.



Figure 4-6 Report Button

4.2.4 Back

Click this button will return to the previous page, the Startup window. Click this button when there is a need to reconnect. This button will be disabled if there is channel still in voltage output state.



Figure 4-7 Back Button

4.2.5 Save as...

Click this button can store all of the setting parameters to a .Solar file for later use and save the trouble of setting details. Do not store the files in the folder of "Desktop" and "My Documents". It is suggested to create an individual file for access.



Figure 4-8 Save the Current Setting Button

If the user wishes to save the parameters used in the Solar Array Soft Panel so that the parameter file can be opened for use at power on next time, click **Save as...** will open a dialog box as Figure 4-9 shows. Select the path and a filename (the extension .fixed will be appended automatically by the device in use) can save the settings. This way the user can save various settings to files with different filenames. The files may take some of the disk space. Multiple setting files can be stored If the disk space is big enough. No file will be saved if Cancel is clicked.

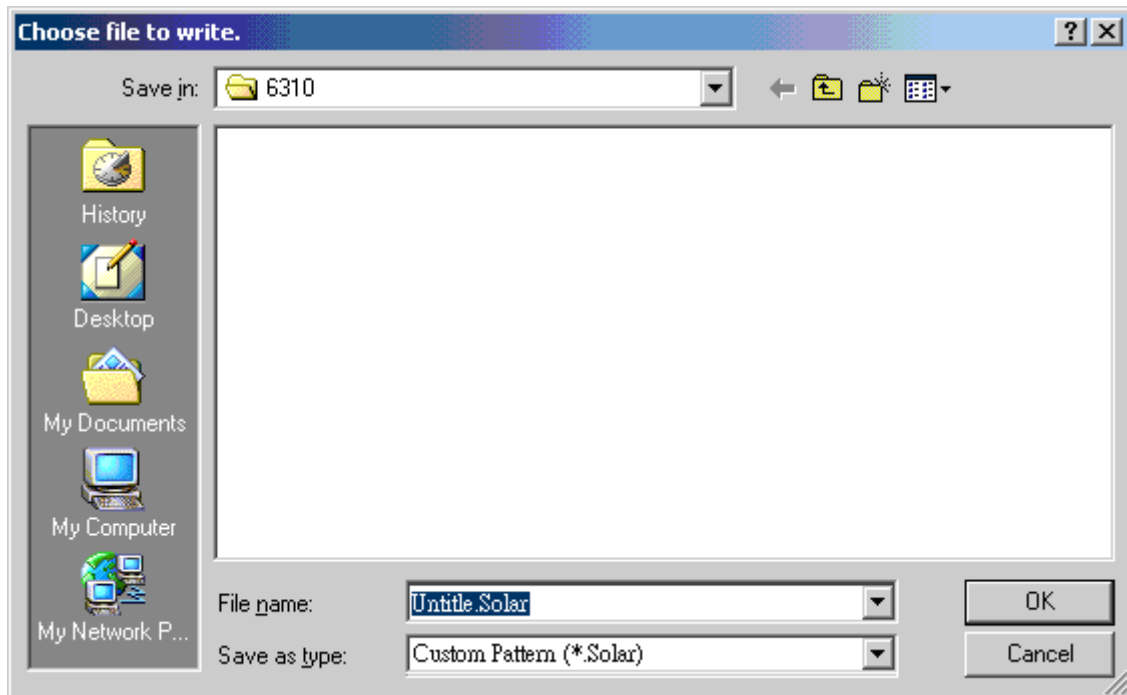


Figure 4-9 **Save as...** Dialog Box

4.2.6 OPEN

Click the button as Figure 4-10 shows can open an existing .Solar file in the hard disk and simplify the parameter input to avoid mistake from occurring. No file will be loaded if Cancel is clicked.



Figure 4-10 Button to Open Solar Array Soft Panel

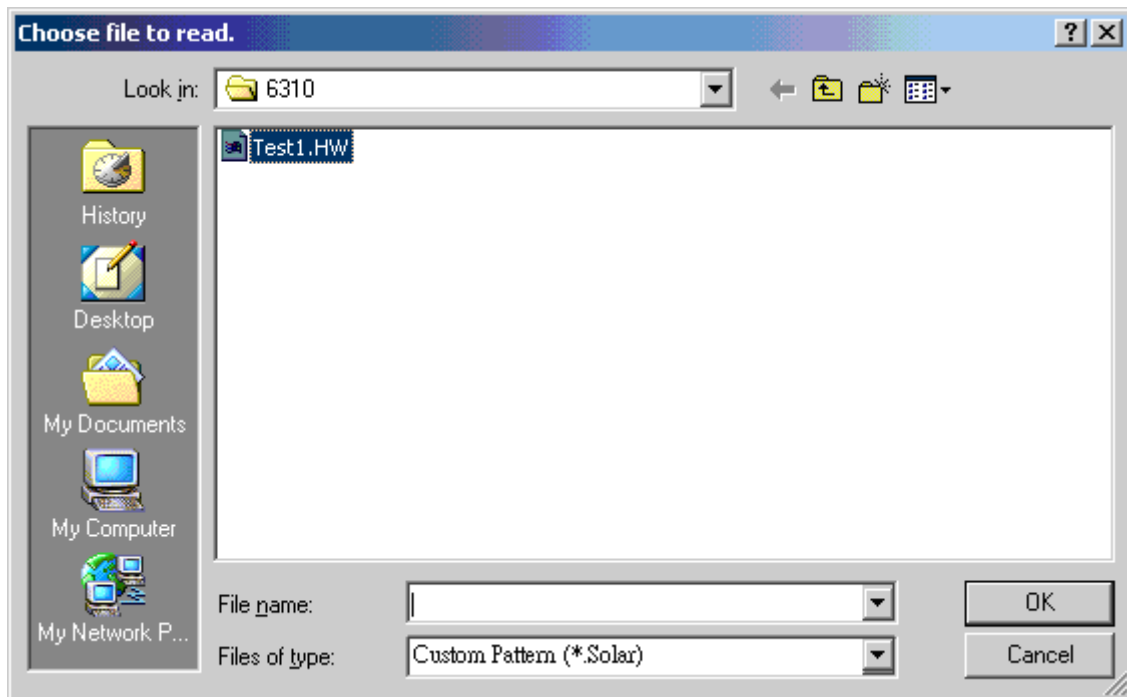


Figure 4-11 Open Dialog Box

4.3 Basic Function

The function of this tab is to set the basic DC voltage output in CV&CC output mode instead of I-V Curve mode for Vset voltage and Iset current. It allows the user to output the basic voltage first and then check if the output is normal.

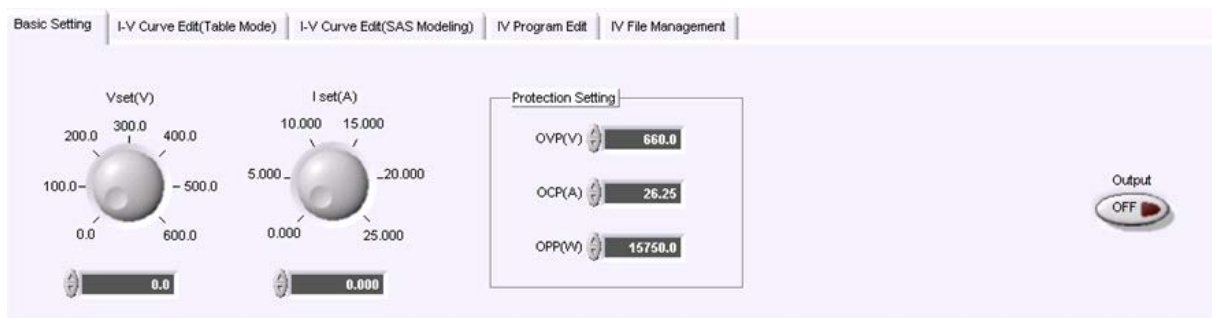


Figure 4-12 Basic Function Tab

OVP (V): It sets the level for over voltage protection. The unit is volt.


OCP (A): It sets the level for over current protection. The unit is ampere.

OPP (W): It sets the level for over power protection. The unit is watt.

4.3.1 Vset

It sets the output voltage (varied by model) in the unit of volt V.

Note

When  is clicked, it will increase or decrease the value of the last decimal once only. Click the value figure to be changed in advance and use the up/down arrow keys on the keyboard can change the value continuously.

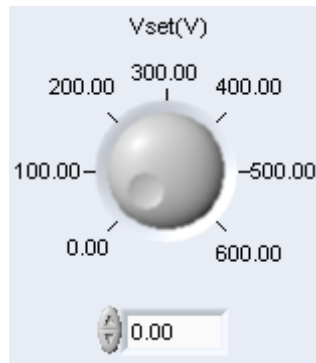


Figure 4-13 Vset

4.3.2 Iset

It sets the output current limit (varied by model) in the unit of ampere A.

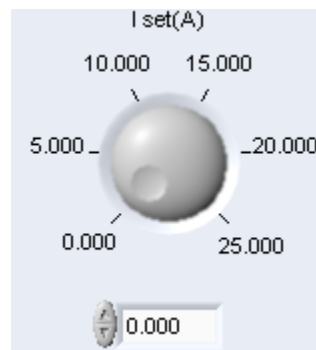


Figure 4-14 Iset

4.3.3 Output

It sets the output DC voltage of 62000H Series DC Power Supply.

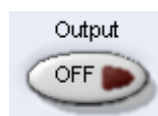


Figure 4-15 Output ON/OFF Button

4.4 I-V Curve Edit (Table Mode)

The function allows the user to create the I-V Curve data in an Excel file and import to a 62000H Series DC Power Supply which up to 100 curves can be created and stored in the memory. This function is able to edit various kinds of I-V Curves or use the Photovoltaic Modeling to create the curve.

Before using this function the PC has to be installed with the Microsoft Office Excel first for operation. The 62000H Series DC Power Supply has a built-in Table mode function that allows inputting maximum 128 points of voltage and current arrays to the memory. The user can edit any I-V in the DC Power Supply for Solar Array, Fuel Cell and battery output simulating application.

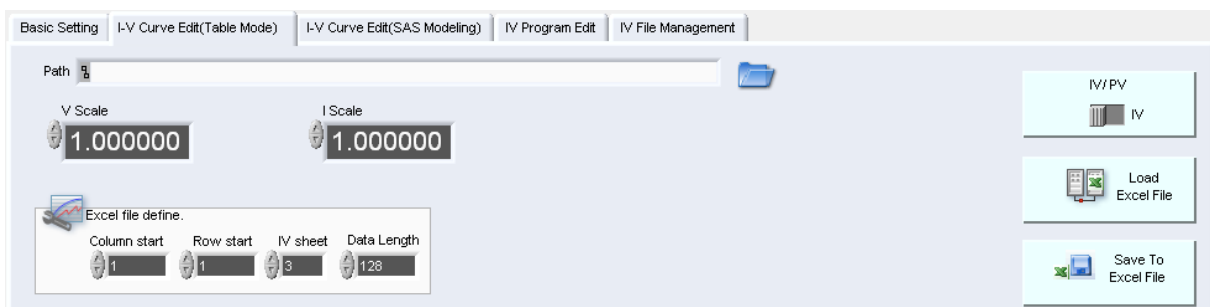


Figure 4-16 IV Curve Edit (Table Mode) Tab

4.4.1 Path

It can select an Excel file to draw the I-V Curve by clicking the open file folder at the right.

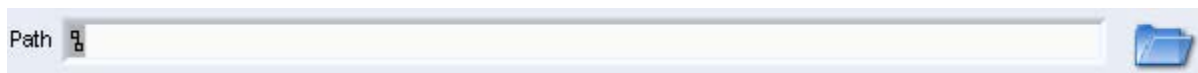


Figure 4-17 I-V Curve Edit (Table Mode) Path Selection

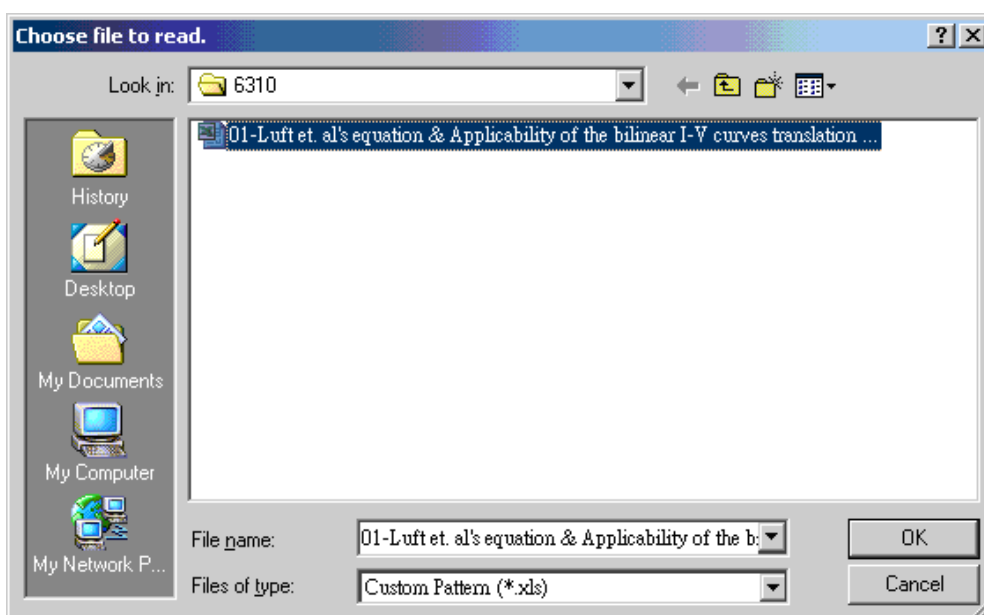
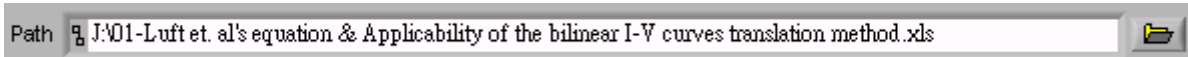


Figure 4-18 IV Curve Edit (Table Mode) Excel File Open Window

Once the file is selected, the path for opening the file will appear:



When the file is opened, the starting position and data length of Excel column will be set automatically to import the data. The user can observe the waveform via the I-V and P-V Waveform Chart or check the data through I -V Table.

Waveform Chart :

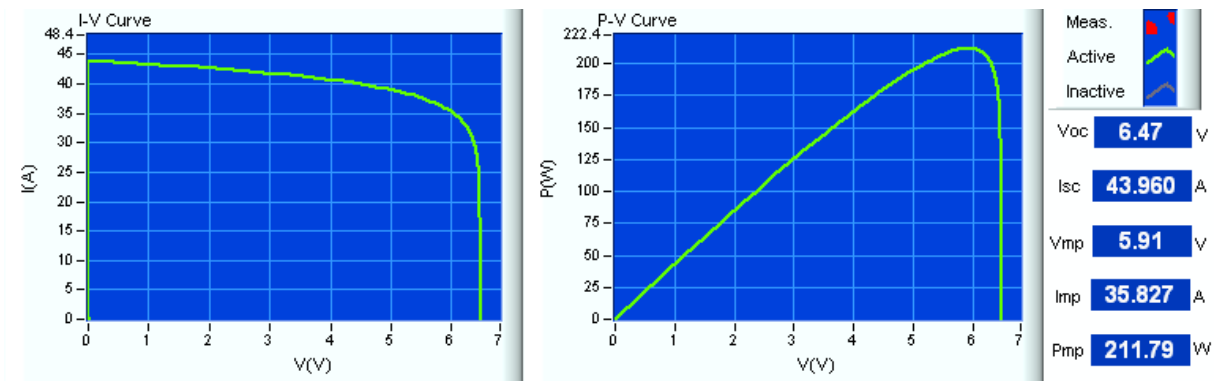


Figure 4-19 IV and PV Curve Chart

4.4.2 I-V Table

The data length can be selected by the Index at the left. The maximum data length specified at present is 128 entries.

	I	V	P
1	8.443	0	0
	8.443	7.7	65
	8.443	15.4	130
	8.443	23.1	195
	8.442	30.8	260

Figure 4-20 I-V Table

4.4.3 Load Excel File

When the file is confirmed or needs to be reloaded, click Load Excel File the program will load in the data of Excel file. Generally it is slower to open the Excel file as it will close and open again, please be patient. Do not open the Excel file before clicking this button.

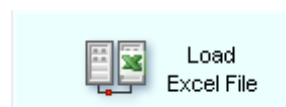


Figure 4-21 IV Curve Edit (Table Mode) Import Data

The definitions of Excel data mapping to I, V and P columns:

I-V Column Start: It maps to columns of Excel table, such as A: 0, B: 0 and only two columns (I, V) are used.

I-V Row Start: It maps to the rows of Excel table, such as 1:0, 2:1, and 3:2.

I-V Sheet: It maps to the Excel sheets, such as sheet1:0, sheet2:1, sheet3:2.

Data Length: It indicates the row count from Row Start, such as 128 which means 128 entries downward.)

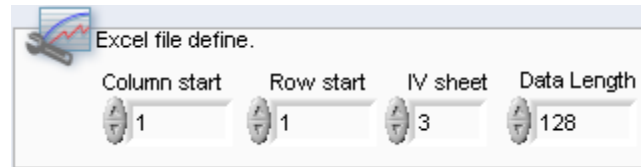


Figure 4-22 I-V Curve Edit (Table Mode) Excel Cell Conversion

4.4.4 Save To Excel File

It saves the table data at present to Excel file. The data loaded from Excel may change the settings due to Scale Rate change, and the settings will be stored in Excel file format if Save is clicked.

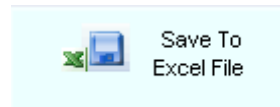


Figure 4-23 I-V Curve Edit (Table Mode) Save to Excel File

Here is the procedure:

1. Click **Save To Excel File** button.

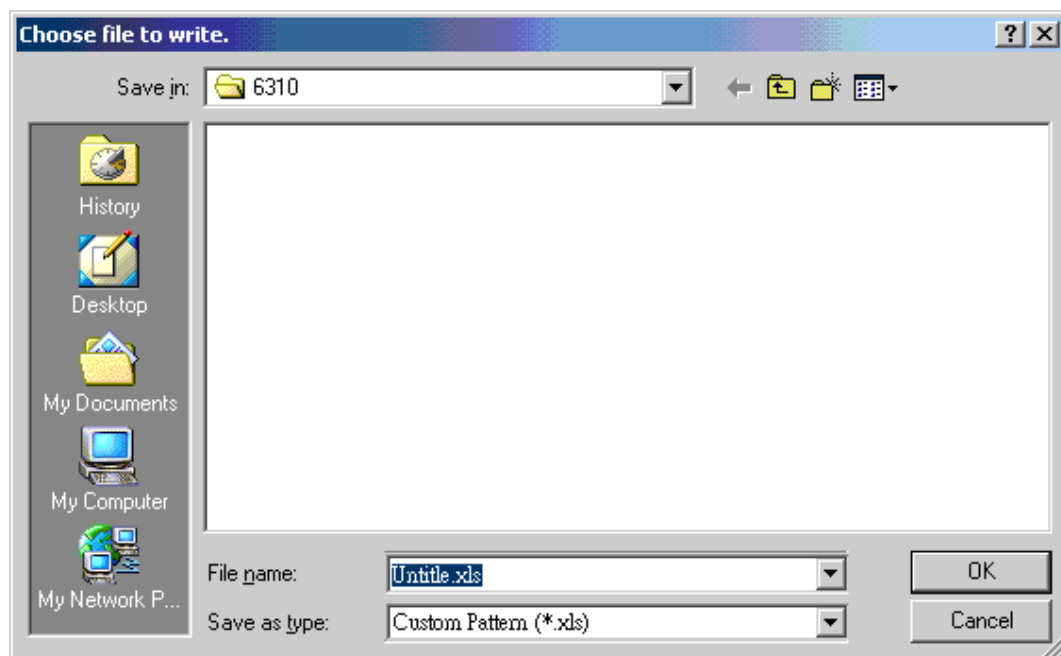


Figure 4-24 I-V Curve Edit (Table Mode) Save as Excel File Window

2. A 'Save as' window will open for the user to enter a filename (extension.xls.) If the file already exists, a message will prompt to ask if the filename will be replaced, cancelled or re-entered for new filename.

4.4.5 IV/PV

This selection maps to the column contents of Excel File. If the data is current and voltage it needs to switch to the left to show IV and if the data is power and voltage, than it should switch to right to show PV so that the loaded data will be correct.

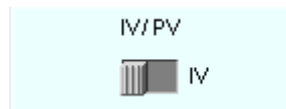


Figure 4-25 IV/PV Selection

4.4.6 V and I Scale

The purpose of these two items is to multiply the number with the imported data and put it back to the table. This function allows the user to adjust the simulation parameters of solar array irradiance and temperature change, or do serial or parallel simulation for solar cell module. This multiplicand is always directed to the data in present table. When the data is imported again, these two parameters will be set to 1. Another way to fine tune the value is to highlight the digits to be changed and press the up or down arrow key to adjust it step by step.

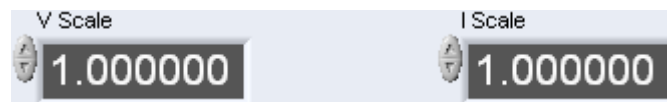


Figure 4-26 IV Curve Edit (Table Mode) V and I Scale

4.4.7 Simulation Curve

When the data is loaded its correctness not only can be confirmed in the table but also from the two Waveform Charts on the top. The two Waveform Charts are I_V Curve and P_V Curve. The X axis of the two charts is voltage while the Y axis is current and power respectively.

Illustration:

- Red dot: Once the voltage is outputted, the measurement is presented by a red dot. After retrieving the voltage and current value, the mapping value will show on the I-V & P-V Waveform Chart in red dot.
- Green line: It is the acting I-V Curve or the curve presented after altered by I Rate or P Rate that is generally called active.
- Gray line: It is the preview line of the next I-V Curve or the previous I-V Curve that is usually inactive.

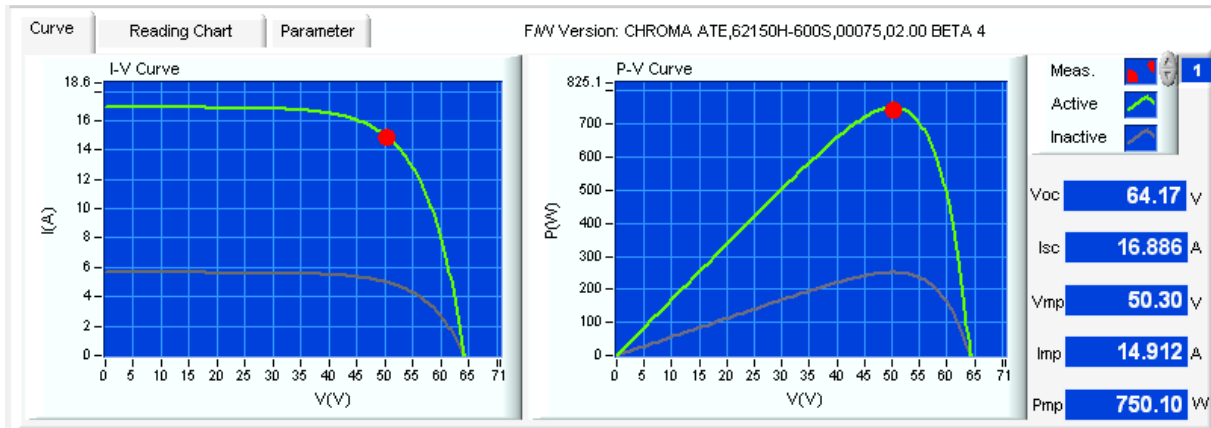


Figure 4-27 IV Curve Edit (Table Mode) Simulation Curve

Once the data is imported, the program will calculate the Voc, Isc, Vmp, Imp and Pmp. Please see the user's manual of 62000H Series DC Power Supply for the definition of Voc, Isc, Vmp, Imp and Pmp.

Voc: Open Circuit Voltage
 Isc: Short Circuit Current
 Vmp: Max. Power Voltage
 Imp: Max. Power Current
 Pmp: Max. Power

Voc **385.01** V
 Isc **3.377** A
 Vmp **300.00** V
 Imp **3.000** A
 Pmp **900.00** W

Figure 4-28 IV Curve Edit (Table Mode) Value Display

4.4.8 Curve and Reading Chart

It is I-V and P-V Curve when Curve is clicked and readings (V, I, P...) when Reading Chart is clicked. These readings will map to the V measure and I measure values displayed on the right. Select Parameter tab can set the maximum coordinate of XY axis for I-V and P-V Curve.

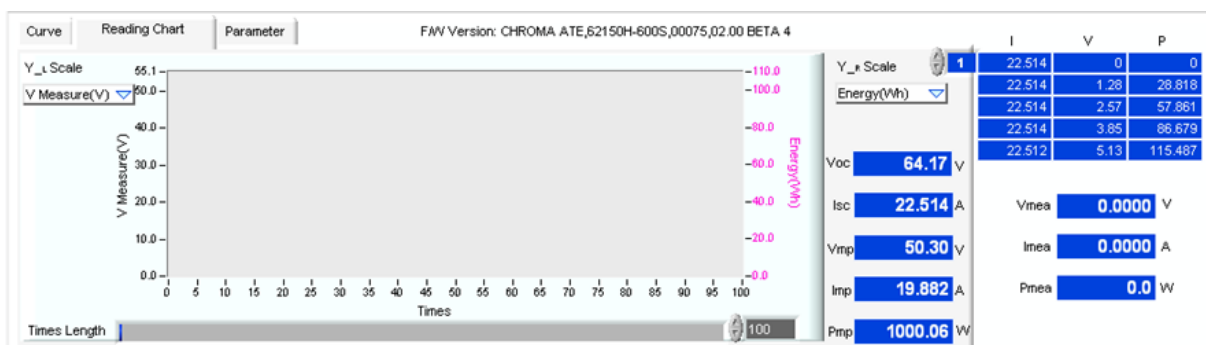


Figure 4-29 Curve and Reading Chart Switch

Time Length: It sets the time length of Reading Waveform X axis; for instance, if the setting is 100, only the 2nd entry to the 101st entry will be seen when the 101st entry of data is imported as the screen will show 100 entries only.



Y_L Scale: The left axis in the Reading Waveform shows the display types for selection. The available ranges are: V Measure, I Measure, P Measure, V Average, I Average, P_Average, Energy and MPP Tracking Efficiency.

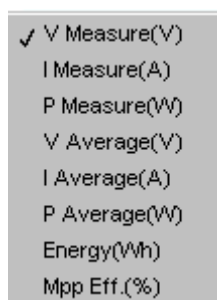


Figure 4-30 Reading Waveform Display Type Selection for the Y axis on the Left

Y_R Scale: Same as the description of Y_L Scale.

4.4.9 V, I and P Readings

When the output of 62000H Series DC Power Supply is On, the program will follow the time interval set by Auto Refresh to read back the readings for display.

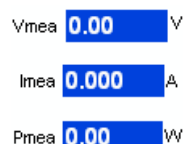


Figure 4-31 V, I and P Readings Display

If the readings deviate the mapping curve for 5 times, an alarm will appear as the figure shows below. Auto Refresh sets the time of each reading.

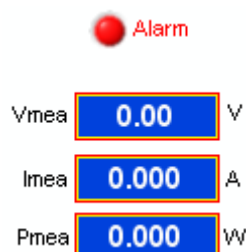


Figure 4-32 V, I, P Readings Display

4.4.10 Auto Refresh

It sets the fastest time to read back the readings. The setting range is 0.5 to 10 seconds. Please be noticed that if the time setting is unable to be divided evenly when conducting MPPT Test, the energy accumulation will vary when the time is due.

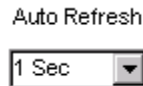


Figure 4-33 Auto Refresh

I-V File No.: This parameter sets the I-V File Number defined by the 62000H Series DC Power Supply. 100 settings are available at present. The number can be used when sending the I-V Curve to the DC Power Supply. Thus, it can set the number directly after reading an Excel File and click I-V File Write to send the Curve to DC Power Supply. The user can click I-V File Read directly and send the data stored in I-V File Number to the I-V Table in the software or use the I-V, P-V Curve waveform to check the existing waveform in the DC Power Supply's relative position.



Figure 4-34 IV File No.

I-V Run: It outputs the I-V File Number voltage specified by the user. It is better to use the I-V File Read to readback the waveform to ensure the I-V Curve and P-V Curve is not the simulated preview graph before conducting the output.



Figure 4-35 IV Run

4.5 I-V Curve Edit (SAS Modeling)

The I-V mathematical expressions suggested by Sandia National Lab and EN50530 regulation are built in to facilitate the user in editing various I-V Curves to test Static MPPT performance and converting efficiency of PV Inverter.



It would require a Power Analyzer to connect to the PV Inverter input and output for efficiency test.

The user is able to set the input parameters of I_{rr} , T_C , I_{rrref} , β , T_{ref} , P_{max} , FF , P_{mp} and V_{mp} . Along with the buttons selection table of Power Level (W) % and V Level (V) 3*7 array buttons, the mapped I-V parameters can be found rapidly and presented on I-V Curve and P-V Curve in graph. The user can check if the curve is the one to be tested and then import it (I-V File Write) to the 62000H Series DC Power Supply.



Figure 4-36 I-V Curve Edit (SAS Modeling) Tab

Operating procedure:

1. First, select the applicable Sandia or EN50530 Testing Protocol parameters tab page and then input the parameters of Irr, TC, IrrREF, β , TREF, Pmax and FF.

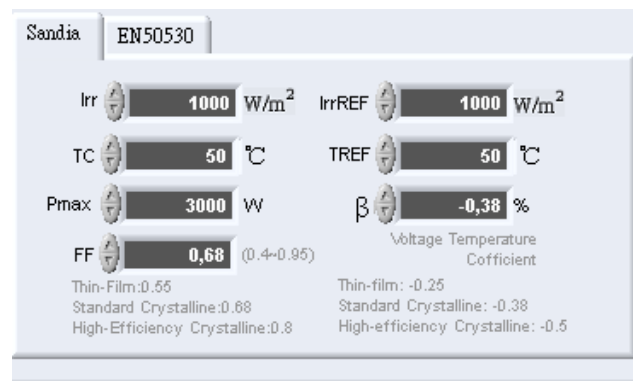


Figure 4-37 Sandia Parameters Tab Page

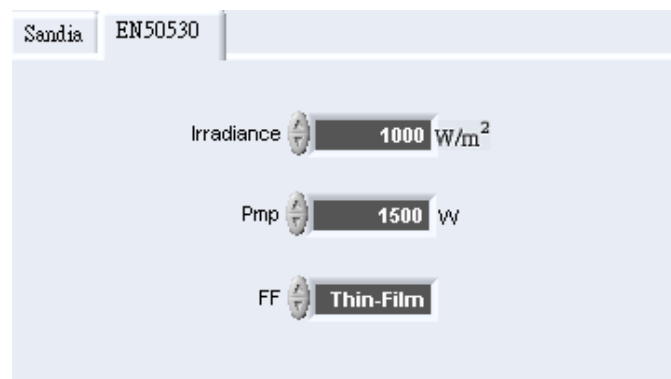


Figure 4-38 EN50530 Parameters Tab Page

Description of each parameter:

Sandia:

TREF:	Cell Temperature @ REF, setting range: -40 ~ +85.
TC:	Cell Temperature, setting range: -40 ~ +85.
Irr:	Irradiance, setting range: 0 ~ 3000.
FF:	Generator Fill Factor, setting range: 0.4 ~ 0.95.
β :	Voltage Temperature Coefficient, setting range: 0 ~ -2.
IrrREF:	Irradiance @ REF, setting range: 0 ~ 3000.
Pmax:	Max Power. Available setting range is varied with the specification of individual model.

EN50530:

Irradiance:	Luminance, setting range: 0 ~ 3000.
Pmp:	Max Power. Available setting range is varied with the specification of individual model.
FF:	c-Si and Thin-Film two factors for selection.

2. V Level contains 3*8 array buttons. The 3 rows are Vmin, Vnom and Vmax, while the 8 columns are % numbers which are 5%, 10%, 20%, 30%, 50%, 75% and 100% in default. Different parameters can be entered based on the requirements.

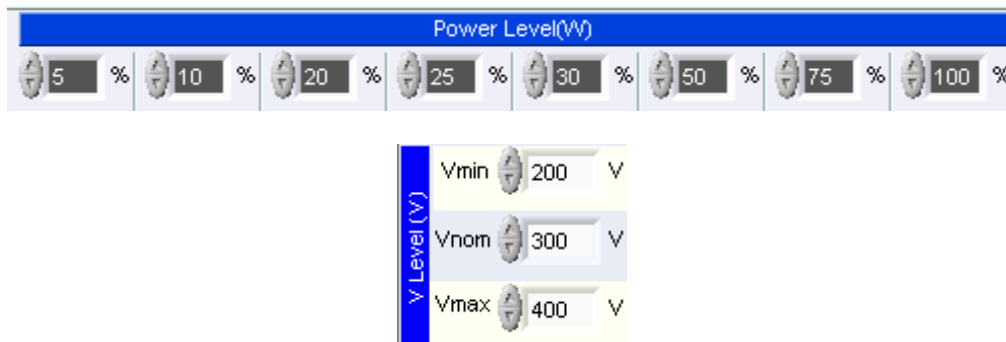


Figure 4-39 Setting Power Level and V Level Parameters

3. Click the button.
Please be noted that when any of the parameter is changed, it is necessary to click the Power Level to be tested again to update the I-V Curve.

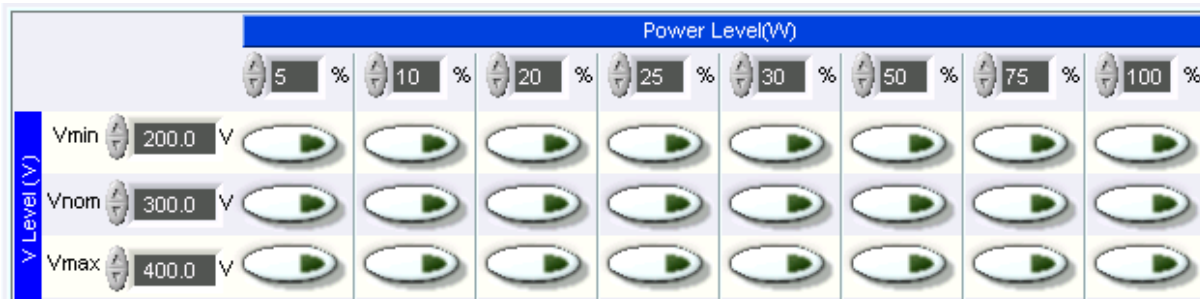


Figure 4-40 Power Level and V Level Buttons

- Ensure the I-V Data in the table is correct.

	I	V	P
1	8.443	0	0
	8.443	7.7	65
	8.443	15.4	130
	8.443	23.1	195
	8.442	30.8	260

Figure 4-41 IV Table Data

- Ensure the I-V Curve and P-V Curve Waveform Chart simulation is as required.

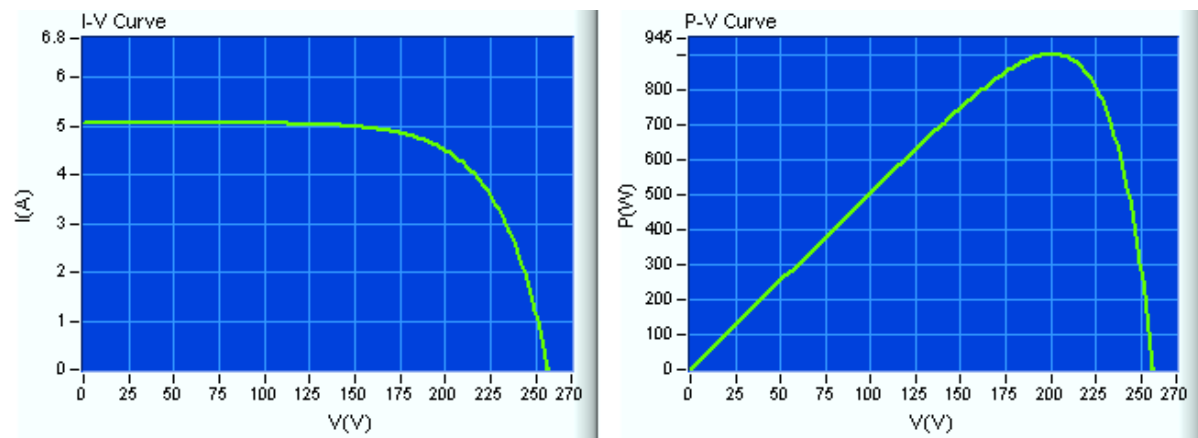


Figure 4-42 I-V and P-V Curve

For example, click the button of row Vnom=300V and column 75% to On and the I-V Data Table and simulation graph can see if the data is correct.



Figure 4-43 I-V Curve Edit (SAS Modeling) Tab

	I	V	P
1	8.443	0	0
	8.443	7.7	65
	8.443	15.4	130
	8.443	23.1	195
	8.442	30.8	260

Figure 4-44 I-V Table Data

Simulation graph:

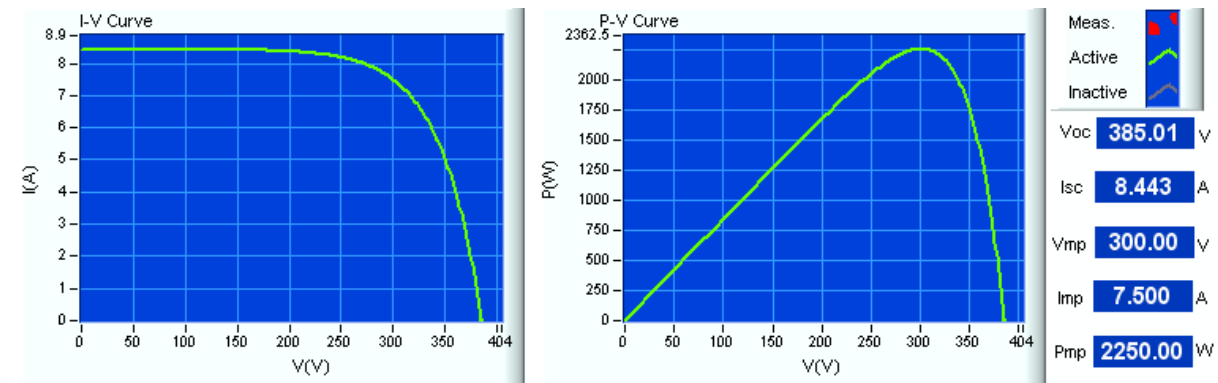


Figure 4-45 I-V Curve Edit (SAS Modeling) Simulation Graph after Clicked the Button

Switch I-V File No. dynamically:

The soft panel also has the function of switching I-V File No. dynamically that is to switch the present I-V curve to another I-V curve during the execution. The user can utilize it to check the readings change status.

Operating procedure:

1. First select an I-V File No. and read it.
2. Set I-V Run to On. The readings can be seen by the red dot on the I-V and P-V Curve. The read speed is able to set Auto Refresh.
3. Switch the I-V File No. to the next I-V File No. to be executed.
4. Click I-V File Read button and the gray line will appear.
5. Click I-V File Write to switch the I-V File No.
6. Check the execution status of the red dot. The previous green line under execution will turn to gray and the previewed gray line will turn to green.
7. Voc, Isc, Vmp, Imp and Pmp are displayed in the green execution line.

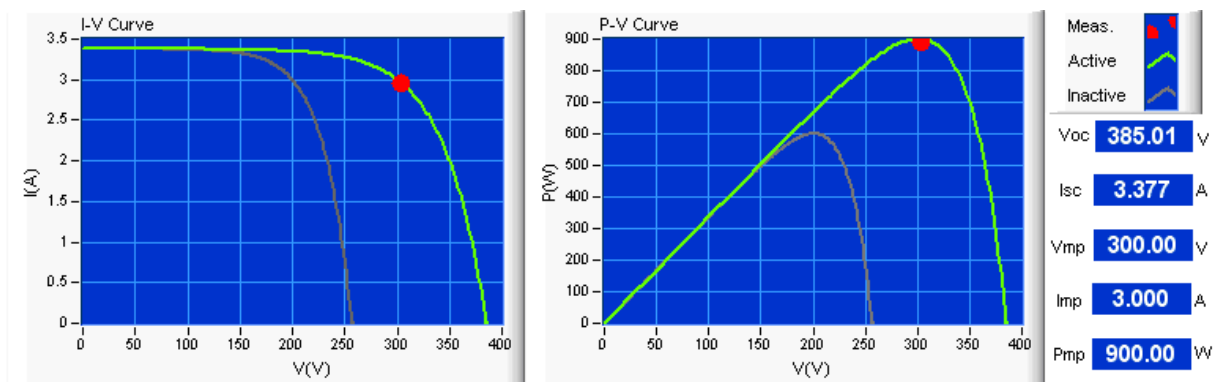


Figure 4-46 Simulation of Switching IV File No. Dynamically after IV Run

4.6 I-V Program Edit

This function allows the user to edit multiple I-V Curves to simulate the sunlight and temperature from dawn to dusk. It can set the execution time of each curve to facilitate the user to simulate the MPPT trace test under the real environmental changes, or to do On-line I-V curve change test for PV Inverter performance analysis.

It can execute 100 sets of I-V File output and each set contains execution time, selected I-V File number and Type.

The I-V Program Edit tab is composed of 10 Programs (1~10) and these 10 Programs compose the test sequences. Each Program can set maximum 100 Sequences; therefore, 1 Program Tab or 10 Program Tabs can be used for setting if there are 100 different sequences to be set. For instance, it can set the Sequence to 100 if only Program 1 is in use, and if 10 Programs are to be used, it can set 10 Sequences each from Program 1 to Program 10 and then use the Chain function to chain the programs.

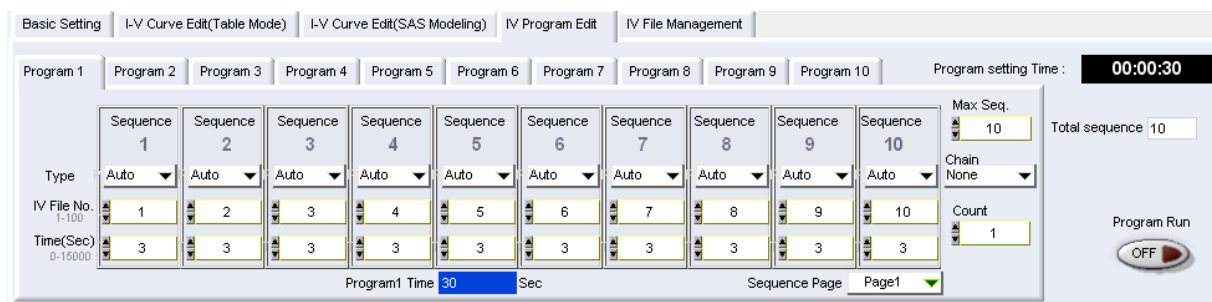


Figure 4-47 IV Program Edit Tab

4.6.1 Program1~Program10

Each Program has Max Seq., Chain, Count and parameters of 100 Sequences for setting. Each Sequence has Type, I-V File No. and Time for setting. Select the page from Sequence Page to view the sequences on other page when there are more than 10 Sequences are set. Select one program from Program 1 ~ Program10 and click Program Run to On can set it as the start program.

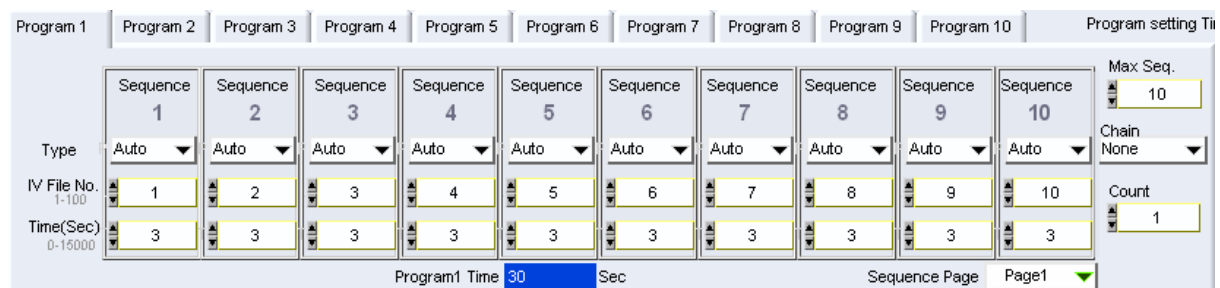


Figure 4-48 Program 1 ~ Program 10 Tab

Max Seq.:

It sets the Sequence amount of each Program. When set, the program will open the equivalent Sequence no. for setting. The program will gray out or reset the sequences when they are reduced. The valid range is 0~100. Since the total amount is 100, the program will check the setting status of other Program and if the sum exceeds 100, a message will prompt

to remind the restriction.

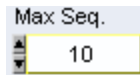


Figure 4-49 Program Max Seq.

Chain:

It sets the chain connection of each Program in a drop-down menu including None, Program 1 ~ Program10. If None is selected, it means the Sequences set in the Program will run once only. If Chain is set to the Program itself, the Sequences set in it will run infinitely until Program Run is set to OFF. If other Program Number is selected, it means the Sequences set in the Program will run once and then skip to the Sequences set in the next specified Program Number. For infinite setting, please check if the Program Time is set to Inf.

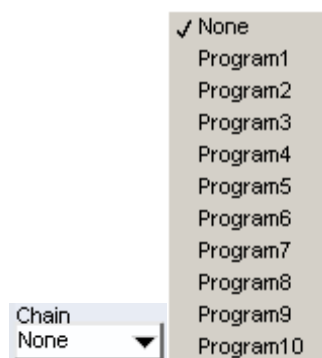


Figure 4-50 Program Chain

Count:

It sets the repeat counts of all Sequences set in the Program. The valid range is 1~15000. It will run Count first and Chain action later.

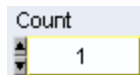


Figure 4-51 Program Count

Program (1~10) Time:

It shows the total time set for the Program including the time of Count but without the time set after Chain.

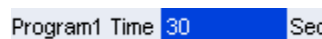


Figure 4-52 Program (1~10) Time

Sequence Page:

It sets the page to display the Sequences. Due to the restriction of screen size, the Sequences can be displayed in one screen are 10, so when the Max Seq. is set over 10 there will be mapping pages for selection. If the setting is 100, Page1~10 will appear for selection.

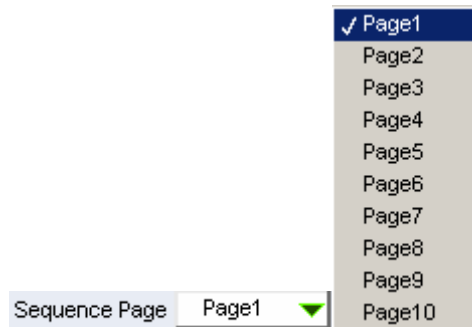


Figure 4-53 Page Selection for Program Sequence

Program Setting Time:

It shows the total execution time of all effective settings in the format of hour:minute:second. When Inf is showed, it means the program is running in infinite loop.



Figure 4-54 Program Execution Time

Once the Program Run is set to ON, the execution time will appear on the top.



Figure 4-55 Run On Execution Time

Total sequence:

It shows the total sequences set in all programs. When it shows 100, it means the setting of Max Seq. cannot be increased. Please be noted that the Total Sequence count is valid even though the setting time of the Sequence under each Program is set 0.

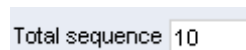


Figure 4-56 Total Sequence in Program

Program Run:

Click it for executing the program. The settings cannot be changed when ON, so the user need to decide the execution procedure or time first before clicking this button. To stop the execution, click the button again and the Run Time will appear while the Sequence background will show in light blue for distinguishing.



Figure 4-57 Program Run ON/OFF

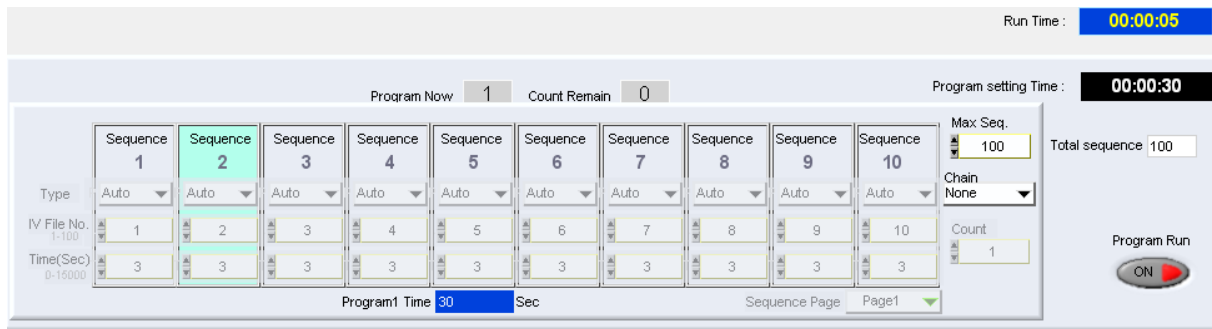


Figure 4-58 Sequence Display after Program Run On

I-V File Number preview function for next sequence: The figure below has two lines in I-V Curve and P-V Curve graphs in green and gray. The green line is the I-V File Curve of present Sequence and the gray line is the I-V File Curve of next Sequence. The red dot is the measurement that can be used to check the change from an I-V Curve to another I-V Curve.

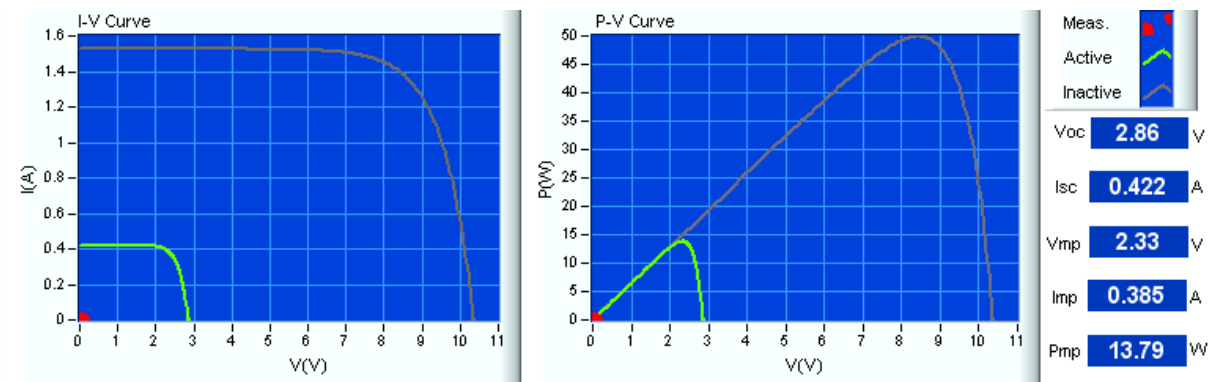


Figure 4-59 IV and PV Curve after Program Run On

Waveform display for program readings:

The display will show in Waveform when running the Program. The readings types available for selection are Vmea, Imea, Pmea, V_ave, I_ave, P_ave, Energy and Mpp. Time Length: it sets the display capacity of Reading Waveform X axis.

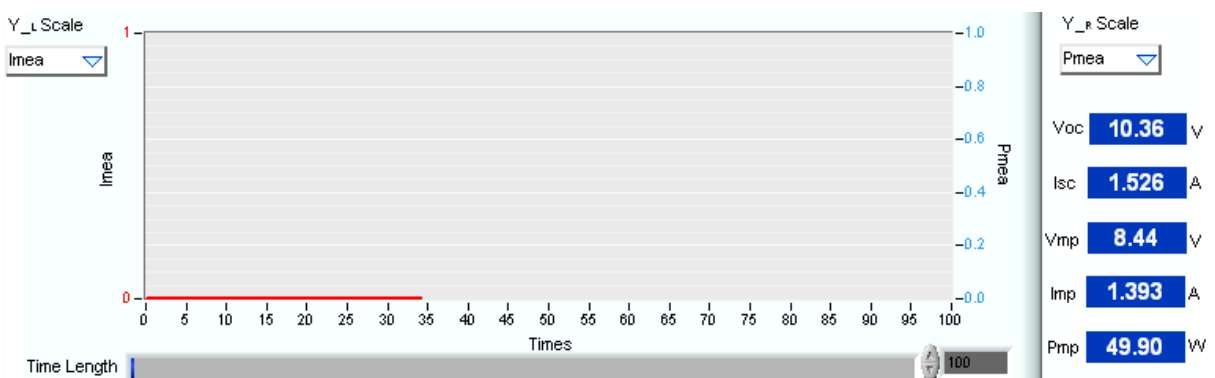


Figure 4-60 I-V Reading Waveform Display after Program Run On

4.6.2 Items in Sequence

Each Sequence is able to set Type, I-V File No. and Time as described below.

Type:

There are Auto and Manual two types for selection. When Auto is selected, it indicates the execution time is the time set by the user. If Manual is selected, it means the time will stop and the button **Next** will prompt to let the user decide when to press it down for execution; meanwhile the time will show infinite and is unable to set.



Figure 4-61 Type Selection in Program Sequence

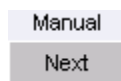


Figure 4-62 Button Appears when Executing Manually

I-V File No.:

It sets the I-V File No. to be used for each Sequence. The numbered I-V and P-V Curve will show in the simulation graphs. The valid range is 1~100.



Figure 4-63 Setting I-V File No. in Program Sequence

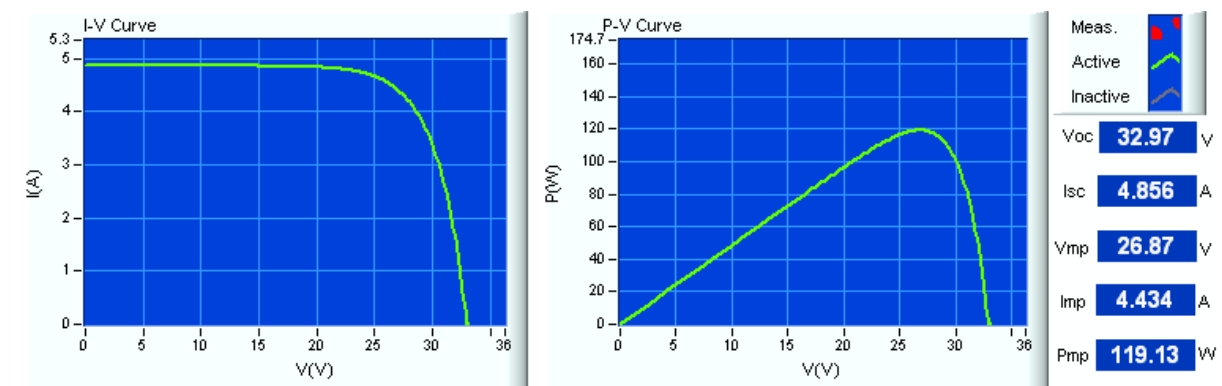


Figure 4-64 I-V and P-V Simulation of I-V File No. in Program Sequence

Time:

It sets the execution time of each Sequence in the unit of second. The time will disappear and invalid for setting when Manual is set. The valid range is 0~15000 Sec. If it sets to 0, it means the execution time is invalid after this Sequence.



Figure 4-65 Setting in Program Sequence

4.7 I-V File Management

This tab is able to transfer the existing 100 I-V Files to another DC Power Supply that has no I-V File to facilitate the user copying the same solar array I-V simulator. Click Read from the existing 100 I-V Files to read the data and save it to the file type applicable for Solar Array Soft Panel. Use the Soft Panel to set the communication interface of the DC Power Supply without I-V File and open the file to write in the data to standalone device and memory. Thus the setting data will be saved when the device is powered off and powered on again. However, it is necessary to ensure the DC Power Supply models are the same.

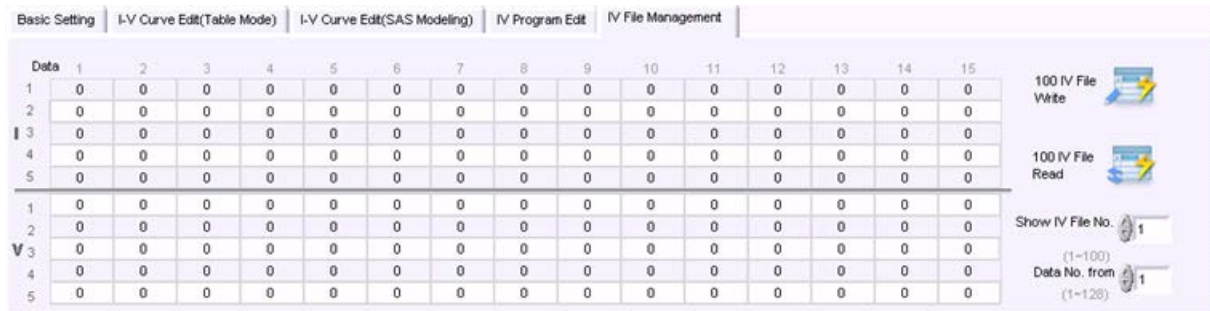


Figure 4-66 I-V File Management Tab

1. V is formed by a 5*16 Table and each row indicates an I or V File. There are 128 columns for each row which means 128 entries.
2. The values in the table of I-V File Management can be changed and written again. As the table can load 100 I-V Files for modification, it is suggested to enter into the I-V File Edit Table when modifying a single file.

0	0	0
0	21	0
0	0	0

Figure 4-67 I-V File Management Table

100 I-V File Write:

It is able to send the Table values in this tab to the DC Power Supply. Since the data volume is quite large, the user has to wait a period of time for process. It would require about 6 seconds if a USB is used and a waiting instruction will appear.

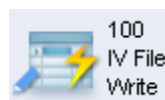


Figure 4-68 100 IV File Write



Figure 4-69 Please Wait for Write or Read

100 I-V File Read:

It is able to send the 100 I-V Files in the DC Power Supply to the Table in this tab. Since the data volume is quite large, the user has to wait a period of time for process. It would require about 6 seconds if a USB is used and a waiting instruction will appear.

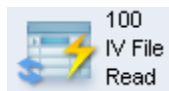



Figure 4-70 100 IV File Read

Show I-V File No.:

It shows the starting row of the Table. As both I and V Table only have 5 rows, it is necessary to set the Table Index here in order to browse forward.



Figure 4-71 Show IV File No.



0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0


Figure 4-72 Mapping Table for Show IV File No.

Data No. from:

It shows the starting column of the Table. As both I and V Table only have 10 columns, it is necessary to set the Table Index here in order to browse forward.



Figure 4-73 Data No. from



0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Figure 4-74 Mapping Table for Data No. from

4.8 MPPT Test

When the I-V Curve is edited, it can be recalled for test and show the Static MPPT performance of PV Inverter for real time tracing. This function allows the user to set the Static MPPT Trace Efficiency test period, and the test time of each dot is suggested to be 60s-600s for the optimal static MPPT EFF% performance analysis.

The test can only be conducted when the I-V Run is ON or the Program is ON. Before clicking MPPT Test to ON, it can set the Run Time first. The $V_{average}$, $I_{average}$, Energy, $P_{average}$ and MPP Tracking Efficiency will be calculated after running the test. Once the run time is due, it will stop counting but the I-V Run is not OFF. The user can clear the count to start from 0 anytime during the process.

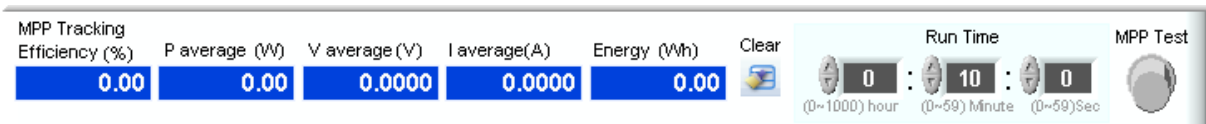


Figure 4-75 MPP Test

Run Time:

It sets the MPP execution time in hour, minute and second. The maximum setting is 1000 hours, 59 minutes and 59 seconds.



Figure 4-76 MPP Test Run Time

Clear:

It clears the V_average, I average, Energy, P_average and MPP Tracking Efficiency 5 parameters. It can be clicked whenever the test is running or not.



Figure 4-77 MPP Test Run Clear

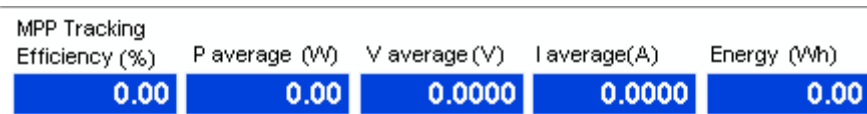


Figure 4-78 Value Displayed after MPP Test Run Clear

V_average, Energy, P_average and MPP Tracking Efficiency:

These 4 items display the value where the V_average and P_average are the average of the entire execution time no matter how many times the I-V File No. has been changed.

MPPT Test:

It runs the MPPT test only when I-V Run or Program is set to ON. Click it can also stop the test. Run Time will show the executed time at present.



Figure 4-79 MPP Test Run ON

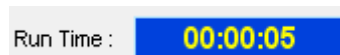


Figure 4-80 MPP Test Run Time

Notice

Taking the DC power measurement, set errors and I-V curve algorithm errors into consideration, the MPPT Efficiency measurement error is $\leq 1\%$. The definition of MPP tracking efficiency is the DC Power Supply output power accumulated after a period of time to divide by the maximum power P_{mp} of the set IV-Curve. The theoretical value does not greater than 100%. However, when the two varied curves have bigger power differences, the MPP tracking efficiency value will exceed 100% at the

variation moment. It will return to normal after a long period of accumulation, for instance when large power curve changes to small power curve.

4.9 Parameter

The screenshot shows the 'Parameter' tab selected. Under the 'I_V & P_V Scale Setting' section, the 'Auto Scale Setting' checkbox is checked. To the right of this section is an 'Advance Setting' button. Below the checkbox, there are three input fields: 'Scale Vmax' containing '12.00', 'Scale Imax' containing '1.000', and 'Scale Pmax' containing '600.00'.

This area is divided into 2 parts: 1.I_V & P_V Scale Setting and 2. Advance Setting.

4.9.1 I_V & P_V Scale Setting

When Auto Scale Setting is selected, it will adjust the maximum of X and Y Axis of IV Curve and PV Curve automatically by software. It will be manual adjustment if not selected. Three selections: Scale Vmax, Scale Imax and Scale Pmax will appear for the user to specify.

This is a smaller version of the 'I_V & P_V Scale Setting' section. It shows the 'Auto Scale Setting' checkbox checked. The input fields are 'Scale Vmax' (12.00), 'Scale Imax' (0.500), and 'Scale Pmax' (300.00).

4.9.2 Advance Setting

This function is to set the Alarm to display when the reading exceeds the standard for certain value.

Click Advance Setting and it will prompt a Password dialog window. The user can input Chroma and click Enter to do the setting.

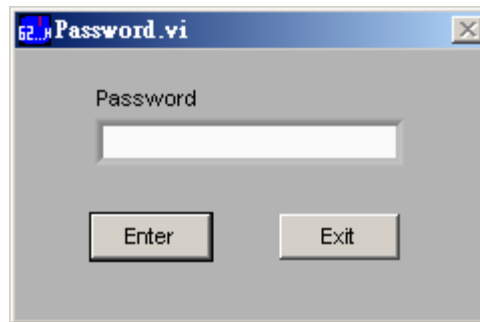


Figure 4-81 Advance Setting Password Dialog Box

Advance Setting has the following parameters: Gain%, Offset%, Control Mode, Input Filter, Output Speed, Setting Margin. Click Invisible to close these settings. When Alarm is valid it indicates the reading > the Table value * Gain%+I limit* Offset%.

Others such as Control Mode, Input Filter, Output Speed and Setting Margin, please see the user's manual of the user's manual of individual device.

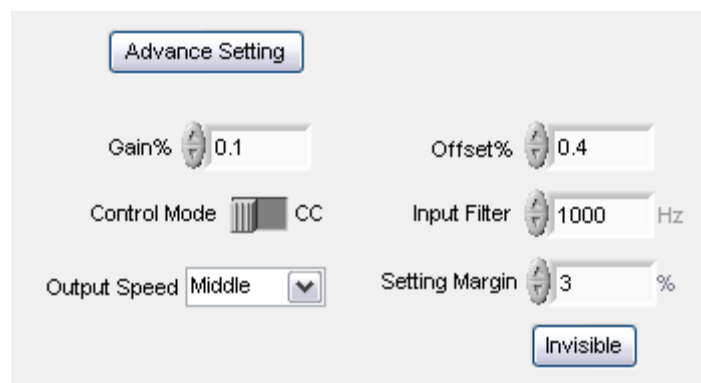


Figure 4-82 Advance Setting Parameters

5. Report

The Report Generator is a tool to record the readings. When the user selects the access path and click Record Start, it will follow the setting to record each reading.

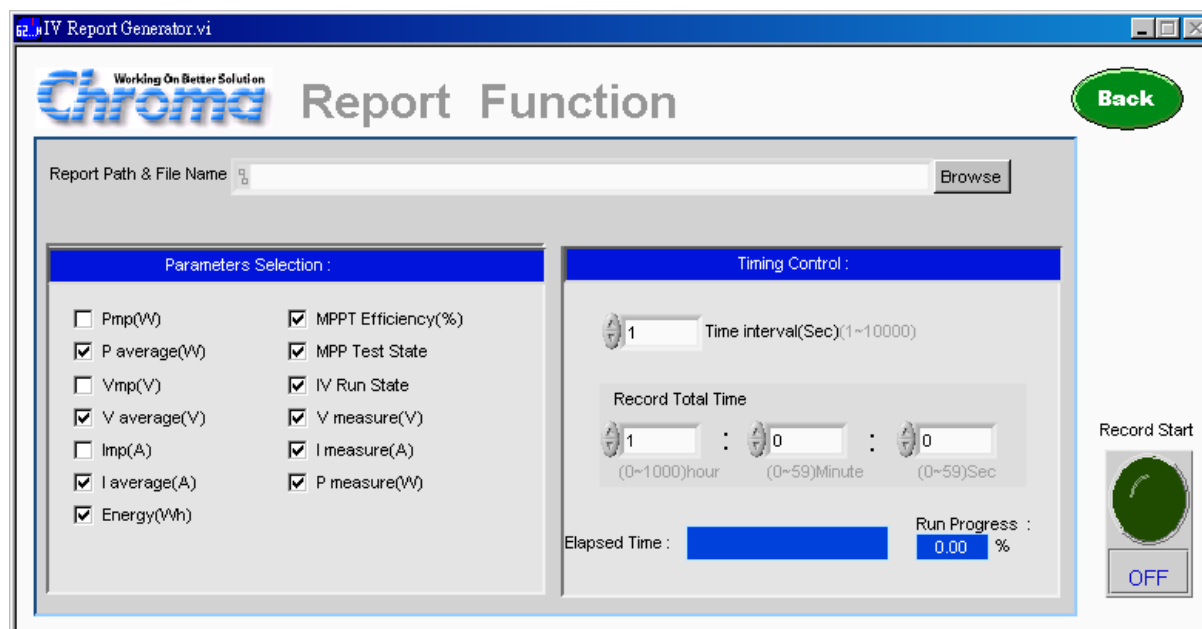


Figure 5-1 Solar Array Simulation Report

5.1 Setting the Parameter

5.1.1 Recording the Set Parameter

There are Pmp, P average, Vmp, V average, Imp, I average, Energy, MPP Tracking Efficiency, MPP Test State, IV Run State, V measure, I measure, P measure 13 parameters. If there is no need to record it, just disable the parameter.

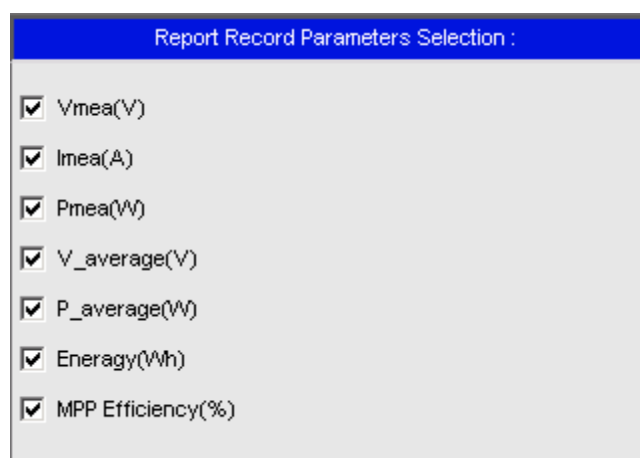


Figure 5-2 Setting Report Record Parameters

5.1.2 Time Recording Parameter

There are Time interval (Sec) and Record Total Time (HH, MM, SS). Time interval (Sec) sets the time waited for measurement. Record Total Time (HH, MM, SS) is to set the measurement time, HH is the setting of hour in the range of 0-1000 while MM is the setting of minute in the range of 0-59 and SS is the setting of second in the range of 0-59.

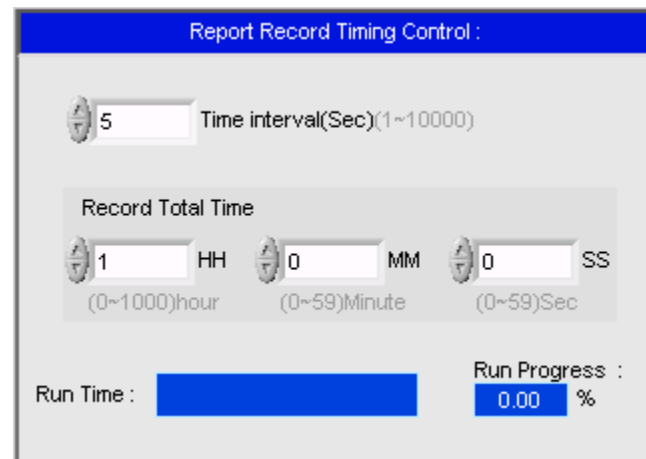


Figure 5-3 Report Record Timing Control

5.1.3 Report Path and File Name

It allows the user to set the filename for storage and the path to access it. Click Browse will prompt a dialog box for the user to select the path and then enter the filename. The duplicate filename will be checked. Do not save the file in the folders of "Desktop" or "My Documents". It is suggested to create an individual folder for access.

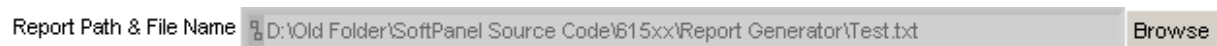


Figure 5-4 Report Path and File Name

5.2 Record Start

Click it can start the record function. No matter it is in Fixed Mode or using other functions, once the setting time is arrived, it will read the parameters from the DC Power Supply immediately. Click it again to set it to OFF can disable the record function.



Figure 5-5 Record Start

Note Please make sure the OS time is correct before running the software and do not change the OS time during execution for proper operation.

In order to let the user know the Report function is already on, there is an indicator in the Fixed Mode in the Main Panel. Once Report Generator is active, the Report indicator will be on to indicate the record function is running.

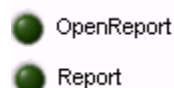


Figure 5-6 Report Indicator in the Main Panel

5.3 Report Example

The example below is the output readings recorded, once per 0.5 second the fastest. If the file is opened via Excel, use tab as the separator.

Time	V measure(V)	I measure(A)	P measure(w)	V average(V)	P average(w)	Energy(wh)	MPP Tracking Efficiency(%)	Mpp Test
10:49:40	0.0000	0.0000	0.0	0.0000	0.00	0.00	0.00	OFF
10:49:41	0.0000	0.0000	0.0	0.0000	0.00	0.00	0.00	OFF
10:49:42	0.0000	0.0000	0.0	0.0000	0.00	0.00	0.00	OFF
10:49:43	0.0000	0.0000	0.0	0.0000	0.00	0.00	0.00	OFF
10:49:44	21.650	0.1110	2.4	0.0000	0.00	0.00	0.00	OFF
10:49:45	20.590	0.1210	2.5	0.0000	0.00	0.00	0.00	OFF
10:49:46	20.710	0.1200	2.5	0.0000	0.00	0.00	0.00	OFF
10:49:47	20.000	0.1250	2.5	0.0000	0.00	0.00	0.00	OFF
10:49:48	19.903	0.1256	2.5	19.903	2.50	0.00	99.80	ON
10:49:49	19.903	0.1257	2.5	19.903	2.50	0.00	99.83	ON
10:49:50	19.903	0.1256	2.5	19.903	2.50	0.00	99.82	ON
10:49:51	19.903	0.1257	2.5	19.903	2.50	0.00	99.83	ON
10:49:52	19.903	0.1257	2.5	19.903	2.50	0.00	99.84	ON
10:49:53	19.903	0.1257	2.5	19.903	2.50	0.00	99.84	ON
10:49:54	19.903	0.1256	2.5	19.903	2.50	0.00	99.84	ON
10:49:55	19.903	0.1256	2.5	19.903	2.50	0.01	99.84	ON
10:49:56	19.903	0.1257	2.5	19.903	2.50	0.01	99.84	ON
10:49:57	19.905	0.5013	10.0	19.904	2.91	0.01	88.21	ON
10:49:58	19.904	0.5017	10.0	19.904	3.59	0.01	91.04	ON
10:49:59	19.903	0.5014	10.0	19.903	4.15	0.01	92.76	ON
10:50:00	19.904	0.5016	10.0	19.903	4.62	0.02	93.92	ON
10:50:01	19.903	0.5015	10.0	19.903	5.02	0.02	94.75	ON
10:50:02	19.903	0.5014	10.0	19.903	5.02	0.02	94.75	ON
10:50:03	19.914	1.2545	13.2	19.904	5.56	0.03	88.26	ON
10:50:04	19.913	1.2548	25.0	19.905	6.81	0.03	90.74	ON
10:50:05	19.913	1.2540	25.0	19.905	7.90	0.04	92.35	ON
10:50:06	19.913	1.2541	25.0	19.906	8.87	0.05	93.48	ON
10:50:07	19.913	1.2546	25.0	19.906	9.74	0.05	94.31	ON
10:50:08	19.913	1.2543	25.0	19.906	10.52	0.06	94.95	ON
10:50:09	19.913	1.2544	25.0	19.907	11.22	0.07	95.46	OFF
10:50:10	21.060	1.1700	24.6	0.0000	0.00	0.00	0.00	OFF
10:50:11	23.190	0.8680	20.1	0.0000	0.00	0.00	0.00	OFF
10:50:12	20.940	1.1810	24.7	0.0000	0.00	0.00	0.00	OFF

Figure 5-7 Report Format

Note The report has an internal data column - Pmp average that is generated by software for user's reference to calculate MPPT Efficiency. The equation (MPPT Efficiency = $P \text{ average} / P_{mp \text{ average}} * 100\%$) and another data column Delta Time(s) will show when Time Interval=0.5s. This data column shows the time base as the reference for calculating the time weighting of average value.

5.4 Screen Control

5.5 Exit

Click this button will exit the Soft Panel.



Figure 5-8 Exit Button

5.6 Back

Click this button will exit the main panel and return to the startup screen of communication settings.

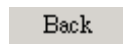


Figure 5-9 Button to Return to Previous Screen

6. Auto Run

This function allows the user to set all test items of Static and Dynamic MPPT in EN50530 and Sandia Lab by clicking the Auto Run function key.

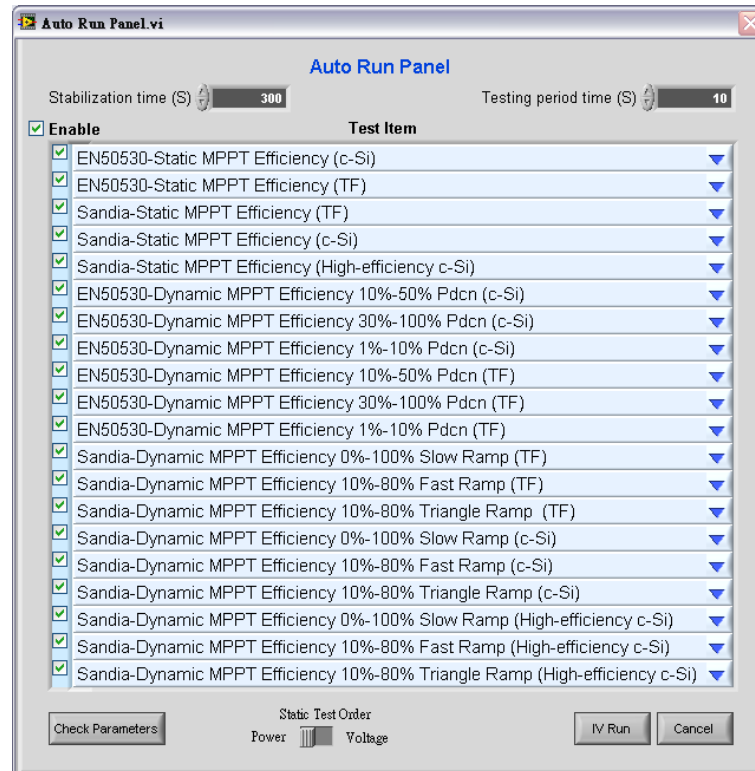


Figure 6-1 Auto Run Panel

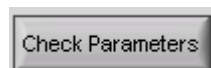
Before doing Auto Run test, the user needs to set the desired $V_{min}/V_{nom}/V_{max}/P_{max}$ in I-V Curve Edit (SAS Modeling) window and Initial setup time/ V_{mp}/P_{mpp} of PV Inverter in Dynamic MPPT Test window first. The user can select the regulation item desired for test in Auto Run Test item. Click IV Run, the Soft Panel will complete the process and generate a report automatically to fill in the test data to Excel file format.

Description of each element:

Stabilization time (S) : It sets the stabilization time for UUT (such as PV Inverter) to track to maximum power point (P_{mp}). The default is set to 300 seconds and the user can adjust it based on the UUT tracking characteristics. The range is 10~65536 seconds.

Testing period time (S) : It sets the period for testing MPPT and conducts MPPT Efficiency measurement after the UUT (such as PV Inverter) tracked the maximum power point. The range is 20~65536 seconds.

Enable ☒ **Test Item** ☒ EN50530-Static MPPT Efficiency (c-Si) : Click Enable can test all selected regulation.



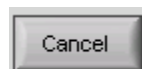
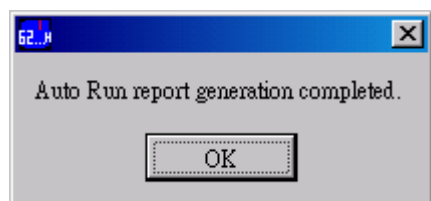
: Before doing Auto Run, press this button can check if the set parameters such as Vmp, Pmpp exceed the standalone device output specification (OVP/OCP/OPP) automatically.



: It activates Auto Run test and ends Auto Run Panel setting. During the test, the



user can click to abort the test. When the test is completed or aborted, an Excel report will generate automatically and prompt the following message.



: It closes the Auto Run setting window and saves the settings on the Panel.



: It allows the user to select the test procedure for Static MPPT Test. If Power is selected, it will change the percentage of output power parameter first when doing Static MPPT Test. If Voltage is selected, it will change the Vmin, Vnom and Vmax parameter of output voltage first when performing Static MPPT Test.

For instance, if Power is selected the parameter change is from Vmin(5% Power)→Vmin(10% Power)..... →Vmin(100% Power), following the order of Vnom(5% Power)→ Vnom(10% Power) → Vnom(100% Power) and Vmax(5% Power) →Vmax(10% Power)..... →Vmax(100% Power). When done, the test data will enter into Excel report automatically.

7. Advanced Dynamic MPPT Test Functions

The advanced Dynamic MPPT Test function has built in Sandia and EN50530 dynamic MPPT test patterns. The user can use the Dynamic MPPT Test function by selecting the Sandia or EN50530 I-V mathematical expressions and test items in the graphical soft panel. It can simulate the luminance and temperature change I-V curve under actual weather to test the PV inverter's dynamic MPPT performance. The user can edit the execution time and temperature change time from low to high luminance by Dynamic I-V curve easily and set its repetition cycle. The GUI will calculate the MPPT performance for analysis after running the test. The software also has test data recording function that can edit the test parameters to be recorded such as voltage, current, power, watt and MPPT performance along with the sampling interval (1 - 10,000s) and total time length to facilitate the analysis and validation of PV inverter. This Dynamic MPPT Test function supports the firmware version 1.1 or above for standalone device.

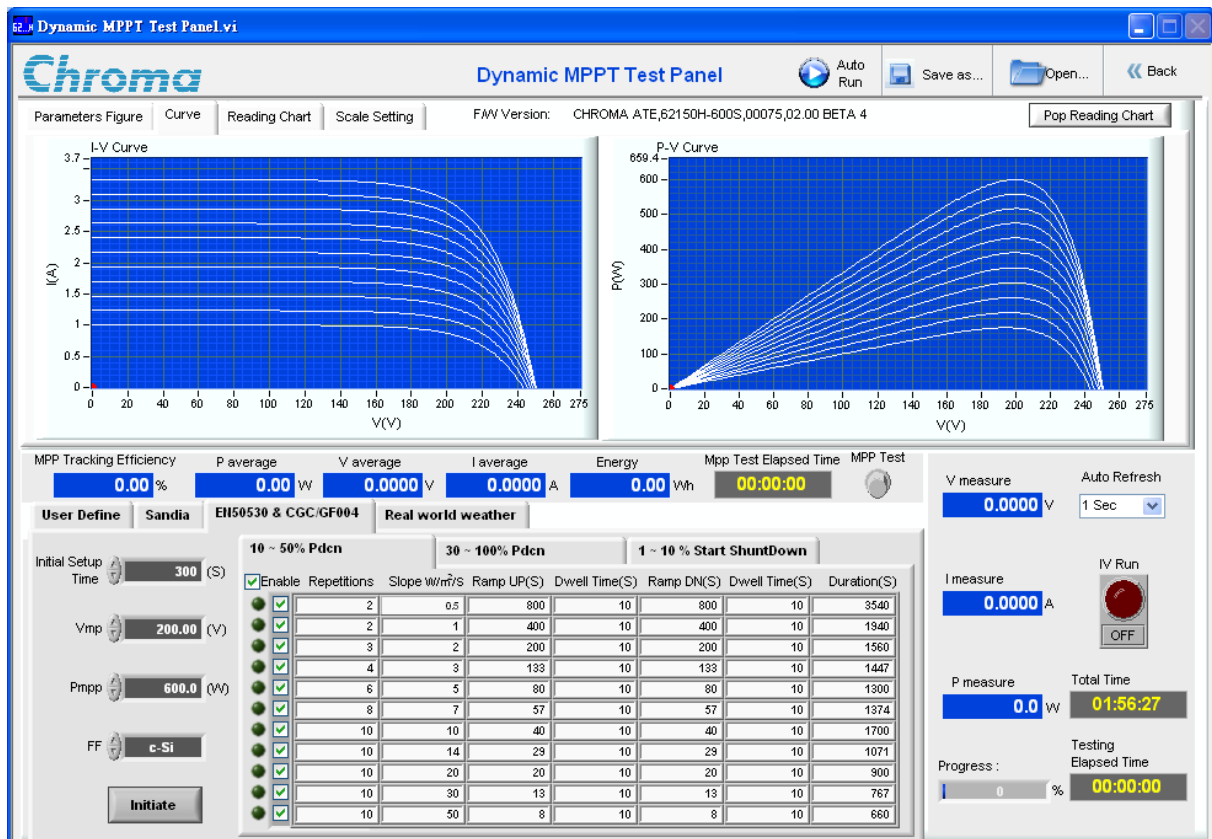
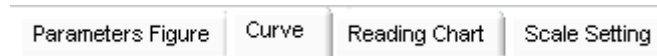


Figure 7-1 Dynamic MPPT Test Panel

7.1 Function Page



The function tab pages are on the upper panel for the user to select the desired display of simulation curve and related parameter settings.

1. Parameters Figure:

This page shows the meaning presented in the irradiance and temperature change curve for various User Define parameters as Figure 7-1 shows.

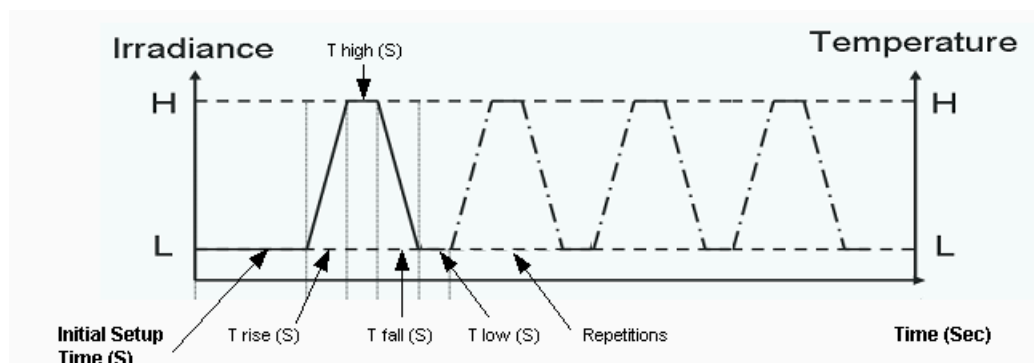


Figure 7-2 Irradiance and Temperature Change Curve

2. Curve:

This page can simulate and display the solar cell characteristics curves edited by the related parameters. There are two characteristics curves, I-V (current and voltage) and P-V (power and voltage) as Figure 7-3 shows.

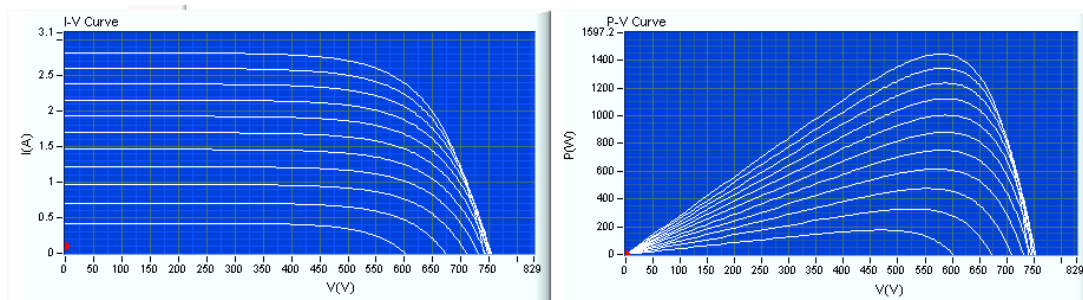


Figure 7-3 I-V and P-V Characteristic Curves

3. Reading Chart:

This page shows 4 reading change curves selected by the user as Figure 7-5 shows. The user can choose the desired reading via the type selection. There are 8 reading types including V mea (voltage) in the unit of Volt, I mea (current) in the unit of Ampere, P mea (power) in the unit of Watt, V average (average voltage) in the unit of Volt, I average (average current) in the unit of ampere, P ave (average power) in the unit of Watt, Energy in the unit of Watt per hour and MPP (MPP Tracking Efficiency) in the unit of percentage as Figure 7-4 shows. Times Length (sec) : It can change the time scale of X-axis for reading curve that can benefit the observation of curve.

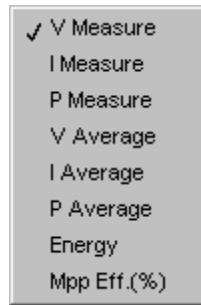


Figure 7-4 Types of Readings

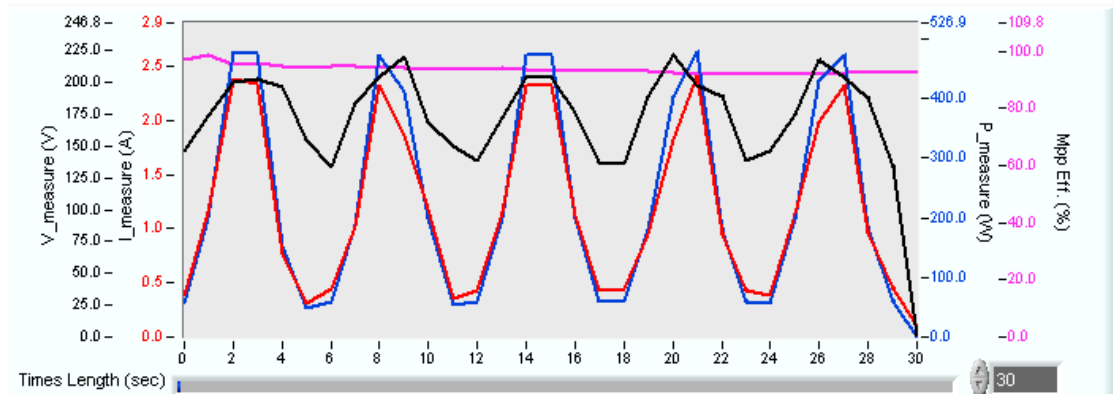


Figure 7-5 4 Types of Reading Change Curves User-defined

4. Scale Setting:

This page sets the maximum range of various reading display curves as explained below.

☐ Auto Scale of Both Curve : It sets if the Y-axis of I-V and P-V curve is auto scaled by software.

☐ Real-time Dynamic MPPT initiated : It sets if redraw I-V and P-V curves in real time when parameter changes.


Scale Vmax of Curve (V) : It sets the maximum voltage of X-axis for I-V curve.

Scale Imax of Curve (A) : It sets the maximum current of Y-axis for I-V curve.

Scale Pmax of Curve (W) : It sets the maximum power of Y-axis for P-V curve.

☐ Auto Scale of All Reading Chart : It sets the Y-axis of all readings on the Reading Chart curves to auto scale by software.


Scale Max. of Vmea (V) : It sets the maximum of V mea (voltage) on Y-axis for Reading Chart curve.

Scale Max. of I_{mea} (A)  2.6


: It sets the maximum of I_{mea} (current) on Y-axis for Reading Chart curve.

Scale Max. of P_{mea} (W)  503.6


: It sets the maximum of P_{mea} (power) on Y-axis for Reading Chart curve.

Scale Max. of V average (V)  186.4


: It sets the maximum of V average (average reading) on Y-axis for Reading Chart curve.

Scale Max. of I average (A)  2.5


: It sets the maximum of I average (average current) on Y-axis for Reading Chart.

Scale Max. of P average (W)  213.5

: It sets the maximum of P average (average power) on Y-axis for Reading Chart curve.

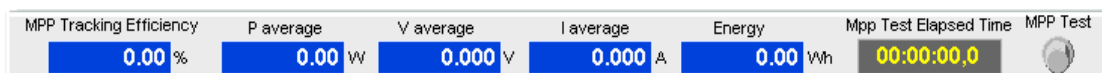
Scale Max. of Energy (Wh)  1.1

: It sets the maximum of Energy on Y-axis for Reading Chart curve.


Scale Max. of MPPT Eff. (%)  108.5

: It sets the maximum of MPP Tracking Efficiency on Y-axis for Reading Chart curve.


7.2 MPPT Testing




This block triggers and shows the MPP (Maximum Power Point) test related information as described below.

MPP Tracking Efficiency  0.00 %

: It shows the maximum MPP tracking efficiency, the unit is percentage.

P average  0.00 W

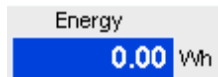
: It shows the overall average of power, the unit is Watt.

V average  0.0000 V

: It shows the overall average of voltage, the unit is Volt.

I average  0.000 A

: It shows the overall average of current, the unit ampere.



: It shows the total energy, the unit is Watt per hour.



: It shows the time MPP Test spent in the format of hour:minute:second.

There is millisecond display during test to reduce the statistical error of time to within 1 second.



: It triggers the MPP test. Click it to start the test and click it again to stop the test. When working with IV Run, the software will delay a period of when executing MPP Test. This MPP Test button will be automatically enabled to start testing. The user can also manually enable the MPP Test before the Initial Setup Time is up.

7.3 Standard Parameters Setting

The regulation parameter settings are on the lower left. There are Sandia and EN50530 standard parameters available for editing and a User Define tab for customizing the parameters so that the DC Power Supply can output the waveform curve based on the settings. The detail of each tab page is described below.



7.3.1 User Define

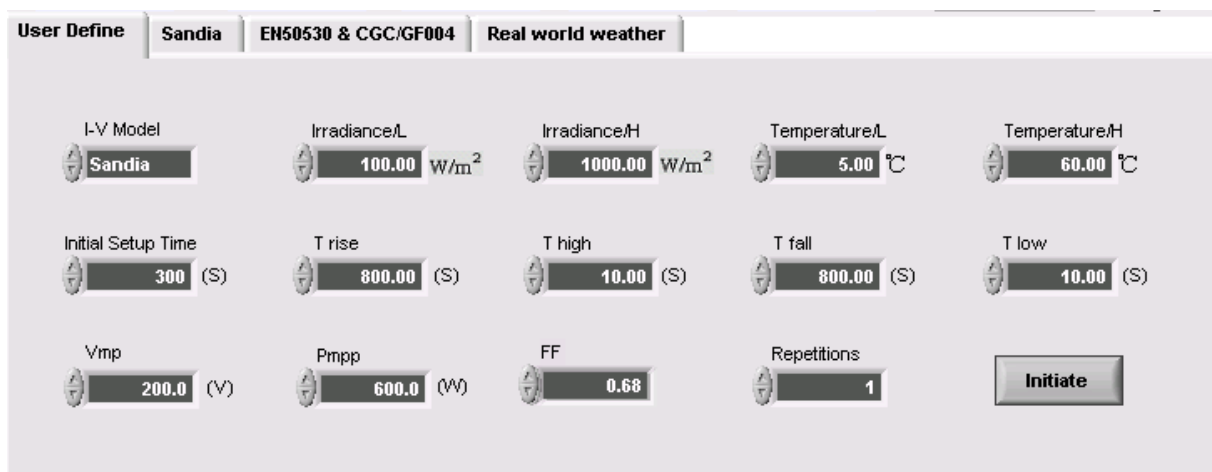



Figure 7-6 User Define Page


This page sets the parameters of user define as the user can set the I-V curve waveform output besides the one set by the regulation standard.

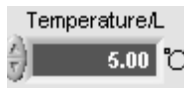


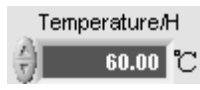
: It selects I-V mathematical simulation built in for use, such as Sandia or

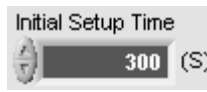
EN50530.


: It sets the parameter of low irradiance within the range of 0~3000.


: It sets the parameter of high irradiance within the range of 0~3000.

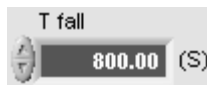
: It sets the parameter of low temperature within the range of -40~+85.


: It sets the parameter of high temperature within the range of -40~+85.

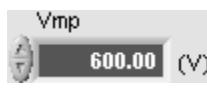
: It sets the time remains for initial irradiance and before temperature change. The range is 0~65536 seconds.


: It sets time for irradiance and temperature to rise. The range is 0~4000 seconds.

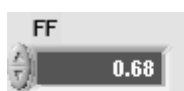
: It sets the time for irradiance and temperature to remain at high. The range is 0~4000 seconds.

: It sets the time for irradiance and temperature to fall. The range is 0~4000 seconds.

: It sets the time for irradiance and temperature to remain at low. The range is 0~4000 seconds.

: It sets the voltage of maximum power point. The unit is Volt and the range is varied by model.

: It sets the maximum power point. The unit is Watt and the range is varied by model.


Thin-Film:0.55
Standard Crystalline:0.68
High-Efficiency Crystalline:0.8 : Varied by the solar cell type, it is suggested to set the Generator Fill Factor.



: It sets the number of times to execute repeatedly. Range: 1~ 65536.



: Click this button can follow the parameters set in the present page to redraw the simulated I-V and P-V curves. This function is invalid if the matching ☐ Real-time Dynamic MPPT initiated is selected.

7.3.2 Sandia

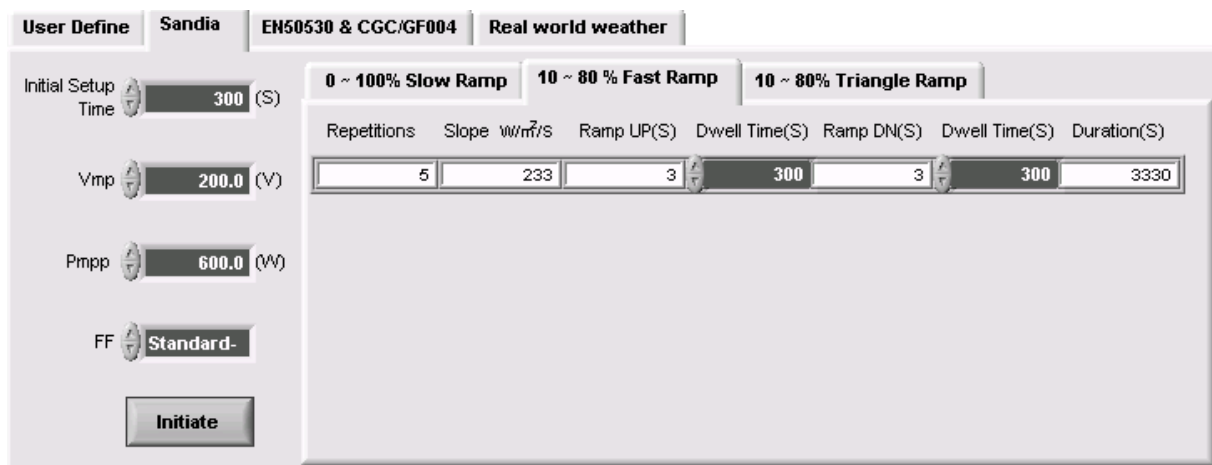
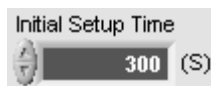


Figure 7-7 Sandia Regulation



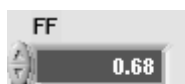
: It sets the time remains for initial irradiance and before temperature change. The range is 0~65536 seconds.



: It sets the voltage of maximum power point. The unit is Volt and the range is varied by model.



: It sets the maximum power point. The unit is Watt and the range is varied by model.

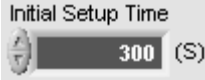


Thin-Film:0.55
Standard Crystalline:0.68
High-Efficiency Crystalline:0.8

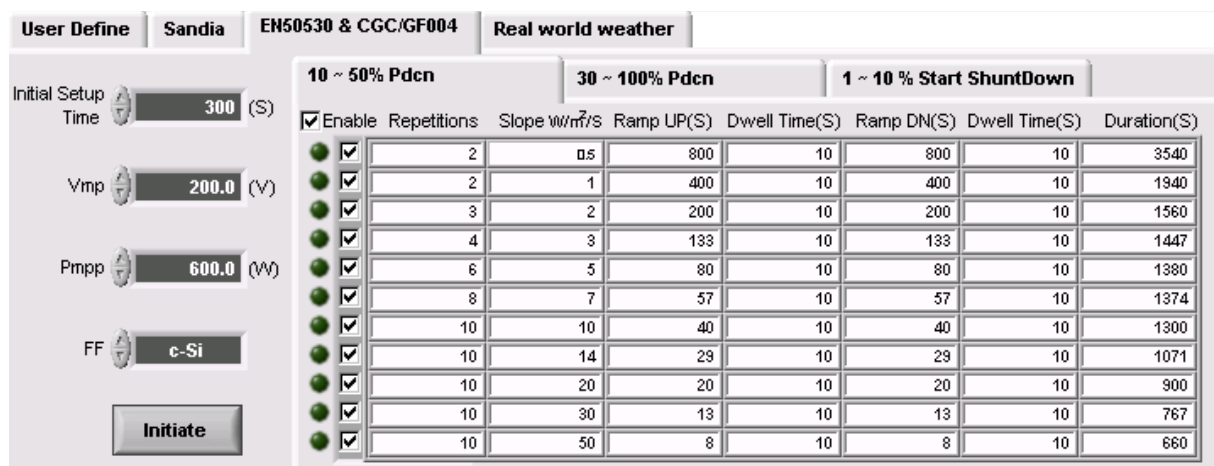
: Varied by the solar cell type, it is suggested to set the Generator Fill Factor.



: Click this button can follow the parameters set in the present page to redraw the simulated I-V and P-V curves.

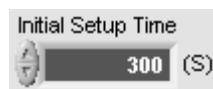
Slow Ramp **Fast Ramp** **Triangle Ramp** : This page can select 3 types of irradiance change parameter for test suggested by Sandia Lab, which are low speed, fast speed and triangle curve simulation. Each tab page has parameter settings defined for user reference that include Repetitions, Slope, Ramp UP(S), Dwell Time(S), Ramp DN(S), Dwell Time(S), and Duration(S) containing  the total execution time (second).

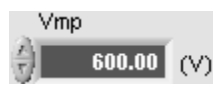
7.3.3 EN50530 and CGC/GF004 Regulations





Enable	Repetitions	Slope W/m ² /s	Ramp UP(S)	Dwell Time(S)	Ramp DN(S)	Dwell Time(S)	Duration(S)
<input checked="" type="checkbox"/>	2	0.5	800	10	800	10	3540
<input checked="" type="checkbox"/>	2	1	400	10	400	10	1940
<input checked="" type="checkbox"/>	3	2	200	10	200	10	1560
<input checked="" type="checkbox"/>	4	3	133	10	133	10	1447
<input checked="" type="checkbox"/>	6	5	80	10	80	10	1380
<input checked="" type="checkbox"/>	8	7	57	10	57	10	1374
<input checked="" type="checkbox"/>	10	10	40	10	40	10	1300
<input checked="" type="checkbox"/>	10	14	29	10	29	10	1071
<input checked="" type="checkbox"/>	10	20	20	10	20	10	900
<input checked="" type="checkbox"/>	10	30	13	10	13	10	767
<input checked="" type="checkbox"/>	10	50	8	10	8	10	660


Figure 7-8 EN50530 Regulation

 : It sets the time remains for initial irradiance and before temperature change. The range is 0~65536 seconds.

 : It sets the voltage of maximum power point. The unit is Volt and the range is varied by model.

 : It sets the maximum power point. The unit is Watt and the range is varied by model.

 : Varied by the solar cell type, it is suggested to set the Generator Fill Factor.

 : Click this button can follow the parameters set in the present page to redraw the simulated I-V and P-V curves.

10~50% Pdcn **30~100% Pdcn** **Start ShuntDown** : This page can select 3 types of irradiance change model suggested by EN50530. Each tab page has parameter settings defined for user reference that include Enable, Repetitions, Slope, Ramp UP(S), Dwell Time(S), Ramp DN(S), Dwell Time(S), and Duration(S) containing the total of



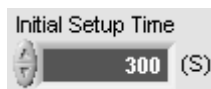
7.3.4 Real World Weather

The real world weather simulation function allows the user to place the actual solar cell array outdoor with photovoltaic inverter to gather the real world weather conditions such as irradiance, temperature and time parameter under the operation of power generation. The user can enter the weather conditions to Solar Array Simulator to do simulation tests on PV Inverter.

The parameter details are described as below:



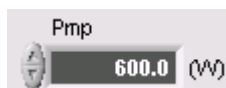
: It selects the built-in I-V mathematical simulation, such as Sandia or EN50530.



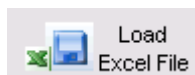
: It sets the time to remain the initial irradiance and temperature before change. The range is 0~65536 seconds.



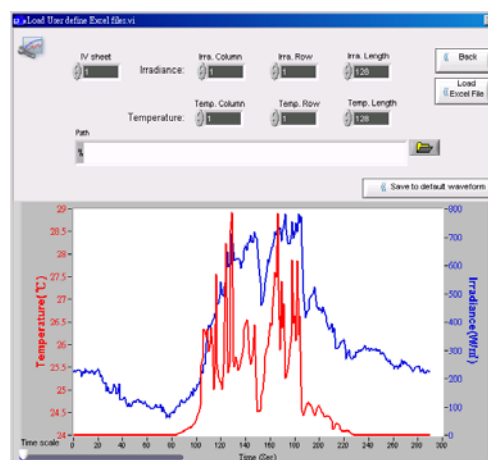
: It sets the normal input operating voltage in volt for the PV Inverter to be tested. The range available for setting is varied with model.



: It sets the maximum input operation power in volt for the PV Inverter to be tested. The range available for setting is varied with model.



: It opens the specified irradiance and temperature change Excel file. The operating window is shown below.



Description of parameters:



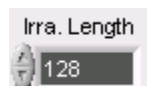
: It specifies the worksheet number of loaded Excel file starting from 1.



: It specifies the starting column of irradiance data for loaded Excel file beginning from 1.



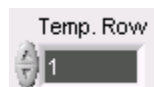
: It specifies the starting row of irradiance data for loaded Excel file beginning from 1.



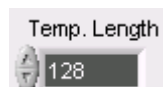
: It specifies the column length of irradiance data for loaded Excel file which is the entry from starting row to end row. The maximum data length is 86400 entries.



: It specifies the starting column of temperature for loaded Excel file beginning from 1.



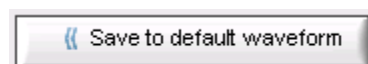
: It specifies the starting row of temperature for loaded Excel file beginning from 1.



: It specifies the data length of temperature column for loaded Excel file which is the entry from starting row to end row. The maximum data length is 86400 entries.



: It specifies the file path and file name. Also follow the specified column and row parameters to load the data file automatically.



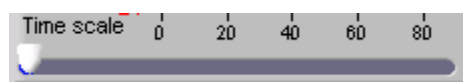
: It saves the curve data displayed in the window as the software default and will load automatically when the software is opened next time.



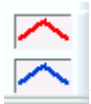
: It closes the operating window and returns to Real World Weather test page and applies the loaded curve data to the curve window on test page.



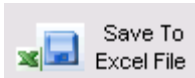
: It reloads the Excel file by the position of specified row and column.



: It adjusts the density of time scale for the user to view the details of curve.



: It sets the attributes of waveform curve such as color, thickness and shape, etc.

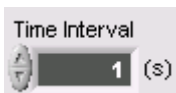


: It saves the temperature and irradiance change data file to another filename. The default filename is Real World Data.xls and the file format is as listed below.

Irradiance	Temperature
100	5
101.125	5.069
102.25	5.138
103.375	5.206
104.5	5.275
105.625	5.344



: It sets the suggested Generator Fill Factor varied by the solar cell type.



: It sets the time interval for inputting the data entry. In addition, the user can load the irradiance and temperature change Excel file to re-specify the time interval for irradiance and temperature change to adjust the test time flexibly. The range available for setting is 1 ~ 65535 seconds.



: Click this button can follow the parameters set in the present page to redraw the simulated I-V and P-V curves.

7.3.5 Real-Time Reading and Test Control Block

This block starts the test and shows the real-time reading data. The detail is described below.

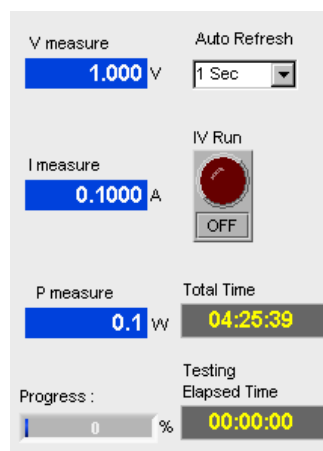
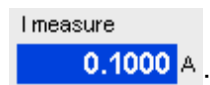


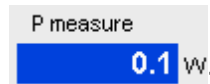
Figure 7-9 Start Test and Real-Time Reading Data



: It shows the UUT output voltage reading in real time in the unit of Volt.



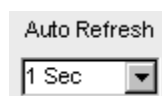
: It shows the UUT output current reading in real time in the unit of Ampere.



: It shows the UUT output power reading in real time in the unit of Watt.



%: It shows the test progress percentage in real time.



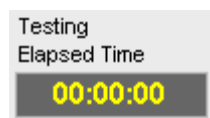
: It selects the interval for sampling (0.5~10 seconds).



: It is the button to start or stop the test.

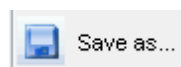


: It shows the total time estimated to spend for all tests.



: It shows the time spent for the test.

7.3.6 Parameter Access Control



: It saves the important parameters set in Dynamic MPPT Test Panel to a *.mpt file. It allows the user to open the file later quickly and apply the same test parameters directly.



: It opens the *.mpt parameter file set and saved previously. It allows the user to load the setting in parameter file directly for test.



: Click this key to return to Main Panel.

8. Regulations for Parameter and I-V Curve Mathematical Models

The I-V and P-V Curve of solar cell simulation represented in the software test screen uses Simplified Photovoltaic I-V Curve and PV generator two types of mathematical models. The imported solar irradiance, environment temperature and the Fill Factor of chip will be calculated by these two mathematical models to generate simulation curve for user reference. The key features of the two mathematical models are described in the sections below.

8.1 Sandia (Simplified Photovoltaic I-V Curve Model)

The following provides a description of a simplified PV I-V curve model. This is the model that shall be used to determine the operating characteristics of the PV Array Simulator and used in the MPPT evaluation.

$$I = I_{SC} \left[1 - C_1 \left(e^{\frac{V}{C_2 \cdot V_{OC}}} - 1 \right) \right]$$

Where

$$C_1 = \left(1 - \frac{I_{MP}}{I_{SC}} \right) \cdot e^{\frac{-V_{MP}}{C_2 \cdot V_{OC}}}$$

$$C_2 = \frac{\frac{V_{MP}}{V_{on}} - 1}{\ln \left(1 - \frac{I_{MP}}{I_{SC}} \right)}$$

To further define the I-V characteristics, the following relationships are assumed:

$$V_{OC} = \frac{V_{MP}}{\sqrt{FF}} \quad \text{and} \quad I_{SC} = \frac{I_{MP}}{\sqrt{FF}}$$

8.1.1 I-V Curve Translation

The following provides a procedure for translating the I-V curve based on changes in irradiance and temperature from reference conditions.

Reference conditions for all simulated PV arrays are:

Reference Irradiance = I_{rrREF} = 1000 W/m²

Reference Array Temperature = T_{REF} = 50 °C

In the following test procedures, the characteristics of the simulated PV array are provided in terms of array fill factor, Maximum Power Point Voltage and Maximum Power Point Power. A simplified PV Array model defining the relationship between these values and other parameters is provided below:

$$P = P_{REF} \times \frac{I_{rr}}{I_{rrREF}} \times \left(1 + \frac{\beta}{100} \times (T - T_{REF}) \right)$$

$$V = V_{REF} \times \frac{\ln(I_{rr})}{\ln(I_{rrREF})} \times \left(1 + \frac{\beta}{100} \times (T - T_{REF}) \right)$$

$$P = V \times I$$

$$FF = \frac{V_{MP} \times I_{MP}}{V_{OC} \times I_{SC}}$$

where:

P = Power, Watts

I_{rr} = Irradiance, W/m²

β = Array temperature Coefficient, %/°C

T = Cell temperature, °C

V = Voltage, V

I = Current, A

FF = Fill factor

Subscripts:

REF = Reference (i.e., at reference or rated conditions)

MP = Maximum Power

OC = Open Circuit

SC = Short Circuit

PV Array Type Descriptions for MPPT Tests

Array #	Array Type	Nominal Fill Factor* (FF)	Temperature Coefficient (β , %/°C)
1	Thin-film	0.55	-0.25
2	Standard Crystalline or Multi-crystalline	0.68	-0.38
3	High-efficiency Crystalline	0.80	-0.50

8.2 EN50530 (PV Generator Model)

MPP to open circuit voltage ratio:

$$FF_v = \frac{V_{MPP;STC}}{V_{OC,STC}}$$

MPP to short circuit current ratio:

$$FF_I = \frac{I_{MPP;STC}}{I_{SC,STC}}$$

Formula for the PV current as a function of PV voltage:

$$I_{PV} = I_{SC} - I_0 \left(e^{\frac{V_{PV}}{V_{OC} V_{AQ}}} - 1 \right) \quad (C.5)$$

Irradiance G and temperature T dependent short circuit current in Equation (C.5):

$$I_{SC} = I_{SC,STC} \frac{G}{G_{STC}} \cdot (1 + \alpha \cdot (T_{PV} - T_{STC}))$$

Irradiance and temperature dependent open circuit voltage in Equation (C.5):

$$V_{OC} = V_{OC,STC} \cdot (1 + \beta \cdot (T_{PV} - T_{STC})) \left(\ln \left(\frac{G}{C_G} + 1 \right) \cdot C_V - C_R \cdot G \right)$$

Irradiance dependent current I_0 in Equation (C.5)

$$I_o = I_{SC,STC} (1 - FF_I)^{(1/(1-FF_v))} \frac{G}{G_{STC}}$$

Constant C_{AQ} in Equation (C.5)

$$C_{AQ} = \frac{FF_v - 1}{\ln(1 - FF_I)}$$

Voltage ration from V_{MPP} at an irradiance of 200 W / m^2 to V_{MPP} at an irradiance of 1000. W / m^2 .

$$V_{L2H} = \frac{V_{MPP} |_{G=200W / m^2}}{V_{MPP} |_{G=1000W / m^2}}$$

The parameter of the PV generator model must be set as follows:

	cSi-technology	Thin film technology	Tolerance
FF_V	0.8	0.72	<1%
FF_I	0.9	0.8	<1%
C_G $[W / m^2]$	2.514E-03	1.252E-03	-
C_V	8.593E-02	8.419E-02	-
C_R $[m^2 / W]$	1.088E-04	1.476E-04	-
V_{L2H}	0.95	0.98	$\pm 1\%$
α $[\% / ^\circ C]$	0.04	0.02	-
β $[\% / ^\circ C]$	-0.4	-0.2	-

9. Shadowed I-V Curve Simulation Panel

The purpose of Shadowed I-V Curve Simulation is to let the user plan the combination of PV Array and perform the Shadowed I-V simulated output on inverter for testing.

Following explains the operation of this simulation panel. First, specify the maximum output voltage and current of connected devices and then define the number of PV Modules as well as PV Strings for series or parallel connection to form a customized PV. This simulation function has a built in battery database that the user can select the model number of solar modular and the manufacturer to simulate. The area for shadow simulation can be set within the range of customized PV Array and output after tuning the Voc, Isc, Vmp and Imp parameters as required. It can also simulate the shadowed I-V curve output and view the curve change as well as the UUT loading status. For example, the soft panel will show the reading status of loading when the PV Inverter is performing MPPT.

Furthermore, the soft panel also has Report and parameters storage functions for analysis and reference. Figure 9-1 shows the simulation panel.

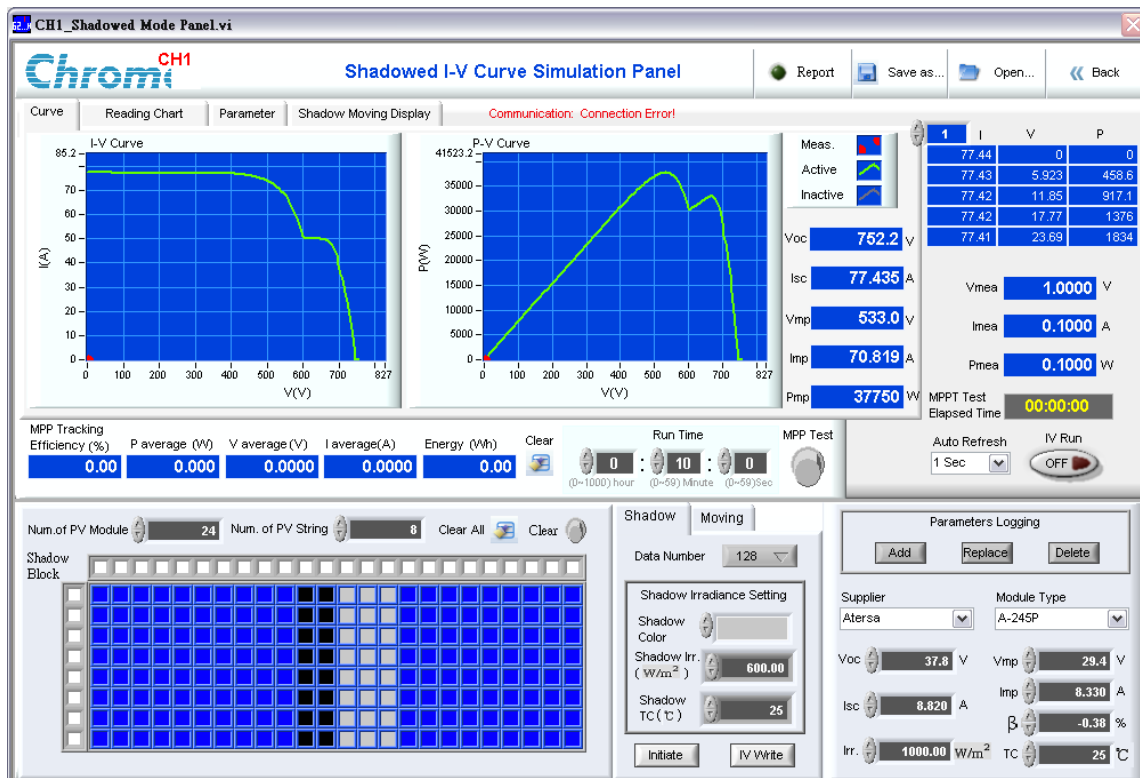


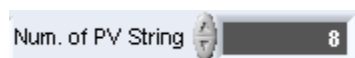
Figure 9-1 Shadowed I-V Curve Main Panel

9.1 Parameters in Shadow Block

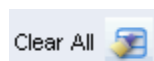
The user can base on the maximum output voltage and current of the connected device to select the number of PV Modules and PV Strings for series or parallel connection and form a customized PV Array. The parameters and buttons are explained below:



: It sets the number of PV Module for series connection. The range is 1- 500 and the system default is 24. When the setting is done, the shadow blocks will increase as the figure shown below.



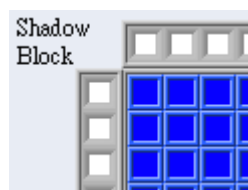
: It sets the number of PV Strings for parallel connection. The range is 1 – 50 and the system default is 8. When the setting is done, the shadow blocks will increase as the figure shown below.



: Click this button to clear all shadow block parameters to the color before setup. Blue indicates the color before shadowed.




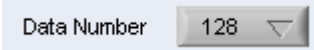
: Click this button to clear the parameters of a certain shadow block. It turns to red when clicked. Click and hold the mouse and move the pointer to select the gray scaled shadow block and clear the parameter gradually. Click this button again to switch back to the original state.

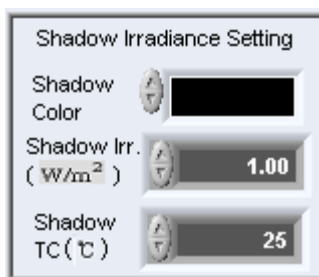


: It sets the shadow block parameters including the color and the shadow irradiance. Click the shadow block can set the active range, shape and color. When Initiate or IV Write button is clicked, it will update the IV curve for the set shadow immediately. Moreover, it can set the shadow range by selecting the checkbox on the top or on the left for entire column or line setup.


9.2 Setting Shadow Irradiance

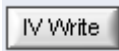
Before setting the previous shadow block, the user needs to define the shadow irradiance and mapped color. Switch the tab page  to set the parameters for Shadow and Moving testing. The parameters and buttons are explained below:

: It sets the IV curve data resolution. It will increase or decrease the data length of combined IV curve when the value is changed. The selectable resolutions are 128, 256, 512, 1024, 2048 and 4096 points 6 kinds of data length to indicate the IV curve resolution. This parameter will affect the time for transmitting the data to the device. The higher resolution the longer the transmitting time is required such as the interval for switch curve.



: It sets the shadow color, irradiance and temperature. There are 6 grayscale colors for Shadow Color setting. Shadow Irr. sets the irradiance for each gray scaled color and the range is 0 – 3000.00. Shadow TC is the environment temperature of the shadowed color and the range is -40 ~ 85°C (degree.)

: Click this button to preview the IV curve in the simulation area.

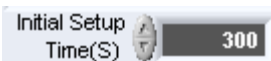
: Click this button not only to redraw the IV curve in the simulation area but also to transfer the IV curve parameter command data to the device and standby for IV curve output.

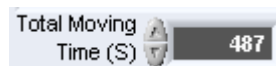
9.3 Setting Shadow Moving

Switching to the shadow Moving page can select 8 directions for moving the shadow to do dynamic simulation and curve output. The parameters and buttons are explained below:



: It sets the shadow moving direction. Click an arrow direction button of the 8 directions. When the cloud is moving for test, the color of entire shadow block will follow the direction for moving and redraw the shadowed waveform in the simulation area.

: It sets the time before moving the curve. The range is 0~65536 seconds.



: It sets the total moving times. The clouding moving will be done within the time set when doing the test. The cloud moves following the direction set until it is out of the settable range and ends the test automatically after the time passed. The maximum setting range is 9999999 seconds. Since the minimum moving out time varies with the IV curve data amount transmitted, the soft panel will be based on the IV curve data resolution set by



to judge and limit the minimum moving out time automatically. Table 9-1 lists the minimum moving out time.

Table 9-1 Minimum Moving Out time

Resolution	Standalone Mode	Master/Slave Mode
128	1 sec.	1 sec.
256	2 sec.	3 sec.
512	3 sec.	4 sec.
1024	4 sec.	5 sec.
2048	5 sec.	6 sec.
4096	6 sec.	8 sec.



: It shows the progress in BAR ratio when performing the cloud moving test.



: It enables and disables the cloud moving action. Click it to execute the cloud moving test immediately. The shadow block parameter icon will move following the direction specified and stop automatically when Total Moving Time is met.

Application:

When testing if the MPPT tracking of an inverter can find the maximum power point on a single Shadow I-V curve, please follow the steps below for setting and operation.

- ◆ First select a battery panel → plan the cell array → set a Shadow region → click Initiate to preview → click I-V Write to write in the parameter to hardware → click I-V Run to output.

When testing if the MPPT tracking of an inverter can find the maximum power point and transient characteristics on two Shadow I-V curves that are doing on-line change, please follow the steps below for setting and operation.

- ◆ First select a battery panel → plan the cell array → set a shadow region → click Initiate to preview → click I-V Write to write in the hardware → click I-V Run → change the Shadow region again → click Initiate to preview (gray I-V curve appears) → click I-V Write to write in the hardware (the blue active line will change to gray line.)

When testing if the MPPT tracking of an inverter can find the maximum power point and transient characteristics on an automatic changing Shadow I-V curve under cloud shade, please follow the steps below for setting and operation.

- ◆ First select a battery panel → plan the cell array → set a shadow region → click Initiate to preview → click I-V Write to write in the hardware → click I-V Run → change the moving direction and total moving time → click GO (the cell array will follow the planned direction to move out of the shadow region automatically).

9.4 Setting PV Modular Database and Parameter

The parameters in this area set the IV curve of basic PV Modular before the shadow starts running. It can categorize the PV Modular basic information by supplier and modular name and then save to the software database for selection. This block is described as below:



: It adds, replaces and deletes the name of PV Modular suppliers as well as the mapping parameters such as modular type, Voc, Isc, Vmp and Imp to or from the selection menu. The detail functions are described below.



: It adds new data. A parameter input window will prompt when this button is clicked. It brings out the Supplier Name automatically as Figure 9-2 shows. The user can re-enter the Supplier Name or Module Type Name in the window with maximum 255 characters. When done, click "OK" to save the data in the soft panel database successfully. The Supplier Name and Module Type Name cannot be empty; otherwise, a warning message of saving failure will prompt as shown in Figure 9-3. Click "Cancel" to quit adding new data. These two parameters are the index of soft panel database thus cannot be duplicated, or an error message will prompt when duplication is encountered.

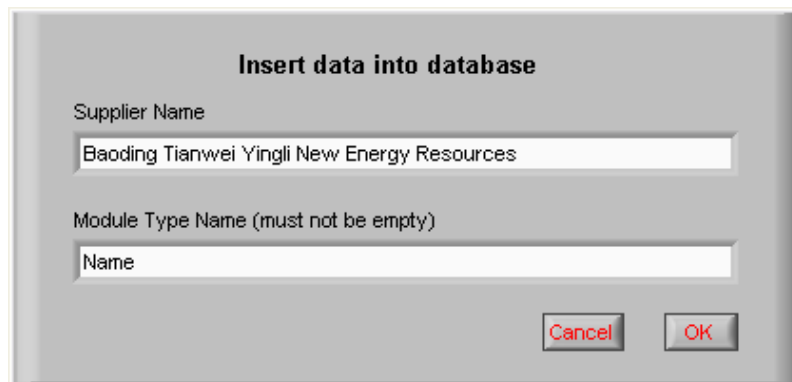


Figure 9-2 Supplier Name and Module Type Name Window

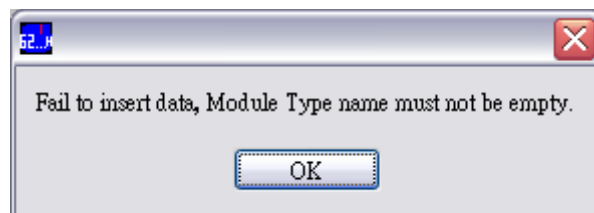


Figure 9-3 Warning Message for Saving Failure



: It replaces the modified data. Click this button will prompt a warning message to confirm if replacing the Voc, Isc, Vmp and Imp parameters in the database that associate with the Module Type displayed on the screen. For the factory default parameters that cannot be changed or deleted, a warning message will appear as Figure 9-4 if modifying them and no modification will be done.

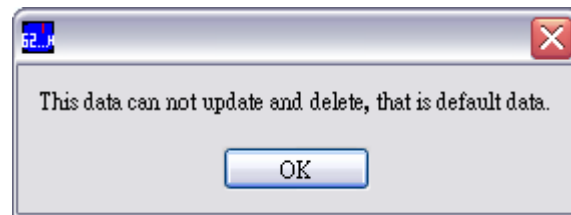


Figure 9-4 Warning Message of Invalid for Modification and Deletion

Delete: It deletes data. Click this button will prompt a warning message to confirm if deleting the Voc, Isc, Vmp and Imp parameters from the database that associate with the Supplier Name and Module Type displayed on the screen. For the factory default parameters that cannot be changed or deleted, a warning message will appear as Figure 9-4 if modifying them and no modification will be done.

Supplier
Baoding Tianwei

: It selects the PV modular supplier name. The contents are loaded and updated from the soft panel database automatically. The associate information such as the Module Type and Voc, Isc, Vmp, Imp parameters will bring out automatically when a supplier is selected.

Module Type
Module Name

: It selects the battery module name that maps to the selected supplier. The associate information such as the Voc, Isc, Vmp and Imp parameters will bring out automatically when a module is selected.

Voc 31.0 V

: It sets the Open Circuit Voltage parameter for PV Modular. The unit is Volt and the maximum output voltage is defined by the connected instrument. Once the value is changed, click Initiate or IV Write will calculate the new IV curve data. This setting will affect the FF value of IV curve. The normal value should be between 0.4~0.95 and the Voc has to be larger than Vmp or a warning message will appear and then return to the previous reason parameter setting.

Isc 8.000 A

: It sets the Short Circuit Current parameter for PV Modular. The unit is Ampere and the maximum output current is defined by the connected instrument. Once the value is changed, click Initiate or IV Write will calculate the new IV curve data. This setting will affect the FF value of IV curve. The normal value should be between 0.4~0.95 and the Isc has to be larger than Imp or a warning message will appear and then return to the previous reason parameter setting.

Vmp 24.0 V

: It sets the Max. Power Voltage for PV Modular. The unit is Volt and the maximum output voltage is defined by the connected instrument. Once the value is changed, click Initiate or IV Write will calculate the new IV curve data. This setting will affect the FF value of IV curve. The normal value should be between 0.4~0.95 and the Voc has to be larger than Vmp or a warning message will appear and then return to the previous reason parameter setting.

Imp 8.000 A

: It sets the Max. Power Current for PV Modular. The unit is Ampere and the maximum output current is defined by the connected instrument. Once the value is changed, click Initiate or IV Write will calculate the new IV curve data. This setting will affect

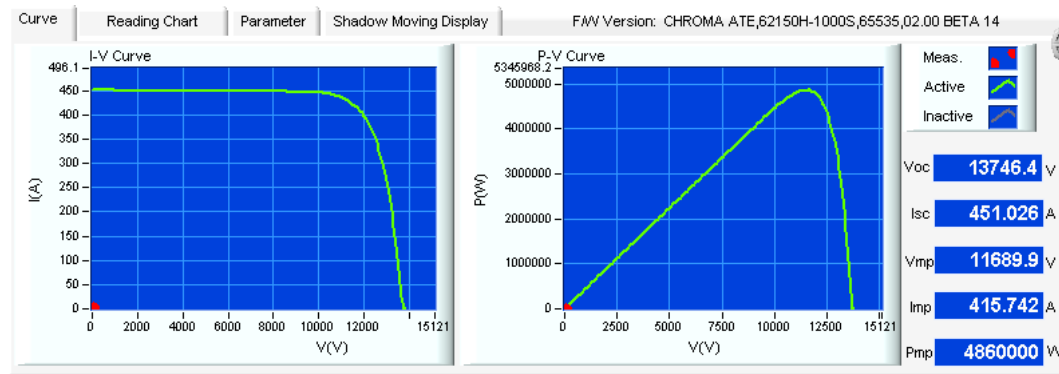
the FF value of IV curve. The normal value should be between 0.4~0.95 and the Isc has to be larger than Imp or a warning message will appear and then return to the previous reason parameter setting.

β % : It sets the Voltage Temperature Coefficient for PV Modular. The range is 0~-2.00 (percentage.)

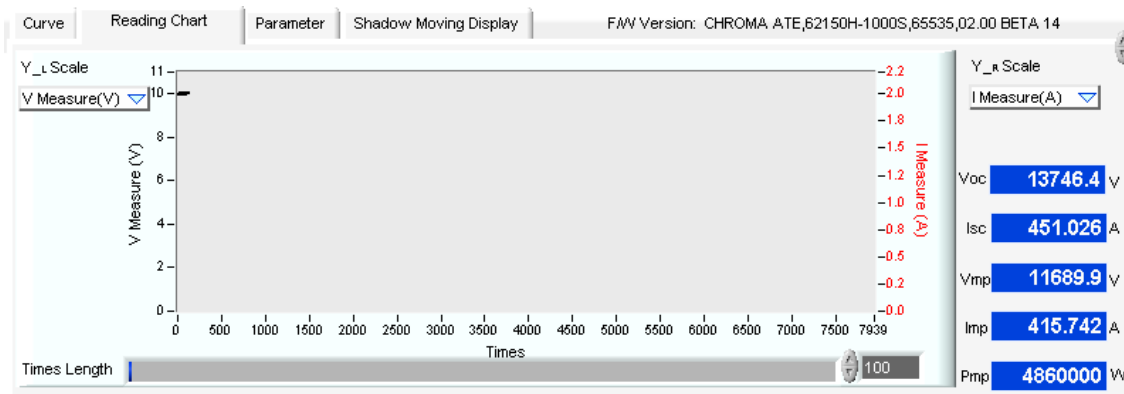
Irr. W/m^2 : It sets the irradiance reference standard (I-V parameters are rated at Standard Test Conditions of irradiance) that is used when testing the Voc, Isc, Vmp and Imp in PV Modular. The range is 0~3000.00 (Watt/per square meter.)

TC $^{\circ}\text{C}$: It sets the the temperature reference standard (I-V parameters are rated at Standard Test Conditions of cell temperature) that is used when testing the Voc, Isc, Vmp and Imp for PV Modular. The range is Celsius -40 ~ 85 $^{\circ}\text{C}$.

9.5 Curve Display Area for Shadow Simulation



For the functions of IV, PV simulation curve, please see section 4.4.7 *Simulation Curve*.



For the functions of Reading Chart, please see section 4.4.8.

Curve Reading Chart Parameter

I_V & P_V Scale Setting

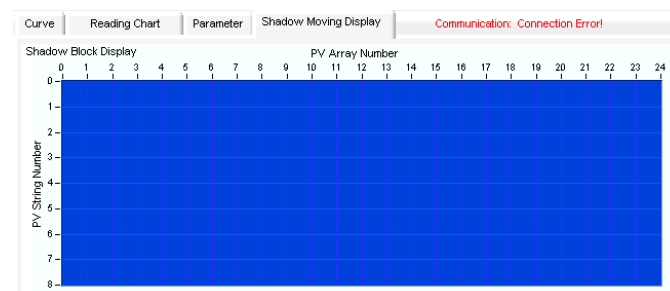
☒ Auto Scale Setting

Scale Vmax:

Scale Imax:

Scale Pmax:

It sets the X and Y axis maximum for IV and PV Curve. Select Auto Scale Setting and the soft panel will adjust the X and Y axis maximum automatically. It means to adjust manually if disabled and the setting of Scale Vmax, Scale Imax and Scale Pmax 3 parameters will be applied.



When Shadow Moving Display page is selected, it will show the user-defined cloud moving status dynamically. The solar array after connected in series or parallel (500*50 PV Array) will become one or several shadow blocks. This page can show the cloud moving status of entire solar array dynamically in real time to get the characteristic change of PV Inverter during tracking performance by simulating, analyzing and utilizing the actual cloud moving area and direction.

9.6 Other Measurement Parameters

1	I	V	P
451	0	0	
451	108.2	48810	
450.9	216.5	97620	
450.9	324.7	146400	
450.9	433	195200	

: It queries and displays the IV curve data. Use the index



on the upper left corner to query the contents of data table. The data length will follow the setting of IV curve data resolution to change between 128 ~ 4096 entries.

V measure

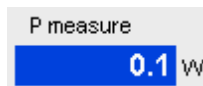
1.000 V

: It shows the UUT output voltage in real time. The unit is Volt.

I measure

0.1000 A

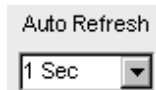
: It shows the UUT output current in real time. The unit is Ampere.



: It shows the UUT output power in real time. The unit is Watt.



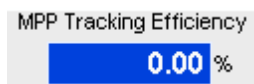
: It shows the time elapsed for MPP Test in the format of hour:minute:second.



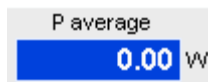
: It selects the time interval for refresh (0.5~10 sec.)



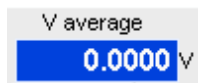
: It starts and stops testing by switching to ON or OFF.



: It shows the MPPT efficiency in percentage.



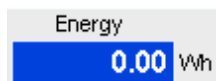
: It shows the total average of power. The unit is Watt.



: It shows the total average of voltage. The unit is Volt.



: It shows the total average of current. The unit is Ampere.

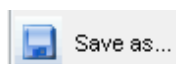


: It shows the total energy. The unit is Watt/hour.



: It triggers the MPP (Maximum Power Point) test. Click it to start testing and click again to stop testing. When working with GO, the software will delay a period of Initial Setup Time when executing shadow testing. This MPP Test button will be automatically enabled to start testing.

9.7 Description of Function Bar



: It saves the parameters set in the soft panel to a file with extension *.shd. It allows the user to open the file and use the same parameters rapidly.



: It opens the parameter file set previously with extension *.shd. It allows the user

to load the parameter settings directly for testing.



: It returns to the Main Panel.



: It enables the Report Generator as a value recording tool. Please see chapter 5 for detail function description.



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