



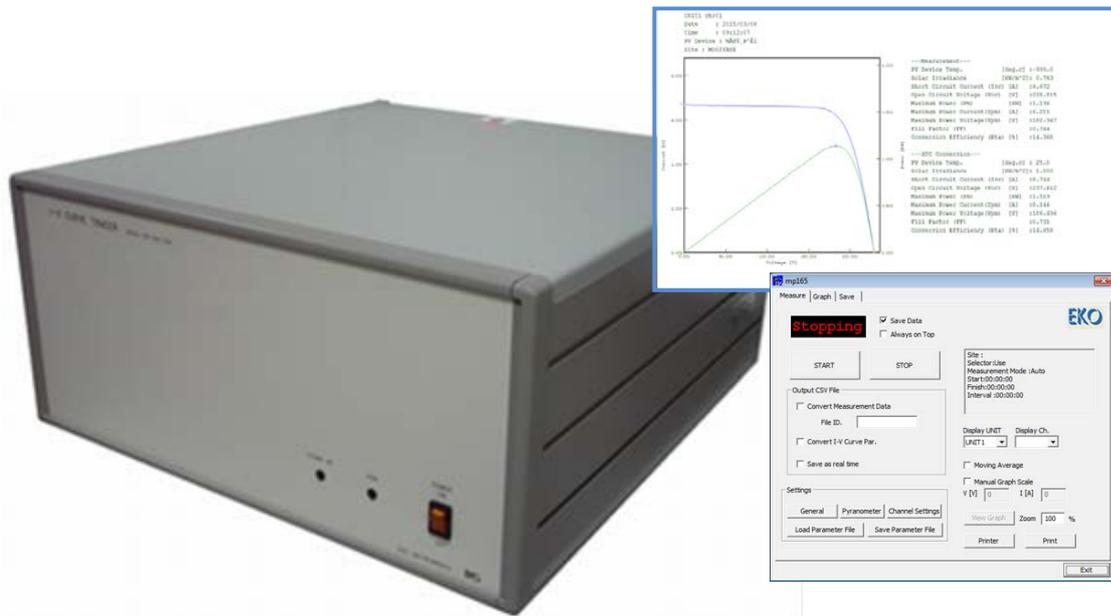
INSTRUCTION MANUAL

I-V Curve Tracer

MP-165

Software Version : 2.3.X.X

Manual Version : 1.1



EKO INSTRUMENTS CO., LTD.



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I. SAFETY PRECAUTIONS

Warning

- Make sure to read thoroughly and understand this manual before operating MP-165.
 - Keep this manual in handy location in case it is needed.
 - Follow the original usage of this device and the direction given on the instruction manual.
 - Always comply with the directions for safety upon understanding the meaning of the directions.
 - For any unclear issues and concerns, please contact EKO before using the device.
-

《About the Instruction Manual》

Although the contents of the instruction manual are carefully written, in case there are any unclear, mistype, or missing information are found, please kindly contact EKO.

FOR SAFE AND PROPER USE



This sign indicates that if it is ignored and the device is use incorrectly, it may cause death or fatal accident.

- When connecting and disconnecting MP-165 to and from the PV device, always check the connector areas by using tester and so on before operating for any risks of electric shocks.
- Connect the PV devices and all the other devices around to the ground by grounding cable. If it is not appropriately grounded, it may cause electric shocks and/or electric leakage accidents.
- Do not touch the terminal block and the power plugs of MP-165 with wet hands. This may cause electric shocks and/or electric leakage accidents.
- When using MP-165, turn OFF and then disconnect the power of the PV device and all the other devices including inverter, and take measurement in a condition which is not connected to anything other than MP-165.
- Always use the connecting terminals and cables which meet the rating capacity of the PV device, and make sure to connect securely so that they will not come off from the connector.
- Do not use for other than its original usage purpose of MP-165.
- Do not disassemble, modify, or touch inside of MP-165.
- Always check the voltage and type (AC/DC) of the power supply whether they are appropriate for MP-165 then turn ON the power switch.
- If smoke or odor from MP-165 is noticed, immediately turn OFF the power switch.
- Do not use MP-165 in a place which applies vibration or impact, with high humidity or dust, extreme temperature changes, or near existence of strong electromagnetic wave. These will lead to breakage.

II. MEASUREMENT SYSTEM

Electronic Load Method I-V Curve Tracer MP-165 is a next generation I-V curve tracer which is capable of measuring the wide range of PV device characteristics from small capacity to big capacity. It is capable of taking samplings of voltage, current, and solar irradiance at the same time; also it is easy to take measurement with artificial light source (sequential illumination). Connecting to computer by using RS-232C connector, it allows to indicate the measured data in graph and saves as file by using the attached measurement software.

III. BASIC SPECIFICATION

1. Specification

Rating Voltage:	400V (Maximum 410V)
Rating Current:	20A (Maximum 21A)
Rating Output:	3000W (Maximum 3100W)
Sweeping Direction:	From direction of $V_{oc} \rightarrow I_{sc}$; sweeping from $I_{sc} \rightarrow V_{oc}$ can be selected from software. ※ However, do not select sweeping direction from $I_{sc} \rightarrow V_{oc}$ for PV cells which would be destroyed by reverse bias, such as dye sensitized PV cells. It may damage the PV cell side.
Bias Function:	In order to accurately measure the open voltage (V_{oc}) and the short circuit current (I_{sc}), the vertical axis and the horizontal axis of voltage and current graph need to intersect each other on the graph. To do so, the bias voltage is applied. There are 2types of bias voltage, sequential bias and reverse bias. Sequential Bias: There is +10~15% of voltage against V_{oc} is added; however, when the V_{oc} is less than 0.6V, there is only 1~1.2V added. Reverse Bias: When the 8 samplings are taken consecutively in the negative voltage range, there is no reverse bias voltage that is lower than this to be added. It depends on the PV device current value, but it will be within -0.5V~-1V. When the sweeping direction is " $I_{sc} \rightarrow V_{oc}$ ", the voltages will change depending on the current range specifically such as, maximum -9V (20A range), -2V (3A range).

Temperature Input: 2 (can be selected from T-type thermocouple or K-type thermocouple on software)

Solar Irradiance Input: 1 (30mV Full Scale)

Light Amount Input (REF): 1(300mV Input, external Shunt Resistance)

Accuracy: 0.5% of FS

Resolution: 1/1000 of FS

Sweep Time: 2~330 sec.

A/D Converter: 16 bit (± 15 bit)

Voltage Range: 400V, 30V

Current Range: 20A, 3A

Effective Data Count: 256 sets (256 each: Voltage, Current, and Light Amount)

Selector Control: Up to 8 PV/Irradiance/Temperature Selectors by EKO

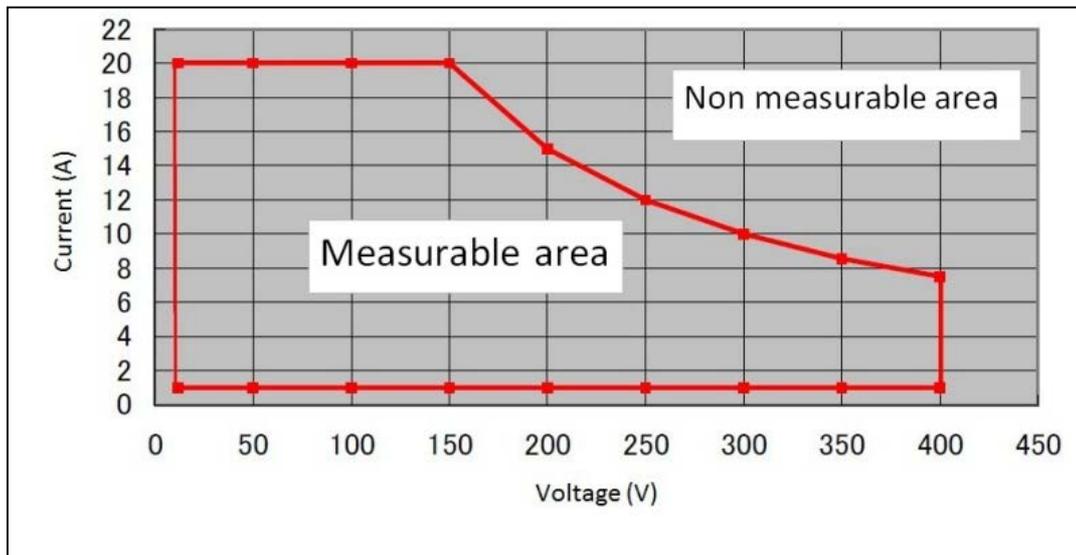
PC Communication: RS-232C 38400bps
8bit, 1 Stop bit, Parity: none, X on/off Flow Control, delimiter CR+LF

External Dimension: 199H x 430W x 450D

Weight: Approximately 15 kg.

Power Source: AC 100V ~ 240V 50/60Hz, 270VA

Measureable Range: Minimum 15[V], 0.5[A]



2. Operating Environment

OS: (XP)/7/8 (Japanese/English Bilingual)

Hard Disk Available Space: 300MByte or more

Display Graphic Resolution: More than 1024x768 dots

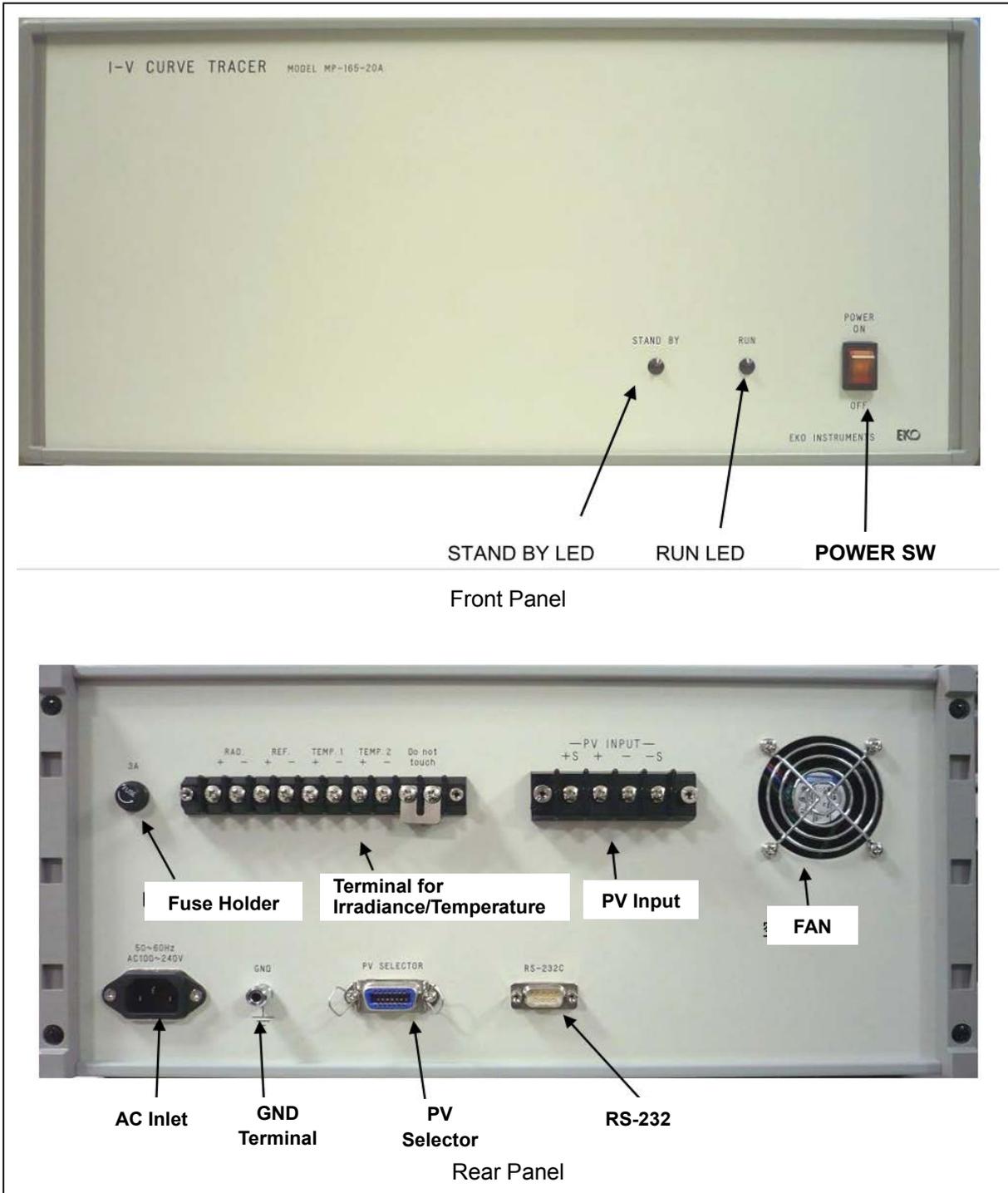
Computer must have more than one available COM Ports.

- **When taking sequential measurements for a long term with using USB-RS232C converter on the PC USB port, the measurements cannot be guaranteed.**
- **Do not use screen saver, power saving functions.**
- **Start the measurement software after finished with software such as virus check and TSR.**

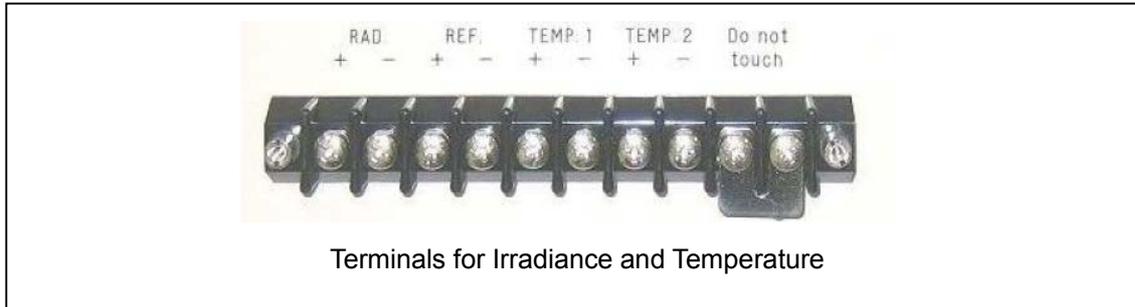
IV. GETTING START

1. MP-165 Parts Name and Descriptions

(1) Front and Rear Panel



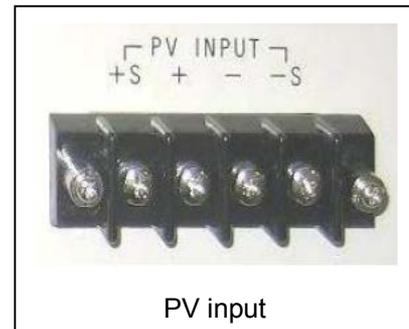
(2) Terminals for Irradiance/Temperature



- RAD: Pyranometer input channel
- REF: Reference cell input channel (External shunt resistance) or Photo-detector
- TEMP1 and TEMP2: 2ch. Thermocouple terminals. T-type or K-type thermocouple can be selected from software.
- Don't Touch: Terminal for terminal block reference temperature measurement (Do NOT touch this terminal)

(3) PV input

- +S : (+) PV module voltage input
- + : (+) PV module current input
- -S : (-) PV module voltage input
- - : (-) PV module current input



(4) PV Selector

Connector for PV/Irradiance/Thermocouple selector, such as MI-520/530/540/510S, MP-303/303S and other selectors. In the case two or more selectors should be controlled by MP-165, cascade connection can be made. Up to 8 selectors can be controlled by MP-165.

(5) RS-232

AC Inlet or GND Terminal 2C to connect PC. RS-232

Caution: Connection the PV module to the MP-165 make sure to switch OFF the main power and disconnect from all ancillary electric equipment (e.g. inverter). Wear electric insulated gloves to protect from electric shocks while connecting the PV module to the MP-165.

2. Package Contents

Check the package contents first; if any missing item or damage is noticed, please contact EKO immediately.

Package Contents

Items	Quantity	Remarks
MP-165 Main Unit	1	
AC code	1	Cable Length: 2.5m
RS-232C cable	1	RS-232 cross cable: 1.5m
Inspection Verification sheet	1	
CD-ROM	1	Instruction Manual & Software

V. SOFTWARE

1. Functions

(1) Measuring Solar Irradiance Intensity

Solar Irradiance Intensity can be measured by connecting a pyranometer. With a measurement value from the pyranometer, I-V curve measurement can be done in auto-range. Manual entering is also available, and converting in to reference value can be done.

NOTE: Auto-range is not recommended.

We recommend to set the range manually to 10% higher than Voc and Isc of the PV modules or a string, in order to avoid over-current by sudden increasing of the solar irradiance.

(2) Measuring PV Cell Back Surface Temperature

The back surface temperature of PV cell is measured per I-V measurement, and it is used for converting in to the value in standard test condition. T-type thermocouple or K-type thermocouple can be connected to 2ch. Also when the back surface temperature of PV cell is already known, the value (fixed value) can be manually entered from PC software.

(3) Measuring I-V Curve

Setup each parameter of the PV cell and measuring condition. Either manual or sequential measurement can be selected. There are two types of sweeping direction; Isc→Voc or Voc→Isc can be selected. Right after the measurement, the graph will be displayed automatically, and calculate and plot the Isc, Voc, and Pmax on the graph.

(4) Graph Display (Offline)

Measured data are saved on disk as daily file; given a particular date, data can be selected from the data list by measured time and displayed on a same graph as taking a measurement.

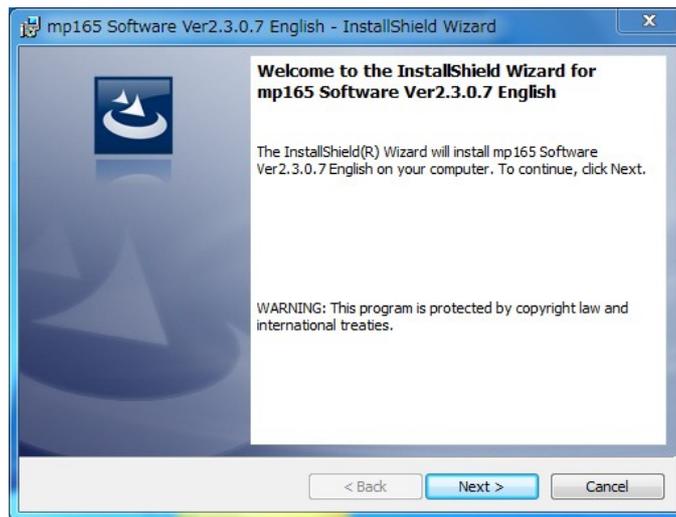
(5) Saving Data (Offline)

Select data with a particular date and time from the data list; this data can be converted into and saved as CSV format of text file.

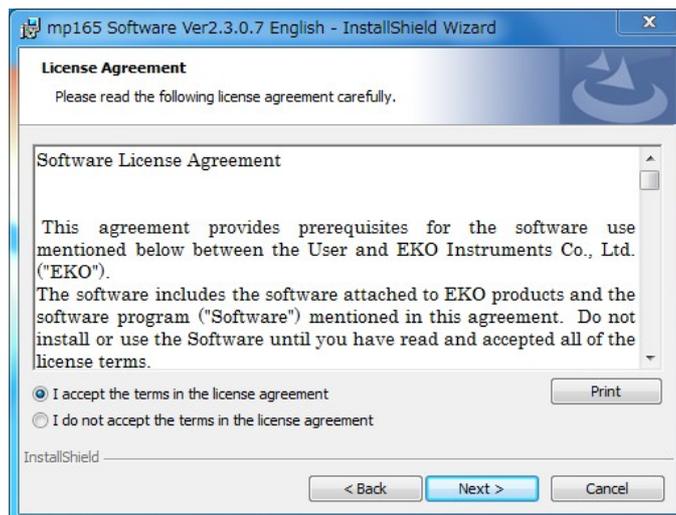
The conversion can be done in bulk, individual, or characteristics value format. These files can be read into spreadsheet software.

2. Installing Software

- (1) Turn on the PC Power, insert the Installation CD-R in the CD Drive as the Windows desktop screen is displayed.
- (2) Open a folder “MP165_20150501” on this Installation Disk then open “English”.
- (3) Double click “Setup.exe”.
- (4) Wizard window for the installation will appear; click [Next >] button to go to the next step.

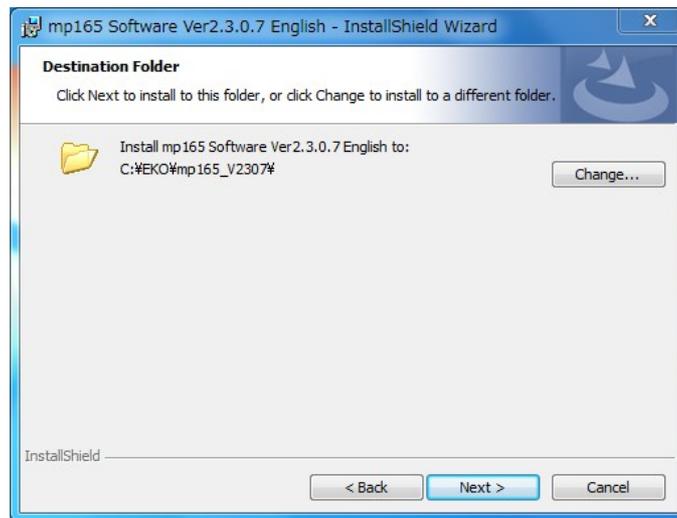


- (5) Below “Software License Agreement” window will appear. Select “I accept the terms in the license agreement” and click [Next >] button



- (6) “Destination Folder” window appears. If the software is installed in “C:\EKO” folder, click [Next >] button to go forward. If installing in different folder, click [Change] button to select a desired folder.

NOTE: When changing the installation folder and using a PC with Windows Vista/7/8 for Operation System, UAC (User Account Control) function will be activated. Trying to access and install and/or save data in a folder which OS is controlling the folder access, it may cause problems. “C:\Program Files”, “C:\ProgramData”, “C:\Windows”, and system drive route folder “C:\” are examples of the controlled folders. When changing the installation folder, make sure to select a folder other than mentioned above.



- (7) Installation confirmation window appears. Confirm the destination folder and click [Install] button to go forward.



- (8) After a while, the screen gets dark and “User Account Control” window appears. Clicking [Yes] button will start installation.

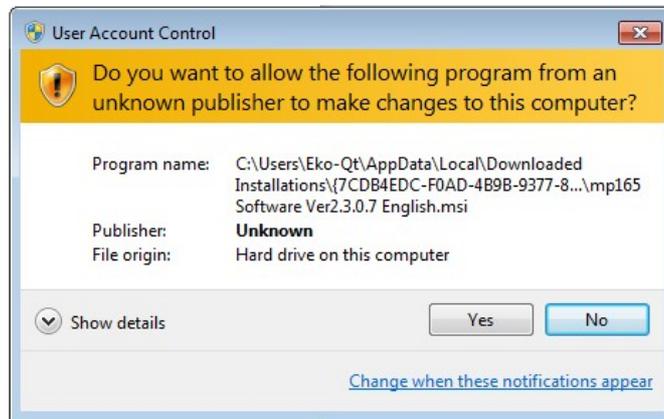
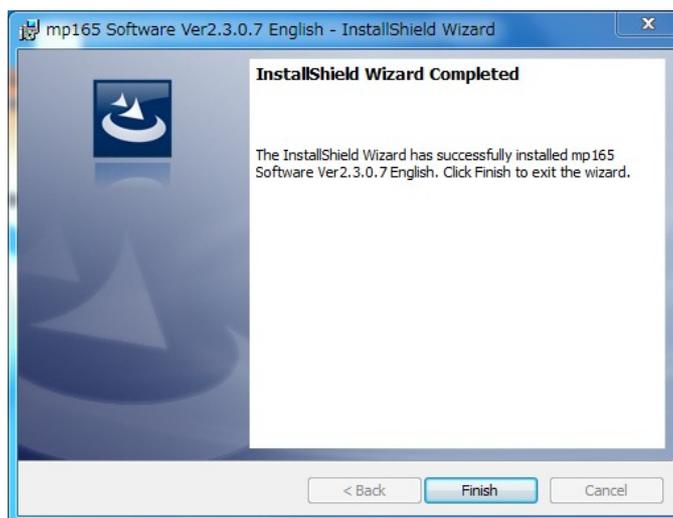


Figure 8-5. User Account

- (9) Once the installation is completed, below window appears. Click [Finish] button to close the installation wizard window.



- (10) When the installation is complete, shortcut icon is created on the desk top. If clicked on “create shortcut in start menu”, below shortcut icon is created.



MP165 Shortcut Icon

NOTE: Do NOT copy and start any older version software in same directory.

3. Uninstalling Software

There are 2 ways for uninstalling the software from PC.

(1) Uninstalling from [Program and Features]

Access in the order of: [Control Panel] → [Program] → [Program and Features] by clicking. Select the program to be deleted. Popup menu will appear by right-clicking on the deleting item; select "Uninstall (U)".

Confirmation message window will appear. To uninstall, click [Yes] button. Soon the item will disappear from the Program and Features window and the software is uninstalled.

(2) Uninstalling from Install Disk

Just like when the software was installed, access from CD-ROM to start-up the Setup.exe for the software to be uninstalled.

Follow the messages indicated on this window and if the software is already installed, "Modify", "Repair", and "Remove" are shown on the window as options.

Select "Remove" on this window and click [Next >] button.

Follow the guide messages and the installed software is uninstalled.

4. Operating Software

When the “mp165_V230x.exe” is started, the main screen window is displayed; in this window, there are three tab menus; “Measure”, “Graph”, and “Save”.

(1) “Measure” Tab Menu

Each functions and definitions of Measure menu display are described as below:

The screenshot shows the 'mp165' software window with the 'Measure' tab selected. The interface includes a menu bar (Measure | Graph | Save), a status bar (Stopping), and several control panels. Callouts on the left side describe the following elements:

- Check here to always keep this window on the top:** Points to the 'Always on Top' checkbox.
- Displays measuring mode:** Points to the 'Stopping' status display.
- Starts Manual/Auto measurement:** Points to the 'START' button.
- Output CSV file format of measurement data. (See “Save” Tab):** Points to the 'Convert Measurement Data' checkbox.
- Save CSV file at measurement:** Points to the 'Save as real time' checkbox.
- Setups channels:** Points to the 'Settings' section.
- Setting pyranometer calibration constant value:** Points to the 'Pyranometer' sub-tab.
- Setups measurement conditions, etc.:** Points to the 'General' sub-tab.

Callouts on the right side describe the following elements:

- Check here to save measured data:** Points to the 'Save Data' checkbox.
- Stop measurement:** Points to the 'STOP' button.
- Setups graphing unit:** Points to the 'Display UNIT' dropdown menu.
- Setups graphing channel:** Points to the 'Display Ch.' dropdown menu.
- Setups movement averaging procedure:** Points to the 'Moving Average' checkbox.
- Setups display range:** Points to the 'V [V]' and 'I [A]' input fields.
- Start printing:** Points to the 'Print' button.

Callouts at the bottom describe the following elements:

- Uploading saved parameters:** Points to the 'Load Parameter File' button.
- Saving setup parameters:** Points to the 'Save Parameter File' button.
- Printer setup:** Points to the 'Printer' button.
- Exit program:** Points to the 'Exit' button.

First, click “General” button to setup the communication, automatic measurement time, and measurement data save location. (If a parameter is already saved, click “Load Parameter File” button to upload the parameter file.)

A) General Setting Dialog

Enter the following items, then click **OK** button.

Site:

Enter the name of the site (for your reference)

COM Port:

Communication port setting with MP-165

Baud Rate:

Communication speed with MP-165 (Usually select "38.4kbps")

Waiting Time for Channel Switching:

Waiting time between channels when switching unit for modules is used (usually setup zero "0" seconds, maximum time is 1.5 seconds).

Measurement Mode:

Manual/Automatic measurement setups

Auto Measurement Schedule:

Measurement start time, end time, and intervals are setup; by clicking the **START** button, measurement for long period of time is started automatically for the assigned time frame.

Sweeping Direction:

Sweeping directions of $I_{sc} \leftarrow V_{oc}$ or $I_{sc} \rightarrow V_{oc}$ can be selected and setup.

Solar Irradiance from Reference Data Measurement:

Solar irradiance value used for STC conversion can be selected from either entering pyranometer or reference cell

Thermocouple Type:

Select either T-type or K-type thermocouple.

Time Adjustments:

● **Time difference setup with UTC**

Coordinate Universal Time, UTC (almost equivalent as Greenwich Mean Time, GMT) will be setup.

This will be registered in AutoSave.prm file when the software is started for the very first time; it automatically acquires this setup and then exits the program.

This function is to display the data measured in different time zone (overseas) with the local time. If measurements are taken within Japan, this setup is not necessary.

● **Local Time Adjustment:**

This function is used to display the data, which was taken with old version software and in different time zone, shown in the local time. If the data is taken with new version software, this process is not necessary.

General Setting Dialog

Data Folder:

Setup the save location for the measured data. (Click **Browse** button, directory becomes available).

Converted Data Folder:

Setup the save location for the converted data. (Click **Browse** button, directory becomes available.)

⌘ **Data Folder and Converted Data Folder should be created before selecting.**

B) **Pyranometer Setup Dialog**

Enter all items listed below and click **OK** button.

Pyranometer Thresholds:

To differentiate the measurement data between normal and insufficient irradiance intensity, setup the irradiance intensity thresholds. When operating the Graph and Save tabs, there are options to show/not show the data with insufficient irradiance intensity.

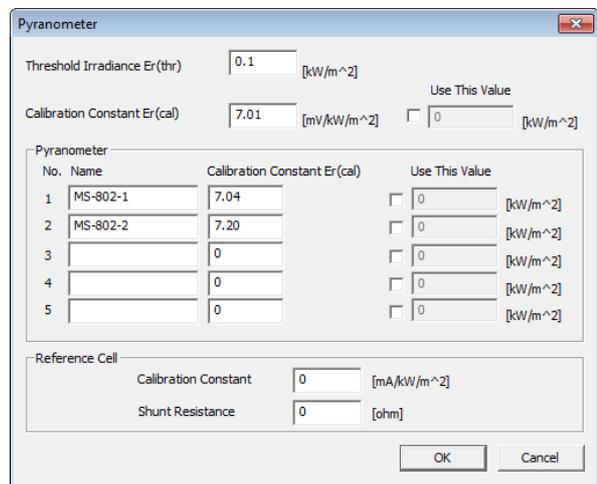
Pyranometer Calibration Constant:

Setup the calibration constant value of a pyranometer which is connected to MP-165.

Pyranometer:

When using Pyranometer switching unit, setup the “name” and “calibration constant” of pyranometers up to 5 units.

⌘ **When using module switching unit and there is only one unit of pyranometer on the main unit, enter the pyranometer name and calibration constant in No. 1 box.** If checked on “**Fixed to This Value**”, the irradiance intensity can be entered as fixed value, and the output characteristics will be graphed with this value. (This is used when using solar simulator and the irradiance intensity is already known.)



Pyranometer Setting Dialog

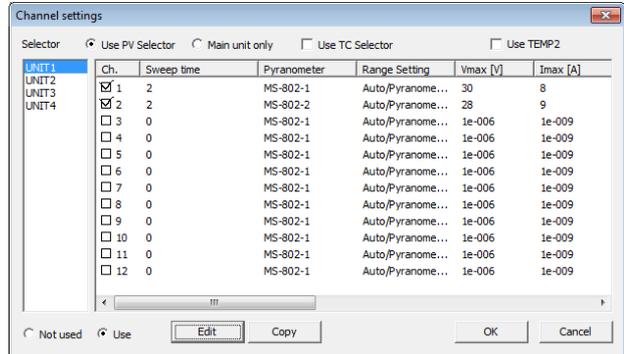
C) Channel Setting Dialog

Setup the following items and click **OK** button.

- **Setup for Using Switching Unit**

Select either to use the PV cell switching unit or only the main unit.

If switching unit is used, check on the “Use switching unit” checkbox. Also, if the switching unit for thermopile (temperature switching unit) is used, check the “Use thermopile switching unit” checkbox.



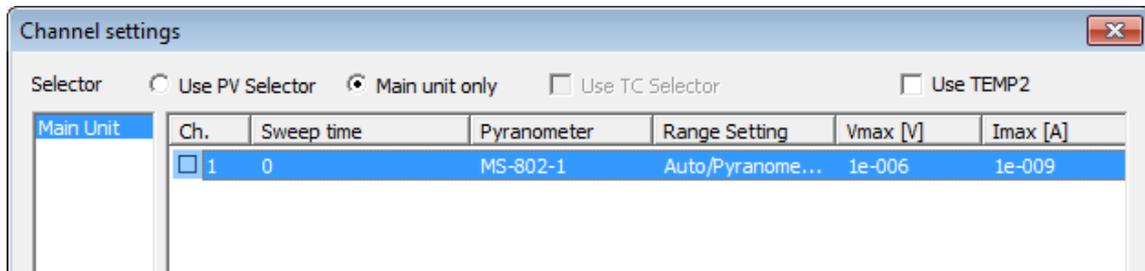
Channel Setting Dialog

- **How to measure 2 thermopiles against 1 PV module**

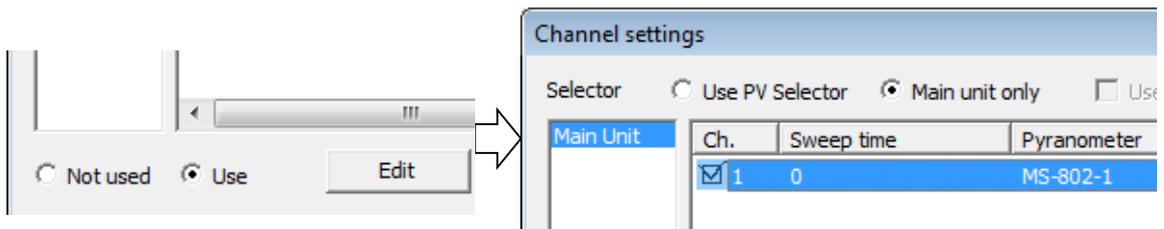
When taking measurement with two thermopiles against one PV module, check “Use T2” checkbox.

- **Channel Settings for When Using only the Main Unit**

Bring the mouse cursor to “ 1” on the Ch. Column and click. Once the channel is selected, the channel line is highlighted as “ 1”.

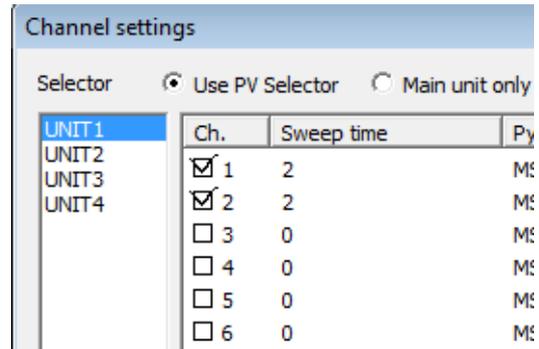


In this condition, it can be setup to use or not use the selected channels either by clicking the radio buttons “Not used” or “Use” at the left bottom of the dialog box or by double clicking the highlighted “ 1”. For the channels selected to use, the square box changes to .



- **Channel Settings for Using Switching Unit**

Select Switching Unit 1 ~ 4 and setup the CHs that are used.



D) Channel Editing Dialog

Setup the following items and click button.

After setting the channel to be used, select the channel part from to and click button; the edit screen for channels will be shown as described below.

Sweeping Time:

Sweeping time for 256 points of I-V curve sampling. 0~330 seconds (Usually it takes approximately 1.4 seconds unconditionally when it is setup at values between 0~1 seconds; when the setup value is more than 2 seconds, the entered value becomes the sweeping time.)

Pyranometer:

This is setup when switching unit is in use. Set it up when only module switching unit is used.

Range Setup:

Settings for Auto-Range/Manual-Range. Select either “Auto/with Pyranometer” or “Manual/with Rating Value”

Rating Voltage Vmax:

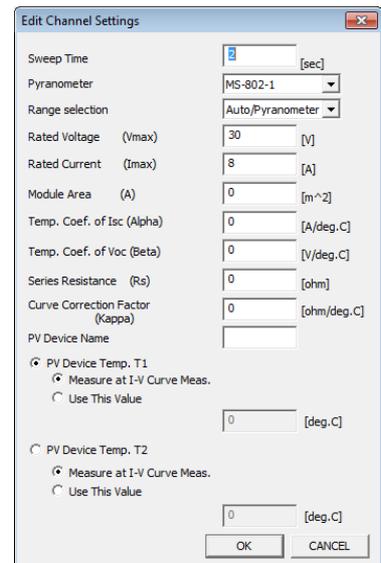
Setting rated voltage of PV module/array to be measured. Usually set the nominal open voltage current (Voc).

Rating Current Imax:

Setting rated current of PV module/array to be measured. Usually set the nominal open current (Isc).

PV Cell Area A:

Setting the area of PV module/array to be measured.



Channel Editing Dialog

Short-Circuit Current Compensation Coefficient α :

Setting short-circuit current compensation coefficient.

Open Voltage Temperature Coefficient β :

Setting open voltage temperature coefficient

Series Resistance R_s :

Setting series resistance.

Curve Correction Factor k :

Setting curve-correction factor.

PV Cell/Module/Array Name:

Setting PV cell/module/array name

PV Cell Temperature T1 and T2:

Choose and check the radio button for either using T1 or T2 for the two thermocouples as PV cell temperature. When the “T2” is not selected to use on the Channel Editing Dialog, it is forced to use T1. Choose either “Measure during I-V measurement” or “Fix to Current Value”. When “Fix to Current Value” is selected, enter temperature value also.

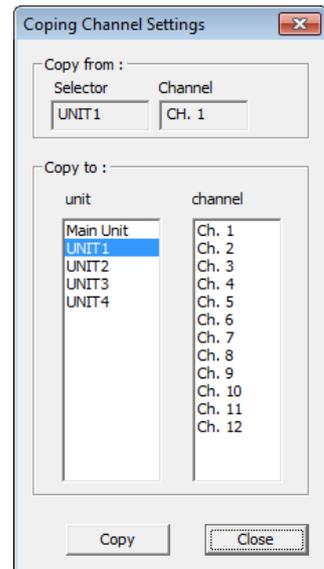
E) Copy Dialog for Channel Information

When using switching unit and multiple number of same type of PV modules/array, select the channel part from 1 to 12 and click **Copy** button; the same setting values are copied to other channel (s).

By selecting the CH. of the original channel and click **Copy** button, the copy dialog of the CH information is displayed.

Channel information is copied by selecting the unit and channel to be copied to, and click **Copy** button. Clicking **Close** button will exit this dialog. Enter all the items above and click **OK** on the Channel Editing Dialog Box.

Once all the settings are done, measurement can be started.



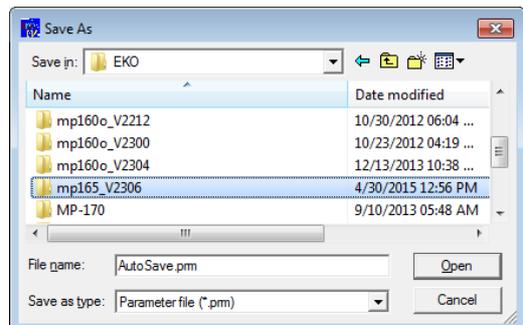
CH Information Copy Dialog

F) Saving Parameters

When parameter setting is done, make sure to save the parameter.

Also, when reading the parameter, assign the location to be saved and load the “*.prm” file.

⌘ **When the program was finished without saving parameters, the setup information at that time will be saved in AutoSave.prm file automatically.**



Parameter Saving

G) Starting the Measurement

When the “Measure” button is clicked, the measurement is started. When it is in the automatic measurement mode, it is indicated as “Standby” while waiting for the measurement. When terminating the automatic measurement, click the **Stop** button.

※ If desired to save the data, check the checkbox for “Save data” prior to taking measurements. (If the checkbox is not checked, the data will not be saved and cannot be reviewed afterwards.)



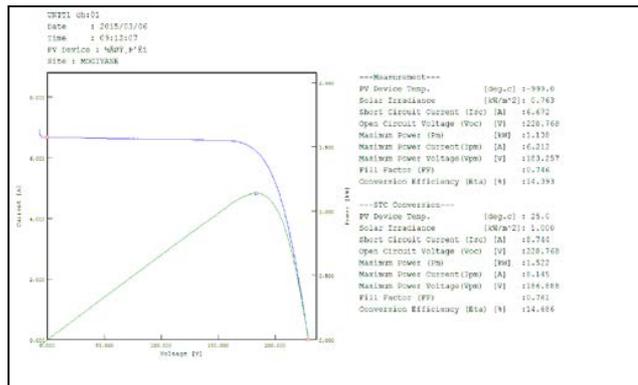
H) Displaying Measurement Results

When measurement is finished, the I-V curve graph will be displayed as shown on the right.

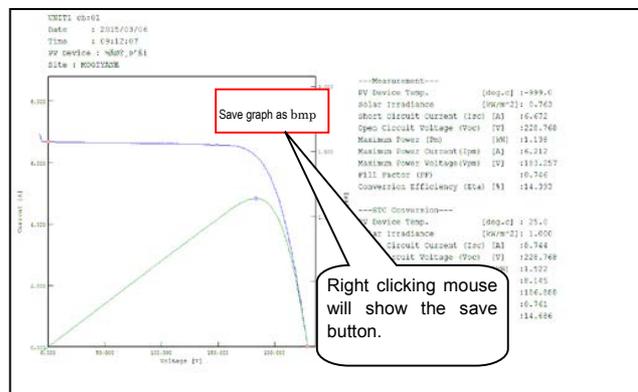
If the graph scale is not shown correctly, check the checkbox for “Assign Display Range”, enter the Vmax and Imax values, then click the **Graph** button again.

Also when using switching unit, select the “Display Unit”, and “Display Ch” to display the specific channel data.

When voluntarily clicking the mouse anywhere on the graph display, the button for saving the graph as bitmap file will appear. Clicking on this save button will save the image as bitmap; select a folder to be saved.

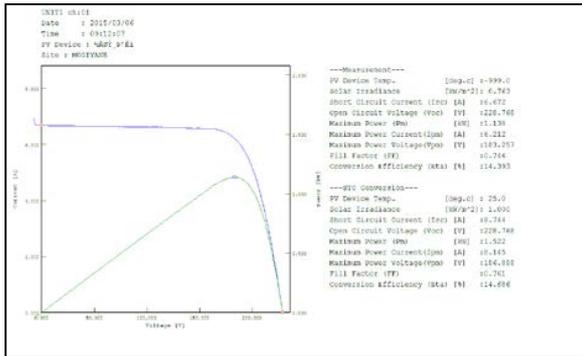


Displaying Measurement Result (I-V Curve)

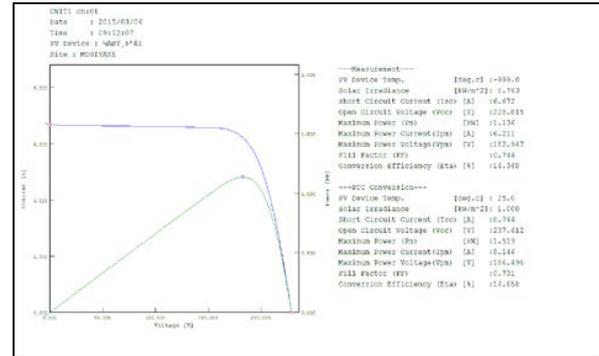


Saving Graph as Bitmap File

l) Movement Av



Without Movement Average Function



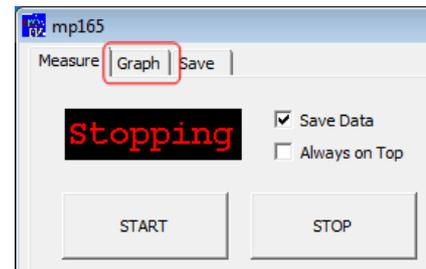
With Movement Average Function

An example of Movement Average Function is shown in below figure. When putting a check on this function, the average value of 10 points data is calculated consequently.

When the Main Window is hidden under the Graph Window and feels difficult to operate, check the checkbox for “Always on Top” prior to start measuring; the Main Window will always be on top on the desktop even if other windows are displayed.

(2) “Graph” Tab Menu

When “Graph” tab is clicked as shown on the left, the option display is displayed as below.



Each function on the Graph Menu is described as below:

- Select a Date from Calendar
- Select Data from Time specification
- Show measured Date
- Show list of units and channels
- Select all channels
- Clear all channels
- Limit showing data by irradiance value
- Select displaying graph
- Select graph indication color
- Displays data
- Same contents as Measure Tab

First, select a measured date on “Graph” tab menu. By clicking the down arrow button on the right side of the date display box, calendar will show.

In order to change the year and month, click the arrow buttons on the top of the calendar.

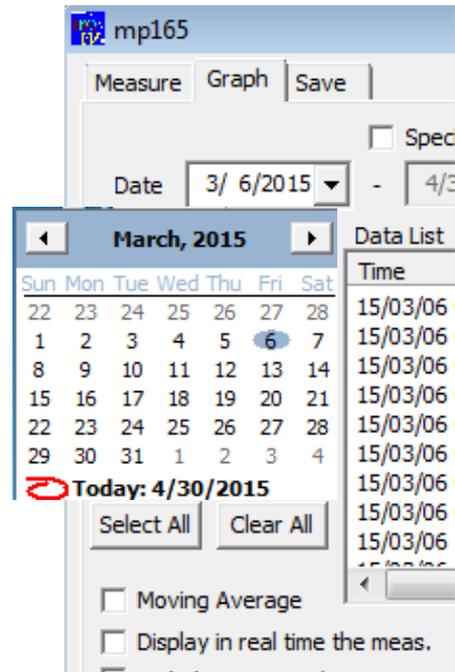
Clicking on the desired date will list the data taken on that particular day on the data list by each hour.

All channels will be selected on the CHANNEL window at first, thus un-select by clicking the “Clear All” button then select the desired units and channels.

Click the data time which to be displayed as graph, the data line becomes highlighted. By clicking the “Graph” button in this condition, the graph is displayed.

If the scale shown is inappropriate, place a check on graph range, enter the values for Vmax and Imax, and then click “Graph” button.

To graph P-V curve and/or STC I-V curve & P-V curve, place a check on .



※ When displaying a graph, setup the same parameter file as the measurement condition. If the parameter file is changed, especially the PV cell parameter and selection of pyranometer/standard cell, the graph will be shown with the STC calculation under the changed parameter file condition. The selection of thermocouple T1/T2 and thermocouple type T/K will effect on the STC conversion.

To change the colors of the I-V curve and/or P-V curve lines, click on the **Graph Color Setting** button and the dialog box for color setting will be shown on the right will be displayed. Select a desired color and click OK button.



To print the I-V curve, display the printer setting dialog box by clicking the **Printer Setting** button. Setup the “Printer”, “Paper”, “Print Direction” and so on then click **OK** button. After displaying the graph to be printed, click the **Print** button. Print dialog box will be displayed; setup the copy quantity and so on then click **OK** button.

(3) "Save" Tab Menu

By clicking the "Save" tab shown on the left figure, the Save Setting display is shown as below. Each function of the Save Menu screen is described as below:

The screenshot shows the 'Save' tab menu with the following callouts and functions:

- Displays Date:** Points to the date selection area.
- Select a date from calendar:** Points to the date selection area.
- Displays a list of Units and Channels:** Points to the Channel list on the left.
- Select/Clear all displaying units and channels:** Points to the 'Select All' and 'Clear All' buttons.
- Limit showing data by irradiance value:** Points to the 'Irradiance range' input fields.
- Converts a selected individual data into a text file:** Points to the 'Convert Selected Data' radio button.
- Convert by the specific value of a selected data into one file:** Points to the 'Convert I-V Curve Par.' radio button.
- Exit program:** Points to the 'Exit' button.
- Execute conversion:** Points to the 'Convert File' button.
- Displays a list of data:** Points to the 'Data List' table.
- Select/Clear all data on the data list:** Points to the 'Clear All' and 'Select All' buttons.
- ID name up to five characters can be given on individual conversion for manual measurement data:** Points to the 'File ID' input field.

Time	Unit	CH	PV D...	Auto...	Irradia...	M
15/03/06 09:12:07	UNIT01	CH01	½Ä...	Manual	0.763043	10
15/03/06 09:15:00	UNIT01	CH01	½Ä...	Auto	0.763333	10
15/03/06 09:20:00	UNIT01	CH01	½Ä...	Auto	0.772029	10
15/03/06 09:25:00	UNIT01	CH01	½Ä...	Auto	0.767971	10
15/03/06 09:30:00	UNIT01	CH01	½Ä...	Auto	0.788406	10
15/03/06 09:35:00	UNIT01	CH01	½Ä...	Auto	0.811884	10
15/03/06 09:40:00	UNIT01	CH01	½Ä...	Auto	0.827101	10
15/03/06 09:45:00	UNIT01	CH01	½Ä...	Auto	0.830725	10
15/03/06 11:25:04	UNIT01	CH01	½Ä...	Manual	1.12609	10

When saving the measured data by converting into text format, set the measured date to be saved and select "UNIT**□ch**" on CHANNEL window, the data for this channel will be displayed on the list. Select the data to be converted from the list item which displayed in order of measured time. Select from Convert All, Convert Selected Data, or Convert by Specific Value and click **Create File** button.

The saving data file is displayed on "File Name".

The converted data are converted into text file in the format described in the next page.

※ **When converting into text file format, setup the same parameter file as the measurement condition. If the parameter file is changed, especially the PV cell parameter and selection of pyranometer/standard cell, the graph will be shown with the STC calculation under the changed parameter file condition. The selection of thermocouple T1/T2 and thermocouple type T/K will affect I-V curve on the STC conversion.**

5. Graph Data and Essential Figure

The items measured on the MP-165 hardware side are only the current, voltage for the PV cell I-V curve, thermocouple (temperature), and voltage for reference cell. For other items such as short-circuit current I_{sc} , open voltage V_{oc} , maximum output P_m , maximum output operating current I_{pm} , maximum output operating voltage V_{pm} , fill factor F.F., conversion efficiency η are all calculated from the actual measurement value of I-V curve and irradiance.

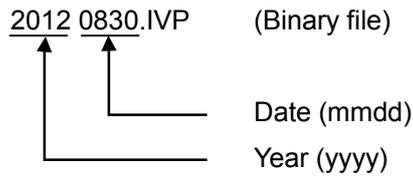
The graph data on the MP-165 software is setup with one decimal point indication for temperature and three decimal points indication for other items. They are not always matched with the essential figures. The measurement accuracy for the current and voltage values for I-V curve is $\pm 0.5\%$ against full scale, thus essential figure will be three figures. (Save file is not also saved with essential figures.)

Calculation method complies with JIS C8913. P_m fits at the approximation curve near the peak of I-V curve; the peak value is set as P_m , and its current value to be I_{pm} and voltage value to be V_{pm} . For open voltage V_{oc} and short circuit current I_{sc} are figured by calculating the cross point by linear approximation points near the I-V curve cuts across each X-axis and Y-axis. The Fill Factor F.F. is calculated with formula $[P_m / (I_{sc} \times V_{oc})]$, and the conversion efficiency η is calculated with formula $[P_m / (PV \text{ cell area} \times \text{irradiance})]$. The fourth decimal point is rounded up and the graph is indicated with three decimal points. Thus the values of P_m will not match completely with the graphed values when the P_m is calculated with formula $[V_{pm} \times I_{pm}]$.

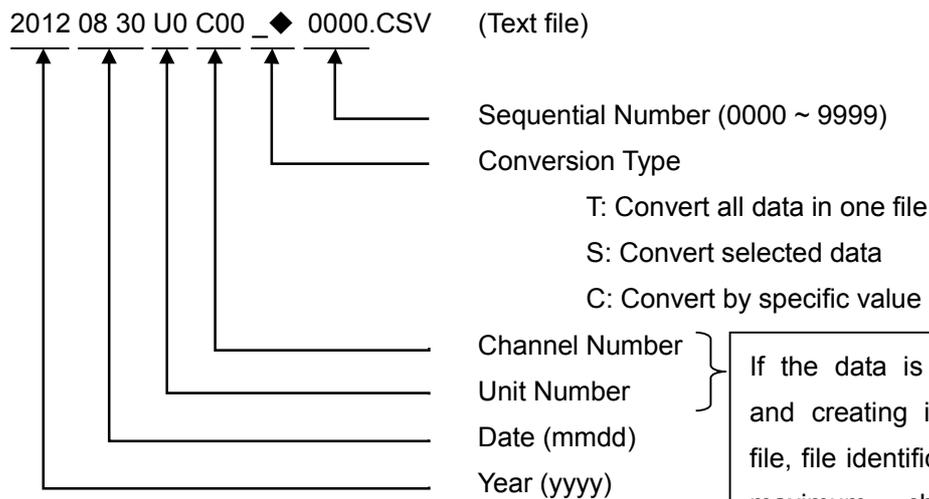
6. Data Format

Measured results are saved as binary file in assigned disk folder by date.

- Naming rule of the binary file is described as below:



- Naming rule of the text file is described as below:



T: Convert all data in one file
S: Convert selected data
C: Convert by specific value

If the data is measured manually and creating individual conversion file, file identification name with five maximum characters can be entered from key operation.

(1) I-V Curve Data File

Format for the text data which is created by Convert All, Convert Selected Data is shown below.

Voc	Isc	Jsc	Pm	Vpm	Ipm	Eta	FF	Voc(stc)	Isc(stc)	Jsc(stc)	Pm(stc)	Vpm(stc)	Ipm(stc)	Eta(stc)
[V]	[A]	[mA/cm ²]	[W]	[V]	[A]	[%]		[V]	[A]	[mA/cm ²]	[W]	[V]	[A]	[%]
228.768	6.672421	0.064376	1138.339	183.2566	6.211725	14.39341	0.74575	228.768	8.744483	0.084368	1522.191	186.8882	8.144932	14.68623
-7.6	6.942	6.942	0.05	-7.6	9.014062									
-7.616	6.937	6.937	0.04	-7.616	9.009062									
-7.568	6.932	6.932	0.08	-7.568	9.004063									
-6.848	6.746	6.746	0.07	-6.848	8.818062									
-5.776	6.676	6.676	0.05	-5.776	8.748062									
-4.72	6.674	6.674	0.06	-4.72	8.746062									
-3.536	6.674	6.674	0.07	-3.536	8.746062									
-2.512	6.672	6.672	0.05	-2.512	8.744062									
-1.392	6.67	6.67	0.04	-1.392	8.742063									
-0.368	6.67	6.67	0.04	-0.368	8.742063									
0.752	6.669	6.669	0.04	0.752	8.741062									
1.808	6.67	6.67	0.04	1.808	8.742063									
2.992	6.67	6.67	0.03	2.992	8.742063									
4	6.669	6.669	0.04	4	8.741062									

Indicates the information of channel and thermocouple used on STC conversion
 Ex.) Used K-t-type thermocouple on T1; (K)
 Used T-t-type thermocouple on T2; (T)

Indicates the sensor used on STC conversion

When converting all, items other than the measurement time is repeated

- Voc : Open Voltage [V]
- Isc : Short-Circuit Current [A]
- Jsc : Short-Circuit Current Density [mA/cm²]
- Pm : Maxi Output [W]
- Vpm : Optimum Operating Voltage [V]
- Ipm : Optimum Operating Current [A]
- Et(η) : Conversion rate [%]
- F.F. : Fill Factor
- Voc(stc) : Open Voltage [V]
- Isc(stc) : Short-Circuit Current [A]
- Jsc (stc) : Short-Circuit Current Density [mA/cm²]
- Pm(stc) : Max Output [W]
- Vpm(stc) : Optimum Operating Voltage [V]
- Ipm(stc) : Optimum Operating Current [A]
- η(stc) : STC conversion efficiency [%]

→ Total 256 Points

VI. CONTACT INFORMATION

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