INSTRUCTION MANUAL

MP-180

I-V Curve Tracer
For Single Measurements

EKO

1. Index

2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.
For any questions, please contact us at one of the EKO offices given below:

2-1. Contact Information

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2-2. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.
EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

In case of any manufacturing defect, the product will be repaired or replaced under warranty. However, the warranty does not apply if:

- Any modification or repair was done by any person or organization other than EKO service personnel.
- The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

2-3. About Instruction Manual

This manual was issued: 2016/09/26

Version Number: 7

2-4. Environment

1. WEEE Directive 2002/96/EC (Waste Electrical and Electronic Equipment)

This product is not subjected to WEEE Directive 2002/96/EC however it should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to designated collection points.

Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

2. RoHS Directive 2002/95/EC

EKO Instruments has completed a comprehensive evaluation of its product range to ensure compliance with RoHS Directive 2002/95/EC regarding maximum concentration values for substances. As a result all products are manufactured using raw materials that do not contain any of the restricted substances referred to in the RoHS Directive 2002/95/EC at concentration levels in excess of those permitted under the RoHS Directive 2002/95/EC, or up to levels allowed in excess of these concentrations by the Annex to the RoHS Directive 2002/95/EC.

EKO

IMPORTANT USER INFORMATION

CE

DECLARATION OF CONFORMITY

We: EKO INSTRUMENTS CO., LTD
1-21-8 Hatagaya Shibuya-ku,
Tokyo 151-0072 JAPAN

Declare under our sole responsibility that the product:

Product Name: I-V Curve Tracer
Model No.: MP-180

To which this declaration relates is in conformity with the following harmonized standards of other normative documents:

Harmonized standards:

EN 61326-1:2006 Class A (Emission)
EN 61326-1:2006 (Immunity)
EN 61000-4-2 EN 61000-4-3
EN 61000-4-4 EN 61000-4-5
EN 61000-4-6 EN 61000-4-8
EN 61000-4-11

Following the provisions of the directive:
EMC-directive : 2006/108/EC
Amendment to the above directive : 2006/95/EC

Date: January 19, 2011

Position of Authorized Signatory: Deputy General Manager of Quality Assurance Dept.

Name of Authorized Signatory: Shuji Yoshida

Signature of Authorized Signatory: Shuji Yoshida

3. Safety Information

EKO Products are designed and manufactured with consideration for safety; however, please make sure to read and understand this instruction manual thoroughly to be able to operate the instrument safely in the correct manner.

Attention to user; pay attention to the instructions given on the instruction manual with this sign.

High voltage is used; pay special attention to instructions given on this instruction manual with this sign to prevent electric leakage and/or electric shocks.

3-1. WARNING/CAUTION

1. Setup

- Please setup grounding wire for the PV devices and the surrounding equipments. With insufficient grounding setup, it may cause electric shock and leakage accidents.
- This product is designed specifically for indoor PV cell measurement, and it is not designed to be used with PV module or array and any other surrounding instruments including inverter for outdoors. If this product is used in such incorrect way, it may lead to damage on the surrounding instruments or accidents.
- The connection terminal and cable used to connect the PV cell should always comply with the rating capacity of the PV cell; the cables are connected securely so that they will not get disconnected from the connected parts.

2. Operation

- Do NOT use this product for any other than its original purpose.
- Do NOT disassemble, modify or touch inside of this product.
- Do NOT use this product in such environment which applies vibrations, impacts, high humidity, many dusts, significant temperature differences, and near the object which generates strong magnetic force and/or electrical wave. These can be cause damage.
- When the product gets overheated or ignited, also if any smoke or odor is noticed, turn off the switch immediately and stop operating.
- All cables connected to this product should be less than 3m in length with shield. If any other types of cables are used, EKO will not be accountable for any damages or troubles occurred with such setup.
- When LAN cable is connected, use LAN cables with CAT5E or STP cable specifications. Also use cables less than 3m lengths between this product and HUB or PC. If any other types of cables are used, EKO will not be accountable for any damages or troubles occurred with such setup.
- For any accidents or errors occurred from using cables which are not attached or optional to this instruments will not be held responsible by EKO.

- The PV terminals (+V, +I, -I, -V), which are located on the front and rear panels of this instrument, are sensitive; make sure to use protections for the static electricity, such as wrist strap, when touching the conduction part of the cable tip or terminal with hand to prevent accidents.

3-2. HIGH VOLTAGE WARNING

1. Power Supply

- Do NOT touch the terminal block and/or power plug with wet hands. This may cause electric shocks and leakage accidents。
- Always check the voltage and its type (AC or DC) of the power supply, match with the power voltage of this product then turn ON the power switch.
- Always check to make sure there are no risks for electric shocks by using testers in connection areas before connecting and removing PV devices to this product.

4. Introduction

I-V Curve Tracer MP-180 is developed as an I-V curve tracer specifically for photovoltaic cells.
This product is used for measuring the voltage-current characteristics of PV cell with solar simulator.
As well as the continuous light, this product is applicable for solar simulator with pulse light by external trigger input.
By using the attached software, automatic open/close shutter control, return sweeping, exponent function sweep, Rs & Rsh measurement, and dark current measurement and so on are available for all kinds of PV cell measurements.

4-1. Main Functions

1. Applicable to Many Types of Photovoltaic Cells

- Measurements with large current up to maximum of 16A and 10μA resolution are possible.
- From a small cell to large efficiency cell, this instrument is applicable to many types of photovoltaic cells, as well as dark current measurement is possible.
- After the measurement, PV cell characteristics (Pm, Isc, Jsc, Voc, Ipm, Vpm, FF, η, STC) and STC converted values/curves can be displayed.

2. PV Cell Evaluation System by Combining with Solar Simulator

- Indoor PV Cell Evaluation System can be constructed by combining with solar simulator.
- By controlling solar simulator shutter, synchronized measurement can be taken.
- Also applicable for pulse-type solar simulator: The measurements can be started with external trigger input for pulse solar simulator.
- Secondary reference PV cell IEC 60904-2 (JIS C8911) can be connected directly.
- Irradiance fluctuation can be corrected with light intensity correction function by connecting reference cell.

3. EKO's Unique Monitoring & Logging Functions

- Voltage, current, and other input data can be displayed on monitor and logged just like data logger.
- With the desired fixed bias voltage is applied on the subjected PV cell, the MP-180 takes samplings at setup measurement intervals then displays graph and takes logging of current, voltage and other input data.

4. Data Evaluation and Management by Software

- Three types of auto-measurement modes can be selected: A single measurement by manual, continuous measurement by setting the measurement frequency and interval, and automatic measurement by setting start and end time and measurement interval.
- By using return-sweeping, hysteresis of I-V curve, which occurs on Die-Sensitized Cell (DSC), can be verified on graph easily and the sweeping time can be adjusted to appropriate setting.
- Voc→Isc sweep, Isc→Voc sweep, and return sweep can be measured.
- Series resistance: Rs, parallel resistance Rsh can be calculated (they are calculated from the I-V curve

slope. Rs can also be measured with IEC 60891/JIS C8913.)

- Process Average and Process Moving Average functions (number of averaging and moving average width can be specified) are available.
- I-V curve and P-V curve graphs can be superimposed.
- Measured data can be saved on computer as binary data, and converts into CSV format type text file which can read selected data in spreadsheet format such as MS Excel.
- Data measured in the past can be viewed by calendar function.
- RS-232C, USB, and LAN can be used as communication interface for computer.
- I-V and P-V curve graph can be printed and saved as image.
- Saved data can be displayed again in graph and/or as numerical data.

5. Safety Functions

- Current surge can be prevented by Current Limiter.
- Electric overload condition can be prevented by thermal guard.

4-2. Package Contents

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

Table 4-1. Package Contents

Items	Quantity	Remarks
MP-180 Main Unit	1	
PV Cable	1	Cable Length: 1.5m, 2sq 4-Conductor Shield
Short Cable	1	Cable Length: 10m, 2sq. 1-pin (Y-terminal on both ends)
AC Cords	1 set	Cable Length: 2.5m, 0.75sq. 3-pin Socket: IEC6030 C13 Plug Type: Specified for each region
USB Cable	1	Cable Length: 2.0m, A-B type (with ferrite core)
CD-ROM	1	Instruction Manual, Software, Software Driver

5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main functions are described below.

1. Front Panel

Figure 5-1. Front Panel

1) Power Switch

This is the power switch for the Main Unit. Green LED will light and power is turned ON by pressing down towards “I”; press down towards “O” will turn OFF the power.

2) PV Terminal

This is the terminal for connecting PV cell. +V and –V are for the voltage measurement terminals and +I and -I are for the current measurement terminals.

※ **This terminal is internally connected to PV terminal on rear panel. When using the front panel side, do not connect anything on the rear panel side.**

※ **Be careful with electrostatic discharge when touching the PV Terminal with hands. It may lead to damaging the instrument.**

3) FG Terminal

This is a Frame Grounding terminal. Connect the shield wire for PV cable here.

※ **This is internally connected to FG terminal on the rear panel side.**

2. Rear Panel

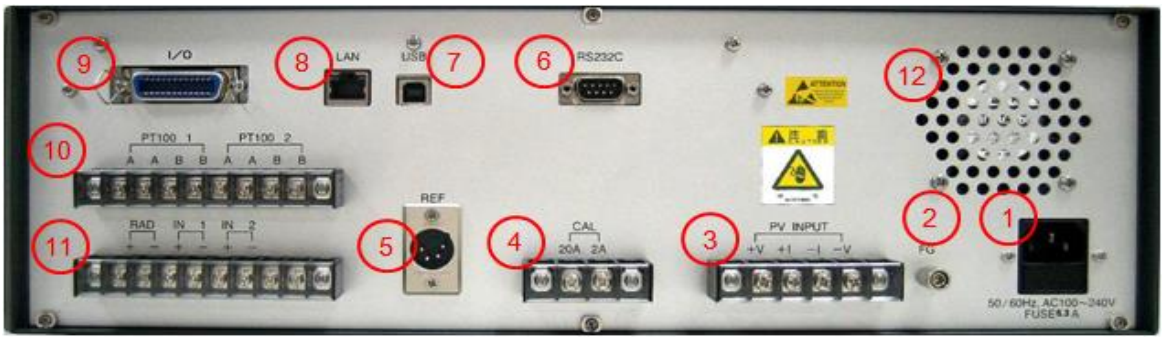


Figure 5-2. Rear Panel

1) AC Inlet

Connect to AC100~240V, 50Hz/60Hz power supply with attached AC cable.

※ **Connect with AC plug with grounding terminal. If using a plug without grounding terminal, ground the FG terminal with earth cable separately.**

2) FG Terminal

This is a Frame Grounding terminal. Connect the shield wire for PV cable here. Even when grounding is not possible from AC plug (a plug with 2 pins), connect the earth wire to this terminal.

※ **This is internally connected to FG terminal on the rear panel side.**

3) PV INPUT

This terminal is for connecting PV cell. +V and –V are for the voltage measurement terminals and +I and -I are for the current measurement terminals.

※ **This terminal is internally connected to PV terminal on front panel. When using the rear panel side, do not connect anything on the front panel side.**

※ **When connecting the PV cable, cover the PV cell to shut down from light and/or wear insulated gloves and boots to prevent from electric shocks**

※ **Be careful with electrostatic discharge when touching the PV Terminal with hands. It may lead to damaging the instrument.**

4) CAL Terminal

This terminal is for maintenance. Do not connect anything on this terminal.

5) REF

This is a connector terminal for connecting reference cell which comply with standard determined by IEC 60904-2 (JIS C8911, Secondary Crystalline-type PV reference cell). If connected other cells which are not compliance to this standard, make sure to check the connector specification.

6) RS232C

This is RS-232C connector to connect with computer. Use the cross cable for RS-232C (interlink cable).

7) USB

This is USB connector to connect with computer. Use the AB-type cable.

8) LAN

This connector terminal is for connecting computer with LAN.

9) I/O

This is connector terminals for shutter control signal input for solar simulator and external trigger input.

10) PT100 1, PT100 2

This connector terminal is for platinum resistance temperature sensor Pt100; there are two channels available.

11) RAD, IN1, IN2

Connector Terminal for Pyranometer (RAD): Connect pyranometer

Connector Terminal for Thermocouple Convertor (IN1): When using thermocouple as temperature sensor, it cannot be connected directly; thus use this terminal and convert into voltage which is proportional to temperature by using thermocouple convertor (transducer for thermocouple).

Backup Terminal for Extension (IN2): Usually not used

12) FAN

This is a fan for cooling. It turns on as the power is turned ON.

5-2. System Structure

1. Photovoltaic Cell Measurement System

To take measurement of a PV cell with MP-180, the system is configured as below for a general structure. MP-180 is applicable to various types of PV cell measurement systems; contact EKO for further details.

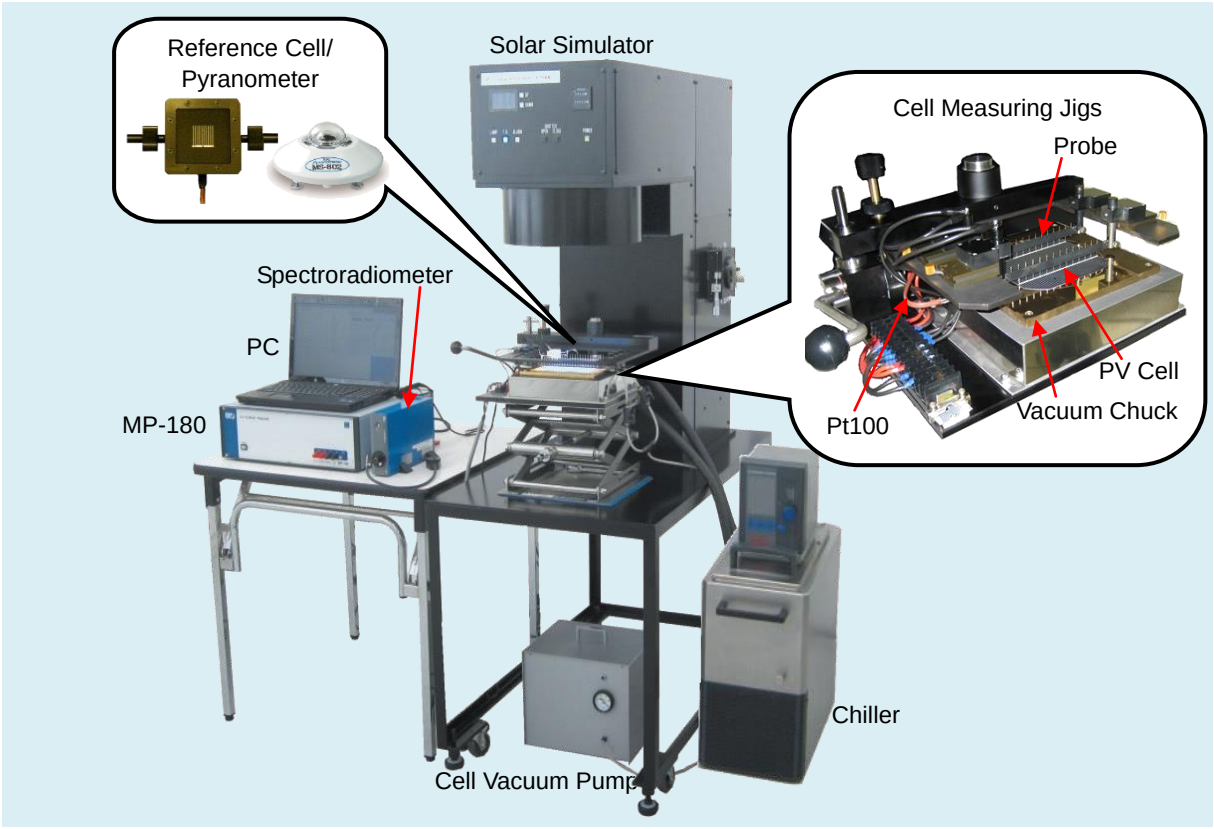


Figure 5-3. PV Cell Measurement System

5-3. Setting

1. Connecting PV Terminal and FG Terminal

Use the attached PV cable for PV terminal; always connect with 4 terminals from the cell base. Depending on the terminal form on the cell side, it may need jigs for measurements.

Connect the PV cable with +V and +I to PLUS terminal, and connect –V and –I to MINUS terminal of the cell.

The FG terminal on the MP-180 and –I terminal should be connected always. By connecting these terminals, noise can be reduced. By floating the measurement system including cell from the earth, it prevents measurements from getting affected by the power-line noise and/or extraneous noise.

However, when the grounding is connected to earth through a jig on the cell terminal of solar simulator side, remove the short-cable. When the short-cable is connected, ground-loop is created and noise may become worse.

Also connecting the shield cable of the PV cable to FG will help reduce noise.

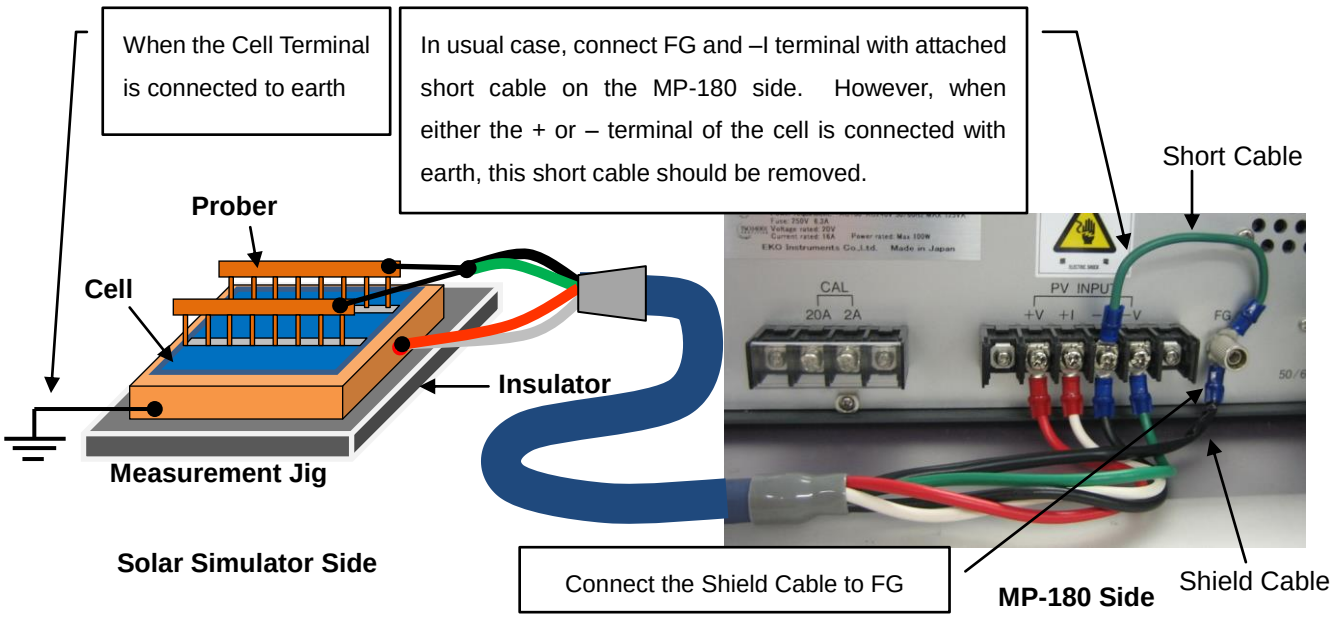


Figure 5-4. Connecting to PV Cell

2. Countermeasure for Static Electricity When Connecting Terminals

MP-180 uses very precise semiconductor part. Although various countermeasures are taken against static electricity, take thorough provisions by using antistatic wrist strap and so on when connecting cables to terminals, to certainly prevent damages by static electricity.

3. Connecting Pt100 Temperature Sensor

There are 3-wire type and 4-wire type for Pt100 sensor; however, this instrument is only available with 4-wire type. See below Figure 5-5 for connection example.

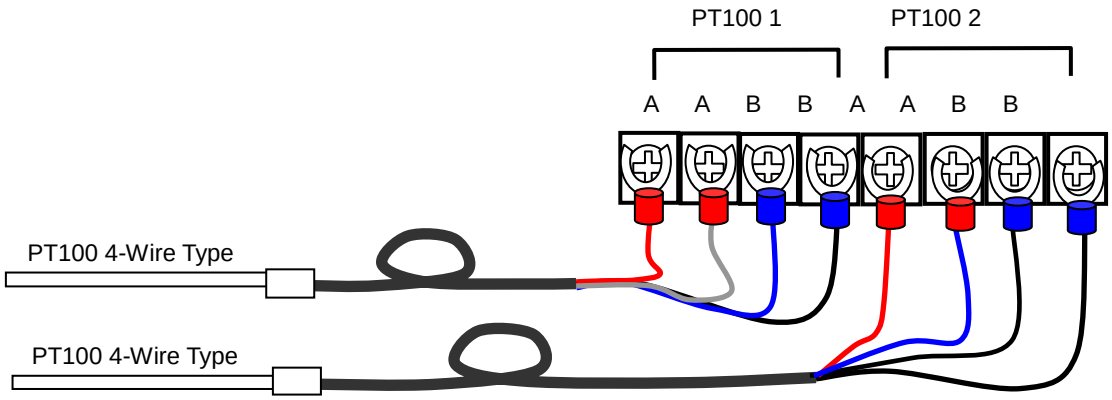


Figure 5-5. PT100 Channel Connection

4. External Input/Output (I/O Connector Pin Layouts)

The external input/output (I/O connector) pin layouts and the internal circuits are described as below:

Table 5-1. Pin Layouts

Pin No.	Signal Details
2	Shutter Control CLOSE (4-wire type), Shutter Control + (2-wire type)
3	Shutter Control OPEN (4-wire type)
6	Shutter Control COM (4-wire type), Shutter Control -(2-wire type)
14	External Trigger Input +
18	External Trigger Input -

※ Amphenol 24 pin connector is used.

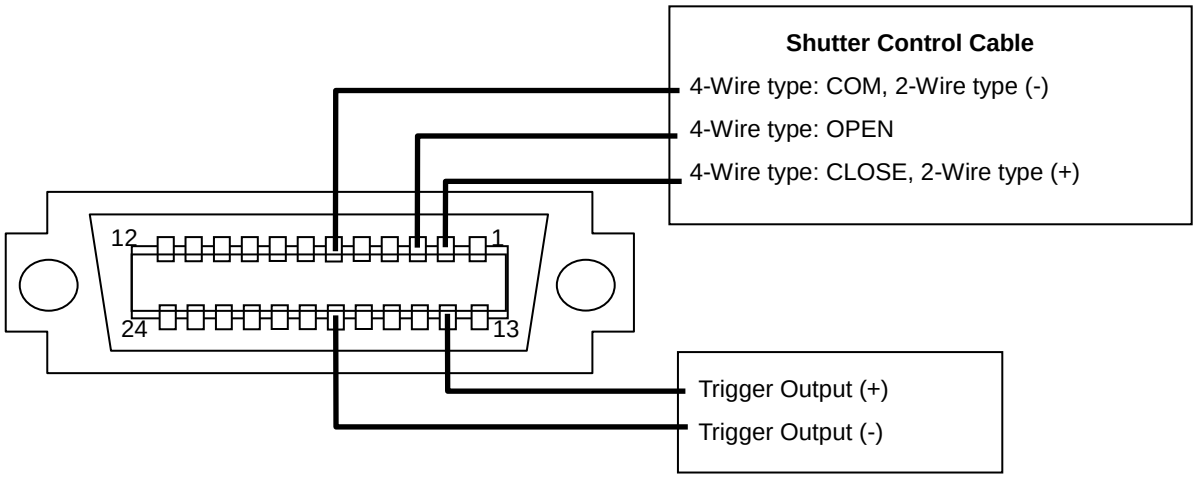


Figure 5-6. Input and Output for I/O Connector

1) Shutter Control Output Circuit

To control the open and close movement of the solar simulator shutter with MP-180, the output port is integrated. There are two types of control by differentiating the shutter control input from the solar simulator side.

A 4-Wire Type: This is a type controls the shutter open and close by separate wires.
Open movement holds the connection between OPEN – COM for about 50 msec.
Close movement holds the connection between CLOSE – COM for about 50 msec.

B 2-Wire type: This is a type controls the shutter open and close by same wire.
Open movement holds the connection between output (+) and output (-).
Close movement breaks the connection between output (+) and output (-).

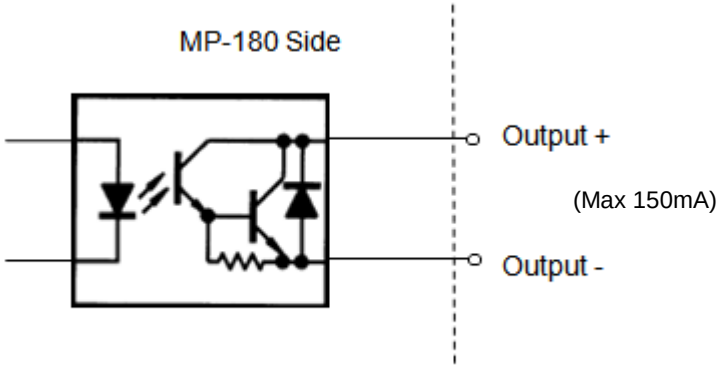


Figure 5-7. Output Circuit

※ Operation of shutter control performance is verified with solar simulators by Wacom and Seric. For older model and/or other manufacturer solar simulator is used, please check directly with the manufacturer to understand the shutter control logic before connecting.

2) External Trigger Input Circuit

MP-180 is integrated with a port which reads the emitting light timing from the pulse-light applicable solar simulator and takes measurement according to the light emission.

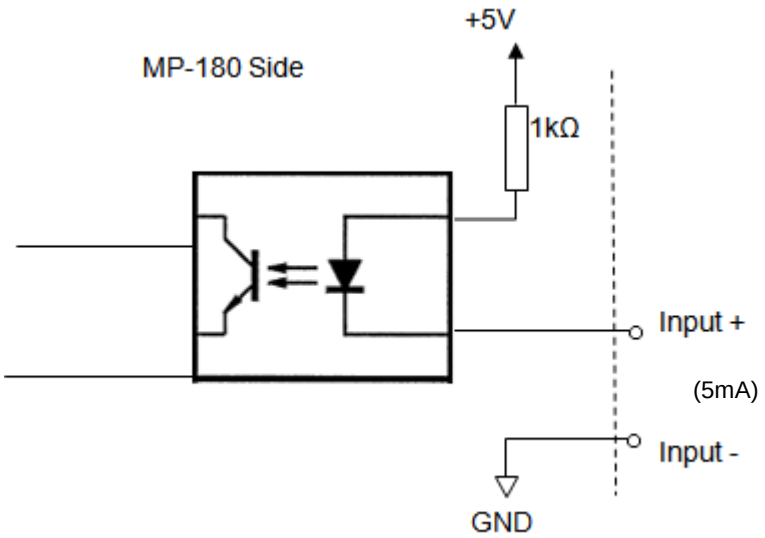


Figure 5-8. Input Circuit

6. Software

This software is designed for taking I-V curve measurements of each type of PV cell under solar simulator using the I-V Curve Tracer MP-180.

6-1. Software Basic Functions

1. Measurement Control and Data Processing

Measurement Control and measuring, calculating, graphing and saving of each characteristic values can be done on computer.

PC Control: I-V measurement, data graphing (I-V, P-V), data filing

Measuring Items: Maximum Power (Pmax), Short Circuit Current (Isc), Short Circuit Current density (Jsc), Open Circuit Voltage (Voc), Maximum Power Current (Ipmax), Maximum Power Voltage (Vpmax), Conversion Efficiency (η), Fill Factor (FF), Irradiation Intensity (Er), Series Resistance Rs, Parallel Resistance Rsh, Temperature 2 channels, STC Conversion.

2. Solar Simulator Irradiance Control

When the PV cell sample is measured under solar simulator, generally the irradiance of solar simulator is setup at 100mW/cm^2 before measurement; however, it is difficult to set the irradiance to 100mW/cm^2 accurately. Therefore, the solar simulator output is adjusted by measuring the light intensity using pyranometer (or silicon sensor) or reference cell.

If the irradiance value is already known, it can be entered by key; however, even during the I-V curve measurement, measure the light intensity at the same time if possible; the irradiance can be standardize to 100mW/cm^2 for calculation by using this light intensity value (STC Conversion). If both the measuring PV cell sample and the pyranometer cannot be placed under the solar simulator irradiance area, make adjustment of the irradiance with pyranometer (or reference cell) first, remove the pyranometer (or reference cell) then measure the PV cell sample. The first measured value for irradiance (if the irradiance value is a known value, it can be entered from key) can be setup as fixed value on the software, and it can be used in the STC conversion.

Also, tight intensity correction function makes correction on I-V curve by detecting the fluctuation of the light intensity value as taking samplings of current, voltage and light intensity values at the same time.

3. Measuring PV Cell Back Surface Temperature

The back surface temperature of the PV cell is measured (or entered from key) before I-V measurement and used as fixed value, or it can be setup to take measurement at each I-V curve measurement.

4. Measuring I-V Curve

Setup the measurement condition by entering each parameters of PV cell. The measurements can be selected from Manual/Continuous/Auto measurements. Right after the measurement, I-V curve graph is displayed automatically.

- Sweeping time can be changed by data quantity, step interval, accumulated number settings. (Can be setup from 0.1sec ~ 300sec)
- Process Average function can be applied by selecting multiple measurement data.
- I-V curve with Process Moving Average applied on the 10 points around the measurement point can be displayed in graphs.

5. Standard Test Condition Conversion Based on IEC 60891

- Data can be converted into standard condition; the conversion formula for I-V Curve standard condition is according to: IEC 60891 (JIS C8913)
- Series resistance Rs calculation based on IEC 60891 (JIS C8913) is available.

6. Graph Display

Select a measurement date from the data list and display the graph.

- Past measurement data can be recalled and displayed by using calendar function.
- It is possible to make Light intensity correction and display multiple graphs in superimposed condition.
- By right clicking the mouse on the displayed mouse, the graph can be saved in bitmap format.
- 10 points before and after the measurement point can be processed with Moving Averaging Process and displayed on a I-V curve graph.
- Multiple measurement data can be selected for averaging process.

7. Save

Select a measurement date and time from the data list, and convert the data into CSV format text file to save. Data can be converted by Convert All, Individual conversion, or Converting by Specific Value.

User can freely select a measurement result from data list, and the result can be displayed as graph and save as text.

8. Printing

Each graph and measurement result can be printed.

6-2. Installation and Uninstallation

If your PC has Windows Vista, 7 or 8 for its operation system, please read [Appendix] before installing the software.

1. Measurement Software Installation

1) Start up the computer and insert the installation disk into the CD disk drive when the desk top screen is displayed.
2) Click the file “Setup.exe” under the “MP180_Software_Ver_1.0.0.X_Installer English” in the installation disk to start the installer.
3) The installer wizard window appears and starts the installation process. Click [Next >] button to go to the next step.

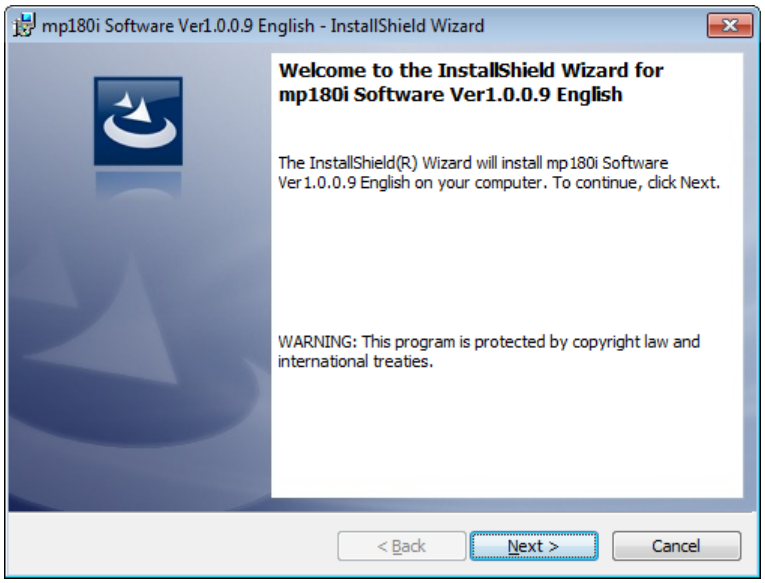


Figure 6-2-1. Installer Wizard Window

4) The screen for “License agreement” window will be displayed; click the radio button for “Agree a software license” and click [Next >] button to go to the next step.

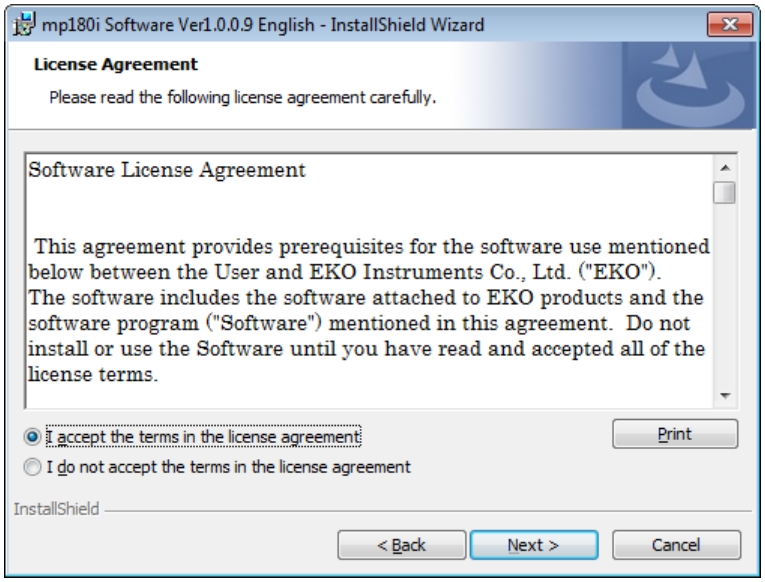


Figure 6-2-2. Software License Agreement Window

5) “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.

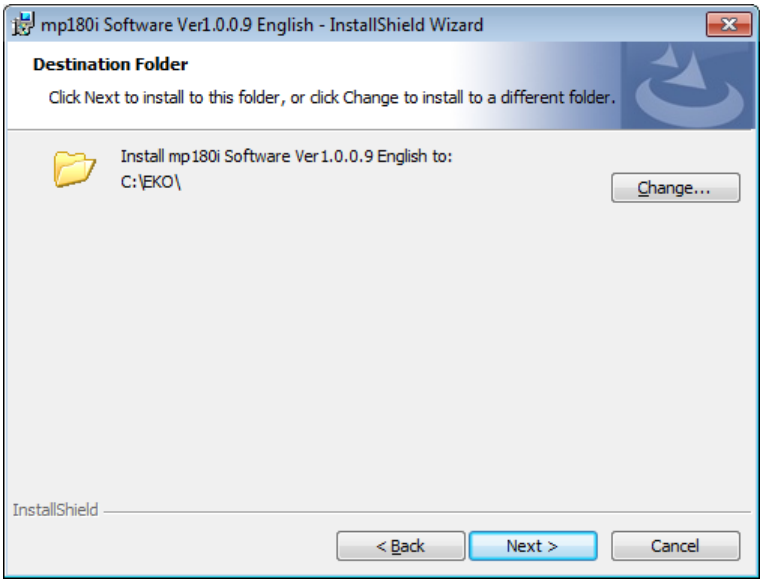


Figure 6-2-3. Destination Folder Setting

6) Confirm the program to be installed and the items to be setup from the “Confirmation” window then click [Install] button to start the installation.

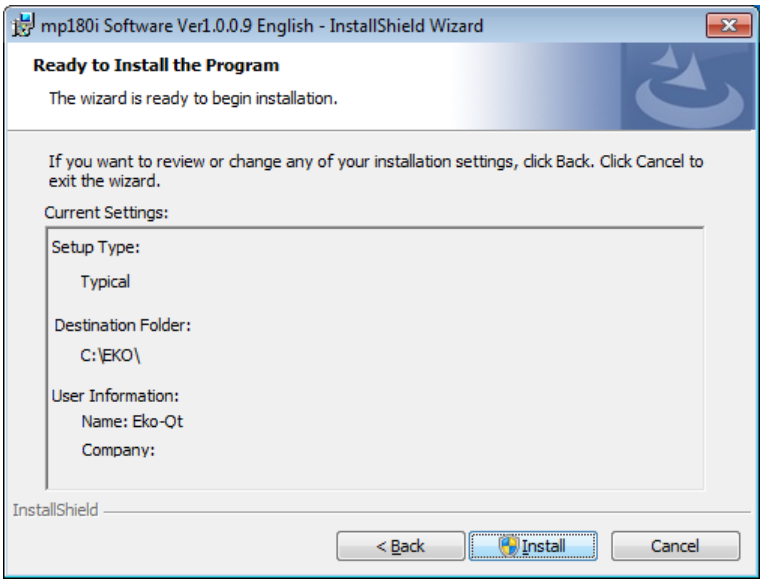


Figure 6-2-4. Installation Confirmation Window

7) After awhile, the screen get dark and “User Account Control” window appears. Clicking [Yes] button will start installation.

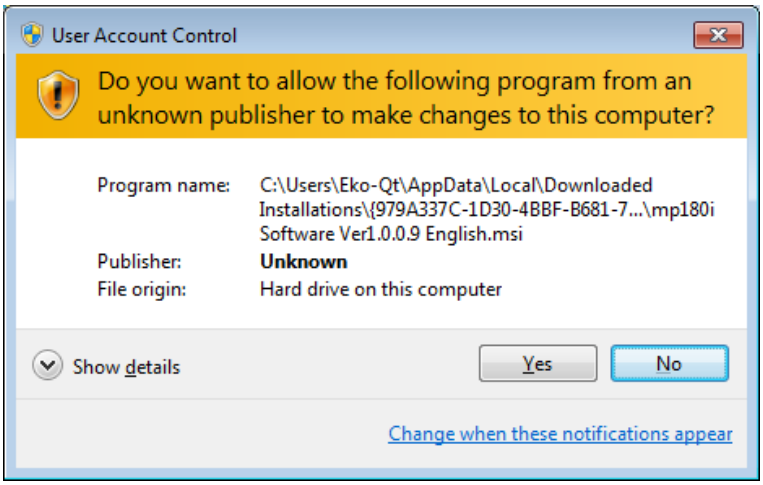


Figure 6-2-5. User Account Control Window

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

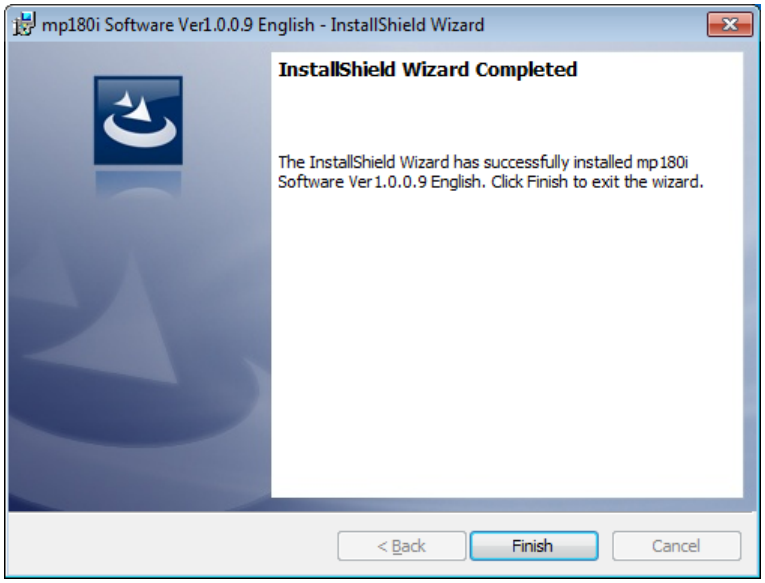


Figure 6-2-6. Wizard Complete Window

9) 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.

Figure 6-2-7. Shortcut Icon

2. Measurement Software Uninstallation

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)”.

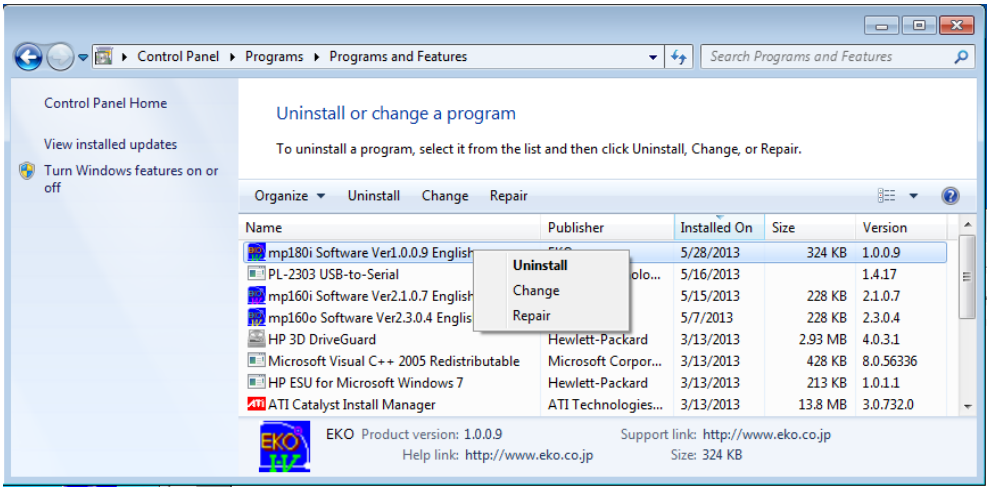


Figure 6-2-8. Uninstalling from “Program and Features”

Below 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.

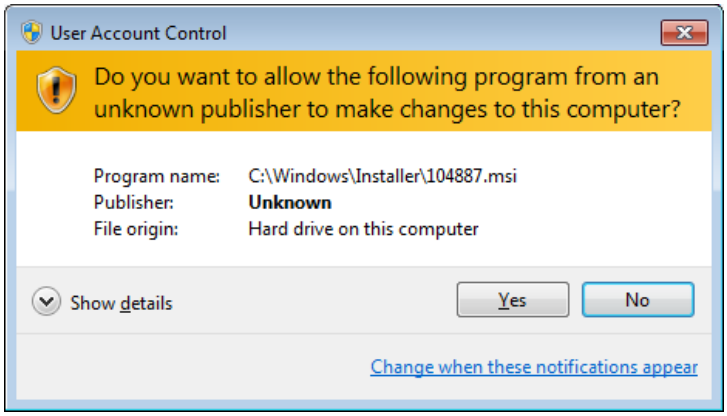


Figure 6-2-9. User Account Control Window

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.

Figure 6-2-10. Program Maintenance Window

3. USB Driver Installation

The Device Driver Software by Future Technology Devices International Ltd. (FTDI) is used for USB.

There are two driver software prepared by FTDI; one is run by EXE, and the USB driver is installed in Windows prior to connecting the USB to the computer. Another type is installed by following the displayed wizard by Windows when the USB device is connected to the computer. Both types of driver software are included in the attached CD-ROM.

When EXE run type software, "**CDM20xxx_Setup.exe**" is started, below Image is displayed; the USB Serial Converter driver and USB Serial Port driver are installed.

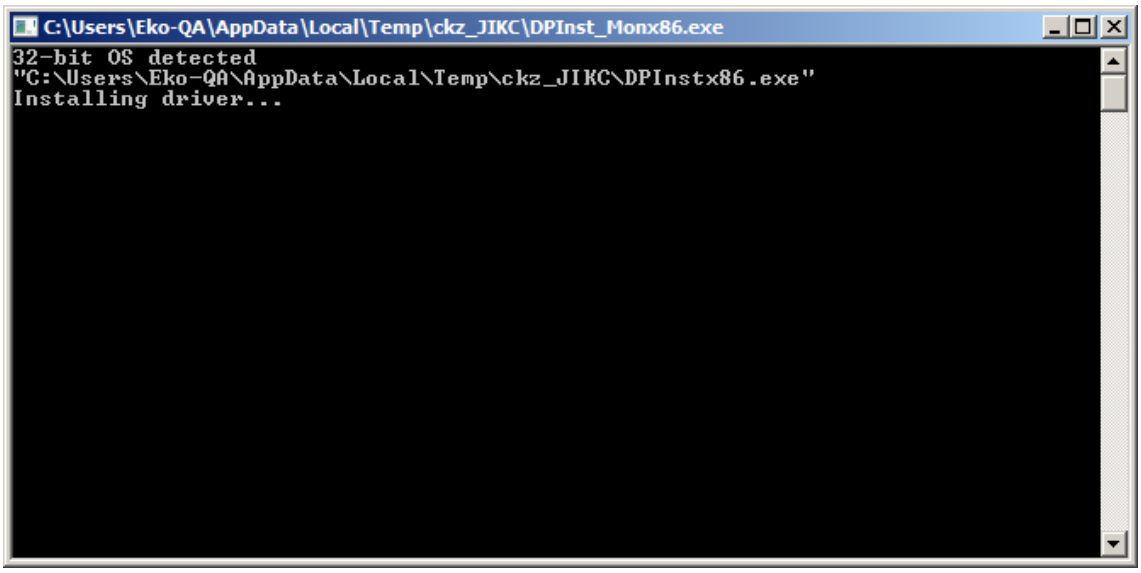


Figure 6-2-11. USB Driver Installation

If an older version device driver is already installed in the computer or any drivers for other USB related devices are installed, problems may occur, such as abnormal communication due to having conflicts with port number assignments and installation gets rejected. In such cases, assign different port number or uninstall both drivers and reinstall.

Wizard type of installation will automatically start when the USB connector is inserted to the PC. Depending on the PC environment, the Wizard may not appear; in such case, manual installation is required. If the user is experienced with PC operation, this method can be used for installation. For such case, updating and reinstalling the device driver have to be done manually from Device Manager. For more details, see FTDI homepage:

URL: http://www.ftdichip.com/Documents/InstallGuides.htm

When installing by wizard method or updating the driver, assign the following folder under attached CD-Rom for the folder originally the driver is installed:

¥CDM 2.0x.xx WHQL Certified

4. Confirming the Completion of USB Driver Installation

Procedure:

1) After the computer is restarted, connect the computer and MP-180 with USB cable.
2) Start “Control Panel” from the Windows.
3) Click “System” icon. Click “Device Manager” inside the “Hardware” tab.
4) Check the Port (COM and LPT) to make sure the USB Serial Port (COM*) is indicated. COM number varies depending on the computer environment.

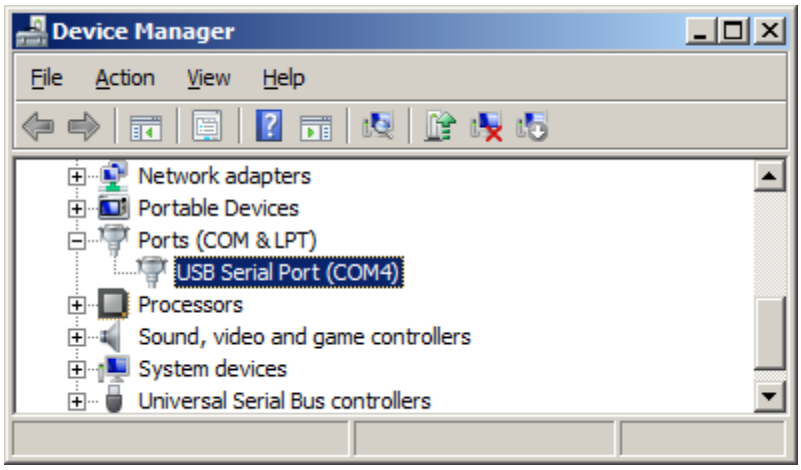


Figure 6-2-12. Device Manager

5) Open the Property window for USB Serial Port and confirm that it states “This device is operating in normal condition”.

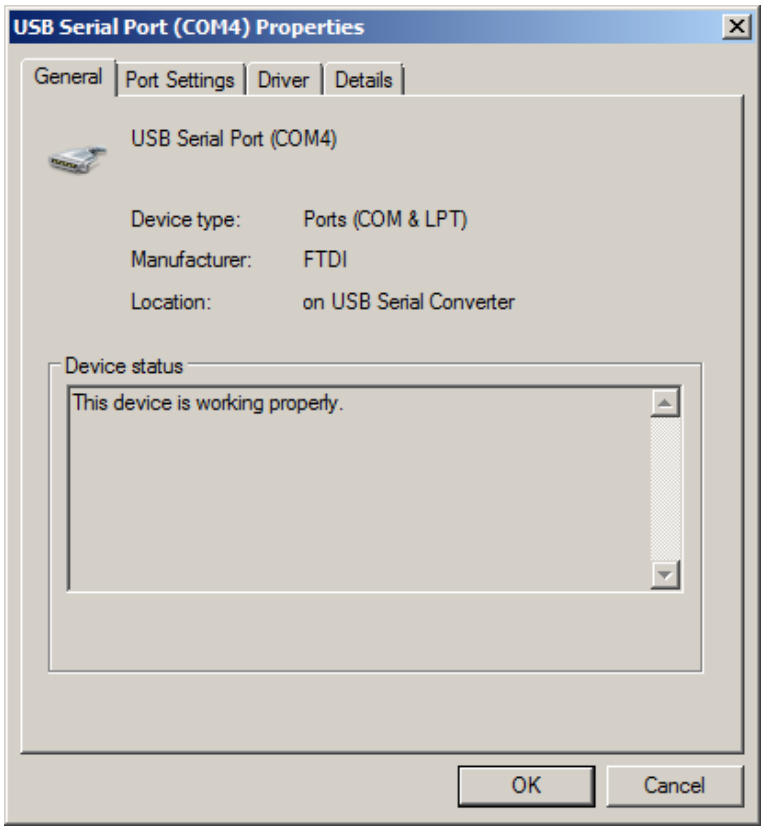


Figure 6-2-13. Port Property for USB Serial Port

Now the installation of the USB Serial Converter Driver and USB Serial Port Driver are complete.

5. Vendor Information of the USB Driver

1) Depending on the OS version on computer and the USB driver version, the installation method may be different.

   If detail information for each OS is necessary, please see the following webpage by FTDI:

   URL: http://www.ftdichip.com/Documents/InstallGuides.htm

2) Download the most recent driver software from the following webpage by FTDI:

   URL: http://www.ftdichip.com/Drivers/VCP.htm

6. Connecting with LAN

The communication with LAN on MP-180 is realized by using a device server called “Xport” by Lantronix, Inc. (http://www.lantronix.com/). LAN is converted into RS-232C by recognizing as virtual COM Port from the software side.

Since it is connected to LAN, the setup is little complicated, thus some knowledge with LAN is required.

The setup procedure for the LAN requires below software; once these are setup, the LAN can be used in the same way as RS-232C by just connecting the LAN cable.

1) Installation of DeviceInstaller and IP address setup
2) Installation of Com Port Redirector and virtual COM Port setup

See Section [A-2. Control by LAN] for detailed setup method.

6-3. Software Operations

When [mp180_Vxxx.exe] is started, the main screen window is displayed; the four tab menus of “Measure”, “Graph”, “Save”, and “Logging” are shown on this window. The menu can be changed by clicking these tabs; when the software is started, always the “Measure” tab is displayed.

1. Measure Tab

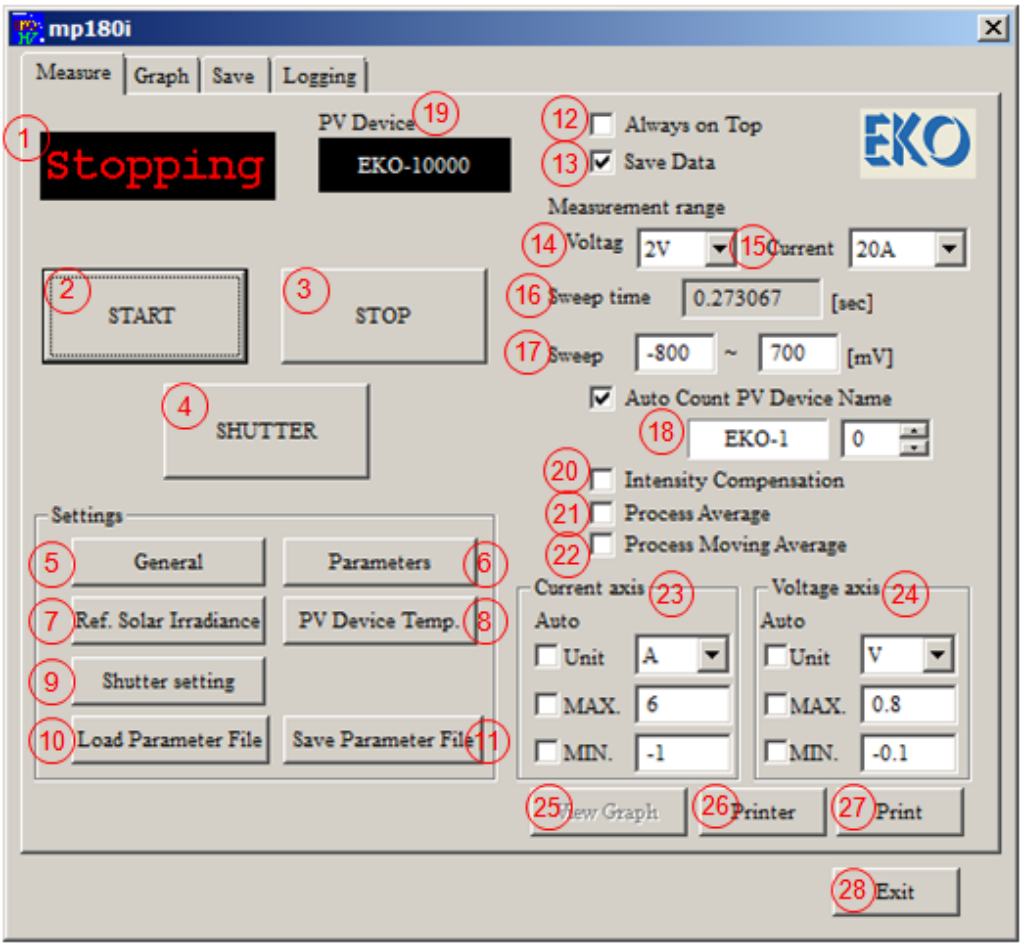


Figure 6-3-1. Software Startup Main Window

Each button and functions are described as below

Table 6-1. Measure Tab Menu

1	Status Indication Window	Indicates the status of the instrument. There are three status indications: “Stopping”, “Measuring”, and “Waiting”
2	[Start] Button	Starts the measurement by clicking this button.
3	[Stop] Button	Stops the measurement by clicking this button during continuous or automatic measurement.
4	[Shutter] Button	Manages open/close of shutter for solar simulator.
5	[General] Button	Clicking this button will display dialog box for general settings, and the measurement conditions can be setup.
6	[Parameters] Button	Clicking this button will display a dialog box for parameter settings, and the parameters of PV device to be measured can be setup.
7	[Ref. Solar Irradiance] Button	Clicking this button will display a dialog box for standard irradiance setting, and a sensitivity constant value of pyranometer and reference cell can be setup.

Table 6-1. Measure Tab Menu - Continued

8	[PV Device Temperature] Button	Clicking this button will display a dialog box for PV device temperature setting, and the channels for temperature measurement can be setup.
9	[Shutter Setting] Button	The shutter for solar simulator can be setup by shutter control type and delay time by [ms] unit.
10	[Load Parameter File] Button	A parameter file, which is already setup and saved in the memory, can be loaded from this button.
11	[Save Parameter File] Button	Setup value can be saved in parameter file with an assigned name.
12	“Always On Top” Checkbox	If this is checked, the main screen window of this software will always be displayed on top of the computer screen.
13	“Save Data” Checkbox	If this is checked, measured data will be saved in an assigned folder automatically. ※ If it is unchecked, the data will not be saved.
14	Measurement Range: Voltage	Voltage range can be selected from this pull-down menu. There are two selections for ranges: 20V and 2V. ※ There is the same function in General dialog box
15	Measurement Range: Current	Current range can be selected from this pull-down menu. The selections are : 20A, 2A, 200mA, 20mA, 2mA, 200μA, and 20μA ※ There is the same function in General Setting dialog box
16	Sweep Time	Displays sweep time of the I-V curve measurement.
17	Sweep Voltage	The start and end voltage for sweep can be entered with [mV] unit, ranges from -20V to +20V; however, with 20A current range, the sweep voltage can be setup between -3V to +20V. ※ By setting the start and end voltage swapped, the sweep direction can be setup in backwards. ※ There is the same function in General Setting dialog box
18	Auto Count PV Device Name Checkbox	If this is checked, data can be identified with the PV device name setup on the Parameter Setting and additional count values of 4-digits numbers from 0 ~ 9999. The 4-digits counter can be setup with any numbers by using the up/down arrow buttons. The count value accumulates by +1 for each measurement; but the count value stays the same as the assigned count value in continuous measurement. The value is shown on the PV device name display.
19	PV Device Display	The measurement data can be identified with the character assigned on the Parameter setting dialog with the four digits count value, in the form of “header character + four count values”.
20	Intensity Compensation Checkbox	If this is checked, the I-V curve measurement with corrected light intensity is displayed. To monitor the fluctuation of the light intensity, reference cell or photon sensor needs to be input from REF connector, and set it in the solar simulator irradiation area during the I-V measurement.
21	Process Average	If this is checked, the I-V data, which is averaged during continuous measurement, is displayed.
22	Process Moving Average	Averaging is done in the I-V curve sampling ranges of 10 near points, and the graph is displayed.
23	Current Axis Setup	Setup the current axis scale and unit on the I-V graph. If checkboxes for Unit, Max, and Min are checked, they will be in automatic setting; when unchecked, voluntary unit with Max and Min values can be setup.
24	Voltage Axis Setup	Setup the voltage axis scale and unit on the I-V graph. If checkboxes for Unit, Max and Min are checked, they will be in automatic setting; when unchecked, voluntary unit with Max and Min values can be setup.

Table 6-1. Measure Tab Menu - Continued

25	[View Graph] Button	I-V curve graph is displayed again after measurement. This is used when unit, graph scale, and/or condition of the correction are changed.
26	[Printer] Button	Printer Setup dialog box is displayed and the detailed setup of printer can be changed.
27	[Print] Button	I-V curve graph can be printed.
28	[Exit] Button	Finishes and exits this software.

1) General Settings

When the General button is clicked, general setting dialog box is displayed, and measurement conditions can be setup. Each function is described as follow.

Once the setup is completed, click OK button. Entered contents are cleared by Cancel button.

(1) Selecting PC Interface

Select a COM Port, which is available for communication, from the pull-down menu. The three types of communications, RS-232C, USB, or LAN, are applicable; however, when using USB or LAN, the computer should be setup beforehand to recognize the USB or LAN as virtual COM Port. (See Section [6-3 Installation & Uninstallation] and [A-2. Control by LAN]).

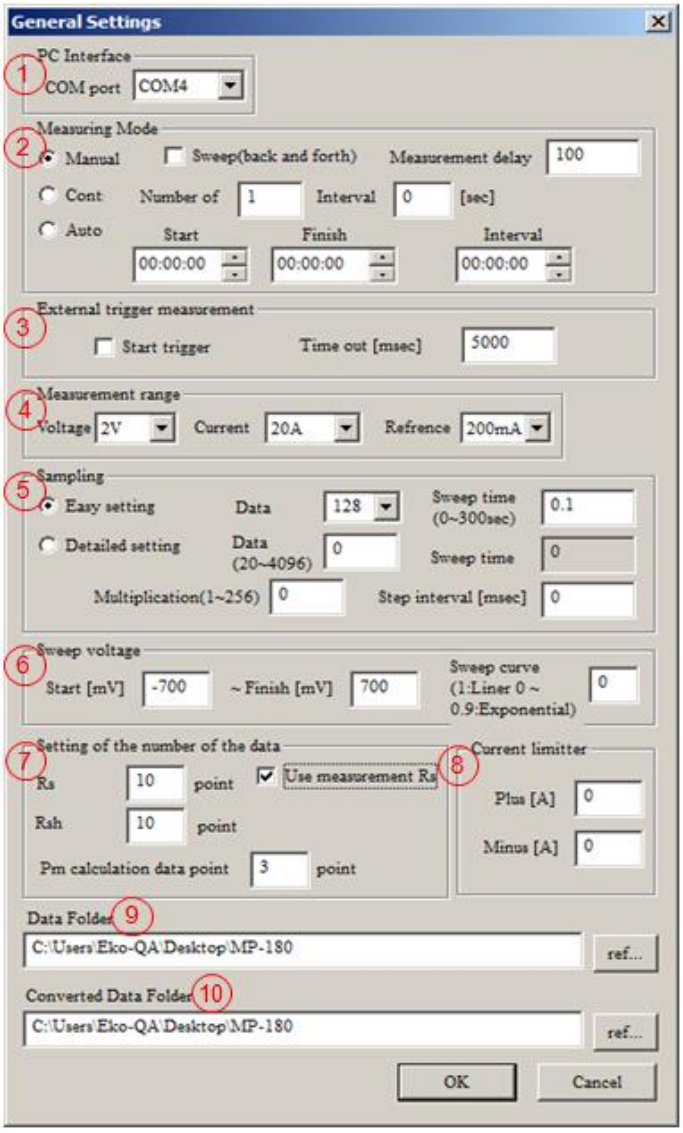


Figure 6-3-2 . General Setting Dialog Box

(2) Selecting Measurement Mode

Measurement mode can be selected from Manual, Continuous (Cont.), or Automatic (Auto) measurement mode.

a. Manual Mode

This measurement mode will take one measurement at a time by clicking the Measure button.

By checking the checkbox for "Sweep (Back and forth), I-V measurement can be taken with sweep process done twice by changing the sweep direction, such as Isc → Voc then Voc → Isc, during the I-V measurement. Depending on the start/end voltage setup, the sweep direction will be determined. When start voltage is smaller than (<) end voltage, the sweep will start from Isc; when start voltage is larger than (>) end voltage, the sweep will start from Voc.

b. Continuous (Cont.) Mode

This mode will take continuous measurement with assigned frequency and interval. The measurement will start when the Measure button is clicked and stops after the measurement is taken for the specified frequency.

c. Automatic (Auto) Mode

This mode will take automatic measurement by setting the measurement start/end time and interval. By clicking the Start button, the measurement will be on Standby until the assigned start time; when the time reaches the assigned start time, the measurement is started automatically.

- Sweep (Back and forth)

  By checking this checkbox, I-V measurement can be taken with sweep process done twice by changing the sweep direction, such as Isc → Voc then Voc → Isc, during the I-V measurement.

- Measurement Delay Time

  Delay time from the measurement start till the sweep can be setup between 7 ~ 10000ms by 1ms unit. There are 4 types of the measurement start timing.

  a. At the timing when the Measure button is pushed in Manual Measurement mode.
  b. At the timing when the Measure button is pushed and when measurement interval time has passed in Continuous measurement mode.
  c. At the timing when the time reached the measurement time on Automatic measurement mode.
  d. At the timing of measuring externally synchronized input when measuring with externally synchronized input function.

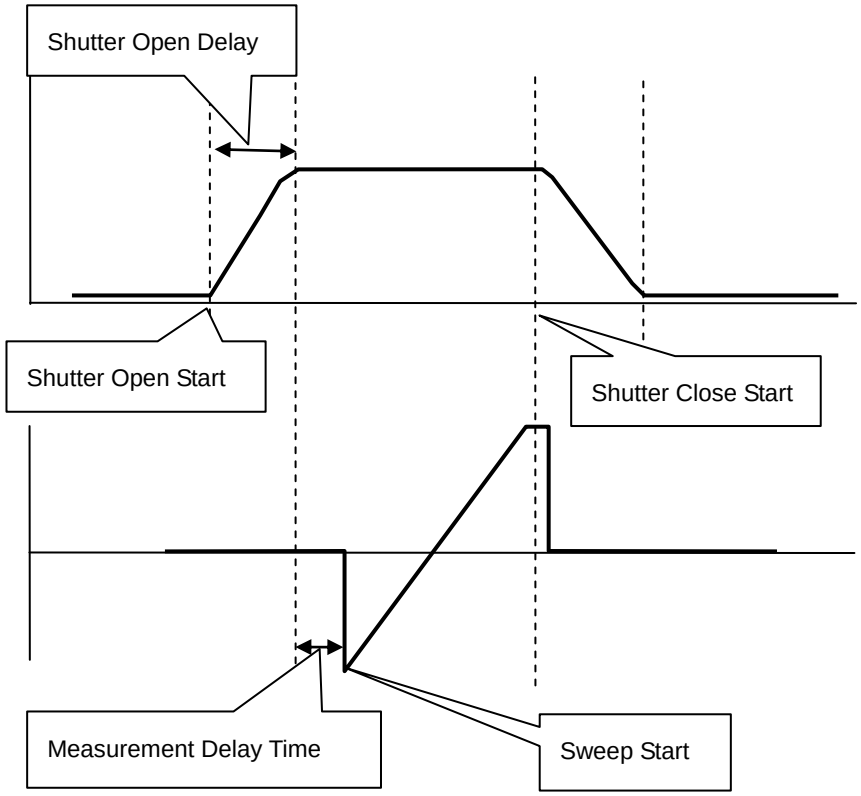


Figure 6-3-3. Solar Simulator Shutter Open/Close Time And Measurement Delay Time

(3) External Trigger Measurement

When this checkbox is checked, the measurement can be started by external triggered input. In such case, the timeout setting can be set up to maximum of 10 seconds. If there is no input from the externally triggered input, it is determined as time-out, and the measurement will not start.

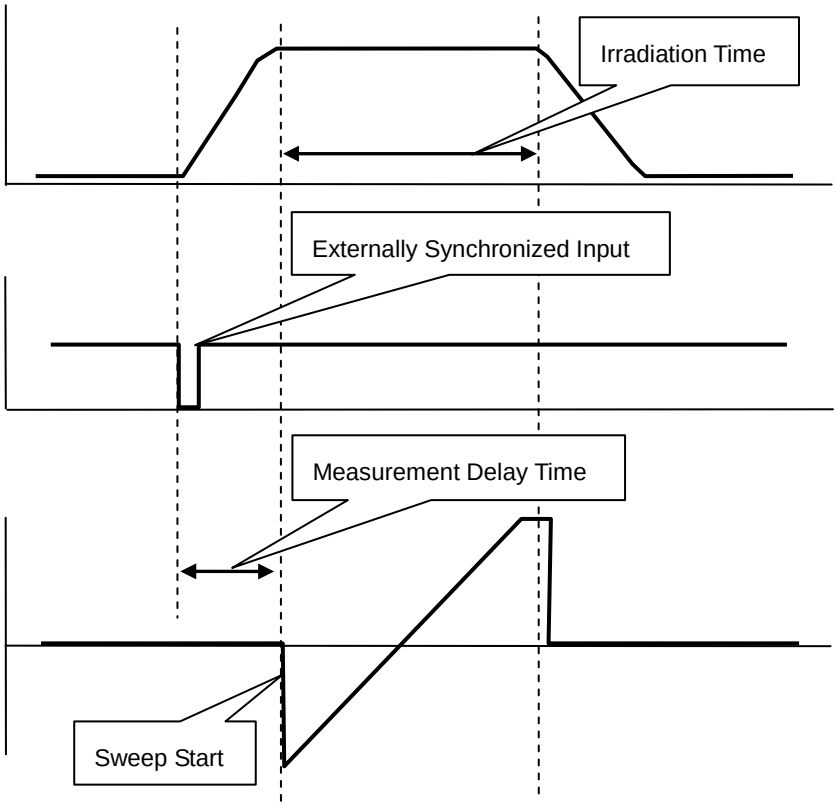


Figure 6-3-4. External Trigger Input during Pulse Light Measurement

(4) Measurement Range

a. Measurement Range Setting for Voltage

PV voltage measurement range can be selected from the pull-down menu.

There are two ranges: 20V and 2V.

b. Measurement Range Setting for Current

PV current measurement range can be selected from the pull-down menu.

There are seven ranges: 20A, 2A, 200mA, 20mA, 2mA, 200μA, and 20μA.

c. Measurement Range Setting for Reference Current

The Reference current measurement range can be selected from the pull-down menu. There are five ranges: 200mA, 20mA, 2mA, 200μA, and 20μA.

(5) Sampling

Sampling can be selected from “Easy setting” or “Detailed setting”.

a. Easy Setting

This is selected when measurement is taken by setting only the data quantity and sweep time.

- “Data” is in pull-down menu format; below numbers can be selected.

128, 256, 512, 1024, 2048, 4096

- Enter the “Sweep Time” between 0 second ~ 300 seconds by key.

b. Detailed Setting

This is selected when measurement is taken by setting data quantity, integrated value, and STEP interval. Sweep time is automatically calculated and displayed.

- Data: any numbers between 20 ~ 4096.
- Multiplication: any numbers between 1 ~ 256.
- Step Interval: from 0.01msec~

✧ Structure of the sampling of MP-180

Please see “Figure 11. Sampling Structure”

➢ In case of Easy Setting:

256 is the maximum of integrated value

For example, the integrated value is smaller or equal to Interval count…

Thus the calculation formula will be:

Sampling Interval = 21.333μs (Fixed value)

Sweep Time = Step Interval x Data Quantity

Step Interval = Sampling Interval x Interval Count

➢ In case of Detailed Setting

Depending on the settings of Step Interval and Multiplication, there are cases that the Interval Count becomes smaller than Multiplication value. In such case, expand the Interval Count to the Multiplication Value.

Thus the calculation formula for Sweep Time would be:

Interval Count = Step Interval / Sampling Interval

Sweep Time = Data Quantity x Sampling Interval

x {Either Multiplication Value or Interval Count, whichever is larger}

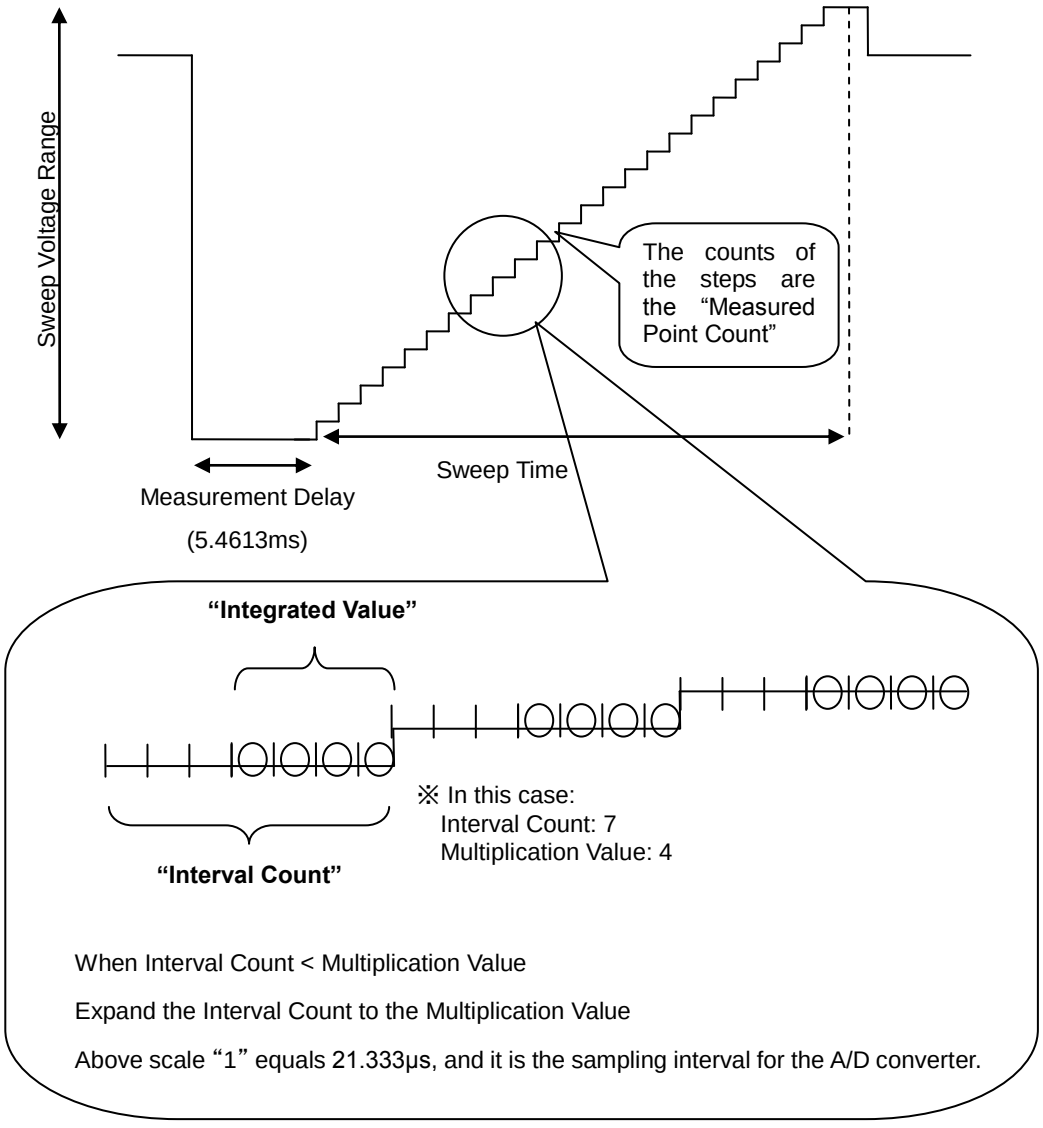


Figure 6-3-5. Sampling Structure

(6) Sweep Voltage

a. Enter the start and end voltage in [mV] unit.

There are some cases that the I-V curve graph is not displayed with assigned voltage due to drop in voltage caused from the measured PV cell and the internal resistance of measurement circuit. This tends to occur especially when the current becomes larger. Setup the sweep voltage by taking several measurements and figure out where the voltage drops.

b. Sweep Curve (1: Liner, 0:Exponential Value)

Enter a value between 0 ~ 1 with 0.1/unit. When the step width of the voltage sweep is processed in linear condition, the data of Voc side becomes sparse, and the measurement points get concentrated on Isc side. To avoid this condition and even out the sampling interval on the graph as much as possible, this setup is used. When the value is set at “1”, the sweep is processed in linear condition but when the value gets closer to zero, the sweep is processed exponentially by curve. This is effective when there are less data.

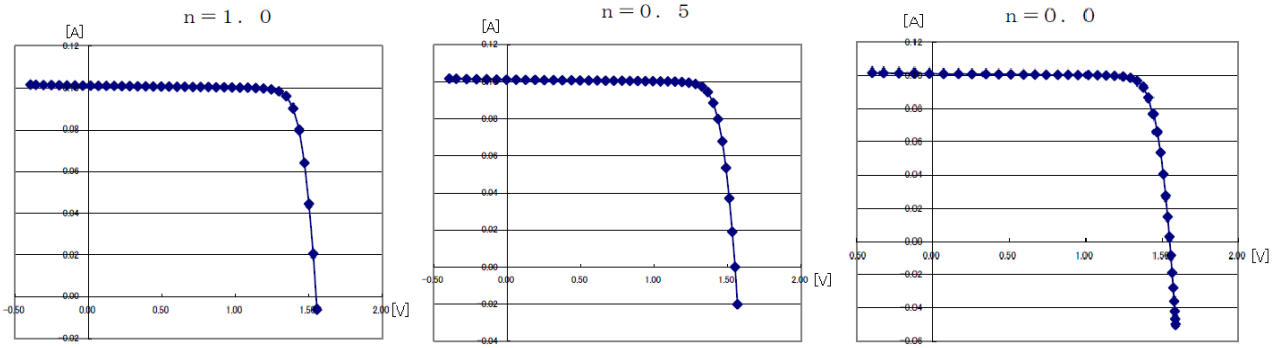


Figure 6-3-6. Exponential Curve Sweep Function

(7) Setting of the Number of the Data

This software calculates the series resistance Rs and shunt resistance Rsh in linear approximation, and maximum output Pm in curve approximation from the I-V curve; there is a function to specify the number of calculation points for the approximation calculation.

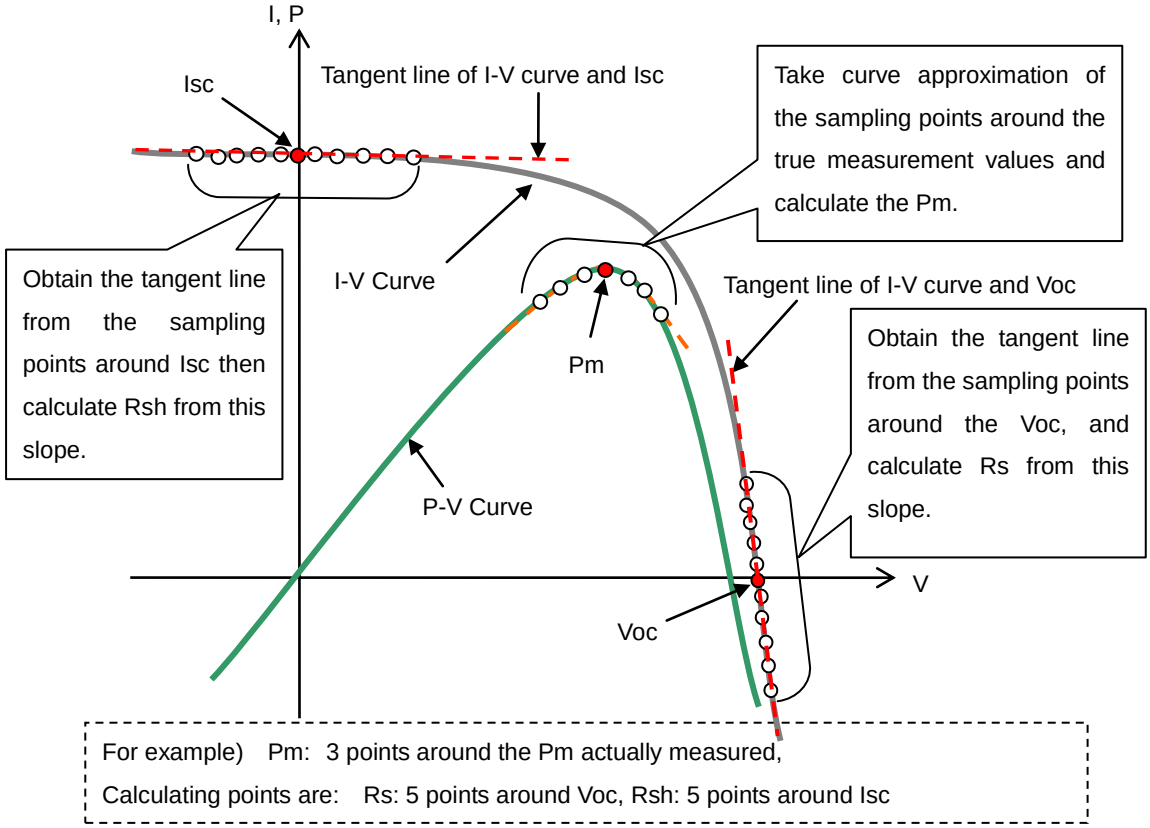


Figure 6-3-7. Determining Calculation Point for Approximation Calculation

- Specifying Rs Calculation Points

  From the sampling points around the Voc, obtain the tangent line of I-V curve and Voc; the Rs is calculated from this slope then graphed. The number of sampling points around the Voc for calculating the tangent line is specified by user.
- Specifying Rsh Calculation Points

  From the sampling points around the Isc, obtain the tangent line of IV curve and Isc; the Rsh is calculated from this slope then graphed. The number of sampling points around the Isc for calculating the tangent line is specified by user.
- When the checkbox for “Use Measurement Rs” is checked, the Rs value calculated from I-V curve will be used on the standard condition conversion (STC conversion). When it is unchecked, the Rs value entered on the Parameter Setting window will be used on the standard condition conversion.
- Specifying Pm Calculation Points

  Pm is determined by curve approximating the near peak on P-V curve with third-order polynomial. The number of sampling points for this curve approximation and the number of sampling points around the maximum power point of the measured value are specified by user.

  ※ **The number of sampling points is defined by the Lagrangian interpolation on IEC 60891 (JIS C8913); however, this method is not used on MP-180 since there are large quantities of measurement points taken on the MP-180, and calculating with this method may cause the curve to concave and not be able to find Pm.**

(8) Current Limiter

a. Current limit setting on the plus side of PV terminal
   This can be setup from 0 ~ 20A
b. Current limit setting on the minus side of PV terminal
   This can be setup from 0 ~ -3A

(9) Data Folder

The I-V measurement data will be saved as binary format data. The directory of a folder is setup to save the data.

(10) Converted Data Folder

The binary data can be converted into CSV format text data at the Save Tab and be saved. The directory of a folder is setup to save the converted data.

Once the setup is completed, click OK button. Entered contents are cleared by Cancel button.

2) Parameter Setting

When the Parameters button is clicked, the parameter setting dialog box will appear as shown on the Image 6-3-8. On this dialog box, six types of PV cell parameters and input channel for the measurement temperature used on STC conversion can be specified. Also there is a box for entering comments/information of six items.

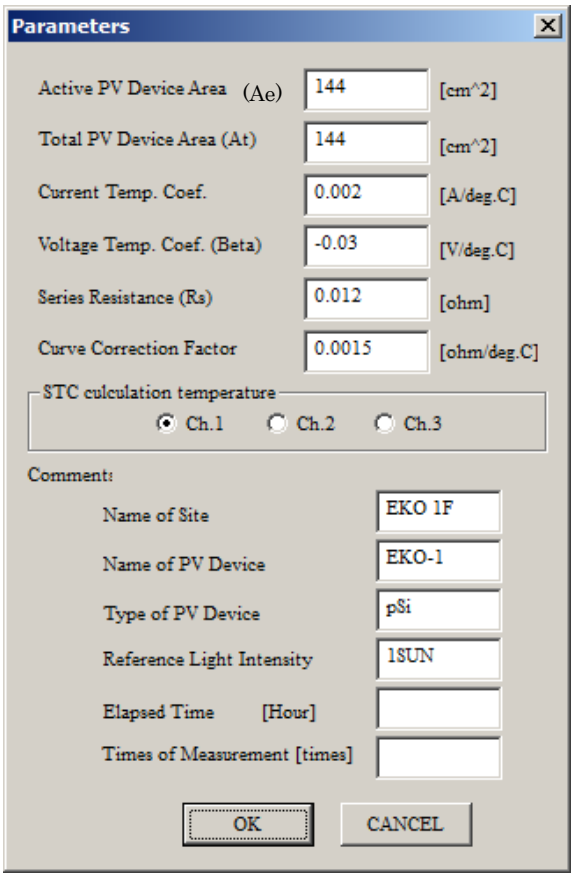


Figure 6-3-8. Parameter Setting Dialog Box

(1) Active PV Device Area: Ae

Enter the area of PV cell which has photoelectric effect. This value will be reflected to True Conversion Efficiency ηa and Short Circuit Current Density Jsc.

(2) Total PV Device Area: At

Enter the PV cell area including the frame and the margins. This value will be reflected to Performing Conversion Efficiency ηt.

(3) Current Temperature Coefficient: α (Used on STC Conversion)

Enter the variation value of the short circuit current when the temperature on the measured PV cell changed by 1°C. Enter the unit in [A/°C].

※ **There are some cases that the graph is indicated with [%/°C]; in such case, uniform the unit by converting the values.**

(4) Voltage Temperature Coefficient: β (Used on STC Conversion)

Enter the variation value of the open circuit voltage when the temperature on the measured PV cell changed by 1°C. Enter the unit in [V/°C].

※ **There are some cases that the graph is indicated with [%/°C]; in such case, uniform the unit by converting the values.**

(5) Series Resistance: Rs (Used on STC Conversion)

Enter the series resistance value of the measured PV cell. It can calculate the actually measured I-V curve; however, enter the value here if the Rs value is already known. This value or actually measured value can be used when calculating the STC conversion. (See [6-3. Software Operation]→[1. Measure Tab] → [(1) General Setting]→[7)Setting the Number of the Data])

(6) Curve Correction Fill Factor: K (Used on STC Conversion)

This is a correction factor defined by IEC 60891 (JIS C8913). Enter the value with unit [Ω/°C]

(7) STC Calculation Temperature

This specifies the temperature channel of MP-180, which measures the PV device temperature. If the measured PV device temperature is maintained at a fixed temperature, a fixed value is entered. (See [6-3. Software Operation] → [1. Measure Tab] → [(4) PV cell Temperature Setting])

(8) Comment Section

The following six information can be entered for the record of each measurement data.

Name of Measurement Site

a. Name of PV Device
b. Type of PV Device
c. Reference Light Intensity
d. Elapsed Time［Hour］
e. Measurement Frequency

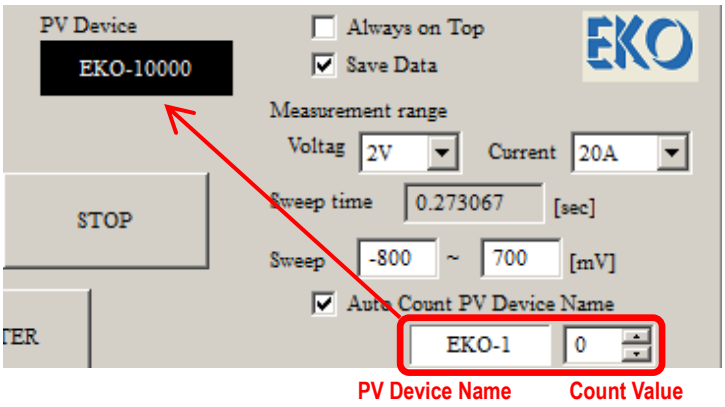


Figure 6-3-9. Name of PV Device

These information are useful for identifying and organizing the data afterwards; it is recommended to enter these information whenever measurement conditions are changed.

The box for “Name of PV Device” is used especially with automatic count function for numbering each measured data; the count value will increase sequentially by each measurement. This count value can be changed as necessary from the Main Window. These information can be saved in data file.

※ **During continuous measurement, the same count value will be entered in the measurement data of specified frequency.**

Once the setup is completed, click OK button. Entered contents are cleared by Cancel button.

3) Reference Solar Radiation Setting

By clicking the “Reference Irradiance Setting” button, the dialog box for Reference Solar Radiation setting will be displayed as shown on Image 6-3-10.

(1) Selecting Reference Solar Radiation

Select either “Measure at I-V Curve Measurement” or “Use This Value for All Measurement” for the irradiance setting.

If “Measure at I-V Curve Measurement” is selected, the irradiance intensity is measured during the I-V measurement.

If “Use This Value for All Measurement” is selected, enter the value in “Solar Irradiance (Er)” box by key or click the Measure button to measure the irradiance and the fixed value will be displayed on the Er box.

The I-V curves measured after this setting will save the irradiance intensity value as setup in this dialog box, either measured during I-V measurement or fixed value.

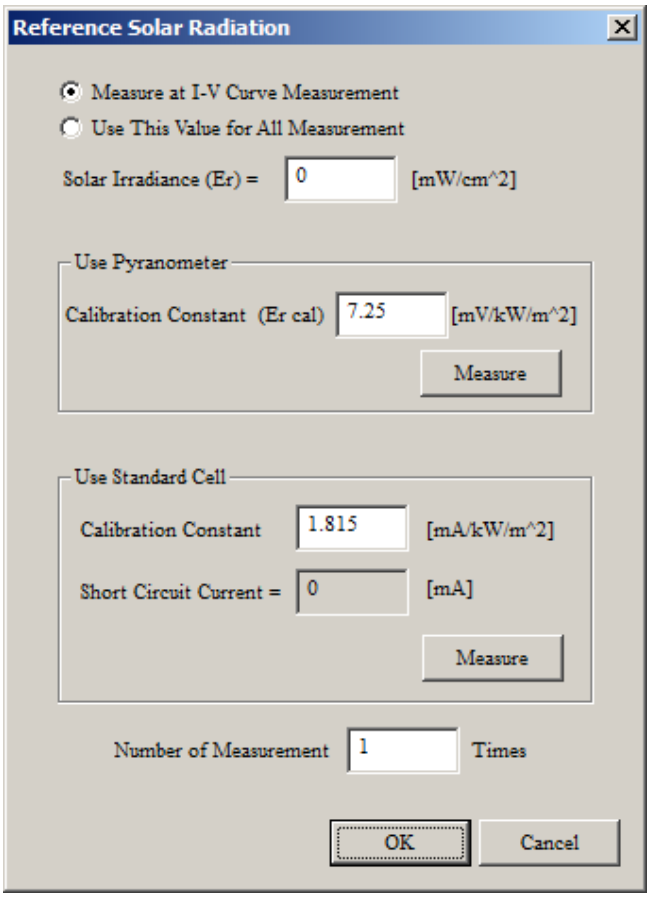


Figure 6-3-10. Reference Solar Radiation Dialog Box

(2) Use Pyranometer

Enter the constant value of the pyranometer connected to the RAD terminal, which is located on the rear panel of the main unit, in the “Calibration Constant (Er cal)” box.

By clicking the Measure button, the MP-180 will measure only the pyranometer and shows the measurement result on the “Solar Irradiance (Er)” box.

Also the data will be saved as “Solar Irradiance (Er)” according to the condition setup on this dialog box when the I-V measurement is taken.

(3) Using Standard Cell

A secondary reference PV cell can be connected directly to “REF” connector on the main unit rear panel. Enter the constant value for the connected secondary reference PV cell in the “Calibration Constant” (Isc Value)

By clicking the Measure button, the MP-180 will measure only the reference cell and shows the result on the “Solar Irradiance (Er)” and “Short Circuit Current” boxes.

When the standard cell can be setup at the same time as the measured PV cell in the solar simulator irradiation area, it synchronizes completely with I-V data, and with the same sampling timing, the short circuit current value which is biased to zero volt against the reference cell is measured and saved as light intensity value

When displaying the graph, check the checkbox for “Light Intensity Compensation” on the Graph Tab. The unevenness of the light source can be corrected by using this data. (See Section (11) Graph Tab, 6) Light Intensity Compensation for more details)

If a value is entered in the “Number of Measurement” box, the measurement will be repeated for the number of times entered. The measured values are averaged and shown as the constant value. This is effective only with the Measure button on this dialog box.

Once the setup is completed, click OK button. Entered contents are cleared by Cancel button.

4) PV Cell Temperature Setting

Temperature Settings dialog box is displayed by clicking the Temperature button.

There are two channels for Pt100 connector terminals and one channel of voltage input terminal for in case thermocouple or other temperature sensors; however, it is necessary to convert the output into the voltage value by connecting to a converter applicable to the sensor.

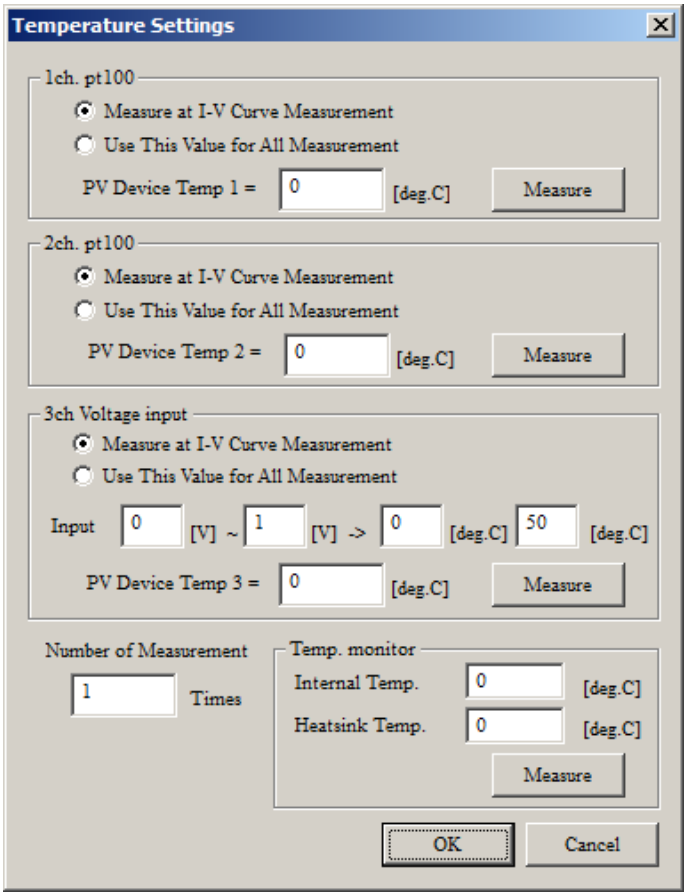


Figure 6-3-11. Temperature Setting Dialog Box

(1) 1ch. pt100

The condition of the Pt100 temperature sensor connected to the “PT100 1” terminal on the main unit rear panel is setup in this box.

This is effective only when the “1ch” is selected for “STC Calculation Temperature” on the Parameter setting dialog box.

Select either “Measure at I-V Curve Measurement” or “Use this Value for All Measurements”.

If “Measure at I-V Curve Measurement” is selected, the “PT100 1” terminal takes measurements at the same time of I-V measurement and the result is recorded on I-V data as PV device temperature.

If “Use this Value for All Measurements” is selected, the value either directly entered in the “PV Device Temperature 1” or the temperature measured by clicking the Measure button will be shown on the “PV Device Temp 1” box as the fixed value.

(2) 2ch. pt100

The condition of the Pt100 temperature sensor connected to the “PT100 2” terminal on the main unit rear panel is setup on this section. This is effective only when the “2ch” is selected for “STC Calculation Temperature” on the Parameter setting dialog box.

Select either “Measure at I-V Measurement” or “Fix to Current Value”.

If “Measure at I-V Measurement” is selected, the “PT100 2” terminal takes measurements at the same time of I-V measurement and the result is recorded on I-V data as PV device temperature.

If “Use this Value for All Measurements” is selected, the value either directly entered in the “PV Device Temp 2” or the temperature measured by clicking the Measure button will be shown on the “PV Device Temp 2” box as the fixed value.

(3) 3ch. Input Voltage

The condition of the temperature sensor connected to the “IN 1” terminal on the main unit rear panel is setup on this section. This is effective only when the “3ch” is selected for “STC Calculation Temperature” on the Parameter setting dialog box.

Setup the ranges of the input voltage for the temperature sensor converter and the ranges of the temperature to be converted.

Example: When Temperature range is 0 ~ 100°C, and using converter with output voltage is 0 ~ 5V
Input Voltage 0 [V] ~ 5 [V] → 0 [°C] ~ 100 [°C]

※ **When the input voltage range is "0 ~ 0V", the OK button cannot be clicked; even when the 3ch is not in use, enter any values.**

Select either "Measure at I-V Measurement" or "Use this Value for All Measurements".
If "Measure at I-V Measurement" is selected, the "IN 1" terminal takes measurements at the same time of I-V measurement and the result is recorded on I-V data as PV cell temperature.
If "Use this Value for All Measurements" is selected, the value either directly entered in the "PV Device Temp 3" or the temperature measured by clicking the Measure button will be shown on the "PV Device Temp 3" box as the fixed value.

(4) Temperature Monitor

The internal temperature of the MP-180 and the heat sink temperature is indicated when the Measure button is clicked. If the internal temperature exceeds 55°C or the heat sink temperature exceeds 60°C, the software takes control and measurement is disabled for 10 minutes to prevent breakage due to overheating.

※ **The semiconductor used on the circuit will generate heat, and it will lead to breakage if excessive current is applied and/or excessive sweeping time is taken. Please always follow this instruction.**

(5) Number of Measurement

If a value is entered in the "Number of Measurement" box, the measurement will be repeated for the number of times entered in this box. The measured values are averaged and displayed. This is effective only with the Measure button on this dialog box.
Once the setup is completed, click OK button. Entered contents are cleared by Cancel button.

5) Shutter Setup

When the Shutter button is clicked, the dialog box for Shutter Setting is displayed. When measurement is taken with a solar simulator with shutter control, check the "Shutter control" checkbox and setup the shutter type (Type) and delay time (Delay), so that the shutter can be automatically opened at start and closed at end of the measurement by setting the shutter type and delay time.

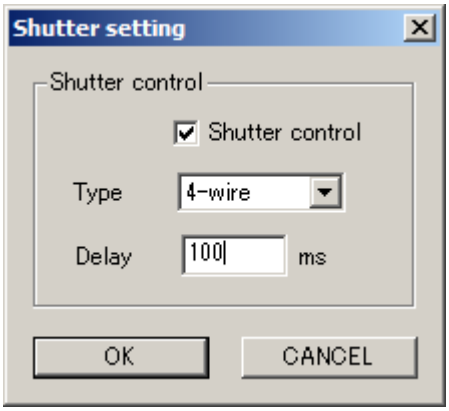


Figure 6-3-12. Shutter Setting

Shutter Control Checkbox: Select to use or not use the shutter control function
Type: 2-wire type or 4-wire type
Delay: Input delay time 0 (zero) and above in [ms] unit.
(From the time signal is sent out till the time shutter is opened completely)

※ **Make sure to check the specification of the solar simulator before setting up.**

6) Saving and Loading the Parameter Setup

The setup information required for measurements can be saved in parameter file, and these files can be uploaded when they are needed.

(1) Saving Parameter Settings

When setup is finished for each parameter, it is recommended to save it as parameter file with appropriate name.

Clicking Save Parameter File button, the "Save As" dialog box will be displayed as shown on Image 18.

Enter the file name and click Save button to save the file.

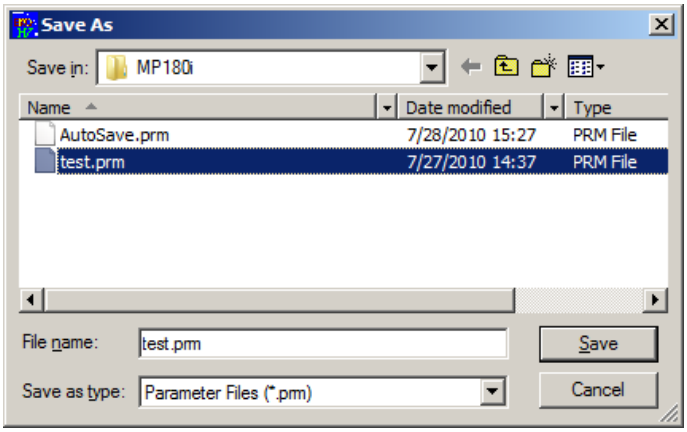


Figure 6-3-13. Saving Parameter

(2) Loading Parameters

This function will upload the setup information saved with assigned name.

When exiting the software, the setup information right before exiting this software is saved in the file called "AutoSave.prm". When the software is started, it will start with the setup information saved in "AutoSave.prm".

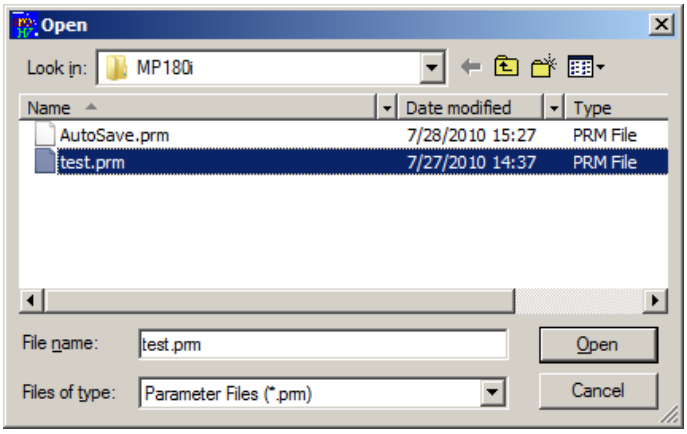


Figure 6-3-14. Loading Parameters

If the setup information which is used often with assigned name, this setup information can be loaded with the following procedure.

By clicking the Load Parameter File button, "Open File" Image (Image 19) is displayed. Go to the folder were the parameter file is saved and select the desired parameter file then click Open button. The setup information saved in the parameter file is loaded.

7) Measurement Status Indication

The Measure button will start the measurement with one of the three modes, which are Manual, Continuous, or Automatic, selected on the General Setting dialog box.

After completing the setup for all measurement condition, clicking Measure button will start the measurement; the status indication window should show "Measuring".

In manual mode, the status indication window will show only "Measuring" or "Stopping".

In continuous mode and automatic mode, the status indication window will show "Standby" in between the measurements.

Clicking Stop button while the "Waiting" status is indicated, the continuous or automatic measurement is terminated, and the status will be indicated "Stopping."

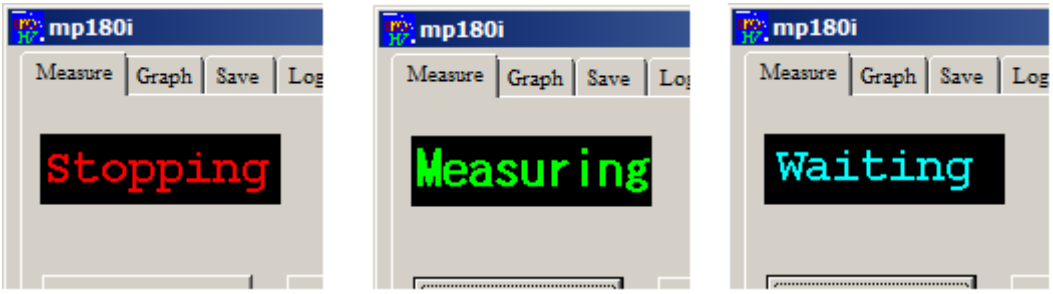


Figure 6-3-15. Status Indication

8) Graph and Graph Scale Settings

The I-V curve graph will be displayed after the measurement is completed. The scale of the displayed graph will be displayed according to the setting of the current axis and voltage axis.

Select the unit from the pull-down menu and enter the maximum and minimum values.

By checking the checkboxes for automatic setting, the software will automatically determines the most appropriate settings for maximum and minimum values. When the View Graph button is clicked, a graph with adjusted scale will be displayed.

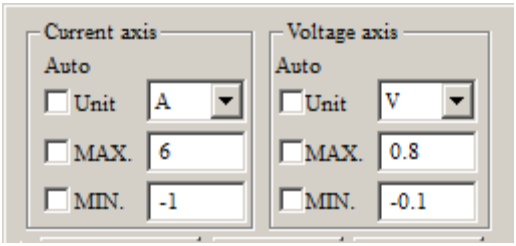


Figure 6-3-16. Current & Voltage Axis Scales Setting

At this stage, the graph can be printed by clicking the Print button; however, make sure the printer is setup before hand from the Printer Setup

By right clicking the graph display window, Save as BMP button will appear; the graph image will be saved as BMP file by clicking this button.

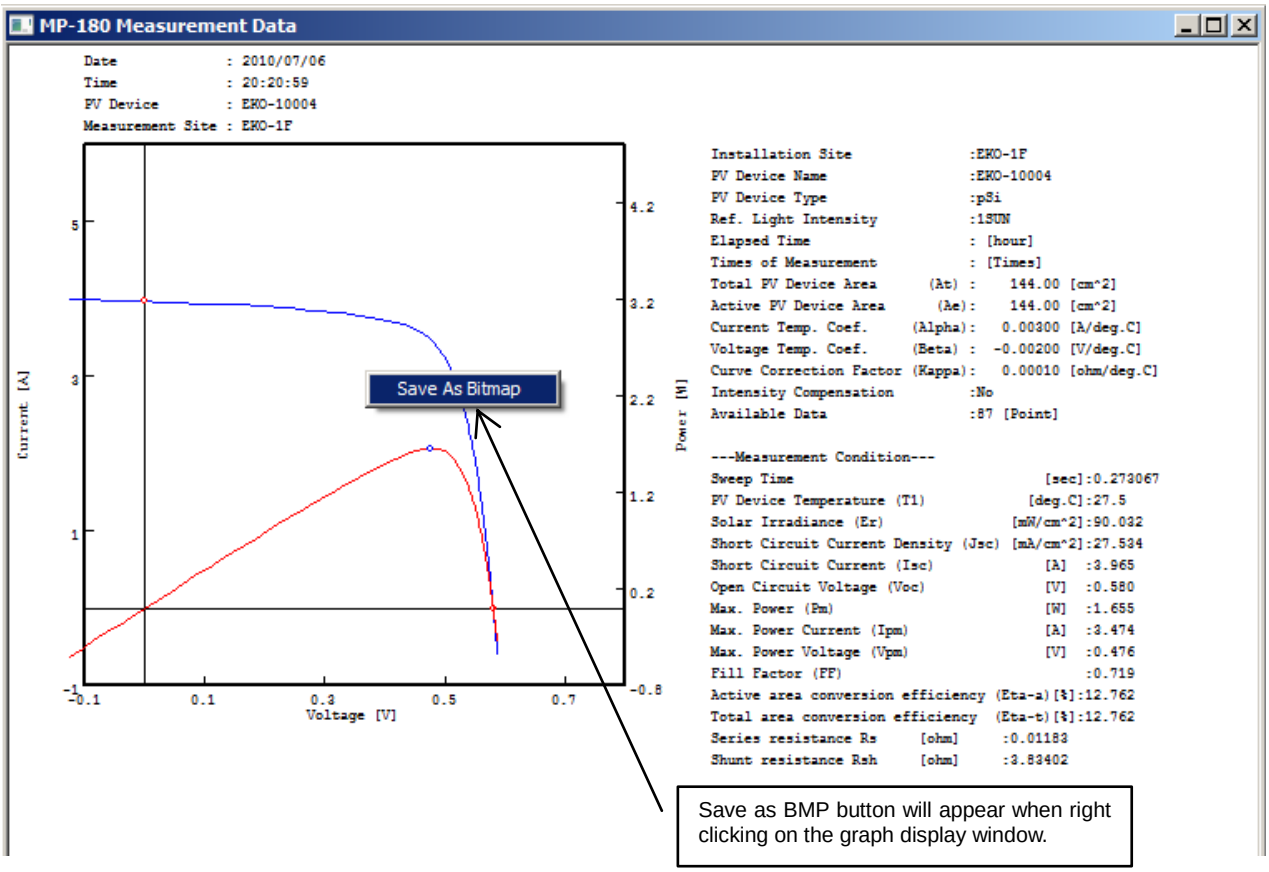


Figure 6-3-17. I-V Curve Graph Display

9) Solar Simulator Shutter Control

Connect the solar simulator shutter control signal to MP-180 and switch the operation mode on the solar simulator to remotely operate. When the Shutter button is clicked, the shutter will open and close by toggle.

When taking I-V measurement, the shutter will automatically open and close after the measurement is completed without clicking the Shutter button.

※ **Depending on the solar simulator manufacturer and model type, the control method of the shutter may vary. With MP-180, it is applicable for 2-wire type and 4-wire type. For any other type, it may need additional circuit in between to make it convertible.**

※ **The time between the shutter control signal input and the shutter open also depends on the solar simulator type. The most suitable shutter delay time needs to be setup on MP-180.** (See [6-3. Software Operation] → [1. Measure Tab] → [5) Shutter Setup])

※ **Although the shutter will be in opened condition when the power is turned on, it does not mean defect. If it is possible to communicate with computer in this condition, click the Shutter button twice to close the shutter. From the next operation, the shutter will repeat Open/Close movement for one click on the Shutter button.**

2. Graph Tab

By clicking the Graph tab, the window will be switched to the Graph tab window. This tab is used when displaying a graph of a measured data and viewing the characteristics value.

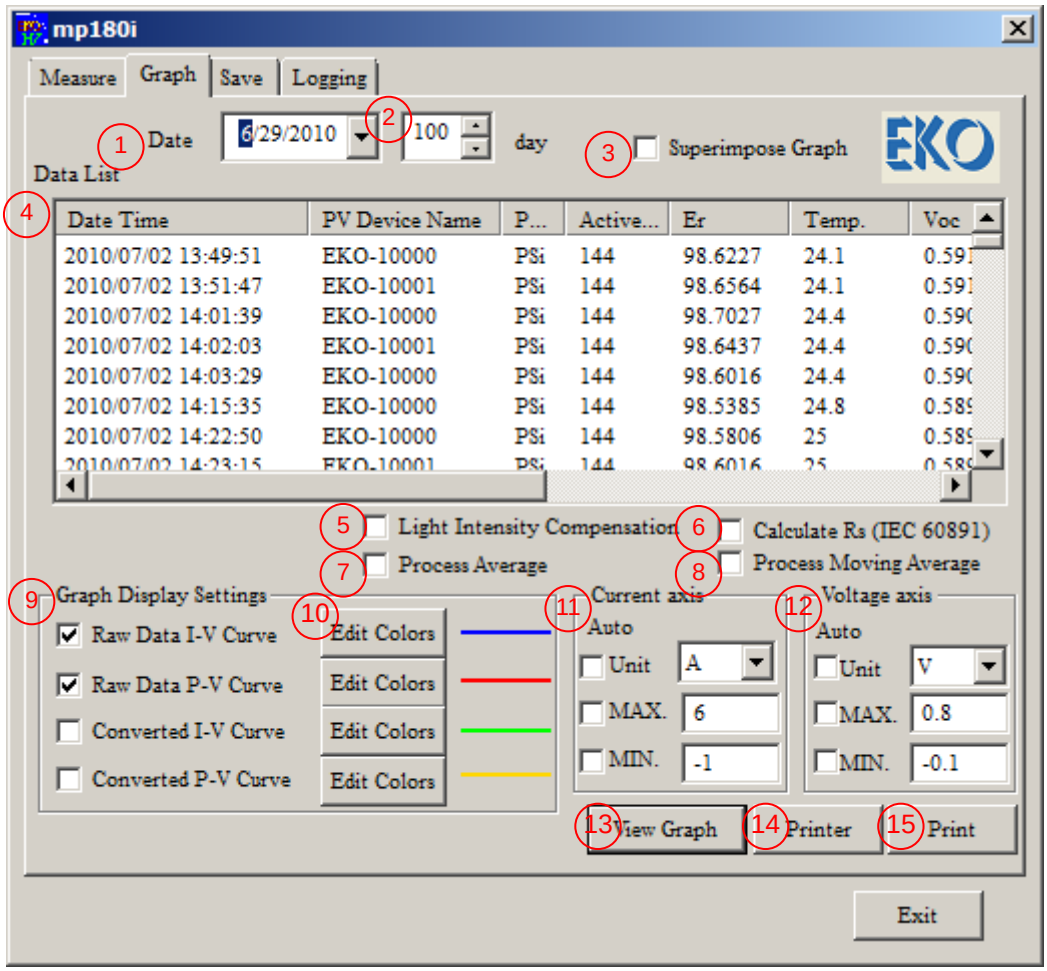


Figure 6-3-18. Graph Tab Window

Each button and functions are described in following page

Table 6-2. Graph Tab Menu

1	Calendar	To display a past measured data, select a specific date from this calendar; the data taken on the specified date is listed on data list.
2	Day Setting	To show additional days of data from the date specified on the calendar, select number of days. 1~100 days can be setup.
3	Superimpose Graph	Multiple data can be selected and the below functions are available. 1) Superimpose and display multiple data on one graph 2) Apply averaging procedure on the multiple data 3) Calculate series resistance Rs in IEC 60891 (JIS C8913)
4	Data List	The data from the specified date are listed in time order and shows the each characteristic. Select the desired data, and graph can be displayed by View Graph button.
5	Light Intensity Compensation	This will correct the unevenness of solar simulator light intensity
6	Calculate Rs	This will calculate the series resistance Rs by IEC 60891 (JIS C8913) method.
7	Process Average	By checking the checkbox, the data is averaged during continuous measurement, and I-V data is displayed.
8	Process Moving Average	Movement averaging process is done on the 10 sampling points on the I-V curve, and the result is displayed on graph.

Table 6-2. Graph Tab Menu - Continued

9	Graph Display Setting	Select to show or not show the I-V curve, P-V curve, Standard Condition I-V curve, and Standard Test Condition P-V curve.
10	[Edit Colors] Buttons	Select the color of the graph lines
11	Current Axis Setup	Setup the scale and unit of current axis on the I-V graph. If checkboxes of the Unit, Max and Min are checked, they will be in automatic setting; when they are unchecked, voluntary unit with Max and Min values can be setup.
12	Voltage Axis Setup	Setup the scale and unit of voltage axis on the I-V graph. If checkboxes of the Unit, Max and Min are checked, they will be in automatic setting; when they are unchecked, voluntary unit with Max and Min values can be setup.
13	[View Graph] Button	Displays the I-V curve graph again after the measurement. This button is used after changing units, graph scales, and correction processes have been applied.
14	[Printer] Button	Printer setup dialog box will show when this button is clicked and allow detailed setup for printer.
15	[Print] Button	I-V curve graph can be printed by clicking this button.

1) Calendar Function

First, select the measurement date of the data to be graphed by using the calendar function on the Graph Tab screen. When the down arrow next to the measured date box is clicked, calendar is displayed. To change the year and date, click the left/right arrow buttons on the sides and set to the desired year and month.

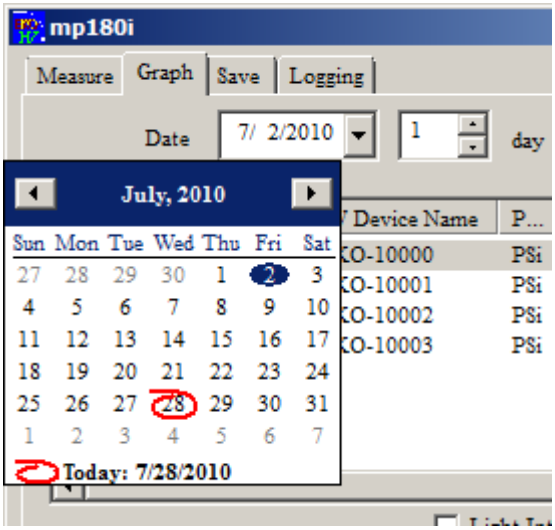


Figure 6-3-19. Calendar

By clicking the date, the data measured that particular day will be displayed in time sequence on the data list.

Select and click a data with desired time from the data list; the selected data will be highlighted.

Then clicking View Graph button will display a graph with I-V curve.

Measurement date can be specified without using the calendar; for example, he year, month, or date will be highlighted by clicking. In this condition, click the up/down arrow key; the number will move up/down. The date also can be entered by key.

On the right side of the Measurement Date, there is a box for specifying number of days which can be added to the measurement date; the additional data are displayed on the data list. This can be setup by clicking the up/down arrow buttons or enter directly by key. 1 ~ 100 days can be setup.

2) Data List

One day's data from specified date are displayed on the data list in order from recent data. If additional days are given, up to 100 days of data can be listed.

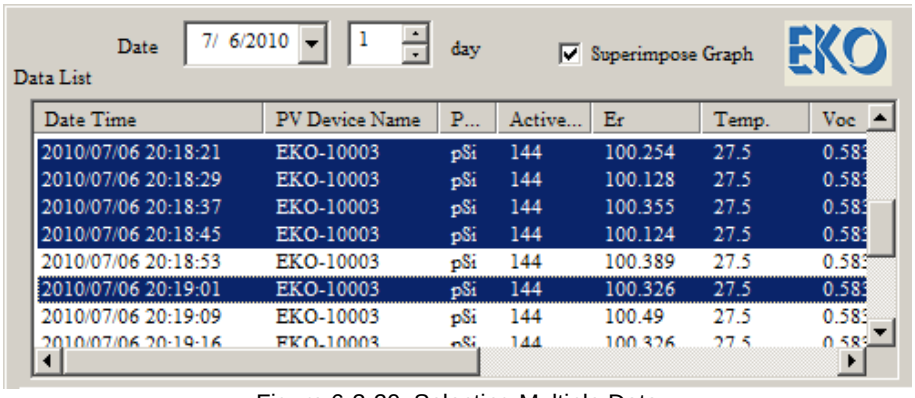


Figure 6-3-20. Selecting Multiple Data

Measured Date/Time, PV Device Name, PV Device Type, Active PV Device Area, Irradiance, Temperature, Voc, Isc, Pm, FF, ηa, Rs, and Rsh, are shown on data list in order.

When a data is clicked, the data line is highlighted, and the graph is displayed by clicking View Graph button.

If the checkbox for the "Superimpose Graph" is checked, and multiple data are selected, graph can be displayed in superimposed condition; functions such as process average and calculation for series resistance Rs by IEC 60891 (JIS C8913) are also available.

To select a block of multiple data, click a first desired data then press down arrow key all the way to the last desired data or click the last desired data by mouse while [Shift] key pressed down. With either method, the selected multiple data will be highlighted.

To select multiple individual data, click a first desired data then click the remaining individual data with mouse as [Ctr] key pressed down or use down arrow key to move the cursor and select with space key.

3) Superimposing Graph

Check the checkbox for "Superimpose Graph" and select multiple data. By clicking View Graph button, the data will be displayed with superimposed condition. Under the graph, each data characteristics are indicated. Up to 10 data can be superimposed.

※ **Only 10 data will be displayed even if more than 10 data are selected.**

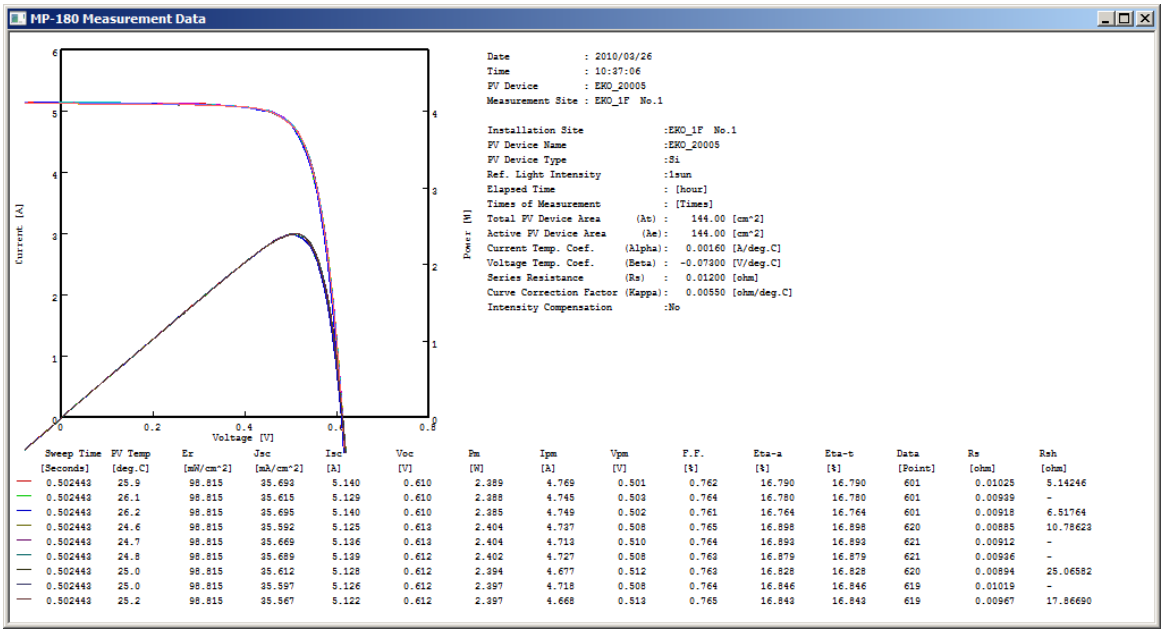


Figure 6-3-21. Superimposing I-V Curve Graphs

4) Process Average

Check the checkboxes for “Superimpose Graph” and “Process Average” and select multiple data desired to apply averaging process. By clicking View Graph button, averaged data will be displayed on graph. Up to 10 data can be superimposed.

※ **Only 10 data will be displayed even if more than 10 data are selected.**

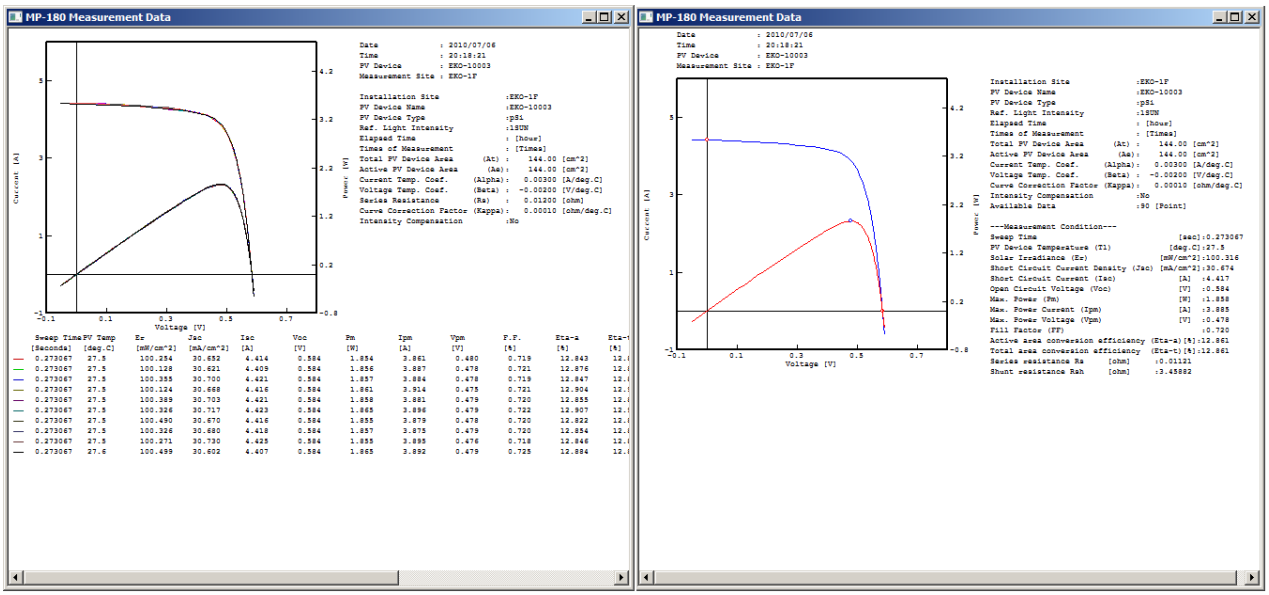


Figure 6-3-22. Process Average

5) Calculating Series Resistance Rs by IEC 60891 (JIS C8913) Method

Measures I-V curve for three times as changing the light intensity of solar simulator by more than 5%.

Switch the tab menu to Graph tab screen. Check the checkboxes for “Superimpose Graph” and “Rs Calculation (IEC 60891/JIS C8913).

Select three I-V curve data, which light intensity has changed, from the data list.

By clicking View Graph button, the following graph is displayed for example.

Rs calculation result section is displayed and the Rs value will be shown if the IEC 60891 (JIS C8913) calculation requirement is met.

※ **If the calculation requirement is not met for Rs, the “Rs calculation result” will not be indicated.**

※ **This Rs calculation result is displayed only on Graph and can be saved as BMP file; however, it cannot be saved as text file.**

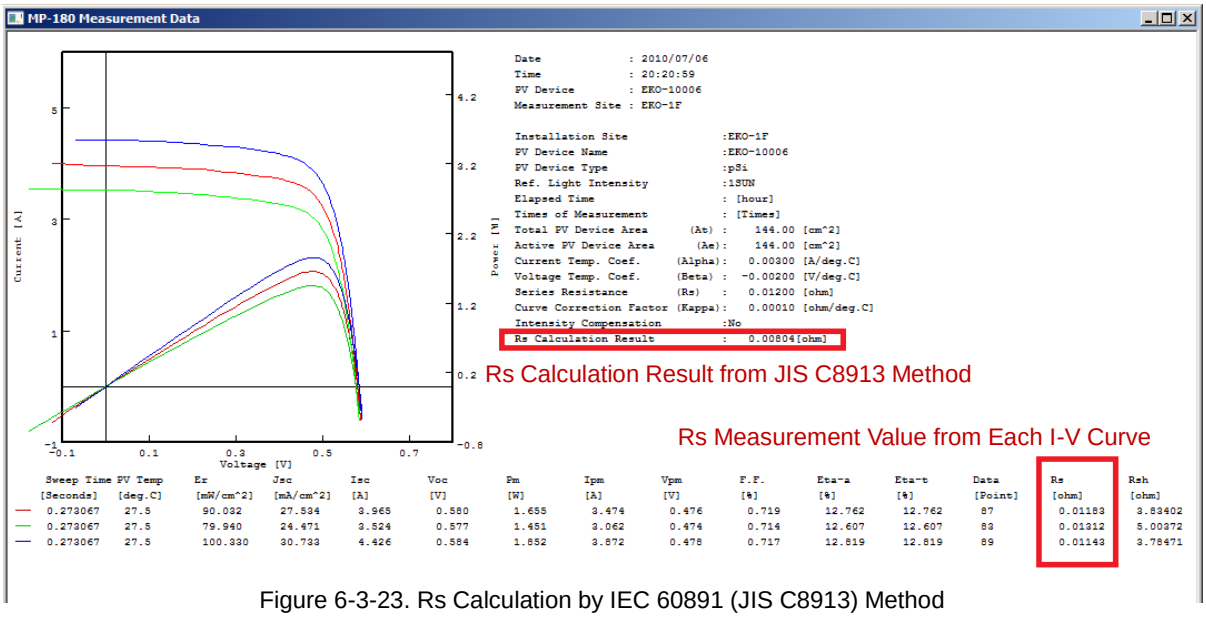


Figure 6-3-23. Rs Calculation by IEC 60891 (JIS C8913) Method

6) Light Intensity Compensation

Checking the checkbox for “Light Intensity Compensation” then click the View Graph button will display I-V curve graph which light intensity is corrected. This function corrects the unevenness of the light source. The light intensity is monitored by photon sensor at the same time of I-V measurement, and the unevenness is corrected against I-V curve.

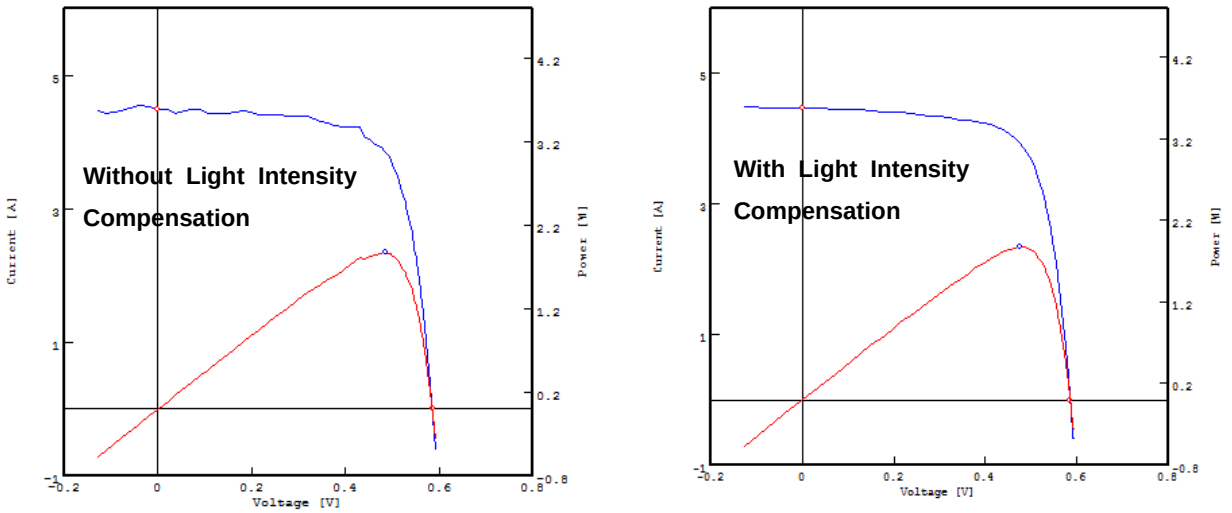


Figure 6-3-24. Light Intensity Compensation

It is effective when the photon sensor has quick response and fluctuation of the light source is moderate; however, if the photon sensor picks up noise, this function will work negatively. Using this function with Process Moving Average will be more effective.

7) Process Moving Average

An example of Process Moving Average function is shown below. By checking the checkbox for “Process Moving Average”, the average value of ten points worth of data is figured consecutively.

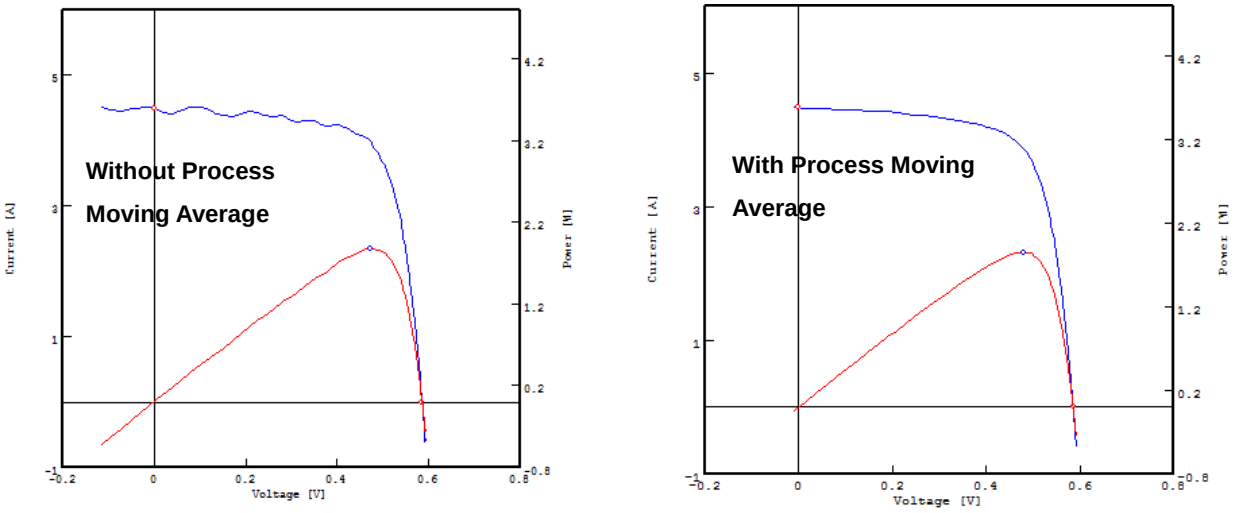


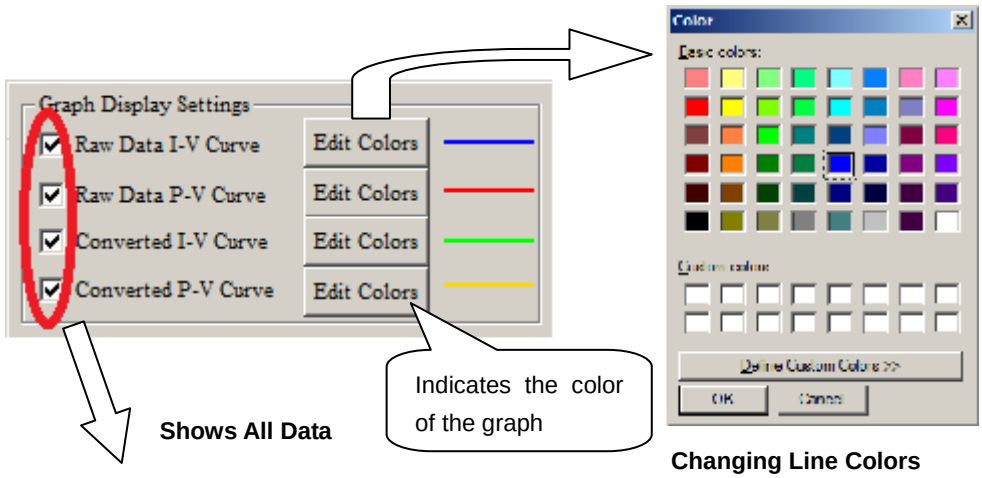
Figure 6-3-25. Process Moving Average

8) Standard Test Condition (STC) Conversion Data

Selecting and checking the checkboxes for these four types, I-V curve, P-V curve, STC I-V curve and STC P-V curve, of graph setting will display or not display the desired data.

※ For graphing the IEC 60891 (JIS C8913) STC conversion, the graph will be displayed properly when the each PV cell parameter and irradiation, PV cell temperature are setup on the Parameter Setting screen; however, if these parameters are not setup, the displayed values will not be valid.

Also when the Line Color buttons are clicked, setup dialog box will appear. Setup desired color and click OK button. The displayed color on the right side will change.



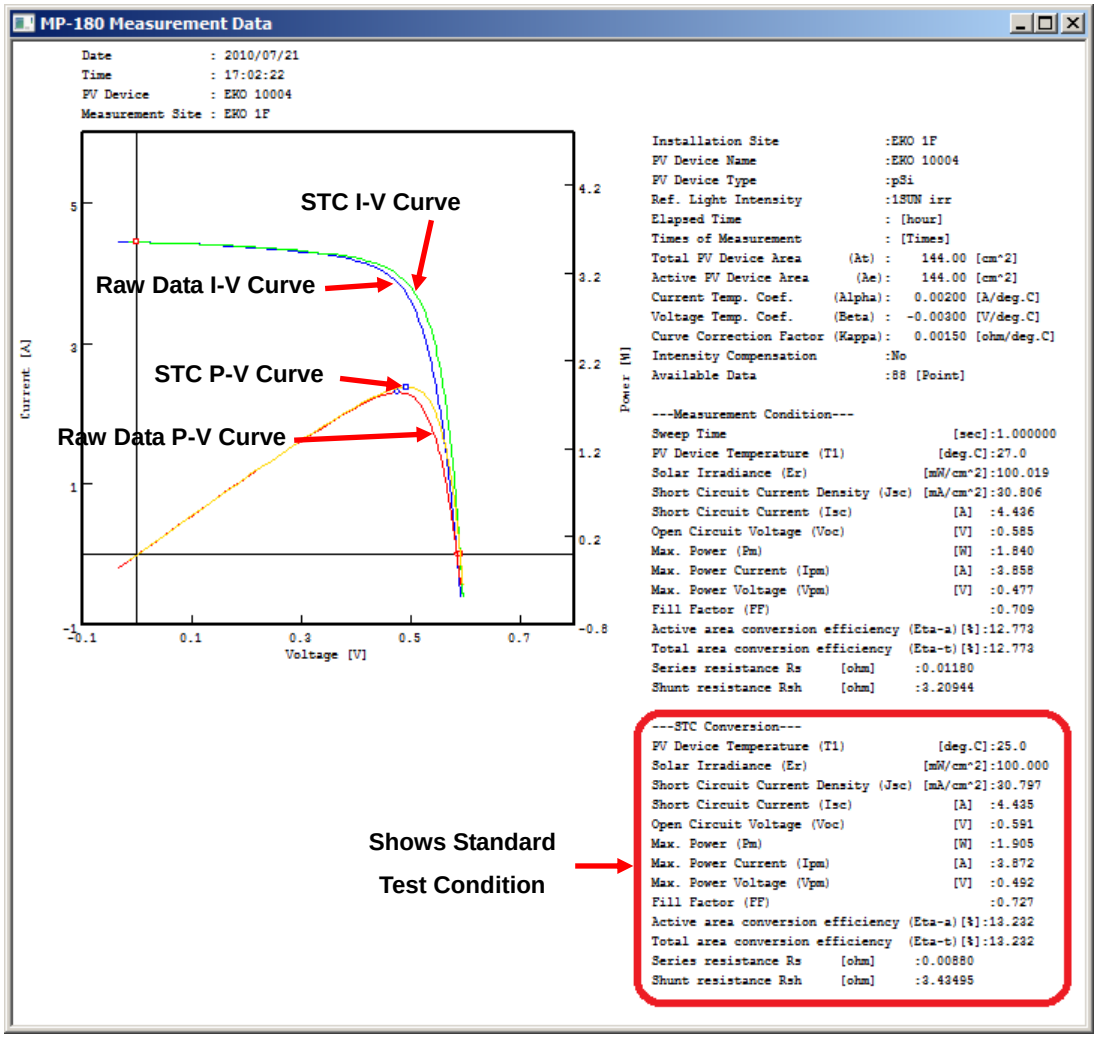


Figure 6-3-26. Displaying All Data

3. Save Tab

The screen will switch to “Save” tab when the Save tab is clicked.

In this screen, the measured I-V data can be converted into SCV format text file.

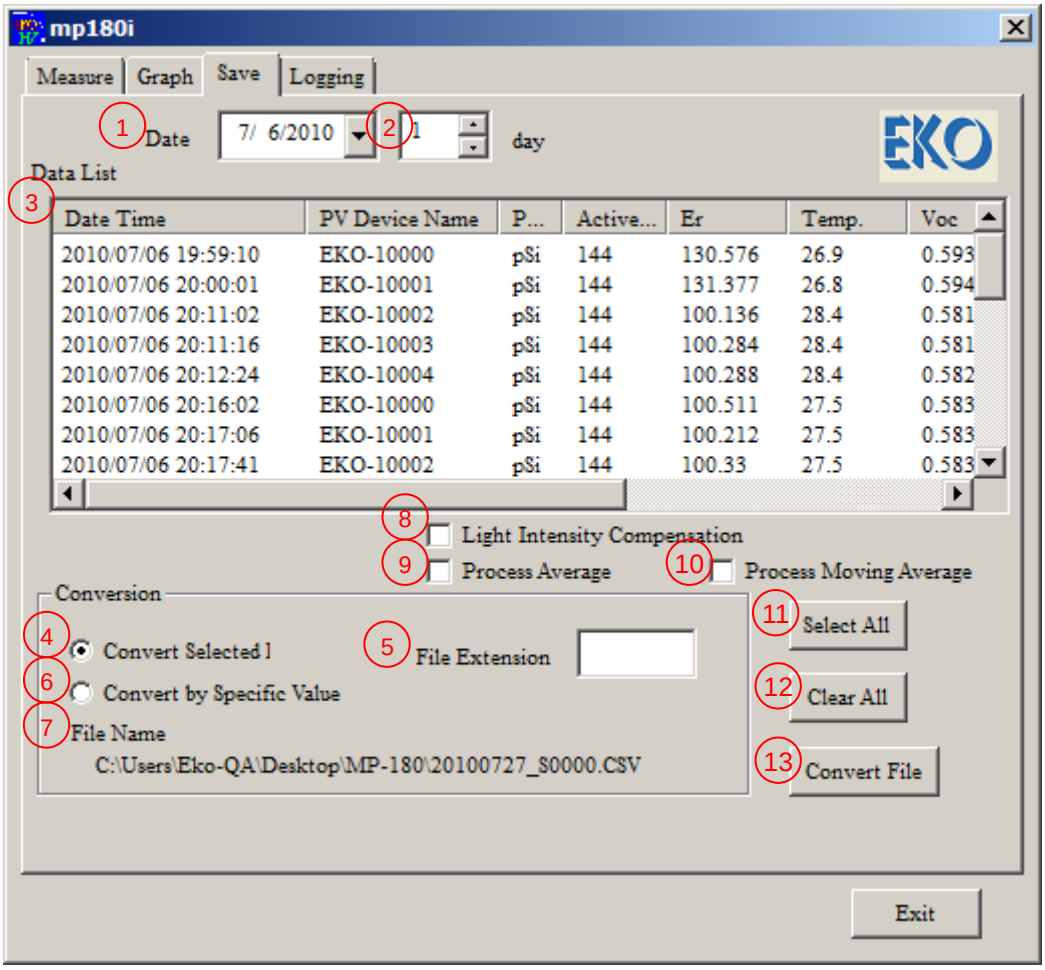


Figure 6-3-27. Save Tab Screen

Each button and functions are described as below

Table 6-3. Save Tab Menu

1	Calendar	To display a past measured data, select a specific date from this calendar; the data taken on the specified date is listed on data list.
2	Additional Days Setting	To show additional days of data from the date specified on the calendar, select number of days. 1~100 days can be setup.
3	Data List	The data from the specified date are listed in time order and shows the each characteristic. Select the desired data, and text conversion can be done by clicking Convert button.
4	Convert Selected Data Radio Button	Activate this radio button when text converting the voltage and current of I-V data and all sampling data of light intensity.
5	File Extension Box	Enter identification name to change the file name when converting individual data manually. Up to 5 numbers and/or alphabetical characters can be entered.
6	Convert by Specific Value Radio Button	Activate this radio button when text converting the characteristic of multiple data into one file.
7	File Name	The file name which to be converted into text file is displayed here.
8	Light Intensity Compensation	Corrects the light intensity unevenness of the solar simulator by checking this checkbox.
9	Process Average	The I-V data processed with averaging during continuous measurement is converted into text format by checking this checkbox.

Table 6-3. Save Tab Menu - Continued

10	Process Moving Average	The 10 points around the I-V curve sampling point is processed with movement averaging and converted into text format by checking this checkbox.
11	[Select All] Button	Clicking this button will select all the data on the data list.
12	[Clear All] Button	By clicking this button will clear the selected status from the selected data on data list.
13	[Convert File] Button	Text is converted according to the requirement by clicking this button.

The measured data is saved into one file per day in binary format.

To process this file with spreadsheet program, such as MS Excel, it is required to convert the file into text data.

There are two types of format for converting into text data; converting only the selected data and converting by a characteristic value and these formats can be used according to needs.

Select the desired I-V data on Graph tab. Even after the graph is displayed and confirmed then go back to the Save tab, the selected and graphed data will remain highlighted on the data list, thus it is easy to convert the desired data into text format.

4. Logging Tab

The Logging tab screen is displayed when the “Logging” tab is clicked.

On this screen, the values of voltage, current, temperature, irradiance, reference cell and so on can be monitored on graph and save into CSV file while the measuring PV device being applied with voluntary constant bias voltage.

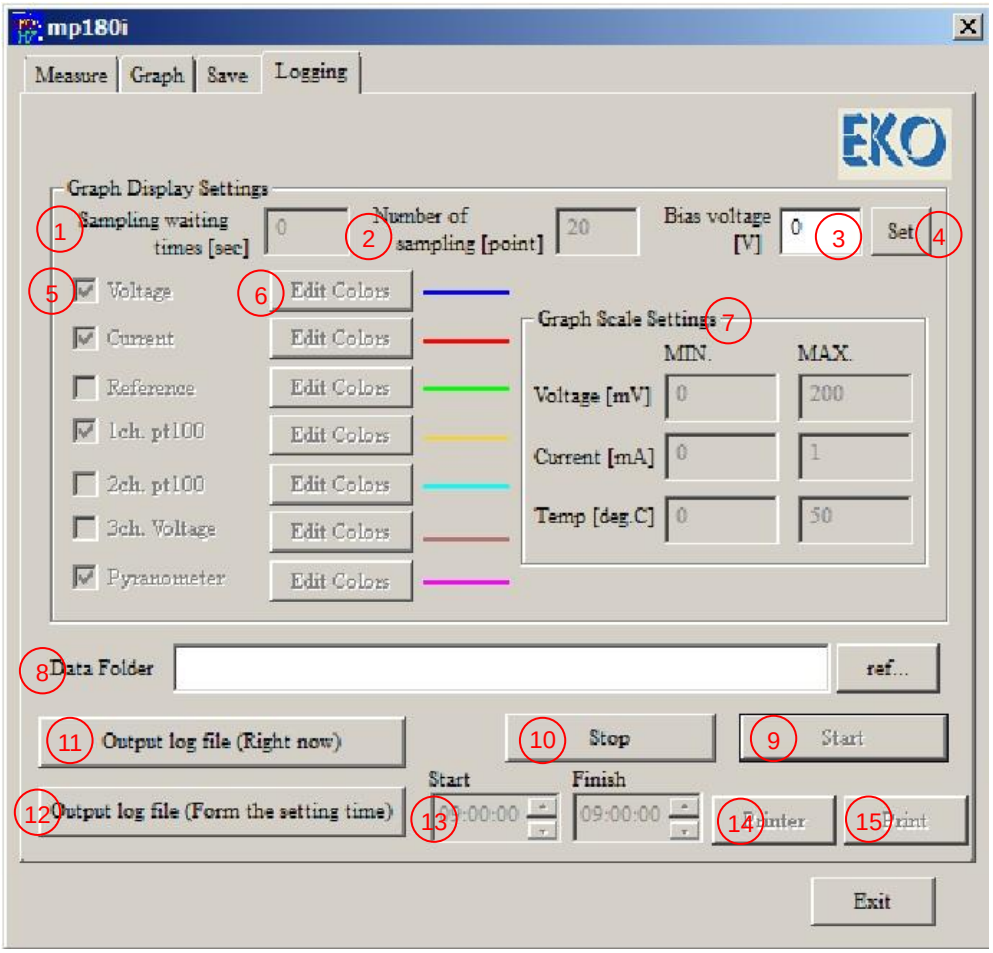


Figure 6-3-28. Logging Tab Screen

Each button and functions are described in following page

Table 6-4. Logging Tab Menu

1	Sampling Waiting Time	The sampling interval for monitoring can be changed. One sampling takes approx. 2sec, and the standby time till the next sampling can be setup.
2	Number of Sampling	Setup the sampling point quantity. This value will be the maximum of the horizontal axis on the monitoring graph.
3	Bias Voltage [V]	Setup the bias voltage value applied against the measuring PV cell.
4	[Set] Button	Starts applying the specified bias voltage by clicking this button.
5	Displaying Data Checkboxes	Select the desired items for monitoring by clicking the checkboxes for Voltage, Current, Reference Cell, Temperature, Temperature2, Voltage (Thermocouple), and Voltage (Pyranometer).
6	[Edit Colors] Buttons	Select the color of the graph lines for each measuring items.
7	Graph Scale Setting	Setup the Max and Min value of the vertical axis of graph scale by entering values here. Each measurement item is sorted into the scales of Voltage, current, and temperature.
8	Data Folder	Setup the folder location and file name for saving the monitoring condition as CSV format text file.
9	[Start] Button	Click this button to start the logging by applying the bias voltage.
10	[Stop] Button	Click this button to stop the logging after the logging has started.
11	[Output Log File (Right Now)] Button	The log file will start recording right after this button is clicked, after logging has started.
12	[Output Log File (from Setting Time)] Button	If desire to output log file from the start to the end time, click this button during logging, after the logging has started.
13	Start/Finish Time Setting	Setup the start and finish time when recording a log file by specifying the start and finish time.
14	[Printer] Button	The printer setup dialog box will be displayed for setting up the details by clicking this button.
15	[Print] Button	Prints I-V curve graph.

When the logging starts, the graph shown below will be displayed.

The horizontal axis of the graph will be the sampling points quantity specified.

The graph is cleared when the sampling reaches the right side, and the graph display will be repeated from the left side.

The bias voltage can be changed during logging; in such case, enter the bias voltage value in “Bias Voltage [V]” box and click Set button then the bias voltage will be changed.

Not like I-V measurement, there will be a constant amount of current will be applied, thus do NOT apply bias voltage near zero volt for a long period of time with PV cell which flows high current. Doing so may cause defect due to overheating. (As a reference, approximately five minutes would be the longest limit with a condition of 10A.)

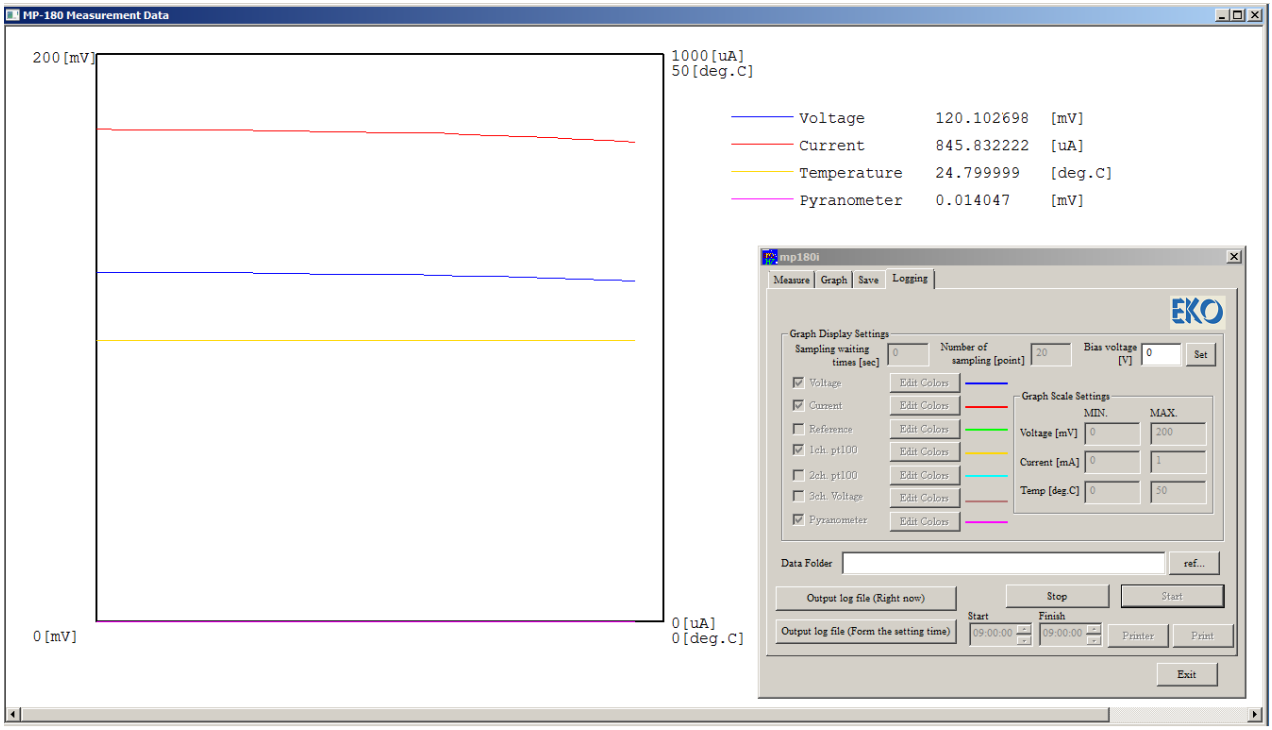


Figure 6-3-29. Monitor Graph

5. Saving Data Format

The measurement result is saved as binary file per day in the disk folder specified.

- Naming for binary file is as follow:

  20100126.IVP (Binary file)

  - Month and Date (mmdd)
  - Year (yyyy)

- Naming for text file is as follow:

  2010 0126 U0 C00 _□ 0000.CSV (Text file)

  - Sequential Number (0000~9999)
  - Specification Code
    - S: Individually converted file
    - C: Converted by characteristics value
  - Channel Number (Indoor software: fixed with “C00")
  - Unit Number (Indoor software: fixed with “U0”)
  - Month and Date (mmdd)
  - Year (yyyy)

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) Collective or Individual Conversion Data File (CSV Format Text File)

By selecting collective conversion, the following data format shown below will be created.

Type of tracer = MP-180
Software Version = 1.0.00
File name = C:¥Program Files¥EKO¥MP180i¥20100702_S0001.CSV
Date = 2010/07/02
Measurement Mode = SIMULATOR
Installation Site =EKO-1F
PV Device Name = EKO-10003
Type of PV Device = PSi
Reference Light Intensity=1SUN
Elapsed time = [Hour]
Measurement times = [times]
Current Temperature Coefficient(Alpha) = 0.00300[A/deg.C]
Voltage Temperature Coefficient(Beta) = -0.00200[V/deg.C]
Curve Correction Factor(Kappa) = 0.00150[ohm/deg.C]
Series Resistance(Rs) = 0.01200[ohm]
Calibration Constant of Pyranometer = 7.250[mV/kW/m^2]
Active area = 144.00[cm^2]
Total area = 144.00[cm^2]
Intensity Compensation = No
Time = 12:03:37
Sweep time[sec] = 0.273067
Temp. T1 [deg.C] = 24.3
Temp. T2 [deg.C] = 0.0
Temp. T3 [deg.C] = 276.6
Use Temp ch.=T1
Solar Irradiance [mW/cm^2] = 98.585

Jsc	Isc	Voc	Pm	Ipm	Vpm	F.F.	Eta-a	Eta-t	Jsc(stc)	Isc(stc)	Voc(stc)	Pm(stc)	Ipm(stc)	Vpm(stc)	Eta-a(stc)	Eta-t(stc)	Rs	Rsh
[mA/cm^2]	[mA]	[mV]	[mW]	[mA]	[mV]		[%]	[%]	[mA/cm^2]	[mA]	[mV]	[mW]	[mA]	[mV]	[%]	[%]	[ohm]	[ohm]
30.30326	4364	590	1856	3829	484.6	0.7	13	13	30.745726	4427.4	588.805	1862.6	3884	479.553	12.9348	12.935	0.012	5.4773
	Voltage	Curren	Light I	STC Vo	STC Current Istc [mA]													
	-89.1	4379	1.791	-95.9	4444													
	-68.6	4377	1.792	-75.5	4442													
	-47.3	4374	1.792	-54.2	4438													
	-26.3	4369	1.791	-33.1	4434													
	-5.09	4364	1.789	-11.9	4429													
	15.55	4361	1.79	8.73	4426													
	35.94	4357	1.79	29.12	4422													
	56.52	4353	1.79	49.71	4418													
	76.44	4352	1.793	69.62	4417													
	97.62	4355	1.797	90.81	4420													
	118.2	4356	1.802	111.4	4420													
	-64.3	5027	1.805	-165	5009													
	-41.1	5025	1.805	-141	5006													
	-18.7	5021	1.804	-119	5002													
	1.896	5016	1.804	-98.4	4997													

Maximum 4096 points

Jsc:	Short Circuit Current Density [mA/cm^2]	Jsc (stc):	Short Circuit Current Density [mA/cm^2]
Isc:	Short Circuit Current [mA]	Isc (stc):	Short Circuit Current [mA]
Voc:	Open Circuit Voltage [mV]	Voc (stc):	Open Circuit Voltage [mV]
Pm:	Maximum Power [mW]	Pm (stc):	Maximum Power [mW]
Ipm:	Best Moving Current [mA]	Ipm (stc):	Best Moving Current [mA]
Vpm:	Best Moving Voltage [mV]	Vpm (stc):	Best Moving Voltage [mV]
F.F.:	Fill Factor	ηa(stc):	Active Area Conversion Efficiency [%]
ηa:	Active Area Conversion Efficiency [%]	ηt(stc):	Conversion Efficiency [%]
ηt:	Conversion Efficiency [%]		

(2) Characteristics Value Conversion Data File (CSV Format Text File)

By selecting the Characteristics Value Conversion, the following data format shown below is created.

Ae:	Active PV Device Area [cm^2]	FF:	Fill Factor
At:	Total PV Device Area [cm^2]	ηa:	Active Area Conversion Efficiency [%]
Er:	Solar Irradiance [mW/cm^2]	ηt:	Conversion Efficiency [%]
T1:	TEMP1 Measurement Temperature [℃]	Jsc (stc):	Std. Condition Short Circuit Current Density [mA/cm^2]
T2:	TEMP2 Measurement Temperature [℃]	Isc (stc):	Std. Condition Short Circuit Current [mA/cm^2]
T3:	TEMP3 Measurement Temperature [℃]	Voc (stc):	Std. Condition Open Circuit Voltage [mV]
Jsc:	Short Circuit Current Density [mA/cm^2]	Pm (stc):	Std. Condition Max. Power Output [mW]
Isc:	Short Circuit Current [mA]	Ipm (stc):	Std. Condition Max. Current [mA]
Voc:	Open Circuit Voltage [mV]	Vpm (stc):	Std. Condition Max. Voltage [mV]
Pm:	Maximum Power [mW]	ηa(stc) :	Active Area Std. Condition Conversion Efficiency [%]
Ipm:	Max. Output Moving Current [mA]	ηt(stc) :	Std. Condition Conversion Efficiency [%]
Vpm:	Max. Output Moving Voltage [mV]		

```
Type of tracer = MP-180
Software Version = 1.0.00
File name = C:\Program Files\EKO\MP180i\20100706U0C00_C0000.CSV
Date = 2010/07/06
Measurement Mode = SIMULATOR
Installation Site =EKO-1F
PV Device Name = EKO-10000
Type of PV Device = pSi
Reference Light Intensity=1SUN
Elapsed time = [Hour]
Measurement times = [times]
Current Temperature Coefficient(Alpha) = 0.00300[A/deg.C]
Voltage Temperature Coefficient(Beta) = -0.00200[V/deg.C]
Curve Correction Factor(Kappa) = 0.00150[ohm/deg.C]
Series Resistance(Rs) = 0.01200[ohm]
Calibration Constant of Pyranometer =  7.250[mV/kW/m^2]
Active area =  144.00[cm^2]
Total area =  144.00[cm^2]
Intensity Compensation = No
```

Time	Name	Type	Sweep	Ae	At	Er	Use	T1	T2	T3	Jsc	Isc	Voc	Pm	Ipm	Vpm	F.F.	Eta-a	Eta-t	Jsc(stc	Isc(stc)	Voc(stc	Pm(stc	Ipm(stc	Vpm(st	Eta-a(s	Eta-t(st	Rs	Rsh
			[sec]	[cm^2	[cm^2	[mW/cm^2]		[deg.C]	[deg	[deg.C]	[mA/cn	[mA]	[mV]	[mW]	[mA]	[mV]		[%]	[%]	[mA/cn	[mA]	[mV]	[mW]	[mA]	[mV]	[%]	[%]	[ohm]	[ohm]
######	EKO-1	pSi	0.273	144	144	130.6	T1	26.9	0	223.1	46.06	6633	593.3	2462	5043	488.2	0.63	13.09	13.09	36.04	5190	599.2	1834	3685	497.5	12.73	12.73	0.01	0.776
######	EKO-1	pSi	0.273	144	144	131.4	T1	26.8	0	24.8	45	6479	594.2	2459	5055	486.5	0.64	13	13	34.85	5019	600.1	1834	3671	499.5	12.73	12.73	0.01	1.155
######	EKO-1	pSi	0.273	144	144	100.1	T1	28.4	0	360.9	30.8	4435	581.9	1844	3862	477.6	0.71	12.79	12.79	30.79	4434	588.7	1940	3870	501.3	13.47	13.47	0.012	3.764
######	EKO-1	pSi	0.273	144	144	100.3	T1	28.4	0	-52.4	30.54	4397	581.6	1839	3886	473.2	0.72	12.73	12.73	30.47	4387	588.4	1932	3893	496.3	13.42	13.42	0.011	3.451
######	EKO-1	pSi	0.273	144	144	100.3	T1	28.4	0	-4.1	30.72	4424	582.1	1856	3882	478.2	0.72	12.85	12.85	30.59	4404	588.9	1949	3882	502	13.53	13.53	0.011	2.634
######	EKO-1	pSi	0.273	144	144	100.5	T1	27.5	0	245.7	30.61	4408	583.8	1856	3884	477.8	0.72	12.82	12.82	30.41	4379	588.7	1862	3867	481.5	12.93	12.93	0.011	5.53
######	EKO-1	pSi	0.273	144	144	100.2	T1	27.5	0	288.7	30.64	4412	583.8	1856	3887	477.5	0.72	12.86	12.86	30.53	4397	588.8	1886	3881	486	13.1	13.1	0.011	3.663
######	EKO-1	pSi	0.273	144	144	100.3	T1	27.5	0	40.5	30.77	4431	583.8	1855	3870	479.3	0.72	12.84	12.84	30.62	4409	588.8	1868	3854	484.8	12.97	12.97	0.011	2.75

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(3) Log File for Logging (CSV Format Text File)

By selecting log file output when logging, the following data format shown below is created.

2010/1/21	20:08:22							
Date	Time	V[mV]	I[mA]	ref[mV]	temp.1[deg	temp.2[deg	Er[mV]	
2010/1/21	20:08:22	0.608931	−0.33137	0.001874	22.9	23.8	0.00718	
2010/1/21	20:08:25	0.609009	−0.33112	0.001887	22.9	23.8	0.007176	
2010/1/21	20:08:50	0.608758	−0.32896	0.001877	22.9	23.8	0.007177	
2010/1/21	20:08:53	0.608767	−0.33236	0.001878	22.9	23.8	0.00718	
2010/1/21	20:08:57	0.608779	−0.33216	0.00188	22.8	23.8	0.007196	
2010/1/21	20:08:59	0.608718	−0.33225	0.001876	22.9	23.8	0.007164	
2010/1/21	20:09:02	0.608741	−0.33219	0.00188	22.9	23.8	0.007198	
2010/1/21	20:09:05	0.6087	−0.33235	0.001877	22.8	23.8	0.007171	
2010/1/21	20:09:08	0.608689	−0.33225	0.001878	22.9	23.8	0.007192	
2010/1/21	20:09:10	0.608699	−0.33216	0.00188	22.9	23.8	0.007176	
2010/1/21	20:09:13	0.608697	−0.33225	0.00188	22.9	23.8	0.007179	
2010/1/21	20:09:16	0.608693	−0.33221	0.001884	22.8	23.8	0.00718	
2010/1/21	20:09:18	0.608639	−0.33244	0.001878	22.8	23.8	0.007183	
2010/1/21	20:09:21	0.608668	−0.3324	0.00188	22.9	23.8	0.007177	

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6. Displayed Data and Essential Numbers

The items measured with MP-180 hardware are only the current and voltage value, irradiance, platinum resistor body (temperature), voltage (temperature), and current for reference cell.

For the other items such as short circuit current Isc, open circuit voltage Voc, maximum output Pm, maximum output moving current Ipm, maximum output moving voltage Vpm, fill factor F.F., conversion efficiency η, series resistance Rs, and shunt resistance Rsh, are all calculated values from the actual measurement value of I-V curve, irradiance, and temperature.

The displayed data on the MP-180 software, for temperature is indicated with one digit for the decimal point, for other items are indicated with three decimal points for the maximum, depending on the unit setting. The number of significant figures do not necessary match. The calculation accuracy of the current and voltage value for I-V curve is ±0.1% thus the number of significant figure is five digits and the sixth digit contains error. (The files are not saved with number of significant figures also.)

The calculation method complies with IEC 60891 (JIS C8913). For Pm, it is fit with curve approximation in the area near the I-V curve peak; the peak value is determined as Pm and its current value of this point as Ipm, voltage value as Vpm. The open circuit voltage Voc and short circuit current Isc are determined by calculating the cross points by straight approximation from the points around the I-V curve crossing each X and Y axis. Curve fill factor F.F. is calculated by Pm/(Isc x Voc); conversion efficiency η is calculated by Pm/(PV Cell Area x Irradiance). To display these values, the fourth decimal number is rounded up to three digits; so, if the values displayed on the software are calculated for Pm by Vpm x Ipm, the displayed value will not match completely to the last digit.

7. Calibration & Troubleshooting

7-1. Calibration

It is recommended to recalibrate the instrument once every 1~2 years. For further information about the calibration and recalibration, please contact EKO.

7-2. Troubleshooting

Check the following items in case of trouble with the instrument. If any questions should remain, contact EKO for further technical support.

Table 7-1 Troubleshooting

Failure	Action
Cannot take measurements	1) Check the PV cell for the polarity. 2) Check the PV terminal for the polarity of the four wires. 3) Setup with appropriate sweeping voltage. 4) Setup with appropriate voltage and current range for measurements. If it is setup at over-range, the current limit will be effective and cannot take measurement. If the range is unknown, measure at the larger ranges and figure out the appropriate range 5) Setup with appropriate graph scale. In some cases, measurement is taken, however due to the graph range setting is not appropriate, the graph is not displayed. 6) Check the “Current Limit” value in the General Setting of software. If this is setup at “0 (zero)”, the measurement cannot be taken. Also make sure to indicate the positive (+) or negative (-). 7) If the sweeping time is set to “zero”, the measurement cannot be taken. Enter an appropriate sweeping time from the sampling section on the “General Setting”.
Cannot take measurements (Continued)	8) If “Easy Setting” is selected in the sampling section of this dialog box, the sweeping time can be entered directly. Sweeping time can also be entered from the Main screen. 9) If selected “Detailed Setting”, the sweeping time will be calculated automatically by setting up the data counts, integrated and step interval values.
I-V curve does not reach the short circuit current Isc.	By specifying the sweeping voltage, adjust the bias voltage value on negative side. For example when measuring and displaying a graph with sweep -0.1V ~ +0.8V, the voltage decreases as the current increases due to the effects of the resistance from cable, contact or series resistances Rs of PV device, and the I-V curve does not reach the sweep voltage on the negative side. With this in mind, adjust and setup the value of sweeping voltage for negative side larger so that the I-V curve will reach the Isc point.
The Maximum Power Pm is plotted off track from the maximum value of P-V curve	The maximum power Pm is calculated with cubic curve approximation. Try changing the point value of maximum power Pm on the item “approximation calculation point”. Setup the point value, larger number of points (i.e. 10 points) for moderate curve, less (i.e. minimum 3 points) for sharp curve.

Table 7-1 Troubleshooting - Continued

Failure	Action
The value of temperature is always indicated with the same value.	1) Check the connection at the temperature channel on rear panel of the main unit. 2) If the “Use This Value for All Measurement” is selected on “Temperature Setting” dialog box, change the selection to “Measure at I-V Curve Measurement” 3) Check if the temperature channel is specified correctly from “Temperature Setting” dialog box.
Abnormal STC conversion value	1) Check the PV cell parameter items from “Parameter Setting” dialog box and make sure all items are entered. The following seven items are required for STC conversion: ➢ PV Device Area Ae, At ➢ Current Temperature Coefficiency α ➢ Voltage Temperature Coefficiency β ➢ Series Resistance Rs ➢ Curve Correction Factor κ ➢ PV Device Temperature (Fixed value or Measure during I-V curve measurement) ➢ Irradiance (Fixed value or Measure during I-V curve measurement) 2) Check the temperature channel which is used for STC conversion in “STC Calculation Temperature” section on “Parameter Setting” dialog box.
Unevenness on I-V Curve	1) The light source may have unevenness. The unevenness of light source can be corrected by connecting a fast response photon sensor such as silicon sensor; place it under the same irradiating surface as the measuring PV cell and take measurement. Check the checkbox for “Light Intensity Compensation” on main screen of the software then take a measurement. This method is effective on significant unevenness. 2) Electrical noise may be picked up. If the grounding is not setup, try setting grounding earth. If the grounding is already setup, try removing it. If the noise does not improve with these actions, use noise cut transformer to remove the noise from AC power. To solve this problem from the measurement condition, it is recommended to measure with setting the integration value to a large number such as more than 100. In this case, adjust the step interval value and setup so the sweeping time will be as desired. To solve this problem on software, the measurement can be taken multiple times and apply process average. By checking the checkbox for “Process Average” with continuous measurement mode, or use “Process Moving Average” for applying averaging process in one measurement; a smooth graph should be displayed.

8. Specification

8-1. Main Unit

Table 8-1. Specification

Items	Details			
Measurement Range	Voltage: 20V, 2V Current: 20A, 2A, 200mA, 20mA, 2mA, 200μA, 20μA Reference: 200mA, 20mA, 2mA, 200μA, 20μA Analog Input: 10V, 1V, 100mV, 10mV			
PV Terminal Input Voltage	Measureable Input Range: 1mV~20V			
	Range	Input Range	Accuracy	Resolution
	20V	0~27.5V	±(0.1%rdg+1mV)	2.4μV
	2V	0~2.5V	±(0.1%rdg+150μV)	0.24μV
PV Terminal Input Current	Measureable Input Range: 10μA~16A			
	Range	Input Range	Accuracy	Resolution
	20A	0~22.7A	±(0.1%rdg+0.3mA)	2.4μA
	2A	0~2.27A	±(0.1%rdg+0.1mA)	0.24μA
	200mA	0~227mA	±(0.1%rdg+10μA)	24nA
	20mA	0~22.7mA	±(0.1%rdg+5μA)	2.4nA
	2mA	0~2.27mA	±(0.1%rdg+1.5μA)	0.24nA
	200μA	0~227μA	±(0.5%rdg+20nA)	24pA
	20μA	0~22.7μA	±(0.5%rdg+5nA)	2.4pA
Reference Input	Measureable Input Range: 10μA~200mA			
	Range	Input Range	Accuracy	Resolution
	200mA	0~227mA	±(0.1%rdg+2.5μA)	24nA
	20mA	0~22.7mA	±(0.1%rdg+50nA)	2.4nA
	2mA	0~2.27mA	±(0.1%rdg+5nA)	0.24nA
	200μA	0~227μA	±(0.1%rdg+1nA)	24pA
	20μA	0~22.7μA	±(0.1%rdg+0.3nA)	2.4pA
Analog Input Pyranometer: RAD Voltage Input: IN1 & Pt100	Range	Input Range	Accuracy	Resolution
	10V	0.75~10V	±(0.1%rdg＋1mV)	0.3mV
	1V	750mV~1.0V	±(0.1%rdg+50μV)	30μV
	100mV	75mV~100mV	±(0.1%rdg+10μV)	3μV
	10mV	0~10mV	±(0.2%rdg+5μV)	0.3μV
	Pt100	-100 ~ +100℃	±(0.2%rdg+0.3℃)	0.1℃
PV Terminal Input Power	MAX 100W			

Table 8-1. Specification - Continued

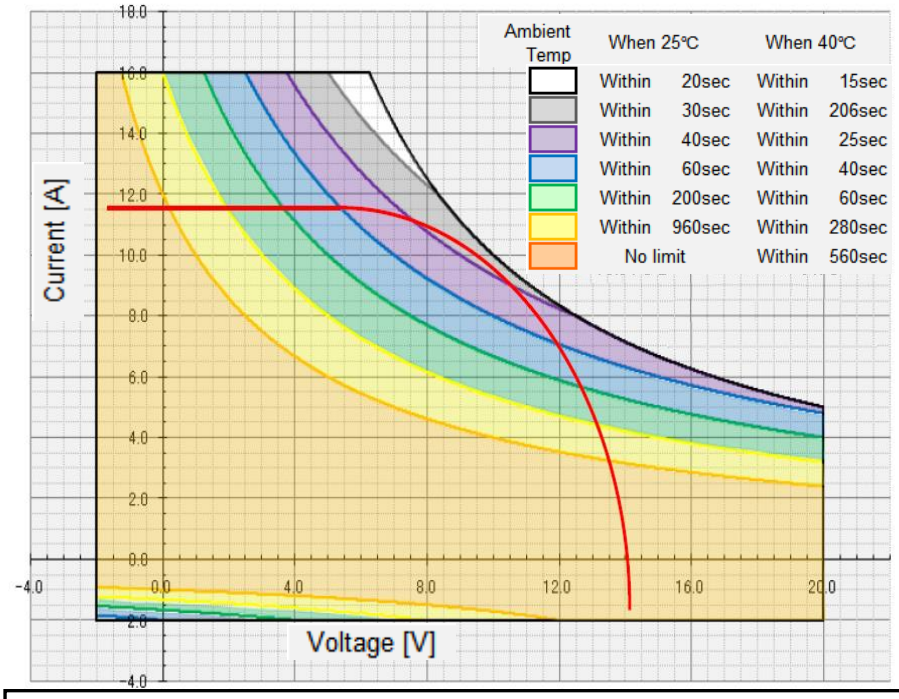
Items	Details	
Measureable Range	 Measurable Range and Measurement Time Limit Range when Setup at 20A Range ※ When measuring I-V, setup the sweeping time within the rating of the PV cell and the measurement time limit indicated above. ※ When logging, setup the stat-end time within the PV cell rating and measurement time limit indicated above. ※ Depending on the ambient temperature, the measuring time limit will vary.	
Sweeping Bias Voltage	20A Range	-2V~+20V
	Below 2A Range	-20V~+20V
I-V Measuring Points	20 ~ 4096 points	
A/D Sampling Time	21.333μs	
Step Width	0.03ms ~ 3000ms	
A/D Sampling Quantity per one point	1 ~ 256 times (Accumulated time: 21.333μs ~ 5.46msec)	
Sweeping Time	5msec ~ 300sec	
Sweeping Method	One-way Sweeping (Isc → Voc, Isc ← Voc), Return Sweeping is capable Sweep step width can be changed from linear ~ exponential	
Measurement Interval	5sec ~ 60minutes	
Communication Interface	RS-232C: RS-232C cross cable or interlink cable USB: USB Cable (AB type, shield cable) LAN: Twist pair & shield cable	
Analog Input	Pyranometer Input	1ch (RAD terminal)
	Pt100 Input	4 Wire-type 2ch (PT100 1, PT100 2)
	Voltage Input Cannel	1ch (IN1 Terminal: for converting to Thermocouple) ※ This will require a separate converter
Digital Input	External Trigger Input	Photo-Coupler Input: 5V, 5mA Measurements can be started by external signal; The delayed time from the trigger input to measurement start is also possible.
Digital Output	Shutter Control Output	Shutter Control for Solar Simulator 1) 2-Wire-type: Photo-Coupler output (Maximum 50mA) Short circuit: OPEN, Open: CLOSE 2) 4-Wire-type: Photo-Coupler output (Maximum 50mA) OPEN signal pulse (more than 50ms) CLOSE signal pulse (more than 50ms)

Table 8-1. Specification - Continued

Items	Details
Operating Environment	Operate in a temperature controlled room. Operate in a room with no dusts. When there are causes of noise and power source nearby, bring the AC power supply from another separate system. If it is not possible, it is recommended to use noise cut transducer.
Operating Temperature Range	Temperature: 5℃~35℃
	Humidity: 20%RH~85%RH (no condensation)
Storing Temperature Range	Temperature: -10℃~60℃ Humidity: 20%RH~85%RH (no condensation)
Outer Dimension	133H × 450W × 459D
Weight	9kg
Power Supply	AC100~240V 50/60Hz (MAX 125VA) Fuse: 6.3A 250V 5φ x 20mm

8-2. Software

Table 8-2. Software Specification

	Details
Software Version	1.0.X.X
Firmware Version	3.4
OS Application	Windows 2000/XP/Vista/7/8 (Japanese/English OS Applicable) ※ If the software is used in Windows Vista/7 environment, please read instructions on “A-1. Installing MP-180 Software on Windows Vista or Windows 7, 8”
Operating Environment	CPU: Pentium/Celeron equivalent, 100MHz or more Memory: 64 MB or more Hard Disk Space Capacity: 300 MB or more Display Resolution: 1024 x 768 dot or more Interface: One of the RS-232C, USB, or LAN must be available
Program Name	mp180_Vxxx.exe
Software Functions	・Single, continuous, and automatic measurement from the software. ・Measurement by external trigger input (applicable on pulse light type solar simulator) ・Measurement with automatic shutter open/close control on solar simulator. ・Setting sampling interval, step interval, sweeping time, accumulated quantity, and data count. ・Graphing I-V curve, P-V curve, I-V (STC) curve, and P-V (STC) curve. ・Displaying multiple I-V curve graphs in superimposed format ・Linear sweep and exponential sweep functions ・Process Moving average, process average, and light intensity compensation ・Database function (Displaying past measurement data list by selecting calendar dates and each graph can be displayed from the data list. ・Converting into CSV text data file (I-V file and Characteristics value summary file) ・Logging Function (graph monitoring and log file output in a condition which bias voltage is voluntary applied)
Measurement Item	・Maximum Power: Pm, Open Circuit Voltage: Voc, Short Circuit Current: Isc, Fill Factor: FF, Power Generating Efficiency: η, Maximum Power Voltage: Vpm, Maximum Power Current: Ipm, Series Resistance: Rs, Shunt Resistance: Rsh, Calculating IEC 60891 (JIS C8913) Method: Rs, IEC 60891 (JIS C8913) Standard Test Condition, Reference Cell Short Circuit Current, Solar Irradiance Intensity, PV Cell Temperature

8-3. Cable Specification

Table 8-3. Cable Specifications

Cable Name	Descriptions
PV Cable	2mm^2 x 4-pin, Shield Cable, 1.5m Outer Diameter: φ10.9 mm Cable Ends: pigtail Wire Colors: Black, White, Red, Green, Shield Cable
Short Cable	2mm^2 x 1-pin Twisted 10cm Outer Diameter: φ2.1 mm Cable Ends: Y terminals (TMEE2Y-4) Wire Color: Green
AC Power Supply Cable	Cable Length: 2.5m, 0.75sq, 3-pin Socket: IEC6030 C13, Plug Type: Specified to each region
USB Cable	Cable Length: 2.0m, A-B Type (with ferrite core)

8-4. Dimensions

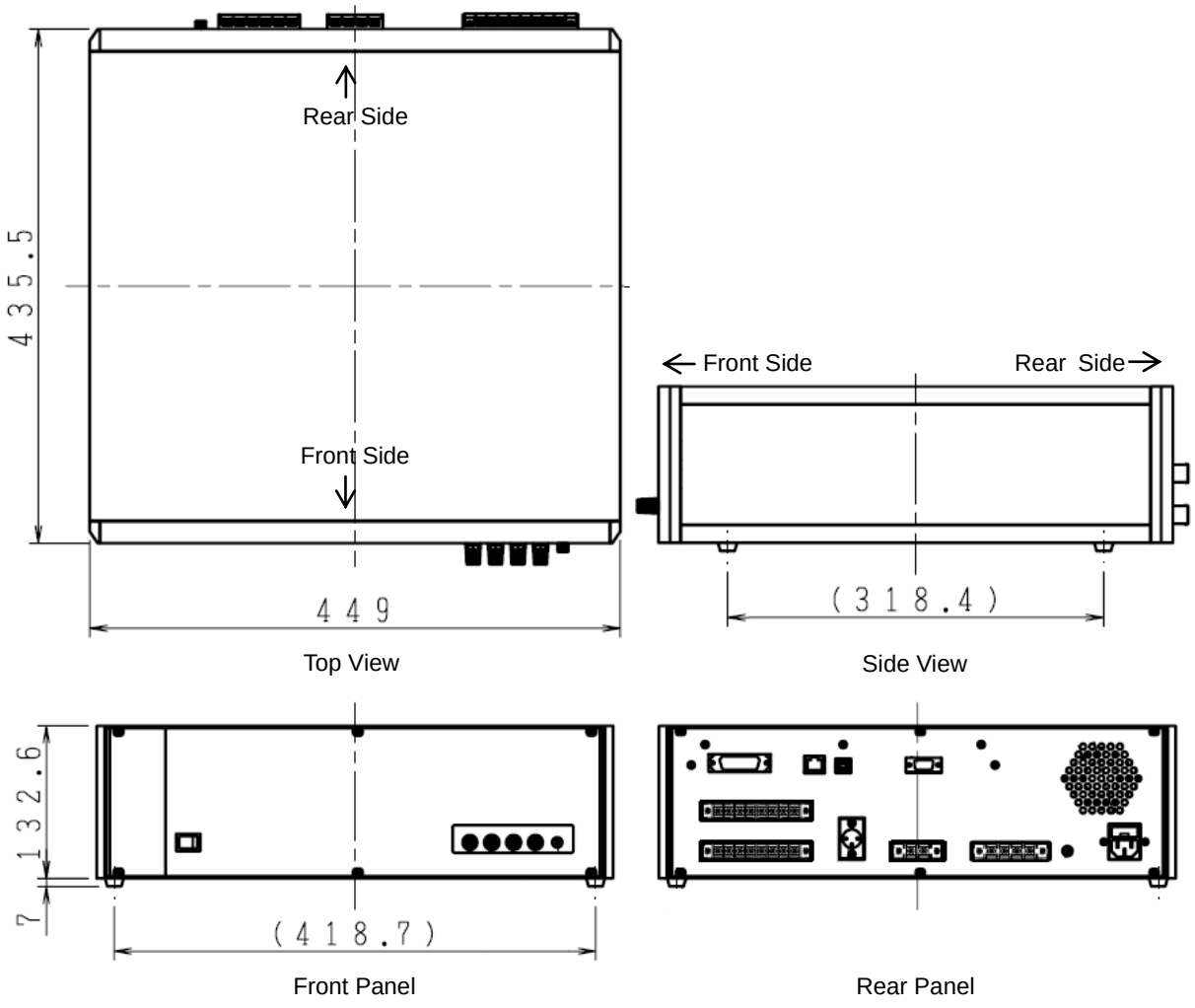


Figure 8-1 Dimension and Each Name and Parts

8-5. Accessories List

Table 8-4. Option Item List

Items	Remarks
Silicon Sensor	ML-020VM, ML-01 (next generation ML-020VM)
Light Intensity Correction Sensor	MP-180S
PV Cable	1.5m 2sq 4-conductor shield (with 2 alligator clips)
PV Cable	1.5m 2sq 4- conductor shield (pig tailed)
PV Cable	1.5m 2sq 4- conductor shield (Y-terminal)
LAN Cable	Uses Twist Pair & Shield Cable Cross/Straight, specified length
External Input/Output I/O Connector Plug	Shutter control output, for trigger input Less than 3m, use shield cable
REF Connector Plug	XLR-4-11C (ITT Cannon)
Pt100 Sensor	2m Metal Sheath type, specified diameter & length
Pt100 Sensor	2m Film
Thermocouple	2m T-type thermocouple
Transducer for Thermocouple	0~100℃ → 0~10V, Power Supply: AC100~240V, thermocouple type specified.

APPENDIX

A-1. Installing Software on Windows Vista / 7 / 8

If the MP-180 software is installed on a computer with OS type either “Windows Vista” or “Windows 7 or 8”, following error may occur due to the User Account Control (UAC) function. This section explains how to avoid these errors to occur.

Error 1: Measured data is not saved in the specified folder.

Error 2: The data converted into text file is not saved in the specified folder, or the file is not created

Error 3: The data was downloaded from MP-180 to PC, but the data was not downloaded in Specified folder.

Error 4: The setup parameter is not reflected on the measurements.

Cause:

The UAC is the basic technology of OS security integrated since Windows Visa version, and its function is to prevent the operating systems from being modified by virus, spyware, malicious software, and so on, but also it becomes effective when operating the unauthorized application with standard user authority; for a first time user may misunderstand this as application software defect.

In usual cases, when a file is created by operating the unauthorized application within secured area, and if the created file is assigned to be saved in the folder under “c:¥Program Files¥EKO” for example, the data file will be created in a totally different file by creating a virtual folder, such as below; therefore, when the user checks the folder “c:¥Program Files¥EKO”, the user cannot find the file in the specified folder.

“C:¥Users¥<user>¥AppData¥Local¥VirtualStore¥Program Files¥EKO”.

In order to avoid such situation, there are several methods which are described below:

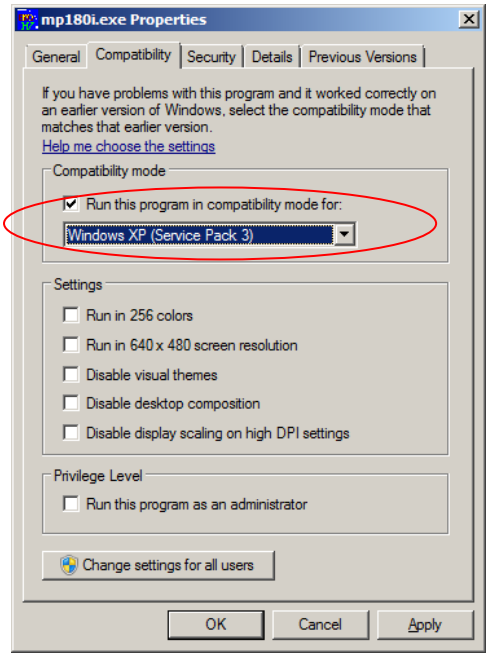
1. Installing the Software in Unsecured Location

The easiest way to avoid the error is to install the application software in a location where it is not protected by the security.

Most of the installer for a usual application software are setup with “C:¥Program Files¥~” as the folder location for installation; therefore, install the software in a folder where it is not protected with security by OS, such as folder creating on desktop or folder created on the “C:¥” drive route.

2. Operate the Application in Window XP Mode

Right click the “Run Application File”, select “Compatibility” tab on the “Property”. In the compatibility mode, check the checkbox for “Run this program with compatible mode” and select “Windows XP (Service Pack 2 or 3)” from the dropdown box right below. Then click OK button.

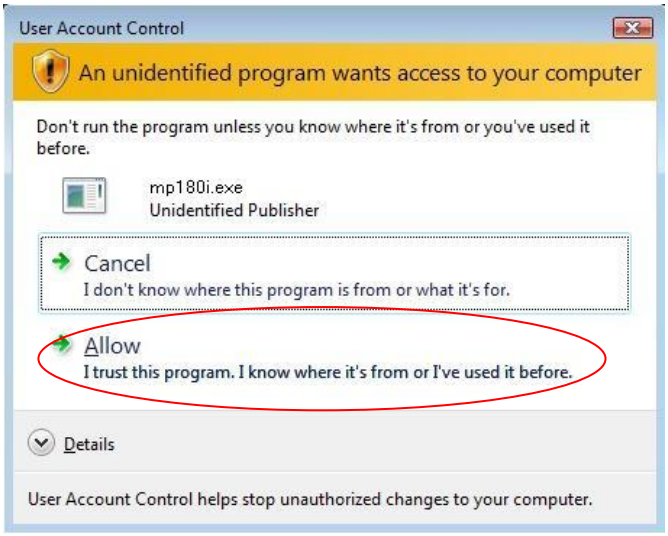


XP Mode Setup

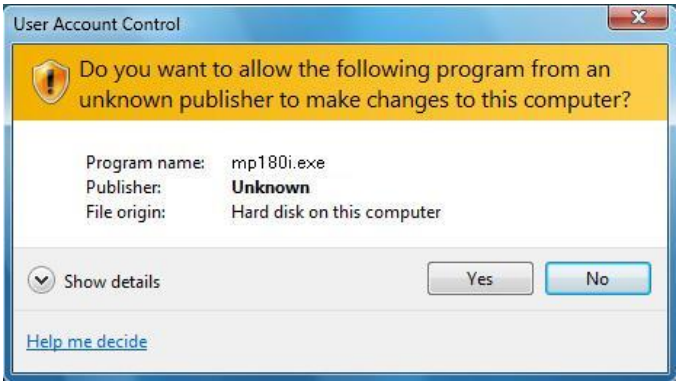
(Common for Windows Vista/7/8)

After completing this setup, the data file will not be created in the virtual folder, but it will be created in the specified folder when running the application.

However, when running the application, the dialog box as shown below is displayed for confirmation; click the “Authorize”.



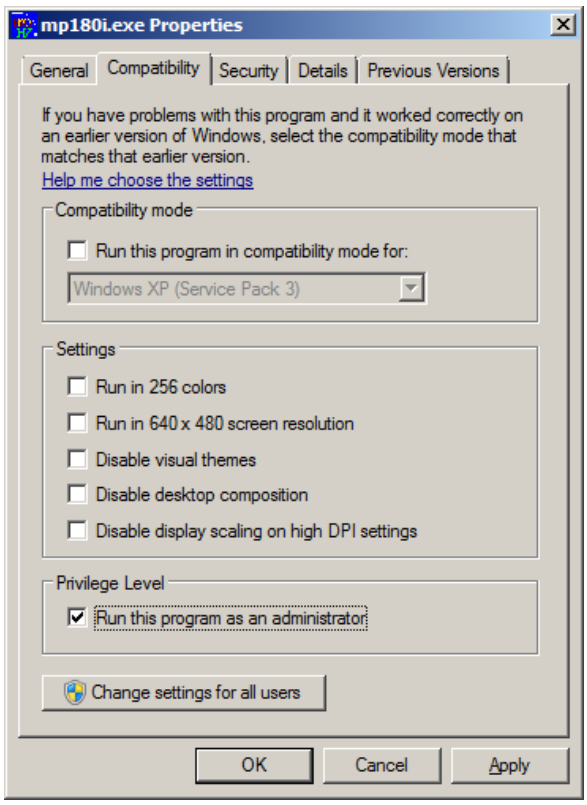
Confirmation Dialog (Windows Vista)



Confirmation Dialog (Windows 7/8)

3. Changing the Application Authorization

This method changes the application authority. Just like the Method 2, right click the “Run Application File”, select “Compatibility” tab on the “Property”. In the compatibility mode, check the checkbox for “Run this program with compatible mode” and click OK button. After setup, the application runs with administrator authority, and operates in the same way as the Method 2.



Changing Application Authority

(Common for Windows Vista/7)

A-2. Connecting with LAN

To communicate with LAN on MP-180, there is a device server called Xport-03R by Lantronix, Inc. (http://www.lantronix.com/index.html). The communication is processed as the LAN is converted into serial communication which uses COM port by virtual COM port driver on the computer side. Thus the operation of the software on computer side is exactly the same screen operation as serial communication (RS-232C), once this is setup.

When actually connecting to LAN, follow the below procedure and install the following two types of software in the computer (device installer and COM port redirector). The setup for LAN on the main unit of MP-180 and setup of COM port on the computer side must be done.

※ This setup requires some knowledge of LAN. If you are not familiar with LAN, ask your LAN administrator.

※ Use CAT5E or STP Cable for the LAN cable. Also use cable which is up to 3m length between the MP-180 and the HUB or the PC.

The device installer and COM port redirector introduced below are applicable to following OS.

32bit OS (x86):	**Windows XP, Windows 2003 Server, Windows Vista, Windows 7, Windows 8, Windows 2008 Server**
64bit OS (x64):	**Windows Vista, Windows 7, Windows 8, Windows 2008 Server**

The installation steps for these 2 types of software are explained with Windows 7 Home Premium environment; if it is installed on other OS environment, follow the steps given on the installation window.

※ When the installer for the DeviceInstaller is executed, first it verifies that the "Microsoft .NET Framework 4.0" is already installed; in case this "Microsoft .NET Framework 4.0" is not installed, it is downloaded from internet automatically. Setup the environment for internet connection first then execute the installer.

These software are regularly updated and downloaded from the Lantronix homepage. The software installed on the EKO CD-ROM is the most up-to-date version at the time of shipment.

The up-to-date version device installer can be downloaded from below link:

http://ltxfaq.custhelp.com/app/answers/detail/a_id/644

The up-to-date version COM port redirector can be downloaded from below link:

http://ltxfaq.custhelp.com/app/answers/detail/a_id/928

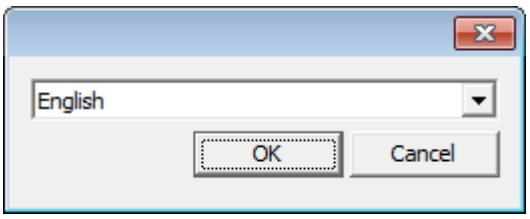
1) Device Installer (for Windows7 Home Edition)

(1) Installing Device Installer

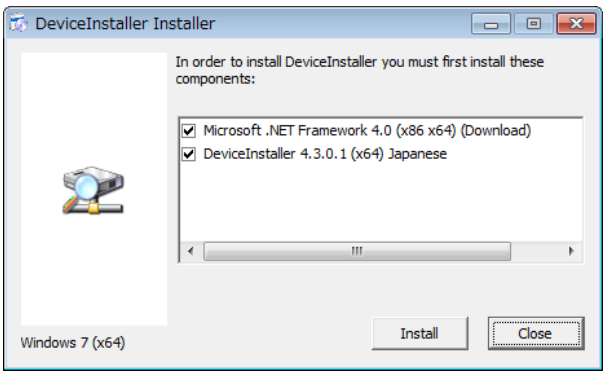
Execute the "**setup_di_x86x64cd_4.3.0.x.exe**" in the [¥utility software¥LAN¥DI] which is installed in the attached CD-ROM.

English/Japanese Language selection window will appear

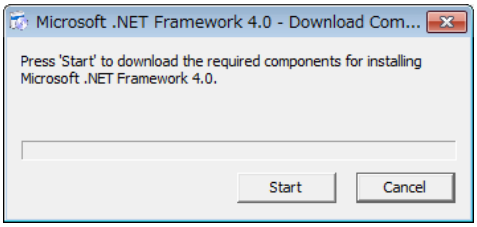
Select English to continue with installation.



This window appears; to continue, click Install button.

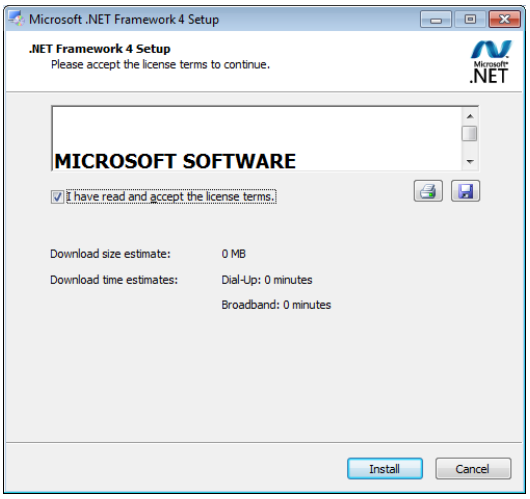


When the downloading the installation conpoments for "Microsoft .NET Framework 4.0" is ready, the window on the right will appear; click Start button and execute the download.

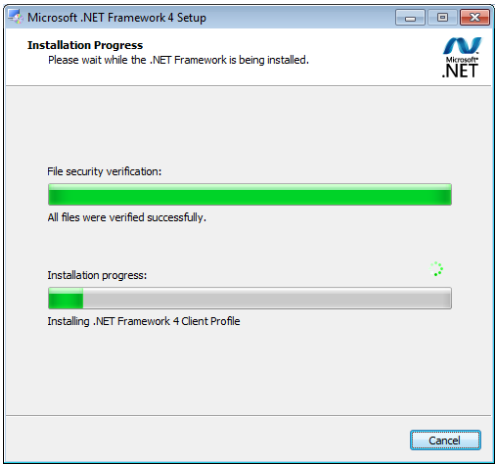


Once the "Microsoft .NET Framework 4.0" download is completed, the setup window is displayed.

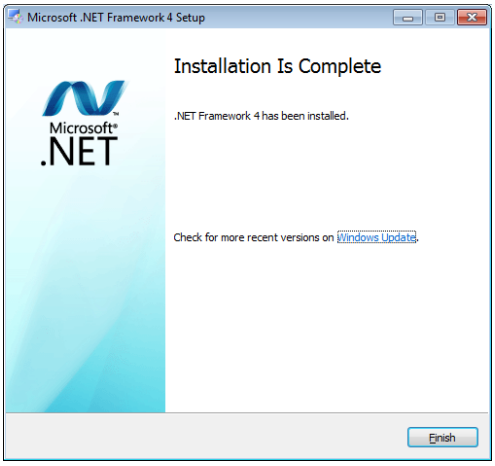
Check the "I have read and accept the license terms." checkbox and click Install button.



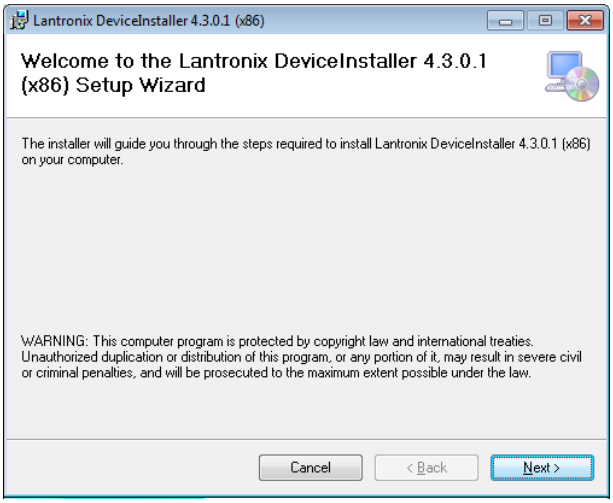
On the next window, the installation status for "Microsoft .NET Framework 4.0" is displayed.



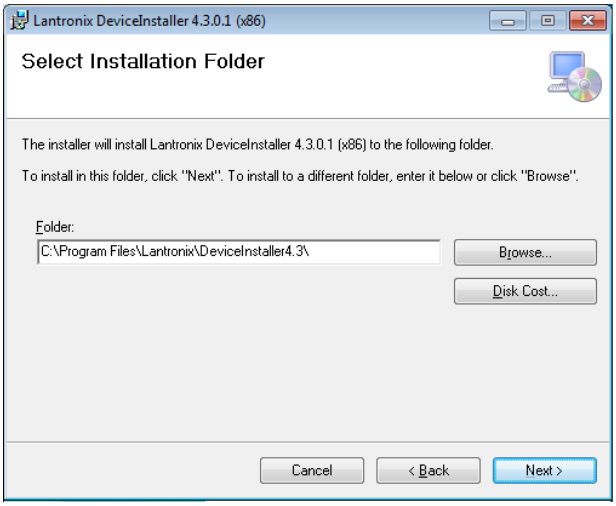
Installation is completed by this window is displayed. Click Finish button.



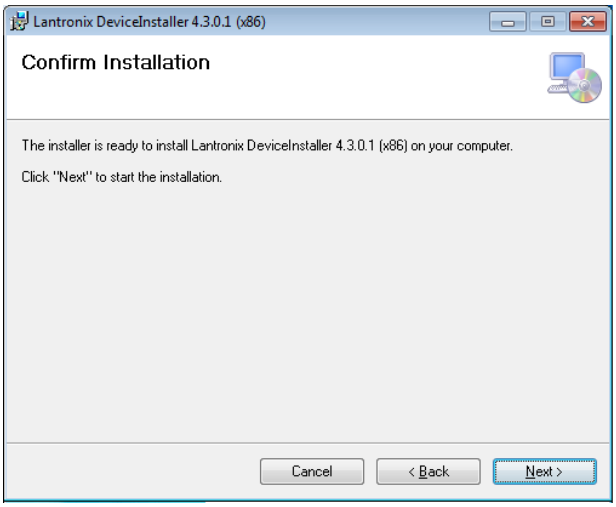
Next, installation of the device installer is started. Click Next (N) > button.



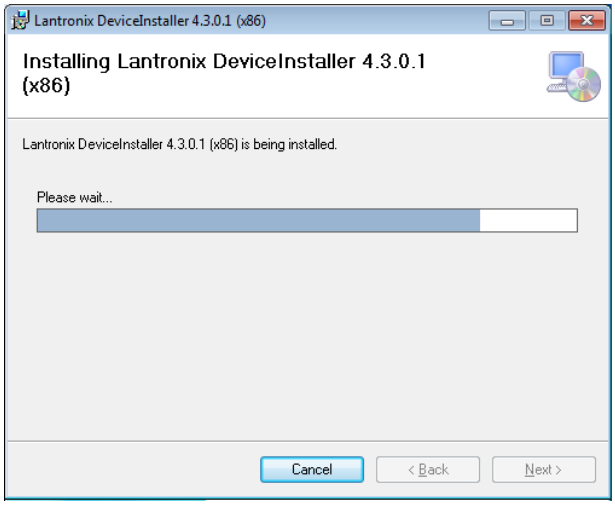
Next, selection window for the installation folder appears. To specify the installation folder, click Brows (R)··· button and select a folder. If specific folder is not necessary, click Next (N) > button and go to the following step.



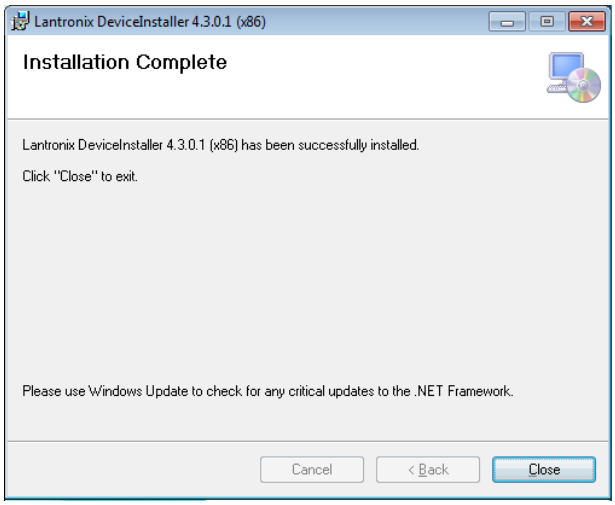
Confirmation window for the installation appears.
Click Next (N) > button and start the installation.



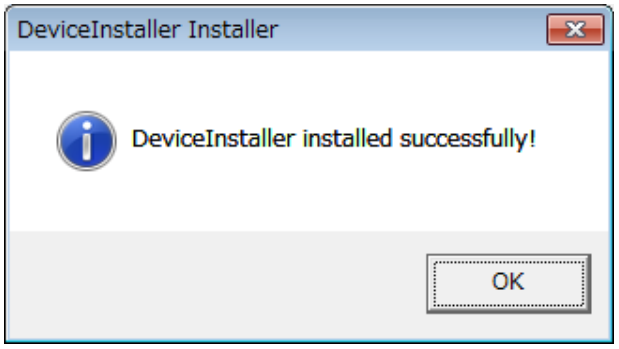
Installation status of device installer is displayed.



Once the installation is completed, the following window appears. Click Close (C) button.

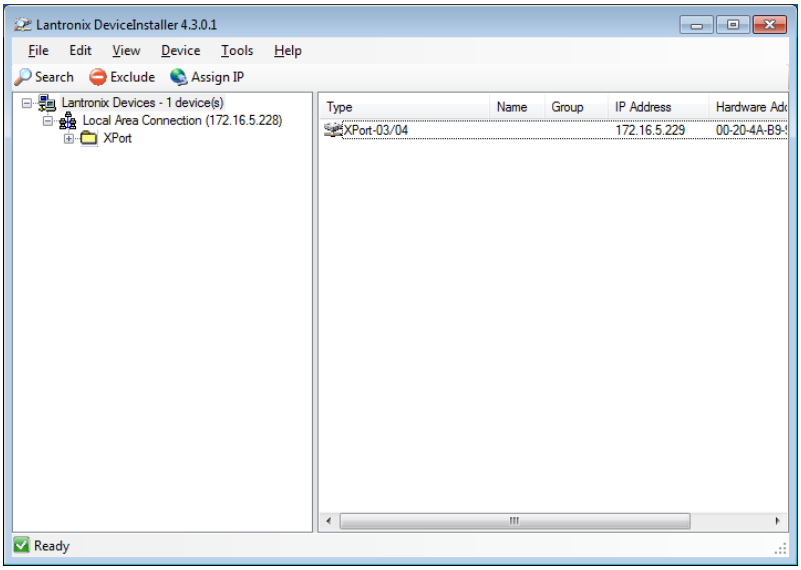


When the installation of device installer is successfully completed, the following window appears.
Click OK button to finish the installation.



(2) Starting DeviceInstaller

Go to: Start Button → [Program] → [Lantronix] → [DeviceInstaller4.3] → [Device Installer] to start the device installer. (It may take time for the software to start up.)

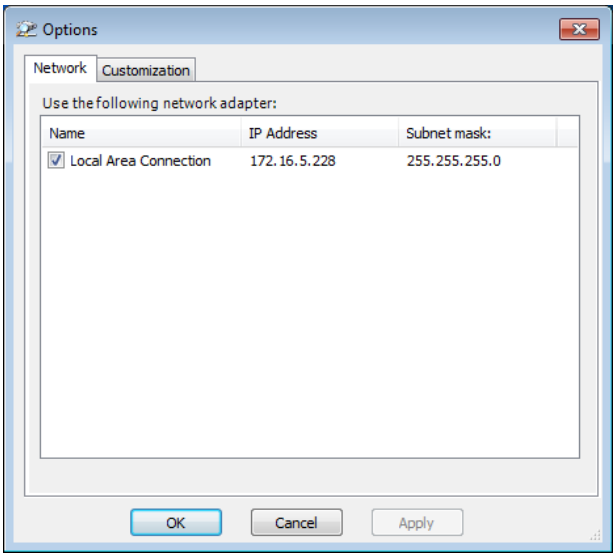


(3) Verifying the Network Adapter

Check if the IP address is matched with your PC by going to [Tool] → [Option] from the startup window menu bar.

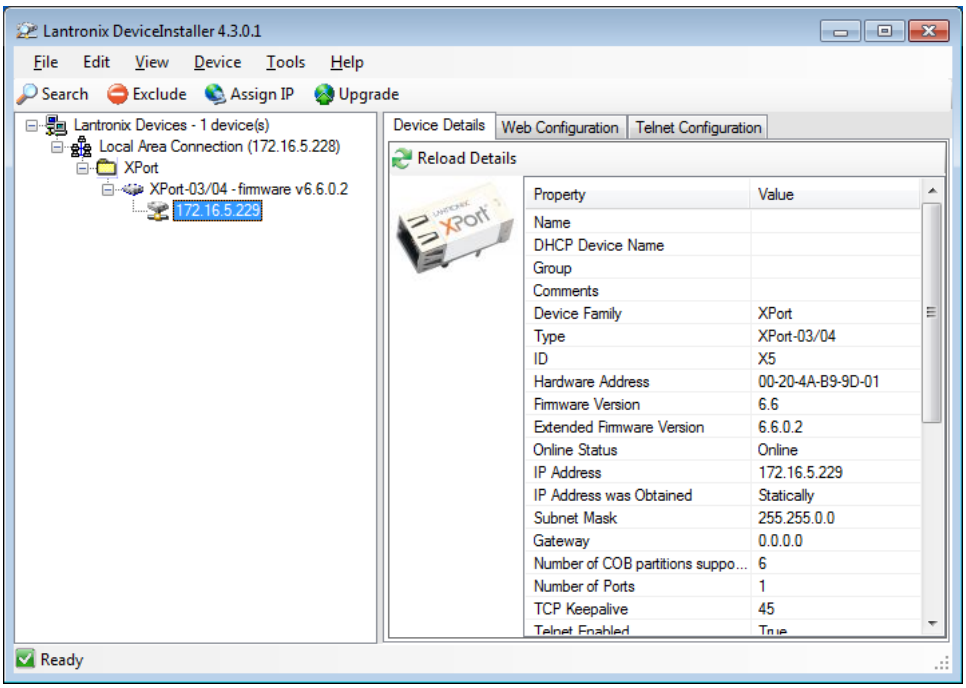
When there are multiple network adapter, select the one used for the communication with device server.

In case the IP address for the PC is not setup, setup the IP address and sub-net mask and so on from the [Network setup] first.



(4) Finding Device Server

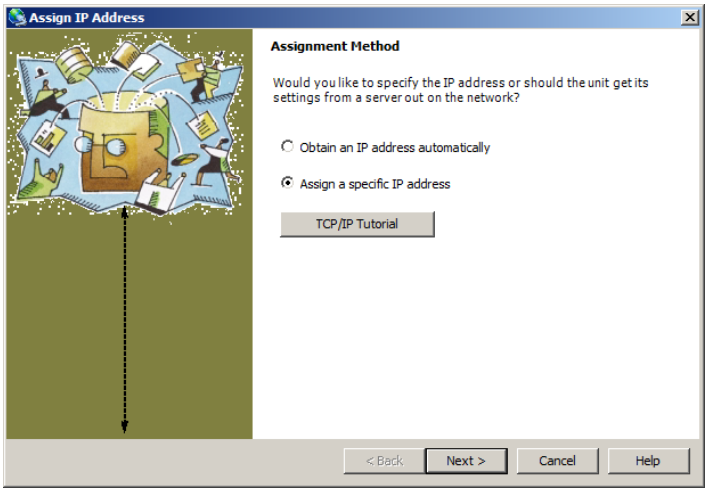
The DeviceInstaller detects he IP address for the device server at the start. Search the device server by clicking [Search] button when necessary, such as when the device server setting has been changed. The IP address of device server on LAN is indicated.



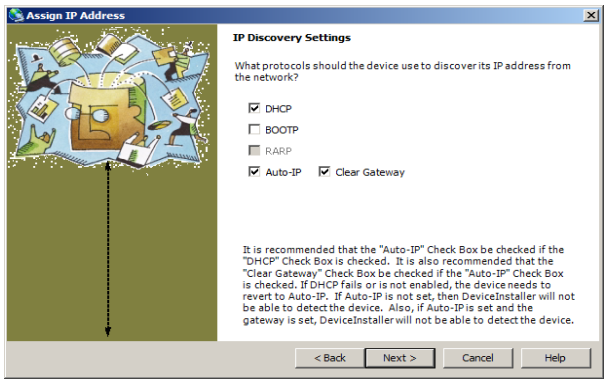
When the device server cannot be found, the condition can be checked by using other device server or PC first then determine whether the device server or the PC environment has problem.

(5) **Setting IP Address for Device Server**

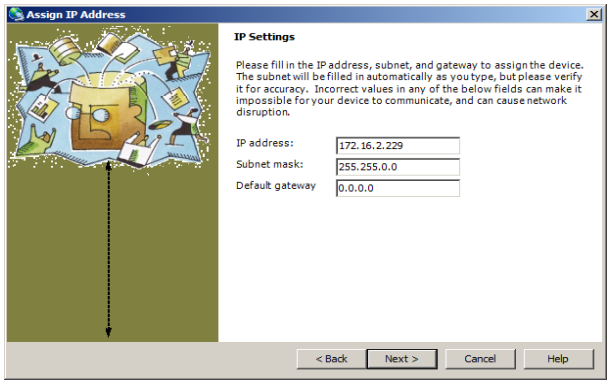
When “Assign IP” is clicked, the screen for “Assign IP Address” is displayed.



Select either “Obtain an IP address automatically” or “Assign a specific IP address” and click Next > button.

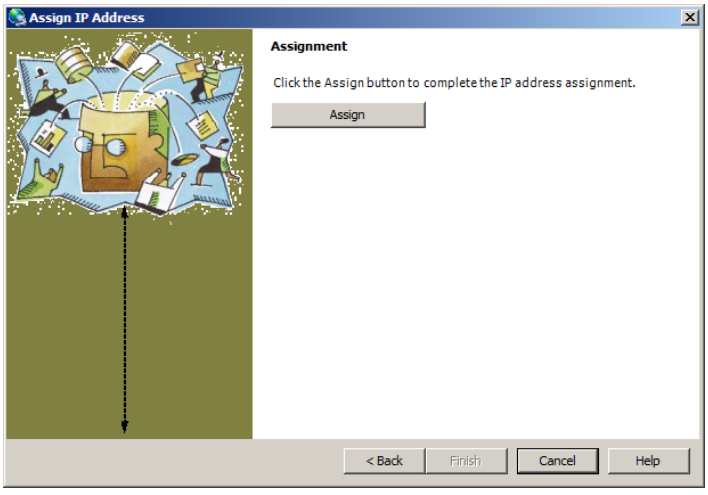


Automatically Obtain IP Address

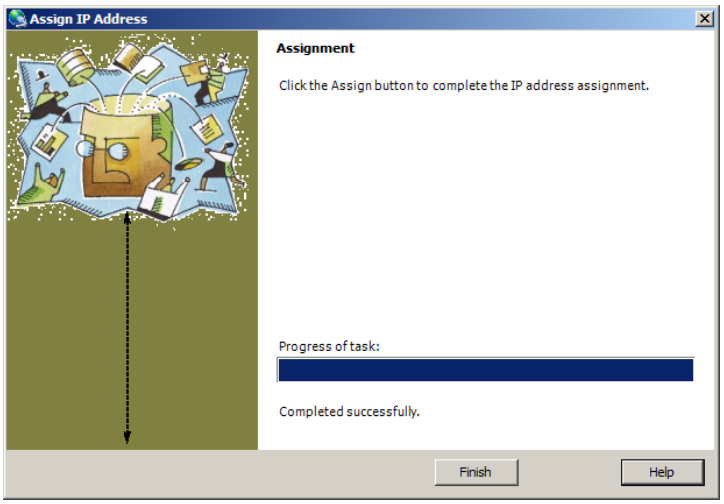


Assign Specific IP Address

This screen will be displayed when clicking Next > button



When the Assign button is clicked, the setup process is started.



Click Finish button.

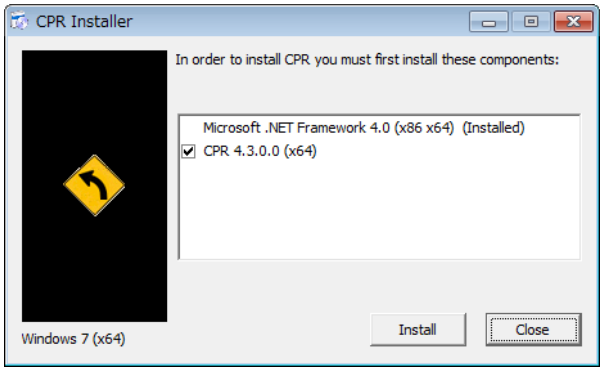
Once the setup is completed, click the Search button once again to check whether the IP address has been assigned.

2) COM Port Redirector (for Windows 7 Home Edition)

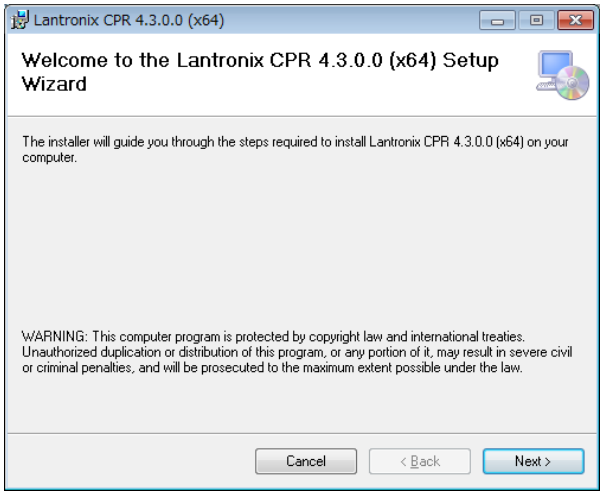
(1) How to install COM Port Redirector

Execute the **"setup_cpr_x86x64cd_4.3.0.x.exei"** in [¥utility software¥LAN¥CPR] in the attached CD-ROM

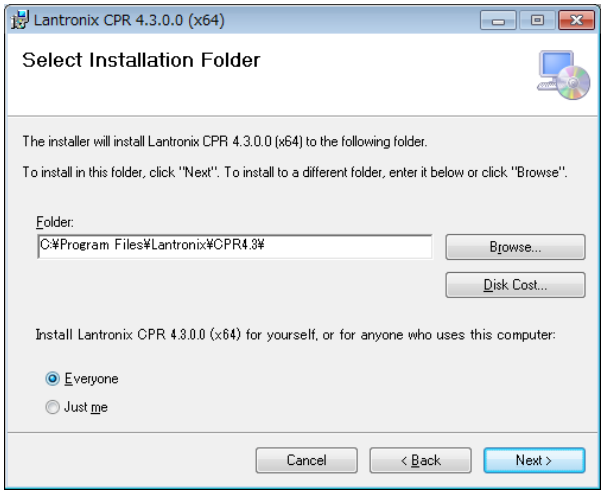
When the "setup_cpr_x86x64cd_4.3.0.x.exei" is started, the window shown on the right appears; click Install button.



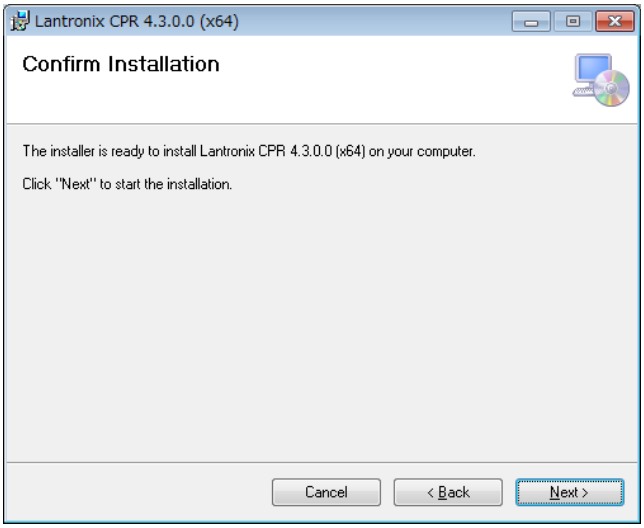
This window appears; click Next > button.



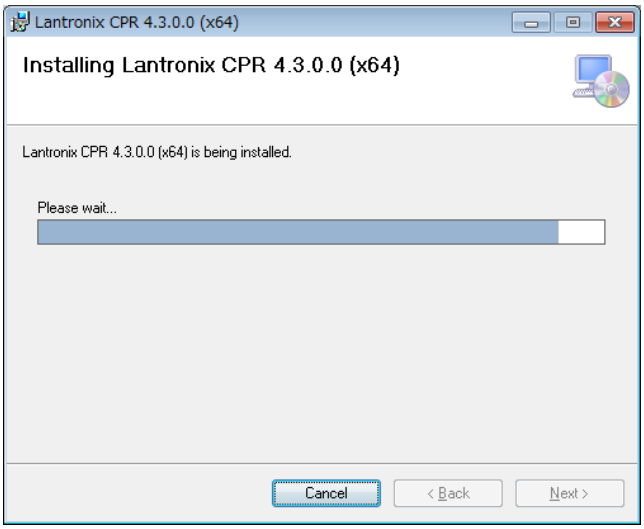
Next, selection window for the installation folder appears. To specify the installation folder, click Brows (R)··· button and select a folder. If specific folder is not necessary, click Next (N) > button and go to the following step.



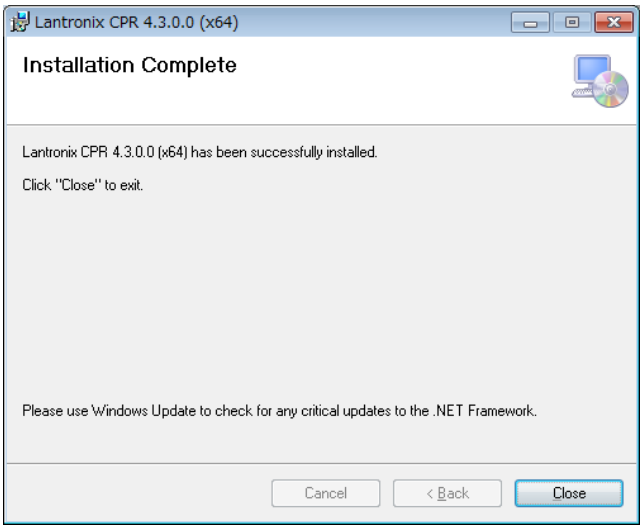
Confirm the installation of CPR4.3.0.x; to continue, click Next > button.



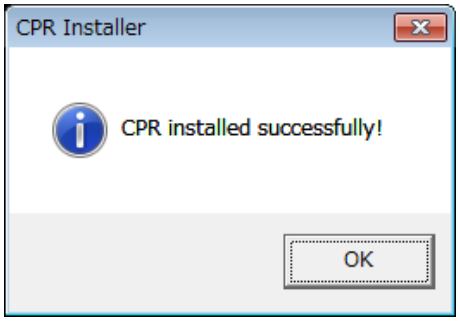
Installation of CPR4.3.0.x is started.



The installation of CPR4.3.0.x is completed. Click Close button.

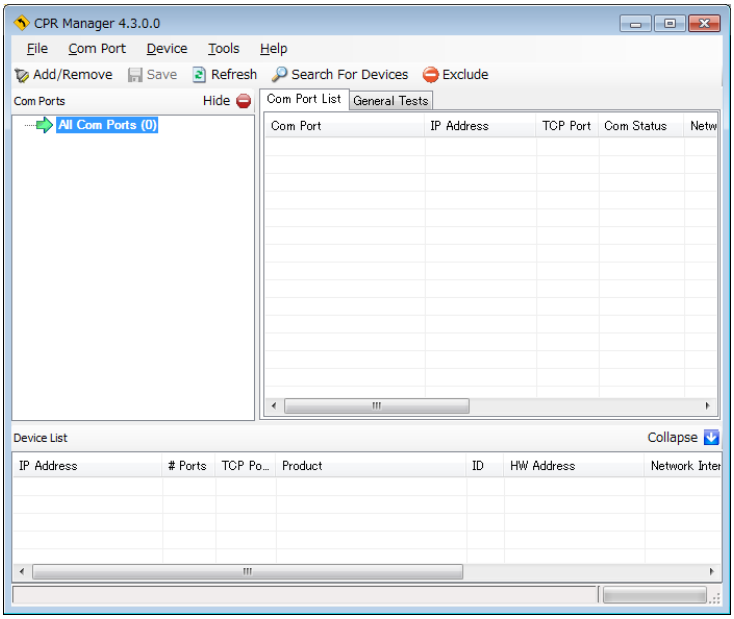


When the installation of COM port redirector is completed successfully, this window appears.
Click OK button and finish the installation.

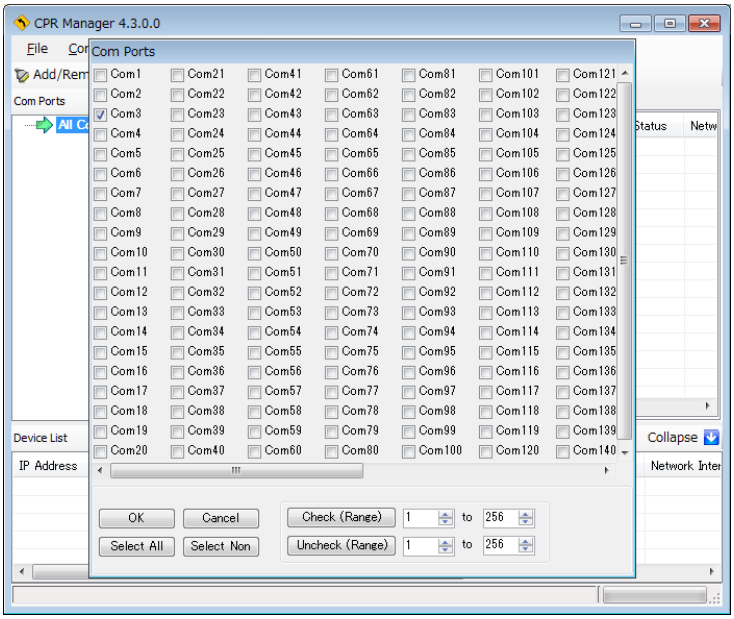


(2) How to operate COM Port Redirector

Start the device installer from Start Button → [Program] → [Lantronix] → [CPR4.3] → [CPR Manager]. (Software may take a while to start up)

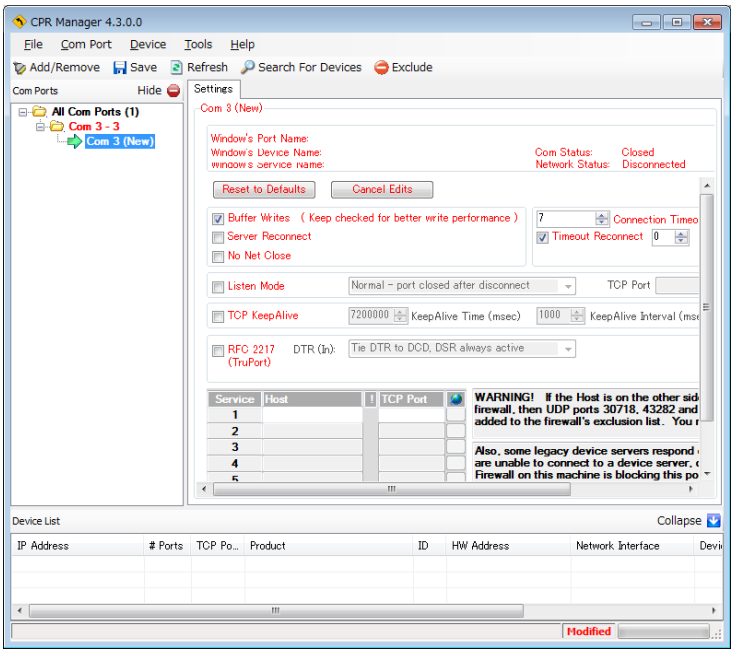


From Menu bar, go to [Com Port] → [Add/Remove] button; the [Com Ports] dialog window will appear. Check the COM port number to be added and click OK.



The added COM numbers are indicated on the "COM Ports" section on the left side of window.

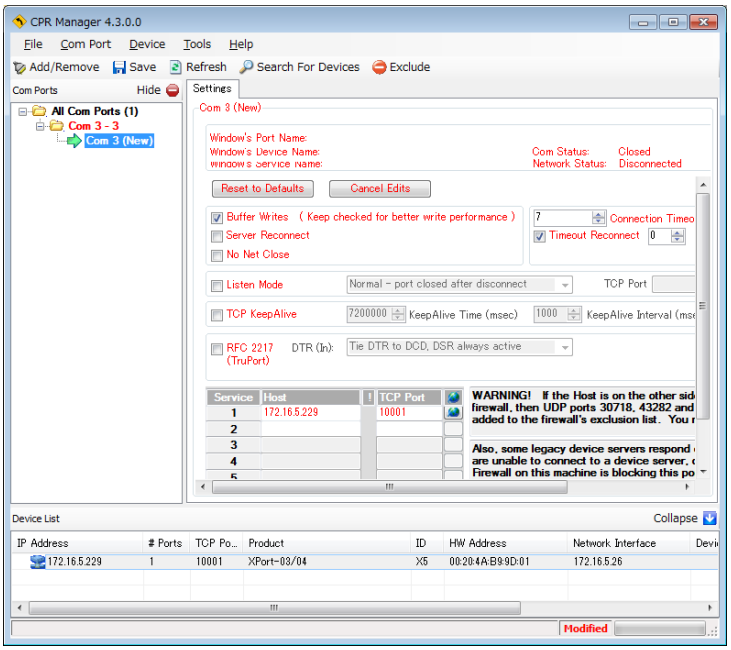
Select the added COM port and go to Menu bar, [Device] → [Search].



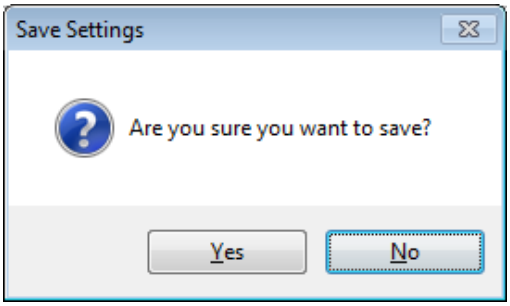
Starts to search and the IP address and so on are listed for the searched device on the "Device List" at the bottom of the window.

Double click the IP address of the device server to be redirected.

The device server IP address and port number are added in red in the "Host" under "Settings" and "TCT Port".

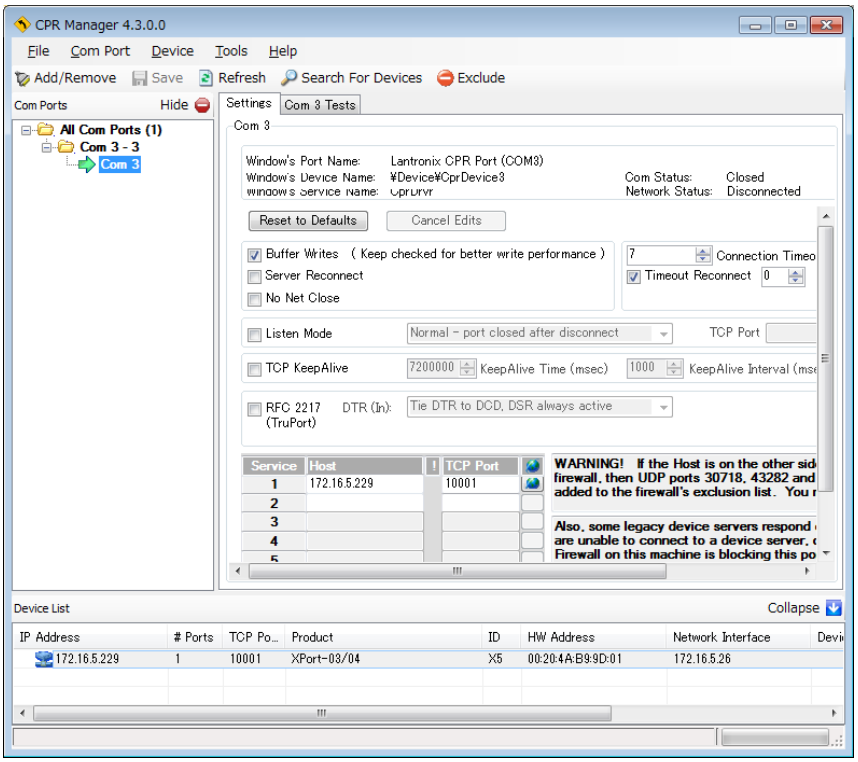


Go to Menu bar, [Com Port] → [Save Settings] and the settings are saved. The confirmation message will appear.



The saved settings are indicated by the letters changing from red to black.

Go to [File] → [Exit] to finish the software.



Above is all for the setting LAN Port; it is now available for communicating with MP-180.

Select the COM port number setup above from the MP-180 measurement software for communication.

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