INSTRUCTION MANUAL

MP-180

I-V Curve Tracer
For Multiple Channel
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: 3

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.

2-5. CE Declaration

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 equipment. 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 to or optional for this instruments will not be subjected to EKO responsibility.

- 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.
Connecting with optional switching units will allow configure all sorts of measurement system using the multiple PV cell, pyranometer, thermocouple, and platinum resistance temperature sensor.

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. Multi-Channel Measurement by Combining with Switching Units

- By connecting each switching units (optional), I-V curve measurements of multiple PV cells (1~12 channels) can be taken sequentially.
- Connecting thermocouple switching unit will allow taking PV cell back surface temperature simultaneously.
- Using pyranometer switching unit will allow connecting maximum 5 units of pyranometers in different direction against the PV cell and take solar irradiance measurements. With combination of temperature measurements, STC conversion can be applied.

4. 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.

5. 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.

6. Safety Functions

- Current surge can be prevented by Current Limiter.(surge current?)
- 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) which is less than 3m in length.

(7) USB

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

(8) LAN

This connector terminal is for connecting computer with PC via LAN. Use a CAT5E, STP cable which is less than 3m in length.

(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).

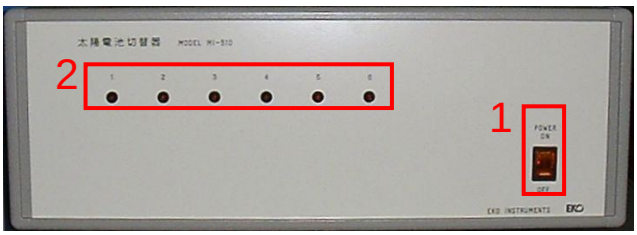
Backup Terminal for Extension (IN2): Usually not used

(12) FAN

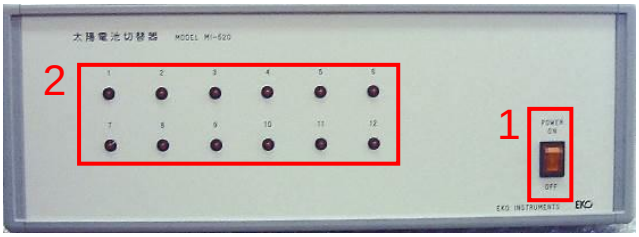
This is a fan for cooling. It turns on as the power is turned ON.

5-2. Switching Units: Parts Name and Descriptions

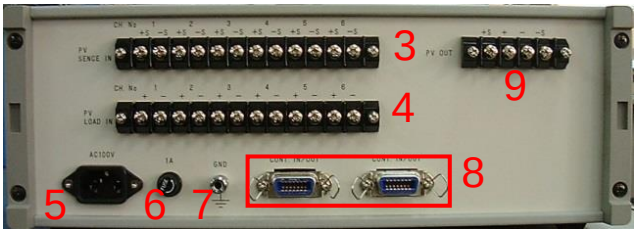
1. MI-510 /MI-510S (6ch.) & MI-520 (12ch.) PV Cell/Module Switching Unit



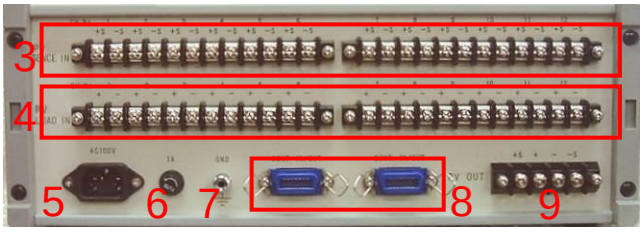
MI-510/510S Front Panel



MI-520 Front Panel



MI-510/510S Rear Panel



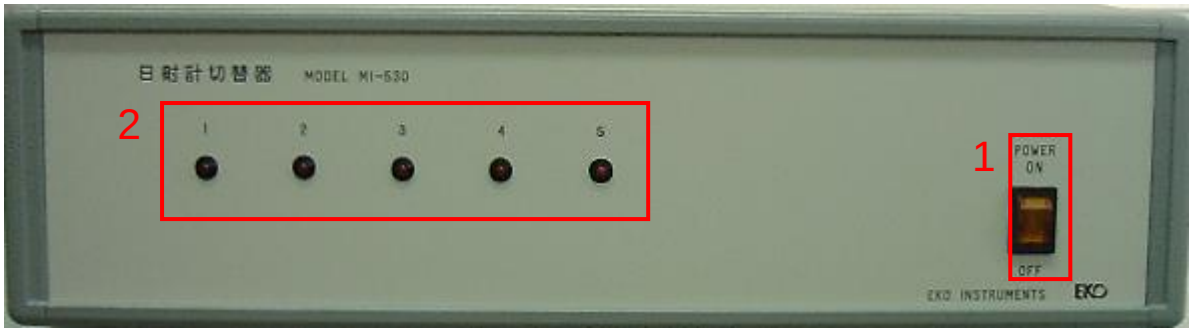
MI-520 Rear Panel

Figure 5-3 MI-510/510S & MI-520 Front and Rear Panel

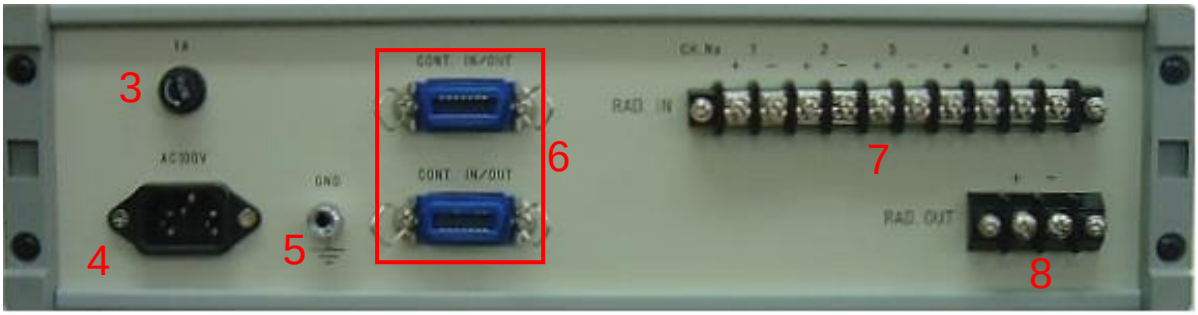
Table 5-1 MI-510/MI-520 Name and Function

	Names	Function & Details
1	Power switch	ON→ Power ON and lamp will be lit OFF→ Power OFF
2	Channel Lamp (1~6)	MI-510/510S: CH1~CH6 MI-520: CH1~CH12 LED of selected channel will turn on.
3	PV SENCE IN	MI-510/510S: CH 1 to 6, +S and -S MI-520: CH 1 to 12, +S and -S Connect the current output cables of PV modules
4	PV LOAD IN	MI-510/510S: CH1 to 6, + and - MI-520: CH1 to 12, + and - Connect the voltage output cables of PV modules
5	AC Inlet	Apply AC100 - 240V, 50/60Hz
6	Fuse holder	1A fuse
7	GND Terminal	Grounding terminal
8	CONT. IN/OUT Connector	2 CONT. IN/OUT connectors available. One is for connecting with MP-160 “PV SELECTOR” connector, and another is for additional switching device (MI-510, MI-520, MI-530 or MI-540). MI-510 and MI-520 can connect maximum of 4 units each.
9	PV OUT Terminal	Connect 4-wire PV cable to PV INPUT of MP-160 Voltage Terminal: +S and –S Terminals Current Terminal: + and – Terminals

2. MI-530 5-Channel Pyranometer Switching Unit



MI-530 Front Panel



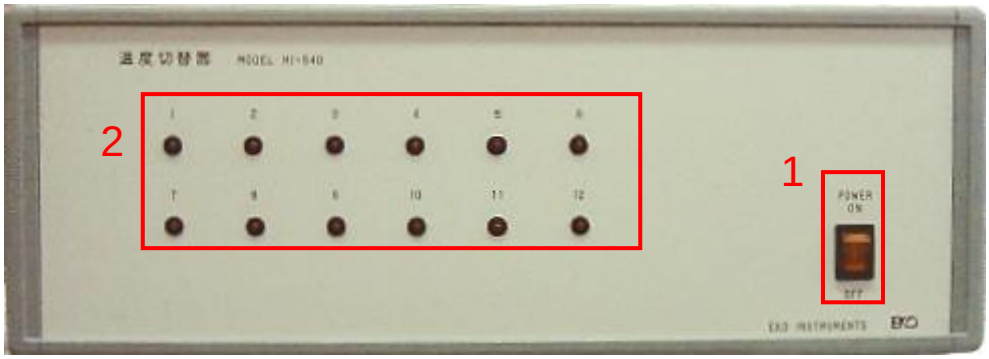
MI-530 Rear Panel

Figure 5-4. MI-530 Front & Rear Panel

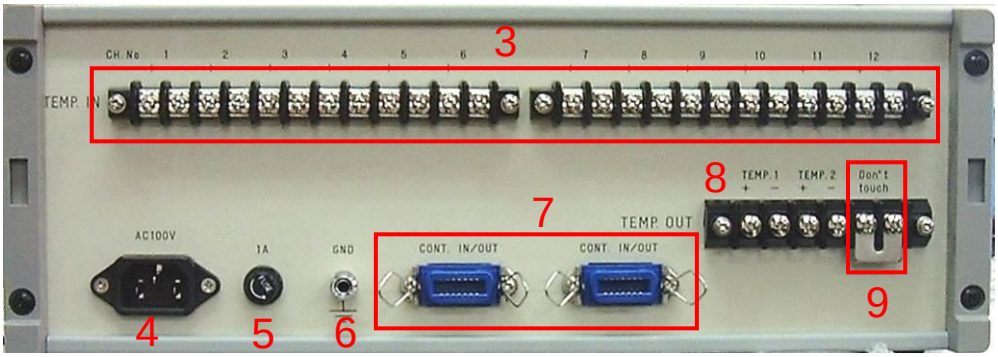
Table 5-2 MI-530 Name and Function

	Names	Function & Details
1	Power switch	ON→ Power ON and lamp will be lit OFF→ Power OFF
2	Channel Lamp (1~5)	LED of selected channel will be lit
3	Fuse holder	1A fuse
4	AC Inlet	Apply AC100 - 240V, 50/60Hz
5	GND Terminal	Grounding terminal
6	CONT. IN/OUT Connector	2 CONT. IN/OUT connectors available One is for connecting with “CONT.IN/OUT” connector on MI-520 or MI-540, and another is for additional switching device. (MI-510, MI-520, MI-530 or MI-540)
7	RAD. IN Terminal (1~5ch.)	Connect the pyranometers CH 1 to 5 (+/-)
8	RAD. OUT Terminal	Selected pyranometer output terminal to MP-160 “RAD +, –“ terminal.

3. MI-540 12-Channel Thermocouple Switching Unit



MI-540 Front Panel



MI-540 Rear Panel

Figure 5-5. MI-540 Front & Rear Panel

Table 5-3 MI-540 Name and Function

	Names	Function & Details
1	Power switch	ON→ Power ON and lamp will be lit OFF→ Power OFF
2	Channel Lamps (1~12)	LED of selected channel will turn on.
3	TEMP. IN Terminal	Connect the T-type thermocouple of PV modules CH 1 to 12, + and -
4	AC Inlet	Apply AC100 - 240V, 50/60Hz
5	Fuse holder	Use 1A fuse
6	GND Terminal	Grounding terminal
7	CONT. IN/OUT Connector	2 CONT. IN/OUT connectors available. One is for connecting with “CONT.IN/OUT” connector on MI-530, and another is for additional switching device. (MI-510, 520, 530 or 540)
8	TEMP. OUT Terminal	TEMP.1 (+, -): Connect with junction cable for T1 to TEMP1 (+. -) terminal of MP-160. TEMP.2 (+. -): Connect with junction cable for T2 to TEMP2 (+. -) terminal of MP-160.

5-3. System Structure

1. Photovoltaic Cell Multi-Channel Measurement System

To take measurement of a PV cell with MP-180, the system is configured as below for a general structure.

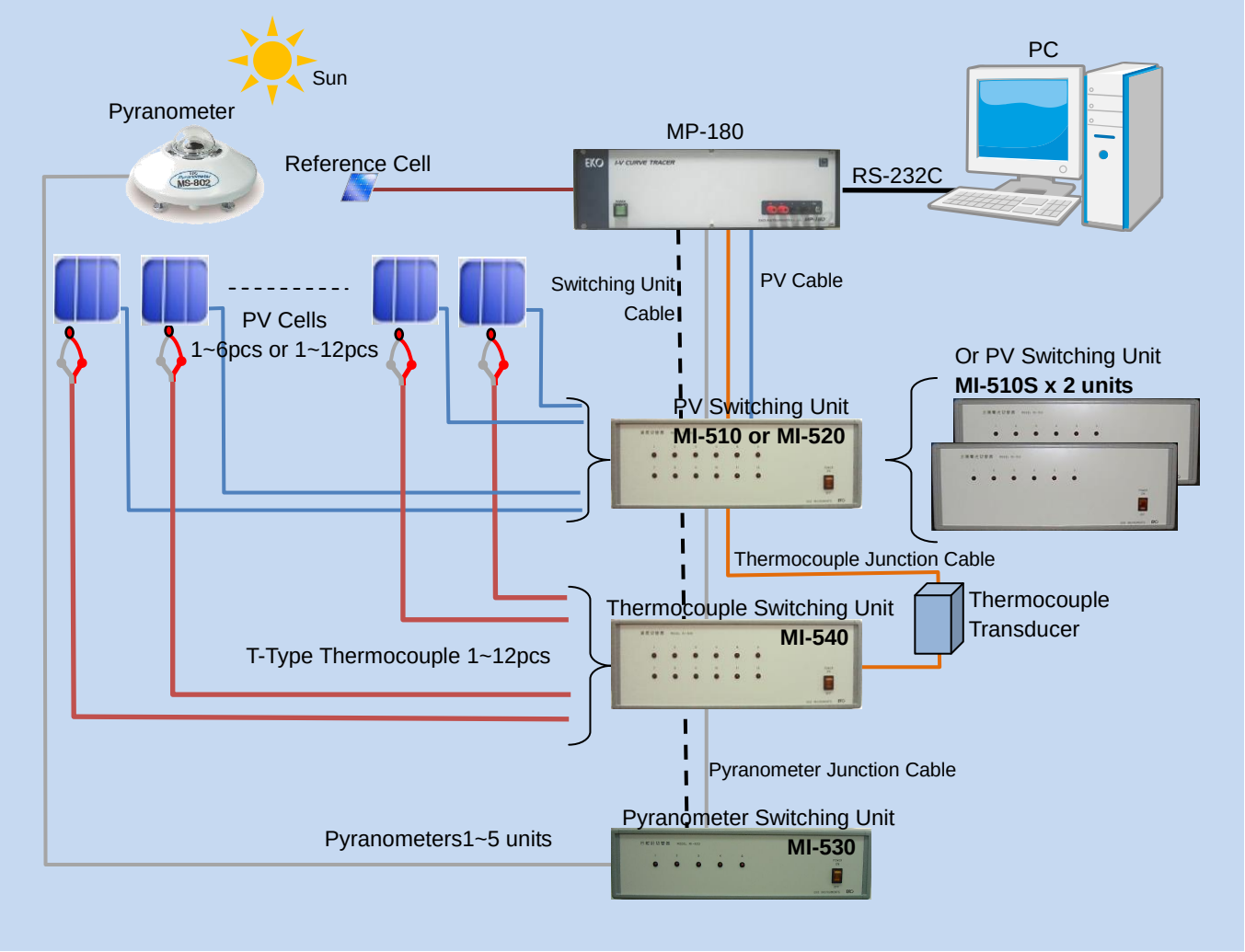


Figure 5-6. 1~6ch PV Cell Measurement System using Switching Units

When measuring I-V curve of multiple PV cells with MP-180, PV cell switching units (MI-510/MI-520/MI-510S) are used in the system. There are PV cell switching units with 6 channels (MI-510/MI-510S) and 12 channels (MI-520). Each PV cell switching unit are assigned to corresponding unit by the internal dip switch setting; however, when using the switching unit with MP-180, only one unit can be controlled.

Also thermocouple switching unit MI-540 can be used for measurements by assigning one PV cell to a thermocouple one-on-one.

Pyranometer switching unit MI-530 can be connected only one unit in the measurement system; 5 units of pyranometers can be connected for zenith, east, west, south, and north direction according to the PV cell direction. This allows to measure the solar irradiance which is required for STC conversion for PV cells facing different direction in one system.

MP-180 is applicable to various types of PV cell measurement systems; contact EKO for further details.

2. System Connections Using PV Cell Switching Units

Connecting one point temperature measurement and 5 pyranometers for one PV cell

Connection diagram is as shown below:

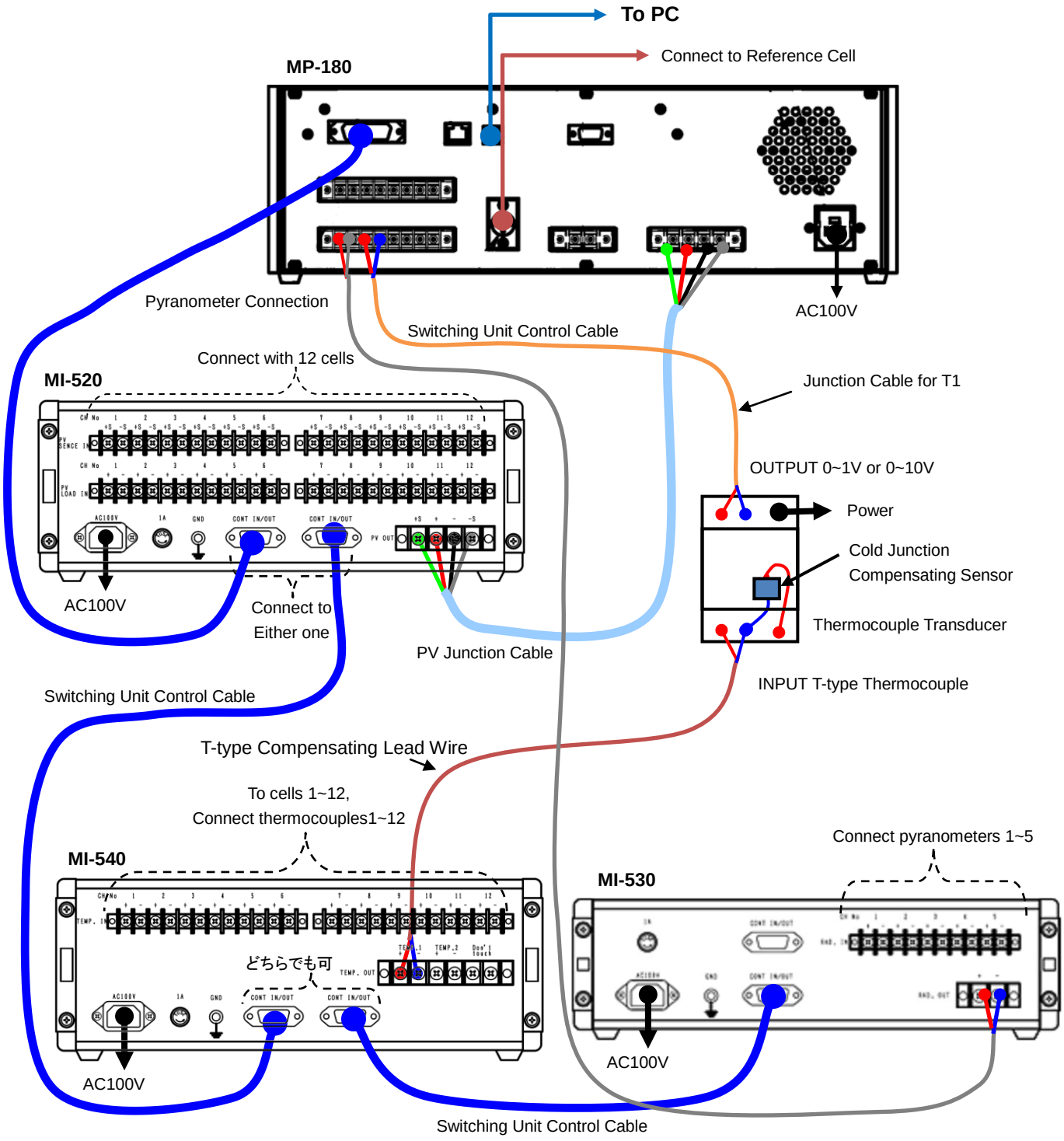


Figure 5-7. Connection for System using PV Cell Switching Unit

5-4. 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.

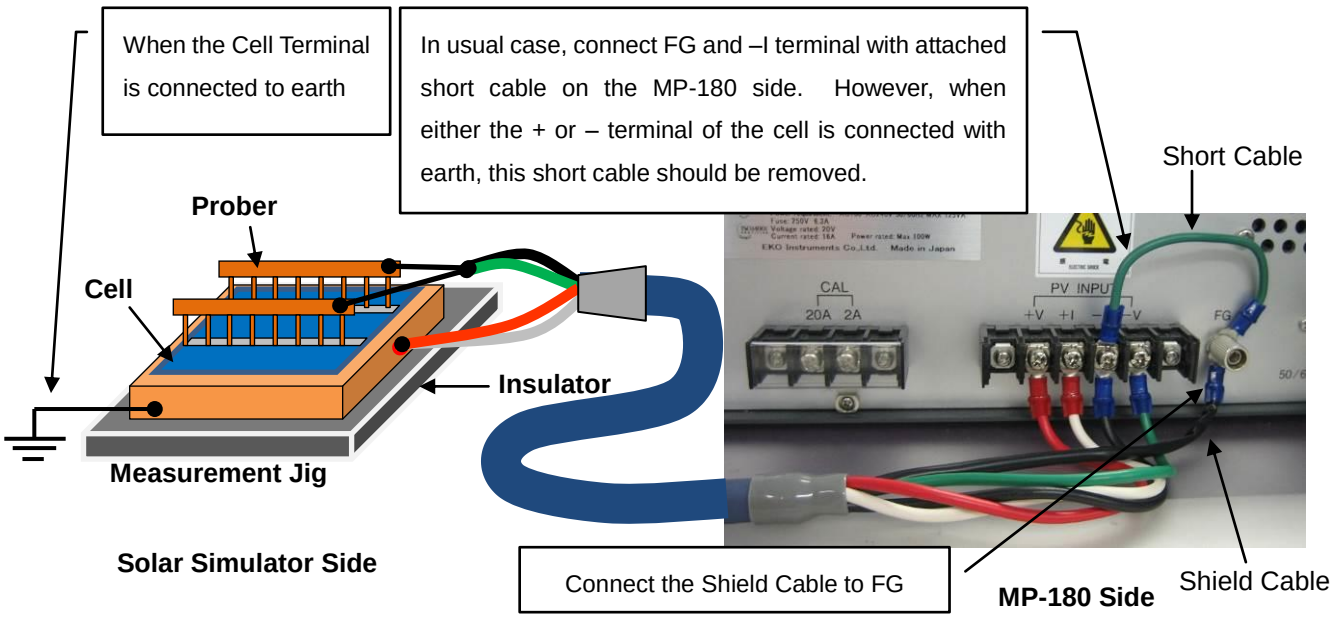


Figure 5-8. Connecting to PV Cell

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 5-9for connection example.

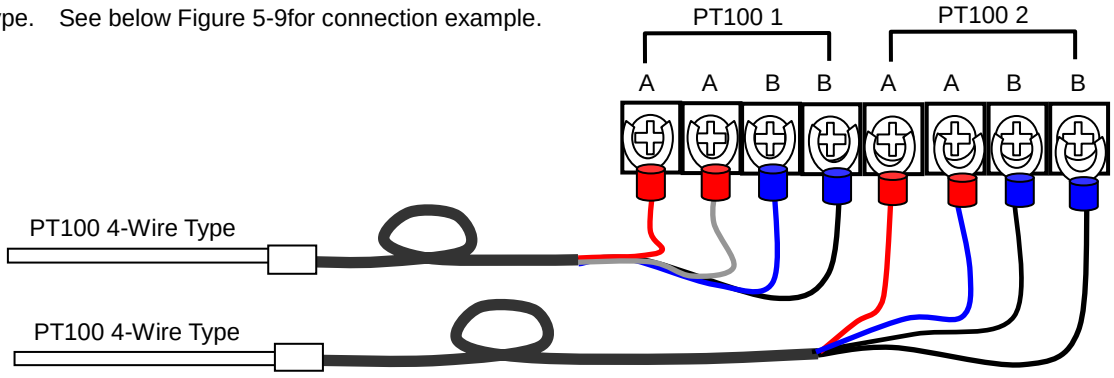


Figure 5-9. PT100 Channel Connection

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 5-4. 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 -
5	Switching Unit Control Signal U1
8	Switching Unit Control Signal D0
9	Switching Unit Control Signal D1
10	Switching Unit Control Signal D2
11	Switching Unit Control Signal D3
12	Switching Unit Control Signal GND

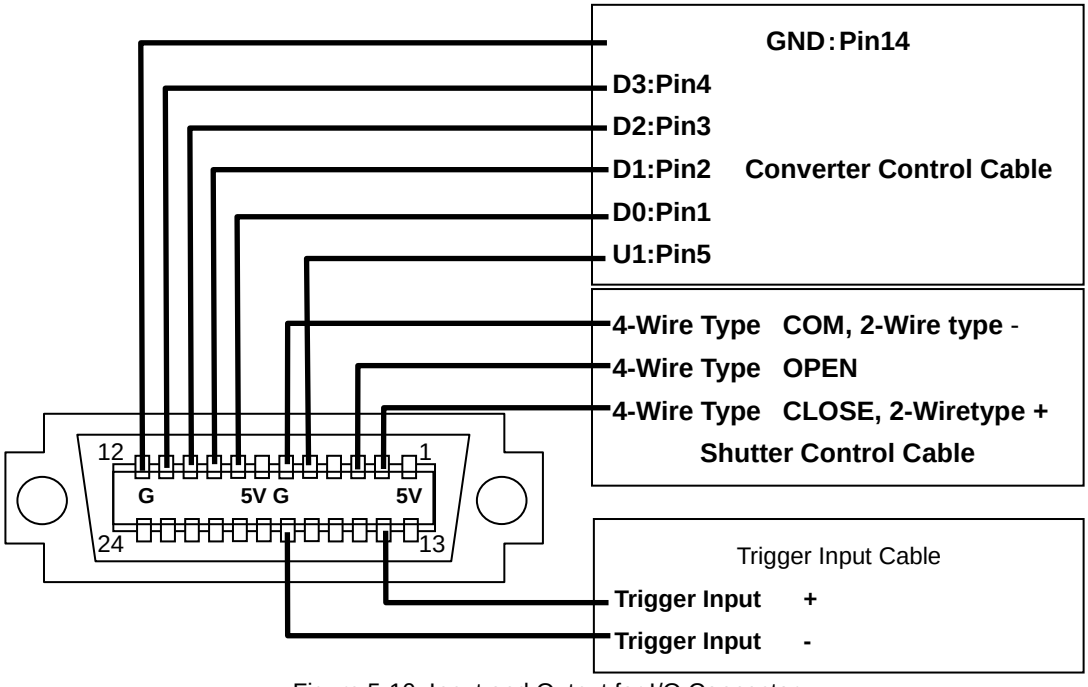


Figure 5-10. Input and Output for I/O Connector

1) Shutter Control Output Circuit

(1) 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 (-).

(2) Switching Unit Control Output Circuit

There is a control output port for each switching unit in the circuit.

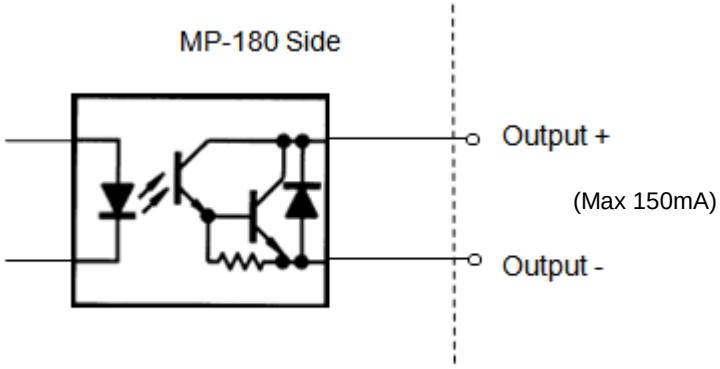


Figure 5-11. Output Circuit

※ Operation of shutter control 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.

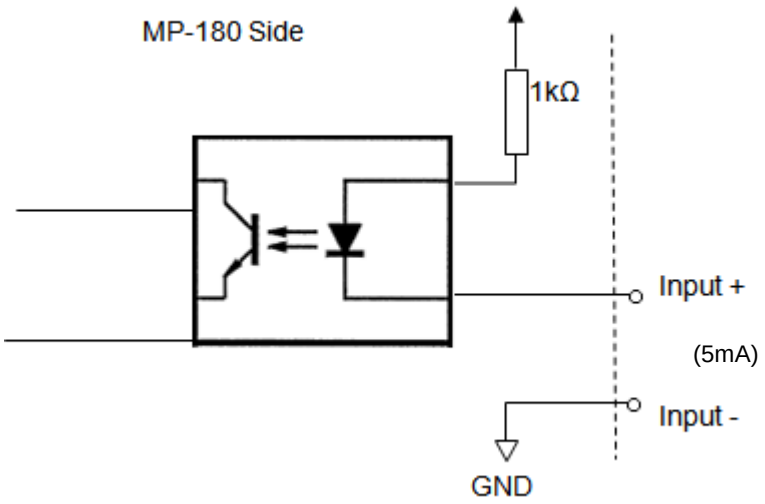


Figure 5-12. Input Circuit

5-5. Connections and Setup

1. Common Procedure for All Switching Unit Types

1) Upper Plate

For the switching units, MI-510/510S/520/530/540, and MP-303 requires to open the upper lid for the unit number and channel number setup. Below explains how to remove the upper plate.

To Remove the Upper Plate

(1) Place the switching unit rear panel facing toward you.
(2) Unscrew the 4 screws at the rear panel.
(3) Remove the side edges.
(4) Pull the upper plate out and remove it.
(5) The dip switch on the PCB will appear.

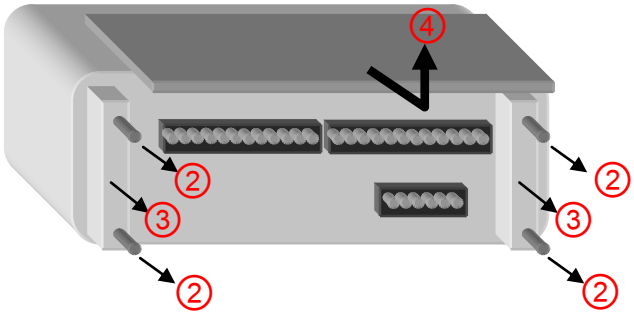


Figure 5-13 Removing Upper Plate

2) Connecting CONT. IN/OUT and PV SELECTOR

There are 2 CONT. IN/OUT connectors on each switching unit. One of the connector is connected to MP-180 PV SELECTOR connector by attached control cable, and other connector can be connected to other switching unit.

Each MI-510 and MI-520 can connect 1 unit.

MI-510S can be setup 2 units as 1set unit, thus maximum of 2 units can be connected.

MI-530 can connect only 1 unit.

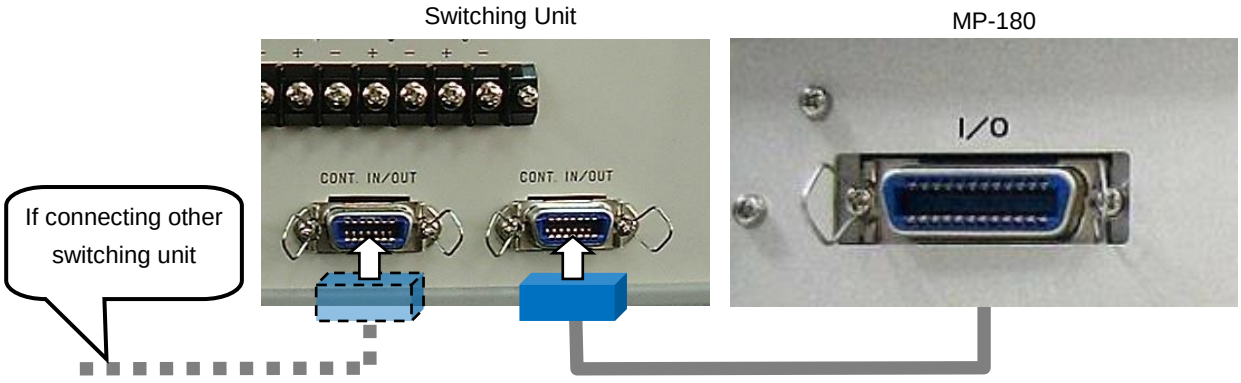


Figure 5-14. PV SELECTOR Connector Connection

2. MI-510/510S/520 Module Switching Unit

1) Connecting to I-V Curve Tracer MP-180: How to Connect PV OUT and PV INPUT

Connect straight to the PV INPUT terminal on the MP-180 rear panel with PV junction cable.

NOTE: Make sure that the power switch is turned OFF when connecting cables.

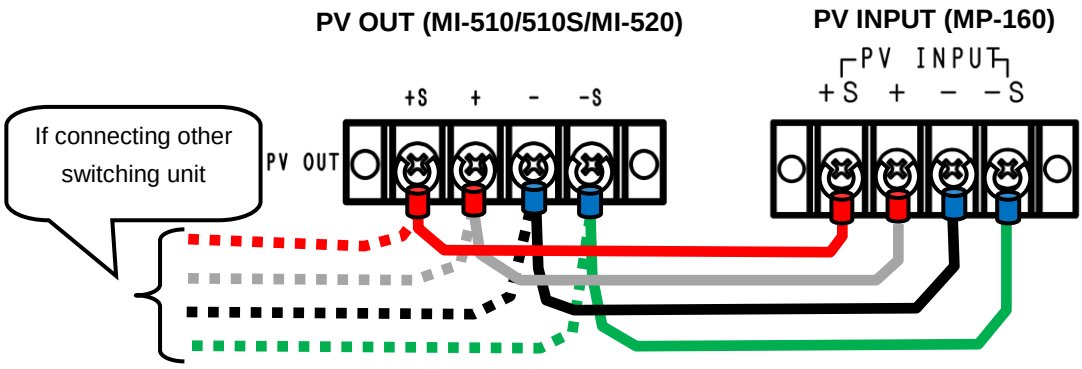


Figure 5-15. MI-510/510S/520 PV OUT & PV INPUT Connection

2) Connecting to PV Module

Connect the PV module current terminal to the + and − of each channels for PV LOAD IN terminal, and connect the voltage terminal to the +S and −S for PV SENCE IN terminal.

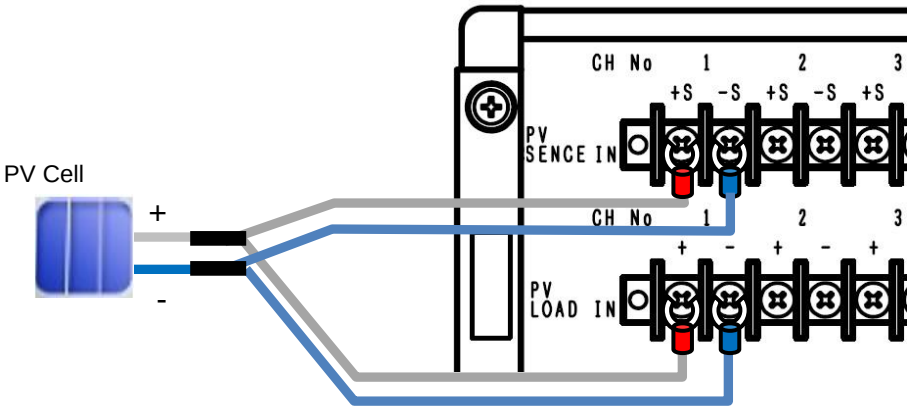


Figure 5-16. MI-510/510S/520 Connecting to PV Module

3) Internal Dip Switch Setting

The internal dip switch is located on the upper circuit board inside the switching unit; thus in order to setup, the upper lid must be removed.

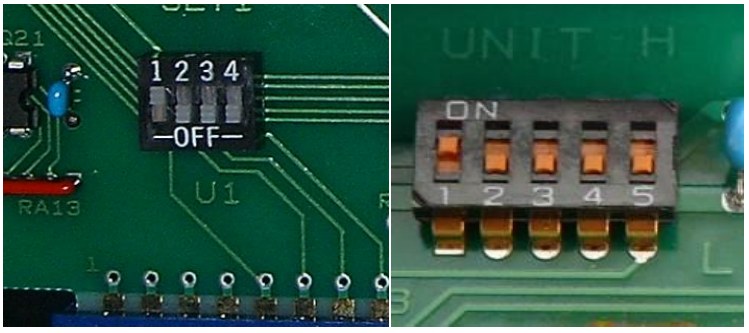
When using multiple units of module switching units, the unit numbers are assigned for identification by setting up the internal dip switches. One unit of module switching unit is assigned as 1 unit.

The dip switch 1~4 represent the UNIT number. When using multiple module switching units, make sure the dip switches are not overlapped.

Corresponding to the units 1~4, setup one of the dip switch to ON.

NOTE: The unit number which can be used with MP-180 is No. 1 only; the channel numbers are from 1ch to 12ch.

NOTE: Multiple bits cannot be turned ON, as well as it will not function if all the bits are turned OFF.



MI-510/520 MI-510S

Figure 5-17. Internal Dip Switch

MI-510S has 1~5 dip switches. The switches 1~4 have same functions as the dip switches in MI-510/520, and 5th one is the switch for a function to manage 2 units of MI-510S with 1 unit of MI-540 (thermocouple switching unit). When the No. 5 dip switch is set to “L (OFF)” side, the PV terminals correspond to 1ch ~6ch; when the No.5 dip switch is set to “H (ON)” side, the PV terminals correspond to 7ch ~ 12ch. This allows to have 12ch module switching unit just like the MI-520 by using 2 units of MS-510S. This function will be necessary when thermocouple switching unit MI-540 is used at the same time, corresponding to 12ch with one unit.

Table 5-5. Dip-Switch Setting (MI-510/510S/520)

Dip SW / Connecting Units Qty.	SW1	SW2	SW3	SW4	SW5	Corresponding Channels
MI-510	ON	OFF	OFF	OFF	–	1~6
MI-520	ON	OFF	OFF	OFF	–	1~12
MI-510S	ON	OFF	OFF	OFF	OFF	1~6
	ON	OFF	OFF	OFF	ON	7~12

3. MI-530 Pyranometer Switching Unit

1) Connecting to I-V Curve Tracer MP-180: How to connect to RAD.OUT Terminal

Connect the attached designated cable to RAD.OUT terminal on the MP-180 rear panel. (See below figure)

Connect the cable end with shield cable to the RAD +, - terminals on MP-180. (Make sure to connect the + and − correctly). Connect the shield cable to GND terminal on MP-180.

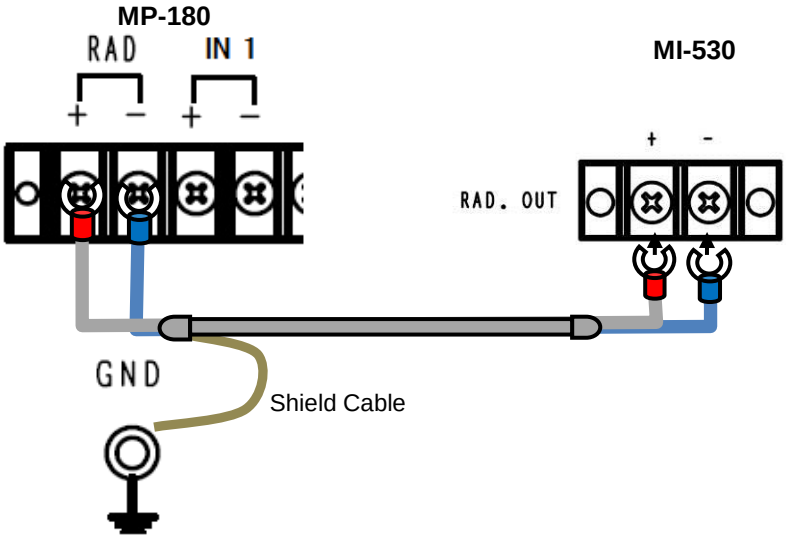


Figure 5-18. MI-530 RAD. OUT Terminal

2) Connecting Pyranometer Output Cable

Connect the pyranometer output cables+ and - to + and − terminals for each channel on MI-530 RAD.IN terminal.

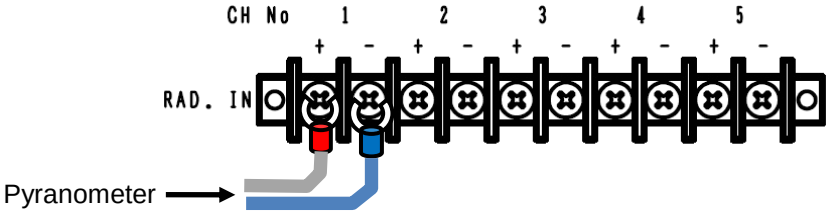


Figure 5-19 MI-530 Terminal

3) Internal Dip Switch Setting

Internal Dip Switch is located on the top circuit board as the upper lid is opened.

How to Setup Dip Switch and Rotary Switch

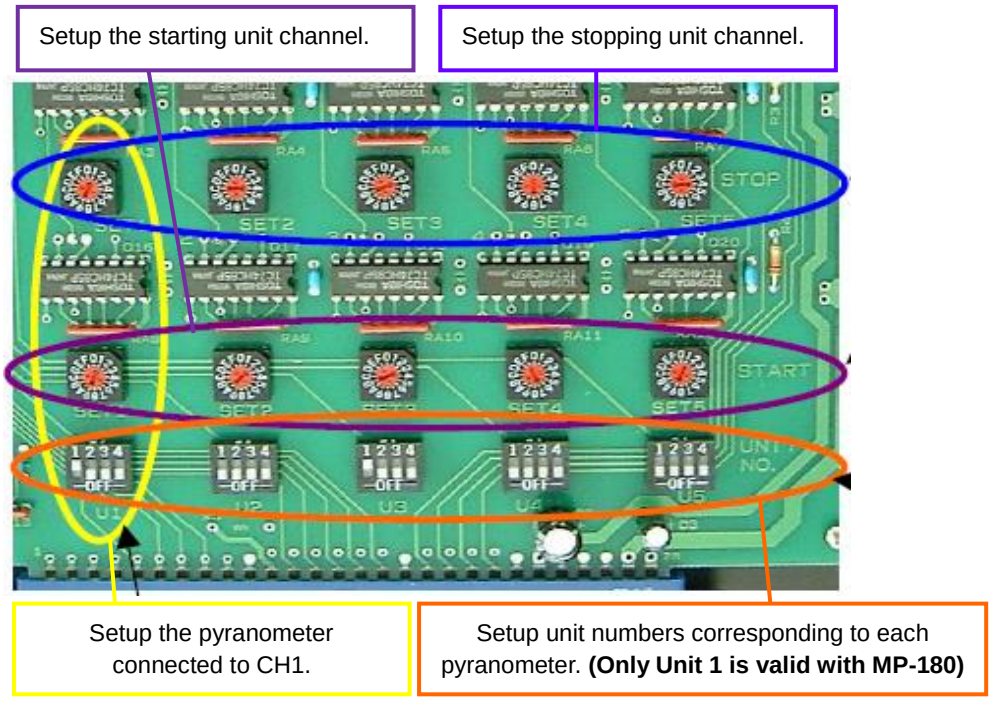


Figure 5-20. MI-530 Dip Switch Setup

Table 5-5. MI-530 Dip Switch & Rotary Switch

Switch Types	Detail
Dip switches (UNIT NO., U1 to U5)	Unit numbers are determined by the settings of internal Dip Switch for PV Module Switching Unit MI-520 connected to MP-180. 1~4 bits for Dip Switch are corresponding to the unit number 1~4 units. **(Only Unit 1 is valid in case of using with MP-180)**
Rotary switches (START, SET1 to SET5)	START rotary switch sets the first PV module number which is setup on MI-510/520 switching unit.
Rotary switches (STOP, SET1 to SET5)	STOP rotary switch sets the last PV module number which is setup on MI-510/520 switching unit.

Numerical encode of the rotary switches use hexadecimal as follows.

PV Module Number	1	2	3	4	5	6	7	8	9	10	11	12
Rotary Switch	1	2	3	4	5	6	7	8	9	A	B	C

(0, D, E and F are not used)

NOTE:

※ Setup all dip switches that are not used for pyranometer channels to OFF

※ One pyranometer cannot be setup with multiple units.

※ Dip switch U1~U5 cannot be set to ON with multiple bits, also it does not function with all bits set to OFF

Example 1)

Pyranometer #1 is assigned to PV module #1 ~ #6

Pyranometer #2 is assigned to PV module #7 ~ #12

PV cells:	12
PV Selector MI-520:	1
Pyranometer Selector MI-530:	1
Pyranometers:	2

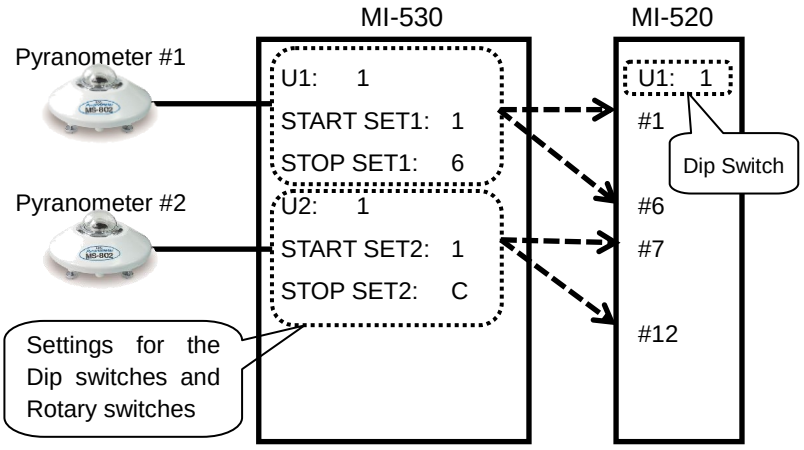


Figure 5-21 MI-530 Connection Example 1

Example 2)

Pyranometer #1 is assigned to PV cells #1 ~ #2

Pyranometer #2 is assigned to PV cells #3 ~ #4

Pyranometer #3 is assigned to PV cells #5 ~ #6

Pyranometer #4 is assigned to PV cells #7 ~ #8

Pyranometer #5 is assigned to PV cells #9 ~ #12

PV cells:	12
PV Selector MI-520:	1
Pyranometer Selector MI-530:	1
Pyranometers:	5

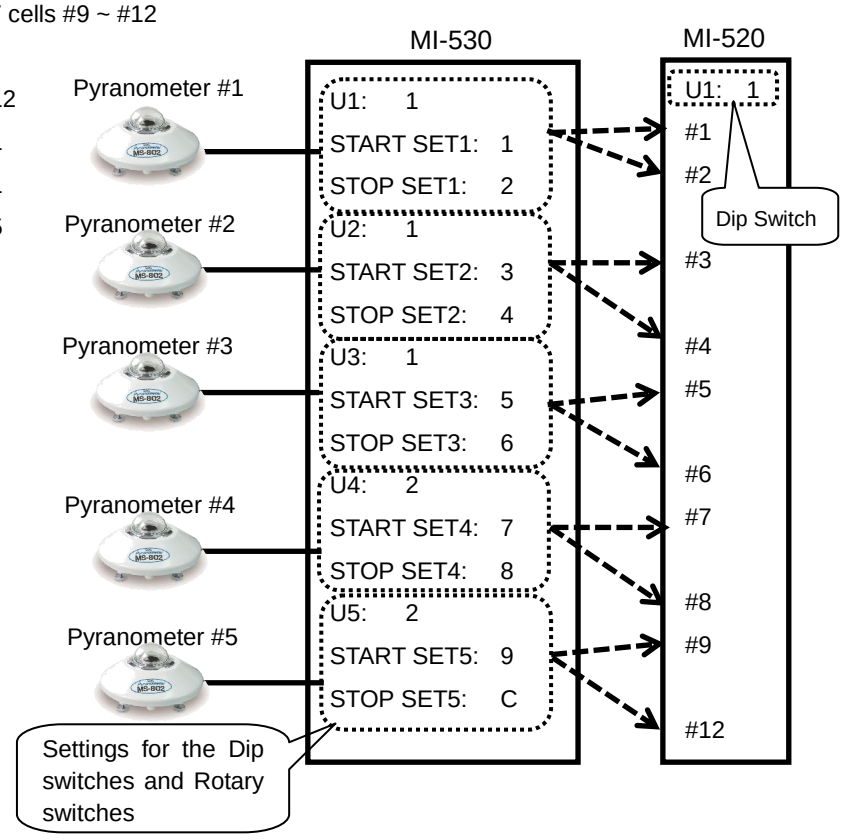


Figure 5-22 MI-530 Connection Example 2

1. MI-540 Thermocouple Switching Unit

1) Connecting to I-V Curve Tracer MP-180

a. TEMP.1 Connection

Connect between the MI-540 TEMP.1 and thermocouple input terminal on the thermocouple transducer with T-type compensating lead wire. Connect between the voltage output side terminals to “IN 1” on the MP-180 rear panel with the T1 junction cable. Confirm the plus and minus terminals before connecting to avoid improper connections.

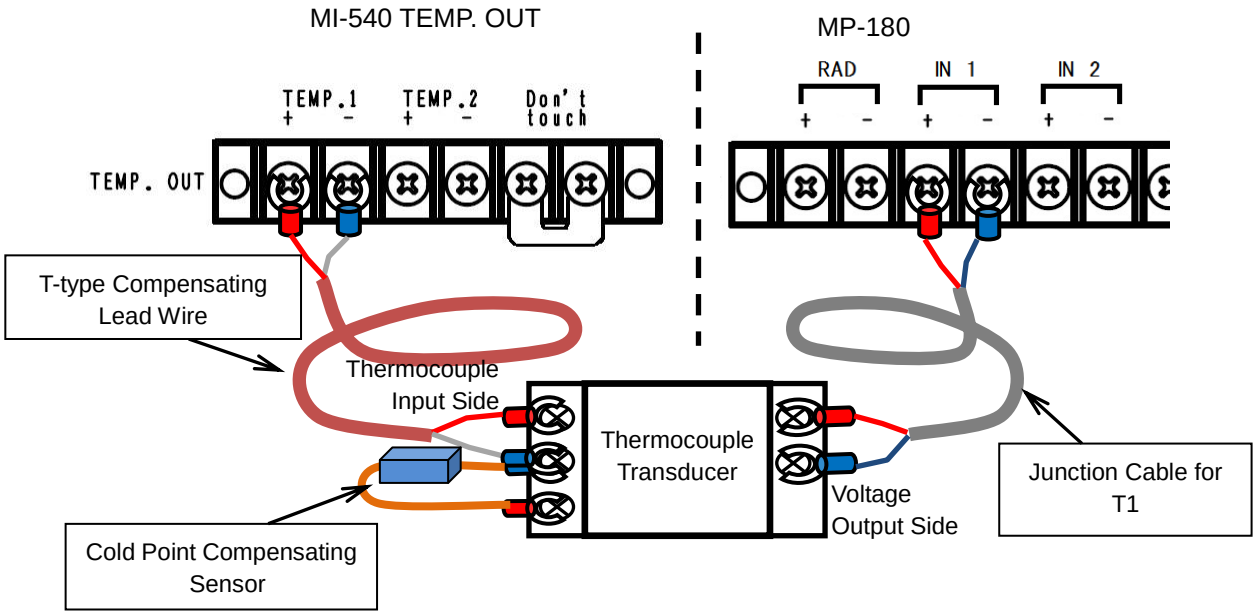


Figure 5-23. MI-540 TEMP.1 Terminal Connection

NOTE: The “TEMP. 2” and “Don’t touch” terminals on the MI-540 will not be used; please do not connect anything.

NOTE: Select “Ch3” for “STC Calculation temperature” and setup with “Temperature Setting: 3ch Voltage Input” in the software.

2) Connecting T-type Thermocouple

Connect to + and – terminals per each channels on “TEMP.IN” terminal with T-type thermocouples + and – cable.

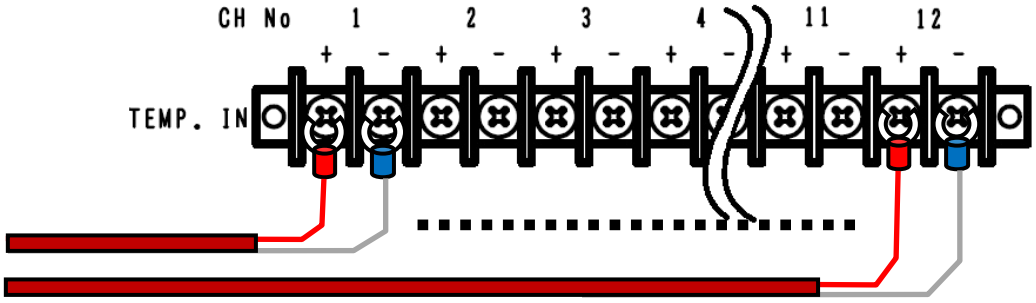


Figure 5-24. MI-540 TEMP. IN Terminal

+: Copper

-: Constantan

3) Internal Dip Switch Setting

Internal Dip Switch is located on the top circuit board as the upper lid is opened.

How to Setup Dip Switch

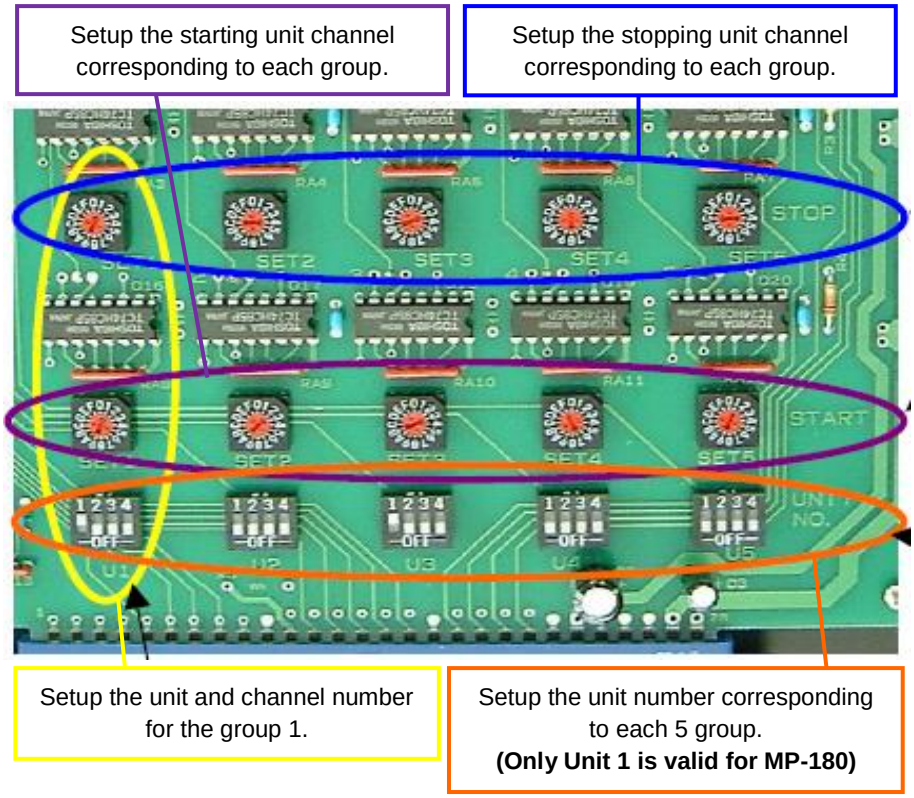


Figure 5-25. MI-540 Dip Switch and Rotary Switch

Figure 5-6. MI-540 Dip Switch & Rotary Switch

Switch Types	Detail
Dip switches (UNIT NO., U1 to U5)	Unit numbers are determined by the settings of internal Dip Switch for PV Module Switching Unit MI-520 connected to MP-180. 1~4 bits for Dip Switch are corresponding to the unit number 1~4 units. **(Only Unit 1 is valid for MP-180)**
Rotary switches (START, SET1 to SET5)	START rotary switch sets the first PV module number which is setup on MI-510/520 switching unit.
Rotary switches (STOP, SET1 to SET5)	STOP rotary switch sets the last PV module number which is setup on MI-510/520 switching unit.

Numerical encode of the rotary switches use hexadecimal as follows.

PV Module Number	1	2	3	4	5	6	7	8	9	10	11	12
Rotary Switch	1	2	3	4	5	6	7	8	9	A	B	C

(0, D, E and F are not used)

NOTE:

※ Setup all dip switches that are not used for pyranometer channels to OFF

※ Duplicate channel number cannot be setup on one unit.

※ When measuring multiple channels, always setup the rotary switches as START < STOP.

※ If the unit is changed, duplicated channel number is possible.

Example 1)

PV modules: 12

PV Selector MI-520: 1

TC Selector MI-540: 1

Setup Module 1~12 on MI-520 and MI-540 in one-on-one condition.

PV Module output cable

Thermocouple cable

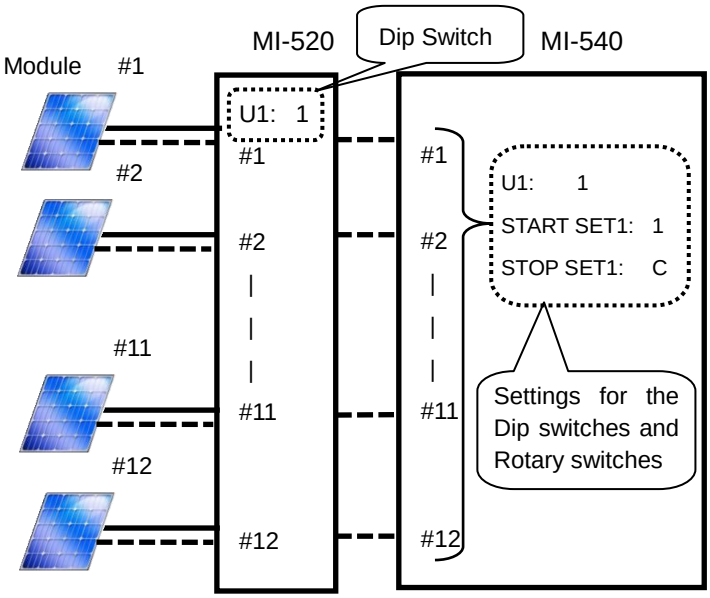


Figure 5-26 MI-540 Connection Example 1

Example 2)

PV modules: 12

PV Selector MI-520: 2

TC Selector MI-540: 1

Setup the MI-540 channels as followings

Unit 1 (Cell No. 1~6)

Unit 2 (Cell No. 7~12)

PV Cable

Thermocouple Cable

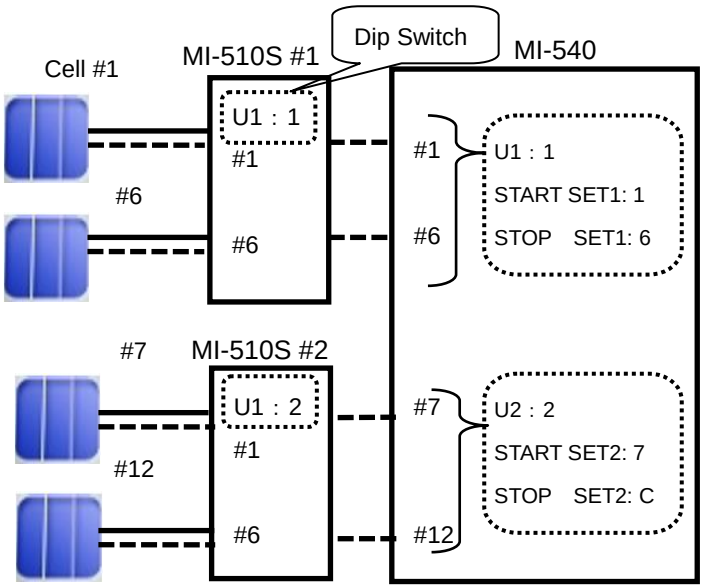


Figure 5-27 MI-540 Connection Example 2

4) Software Setting

When measuring temperature using MI-540, there is software setting which must be set always on the software. The thermocouple input is imported by converting into voltage, thus select "3ch Voltage Input" in the temperature setting dialog, place a check on measure when measuring the IV measurements, and set the temperature range which the input voltage range is converted. In the example shown on the figures (Figure 5-28 & 5-29), the 0-10V is setup as 0-200℃.

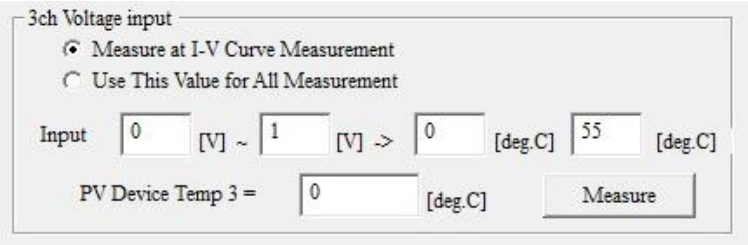


Figure 5-28. Software Setting for MI-540 1

Figure 5-29. Software Setting for MI-540 2

Also when STC conversion is used, select "Ch.3" for the item "STC Calculation Temperature" in the General setting dialog.

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, light 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_2.1.x.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.

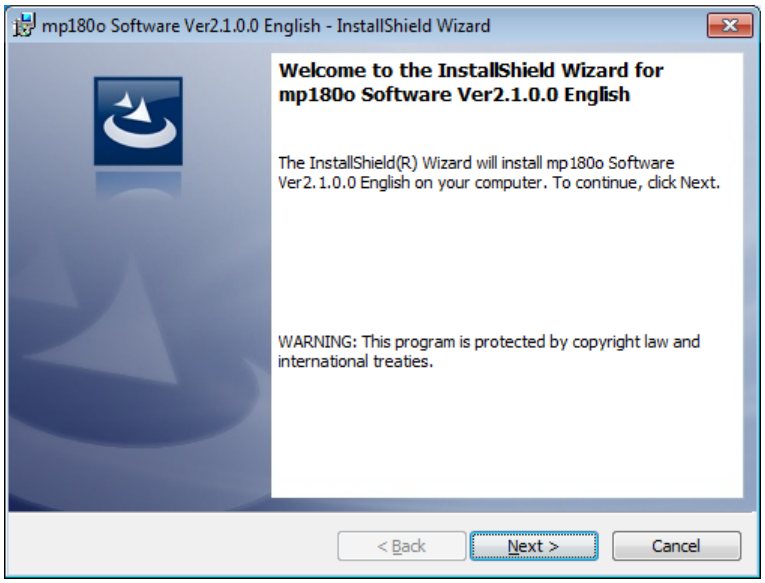


Figure 6-2-1. Installer Wizard Window

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.

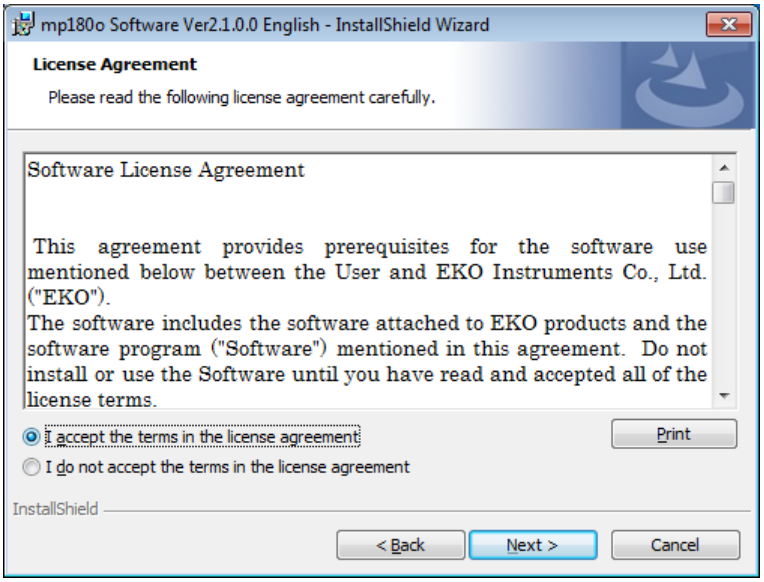


Figure 6-2-2. Software License Agreement Window

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.

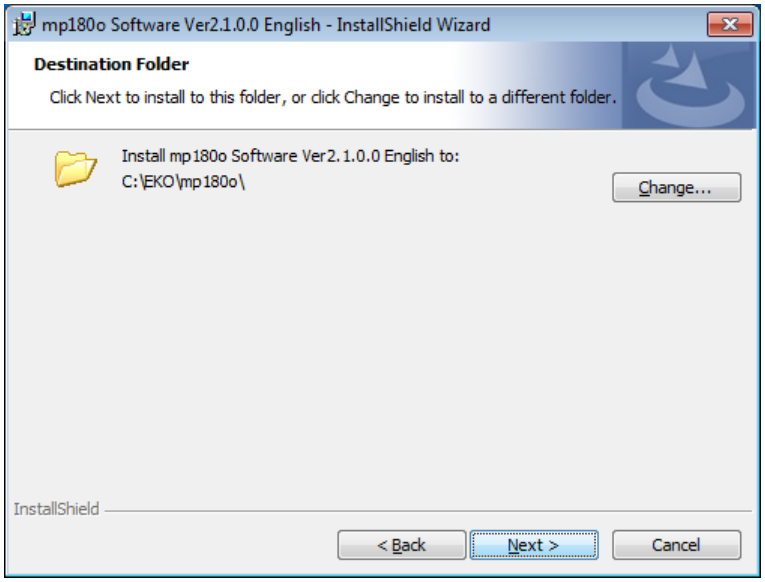


Figure 6-2-3. Destination Folder Setting

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.

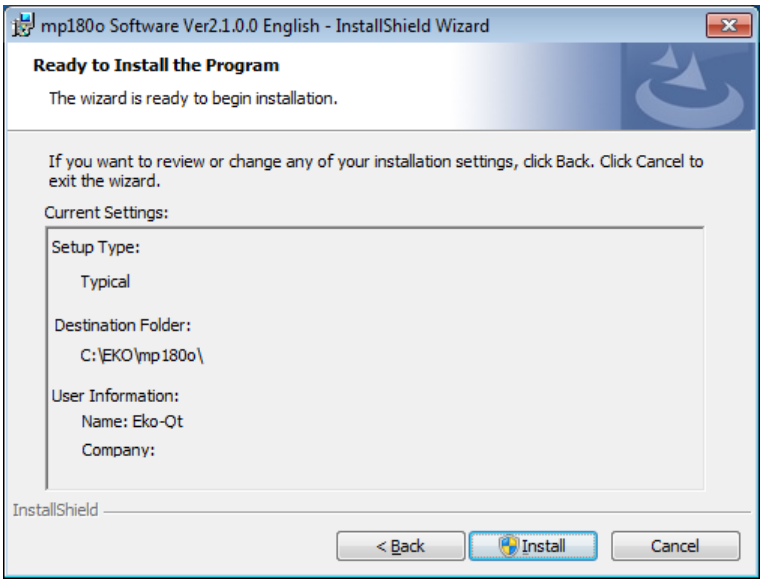


Figure 6-2-4. Installation Confirmation Window

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

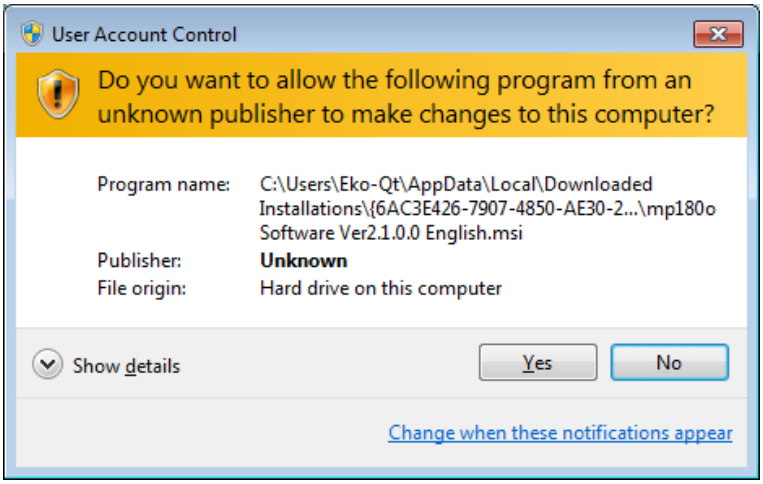


Figure 6-2-5. User Account Control Window

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

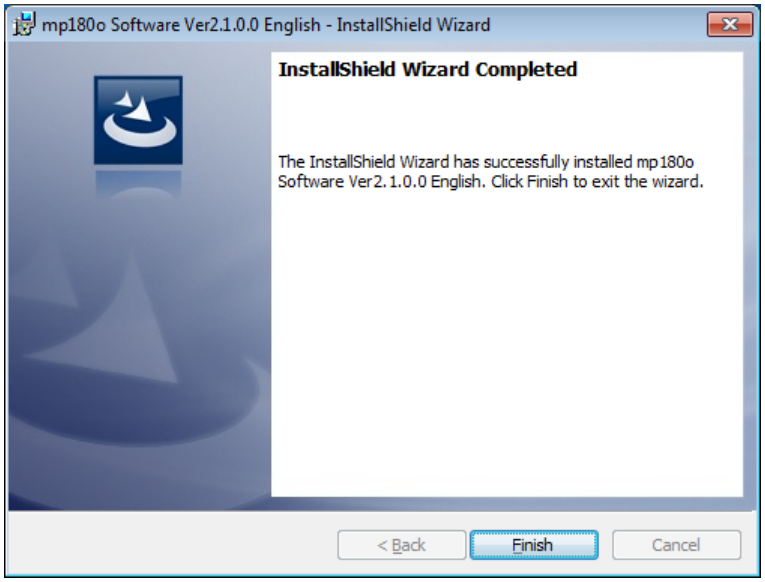


Figure 6-2-6. Wizard Complete Window

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.

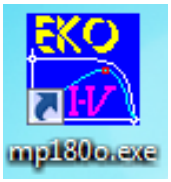


Figure 6-2-7. Shortcut Icon

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)”.

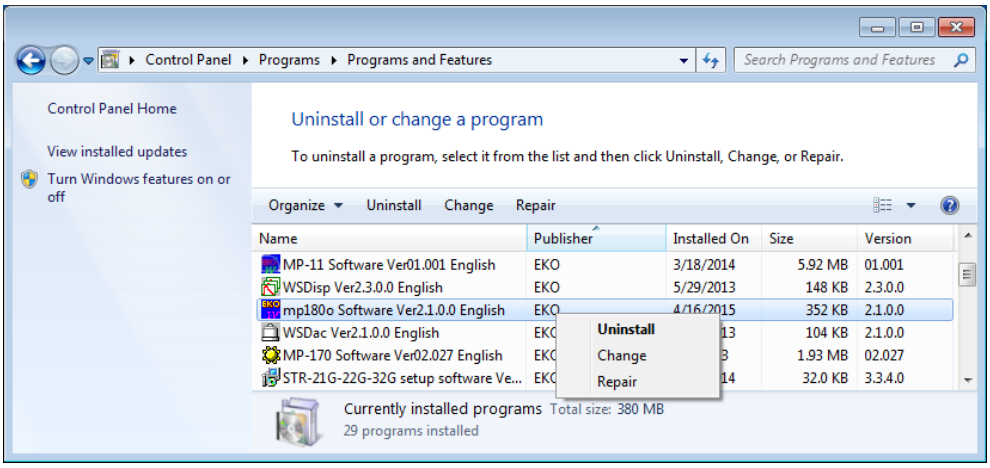


Figure 6-2-8. Uninstalling from “Program and Features”

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.

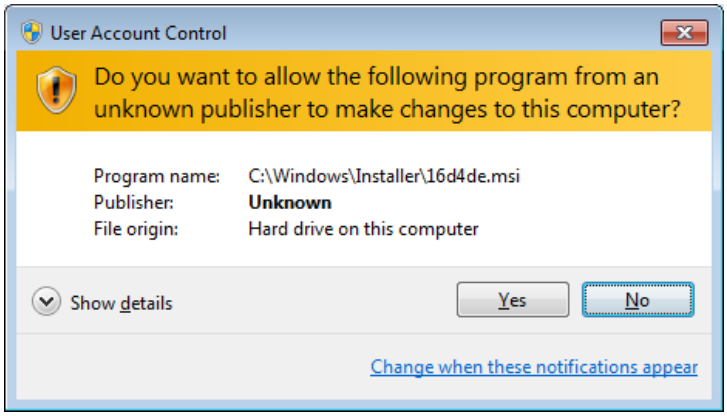


Figure 6-2-9. User Account Control Window

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

6-3. Driver Software Installation

1. 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, under “USB” folder.

When EXE run type software, start the “**CDM v2.08.30 WHQL Certified for Windows 8.1.exe**” with administrator account.

To execute with administrator account, right click the exe file and select “Run as Administrator (A)…”.

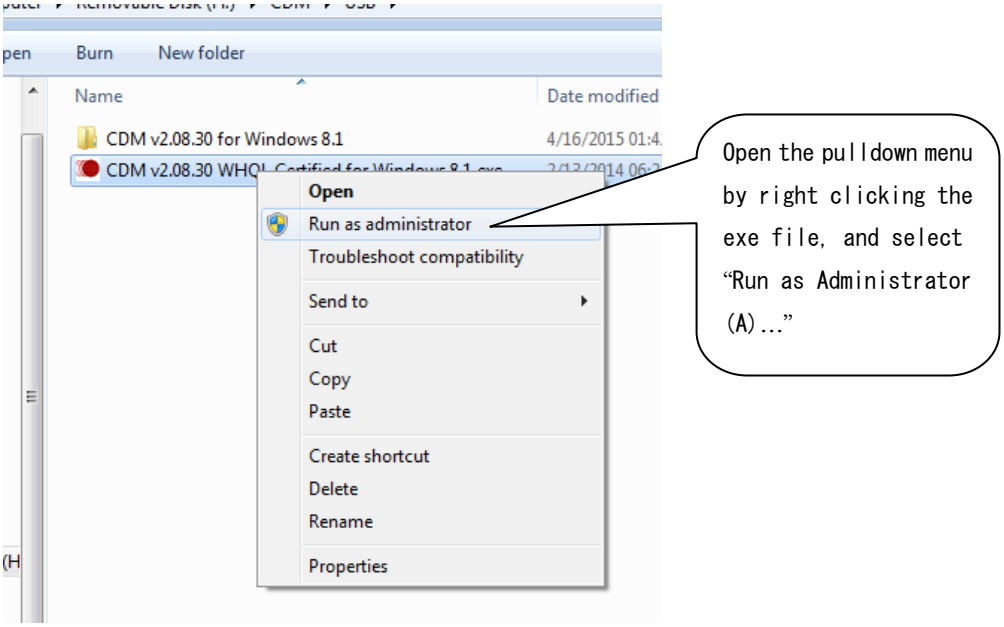


Figure 6-3-1. USB Driver Installation by Administrator

Below window will appear. Click [Extract] and start the installation. The USB Serial Converter driver and USB Serial Port drivers are installed.

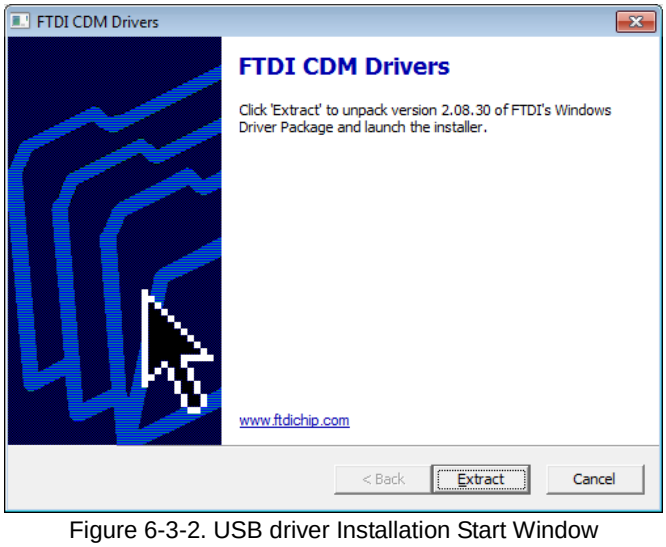


Figure 6-3-2. USB driver Installation Start Window

Driver installation starts.

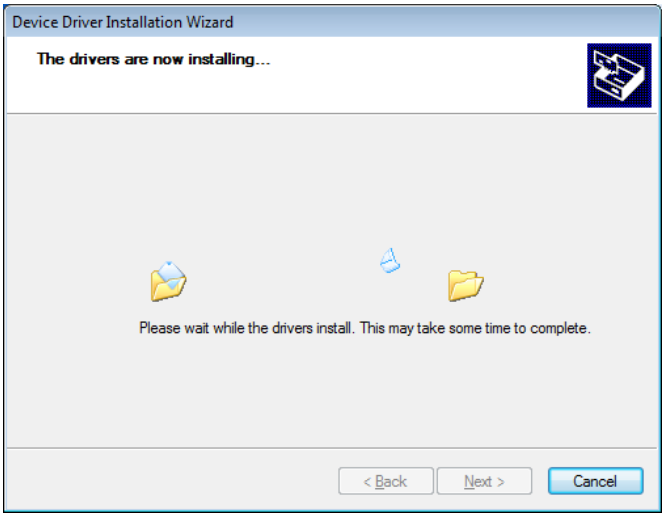


Figure 6-3-3. USB Driver Installing

During the installation, warning message appears. Since two types of drivers are installed, the waning message will appear twice as well. Select “Install this driver software (I)” for both messages and continue the installation.

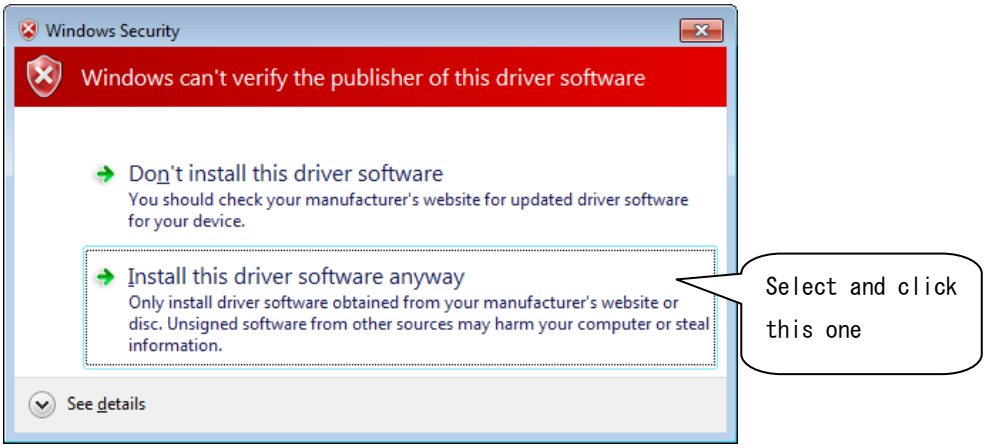


Figure 6-3-4. Security Warning

When the installation is completed, completion window will appear. Click “Finish” button to finish the installation.

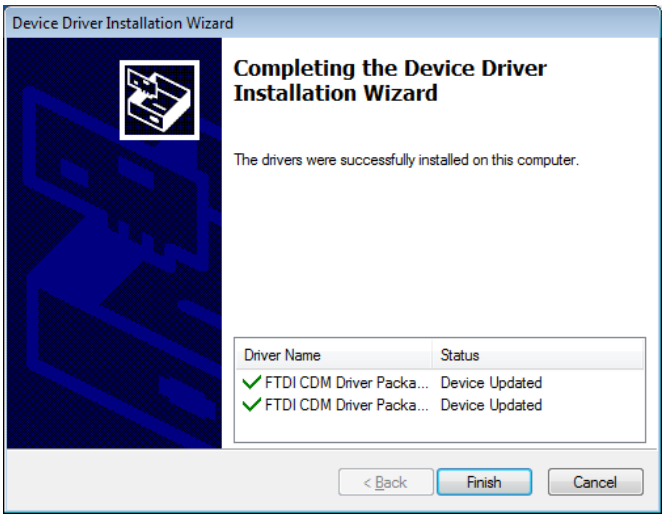


Figure 6-3-5. USB Driver Installation Completed

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 v2.08.30 for Windows 8.1

2. 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.

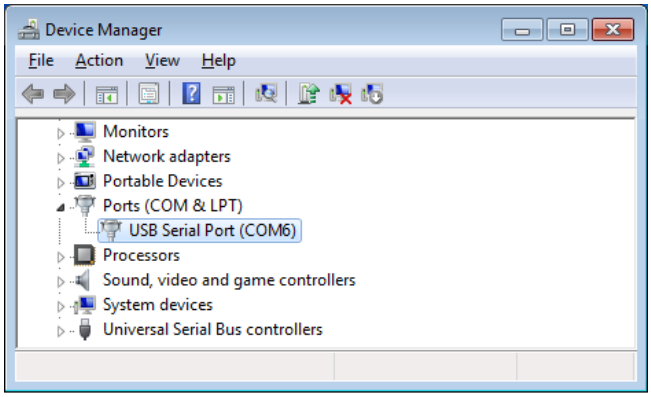


Figure 6-3-6. Device Manager

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

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

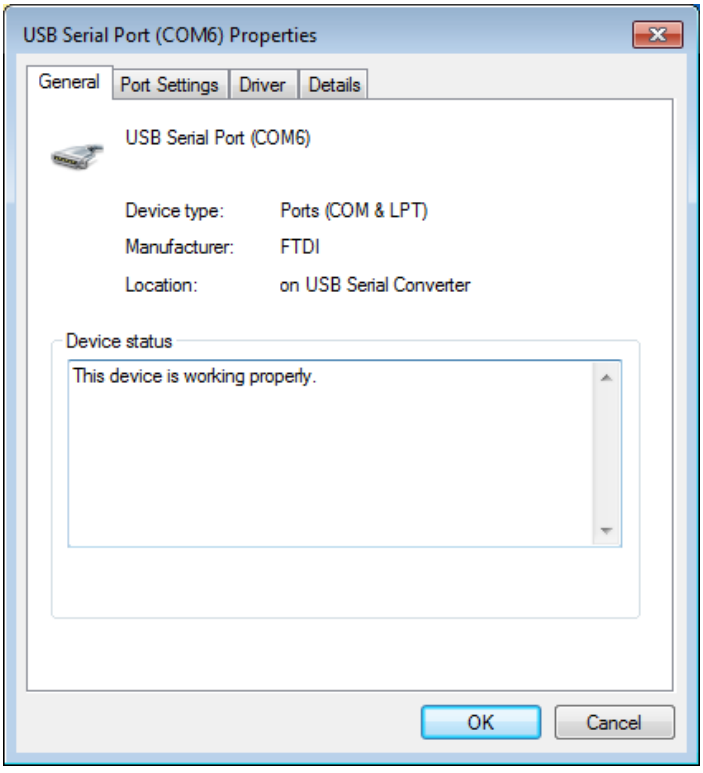


Figure 6-3-7. Port Property for USB Serial Port

3. 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

Cautions for Installation:

- If the PC which software is installed is connected to network, you have to have administrator authorization or you cannot install this software. Please consult with your administrator.
- If the decimal point symbol is setup with “comma” instead of “period” in the Windows Control Panel, Area and Language Option setting (Area Option/Customize/Customize Area Options), there will be malfunctions with data text conversion and graph display. Do not setup the decimal point symbol with “comma”.
- When installing the English version software on PC which OS setting is other than Japanese, such as German, maybe setup with “comma” for the decimal point symbol for the setting in “Customize Area Options” in Area and Language Option setting (Area Option/Customize/Customize Area Options). In such case, it may cause problems with text conversion and graph display; thus, lease change the decimal point symbol from “comma” to “period”.
- If system local (a type of language setting) in the OS is changed, it may corrupt the characters.

4. Connecting with LAN

The communication with LAN on MP-180 is realized by using a device server called “Xport” by Lantronix, Inc..
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

With above procedures, 2 types of softwares are installed. Once they are setup, you only need to connect the LAN cable, and use just as the RS-232C.
See [MP-180 Manual_SingleManual.pdf], Section [A-2. Control by LAN] for detailed setup.

6-4. 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

Each button and functions are described as below.

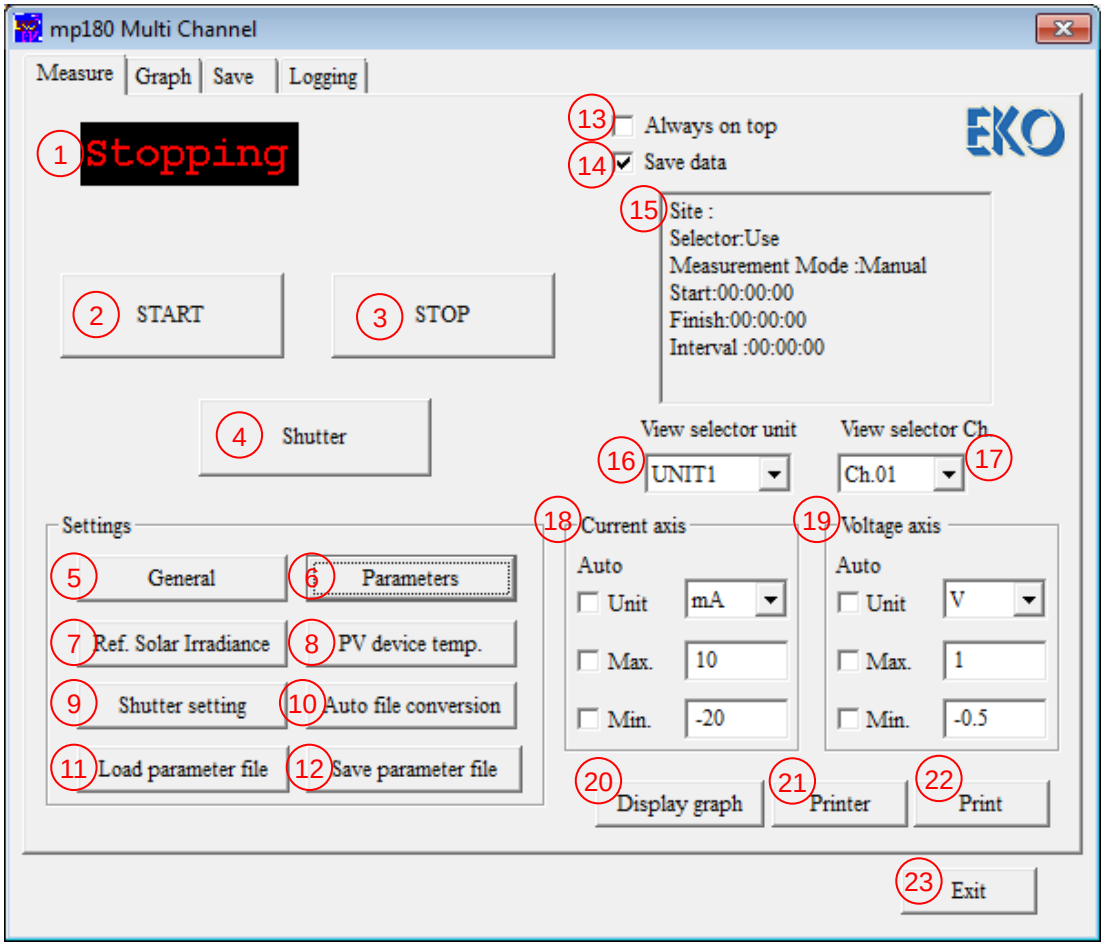


Figure 6-4-1. Software Startup Main Window

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 connected to each channel 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	[Auto File conversion] Button	Clicking this button will display a dialog box for setting the conditions for automatically generating CSV file simultaneously while taking measurements.
11	[Load Parameter File] Button	A parameter file, which is already setup and saved in the memory, can be loaded from this button.
12	[Save Parameter File] Button	Setup value can be saved in parameter file with an assigned name.
13	“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.
14	“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.
15	Measurement Information Display	Displays the measurement conditions. (Location, switching unit, measurement mode, measurement start/finish time, measurement interval)
16	View Selector Unit	Displays the unit number which to be displayed on graph. Unit number can be selected from pulldown menu.
17	View Selector Ch.	Displays the channel number which data to be displayed on graph. Channel number can be selected from pulldown menu.
18	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.
19	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.
20	[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.
21	[Printer] Button	Printer Setup dialog box is displayed and the detailed setup of printer can be changed.
22	[Print] Button	I-V curve graph can be printed.
23	[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.

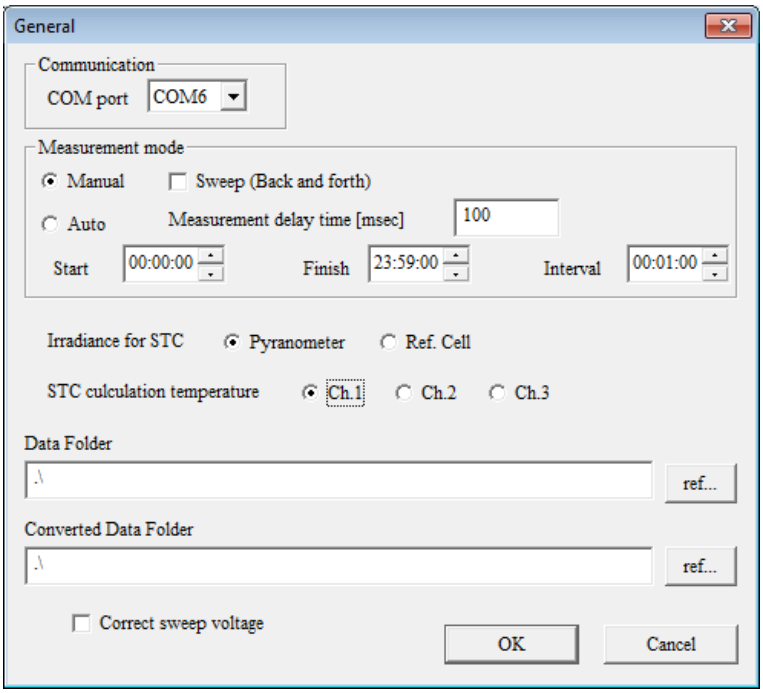


Figure 6-4-2. General Settings

(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]).

(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. 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 it reaches the assigned start time, the measurement starts automatically.

(3) Sweep (Back and forth)

By checking this checkbox, delay time can be setup for the time measurement starts to the sweep starts. The delay time can be setup by 1ms in between the range of 7 and 10000ms. There are 2 types of measurement start timing as followings:

a. The moment when the measurement start button is clicked in the manual measurement mode.

b. When the time reached to the measurement start time in the automatic measurement mode.

(4) Measurement Delay Time

By checking this checkbox will take measurement with round-trip sweep. Measurements are taken twice by changing the sweep direction in order of Isc → Voc then Voc → Isc.

(5) Solar Irradiance for Calculating STC

Select between using pyranometer or reference cell for the solar irradiance value which is necessary for the standard test condition (STC) conversion.

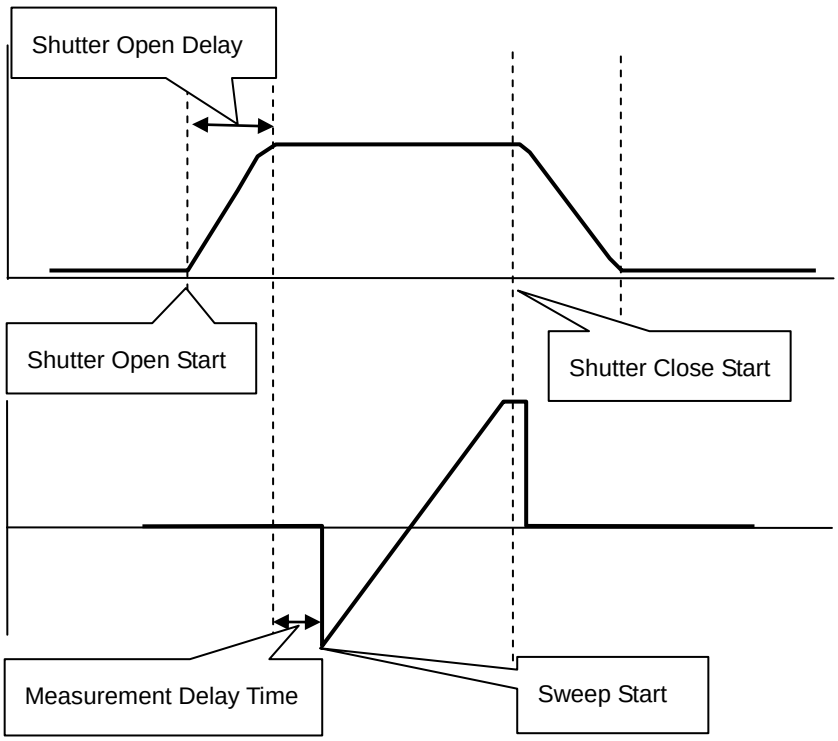


Figure 6-4-3. Solar Simulator Shutter Open/Close Time And Measurement Delay Time

(6) Temperature for Calculating STC

Assign the temperature channel which is measuring the temperature of PV cell which is measured. If the temperature of the PV cell is maintained at a certain temperature by using environmental test chamber, a fixed value can be setup. (See [6.4 Software Operation], section [(5) PV Cell Temperature Setting])

When measuring the temperature with thermocouple using Thermocouple Switching Unit MI-540 and Thermocouple Transducer, select Ch3 for the “Temperature for STC Calculation” in the General Settings dialog box. Select Ch3 in the Temperature Setting dialog box and set the conversion temperature against the input voltage.

(7) Data Saving Directory

I-V measurement data is saved as binary format data. Assign the folder for saving this data.

(8) Converted Data Saving Directory

The binary data can be converted into CSV format text data and save from the Save tab setting. Saving folder can be assigned for this converted data.

(9) Sweep Voltage Correction

By checking this checkbox will allow the sweeping with corrected sweep voltage.

This is used when the set sweep cannot be used with sweep voltage setup due to voltage drop by the interconnection resistance during sweep. This function detects the voltage drop and corrects the voltage value by adding the voltage amount which had dropped so that the sweep will be applied.

2) Channel Setting Dialog

The dialog box shown on Figure 6-4-4 will appear when the “Channel Setting” button is clicked.

Setup the channels and switching units which are used in the measurements are setup in this dialog box.

Setup the following items and click “OK” button.

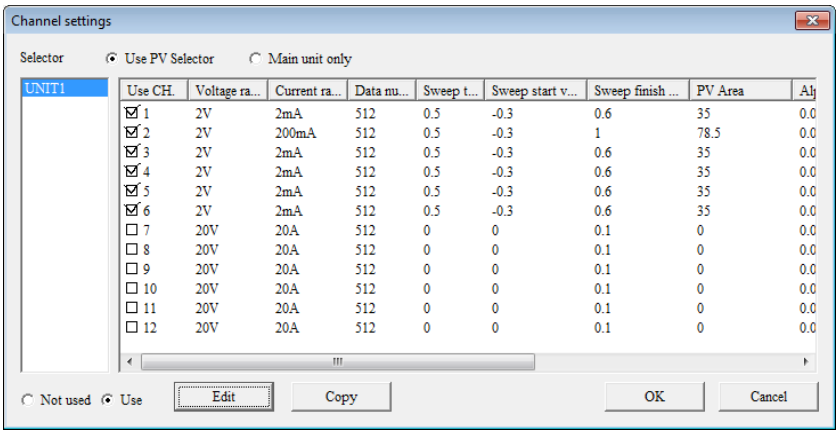


Figure 6-4-4. Channel Setting Dialog

(1) Switching Unit Setup

Select either to use PV Module Switching Unit or only MP-180 main unit.

If PV Module Switching Unit will be used, check the “Use” radio button.

(2) Channel Specification Setting: Using only the Main Unit

Bring the cursor to the “☐ 1” under the Ch. row and click to select this item. When the item is selected, the selected line is highlighted.

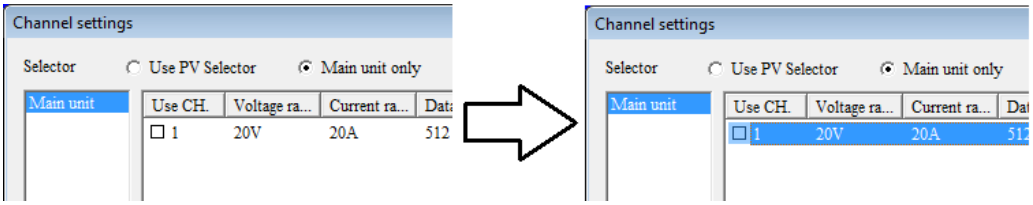


Figure 6-4-5. Channel Setting – Using MP-180 Only 1

From this condition, either to click one of the radio buttons at the left bottom of the Channel Setting dialog box or double clicking the selected channel, the selected channel can be set to “Use” or “Not Use”. The channels to be used will be indicated by a check in the checkbox.

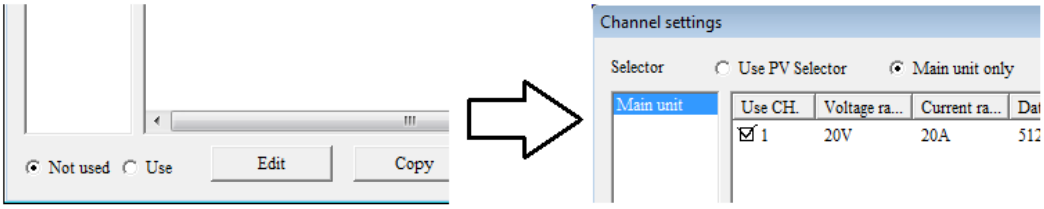


Figure 6-4-6. Channel Setting – Using MP-180 Only 2

(3) Using Switching Units

For standard specification for MP-180, only one unit of switching unit can be connected.

Place checks on “Use CH.” checkboxes for the channel which will be used.

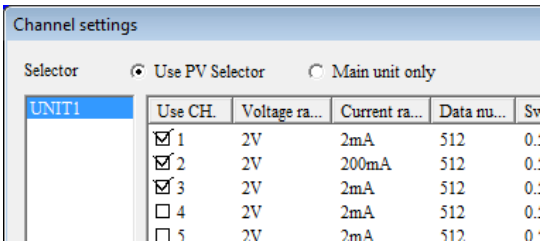


Figure 6-4-7. Channel Settings - Using Switching Units

(4) Copying Channel Information

When using multiple same PV cells with Switching Units, select from 1~12 Channels in “Channel” list and click “COPY” button; same setting values are copied to other channels.

Select the CHs which are used by the original channel and click “COPY” button to display the copy dialog box for the CH. information.

Select the unit and channels which are used by the original channel and click “COPY” button to copy the channel information. Click “Close” button to exit this dialog box.

Enter all the information and settings described above and click the “OK” button on the Channel Setting dialog box. The measurement can be started once the settings are completed.

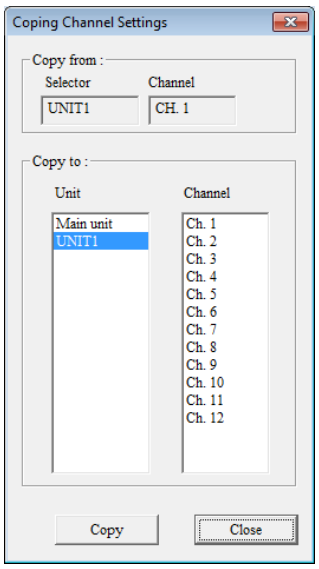


Figure 6-4-8. CH Information Copy

3) Editing Channels

After setup the channels to be used, select the 1~12 channel part and click “Edit” button; the Parameter Setting dialog box will appear. Setup the following items and click “OK” button.

NOTE: Underlined parameters are required to setup.

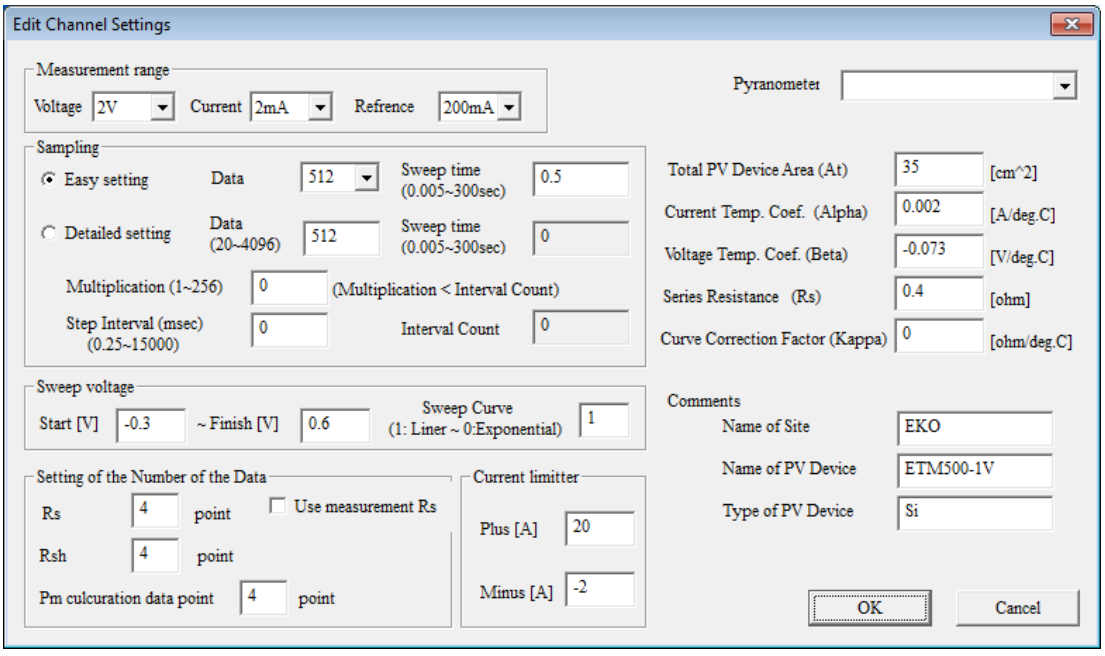


Figure 6-4-9 Edit Channels Settings

(1) 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.

(2) 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 0.005 second ~ 300 seconds by key.

b. Detailed Setting

This is selected when measurement is taken by setting data quantity, integration 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 0.25 ~ 15000msec

✧ Sampling Structure of MP-180

Please see “Figure 6-4-10. Sampling Structure”

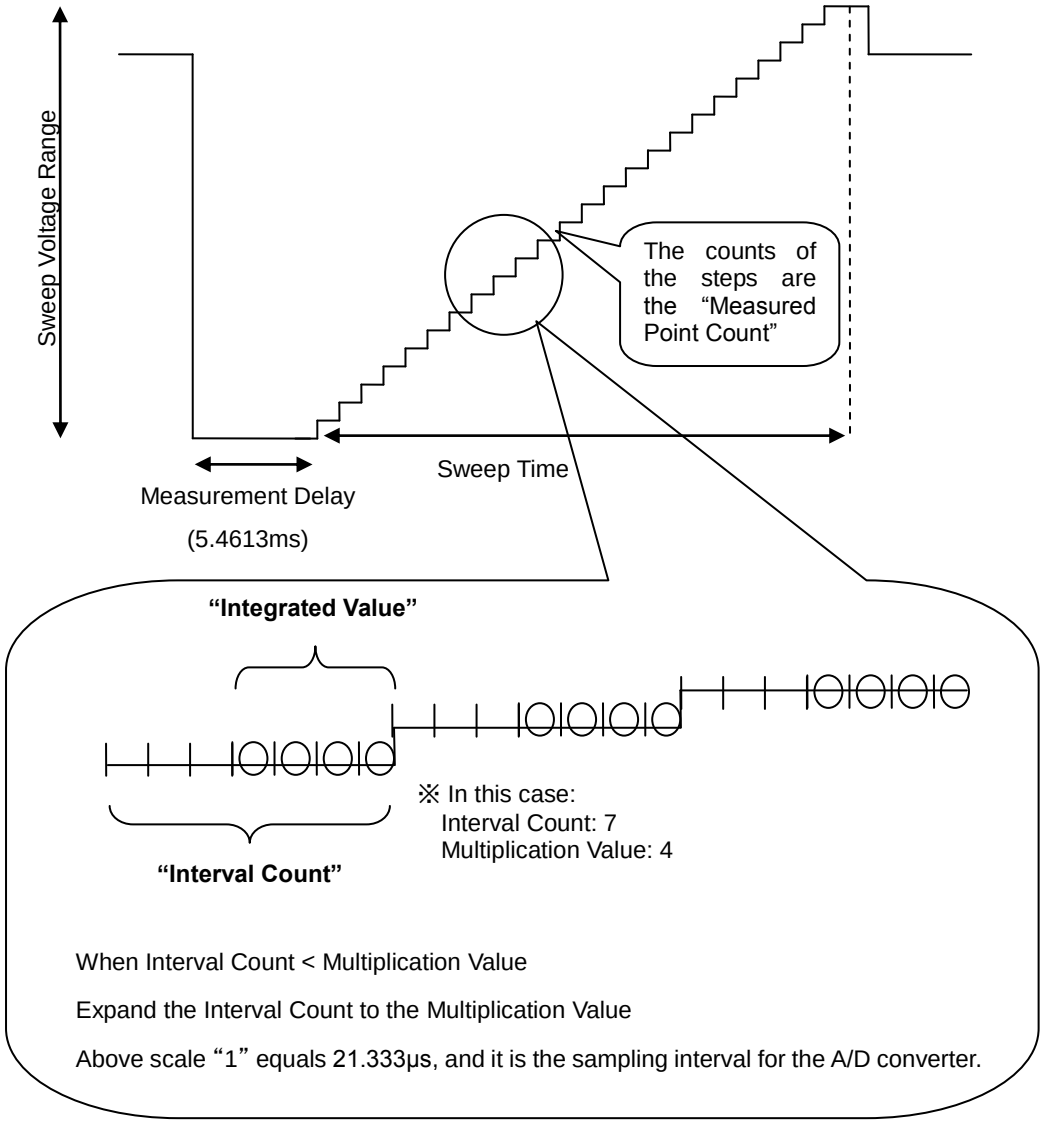


Figure 6-4-10. Sampling Structure

- In case of Easy Setting:

  256 is the maximum of integrated value

  For example, the integration 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}

(3) 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 internal resistance of the measured PV cell and the 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.

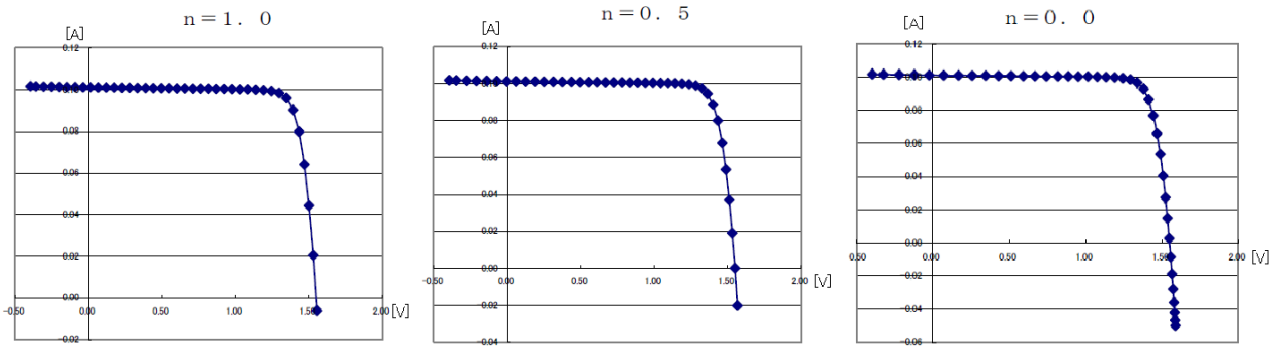


Figure 6-4-11. Exponential Curve Sweep Function

(4) 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.

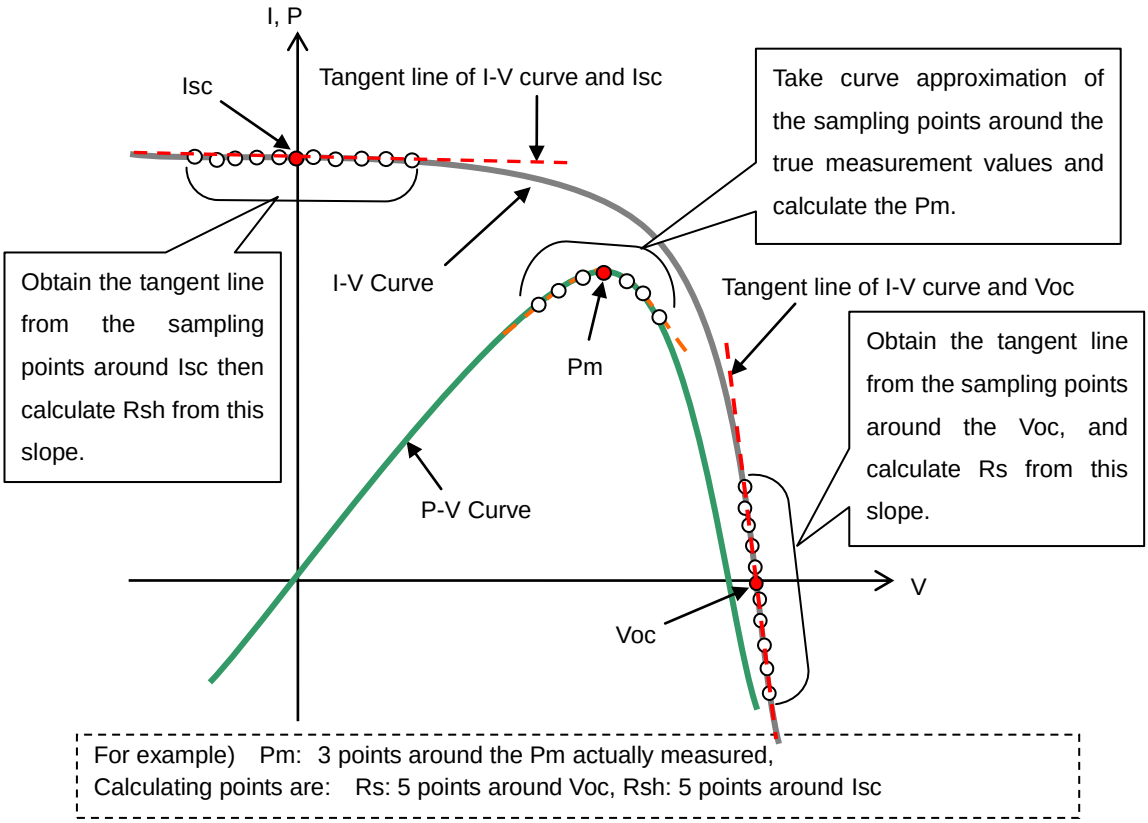


Figure 6-4-12. Determining Calculation Point for Approximation Calculation

- 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.**

(5) Current Limiter

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

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

(6) Pyranometer to be Used

Select the pyranometer which will be used in the STC conversion.

If PV Module Switching Unit is used, up to 5 units of pyranometers can be registered in the Pyranometer section on Reference Solar Irradiance Setting dialog box, which is displayed by clicking the “Pyranometer” button. Select the corresponding pyranometer from the pulldown menu “Pyranometers”

(7) PV Device Area At

Enter the PV cell area in cm^2 unit.

(8) Current Temperature Coefficient α (Used in STC conversion)

Enter the variable value of the short circuit current when the PV cell temperature changed by 1℃. Enter the value with unit [A/℃]. This will be used in STC calculation.

NOTE: This value may be expressed with [%/℃] unit; in such case, convert the value into [V/℃] for entering the value in this section.

(9) Voltage Temperature Coefficient β (Used in STC conversion)

Enter the variable value of the open circuit voltage when the PV cell temperature changed by 1℃. Enter the value with unit [V/℃]. This will be used in STC calculation.

NOTE: This value may be expressed with [%/℃] unit; in such case, convert the value into [V/℃] for entering the value in this section.

(10) Series Resistance Rs (Used in STC conversion)

Enter the PV cell series resistance. Actual I-V curve measurement value can be calculated; however, if the known Rs value is available, enter this value. Either to use this value or the actual measurement value in the STC calculation can be selected. (See [6-4. Software Operation], [(1) General Settings], [7) Calculation Point])

(11) Curve Correction Factor K (Used in STC conversion)

Correction factor defined in IEC 60891 (JIS C8913). Enter with unit [Ω/℃].

(12) Comments

Comment section is not directly related to the measurements, but there are following 3 items to comment:

a. Name of Site

b. Name of PV Device

c. Type of PV Device

4) 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 6-30.

(1) Selecting “Measured Value/Fixed Value” for Solar Irradiance

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.

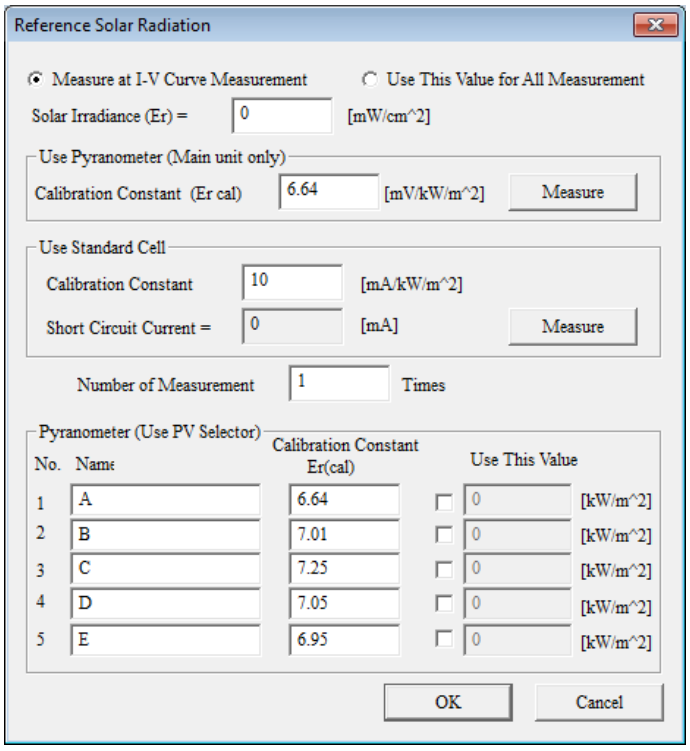


Figure 6-4-13. Reference Solar Radiation Dialog Box

(2) Use Pyranometer (Main Unit Only)

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.

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) Pyranometer (Use PV Selector)

When multi-channel measurement is taken by connecting the PV Module Switching Unit, pyranometers will be able to connect and register up to 5 units. If only the PV Module Switching Unit and the pyranometer connection terminal on the MP-180 is used, and not using the Pyranometer Switching Unit, register the pyranometer to No.1. Setup the pyranometer in the order of the dialog boxes described above, Channel Settings → Parameters

5) 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.

(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.

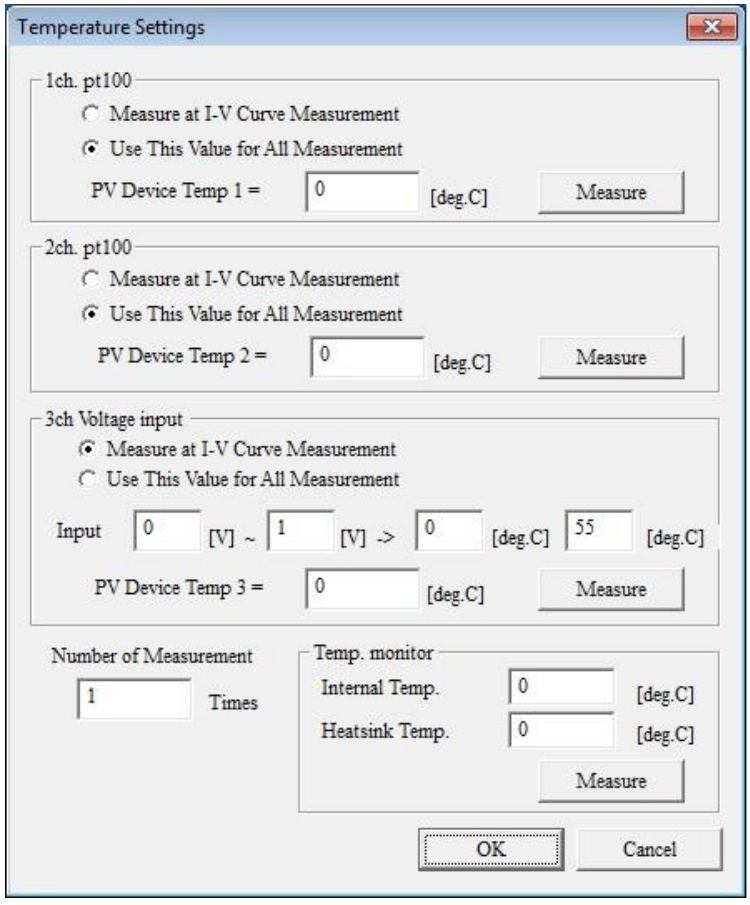


Figure 6-4-14. Temperature Setting Dialog Box

(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.

6) 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.

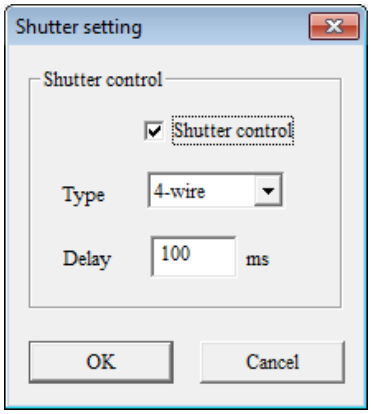


Figure 6-4-15. Shutter Setting

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.**

7) Automatic CSV File Conversion Setting

a. Convert Selected Data: Check here when text converting the voltage and current of I-V data and all sampling data of light intensity.

b. File Extension: Enter identification name to change the file name when converting individual data manually. Up to 5 numbers and/or alphabetical characters can be entered.

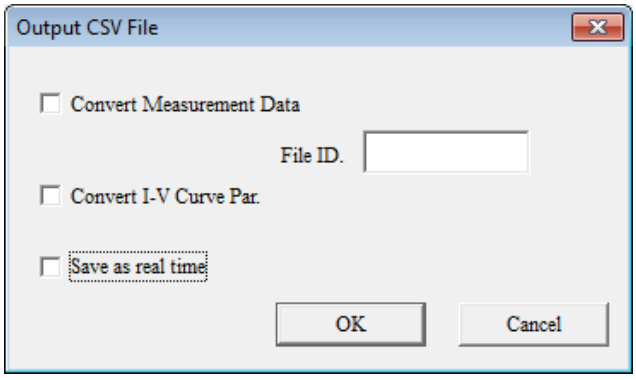


Figure 6-4-16. CSV Automatic File Conversion Setting

c. Convert by Specific Value: Check here when text converting the characteristic of multiple data into one file.

d. Save as Real Time: The time for the measurement data is provided from the clock on PC; however, in case of multi-channel measurement using PV Switching Units, all channels cannot take measurements simultaneously thus the measurements are taken from the younger number sequentially. When the time reaches the measurement time, the PC sends the command to MP-180 for measurement start just once. MP-180 receives this command and takes measurements on all channels by switching from one by one. Once the measurements are completed in all channels, the measurement data from all channels are sent to PC.

- Uncheck this function:
  PC will first assign the time, when the "measurement start" command is issued, to each data as the measurement time of all channels. The measurement times between the first and last channels will have larger gap from the actual measurement time as the number of channels becomes larger.
  Uncheck this function if it is better to have same measurement time for each channel for processing the data.

- Check this function:

  The measurement time which is estimated by calculating the number of channels and interval time between the channels are assigned to each channel data.

  NOTE: HOWEVER, if you want to save with real-time, there should not be any channel which is unused among the used channels. If there an unused channel in middle of channel series, the measurement time will be saved with some shifts as long as the unused channels from that unused channel and on.

8) 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.

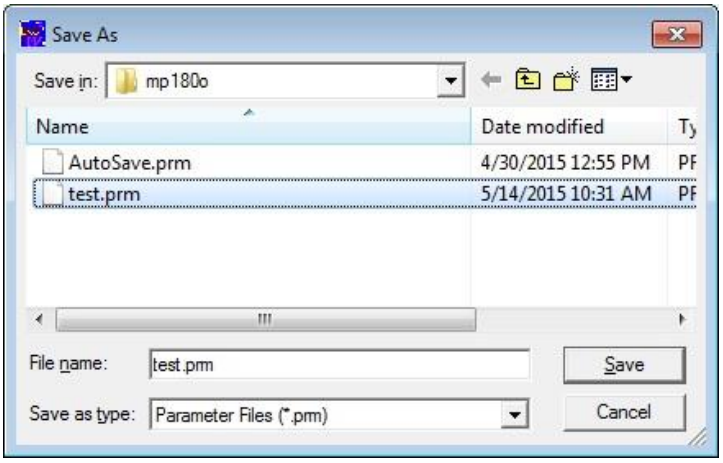


Figure 6-4-17 Saving Parameter

(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”.

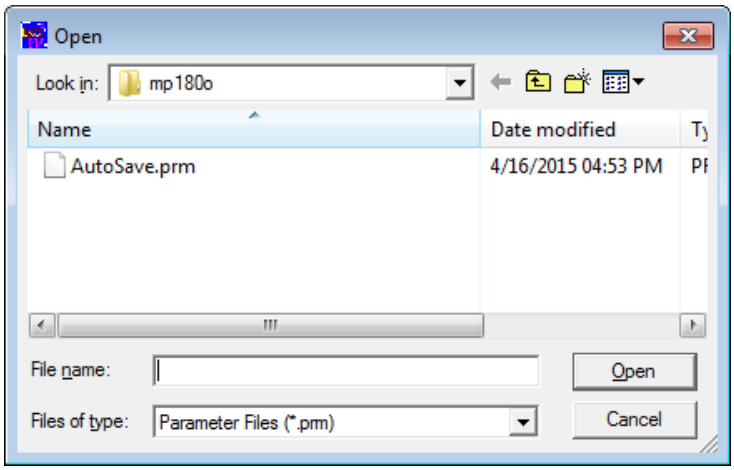


Figure 6-4-18. Loading Parameters

By clicking the Load Parameter File button, “Open File” Image (Figure 6-31) 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.

9) 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.”

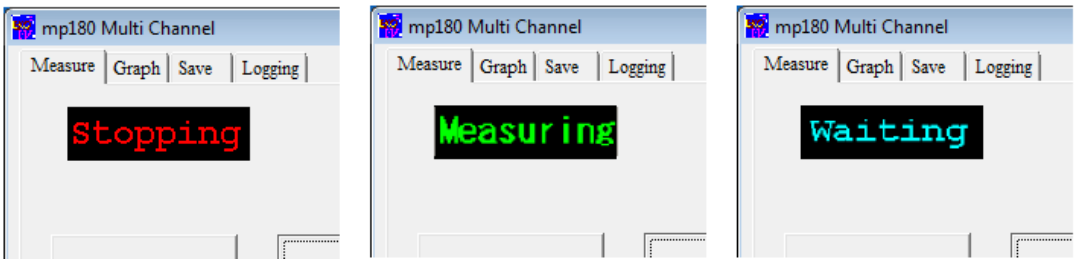


Figure 6-4-19. Status Indication

10) 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.

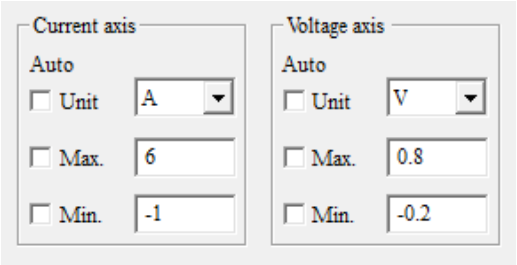


Figure 6-4-20. Current & Voltage Axis Scales Setting

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.

At this stage, the graph can be printed by clicking the Print button; however, make sure the printer is setup beforehand 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.

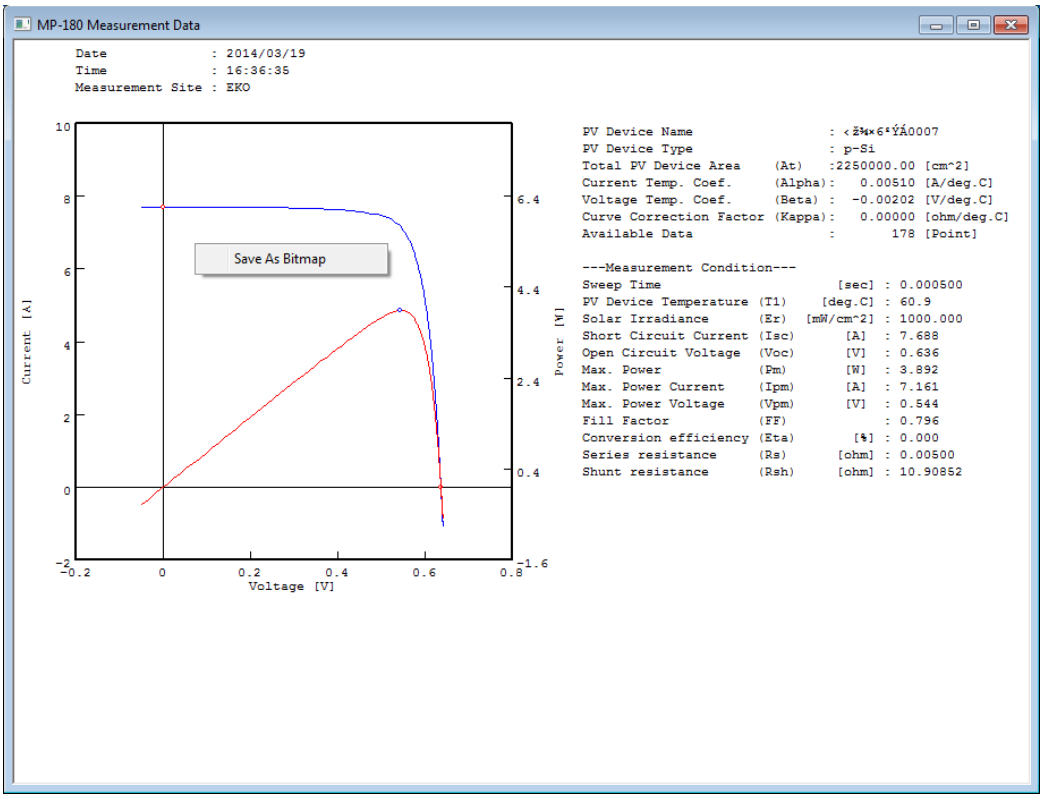


Figure 6-4-21. I-V Curve Graph Display

11) 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 [6-4. Software Operation] → [1. Measure Tab] → [6) 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. Each button and functions are described as below.

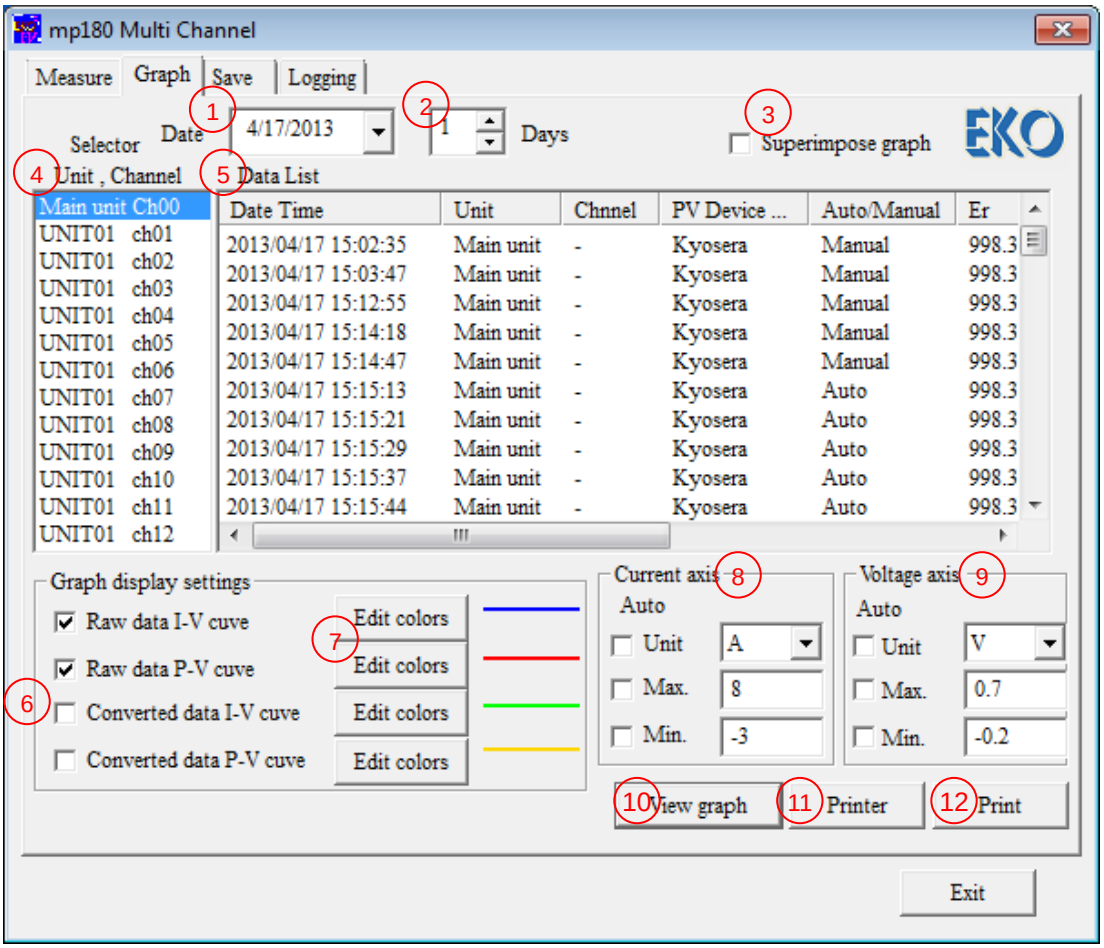


Figure 6-4-22. Graph Tab Window

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	CHANNEL	A list of Unit numbers and Channel numbers are displayed here.
5	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.
6	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.
7	[Edit Colors] Buttons	Select the color of the graph lines

Table 6-2. Graph Tab Menu - Continued

8	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.
9	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.
10	[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.
11	[Printer] Button	Printer setup dialog box will show when this button is clicked and allow detailed setup for printer.
12	[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.

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.

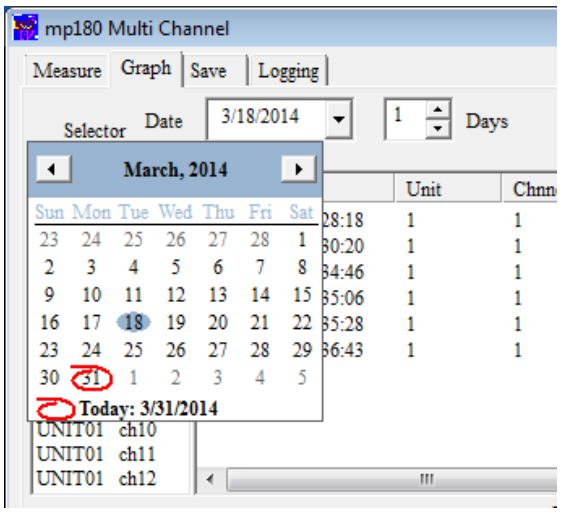


Figure 6-4-23. Calendar

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.

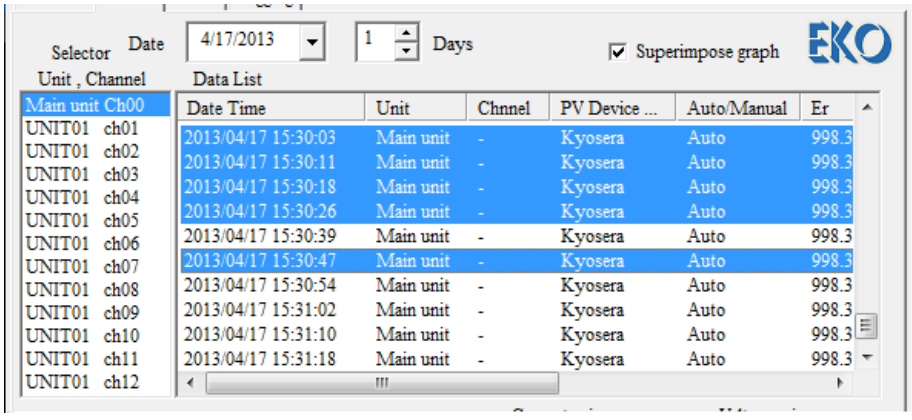


Figure 6-4-24. Selecting Multiple Data

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.

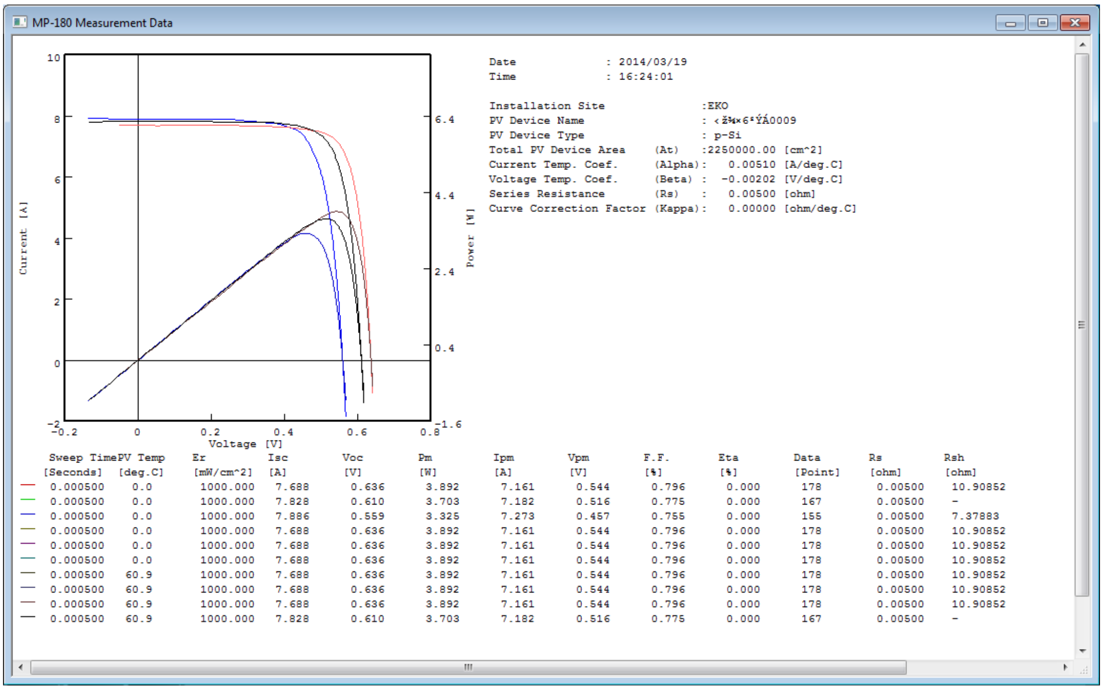


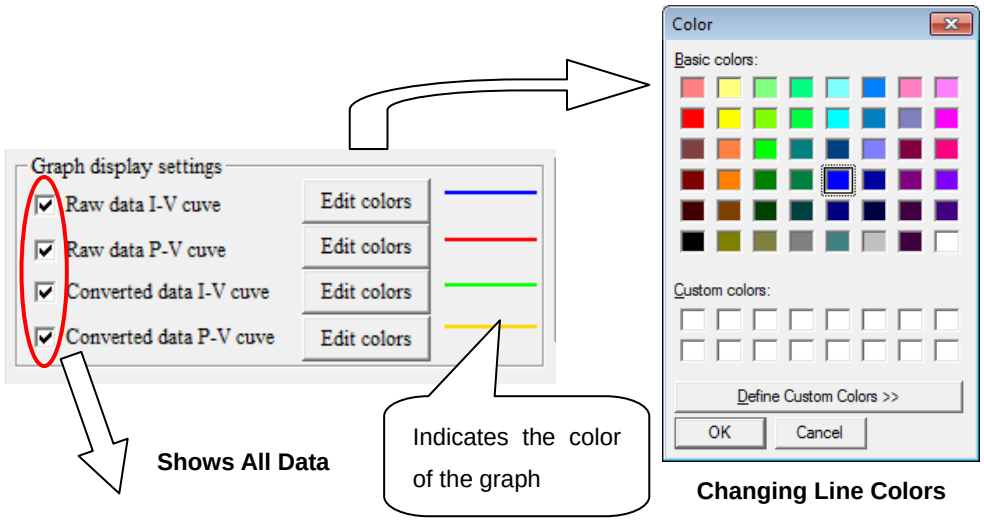
Figure 6-4-25. Superimposing I-V Curve Graphs

4) 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.



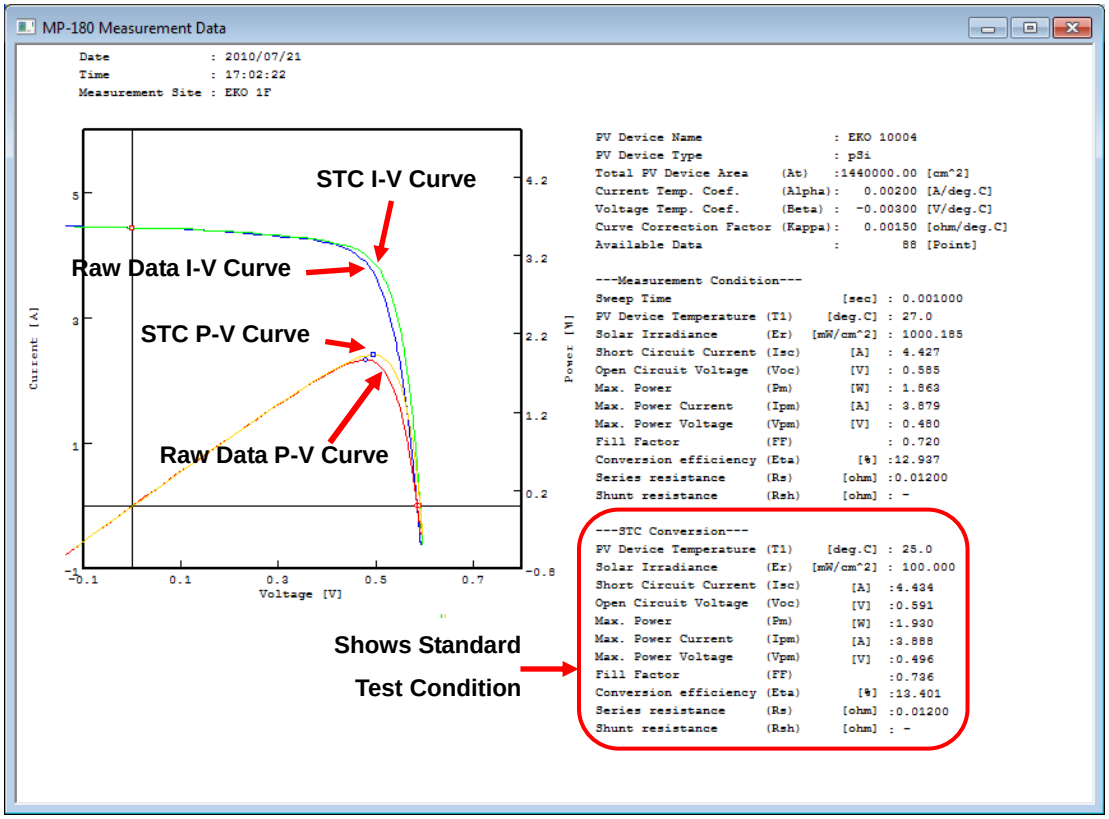


Figure 6-4-26. Displaying All Data

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 CSVformat text file. Each button and functions are described as below

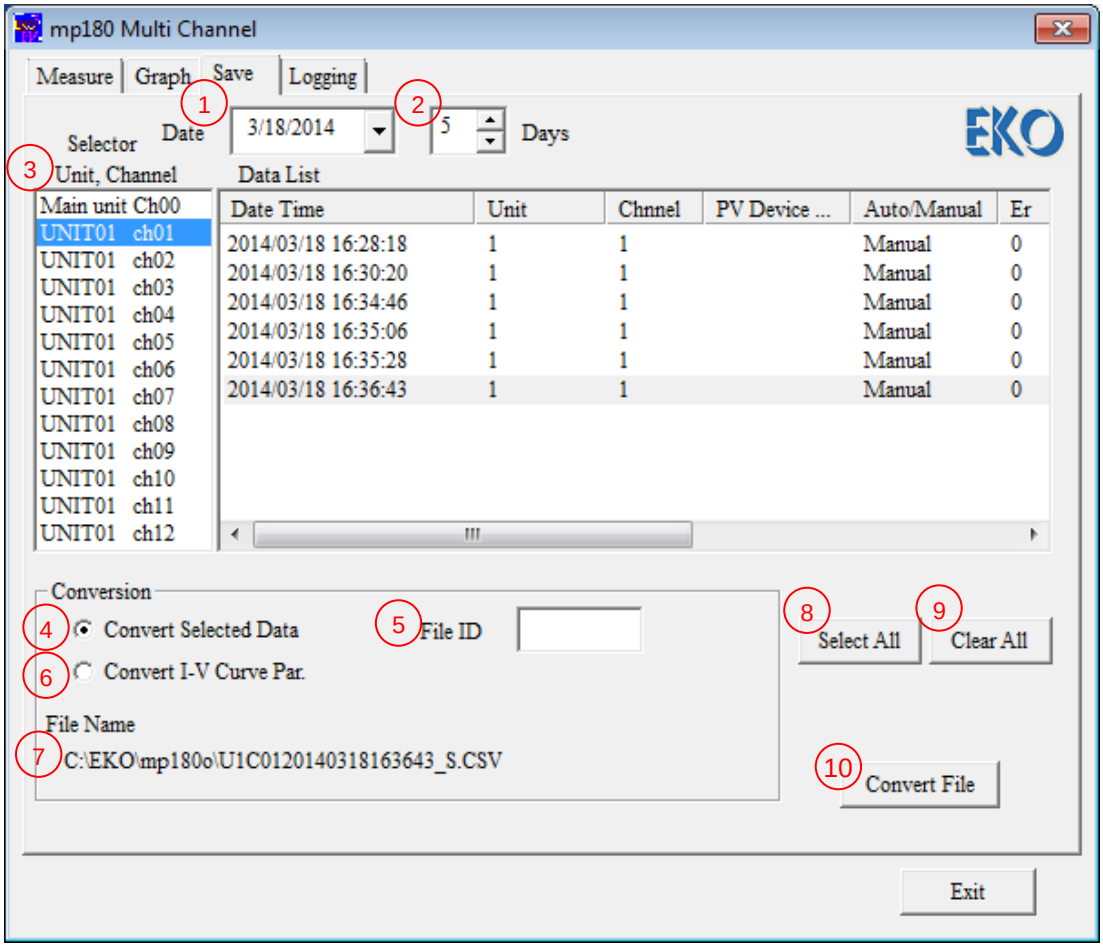


Figure 6-4-27. Save Tab Screen

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/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	[Select All] Button	Clicking this button will select all the data on the data list.
9	[Clear All] Button	Click this button to clear the selected data on data list.
10	[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. Each button and functions are described as below.

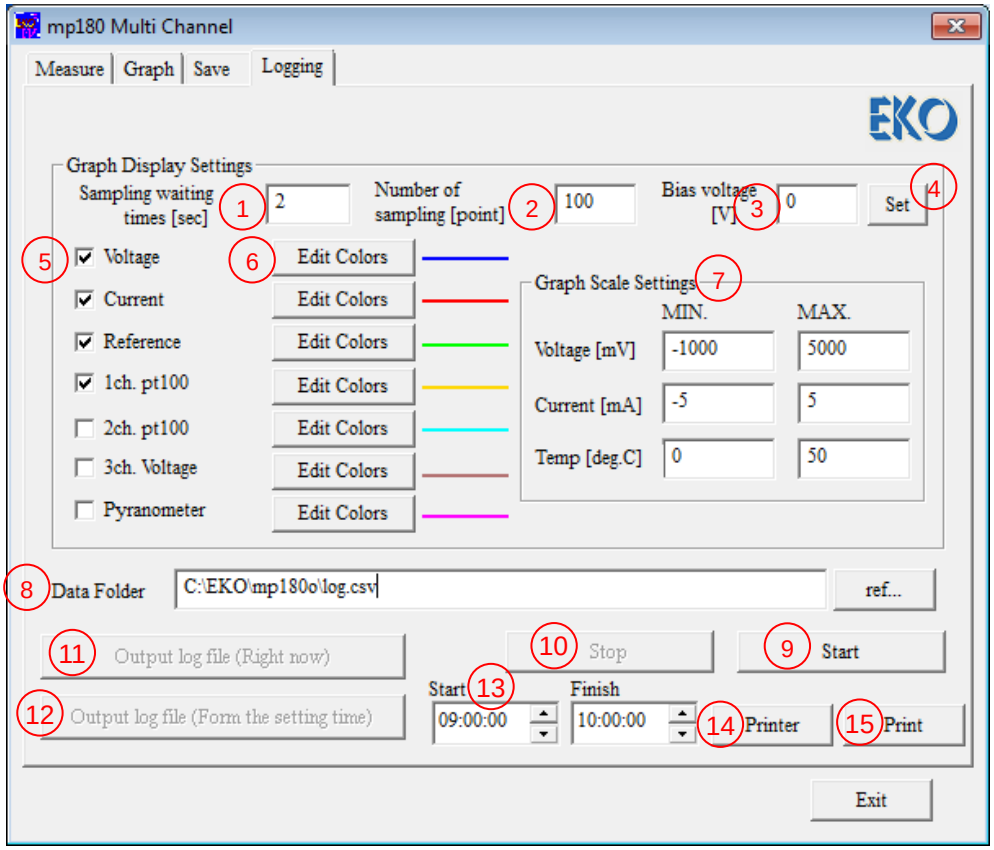


Figure 6-4-28. Logging Tab Screen

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 between the samplings can be setup.
2	Number of Sampling Points	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.

Table 6-4. Logging Tab Menu - Continued

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.

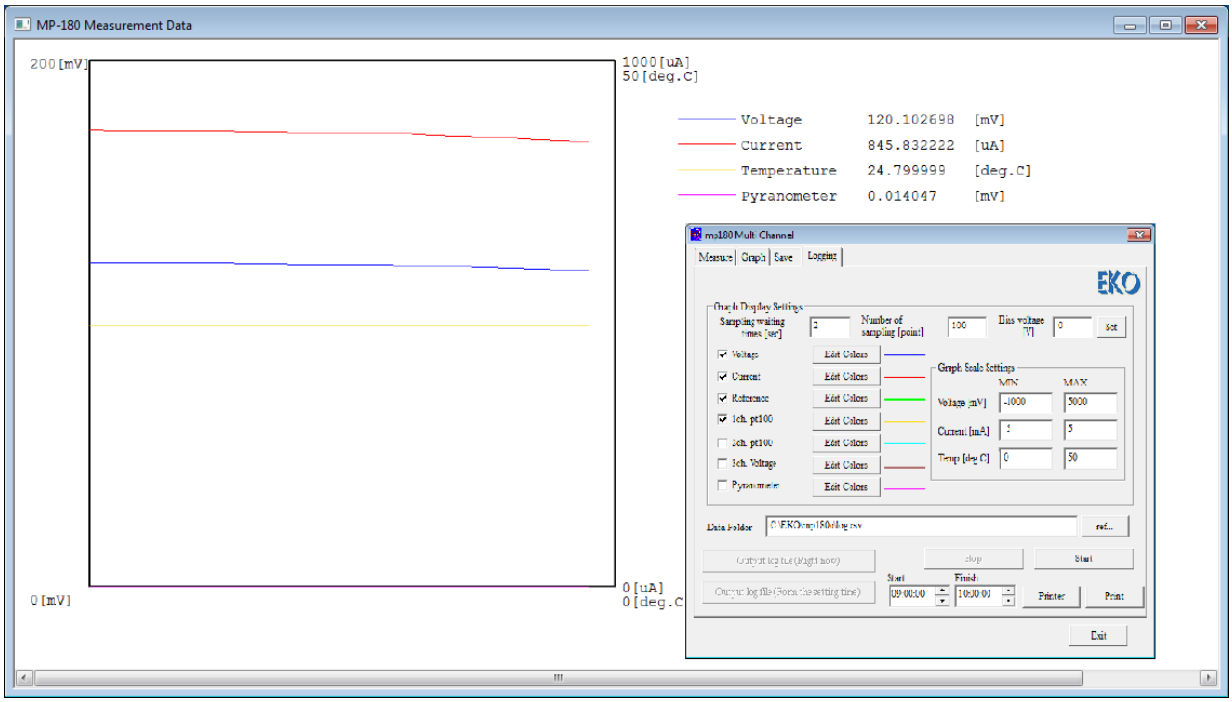


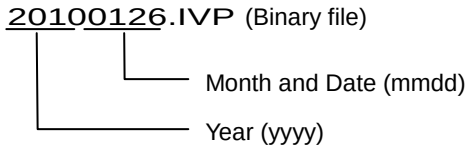
Figure 6-4-29. Monitor Graph

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.)

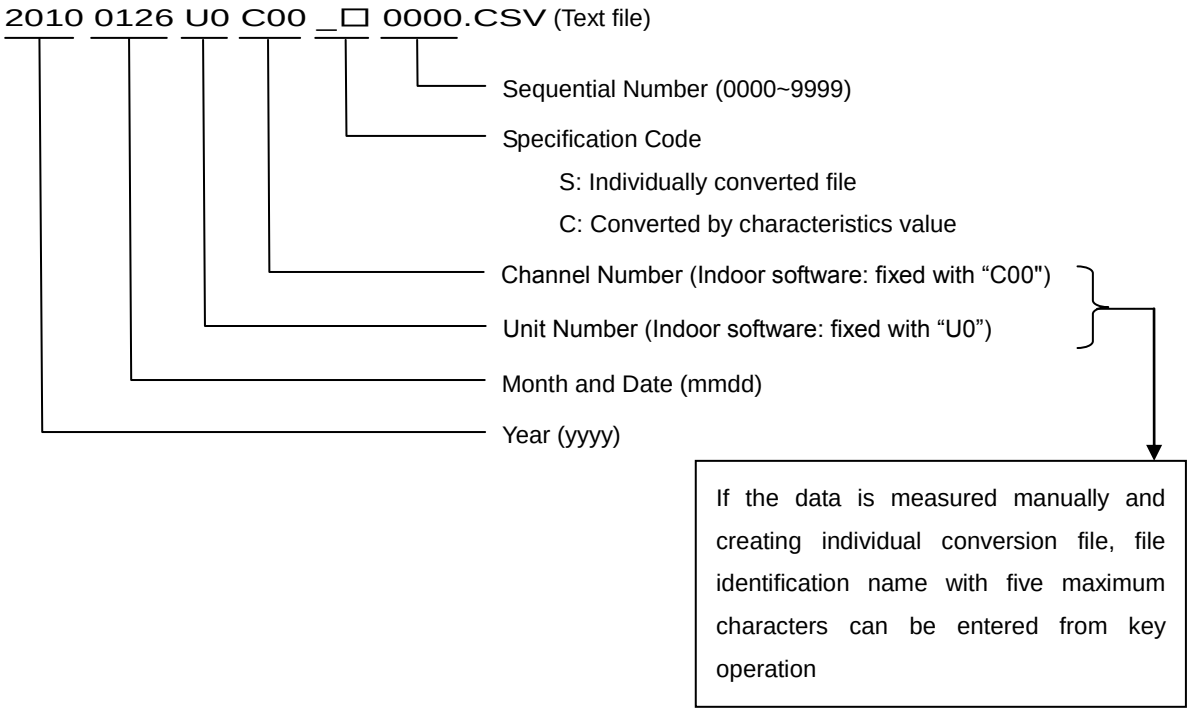
5. Saving Data Format

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

- Naming for binary file is as follow:



- Naming for text file is as follow:



(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 = 2.1.0.0
File name = C:\Users\Eko-Qt\Desktop\New folder\U1C0120150330120002_S.CSV
Date = 2015/03/30
Start - Stop time= 04:00:00-20:00:00
Measurement Mode = Auto
Installation Site =EKO
PV Device Name = InGaP
Type of PV Device =
Current Temperature Coefficient(Alpha) = 0.00000[A/deg.C]
Voltage Temperature Coefficient(Beta) = 0.00000[V/deg.C]
Curve Correction Factor(Kappa) = 0.00000[ohm/deg.C]
Series Resistance(Rs) = 0.00000[ohm]
Calibration Constant of Pyranometer = 7.040[mV/kW/m^2]
Active area = 0.00[cm^2]
Time = 12:00:02
Sweep time[sec] = 0.513365
Temp. T1 [deg.C] = 0.0
Temp. T2 [deg.C] = 0.0
Temp. T3 [deg.C] = 0.2
Use Temp ch.=T1
Solar Irradiance [mW/cm^2] = 103.771
Sweep direction = Isc -> Voc

At:	Total PV Device Area [cm^2]
Er :	Solar Irradiance [W/cm^2]
T1:	TEMP1 Measurement Temperature [°C]
T2:	TEMP2 Measurement Temperature [°C]
T3:	TEMP3 Measurement Temperature [°C]
Voc:	Open Circuit Voltage [V]
Isc:	Short Circuit Current [A]
Pm:	Maximum Power [W]
Vpm:	Max. Power Moving Voltage [V]
Ipm:	Max. Power Moving Current [A]

FF:	Fill Factor
η:	PV Cell Conversion Efficiency [%]
Voc (stc):	Std. Condition Open Circuit Voltage [mV]
Isc (stc):	Std. Condition Short Circuit Current [mA/cm^2]
Pm (stc):	Std. Condition Max. Power Output [mW]
Vpm (stc):	Std. Condition Max. Power Voltage [mV]
Ipm (stc):	Std. Condition Max. Power Current [mA]
η(stc):	Std. Condition Conversion Efficiency [%]
Rs:	Series Resistance [Ω]
Rsh:	Parallel Resistance [Ω]

Voc	Isc	Pm	Vpm	Ipm	Eta	F.F.	Voc(stc)	Isc(stc)	Pm(stc)	Vpm(stc)	Ipm(stc)	Eta(stc)	Rs	Rsh
[V]	[A]	[W]	[V]	[A]	[%]		[V]	[A]	[W]	[V]	[A]	[%]	[ohm]	[ohm]
1.371447	0.031474	0.030837	1.200603	0.025685	0	0.714408	1.369003	0.03033	0.029466	1.198019	0.024595	0	0	558.3416

	Voltage V [	Current I [A	Light Intens	STC Voltag	STC Current Istc [A]
	-0.20585	0.031874	0	-0.20585	0.03073
	-0.19315	0.031834	0	-0.19315	0.03069
	-0.17926	0.031808	0	-0.17926	0.030664
	-0.16528	0.031794	0	-0.16528	0.03065
	-0.15133	0.031773	0	-0.15133	0.030629
	-0.13737	0.031724	0	-0.13737	0.03058
	-0.1241	0.031699	0	-0.1241	0.030555
	-0.11012	0.031685	0	-0.11012	0.030542
	-0.09624	0.031682	0	-0.09624	0.030538

→ Maximum 4096 points

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

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

At:	Total PV Device Area [cm^2]	FF:	Fill Factor
Er :	Solar Irradiance [W/cm^2]	η:	PV Cell Conversion Efficiency [%]
T1:	TEMP1 Measurement Temperature [°C]	Voc (stc):	Std. Condition Open Circuit Voltage [mV]
T2:	TEMP2 Measurement Temperature [°C]	Isc (stc):	Std. Condition Short Circuit Current [mA/cm^2]
T3:	TEMP3 Measurement Temperature [°C]	Pm (stc):	Std. Condition Max. Power Output [mW]
Voc:	Open Circuit Voltage [V]	Vpm (stc):	Std. Condition Max. Power Voltage [mV]
Isc:	Short Circuit Current [A]	Ipm (stc):	Std. Condition Max. Power Current [mA]
Pm:	Maximum Power [W]	η(stc):	Std. Condition Conversion Efficiency [%]
Vpm:	Max. Power Moving Voltage [V]	Rs:	Series Resistance [Ω]
Ipm:	Max. Power Moving Current [A]	Rsh:	Parallel Resistance [Ω]

Type of tracer = MP-180
Softw are V ersion = 2.1.0.0
File name = C:\Users\Eko-Qt\Desktop\New folder\U0C0020130417_C.CSV
Date = 2013/04/17
Start - Stop time= 00:00:00-23:59:00
Measurement Mode = Manual
Installation Site =EKO B1
PV Device Name = Kyosera0000
Type of PV Device = pSi
Current Temperature Coefficient(Alpha) = 0.00200[A/deg.C]
Voltage Temperature Coefficient(Beta) = -0.00500[V/deg.C]
Curv e Correction Factor(Kappa) = 0.00000[ohm/deg.C]
Series Resistance(Rs) = 0.00500[ohm]
Calibration Constant of Pyranometer = 7.250[mV/kW/m^2]

Time	Name of PV Device	Total PV Device Area	Sweep Direction	Sweep Time	Irradiance Er	Ref	Use sensor ?	T1	T2	T3	Use ch. ?	Voc	Isc	Pm	Vpm	Ipm	Eta	F.F.	Voc(stc)	Isc(stc)	Pm(stc)	Vpm(stc)	Ipm(stc)	Eta(stc)	Rs	Rsh
		[cm^2]		[sec]	[mW/cm^2]			[deg.C]	[deg.C]	[deg.C]		[V]	[A]	[W]	[V]	[A]	[%]		[V]	[A]	[W]	[V]	[A]	[%]	[ohm]	[ohm]
15:14:18	Kyosera0003	2250000	Isc -> Voc	0.0005	99.8340011	0	Fixed value	25.8	0	0	T1	0.608996	7.757285	3.643602	0.510284	7.140342	0.000162	0.77127	0.558927	0.775866	0.289425	0.447517	0.447315	0.000129	0.005	95.834778
15:14:47	Kyosera0004	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.8	0	0	T1	0.609238	7.745548	3.647037	0.509897	7.1525	0.000162	0.772861	0.559366	0.779452	0.292593	0.449416	0.449234	0.00013	0.005	31.904908
15:15:13	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.608911	7.749823	3.648812	0.510573	7.146499	0.000162	0.773225	0.558915	0.775793	0.297776	0.45222	0.452047	0.000132	0.005	91.33
15:15:21	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.8	0	0	T1	0.609177	7.753586	3.644237	0.50782	7.176243	0.000162	0.771544	0.558619	0.773915	0.294789	0.43674	0.436575	0.000131	0.005	0
15:15:29	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.609296	7.749624	3.649849	0.509775	7.159729	0.000162	0.772976	0.559283	0.774478	0.293288	0.448983	0.448803	0.00013	0.005	3.850828
15:15:37	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.609349	7.747614	3.650573	0.507129	7.198509	0.000163	0.773262	0.559481	0.776165	0.295491	0.451115	0.450921	0.000131	0.005	0
15:15:44	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.8	0	0	T1	0.609037	7.744733	3.651135	0.512245	7.127713	0.000163	0.774086	0.560376	0.779499	0.29653	0.471222	0.470974	0.000132	0.005	0
15:15:52	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.609328	7.759643	3.652096	0.509277	7.171133	0.000163	0.772412	0.559438	0.774846	0.290981	0.44675	0.446526	0.000129	0.005	42.590027
15:16:00	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.608963	7.755386	3.648154	0.505725	7.213705	0.000162	0.772485	0.559185	0.776544	0.288506	0.447924	0.447697	0.000128	0.005	10.197828
15:16:08	Kyosera0005	2250000	Isc -> Voc	0.0001	99.8340011	0	Fixed value	25.7	0	0	T1	0.6093	7.751226	3.656296	0.512792	7.130173	0.000163	0.774176	0.559972	0.776021	0.293771	0.454099	0.453869	0.000131	0.005	0

(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 power moving current Ipm, maximum power 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

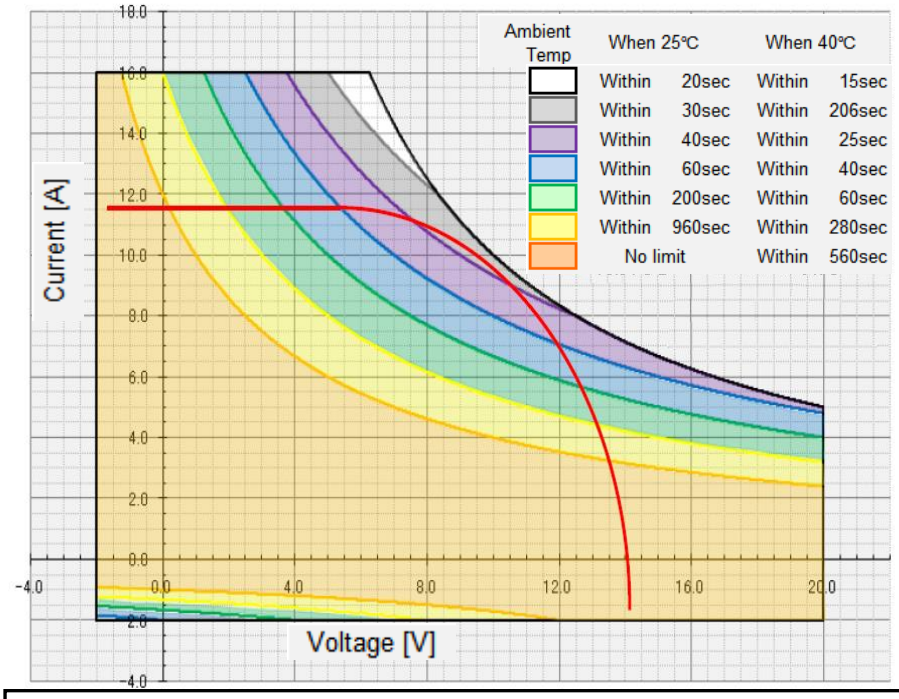
Items	Details	
Measureable Range	 Measurable Range and Measurement Time Limit Range when Setup at 20A Range ※ When measuring I-V, setup the sweeping time within the rating of the PV cell and the measurement time limit indicated above. ※ When logging, setup the stat-end time within the PV cell rating 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, Negative Trigger Measurements can be started by external signal; The delayed time from the trigger input to measurement start is also possible.

Table 8-1. Specification - Continued

Items	Details	
Digital Output	Shutter Control Output	Shutter Control for Solar Simulator 1) 2-Wire-type: Photo-Coupler output (Maximum 150mA) Short circuit: OPEN, Open: CLOSE 2) 4-Wire-type: Photo-Coupler output (Maximum 150mA) OPEN signal pulse (more than 50ms) CLOSE signal pulse (more than 50ms)
	Switching Unit control	Control for Each Switching Unit 1) PV Module Switching Unit (MI-510, MI-520, MI-520S) 2) Pyranometer Switching Unit (MI-530) 3) Thermocouple Switching Unit (MI-540)
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	2.1.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
Software Functions	・Single, continuous, and automatic measurement from the software. ・Automatic CSV file saving function ・Multi-channel measurement by PV Module Switching Unit ・Multi-channel measurement by Thermocouple Switching Unit ・Multi-channel measurement by Pyranometer Switching Unit ・Round-trip sweep functions: Isc->Voc、Voc->Isc ・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 ・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. Option Items List

Table 8-3. Option Item List

Items	Remarks
PV Module Switching Units	MI-510 (6 channels, 7A) MI-520S (6 channels, 20A) MI-520 (12 channels, 7A)
Pyranometer Switching Unit	MI-530
Thermocouple Switching Unit	MI-540
Silicon Sensor	ML-01
Light Intensity Correction Sensor	MP-180S
PV Cable	1.5m 2sq 4-conductor shield (with 2 alligator clips)
	1.5m 2sq 4- conductor shield (pig tailed)
	1.5m 2sq 4- conductor shield (Y-terminal)
Switching Unit Control Cable	70cm Flat cable, Centronics Connector 24pin – 14pin
LAN Cable	Uses Twist Pair & Shield Cable Cross/Straight, specified length
Pt100 Sensor	2m Metal Sheath type, specified diameter & length
	2m Film
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)
Transducer for Thermocouple	0~100℃ → 0~10V, Power Supply: AC100~240V, thermocouple type specified.
Thermocouple	2m T-type thermocouple

8-4. Switching Units Specifications

Table 8-4. MI-510/MI-510S/520/530/540, MP-303 Specifications

Items	MI-510	MI-510S	MI-520	MI-530	MI-540
Channel Qty.	6	6	12	5	12
Input Switching	PV Cell	PV Cell	PV Cell	Pyranometer	T-type Thermocouple (Copper – Constantan)
Number of devices to be connected to MP-180	1	1 ~ 2	1	1	1
Switching Capacity	DC20V, 7A	DC20V, 20A	DC20V, 7A	DC30V, 1A	---
Control Input	TTL				
Power Supply	AC100 ~ 240V, 50/60Hz				
Fuse	1A, 250V (φ5 x 20mm)				
Power Consumption	30VA				
Operation Conditions	Temperature: 0 to 40℃,				
Outer Dimensions	370 (w) x 133 (h) x 350 (d) mm	450 (w) x 155 (h) x 450 (d) mm	370 (w) x 133 (h) x 350 (d) mm	370 (w) x 99 (h) x 350 (d) mm	370 (w) x 133 (h) x 350 (d) mm
Weights	5kg	12.3kg	5kg	4kg	5kg

8-5. Cable Specification

Table 8-5. 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)

Table 8-6. MI-510/520 Cable Specification

Cables	Details
AC Cable	Cable Length: 2.5m VCTF, 0.75sq x 3, Rating: 125V-7A
PV Cable	MVVS, 2sq x 4pin Shield Cable, Y-terminal (1.25Y-4)
Junction Cable	Cable Length: Approx. 70cm MVVS, 2sq x 4pin Shield Cable, Y-terminal on both ends (1.25Y-4)
Switching Unit Control Cable	Flat Cable: 70cm Centronics Connector 24pin - 14pin

Table 8-7. MI-530/540 Cable Specification

Cables		Details
AC Cable	Cable Length: 2.5m VCTF, 0.75sq x 3, Rating: 125V-7A	
PV Cable Junction Cable	MI-530:	SKVV, 0.5sq x 2pin Shield Cable, Y-terminal (1.25Y-4)
	MI-540:	T-type Thermocouple, Y-terminal (1.25Y-4)
Switching Unit Control Cable AC Cable	MI-530:	SKVV, 0.5sq x 2pin Shield Cable, Y-terminal (1.25Y-4)
	MI-540:	T1: SKVV, 0.5sq x 2pin Shield Cable, Y-terminal (1.25Y-4) T2: T-type Thermocouple or T-type Compensating Lead Wire, Y-terminal (1.25Y-4)
PV Cable	Flat Cable: 70cm Centronics Connector 14pin - 14pin	

8-6. Dimensions

1. MP-180

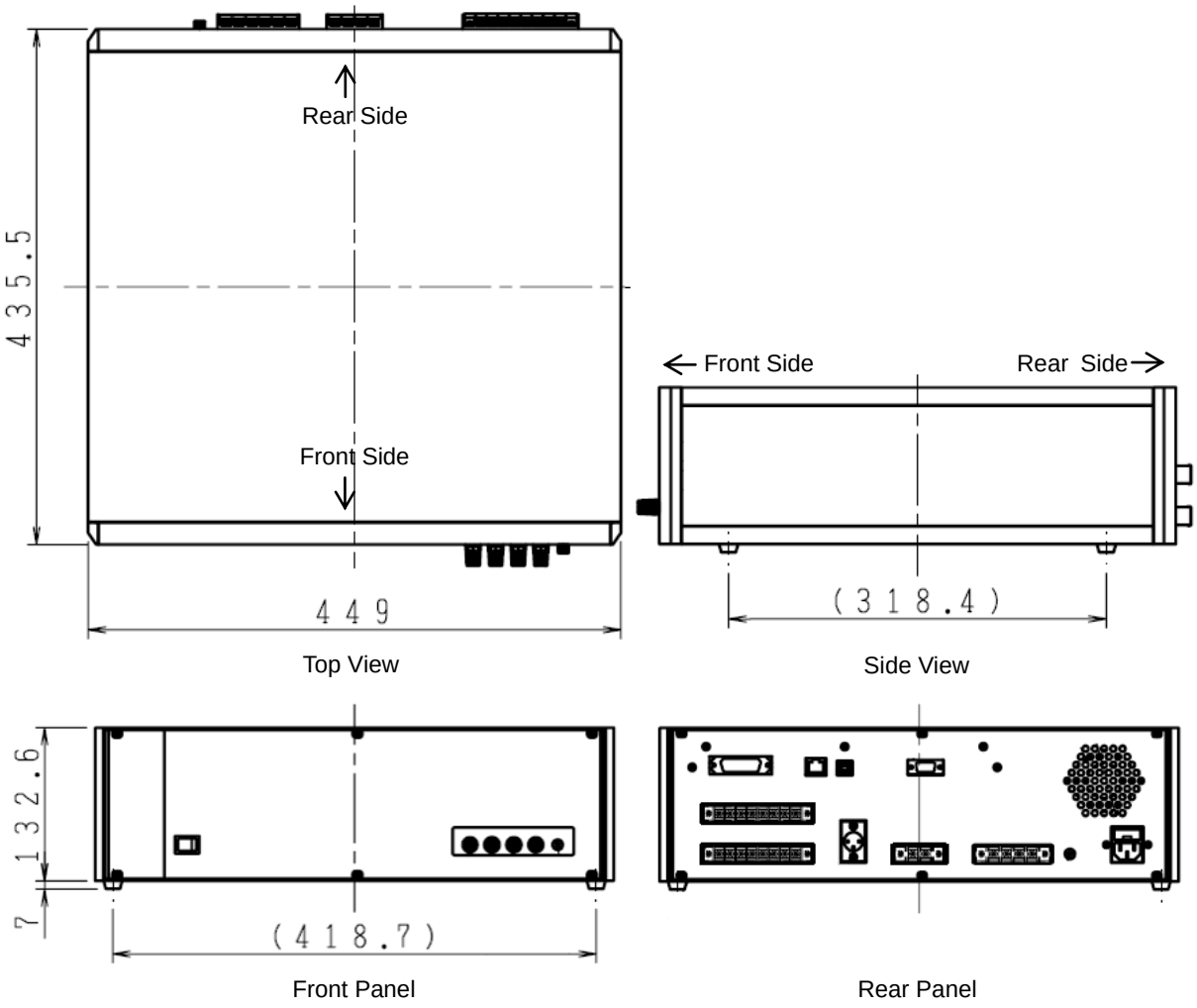


Figure 8-1 Dimension and Each Name and Parts

2. Switching Units Dimensions

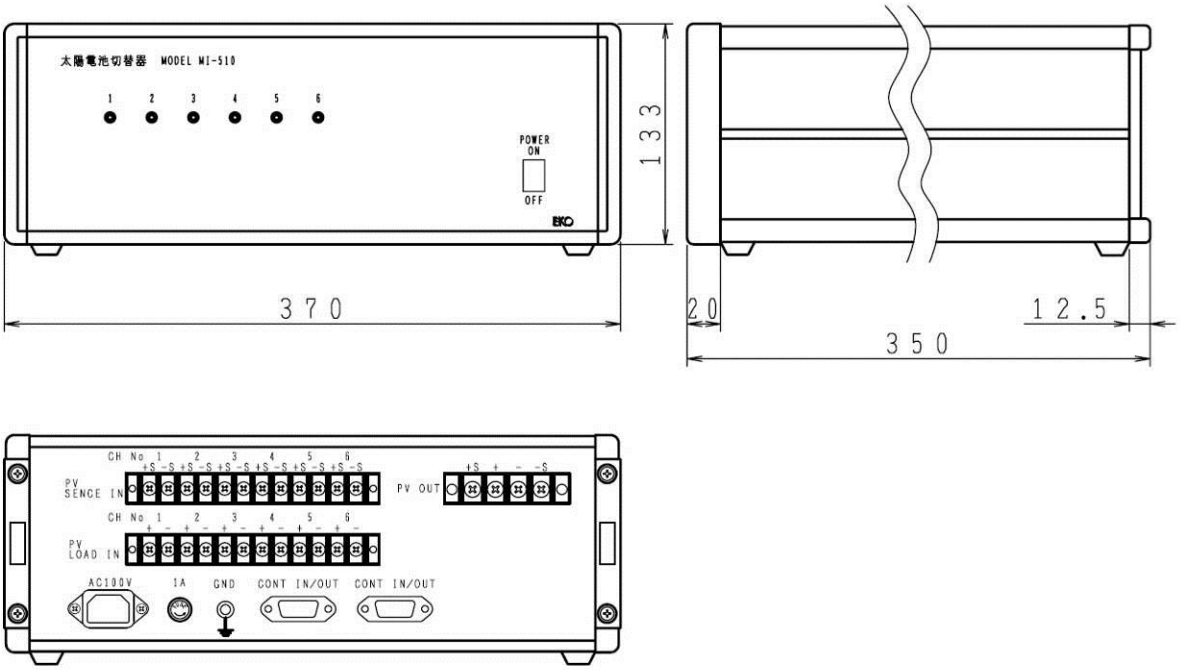


Figure 8-2. MI-510 Dimension

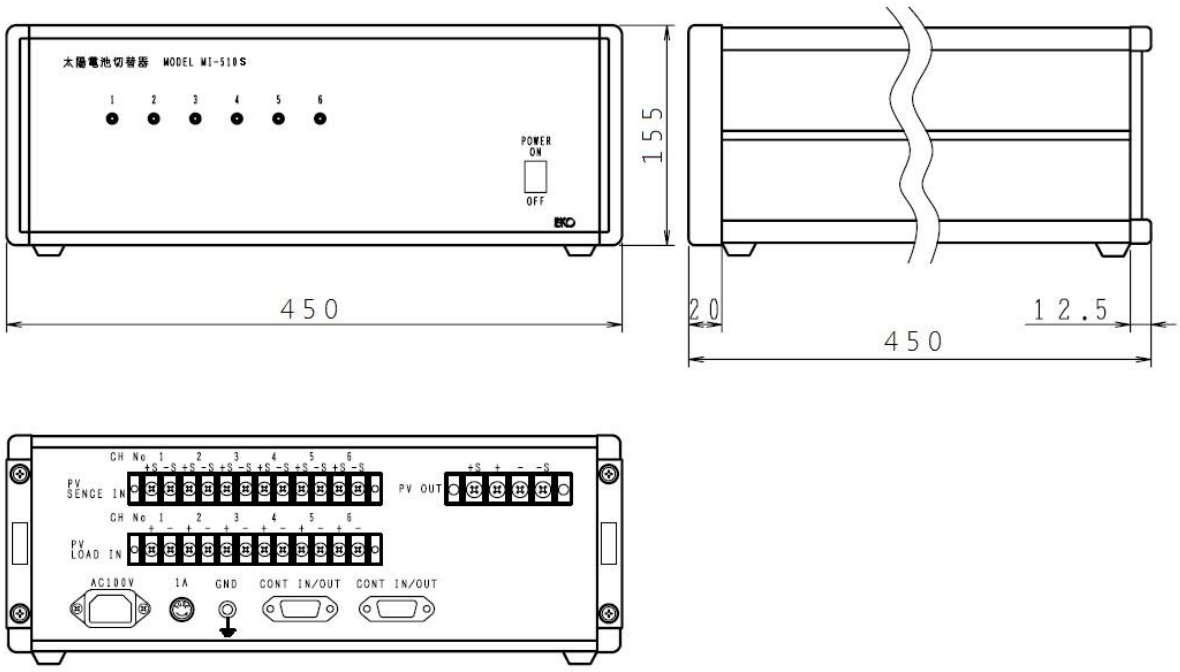


Figure 8-3. MI-510S Dimension

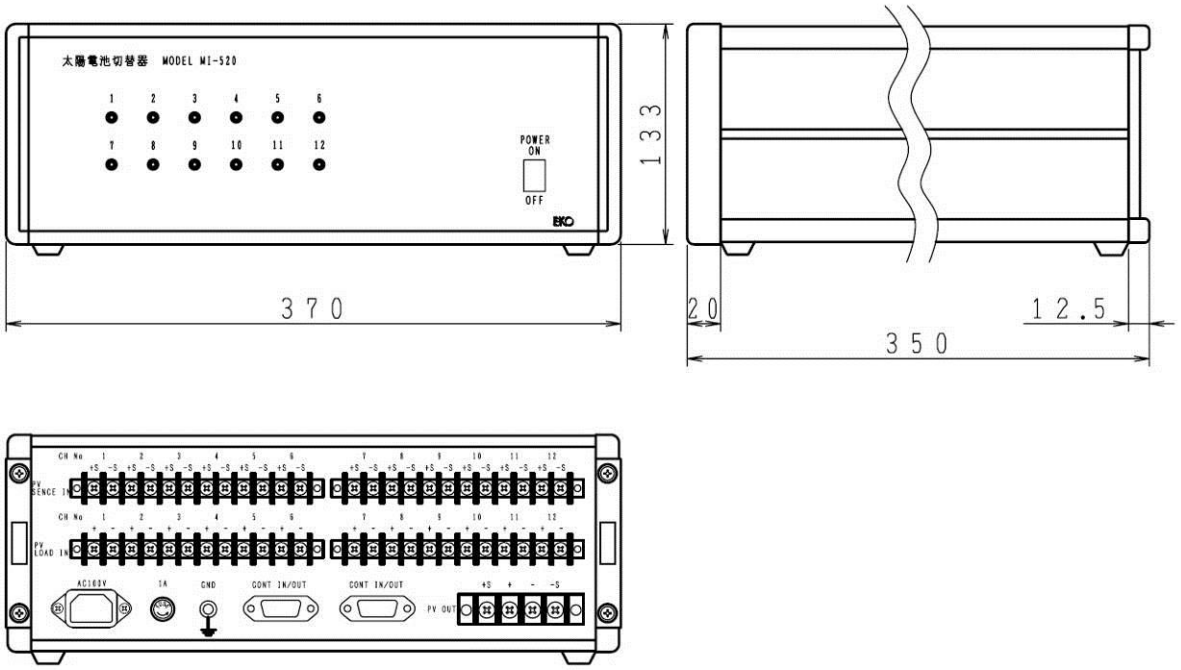


Figure 8-4. MI-520 Dimension

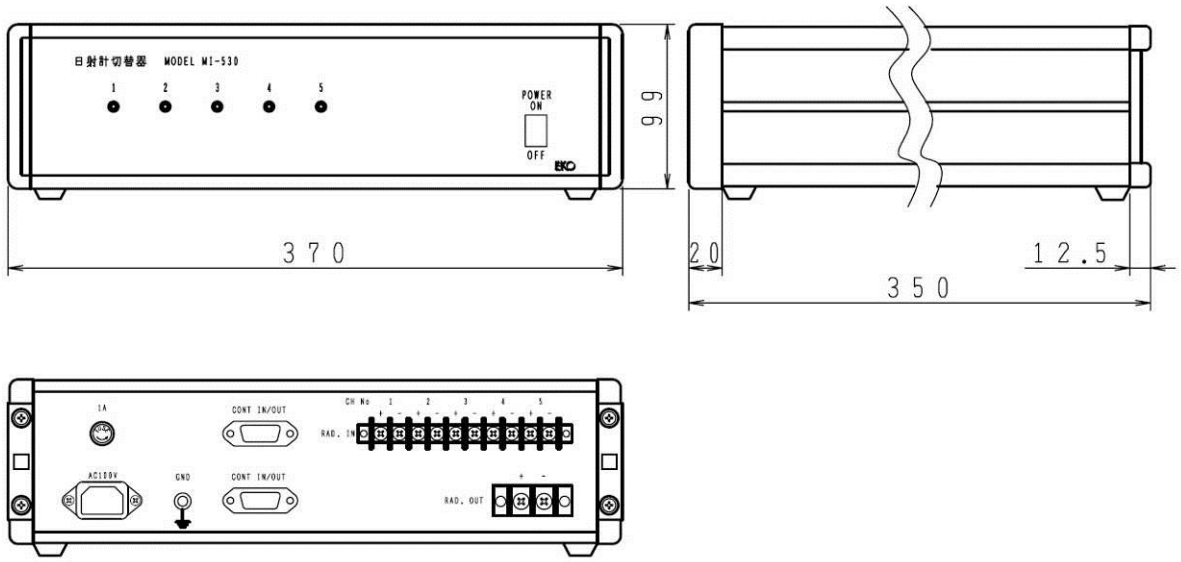


Figure 8-5. MI-530 Dimension

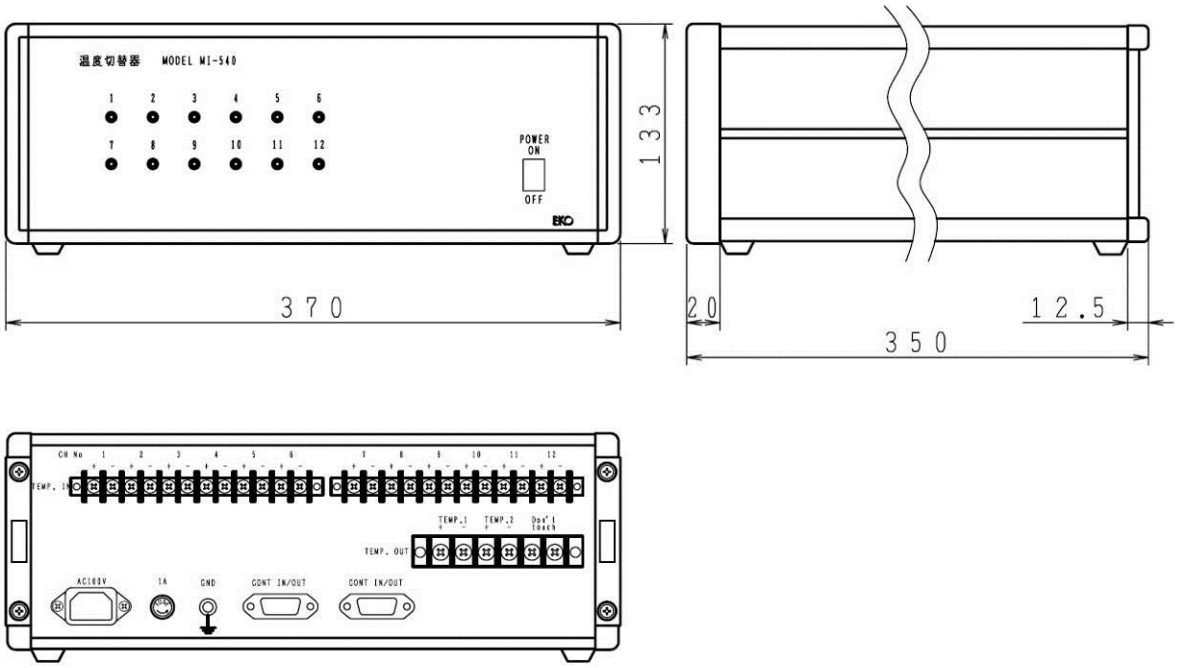


Figure 8-6. MI-540 Dimension

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