

INSTRUCTION MANUAL

I-V Curve Checker

MP-11



EKO

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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

EKO INSTRUMENTS CO., LTD.

Asia, Oceania Region

www.eko-instruments.com	EKO INSTRUMENTS Co., Ltd.	Tel: +81 (3) 3469-6711
info@eko-instruments.com	1-21-8 Hatagaya, Shibuya-ku	Fax: +81 (3) 3469-6719
	Tokyo, 151-0072 Japan	

Europe, Middle East, Africa, South America Region

www.eko-instruments.com	EKO INSTRUMENTS Europe B.V.	Tel: +31 (0)70 3050117
sales-eu@eko-instruments.com	Lulofsstraat 55, Unit 28,	
	2521 AL, Den Haag, The Netherlands	

North America Region

www.eko-instruments.com	EKO INSTRUMENTS USA Inc.	Tel: +1 408-977-7751
sales-usa@eko-instruments.com	111 North Market Street, Suite 300	Fax: +1 408-977-7741
	San Jose, CA 95113 USA	

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 the instruction manual.

2-3. About Instruction Manual

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This manual was issued: 2024/4/15

Version Number: 12

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



IMPORTANT USER INFORMATION



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 Checker
Model No.: MP-11

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

Harmonized standards:

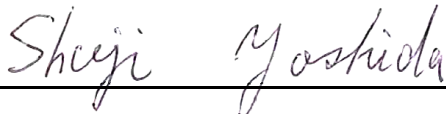
EN 61326-1:2006 Class A (Emission)
EN 61326-1:2006 (Immunity)
EN 61000-4-2 EN 61000-4-3
EN 61000-4-4 EN 61000-4-5
EN 61000-4-6 EN 61000-4-8
EN 61000-4-11

Following the provisions of the directive:
EMC-directive : 2004/108/EC
Low Voltage Directive : 2006/95/EC

Date: May 28, 2014

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

Name of Authorized Signatory: Shuji Yoshida

Signature of Authorized Signatory: 

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.



WARNING CAUTION

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



HIGH VOLTAGE WARNING

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. Handling

- DO NOT use MP-11 for other than its original purpose.
- DO NOT disassemble, modify or touch inside of MP-11.
- Check the main supply voltage corresponding to the voltage requirements of the MP-11 power adapter.
- Use ONLY the AC/DC adapter, which is assigned to the MP-11. Using other types of power adapters will cause potential risk for damage. EKO will NOT take responsibilities in case of damage or accidents occurrence with use of cables other than attached to MP-11. Data taken with other cables will NOT be assured.
- Make sure that the connection terminals and cables used for connecting PV modules/strings/arrays satisfy their rating capacity
- Connect probes securely so that they will not easily come off from the terminals.
- DO NOT connect to PV strings/arrays, which exceed the rated maximum voltage 1000V, current 30A, and power 18kW.
- To avoid the risk of damage, switch ON the MP-11 power first, before connecting the PV module/array to be measured, and disconnect the PV module/array before turning OFF the MP-11.
- Disconnect power conditioner or inverter, before connecting MP-11 to PV module/string/array.
- Switch ON MP-11 before connecting to PV module/string/array
- Disconnect PV module/string/array before Switch Off MP-11
- If you notice any smoke or odor from MP-11, turn OFF the power immediately.

2. Operating Environment

- DO NOT expose the MP-11 to strong mechanical vibrations and/or impact, high humidity and water, dust, extreme temperature differences, and near objects that generate strong magnetic and/or electric fields to prevent possible damage to the MP-11 or potential risk to the operator.
- When using MP-11 at the outdoor field, make sure to connect the grounding wire to the grounding terminal.
- MP-11 can't be used in rainy weather. DO NOT use when it may rain.
- Do not expose the main unit to excessive heat sources (long term exposure to sun light), as the electronics might become overheated and will switch off.



3-2. HIGH VOLTAGE WARNING

1. Power Supply

- When using MP-11 on outdoor field, always use/wear isolating safety items (conductive rubber gloves, boots, etc.) for protection from electric shocks during operation.
- Be aware of any potential risks for electric shock. When connecting electric cables to and disconnecting from the PV module/array, wear high-voltage rubber insulating gloves and boots as hazardous voltages may cause electric shock.
- When connecting to and disconnecting from the PV module/array, always check for any risks for electric shock by testing the connecting area with tester, etc. before connecting or disconnecting.
- Do not touch the terminal block and power source plugs with wet hands. This may cause electric shocks and/or electric leakages.
- For safety reasons the PV power system and MP-11 should be operated by authorized electric engineers only.
- Disconnect power conditioner or inverter before measurements.
- Always switch On MP-11 before connecting to PV module/ string/array
- Securely connect probes to PV module/string/array before measurements.
- Always disconnect PV module/string/array before switching Off MP-11.

4. Introduction

The robust portable battery operated MP-11 I-V Checker enables the operator to perform accurate I-V performance measurements and inspection of PV modules or arrays on site. For direct control of the measurement functions and analyzing measurement results, the Main Unit has a key-pad and Graphical LCD display. The MP-11 offers an all in one measurement solution to make PV module testing very easy, hence all required accessories like the radiation sensor, temperature sensors, cables and PC software for control and extended data analysis are included.

The MP-11 I-V Checker is capable to measure I-V curves based on the parameters (V_{pm} , I_{pm} , P_{max} , V_{oc} , I_{sc} , FF , T_{mod} , η_{eff}) of any PV module types and arrays, also called strings. It is highly suitable during PV module installation, for making routine checks for inspection of energy yield, tracing module performance and potential defects and general maintenance checks. The MP-11 can be used for almost any Module type as long as the output fits in the range (10 – 1000V / 100mA - 30A / 10W - 18 kW).

*) See Applicable PV module/Array in 11. Specification

The MP-11 measuring principle is based on the capacitive electronic load method, which makes it a compact measurement device with a wide measuring range (Voltage, Current and Power). With traditional I-V curve tracers, sensors had to be at the place where the PV module is situated, which consequently requires long cables between the PV module and I-V curve tracer. By using the remote Sensor unit installed near the PV module accurate measurements can be performed and data can be stored on board. The MP-11 is unique due to the integrated removable Sensor Unit. The Sensor Unit contains an integrated high precision pyranometer, which is based on a Si Photodiode and data logger to store the measured data of the internal or external sensor and 2 temperature sensors. It is used to measure the solar irradiance in simultaneously with the PV module, PV module back surface temperature and ambient temperature. The input terminals for external sensors are available on the Sensor Unit to connect any EKO pyranometer type, such as MS-802 (ISO Secondary standard), MS-402/MS-410 (ISO First Class), MS-602 (ISO Second Class), ML-01 (Silicon type) or reference cell as sometimes required by directive or spectral match with the modules installed. With the built in data logger, the measurement data can be recorded for maximum of one day. After the test, the data can be easily transferred from the Sensor Unit to the Main Unit by connecting it through the sensor unit cable.

The Main Unit is capable of measuring, displaying and analyzing data, all functions that can be accessed through the front panel keypad. Up to 300 I-V curves can be stored on board, which is mostly sufficient for one day. On top of that extensive data analysis and data storage, data format conversion to a (.CSV) file format can be done using the PC with the MP-11 control software. The I-V curve measurement data displayed on the Main Unit are automatically converted into STC values, known as Standard Test Conditions (STC) values complying to the IEC 60891 and JIS C8914/8919/8940 Standard. This way measurement values converted to STC values can be better quantitatively compared when the data are obtained during different environmental or atmospheric conditions (Global radiation, Temperature) or inter compared between different types of modules.

For the ease of use, most common physical constants like Alpha, Beta, Kappa and R_s are pre-set and can be selected to make the STC conversion. For more specific module types those parameters and other module settings can be customized and stored as a personal file.

More specific information about the measurement system set up, operating the MP-11, PC software and technical specifications are written in the each chapter or section of this manual.

4-1. Main Functions

1. Portable

MP-11 housing was designed with “portable” all-in one concept in mind, emphasizing the user-friendliness and safety at the operation site. The instrument housing is made of electrically insulated resin for safety purposes. The portable single case I-V tracer offers a space to accommodate the Sensor Unit, cables, and connectors.

2. Measurements Up To Maximum of 18kW

MP-11 can measure the performance characteristics of PV strings and arrays up to 18kW. But also single low power modules can be measured accurately.

3. Sensor Unit

It is designed to provide maximum flexibility for any measurement situation. The Sensor Unit with built-in data logger can work independently from the Main Unit without cable connection; it can be setup and adjusted to the same tilted angle and direction as the subjected PV module. Since the Sensor Unit has a built-in data logger, it can be separated from the Main Unit regardless the distance between MP-11 main unit and best location to perform the radiation and module temperature measurements. The Solar irradiance can be measured either with the small pyranometer integrated with the Sensor Unit or through an external radiation sensor connected to the terminal blocks on the back-side. 2 temperature channels are available to measure the Modules backside temperature and ambient temperature with T-type Thermocouple



Figure 4-1.

Separate Main Unit & Sensor Unit

When used remotely, the time stamped irradiance and temperature data can be easily downloaded to the Main unit when connecting the sensor unit. When the Sensor Unit and the Main Unit are permanently connected, it is possible to display real time measurement.

4. STC Conversion Compliance to IEC 60891 Standard

MP-11 is capable to perform the STC conversion for crystalline PV modules complying to the IEC 60891 (and the JIS C8914/8919/8940) by using measured irradiance and module temperature. Therefore, if the module parameters (Alpha, Beta, Kappa, Rs, module size) for one PV module are set, it automatically calculates the operating performance as measured under standard test conditions (@ 1000 W/m² / 25°C) for the total array. (Note: MP-11 doesn't have spectrum conversion function to AM1.5.)

5. Auto Measurement

For extensive analysis of the module or sting performance, MP-11 has an auto measurement function to perform consecutive measurements during the day. The full data set can be displayed as,

- Solar irradiance vs. Maximum output power (Pm)
- Solar irradiance vs. Open Circuit Voltage (Voc)
- Solar irradiance vs. Short Circuit Current (Isc)

6. Quick Sweep Time Measurement

The Solar irradiance and the power consequently generated by the PV module can change within a fraction of a second. If the sweep time takes too long, the change in the solar irradiance will not be properly taken into account during the I-V measurement and final STC conversion. The change of solar irradiance has a large impact with respect to the I-V curve measured by the IV checker with longer sweep time. The MP-11 perfectly measures the PV module performance.

7. Characteristics Graph Display

LCD on the Main Unit is capable of displaying the following characteristics graphs. It is useful for diagnosing defects of PV devices.

- di/dV -V characteristics which is the I-V characteristics differentiated in first order
- Scalable I-V curve graph (x2, x4 to x8) for allowing to check even a slight distortion on the I-V curve

8. Measurement data

The Main Unit is capable of measuring, displaying, analyzing and storing measurement data; all functions that can be accessed through the front panel key pad. Up to 300 I-V curves can be stored on board, which is mostly sufficient for one day.

9. Easy report creation

Measurement report file in Excel format, which includes I-V curve result, can be easily created by PC software after downloading measured data from MP-11. The report format can be customized by the user.

10. Protection Features

When the internal temperature exceeds 55°C, the CPU stops until the temperature becomes less than 45°C so that measurements cannot be taken.

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

Standard Items	Qty.	Remarks	Item No. *)
MP-11 Main Unit	1	Main Unit contains the following items:	
Sensor Unit	1		
PV Probe & Alligator Clips	2	1.5m: Red (+), Black (-)	1
Earth Cable	1		2
Sensor unit Cable	1	3m; Main Unit – Sensor Unit Communication	3
USB Cable	1	2m; Main Unit – PC Communication	4
T-type Thermocouple	2	3m	5
Battery Receptacle Box	1	8pcs AA	6
Fixing Plate for Battery Receptacle Box	1		7
Accessory Carrying Pouch	1		8
AC Adapter **)	1	AC100-240; 12V, 1.0A	9
Ni-mH Battery Charger Set	2	Set of 4pcs AA size Low Self-Discharge Ni-mH rechargeable batteries (Panasonic eneloop) (Japan: Standard attached, other area: Optional)	10
006P 9V Battery	1	For sensor unit power supply (Japan only)	11
Shoulder Strap	1		12
Inspection Report	1		
Instruction Manual	1		
CD-ROM	1	Includes Instruction Manual, Measurement Software, Device Driver	

*) Item No. shows the number of each item in Figure 4-2.

**) For some overseas customers, due to import/export regulations, the AC adapter cannot be included.
In that case, please purchase and use an AC adapter with equivalent specifications in your country.

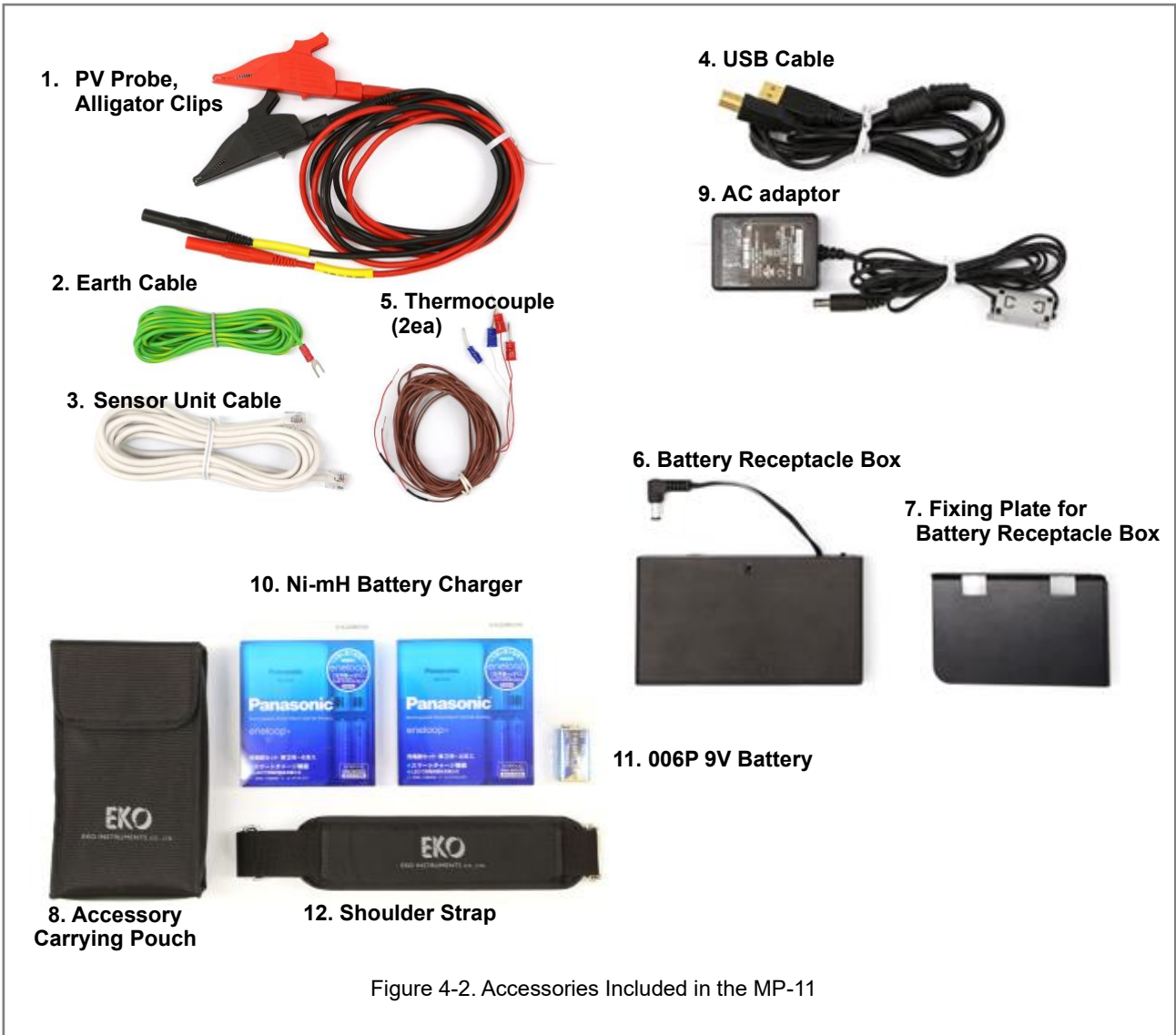


Figure 4-2. Accessories Included in the MP-11

5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main functions are described below.

1. Main Unit

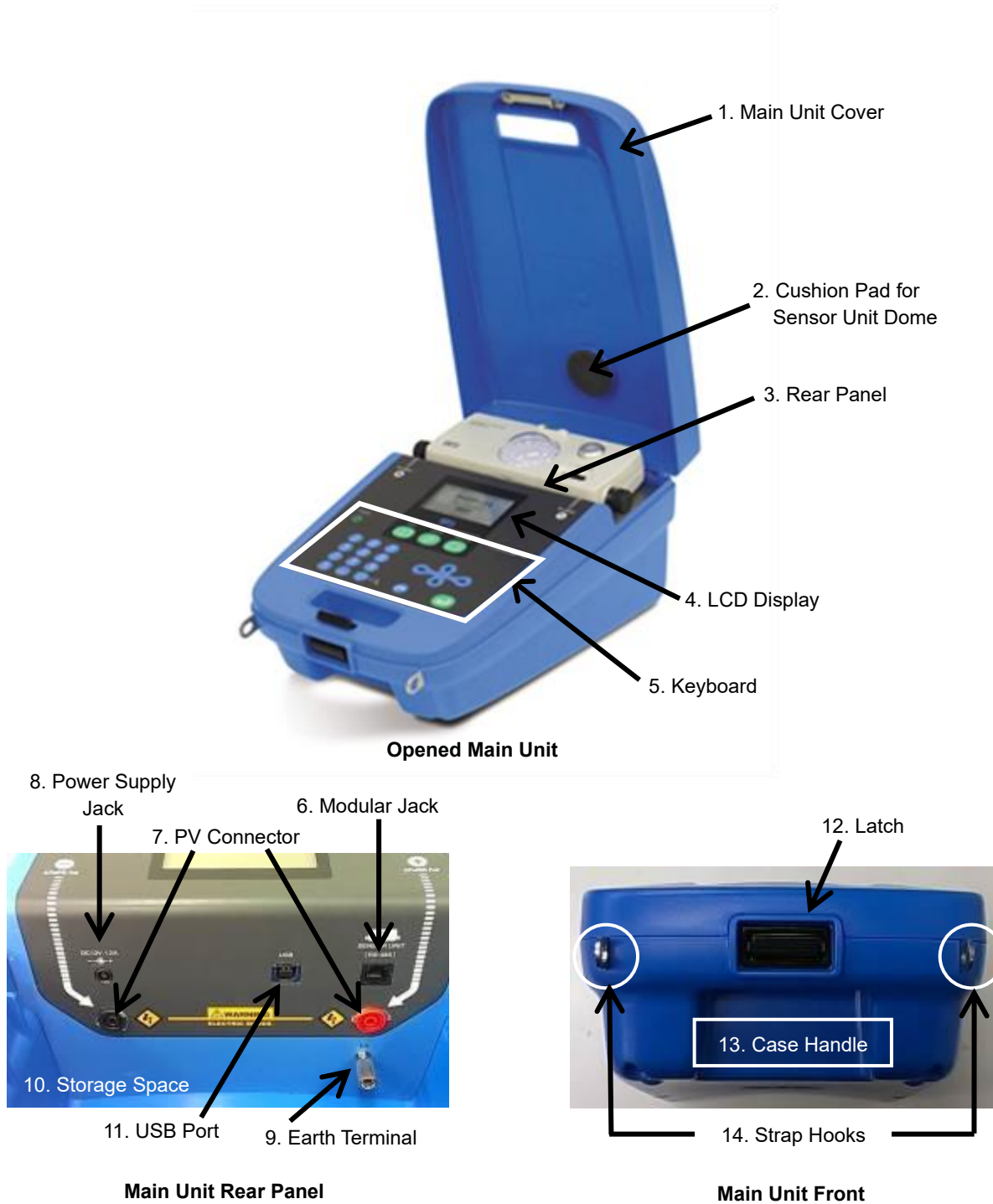


Figure 5-1. Main Unit Parts Name and Functions

Table 5-1. Parts Name and Function -- Main Unit

	Parts Name	Details
1	Main Unit Cover	All components, such as the sensor unit and the cables, can be stored inside the main unit. The cover can be removed with the lid open.
2	Cushion Pad for Sensor Unit Dome	Hold and protects the sensor unit dome inside the main unit.
3	Rear Panel	The connections for PV jacks (+/-), module jack, DC jack for the Battery Receptacle Box are on the rear panel.
4	LDC Display	Displays the operation menu and measurement results.
5	Key Board	Operations, such entering parameters and starting measurements, are done from this key board.
6	Modular Jacks	Used for the communication between the main unit and the sensor unit.
7	PV connector	There plus (+) and minus (-) jacks.
8	Power Supply Jack	Connect either AC adaptor or Battery Receptacle Box.
9	Earth Terminal	Connect ground for safety.
10	Storage Space	Sensor unit and the cables are stored in this space.
11	USB Port	Used for downloading/uploading the data to and from the PC.
12	Latch	Push this latch button to and lift the cover to open the Main unit cover.
13	Case Handle	Insert your fingers here for carrying the main unit.
14	Strap Hooks	Shoulder straps are attached to these hooks.

2. Sensor Unit

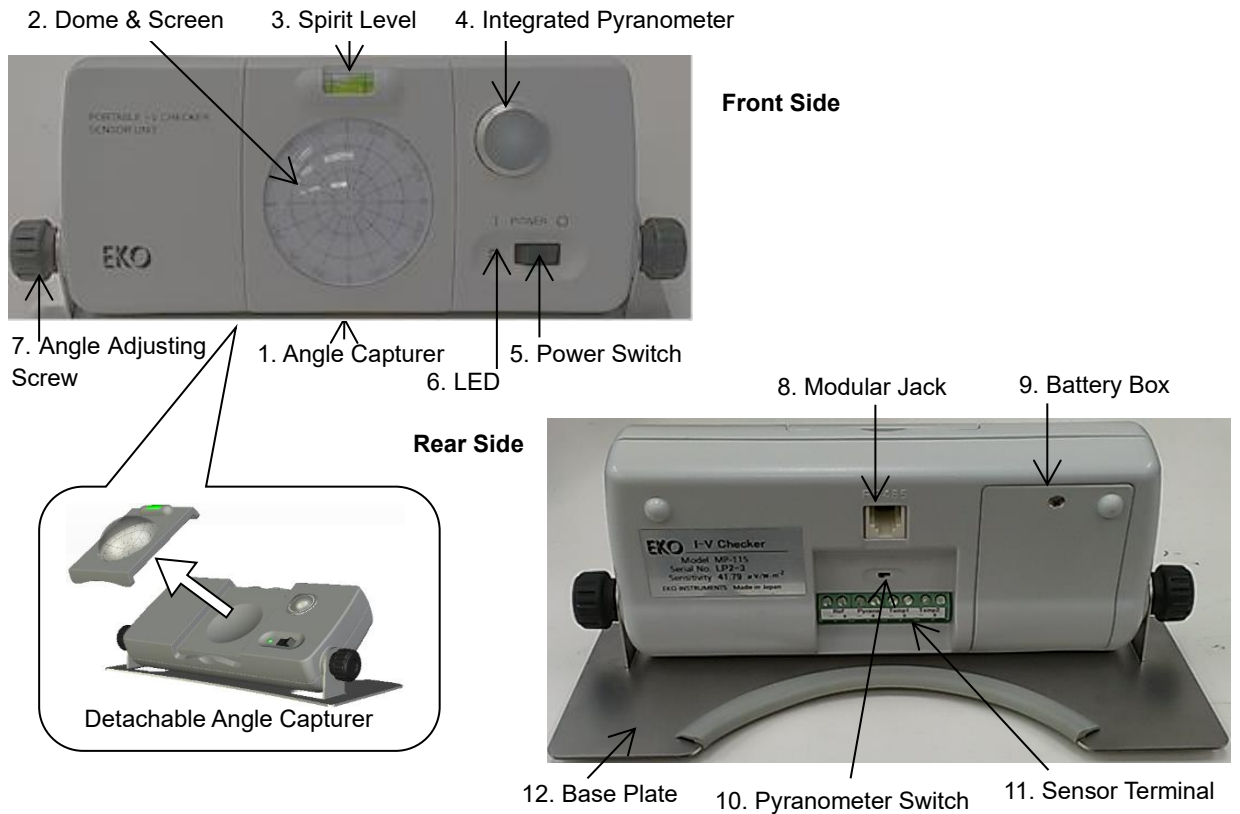


Figure 5-2. Sensor Unit Parts Name and Function

Table 5-2. Parts Name and Function – Sensor Unit

	Parts Name	Details
1	Angle Capturer	Detachable from the sensor unit by snap on. Using this part to setup the sensor unit in the same slope angle as the subjected PV panel for solar radiation measurements. See [5-3. Setting] for more details.
2	Dome & Screen	
3	Spirit Level	Used for level adjustment for the angle capturer and sensor unit.
4	Integrated Pyranometer	Measures solar irradiance.
5	Power Switch	Switch ON/OFF for the Sensor Unit
6	Power LED	When the power is turned on, the LED lamp light and blinks every 1sec. When the LED blinks fast, it indicates low battery condition.
7	Angle Adjustment Screws	Loosen this screw to make angle adjustment for the sensor unit. Tighten the screw once the angle position is determined.
8	Modular Jack	Used for the communication between the main unit and sensor unit.
9	Battery Box	For 006P
10	Pyranometers Switch	Select either integrated pyranometer on sensor unit or the external pyranometer. Integrated pyranometer → IN, external pyranometer → EXT
11	Sensor Terminal Block	Ref : Reference cell can be connected. Pyrano : An external pyranometer can be connected. Temp1 : A temperature sensor (thermopile 1) can be connected. Temp2 : A temperature sensor (thermopile 2) can be connected.
12	Base Plate	

3. Battery Receptacle Box



Figure 5-3. Battery Receptacle Box

The Battery Receptacle Box can be opened by sliding the front side panel in the direction as shown on the left for inserting and replacing batteries.

Replace the batteries with 8 AA size nickel-metal hydride (Ni-MH) batteries.

Turn ON the switch when the battery is used for operation.

⚠ Ni-H type batteries cannot be recharged with this unit; use the charger attached to this instrument.

✘ Do not use new batteries, old batteries and different types of batteries mixed together.

✘ Do not leave batteries inside the battery receptacle box when the MP-11 will not be used for a while.



Figure 5-4. Battery Receptacle Box in Storage Space

Battery receptacle box can be stored inside the Main Unit storage space.

Tilt the battery receptacle box to insert it inside the storage space then fix it with battery receptacle box fixing plate in place using screws.

5-2. System Configuration

EKO has achieved composing a product with wide range of PV module/array capacity from 10W to 18kW and high measurement accuracy. MP-11 is capable for taking measurements with maximum rating voltage of 1000V and maximum rating current of 30A in the maximum power range of 18kW.

The system configuration is shown as below:

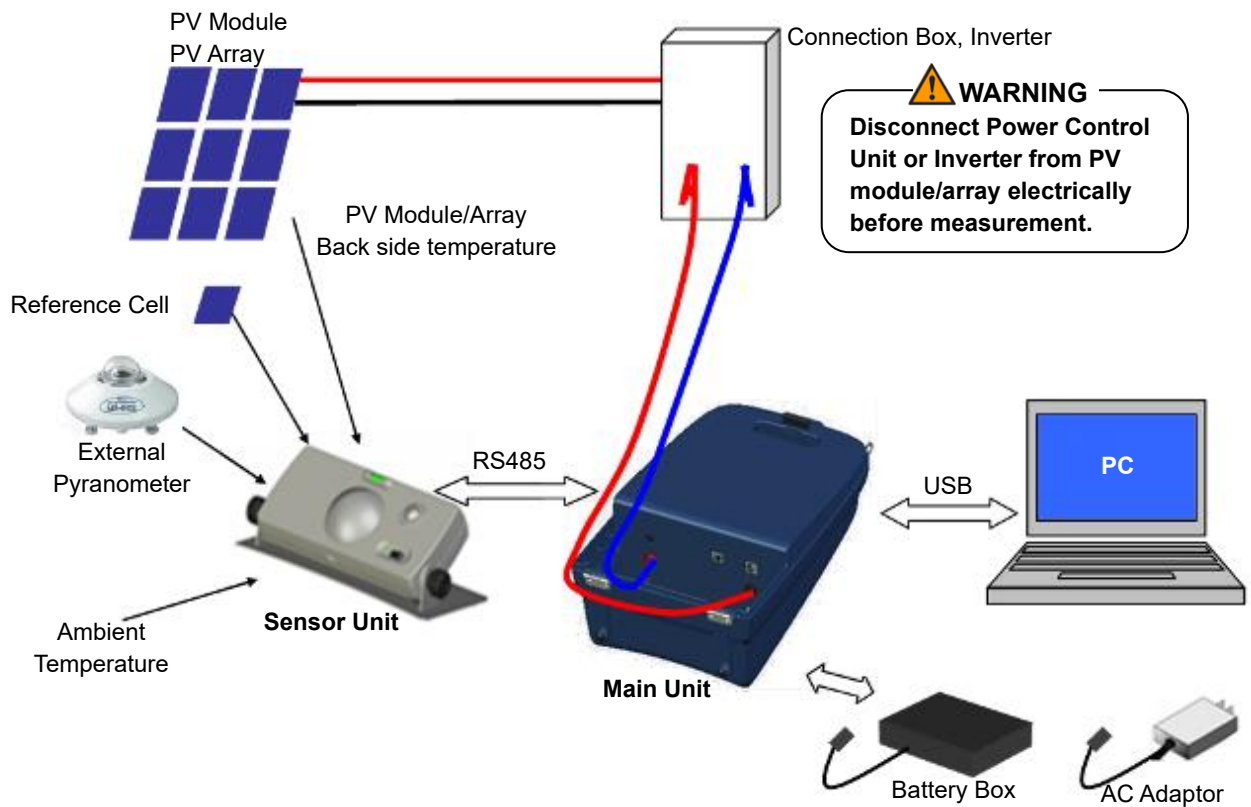


Figure 5-5. System Configuration

5-3. Setting



FOR INSTALLATION AND CONNECTION OF MP-11, ALWAYS FOLLOW BELOW INSTRUCTIONS:

- ※ To avoid hazardous electric shocks, wear protective wears (such as insulating rubber gloves and boots).
- ※ Do not connect to PV array which ratings are more than 30A, 1000V and 18kW ratings.
- ※ To avoid any trouble with the use of MP-11, always turn ON the MP-11 first then connect with PV module/array, and disconnect with PV module/array before turning OFF the MP-11.
- ※ Make sure to completely disconnect the PV module/array, which is subjected for measurement, from power conditioner before measurements.
- ※ Do not leave the MP-11 in direct sunlight for a long period of time. When the internal temperature exceeds more than 55°C, measurements cannot be taken. Once the internal temperature decreases below 45°C, MP-11 becomes operable by pressing the power button again.

1. Main Unit Connection

1) Power Connection

Connect either Battery Receptacle Box output plug or AC Adaptor to the Power Supply Connector on the rear panel.

2) PV Probe Connection

Plug in the Red PV Probe (+) on the PLUS terminal and Black PV Probe (-) on the MINUS terminal on the inside back face.

Connect the gator grips, on the end the PV Probes, to the PV module/array terminal block. Make sure the PLUS and MINUS when connecting them.



Figure 5-6. Rear Panel

3) Sensor Unit Connection

Connect the Main Unit and the Sensor Unit with modular cable.

4) PC Connection

To connect the MP-11 to PC, plug the USB cable connector in the USB terminal on the rear panel.

5) Earth Connection

For safety, make sure to connect the earth terminal to ground. Adjust one end of the earth cable as needed.

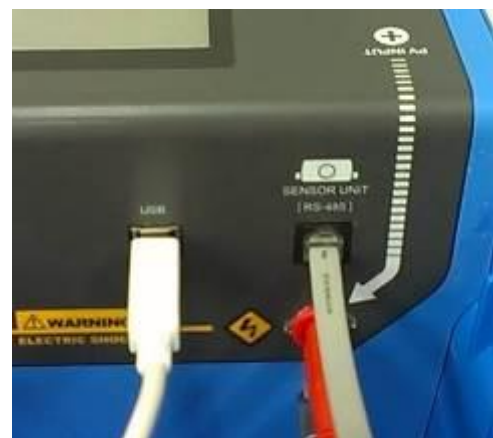


Figure 5-7. Rear Panel Connections

2. Sensor Unit Setup

- 1) Time Synchronization between the Sensor Unit and Main Unit
 - a. Turn on the Main Unit power
 - b. Adjust the Main Unit time as necessary
 - c. Connect the Main Unit and Sensor Unit with modular cable.
 - d. Turn on the Sensor Unit power. The LED lamp beside the power supply switch starts to blink.
The Sensor Unit time is synchronized with the Main Unit automatically.

※ **Once the time synchronization is completed, do not turn off the Sensor Unit power.**

If the Sensor Unit power is turned off, the internal clock setting will be cleared.

When error message appears, check for Sensor Unit power switch or modular cable connection; make sure the Sensor Unit is not turned to OFF.

For more details on error message, see [8-2. Starting MP-11] and [9-2. Error & Warning Messages]

- 2) Measurement With/Without Modular Cable

Select either to take measurement with or without the modular cable connection.

- Taking measurements without modular cable connection:

The data saved in the Sensor Unit need to be downloaded to the Main Unit after the measurements.

※ **When using MP-11 without modular cable, make sure to insert batteries in Sensor Unit.**

※ **When using Sensor Unit with batteries, LED lamp blinks every 1sec; when LED lamp starts to blink every 0.5sec, it means the battery is low. Please replace the batteries.**

※ **If the battery power is low, Sensor Unit may restart when modular cable is connected/disconnected or Main Power is powered ON/OFF. There is no effect to the data saving and data loading functions; however, the batteries need to be replaced.**

- Taking measurements with the modular cable connection:

The measurement data from the Sensor Unit can be monitored on the Main Unit in real time, and no need to be downloaded after the measurement.

- 3) Sensor Unit Setting using Angle Capturer

- a. Set the Pyranometer Switch on the back side of the Sensor Unit to "INT" (integrated small pyranometer).
- b. Remove the Angle Capturer from the Sensor Unit.
- c. Place the Angle Capturer on the subjected PV
- d. Panel surface then adjust the level using the integrated spirit level.
- e. Confirm the shades of marker positions, which are marked on the Angle Capturer dome, on the screen scale (see the image "a" on the right); keep the record of this position by writing down or taking a picture.
- f. Place Sensor Unit near the PV panel where it does not get shaded and set the Angle Capturer back on Sun Sensor Unit.
- g. Adjust the Sun Sensor direction and angles using the adjusting screws on the sides of the Sun Sensor unit, so that the shades of the dome markers are in the same position as in the earlier step (see image "b" on the right); once the position is determined,



Confirm & record the position of the shade.



Place Angle Capturer on the Sensor Unit and adjust the position so the shade mark is in the same position as recorded.
Figure 5-8. Sensor Unit Installation

tighten the side adjusting screws.

- h. Remove the Angle Capturer during the measurements so that radiation measurements would not be affected by dome reflections and shades.
- i. Finally, turn ON the Sensor Unit power and setup the parameter and take measurements according to the procedure described in the [8. MP-11 Operation].

4) Using External Pyranometer, Reference Cell, and Temperature Sensor

- a. Set the switch on the back of Sensor Unit to [EXT] side.
- b. Connect each cable for external pyranometer, reference cell, to their terminal block to the terminal block on the back of Sensor Unit.



INT ◀ PYR ▶ EXT
Switch to [EXT] for external sensors

Figure 5-9. Terminal block Setting

Table 5-3. Connecting the sensor unit terminal block

Terminal block		Connection sensor
Ref	-	Connect the reference cell.
	+	
Pyrano	-	Connect an external pyranometer.
	+	
Temp1	-	Connect the thermocouple 1 for the backside of the solar cell.
	+	
Temp2	-	Connect thermocouple 2 for outside air temperature measurement.
	+	

- c. At last, turn ON the Sensor Unit power. Follow [8-4. Setting Menu] to setup the parameter setting then take measurements.

- ※ Before taking measurements, make sure to enter the sensitivity value for the pyranometer or reference cell in the parameter setting step on the Main Unit. (See [8-4. Setting Menu] for parameter setting details.)
- ※ Do not place the Sensor Unit where high temperature radiation heat; the Sensor Unit may stop operation due to decrease in battery voltage by extreme temperature increase inside the unit.

6. MP-11 Applications

6-1. Case-by-Case Applications for MP-11

Categorizing MP-11 applications into the following cases, in the section introduces and explains each application example and their task flows in simple overview.

✧ Measurements without PC control

Case 1: Measurements with Unit Only

Case 2: Measurements with Main Unit, Sensor Unit, and Thermocouples

Case 3: Measurements with Main Unit, External Pyranometer, Thermocouples

Case 4: Downloading Measurement Data on Main Unit to PC

Case 5: Uploading Measurement Data on PC to Main Unit

✧ Measurements with PC control

Case 6: PC-controlled Measurements with Main Unit Only

Case 7: PC-controlled Measurements with Main Unit, Sensor Unit, and Thermocouples

Case 8: PC-controlled Measurements with Main Unit, External Pyranometer, and Thermocouples

Following information are provided in the each application case; use this section for reviewing the overall configuration of system and task flow, as well as for indexing the details for each measurement step.

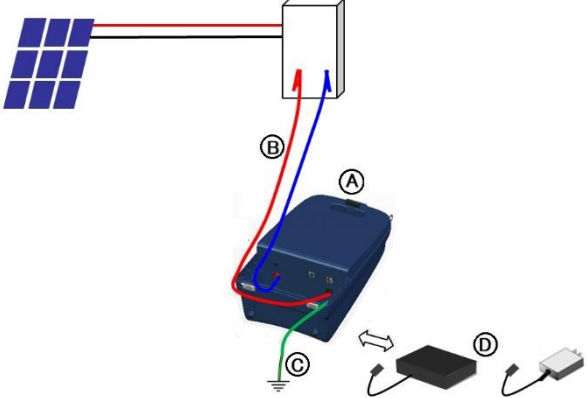
- Measurement Items
- Intended use purpose and features
- Measurement System (used devices and cable connection overview)
- Overall procedure
- Reference Sections for details of each step

Following steps are necessary steps to take prior to the measurements using MP-11. Neglecting to take these steps may lead to troubles such as unsuccessful measurements and measurement data with mismatched dates/time.

Procedure		Referenced Sections
1	Open the MP-11 package and check the contents.	4-2. Package Contents
2	Check the Sensor Unit battery status	5-3. Setting
3	Turn ON the MP-11 Main Unit power.	8-2. Starting MP-11
4	Check the MP-11 Main Unit battery status.	5-1. Parts Name and Descriptions 8-2. Starting MP-11 8-3. Main Menu & Monitoring Screen
5	Setup the date and time on MP-11 Main Unit.	8-4. Setting Menu8-
6	Turn OFF the MP-11 Main Unit power.	8-2. Starting MP-118-

CASE 1



Using only MP-11 Main Unit

Measurement Item	Measurement Condition	
<ul style="list-style-type: none"> I-V Characteristics 	<ul style="list-style-type: none"> Taking measurement of PV module/array on a high location. Not necessary to take irradiance, module/array back surface temperature, and ambient temperature measurements by using fixed values 	
Required Items	Configuration Image	
<ul style="list-style-type: none"> A. MP-11 Main Unit B. PV Probes (1.5m, Red 1pc, Black 1pc) C. Grounding Cable (3m) D. Battery Receptacle Box or AC Adapter (1.8m) 		
	Procedure	Reference Sections
1	<p>⚠ WARNING</p> <p>Completely disconnect the PV module/array, which is subjected for measurement, from the relating devices such as power conditioner.</p>	3-1, 3-2
2	<p>⚠ WARNING</p> <p>Ground the MP-11 with grounding cable.</p>	5-3
3	Turn ON the MP-11 Main Unit power.	8-2
4	<p>⚠ WARNING</p> <p>Setup the measurement parameters:</p> <ul style="list-style-type: none"> ✓ [Main Unit Only] ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ (Fixed irradiance and temperature values) 	8-4
5	<p>⚠ WARNING</p> <p>As the power turned ON, connect the MP-11 to the PV module/array.</p>	8-5
6	Start Measurement	8-5
7	Display and analyze the measured data	8-5, 8-6
8	<p>⚠ WARNING</p> <p>Disconnect the MP-11 from the PV module/array as the Main Unit power still turned ON.</p>	3-1, 3-2
9	Turn OFF the MP-11 Main Unit power.	8-2
10	Disconnect the grounding cable from the MP-11 Main Unit.	5-3
11	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2

CASE 2

Using MP-11 Main Unit, Sensor Unit and Thermocouples



Measurement Item		Measurement Condition
<ul style="list-style-type: none"> ● I-V Characteristics ● Irradiance ● Temperature 		<ul style="list-style-type: none"> ● Taking measurement of PV module/array on a high location. ● Necessary to take irradiance, PV module temperature, and ambient temperature measurements ● To measure and analyze the PV module/array by using only MP-11 and some accessories.
Required Items		Configuration Image
A. MP-11 Main Unit B. PV Probes (1.5m, Red 1pc, Black 1pc) C. Grounding Cable (3m) D. Battery Receptacle Box or AC Adapter (1.8m) E. Sensor Unit F. Modular Cable (3m) G. Thermocouple (3m, 2pcs)		
	Procedure	Reference Sections
1	⚠ WARNING Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.	3-1, 3-2
2	Check the switch on the Sensor Unit rear panel; it should be setup with [INT].	5-3
3	Connect thermocouple cables to the Sensor Unit and setup the other end of thermocouple cable at the measuring position.	5-3
4	Connect the Sensor Unit to the Main Unit.	5-3
5	Remove the Angle Capturer from the Sensor Unit and place it on the PV module/array; confirm the angles.	5-3
6	Place the Angle Capturer back on the Sensor Unit; place the Sensor Unit near the PV module/array in the same angles confirmed with the Angle Capturer.	5-3
7	Remove the Angle Capturer from the Sensor Unit before the measurement.	5-3
8	⚠ WARNING Ground the MP-11 Main Unit with grounding cable.	5-3
9	Turn ON the Sensor Unit power.	5-3
10	Turn ON the MP-11 Main Unit power.	8-2
11	Setup the Measurement Parameters: <ul style="list-style-type: none"> ✓ Check [Use Sensor Unit] ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ Select Irradiance Sensor Type ✓ Enter Pyranometer/Reference Cell constant value ✓ PV module/array parameter setting 	8-4
12	In case of using the Sensor Unit with cable-less connection to the Main Unit: While the Sensor Unit power turned ON, disconnect the modular cable between the Sensor Unit and the Main Unit	5-3

13	 WARNING While the power is turned ON, connect the MP-11 to PV module/array.	8-5
14	Start measurement	8-5
15	In case of using the Sensor Unit with cable-less connection to the Main Unit: Connect the Sensor Unit to MP-11 Main Unit and download the irradiance and temperature measurement data from the Sensor Unit.	8-4
16	Display and analyze the measured data	8-5, 8-6
17	 WARNING Disconnect the PV module/array from MP-11 while the power is still turned ON.	3-1, 3-2
18	Turn the MP-11 Main Unit power OFF.	8-2
19	Turn the Sensor Unit power OFF.	5-3
20	Disconnect the thermocouple cables from the Sensor Unit	5-3
21	Disconnect the Sensor Unit from MP-11 Main Unit.	5-3
22	Place the Angle Capturer back on the Sensor Unit.	5-3
23	Remove the grounding cable from MP-11 Main Unit.	5-3
24	Return the components, such as the Sensor Unit, thermocouple cables, and PV probes back in their places.	5-3
25	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2

CASE 3

Using MP-11 Main Unit, External Pyranometer and Thermocouples

Measurement Item		Measurement Condition
<ul style="list-style-type: none"> I-V Characteristics Irradiance Temperature 		<ul style="list-style-type: none"> Taking measurement of PV module/array on a high location. Using a high precision pyranometer installed at the site for irradiance data
Required Items		Configuration Image
<ul style="list-style-type: none"> A. MP-11 Main Unit B. PV Probe (1.5m, Red 1pc, Black 1pc) C. Grounding Cable (3m) D. Battery Receptacle Box or AC Adapter (1.8m) E. Sensor Unit F. Moduler Cable (3m) G. Thermocouple (3m, 2pcs) H. External Pyranometer* I. Output Cable for the External Pyranometer* <p>*Not included in the MP-11 package</p>		
	Procedure	Reference Sections
1	<p>⚠ WARNING</p> <p>Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.</p>	3-1, 3-2
2	Set the switch on the Sensor Unit rear panel to [EXT] position.	5-3
3	Connect thermocouple cables to the Sensor Unit and setup the other end of thermocouple cable at the measuring position.	5-3
4	Connect an external pyranometer to the Sensor Unit.	5-3
5	Connect the Sensor Unit to the Main Unit.	5-3
6	<p>⚠ WARNING</p> <p>Ground the MP-11 Main Unit with grounding cable.</p>	5-3
7	Turn ON the Sensor Unit power.	5-3
8	Turn ON the MP-11 Main Unit power.	8-2
9	<p>Setup the Measurement Parameters:</p> <ul style="list-style-type: none"> ✓ Check [Use Sensor Unit] ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ Select Irradiance Sensor Type ✓ Enter Pyranometer/Reference Cell constant value ✓ PV module/array parameter setting 	8-4
10	<p>In case of using the Sensor Unit with cable-less connection to the Main Unit:</p> <p>While the Sensor Unit power turned ON, disconnect the modular cable between the Sensor Unit and the Main Unit</p>	5-3

11	 WARNING While the power is turned ON, connect the MP-11 to PV module/array.	3-1, 3-2
12	Start measurement	8-5
13	In case of using the Sensor Unit with cable-less connection to the Main Unit: Connect the Sensor Unit to MP-11 Main Unit and download the irradiance and temperature measurement data from the Sensor Unit.	8-4
14	Display and analyze the measured data	8-5, 8-6
15	 WARNING Disconnect the PV module/array from MP-11 while the power is still turned ON.	3-1, 3-2
16	Turn the MP-11 Main Unit power OFF.	8-2
17	Turn the Sensor Unit power OFF.	5-3
18	Disconnect the thermocouple cables from the Sensor Unit	5-3
19	Disconnect the External Pyranometer from the Sensor Unit	5-3
20	Disconnect the Sensor Unit from MP-11 Main Unit.	5-3
21	Remove the grounding cable from MP-11 Main Unit.	5-3
22	Return the components, such as the Sensor Unit, thermocouple cables, and PV probes back in their places.	5-3
23	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2

CASE 4

Analyzing and Managing MP-11 Main Unit Measurement Data on PC

Measurement Item	Measurement Condition	
N/A	<ul style="list-style-type: none"> Managing the measured data on PC Using the measured data on another application 	
Required Items	Configuration Image	
A. MP-11 Main Unit B. Battery Receptacle Box or AC Adapter (1.8m) C. USB Cable (2m) D. PC Installed with MP-11 Software	<p>The diagram illustrates the setup for connecting the MP-11 Main Unit to a PC. It shows a blue MP-11 Main Unit (A) connected to a black Battery Receptacle Box or AC Adapter (B) via a USB cable (C). The Battery Receptacle Box is also connected to a laptop (D) via another USB cable. A double-headed arrow (C) indicates the communication link between the Main Unit and the PC.</p>	
	Procedure	Reference Sections
1	Connect MP-11 Main Unit to PC with USB cable.	5-3
2	Turn the MP-11 Main Unit power ON.	8-2
3	Turn ON the PC and startup the MP-11 I-V Checker Software	9-3
4	Setup the communication port between the MP-11 Main Unit and the PC	9-3
5	Setup the folder for loading the data.	9-3
6	Start downloading the measured data	9-3
7	After the data loading is completed, select whether to delete the measurement data from the Main Unit	9-3
8	Display and analyze the measured data.	9-3
9	Exit the MP-11 I-V Checker Software.	9-3
10	Turn the MP-11 Main Unit power OFF.	8-2
11	Disconnect the MP-11 Main Unit from the PC.	5-3
12	Shutdown the PC	-

CASE 5

Using the Measurement Data from PC on MP-11 Main Unit

Measurement Item	Measurement Condition	
N/A	<ul style="list-style-type: none"> Comparing the measured data at the site against the past measured data. 	
Required Items	Configuration Image	
A. MP-11 Main Unit B. Battery Receptacle Box or AC Adapter (1.8m) C. USB Cable (2m) D. PC Installed with MP-11 Software	<p>The diagram illustrates the setup for data transfer. It shows a blue MP-11 Main Unit (labeled A) connected to a laptop PC (labeled D) via a USB cable (labeled C). A black Battery Receptacle Box or AC Adapter (labeled B) is also connected to the Main Unit. The PC screen displays a blue interface.</p>	
	Procedure	Reference Sections
1	Connect MP-11 Main Unit to PC with USB cable.	5-3
2	Turn the MP-11 Main Unit power ON.	8-2
3	Turn ON the PC and startup the MP-11 I-V Checker Software	9-3
4	Setup the communication port between the MP-11 Main Unit and the PC	9-3
5	Upload the measurement data to the MP-11 Main Unit.	9-3
6	Verify the uploaded data on the MP-11 Main Unit	9-3
7	Exit the MP-11 I-V Checker Software.	9-3
8	Turn the MP-11 Main Unit power OFF.	8-2
9	Disconnect the MP-11 Main Unit from the PC.	5-3
10	Shutdown the PC	-

CASE 6

Controlling the Measurement using only MP-11 Main Unit from PC

Measurement Item	Measurement Condition	
<ul style="list-style-type: none"> I-V Characteristics 	<ul style="list-style-type: none"> Managing the measured data on PC Using the measured data on another application Centralizing the measurement control, data analysis and management on PC Irradiance, PV module/array temperature, and ambient temperature data are not required or using fixed values for these parameters 	
Required Items	Configuration Image	
<ul style="list-style-type: none"> A. MP-11 Main Unit B. PV Probe (1.5m, Red 1pc, Black 1pc) C. Grounding Cable (3m) D. Battery Receptacle Box or AC Adapter (1.8m) E. USB Cable (2m) F. PC Installed with MP-11 Software 		
	Procedure	Reference Sections
1	<p>⚠ WARNING</p> <p>Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.</p>	3-1, 3-2
2	<p>⚠ WARNING</p> <p>Ground the MP-11 Main Unit with grounding cable.</p>	5-3
3	Turn ON the PC and startup the MP-11 I-V Checker Software	9-3
4	Connect MP-11 Main Unit with P.	5-3
5	Turn the MP-11 Main Unit power ON.	8-2
6	Setup the communication port between the MP-11 Main Unit and the PC	9-3
7	Synchronize the date and time between the MP-11 Main Unit and the PC	9-3
8	<p>Setup the Measurement Parameters:</p> <ul style="list-style-type: none"> ✓ Use Only Main Unit setting ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ (Fixed values for irradiance and temperatures) ✓ Specify data saving settings 	9-3
9	<p>⚠ WARNING</p> <p>While the power is turned ON, connect the MP-11 to PV module/array.</p>	3-1, 3-2
10	Start measurement	9-3
11	Display and analyze the measured data	9-3
12	<p>⚠ WARNING</p> <p>Disconnect the PV module/array from MP-11 while the power is still turned ON.</p>	3-1, 3-2

13	Turn the MP-11 Main Unit power OFF.	8-2
14	Remove the grounding cable from MP-11 Main Unit.	5-3
15	Disconnect the MP-11 Main Unit from the PC.	5-3
16	Exit the MP-11 I-V Checker Software and shut down the PC.	9-3
17	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2



CASE 7

Controlling Measurements on PC using MP-11 Main Unit, Sensor Unit, and Thermocouple

Measurement Item	Measurement Condition
<ul style="list-style-type: none"> ● I-V Characteristics ● Irradiance ● Temperature 	<ul style="list-style-type: none"> ● Managing the measured data on PC ● Using the measured data on another application ● Centralizing the measurement control, data analysis and management on PC ● Necessary to take irradiance, PV module/array temperature, and ambient temperature data

Required Items	Configuration Image
<ul style="list-style-type: none"> A. MP-11 Main Unit B. PV Probes (1.5m, Red 1pc, Black 1pc) C. Grounding Cable (3m) D. Battery Receptacle Box or AC Adapter (1.8m) E. Sensor Unit F. Moduler Cable (3m) G. Thermocouple (3m, 2pcs) H. USB Cable (2m) I. PC Installed with MP-11 Software 	

	Procedure	Reference Sections
1	<p>⚠ WARNING</p> <p>Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.</p>	3-1, 3-2
2	Check the switch on the Sensor Unit rear panel; it should be setup with [INT].	5-3
3	Connect thermocouple cables to the Sensor Unit and setup the other end of thermocouple cable at the measuring position.	5-3
4	Connect the Sensor Unit to the Main Unit.	5-3
5	Remove the Angle Capturer from the Sensor Unit and place it on the PV module/array; confirm the angles.	5-3
6	Place the Angle Capturer back on the Sensor Unit; place the Sensor Unit near the PV module/array in the same angles confirmed with the Angle Capturer.	5-3
7	Remove the Angle Capturer from the Sensor Unit before the measurement.	5-3
8	<p>⚠ WARNING</p> <p>Ground the MP-11 Main Unit with grounding cable.</p>	5-3
9	Turn ON the Sensor Unit power.	5-3
10	Turn ON the MP-11 Main Unit power.	8-2
11	<p>⚠ WARNING</p> <p>Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.</p>	3-1, 3-2
12	Turn ON the PC and startup the MP-11 I-V Checker Software	9-3
13	Setup the communication port between the MP-11 Main Unit and the PC	9-3
14	Synchronize the date and time between the MP-11 Main Unit and the PC	9-3



15	<p>Setup the Measurement Parameters:</p> <ul style="list-style-type: none"> ✓ Check [Use Sensor Unit] ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ Select Irradiance Sensor Type ✓ Enter Pyranometer/Reference Cell constant value ✓ PV module/array parameter setting ✓ Specify data saving settings 	9-3
16	<p> WARNING While the power is turned ON, connect the MP-11 to PV module/array.</p>	3-1, 3-2
17	Start measurement	9-3
18	Display and analyze the measured data	9-3
19	<p> WARNING Disconnect the PV module/array from MP-11 while the power is still turned ON.</p>	3-1, 3-2
20	Turn the MP-11 Main Unit power OFF.	8-2
21	Turn the Sensor Unit power OFF.	5-3
22	Disconnect the thermocouple cables from the Sensor Unit	5-3
23	Disconnect the Sensor Unit from MP-11 Main Unit.	5-3
24	Place the Angle Capturer back on the Sensor Unit.	5-3
25	Remove the grounding cable from MP-11 Main Unit.	5-3
26	Disconnect the MP-11 Main Unit from the PC.	5-3
27	Exit the MP-11 I-V Checker Software and shut down the PC.	9-3
28	Return the components, such as the Sensor Unit, thermocouple cables, and PV probes back in their places.	5-3
29	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2

CASE 8

Controlling Measurements on PC using MP-11 Main Unit, External Pyranometer, and Thermocouple

Measurement Item	Measurement Condition
<ul style="list-style-type: none"> I-V Characteristics Irradiance Temperatures 	<ul style="list-style-type: none"> Managing the measured data on PC Using the measured data on another application Centralizing the measurement control, data analysis and management on PC Using high precision pyranometer installed at the site
Required Items	Configuration Image
<p>A. MP-11 Main Unit</p> <p>B. PV Probe (1.5m, Red 1pc, Black 1pc)</p> <p>C. Grounding Cable (3m)</p> <p>D. Battery Receptacle Box or AC Adapter (1.8m)</p> <p>E. Sensor Unit</p> <p>F. Moduler Cable (3m)</p> <p>G. Thermocouple (3m, 2pcs)</p> <p>H. External Pyranometer*</p> <p>I. Output Cable for the External Pyranometer*</p> <p>J. USB Cable (12)</p> <p>K. PC Installed with MP-11 Software</p> <p>*Not included in the MP-11 package</p>	

	Procedure	Reference Sections
1	<p>⚠ WARNING</p> <p>Disconnect the PV module/array, which is subjected to take measurement, from the relating devices such as power conditioner completely.</p>	3-2, 3-2
2	Set the switch on the Sensor Unit rear panel to [EXT] position.	5-3
3	Connect thermocouple cables to the Sensor Unit and setup the other end of thermocouple cable at the measuring position.	5-3
4	Connect an external pyranometer to the Sensor Unit.	5-3
5	Connect the Sensor Unit to the Main Unit.	5-3
6	<p>⚠ WARNING</p> <p>Ground the MP-11 Main Unit with grounding cable.</p>	5-3
7	Connect MP-11 Main Unit to PC.	5-3
8	Turn ON the Sensor Unit power.	5-3
9	Turn ON the MP-11 Main Unit power.	8-2
10	Turn ON the PC and startup the MP-11 I-V Checker Software	9-3
11	Setup the communication port between the MP-11 Main Unit and the PC	9-3
12	Synchronize the date and time between the MP-11 Main Unit and the PC	9-3

13	<p>Setup the Measurement Parameters:</p> <ul style="list-style-type: none"> ✓ Check [Use Sensor Unit] ✓ Auto or Manual Measurement Setting ✓ Measurement Range ✓ Select Irradiance Sensor Type ✓ Enter Pyranometer/Reference Cell constant value ✓ PV module/array parameter settings ✓ Specify data saving settings 	9-3
14	<p> WARNING While the power is turned ON, connect the MP-11 to PV module/array.</p>	3-1, 3-2
15	Start measurement	9-3
16	Display and analyze the measured data	9-3
17	<p> WARNING Disconnect the PV module/array from MP-11 while the power is still turned ON.</p>	3-1, 3-2
18	Turn the MP-11 Main Unit power OFF.	8-2
19	Turn the Sensor Unit power OFF.	5-3
20	Disconnect the thermocouple cables from the Sensor Unit	5-3
21	Disconnect the External Pyranometer from the Sensor Unit	5-3
22	Disconnect the Sensor Unit from MP-11 Main Unit.	5-3
23	Remove the grounding cable from MP-11 Main Unit.	5-3
24	Disconnect the MP-11 Main Unit from the PC.	5-3
25	Exit the MP-11 I-V Checker Software and shut down the PC.	9-3
26	Return the components, such as the Sensor Unit, thermocouple cables, and PV probes back in their places.	5-3
27	Reconnect the power conditioner and other related devices which were disconnected before taking measurement with MP-11.	3-1, 3-2

7. I-V Curve shape and possible cause

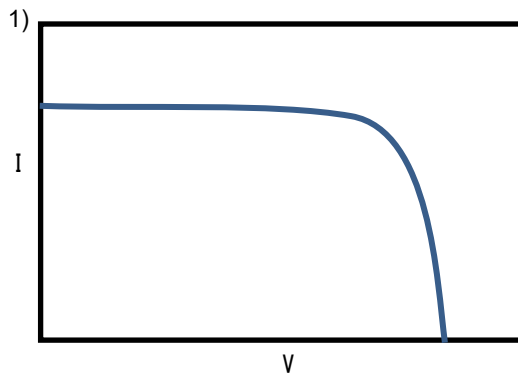
The I-V curve gives useful information on the performance of PV arrays, strings and modules through the shape of the I-V curve and measured parameters. It also provides additional details of the PV device's environmental conditions, such as irradiance, temperature, shade, unexpected error and so on.

This chapter shows some examples of I-V curve shape and suggestions of possible cause.

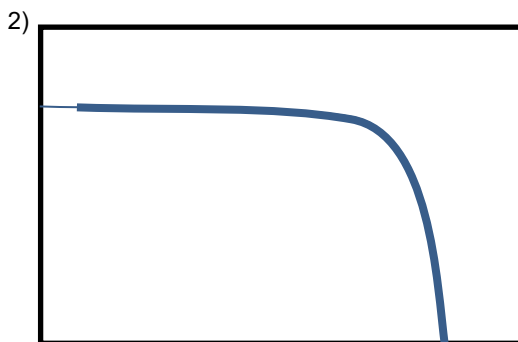
Note: Suggestions shows possible cause only. There are other reasons that cause a particular I-V shape.

7-1. I-V curve shape and possible cause

- Thin line: Ideal I-V curve for reference
- Bold line: Measured I-V curve

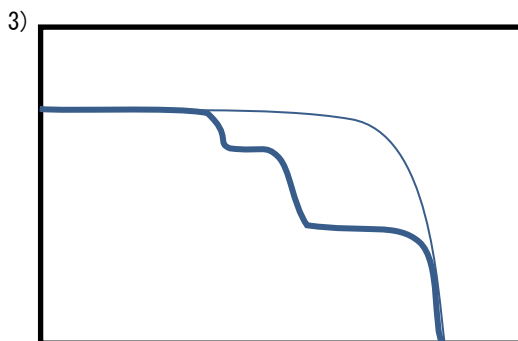


Good and standard measurement



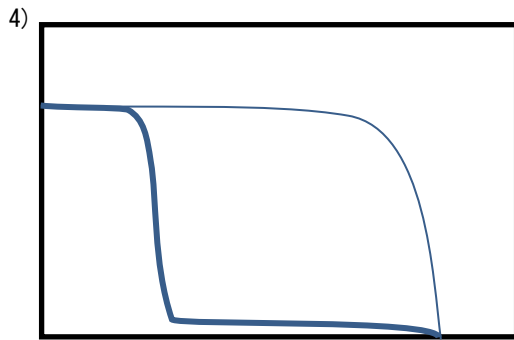
Curve doesn't start from Y-axis ($V=0$)

- Very short sweep time with higher I_{sc} and lower V_{oc} compensating reverse bias effect (There is no error on I-V curve itself)



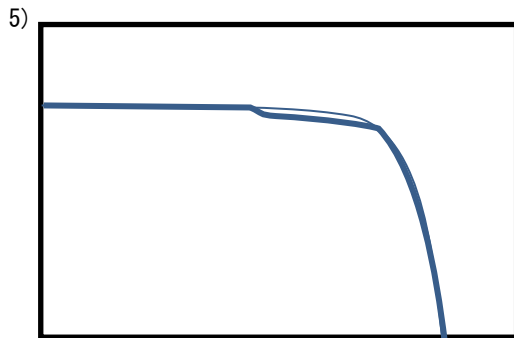
Unexpected shape with stepped missing part

- A few modules (or clusters) with low irradiation or small shadow.



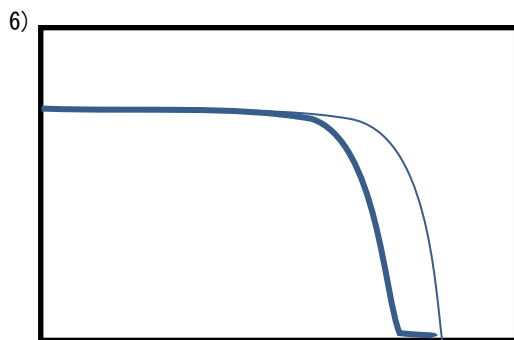
Unexpected shape with large missing part

- Many of modules with low irradiation or large shadow



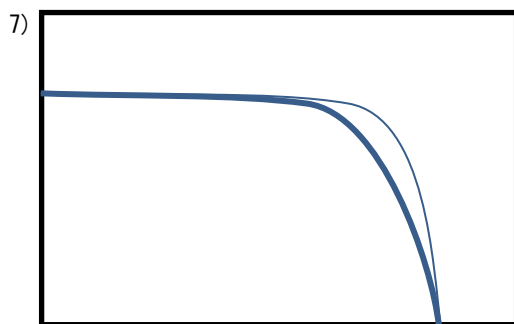
Unexpected shape with small missing part around Pm

- A few modules (or clusters) with low irradiation or small shadow
- Uneven pollution of module surface
- A few hotspots on module
- Variation of module performance, such as Isc, mismatch in a couple of modules in a string



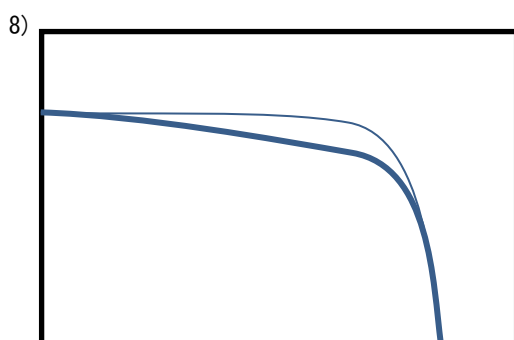
Unexpected shape with missing between Voc and around Pm

- One module or a few modules with low irradiation



Unexpected shape with moderate slope from Voc

- Large series resistance of PV cables or high contact resistance of connectors
- Degradation of interconnect in module



Unexpected shape with steep slope from Isc

- Small parallel resistance of module.
- Damaged bypass diode in connection box of module

8. MP-11 Operation

8-1. MP-11 Key Operation

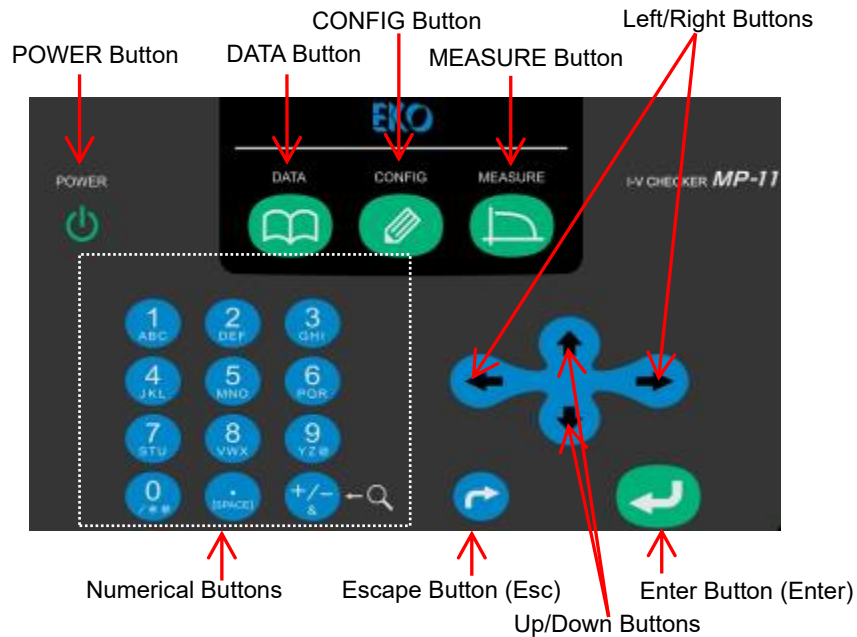


Figure 8-1. Operation Panel

Table 8-1. MP-11 Operation Panel Buttons

Buttons	Functions			
POWER Button	Turns ON the power by pushing the button Turns OFF by holding down on the button for 5sec.			
DATA Button	Function key that is related to displaying the measured data.			
CONFIG Button	Function key that is related to measurement setup.			
MEASURE Button	Function key that starts the measurement (starts immediately when it is pressed)			
Up/ Down Buttons	Used when selecting menus. It becomes Monitor function when pressed on Main Menu Display.			
Left/Right Buttons	Used when selecting parameters and moving the zoomed up display screen.			
ENTER Button	Used when going forward with the process and determining to input.			
Esc Button	Used when returning to the previous display and terminating a process			
Numerical Buttons	Used as numbers, as well as in the manner of table below by pressing multiple times. [+/-] key is used in I-V curve graph display for changing the scales of the display as x2, x4, and x8.			
	#	Functions	#	Functions
	1	1, A, B, C	7	7, S, T, U
	2	2, D, E, F	8	8, V, W, X
	3	3, G, H, I	9	9, Y, Z, @
	4	4, J, K, L	0	0, /, *, #
	5	5, M, N, O	.	., [SPACE]
	6	6, P, Q, R	+/-	+/-, &

8-2. Starting MP-11

- ⚠️ ※ Always switch ON the MP-11 power FIRST then connect the PV module/array.
- ⚠️ ※ Always disconnect the PV module/array FIRST then Switch OFF the MP-11 power.

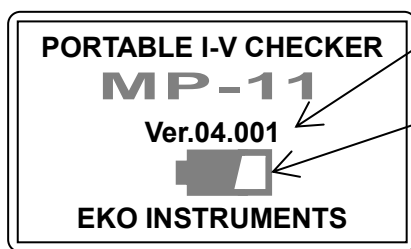
1. Start Up

Insert the AC adaptor or Battery Receptacle Box plug in the MP-11 Power Supply connector.

To turn MP-11 on, press the POWER button  on the operation panel.

2. Start Screen

When the MP-11 Main Unit is turned ON, the following screen appears on the LCD display.



Start Screen

Firmware version number

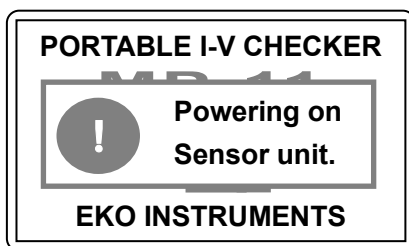
Battery Status Gauge

When using Battery for power supply, the Battery Status Gauge is displayed as the Main Unit is powered ON.

NOTE: The Battery Status Gauge is only for your reference; there may be some differences for the actual remaining battery power

3. [Powering on Sensor Unit] Message

On MP-11, there is a function to synchronize the time between the Main Unit and Sensor Unit when the Main Unit is powered ON. If the Sensor Unit is not connected to the Main Unit or Sensor Unit power is not turned ON even though it is connected to the Main Unit, the “Powering on Sensor unit.” Warning message appears on the screen.



“Powering on Sensor Unit”
Warning Message

Warning Message “Powering on Sensor unit.”

If the Sensor Unit is not used, press any button to remove the warning message.

The Main Unit cannot be powered OFF with this warning message displayed; press any key and remove this message before powering OFF.

For more details of warning messages, refer to [9-2. Error and Warning Messages]

- ◇ Using the Sensor Unit to take measurements:
Connect the Main Unit and the Sensor Unit with modular cable; turn ON the Sensor Unit power first then turn ON the Main Unit power. Always follow this order when the Sensor Unit is used.
After the time synchronization between the Sensor Unit and the Main Unit, the “SU” is indicated at right top on the Main Menu screen.
- ◇ Not using the Sensor Unit to take measurements:
After the “Powering on Sensor Unit” warning message appears on the start screen, press any key to

remove the warning message; the Main Menu screen is displayed and operation is available.

There is "NO SU" indicated at the right top on the Main Menu. (See [8-4. Setting Menu] > [2. Measurement Parameter Setting] for more details)

⚠ NOTE: If the time synchronization between the Sensor Unit and the Main Unit did not succeed, the Main Unit may not be able to read the Sensor Unit data or may read the unmatched data from the Sensor Unit.

4. Powering OFF the MP-11

To turn OFF the MP-11 power, press and hold the POWER key for a while.

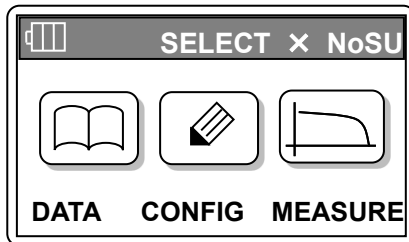
The power is turned off after "Shutdown Running"

NOTE: Always make sure there are no messages displayed on the LCD display after powering OFF.

8-3. Main Menu & Monitoring Screen

1. Main Menu Screen

After the Start Screen, Main Menu screen appears.



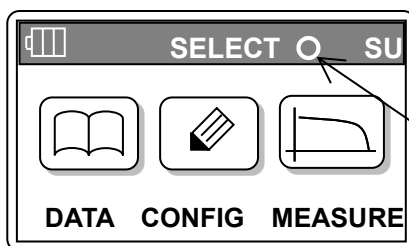
Main Menu Screen

MEASURE: Starts measurement right away by pushing this button.
(Wait for 30 seconds or more /15 seconds or more between each measurement)

CONFIG: Goes to each configuration setting menu.

DATA: Goes to display menu for measurement data.

Each function can be selected by pressing each [DATA], [CONFIG], and [MEASURE] button.

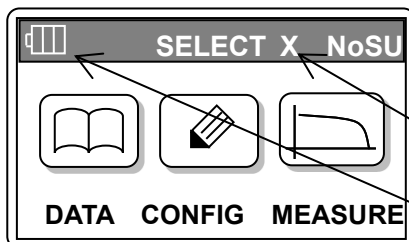


Sensor Unit Connected

SU: Sensor Unit is selected

O: The Main Unit has completed the connection with Sensor Unit

(NOTE: [O] appears around 5 seconds after the Sensor Unit is connected and the Main Unit has recognized the Sensor Unit.)



Sensor Unit NOT Connected

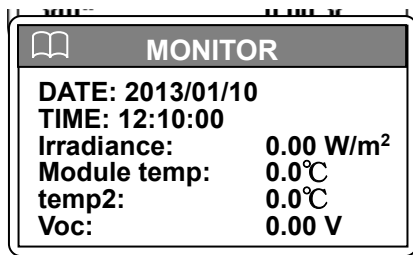
NoSU: Sensor Unit is not selected

X: There is not connection with Sensor Unit

Battery Status Gauge

2. Monitor Screen

Monitor screen is displayed with using Up/Down buttons from the Main Menu screen; the date, time, irradiance, module temperature, temp2, and PV terminal voltage are displayed. If the Sensor Unit is not connected, the irradiance and temperature are indicated as 0.00 W/m², 0.0 °C, and 0.0 °C.



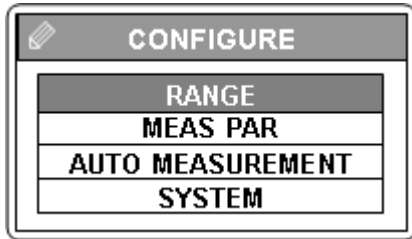
Monitor Screen

DATE:	Date (YYYY/MM/DD)
TIME:	Current time
Irradiance:	(According to the internal pyranometer, external pyranometer, or Ref. terminal inputs setting.)
Module temp:	Terminal input temperature
temp2:	Terminal input temperature
Voc:	Open Circuit Voltage Voc :(PV terminal voltage)

8-4. Setting Menu

Setting Menu screen appears when "CONFIG" is selected from the Main Menu screen.

There are following options on the Setting Menu screen.



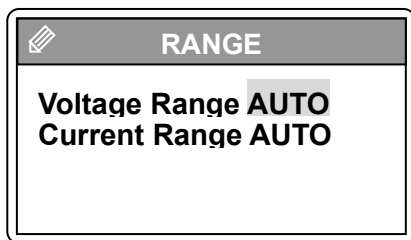
Setting Menu

RANGE:	Range Setting
MEAS PAR:	Measurement Parameter Setting
AUTO MEASUREMENT:	Auto Measurement Setting
SYSTEM:	Environmental Condition Setting

1. Range Setting

Enter the measurement range of the subjected PV module or array for measurements.

From below contents, the ranges can be selected using the Left/Right buttons.



Range Setting

Voltage Range Setting

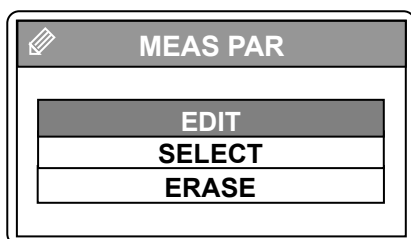
Voltage Range: 100V, 600V, 1000V, AUTO
(Default setting: "AUTO")

Current Range Setting

Current Range: 2A, 10A, 30A, AUTO
(Default setting: "AUTO")

2. Measurement Parameter Setting

Measurement Parameter Setting screen is displayed when the "MEAS PAR" is selected from the Setting Menu screen. There are following options for the Measurement Parameter Setting screen.

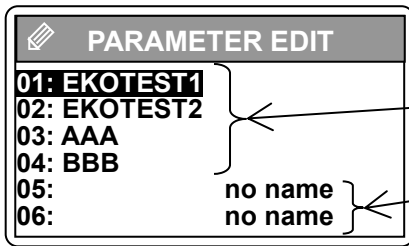


Measurement Parameter Setting

EDIT:	Edit parameter
SELECT:	Select registered parameter
ERASE:	Delete parameter

1) Edit Parameter

Registered parameter list is displayed when the “EDIT” is selected from the Measurement Parameter Setting screen.



Parameter list which is already registered.

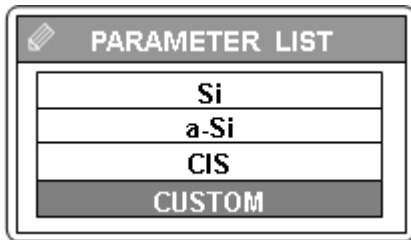
No parameters registered.

Registered Parameter List

A. Module Parameter Setting

Bring the cursor to the subjected parameter name for editing by using the Up/Down buttons then press the Enter button. “PARAMETER LIST” list appears at first. In this list, there are Si (Mono-crystal/Poly-crystal Silicon), a-Si (non-crystalline, amorphous), CIS (CIS-type Thin Film), and Custom with reference values already provided.

The input values for the Custom parameter are also provided as below for the default.



There are reference values for the “ α , β , R_s , κ ” given for 3 types of modules. These values can be edited on this screen

NOTE: The given parameter values for the Si, a-Si, and CIS are only reference values. For better precision measurements, set the parameters with the values provided on the catalog for the modules, which to be measured.

Registered Parameter List

01 PARAMETER 2/2		
Area	1.3230	m ²
Alpha	0.0026	A/deg
Beta	-0.0900	V/deg
Rs	0.6000	ohm
K	0.0020	ohm/deg
Connection	S:01 P:01	

Si Parameter Screen

01 PARAMETER 2/2		
Area	1.1790	m ²
Alpha	0.0009	A/deg
Beta	-0.20000	V/deg
Rs	7.0000	ohm
K	-0.1500	ohm/deg
Connection	S:01 P:01	

a-Si Parameter Screen

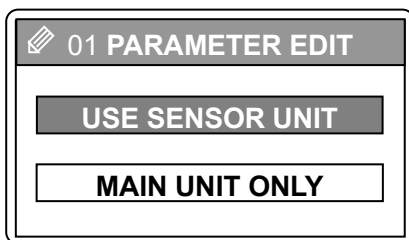
01 PARAMETER 2/2		
Area	1.2280	m ²
Alpha	0.0002	A/deg
Beta	-0.0660	V/deg
Rs	2.0000	ohm
K	-0.0090	ohm/deg
Connection	S:01 P:0	

CIS Parameter Screen

PV Module/Array Parameter Setting Screens

B. Sensor Unit Options

In the next screen on Sensor Unit Option screen, determine whether to use the Sensor Unit or not.



Select either the “USE SENSOR UNIT” or “MAIN UNIT ONLY” and press the Enter button.

On the next page, steps are described on how to edit the parameters in the cases of using the Sensor Unit and Main Unit Only.

Sensor Unit Option Screen

USE SENSOR UNIT	MAIN UNIT ONLY
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">✎ 01 PARAMETER 1/2</p> <p>Name EKOTEST1 Voltage Range AUTO Current Range AUTO Sensor PYR Cal 46.00 mV/kW · m²</p> </div> <p style="text-align: center;">Range & PYR Calibration Value Setting</p> <p>[Voltage Range]→ Select a voltage range [Current Range]→ Select a current range [Sensor]→ Select a radiation sensor (Pyranometer: PYR/Ref. Cell: REF) [Cal]→ Enter Pyranometer/Ref. Cell sensitivity</p> <p>When “Sensor: PYR” is selected for the “Sensor”, enter the sensitivity value of the pyranometer. For the internal pyranometer, the sensitivity is stated on the back of the Sensor Unit. For the external pyranometer, use the sensitivity stated on the pyranometer.</p> <p>NOTE: When external pyranometer is used, connect the pyranometer to PYR terminal and <u>set the switch to the EXT side.</u></p> <p>When “Reference Cell: REF” is selected for the “Sensor”, the entering unit for the sensitivity will be in [mV/kW · m²] and setting value will be determined by the following calculation:</p> <p>[Reference Cell Current Value] (mA/kW · m²) × 0.1(Ω)</p> <p>For Example, when connecting a reference cell which flows 125mA at 1kW/m², it will generate the following amount of voltage: 125mA × 0.1Ω = 12.5mV Therefore, enter “12.5 [mV/kW · m²]”.</p> <p>NOTE: When reference cell is used, connect it to the REF terminal. NOTE: Reference cell which flows more than 500mA cannot be connected to REF terminal.</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">✎ 01 PARAMETER EDIT</p> <p style="text-align: center;">Set Irr & Temp ?</p> <p style="text-align: center;">YES NO</p> </div> <p style="text-align: center;">Irradiance & Temp Input Options</p> <p>Select whether to use fixed values for the irradiance and temperature.</p> <p>Selected [YES]:</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">✎ 01 PARAMETER EDIT</p> <p>Irradiance: 1000.00 W/m² Module temp.: 25.0°C</p> </div> <p style="text-align: center;">Irradiance & Temp Fixed Value Input</p> <p>Enter the irradiance value in [Irradiance] Enter temperature value in [Module temp]</p> <p>Selected [NO]:</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">✎ 01 PARAMETER EDIT</p> <p>Name EKOTEST1 Voltage Range AUTO Current Range AUTO</p> </div> <p style="text-align: center;">Range Option</p> <p>[Voltage Range]→ Select the voltage range (100V, 600V, 1000V, AUTO) [Current Range] → Select the current range (2A, 10A, 30A, AUTO)</p>

01 PARAMETER 2/2		
Area	1.00	m ²
Alpha	0.001	A/deg
Beta	-0.003	V/deg
Rs	0.10	ohm
K	0.00	ohm/deg
Connection	S:01 P:01	

Module Parameter Editing Page

Setup the following parameters and press Enter button.

[Area]→ PV module area

[Alpha]→ Short Circuit Current Temperature Coefficient

When the catalog value unit is in [%/deg], convert the unit to [A/deg] and then enter the value. For example:

$$\text{Alpha} = 0.06 \text{ [%/deg]}$$

When Short Circuit Current $I_{sc} = 8.63\text{A}$, it can be converted into:

$$(8.63/100) \times 0.06 = 0.00578 \text{ [A/deg]}$$

[Beta]→ Open Circuit Voltage Temperature Coefficient

When the catalog value unit is in [%/deg], convert the unit to [V/deg] and then enter the value. For example:

$$\text{Beta} = -0.33 \text{ [%/deg]}$$

When Open Circuit Voltage $V_{oc} = 45.4\text{V}$, it can be converted into:

$$(45.4/100) \times (-0.33) = -0.14982 \text{ [V/deg]}$$

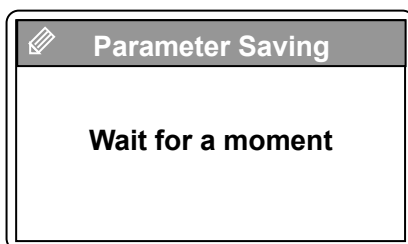
[Rs]→ Series Resistance

[K]→ Curve Correction Factor

[Connection]→ S: Number of modules in series

P: Number of modules in parallel

When the parameter editing is complete, press the Enter button.



Parameter Saving Message

After the Enter button pressed, the parameter saving message appears as shown on the left and the parameter is saved.

NOTE: However, the parameter will not be saved in the parameter list if the Sensor Unit is not used and selected [NO] for the irradiance and temperature parameter setting since it will be just a temporary parameter setting.

NOTE: Status of Sensor Unit connection is shown in right-upper side of main menu display.

2) Selecting Registered Parameter

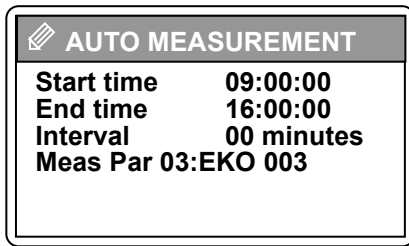
Select the [SELECT] from the Parameter Menu screen using the Up/Down buttons; the [PARAMETER LIST] is displayed. Bring the cursor to the parameter name which to be setup and press [Enter] button to run the measurement with this parameter setting.

3) Deleting Parameters

Select [ERASE] from the Parameter Menu screen using the Up/Down buttons; the [PARAMETER LIST] is displayed. Bring the cursor to the parameter name which to be deleted and press [Enter] button to delete.

3. Auto Measurement Setting

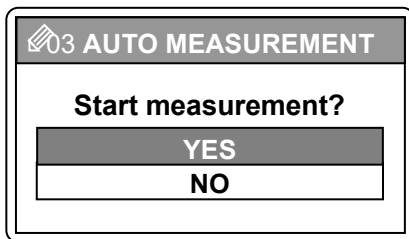
AUTO MEASUREMENT setting screen will appear by selecting [AUTO MEASUREMENT] from the Setting Menu screen. After connecting the PV probes and setup the Sensor Unit, follow the next steps to take the auto measurements.



Auto Measurement Setting

Enter the [Start time], [End time], [Interval] information.

[Meas Par XX] indicates the parameter number which is selected for the auto measurement.



Auto Measurement Start/Cancel

To start the auto measurement, select [YES].

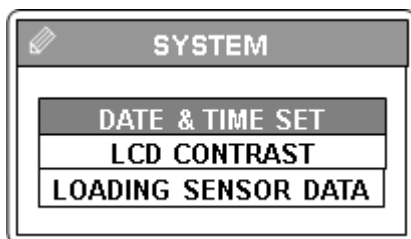
To cancel the measurement, select [NO].

- ※ **Automatic measurement function beyond midnight cannot be set on main body.**
- ※ **Recommend not to measure over a couple of days in Auto Measurement mode even if using PC software because of instability of Operation System**
- ※ **During the auto measurement, the power auto off function will not be effective even if the Battery Receptacle Box is in use.**
- ※ **The measurement data are saved sequentially from 0 (zero) to 300 in the Main Unit memory. When the memory exceeds 300, the data are overwritten with newer data from 0 (zero). It is recommended to download and save the data to PC after use to clear the Main Unit memory, and manage the data on the PC as much as possible.**

4. System Menu

The System Menu screen appears when [SYSTEM] is selected from the Setting Menu screen.

Below are the options available on the System menu screen.



System Menus

[DATE & TIME SET]→

Date & time setting

[LCD CONTRAST]→

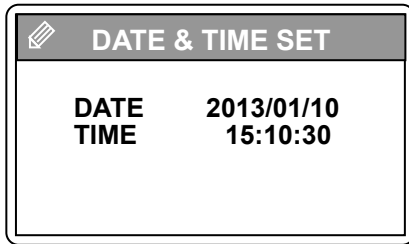
LCD contrast adjustment

[LOADING SENSOR DATA]→

Downloading Sensor Unit data to the Main Unit

1) Date & Time Setting

When [DATE & TIME SET] is selected from the System Menu screen, date and time setting screen appears. The Main Unit date and time can be setup from this screen. Use Left/Right buttons and the numerical buttons to adjust the date and time.



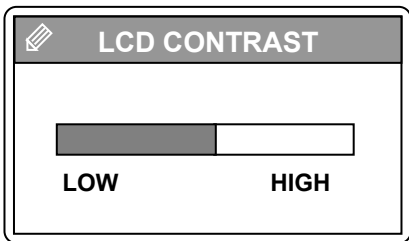
[DATE]→ YYYY/MM/DD

[TIME]→ hh:mm:ss

Date & Time Setting Screen

2) LCD Contrast Adjustment

When [LCD CONTRAST] is selected from the System Menu screen, the LCD contrast adjustment screen appears.



Use Left/Right buttons to adjust the LCD contrast to your desirable contrast.

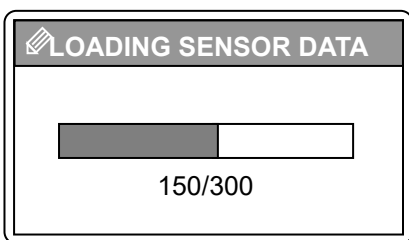
LCD Contrast Adjustment

3) Loading Sensor Unit Data

When the measurements were taken without connecting the Main Unit and the Sensor Unit, the Sensor Unit data must be downloaded to the Main Unit by connecting each other with modular cable.

Connect the Main Unit and the Sensor Unit with modular cable then turn ON the Sensor Unit power.

Select [LOADING SENSOR DATA] on the System Menu screen to download the Sensor Unit data to the Main Unit.



The data loading status can be monitored by the indicator and counter.

Loading Sensor Unit Data


※ The Sensor Unit measurement data should be downloaded to the Main Unit within the day of measurements taken. Although the data recorded by the Sensor Unit has time information, they are not provided with date information. There may be some risks that the Sensor Unit data cannot be loaded to the Main Unit or the data between the Main Unit and Sensor Unit may not match by dates if the Sensor Unit data are loaded on another day.

Same problem may occur when the Main Unit and the Sensor Unit were synchronized with time successfully.

8-5. Measuring

After setting the parameters as described in [6-4 Setting Menu], take the measurements according to the following procedure.

1. Connecting Between Main Unit and PV Module

 1) **Completely disconnect the power conditioner (inverter) or any other devices from the PV Array/Module when taking measurements.**

2) Connect the PV Probes to the Main Unit.

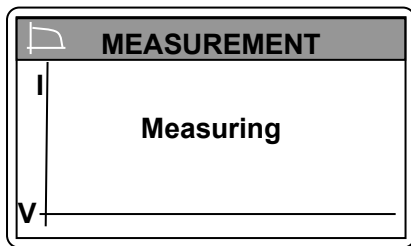
Turn ON the Main Unit power then clamp the alligator clips attached to the PV Probes to the PV module terminals.

NOTE: Make sure the PV Probes are connected with correctly with the PLUS and MINUS electrical poles.

PLUS (+)	Red PV Probe
MINUS (-)	Black PV Probe

2. Measurement

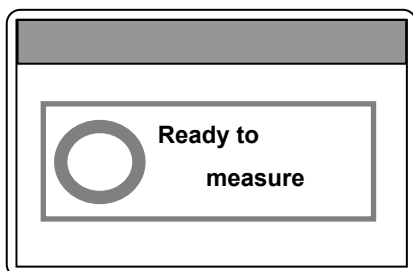
Next, execute the measurement by pressing the [MEASURE] button while the LCD screen displaying the Main Menu screen or Monitor screen.



Measuring Screen

Measuring Screen during the Measurement

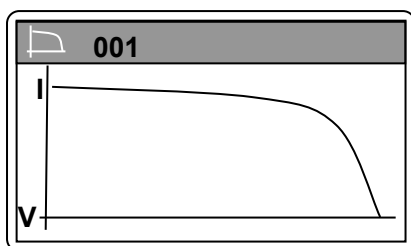
It takes approximately 5 seconds to display measurement result from pushing measure button.



Screen about ready to measure

Screen about ready to measure

After completing a measurement, when MP-11 can perform the next measurement, the screen will be displayed. If operators press the ESC button when the screen is displayed, MP-11 return to the measurement result screen or main menu, then MP-11 can perform measurement by pressing Measure button.



Measurement Result Screen

Measurement Result Graph

After completing the measurement, the graph display switches by the following order each time the Enter button is pressed.

I-V Curve

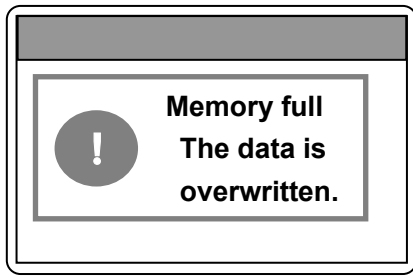
P-V Curve

dI/dV—V Curve (Derivation Curve)

Measurement Information

Characteristics Value 1

Characteristics Value 2



Caution screen about the overwriting

Caution screen about memory full

When the MP-11 has 300 measurement data and push Measure button, MP-11 shows the caution screen which indicates the data is overwritten because the memory is full. If operators press the ESC button when the screen is displayed, the MP-11 will return to the main menu without executing measurement. On the other hand, if operators press Measure button while the screen is displayed, MP-11 will perform measurement and overwrite the stored data. Please delete the measurement data or save the data into PC then delete it. (Refer to [8-6. Data Display Menu] and [9-3. Software Operation])

- 1) Measurement interval (time between last measurement to next measurement) depends on the range of voltage and current selected at the previous measurement. If operators use auto range mode, the interval depends on the combination of the range of voltage and current used at the previous measurement.

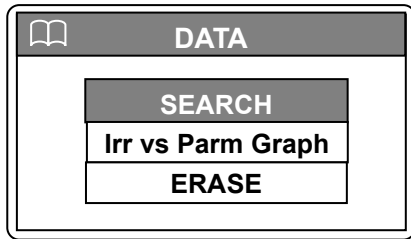
The range of voltage and current, and measurement interval

Voltage range	Current range	Measurement interval
1000V	30A	Approx. 30 seconds
1000V	10A	Approx. 30 seconds
1000V	2A	Approx. 30 seconds
600V	30A	Approx. 30 seconds
600V	10A	Approx. 15 seconds
600V	2A	Approx. 15 seconds
100V	30A	Approx. 15 seconds
100V	10A	Approx. 15 seconds
100V	2A	Approx. 15 seconds

NOTE: When Battery Receptacle Box is used during the measurement, the auto power off function will be effective. If there is no key operation performed, the power automatically shuts down within 10 minutes to save the energy.

8-6. Data Display Menu

The Data Menu screen is displayed when [DATA] button is pressed from the Main Menu screen.



Data Menu Screen

- [SEARCH]→ Searches and displays the measurement data
- [Irr vs Parm Graph]→ Displays graph for the irradiance and each PV module parameter.
- [ERASE]→ Deletes already saved data.

1. Searching Saved Data

The Data List screen is displayed when [SEARCH] is selected, and the data which are saved in the Main Unit memory are displayed in a list.

NOTE: The data uploaded from the software on the PC are registered from the memory number 301.

Memory No.	YY/MM/DD	Hh:mm:ss
001:	13/01/10	12:10:00
002:	13/01/10	12:11:00
003:	13/01/10	12:12:00
004:	13/01/10	12:13:00
005:	13/01/10	12:14:00
006:	13/01/10	12:15:00

Data List

Memory No.	YY/MM/DD	Hh:mm:ss
↓	↓	↓
001:	13/01/10	12:10:00
002:	13/01/10	12:11:00

(Up to 300 data can be saved)

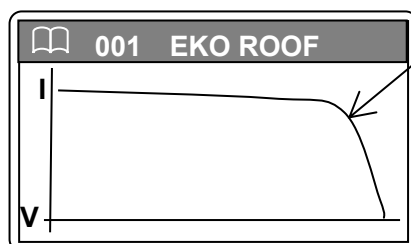
2. Displaying Data Graph

Select the date of data to be displayed on graph from the data list on Data List screen by using the Up/Down buttons and press [Enter] button.

By pressing Enter button repeatedly, the graphs are displayed in the following order:

- ◇ I-V Curve (x-axis: Voltage (V), y-axis: Current (A))
- ◇ P-V Curve (x-axis: Voltage (V), y-axis: Power (W))
- ◇ (dI/dV)-V Curve (x-axis: Voltage (V), y-axis: Derivative Value)
- ◇ Measurement Information
- ◇ Characteristics Value 1/2
- ◇ Characteristics Value 2/2

:(Repeat above)

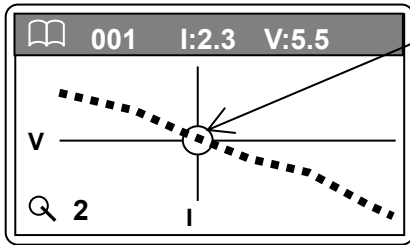


I-V Curve Graph

I-V Curve (x-axis: Voltage (V), y-axis: Current (A))

I-V curve graph shows the voltage-current characteristics of the PV module under the conditions of irradiance, ambient temperature and the PV back surface temperature.

The crossing point of curve on the x-axis (voltage) is called Open Circuit Voltage, Voc, and the crossing point of curve on the y-axis (current) is called Short Circuit Current, Isc.



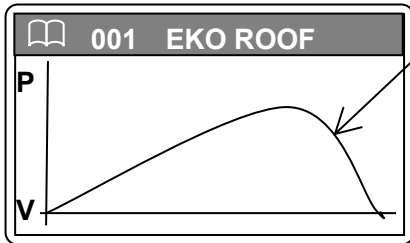
Enlarged I-V Curve Graph

I-V Curve Zoomed View

Pressing the +/- button while the I-V curve is displayed will show the graph in zoomed-up view; the zoom up effect changes by x2, x4, and x8 as each time the +/- button is pressed.. Also the graph can be moved by Left/Right buttons +/- to change the displayed area.

The current (A) and voltage (V) values are indicated at the top of the screen.

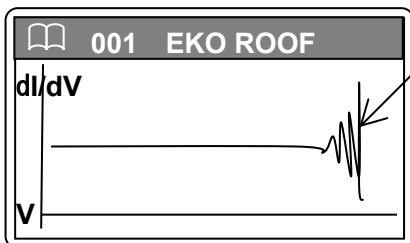
Use this function to find the slight reverse curve point on I-V curve.



P-V Curve Graph

P-V Curve (x-axis: Voltage (V), y-axis: Power (W))

P-V curve graph is a graph which is corrected from I-V curve to Voltage and Power relationship. When a graph is indicated with x-axis for voltage and y-axis for power, the power peak point is called "maximum power, Pm".

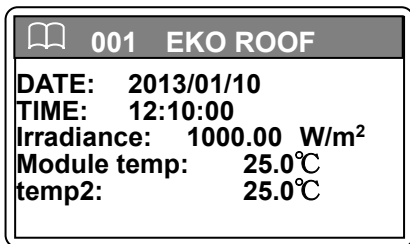


Derivation Graph

Derivation Curve (x-axis: Voltage (V), y-axis: Derivation Value)

Derivation curve is a graph which determines whether there is a reverse curve point in the I-V curve by taking the y-axis for derivation value for current against a graph to x-axis for voltage (V) (dI/dV).

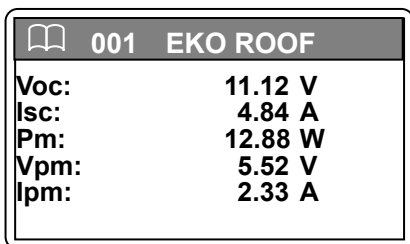
The I-V curve gets distracted if there is a hotspot or shade in a part of PV module or part of cells in the PV modules are defected and deteriorated. With this function, even a subtle distraction which is difficult to see on the I-V curve is emphasized and indicated clearly.



Measurement Information

Measurement Information

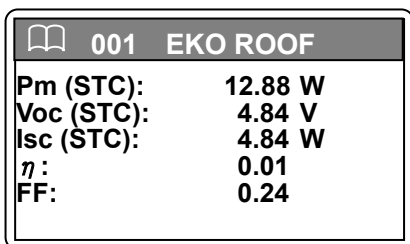
DATE:	YYYY/MM/DD
TIME:	hh:mm:ss
Irradiance:	Solar Irradiance (W/m ²)
Module temp.:	PV Module Back Surface Temperature (°C)
temp2:	Ambient Temperature (°C)



Characteristics Values 1/2

Characteristics Values 1/2

Voc:	Open Circuit Voltage (V)
Isc:	Short Circuit Current (A)
Pm:	Maximum Power (W)
Vpm:	Maximum Power Voltage (V)
Ipm:	Maximum Power Current (A)



Characteristics Values 2/2

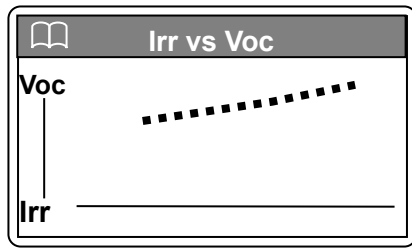
Characteristics Values 2/2

Pm(STC):	Standard Test condition Maximum Power (W)
Voc(STC):	Standard Test condition Open Circuit Voltage (V)
Isc(STC):	Standard Test condition Short Circuit Current (A)
η:	Power Generation Efficiency (%)
F.F.:	Fill Factor (Curve Correction Factor)

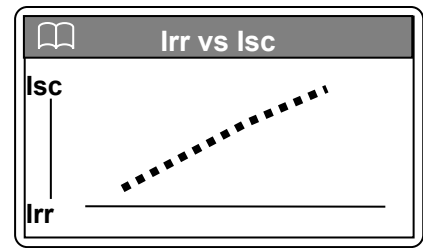
※ The conversion values Pm(STC), Voc(STC), and Isc(STC) for the IS IEC 60891 standard test condition are effective when the solar irradiance more than 700W/m². Also all PV module parameters: α, β, K, Rs, and module area are filled in the parameter setting screen.

3. Irradiance vs. Parameter (Pm, Voc, Isc, FF) Graphs

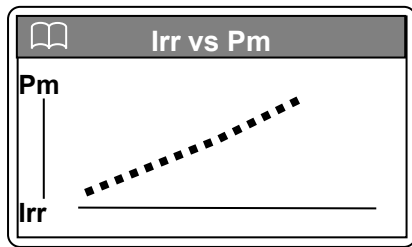
When multiple measurements are taken with same measurement conditions in one day by continuous measurement, graphs with Pm, Voc, Isc, and FF against solar irradiance can be displayed by selecting [Irr vs Parm Graph] from Data Menu screen using Up/Down buttons.



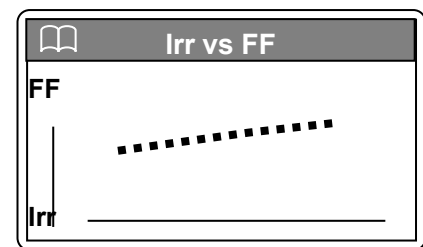
Irr vs. Voc Graph



Irr vs. Isc Graph

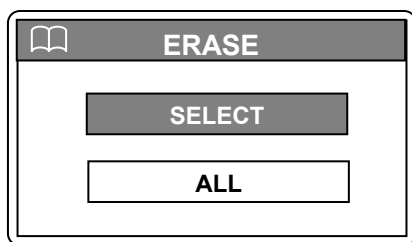


Irr vs. Pm Graph



Irr vs. FF Graph

4. Deleting Data



Erase Menu

Erase menu is displayed when [ERASE] is selected from Data Menu screen using Up/Down buttons.

To delete data:

To Delete Individual Data	To Delete All Data
<p>Select [SELECT].</p> <p>When the [DATA LIST] appears, bring the cursor to the data number which to be deleted then press [Enter] button. The selected data number is erased.</p> <p>[Erase Individual Data] screen appears; select [YES] and press enter key to delete the data of the selected data number. To cancel, select [NO].</p> <div> </div> <p style="text-align: center;">Data List</p> <div> </div> <p style="text-align: center;">Erase Individual Data Screen</p>	<p>Select [ALL] and press Enter button.</p> <p>“Erase All” message appears; select [YES] and press [Enter] button. All data are erased.</p> <p>To cancel, select [NO].</p> <div> </div> <p style="text-align: center;">Erase All Screen</p>

※ The data uploaded from PC, which are numbered from 301 and up, can be deleted only from the software by connecting the PC to the Main Unit.

9. Software

This software is dedicated software for MP-11. The data measured with MP-11 Main Unit is downloaded to PC and they can be analyzed on this software. It also allows measurement control. The measured data can be converted into text data in CSV format and processed with spreadsheet software, such as Microsoft® Excel.

9-1. Software Installation and Uninstallation

This software is applicable for both English and Japanese. The software automatically determines the language used on the PC which the software is installed; if the PC uses English, the software is displayed in English. However, there are separate installer software files available for English and Japanese.

1. Software Installation

- 1) Insert the attached software installation CD into the CD drive on the PC while the Windows desktop is displayed on the screen.
- 2) From the installation disk, select [MP11_Software_Ver**.***_Installer] → [English] and click the "Setup.exe" to start up the installer
- 3) Installer wizard window appears; click [Next] to proceed to the following step.



Figure 9-1-1. Installation Wizard Start-up Window

- 4) [Software Usage Agreement] window appears; select “Agree” and click [Next] button to go to the next step.

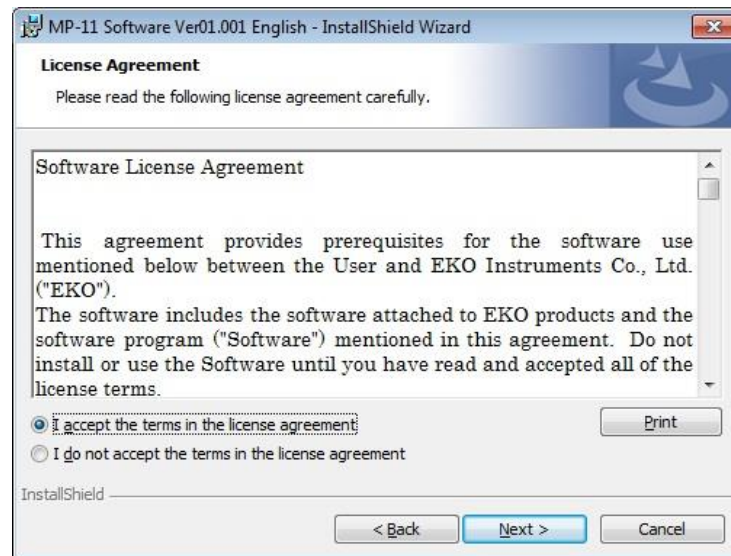


Figure 9-1-2. Software Usage Agreement Window

- 5) [Select Installation Folder] window appears.
- Assign a folder where the software to be installed. If you wish to install the software in the [C:¥EKO] folder, click [Next] button to go to the next step. To install the software in a specific folder, select the folder by clicking [Change] button.
- ※ **When changing the installation folder, if the operation system of the PC is Windows Vista/7/8, UAC (User Account Control) function will be effective. Installing in folder where the OS is limiting access, such as “C:¥Program Files”, “C:¥ProgramData”, “C:¥Windows”, and system drive route folder “C:¥”, will cause problems. Avoid these folders when installing the software in specific folder.**

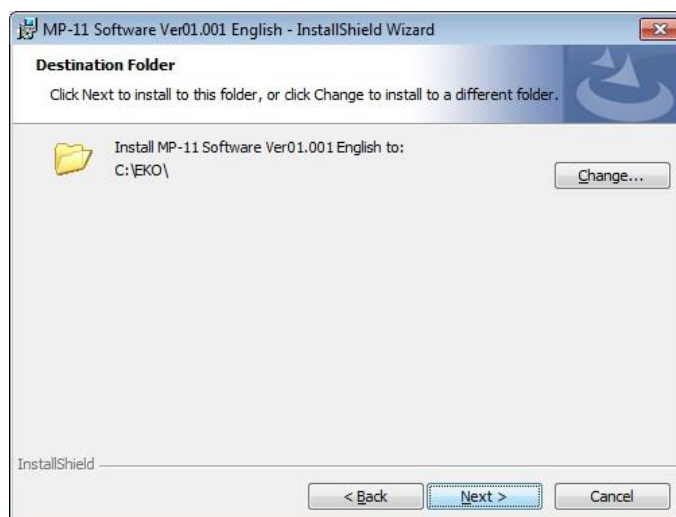


Figure 9-1-3. Select Installation Folder Window

- 6) [Confirm Installation] window appears.
Confirm the installing folder and click the [Install] button to go to the next step.



Figure 9-1-4. Confirm Installation Window

- 7) After a while, [User Account Control] window appears.
Click [Yes] to start the installation.

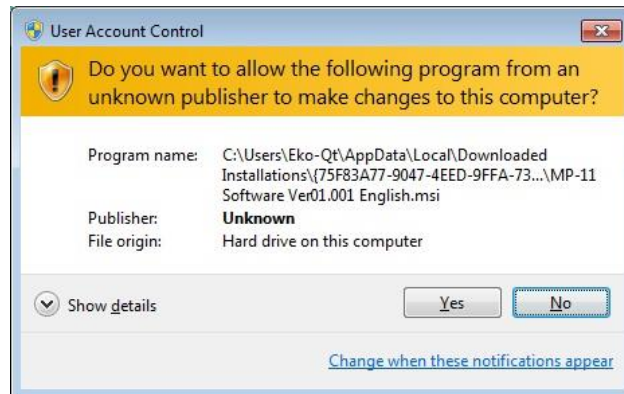


Figure 9-1-5. User Account Control Window

- 8) [Installation Complete] window
Once the installation has completed, following window appears. Click [Finish] button to close the installer wizard window.



Figure 9-1-6. Installation Complete Window

9) Shortcut

Once the installation is completed, following shortcut icon is created on the desktop.

If [Create shortcut in Start Menu] is checked, during the installation process, shortcut icon is also created in the Windows Start Menu.



Figure 9-1-7. Shortcut Icon

2. Software Uninstallation

There following 2 methods to uninstall the software.

1) Uninstalling the software from Control Panel [Program and Function]

Go to [Control Panel] → [Programs] → [Program and Function].

Select and right click on the program to be deleted. Select [Uninstall (U)] from the popup menu.

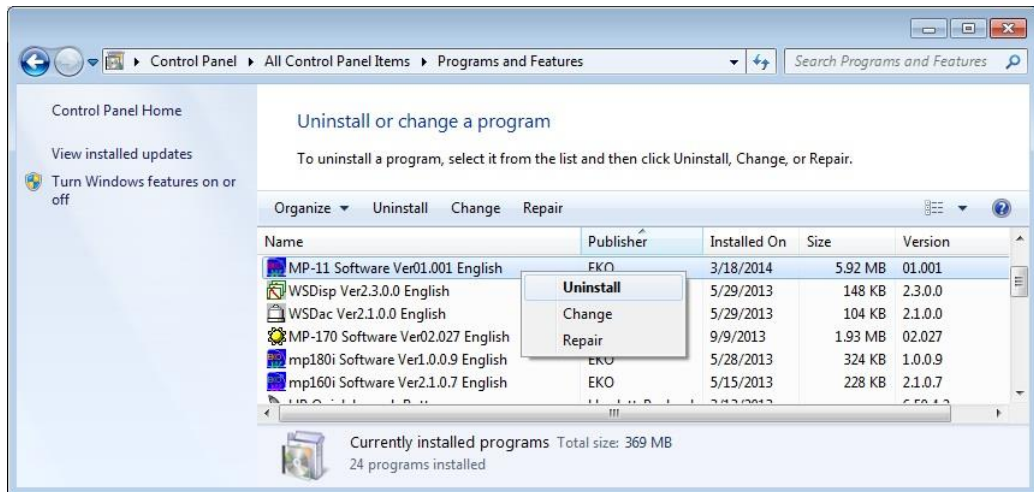


Figure 9-1-8. Uninstallation from “Program & Function”

Following message appears; to surely delete the software, click [YES] button.

After a while the program disappears from the [Program and Function] list, and the uninstallation can be confirmed.

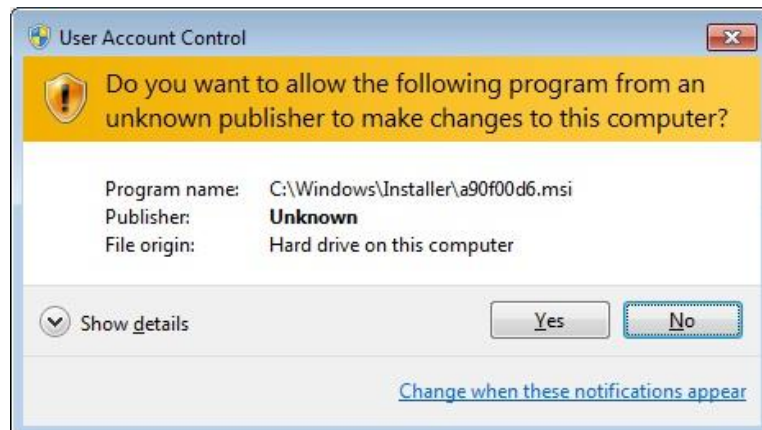


Figure 9-1-9. User Account Control Message

2) Uninstalling the software from the Install Disk

Just like when the software was installed, start up the “Setup.exe” of the software to be deleted from the DC-ROM. Follow the instructions provided by the wizard, and eventually the wizard window appears with “Modify (M)”, “Repair (P)”, and “Remove (R)” if the software is already installed in this PC.

Select “Remove (R)” and click [NEXT] button.

Follow the instruction provided by the wizard to start the uninstallation process.



Figure 9-1-10. Uninstalling from the CD-ROM

9-2. USB Driver Installation

1. USB Driver Installation

The USB for MP-11 uses the device driver software by Future Technology Devices International Ltd. (FTDI). There are 2 driver software provided by FTDI. Both driver software is included in the attached CD.

One is EXE-run type driver software, and this type of driver software is installed in Windows prior to connecting the USB device to the PC. Another type of USB driver installation is that when the USB connector is inserted to the PC, the wizard appears to process the installation.

Both driver software is included in the attached CD-ROM inside "USB" folder.

◇ Installing by EXE-run type driver

- (1) Startup the [CDM v2.08.30 WHQL Certified for Windows 8.1.exe] with administrator authority
- (2) , by right clicking the EXE-run driver and select the "Run as administrator "

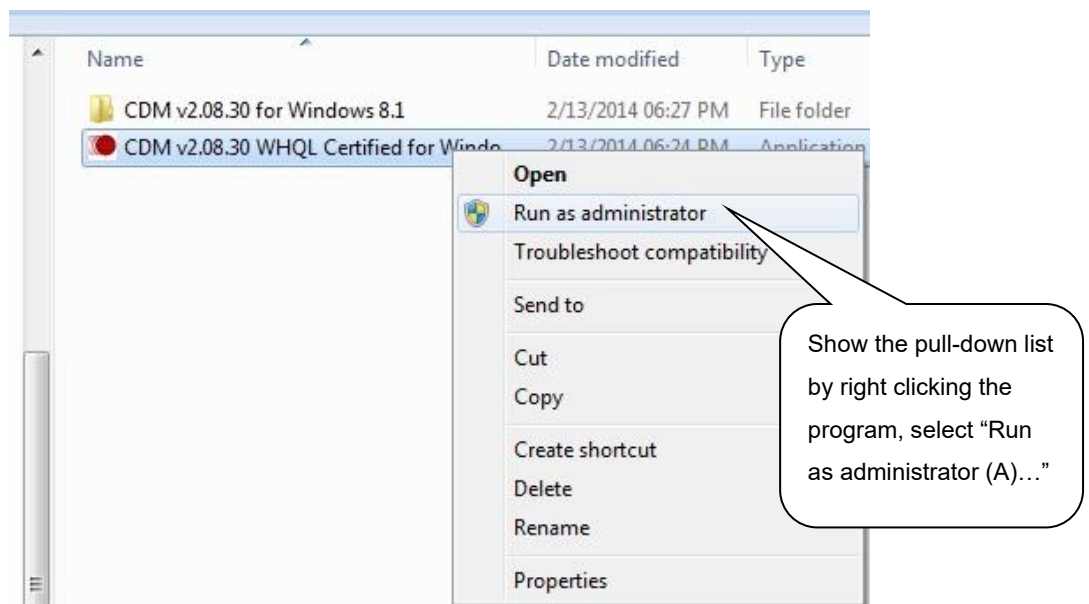


Figure 9-2-1. Installing USB Driver with Administrator authority

- (3) Below window appears; click [Extract] to start the installation.
USB Serial Converter driver and USB Serial Port driver are installed.

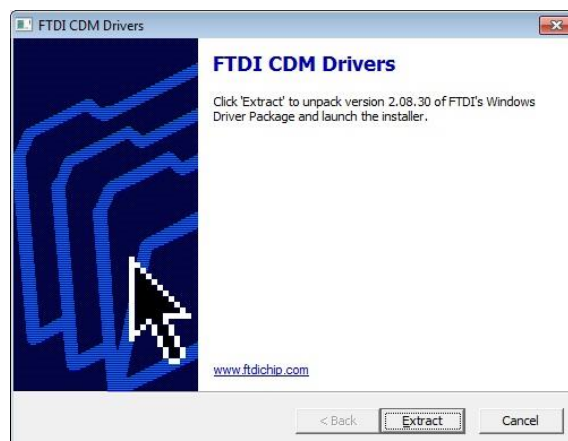


Figure 9-2-2. USB Driver Installation Start Window

- (4) Driver installation is started

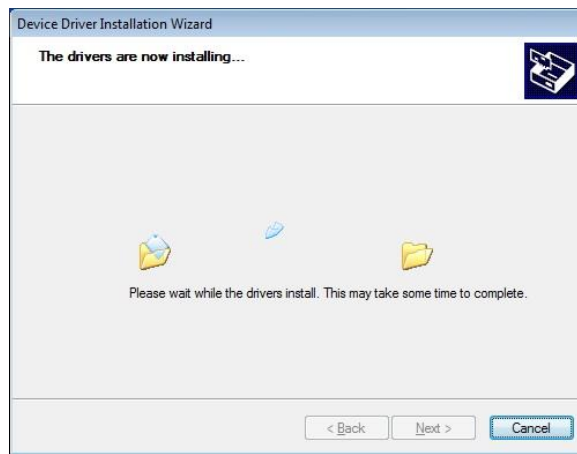


Figure 9-2-3. USB Drier Installation Window

- (5) Security warning message appears.

Since there will be 2 types of drivers are installed, this security message appears twice.

Select "Install this driver software (I)" for both messages and continue with the installation process.



Figure 9-2-4. Security Warning Message Window

- (6) Installation Complete window appears. Click [Finish] button to complete the installation.



Figure 9-2-5. USB Driver Installation Complete Window

There are some cases that the driver results in unsuccessful installation due to some conflicts, such as older version device installer is already installed in the PC or other USB device driver is installed and conflicting the port numbers. In such case change the port number to unoccupied number to avoid conflicts or uninstall and reinstall the both drivers.

✧ Installing by Wizard

The Wizard type installation automatically starts up the installation wizard when the USB connector is inserted into the PC.

Depending on the PC environment, the wizard may not appear; in such case, the USB driver must be installed manually from Device Manager. The device driver needs to be updated and reinstalled also from Device Manager.

For further details, refer to the following URL for FTDI Ltd.

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

For installation and updating the driver software in the wizard format, assign the following folder which is in the attached DC-ROM for the original driver installation folder.

¥CDM v2.08.30 for Windows 8.1

2. Confirming Completion of USB Driver Installation

- 1) After the PC is restarted, connect the PC and MP-11 Main Unit with USB cable.
- 2) Open the [Control Panel] from Windows.
- 3) Click the [System] icon. Click the [Device Manager] which is in the System window.
- 4) Check the Port is assigned with USB Serial Port (COM*). The COM number will change depending on the PC environment.
- 5) Open the USB Serial Port property window and verify there is a statement on the Device status section as “this device is working properly”.

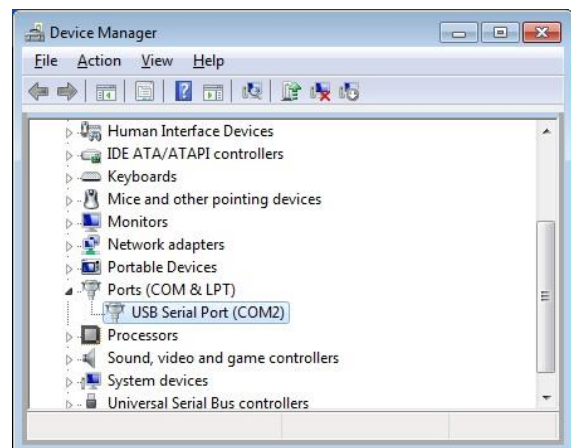


Figure 9-2-6. USB Driver Install Confirmation

Then finally the USB serial converter driver and USB Serial Port Driver software installations are completed.

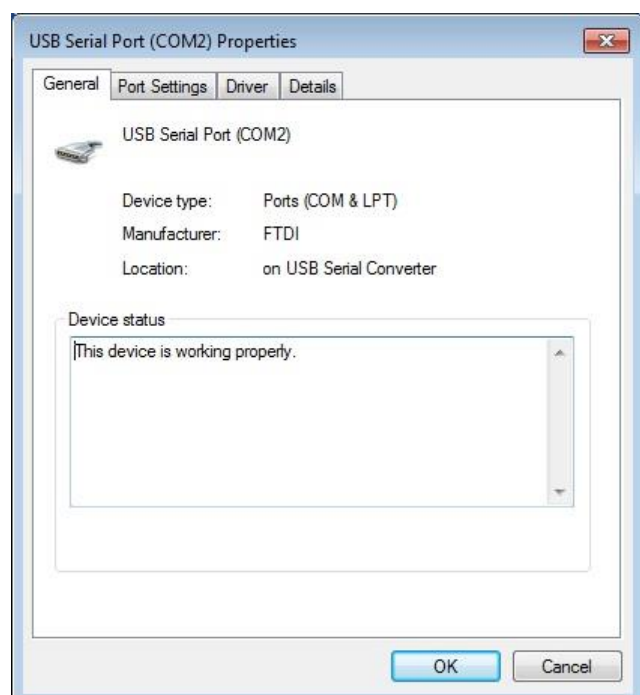


Figure 9-2-7. USB Serial Port Property Window

3. Vendor information of the USB Driver

- 1) Depending on the PC's OS version and USB driver software version, the installation steps may vary.
For more details of installation guide for each OS type, see below URL provided by FTDI Ltd.
URL: <http://www.ftdichip.com/Documents/InstallGuides.htm>

- 2) The newest driver software can be downloaded from FTDI Ltd. (Future Technology Devices International Ltd.) website at below URL.
URL: <http://www.ftdichip.com/Drivers/VCP.htm>

Cautions for Software Installation:

- ※ If the PC which the software is installed is connected to a network, the software cannot be installed without administrator authorization. Contact network administrator as necessary.
- ※ If the English version software is installed in a PC which OS language is other than Japanese or English (i.e. German), the fraction symbol may be setup with "comma (,)" instead of "period (.)" as default setting. This setting will cause problem in text conversion and graph display on this software. Change the setting of the comma indication by accessing to the "Area and Language Option" from below steps.
 1. Go to: Windows Start → Control Panel → Area and Language Option
 2. On "Format" tab, click [Additional Setting] button to open a dialog "Custom Format", "Number" tab, "Symbol for decimal point (D):"
- ※ If the system locale (one of the language setting) for the OS is changed, the fonts may get corrupted.

9-3. Software Operations

To operate the MP-11 from PC using this software, connect the MP-11 Main Unit and PC with attached USB cable and turn ON the Main Unit power.

To start this software, go to [Start] → [EKO] → [MP-11].

When this software is started, the Main Window appears. There are 4 tabs [Measure], [Graph], [Save] and [Irr. Vs Par.]. By clicking each tab, each tab display changes. When the software started the [Measure] tab is displayed as default.

1. Measure Tab

On the Measure tab, measurement parameter can be setup and take measurements.

Each button function is described below.

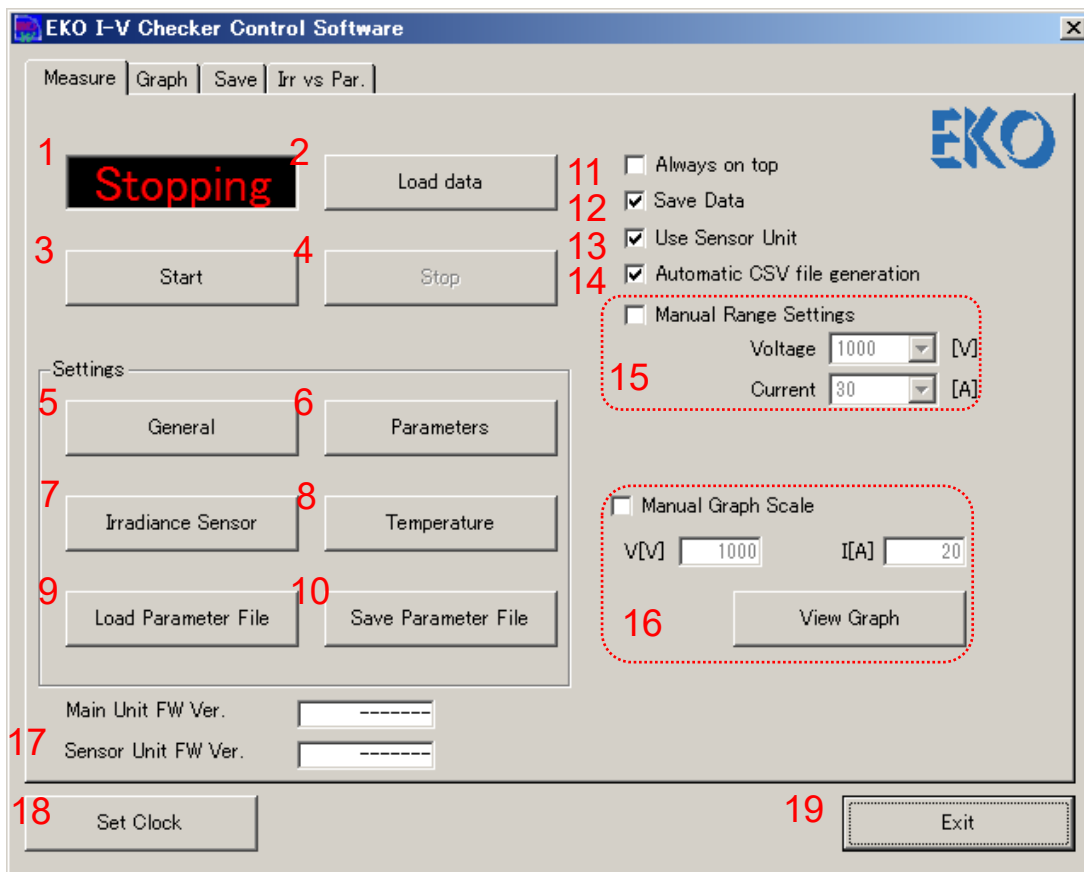


Figure 9-3-1 Measure Tab

Table 9-1. Measure Tab Functions

No	Functions	Details
1	Measurement Status Display	Indicate statuses of "Stop", "Standby", or "Measuring"
2	Load Data Button	Upload measured data from MP-11
3	Start Button	Start measurement
4	Stop Button	Terminate measurement

Table 9-1. Measure Tab Functions - Continued

No	Functions	Details
5	General Button	Setup measurement conditions
6	Parameters Button	Setup PV modules or arrays parameter setting
7	Irradiance Sensor Button	Setup pyranometer setting
8	Temperature Button	Setup temperature setting
9	Load Parameter File Button	Upload saved parameter file
10	Save Parameter File Button	Save the setting contents in a file
11	Always on top Checkbox	Check here to have this window always on top on the desktop
12	Save Data Checkbox	Automatically save data
13	Use Sensor Unit Checkbox	Check here when using the Sensor Unit
14	Automatic CSV file generation Checkbox	Check here to automatically generate CSV file
15	Manual Range Settings Checkbox	Check here for manual operation and enter the rating voltage/current
16	Manual Graph Scale Checkbox	Check here and enter values to assign the graph range
17	Main Unit FW Ver.* Sensor Unit FW Ver.**	Indicate firmware versions of MP-11 Main Unit and Sensor Unit
18	Set Clock Button	Synchronize the clock on the MP-11 Main Unit and connected Sensor Unit with PC clock
19	Exit Button	Finish the application

*The firmware version numbers are indicated when the PC/software makes communication first time with the MP-11 (for setting and file upload).

**If the Sensor Unit is not connected or not powered ON at the time of initial firmware version read out, the Sensor Unit firmware version will not be indicated. The firmware version information will not be read out in any other communications after the initial read out.

1) General Setting

When [General] button is clicked, below dialog window appears.

- (1) Select Communication Port (COM port No.)
COM1 to COM16 are available. If all COM ports are occupied by the other applications already installed in the PC, COM port number above 16 may be assigned automatically and in some cases the COM number does not show; in such case, change the COM port number from the Device Manager.

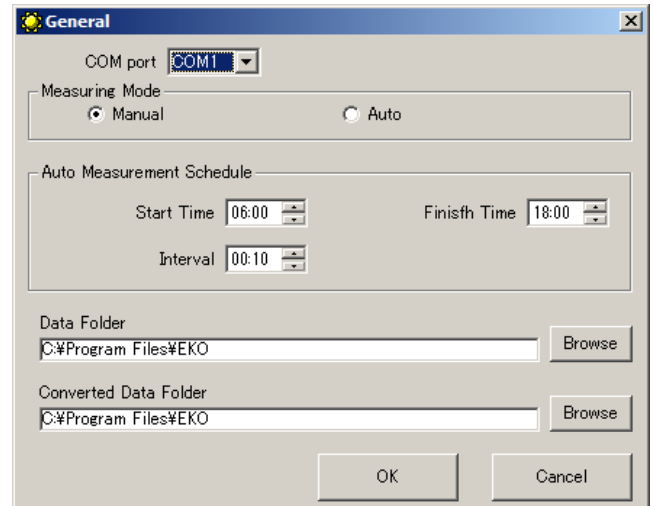


Figure 9-3-2 General Setting

(2) Selecting Measurement Mode

- ◇ Manual: The [Start] button has to be pushed for each measurement.
- ◇ Auto: The measurement is taken automatically by the measurement interval setup for start and end time.

(3) Auto Measurement Schedule

Enter measurement “start time”, “finish time” and “interval” in the [Auto Measurement Schedule] section.

(4) Select Directory Folder for Data Saving

Select a directory folder for the data to be saved.

When the [Browse] button is clicked, “Browse for Folder” dialog window appears.

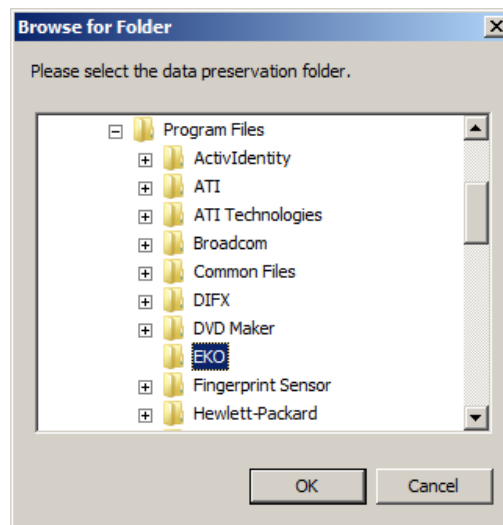


Figure 9-3-3. Browse for Folder

Assign a directory with following function:

- a. Directory Tree Window
Select a folder
- b. Key Entering
Folder can be assigned by key entering
- c. Pull-down Menu for Drive Selecting
Drive can be changed with pull-down menu.
- d. Create New Folder
A new folder can be created under a desired directory by clicking this button.
After folder is created, change the folder name by key entering.

(5) Select a folder for Converted Data Folder to save the converted data.

Click [OK] button after the setting is completed. Click [Cancel] button to clear all entered information.

2) Parameters Setting

When [Parameters] button is clicked, the parameter setting dialog window is displayed as shown below.

- (1) The PV Device Area (Area), Current Temperature Coefficient (α), Voltage Temperature Coefficient (β), Series Resistance (R_s), Curve Correction Factor (K) are entered with values from one PV module
- (2) By entering the quantity of PV module in series and parallel, they are calculated into the parameter for overall PV array, and it used for the IEC 60891 standard condition conversion.
- (3) The Comments section is not directly related to the measurement parameter; however, for data identification purpose, the information entered in this section is useful for organizing the data. It is recommended to enter information every time the measurement condition is changed. This information is also saved in the data file.

The screenshot shows a dialog box titled "Parameters" with a close button in the top right corner. The dialog contains the following fields and controls:

- PV Device Area (A): m²
- Current Temp. Coef. (Alpha): A/degC
- Voltage Temp. Coef. (Beta): V/degC
- Series Resistance (Rs): ohm
- Curve Correction Factor (Kappa): ohm/degC
- PV Array Combination:
 - Series:
 - Parallel:
- Comments:
 - Site Name:
 - PV Device Name:
 - PV Device Type:
- Buttons: Download, Upload, Cancel

Figure 9-3-4. Parameters Setting

- (4) Then click the [Upload] button to upload the parameter setting setup in above steps from the PC software to MP-11 Main Unit.

NOTES:

- ✧ The parameter information uploaded by the [Load Parameter File] button on the Measure Tab can also be uploaded and/or downloaded; however, the updated parameter information will not be reflected unless the [Upload] button on Parameter Setting dialog window is clicked.
- ✧ MP-11 Main Unit will take measurement according to the uploaded parameters setting; however, the contents of the parameters setting which was uploaded from the PC software cannot be verified on MP-11 Main Unit
- ✧ In case the parameters setting did not get uploaded to MP-11 successfully even though the parameters were setup by following the above steps, the Standard Test Condition calculation will not be reflected to the measurement data.
- ✧ Also when the MP-11 Main Unit power is turned OFF, the uploaded parameters will be erased. The parameters setting uploaded from PC to MP-11 Main Unit cannot be saved on the MP-11 Main Unit memory.

To download the parameters setting which is saved in the MP-11 to the PC software, click [Download] button. By using this button, the uploaded parameters setting can be downloaded back to PC software and verify the contents.

3) Reference Solar Irradiance Setting

Reference Solar Irradiance dialog window appears when the [Irradiance Sensor] button is clicked.

- (1) Select a sensor which will measure the irradiance; choose from pyranometer or reference cell. Enter the sensitivity of the selected sensor.
- (2) Enter the Threshold Irradiance (E_r) and Averaging value (mean number). Threshold irradiance value is a setup value which hides the data less than the set irradiance from the display tab or save tab, also hides data from data lists on irradiance graph tab.
- (3) Irradiance is measured by clicking the [Measure] button.
- (4) After the values are entered, click [OK] button. To clear all entered values, click [Cancel] button.

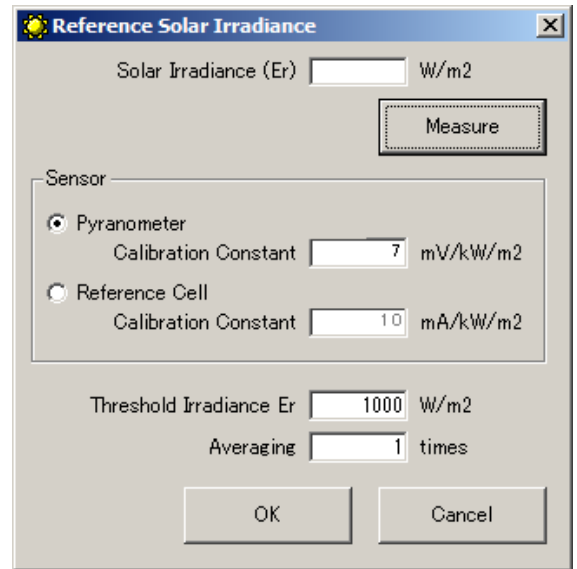


Figure 9-3-5. Reference Solar Irradiance Setting

4) PV Module/Array Temperature Setting

When [Temperature] button is clicked, below dialog window appears.

The “PV Device Temp. (Temp.1)” represents the PV module/array temperature input to “Temp 1” on the Sensor Unit terminal block; this value will be used in the conversion for Standard Test Condition.

The “Temperature (Temp.2)” represents the ambient temperature, input to the Temp2 on the Sensor Unit terminal block.

By clicking each [Measure] button, the measured values will appear in each box.

The “Averaging” represents the number of time to average the measurements. The measurements are repeated as many times as the entered value in this box.

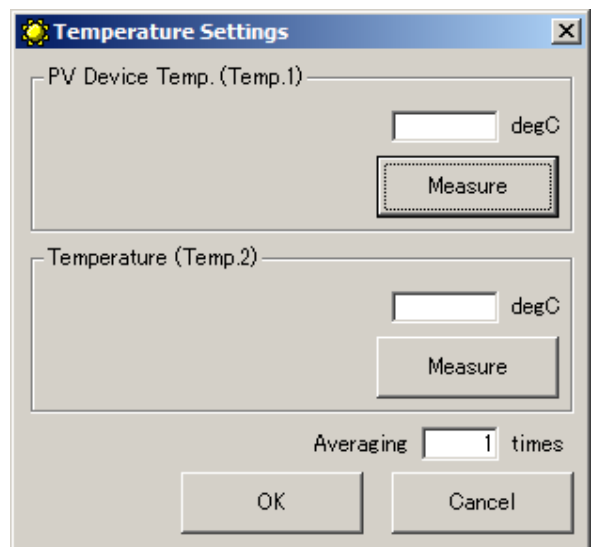


Figure 9-3-6. Temperature Settings

After the values are entered, click [OK] button. To clear all entered values, click [Cancel] button.

5) Save Parameter File

Once the parameter setting is completed, click [Save Parameter File] button; it is recommended to save with appropriate setup contents on the name. Click [Save] button after entering the file name.

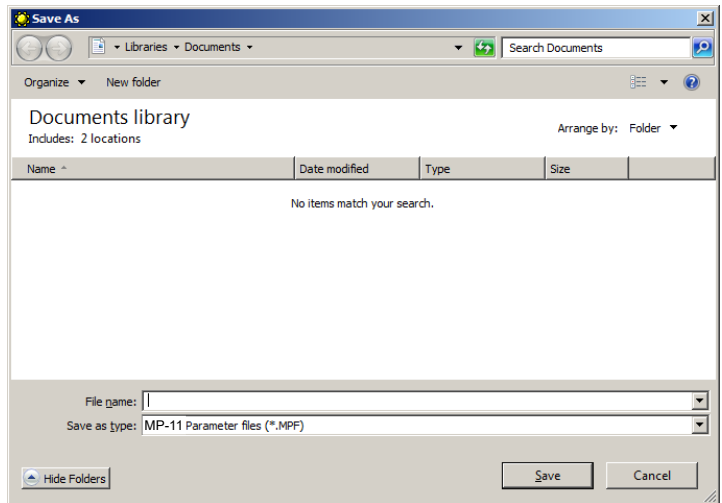


Figure 9-3-7. Save As

6) Load Parameter File

By selecting a file name same as the one saved last time and clicking the [Load Parameter File] button parameter setting was saved in the past can be recalled when next time the software is started up.

Select a file name then click [Open] button.

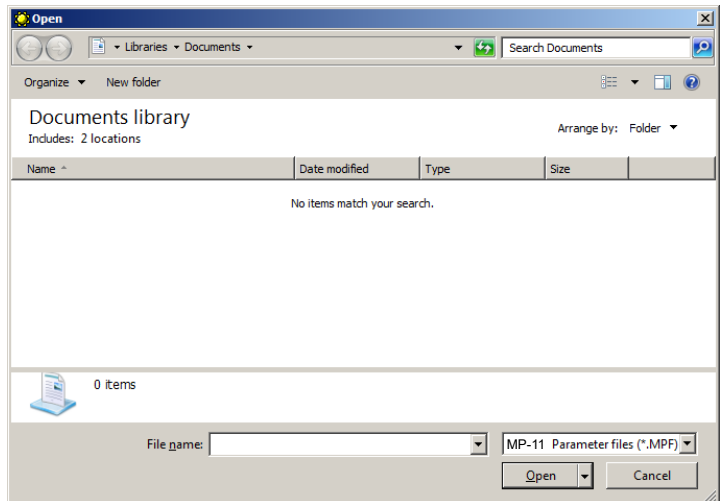


Figure 9-3-8. Open

However, although the parameter information uploaded from this process would include the PV module/array parameter information, the PV module/array parameter information will not be reflected to MP-11 Main Unit just by clicking the [Start] button. The parameter information must be transferred to MP-11 Main Unit by clicking the [Upload] button from the Parameter Setting dialog window.

Now all settings are complete and ready to take measurements.

Before going to the next step to take measurements, make sure the MP-11 is setup in the following manner.

- (1) Connect between the MP-11 Main Unit and PC with attached USB cable.
- (2) Setup the parameters according to the procedures described in above section.
- (3) Connect the PV probes to the MP-11 Main Unit and turn ON the Main Unit power then clamp the PV module/array terminal blocks with alligator clips on the PV probes.

CAUTION: Make sure the polarities (+/-) of the PV probes are correct!

7) Measurement Start

By clicking the [Start] button on the “Measure” tab, the measurement will start and [Measurement Status Display] is indicated as “Measuring”. The measurement will stop when [Stop] button is clicked. After the measurement is completed, below graph is displayed.

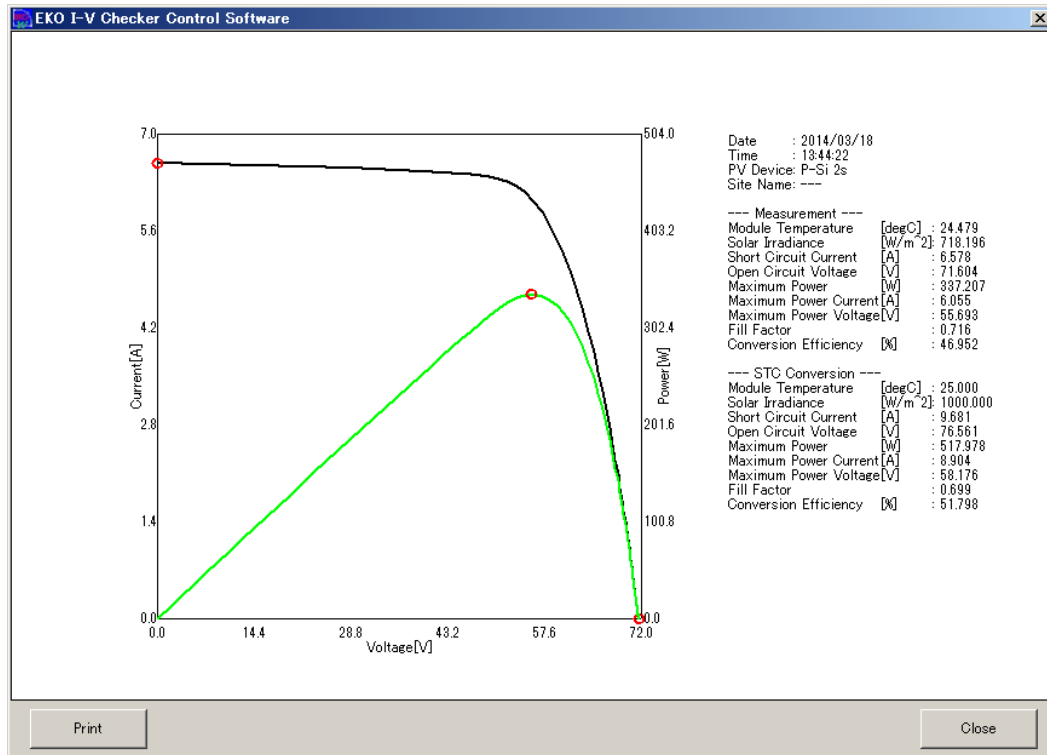


Figure 9-3-9. Measurement Graph

8) Loading Data

After taking a measurement only by using the MP-11 Main Unit and while the MP-11 Main Unit and the PC are connected with USB cable, the measured data can be downloaded to the PC software from the MP-11 Main Unit memory by clicking the [Load Data] button. While downloading the data, the Data Load dialog window appears, indicating the data loading status by counts.

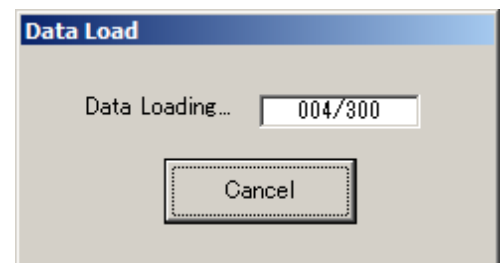


Figure 9-3-10
Data Loading Status Counter Display

In meantime, the MP-11 Main Unit LCD screen displays as shown on the right.

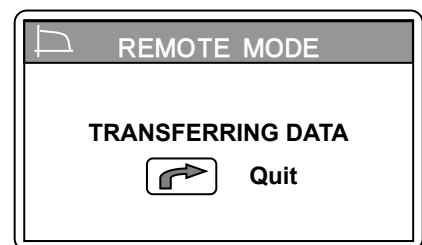


Figure 9-3-11
The Main Unit Data Loading Status LCD Screen

Once the data transferring process is completed, the data loading status counter display will disappear automatically; however, the MP-11 Main Unit LCD screen remains as shown on the right, so press “Esc” button.

The data will be saved in the folder assigned in the General Dialog Window, “Data Folder”.

After the data are downloaded to the PC, a message appears to verify whether to delete the data from the Main Unit; select either [Yes] or [No] button.

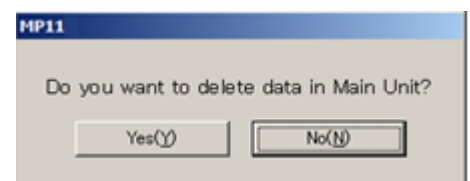


Figure 9-3-12 Delete Confirmation

2. Graph Tab

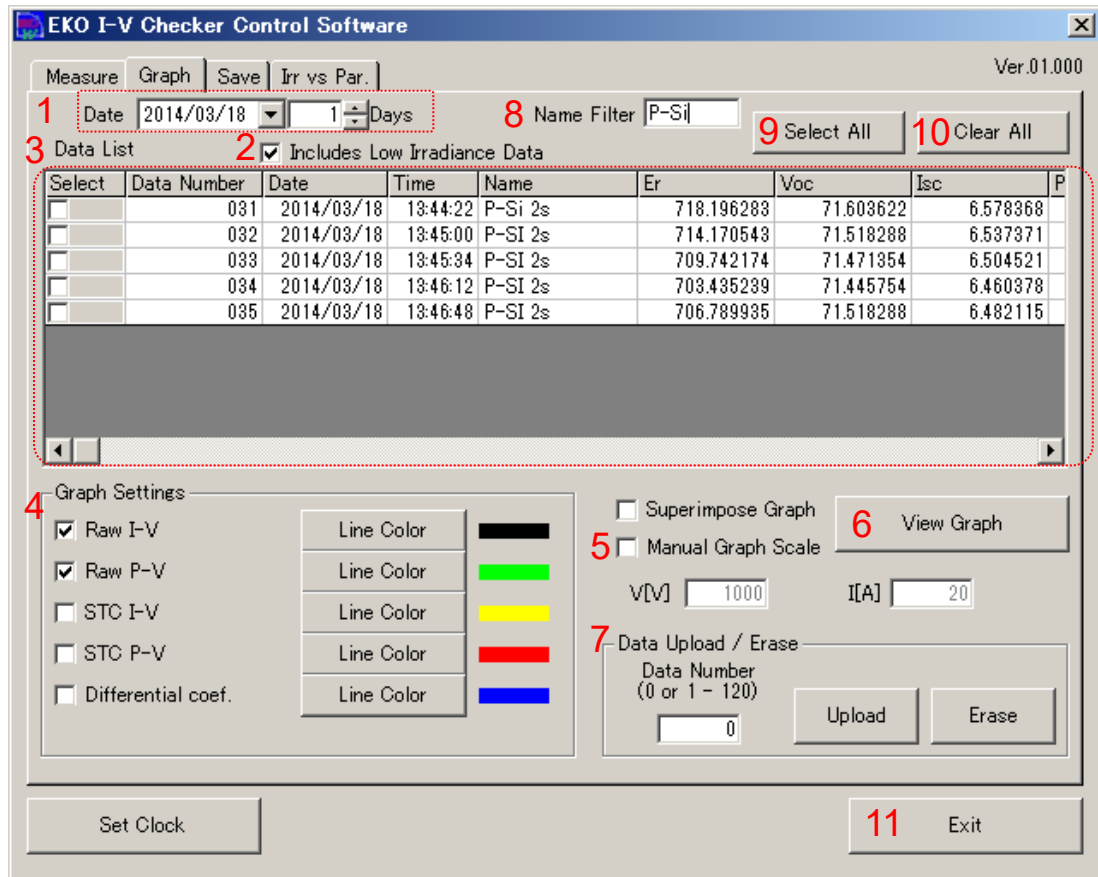


Figure 9-3-13. Graph Tab

Table 9-2. Graph Tab Functions

	Functions	Details
1	Date (Calendar Function), __Days	Displays the measured dates. By clicking the dropdown list button, calendar appears and allows to select desired date from the calendar by click. Also multiple days of data can be displayed on the list by setting the number of days from the first measurement date.
2	Includes Low Irradiance Data checkbox	Check here to list the measurement data with irradiance lower than the threshold setup in the "Reference Solar Irradiance" setting.
3	Data List	List of data which are subjected to the measurement date(s) are listed in this window.
4	Graph Settings	Check the item(s) to be displayed on graph. Each graph line can be modified with desired color.
5	Manual Graph Scale Checkbox	Check here and enter the values for voltage and current to change the scales for graph display.
6	View Graph Button	Click to show the graph for the subjected data.
7	Data Upload/Eraser	Enter the data number here, and click [Upload] to upload the data from PC to MP-11 Main Unit, or [Eraser] to erase the data from MP-11 Main Unit.
8	Name filter	Narrows down the data search by PV module/array name. Enter the PV module/array name and press Enter key.
9	Select All Button	Select all data listed in the data list.
10	Clear All Button	Clear all data selected in the data list
11	Exit Button	Exit this application.

1) Measurement Date Setting

First set the measurement date to select the data to be displayed.

- (1) By clicking the dropdown button located on the right side of the date box, a calendar appears.
- (2) To change the years, click the Year title; the up/down buttons appears on the right. Click the up/down buttons to change the year.
- (3) To change the month, click the Month title. List of 12 months appears. Desired month can be selected either from this dropdown list or by using the left/right arrows at both sides of the Month/Year title. As the Month title changes, the calendar also changes accordingly.
- (4) Click the subjected date on the calendar.
- (5) If necessary, setup the [__Days] box by entering the number to show the data for the multiple days from the selected measurement date.
- (6) As the date setting is completed, the subjected data are displayed in the Data List box.

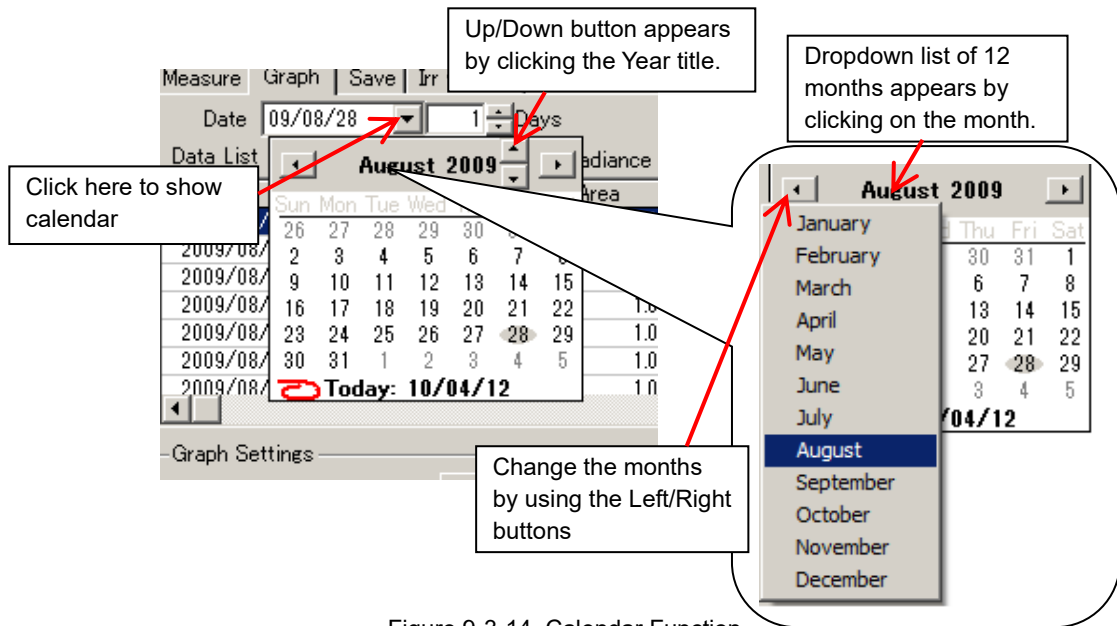


Figure 9-3-14. Calendar Function

2) Graph Setting

Select a data which to be displayed on the graph from the Data List; while the selected data is highlighted, click [View Graph] button to show the graph.

If the displayed graph scale is not appropriate, place a check on [Manual Graph Scale] checkbox and enter the desired ranges for voltage and current; click the [View Graph] button again.

There are 7 characteristics which can be selected to show on a graph by placing check(s) on the item(s). The color of each graph line can be selected from the pallet by clicking the [Line Color] button.

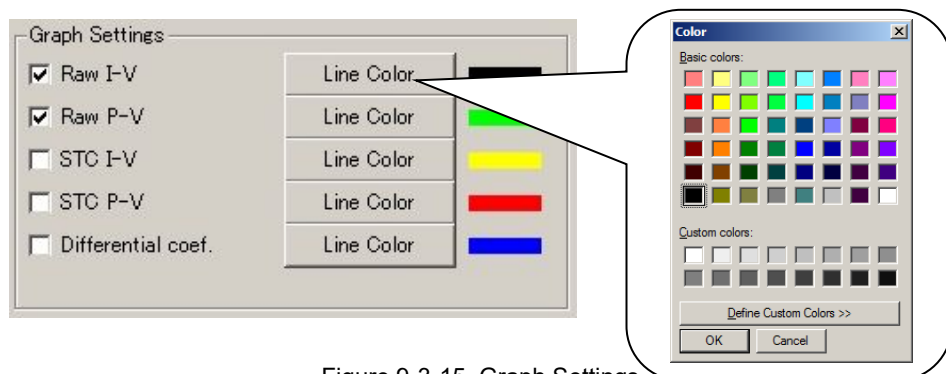


Figure 9-3-15. Graph Settings

When the graph setting is completed, click [View Graph] button once again to show the graph.

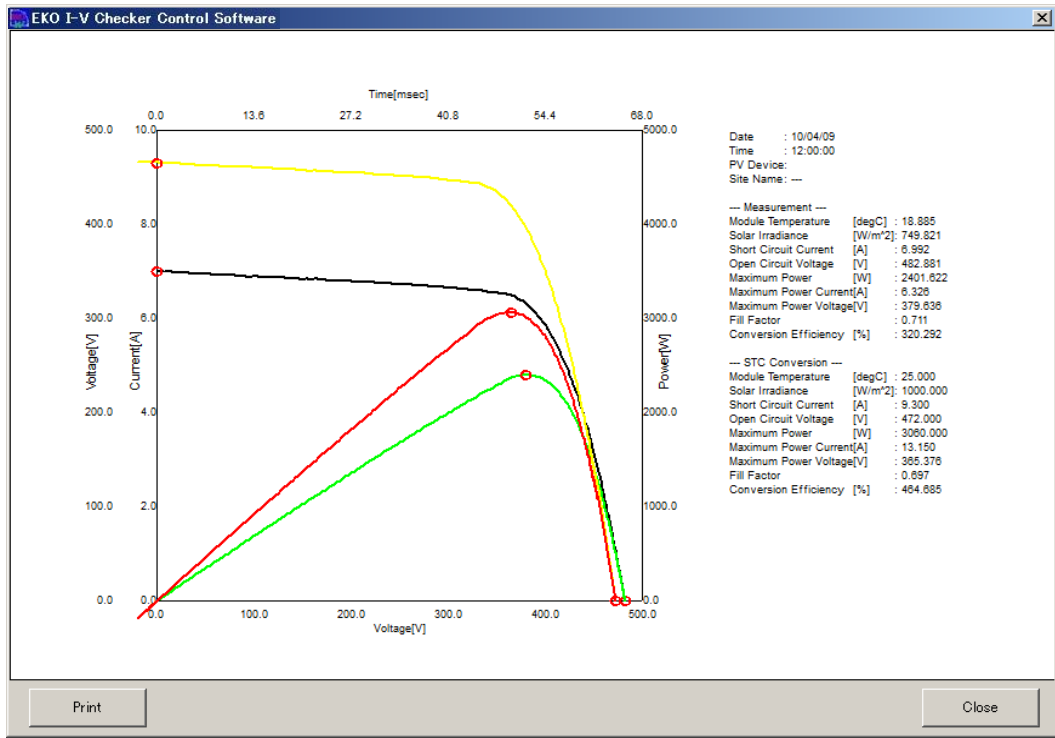


Figure 9-3-16. Graph Display: Color Change

3) Graph Superimposing Function

Up to 10 data can be displayed on a graph by superimposing mode for multiple data comparison.

Select measurement data from the data list by checking the checkboxes; also check the Superimpose checkbox then click "View Graph" button to show the superimposed graph.

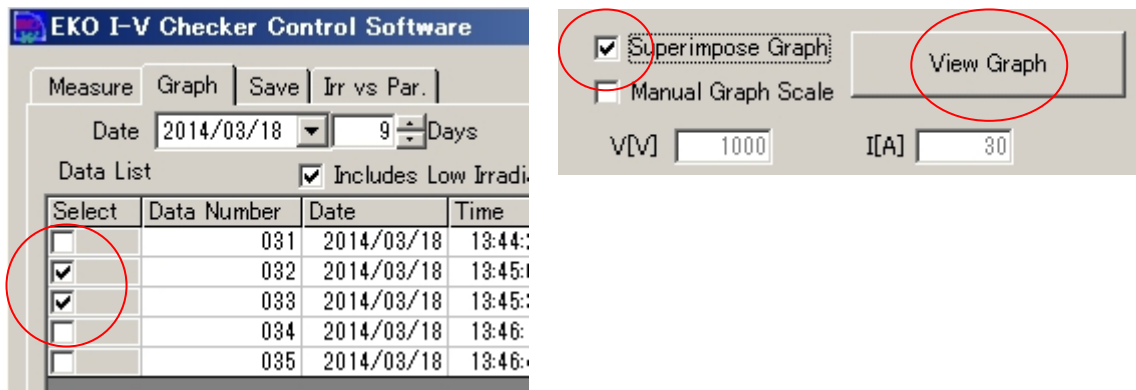


Figure 9-3-17. Superimposing Graph Setting

4) Data Upload/Eraser

Data uploading is to transfer the measured data into the MP-11 Main Unit memory.

There are up to 300 measurement data can be saved by assigning the memory numbers from 001 to 300. The data uploaded from PC side can be also saved up to 120 measurement data, which are assigned with numbers from 301 to 420.

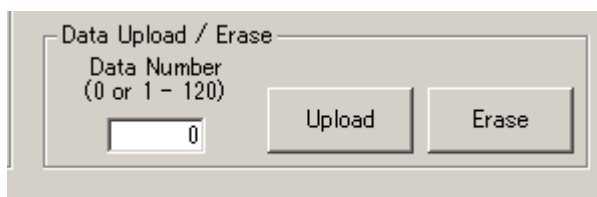


Figure 9-3-18. Data Upload/Eraser

(1) Uploading Data

Assign a number between 1 through 120 as uploading number to the measurement data, which is selected from the Data List, and click the [Upload] button will upload this selected measurement data to the MP-11 Main Unit memory. The uploaded measurement data is assigned to the memory numbers between 301 through 420 section in the MP-11 Main Unit memory.

Assigning "0 (zero)" to a measurement data will register the measurement data to a free number above 301 from the lower numbers.

(2) Erasing Data

To delete the measurement data registered in the MP-11 Main Unit memory, enter the data memory number and click [Erase] button. If the data memory number is "301", enter just "1", same as the number entered when the data was uploaded.

By entering "0 (zero)" and click [Erase] button, all data memory registered in the numbers between 301 through 420 are deleted all at once.

NOTE: The measurement data registered in the data memory numbers 301~420 in the MP-11 Main Unit memory cannot be deleted by the key operation on the Main Unit. Always connect the Main Unit with PC and delete the data from the software side.

3. Save Tab

Below window will show when the Save tab is clicked.

Since the data measured by MP-11 are not in a format which can be viewed on spreadsheet software, such as Microsoft Excel, the measurement data are converted in CSV file format (which can be viewed on spreadsheet software) on this tab, and saved in a specified folder.

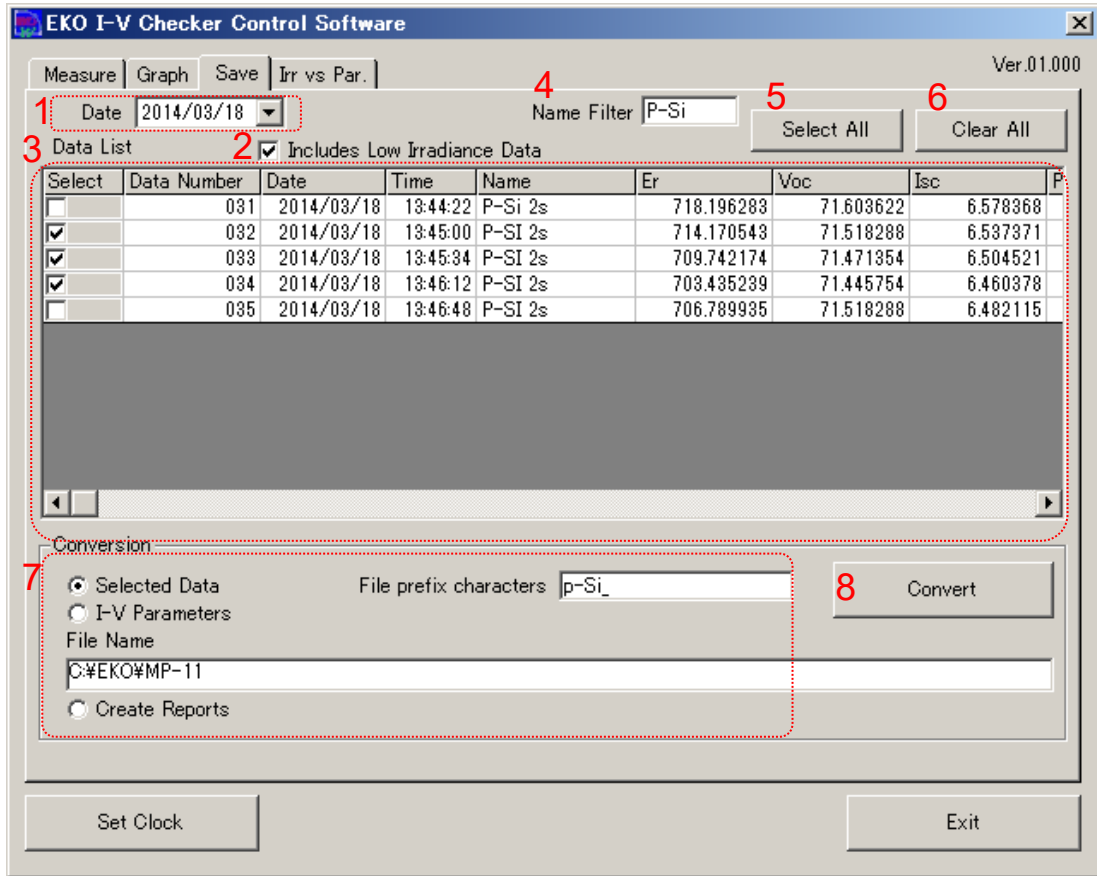


Figure 9-3-19. Save Tab

Table 9-3. Save Tab Functions

	Functions	Details
1	Date (Calendar Function)	Displays the measured dates. By clicking the dropdown list button, calendar appears and allows to select desired date from the calendar by click.
2	Includes Low Irradiance Data checkbox	Check here to list the measurement data with irradiance lower than the threshold setup in the "Reference Solar Irradiance" setting.
3	Data List	List of data which are subjected to the measurement date(s) are listed in this window.
4	Name filter	Narrows down the data search by PV module/array name. Enter the PV module/array name and press Enter key.
5	Select All Button	Select all data listed in the Data List at once.
6	Clear All Button	Unselect the multiple data which are selected in the Data List at once.
7	Conversion	Select methods of saving text data or creating reports and enter the file prefix character for identification. Saved file name is displayed on the "File Name" section with full path.
8	Convert Button	Execute the text file conversion and creates a file by clicking this button.

1) To Save File:

- (1) Enter a measurement date either by directly entering the date in the Date box or select from the calendar function. The data measured on this specific date are listed on the Data List box. If the “Include Low Irradiance Data” checkbox is checked, the measurement data with low irradiance will also appear on the data list.
- (2) Select a conversion type from “Selected Data” or “I-V Parameters” for the text data format of preference. (For more information on data format, see [9-4. Save Data Format] section.)
- (3) Place check(s) in the “Select” column in the Data List box for the data to be converted into text data. If all data to be converted, click [Select All] button. To unselect all selected data, click [Clear All] button.
- (4) Enter specific characters in the “File prefix characters” box. The characters entered here will be inserted at the head of the file name generated by the file conversion and CSV format file. Follow the file naming rule described in the [9-4. Save Data Format] section.
- (5) Finally click on the [Convert] button to save the CSV file in the assigned folder with the file name entered in the previous step. Saved file name appears on the “File Name” section with full path.
- (6) Select “Create Report” and measurement data then click [Convert] button; the simple report file is created in Excel format in the specified folder.

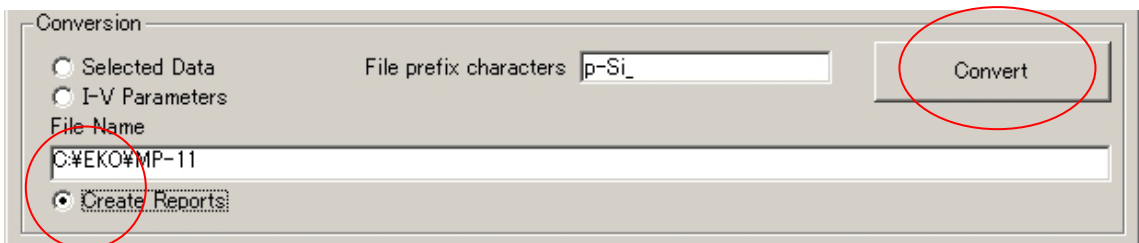


Figure 9-3-20. Create Reports

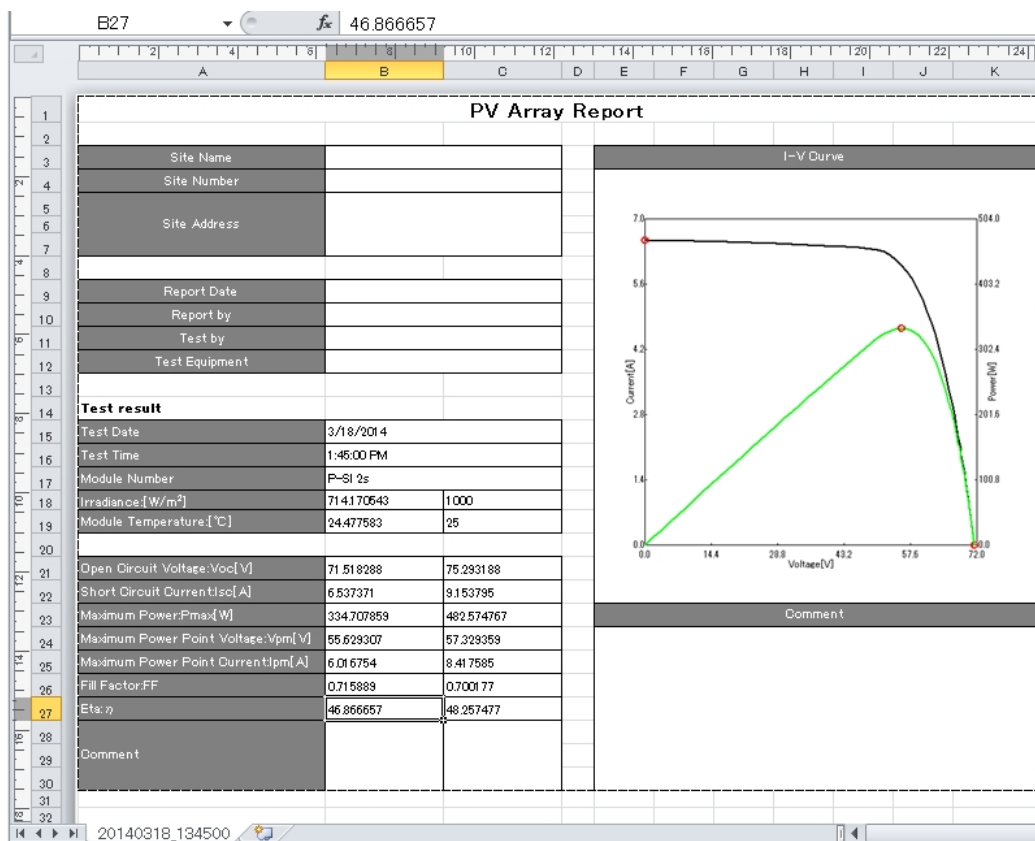


Figure 9-3-21. Report file

2) Customizing the Report File

The report file format can be customized. In order to customize the report format, Microsoft Excel application is required.

- (1) Open the "Format.xls" file which is included in the MP-11 software install folder.
- (2) Make changes to the report format by editing the "Format" sheet in this file.
 - The cells are already assigned with measurement values, etc., but the "define" sheet provided; assign the cells which to be shown on the customized report format.
 - Example: To show the "Time" in the cell "C12", set up the format sheet as | TIME | C12|
 - To show graph on the report, assign the displaying range by selecting the left top cell and right bottom cell.
 - Example: | Graph| F5:H22|
- (3) Save the "Format.xls" after the editing is finished.

NOTE: Do not change the File name and Sheet name.

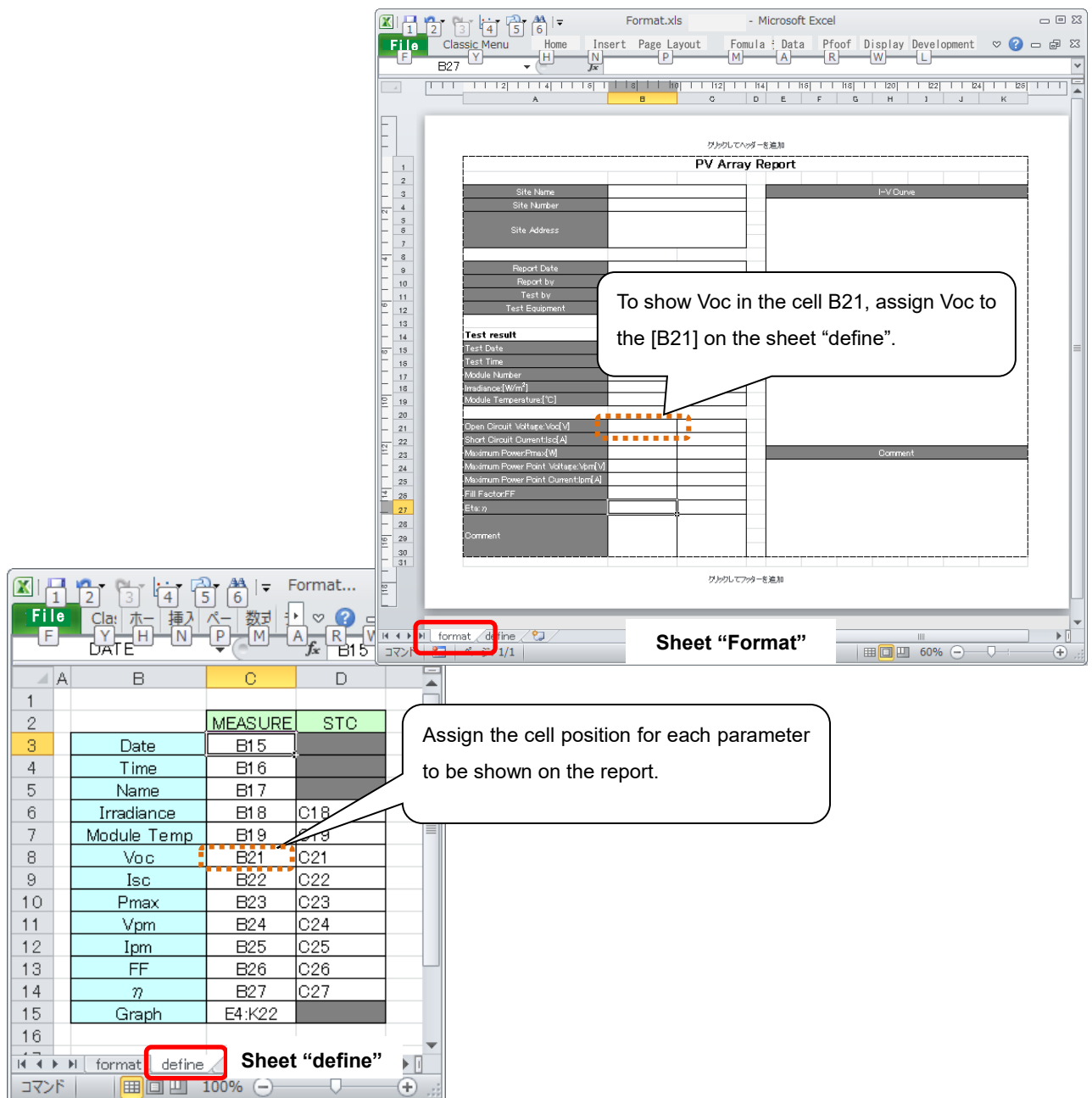


Figure 9-3-22 Customizing Report File

3. Irr vs Par. Tab

Below window appears when the “Irr vs Par.” Tab is clicked.

When already measured data are saved consecutively, each characteristics value against the irradiance can be displayed on graph.

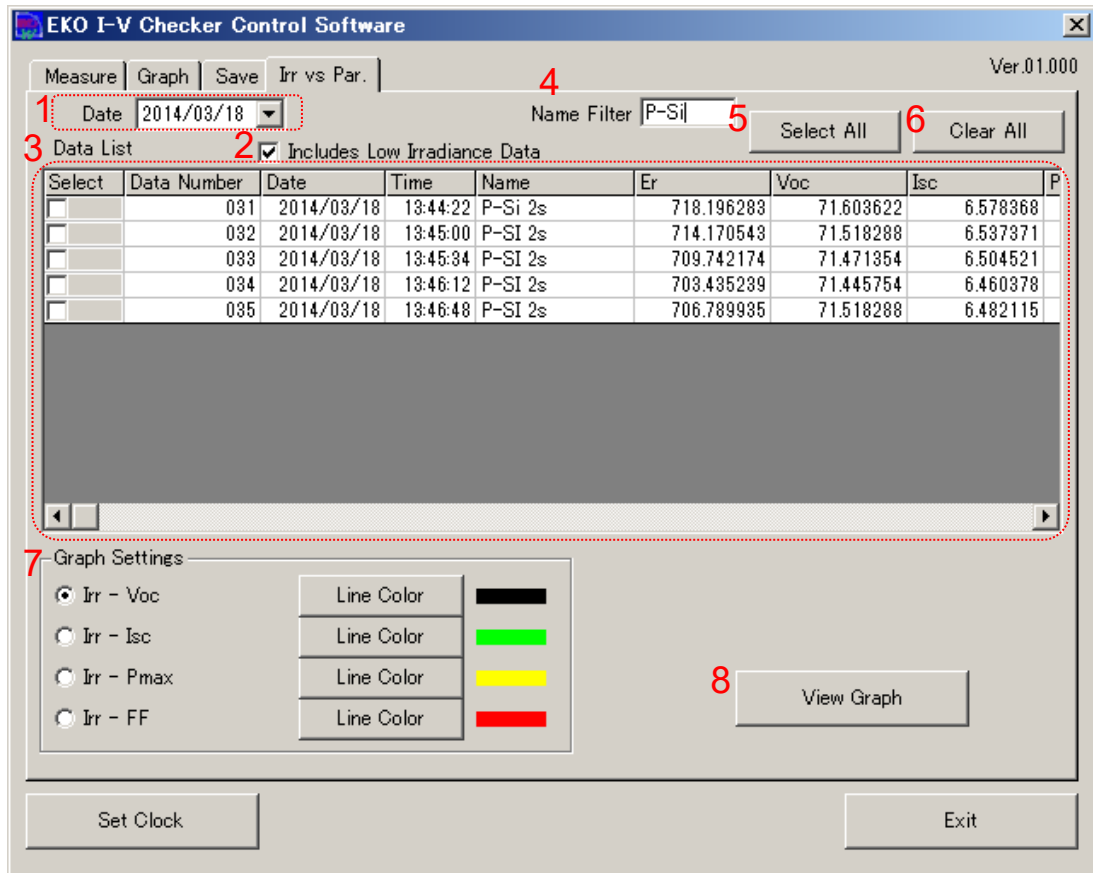


Figure 9-3-23. Irr. Vs. Par Tab

Table 9-4. Irr. Vs. Par. Tab Functions

	Functions	Details
1	Date (Calendar Function)	Displays the measured dates. By clicking the dropdown list button, calendar appears and allows to select desired date from the calendar by click.
2	Includes Low Irradiance Data checkbox	Check here to list the measurement data with irradiance lower than the threshold setup in the “Reference Solar Irradiance” setting.
3	Data List	List of data which are subjected to the measurement date(s) are listed in this window.
4	Name filter	Narrows down the data search by PV module/array name. Enter the PV module/array name and press Enter key.
5	Select All Button	Select all data listed in the Data List at once.
6	Clear All Button	Unselect the multiple data which are selected in the Data List at once.
7	Graph Setting	Select graph(s) of Irradiance vs each characteristics value. From the [Line Color] button, each graph line color can be changed to desired color.
8	View Graph Button	Click this button to show the subjected data graph.

1) Irradiance vs. Open Circuit Voltage Graph

The changes in the open circuit voltage against the irradiance can be graphed from the data acquired by the continuous measurements; the Irradiance (W/m^2) on X-axis and Open Circuit Voltage (V_{oc} , V) on the Y-axis.

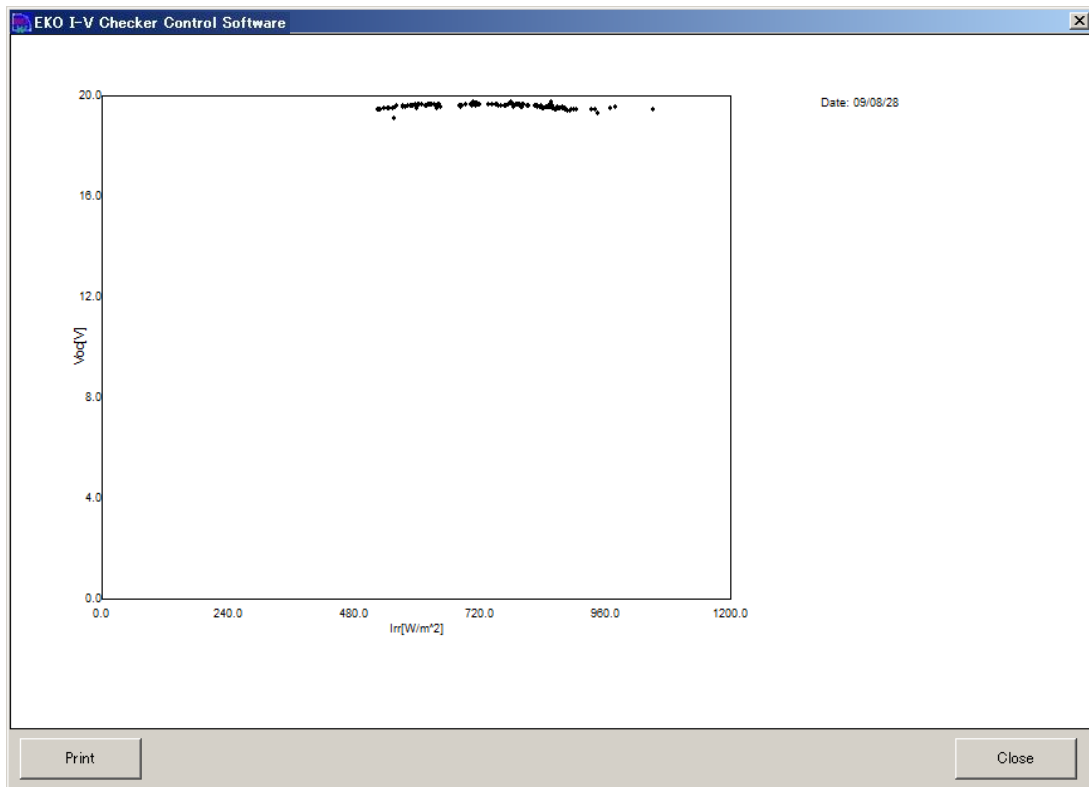


Figure 9-3-24. Irradiance vs. Open Circuit Voltage Graph

2) Irradiance vs. Short Circuit Current Graph

The changes in the open circuit current against the irradiance can be graphed from the data acquired by the continuous measurements; the Irradiance (W/m^2) on X-axis and Open Circuit Current (I_{sc} , A) on the Y-axis.

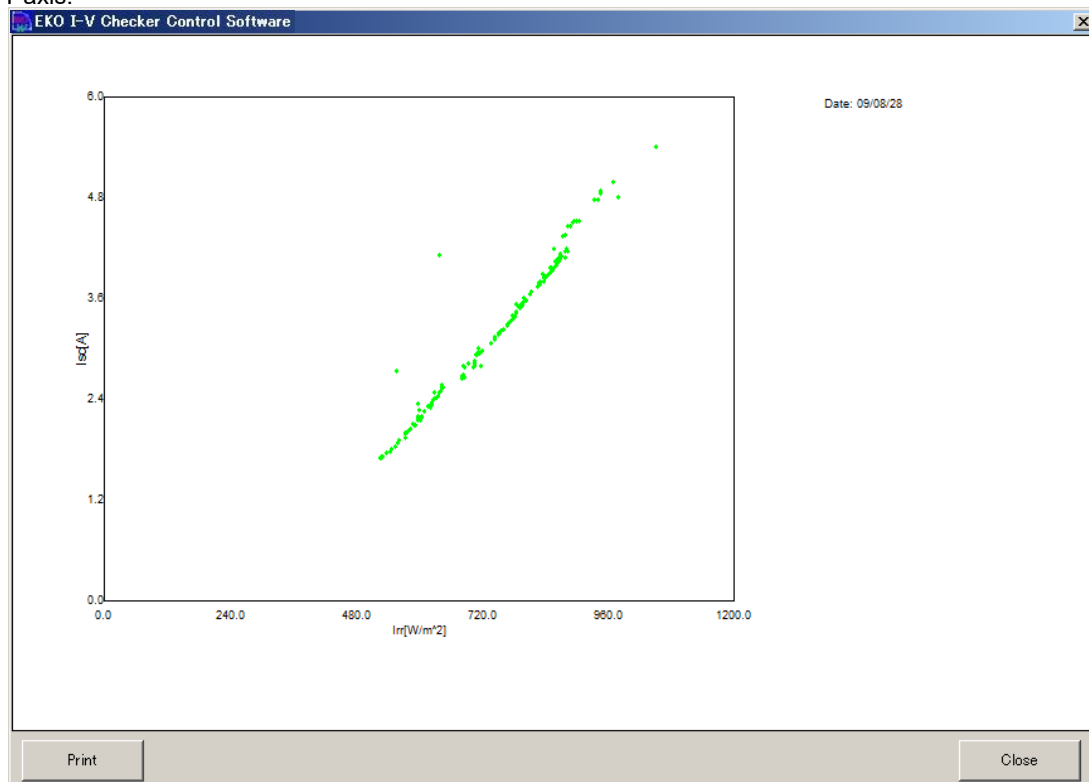


Figure 9-3-25. Irradiance vs. Short Circuit Current Graph

3) Irradiance vs. Maximum Power Graph

The changes in the maximum power against the irradiance can be graphed from the data acquired by the continuous measurements; the Irradiance (W/m^2) on X-axis and Maximum Power (P_m , W) on the Y-axis.

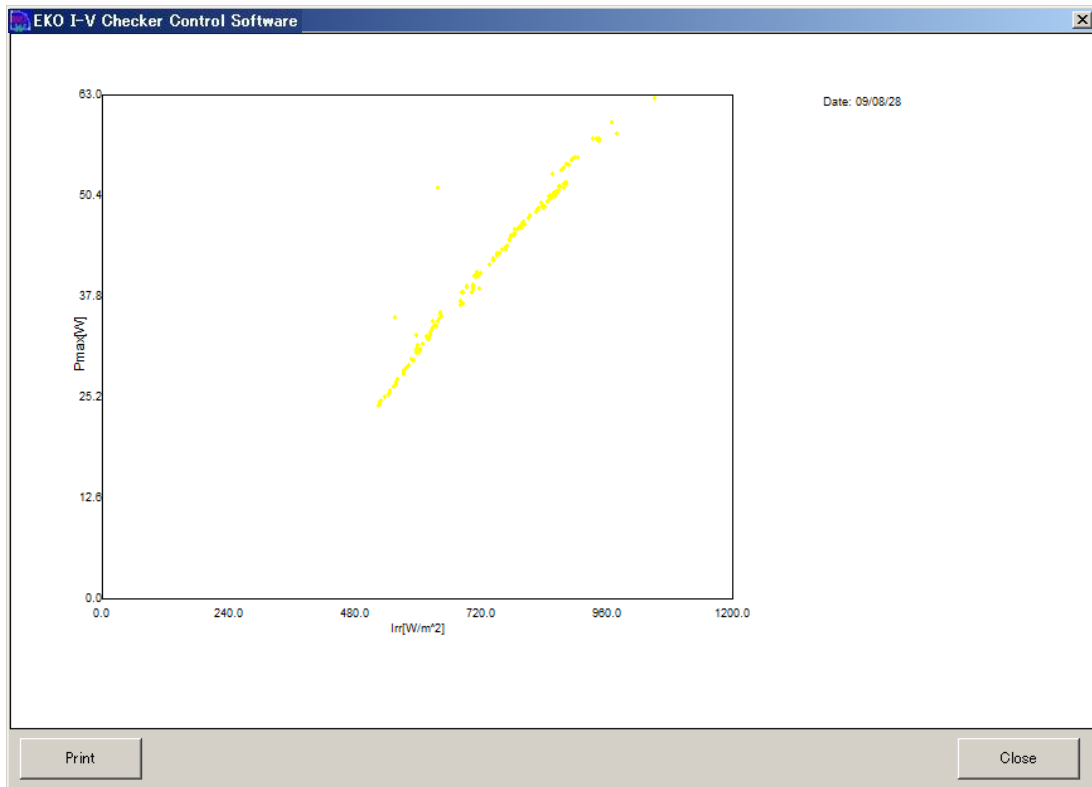


Figure 9-3-26. Irradiance vs. Maximum Power Graph

4) Irradiance vs. Fill Factor Graph

The changes in the fill factor, F.F., against the irradiance can be graphed from the data acquired by the continuous measurements; the Irradiance (W/m^2) on X-axis and Fill Factor (F.F.) on the Y-axis.

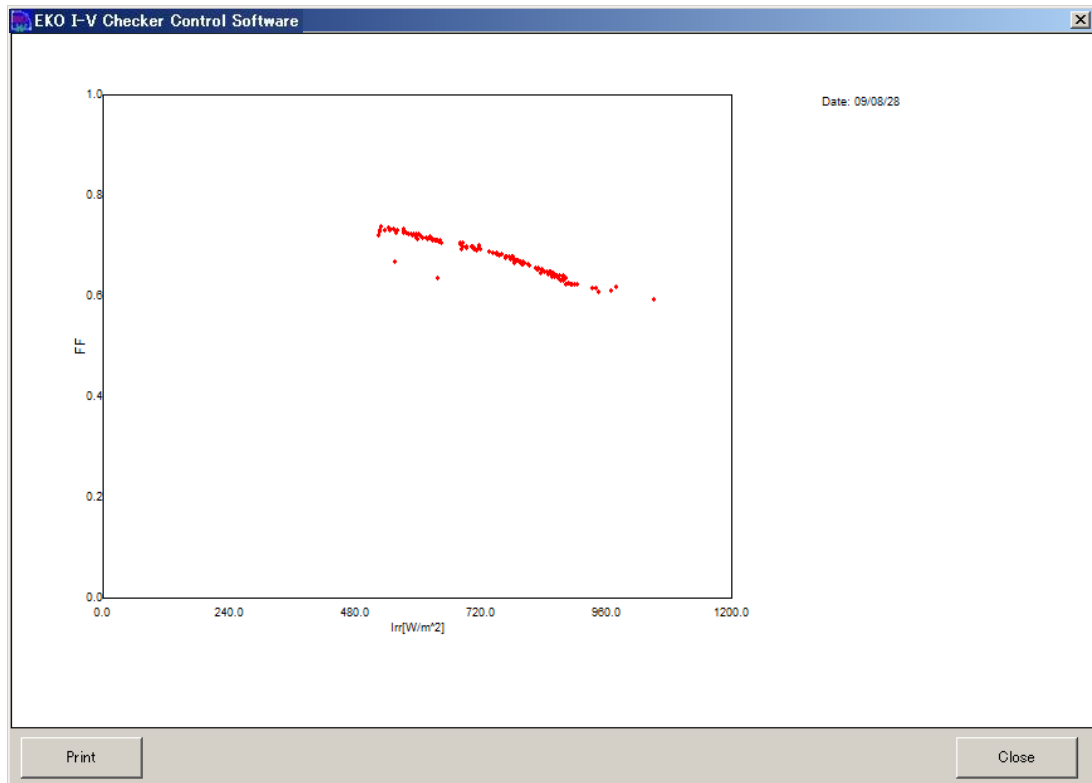


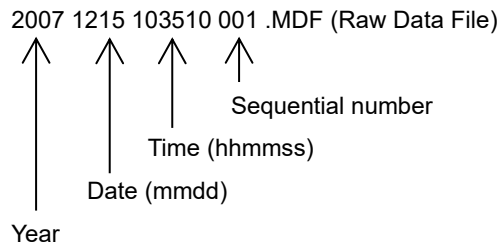
Figure 9-3-27. Irradiance vs. Fill Factor Graph

9-4. Save Data Format

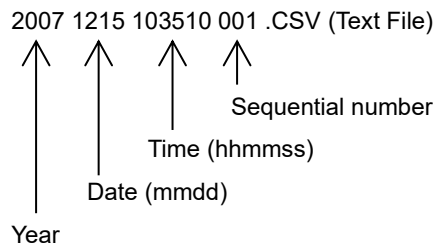
Measurement results are saved daily as raw data in specified folder in the following manners.

1. Rules for Data File Name

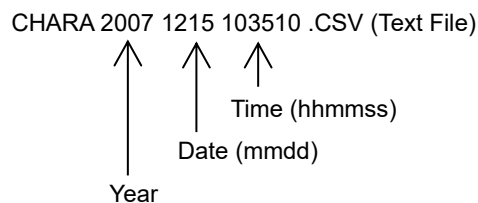
◇ Raw Data File



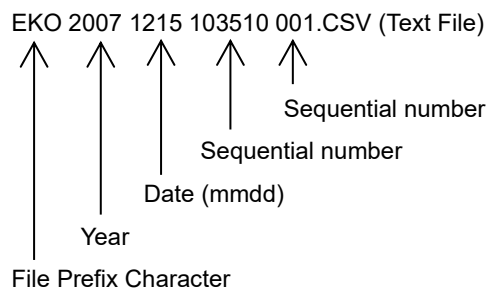
◇ Individual Conversion Data file and Auto-Generated CSV File



◇ Characteristics Value Text File



◇ Individual Conversion Data file and Auto-Generated CSV with File Prefix Character



◇ File Prefix Character Rule

Maximum Character Quantity: 16

Usable Prefix Characters: Alphanumeric characters, -(hyphen), _(under-bar)

Head Character: Only alphanumeric characters

2. Individual Conversion Data File(CSV Conversion Method)

By selecting the individual conversion, following data format is generated.

Name	String-3
Date	2014/3/9
Time	12:30:42
Temperature[degC]	31.752979
Voltage Range[V]	600
Current Range[A]	10
Sampling Pitch[uS]	10
Sensor	Pyranometer
Calibration Constant (Er cal) [mV/kW/m ²]	49.94
PV Device Area[m ²]	1.6421
Current Temp. Coef.[A/degC]	0.00463
Voltage Temp. Coef.[V/degC]	-0.135
Series Resistance (Rs) [ohm]	0
Curve Correction Factor	0
(Kappa) [ohm/degC]	
Series Modules	11
Parallel Modules	1
Solar Irradiance (Er) [W/m ²]	1084.70803
PV Device Temp.[degC]	57.502277
Isc[A]	9.822796
Voc[V]	376.202089
Pm[W]	2523.12274
Ipm[A]	8.915196
Vpm[V]	283.013728
Eta[%]	12.87755
FF	0.682782
Er (stc) [W/m ²]	1000
T (stc) [degC]	25
Isc (stc) [A]	8.95452
Voc (stc) [V]	418.278064
Pm (stc) [W]	2656.561412
Ipm (stc) [A]	8.131098
Vpm (stc) [V]	326.71618
Eta (stc) [%]	14.707118
FF(stc)	0.709271
Voltage[V]	Current[A]
0	9.823
0.12	9.829
:	:
:	:

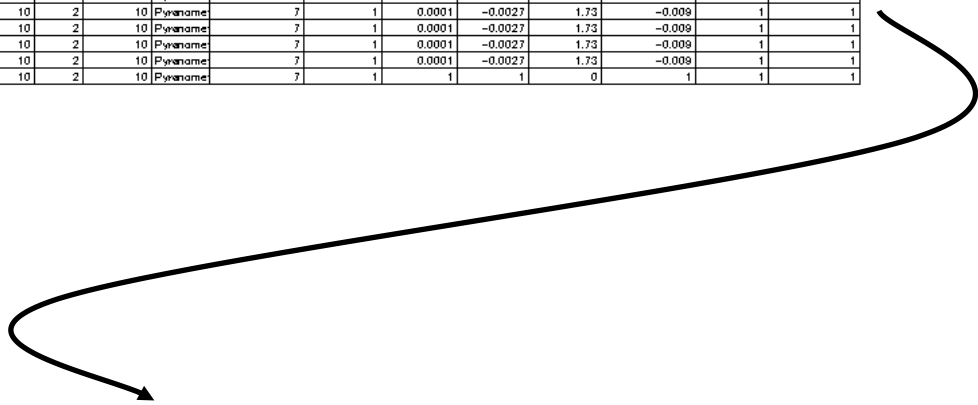
*) 402 pairs of voltage and current are stored in CSV file.

*) The first pair shows data of Isc point. The last pair shows data of Voc point.

3. Characteristics Conversion Data File (CSV File Conversion)

By selecting the Characteristics Conversion, following data format is generated.

Name	Date	Time	Temperature [degC]	Voltage Range [V]	Current Range [A]	Sampling Pitch [uS]	Sensor	Calibration Constant (E _{ref}) [mV/kW/m ²]	PV Device Area [m ²]	Current Temp. Coef. [A/degC]	Voltage Temp. Coef. [V/degC]	Series Resistance (R _s) [ohm]	Curve Correction Factor (K _{corr}) [ohm/degC]	Series Modul	Parallel Modules
TEST-1	2010/4/12	10:15:08	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:21:34	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:28:20	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:29:28	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:30:58	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:31:58	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:32:58	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:33:58	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	10:34:58	25	10	2	10	Pyname	7	1	0.0001	-0.0027	1.73	-0.009	1	1
TEST-1	2010/4/12	14:28:04	25	10	2	10	Pyname	7	1	1	1	0	1	1	1



Solar Irradiance (E _r) [W/m ²]	PV Device Temp. [degC]	I _{sc} [A]	V _{oc} [V]	P _m [W]	I _{mp} [A]	V _{mp} [V]	E _{ref} [K]	FF	E _r (sto)[W/m ²]	T (sto)[degC]	I _{sc} (sto)[A]	V _{oc} (sto)[V]	P _m (sto)[W]	I _{mp} (sto)[A]	V _{mp} (sto)[V]	E _{ref} (sto)[K]	FF (sto)
1000	25	0.7773	4.98991	0.98676	0.324217	3.074382	0.098676	0.258989	1000	25	0.777292	4.997888	0.996781	0.324217	3.0744	0.0997	0.2588
1000	25	0.7615	4.990152	0.98395	0.310591	3.087608	0.098395	0.252353	1000	25	0.761477	4.986394	0.989952	0.310591	3.0878	0.0989	0.2525
1000	25	0.7332	4.991542	0.95641	0.315272	3.033592	0.095641	0.261296	1000	25	0.733245	4.992152	0.955409	0.315272	3.0336	0.0956	0.2512
1000	25	0.7341	4.990409	0.95852	0.309809	3.094233	0.095852	0.261855	1000	25	0.734148	4.97202	0.958622	0.309809	3.0942	0.0959	0.2626
1000	25	0.827	4.991701	1.00141	0.324654	3.084592	0.100141	0.242595	1000	25	0.826985	4.961405	1.001411	0.324654	3.0846	0.1001	0.2441
1000	25	0.9522	4.985654	1.20018	0.485162	2.590141	0.120018	0.252794	1000	25	0.95223	4.986598	1.200184	0.485162	2.5901	0.12	0.2538
1000	25	0.9468	4.989315	1.19252	0.451164	2.64332	0.119252	0.252523	1000	25	0.946887	4.970646	1.192923	0.451164	2.6433	0.1193	0.2535
1000	25	0.9298	4.985183	1.19839	0.452056	2.646377	0.119839	0.258167	1000	25	0.929593	4.983484	1.198399	0.452056	2.6464	0.1198	0.2593
1000	25	0.9525	4.990626	1.19335	0.452655	2.640772	0.119335	0.251469	1000	25	0.952464	4.988063	1.193358	0.452655	2.6408	0.1195	0.2531
1000	25	0.5404	5.011198	0.64366	0.208799	3.093214	0.064366	0.238517	1000	25	0.540354	2.780918	0.643681	0.208799	3.0932	0.0646	0.4329

10. Maintenance & Troubleshooting

10-1. Maintenance

To maintain accurate measurement, it is recommended to check and do the following:

1. Storage Condition

If the MP-11 is not used for a long period of time, remove the batteries from the Battery Receptacle Box and place the MP-11 in a place with less humidity. Insert new batteries before use.

2. Sensor Unit

Clean the sensor part of the integrated pyranometer and the angle capturer glass dome by wiping with soft clothes before use.

3. Recalibration

It is recommended to recalibrate the instrument every 1~2 years. For further details of recalibration service, contact EKO or your nearest distributor.

10-2. Error & Warning Messages

In this section describes the meanings of error and warning messages which may appear during the operation of MP-11 and software, and how to correspond to these messages.

1. MP-11 Main Unit Error and Warning Message

Table 10-1. MP-11 Main Unit Error and Warning Messages











Messages	Definitions and Corresponding
 Powering on Sensor unit.	<p>The Sensor Unit is not connected to the Main Unit with modular cable and/or the Sensor Unit power is not turned ON.</p> <p>Check the cable connection between the Main Unit and Sensor Unit make sure they are connected properly and the Sensor Unit power is turned ON. Once the proper connection is confirmed and time synchronization is completed, this message will disappear automatically.</p> <p>If the Sensor Unit is not used, press any key to remove this message.</p>
 REVERSE CONNECTION!	<p>The PV probes are connected with reverse polarity (plus/minus terminals), and the measurement is terminated.</p> <p>Check the PV probe polarity and reconnect as necessary.</p>
 Not ready for next measure! Wait 30 sec.	<p>MP-11 is not ready, and at least 30 seconds interval is required between each measurement. This is to prevent MP-11 from aging faster by the internal parts heating up constantly. Wait for more than 30 seconds before taking the next measurement.</p>
 Not ready for next measure! Wait 10 sec.	<p>MP-11 is in “not ready for measurement” mode continuously; wait for 10 more seconds to be able to start the measurements.</p>
 Voltage Out of range!	<p>The Open Circuit Voltage for PV module/array terminal to be measured more than maximum voltage of setting range. Set upper voltage range and measure again.</p> <p>If the setting range is 1000V or Auto Range, measured voltage is over maximum voltage to measure. Stop measurement immediately; it may cause damage to MP-11.</p>
 Current Out of range!	<p>The Short Circuit Current for PV module/array terminal to be measured is more than maximum current of setting current range. Set upper current range and measure again.</p> <p>If the setting range is 30A range or Auto Range, measured current is over maximum current to measure. Stop measurement immediately; it may cause damage to MP-11.</p>

Table 10-1. MP-11 Main Unit Error and Warning Messages

Messages	Definitions and Corresponding
 <p>High internal temp. Do not start meas.</p>	<p>The MP-11 internal temperature exceeded 55°C.</p> <p>Possible causes for the high temperature are:</p> <ol style="list-style-type: none"> Taking measurements for a long time in a direct sun light. Taking measurements in high ambient temperature. Taking measurements on PV module/array which is close to or exceeding the MP-11 maximum rating. <p>In case of a. or b., turn OFF the power and leave the MP-11 in a shaded cooler place for a while until the internal temperature cools down. When restarting the measurement, place the MP-11 Main Unit in a shade while it takes measurements.</p> <p>Even if the measuring PV module/array is within the maximum rating, take longer measurement interval as much as possible. Please avoid taking measurements with PV module/array that exceed the maximum rating.</p>
 <p>Measure Error Occurred!</p>	<p>Measurement error occurred due to some cause.</p> <p>Retry the measurement and if this message reappears again, contact EKO for repair.</p>
 <p>Internal Failure Occurred!</p>	<p>Failure occurred inside the MP-11 Main Unit.</p> <p>Stop taking measurements and contact EKO for repair.</p>
 <p>Memory full The data is overwritten.</p>	<p>Memory full</p> <p>Memory is full because MP-11 has 300 measurement data inside.</p> <p>Delete the measurement data or save the data into PC then delete it.</p>

2. MP-11 Software Error and Warning Messages

Table 10-2. MP-11 Software Error and Warning Messages

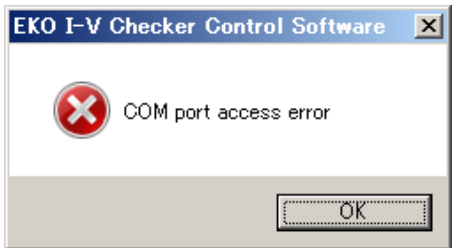
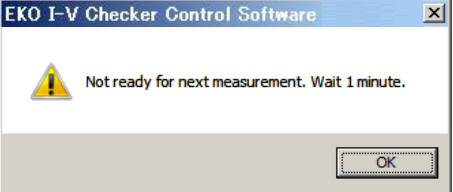

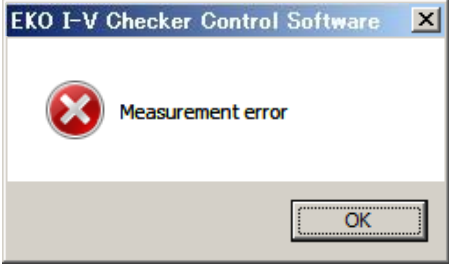

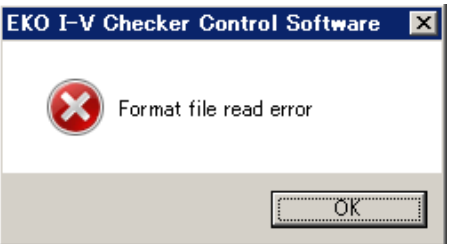
Message	Definitions and Corresponding
	<p>COM port number is not setup properly.</p> <p>This message may appear when [Start], [Load Data], or [Set Clock] buttons are clicked, as well as when MP-11 is operated after a while that there was no operation performed.</p> <p>Check the USB cable and make sure it is connected properly.</p> <p><u>To verify the appropriate COM port number:</u></p> <p>Without connecting the MP-11 and PC with USB cable, check the COM port number, which is listed under “COM Port” dropdown list on the “General” dialog window accessed from [General] button on Measure tab. Then connect the MP-11 and PC with USB cable and check the COM port number listed on the dropdown list again. If a new COM port number is added, this would be the assigned COM port number.</p> <p>If there is only COM1 from the beginning, select this COM1.</p> <p>In case there are multiple COM numbers listed, and there is no COM number added by inserting the USB cable, reinstall the USB driver.</p>
	<p>Measurement Interval Warning Message.</p> <p>When the interval between two measurements is less than 1 minute, this message appears.</p> <p>To prevent the MP-11 internal temperature increase, wait more than 1 minute before taking the next measurement.</p>
	<p>The MP-11 internal temperature exceeded 55°C.</p> <p>Possible causes for the high temperature are:</p> <ol style="list-style-type: none"> Taking measurements for a long time in a direct sun light. Taking measurements in high ambient temperature. Taking measurements on PV module/array which is close to or exceeding the MP-11 maximum rating. <p>In case of a. or b., turn OFF the power and leave the MP-11 in a shaded cooler place for a while until the internal temperature cools down. When restarting the measurement, place the MP-11 Main Unit in a shade while it takes measurements.</p> <p>Even if the measuring PV module/array is within the maximum rating, take longer measurement interval as much as possible. Please avoid taking measurements with PV module/array that exceed the maximum rating.</p>

Table 10-2. MP-11 Software Error and Warning Messages - Continued

Message	Definitions and Corresponding
	<p>Either the PV module/array is over range or PV probes are connected in reverser polarity when [Start] button is clicked.</p> <ul style="list-style-type: none"> ✧ The Open Circuit Voltage and/or the Short Circuit Current for PV module/array terminal to be measured are more than 1030V and/or 36A, which are over the MP-11 measureable range. Stop measurement immediately; it may cause damage to MP-11. ✧ The PV probes are connected with reverse polarity (plus/minus terminals), and the measurement is terminated. Check the PV probe polarity and reconnect as necessary.
	<p>When [Set Clock] button is clicked, this message appears. Communication error between the MP-11 and PC software, or MP-11 failure had occurred.</p> <p>Check the cable connection condition between the PC and MP-11 Main Unit; make sure the MP-11 power is turned ON then retry the [Set Clock] button.</p> <p>If this error message still appears, contact EKO for further assistance.</p>
	<p>This message appears when preparing report and the Format.xls file cannot be found.</p> <p>Make sure the Format.xls file is in the same folder as MP11.exe file. If these 2 files are not in the same folder, this "Format file read error" occurs. If this file is deleted, uninstall the I-V checker control software and reinstall. (For installation and uninstallation of the software, see [9-1. Software Installation and Uninstallation])</p>

10-3. Troubleshooting

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

Table 10-3. Troubleshooting

Symptoms	Countermeasure
I-V Curve cannot be measured.	<ul style="list-style-type: none"> • Make sure the PV module/array capacity is not exceeding the MP-11 measureable range limit. • Fuse may be blown. MP-11 is a precision instrument; DO NOT OPEN the instrument to prevent secondary accident. Immediately contact EKO for fuse replacement.
PC and the Main Unit are not communicating.	<ul style="list-style-type: none"> • Check whether the USB driver is properly installed in the PC. • Check the COM port number selection in the General Setting.
Cannot take continuous measurement	Check the time setting; the end time maybe setup earlier than the start time.
Isc side of the I-V Curve is higher.	This is not a defect. This condition maybe seen when most of the modules /strings are shaded or large capacity PV devices, such as amorphous PV module/array and HIT PV module/array, are measured. This condition cannot be avoided with the capacitive load method used on this I-V Checker; however, the value for the Isc are calculated with linear approximation from the flat area of the I-V Curve, and it is taken measures not to affect the value itself as much as possible.
<ul style="list-style-type: none"> • FF value of a measured I-V Curve is too small. • Isc side of a measured I-V Curve is too far apart from the vertical axis of the graph. 	The cable for PV module/array maybe too long or the junction resistance maybe too big. The parts of resistance for measurement circuit and the cable will affect the measurement value. A PV module/array with relatively low voltage and large current value may cause this condition.
The date/time setting goes out of order.	MP-11 uses a backup battery which maintains the internal clock operation. Thus when the batteries die, the setup date and time will be cleared. Always check the date and time before use; when they are out of order, set up again.
The parameters setup from PC are not reflected on the Main Unit.	MP-11 is capable of setting the parameters from PC when using it with PC connected; however, the parameter setup from PC is erased when the power of Main Unit is turned off. Set the parameters on the Main Unit again.

Table 10-3. Troubleshooting - Continued

Symptoms	Countermeasure
<p>The Sensor Unit data are not reflected on the Main Unit.</p>	<p>The Sensor Unit may not be setup properly or there may be a communication problem between the Main Unit and the Sensor Unit.</p> <ul style="list-style-type: none"> • Check the pyranometer switch (INT/EXT, for internal or external pyranometer) is set correctly. → [5-3. Setting], [2. Sensor Unit Setup] • Check the time is properly synchronized between the Main Unit and the Sensor Unit. → [8-2. Starting MP-11] • In case of taking measurement without the Sensor Unit connected to the Main Unit, the Sensor Unit data need to be loaded to the Main Unit after the measurement. Check whether the Sensor Unit data is properly loaded to the Main Unit. → [8-4. Setting Menu], [4. System Menu], [3) Loading Sensor Unit Data] • In case of taking measurement by software operation, it is required to check the “Use Sensor Unit” checkbox and take measurements. Check to see if the checkbox is checked. → [9-3. Software Operations], [1. Measure Tab]
<p>Power does not turn on although the POWER button on the Main Unit is pressed.</p>	<p>When Battery Receptacle Box is used, there are some cases that the power does not come ON right away after the plug is connected with the Battery Receptacle Box DC jack and pressing the Power button. In such case, wait for a few seconds then press the Power button.</p> <p>When the power is turned ON, more current is consumed than the usual operation; it needs a few seconds to recharge the super capacitor before the power can be turned ON. Waiting time may vary depending on the conditions such as ambient temperature and the battery consumption; give 5 to 10 seconds after plugging the Battery Receptacle Box and powering ON the Main Unit.</p>
<p>STC conversion value has large error.</p>	<p>The guideline value of irradiance is 700(W/m²) or more for the IEC 60891 standard test condition conversion P_m (STC), V_{oc} (STC), and I_{sc} (STC) values. Also, the accuracy is improved by entering all standard values, such as the PV module parameters: α, β, K, R_s, and module area, for the PV module to be measured, in the “Parameter” setting on the software.</p>

11. Specification

11-1. Specification

Table 11-1. Specification*)

Items	Specifications	
Measurement Range	Voltage	10V~1000V
	Current	100mA~30A
	Power	10W~18kW
Measurement Range/ Resolution	Voltage Range	1000V (Over Range 3%), 600V (Over Range 10%) 100V (Over Range 15%) Minimum resolution for voltage measurement: 0.01V
	Current Range	30A (Over Range 20%) 10A (Over Range 20%) 2A (Over Range 20%) Minimum resolution for current measurement: 0.01A
	Auto Range Function	Both voltage & current will be Auto Range when setting up with Auto Range
Measurement Accuracy	Voltage Measurement Accuracy	Within $\pm 1.0\%$ of Full Scale (each voltage range)
	Current Measurement Accuracy	Within $\pm 1.0\%$ of Full Scale(each current range)
PV Measurement Method	Capacitive Load Method with Reverse bias function	
Measurement Sampling	Sweep Time	4ms to 640ms (Depending on the PV module/array characteristics)
	Sampling Data Points	Fixed 400 points
Applicable PV Module/Array	Crystalline Silicon, Compound Semiconductor type PV panel/string/array	
	<p style="text-align: center;">Guideline of applicable measurement</p> <p style="text-align: center;">*) Depending on the characteristics of PV module/array and power generating condition in these areas, large measurement error or faulty I-V curve may be seen in results.</p>	


Table 11-1. Specification - Continued

Items	Specifications	
Graph Display	I-V curve graph, P-V curve graph, Derivation Graph • I-V curve graph partial enlargement function	
Measurement Parameters	• Open Circuit Voltage: Voc, Short Circuit Current: Isc, Max. Output Power: Pm • Max. Output Power Voltage: Vpm, Max. Output Power Current: Ipm, Fill Factor: FF, Power Generation Efficiency: η • STC Conversion Values (Voc, Isc, Pm)	
STC Conversion Functions	PV parameter setting function (α , β , κ) • Complying to IEC 60891 and JIS C8914/8919/8940 • Conversion by measured Irradiance, Module temperature Note) No conversion to AM1.5 by spectrum	
	PV Module Parameter Settings: (α , β , κ , Rs, module size)	
	Parameter setting save capacity: 70 settings	
	Automatically calculates STC conversion from the irradiance measured by sensor unit pyranometer/reference cell and module temperature and display on graph. • Use fixed irradiance and module temperature values setup prior to measurement when sensor unit is not connected.	
PV Measurement Functions	Measurement Time	Within 5 seconds (Time between pressing Measure button and measurement result is displayed)
	Manual Measurement	• Min. Measurement Interval: 30 sec / 15 sec (Time between last measurement to the next measurement) • Waiting time till the next measurement is indicated in 2 steps
	Auto Measurement	• Interval Time: 1 to 60minutes (Time between measurement start to the next measurement start) > Setting Resolution: 1 minute • Measurement Setting Time Range: 00:00~23:59 *) Measurement beyond midnight cannot be set.
	Measurement Data Save Function	• Saved Data Quantity: 300 data (Data is overwritten when it exceeds 300) • Search saved data, display graph & parameter • Display graph with Irradiance vs. Voc/Isc/Pm/FF from saved data • Saved data deletion
	Monitor Function	In Manual Mode, measure and display the Voc, irradiance, module temperature and ambient temperature (when connected with Sensor Unit) every 2 seconds.
PV Input Terminal	4mm ϕ Test Lead Terminal (+, -), FG Terminal	

Table 11-1. Specification - Continued

Items	Specifications		
Other Sensor Functions	Sensor Unit	<ul style="list-style-type: none"> •Pyranometer Input:: Measurement accuracy within 1.5% of Full Scale 	
		<ul style="list-style-type: none"> ➤ Integrated Pyranometer: < 1.5kW/m² ➤ External Pyranometer Input: < 100mV 	
		<ul style="list-style-type: none"> - Applicable with EKO MS-602/802, ML-020VM, ML-01 - Pyranometer mode changed by switch on Sensor Unit rear panel Setup sensitivity as parameter for using external pyranometer	
		<ul style="list-style-type: none"> •Reference Cell Input: < 500 mA: Within 2.0% of Full Scale 	
		<ul style="list-style-type: none"> •Thermopile Input: -50°C to +100°C (T-type) 2ch: Module temp. & ambient temp. 	
Remote Sensing Functions	Disconnect Sensor Unit from Main Unit, log the sensor data then upload the sensor data by I-V measurement timing as Sensor Unit connected after the measurements to execute the STC conversion.		
Protection Features	Warning Messages	Warning message given and measurements restricted in below status: <ul style="list-style-type: none"> • Measurements within minimum measurement interval: When pressing Measure button within the minimum interval from the last measurement. • PV terminals reverse connection warning: When the PV terminals (+/-) are connected in reverse connection. • Over range: When the voltage/current are setup over the over range limits in each setting (1000V/30A range for Auto Range) • Internal temperature increase: When the Main Unit internal temperature increased abnormally (measurements not allowed till the internal temperature cools down to a certain temperature.) 	
	Auto-Detection function for Internal Circuit Failure	Automatically detects internal circuit failure and gives warning. NOTE: When the internal circuit failure is detected, measurements cannot be taken	
Communication Interface	PC Communication	USB 2.0 x1	
	Sensor Unit Connection	RJ-11(6-wire Sensor Unit Cable)/RS-485 Protocol x 1	
Operation Panel (Main Unit Control Panel)	Power Key	Power On: Press Power key to turn ON Power Off: Press and hold Power key over 2 seconds to turn OFF	
	Ten-Key	Alphanumeric and symbolic characters	
	Cursor Key	Menu operation	
	Function Keys (Basic Operations)	<ul style="list-style-type: none"> • [MEAS]: Execute measurement • [CONFIG]: Main Unit setting • [DATA]: Data Search, display, and operation • [Enter] Key • [Return] Key 	
	LCD Display	Reflection Type 128 x 64 dot, non-backlight, color contrast adjustment	
Other Functions	Time Keeping Function	Maintains the current date and time; saves measurement date and time with the data <ul style="list-style-type: none"> • Time is maintained by the internal battery • Time can be adjusted to desired time 	

Table 11-1. Specification - Continued

Items	Specifications		
Power Supply	Main Unit	AC Adaptor **:100V~240V 50Hz/60Hz DC12V 1.0A DC PLUG EIAJ RC5320A TYPE4 center plus ($\phi 5.5 \times 3.3$ center pin: 1.0 ϕ) 	
		External Battery Receptacle Box	AA size batteries x 8pcs (Recommended: Alkaline or Low Self-Discharge Ni-mH batteries) ➤ Connect to AC adaptor input ➤ Standard operation hours: More than 8 hours ✧ With fully charged Low Self-Discharge Ni-mH battery (1900mAh), 5min. interval and connected to Sensor Unit. NOTE: Using batteries other than recommended may have significantly shorter operation hours. NOTE: No battery charger function on the Main Unit ➤ Battery remaining power is indicated in 3 steps when operated with battery
		Operating Input Voltage Range: 9.0 - 12.5V	
		Consumption Current	Max. 310mA (with Sensor Unit connection and 12.0V input)
		Auto Power Off Function	Power automatically turned OFF with external battery operation at less than a certain voltage, and no operation performed for 10 minutes. (No auto power off during auto measurement mode)
	Sensor Unit	<ul style="list-style-type: none"> • 006P Battery 9V x 1, consumption current: max. 60mA, 8 hours continuous operation (Alkaline battery : recommended) • Power supplied from Main Unit when connected with Main Unit. • Power Supply LED: Blinking speed changes by the power supply (battery) status). <ul style="list-style-type: none"> ➤ When connected to Main Unit: Blinks by 0.5sec. interval ➤ When in remote (battery) operation: <ul style="list-style-type: none"> ✧ 1sec. interval: Has enough battery power ✧ 0.5sec. interval: Power is getting low; replace the battery ✧ 0.25 sec. interval: Almost no power remained (Cannot communicate with Main Unit) 	
Dimensions	Main Unit	W230 x D320 x H180mm	
	Sensor Unit	W210 x D85 x H55mm (horizontal position)	
Weights	Main Unit	2.5kg (without battery and accessories)	
	Battery Receptacle Box	500g (with AA size batteries x8pcs)	
	Sensor Unit	500g	
	Cables and Accessories	300g (with AC adaptor and Ni-mH batteries x2)	
Operation Environment	Temperature Range	0°C to 45°C	
	Humidity Range	35%RH to 85%RH (No condensation)	
Storage Environment	Temperature Range	-20°C to 70°C (Stored in original packaging)	
	Humidity Range	30%RH to 65%RH (Stored in original packaging)	

*) All specifications are subject to being changed without any notice.

***) For some overseas customers, due to import/export regulations, the AC adaptor cannot be included.
In that case, please purchase and use an AC adaptor with equivalent specifications in your country.

11-2. Software

Table 11-2 Software Specifications

Items		Details
Program Name		EKO I-V Checker Control Program
Software Version		01.001
Firmware Version		04.10x
Applicable OS		Microsoft Windows 7 / 8 / 8.1 / 10 / 11
License		No restriction to install
Operation Environment		CPU: OS should be able to operate Memory: Same as above HDD Capacity: More than 100MB Display Resolution: More than 640 x 480 Interface: USB2.0 should be available
Communication Method		MP-11 can be operated via USB Port (Virtual COM Port)
Measurement Items		Irradiance, Voc, Isc, Pmax, FF, η , Vpm, Ipm, module temperature, ambient temperature, STC conversion values (Voc, Isc, Pm)
Software Functions	Measurement Control	<ul style="list-style-type: none"> • Manual Measurement • Auto Measurement: <ul style="list-style-type: none"> Measurement start & finish time setting: 00:00 ~ 23:59 (Finish time must be later than start time) Measurement interval setting: 1min ~ 23hours 59 minutes *) Cannot setup continuous measurement going over the 00:00 *) Recommend setting up not to measure over a couple of days in Auto Measurement mode because of instability of Operation System • Sensor Unit Setting • Manual (range) measurement setting, voltage/current range setting • Data saving setting, auto generation setting of CSV data file • Measurement data graph display range setting
	Data Display	<ul style="list-style-type: none"> • Measurement date setting for display data • Automatic exclusion of data with insufficient irradiance • Filtering by PV module/array name • Measurement data list: <ul style="list-style-type: none"> List data specified by measurement date with main parameters. Display Data: Data number, date, time, PV module/array name, PV module/array area, irradiance, Voc, Isc, Pmax, FF, η, Vpm, Ipm, Data sorting function in each display; ascending/descending order switch • Graph Display Functions: Display following graphs for data specified from the list (display all at once by setting multiple items) <ul style="list-style-type: none"> I-V curve, P-V curve, I-V/P-V (standard condition conversion), derivation curve Displaying range, graph curve color setting Superimposing display: By selecting multiple data, all data are displayed on the same graph by superimposed mode. (Max 10 data)

Table 11-2 Software Specifications - Continued

Items		Details
Software Functions	Data Saving	<ul style="list-style-type: none"> • Save data measurement date setting • Automatic exclusion of data with insufficient irradiance • Filtering by PV module/array name • Measurement data list: List data specified by measurement date with main parameters. Save data: Data number, date, time, PV module/array name, PV module/array area, irradiance, Voc, Isc, Pmax, FF, η, Vpm, lpm, Data sorting function in each display; ascending/descending order switch • Create Individual Conversion File CSV file): Save the data selected from the data list into CSV format data File ID setting (8 alphanumeric characters): Added at the head of the CSV file name for file identification. • Characteristics Value Conversion: Generate file with parameter list for the selected data. • Prepare Report Function: Report file created for the data selected. Report file in Microsoft Excel format.
	Irradiance Graph Display	<ul style="list-style-type: none"> • Save data measurement date setting • Automatic exclusion of data with insufficient irradiance • Filtering by PV module/array name • Display following graphs for the data selected from the data list Irradiance – Voc, Irradiance-Isc, Irradiance-Pmax, Irradiance-FF
	Other Functions	<ul style="list-style-type: none"> ◇ Main Unit time setting function ◇ Reading and displaying firmware version from Main Unit and Sensor Unit. ◇ Parameter Setting: Upload & download PV module/array area, short circuit current temperature coefficient, open circuit voltage temperature coefficient, series resistance, curve correction factor, PV module quantity, comment (installation site name, PV module/array name, PV module/array type) ◇ Reference Irradiance Setting: Irradiance measurement, pyranometer/reference cell sensitivity setting Irradiance threshold, averaging measurement frequency ◇ Temperature Setting: PV module/array temperature and ambient temperature measurements, averaging measurement frequency setting ◇ Parameter file upload, saving ◇ Connection port selection ◇ Data Saving Folder Setting: Specify a folder for saving measurement data. • Common folder for display and save data file ◇ Record File Data Output Folder Setting: Assign a folder for saving record file. ◇ Simple Report Output: Creating report of specified measurement data results in Microsoft Excel*) format. Report format can be modified by Microsoft Excel

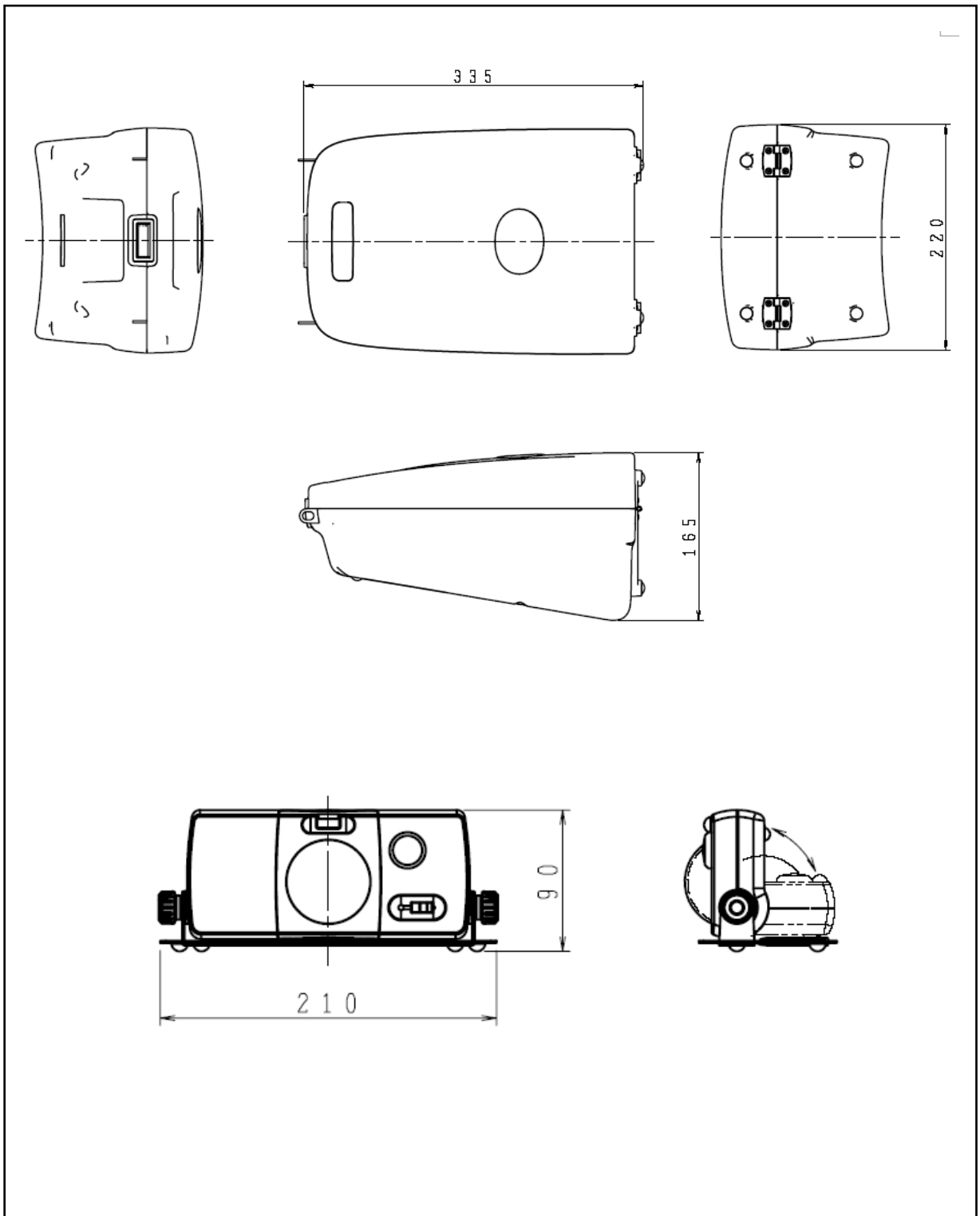
*) "Excel" is a brand name by Microsoft

11-3. Option

Table 11-3. Option

Item	Content	Part Number
AC Conversion Plug C-type	1 plug for AC Plug type conversion from A-type to C-type	MP-11-CP-C
Ni-mH battery charger (8 AA size batteries)	Including 8 AA size Low Self-discharge Ni-mH rechargeable batteries	MP-11-BB

11-4. Dimensions





EKO Asia, Oceania

1-21-8 Hatagaya,
Shibuya-ku, Tokyo
151-0072 Japan
P. +81.3.3469.6711
F. +81.3.3469.6719
info@eko-instruments.com
www.eko-instruments.com

EKO North America

111 North Market Street,
Suite 300, San Jose,
CA 95113, USA
P. +1-408-977-7751
F. +1-408-977-7741
sales-usa@eko-instruments.com
www.eko-instruments.com

**EKO Europe,
Middle East, Africa,
South America**

Lulofsstraat 55, Unit 28,
2521 AL, Den Haag,
The Netherlands
P. +31 (0)70 3050117
sales-eu@eko-instruments.com
www.eko-instruments.com