MP-11

EK**O**

1. Index

2. 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 (Vpm, Ipm, Pmax, Voc, Isc, FF, Tmod, ηeff) 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 3. 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 Rs 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.

The main functions of MP-11 are as follows:

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

Figure 4-1.
Separate Main Unit & Sensor Unit

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

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/m^2 / 25ºC) 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℃, the CPU stops until the temperature becomes less than 45℃ so that measurements cannot be taken.

3. Specifications

3-1. Sensor Specifications

Table 3-1 Sensor 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 ±1.0% of Full Scale (each voltage range)
	Current Measurement Accuracy	Within ±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 Guideline of applicable measurement (Measurable area / Unmeasurable area * graph: Current [A] vs Voltage [V]) 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.	

Table 3-1. 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.

Items		Specifications
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 3-1. Specification - Continued

Items		Specifications		
Other Sensor Functions	Sensor Unit	・Pyranometer Input::	Measurement accuracy within 1.5% of Full Scale	
		➢ Integrated Pyranometer: ➢ External Pyranometer Input:	< 1.5kW/m^2 < 100mV	
		- 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		
		・Reference Cell Input:	< 500 mA: Within 2.0% of Full Scale	
		・Thermopile Input:	-50℃ to +100℃ (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: ・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)	・[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 ・Time is maintained by the internal battery ・Time can be adjusted to desired time		

Table 3-1. Specification - Continued

Items			Specifications
Power Supply	Main Unit		AC Adaptor **⁾ :100V～240V 50Hz/60Hz DC12V 1.0A DC PLUG EIAJ RC5320A TYPE4 center plus （φ5.5×3.3 center pin：1.0φ）　⊖—◉—⊕
		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		・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). ➢ When connected to Main Unit:　Blinks by 0.5sec. interval ➢ When in remote (battery) operation: 　✧ 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℃ to 45℃
	Humidity Range		35%RH to 85%RH (No condensation)
Storage Environment	Temperature Range		-20℃ to 70℃ (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 adapter cannot be included.
　In that case, please purchase and use an AC adapter with equivalent specifications in your country.
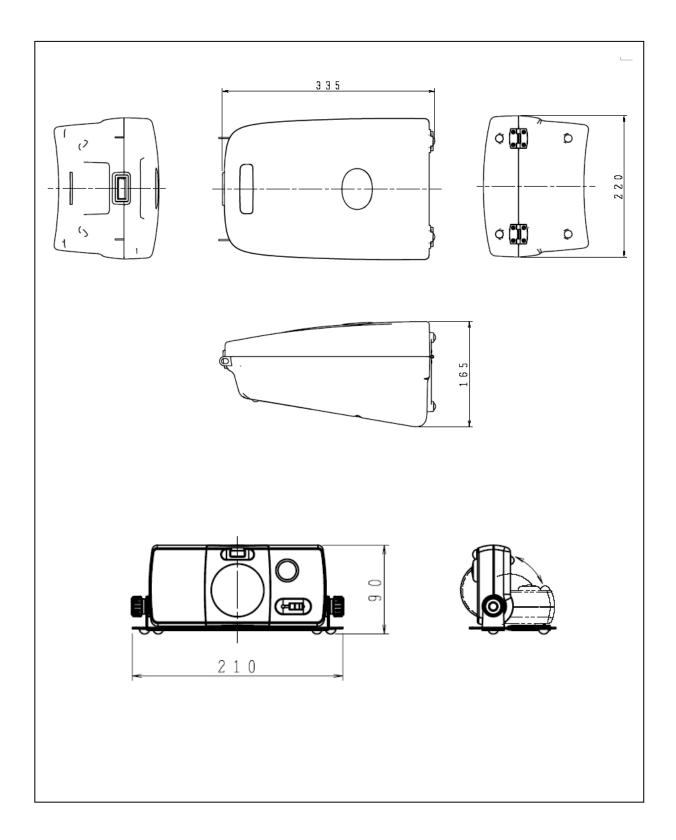
3-2. Software Specifications

Table 3-2 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 HHD 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	・ Manual Measurement ・ Auto Measurement: 　　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	・ Measurement date setting for display data ・ 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. 　　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) 　　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 3-2 Software Specifications - Continued

Items		Details
Software Functions	Data Saving	・ 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, Ipm, 　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 alphanumerical 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	・ 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	✧ 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

3-3. Dimensions

4. Standard Items & Accessories

Table 4-1. Package Contents

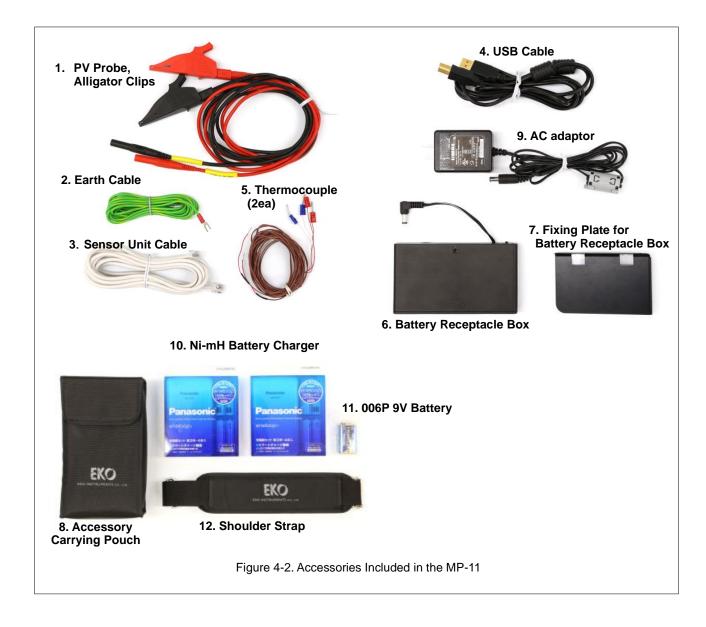| Standard Items	Qty.	Remarks	Item No.*)
MP-11 Main Unit	1	Main Unit contains the following items:	
Sensor Unit	1		
PV Probe & Alligator Clips	2	1.5m: Red (+), Black (-)	1
Earth Cable	1		2
Sensor unit Cable	1	3m; Main Unit – Sensor Unit Communication	3
USB Cable	1	2m; Main Unit – PC Communication	4
T-type 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: Optinal)	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.

Table 4-2. Accessories List

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

1. PV Probe, Alligator Clips
2. Earth Cable
3. Sensor Unit Cable
4. USB Cable
5. Thermocouple (2ea)
6. Battery Receptacle Box
7. Fixing Plate for Battery Receptacle Box
8. Accessory Carrying Pouch
9. AC adaptor
10. Ni-mH Battery Charger
11. 006P 9V Battery
12. Shoulder Strap

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

5. APPENDIX

5-1. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.

EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

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

➢ Any modification or repair was done by any person or organization other than EKO service personnel.

➢ The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

5-2. 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.

5-3. CE Declaration

EKO

CE

DECLARATION OF CONFORMITY

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

Declare under our sole responsibility that the product:

Product Name: I-V Curve 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: *Shuji   Yoshida*

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