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Portable I-V curve tracer

I-V Checker

MP-170

Operation Manual



Conforms to CE marking

April 2008

EKO Instruments Co., Ltd.

1. Safety Precautions

The products of EKO Instruments Co., Ltd. are designed and manufactured with consideration of safety; however, unexpected accident may occur depending on the way it is used. Therefore please thoroughly read this manual and operate the system correctly by following this manual.

Warnings/Cautions	Neglecting this sign will invite serious or fatal accidents.
Cautions of high voltage	High voltage is applied to this part. Neglecting this sign will invite serious or fatal accidents.
Prohibitions	This sign indicates that you MUST NOT do it.
Obligations	This sign indicates that you MUST do it.

D A N G E R



HAZARDOUS VOLTAGE



ELECTRIC HAZARD

Wear high-voltage rubber insulating gloves and boots

Check polarity (+/-) connections to array/module before operation

Do not operate MP-170 in rainy or wet conditions

Do not open and disassemble MP-170

Warnings

- Wiring to the PV power system has to be performed by authorized personnel with the protective equipment for electric shock.

- Check the position and polarity of PV power output that the cables of MP-170 are connected. Wrong connection may cause electric shock and damage the PV power system and MP-170.

- Do not work with wet hands especially when connecting the terminal block and/or the electrical outlet. There is a possibility of causing shock hazard or electric leakage.

- Disconnect PV DC power line from the PV peripheral equipment of the PV power system including the power conditioner, inverter, charge controller and batteries. I-V measurement with these equipments may cause the damage of MP-170 and the equipment. MP-170 measures only DC power from PV module/array.

- Use cables and connection terminals that satisfy the stated electric power capacity for the PV device. Connect them surely so that they will not come off from the connectors.

- Do not use MP-170 for other than original purpose.

- Do not open, disassemble, modify, or touch the inside of MP-170. High power electricity may still remain inside of MP-170, and it may cause electric shock.

- Check and make sure the power supply voltage to MP-170 (DC12V) before turning ON the power switch of MP-170 and the power supply.

- Do not use any other AC adapter other than the one supplied.

- Turn off the power of MP-170 immediately when you notice any smoke or abnormal odor occurring from MP-170.

- Do not use MP-170 in places where it is exposed to vibrations, impact shock, high humidity, dust, sudden temperature changes and/or near any object which has strong magnetic or electric fields.

- Do not use MP-170 in rainy or wet conditions. MP-170 is not waterproofed.

- Do not use any other cables other than the ones supplied. Using other cables may cause accidents and/or damage, such as electric shock and/or leakage. EKO does not take responsibility and does not guarantee accuracy of the measurement in such case.

- The actual output voltage, current and power from PV module/array should be within the maximum input range of MP-170. Otherwise EKO does not take responsibilities for any damage or problem occurrences, even if MP-170 is in the 1 year guarantee period.



Cautions < about operation manual >

- Before operating MP-170, thoroughly read and understand this manual.

- Keep this operation manual on hand to be able to use it when necessary.

- Follow this operation manual and the original operation method of MP-170.

- Understand and follow the safety instruction of this operation manual.

- Contact EKO Instruments Co., Ltd. whenever you have any question or concern.

- Although we are taking all possible measures to ensure the content of this operation manual, you may find any unclear, wrong or incomplete description. We would appreciate your cooperation to let us know if such case may occur.

CE

DECLARATION OF CONFORMITY

According to EC guideline 89/336/EEC 93/68/EEC

We: EKO INSTRUMENTS CO., LTD.
2-1-6 Sasazuka Shibuya-ku, Tokyo
151-0073 JAPAN

Declare under our sole responsibility that the product:

Product: I-V Checker
Identification: Type Designation:MP-170
Equipment Class:A (EN 55011:1998+A1+A2)
Equipment Group:1(EN 55011:1998+A1+A2)

To which this declaration relates is in conformity with the European, harmonized and Published standards at date of declaration:

Tested acc. to: EN 61326:1997+A1+A2+A3
EN 55011:1998+A1+A2
EN 61000-3-2:2000+A2
EN 61000-3-3:1995+A1+A2

Following the provisions of the directive:

EMC-directive : 89/336/EEC
Amendment to the above directive:93/68/EEC

EU Agency:

Company Name: CCT b.v.
Company Address: Larixlaan 3, 6711 NL EDE , The Netherlands
Tel: +31-318-650997 Fax: +31-318-650996

Tokyo Japan, 04/18/2008

Makoto Hosoda
Deputy General Manager of R&D Center
Meteorology, Environment and New Energy Division

Makoto Hosoda

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3. Outline of MP-170

3-1. Outline

Portable I-V curve tracer "I-V Checker" MP-170 is designed to measure DC output from a PV array or module. Purposes of measurement include evaluation, checking system failures, and maintenance of the PV power system. MP-170 uses capacitor load method to measure the I-V curve which makes high power measurements possible. Compact size, high performance and accuracy are achieved from EKO's long experiences in PV measurement.

MP-170 consists of the Main unit and the Sensor unit. The Main unit is not only capable of taking measurement, showing graph, and analyzing data by key pad operation, it can also transfer the measured data to the PC by connecting with USB and analyze data on the PC by using the MP-170 software.

Also, the Sensor unit has a built-in Si-pyranometer, and this allows the measurement of incident solar irradiance and the back-side temperature of the PV module while measuring the I-V curve on the Main unit at the same time; this makes the conversion for Standard Test Condition (STC) complying with JIS C8914 standard easy. Also, the external input terminal on the Sensor unit can be connected with not only EKO pyranometers (MS-802, MS-402, and MS-601), reference cell, and/or thermocouple, and the data can be stored.

The Main unit and the Sensor unit can transfer the data by connecting with modular cable; the solar irradiance data and temperature data measured on the Sensor unit can be transferred to the Main unit.

3-2. Functions

MP-170 has more outstanding features compared to the traditional I-V curve tracer.

- The Sensor Unit can be separated from the Main unit.
- By setting up the internal time on the Sensor unit and the Main unit, it is possible to measure without cables.
- Built-in Si-pyranometer is in the Sensor unit.
- High precision pyranometer can be connected to the Sensor Unit.
- The Angle capturer easily indicates the tilt-angle and the direction of the PV module/array to be measured, and setup the built-in Si-pyranometer on the Sensor unit in the same position as the module/array.
- It is possible to measure the PV module/array I-V curve on the Main unit and the irradiance and the temperature on the Sensor unit separately.
- The traditional I-V curve tracer had to be setup by climbing up a high place where the PV power system is located, then place the sensor, and pull the cables of radiation

sensors, thermocouple and so on all the way to the measuring unit. For having the above features, it is possible to take a cable-less measurement, which only the Sensor unit is setup by the PV module/array in the same angle and direction, and the Main unit is away from the connection point for the PV module/array. The long cable connection is unnecessary, and makes the measurement easy.

- By connecting the Main unit and the Sensor unit with communication cable after the measurement, the same time frame data can be downloaded from the Sensor unit and reflect to the I-V curve data by each measurement.
- It is possible to take measurements as monitoring the irradiance and temperature on the real-time by connecting the Main unit and the Sensor unit with modular cable. The power for the Sensor unit is supplied from the Main unit only when the AC adopter on the Main unit is used.
- MP-170 has STC conversion function for the JIS C8914.
- When measuring the PV array, there are setup function for the row and column count of the array; if the module parameters of one module, there is no need for calculating the PV parameters as long as the array has the same model modules, and the array parameters is calculated automatically and possible to figure out the standard condition.
- The automatic measurement is possible up to 1 day by setting up the start and end measurement time and the interval.
- When one-day worth of data is measured with automatic measurement, each of the following can be graphed: the irradiance vs. Pmax, irradiance vs. Voc, irradiance vs. Isc.
- di/dV-V characteristics, which is the first differential of I-V curve, can be indicated above the LCD on the Main unit; this is useful for diagnosis of PV module/array failure.
- I-V curve graph can be shown in x2, x4, and x8 zoom above the LCD on the Main unit and be able to check the fine warps on the I-V curve, which is useful for diagnosis of PV module/array failure.
- MP-170 is designed with assumption for wide range of measurement as the concept. As the result, it is possible to measure wide range such as voltage: 10V ~ 1000V, current: 1A~20A, power: 10W~10kW. (The minimum voltage is 10V and the minimum current is 1A; the measurement lower than these values cannot be measured. Even if measurement was possible, the measured values cannot be assured.)
- MP-170 measures I-V curve of PV module / array by capacitive load method.
- The Sensor Unit can measure solar irradiance, reference cell output, temperature on the backside of PV module/array and outside temperature.
- The Main unit and Sensor Unit communicate with RS-485. Both online and offline operation can be chosen while measuring. The data can be transferred from the Sensor unit to the Main unit after the measurement.
- MP-170 is equipped with a shoulder strap for convenient.

3-3. Characteristics

(1) Portable

Having the "portable" concept in mind, MP-170 is designed with emphasis on the user-friendliness and the safety in the field measurement. The Main unit case is made of resin, which is isolated from electricity, for safety. The unit is designed as one-unit case, which can store the Sensor unit, cables, and so on for carrying convenience. Connect the PV-cables to the PV module/array and push the "MEASURE" button is all needed to take measurement.

(2) Detachable Sensor Unit



MP-170 designed so that the Sensor unit can be separated from the Main unit, which can be setup and adjusted as the same angle as the PV module/array. It is not like the wired communication and radio wave signal type of wireless communication, so they can be separated regardless the distance or the clearance.

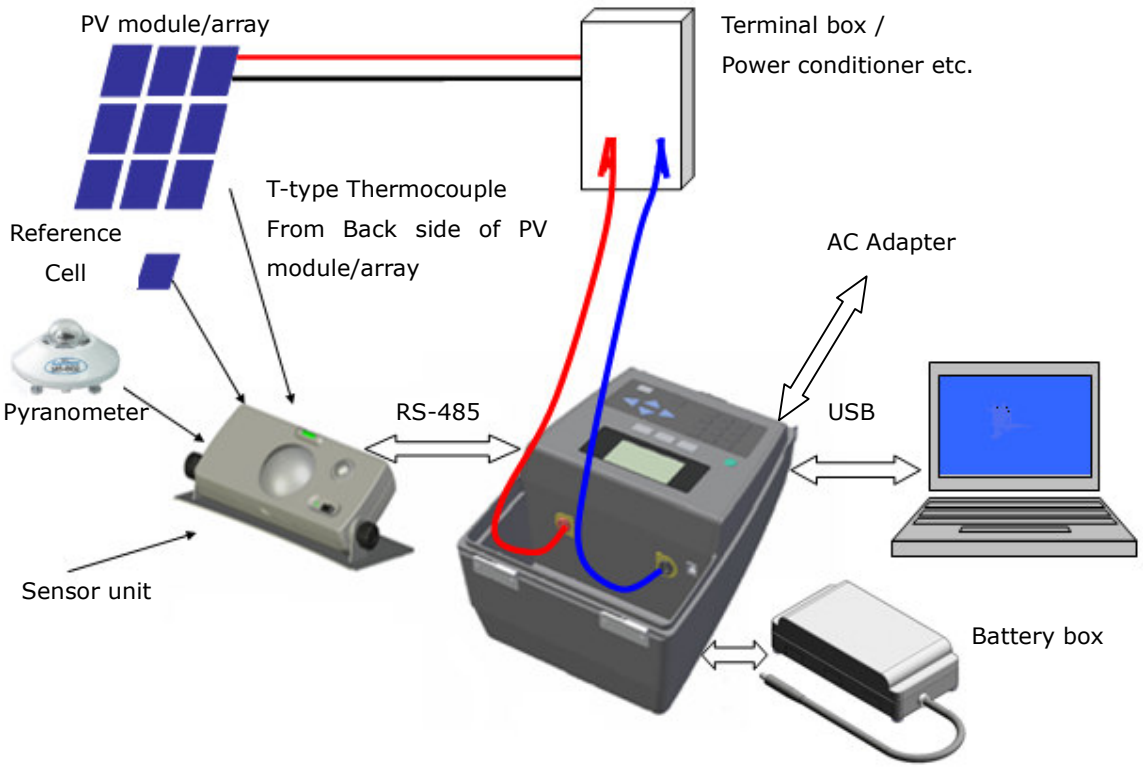
The incident solar irradiance can be measures with Si-pyranometer, which is built in the Sensor unit. Also, external pyranometer, reference cell, and/or T-type thermocouple can be connected to the terminal on the back side of the Sensor unit.

When using as cable-less, connect the Sensor unit with the Main unit with modular cable after the measurement is taken, and the solar irradiance and temperature data with measuring time can be downloaded to the Main unit from the Sensor unit.

Real-time measurement is possible with connecting the Sensor unit and the Main unit with modular cable. In this case, power supply to the Sensor unit from the Main unit is possible only when the Main unit is plugged with AC adapter.

MP-170 is designed to be able to take measurements flexibly in any measuring conditions.

3-4. System Configuration



4. Name and function of each part

4-1. MP-170 package



1) Top cover (can be removed by sliding the cove to the right.)
2) Front panel
3) LCD
4) PV-Cable (Red, +)
5) PV-Cable (Black, -)
6) Rear panel
7) Key pad
8) Dome protector
9) Sensor unit
10) Shoulder strap
11) AC adapter
12) USB cable (The Main unit – PC connection)
13) T-Thermocouple (3m x 2pcs)
14) Modular cable (The Main unit – the Sensor unit connection)
15) Grounding wire
16) Battery box
17) Battery pouch

4-2. MP-170

Front panel



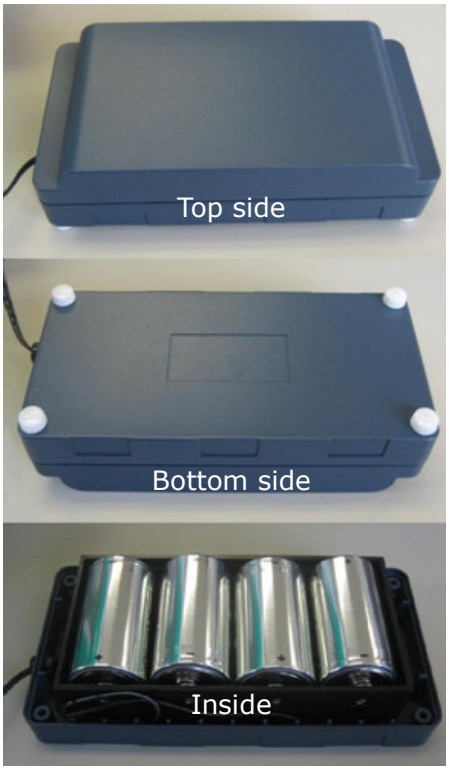
1) Strap hooks (on the left and right side to hook the shoulder straps)
2) Latch button (lift the top cover as pushing this button to open)
3) Carrying handle (place your hand here to carry the Main unit)
4) DC power input from AC adapter
5) USB port (use when down/uploading data to/from PC)

Rear panel



1) Modular inlet (The Main unit – the Sensor unit connection)
2) Battery power input from the battery box
3) PV-cable input (+ , Red)
4) PV-cable input (- , Black)
5) Storage (Sensor unit and the cables are stored here.)
6) Grounding terminal

4-3. Battery box



Setting batteries

By unscrewing 4-white screws at the bottom side corners of the battery box, the box can be opened.

NOTE

1) Check the directions (polarity, +/-) of batteries
2) Remove batteries when it is not in use for a long time

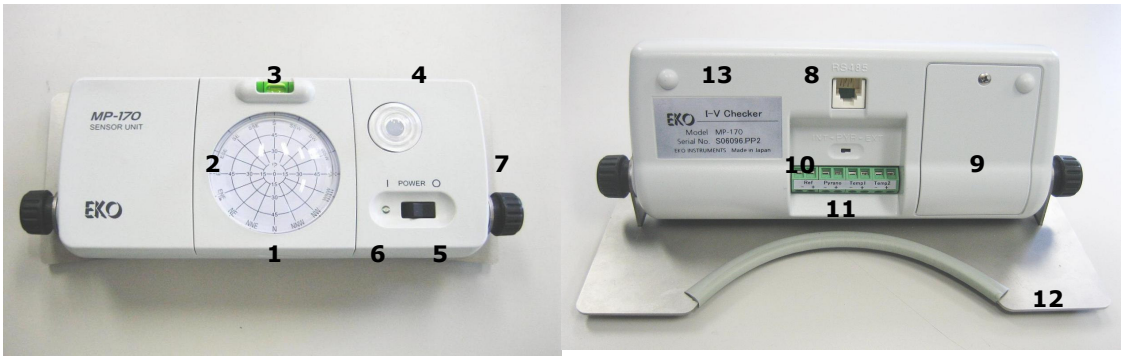
Batteries

D size, 4 pcs

Alkaline or Ni-H batteries are recommended for longer operation.

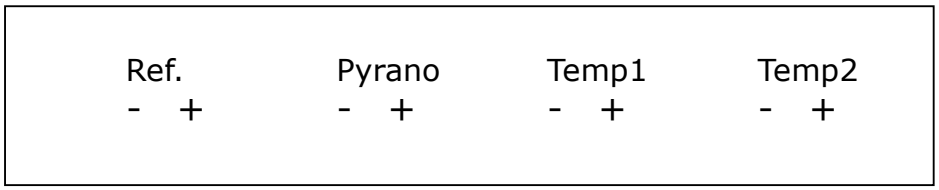
The battery box does not have a charge function.

4-4. Sensor unit



1) Angle capturer
2) Dome, Angle screen
3) Level
4) Built-in Si-pyranometer
5) Power switch
6) Power indicator LED
7) Angle adjusting screw
8) Modular inlet
   The Main unit – the Sensor unit connection
9) Battery box (006P x 1pc)
10) Reference sensor selector
    INT – Internal pyranometer
    EXT – External pyranometer
11) Terminal block
12) Base plate
13) Product label (Calibration constant of the internal pyranometer is shown)

Terminal block assignment



Ref : Reference cell input (100mA, Internal 0.1Ω shunt resistance)
Pyrano : Pyranometer input (15mV)
Temp1 : T-Thermocouple input, Used for PV module back side temperature and STC conversion
Temp2 : T-Thermocouple input, Recorded into data. Normally use for air temperature

* To use EXTERNAL pyranometer or reference cell, the Reference sensor selector is switched to EXT.

5. Setting up

5-1. The Main unit

DANGER

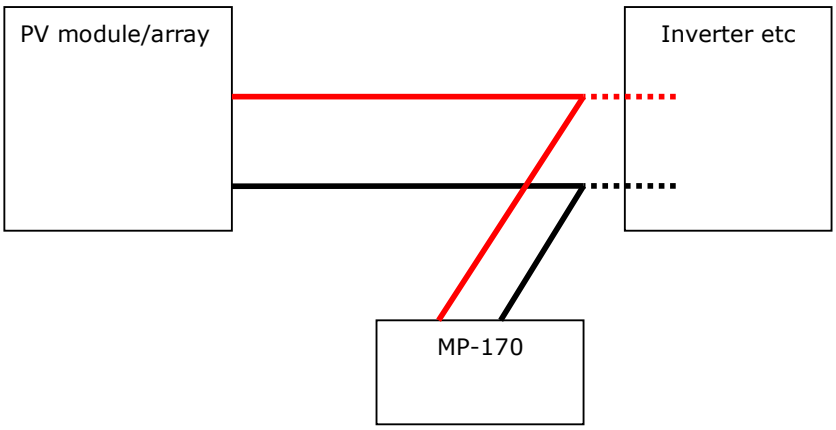
HAZARDOUS VOLTAGE
ELECTRIC HAZARD

- Wear high-voltage rubber insulating gloves and boots
- Check polarity (+/-) connections to array/module, before operation
- Do not operate MP-170 in rainy or wet conditions
- Do not disassemble MP-170
- Operation to PV power system should be done by an authorized electric engineer.
- For safety, please connect the grounding wire to the grounding terminal; however, modify one end of the grounding wire to fit the terminal if necessary.

DC line configuration

- PV power should be blocked from any load such as an inverter or power conditioner for I-V curve measurement.
- Arrange the connection or inverter settings, MP-170 can measure the PV array/module output only.

-I-V curve measurement with working inverter/conditioner may cause alarm or defect of MP-170, inverter or conditioner.



* NOTE *

Use MP-170 within the following range.
Maximum input power: 10kW
Maximum input voltage: 1000V @10A
Maximum input current: 20A @500V
Check the polarity of connection terminal.
Confirm the polarity of output before connecting the cables.

1) The Main unit



Connections

a) Battery box

Connect the DC plug of the Battery box to the Battery power input.

b) PV-cables

Insert PV-cables into PV inputs.

+: Red

-: Black

Gator grips of PV cables are connected to PV DC outputs.

c) The Sensor unit

Connect the Main unit and the Sensor unit by the modular cable.

2) Fastening the shoulder strap



Fasten the shoulder strap on the strap hooks tightly.

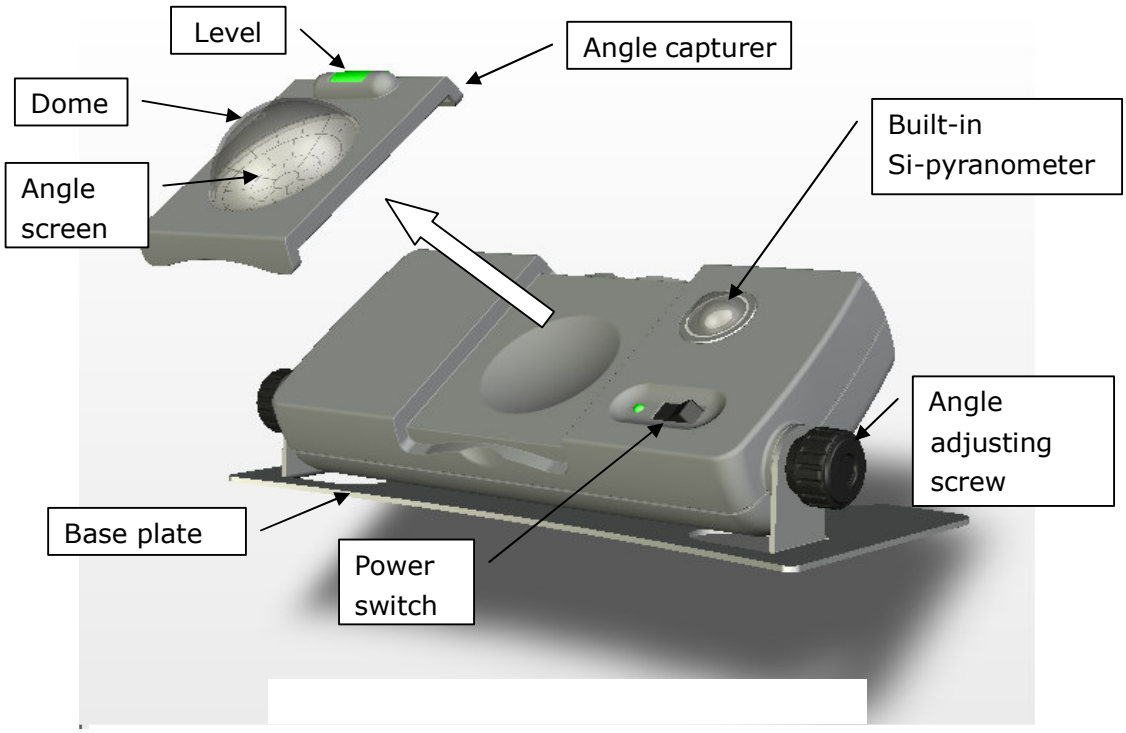
3) Attaching the Battery pouch



Feed the shoulder strap through hole on the back side of the Battery pouch.

5-2. Sensor unit settings

1) Sensor unit



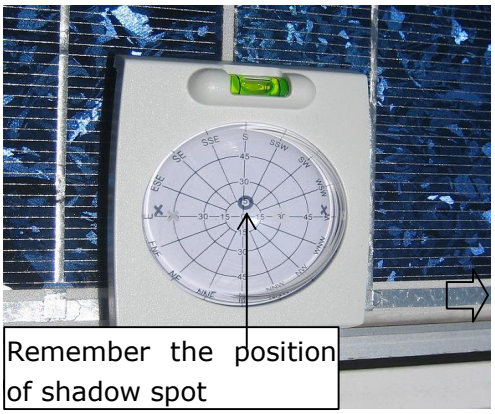
The Sensor unit is data logging device to record the output from the built-in Si-pyranometer, T-type thermocouples and external pyranometer or reference cell. The unit has the Angle capturer to find the angle and direction of PV module/array. The Angle capturer has the radial angle screen, dome, and the level, which they can be taken off from the Sensor unit itself easily.

2) Setting up the Sensor unit

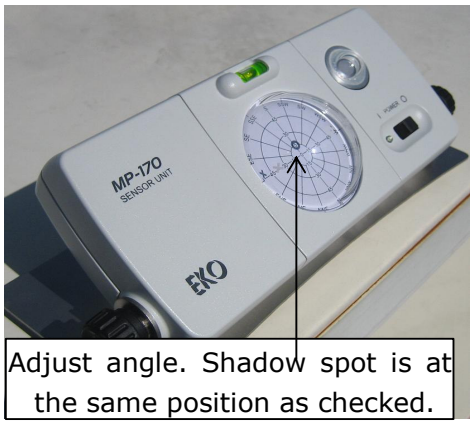
1. Setup the time on the Sensor unit and the Main unit at first.
   a. Adjust the time on the Main unit, then turn off the power.
   b. Connect the Sensor unit with modular cable.
   c. Turn on the Sensor unit power first.
   d. Then turn on the Main unit power.
   e. When the LCD display on the Main unit changes to Menu screen, then the time is synchronized.
      If error message appears, check whether the modular cable or the Sensor unit power switch is on OFF, and then try again from the start.
2. Determine whether to measure with or without the modular cable.
   a. When measuring without the modular cable, make sure the Sensor unit is working by battery. Also, this measurement requires downloading the data from the Sensor unit to the Main unit after taking the measurement.
   b. If measuring with modular cable, the battery in the Sensor unit is not needed as long as the Main unit is plugged in with AC adapter, which can supply the power to the Sensor unit. Also, the measuring data taken from the Sensor

unit can be transferred on the Main unit in real time.

3. Remove the Angle Capturer from the Sensor unit.
4. Place the Angle Capturer on the target PV module/array.
5. Check the position of the 3 markers on the radial angle scale in the Angle Capturer dome. Remember, or note if necessary, the one or more shadow spot positions out of the 3 markers.
6. Setup the Sensor unit on a location close by the PV module/array which is not shaded, and place the Angle Capturer back on the Sensor unit.
7. Adjust the Sensor unit's direction and angle so that the shadow spots of the markers that were taken earlier will be in same position on the scale. Once the position is determined, tighten the angle adjusting screws to fasten.
8. When taking measurements, remove the Angle capturer not to make shadow for the Built-in Si-pyranometer.
9. Before taking measurements, enter the calibration values of the pyranometer or the reference cell at the parameter setting on the Main unit.



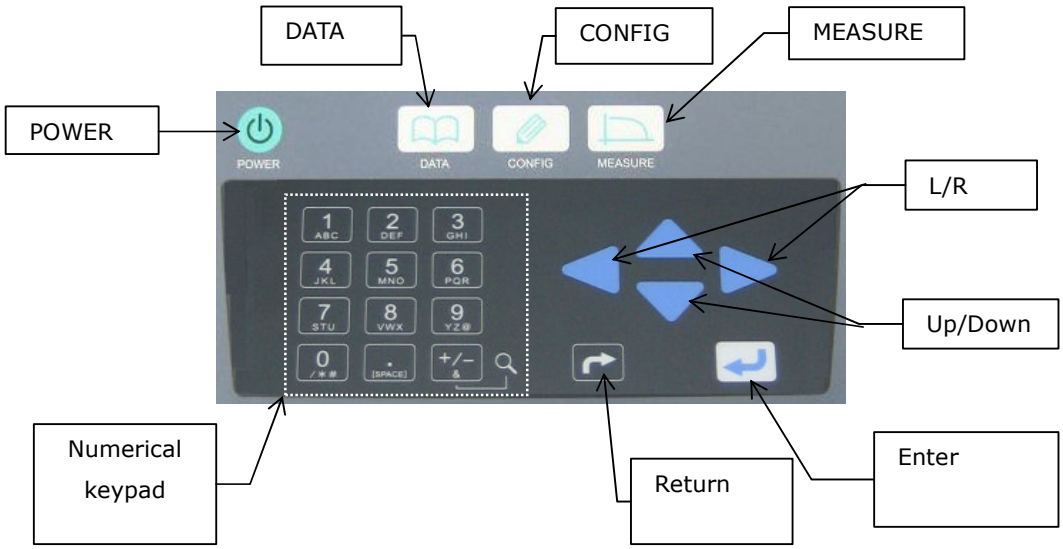
Remember the position of shadow spot



Adjust angle. Shadow spot is at the same position as checked.

6. Operation

6-1. Key pad



POWER : Main power switch of the Main unit
Power ON - Press the power switch
Power OFF - Keep pressing Power switch for 5 seconds.
CONFIG : Manage measurement settings
DATA : Data management function
MEASURE : Start measurement
Press this key to start measurement with currently set parameters
Up/Down : Select menu items
Screen switches from main menu to monitoring screen
Left/Right : Change menu and data items
Enter : Go to next menu or confirm input item
Return : Back to the item before
Ten-key : Numerical input and the following functions

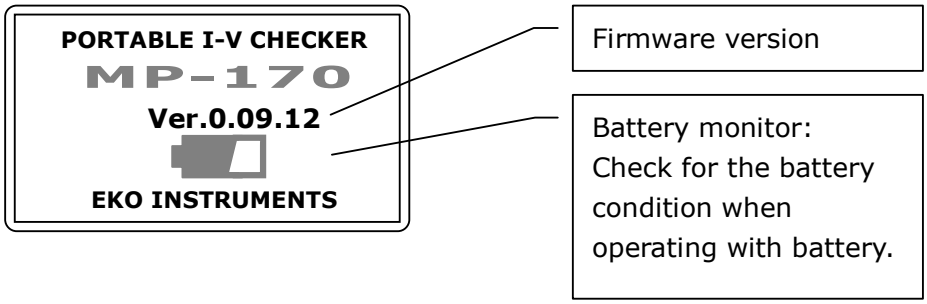
Key	Assignment	Key	Assignment
1	1, A, B, C	7	7, S, T, U
2	2, D, E, F	8	8, V, W, X
3	3, G, H, I	9	9, Y, Z, @
4	4, J, K, L	0	0, /, *, #
5	5, M, N, O	.	., sp
6	6, P, Q, R	+/-	+/-, & I-V curve display size adjustment by x2, x4, and x8

6-2. Starting MP-170

1) Connect the Main unit and the Sensor unit with modular cable.

2) Power ON the sensor unit
After power on the sensor unit, the Green LED will light for a few seconds and then start blinking once a second

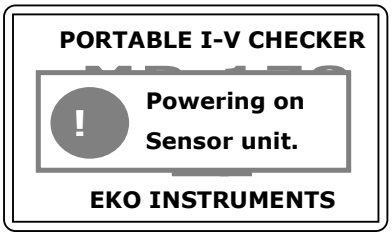
3) Power ON the Main unit
Start screen appears on the LCD display.



After getting the connection and time is synchronized between the Main unit and the Sensor unit, the main menu screen is shown.

When "Powering on Sensor unit." appears:

A) Check the connection and power of the sensor unit.
B) Turn ON the Main unit and the Sensor unit again.



Press any key to go to main menu.

4) Start Screen

After turning on the Main unit, see whether the Sensor unit is connected with the Main unit through modular cable. The warning message "Powering on Sensor Unit" will show if it is not connected with the modular cable or not communicating through the modular cable.

5) The Message Screen for Indication of Power ON of the Sensor Unit

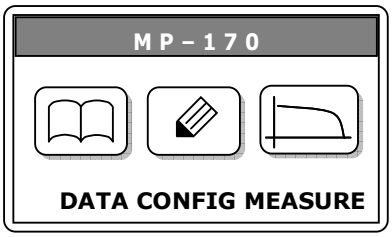
If the Sensor unit is not in use, press any key from this condition; the main menu screen should be shown and be able to continue on the operation. If the Sensor unit is used, connect the Sensor unit to the Main unit with modular cable; turn ON the Sensor unit power after turning ON the Main unit power. The time is synchronized automatically between the Sensor unit and the Main unit without any warning messages and so on.

Go through this process for each use of the Sensor unit.

* If the time did not get synchronized, it may not be able to upload the data from the Sensor unit or may upload the data, which the dates do not match with the Main unit.

6-3. Main menu

1) Main menu



DATA : Go to data management menu

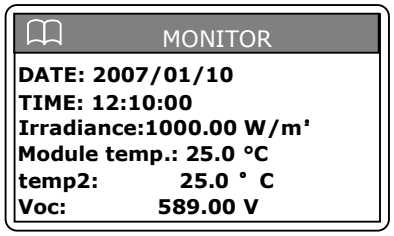
CONFIG : Go to parameter setting menu

MEASURE : Start measurement

NOTE : Give at at least 1 minute interval for each measurement)

Select menu by pressing these keys

2) Monitoring screen



Press Up/Down key from the main menu, the screen goes to monitoring screen, which shows the date, time, irradiance, module temp., temp.2, and Voc.

If the sensor unit is not connected, the irradiance and temperature values will be shown with fixed values as 1000.00 W/ m², 25.0°C.

6-4. Measurement

1) Measuring Screen

Connect the PV-cables to the Main unit PV input terminal; connect the red cable to the plus (+) and black cable to the minus (-) of the PV array/module. When taking measurements, the PV array/module must be completely disconnected from power conditioners (inverter) and such.

The measurement can be started immediately by just pressing the MEASURE key when the screen is on MAIN MENU or MONITOR screen.

*When taking measurements of large capacity PV arrays, wait at least 1 minute for taking next measurement; rising of the internal temperature may shorten the life of the device.

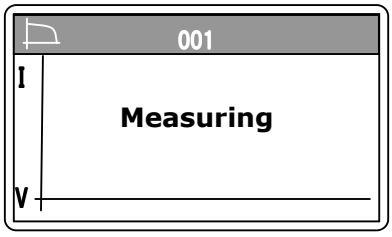
After confirming the connection, press MEASURE and MP-170 starts measurement.

* NOTE *

Before starting the measurement, set the calibration value of pyranometer or reference cell

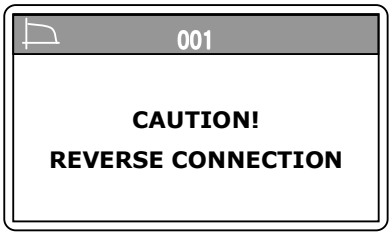
The measurement is started with the MEASURE key, the range is set to 1000V, 20A.

For most accurate results in measurement and STC conversion, set the parameters to the same values as in the CONFIG menu.



Measurement screen

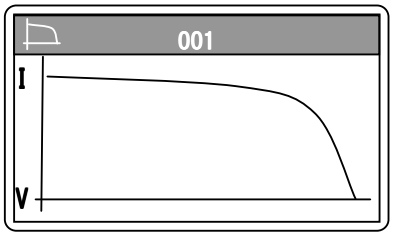
It takes about 10 seconds to complete.



Warning message for Reverse Connection

If connected polarity of the PV cable (+/-) is incorrectly, this warning is indicated and stops taking measurement.

Result screen

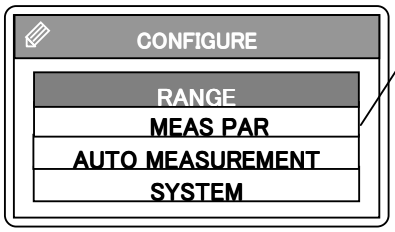


By pressing ENTER, the screen changes
1 I-V (x-axis: Voltage [V], y-axis: Current [A])
2 P-V (x-axis: Voltage [V], y-axis: Power [W]
3 dI/dV-V (x-axis: Voltage [V], y-axis: Differential of I-V curve)
4 Measurement information
5 Measured parameters 1
6 Measured parameters 2

In this case, the measurement is taken at the ranges, 1000V, 20A at the maximum ranges for both voltage and current. When accuracy is demanded, it is recommended to setup the range before taking measurement if the measurement range is already known.
Within about 10 seconds after taking the measurement, the I-V curve appears on the screen. Pressing the ENTER key will change the screen in the above order. (The indicated contents are same as the "Data Management Menu.")

6-5. Configuration

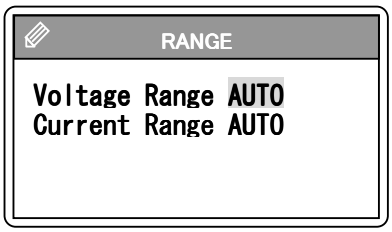
By pressing CONFIG, the menu switches to the configuration menu. The configuration menu screen contains the following options.



RANGE: Range settings
MEAS PAR: Measurement parameter settings
AUTO MEASUREMENT: Auto measurement settings
SYSTEM: Misc. parameter settings

1) Range settings

Configurations are setup when taking only the I-V curve measurement without the Sensor unit or when setting the measurement range manually.
Enter the measurement range of the PV module/array for subjected to measure. The below ranges can be selected by pressing L/R key.



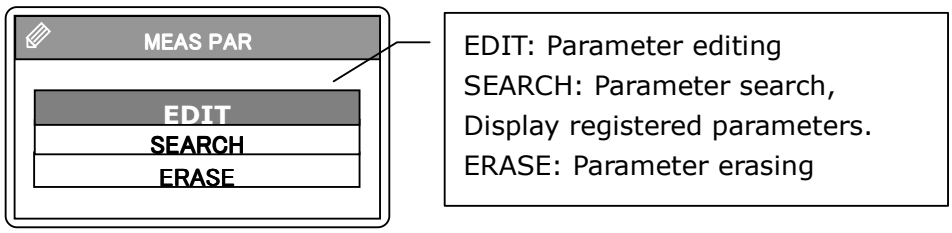
Voltage Range: 10V, 100V, 1000V, AUTO
(Default: AUTO)

Current Range: 2A, 10A, 20A, AUTO
(Default: AUTO)

*Auto range takes the measurement after the appropriate range is determined from the pre-measurement; therefore, it takes longer time than manual measurement.

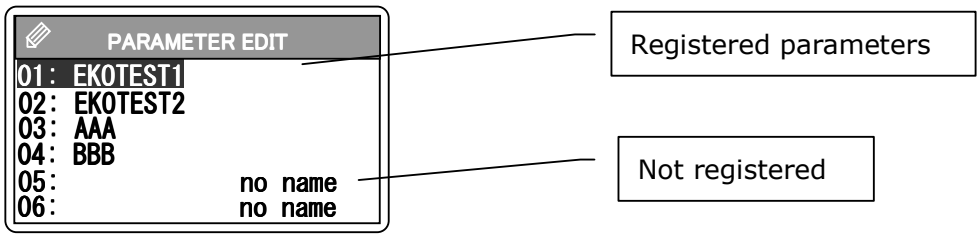
2) Parameter settings

By pressing MEAS PAR, the "Parameter menu" screen appears. There are following options given on the Parameter menu screen.



A) Parameter Editing

Choose "EDIT" on MEAS PARA menu, and "Registered Parameter list" will be displayed.



Select a parameter by using Up/Down key and press ENTER.
"Use Sensor Unit" screen will appear, and the following two options are given.

a.USE SENSOR UNIT: Use the Sensor unit

b.MAIN UNIT ONLY: Use only the Main unit

When using the Sensor unit, select the "USE SENSOR UNIT" on the "01 PARAMETER EDIT" screen (Sensor Unit Selection). The "01 PARAMETER 1/2" screen (Range and Pyranometer) is displayed; enter the parameter name, measurement range, pyranometer Calibration value. By pressing the ENTER key, "01 PARAMETER 2/2" screen (PV Device Parameter) is displayed next; setup each PV module's parameter, then press ENTER. The parameter is saved with the name just entered.

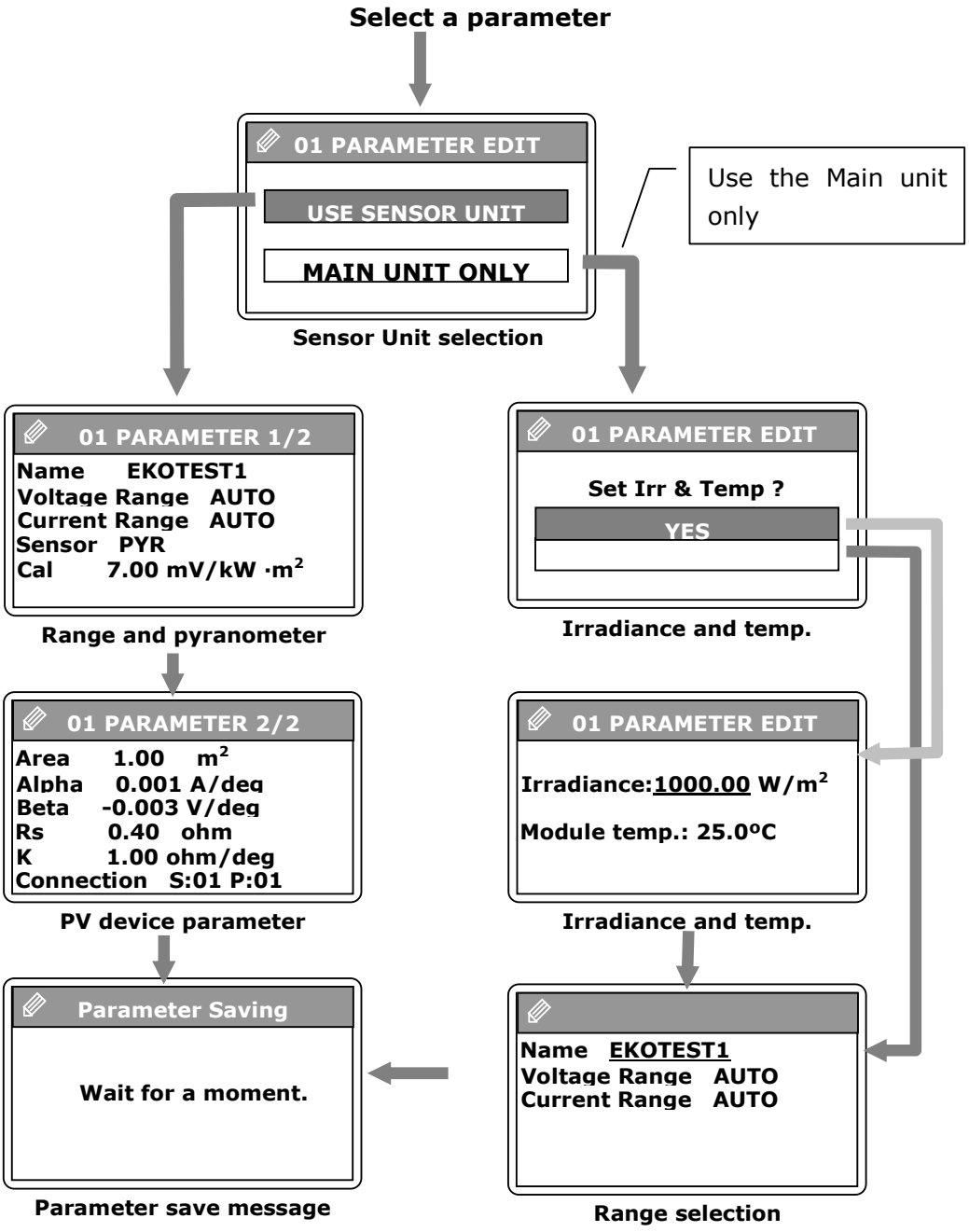
When taking only the I-V curve measurement without using the Sensor unit, select the "MAIN UNIT ONLY" on the "01 PARAMETER EDIT" screen (Sensor Unit Selection). The next "01 PARAMETER EDIT" screen (Irradiance and Temp.) is displayed, and the irradiance and the back side temperature of the PV device can be entered. Once entered the values, press ENTER key then the go to the next "01 PARAMETER EDIT" screen (Range Selection).

Enter "NO" on the 2nd "01 PARAMETER EDIT" screen (Irradiance and Temp.), "Range Setup" screen is displayed and allows setup the voltage and current

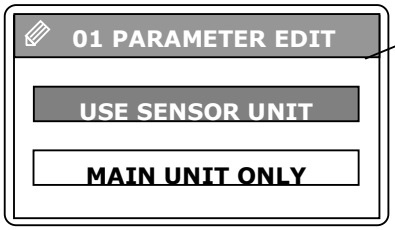
range. After entering the range values, press the ENTER key and the setup parameter will be saved.

(*In this case of parameter setting is only a temporary and will not be saved in the parameter list.)

Parameter setting flow



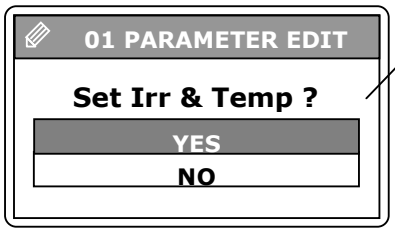
Each Parameter setting screen Contents



Sensor Unit selection

USE SENSOR UNIT -> Using Sensor Unit

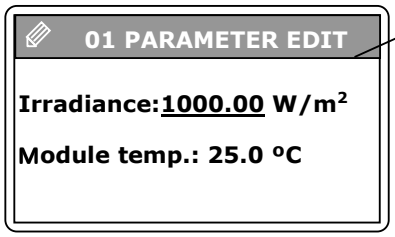
MAIN UNIT ONLY -> Using only Main Unit



Irradiance and temp.

YES -> Set solar irradiance and temperature manually

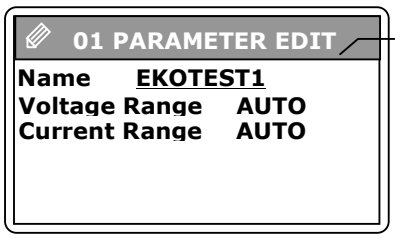
NO -> No change



Irradiance and temp.

Irradiance -> Set solar irradiance to be used for measurement

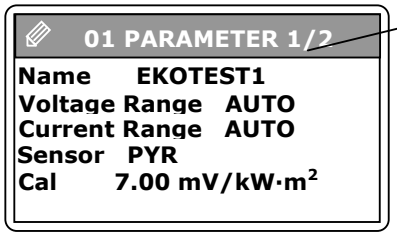
Module temp. -> Set temperature to be used for measurement



Range selection

Voltage Range -> Voltage range Setting (10V, 100V, 1000V, AUTO)

Current Range -> Current range Setting (2A, 10A, 20A, AUTO)



Range and pyranometer

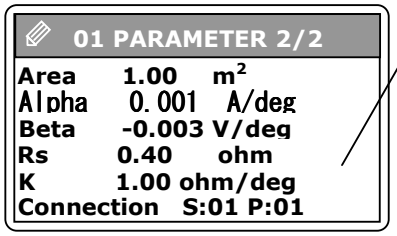
- Voltage Range -> Voltage range Setting

- Current Range -> Current range setting

- Sensor -> Select pyranometer or reference cell
  PYR: Pyranometer
  REF: Reference cell

- Cal -> Pyranometer/Reference cell calibration value

  *Input the calibration value on the label on the reverse side of the Sensor Unit. If using another pyranometer, input its own calibration value.



PV device parameter

- Area -> Area of PV device
- Alpha -> Current-temp. coefficient
- Beta -> Voltage-temp. coefficient
- Rs -> Series resistance
- K -> Curve correction factor
- Connection -> PV array connection
  S: Serial modules
  P: Parallel modules

B) Searching Registered Parameter

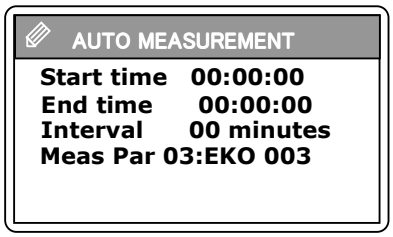
Select "SEARCH" on the Parameter menu screen with up/down key; the "Registered Parameter List" will be displayed. Move the cursor to the parameter to be set and press ENTER key then the measurement can be taken with the selected parameter setting.

C) Deleting a Parameter

Select "ERASE" on the Parameter menu screen with up/down key; the "Registered Parameter List" will be displayed. Move the cursor to the parameter to be deleted and press ENTER key. The selected parameter is deleted from the list.

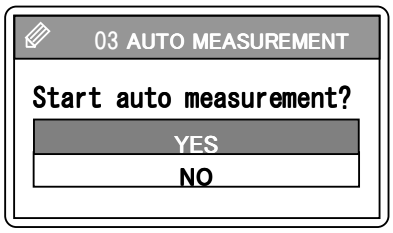
3) Auto measurement

Selecting the "AUTO MEASUREMENT" on the Setup menu, "Auto Measurement Setup" screen is displayed. After setting up the PV cable connection and Sensor unit, automatic measurement can be done in the following procedure.



Input "Start time", "End time" and "Interval". Selected parameter No. and file name are shown.

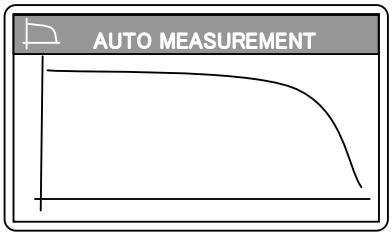
* NOTE *
Schedule is valid only for the day measurement is started. It is not effective for the next day.



Select "YES" to start if starting the automatic measurement. Select "NO" to cancel.

*Setup of the voltage and current range on the automatic measurement requires a close attention. When measurement is taken with "AUTO MEASUREMENT", the first measurement is taken at the Maximum range, and from the second time, the measurements are taken at the range values automatically determined from the first measurement. Thus if the weather changes suddenly, there will be a possibility that the range determined from the first measurement may not become appropriate. When the maximum value of the PV device is already known, taking measurements with fixed range is recommended as much as possible.

*Long period of AUTO MEASUREMENT cannot be performed (limited up to 1 day).



IV curve of each measurement is displayed on the LCD.

* NOTE *

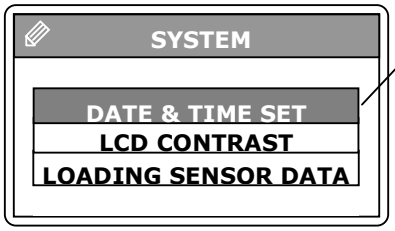
MP-170 sets an appropriate range after pre-measurement in auto measurement mode. It takes longer time than manual measurement.

When weather condition changes while measurement, a range from pre-measurement will be inappropriate for current measurement.

In this case, use manual range.

4) System menu

Select the "SYSTEM" on the Setup menu screen; the “System Menu” is displayed. There are following option items on the System menu screen.



DATE & TIME SET —> Date, Time Setup

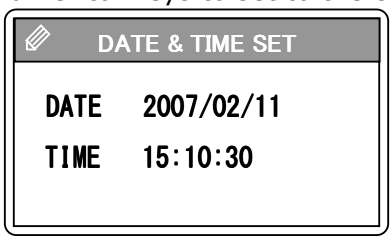
b . LCD CONTRAST — > LCD Contrast Adjustment

C. LOADING SENSOR DATA

—> Data downloading from Sensor unit

A) Date, Time setting

Select “DATE & TIME SET” on the System menu screen; the date and time setup screen is displayed. The current date and time can be setup. Use the L/R keys and the numerical keys to set to the current date and time.

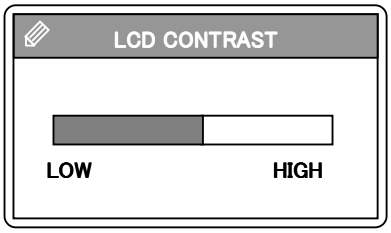


Enter Format: YYYY/MM/DD

*NOTE: The Main unit does not use backup batteries, such as lithium battery, and use super-capacitor, instead. Therefore, when the batteries dies, the date and time that have been setup will be cleared after 3 days or so. Please check and setup the date and time before use.

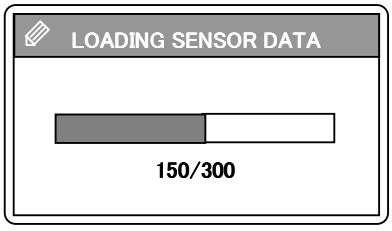
B) LCD Contrast

Select “LCD CONTRAST” on the System menu screen. The LCD contrast adjustment screen is displayed.



Adjust LCD contrast with the indicator by using L/R keys.

C) Download the sensor-unit data



1) Connect MP-170 and Sensor-unit with a modular cable.
2) Turn on the power switch of the sensor-unit.
3) Select “LOADING SENSOR DATA”.
4) Download starts and the transferring status is shown.

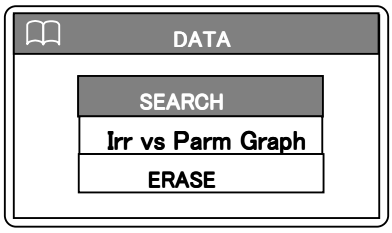
* NOTE *

Download the Sensor unit data to the Main unit within the same day the measurement is taken. Even though the time information is included in the recorded data on the Sensor unit, there is no information for the year and date. If the data was downloaded after the date has changed, it is possible that either the data cannot be downloaded or download the data which has unmatched date information.

The same condition may occur when the date is not synchronized with the Sensor unit.

6-6. Data display

Select "DATA" on Main menu. "Data menu" is displayed on the screen.

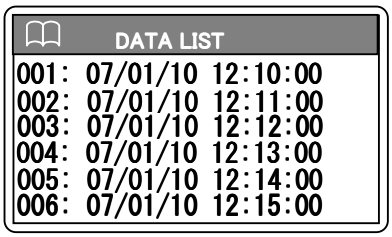


Data menu

- SEARCH -> Search saved data.
- Irr vs Parm Graph -> Display the graph of solar irradiance and measured PV parameters.
- ERASE -> Erase saved data.

1) Search Saved data

Select "SEARCH", then it displays the "DATA LIST", and the data list saved on the Main unit memory is displayed.



Data list

Data no. YY/MM/DD Hr:Min:Sec

001: 07/01/10 12:10:00
002: 07/01/10 12:11:00

(Max. 300 data can be stored.)

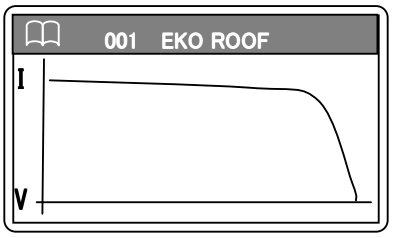
2) Data display

Select the date and time of the data with Up/Down cursor from the "DATA LIST" screen and press Enter.

Press Enter again and the data will be displayed in the following order.

- I-V Curve (Voltage[V] on X axis, current[A] on Y axis)
- P-V Curve (Voltage[V] on X axis, power[W] on Y axis)
- (dI/dV)-V Curve (Voltage[V] on X axis, derivative value on Y axis)
- Measurement information
- Characteristic value 1/2
- Characteristic value 2/2

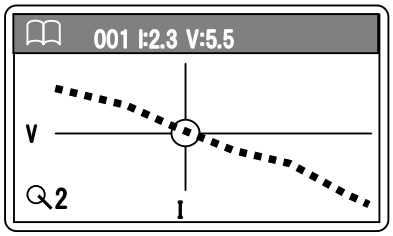
: (Repeated)



I-V curve graph

I-V curve Voltage[V] on X axis
Current[A] on Y axis

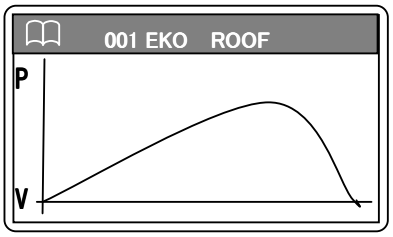
I-V curve graph shows the voltage and current characteristics of a PV battery in the condition of irradiance, air temp., and PV temp. at the time of measurement. The crossing point of x-axis (Voltage axis) and the curve is called "Open Circuit Voltage(Voc)", and the crossing point of y-axis (Current axis), and the curve is called "Short Circuit Current (Isc)."



I-V curve zooming display

I-V curve zooming display

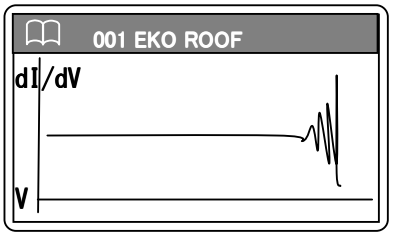
While I-V curve is displayed, press +/- key; the graph is zoomed in x2, x4 and x8 in order. Press [<]. [>] keys to move the area displayed. The center value of the Voltage [V] and the current [A] are numerically shown on top part of the graph. Use this function to detect smaller changes of measured values.



P-V curve graph

P-V curve Voltage[V] on X axis
Power[W] on Y axis

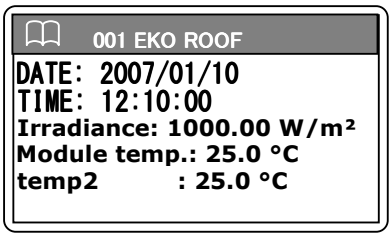
P-V curve graph is a graph which the I-V curve is converted into the voltage-power relationship. X-axis is voltage, and Y-axis is power, and the Peak of P-V curve in this condition is called Pmax.



Differential curve Voltage[V] on X axis
dI/dV on Y axis

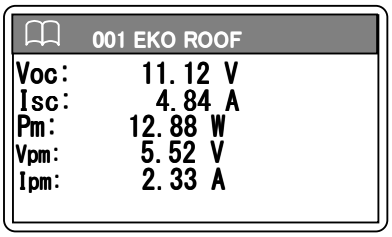
Differential curve takes the differential values of current against the voltage when the x-axis is voltage and y-axis is differential data, and determine to see whether there is any change in the curve.

The I-V curve is disturbed when there are hot spot or shades, defects and/or deterioration on the PV cells. This graph indicates the small disturbance, which are difficult to read on the I-V curve, clearly emphasized.



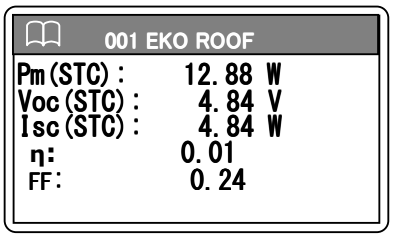
Measurement information

DATE: YYYY/MM/DD
TIME: HH:MM:SS format
Irradiance: [W/m²]
Module temp.: PV device temp. on back side. [°C]
temp2: Air temp. [°C]



PV Parameters (screen 1/2)

Voc: [V]
Isc: [A]
Pm: Pmax[W]
Vpm: Voltage Pmax[V]
Ipm: Current Pmax[A]



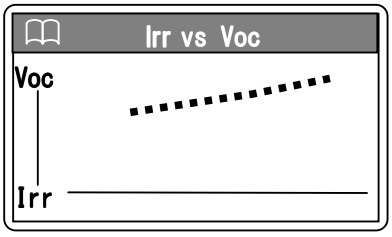
PV parameters (screen 2/2)

Pm(STC): [W]
Voc(STC): [V]
Isc(STC): [A]
η : Efficiency[%]
F.F. : Fill factor

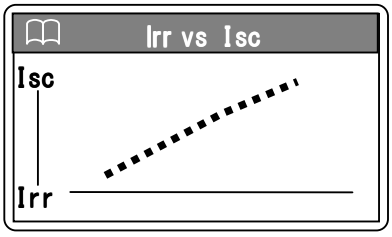
* Notes for STC conversion
  1) Pm(STC), Voc(STC), Isc(STC) are valid in case that the solar irradiance is over 700W/m^2.
  2) Following parameters are all required to enter: α, β, κ, Rs, module area.

3) Solar Irradiance vs. Parameters (Pm, Voc, Isc, FF) Graph Display

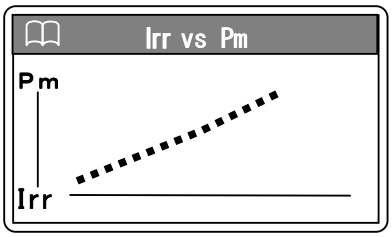
If data is taken for multiple times in the same conditions on the same day by continuous measurement, select "Irr vs Parm Grph" from "Data menu" by using up/down keys will show the graph, which indicates the changes of the solar irradiance of the day selected against Pm, Voc, Isc, and FF.



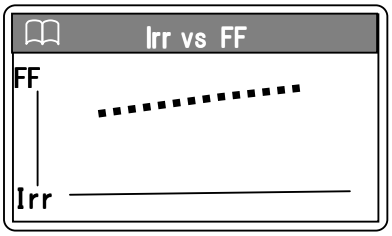
Irr vs Voc graph display



Irr vs Isc graph display



Irr vs Pm graph display

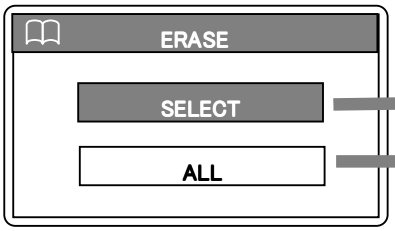


Irr vs FF graph display

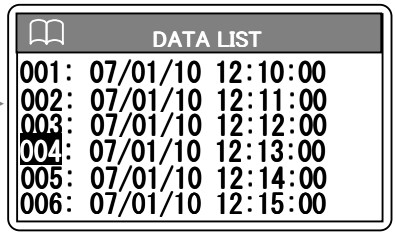
4) Erase data

Select "ERASE" on the Data menu by using up/down key will display "Erase Data menu". Select "SELECT" , then it displays the "Saved Data List", move the cursor to the data which to be deleted, and press ENTER key; the selected data is erased from the list.

If all the data is to be erased, select "ALL" from the "ERASE" data menu", and press ENTER key. The "All Data Erased Confirmation" display is shown; select "YES" and press ENTER key, then all the data should be erased completely.

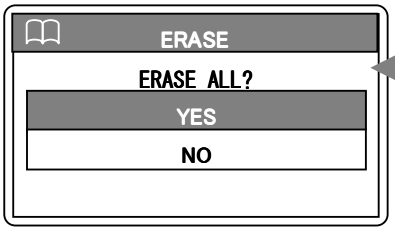


Erase Data menu



Saved data list

1) Select data with "Upper" / "Lower" key and press Enter key.
2) Select "YES" to erase the selected data
3) Select "NO" to cancel



All data erase confirmation display

7. Software

This software is designated for I-V Checker MP-170. The data that is taken on the MP-170 Main unit can be downloaded, analyzed, and so on, on the PC. Also, measurement control from this software is possible. The measured data is converted into CSV format text data and can be processed with calculation software such as Excel.

7-1. Software Basic Functions

The functions of this software are described below.

(1) Data can be downloaded from the Main unit to PC.
(2) Connect the Main unit and PC allows the measurement control from PC.
(3) There are functions to show the following graphs:
I-V, P-V, dI/dV-V, I-T, V-T, STC I-V, STC P-V Curve, Solar Irradiance-Voc, Solar Irradiance-Isc, Solar Irradiance-Pm, Solar Irradiance-FF
(4) The data can be converted and saved in text CSV format.
(5) The data can be uploaded from PC to the Main unit.
(6) The data can be managed by the calendar based database.

*NOTE: When decimal point is used, comma (,) is used for the point in some languages. This will cause a deformed graph curve. To prevent this, please check the following setting and change the decimal point setting from "comma (,)" to "period (.)".

1) From the "Start" menu on the Window, open "Control Panel".
2) Select "Area and Language Option" and double click.
3) "Area and Language Option" window will popup.
4) In the "Standard Format" section on the "Area Option" tab, click "Customize"
5) Change the "Decimal Symbol (D)" on the "Numbers" tab and change it to "Period (.)"

7-2. Software installation

Software Installation

Start "MP170Setup.msi" in the "English" folder on the CD-ROM. There should be a file named "MP170setup.msi" in the folder. Double click the file and the setup wizard will start. Proceed installation according to the setup wizard. Default installation folder is setup as "C:¥Program files¥EKO¥".Assign another folder name if needed. Click NEXT (N) > to continue installation.

a. Select Install Folder
Select the "All User/This User Only". If the PC is connected to network and allowing all users to be the software user, then login the PC as administrator then check the "All User". Click NEXT (N) > to continue installation.
b. Confirmation of Installation

The preparation for installation is complete. Clicking on NEXT (N) > will start the installation. Click < Back (B) for correcting the setting; click Cancel to cancel the installation process.

As the installation starts, the indicator for the installation status is displayed.

c. Completion of Installation
Once the installation is completed, the completion notice screen is shown. Click Close (C).

The installation of the software has been completed at this point; however, in order to connect the Main unit and the PC requires USB driver installation. USB driver installation is explained in the next section.

*If the PC, which is to install this software, is connected to a network, administrator authorization is required to install. Please Contact your network administrator.

USB drivers

Installation of both "USB Serial Converter" and "USB Serial Port" drivers
(Installation on WindowsXP)

USB Serial Converter driver Installation

1) Start up the Windows on the PC and power on the Main unit
2) Connect the Main unit and PC with USB cable
3) Windows finds "New device" (USB <-> Serial)
4) "Found New Hardware Wizard" starts
5) In "Connect to Windows Update" of the wizard,
   Select: "No, not this time" (WindowsXP)
   Nothing (Windows 2000)
   (*this window may not popup depending on the PC. If the window does not popup, proceed to "Next".)
   Then click "Next"
6) Select "Install from a list or specific location (Advanced)"
7) "Search for appropriate driver in the following location" is selected and make sure the "Include the following location" is checked. If it is not checked, please check.
   Click "Next".
8) Select "CDM2000" folder in "FTDI Driver" folder on the CD.
   Click "OK".
9) Make sure there is the selected folder name appears on the "Include the following location". Click "Next".
10) The USB Serial Converter driver installation will start automatically. Go to next step if an error message (file not found etc.) appears.
11) Once the dialog box appears for the USB Serial Converter driver

installation completion, click "Complete" button.

12) The USB Serial Converter driver installation is complete. Now continue to the installation of US Serial Port driver.

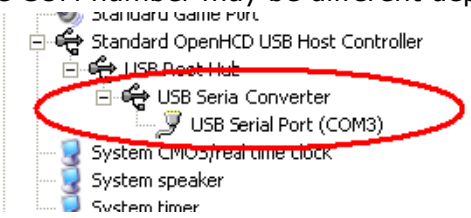
USB Serial Port driver Installation

1) Once the USB Serial Converter driver has been installed, Windows shows "New hardware" (USB Serial Port) popup message.
2) "Found New Hardware Wizard" starts.
3) In "Connect to Windows Update" of the wizard,
   Select: "No, not this time" (WindowsXP)
   Nothing (Windows 2000)
   Then press "Next".
4) Select "Install from a list or specific location (Advanced)". Click "Next".
5) "Search the appropriate driver in the following location" is selected, and make sure "including the following location" is checked. If not, check. Click "Detail" button.
6) Select "CDM2000" folder in "FTDI Driver" folder on the CD. It is the same folder as the USB Serial Converter driver. Click "OK".
7) Make sure the selected folder name appears on the "including the following location." Click "Next".
8) USB Serial Port driver installation starts automatically. Go to next step if an error message (file not found etc.) appears.
9) The USB Serial Port driver installation complete dialog box appears; click "Complete" button.
10) Once the installation has been completed, "Found New Hardware" message will popup.
11) Re-boot the PC.

Now the installation of USB Serial Port has been completed. Continue to confirming the completion of installation.

Confirm the Installation

1) Once the PC is restarted, connect the Main unit and the PC with USB cable.
2) Start the "Control Panel" on the Windows.
3) Start the "System". If use WindowsXP, select "System" from "Performance & Maintenance".
4) Start "Device Manager" from "Hardware".
5) Confirm the COM port number created by FTDI USB driver.
   The COM number may be different depending on the PC.



6) Start the USB Serial Port property window and check the USB Serial Port is indicated "This device is properly operating."

Now the installation for the USB Serial Converter driver and the USB Serial Port driver is completed.

7-3. How to Uninstall the Software

When this software is updated and new version software is distributed, the older version has to be uninstalled before updating.
The uninstalling instruction is same as the usual Windows applications; go to "Control Panel" and select "Add/Delete Program". Select "MP-170 Control Program" and click Delete button to start the uninstall process.

The dialog for the Add/Delete Program is displayed.
Click "Yes (Y)" button, starts the uninstall process.

Uninstalling FTDI USB driver

1) Start "Control Panel" from the Window.
2) Select "Add/Delete Program".
3) Click the "Change and Delete" button on the FTDI USB Serial Converter Drivers.
4) The dialog box appears; click "Continue" button.
5) On the next dialog box appears; click "Finish" button. The ID number may be different depending on the PC.
6) The un-installation of the driver is completed.

Cautions:

1) **The COM number on the USB Serial Port is different for each USB port on PC. In order to stabilize the system, please use the same USB port as much as possible in each time for use.**
2) **When operating the MP-170 using the MP-170 control program, please connect the PC and the MP-170 with USB cable before starting the program. Also, please disconnect the USB cable after the program is closed.**
3) **Please download the first driver software from the FTDI (Future Technology Devices International Ltd.) company website.**
   URL: http://www.ftdichip.com/
   Select "VCP" from the "Drivers" menu on the left side and download the OS driver to be used.

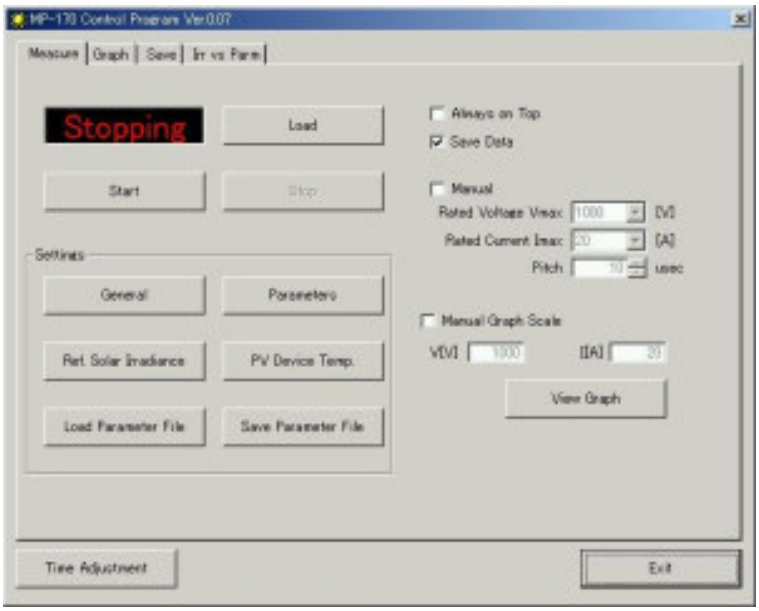
7-4. Software operation

When this software is started, the main screen is displayed. There are 4 tabs, Measurement, Display, Save, and Irr vs Parm; clicking on the tabs will change the screen display. The Measurement tab is displayed as default in the start.

Measure Measurement settings
Graph Graph display settings
Save Saving CSV converted data file
Irr vs Parm Graph displaying daily trends of solar irradiance and parameters

1) Measure window

Starting the software, the window starts with the Measure tab on top.
The Measure tab functions are the measurement and each setup functions.
Each button function is described below.

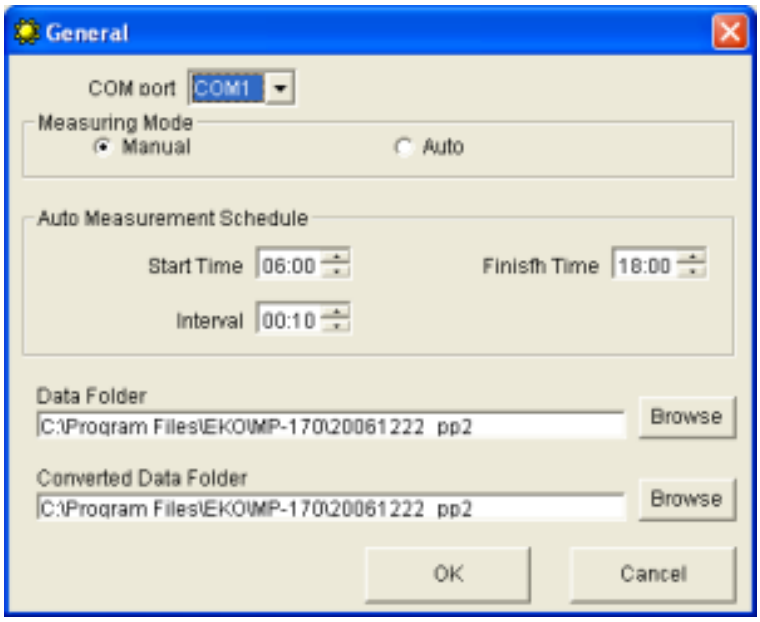


Always on Top : This window is always on top.
Save Data : Save measurement data while this box is checked.
Load : Loading the stored data from MP-170 to PC
Stopping, **Waiting** and **Measuring** : Measurement status indicator
Start : Start measuring
Stop : Stop automatic measuring
General : Measurement condition settings
Parameters : PV device parameters settings
Ref. Solar Irradiance : Pyranometer/Ref. Cell settings
PV Device Temp. : Thermocouple temperature sensor settings
Load Parameter File : Load existing parameter file
Save Parameter File : Save created parameter file

Manual: Set Voltage and Current range from this menu.
Graph scale: Set the graph scale manually

A) General - Measure

When click on the General button, below dialog box is displayed.



- COM port
  Select a COM port, from COM1 ~ COM4, to be used for MP-170.

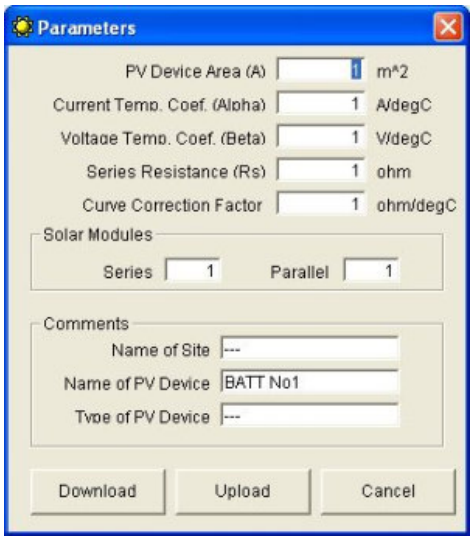
- Measuring Mode
  a. Manual: Press START every time for Manual measurement.
  b. Auto: Automatic measurement between Start Time and Finish Time with setting Interval.
- Auto Measurement Schedule : Set Start Time, Finish Time and Interval.
- Data Folder : Set the measurement data folder.
- Converted Data Folder : Set the converted data folder.

When finished entering, click "OK" button. If "Cancel" button is clicked, the entered settings are cleared.
Click the "Brows" button on the right side of the Save directory, the "Brows" window will popup. Assign the directory by using the following functions:

a) Directory Tree window
   Select folder
b) Key Enter
   Allows you to setup the folder by entering with keys
c) Dropdown list
   Change the drive by selecting from the dropdown list.

Once the entering is completed, click "OK" button. If "Cancel" button is clicked, the entered settings will be cleared.

B) Parameters - Measure



When the "Parameter Setting" button is clicked, the parameter setting dialog box is displayed as shown above.

Enter one piece of PV module parameter in the PV device area (Area), Current Temperature Coefficient (Alpha), Voltage Temperature Coefficient (Beta), Series Resistance (Rs), and Curve Correction Factor (K).
Next, enter the quantity of the PV module in series and parallel to calculate the overall PV array parameter, which is used for JISC8914 STC conversion.

In the comments section, this does not relate directly with the measurement; however, for the identification of the data, it will be useful for organizing the data afterwards. Therefore, it is recommended to enter in each time the measurement condition is changed. Also these items will be saved in the data file.

- PV Device Area
  The area of one PV module in the array

- PV parameters
  These parameters are used for correct STC conversion.
  Normally Rs and temperature coefficients are internal data of PV module manufacturer.

The following values are an example of p-Si module.
  Current Temperature Coefficient (Alpha): 0.002
  Voltage Temperature Coefficient (Beta) : -0.07
  Series Resistance (Rs) : 0.5
  Curve Correction Factor : 0.005

- Solar Modules
  Input the number of series and parallel connections (rows and lines) in the array construction.

- Comments
  Use for the information of measurement

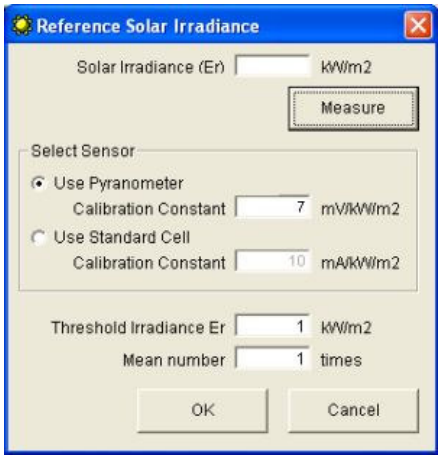
- Download
Download the existing set of parameters from MP-170.

- Upload

Upload the parameter which is setup on the software to the Main unit.
The MP-170 takes measurement with the uploaded parameter; however, there is no function to save the uploaded parameter in the memory, thus please manage it on the PC itself.

*It is possible to save/load the parameter settings which were uploaded from clicking on the "Load" button on the Measure tab screen; however, this information is not uploaded unless the "Upload" button is clicked.

C) Ref. Solar Irradiance - Measure



When the "Ref. Solar Irradiance" button is clicked, the dialog box shown above is displayed.
Select the sensor which measures the solar irradiance. Choose either the pyranometer or the reference cell. Enter the calibration value of chosen sensor.

Enter Threshold Irradiance (Er) and Averaging measuring count. The threshold irradiance is a setup value which hides the data that are the values below the set solar irradiance or that are assigned on the data list in the graph tab, save tab, and/or irr. Graph tab.

Click Measure, and the pyranometer data is displayed.

Once the entering is completed, click "OK" button. If "Cancel" button is clicked, the entered settings will be cleared.

D) Temperature settings -Measure



Click the Temperature button on Measure tab.

Select whether to measure the PV device temperature during the I-V measurement is taken or to setup as fixed value of current temperature.
Temp.1 is used for the STC calculation. Temp.2 is saved just for the record and it is not used for any calculation. Click Measure button, and the measured temperature are displayed. For the measuring count is entered with the averaging count. The averaged value of temperature measurement taken as entered is shown.
Once the entering is completed, click "OK" button. If "Cancel" button is clicked, the entered settings will be cleared.

E) Load Parameter File - Measure

Click Save Parameter File after setting all parameters, and save it with any file name you like. Click Save(S) once the file name is entered.

F) Save Parameter File - Measure

These saved parameters can be restored by clicking Load Parameter File and selecting the same file.
Click Open(O) after choosing the file.

However, even though the parameter file downloaded here contains the PV device parameter information, they will not be uploaded on the Main unit even if the "Start Measure" button is clicked. Open the parameter setting dialog box and click the "Upload" button to upload the PV device parameter to the Main unit in order to start taking measurement.

G) Start, Stop (Measurement) - Measure



Connect PV probes to MP-170 main unit and turn on power switch. Attach the gator grips at the terminal of PV device. Be careful not to reverse the polarity.
Connect USB cable between PC and MP-170 main unit.

Click Start button; the measurement starts and then Measure is displayed on the measurement status indicator.

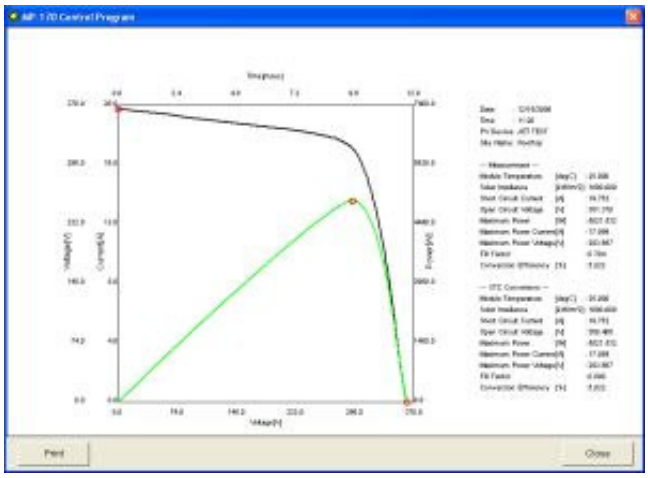
Click Stop to stop the measurement during consequent measurement,

* Check "Save Data" to save the data. When the "Save Data" is not checked, the results will not be saved.

*When measuring a large capacity PV array, wait at least 1 minute before taking next measurement. Due to the internal heat of the Main unit rising may shorten the life of the MP-170.

H) Graph

After the measurement, the result will be displayed.



I-V curve is shown after the measurement.
The shown above is an example of a measurement taken manually.
Click Print to print out the graph.
However, make sure to run the "Printer Setup" before hand, and it is in the printable condition.

I) Load (Data loading from MP-170) - Measure

Click "Load Data" after connecting MP-170 and PC with USB cable, and the saved data on MP-170 are transferred to PC. The counter number is shown while the data are loaded. Meanwhile, "Quit" is shown on the LCD screen on the Main unit; once the download is completed, the counter number screen automatically disappears. Press "Return" button on MP-170 after finishing the data transfer.

Data are stored in the "Data Folder" of "General" setting tab.

J) COM Port Error Message

After clicking "Start", "Load Data", or "Adjust Time", the error message "COM Port Upload Error" may popup.

This may occur when the COM Port number is not correctly setup.

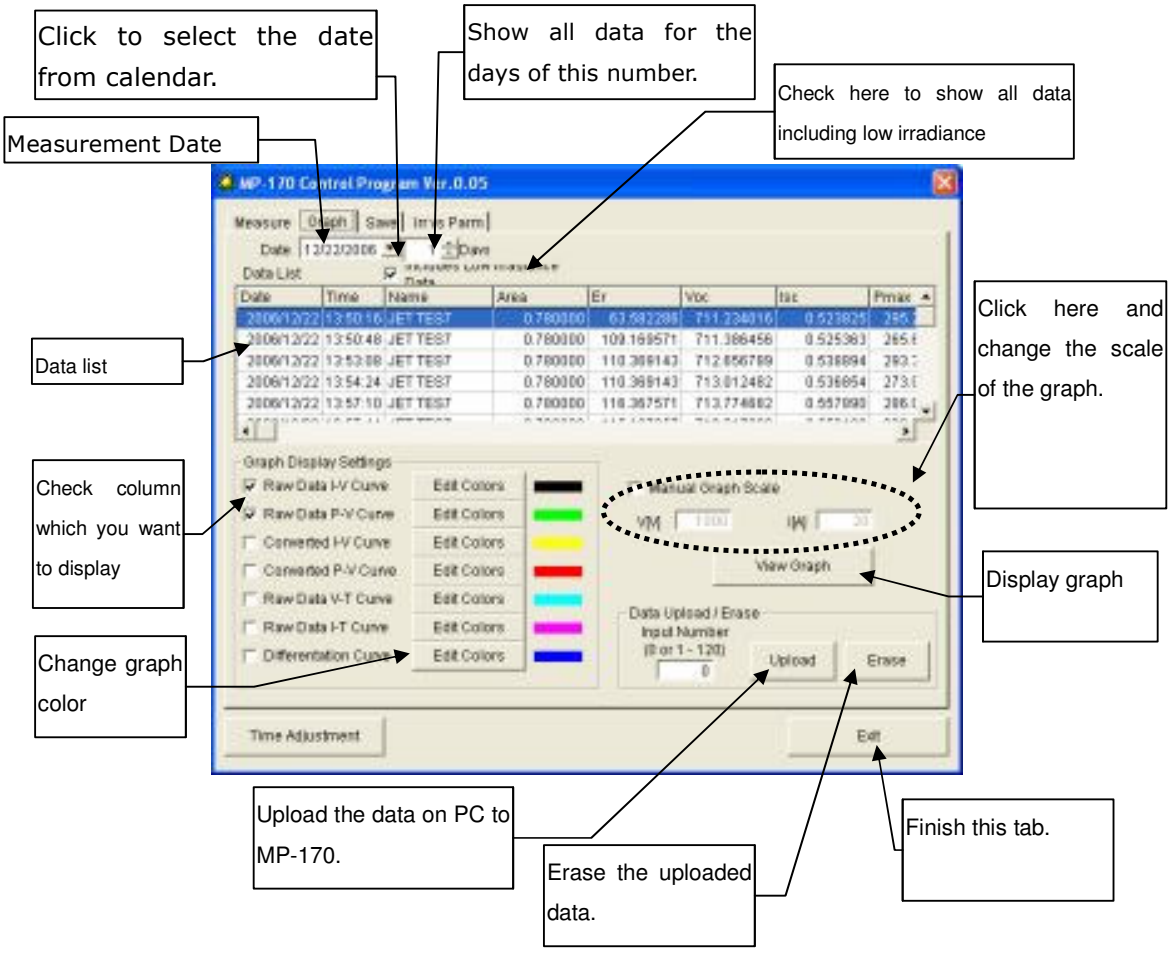
In such case, once disconnect the USB connector on the PC side and click the dropdown list of the communication port on General Setting. The COM Port numbers are shown. (COM1 always is shown)

Next, connect the USB connector on the PC. Check the communication port on the General Setting again. If the COM Port number has increased more than earlier, then the increased number is the assigned number for the USB. Select that number.

If the COM Port number has not increased, then select COM1. If there is multiple numbers of COM Port numbers from the start, and there are no changes, re-install the USB driver from the start.

*Even when the communication was thru once before, if the MP-170 was not used for a long period of time and tried to use it, the "COM Port upload Error" message may popup. Also, this may occur after the General Setting dialog box has been opened and modified. In such case, please go through the same process. If the communication does not get through, please check the communication port again. If the COM Port number is disappeared, either to disconnect and then connect the USB connector or to connect to another SUB port on the PC and setup the COM Port number again.

2) Graph window



A) How to use Calendar

Click the date dropdown button; the calendar is displayed.
If the year is clicked on the calendar, the up/down arrow is displayed.
Click the left arrow on the top of the calendar takes back to the month before.
Click the right arrow on the top of the calendar takes forward to the month ahead.
Click on the month will give the dropdown of the all twelve months.

On the ”Graph" tab menu, select the measurement date first. Click the drop arrow on the right side of the date indication will display the calendar.
When changing the years, move the mouse cursor on the top of the year indicator and left click. The drop arrow appears; click the up/down arrow to change the years.
To change the month, move the mouse on the month indicator; dropdown menu will appear by left clicking. Either select the month or click the left/right arrow keys will display the monthly calendar. Then click the desired date on the calendar.
Once the year, month, and date are selected, the list of data which was taken for that day is displayed in timely order. Click the date of data to be graphed, the row is indicated as selected. Click “Graph” button in this condition will display the graph.
Also, the data can be graphed for the days assigned on the right side of the calendar indicator “1 Day”.

B) Graph Indication

There are 7 types of graphing on the Graph tab.

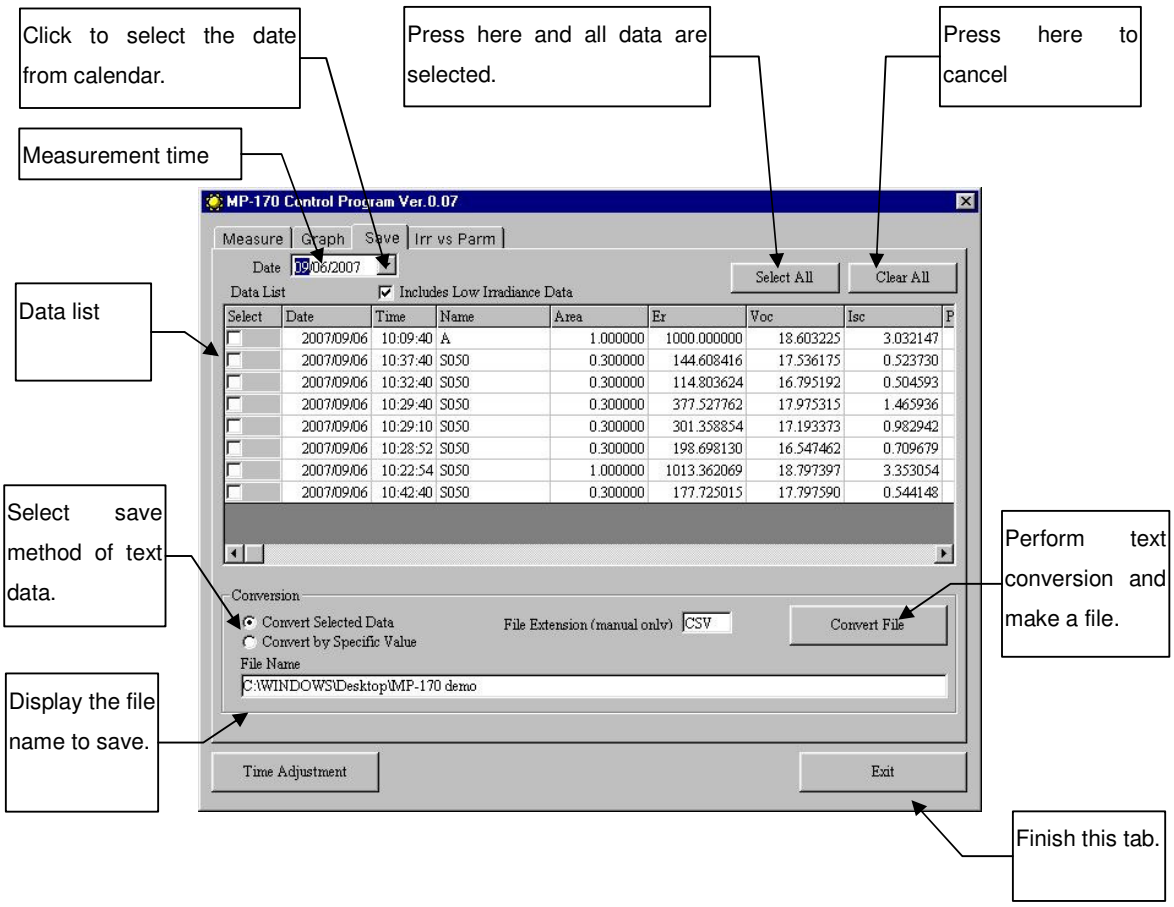
a. I-V Curve (Measured Value)
b. P-V Curve (Measured Value)
c. I-V Curve (Converted)
d. P-V Curve (Converted)
e. V-T Curve (Measured Value)
f. I-T Curve (Measured Value)
g. Differential Curve (dI/dV-V Curve)

Check the items to be graphed and click “Graph” to display the graphs.

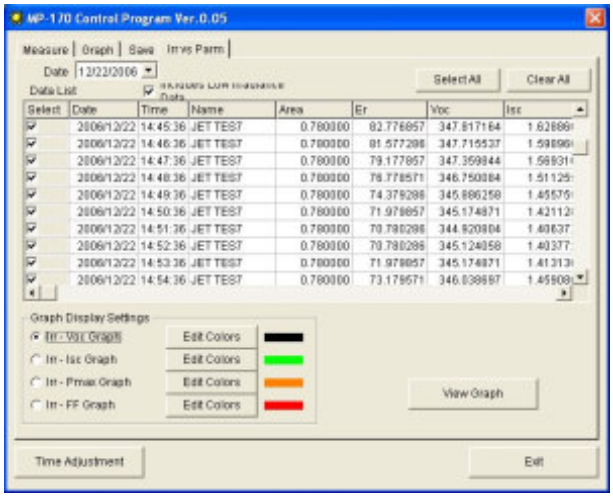
Graph Colors
By clicking the “Graph Color Setting” button on the right side of the each graph data item, the “Color Setting” dialog box will appear. Click on the color that you want to use and click “OK”; the color of the graph will change as assigned.

3) Save windows

Click "Save" tab and the following window is shown.
The functions for each button are described.



A) "Irr vs Parm" window



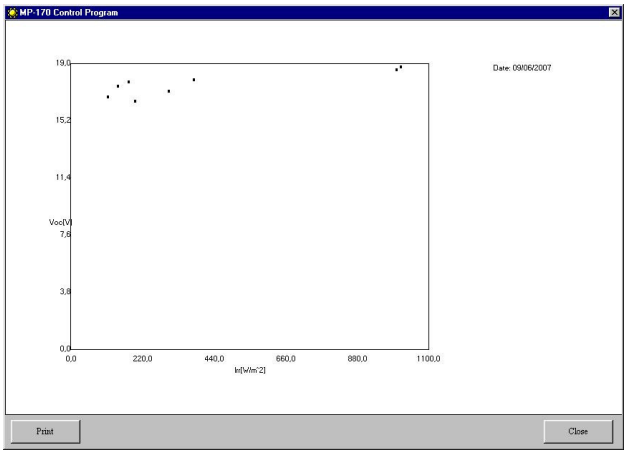
The settings of daily trend graph displaying of 4 parameters
The graph is displayed as relation between solar irradiance and each parameter.

1) Voc
2) Isc
3) Pmax
4) FF

To view the graph,

1) Select data by specific date
2) Select target data by setting "Select checked" or "Select All".
   To clear selection, press "Clear All".
3) Select a graph style from "Graph Display Settings"
4) Click "View Graph"

"Includes Low Irradiance Data"
Display all data if data was measured under the solar irradiance that set as "Threshold Irradiance"



Irr - Voc Graph
X-axis : Solar irradiance [W/m^2]
Y-axis : Voc [V]
The changes of the Voc against the solar irradiance

Irr - Isc Graph
X-axis : Solar irradiance [W/m^2]
Y-axis : Isc [I]
The changes of the Isc against the solar irradiance

Irr - Pmax Graph
X-axis : Solar irradiance [W/m^2]
Y-axis : Pmax [W]
The changes of the Pmax against the solar irradiance

Irr-FF Graph
X-axis : Solar irradiance [W/m^2]
Y-axis : FF
The changes of the FF against the solar irradiance

7-5. Data format

File name

Measurement (raw) data

yyyymmddhhmmssxxx.MDF

Example: 20071215103510001.MDF
Measurement in 2007, Dec. 15 at 10h35m10s
Data sequence is #001
Data extension is MDF

I-V curve converted data

yyyymmddhhmmssxxx.CSV

Example: 20071215103510001.CSV
Measurement in 2007, Dec. 15 at 10h35m10s
Data sequence is #001
Data extension is CSV

PV parameters converted data

CHARAyyyymmddhhmmss.CSV

Example: CHARA20071215103510.CSV
CHARA: Identifier
Measurement in 2007, Dec. 15 at 10h35m10s
Data extension is CSV

1) Data format – I-V curve converted data file (CSV format)

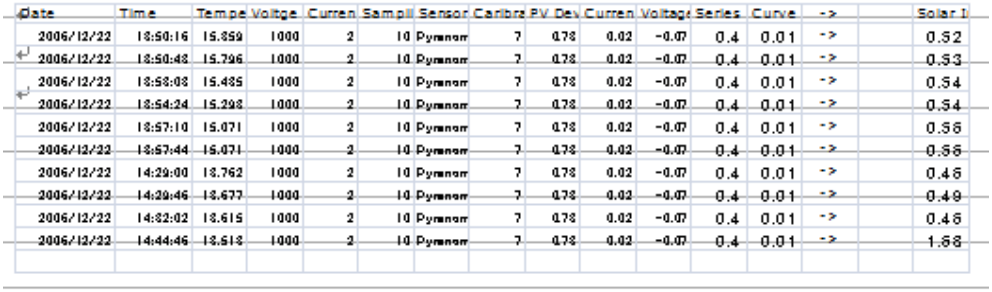
Name	TEST_1
Date	2006/12/22
Time	14:44:46
Temperature[degC]	13.513
Voltage Range[V]	1000
Current Range[A]	2
Sampling Pitch[uS]	10
Sensor	Pyranometer
Calibration Constant (Er cal)[mV/kW/m^2]	7
PV Device Area[m^2]	0.78
Current Temp. Coef.[A/degC]	0.02
Voltage Temp. Coef.[V/degC]	-0.07
Series Resistance(Rs)[ohm]	0.4
Curve Correction Factor (Kappa)[ohm/degC]	0.01
Series Modules	24
Parallel Modules	1
Solar Irradiance (Er)[W/m^2]	85.176286
PV Device Temp.[degC]	13.6843
Isc[A]	1.675681
Voc[V]	348.52855
Pm[W]	402.844002
Ipm[A]	1.400445
Vpm[V]	287.654195
Eta	0.252646
FF[%]	0.689775
Er (stc)[W/m^2]	1000
T (stc)[degC]	25
Isc (stc)[A]	62.964673
Voc (stc)[V]	475.22682
Pm (stc)[W]	9413.024916
Ipm (stc)[A]	62.964673
Vpm (stc)[V]	149.496923
Eta (stc)	0.502833

Voltage[V]	Current[A]
2.744	1.684
4.218	1.681
5.335	1.689
;	;
;	;

I-V data can be stored from data point 1 to 400

2) PV parameters converted data file (CSV format)

By selecting "Convert by Specific Value" conversion, the following data is created.



Date	Time	Tempe	Voltge	Curren	Sampli	Sensor	Caribra	PV Dev	Curren	Voltage	Series	Curve	->		Solar I
2006/12/22	13:50:16	15.859	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.52
2006/12/22	13:50:48	15.796	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.53
2006/12/22	13:53:03	15.485	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.54
2006/12/22	13:54:24	15.298	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.54
2006/12/22	13:57:10	15.071	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.56
2006/12/22	13:57:44	15.071	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.56
2006/12/22	14:29:00	13.762	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.46
2006/12/22	14:29:46	13.677	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.49
2006/12/22	14:32:02	13.615	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		0.46
2006/12/22	14:44:46	13.513	1000	2	10	Pyranom	7	0.78	0.02	-0.07	0.4	0.01	->		1.68

Data items (left to right in CSV format)

Name
Date
Time
Temperature[degC]
Voltage Range[V]
Current Range[A]
Sampling Pitch[uS]
Sensor
Calibration Constant (Er cal)[mV/kW/m^2]
PV Device Area[m^2]
Current Temp. Coef.[A/degC]
Voltage Temp. Coef.[V/degC]
Series Resistance(Rs)[ohm]
Curve Correction Factor (Kappa)[ohm/degC]
Series Modules
Parallel Modules
Solar Irradiance (Er)[W/m^2]
PV Device Temp.[degC]
Isc[A]
Voc[V]
Pm[W]
Ipm[A]
Vpm[V]
Eta
FF[%]
Er (stc)[W/m^2]
T (stc)[degC]
Isc (stc)[A]
Voc (stc)[V]
Pm (stc)[W]
Ipm (stc)[A]
Vpm (stc)[V]
Eta (stc)

8. Maintenance

8-1 Daily maintenance

- Clean the domes of the angle capture and the pyranometer with soft cloth before using MP-170.
- Use fresh battery
- Adjust the clock of the Main unit and the Sensor unit before starting measurement.

8-2 Storing note

- Remove batteries when MP-170 is not in use for a long time.
- Store MP-170 in low humidity condition.

9. Trouble shooting

9-1. Communication errors

- Confirm USB driver is installed to PC.

- "COM port access error" is displayed when Start, Load, Set Clock is clicked.
  It is possible that the COM port number is not properly set.
  Remove the USB cable from PC and go to "COM port" of "General" window. The COM number (usually COM1) is shown.
  Connect USB cable again and go to "COM port" again. If a larger COM port number is shown, select this by pressing OK .
  Select COM1 if this is shown in both cases.
  If there are multiple COM ports and the number has not changed after removing the USB cable, reinstall the USB driver and repeat this procedure.

9-2. Measurement errors

- **Unable to measure I-V curve**
  a) Confirm that output voltage, current and power of PV module / array are within the specifications of MP-170.
  b) Internal fuse maybe broken.
  DO NOT open MP-170 to avoid secondary defects.
  Send MP-170 back to EKO.

- **Data of the Sensor unit is not synchronized with the data of the Main unit.**
  The backup battery is not equipped in the Main unit. In order to maintain the internal clock running continuously, when the battery dies; instead, a super capacitor is used. Therefore, the time that had been setup is cleared in approximately 3 days after the battery has died.
  Confirm that the both clocks of the Main unit and the Sensor unit are synchronized before starting the measurement.
  (For environment-friendly purpose, EKO does not accept Lithium battery.)
- **Unable to measure continuously.**
  Check whether the starting time is setup earlier than the finishing time.

- **Rising I-V curve in Isc side**
  It is not broken. This condition occurs when large junction-capacitance PV devices, such as amorphous-Si and HIT, are measured.
  With the capacitor load method on MP-170 cannot avoid such problem; however, MP-170 obtains Isc from linear approximation which minimizes the rising curve.

- **FF is low, I-V curve apart from Isc**
  Either the PV device cable is too long, or the resistance of the connection is too high. The resistance amounts on MP-170's measuring circuit and the cable are influencing this problem. This happens when using low voltage and high current PV devices.

- **The power does not come ON**
  This condition may occur when the batteries or the AC adapter are not used and the power switch is pushed, then tried to turn on the power.
  This problem can be solved by plug/unplugging the power.
  When using AC adapter: Unplug and then plug again, then push the Power switch key.
  When using batteries: May be due to changing batteries. Take out the batteries and place them back in again, then push the Power switch key.

10. Specifications

Item		Content
PV power input range	Voltage	- 10V ~ 1000V
	Current	- 1A ~ 20A
	Power	- 10W ~ 10kW
Maximum input range		- Power 10kW @500V and 20A, @1000V and 10A - Voltage 1000V @10A, 500V@20A - Current 20A @500V, 10A@1000V
Measurement accuracy *A/D converter output use reference input		- Voltage: +/-1.0% FS or less (10V range) +/-1.0% FS or less (100V range) +/-1.0% FS or less (1000V range) - Current: +/-1.0% FS or less (2A range) +/-1.0% FS or less (10A range) +/-1.0% FS or less (20A range) - Pyranometer: +/-1.5% FS or less - Reference cell: +/-1.5% FS or less - Temperature: +/-1ºC or less at 25ºC
Input		- PV device output 1ch (+/-) - Temperature 2ch (T-type Thermocouple -50ºC ~ +100ºC) - Pyranometer 1ch (0 ~ 15mV) - Reference Cell 1ch (0 ~ 100mA, Internal shunt resistor 0.1Ω)
Range settings		- Voltage: 10V, 100V, 1000V, AUTO - Current: 2A, 10A, 20A, AUTO
Interface		- Main unit - PC: USB - Main unit - Sensor Unit: RS-485
Key operation		- numeric keypad + cursor key + function key (flat-panel keyboard)
Memory		- 300 sets of I-V curve data can be stored
Data points		- 10μ second per point (fixed sweep time) - 400 points per one I-V curve
LCD		- reflective LCD, 128 x 64 dots, no-backlight
Power supply	Main unit	- D size battery x 4 (about 5 hours in 10 minutes interval continuous measurement) - Power consumption: maximum 300mA - Ni-H battery also available. or - AC adapter AC100 ~ 240V, 50/60Hz, DC9V 1.3A (EIAJ-3 plug, Center +) - Power consumption: maximum 180mA
	Sensor Unit	- 006P Dry battery x 1 (9V) Power consumption: maximum 20mA
Dimension		- Portable size Main unit: W230 x D300 x H160 mm (Cover including, feet excluded) Sensor unit: W210 x D85 x H55 mm (horizontal: feet excluded)

Weight	- Main unit: 3.0kg , Plastic + Aluminum - Sensor unit: 480g, Plastic - Cables: 300g
Environment	Operation: Temperature 0 ~ 50ºC (without direct sunlight exposure) Humidity 35 ~ 85%RH (without condensation) Storage : Temperature -20 ~ +70ºC (packed in carton box) Humidity 30 ~ 60%RH (packed in carton box)

Software specification

Operating System	- Windows2000/XP/Vista
Software Function	- One time, continuous measurement from software AUTO range of power current is MAX in one time measurement, and follow-up the range in continuous measurement for the second time or later - Loading configuration parameter and data from the main body of MP-170 - Display of I-V curve, P-V curve, V-T curve, I-T curve, and dI/dV-V curve - Display of daily compiled graph of Solar Irradiance vs Pm, Voc, Isc - Data base function (Browsers data and displays graphs by selecting date from the calendar) - Data conversion to CSV text file (each measured data, characteristic compiled data) - Time synchronization with main body of MP-170 - Upload to main body memory of MP-170
Measurement Parameters	- Maximum Power(Pm), Open Circuit Voltage(Voc), Short Circuit Current(Isc), Fill Factor(FF), Conversion Efficiency(η), Maximum Power Voltage(Vpm), Maximum Power Current(Ipm), STC conversion (JIS C8914)



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