MPPT Electric Load

MP-410

EKO
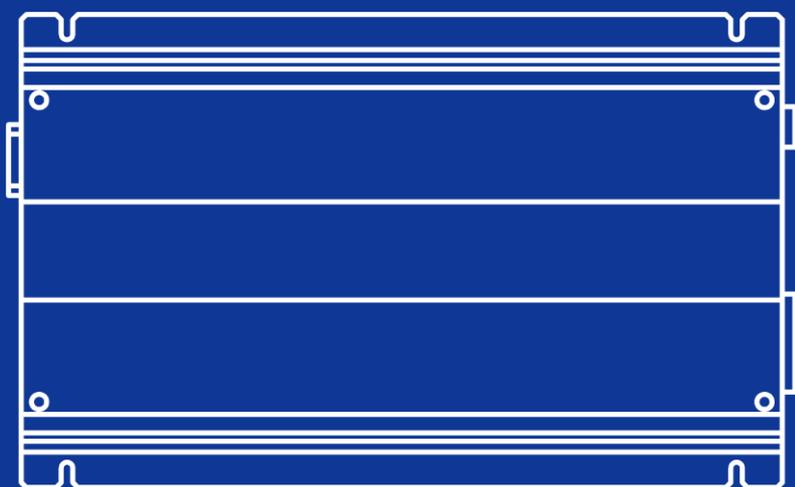
1. Index

2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.

For any questions, please contact us at one of the EKO offices given below:

2-1. Contact Information

EKO INSTRUMENTS CO., LTD.		
Asia, Oceania Region		
eko.co.jp info@eko.co.jp	EKO INSTRUMETNS Co., Ltd. 1-21-8 Hatagaya, Shibuya-ku Tokyo, 151-0072 Japan	Tel: +81 (3) 3469-6711 Fax: +81 (3) 3469-6719
Europe, Middle East, Africa, South America Region		
eko-eu.com info@eko-eu.com	EKO INSTRUMENTS Europe B.V. Lulofsstraat 55, Unit 32, 2521 AL Den Haag, The Netherlands	Tel: +31 (0)70 3050117 Fax: +31 (0)70 3840607
North America Region		
eko-usa.com info@eko-usa.com	EKO INSTRUMENTS USA Inc. 95 South Market Street, Suite 300 San Jose, CA 95113 USA	Tel: +1 408-977-7751 Fax: +1 408-977-7741

2-2. Warranty and Liability

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

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

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

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

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

2-3. About Instruction Manual

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2-4. Environment

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

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

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

2. RoHS Directive 2002/95/EC

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

3.   Safety Information

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

	WARNING CAUTION	Attention to user; pay attention to the instructions given on the instruction manual with this sign.
	HIGH VOLTAGE WARNING	High voltage is used; pay special attention to instructions given on this instruction manual with this sign to prevent electric leakage and/or electric shocks.
	HIGH TEMPERATURE WARNING	The instrument part becomes hot. Touching or getting close to the devise may lead serious injury.

3-1. WARNING/CAUTION

Setup

➢ Make sure to mount this instrument on a metal frame.

➢ This instrument cannot be connected in parallel.

➢ This instrument is not waterproof designed. Do not use this instrument in any indoor or outdoor environment with high condensation and humidity.

➢ Make sure to connect the main body of this instrument to ground.

➢ Do not connect to battery supply. Use this instrument for PV module evaluation only.

➢ Depending on the rating of PV module used, use external cooling fan.

➢ Connecting terminal for the PV module on this instrument is not treated with lightning surge. To protect the PV module from lightning surge, make sure to take countermeasure for lightning surge.

➢ This instrument supplies power from the attached AC adaptor.

3-2. HIGH VOLTAGE WARNING

PV Module Connecting Terminal

➢ High voltage is applied to the terminal for PV module connection on this instrument. Be very careful handling the connections terminals to avoid electric shocks.

➢ Wear insulated protective gloves and as such when touching this instrument.

3-3. HIGH TEMPERATURE WARNING

Metal Parts

➢ This instrument dissipates the power generated by the PV module, therefore the device will get very hot.

➢ During operating, you may burn yourself when touching the instrument with bare hands; be very careful with handling.

➢ When handling and touching this instrument, disconnect the device from the PV module and turn OFF the power of the instrument. Before touching sufficiently cool off the instrument.

4. Introduction

The MP-410 Electronic Load is an active electronic load which can be connected to a PV module to track and control the Maximum Power Point (MPP) of a PV module.

The MP-410 electric load can be used for continuous module performance evaluation of single PV modules up to 300W. Based on the advanced MPP tracking function the PV module power will be automatically regulated and can be monitored when exposed to solar irradiance or sun simulator. Contrary to regular I-V tracers the MP-410 can provide uninterrupted information about the maximum performance operating point of the module and is the best solution to rate a PV module under variable weather conditions. The output (I and V) can be independently measured, by using external shunt resistors in combination with an additional data-logger or measurement device.

The MP-410 can be used stand alone or in combination with the MP-160 I-V tracer system. In combination with the MP-160 I-V tracer system, the PV module can be kept at the MPPT between two I-V measurements. In this case the PV modules remain under load and can be tested under realistic field conditions. This way long term performance and potential aging effects can be monitored at module level.

4-1. Main Functions

1. Maximum Power Point Tracking Function

By connecting this instrument to a operating PV module, the MP-410 controls the operating point of PV module.

Maximum Tracking Voltage:	200V (200V range) or 50V (50V range)
Maximum Tracking Current:	10A
Maximum Tracking Power:	250W (Ambient Temperature 30℃ with cooling)
	300W (Ambient Temperature 20℃ with cooling)
Minimum Tracking Voltage:	5.0V
Minimum Tracking Current:	10.0mA

2. Maximum Power Point Search Function

MP-410 MPP search function will work under condition of partial shading of the PV module.

3. MPPT Operation Status Indication/Output

Operating status can be checked from the LED indicators on the front panel of MP-410.

4. Manual Switching for Voltage Range

MP-410 can operate in two ranges, respectively 200V and 50V. The voltage range can be manually set by a DIP switch (DSW).

5. Operating Point Voltage Hold Function

The tracking operation is temporarily stopped and holds the PV module output voltage.

When the hold input of the mini-DIN terminal is set to "Low", the tracking operation stops and the PV module voltage is fixed with the voltage of the time it is stopped. When the hold input is set to "Hi", the tracking operation restarts.

While the voltage is on hold and the Voc of the PV module becomes "less than the voltage on hold", it automatically updates the operation point to Voc x 0.85.

When this function is used, a separate mini-DIN 9P cable is required.

6. Protection Functions

Overheat Protection

When the body temperature exceeds 80℃, operation will be terminated to protect the electronics. (When the temperature cools down below 70℃, the operation restarts automatically)

Over-voltage Protection

The PV input is protected against over-voltage and will automatically deactivate. When the input voltage gets below the rated voltage, operation restarts automatically.

Over-current Protection

The PV input is protected against over-current by a fuse.

4-2. Package Contents

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

Table 4-1 Package Contents

Standard Items	Qty.	Remarks
MP-410	1	
AC Adapter	1	IN : 120/240Vac (90V~264V), 50/60Hz OUT : 12V, 1A
Spare Fuse	1	φ6.35×31.8 mm, 250V, 15A
Inspection Report	1	
Instruction Manual	1	

5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main functions are described below.

1. Panel
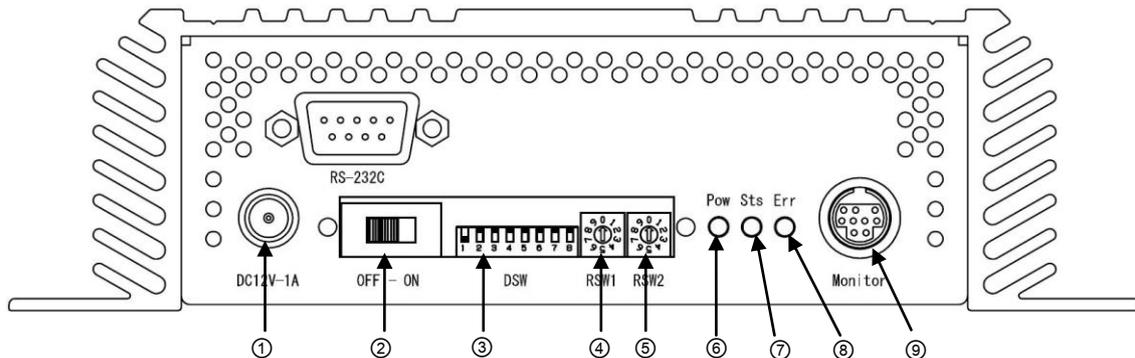
Figure 5-1-1(a). Panel (without cover)
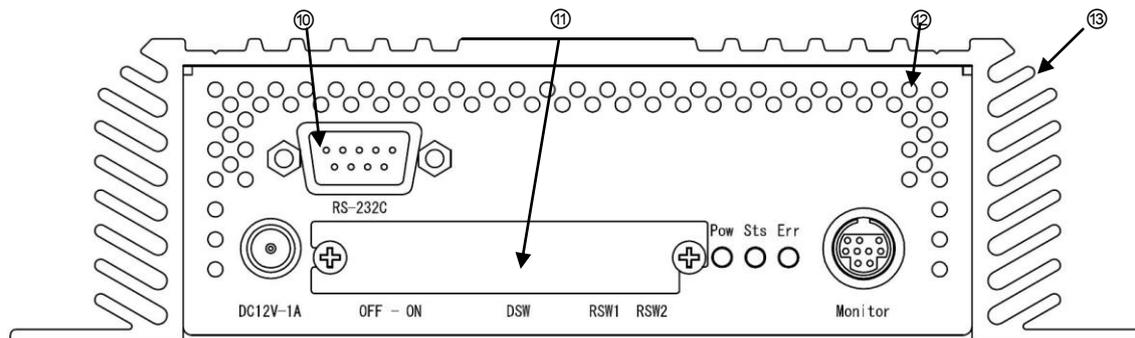
Figure 5-1-1(b). Panel (with cover)

Table 5-1-1. Panel Side Parts Name and Description

No	Parts Name	Description	Reference
①	DC Jack for Power	Connect AC adapter (attached, 12Vdc)	-
②	Power Switch	Power Switch	-
③	DIP Switch (DSW)	Operation Mode/Parameter Setup	⇒Pg.15
④	Rotary Switch1 (RSW1)	Rotary Switch for Pmax Search Function Setup	⇒Pg.16
⑤	Rotary Switch 2 (RSW2)	Not used	-
⑥	Power LED (Green)	Lights on during Power ON	-
⑦	Tracking Status Indicator LED (Yellow)	For checking the tracking status	-
⑧	Error Indication LED (Red)	Lights on or links when error occur	-
⑨	External Input & Output control / Monitor Terminal	mini-DIN Terminal	⇒Pg.13
⑩	RS-232C Port	For maintenance	-
⑪	Panel Cover	Panel Cover	-
⑫	Vent	Vent	-
⑬	Radiator Fin	Radiator Fin	-

2. PV Module Connecting Side
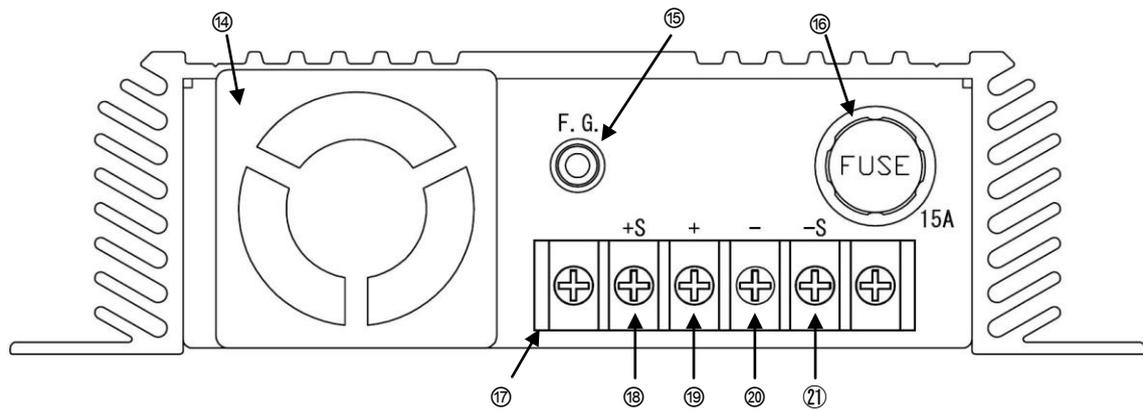
Figure 5-1-2. PV Module Connecting Side (without Terminal Cove)

Table 5-1-2. PV Module Connecting Side Parts Name and Description

No	Parts Name	Description	Reference
⑭	Cooling Fan	Internal Cooling Fan	-
⑮	F.G.	Grounding Terminal	-
⑯	FUSE Box	Overcurrent Protection Fuse (15A)	-
⑰	PV Module Connection Terminal	PV Module connection (Applicable for 4-Wire and 2-Wire)	⇒Pg.11
⑱	+S	PV Module voltage sense (+)	-
⑲	+	PV Module current pathway (+)	-
⑳	-	PV Module current pathway (-)	-
㉑	-S	PV Module voltage sense (-)	-

5-2. Setup

Wear insulated protective wears such as gloves to avoid any accidents and injury from electric shocks.

1. Recommended Setup

Following the setup is recommended for optimal usage and performance of the MP-410.

1) Mount the MP-410 on a metal frame.

2) Place the MP-410 more than 100mm away from walls and other objects for natural ventilation or forced cooling.

3) Forced cooling using a ventilator is recommended, setup 2 units of additional cooling fans around the MP410 as shown on Figure 5-2-1.

- Example of additional Cooling Fan to be used

  (The additional cooling fans are not included in the package)

  Size: 120mm (120mm x 120mm)

  Wind Volume: 2.6m^3/min

- 1st Fan Unit: Setup so that the air will flow perpendicular to the MP-410 top surface.

- 2nd Fan Unit: Setup so that the air will flow towards the vent.

MP-410 units cannot be connected in parallel to each other.
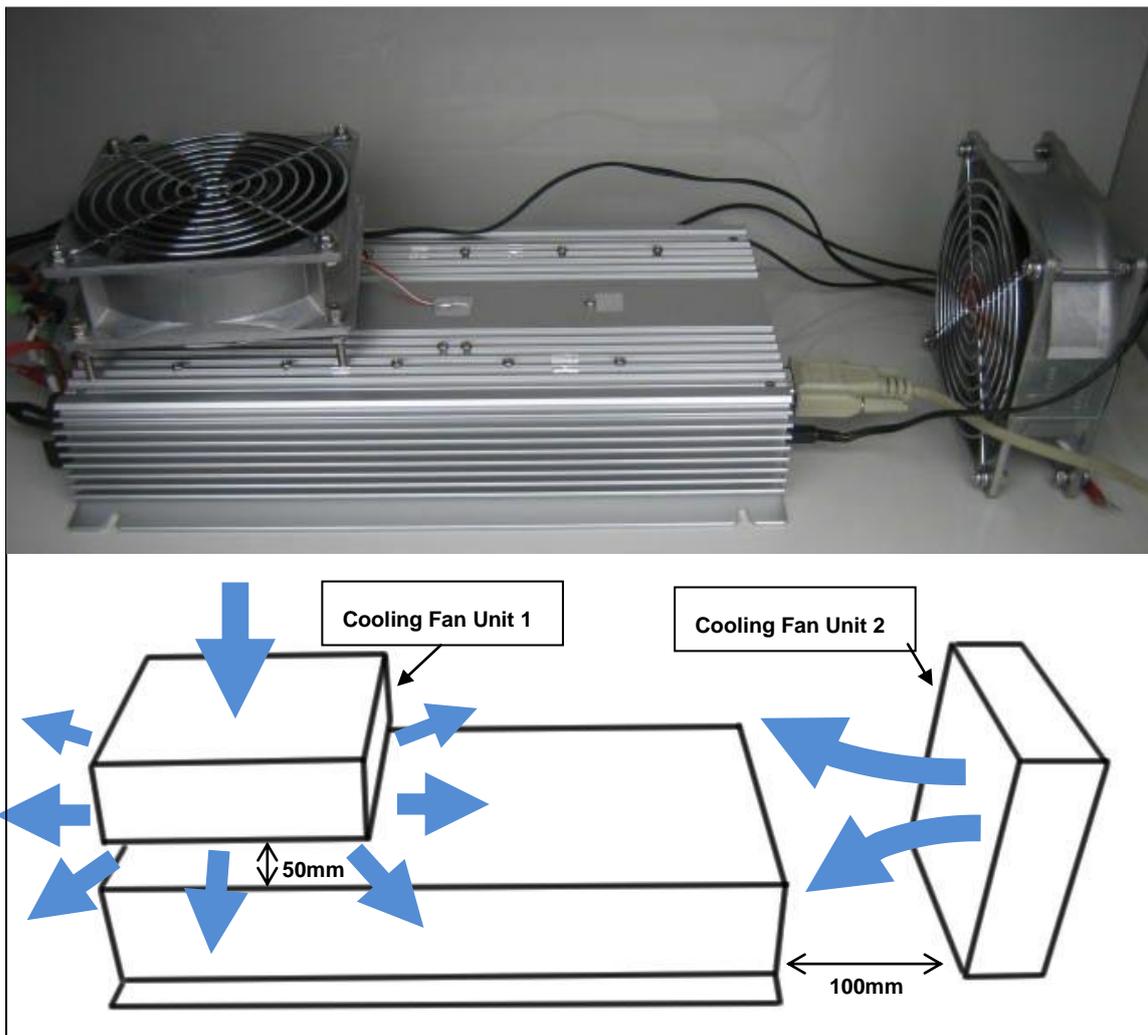
Figure 5-2-1. Recommended Setup for MP-410

2. Connecting to PV Module

When the MP-410 is connected to a PV module, it can be connected either by 2-wire (+,-) or 4-wire (+S, +, -, -S) connections. Short circuiting the +S and +, -S and – at the terminal can be used as 2-wire type.
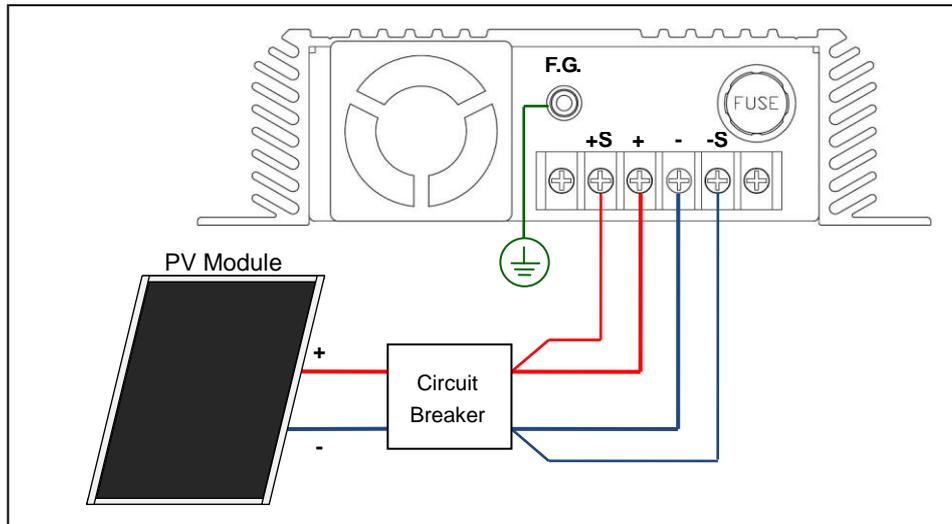
Figure 5-2-2(a). Connecting to PV Module (In-case of 4-wire method)
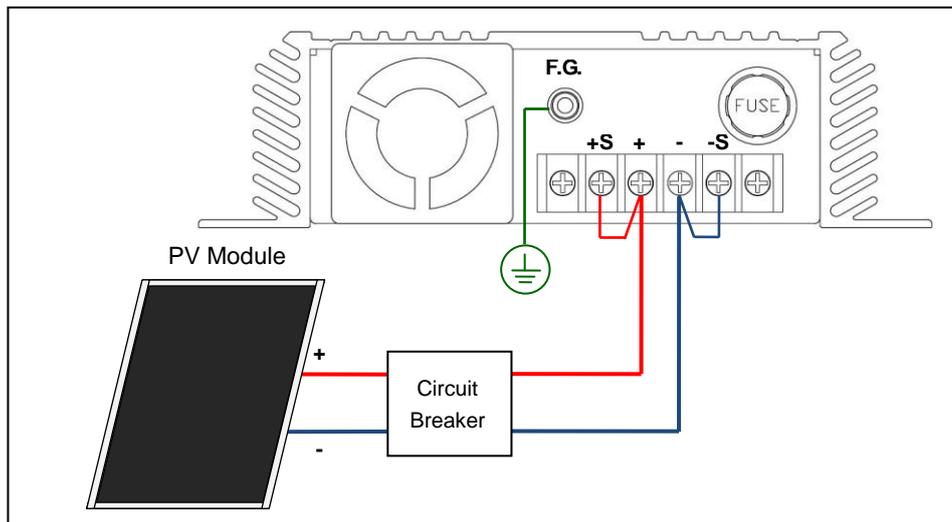
Figure 5-2-2(b). Connecting to PV Module (In-case of 2-wire method)

3. Measuring Voltage/Current

The MP-410 does not have an internal function to measure the Pm voltage/current/power. In order to measure these parameters, external shunt resistors and datalogger or measurement device needs to be setup as shown below.
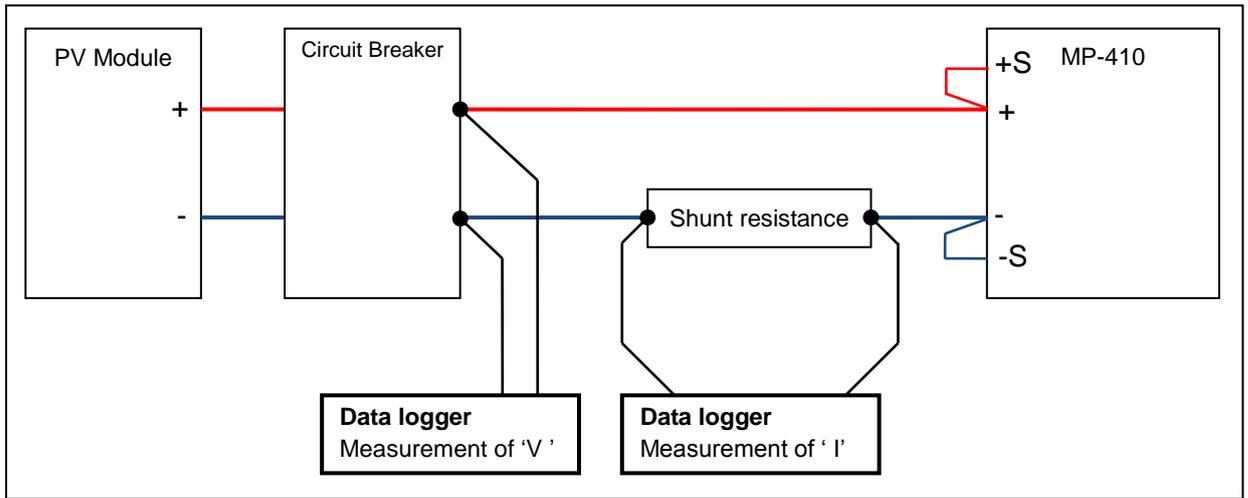
Figure 5-2-3(a). Voltage & Current Measurement Setup (In-case of 2-wire method)
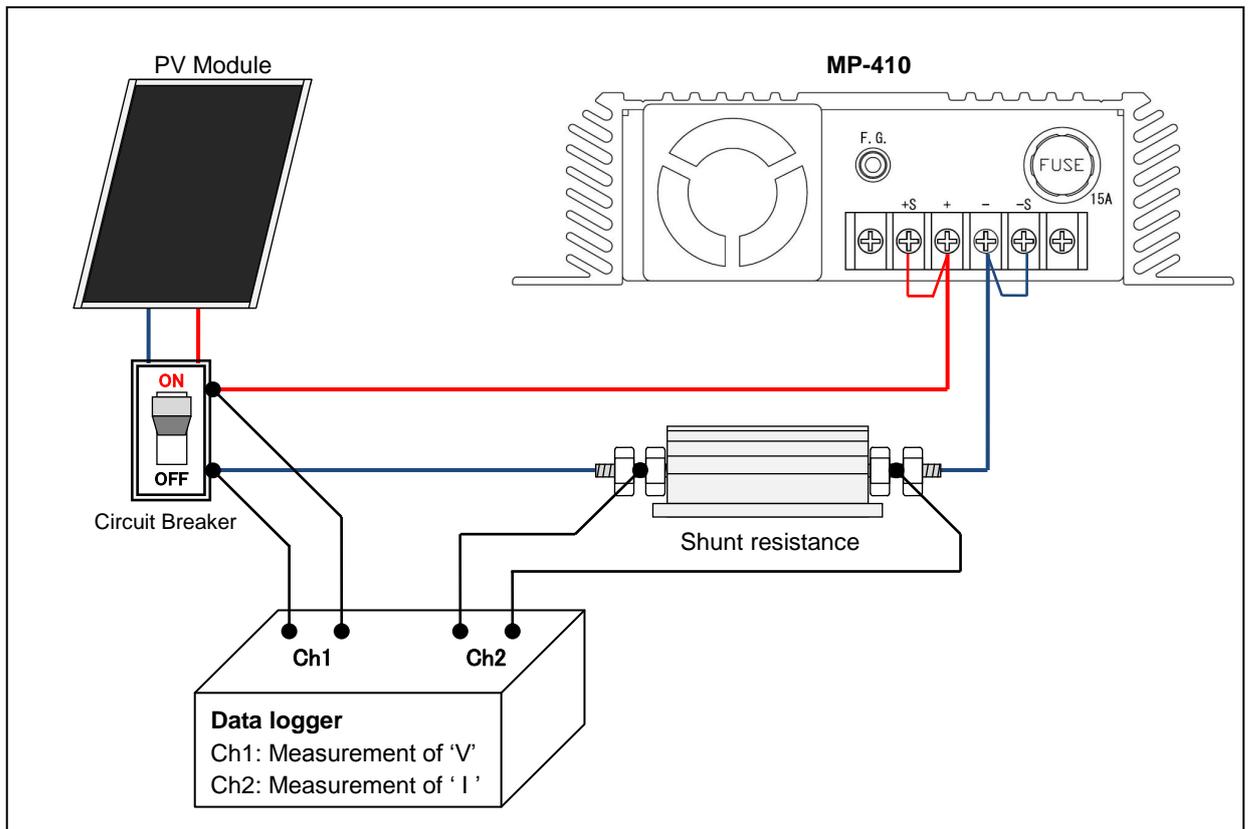
Figure 5-2-3(b). Voltage & Current Measurement Setup (In-case of 2-wire method)

4. External Input & Output Control/Monitor Terminal Connection

By connecting the input/output control terminal or monitor terminal, the condition of MP-410 can be recorded.
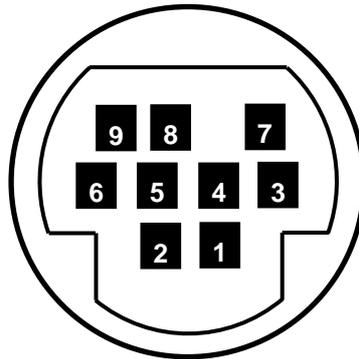
Figure 5-2-4. External Input & Output Control/Monitor Terminal: Terminal Numbers

Table 5-2-1. External Input & Output Control/Monitor Terminal Functions

Pin No	Input/Output	Function	Remarks
1	—	N/A	N/A
2	GND	GND	GND
3	—	N/A	N/A
4	GND	GND	GND
5	Output	Pmax Searching Status	Open Collector[*1] (Pull-up Voltage <3~12V, Current <100mA) Hi: Pmax Tracking Low: Pmax Searching
6	Output	Pmax Tracking Status	Open Collector[*1] (Pull-up Voltage <3~12V, Current <100mA) Hi: Searching Pmax by hill climbing method Low: Pmax Tracking
7	Output	Sampling Timing	Open Collector[*1] (Pull-up Voltage <3~12V, Current <100mA) t1: OFF-Time approx. 4ms t2: Sampling Cycle approx. 200ms
8	Input	Hold	Already pulled up internally (3.3V, 1kΩ) Hi: Pmax Tracking Low: Maintain Operation Point Voltage[*2]
9	GND	GND	GND
Shield	GND	Shield	

[*1] When connecting to recorder such as data logger, pull up the voltage to 3V~12V.

[*2] For Pull-up resistance, adjust the current so that it will be less than 10mA.

1) Pmax Searching Status Output

Shows the searching status of Pmax. When MP-410 is in searching status, the operation point goes off from the Pmax temporary, thus only the tracking value can be extracted by using "Pmax Searching Status Output" when monitoring the operation pints externally. (Pmax serach can be performed by setting the rotary switch 1 to "1" ~ "4".)

2) Pmax Tracking Status Output

There are cases that Pmax tracking goes off the track temporary due to such as sudden change in irradiance. By using the "Pmax Tracking Status Output", the status of Pmax tracking can be checked.

3) Sampling Timing Output

Connecting to external trigger input on device such as data logger will allow acquiring data which is synchronized with the operation of MP410.

4) Hold Input

Setting the hold input terminal to "Low" while the MP-410 is in operation will allow the operation point voltage to be fixed by stopping the Pmax tracking operation.

※ When "Voltage at hold > Voc for measurement subjected PV module", the operation point voltage will be changed to: Voc x 0.85.

※ The hold input is pulled up to 3.3V MP-410 internally.   (Pull-up Resistance: 1kΩ)

※ Connect the hold input to open collector or such as relay between the GND.
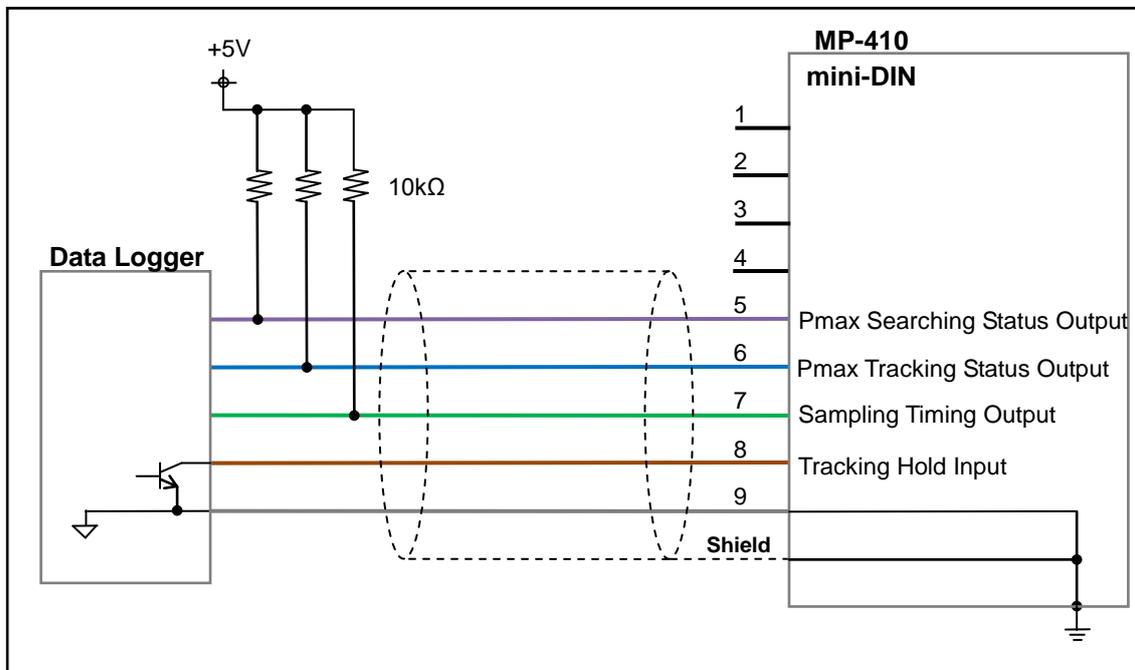
Figure 5-2-5. Connection Example: Connecting mini-DIN Terminal and Data Logger

5. Turning Power ON

Do not turn ON the power of MP-410 until connection to the PV modules and set-up are completed.   If a circuit breaker exists between MP-410 and PV module, turn ON the circuit breaker after the MP-410 is turned ON.

1)   When a circuit breaker exists between MP-410 and PV module, make sure the circuit breaker is turned OFF (shut off).

2)   Make sure all the connections are completed for MP-410.

3)   If the cover is attached on the panel, loosen the screws on both sides of cover and remove it.
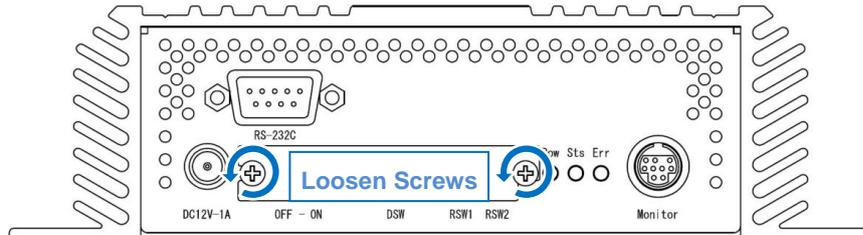
Figure 5-2-6(a). Removing Panel Cover 1
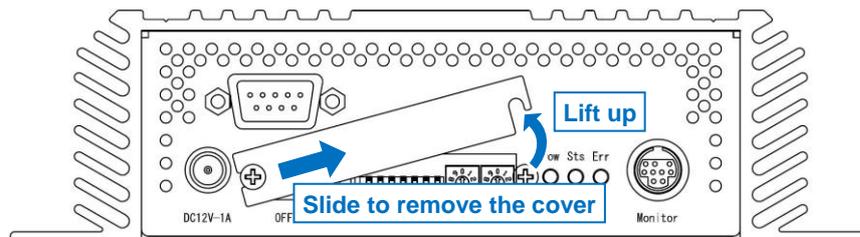
Figure 5-2-6(b). Removing Panel Cover 2

4)   The slide switch is located on the left side of the panel.   Turn ON the power switch.
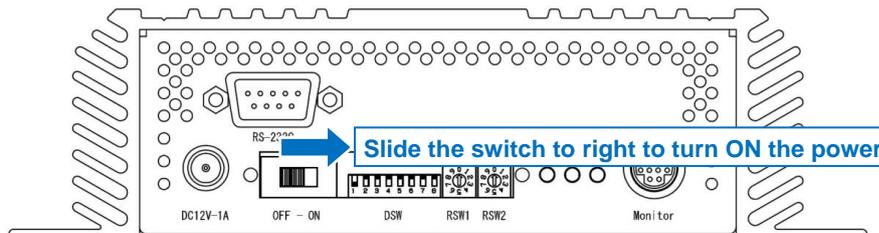
Figure 5-2-6(c). Turning ON the Power

5)   Place the cover back on the panel

6)   Make sure the power LED (Green) on the panel is light.

      (Other LED also lights on and/or blink, but it is normal operation)

7)   If circuit breaker exists between MP-410 and PV module, turn ON the circuit breaker.

6. Turning Power OFF

During operation the MP-410 will be hot; to turn off the power and let it cool down by first turning OFF the circuit breaker. Use safety gloves to avoid skin burn.

To witch off the MP-410 power, follow the procedure described in above [4. Turning Power ON].

5-3. Setting

1. DIP Switch

Operating mode and parameters can be setup by using the dip switch on the MP-410 panel.   To activate the setup, the MP-410 power must be turned ON once again.
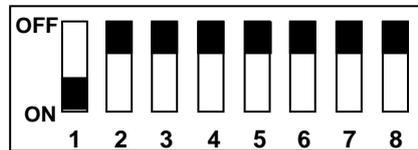
Figure 5-3-1. DIP Switch (DSW)

Table 5-3-1. DIP Switch (DSW) Setup

DSW No	Function	ON (Lever Down)	OFF (Lever Up)
1	N/A	Always ON	N/A
2	N/A	N/A	Always OFF
3	N/A	N/A	Always OFF
4	Range Switch	50V Range	200V Range
5	N/A	N/A	Always OFF
6	N/A	N/A	Always OFF
7	N/A	N/A	Always OFF
8	N/A	N/A	Always OFF

2. Rotary Switch

Pmax search function ON/OFF and search term can be setup by using the rotary switch 1 (RSW1) which is located on the MP-410 panel.   To activate the changes made on RSW1, MP-410 must be restarted.   To activate the setup, the MP-410 power switch must be turned ON once again.
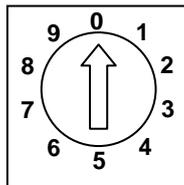
Figure 5-3-2. Rotary Switch 1 (RSW1)

Table 5-3-2. Rotary Switch 1 (RSW1) Setup

RSW1 No	Pmax Searching Cycle
0	OFF
1	1 minute
2	5 minutes
3	10 minutes
4	30 minutes
5	N/A
6	N/A
7	N/A
8	N/A
9	N/A

5-4. Operations

1. Operation Mode
MP-410 has a tracking mode, standby mode, and error stopping mode.

➤ Tracking Mode

Tracking conditions
(1) Input Voltage > 5.0V
(2) Input Current > 10.0mA
(3) Radiator Fin Temperature < 80℃

Operation at the Tracking Start
When the power is turned ON, the operation point moves to Open Circuit Voltage (Voc) then to the operation point with voltage at 85% of Voc. If the tracking conditions can be achieved, the Pmax will be tracked by the so called "hill-climbing method".
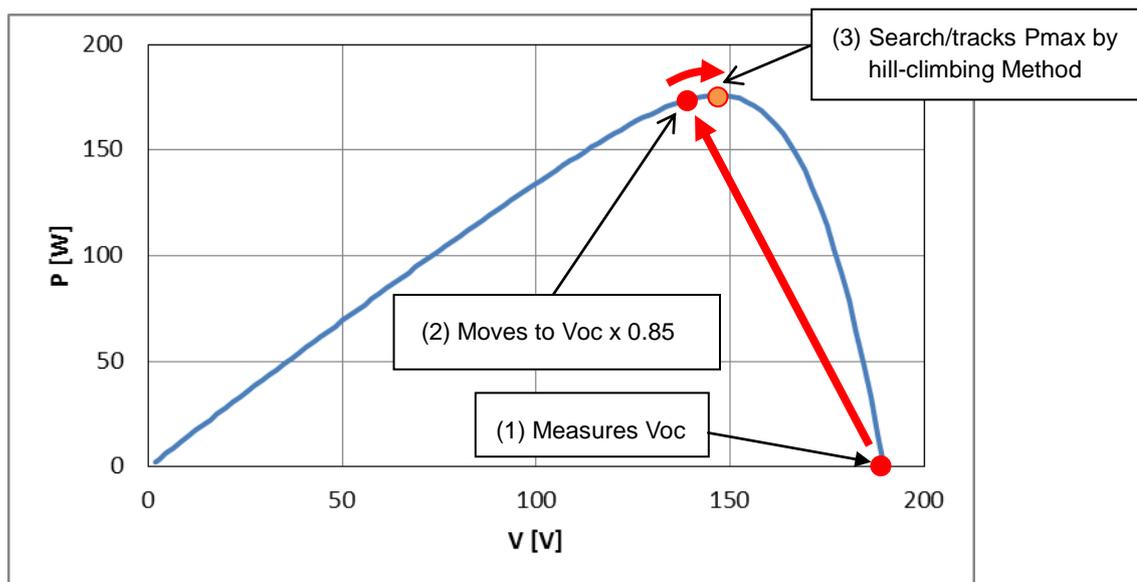
Figure 5-4-1. MPPT Tracking Operation

➤ Standby Mode
When the tracking requirements are not fulfilled, MP-410 will be in standby mode and the operation point moves to Voc point. If the tracking requirements are met, the tracking operation will start automatically.

➤ Error Stopping Mode
There are 2 main reasons to activate the stopping mode, and will be indicated by LED light on or blinking.
(1) Cooling Fan Trouble
    Detects the stopped cooling fan due to some trouble and automatically stops the operation of tracking. Later when the cooling fan rotation is detected, it starts the MP-410 operation automatically.
(2) Input Over Range
    When a voltage more than approximately 110% of setup range is input, MP-410 determines it as over range and tracking operation is stopped.

2. Pmax Search Function

Due to "partial cell damage" and/or "partial shading" conditions, PV modules sometimes show output characteristics as illustrated in the image below. In such case, simply using hill-climbing method with Voc and short circuit current (Isc) for searching the Pmax may lead to a wrong setting point of Pmax. In order to prevent such problem, the MP-410 has a function which automatically searches for the Pmax point. Pmax search is performed periodically and searching time interval and turning OFF the search function can be setup with using rotary switch 1.
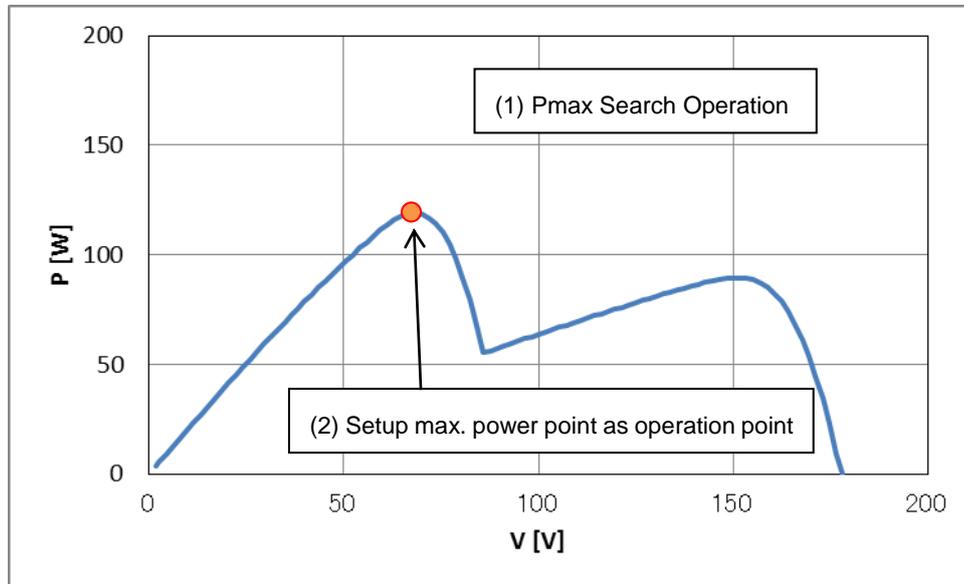
Figure 5-4-2. Pmax Search Function

6. Maintenance & Troubleshooting

6-1. Maintenance

To maintain accurate measurement and operation, it is recommended to check the cooling fan periodically Clogged cooling fan will lead to overheating and stops the operation of MP-410.　Regularly clean the fan.

6-2. Troubleshooting

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

Table 6-1. Troubleshooting

No	Failure	Action
1	Tracking operation does not start	• Fuse may be blown.　Replace the fuse. (See Failure No6) • Connections may not be properly made. Check the connections. • If the PV module voltage is 5V or less, automatic tracking won't start. • DIP switch setting may not be appropriate. Turn off the power then switch ON only the No.1 DIP switch and switch OFF all the other No. 2~8 levers then turn on the power again.
2	Power LED (green) does not light on.	• Main power switch may be turned OFF. • AC adapter may be disconnected. • MP-410 is not powered from PV module; AC adapter is required for power supply.
3	Only Power LED (green) lights on.	• DIP switch setting may not be appropriate.　Turn off the power then switch ON only the No.1 DIP switch lever and switch OFF all the other No. 2~8 levers then turn on the power again.
4	Tracking Status Indicator LED (yellow) keeps blinking.	• Fuse maybe blown.　Replace the fuse • PV module may be connected in reversed condition.　Check the connection. • Depending on the condition with frequent PV module output characteristics and /or irradiance changes may cause the Pmax search to take longer time. Irradiance change and shading effect may cause this LED to blink as well.
5	Error LED (red) is on.	• When the MP-410 body temperature exceeds 80℃, the tracking operation is temporary stopped until the temperature decreases below 70℃ then the operation automatically restarts. • When the cooling fan stops unexpectedly, MP-410 stops the tracking operation for a while.　At this time the error LED lights on.　Check for any dusts and clogs on the cooling fan. Once the cooling fan starts operating, MP-410 will also restart the operation automatically. • Applying a voltage that exceeds the rated input voltage will stop the tracking operation.　Check to make sure the connected PV module is not exceeding the rated voltage. The operation will automatically restart when the input voltage gets below the rated voltage.

Table 6-1. Troubleshooting - Continued

No	Failure	Action
6	Fuse has blown.	• Make sure the PV module specifications (Open Circuit Voltage: Voc, Short Circuit Current: Isc) don't exceed the rated specifications of the MP-410. • Fuse needs to be replaced. Use the fuse with following specification: Size: φ6.35 x 31.8 mm Rating: More than 250V, 15A Type: Fast Blow
7	Cooling fan is stopped.	• MP-410 has a function to automatically stop the cooling fan. The cooling fan stops when the following conditions are met (as such as at night): Input Voltage < 5V Input Current < 10mA Body Temperature < 30℃ • Cooling fan may be broken.　Repair is required; please contact EKO.

7. Specification

7-1. Absolute Maximum Ratings

Table 7-1. Absolute Maximum Ratings

Characteristics	Details
Input Voltage	Max. 235V
Input Current	Max. 20A
External Pull-up Voltage for Status Signal Output	Max. 50V

7-2. General Specification

Table 7-2 General Specifications

Characteristics	Details

MPPT Operation	1) Pmax tracking function by hill-climbing method from Voc
	2) Pmax searching function
	  • Function ON/OFF and search cycle can be setup by Rotary Switch 1
	    ➢ OFF, 1, 5, 10, and 30 minutes
	3) Tracking time interval: approx. 200ms

Rating Value	Tracking Voltage Range: V=5 ~ 200V (200V Range)
	                                V=5 ~ 50V (50V Range)
	                                (Over range approximately 10%)
	Tracking Current Range: I=0.01 ~ 10A
	                                (Over range approximately 10%)
	Maximum Tracking Power: P=250W (Ambient Temp. 30℃)*
	                                  P=300W (Ambient Temp. 20℃)*
	*See Figure 7-3-1 for details of ambient temperature and maximum tracking power.

Tracking Voltage Step Width	0.1V: 5V ≦ Input Voltage ＜ 50V 0.2V: 50V ≦ Input Voltage ＜ 100V 0.5V: 100V ≦ Input Voltage
Power Resolution	0.05W
PV Module Connection Terminal	4-Terminals (Screw type terminal: +S, +, -, -S), FG Terminal (For 2-wire type, short circuit +S & + and –S & - at the terminal)
I/F for Maintenance	・RS-232C D-sub 9pins 1Port For managing and maintenance of firmware update.

Table 7-2 General Specifications - Continued

Characteristics	Details
External In/Output Control / Monitoring Terminal	mini-DIN 9pins

Pin No	In/Output	Function	Remarks
1			Open
2	GND	GND	
3			Open
4	GND	GND	
5	Output	Pmax Search Status	Open Collector
6	Output	Pmax Tracking Status	Open Collector
7	Output	Sampling Timing	Open Collector
8	Input	Hold	Internal Pull-Up (3.3V)
9	GND	GND	
Shield	GND	GND	

Status Indication	Power Status (ON/OFF) Indication x 1 (Green) Tracking Status Indication x 1 (Yellow) Error Indication x 1 (Red)

Status	Green	Yellow	Red
Power OFF	OFF	OFF	OFF
Pmax Searching	ON	Blink (0.5s)	OFF
Pmax Tracking	ON	ON	OFF
Fan Abnormal & Stop	ON	OFF	ON
Temp. > 80℃	ON	Blink	ON
Over Range	ON	OFF	ON (2s)
Fuse Blown	ON		

DIP Switch (DSW)

Operation Mode/Parameter Setting

DSW No	Function	ON (Lever Down)	OFF (Lever Up)
1	N/A	Always ON	N/A
2	N/A	N/A	Always OFF
3	N/A	N/A	Always OFF
4	Range Switch	50V Range	200V Range
5	N/A	N/A	Always OFF
6	N/A	N/A	Always OFF
7	N/A	N/A	Always OFF
8	N/A	N/A	Always OFF

Table 7-2 General Specifications - Continued

Characteristics	Details
Rotary Switch 1 (RSW1)	Pmax Search Function Setting

RSW1 No	Pmax Searching Cycle
0	OFF
1	1 minute
2	5 minutes
3	10 minutes
4	30 minutes
5	N/A
6	N/A
7	N/A
8	N/A
9	N/A
Rotary Switch 2 (RSW2)	Not Used
Temperature Condition (Outside Temperature)	0℃ ～ +50℃、0%RH ~ 85%RH (No condensation)
Body Size	(D) 323mm x (W) 188mm x (H) 50.5mm
Weight	2kg
Safety Functions	・Temperature Protection Function 　　Tracking automatic stop at radiation fin temperature > 80℃ 　　Tracking automatic restart at radiation fin temperature < 70℃ ・Temperature Switch 　　PV terminal open at radiation fin temperature > 90℃ 　　Automatic restart at radiation fin temperature < 90℃ ・Over-Current Protection Fuse (15A, between PV +/- terminal) ・Cooling Fan Break Down Detector Function 　　Cooling fan stop → Tracking stop ・Self Restart Function 　　Self restarting function by watch-dog function
Other Functions	・Cooling Fan (Automatic stop function depending on operation condition) 　Stopping Condition 　Pmax non-tracking status as well as radiation fin < 30℃
Power Supply	Slide switch for Power ON/OFF DC+12V, 300mA AC Adapter (IN: AC100~240V, 50~60Hz, OUT:DC12V, 1A) (Attached)
Power Consumption	3.6W

7-3. Maximum Load against Ambient Temperature

Use MP-410 within the range shown below in Figure 7-3-1.
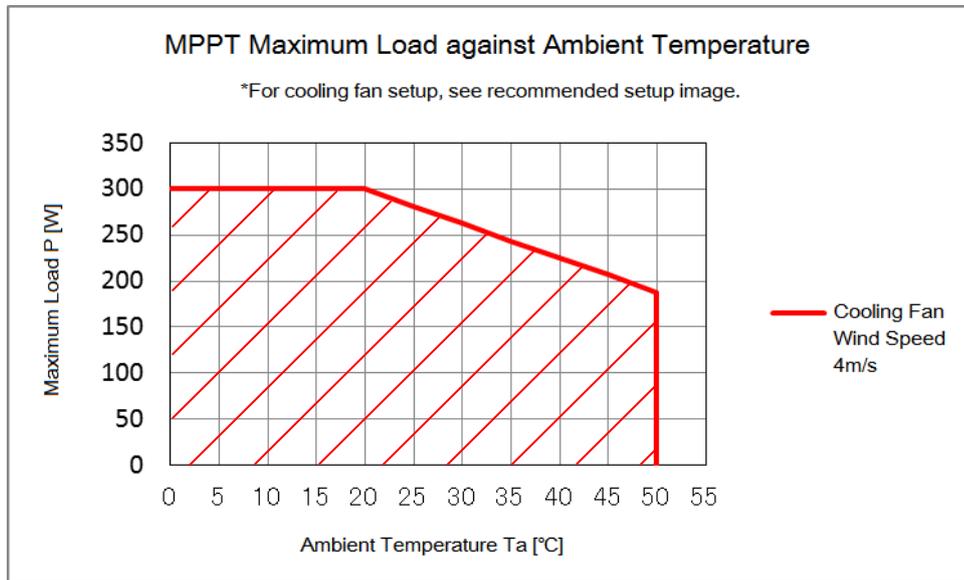

Figure 7-3-1. MPPT Maximum Load against Ambient Temperature
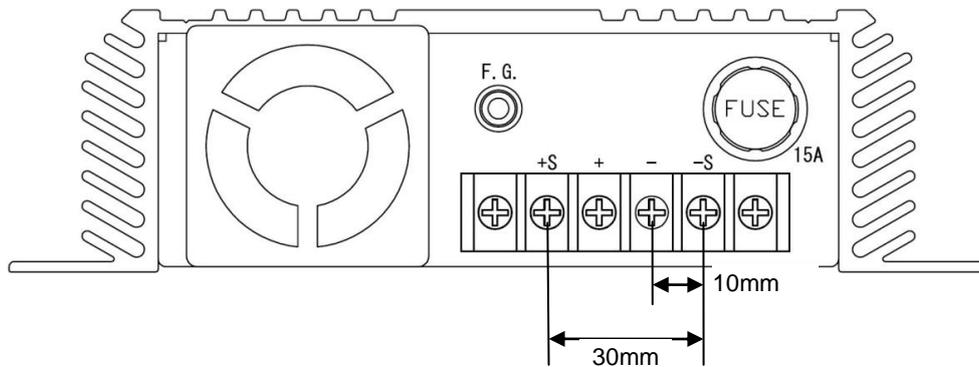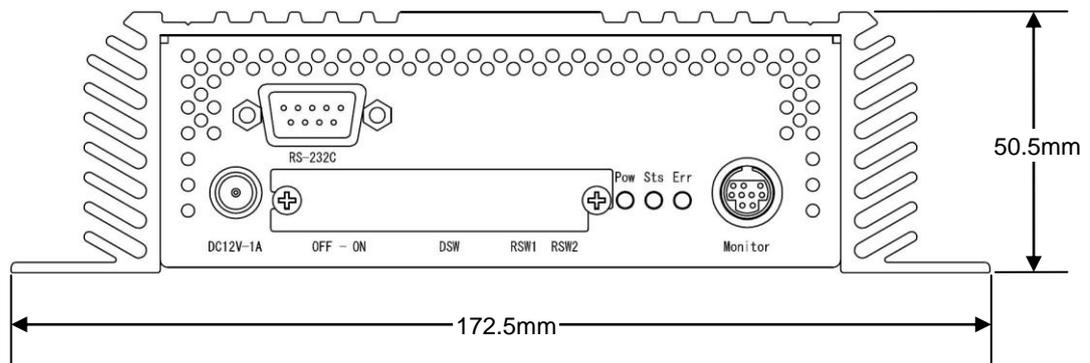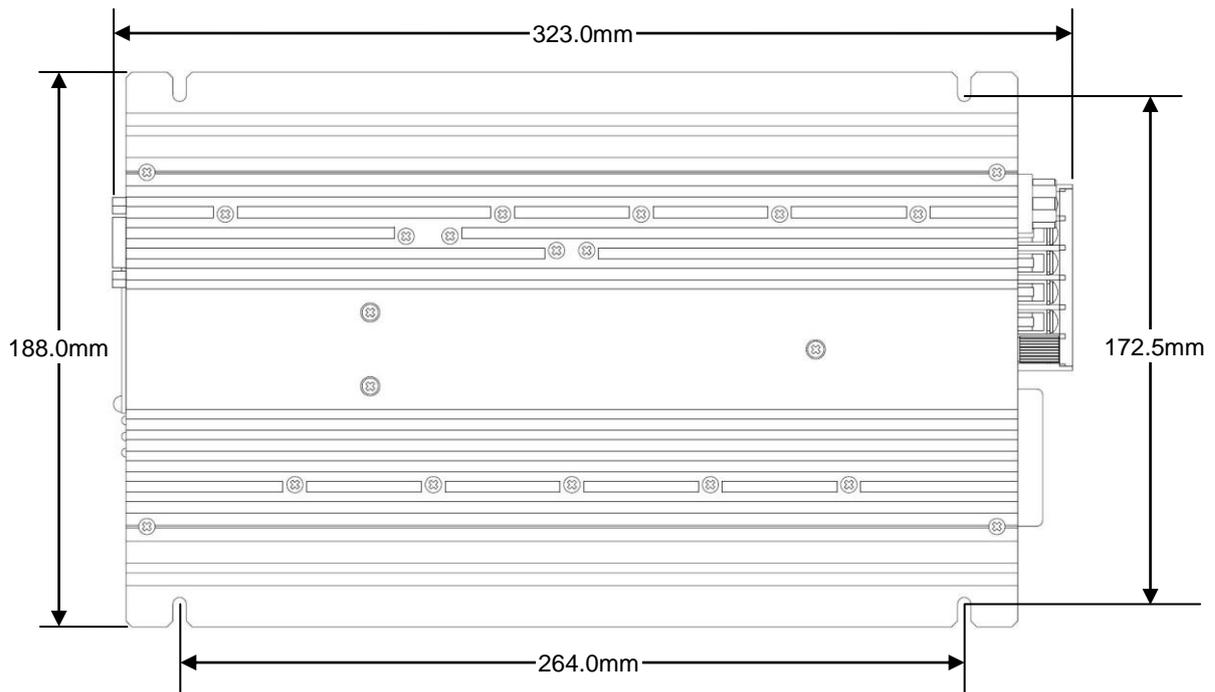
7-4. Dimensions

Figure 7-5-1. MP-410 Dimensions

EKO

EKO Asia, Oceania

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

EKO North America

95 South Market Street,
Suite 300, San Jose,
CA 95113, USA
P. +1-408-977-7751
F. +1-408-977-7741
info@eko-usa.com
www.eko-usa.com

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

Lulofsstraat 55, Unit 32,
2521 AL, Den Haag,
The Netherlands
P. +31 (0)70 3050117
F. +31 (0)70 3840607
info@eko-eu.com
www.eko-eu.com

EKO INSTRUMENTS