



USER MANUAL

Solar Panel - Single Glass Modules



IMPORTANT SAFETY INSTRUCTIONS

This manual contains important safety instructions for the Photovoltaic solar module of AMPS MIDDLE EAST FZ-LLC (hereafter referred to as “AMPS MIDDLE EAST FZ”). Installers should follow all safety precautions described in this guide as well as local codes when installing a module.

Installing solar photovoltaic systems requires specialized skills and knowledge. Installation should only be performed by qualified personnel. Before installing a solar photovoltaic system, installers should familiarize themselves with its mechanical and electrical requirements. Keep this guide in a safe place for future reference and in case of sale or disposal of the modules. For any questions, please contact our quality personnel for technical support.

1. Introduce

This Installation Manual contains essential information for electrical and mechanical installation that you must know before handling, installing modules. This Manual also contains safety information you need to be familiar with. All the information described in this Manual is the intellectual property of us and is based on the technologies and experience that have been acquired and accumulated by us.

This Manual does not constitute a warranty, expressed or implied. We do not assume responsibility and expressly disclaims liability for loss, damage, or expense arising out of or in any way connected with installation, operation, use or maintenance of modules. No responsibility is assumed by us for any infringement of patents or other rights of third parties that may result from use of modules. We reserve the right to make changes to the product, specifications or installation manual without prior notice.

Failure to comply with the requirements listed in this manual will invalidate the Limited Warranty for modules as provided by us at the same time of sale to the direct customer, Additional recommendations are provided to enhance safety practices and performance results. Please provide a copy of this manual to the PV system owner for their reference, and inform them of all relevant aspects of safety, operation, and maintenance.

2. Safety Precautions

2.1 General Safety

Modules are designed to meet the requirements for the standards IEC 61215-1:2016, IEC61215-1-1:2016, IEC61215-2:2016, IEC61730-1:2016 and IEC61730-2:2016 that have safety class II according to IEC 61140. The construction meets Class C fire rating for UL790.

When modules are mounted on rooftops, the roof must have a fire resistance covering suitable for this application. Rooftop PV systems should only be installed on rooftops capable of handling the additional weighted load of PV system components, including modules, and have a complete analysis of the structure performed by a certified building specialist or engineer.

For your safety, do not attempt to work on a rooftop until safety precautions have been identified and taken, including without limitation: fall protection measures, ladders or stairways, and personal protective equipment.

For your safety, do not install or handle modules under adverse conditions, including without limitation strong or gusty winds, and wet or frosted roof surfaces.

2.2 Electrical performance safety

Photovoltaic modules can produce DC electricity when exposed to light and therefore can produce an

electrical shock or burn. DC voltage of 30 Volts or higher is potentially lethal.

Modules produce voltage even when not connected to an electrical circuit or load. Please use insulated tools and rubber gloves when working with modules in sunlight.

Modules have no on/off switch. Modules can be rendered inoperative only by removing them from sunlight, or by fully covering their front surface with cloth, cardboard, or other completely opaque material, or by working with modules face down on a smooth, flat surface.

In order to avoid arcs and electrical shock, please do not disconnect electrical connections under load. Faulty connections can also result in arcs and electrical shock. So please keep connectors dry and clean, and ensure that they are in proper working condition. Never insert metal objects into the connector, or modify them in any way in order to secure an electrical connection.

Modules can produce higher output than the rated specifications. Industry standard ratings are made at Standard Test Conditions of 1000 W/m² Irradiance, 25°C Cell Temperature and 1.5 Air Mass.

Reflection from snow or water can increase sunlight and therefore boost current and power. In addition, colder temperatures can substantially increase voltage and power.

If the glass or other material is damaged, please wear personal protection equipment and separated the module from the circuit.

Do not touch the modules if it's wet, unless during the cleaning procedure. At the same time the cleaning operation should according to the manual.

Do not touch the wet connector without protecting yourself with personal protection equipment or rubber gloves. Do not use mirrors or other magnifiers to concentrate sunlight onto the modules.

If instructions are provided allowing modules to be installed in parallel electrically, the installation instructions shall specify that each module (or series string of modules so connected) shall be provided with the maximum series fuse. Recommended maximum series is $[\text{Max System voltage } V / (1.25 * V_{oc})]$, parallel module configurations is $[\text{fuse rating} / 1.25 * I_{sc}]$.

2.3 Operating safety

Do not open the package of modules until they are ready to be installed during transportation and storing. At the same time please protect the package against exposure to damage. Secure pallets from falling over.

Do not exceed the maximum height of pallets to be stacked, as indicated on the pallet packaging. Store pallets in a cool and dry location until the modules are ready to be unpackaged.

Do not lift the modules by grasping the modules' junction box or electrical leads in any condition.

Do not stand or step on the modules.

Do not drop the modules on another module.

Do not place any heavy objects on the modules to avoid glass breakage.

Be cautious when setting the modules down on to a surface, especially on the corner of the modules. Inappropriate transport and installation may break the modules.

Do not attempt to disassemble the modules, and do not remove any attached nameplates or components from the modules.

Do not apply paint or adhesive to the modules top surface.

To avoid damage to the backsheet, do not scratch or hit the backsheet.

Do not drill holes in the frame. This may compromise the frame strength and cause corrosion of the frame.

Do not scratch the anodized coating of the frame (except for grounding connection). It may cause corrosion of the frame or compromise the frame strength.

Do not attempt to repair the modules with damaged glass or backsheet.

Work only under dry conditions, and use only dry tools. Do not handle modules when they are wet unless wearing appropriate protective equipment.

When storing uninstalled modules outdoor for any period of time, always cover the modules and ensure that the glass faces down to stop water from collecting inside the modules and causing damage to exposed connectors.

2.4 Fire Safety

Consult your local authority for guidelines and requirements for building or structural fire safety.

Roof constructions and installations may affect the fire safety of building. Improper installation may create hazards in the event of a fire.

Use appropriate components such as fuses, circuit breaker and grounding connector as requires by local authority. Do not use modules where flammable gasses may be generated.

3. Installation Condition

3.1 Installation position and working environment

Do not use mirrors or other magnifiers to concentrate sunlight onto the modules.

Modules must be mounted on appropriate mounting structures positioned on suitable buildings, the ground, or other structures suitable for modules (e.g. carports, building facades or PV trackers).

Modules must not be installed in locations where they could be submerged in water.

Modules should be installed in locations where the altitude is less than 2000m.

The modules are suitable for operation in outdoor non-weather protected locations, exposed to direct and indirect solar radiation, in an environmental temperature range of at least $-40\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ and up to 100 % relative humidity as well as rain. The temperature limits are defined as the monthly average high and low of the installation site.

Ensure modules are not subject to wind or snow loads exceeding the maximum permissible loads.

The modules should be installed in a location where there's no shading throughout the year. Ensure there's no obstacle to block light near the installation site.

Lightning protection is recommended for PV systems that are to be installed in locations with high probability of lightning strikes.

Do not use modules near equipment or in locations where flammable gasses may be generated or collected.

Modules cannot be installed or used in extreme areas or weather conditions, and highly corrosive areas should be considered carefully. Please adopt appropriate measures to ensure the performance and safety of the modules when they are installed or operated in areas with heavy snow, extremely cold, strong wind, or near an island or desert that is prone to produce salt fog, or near water.

Modules have passed the IEC61701 salt-mist, but galvanic corrosion can occur between the aluminum frame of the modules and mounting or grounding hardware if such hardware is comprised of dissimilar metals. Modules can be installed at seaside locations 50m to 500m from the sea, but the components should be protected against corrosion.

The irradiance reflected on the rear of the bifacial solar modules shall not exceed $300\text{W}/\text{m}^2$.

3.2 Tilt Angle of Installation

The installation of PV module string should be in the same orientation and the same installation angle. Different installation directions and installation angles will lead to the mismatches in current and voltage which is caused by different light absorption of different PV modules, this mismatch will cause the PV system power output loss.

The largest power will be generated when direct sunlight on solar PV module. For modules which are installed on the fixed brackets, the best installation angle should be selected to ensure the maximum power output can be generated at winter time, if the angle can guarantee enough power output during the winter, it will make the whole solar PV system in the rest of the year can have enough power output also.

Solar modules are recommended to be installed at an optimized tilt angle to maximize the energy output. For detailed information on the best installation angle, please refer to standard solar photovoltaic installation guides or consult a reputable solar installer or systems integrator. Dust building up on the surface of the modules can impair module performance. We recommend installing the modules with a tilt angle of at least 10°, making it easier for dust to be washed off by rain. Any faults caused by and/or attributable to tilt angle less than 10 degrees are not covered by the manufacturer’s warranty. It is roughly equal to the latitude of the project site as a rule of thumb, facing toward the equator. Optimized system designs must incorporate other local requirements.

Installation inclination refers to the Angle between the module and the ground plane, as shown in Figure 1.

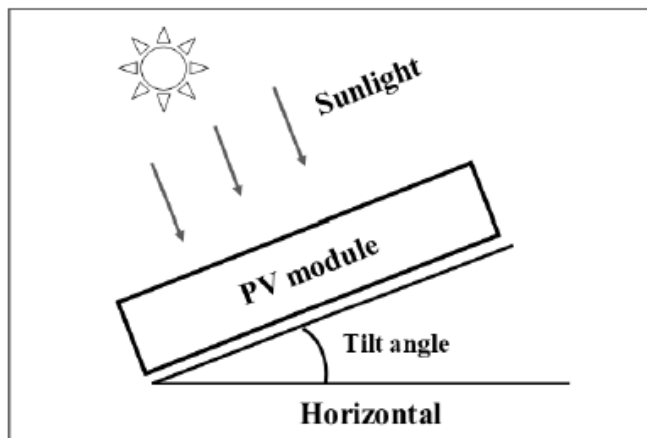


Fig.1 Tilt angle

Table 1 Recommended tilt angle for fixed systems

Latitude	Tilt angle
0° ~ 15°	15°
15° ~ 25°	The same latitude
25° ~ 30°	Same latitude +5°
30° ~ 35°	Same latitude +10°
35° ~ 40°	Same latitude +15°
40°+	Same latitude +20°

3.3 INSTALLATION REQUIREMENTS FOR BIFACIAL MODULE

Under the certain installation conditions, the backside of bifacial cells module will also generate electricity power after receiving the reflected light, which will bring additional power generation gain to the power station system.

The shading on the module surface will affect the power generation much, the module should be installed in the place where the module cannot be shadowed totally (such as the shadow from building, chimney and tree etc.), and even the partially shading (such as the dirt, snow and aerial wire etc.) should be avoided.

The generation gain is related to the ground reflectivity, the module installation height to the ground, the array spacing and the shadow shading to the module backside.

Generally speaking, the reflectance is various with the different ground (See table 2), and this will lead to different power generation gain.

Table 2 reflectivity of different surfaces

The ground type	Water	Grassland	Ground	Concrete	Sand	Snow
Reflectivity range(%)	5-12	12-25	20-33	20-40	20-40	80-85

Due to the different ground clearance height will affect the power generation gain, it is recommended to install the module at a height from 0.5m to 2m. See Fig. 2.

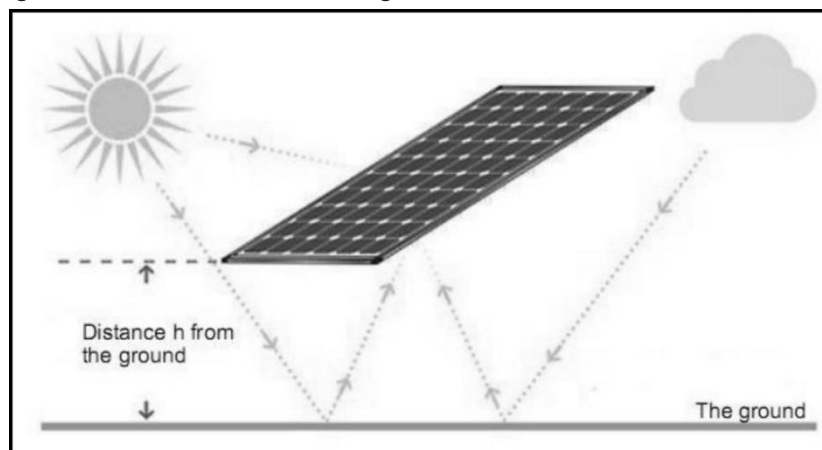


Fig. 2 Distance from the earth

In the system design, besides the ground type and the module installation height to ground, the proper array spacing and how to avoid shadow shading on the back need to be considered too, please consult with the professional system designer.

4. Mechanical Installation

4.1 Conventional requirements

Ensure the installation method and supporting system of modules is strong enough to make the nodules can withstand all the load conditions. The Installer should provide this guarantee. The installation supporting system should be tested by the third-party organization with the analysis ability of Static Mechanical, according to the local national or international standards.

The fire rating of this module is valid only when mounted in the manner specified in the mechanical mounting instructions. The module is considered to be in compliance with IEC61730-2:2016 only when the

module is mounted in the manner specified by the mounting instructions. Based on standards IEC61730-2:2016 standard, when for the rooftop mounting, the rooftop covering material should have class C fire resistance at least.

The modules mounting structure should be made of durable, corrosion-resistant and UV-resistant material. Modules should be securely attached to the mounting structure.

In regions with heavy snowfall in winter, select the height of the mounting system. So that the lowest edge of the modules is not covered by snow for any length of time. In addition, ensure that the lowest portion of the modules is placed high enough so that it is not shaded by plants or trees or damaged by flying sand.

When the modules are supported parallel to the surface of the building wall or roof, a minimum stand-off of 102 mm (4 inches) between the modules and the surface of the wall or the roof is required to allow air to circulate behind the modules for heat dissipation. The position of junction box should be on the top side, and away from the ground.

Do not attempt to drill holes in the glass surface and the modules frames of the modules as this will void the warranty.

Before installing modules on a roof, ensure the roof coverings should have fire resistant Class C. In addition, any roof penetration required to mount the modules should be properly sealed to prevent leaks.

Dust building up on the surface of the modules can impair with modules performance. We recommend installing the modules with a tilt angle of at least 10 degrees, making it easier for dust to be washed off by rain.

Observe the linear thermal expansion of the modules frames (the recommended minimum distance between two modules is 1 cm).

Always keep the backsheet of the panel free from foreign objects or structural elements, which could come into contact with the panel, especially when the panel is under mechanical load.

A module with exposed conductive parts is considered to be in compliance with IEC TS 62548:2013 only when it is electrically grounded in accordance with the instructions presented below and the requirements of the national regulations. Any module without a frame (laminated) shall not be considered to comply with the requirements of IEC 61215-1:2016, IEC61215-1-1:2016, IEC61215-2:2016, IEC61730-1:2016 and IEC61730-2:2016 unless the module is mounted with hardware that has been tested and evaluated with the module under this standard or by a field Inspection certifying that the installed module complies with the requirements of IEC TS 62548:2013.

Metals with the aluminum frame of the modules that will result in galvanic corrosion. An addendum to IEC 60950-1 Table J.1 that recommends metal combinations not exceeds an electrochemical potential difference of 0.6 Volts.

Modules can be mounted in landscape or portrait orientation.

4.2 Installation methods for normal modules

4.2.1 Modules installed with mounting holes

Modules should be bolted to support structures through total 8 mounting holes located in the frame's back flanges with minimum positive design load 1600Pa (Safety factor is 1.5) and negative design load 1600Pa (Safety factor is 1.5).

Refer to what is shown in Figure 1 (Mounting Details). Besides, two or more screws or two full threads of a single screw shall engage the metal.

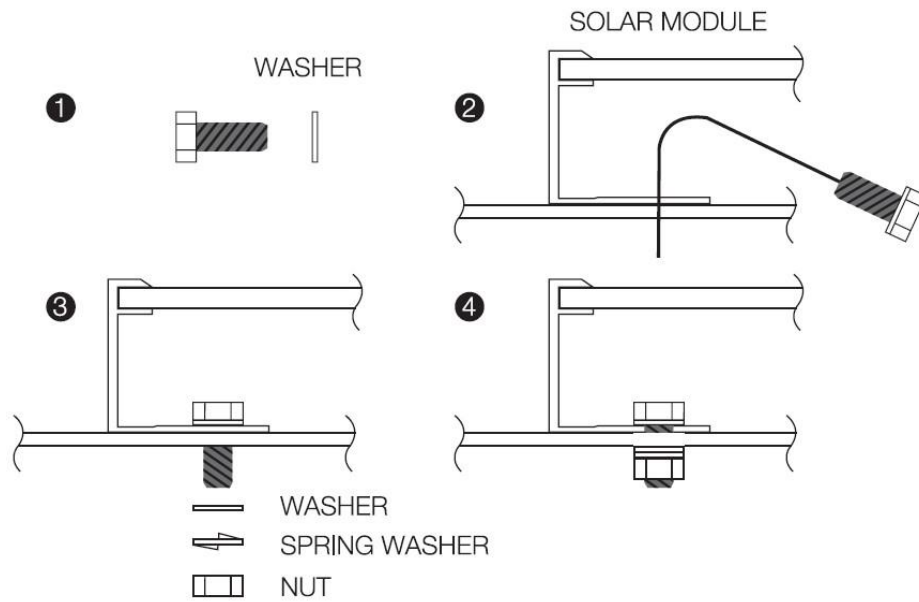


Fig. 3 Mounting Details

For your reference, please use the components specified in below:

1.Bolt

Material: Stainless Steel

Size and Length: M8*16mm

2.Washer

Material: Stainless Steel

Size: M8

3.Spring Washer

Material: Stainless Steel

Size: M8

4.Nut

Material: Stainless Steel

Size: M8

Recommended torque is between 14N.m to 20N.m.

4.2.2 Modules installed with clamps

Modules should be mounted using specialized clamps as shown in Figure 2. Remark: Some combinations of the material could be used, regarding the detailed information, please refer to the listing report.

- A) A module should be attached on a supporting structure rail by metal clamps. It is recommended to use the clamps under the following condition or approved by system installation:
 Size: Clamp A width $\geq 50\text{mm}$, Clamp A width $\geq 38\text{mm}$
 Thickness: Following as Clamp A and Clamp B
 Material: Aluminum Alloy 6063-T5
 Bolt: Stainless Steel, M8
 Nut: Stainless Steel, M8
 Washer: Stainless Steel, M8
- B) Recommended bolt torque range: 18N.m to 24N.m.
- C) The modules clamps should not contact the front glass or deform the frame in any way. Avoid shading effects from the modules clamps. Drainage holes on the modules frame should not be closed or obscured by the clamps. Besides, two or more screws or two full threads of a single screw shall engage the metal.
- D) This mounting method is designed for positive load 1600Pa (Safety factor is 1.5) or negative load 1600Pa (Safety factor is 1.5). Only those types which have been qualified could use this method.
- E) Mounting method (showed in the table below): $a=1/4*L\pm 50\text{mm}$.

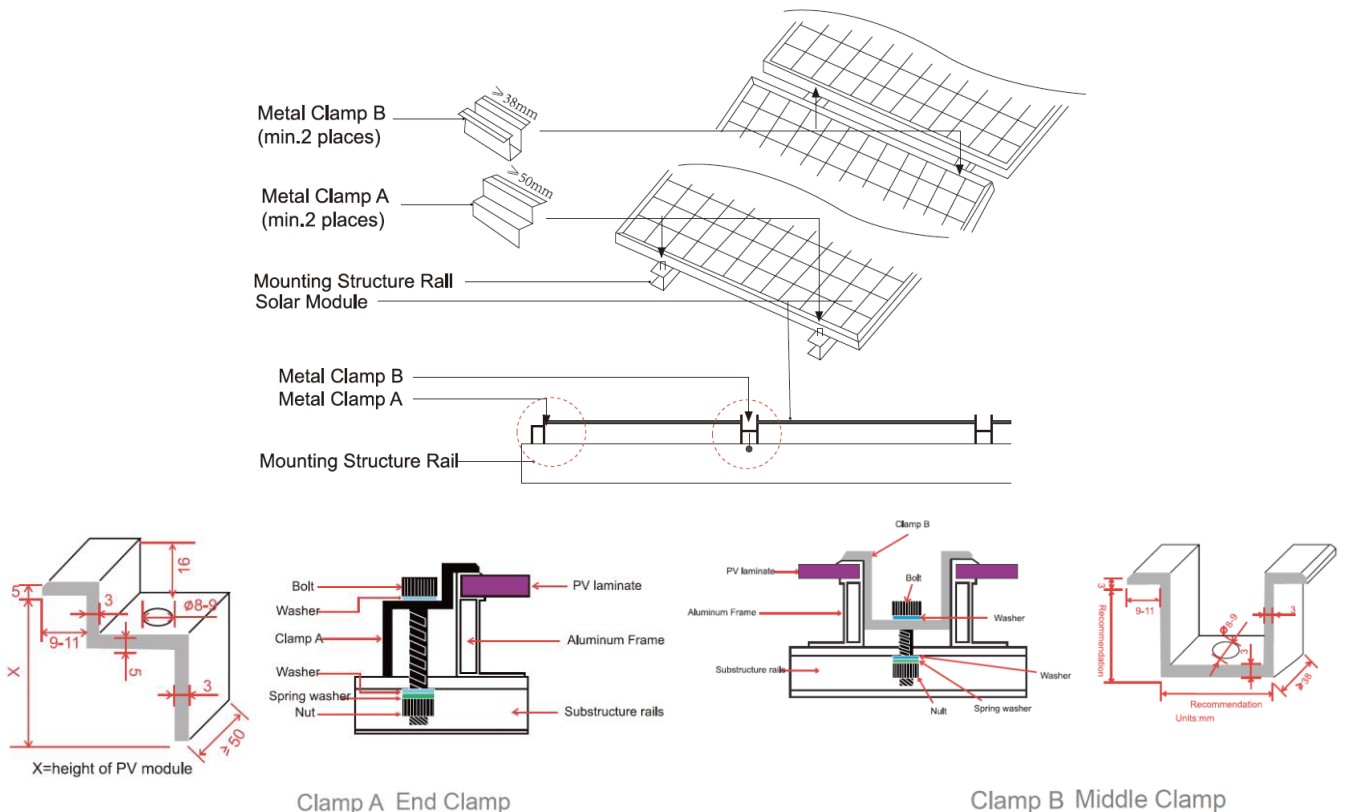
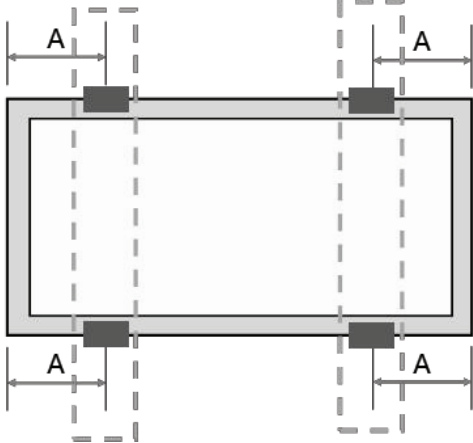


Fig. 4

Module	Mechanical Load Pressure	Mounting Direction
EMxxxMP - xxxW P type Single glass EMxxxMP - xxxW P type Single glass	Designed mechanical load 3600/2400, safety factor 1.5	 <p data-bbox="869 651 1273 680">A=1/4L±50mm; L=Module length</p> <p data-bbox="722 696 815 725">*NOTE:</p> <ol data-bbox="722 748 1437 943" style="list-style-type: none"> 1. The crossbeam is perpendicular to the long side frame. 2. The above described distance is from the module edge to the middle of the clamp. Clamps length ≥60mm. 3. Need two support rails below the PV module to make sure the Mechanical load.
EMxxxMP - xxxW P Type Single Glass EMxxxTP - xxxW N Type Single Glass	Designed mechanical load 3600/1600, safety factor 1.5	

5. Electrical Installation

5.1 Electrical Property

Rated electrical characteristics such as Pmax is within +/-3% and Voc within +/-3% and Isc within +/-4% of tolerance values at Standard Test Conditions. Under normal conditions, the photovoltaic modules may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of short circuit current, Isc, and open circuit voltage, Voc, marked on modules should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fusing sizes, and size of controls connected to the modules output.

For a module or panel in abnormal condition, the multiplying 1.25 factor at conditions of an irradiance of 125 mW/cm², AM 1.5 spectrum, and a cell temperature of minus 10°C for Voc and plus 75°C for Isc should be taken into consideration.

The maximum number of modules that can be connected in a series string should be calculated in accordance with applicable regulations in such a way that the specified maximum system voltage of the modules and all other electrical DC components will not be exceeded in open-circuit operation at the lowest temperature expected at the PV system location. For this, the IEC TS62548:2013 is to be a reference. The parallel number is 1.

An appropriately rated over-current protection device should be used when the reverse current could exceed the value of the maximum fuse rating of the modules. An over-current protection device is required for each series string if more than two series strings are connected in parallel.

5.2 Cables and Wiring

The junction boxes have been designed to be easily interconnected in series for their well-connected cable and the connector with IP67 (IP68) protection grade. Each module has two single-conductor wires, one positive and one negative, which are pre-wired inside the junction box. The connectors at the opposite end of these wires allow easy series connection of adjacent modules by firmly inserting the positive connector of a module into the negative connector of an adjacent module until the connector is fully seated.

Use field wiring with suitable cross-sectional areas that are approved for use at the maximum short-circuit current of the modules. We recommend installers use only sunlight resistant cables qualified for direct current (DC) wiring in PV systems. And the rated system voltage of PV wire should be not than PV modules.

Each PV module has two PV cables which can withstand 85°C temperature and they are sunlight resistant (UV). The cross-sectional area of the cable is 4mm² or 12AWG, and the external diameter is 5mm~7mm. The minimum bending radius of the cables must be 43mm. Any cable damage caused by bending too much or cable management system is not covered under warranty. Plug & Play connectors are included at the end of each cable. All other cables used to connect the direct current system shall have similar (or higher) specifications, and should have the suitable insulation ability which can suffer the possible maximum system Voc. We require all cables and electrical connections to comply with the electrical regulations of the countries where the PV system is installed.

Cables should be fixed to the mounting structure in such a way that mechanical damage of the cable and/or the modules is avoided. Do not apply stress to the cables. For fixing, use appropriate means, such as sunlight resistant cable ties and/or wire management clips specifically designed to attach to the module frame. While the cables are sunlight resistant and waterproof, where possible, avoid direct sunlight exposure and water immersion of the cables. Cable arrangement must comply with local laws and regulations.

5.3 Connector

Keep connectors dry and clean, and ensure that connector caps are hand tight before connecting the modules. Do not attempt making an electrical connection with wet, soiled, or otherwise faulty connectors. Avoid sunlight exposure and water immersion of the connectors. Avoid connectors resting on the ground or roof surface.

Faulty connections can result in arcs and electrical shock. Check that all electrical connections are securely fastened. Make sure that all locking connectors are fully engaged and locked. Besides, the connector should be mated with its original female or male connector of the same supplier.

Type	Manufacture	System Voltage	Rated Current	Temperature Rating
05-8	Zhejiang Renhe Photovoltaic Technology Co.,Ltd	DC 1500V	30A	-40°C to +85°C
PV-CY03L	Zhejiang Chuangyuan Photovoltaic Technology Co.,Ltd	DC 1500V	30A	-40°C to +85°C
RHC2xyzu	Zhejiang Renhe Photovoltaic Technology Co.,Ltd	DC 1500V	35A	-40°C to +85°C
PV-KST4-EVO 2/xy-UR; PV-KBT4-EVO 2/xy-UR	Stäubli Electrical Connectors AG	DC 1500V	45A	-40°C to +85°C
QC4.10-cds	QC Solar (Suzhou) Corporation.	DC 1500V	41A	-40°C to +85°C
PV-ZPJ030A	The 40th Institute of China Electronic Technology Group Corporation	DC 1500V	38A	-40°C to +85°C
PV-CY20L	Zhejiang Chuangyuan Photovoltaic Technology Co.,Ltd	DC 1500V	40A	-40°C to +85°C

5.4 Bypass Diodes

If PV module part by shadow block, which can lead to reverse voltage related to solar cells, PV modules in other unaffected battery string or other PV modules in the system and current will force through keep out part of the power loss and heat affected cell. When the PV module is connected in parallel with the bypass diode, the current in the system will flow directly through the diode, so as to bypass the blocked part of the PV module and minimize the heating degree and power consumption of the PV module.

Please do not try to open the junction box to replace the diode, or even when the diode problem, please do this work by professionals.

Type	Manufacture	Rated current
PS4025	Yangzhou Yangjie Electronic Technology Co.,Ltd.	15A
FMK4530T	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	20A
FMK4530B	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	20A
MK3045	Zhejiang Renhe Photovoltaic Technology Co.,Ltd. / Yangzhou Yangjie Electronic Technology Co.,Ltd. / ChangZhou Star Sea Electronics Co.,Ltd.	20A
FMK5040D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	25A
FMK4545D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	25A
FMK4560T	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	25A
MK4045	Zhejiang Renhe Photovoltaic Technology Co.,Ltd. / Yangzhou Yangjie Electronic Technology Co.,Ltd. / ChangZhou Star Sea Electronics Co.,Ltd.	25A

RMK4545T	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	25A
FMK5060D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	30A
MK5045	Zhejiang Renhe Photovoltaic Technology Co.,Ltd. / Yangzhou Yangjie Electronic Technology Co.,Ltd. / ChangZhou Star Sea Electronics Co.,Ltd.	30A
RMK4545D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	30A
RMK4550D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	30A
RMK4555D	Zhejiang Renhe Photovoltaic Technology Co.,Ltd.	30A
GF30SQ045	Yangzhou Yangjie Electronic Technology Co.,Ltd.	15A
QCMK4045	QC Solar (Suzhou) Corporation.	25A
QCMK4045B	QC Solar (Suzhou) Corporation.	25A
QCM4045	QC Solar (Suzhou) Corporation.	25A
QCMK5045	QC Solar (Suzhou) Corporation.	30A
QCM5045	QC Solar (Suzhou) Corporation.	30A
QCM5045B	QC Solar (Suzhou) Corporation.	30A
30SQ050	QC Solar (Suzhou) Corporation.	20.2A
30SQ050A	QC Solar (Suzhou) Corporation.	25A
GFMK4045	Hangzhou Lion Microelectronics Co.,Ltd.	25A
GFMK6045	Hangzhou Lion Microelectronics Co.,Ltd.	30A
30SQ045-SL	Yangzhou Yangjie Electronic Technology Co.,Ltd. Hangzhou Daoming Microelectronics Co.,Ltd.	25A
25SQ045	Yangzhou Yangjie Electronic Technology Co.,Ltd.	20A
30SQ045	Yangzhou Yangjie Electronic Technology Co.,Ltd.	20A
40SQ045	Yangzhou Yangjie Electronic Technology Co.,Ltd.	30A

6. Grounding

The modules use an anodic oxidized aluminum frame to resist corrosion. So the frame of modules should be connected to the equipment grounding conductor to prevent thunder and electrical shock. All PV module frames and mounting brackets must be properly grounded in accordance with the applicable national electrical code.

When grounding, the grounding device must be fully in contact with the frame aluminum alloy and the installation bracket, through the oxide film on the frame surface and the insulation layer of the bracket. Please do not drill any additional ground holes on the border of the assembly.

The grounding method should not result in the direct contact of dissimilar metals with the aluminum frame of the modules that will result in galvanic corrosion. Metals with the aluminum frame of the modules that will result in galvanic corrosion. An addendum to IEC 60950-1 that recommends metal combinations not exceeds an electrochemical potential difference of 0.6 Volts. The frame rails have pre-drilled holes marked with a grounding sign. These holes should be used for grounding purposes and should not be used for mounting the modules. Where common grounding hardware (nuts, bolts, star washers, spilt-ring lock washers, flat washers

and the like) is used to attach a listed grounding/bonding device, the attachment should be made in conformance with the grounding device manufacturer's instructions. Common hardware items such as nuts, bolts, star washers, lock washers and the like have not been evaluated for electrical conductivity or for use as grounding devices and should be used only for maintaining mechanical connections and holding electrical grounding devices in the proper position for electrical conductivity. Such devices, where supplied with the module and evaluated through the requirements in UL 1703, may be used for grounding connections in accordance with the instructions provided with the module.

6.1 Grounding by using grounded clamp

There is a grounding hole with 4.2 mm diameter on the edge side closer to the middle of the back frame of the modules. The middle line of the grounding mark is overlapped with the grounding hole, and the direction is same as the longer frame.

The grounding between modules should be approved by qualified electrician. And the grounding device should be produced by qualified electrical manufacture. The recommended twist torque value is 2.3 Nm. A copper core in size of 6 mm² can be used as grounding clamp. The copper wire should not be squashed during the installation.

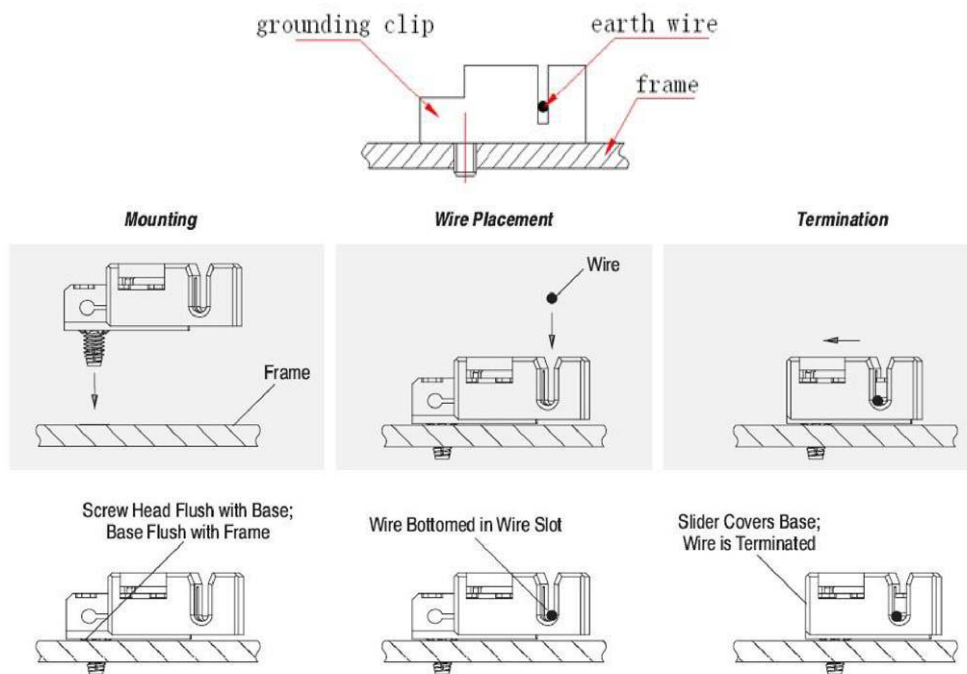


Fig. 5: Installation Methods

Note: The figure above is using TYCO. 1954381-1 (recommended)

6.2 Other professional grounding devices

The electrical contact points of all the above grounding methods should penetrate the anodized film of the aluminum frame. PV modules can be grounded by other grounding devices, which must be reliable and certified. The manufacturer's requirements should be followed.

7. Operation and Maintenance

It is required to perform regular inspection and maintenance of the modules, especially within warranty scope. It is the user's responsibility to report to the supplier regarding the damages found within 2 weeks.

The dust accumulated on the front transparent substrate may reduce the power output, and may even cause regional hot-spot effect. The industrial effluents or bird drops may be serious cases, and the extent of the severity depends on the transparency of the foreign objects. It's usually not dangerous of the accumulated

dust to reduce the sunshine, because the light intensity is still homogeneous and the power reduction usually is not obvious.

When modules are the work, there should exist environmental influence factors to cast shadows and cover part or even all of the modules, such as other modules, system support, bird drops and a lot of dust, clay or plant and so on, these may distinctly reduce the power output. We advise that there should be no obstructed object over the modules surface at any time.

The cleaning frequency depends on the accumulating velocity of the fouling. In many instances the front subs substrate goes cleaned with the rain, and we can decrease the cleaning frequency. It is recommended to wipe the glass surface with wet sponge or soft cloth. Please do not clean the glass with cleaning agent which contains acid or alkali.

8.1 Module appearance inspection

Inspect the modules visually to find if there are appearance defect, the following two types need more attention especially:

- A) Whether the glass is broken;
- B) Corrosion along the cells' bus-bar.

The corrosion is caused by the dampness infiltrated into the modules when the surface encapsulation material damaged during the installation or transportation.

- C) If there is burning vestige on the backsheet

8.2 Connector and cable inspection

It is recommended to conduct electrical preventive inspection and maintenance every 6 months.

Check the tightness of the connector and whether there is any external sheath damage or direct sunlight, and whether the connection is solid.

Check electrical leakage to ground.

Check the sealing gels of the junction box for any damage.

8.3 Cleaning

Dust accumulation on the glass surface of the module will reduce its power output and may cause hot spots. So the surface of PV modules should be kept clean. Maintenance work should be performed at least once six months or frequently. Warning: It should be carried out by trained personnel.

The back surface of the module normally does not need to be cleaned but, in the event this is deemed necessary, avoid the use of any sharp projects that might damage the penetrating the substrate material.

8.4 Troubleshooting

After the module is put into use, the photovoltaic system cannot work normally. Please inform the installer immediately. It is recommended to carry out preventive inspection every 6 months. Do not replace components without authorization. If inspection and maintenance of electrical or mechanical properties are required, qualified and professionally trained professionals should be allowed to operate to avoid electric shock or casualties.

Appendix 1: Performance at STC

EMxxxMP - xxxW P type Single glass Series :

Module	EM525MP - 525W P type Single glass	EM530MP - 530W P type Single glass	EM535MP - 535W P type Single glass	EM540MP - 540W P type Single glass	EM545MP - 545W P type Single glass	EM550MP - 550W P type Single glass
Open-circuit voltage (tolerance) [V]:	49.92 ± 2%	49.61 ± 2%	49.87 ± 2%	49.95 ± 2%	50.04 ± 2%	50.28 ± 2%
Short-circuit current (tolerance) [A]:	13.60 ± 2%	13.66 ± 2%	13.72 ± 2%	13.78 ± 2%	13.84 ± 2%	13.90 ± 2%
Voltage at max. power [V]:	41.14	41.28	41.51	41.70	41.92	42.11
Current at max. power [A]:	12.76	12.84	12.89	12.95	13.00	13.06
Max. power (tolerance) [W]:	525 ± 3%	530 ± 3%	535 ± 3%	540 ± 3%	545 ± 3%	550 ± 3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25
Temperature Coefficient of Pmax	-0.381 %/°C					
Temperature Coefficient of Voc	-0.276 %/°C					
Temperature Coefficient of Isc	+0.046 %/°C					

EMxxxMP - xxxW P type Single glass Series :

Module	EM440MP - 440W P type Single glass	EM445MP - 445W P type Single glass	EM450MP - 450W P type Single glass	EM455MP - 455W P type Single glass
Open-circuit voltage (tolerance) [V]:	41.01 ± 2%	41.22 ± 2%	41.48 ± 2%	41.75 ± 2%
Short-circuit current (tolerance) [A]:	13.74 ± 2%	13.82 ± 2%	13.88 ± 2%	13.93 ± 2%
Voltage at max. power [V]:	34.21	34.42	34.67	34.92
Current at max. power [A]:	12.86	12.93	12.98	13.03
Max. power (tolerance) [W]:	440 ± 3%	445 ± 3%	450 ± 3%	455 ± 3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25
Temperature Coefficient of Pmax	-0.381 %/°C			
Temperature Coefficient of Voc	-0.276 %/°C			
Temperature Coefficient of Isc	+0.046 %/°C			

EMxxxMP - xxxW P Type Single Glass Series :

Module	EM570MP - 570W P Type Single Glass	EM575MP - 575W P Type Single Glass	EM580MP - 580W P Type Single Glass	EM585MP - 585W P Type Single Glass	EM590MP - 590W P Type Single Glass	EM595MP - 595W P Type Single Glass	EM600MP - 600W P Type Single Glass	EM605MP - 605W P Type Single Glass	EM610MP - 610W P Type Single Glass	EM615MP - 615W P Type Single Glass
Open-circuit voltage (tolerance) [V]:	40.64 ± 2%	40.84 ± 2%	41.04 ± 2%	41.24 ± 2%	41.44 ± 2%	41.64 ± 2%	41.84 ± 2%	42.04 ± 2%	42.24 ± 2%	42.44 ± 2%
Short-circuit current (tolerance) [A]:	18.45 ± 2%	18.50 ± 2%	18.55 ± 2%	18.60 ± 2%	18.65 ± 2%	18.70 ± 2%	18.75 ± 2%	18.80 ± 2%	18.85 ± 2%	18.90 ± 2%
Voltage at max. power [V]:	33.35	33.57	33.76	33.95	34.14	34.35	34.54	34.75	34.94	35.10
Current at max. power [A]:	17.09	17.13	17.18	17.23	17.28	17.32	17.37	17.41	17.46	17.52
Max. power (tolerance) [W]:	570 ± 3%	575 ± 3%	580 ± 3%	585 ± 3%	590 ± 3%	595 ± 3%	600 ± 3%	605 ± 3%	610 ± 3%	615 ± 3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	30	30	30	30	30	30	30	30	30	30
Temperature Coefficient of Pmax	-0.381 %/°C									
Temperature Coefficient of Voc	-0.276 %/°C									
Temperature Coefficient of Isc	+0.046 %/°C									

EMxxxTP - xxxW N Type Single Glass Series (for 182x91 cell):

Module	EM550TP - 550W N Type Single Glass	EM555TP - 555W N Type Single Glass	EM560TP - 560W N Type Single Glass	EM565TP - 565W N Type Single Glass	EM570TP - 570W N Type Single Glass	EM575TP - 575W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	50.23±3%	50.43±3%	50.63±3%	50.83±3%	51.03±3%	51.23±3%
Short-circuit current (tolerance) [A]:	13.94±4%	14.00±4%	14.06±4%	14.12±4%	14.18±4%	14.24±4%
Voltage at max. power [V]:	41.83	42.01	42.17	42.35	42.51	42.69
Current at max. power [A]:	13.15	13.21	13.28	13.34	13.41	13.47
Max. power (tolerance) [W]:	550±3%	555±3%	560±3%	565±3%	570±3%	575±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25
Temperature Coefficient of Pmax	-0.310 %/°C					
Temperature Coefficient of Voc	-0.26 %/°C					
Temperature Coefficient of Isc	+0.046 %/°C					

EMxxxTP - xxxW N Type Single Glass Series (for 182x94 cell):

Module	EM580TP - 580W N Type Single Glass	EM585TP - 585W N Type Single Glass	EM590TP - 590W N Type Single Glass	EM595TP - 595W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	52.21 ± 3%	52.41 ± 3%	52.61 ± 3%	52.81 ± 3%
Short-circuit current (tolerance) [A]:	14.02 ± 4%	14.09 ± 4%	14.16 ± 4%	14.23 ± 4%
Voltage at max. power [V]:	43.22	43.37	43.51	43.65
Current at max. power [A]:	13.42	13.49	13.56	13.63
Max. power (tolerance) [W]:	580 ± 3%	585 ± 3%	590 ± 3%	595 ± 3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25
Temperature Coefficient of Pmax	-0.310 %/°C			
Temperature Coefficient of Voc	-0.26 %/°C			
Temperature Coefficient of Isc	+0.046 %/°C			

Appendix 2: Performance at low irradiance

EMxxxMP - xxxW P type Single glass Series:

Module	EM525MP - 525W P type Single glass	EM530MP - 530W P type Single glass	EM535MP - 535W P type Single glass	EM540MP - 540W P type Single glass	EM545MP - 545W P type Single glass	EM550MP - 550W P type Single glass
Open-circuit voltage (tolerance) [V]:	43.31±2%	43.48±2%	43.71±2%	43.78±2%	43.86±2%	44.07±2%
Short-circuit current (tolerance) [A]:	3.05±2%	3.06±2%	3.07±2%	3.09±2%	3.10±2%	3.11±2%
Voltage at max. power [V]:	36.45	36.57	36.77	36.94	37.14	37.31
Current at max. power [A]:	2.76	2.77	2.79	2.80	2.81	2.82
Max. power (tolerance) [W]:	100±3%	101±3%	102±3%	103±3%	104±3%	105±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25

EMxxxMP - xxxW P type Single glass Series:

Module	EM440MP - 440W P type Single glass	EM445MP - 445W P type Single glass	EM450MP - 450W P type Single glass	EM455MP - 455W P type Single glass
Open-circuit voltage (tolerance) [V]:	35.94±2%	36.13±2%	36.35±2%	36.59±2%
Short-circuit current (tolerance) [A]:	3.08±2%	3.09±2%	3.11±2%	3.12±2%
Voltage at max. power [V]:	30.31	30.49	30.71	30.94
Current at max. power [A]:	2.78	2.79	2.81	2.82
Max. power (tolerance) [W]:	84±3%	85±3%	86±3%	87±3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25

EMxxxMP - xxxW P Type Single Glass Series:

Module	EM570MP - 570W P Type Single Glass	EM575MP - 575W P Type Single Glass	EM580MP - 580W P Type Single Glass	EM585MP - 585W P Type Single Glass	EM590MP - 590W P Type Single Glass	EM595MP - 595W P Type Single Glass	EM600MP - 600W P Type Single Glass	EM605MP - 605W P Type Single Glass	EM610MP - 610W P Type Single Glass	EM615MP - 615W P Type Single Glass
Open-circuit voltage (tolerance) [V]:	35.64±2%	35.79±2%	35.97±2%	36.14±2%	36.32±2%	36.49±2%	36.67±2%	36.85±2%	37.07±2%	37.21±2%
Short-circuit current (tolerance) [A]:	4.17±2%	4.18±2%	4.19±2%	4.20±2%	4.21±2%	4.23±2%	4.24±2%	4.25±2%	4.26±2%	4.27±2%
Voltage at max. power [V]:	29.18	29.37	29.54	29.71	29.87	30.06	30.22	30.41	30.59	30.81
Current at max. power [A]:	3.76	3.77	3.78	3.79	3.80	3.81	3.82	3.83	3.84	3.85
Max. power (tolerance) [W]:	110±3%	111±3%	112±3%	113±3%	114±3%	114±3%	115±3%	116±3%	117±3%	118±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	30	30	30	30	30	30	30	30	30	30

EMxxxTP - xxxW N Type Single Glass Series (for 182x91 cell):

Module	EM550TP - 550W N Type Single Glass	EM555TP - 555W N Type Single Glass	EM560TP - 560W N Type Single Glass	EM565TP - 565W N Type Single Glass	EM570TP - 570W N Type Single Glass	EM575TP - 575W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	44.02±3%	44.20±3%	44.37±3%	44.55±3%	44.72±3%	44.90±3%
Short-circuit current (tolerance) [A]:	3.12±4%	3.14±4%	3.15±4%	3.16±4%	3.18±4%	3.19±4%
Voltage at max. power [V]:	37.05	37.22	37.36	37.52	37.66	37.82
Current at max. power [A]:	2.84	2.85	2.87	2.88	2.90	2.91
Max. power (tolerance) [W]:	105±3%	106±3%	107±3%	108±3%	109±3%	110±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25

EMxxxTP - xxxW N Type Single Glass Series (for 182x94 cell):

Module	EM580TP - 580W N Type Single Glass	EM585TP - 585W N Type Single Glass	EM590TP - 590W N Type Single Glass	EM595TP - 595W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	45.76±3%	45.93±3%	46.11±3%	46.28±3%
Short-circuit current (tolerance) [A]:	3.14±4%	3.16±4%	3.17±4%	3.19±4%
Voltage at max. power [V]:	38.29	38.42	38.55	38.67
Current at max. power [A]:	2.90	2.92	2.93	2.95
Max. power (tolerance) [W]:	111±3%	112±3%	113±3%	114±3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25

Appendix 3: Performance at NMOT

EMxxxMP - xxxW P type Single glass Series:

Module	EM525MP - 525W P type Single glass	EM530MP - 530W P type Single glass	EM535MP - 535W P type Single glass	EM540MP - 540W P type Single glass	EM545MP - 545W P type Single glass	EM550MP - 550W P type Single glass
Open-circuit voltage (tolerance) [V]:	45.63±2%	45.80±2%	46.04±2%	46.12±2%	46.20±2%	46.42±2%
Short-circuit current (tolerance) [A]:	11.56±2%	11.61±2%	11.66±2%	11.72±2%	11.77±2%	11.82±2%
Voltage at max. power [V]:	37.50	37.62	37.83	38.01	38.21	38.39
Current at max. power [A]:	10.75	10.82	10.86	10.91	10.96	11.01
Max. power (tolerance) [W]:	403±3%	407±3%	411±3%	415±3%	419±3%	423±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25
Nominal Module Operating Temperature(NMOT)	45±2°C					

EMxxxMP - xxxW P type Single glass Series:

Module	EM440MP - 440W P type Single glass	EM445MP - 445W P type Single glass	EM450MP - 450W P type Single glass	EM455MP - 455W P type Single glass
Open-circuit voltage (tolerance) [V]:	37.86±2%	38.06±2%	38.30±2%	38.55±2%
Short-circuit current (tolerance) [A]:	11.68±2%	11.75±2%	11.80±2%	11.84±2%
Voltage at max. power [V]:	31.19	31.37	31.60	31.83
Current at max. power [A]:	10.84	10.90	10.94	10.98
Max. power (tolerance) [W]:	338±3%	342±3%	346±3%	350±3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25
Nominal Module Operating Temperature(NMOT)	45±2°C			

EMxxxMP - xxxW P Type Single Glass Series:

Module	EM570M P - 570W P Type Single Glass	EM575M P - 575W P Type Single Glass	EM580M P - 580W P Type Single Glass	EM585M P - 585W P Type Single Glass	EM590M P - 590W P Type Single Glass	EM595M P - 595W P Type Single Glass	EM600M P - 600W P Type Single Glass	EM605M P - 605W P Type Single Glass	EM610M P - 610W P Type Single Glass	EM615M P - 615W P Type Single Glass
Open-circuit voltage (tolerance) [V]:	37.55±2%	37.71±2%	37.89±2%	38.08±2%	38.26±2%	38.45±2%	38.63±2%	38.81±2%	39±2%	39.19±2%
Short-circuit current (tolerance) [A]:	15.69±2%	15.73±2%	15.77±2%	15.81±2%	15.86±2%	15.90±2%	15.94±2%	15.98±2%	16.03±2%	16.08±2%
Voltage at max. power [V]:	30.40	30.60	30.77	30.95	31.12	31.31	31.49	31.67	31.85	32.03
Current at max. power [A]:	14.40	14.44	14.48	14.52	14.56	14.60	14.64	14.67	14.72	15.06
Max. power (tolerance) [W]:	438±3%	442±3%	446±3%	449±3%	453±3%	457±3%	461±3%	465±3%	469±3%	473±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	30	30	30	30	30	30	30	30	30	30
Nominal Module Operating Temperature(NMOT)	45±2°C									

RSxxxS8-144NT / RSxxxS8B-144NT / RSxxxS8T-144NT Series (for 182x91 cell):

Module	EM550TP - 550W N Type Single Glass	EM555TP - 555W N Type Single Glass	EM560TP - 560W N Type Single Glass	EM565TP - 565W N Type Single Glass	EM570TP - 570W N Type Single Glass	EM575TP - 575W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	47.88±3%	48.07±3%	48.26±3%	48.45±3%	48.64±3%	48.83±3%
Short-circuit current (tolerance) [A]:	11.26±4%	11.31±4%	11.35±4%	11.40±4%	11.45±4%	11.49±4%
Voltage at max. power [V]:	39.39	39.55	39.64	39.79	39.98	40.13
Current at max. power [A]:	10.56	10.62	10.67	10.73	10.78	10.84
Max. power (tolerance) [W]:	416±3%	420±3%	423±3%	427±3%	431±3%	435±3%
Maximum system voltage [V]	1500	1500	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25	25	25
Nominal Module Operating Temperature(NMOT)	45±2°C					

EMxxxTP - xxxW N Type Single Glass Series (for 182x94 cell):

Module	EM580TP - 580W N Type Single Glass	EM585TP - 585W N Type Single Glass	EM590TP - 590W N Type Single Glass	EM595TP - 595W N Type Single Glass
Open-circuit voltage (tolerance) [V]:	49.60±3%	49.79±3%	49.98±3%	50.17±3%
Short-circuit current (tolerance) [A]:	11.26±4%	11.31±4%	11.37±4%	11.43±4%
Voltage at max. power [V]:	40.22	40.37	40.51	40.60
Current at max. power [A]:	10.84	10.90	10.96	11.01
Max. power (tolerance) [W]:	436±3%	440±3%	444±3%	447±3%
Maximum system voltage [V]	1500	1500	1500	1500
Series Fuse Rating [A]	25	25	25	25
Nominal Module Operating Temperature(NMOT)	45±2°C			



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