



# **SOLAR PV MODULE INSTALLATION OPERATION AND MAINTENANCE MANUAL**

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## 1. INTRODUCTION

This installation guide contains information about the Safe Handling, Installation and Maintenance of the Solar Modules supplied by FS GREEN ENERGIES PRIVATE LIMITED. (Hereafter referred as “FSGEPL”).

**Trade mark:-**



**Fig.1**

All instructions in this guide should be read and understood before handling and installation of these Modules. If there are any questions, please contact FS GREEN ENERGIES PRIVATE LIMITED Sales department for clarification. Keep this guide in a safe place for ready reference for the care and maintenance of the Modules and also for use in case of sale or disposal of the modules. The module is considered to be in compliance with this standard only when the module is mounted in the manner specified by the mounting instructions. A module with exposed conductive parts is considered to be in compliance with this standard only when it is electrically grounded in accordance with the manufacturer's instructions and the requirements of the National Electrical Code, ANSI/NFPA 70 (2014- 2017).

## 2. GENERAL NOTES & INSTRUCTIONS

- Modules are used for ground mounted, Residential & Commercial roof tops. Installing solar photovoltaic systems may require specialized skills and knowledge. Installation should be performed only by qualified persons.
- Before installing the Modules in a solar power system/plant, the installer should become familiar with the mechanical and electrical requirement for such a system. Make sure the modules meet the technical requirements of the system as a whole.
- Ensure that other system components (BOS) do not exert damaging mechanical or electrical influences on the modules. The installer should conform to all the safety precautions in the guide when installing the modules.
- Note that in addition to the instructions given in this guide, the installers should follow all the Local Civil, Mechanical & Electrical Codes relevant to the installation of the Solar Photovoltaic Systems. Installers should assume the risk of injury that might occur during installation, including, without limitation, the risk of electric shock. These Solar modules are designed for outdoor use.
- Modules may be mounted on the ground, on rooftops or vehicles. Proper design of support structures is the responsibility of the system designers and installers. **Suggestions for mounting are given in Section 9.** Do not attempt to disassemble the modules, and do not remove any attached labels/nameplates or components from the modules.
- Do not apply paint or adhesive to module top surface. Artificially concentrated sunlight producing a PV module's current above the value reported on the nameplate shall not be directed onto the front or back face of the PV Module.
- When installing the system, abide with all local, regional and national statutory regulations for safety and installation. Obtain a work/building permit wherever necessary.

### 3. SAFETY MEASURES

#### 3.1 PRECAUTIONS

- 3.1.1** Keep children away from the system while transporting and installing mechanical and electrical components.
- 3.1.2** Deploy only trained persons in handling and installation of the Modules.
- 3.1.3** One individual module may generate voltage more than 40V DC when exposed to direct sunlight. Contact with a DC voltage of 40V or more is potentially hazardous.
- 3.1.4** Remember that when modules are connected in series, the total voltage is equal to the sum of the individual module voltages. If modules are connected in parallel, the total current is equal to the sum of individual module currents.
- 3.1.5** Danger of death from electric shock! The following points must be observed when handling the solar modules to avoid the risk of fire, sparking and fatal electric shock.
- Do not insert electrically conducting parts into the plugs or sockets.
  - Do not fit solar modules and wiring with wet plugs and sockets.
  - Exercise utmost caution when carrying out work on wiring and safety equipment (use insulated tools, insulated gloves, etc.).
  - Do not use damaged modules. Exercise utmost caution when working on wiring and the inverter. Be sure carefully to follow manufacture's installation instructions.
  - Do not connect or disconnect the Modules when they are energized. Completely cover the module with an opaque material during installation to keep electricity from being generated.
  - Do not wear metallic rings, watchbands, ear, nose, lip rings or other metallic devices while installing or troubleshooting photovoltaic systems.
  - Use only insulated tools that are approved for working on electrical installations.
  - Never disconnect the solar generator from the inverter while the inverter is connected to the mains grid.
  - Disconnect the AC side on the inverter first before disconnecting the DC side.
  - Use safe circuit breakers for the isolation.
  - Ensure cable connections in perfect condition (no splitting, soiling or other contamination)
- 3.1.6** Abide with the safety regulations for all other components used in the system, including wiring and cables, connectors, charging regulators, inverters, storage batteries and rechargeable batteries, etc.
- 3.1.7** Use only equipment, connectors, wiring and support frames suitable for a solar electric system.
- 3.1.8** Always use the same type of module within a particular photovoltaic system.

#### 3.2 FIRE SAFETY

In the case of a fire, SPV modules may produce dangerous voltage/surge current, even if they have been disconnected from the inverter, or have been partly or entirely destroyed, or the naked wiring destroyed. In the event of fire, inform the fire/safety team about the particular hazards from the PV system, and stay away from all elements of the PV system during and after a fire until the necessary steps have been taken to mitigate the risk. Before mounting the module, please consult your local building department to determine approved roofing materials.

Any module or panel mounting system has limitations on specific inclination required to maintain a specific System Fire Type 22 Rating for Topcon whereas it is Fire Type 4 for PERC The fire rating of the module is valid only when

mounted in the manner specified in the mechanical mounting instructions. A minimum slope of 5 in/ft. for installation over a roof is required to maintain the fire Type 22 rating. Refer to your local authority for guidelines and requirements for building or structural fire safety. For roof application, the Modules should be mounted over a fire resistant covering rated for the application. Ensure that all connections are securely made with no gap between the contacts. Any gap can result in electrical arcing that can cause a fire hazard and/or an electric shock. Do NOT use water to extinguish fires of an electrical origin.

Module Series	Specific construction	Marking
FST-M10.156G-XXX	Superstrate: 2 mm thick; Top encapsulant: 0.5 mm thick Bottom encapsulant: 0.5 mm thick; Substrate: 2 mm thick; Frame: Yes (Metallic)	Module Fire Performance: Type: 22
FST-M10.144G-XXX		
FST-M10.132G-XXX		
FST-M10.120G-XXX		
FST-M10.108G-XXX		
FSP-M10.156W-XXX	Superstrate: 3.2 mm thick; Top encapsulant: 0.5 mm thick Bottom encapsulant: 0.5 mm thick; Substrate: 0.3 mm thick; Frame: Yes (Metallic)	Module Fire Performance: Type: 04
FSP-M10.144W-XXX		
FSP-M10.132W-XXX		
FSP-M10.120W-XXX		
FSP-M10.108W-XXX		
FSP-M10.156B-XXX		
FSP-M10.144B-XXX		
FSP-M10.132B-XXX		
FSP-M10.120B-XXX		
FSP-M10.108B-XXX		

#### 4. PV MODULE HANDLING, UNPACKING AND STORAGE

- The pallet packaging is not water or weatherproof. Prior to installation, and to avoid any damage or degradation to the packaging or panel components, pallets and panels must be stored in a protected environment, ideally in internal storage conditions, where it is shielded from the elements, e.g., rain, dust, and direct sunlight.
- If overnight external storage in an uncontrolled environment is unavoidable, the panels and the pallet packaging must be protected from direct exposure to the elements and from contact with the ground, including earth, mud etc.
- If pallets are stored temporarily outside then place a protective covering over the pallet to protect it from direct weathering and Do NOT stack more than the 1 pallet on top of each other.
- The handling of Modules requires great diligence. Therefore, caution is required while unpacking, transporting and temporarily storing these Modules.
- Do NOT use a knife to cut the zip-ties, always use wire cutting pliers.
- Do NOT place modules directly on top of each other without corner protect. Do not carry the Module on Head.
- When carrying a bigger Module, two or more people should carry it by its frame and wear non-slip gloves (to avoid injury by a slipping Module, cuts by the edge of a frame etc.). Do not leave the Module unsupported or unsecured prior to installation.
- Store Modules in a dry and ventilated room.
- Do not place Modules on an uneven surface, for example, wind can cause a Module which is leaning against a fence to fall and break.

- Avoid applications of excessive bending or twisting of the Module, it may cause severe micro-cracks at the cell level, which in turn may compromise Module reliability.
- A Module with broken glass or torn backsheet cannot be repaired and must not be used since contact with any Module surface or the frame can produce electrical shock.
- At the installation site, take care to keep Modules and particularly their electrical contacts clean.
- Broken or damaged Modules must be handled carefully and disposed of properly. Broken glass can be sharp and may cause injury if not handled with appropriate protective equipment.
- Do not stand, step, walk and/or jump on the Module. Do not drop or place objects on the Modules (such as tools.)
- Do not mark the Modules with sharp instrument. Particularly attention should be taken to avoid Module backsheet to come in contact with sharp objects, as scratches may directly affect product safety and reliability.

### **CAUTION**

In any case **DO NOT STAND OR STEP** on the modules, **Do not drop or place objects on the module(s) (such as tools), do not thump / give extra pressure on the surface of the module(s) as localized high loads can induce severe micro -cracks at the cell level, which in turn may compromise module reliability. Failure to comply with above caution will void FSGEPL's warranty.**

## **5. PRODUCT IDENTIFICATION**

Each module has one Label pasted on its rear side next to the junction box and one label pasted inside the glass which is laminated. Below are the details,

### **5.1 UNIQUE MODULE SERIAL NUMBER**

Format FSZYMMDDXXXXX

FS- COMPANY INITIALS

Z- CELL TECHNOLOGY ( P- PERC, T- TOPCON)

YY- YEAR OF MANUFACTURING

MM- MONTH OF MANUFACTURING

DD- MONTH OF MANUFACTURING

XXXXX- UNIQUE SERIAL NO. STARTS WITH 00001

### **5.2 BACK LABEL**

It will be having below details;

- Model number
- Electrical data under STC, BNPI and BSI conditions: rated power, rated current, rated voltage, open circuit voltage, short-circuit current with measurement tolerance
- Maximum System Voltage: 1500VDC
- Class for protection against electrical shock: Class II Maximum overcurrent protection rating Safety Warnings
- Name and Address of the Manufacturer

Rated maximum system Voltage is 1500 V DC, Recommended Safety Fuse Rating is 30A and the modules are evaluated for fire rating class A as standalone modules under IEC 61730-2. Temperature coefficient for voltage at open-circuit, maximum power and short-circuit current is

TEMPERATURE CHARACTERISTICS		
Parameters	PERC	Topcon
Pmax Temp. Coefficient	- 0.31	- 0.28
Voc Temp. Coefficient	- 0.23	- 0.23
Isc Temp. Coefficient	+ 0.03	+ 0.03
Operating Temp.	-40°C to + 70°C	
Nominal Operating Cell Temp.	45±2°C	

**Table-1**

### 5.3 INSIDE LAMINATE LABELS

A serial number label with barcode is also pasted on the front surface below the glass on the top right corner. RFID tag is optional and these can be placed either inside the laminate or on the backside of module which will contain the Serial Number and Data pertaining to module.

Do not peel of any label from the PV module. If the label is removed, the product warranty will no longer be valid. Refer to the data label given on the back side of the module for interface purposes. For reporting any problems related to the Module, always refer both the Model Number and the Unique Serial Number in the correspondence.

## 6. APPLICABLE PRODUCTS

FST-M10.156G-XXX	FSP-M10.156W-XXX	FSP-M10.156B-XXX
FST-M10.144G-XXX	FSP-M10.144W-XXX	FSP-M10.144B-XXX
FST-M10.132G-XXX	FSP-M10.132W-XXX	FSP-M10.132B-XXX
FST-M10.120G-XXX	FSP-M10.120W-XXX	FSP-M10.120B-XXX
FST-M10.108G-XXX	FSP-M10.108W-XXX	FSP-M10.108B-XXX

**Table-2**

- For Electrical Parameters and other detail notes, please refer respective MODEL TDS.
- Rated electrical characteristics may be observed to vary within 10% of the values measured at standard test conditions (1 000 W/m<sup>2</sup>, 25 °C, spectral irradiance equal to AM1.5 according to IEC TS 61836). For bifacial PV modules, all electrical data shall be shown as relative to STC, BNPI and a BSI on the front side of the module, plus bifaciality coefficients at STC according to IEC TS 60904-1-2 and IEC 61215-1.

## 7. ENVIROMENTAL CONSIDERATIONS

FSGEPL modules are certified for IEC 61215, IEC 61730-I &II, IEC TS 62804-1. In addition to the required IEC certification to meet European standards, FSGEPL products have also been tested and certified for resistance to ammonia fumes (IEC 62716) that may be present in barns sheltering cattle, pigs, as well as sustainability for Installation in Humid (coastal) areas of high sand storms. Although FSGEPL PV modules have passed Salt mist (IEC 61701) corrosion test with a salt concentration of 5 % by weight, galvanic corrosion can occur between the aluminum frame and mounting or ground materials if such materials are made of dissimilar metals.

### Environmental Conditions

Ambient temperature: -40 °C to +50 °C

Operating temperature: -40 °C to the upper limit set by a 98th percentile module operating temperature of 70 °C  
The relative humidity shall be below 85 %.

The maximum altitude is up to 2000 m above sea level.

**NOTE :** The mechanical load bearing capacity depends upon the Installer's mounting methods and failure to follow the instructions of this manual may result in different capabilities to withstand snow and wind loads. The system installer should ensure that installation methods used meet these requirements and any local codes and regulations.

## 8. SITE SELECTION

- PV modules should be installed in a place where there is no shading across the location throughout the year. Shading can be minimized by having the distance between the obstruction and solar array is more than thrice the height of obstruction.
- Solar module is recommended to be installed at an optimized tilt angle to maximize the energy output. It is roughly equal to the latitude of the project site as a rule of thumb, facing to equator. But always design the plant based on local situations to find out the optimum conditions.
- PV modules should typically face south in the northern hemisphere and north in southern hemisphere. FSGEPL modules can be mounted either in landscape or portrait orientation however the impact of dirt shading the solar cells can be minimized by orienting the product in portrait.
- Modules shall be mounted with the orientation and tilt angle required for consistent performance (seasonally, yearly). The location selected shall have direct access to sunlight from 9:00 AM to 3:00 PM on the shortest day of the year.
- A minimum slope of 5 in/ft. for installation over a roof is required to maintain the fire Type 22 rating. Refer to your local authority for guidelines and requirements for building or structural fire safety. For roof application, the Modules should be mounted over a fire resistant covering rated for the application.

## 9. MOUNTING INSTRUCTIONS

### 9.1 GENERAL INSTRUCTIONS

- For high wind and snow loads extra clamping arrangement from module to structure is recommended.
- Load calculations based on the local wind speeds and environments are left to the system designers or installers.

### 9.2 SELECTION OF PROPER SUPPORT FRAME

- Always observe the instructions and safety precautions included with the support frames to be used with the modules.
- The Supporting Structure must be designed such that it is compatible to the Aluminum frame used for mounting and according to the load calculations.
- Ensure that the mounting system can also withstand the anticipated wind and snow loads
- The support module mounting structure must be made of durable, corrosion-resistant and UV-resistant material.
- All hardware like bolts, nuts & washers should be of stainless steel so as to eliminate the possibility of rust.
- The structure that the module is mounted to must be designed by qualified engineers in accordance with local building codes for site-specific wind, seismic, snow and gravitational loads. Mounting the module to a structure designed by qualified professionals only. Aluminum profile should be appropriately installed during



installation; however the means of attachment to the support structure is to be designed by a qualified engineer in accordance with local building codes for site- specific wind, seismic, snow and gravitational loads.

### 9.3 MODULE MOUNT

- When installing a module ensure that it is securely fastened and will not work loose as a result of wind or snow loads.
- Do not install modules on a roof or building during strong winds to prevent accidents due to fall.
- Modules can usually be mounted by using the following methods: fixed installation-mounting with bolts, fixed installation-mounting with clamps and tracker installation.

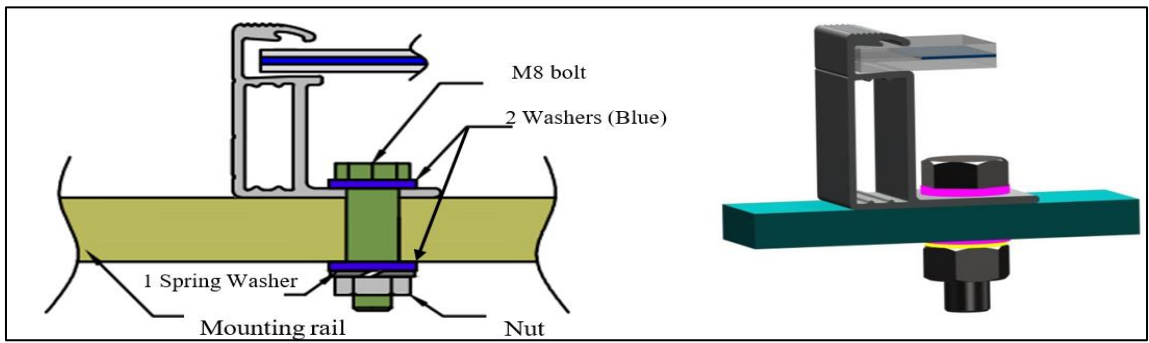
#### Note:

1. All installation methods herein are only for reference, and they are based on the test results from third-party tests and FSGEPL internal tests;
2. FSGEPL solar will not provide related mounting accessories, the system installer or trained professional personnel must be responsible for the PV system's design, installation, and mechanical load calculation and system security;
3. Before installation, the following items shall be addressed:
  - a) Visually check the module for any damage. Clean the module if any dirt or residue remains;
  - b) Check if module serial number stickers match.
  - c) The maximum loads that different types of modules can withstand on the front side and back side are dependent on installation methods, which can be referred to tables. If there is heavy snow and strong wind on the module installation site, take special protection to meet the actual requirements;  
Maximum Test Load = 1.5 (Safety factor) x Design load
  - d) The module must be mounted on the bracket according to the following installation. If there are other installation, please consult FSGEPL and obtain approval, otherwise the warranty will be invalid;
  - e) Under the mounting method of the fixed bracket as specified in this manual, the modules will be concave to varying degrees due to the gravity, which is a normal physical phenomenon and does not affect the normal use and performance of the modules. Any other external forces will cause additional sinking of the modules, so any operation of the modules should comply with this manual.

#### 9.3.1 MOUNTING WITH BOLTS

Install the module on the rack using anti-corrosion bolts, elastic washers and flat washers with sufficient torque to allow the module to be properly secured. The reference value of tightening torque for M8 bolt is 16-20 N\*M, and for M6 bolt is 9-12 N\*M. If special mounting system or special installation method is required, please reconfirm with the supplier of the racking system regarding the torque value. See Figure 2 for detailed installation information.

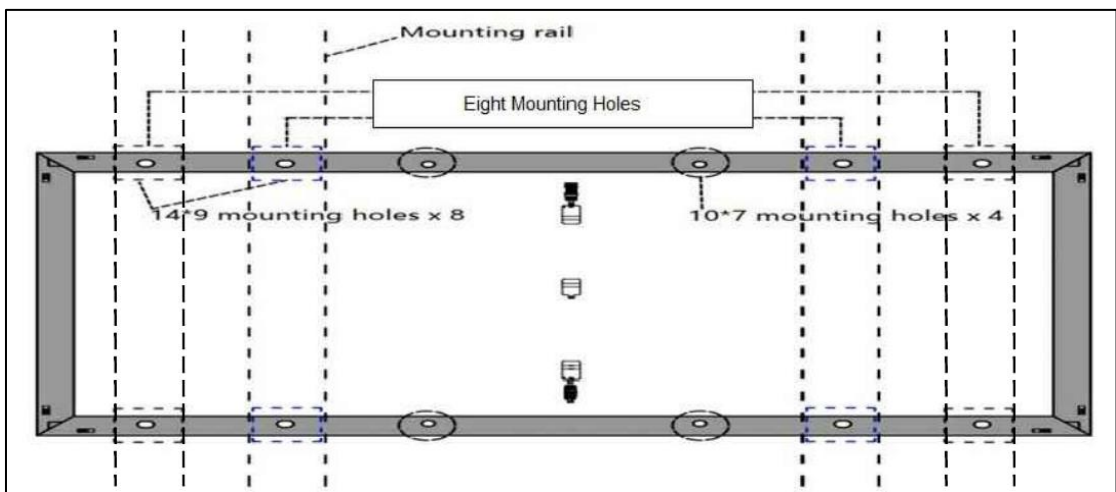
See Figure 3 for the module models with corresponding installation positions for bolt installation (using 4 inner holes), Figure 4 for the module models with corresponding installation positions for bolt installation (using 4 outer holes) and Table 3 lists different sizes of bolts for different mounting holes.



**Fig. 2**

Mounting hole (mm)	Recommended bolt size
14 x 9	M8
10 x 7	M6 ( For Tracker Method Only)

**Table 3**



**Fig. 3**

Module Type	8 Bolt installation (Test Load Pa)		
	Design Load	Y Pitch (mm)	X Pitch (mm)
FST-M10.156G-XXX	3600/1600 with 1.5 Safety Factor	1600, 1200	1092
FSP-M10.156W-XXX			
FSP-M10.156B-XXX			
FST-M10.144G-XXX			
FSP-M10.144W-XXX		1400, 1000	
FSP-M10.144B-XXX			
FST-M10.132G-XXX			
FSP-M10.132W-XXX			
FSP-M10.132B-XXX			
FST-M10.120G-XXX			
FST-M10.108G-XXX			
FSP-M10.120W-XXX			
FSP-M10.108W-XXX			
FSP-M10.120B-XXX			
FSP-M10.108B-XXX			

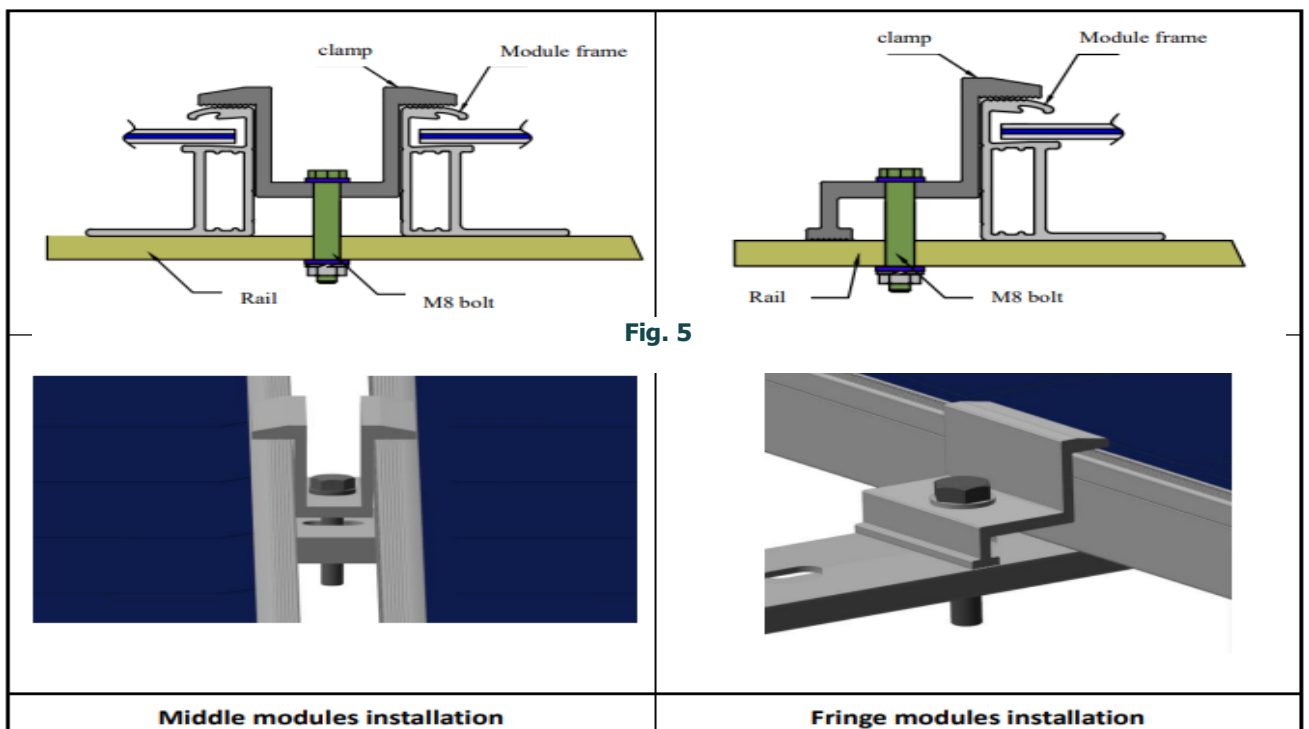
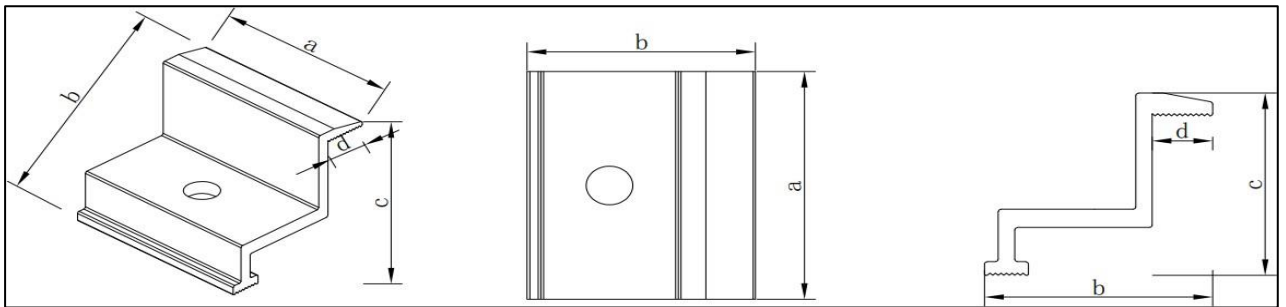
**Table-4**

### 9.3.2 MOUNTING WITH CLAMPS

The clamps must not be installed in contact with the front glass of the module and must not deform the module frame. Ensure that the clamps do not create a shadow on the module. Under no circumstances may the frame be altered. When choosing the mounting method for the clamps, make sure that there are at least four clamps on each module. The different mounting positions of the clamps determine the maximum load capacity of the module. Figures mentioned below show the different mounting methods and the positions of the clamps for the different mounting methods. Depending on the local wind and snow loads, if there is a possibility of excessive load combinations, additional clamps are required to ensure that the module has enough load carrying capacity. The torque value applied during installation of the clamps should be high enough to securely hold the module (consult installer or bracket supplier for exact torque value).

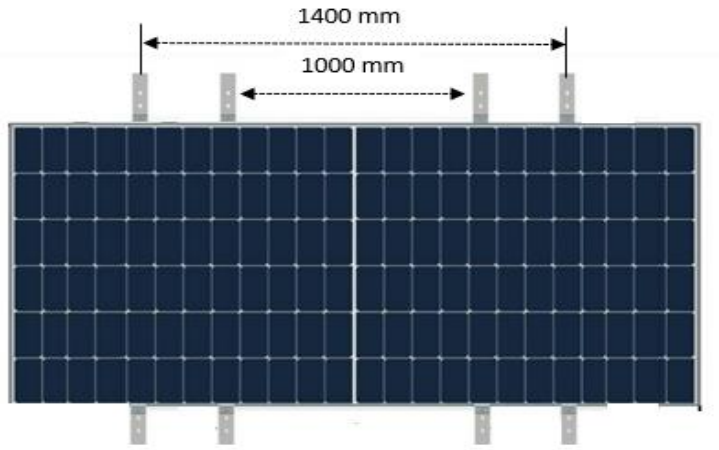
The length of the clamp should be  $L \geq 50\text{mm}$  and the thickness  $t \geq 4\text{mm}$ . Height of side clamp is consistent with the height of module frame, make sure the clamp is firmly attached to the frame after installation (The clamp must be at least  $D \geq 10\text{mm}$  overlap with the Module frame, the clamp section can be changed to ensure reliable installation of the Module). The bolt torque of the fixed block should be determined according to the mechanical design standards of the bolts and clamps used by the customer, such as: M8:15 ~18 N·m.

The mounting clamp should be made of aluminum alloy first, recommended 6005-T6 material,  $R_{p0.2} \geq 225\text{Mpa}$ ,  $R_m \geq 265\text{Mpa}$ . In high load environments or when short-side overlapping installation, it is recommended to use reinforcing mounting clamp for installation of very large module, such as side reinforcing clamp or arc-shaped clamp.



**Middle modules installation**

**Fringe modules installation**



**Fig.6**

**Long side clamp installation**

<b>Module Type</b>	<b>Clamp installation on long side (+3600Pa/− 16000Pa) Safety Factor 1.5 in Fig. 7</b>
Frame height	35
FST-M10.156G-XXX	Y1- 1600, Y2- 1200
FSP-M10.156B-XXX	
FSP-M10.156W-XXX	
FST-M10.144G-XXX	Y1- 1400, Y2- 1000
FSP-M10.144W-XXX	
FSP-M10.144B-XXX	
FST-M10.132G-XXX	
FSP-M10.132W-XXX	
FSP-M10.132B-XXX	
FST-M10.120G-XXX	
FST-M10.108G-XXX	
FSP-M10.120W-XXX	
FSP-M10.108W-XXX	
FSP-M10.120B-XXX	
FSP-M10.108B-XXX	

**Table -5**

## 10. ELECTRICAL CONFIGURATIONS

### 10.1 GENERAL INSTRUCTIONS

- Each module comes with a permanently attached Junction Box with cables 1X4.0mm<sup>2</sup>, ambient temp -40 to +70°C, rated voltage 1500 VDC, 35 250-400 meter length certified against IEC 62930, type 131, fitted with below mentioned connector, and contains 3 Schottky diode.

PV Connector Manufactured by	Male Connector Model No.	Female Connector Model No.	Mating Connector	Model series
Zhejiang Zhonghuan Sunter PV Technology Co. Ltd	PV-ZH202B	PV-ZH202B	Same manufacturer and model of connector	FST-M10.156G-XXX FST-M10.144G-XXX FST-M10.132G-XXX FST-M10.120G-XXX FST-M10.108G-XXX
NINGBO GZX PV Technology Co., Ltd.	PV-GZX1500	PV-GZX1500	Same manufacturer and model of connector	FSP-M10.156B-XXX FSP-M10.144B-XXX FSP-M10.132B-XXX FSP-M10.120B-XXX FSP-M10.108B-XXX
DhashPV technologies Pvt. Ltd	DS01	DS01	Same manufacturer and model of connector	FSP-M10.156W-XXX FSP-M10.144W-XXX FSP-M10.132W-XXX FSP-M10.120W-XXX FSP-M10.108W-XXX

- Several modules are connected in series and then in parallel to form a PV array, especially or application with a high operation voltage.
- When connected in series, all modules must have the same amperage. When connected in parallel, the modules should be of the same rating and specification.
- Do not use modules of different configurations in the same array.
- If modules are connected in series, the total voltage is equal to the sum of individual voltages.
- The number of modules that can be connected in series is limited by the Maximum System Voltage Rating which is 1500V DC. In North America, residential and commercial (office) installations are limited to 600 V MSV, AC or DC. A 1500 V MSV rating is only applicable to restricted access industrial installations, away from the general public. Even if the module's insulation had been certified to 1500 V, this cannot be allowed as the MSV Rating in all installation circumstances.
- Recommended maximum series/parallel module configurations; [fuse rating / (Isc\*1.56)].
- Note: The electrical characteristics such as Vmp, Imp & Pmp mentioned on the Module Data Sheet are based on measurements made with +/-2% accuracy at standard test conditions (irradiance of 1000W/m<sup>2</sup>, AM 1.5 spectrums, and module temperature of 25° ±2 °C) according to IEC 60904-3.
- Under normal outdoor conditions the module may produce current and voltages that are different than those listed in the data sheet. Accordingly, during system design, values of Voc and Isc should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor amperage, fuse ratings and size of controls connected to the modules or system output.

- A photovoltaic module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Factors to consider include module temperature and front side irradiance (and, for bifacial modules, ground or roof albedo, row spacing, and installation height). Accordingly, the values of VOC and ISC (or for bifacial modules, ISC-aBSI) marked on this PV module should be multiplied by a factor of 1,25 when determining voltage and current ratings for components connected to the PV output.”The safety factor of 1,25 given for the minimum voltage rating of the components in the example statement above may be modified during the design of a system according to the minimum temperature of the location of the installation and the temperature coefficient for VOC. The safety factor of 1,25 given for conductor current ratings values for ISC (or for bifacial modules, ISC-aBSI) may be adjusted based on the maximum values of irradiance incident on the front side of the module (and the rear side for bifacial modules). To this purpose, a full simulation for the specific location and module orientation (and for bifacial modules, ground albedo, row spacing and installation height) is required. Further guidance for the choice of a safety factor other than 1,25 is given in IEC 62548/ National Electrical Code.
- For applications requiring high currents, several photovoltaic modules can be connected in parallel; the total current is equal to the sum of individual currents.
- Refer local (country specific) wiring regulations to determine system wire size, type, and temperature.
- The cross-section area of cable and the capacity of connector must be selected to suit the maximum system short circuit current. Recommended cross section area of cable is 4mm<sup>2</sup> for a single module.
- To minimize risk in the event of an indirect lightning strike, avoid forming array loops when designing the system.
- Application class, Equipment Protection Class for PV modules: II.
- Any limitations on wiring methods that apply to the wiring compartment or box is nil.

## 10.2 GROUNDING OF MODULE

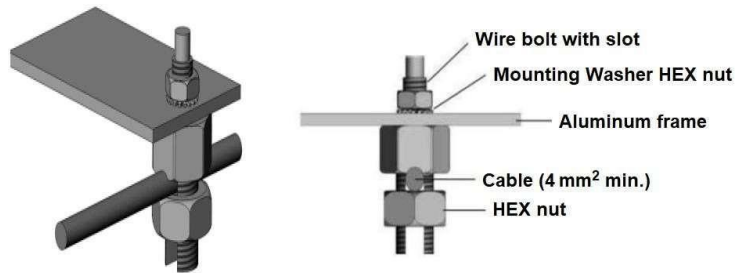
- Solar modules require the grounding to Reduce or eliminate shock and fire hazards and for protection from damages due to lightening, or it may be mandatory as per local or national regulation.
- The installer of a PV system is responsible for grounding of all structures.
- The main earth ground must only be connected by a qualified electrician.
- The Module supplied will have One Grounding Hole of 4mm on the frame. The grounding wire can be attached to the modules using a SS bolts or washers. Securely tighten the grounding wire to the module frame with the screw and washers made of corrosion resistant ss. Please ensure that the material used must not corrode it or induce corrosion (Galvanic effect). Please ensure that the modules are earthed properly with the correct wire size as per the local requirements. A possible grounding method is displayed below.
- Grounding hole of the PV module



- a) The grounding method of the frame of arrays shall comply with the NEC NFPA 70, issue date 2017, article 250. In Canada, installation should be done in accordance with CSA C22.1, Safety Standard for Electrical Installations, Canadian Electrical Code, Part 1, and other applicable local standards.
- b) The aluminium frame should not come in direct contact with any copper wire, so special grounding device should be used as discussed below.

**Grounding Method 1:** Tyco grounding bolt #2058729-1 (UL listed KDER E69905)

The Tyco grounding bolt comprises of wire bolt & slot, Hex washer nut (with star washer) and Hex nut (refer to Fig. 11). The Hex washer nut shall be 8.73 mm thick, made of stainless steel. The grounding device should fully conduct between frame, structure and earthing wire. Tightening torque shall be 16-20 Nm.



Grounding mechanism of the PV module, using Tyco grounding bolt #2058729-1

### 10.3 GROUNDING OF DC –VE BUS OF ARRAY

It is advisable to ground the DC –ve bus in the system, so that the cells in the module would be prevented from seeing high –ve potentials.

Note that the DC side grounding may have to be done in the Inverters and therefore, the Inverters used in the system must be designed to provide a DC –ve bus grounding, with all the safety features required as per local electrical code. Please check with your inverter supplier about this option while selecting the suitable inverter for this purpose.

### 10.4 WIRING

- Read and follow the general instructions given in Section 10.1 and also the safety instructions given section 4.
- The min. cable diameters for the installation of the modules must be 4 mm<sup>2</sup>.
- Connect the Modules in series or parallel according to the system design, recommended max. Series/parallel module configuration is Max. 32 modules in serial and 2 serial circuits on parallel.
- Note that the +ve and –ve terminal use mating type of connectors. The –ve connector can only mate with the +ve connector to avoid wrong connections. However, to connect the modules in parallel, one would need extension cables/connectors.
- Ensure all the connections are safe and tight without any stress either on cables or connectors.
- Use cable extensions and plugs that are designed for outdoor applications.
- While connecting the modules do not exceed the specified maximum system voltages and cables should meet the specified current ratings of the arrays.
- Provide a 25 A fuse in each series of Modules at a JB.
- To verify wiring of module array, check the open circuit voltage of the string based on Voc of module. If the measured open circuit voltage (Voc) is within the limits, go ahead with connection to Inverter.

## 10.5 DIODES

- Blocking diodes prevent current flowing from the battery to the module when no electricity is being generated. It is recommended to use blocking diodes when a charging regulator is not used. Consult a specialist dealer to select suitable type of Diode to be used.
- In systems with more than two modules in series, high reverse current can flow through cells that are shaded partially or outright when part of a Module is shaded, and the rest is exposed to the sun. These currents can cause the affected cells to get very hot and could even damage the module. To protect module from such high reverse currents, by-pass diodes are used in module.

Model series	Junction Box	Diode
FST-M10.156G-XXX FST-M10.144G-XXX FST-M10.132G-XXX FST-M10.120G-XXX FST-M10.108G-XXX	Zhejiang Zhonghuan Sunter PV Technology Co. Ltd; PV-ZH011C-5M	Zhejiang Zhonghuan Sunter PV Technology Co. Ltd; MK5045; 50A
FSP-M10.156B-XXX FSP-M10.144B-XXX FSP-M10.132B-XXX FSP-M10.120B-XXX FSP-M10.108B-XXX	NINGBO GZX PV Technology Co., Ltd. PV-GZX306	NINGBO GZX PV Technology Co., Ltd. GF5045E
FSP-M10.156W-XXX FSP-M10.144W-XXX FSP-M10.132W-XXX FSP-M10.120W-XXX FSP-M10.108W-XXX	DhashPV technologies Pvt. Ltd. DSJB12y(b)	DhashPV technologies Pvt. Ltd. DS4045T

## 10.6 BATTERY CONNECTION

- When solar modules are used to charge batteries, the battery must be installed in a manner which will protect the performance of the system and the safety of its users. The battery should be away from the main flow of people and animal traffic.
- The battery must be protected from sunlight, rain, snow, debris, and placed in a well ventilated place.
- Most batteries generate hydrogen gas when charging, which is explosive. Do not light matches or create sparks near the battery bank.
- When a battery is installed outdoors, it should be placed in an insulated and ventilated battery case specifically designed for the purpose.

## 10.7 GRID CONNECTION SYSTEM

The DC electrical energy generated by photovoltaic systems can be converted to AC and connected to a utility grid system. As local utilities' policies on connecting renewable energy systems to their grids vary from region to region, consult a qualified system designer or integrator to design such a system. Permits are normally required for installing such a system and the utility must formally approve and inspect such a system before it can be accepted.



## 11. DISCLAIMER OF LIABILITY

Since Installation and Maintenance of the Module are beyond (FSGEPL) company's control; FSGEPL does not assume responsibility and expressly disclaims liability for loss, damage, injury or expense arising out of or in any way connected with such installation, operation, use or maintenance of the Modules.

FSGEPL assumes no responsibility for any infringement of patents or other rights of third parties that may result from use of the Module. No license is granted by implication or otherwise under any patent or patent rights. The information in this Manual is based on our knowledge and experience and is believed to be reliable; but such information including product specifications (without limitations) and suggestions do not constitute a warranty, expressed or implied. FSGEPL reserves the right to make changes to the product, specifications or this manual without prior notice.

## 12.COMMISSION AND MAINTENANCE

### 12.1 TESTING

- Test all electrical and electronic components of the system before using it. Follow the instructions in the guides supplied with the components and equipment.
- Check the open-circuit voltage of every series of modules by a digital multi meter (fluke 179 series are recommended). The measured values should correspond to the sum of the open-circuit voltages of the individual module.
- Check the short-circuit current of every series circuit. It can be measured directly by a digital multi meter (such as Fluke 179) connected in the two terminals of series circuit or module, or with any load such as PV illumination to make a rough measurement. Attention, the rated scale of the ammeter or the rated current of load should more than 1.25 times of the rated short-circuit current of series module. The rated current is given in the Data-Sheet corresponding to the type of module used. The measured value can vary significantly, depending on weather conditions, the time of day and shading of the module.

### 12.2 TROUBLE SHOOTING LOW VOLTAGES

- If the drop in the Open Circuit Voltage is nominally low (<5%), then probable causes are higher temperature of the modules or lower irradiance. If these causes are eliminated, then look out for other causes.
- Excessive voltage drop is typically caused by improper connections at the terminals or defective bypass diodes.
- First, check all wiring connections to make sure all connections are correct.
- Check the open-circuit voltage of each module in the series.
- Fully cover the modules in the series with an opaque material.
- Disconnect the wiring at both terminals of all the modules.
- Remove the opaque material from the modules to be checked and measure the open- circuit voltage at its terminals.
- If the measured voltage is only half of the rated, this indicates a defective bypass diode. Refer the issue to Customer Support.
- If the diodes are working fine, and yet the measured voltages are lower than the rated voltages, then report the issue to Customer Support.

## 12.3 MAINTENANCE & CLEANING GUIDLINES

FSGEPL recommends the following maintenance in order to ensure optimum performance of the module:

- **Type of Water:** Reverse osmosis (RO) water is an ideal option. If RO is not available, rainwater or tap water can be used. Tap water must be of low mineral content with total hardness less than 75 mg/L. In case mineral content of water used is more than 75 mg/L but less than 200 mg/L, the water must be squeezed off to prevent scale build up over module surface.
- **Water Pressure:** Water pressure should not exceed 35 Bar at the nozzle. Use of high pressure hoses for cleaning may exert excess pressure and damage the modules.
- **Water Temperature:** Temperature of water used for cleaning should be same as module temperature at the time of cleaning (difference should not be greater than 20°C at maximum. Cleaning should be carried out when the modules are cool to avoid thermal shock which can potentially cause cracks on the modules.

Clean modules in accordance with the module manufacturer's instructions. Clean the surface of the module as necessary.

- Dirt must never be scraped or rubbed away when dry, as this will cause micro-scratches on the module.
- Check the electrical and mechanical connections at least once every six months to verify that they are clean, secure and undamaged.
- All fastenings are tight and secure and free of corrosion.
- All cable connections are secure, tight, clean and free of corrosion.
- Cables are not damaged in any way.
- Check the earthling resistance.
- If any problems are notice, get them investigated and resolved by a competent specialist.
- **Attention:** Observe the maintenance instructions for all components used in the system, such as support frames, charging regulators, inverters, batteries etc.
- If any components of the Modules such as diode, junction box, plug connectors are found to be defective, do not attempt to change or replace. Report the issue to Customer Support.
- The installer/system owner may contact FSGEPL at the following address for further clarifications regarding the safe installation and maintenance of the solar panels.

FS GREEN ENERGIES PRIVATE LIMITED

Samanvay House, Near Urmi Society and Alkapuri Haveli,

Jetalpur Road, Alkapuri, Vadodara, Gujarat, 390007, INDIA

## ANNEXURE 1: LIST OF APPLICABLE MODELS

Model	Condition	Open Circuit Voltage at STC, (V dc)	Rated Voltage at STC, (V dc)	Maximum System Voltage, (V dc)	Rated Current at STC, (A dc)	Short Circuit Current at STC, (A dc)	Rated Maximum Power at STC, (W)	Maximum Series Fuse, (A)	Protection Class (IEC 61140)
<b>Modules with Glass to Glass Topcon</b>									
FST-M10.156G-630	STC	57.06	46.49	1500	13.55	14.14	630.00	30	II
	BNPI	57.06	46.49	1500	14.77	15.41	693.00	30	II
FST-M10.156G-625	STC	56.96	46.33	1500	13.49	14.09	625.00	30	II
	BNPI	56.96	46.33	1500	14.70	15.36	687.50	30	II
FST-M10.156G-620	STC	56.87	46.20	1500	13.42	14.04	620.00	30	II
	BNPI	56.87	46.20	1500	14.63	15.30	682.00	30	II
FST-M10.156G-615	STC	56.79	46.07	1500	13.35	13.98	615.00	30	II
	BNPI	56.79	46.07	1500	14.55	15.24	676.50	30	II
FST-M10.156G-610	STC	56.70	45.90	1500	13.29	13.90	610.00	30	II
	BNPI	56.70	45.90	1500	14.49	15.15	671.00	30	II
FST-M10.144G-585	STC	52.45	43.10	1500	13.58	14.00	585.00	30	II
	BNPI	52.45	43.10	1500	14.80	15.26	643.50	30	II
FST-M10.144G-580	STC	52.25	42.95	1500	13.51	13.94	580.00	30	II
	BNPI	52.25	42.95	1500	14.73	15.19	638.00	30	II
FST-M10.144G-575	STC	52.05	42.80	1500	13.44	13.88	575.00	30	II
	BNPI	52.05	42.80	1500	14.65	15.13	632.50	30	II
FST-M10.144G-570	STC	51.85	42.65	1500	13.37	13.82	570.00	30	II
	BNPI	51.85	42.65	1500	14.57	15.06	627.00	30	II
FST-M10.144G-565	STC	51.65	42.50	1500	13.31	13.76	565.00	30	II
	BNPI	51.65	42.50	1500	14.51	15.00	621.50	30	II
FST-M10.144G-560	STC	51.45	42.33	1500	13.25	13.70	560.00	30	II
	BNPI	51.45	42.33	1500	14.44	14.93	616.00	30	II
FST-M10.132G-535	STC	48.68	39.93	1500	13.40	13.82	535.00	30	II
	BNPI	48.68	39.93	1500	14.61	15.06	588.50	30	II
FST-M10.132G-530	STC	48.63	39.73	1500	13.34	13.72	530.00	30	II
	BNPI	48.63	39.73	1500	14.54	14.95	583.00	30	II
FST-M10.132G-525	STC	48.58	39.53	1500	13.28	13.62	525.00	30	II
	BNPI	48.58	39.53	1500	14.48	14.85	577.50	30	II
FST-M10.132G-520	STC	48.53	39.33	1500	13.22	13.53	520.00	30	II
	BNPI	48.53	39.33	1500	14.41	14.75	572.00	30	II
FST-M10.120G-485	STC	44.27	36.23	1500	13.40	13.81	485.00	30	II
	BNPI	44.27	36.23	1500	14.61	15.05	533.50	30	II
FST-M10.120G-480	STC	44.21	36.06	1500	13.31	13.69	480.00	30	II
	BNPI	44.21	36.06	1500	14.51	14.92	528.00	30	II
FST-M10.120G-475	STC	44.16	35.85	1500	13.25	13.59	475.00	30	II
	BNPI	44.16	35.85	1500	14.44	14.81	522.50	30	II
FST-M10.120G-470	STC	44.12	35.63	1500	13.19	13.50	470.00	30	II
	BNPI	44.12	35.63	1500	14.38	14.72	517.00	30	II
FST-M10.108G-440	STC	40.06	32.75	1500	13.46	13.86	440.00	30	II
	BNPI	40.06	32.75	1500	14.67	15.11	484.00	30	II
FST-M10.108G-435	STC	39.95	32.58	1500	13.35	13.75	435.00	30	II
	BNPI	39.95	32.58	1500	14.55	14.99	478.50	30	II
FST-M10.108G-430	STC	39.79	32.38	1500	13.28	13.67	430.00	30	II
	BNPI	39.79	32.38	1500	14.48	14.90	473.00	30	II
FST-M10.108G-425	STC	39.75	32.15	1500	13.22	13.57	425.00	30	II
	BNPI	39.75	32.15	1500	14.41	14.79	467.50	30	II
FST-M10.108G-420	STC	39.71	31.91	1500	13.16	13.48	420.00	30	II
	BNPI	39.71	31.91	1500	14.34	14.69	462.00	30	II

Model	Condition	Open Circuit Voltage at STC, (V dc)	Rated Voltage at STC, (V dc)	Maximum System Voltage, (V dc)	Rated Current at STC, (A dc)	Short Circuit Current at STC, (A dc)	Rated Maximum Power at STC, (W)	Maximum Series Fuse, (A)	Protection Class (IEC 61140)
<b>Modules with Glass to Transparent Backsheet PERC</b>									
FSP-M10.156B-590	STC	54.10	45.00	1500	13.11	13.61	590.00	25	II
	BNPI	54.10	45.00	1500	14.29	14.83	646.64	25	II
FSP-M10.156B-585	STC	54.00	44.86	1500	13.04	13.54	585.00	25	II
	BNPI	54.00	44.86	1500	14.21	14.76	641.16	25	II
FSP-M10.156B-580	STC	53.90	44.72	1500	12.97	13.46	580.00	25	II
	BNPI	53.90	44.72	1500	14.14	14.67	635.68	25	II
FSP-M10.156B-575	STC	53.80	44.57	1500	12.90	13.37	575.00	25	II
	BNPI	53.80	44.57	1500	14.06	14.57	630.20	25	II
FSP-M10.156B-570	STC	53.70	44.36	1500	12.85	13.30	570.00	25	II
	BNPI	53.70	44.36	1500	14.01	14.50	624.72	25	II
FSP-M10.144B-555	STC	50.25	42.27	1500	13.15	13.89	555.00	25	II
	BNPI	50.25	42.27	1500	14.33	15.14	608.28	25	II
FSP-M10.144B-550	STC	50.10	42.13	1500	13.07	13.83	550.00	25	II
	BNPI	50.10	42.13	1500	14.25	15.07	602.80	25	II
FSP-M10.144B-545	STC	49.95	41.96	1500	13.00	13.76	545.00	25	II
	BNPI	49.95	41.96	1500	14.17	15.00	597.32	25	II
FSP-M10.144B-540	STC	49.80	41.82	1500	12.93	13.70	540.00	25	II
	BNPI	49.80	41.82	1500	14.09	14.93	591.84	25	II
FSP-M10.144B-535	STC	49.59	41.66	1500	12.86	13.63	535.00	25	II
	BNPI	49.59	41.66	1500	14.02	14.86	586.36	25	II
FSP-M10.144B-530	STC	49.35	41.45	1500	12.81	13.56	530.00	25	II
	BNPI	49.35	41.45	1500	13.96	14.78	580.88	25	II
FSP-M10.144B-525	STC	49.19	41.30	1500	12.72	13.48	525.00	25	II
	BNPI	49.19	41.30	1500	13.86	14.69	575.40	25	II
FSP-M10.132B-500	STC	45.73	38.73	1500	12.91	13.68	500.00	25	II
	BNPI	45.73	38.73	1500	14.07	14.91	548.00	25	II
FSP-M10.132B-495	STC	45.55	38.55	1500	12.84	13.61	495.00	25	II
	BNPI	45.55	38.55	1500	14.00	14.83	542.52	25	II
FSP-M10.132B-490	STC	45.31	38.31	1500	12.79	13.54	490.00	25	II
	BNPI	45.31	38.31	1500	13.94	14.76	537.04	25	II
FSP-M10.132B-485	STC	45.13	38.19	1500	12.70	13.46	485.00	25	II
	BNPI	45.13	38.19	1500	13.84	14.67	531.56	25	II
FSP-M10.132B-480	STC	45.07	37.97	1500	12.64	13.37	480.00	25	II
	BNPI	45.07	37.97	1500	13.78	14.57	526.08	25	II
FSP-M10.120B-455	STC	41.72	34.88	1500	13.06	13.73	455.00	25	II
	BNPI	41.72	34.88	1500	14.24	14.97	498.68	25	II
FSP-M10.120B-450	STC	41.59	34.72	1500	12.97	13.67	450.00	25	II
	BNPI	41.59	34.72	1500	14.14	14.90	493.20	25	II
FSP-M10.120B-445	STC	41.43	34.53	1500	12.89	13.60	445.00	25	II
	BNPI	41.43	34.53	1500	14.05	14.82	487.72	25	II
FSP-M10.120B-440	STC	41.39	34.38	1500	12.80	13.53	440.00	25	II
	BNPI	41.39	34.38	1500	13.95	14.75	482.24	25	II
FSP-M10.120B-435	STC	41.23	34.17	1500	12.74	13.45	435.00	25	II
	BNPI	41.23	34.17	1500	13.89	14.66	476.76	25	II
FSP-M10.108B-410	STC	37.53	31.64	1500	12.96	13.64	410.00	25	II

	BNPI	37.53	31.64	1500	14.13	14.87	449.36	25	II
FSP-M10.108B-405	STC	37.38	31.49	1500	12.86	13.57	405.00	25	II
	BNPI	37.38	31.49	1500	14.02	14.79	443.88	25	II
FSP-M10.108B-400	STC	37.33	31.32	1500	12.77	13.50	400.00	25	II
	BNPI	37.33	31.32	1500	13.92	14.72	438.40	25	II
FSP-M10.108B-395	STC	37.17	31.05	1500	12.72	13.43	395.00	25	II
	BNPI	37.17	31.05	1500	13.86	14.64	432.92	25	II
FSP-M10.108B-390	STC	36.92	30.93	1500	12.61	13.34	390.00	25	II
	BNPI	36.92	30.93	1500	13.74	14.54	427.44	25	II

Model	Condition	Open Circuit Voltage at STC, (V dc)	Rated Voltage at STC, (V dc)	Maximum System Voltage, (V dc)	Rated Current at STC, (A dc)	Short Circuit Current at STC, (A dc)	Rated Maximum Power at STC, (W)	Maximum Series Fuse, (A)	Protection Class (IEC 61140)
<b>Modules with Glass to White Backsheet PERC</b>									
FSP-M10.156W-590	STC	54.10	45.00	1500	13.11	13.61	590.00	25	II
FSP-M10.156W-585	STC	54.00	44.86	1500	13.04	13.54	585.00	25	II
FSP-M10.156W-580	STC	53.90	44.72	1500	12.97	13.46	580.00	25	II
FSP-M10.156W-575	STC	53.80	44.57	1500	12.90	13.37	575.00	25	II
FSP-M10.156W-570	STC	53.70	44.36	1500	12.85	13.30	570.00	25	II
FSP-M10.144W-555	STC	50.25	42.27	1500	13.15	13.89	555.00	25	II
FSP-M10.144W-550	STC	50.10	42.13	1500	13.07	13.83	550.00	25	II
FSP-M10.144W-545	STC	49.95	41.96	1500	13.00	13.76	545.00	25	II
FSP-M10.144W-540	STC	49.80	41.82	1500	12.93	13.70	540.00	25	II
FSP-M10.144W-535	STC	49.59	41.66	1500	12.86	13.63	535.00	25	II
FSP-M10.144W-530	STC	49.35	41.45	1500	12.81	13.56	530.00	25	II
FSP-M10.144W-525	STC	49.19	41.30	1500	12.72	13.48	525.00	25	II
FSP-M10.132W-500	STC	45.73	38.73	1500	12.91	13.68	500.00	25	II
FSP-M10.132W-495	STC	45.55	38.55	1500	12.84	13.61	495.00	25	II
FSP-M10.132W-490	STC	45.31	38.31	1500	12.79	13.54	490.00	25	II
FSP-M10.132W-485	STC	45.13	38.19	1500	12.70	13.46	485.00	25	II
FSP-M10.132W-480	STC	45.07	37.97	1500	12.64	13.37	480.00	25	II
FSP-M10.120W-455	STC	41.72	34.88	1500	13.06	13.73	455.00	25	II
FSP-M10.120W-450	STC	41.59	34.72	1500	12.97	13.67	450.00	25	II
FSP-M10.120W-445	STC	41.43	34.53	1500	12.89	13.60	445.00	25	II
FSP-M10.120W-440	STC	41.39	34.38	1500	12.80	13.53	440.00	25	II
FSP-M10.120W-435	STC	41.23	34.17	1500	12.74	13.45	435.00	25	II
FSP-M10.108W-410	STC	37.53	31.64	1500	12.96	13.64	410.00	25	II
FSP-M10.108W-405	STC	37.38	31.49	1500	12.86	13.57	405.00	25	II
FSP-M10.108W-400	STC	37.33	31.32	1500	12.77	13.50	400.00	25	II
FSP-M10.108W-395	STC	37.17	31.05	1500	12.72	13.43	395.00	25	II
FSP-M10.108W-390	STC	36.92	30.93	1500	12.61	13.34	390.00	25	II