



Moser Baer Solar Limited

Doc. No. PV/TF1/ENG/WI/ 035

Rev No. 00, Rev Date:15/06/2011

**Amorphous-Silicon Thin Film
Solar PV Module-Installation Manual
For Full Size MBTF 400 Modules
With Bonded Back Rails**

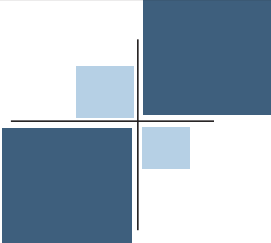


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Index

1.0	Introduction	3
1.1	Disclaimer of Liability	3
2.0	Safety Guidelines	4
2.1	Fire Rating	4
2.2	Inspection	4
3.0	Electrical Characteristics	5
4.0	Electrical Configurations	6
4.1	Electrical Connections	6
4.2	Series Connection	6
4.3	Parallel Connection	6
4.4	Bypass Diodes	7
4.5	Blocking Diodes	7
4.6	Battery	7
5.0	Module Mounting	7
5.1	Mounting Configurations	7
5.2	Site Selection	8
5.3	Module Tilt Angle	9
5.4	Mounting Instructions	10
5.5	Wiring & Connections	13
5.6	Grounding	16
6.0	Maintenance	17





1.0 Introduction

This guide contains safety, installation and application information which you are required to be familiar with, before using your Amorphous-Silicon Thin Film Solar photovoltaic modules supplied by Moser Baer Solar Limited.

Moser Baer Solar Limited offers Thin Film modules based on Amorphous Silicon Single-Junction Technology. The modules are manufactured using Applied Materials' Sunfab technology in a fully automated line. They are available in 3 sizes: Quarter (1300mm x 1100mm), Half (1300 mm x 2200mm) and Full (2600mm x 2200 mm).

These full size MBTF 400 bonded back rail modules are particularly suitable for large, grid connected photovoltaic systems and offer excellent cost benefits. The modules are available with the option of bonded back rails providing flexibility to the installer.

1.1 Disclaimer of Liability

Moser Baer Solar Limited does not assume responsibility and expressly disclaims its liability for any loss, damage, expense or liability whatsoever arising out of, or in any way connected with the installation, operation, use, or maintenance of Amorphous-Silicon Thin Film Solar photovoltaic modules ("Modules") in accordance with this manual. Moser Baer Solar Limited assumes no responsibility and liability for any infringement of patents, copyright or other rights whatsoever of third parties which may result from installation, operation, use or maintenance of Modules. No license is granted by implication or otherwise under any patent, copyright or other intellectual property rights, whether registered or not. The information in this manual does not constitute an expressed and/or implied warranty. Moser Baer Solar Limited reserves the right to make changes to the Modules, specifications, or manual without notice.

2.0 Safety Guidelines



Danger! Modules are a source of Direct Current (DC) Voltage and Current when under load and when exposed to light. Direct current can arc across gaps and may cause injury or death if improper connection or disconnection is made, or if contact is made with module leads that are frayed or torn. Do not connect or disconnect modules when current from the modules or an external source is present. Cover all modules in the PV array with an opaque cloth or material before making or breaking electrical connections.

Important! Read the manual instructions in its entirety before installing, wiring, or using this product in any way. Failure to comply with these instructions will invalidate the Moser Baer Solar Limited Warranty for PV Module.

- All installations must be performed in compliance with the National Electrical Code (NEC) and any applicable local codes.
- The handling, transportation and installation of solar modules require a great degree of skill and should only be performed by trained and authorized personnel.
- There are no user serviceable parts within the module. Do not attempt to repair any part of the module.
- Remove all metallic jewelry prior to installing this product to reduce the chance of accidental exposure to live circuits.
- Use insulated tools and wear Personal Protective Equipment (gloves, insulating shoes etc.) to reduce the risk of electric shock.
- Do not stand on, drop, scratch, or allow objects to fall on modules.
- If the front or back glass is found broken, contact with any module surface or attached parts (i.e., bonded rails) may cause electric shock.
- To avoid the hazard of electric shock, work only under dry conditions, with dry modules and tools. Do not install modules during periods of high wind.

2.1 Fire Rating

Fire rating of the module is class C.

2.2 Inspections

Follow the requirements of applicable local and national electrical safety codes.



3.0 Electrical Characteristics

- The module electrical ratings are measured under Standard Test Conditions (STC) of 1 kW/m² irradiance, AM 1.5 spectrum and a cell temperature of 25° C. These modules are approved for Application Class A. Refer to Figure 1 for a measured I-V curve of a typical full size Thin Film module. The table below provides characteristic electrical data of full size TF modules before and after degradation. The Full size MBTF 400 modules are available from stabilized power of 350W, 360W, 370W, 380W, 390W & 400W.

Electrical Parameters	Units	Bin 350 W	Bin 360 W	Bin 370 W	Bin 380 W	Bin 390 W	Bin 400W
Initial / Stable							
Maximum Power	W	418/350	430/360	442/370	454/380	466/390	478/400
Power Output Tolerance	%	± 3	± 3	± 3	± 3	± 3	± 3
Open Circuit Voltage, Voc	V	187.2/184.2	189.4/186.4	190.1/187.1	190.9/187.8	192.8/189.7	195.0/191.9
Short Circuit Current, Isc	A	3.45/3.29	3.45/3.29	3.44/3.28	3.42/3.27	3.42/3.27	3.44/3.28
Maximum Power Voltage, Vmp	V	141.1/133.6	144.6/136.9	148.0/140.2	151.4/143.4	154.3/146.1	157.0/148.7
Maximum Power Current, Imp	A	2.96/2.62	2.98/2.63	2.99/2.64	3.00/2.65	3.02/2.67	3.04/2.69
Maximum System Voltage	V	1000	1000	1000	1000	1000	1000

“The electrical characteristics are within ± 3 % of the indicated values of Isc, Voc and Pmax under standard test conditions (irradiance of 1000 W/m², AM 1.5 spectrum, and a cell temperature of 25 degree C (77 degree F) ”. The measurement uncertainty is estimated to be about ± 5%.

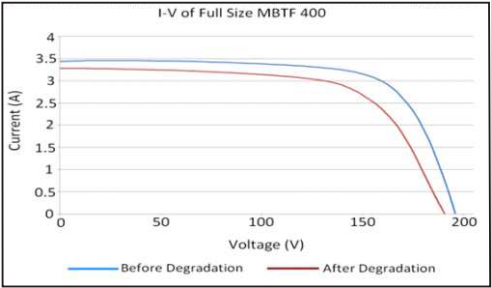


Fig 1: I-V curve of a typical full size MBTF 400 module taken at STC for before and after degradation

Electrical Performance

A photovoltaic module may produce more current and/or voltage than reported at STC. Sunny/cool weather and reflection from snow or water can increase current and power output. It is customary, to multiply the values of I_{sc} and V_{oc} marked on the module by a factor of 1.25, when determining component voltage ratings, conductor ampacities, fuse sizes, and size of controls connected to PV output. An additional 1.25 multiplier may be required by the NEC for sizing fuses and conductors as described in the NEC Section 690-8.

4.0 Electrical Configurations

4.1 Electrical Connections

Modules may be connected in series and/or parallel to achieve the desired electrical output as long as certain conditions are met. Please use modules with approximately the same current ratings when connecting them in series in a string, to minimize module mis-match.

4.2 Series Connection The modules may be wired in series to produce the desired voltage output.

The manufacturer rates the junction box of our modules for 600V, 10 amps for residential applications (one and two family structures), according to UL certification. However, according to IEC certification, the junction box can be used up to 1000 V in commercial applications.

Maximum series fuse is 6 Amps.

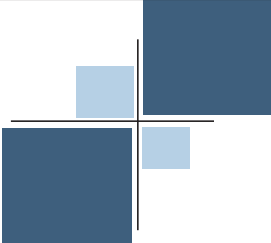
Do not exceed the maximum system voltage indicated in our specifications.

4.3 Parallel Connection

The modules may be combined in parallel to produce the desired current output. Depending upon size of individual string and number of strings in an array, they may be required to be fused. Please refer to the NEC Article 690 for additional fusing requirements.

For modules installed in parallel electrically, each module (or series string of modules so connected) shall be provided with the maximum series fuse as specified.

While making parallel connections in the Junction Boxes, disconnect the series fuses in the Array (String) Junction Box to avoid “arcing”.



4.4 Bypass Diodes

When modules in series strings are shaded partially, they may operate in reverse bias mode (as current from other un-shaded areas is forced to flow through the shaded area) and dissipate power as heat. The use of a bypass diode will minimize both heating and array current losses. Moser Baer Solar Limited Thin Film modules are equipped with a bypass diode of 10 A in the Junction Box when shipped from the factory.

4.5 Blocking Diodes

Blocking Diodes **MUST** be used in every single string of modules (a string is an array of modules connected in series) in reverse bias mode in the Array Junction Box. This is required to prevent reverse currents flows from other parallel circuits into the PV Array strings.

4.6 Battery

When solar modules are used to charge batteries, the battery must be chosen and installed in a manner, so that it matches the rating of the PV system and ensures safety of its users. Please note that the battery is not supplied with the module. Follow the battery manufacturer's guidelines regarding installation, operation and maintenance recommendations. In general, the battery (or battery bank) should be protected from the environment and contact by humans/animals.

Select a battery site that is protected from sunlight, rain, snow, debris, and is well ventilated. Most batteries generate hydrogen gas when charging, which can be 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.

Proper handling of battery should be done, to prevent spillage of electrolyte, and resultant acid burns. Water source should be available next to the battery installation site.

5.0 Module Mounting

5.1 Mounting Guidelines

The module should be mounted such that the cells are vertical, and the Junction Box should be oriented such that the connector outlets of the Junction Box point downward away from the top of the module.

Moser Baer Solar Limited modules should be mounted in locations that meet the following requirements:

Operating Temperature: All Moser Baer Solar Limited modules must be mounted in environments that ensure they will operate within the following operating temperatures:

Maximum Operating Temperature = +70 deg Celsius

Minimum Operating Temperature = -40 deg Celsius

Care should be taken to provide adequate ventilation behind the modules, especially in hot environments.

Design Strength: Moser Baer Solar Limited modules are designed to meet a maximum positive (or upward, e.g. wind) and negative (or downward, e.g. static load) design pressure of 2400 Pa on the front and back. When mounting modules in snow-prone or high-wind environments, special care should be taken to mount the modules in a manner that provides sufficient design strength while meeting local code requirements.

5.2 Site Selection

The solar modules should be mounted in a location where they will receive maximum sunlight throughout the year. Ensuring adequate Sunlight exposure is the responsibility of the end installer. We have provided general guidelines for the user which can be followed.

- In the Northern Hemisphere, the modules should face south, and in the Southern Hemisphere, the modules should face north.
- When choosing a site, avoid trees, buildings or obstructions which could cast shadows on the solar modules especially during the winter months when the arc of the sun is lowest over the horizon.
- PV modules are not to be installed around or near open flames, flammable gases or vapors, constant wetting/moisture (fountains), salt air conditions, or other corrosive chemicals/vapors.
- As a rule, if the system power production is adequate in the winter, it will be satisfactory during the rest of the year.

5.3. Module Tilt Angle

Moser Baer Solar Limited series modules produce the most power when they are pointed directly at the sun. The optimum tilt of the modules is the responsibility of the installer. The section below is to be followed as a general guideline while finalizing the module tilt during installation.

For standalone installations the solar modules should be tilted for optimum winter performance. The solar module tilt angle is measured between the solar modules and the ground. Refer to the recommended module tilt angle table for your site.

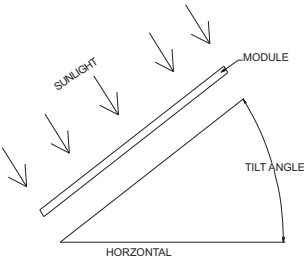


Fig 2: Recommended Tilt Angles for Stand Alone Fixed Systems—Based on Winter Performance

Tilt angle table:

Site Latitude In Degrees	0° to 15°	15° to 25°	25° to 30°	30° to 35°	35° to 40°	40°+
Fixed Tilt Angle	15°	Same As Latitude	Latitude +5°	Latitude +10°	Latitude +15°	Latitude +20°

For grid tie installations where the solar modules are attached to a permanent structure, the solar modules should be tilted at an angle equal to the site's latitude. This will typically result in the highest annual energy output.

“Artificially concentrated sunlight shall not be directed on the module or panel”

5.4 Mounting Instructions



To avoid hazard of electric shock and injury, cover the entire front surface of the PV module with a dense, opaque material, during installation and handling of the modules.

The end installer of the thin film Photovoltaic (PV) modules is responsible for the design and integrity of the mounting structure of the modules.

Moser Baer Solar Limited modules incorporate bonded rails on the back glass, which can be used to mount the panels on an appropriate mounting structure. The bonded rails are made from galvanized steel, and are designed to pass the wind load test. The bonded rails are designed to be 1-2 mm higher than the Junction Box thickness, so that the Junction Box is protected from mechanical impact. Bonded rails attach to ground support rails provided by the installer. Please note that the mounting structure materials should be compatible with the PV module rails, so that galvanic corrosion does not occur to either PV rail or mounting structure.

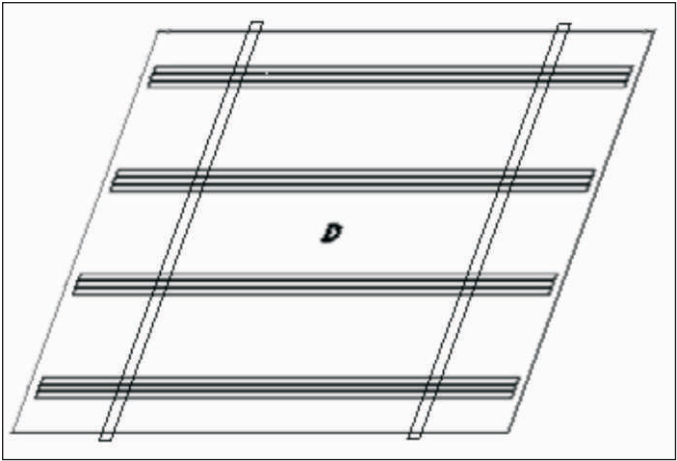


Fig 3: Ground Support rail mated with the Bonded Rails.

The key dimensions of the modules with Bonded Rails are shown in Figure 4 below, to help a structural engineer design the supporting structure. Note all dimensions are in millimeters unless otherwise specified.

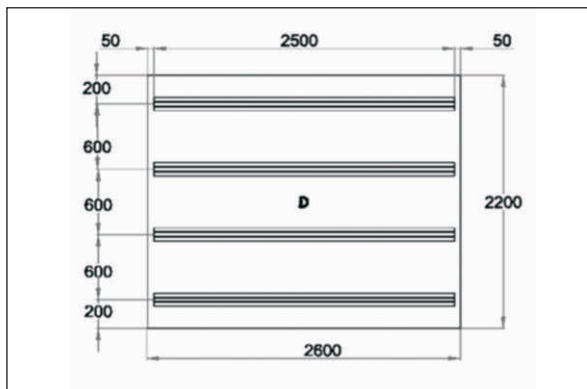
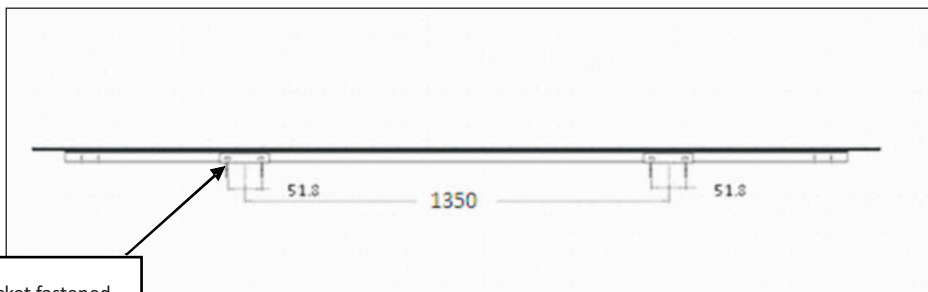


Fig 4: Rail positioning at the back of a full size panel

Modules are available with Rivets or clamps for attaching the bonded rail to the ground support structure. In case of clamps, as shown in figure 5, one part of the attachment bracket can be attached to the rail with #10 x 1/2" sheet metal screws. The brackets have a U-shape design (refer to figure 6) that connects with the structure and can hold a supporting rail up to a width of 50.8mm. To fasten the bracket to the ground mounting structure, holes are provided in the attachment bracket. These holes have a diameter of 10mm, and are designed for bolts of size M8 x 65mm.



Bracket fastened
by four #10 sheet
metal screws

Fig 5: Attachment brackets screwed to Rails

Hole of Dia. 10 mm,
designed for Bolt of
size M8 x 65mm

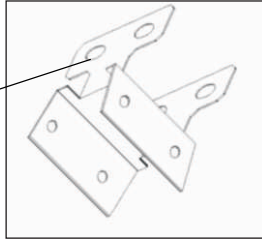
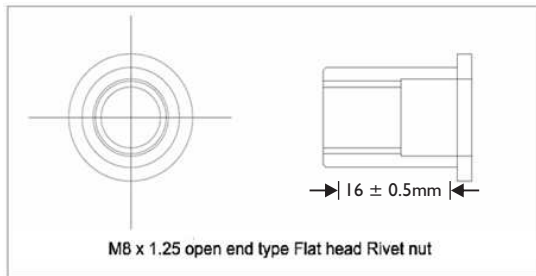
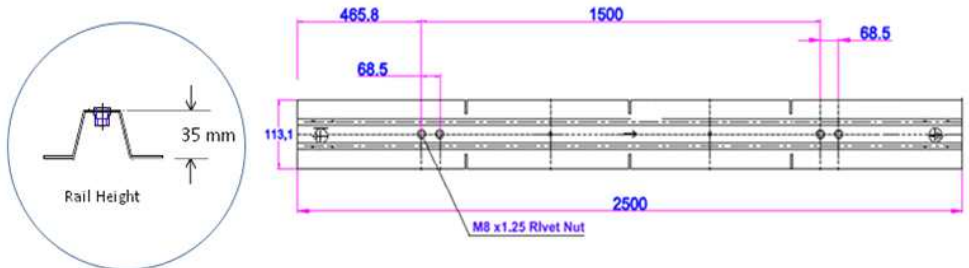


Fig 6: Three-Dimensional view of Attachment Brackets

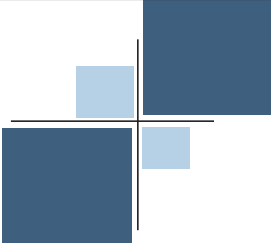
In case of rail with rivets, rivets of standard M8 are used for attaching the bonded rail to the ground support structure



In case of rail with rivets, the position of the rivet nut is shown below



Positioning of the rivet nut on rail



While installing the modules, the following points should be kept in mind:

- Thin Film full size modules do not have a frame; hence the handling of these modules is critical.
- Un-loading, un-packing and storage at site must be done carefully and by trained personnel only.
- The structure should be designed in such a way that the module doesn't experience any kind of mechanical stress after installation. Modules should not be stressed due to misalignment of holes for fasteners. It should be capable of supporting the weight of the PV modules and snow loading (if applicable to the site). It should also be able to withstand seismic loading in the corresponding applicable seismic areas.
- The members of the structures which would be holding the rails shall be absolutely straight so that the rail clamps/brackets fit in /slide in smoothly without causing any tension to the Module.
- An air gap of atleast 25-30 mm gap must be provided between the two adjacent modules for passage of the air to reduce the wind pressure on the module. This checks the buckling in the Modules as well as reduces the wind loading of the module mounting structure at vulnerable points of reaction.
- While installing, modules MUST be covered with opaque cloth to avoid any sunshine falling onto the modules to prevent any electrical shock. Exposure to sunlight instantly energizes the modules and poses a shock risk.
- Grounding should be done as per instructions given.
- The modules shall be mounted so that the junction box shall be in the uppermost position to minimize the ingress of water.

Mounting of solar modules can be done in the following ways - direct, integral or above the roof. A clearance of 200 mm from the roof should be provided for better air circulation between the modules and the roof.

For a non-integral mounting, the module is to be mounted over a fire resistant roof covering rated for the application. DIN 4102 or Equivalent Passive Fire Protection (PFP) could be used for roofs. For example materials like perlite, vermiculite, calcium silicate, gypsum, intumescent epoxy are best used for the purpose.

5.5 Wiring & Connections

Selection of wires and cables to be used in a PV system is a very important design activity to get maximum utilization of generated power output. All wiring should be done in accordance with the applicable local electrical codes and be performed by a qualified and certified professional.

The Moser Baer Solar Limited modules have sealed Junction Boxes to protect the connections. The modules use Junction Boxes made by Multi-Contact, with part No. PV-JB/SM-D.

Series	(ZKLA)Wire types	Wire size (AWG)	Number of Strands	Type of Connector	Outer Cable Diameter Range
PV-KST4/6II-UR	PV Wire	12	7 - 52	Male	6.05 – 7.0 mm
PV-KBT4/6II-UR	PV Wire	12	7 - 52	Female	6.05 – 7.0 mm

Field Junction boxes should conform to IP 65 specifications, which are suitable for wet locations. The over current protection has to be taken into account while deciding a wire / cable size. Normally the current in a circuit is multiplied by a factor of 1.25 for arriving at the actual size of the copper conductor.

Wiring Instructions:

1. When connecting modules in strings always install a suitable Blocking Diode at the end of each string to decouple the strings. The voltage rating of Blocking Diode should be 20% higher than the total voltage produced by the numbers of modules in the string.
2. Use of PV-Wire as per UL 4703 for wet and dry locations is recommended as it is UL certified. The Wires and Cables must conform to NEC guidelines.
3. Wires and Cables should have Flexible Multi-strand Copper conductor of 1000 Volts Grade.
4. Wires and cables should have inner PVC Sheath insulation and Outer Sheath FRLS insulation. They should be UV Resistant for outdoor usage and have General purpose PVC insulation for underground laying of cables. Guidelines for thickness of insulation may be referred from NEC.
5. Use cable trays for cable routing from String Junction Box to other junction boxes for paralleling the connections and upto the inverters.
6. Use Fire Resistant Cables for outdoors.
7. Follow NEC procedures for cabling work.
8. While making parallel connections in the Junction Boxes, disconnect the series fuses in the Array (String) Junction Box to avoid "arcing".
9. Please note that both the connectors and cables should be made of sunlight-resistant material.
10. The integral output connector should only be used where they will not interrupt current.

Please note that if any parts or tools are used, which have not been recommended by Multi-Contact, then neither safety nor compliance with the technical data can be guaranteed.

A switch or circuit breaker should be installed to isolate the PV array during maintenance and assembly/disassembly operations. This same recommendation applies to the battery circuit, so another switch or circuit breaker is required.

The following sequence should be followed for disconnecting the load.

- i) Switch OFF the Load Breaker in the Distribution Box.
- ii) Switch OFF the Inverter
- iii) Switch OFF the PV Array Breaker
- iv) Switch OFF the Battery Breaker if battery back-up system exists.
- v) Disconnect the string fuses of the PV Array if some work is to be carried out in the string.

Fuses are generally used to protect any current carrying conductor. Fuses and cables in the array circuit are typically sized for the maximum current along with the appropriate multiplication factors. Series Fuse rating of 6 Amps per string are recommended. Only fuses rated for DC current should be used.

5.6 Grounding

A ground conductor should be attached to a grounding lay-in lug mounted at one of the four designated grounding holes on the module frame. A grounding lug, IlSCO GBL-4DB tin plated to be used, with M5 stainless steel hardware (screw, lock washer, and washer). The assembly must be torqued to 6.1 Nm. Please refer to NEC Article 690 on grounding PV arrays for specific requirements. The grounding method of the rails of arrays shall comply with the NEC, article 250. The Grounding is achieved through securement to the array frame. The array frame shall be grounded in accordance with NEC Article 250.

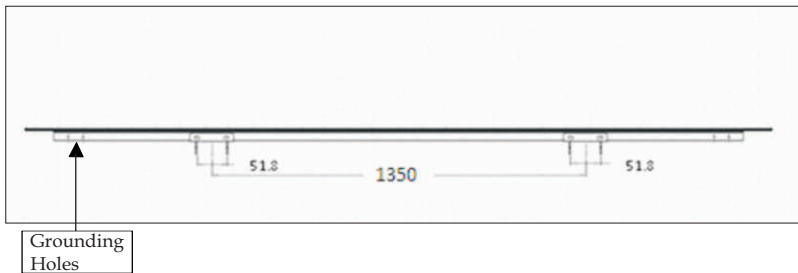


Fig 9a : Module Grounding in Rails with clamps



Fig 9b : Module Grounding in Rails with rivets

The module is to be grounded by 2 grounding lugs (1 per rail) at the location shown above (holes provided).

Moser Baer Solar Limited recommends grounding the negative pole of the PV inverter / generator for it's a-Si thin film PV modules. This is needed to reliably protect the TCO layer against corrosion, thereby preventing any loss in module performance and assuring consistent output.

5.7 Tools / Materials

Thin Film Solar Module 2600 mm X 2200 mm

Rail Clamp

Ilscs GBL-4DB (with tin plating)

Sheet metal screws # 10 x 1/2" with zinc plating

M5 Lock Washer stainless steel

M5 Washer stainless steel

M5 x 0.8 x 16 mm socket head screw stainless steel

M8 Lock Washer stainless steel

M8 Washer stainless steel

M8 x 1.25 x 65 mm socket head screw stainless steel

Socket sets

Wrenches

Crimping tool (Assembly tool - Crimping tool model PV-CZM-18100 for 12-14 AWG wire (1.5/2.5/4 mm²), PV-CZM-19100 for 12-10 AWG wire (2.5/4/6 mm²).

Cable glands nut may use open-ended spanner, model PV-MS.

6.0 Maintenance

Maintenance is recommended to maintain optimal performance of the solar modules. Inspect all modules annually for safe electrical connections, mechanical integrity and any signs of corrosion. It is recommended to have an authorized professional to carry out the inspection or maintenance to avoid hazard of electric shock and injury.

If some maintenance work is required to be done, the sequence of actions given above for disconnecting the load has to be followed.

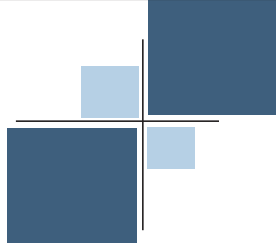
Periodically, the module surface should be cleaned with water and a soft cloth or sponge. Fingerprints on the module surface may be removed with standard glass cleaner. Do not use harsh cleaning materials such as scouring powder, steel wool, scrapers, blades, or other sharp instruments to clean the glass surface of the module. Usage of such materials will invalidate the product warranty.

The following recommendations shall be followed for cleaning of thin film modules:

1. Cleaning of the modules must be performed regularly. The modules may require frequent cleaning when installed in hot desert or dusty environment.
2. Best suitable ambient temperatures for cleaning our Thin Film Modules is be 25 deg Celsius.
3. Modules must be cleaned in between 6 pm to 8 am.
4. Initial module cleaning shall be done with wet linen and then followed with water.

Do :

- All installations must be performed in compliance with the National Electrical Code (NEC) and / or any applicable local codes.
- The handling, transportation and installation of solar modules require a great degree of skill and should only be performed by trained and authorized personnel. Un-loading, un-packing and storage at site must be done carefully and by trained personnel only.
- Remove all metallic jewelry worn on your body such as chains , rings , watches and coins from the pockets prior to installing this product to reduce the chance of accidental exposure to live circuits.
- Use insulated tools and wear Personal Protective Equipment (gloves, insulating shoes etc.) to reduce the risk of electric shock.
- When choosing a site, avoid trees, buildings or obstructions which could cast shadows on the solar modules especially during the winter months when the arc of the sun is lowest over the horizon.
- To avoid the hazard of electric shock, work only under dry conditions, with dry modules and tools.
- An air gap of atleast 25-30 mm gap must be provided between the two adjacent modules for passage of the air to reduce the wind pressure on the module. This checks the buckling in the



Modules as well as reduces the wind loading of the module mounting structure at vulnerable points of reaction.

- Grounding should be done as per instructions given. Mounting of solar modules can be done in the following ways - direct, integral or above the roof.
- For a non-integral mounting, the module is to be mounted over a fire resistant roof covering. DIN 4102 or Equivalent Passive Fire Protection (PFP) could be used for roofs. For example materials like perlite, vermiculite, calcium silicate, gypsum, intumescent epoxy are best used for the purpose.
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- Modules must be cleaned in between 6 pm to 8 am.
- Initial module cleaning should be done with wet linen and then followed with water.

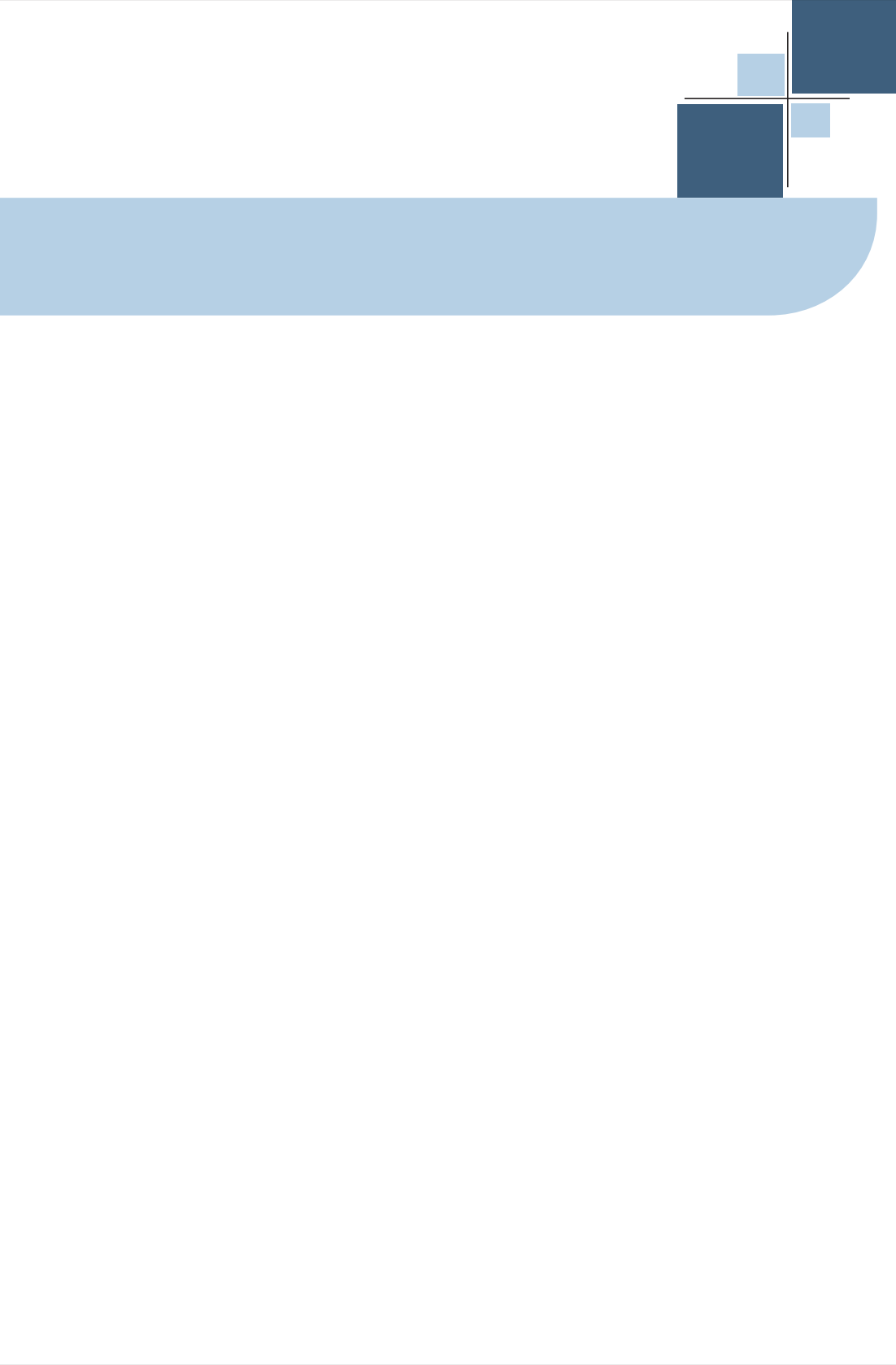
Don't :

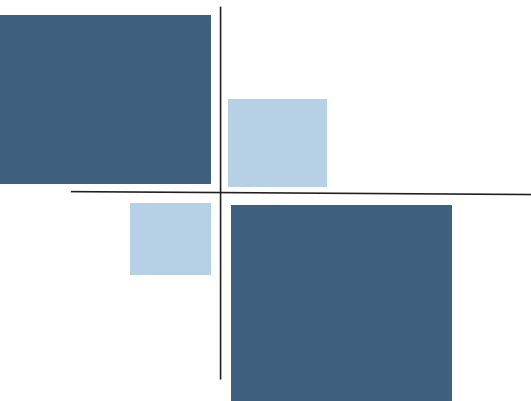
- There are no user serviceable parts within the module. Do not attempt to repair any part of the module.
- Do not stand on, drop, scratch, or allow objects to fall on modules.
- Do not use knife and / or sharp objects to tamper with module surfaces , junction box area and module edges.
- Do not install modules during periods of high wind.
- Do not use harsh cleaning materials such as scouring powder, steel wool, scrapers, blades, or other sharp instruments to clean the glass surface of the module.
- Do not clean the module during high ambient temperatures.
- Please never ever use connectors of improper ratings.
- Please do not use fuses other than the specified ratings
- Please do not keep connector connections loose.



Caution to be taken during unloading of modules:

- ✓ Please do not handle manually
- ✓ Weight of each full size module without rails is 100 Kgs
- ✓ It is advisable to have an equipment with suction cups to hold the module and unload from the crate
- ✓ After removal of modules, place them in such a way avoiding rubbing with another module/steel rails. Rubbing will lead to scratches and can damage modules





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