

INSTALLATION MANUAL



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CONTENTS

INTRODUCTION	3
DISCLAIMER OF LIABILITY	3
GENERAL INFORMATION.....	3
GUIDELINES & PRECAUTIONS FOR UNPACKING, HANDLING & STORAGE OF PV MODULE	5
CLIMATIC CONDITIONS.....	6
NOTES ON INSTALLATION	6
SPECIFICATIONS.....	7
SOLAR PV MODULE MOUNTING GUIDELINES.....	7
GROUNDING.....	10
ELECTRIC WIRING	11
CABLE PROTECTION.....	12
DIODES.....	12
MAINTENANCE SAFETY	13
GENERAL SAFETY	13
GUIDELINES & PRECAUTIONS FOR CLEANING OF PV MODULE	14



INTRODUCTION

This manual contains information regarding installation, operation, maintenance and safe handling of WAAREE Photo Voltaic (PV) Modules. Before installation or using the PV Modules, it is important to read this manual and understand the instructions carefully.

DISCLAIMER OF LIABILITY

Since the use of this Installation, Operation and Maintenance Manual and the conditions of installation, operation, use and maintenance of the Module are beyond WAAREE's control; WAAREE 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.

WAAREE 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. WAAREE reserves the right to make changes to the product, specifications or this manual without prior notice.

GENERAL INFORMATION

The installation of solar PV Modules requires great degree of skills, it should only be performed by a qualified and licensed professional, including, without limitation, licensed contractors and licensed electricians. The installer assumes the risk of all injury that might occur during installation, including without limitation, the risk of electric shock.



For your safety and the safety of others, please read the entire Installation, Operation and Maintenance Manual carefully prior to installing, wiring, operating and performing maintenance of PV modules. Also, carefully read the Module Data Sheet provided with this product. Determine local permits, installation and inspection requirements before installing module(s). If not otherwise specified, it is recommended that the requirements of the National Electric Code (NEC) be followed.



The photovoltaic Module produces electricity when exposed to the sunlight, even at low light levels or when other sources illuminate the front face. The voltage of a single Module is less than 50 V DC. However, the voltage increases as Modules are connected in series and the available current increases as the Modules are connected in parallel. Thus, for a Module connected within a system, contact with electrically active parts of the Module such as terminals can result in lethal shock, sparks and burns. The only way to eliminate this hazard is to prevent exposure of the Module(s) to light.



To avoid the hazard of electric shock and injury when installing, wiring, operating and maintaining the PV modules, below guidelines shall be strictly followed.

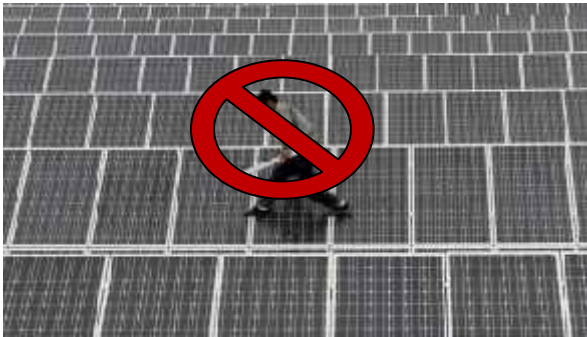
- Cover the entire front surface of the PV Module with a dense, opaque material such as cardboard box, during installation and handling of the Modules.
- Do not expose Back sheet directly to sunlight.
- Work only under dry conditions, with dry Modules and Insulated tools.
- Be sure to completely ground all Modules.
- Since sparks may occur, do not install the Module where flammable gases or vapors are present.
- Module installation and operation should be performed by qualified personnel only. Children and unauthorized persons should not be allowed near the installation of PV Modules.
- Use Module for its intended function only.
- Be sure that all other system components are compatible, and they do not subject the Module to mechanical or electrical hazards.
- Do not touch terminals while Module is exposed to light or during installation. As a precaution use properly insulated tools only.
- Do not damage or scratch the back sheet of the Module.
- Do not use the junction box to hold or transport the Module.
- Do not drop Module or allow objects to fall on the Module.
- Do not stand or step on the Module.
- Do not disassemble, modify or adapt the Module or remove any part or labeling installed/ pasted by the manufacturer.
- When carrying a Module, two or more people should carry it by its frame wearing non-slip gloves (to avoid injury by a slipped Module, or by the edge of frame, and so on).
- Only PV Modules with the same cell type and size should be connected in series.
- Avoid uneven shade on the PV Module surface. Shaded cells may become hot (hot spot phenomenon) which may result in permanent damage to the Module.
- Do not drill holes in the frame or glass of the Module, it may compromise the frame strength and cause corrosion of the frame and also voids the warranty.
- Do not treat back sheet and front surface of the Module with paint and adhesives.
- Do not artificially concentrate light on the Module.
- Do not wear metallic jewelry while installing or trouble shooting the Module.



- Do not change the wiring of bypass diodes.



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 WAAREE's warranty.



GUIDELINES & PRECAUTIONS FOR UNPACKING, HANDLING & STORAGE OF PV MODULE

- The handling of Modules requires great diligence. Therefore, caution is required while unpacking, transporting and temporarily storing these Modules.
- Unpack Module pallet with extreme care. Be careful while unpacking, transporting and storing the Modules. Avoid Module mishandling during unloading.
- Do not stack more than the maximum amount of allowable pallets on top of each other.
- At the installation site, take care to keep Modules and particularly their electrical contacts clean.
- 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.



- Broken or damaged Modules must be handled carefully and disposed off 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.

CLIMATIC CONDITIONS

- The relative humidity shall be below 85 %.
- WAAREE Modules are rated for Mechanical load 5400 Pa on the front and 2400 Pa on the rear.
- Operating Temperature of Modules shall be within -40°C to 85°C with ambient temperature -20°C to 50°C

Note: - Rated electrical characteristics are within 10% of the values measured at Standard Test Conditions (STC) of 1000W/m² irradiance, 25°C cell temperature and AM 1.5.

- Under normal conditions, a photovoltaic Module may experience conditions that produce more current and voltage than reported at standard component test conditions. Accordingly, the values of Isc and Voc marked on UL listed Modules should be multiplied by a factor of 1.25 when determining voltage ratings, conductor capacities, fuse sizes, and size of controls connected to the Module output.

NOTES ON INSTALLATION

- Please read this guide completely before installation or use of the Modules.
- 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 9:00A.M. to 3:00P.M. on the shortest day of the year. Calculate the tilt angle by using the site latitude, with Modules facing south in the northern latitudes and north in the southern latitudes. This will result in consistent energy output throughout the year.
- A minimum slope of 5 in/ft. for installation over a roof is required to maintain the fire class 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.
- Modules should be firmly fixed in place in a manner suitable to withstand all expected loads, including wind and snow loads. Module mounting holes are provided for easy installation and proper mechanical loading.
- The Modules shall be mounted so that the junction box remains in the uppermost position to minimize the ingress of moisture/water.
- Appropriate material should be used for mounting hardware to prevent the Module frame, mounting structure etc. from corrosion.
- Install Modules where they are not shaded by obstacles like buildings and trees. Especially pay attention to avoid partial shading of Modules by obstacles during the daytime.



- Clearance between the Module frame and the mounting surface is required to allow cooling air to circulate around the back of the Module. This also allows any condensation or moisture to dissipate. The Module should never be sealed to the mounting surface with sealant that prevents air from circulating under the Module. For roof mounted systems, provide adequate rear ventilation (100mm: 4inch gap minimum) for cooling of Modules.
- Please contact WAAREE'S authorized representative for any questions regarding mounting profiles for Modules.

SPECIFICATIONS

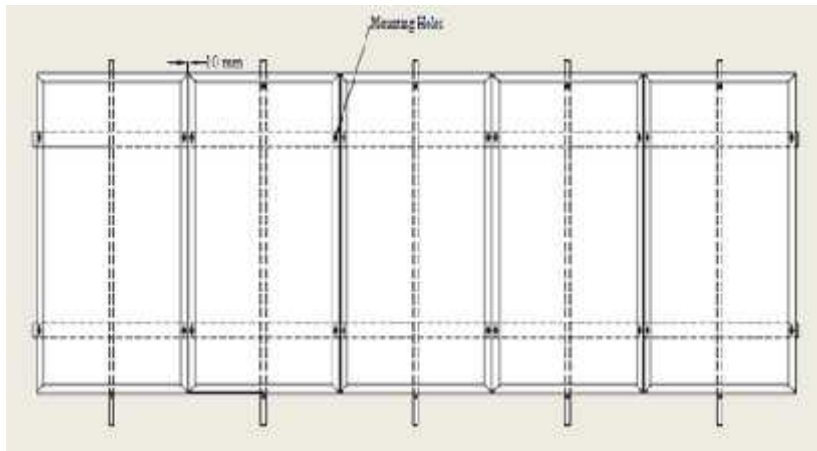
- Please refer latest Module datasheet for Specifications.

SOLAR PV MODULE MOUNTING GUIDELINES

General Mounting Guidelines:

- The Module should be facing true south in northern hemisphere and true north in southern hemisphere for maximum power production.
- We recommend leaving a space of at least 10 mm between two Modules considering linear thermal expansion of the Module frames.
- Since sparks may occur, do not install the Module where flammable gases or vapors are present.
- During installation all local and national electrical and building codes and regulations shall be strictly observed.
- Avoid using a mounting method that will block the drainage holes in the Module frame.
- Do not install SPV Modules in a location where they will be immersed in or continually exposed to water.
- Site-specific loads such as wind and snow need to be taken into consideration to ensure that the pressure of such a load does not exceed the specified maximum load.
- Always abide by the instructions and safety precautions included with the Module. The mounting structure and all hardware like bolts, nuts and washers should be of stainless steel so as to eliminate the possibility of rust.
- When installing a free standing ground mounted system, be sure to select the appropriate height of the support Module mounting structure. It is also important to select the appropriate height of the mounting system to prevent the lowest edge of the Module from being covered by snow for a long time in areas that experience heavy snowfall.



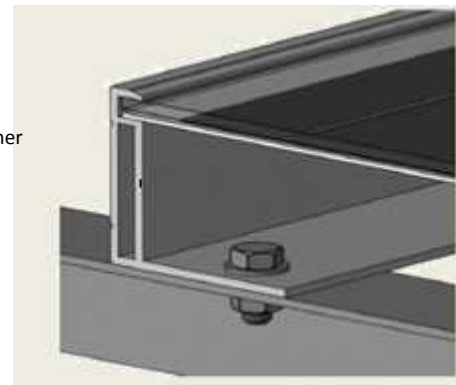
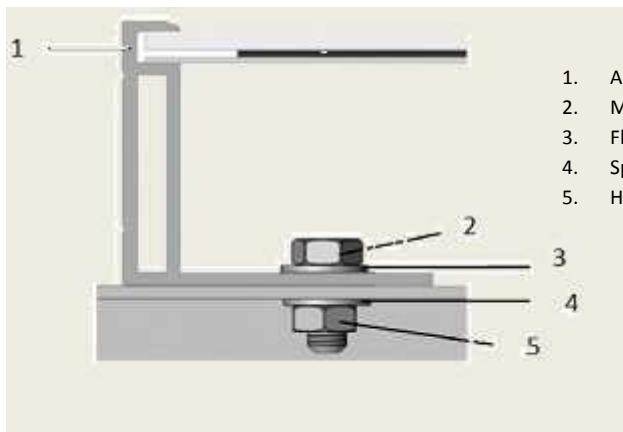


A Sample drawing is shown for installation of Module

(a) Mounting guidelines for Bolting of Modules:-

Modules must be mounted on mounting holes located at rear side with the M6 stainless steel nut, bolt and washer. It is recommended to use stainless steel fixing only. Module mounting must use the pre-drilled mounting holes in the frame. Always select the length of mounting screw after considering a clearance of 5-10 mm between the Module back face & screw face to avoid any breakage of Module while tightening.

Note: - **Do not drill additional mounting holes on the frame & glass surface of the Module.**
Doing so will void the warranty.



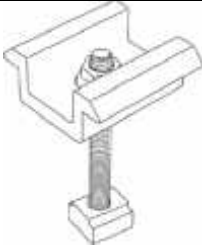
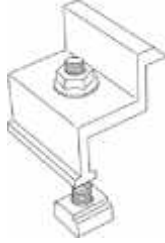
(b) Mounting guidelines for Clamping of Modules:-

Each Module must be securely fixed to the mounting structure at a minimum of four points. The Module clamps shall not come into contact with the front glass and must not deform the frame. Be sure to avoid shadowing effects from the Module clamps. The Module frame is not to be modified under any circumstances. When choosing this type of clamp-mounting method, please be sure to use at least four clamps on each Module, two clamps should be attached on each long sides and 2 clamps on each short side of the Module. Depending on the local wind and snow loads, if excessive pressure load is expected, additional clamps or support would be required to ensure that the Module can bear the load. The applied

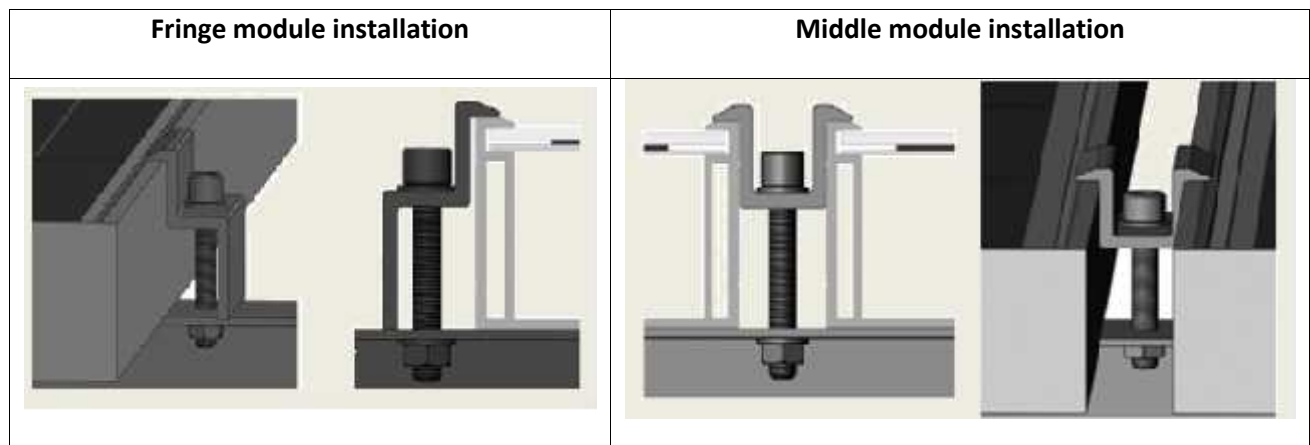


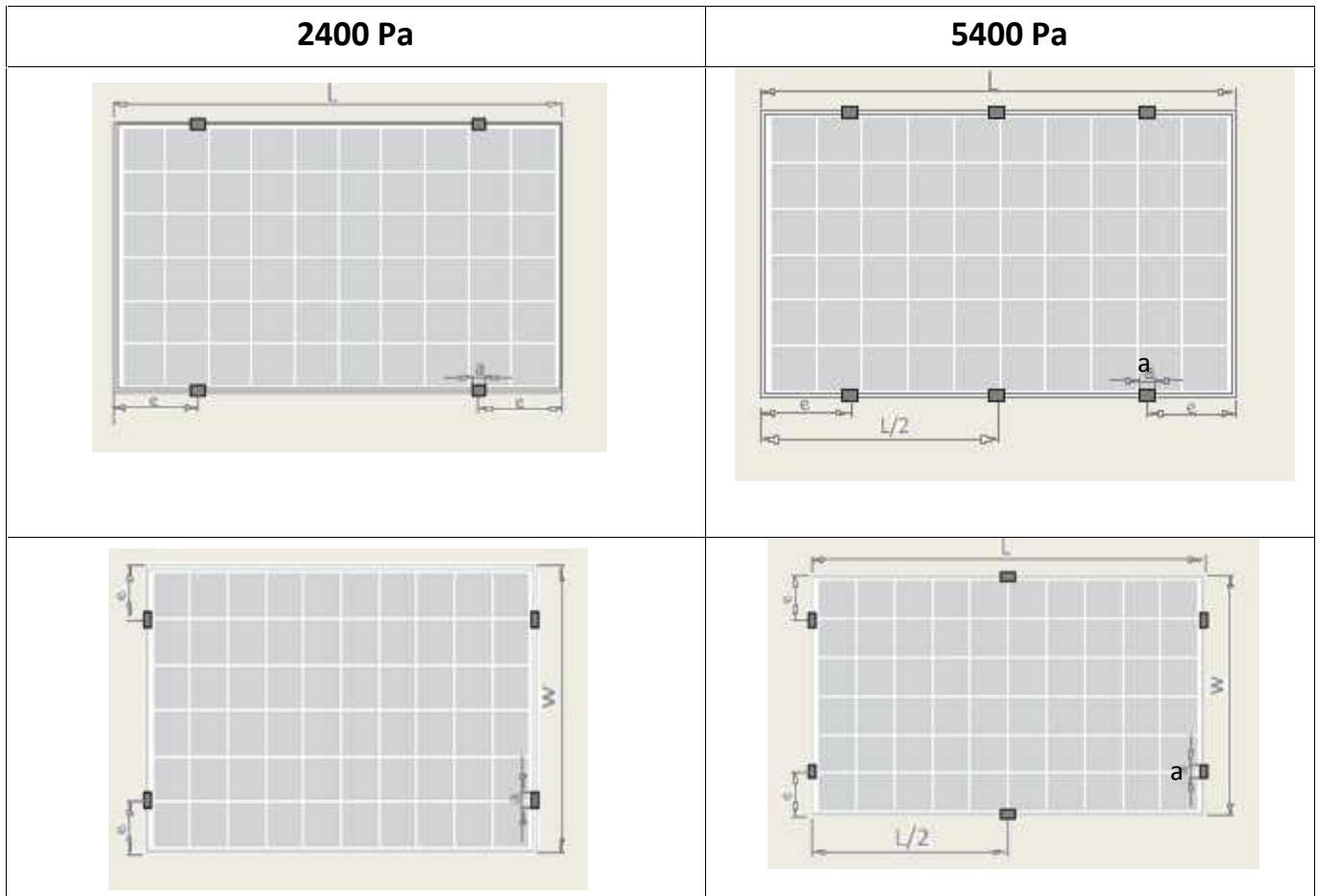
torque shall be big enough to fix it steadily. For safety, it is better to follow the clamp manufacturer's recommendations.

Clamp types:-

<p>Mid clamps: - They hold each neighbouring panel on the purlin.</p>	
<p>End clamps: They hold the panel at fringes at their position.</p>	

INSTALLATION DIAGRAM:-





Note: - The clamp position must be in range $L/8 \leq e \leq L/4$, $a \geq 6\text{cm}$

GROUNDING

All Module frames and mounting racks must be properly grounded in accordance with respective national electrical code. The earth grounding connection shall be done by a qualified electrician. The longer sides of the Module frames are equipped with predrilled Earthing holes in their centre. These holes shall be used only for grounding purposes and not for mounting purpose. The grounding wire must be properly fastened to the Module frame to assure good electrical contact. Use the recommended type or an equivalent connector for this wire.

Module frames should be connected to an earth ground for safety and protection from lightning. A good connection between the grounding hardware is essential for an effective ground. The anodization on a Module frame provides a coating to minimize the corrosion due to weather and it acts as a barrier that reduces the effectiveness of the grounding connection. For an adequate ground, the grounding hardware should pierce the anodization layer. WAAREE Modules are provided with earthing hole and same must be used for the purpose.



Proper grounding is achieved by bonding the Module frame(s) and all metallic structural members together continuously using a suitable grounding conductor. The grounding conductor or strap may be copper, copper alloy, or any other material acceptable for use as an electrical conductor. The devices have to be installed in accordance with the grounding device manufacturer's specified instructions. The grounding must be cross verified for its proper continuity.

Note: - "Please avoid negative bias of the cells with respect to the grounded frames".

ELECTRIC WIRING

- All wiring should be done in accordance with applicable electrical codes.
- All wiring should be done by a qualified, licensed professional. Wiring should be protected to help ensure personal safety and to prevent its damage.
- Modules can be wired in series to increase voltage. Connect wires from positive terminal of one Module to the negative terminal of the next Module. All Modules connected in series should be of the same model number and/or type.
- Connect Modules in parallel to increase current. Connect wires from the positive terminal of the one Module to the positive terminal of the next Module. Do not connect Modules in parallel without using a connection box.
- WAAREE Modules contain factory installed bypass diodes. If the Modules are incorrectly connected to each other, the bypass diodes, cables, or junction box may be damaged.
- The term "array" is used to describe the assembly of several Modules on a support structure with associated wiring. Use wire that is sunlight resistant and is insulated to withstand the maximum possible system open circuit voltage. Check your local codes for requirements.
- Use system wiring with suitable cross-sectional areas and connectors that are approved for use at the maximum short-circuit current of the Module.
- The maximum open circuit voltage of the system must not be greater than the specified maximum system voltage for the Module. The Module open-circuit voltage (Voc) increases with decrease in temperature and therefore allowable maximum system voltage must take into account the lowest temperature that is attainable in the area where the Module is intended to be used.
- When reverse currents can exceed the value of the maximum protective fuse, a properly rated and certified over current device (fuse or circuit breaker) must be connected in series with each Module or string of Modules.
- Match the polarities of cables and terminals when making the connections; failure to do so may result in damage to the Module.
- Connecting Modules in reverse polarity to a high current source, such as a battery, will destroy the bypass diodes and render the Module inoperative. Bypass diodes are not user replaceable.
- The junction box, cable and connectors shall not be altered in any case. Modules with a suspected electrical problem should be returned to WAAREE for inspection and possible repair or replacement as per the warranty policy shall be provided by WAAREE.



CABLE PROTECTION

- The values of short-circuit current and open-circuit voltage marked on this Module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current carrying capacity, fuse sizes and size of controls connected to the PV output.
- Secure the cables to the mounting system using UV-resistant cable ties.
- Protect exposed cables from damage with appropriate precautions (e.g. locate them within plastic conduit).
- Avoid exposure to the direct sunlight.
- Ensure that the cables will be away from areas where water can form puddles.
- When disconnecting wires under load, an electric arc may result. Such arcs may start fires and may otherwise create problems. To disconnect the PV system while under load, turn off the inverter first and then switch on the DC-circuit breaker.

DIODES

- **BYPASS DIODES**

When the Modules are shaded partially, it may cause reverse voltage across cells or Modules, because the current from other cells in the same series is forced to flow through the shaded area. This may cause undesirable heating to occur. When a bypass diode is wired in parallel with the series string, the forced current will flow through the diode and bypass the shaded Module, thereby minimizing Module heating and array current losses. The use of a diode to bypass the shaded area can minimize both heating and array current reduction.

Note: - All WAAREE Modules are equipped with factory installed bypass diodes. The factory installed diodes provide proper circuit protection for the systems within the specified system voltage, so that you do not need any other additional bypass diodes. If your system specifications require you to add or change diodes, please contact authorized WAAREE representative for recommendations for the proper diode type.

- **BLOCKING DIODES**

Blocking diodes are typically placed between the battery and the PV Module output to prevent battery discharge at night. WAAREE Modules do not contain a blocking diode when shipped from the factory. It is recommended that a charge controller be used to prevent the batteries from being overcharged and discharged at night.

Note: - The non-use of blocking diode or any reverse current protection in battery operated system will void all applicable warranties.



MAINTENANCE SAFETY

Safety instructions must be followed during maintenance of PV Modules. Any Maintenance work must be performed by a certified installer/servicer to ensure system integrity and safety.

- Do not pull the PV cables. Do not place/drop objects onto the PV Modules.
- Do not damage, pull, bend or place heavy material on Junction box, cables & connectors.
- Upon completion of any service or repairs, ask the installer/servicer to perform routine checks to determine that the PV Modules are in safe and proper operating condition.
- Do not stand or step on the Module.
- Do not disassemble, modify or adapt the Module or remove any part or labeling installed/ pasted by the manufacturer.
- Do not drill holes in the frame; do not treat back sheet and front surface of the Module with paint and adhesives.
- Do not artificially concentrate light on the Module.

GENERAL SAFETY

- Follow all permission, installation and inspection requirements.
- Before installing Modules, contact the appropriate authorities to determine permissions, installation, and inspection requirements which shall be followed.
- Electrically ground Modules for all systems of any voltage.
- If not otherwise specified, it is recommended that requirements of the latest National Electrical Code or other national or international electrical standards be used.
- Be sure that the construction or structure (roof, facade, etc.) where the Modules are being installed has enough strength. For Modules mounted on roofs, special construction or structures may be required to help provide proper installation. Both roof construction and Module installation design affects the fire resistance of a building. Improper installation may contribute to fire hazards. Additional devices such as ground fault detector, fuses, and disconnects may be required.
- Do not use Modules of different specifications in the same system.
- Only PV Modules with the same cell size should be connected in series.
- Follow all safety precautions of other system components used.
- Wiring and grounding method of the frame of arrays shall comply with national, regional and local codes, laws and standards.
- PV Modules shall be installed and maintained by qualified personnel, only installation/service personnel should have access to the PV Module installation site.
- Keep children away from PV Modules.
- Prior to installation, do not store Modules outdoors or in a damp environment.
- When PV Modules are installed on roofs or any other structures above ground, appropriate safety practices should be followed and appropriate safety equipment should be used in order to avoid possible safety hazards. Note that the installation of PV Modules on some roof types may require the addition of fireproofing, as required by local building/fire codes.
- Follow all safety precautions of other components used in the system.



- In order to avoid risk of injury or electrical shock, do not allow anyone (unqualified or having limited knowledge of PV Modules) to handle damaged PV Modules. Place defective PV Modules in cartons so that no light falls on PV cell.
- Avoid uneven shade on the PV Module surface. Shaded cells may become hot (“hot spot” phenomenon) which may result in permanent damage to the Module.
- Never expose PV Modules to sunlight concentrated with mirrors, lenses or other means.
- The maximum open circuit voltage of an array must not be greater than the specified maximum system voltage. Voltage is directly proportional to the number of PV Modules in series and is affected by weather conditions.

GUIDELINES & PRECAUTIONS FOR CLEANING OF PV MODULE

- It is common for dust and dirt particles to accumulate on the surface of the Module. This can reduce the optimal output performance of the solar Modules. Normally, the accumulated dust can be washed with water, but in some instances some maintenance is recommended to clean the surface of the glass with water and a soft cloth or sponge to remove layer of dirt. A mild non-abrasive detergent may be applied to remove persistent dirt.
- PV Module Cleaning should be done only by properly trained personnel who understand the risks of applying water to electrical components.
- It is advisable to perform periodic inspection of the Modules for damage to glass, backsheet, frame, junction box or external electrical / loose connections and corrosion by the authorized professional.
- No aggressive and abrasive cleansers or chemicals should ever be used on the coated front glass. No alkali-based chemicals should be used, including ammonia based solutions.
- Always wear rubber gloves for electrical insulation while maintaining, washing or cleaning Modules. Appropriate electrically insulating Personal Protective Equipment (PPE) must be worn during any cleaning or inspection operations.
- Acceptable Module cleaning methods are to spray the Modules with low-pressure water closely matched in temperature to the Module or to use a dry brushing technique. Do not apply water that is more than 20°C warmer or colder than Module surface temperature as during the generation time the temperature of Module is higher and washing may cause thermal stress in Module.
- Always make sure that Cleaning should not be done during Generation time, the recommended time to clean Modules is from dusk to dawn when production is not affected and risk of electrical shock hazard is minimized.
- For cleaning of Modules Fresh water (TDS < 1500 mg/l) may be used. If needed, a mild, non-abrasive, non-caustic detergent with a final fresh water and detergent solution mix between 6.5 < pH < 8.5 at 25°C may be used.
- When using water, RO water provides the best results. In absence of RO water, tap water with low mineral content (total hardness <75 mg/l) or deionized water may be used. Calcium should not exceed: 75 mg/ml. Do not use solutions containing hydrochloric acid, D-Limonene, ammonia or sodium hydroxide.
- Clean the Module either with a soft sponge or a soft rubber wiper. Do not use abrasive cleaners or degreasers on the Module. Do not scrub the Module with abrasive brushes. Such brush fibers may scratch the glass, reducing the power output of the panel.



- In case if soft water (with low mineral content) is not available, Module can be dry cleaned with the help of a soft cloth or with soft sponge to remove dirt, dust. One can also use wet cloth, sponge to clean dirt which is not easily removed by dry cleaning.
- Do not clean or spray water at the Junction Box or any area on the backside of the Module.
- Frequency of Cleaning will vary depending upon any special conditions in the area where the Modules are installed. Modules installed in high windy or dusty areas should be inspected more frequently.
- If excessive soiling is present, a non-conductive soft brush, sponge, or other mild agitating method may be used before using water. Ensure brushes or agitating tools are not abrasive to glass.
- Module damage that arises as a result of improper cleaning will not be warranted by WAAREE Energies Ltd.
- Do not clean the glass surface with chemicals. Do not let water stay on the glass surfaces of PV Modules for a long time. This creates a risk of permanent damage to the glass, such as white efflorescence, otherwise known as “glass disease,” which may cause reduced power output.
- To avoid dirt accumulation or white efflorescence due to water accumulation, do not install PV Modules horizontally (flat).

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