swelect

Stay powerful when sun shines. And thereafter...

INSTALLATION
OPERATIONAL AND
MAINTENANCE MANUAL FOR
SWELECT HHV SOLAR PHOTOVOLTAICS PRIVATE LIMITED
MODULES

CONTEXT

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Thank You for selecting **SWELECT HHV SOLAR PHOTOVOLTAIC (SHPV) Modules**

Please read and comprehend this manual completely before installing the Solar PV (SPV) Modules. In order to obtain a trouble free operation, it is necessary to follow the instructions described in this manual. Any non-adherence to the instructions will make SHPV modules ineligible for warranty claims.

1. DISCLAIMER OF LIABILITY

- The usage of this manual, installation, and handling of SHPV modules are beyond SHPV's control. SHPV does not assume any responsibility against failure to follow instructions, resulting into any Loss, Damage, Injury, and Expenses due to improper Installation, Handling, Usage, and Maintenance
- No responsibility is assumed by SHPV for any Infringement of IPR (Intellectual Property Rights), and other rights of third parties, which may result from use of the module. No license is guaranteed by implication or otherwise, under any patent rights
- The information in this manual is based on SHPV's knowledge and experience, and is believed to be reliable, but such information including product specification (without limitations), and suggestions do not constitute a warranty, expressed or implied. SHPV reserve the rights to change the manual and module specification without prior notice
- The term PV module or module mentioned in this manual refers to is the Mono-facial and Bi-facial solar modules.

2. SAFETY PRECAUTIONS

- SHPV modules are of Class A Application PV modules that generate electricity upon direct exposure to light, and can produce electric shock. Use of insulated tools and gloves is recommended while working with modules under light. No metallic contacts should be on the human body
  (Les modules SHPV sont des modules PV d'application de classe A qui génèrent de l'électricité lors d'une exposition directe à la lumière et peuvent produire un choc électrique. L'utilisation d'outils et de gants isolés est recommandée lorsque vous travaillez avec des modules sous la lumière. Aucun contact métallique ne doit se trouver sur le corps humain)

- Hazardous voltage (IEC 61730: higher than 50V DC; EN 61730: higher than 120V), hazardous power applications (higher than 240W) where general contact access is anticipated (modules qualified for safety thorough EN IEC 61730-1 and -2 within this application class are considered to meet the requirements for safety class II)
  (Tension dangereuse (CEI 61730: supérieure à 50 V CC; EN 61730: supérieure à 120 V), applications d'alimentation dangereuses (supérieures à 240 W) où un accès général aux contacts est prévu (modules qualifiés pour la sécurité conformément aux normes EN CEI 61730-1 et -2 dans ce cadre). la classe d'application sont considérées comme répondant aux exigences de la classe de sécurité II)

- The objective of this manual is to provide the customer(s) clear instructions on how to mount the

PV modules to ensure compliance with certification and regulatory requirements

(L'objectif de ce manuel est de fournir au(x) client(s) des instructions claires sur la façon de monter les modules PV afin de garantir la conformité aux exigences de certification et réglementaires)

- Further, you are advised to consult the local authorities (if there are any statutory requirements) before mounting the PV modules. Ensure that the mounting instructions described in this manual meet their requirements
  (De plus, il est conseillé de consulter les autorités locales (s'il existe des exigences légales) avant de monter les modules PV. Assurez-vous que les instructions de montage décrites dans ce manuel répondent à leurs exigences)

- No one should stand on the front side, and back side of the PV module, as non-uniform localized pressure will cause damage to the solar cells inside the module
  (Personne ne doit se tenir à l'avant et à l'arrière du module photovoltaïque, car une pression localisée non uniforme endommagerait les cellules solaires à l'intérieur du module)

- The front surface of the module is constructed with tempered glass, and hence it should be handled with utmost care. If the glass breaks, then human contact with the surface can lead to electric shock, particularly when the ambient condition is wet. Broken modules cannot be repaired and it should be disposed properly, as per the electronic disposal regulations
  (La surface avant du module est construite en verre trempé et doit donc être manipulée avec le plus grand soin. Si le verre se brise, le contact humain avec la surface peut entraîner un choc électrique, en particulier lorsque les conditions ambiantes sont humides. Les modules cassés ne peuvent pas être réparés et doivent être éliminés correctement, conformément aux réglementations relatives à l'élimination des appareils électroniques)

- Any loose connection in connectors of PV module can cause electrical arcing and can lead to fire hazard. Ensure that all the electrical connectors should be well protected against corrosion and soiling. Ensure that connectors are corrosion free, and cleaned, with absolutely no gaps between the contacts. Gaps can result in Electrical Arcing leading to Fire Hazards.
  (Toute connexion desserrée dans les connecteurs du module PV peut provoquer un arc électrique et conduire à un incendie. Assurez-vous que tous les connecteurs électriques soient bien protégés contre la corrosion et salissure. Assurez-vous que les connecteurs sont exempts de corrosion et nettoyés, sans aucun espace entre les contacts. Les lacunes peuvent entraîner des arcs électriques entraînant des risques d'incendie)

- For personal safety, do not install / handle PV modules under adverse environmental conditions viz. gusty winds, wet frosted roof surfaces etc. Modules should always be dry while installing
  (Pour votre sécurité personnelle, n'installez/ne manipulez pas de modules PV dans des conditions environnementales défavorables, à savoir. vents violents, surfaces de toit mouillées et givrées, etc. Les modules doivent toujours être secs lors de l'installation)

- Ensure the polarity of the modules / strings are not reversed, considering other modules in the string (Assurez-vous que la polarité des modules/chaînes n'est pas inversée, en tenant compte des autres modules de la chaîne)
- Concentrating artificial sunlight on PV module is not allowed, as it will degrade its performance and life cycle
  (La concentration de la lumière artificielle sur le module PV n'est pas autorisée, car cela dégraderait ses performances et son cycle de vie)

- SHPV modules are certified for operating in installations at voltages below $1500V_{dc}$. The maximum system voltage of $1500V_{dc}$ must be considered while taking into account the temperature ranges in the location of power plant. Mixing of power classes in one string is not allowed and can be harmful. Damages to modules due to such mixing can lead to invalidity of product warranty
  (Les modules SHPV sont certifiés pour fonctionner dans des installations à des tensions inférieures à 1 500 Vdc. La tension maximale du système de 1 500 Vcc doit être prise en compte en tenant compte des plages de température à l'emplacement de la centrale électrique. Le mélange de classes de puissance dans une même chaîne n'est pas autorisé et peut être nocif. Les dommages aux modules dus à un tel mélange peuvent entraîner l'invalidité de la garantie du produit)

- Do not damage or scratch the front or back surfaces of the module
  (N'endommagez pas et ne rayez pas les surfaces avant ou arrière du module.)

- Do not punch or drill holes in the frame, it may cause corrosion to the frame
  (Ne percez pas et ne percez pas de trous dans le cadre, cela pourrait provoquer de la corrosion sur le cadre.

- To allow for increased output of a module resulting from certain conditions of use, the installation instructions for a module shall include the following statement, and under normal conditions, a photovoltaic module is likely to experience conditions that produce more equivalent current and/or voltage than reported at standard test conditions.
  (Pour permettre une production accrue d'un module résultant de certaines conditions d'utilisation, les instructions d'installation d'un module doivent inclure la déclaration suivante, et dans des conditions normales, un module photovoltaïque est susceptible de connaître des conditions produisant un courant et/ou une tension plus équivalente. que rapporté dans des conditions de test standard)

- 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)
  (Le module est considéré comme conforme à cette norme uniquement lorsqu'il est monté de la manière spécifiée dans les instructions de montage. Un module avec des parties conductrices

exposées est considéré comme conforme à cette norme uniquement lorsqu'il est électriquement mis à la terre conformément aux instructions du fabricant et aux exigences du National Electrical Code, ANSI/NFPA 70 (2014-2017))

The details described in this manual are applicable for the photovoltaic modules of family type:

Cell Size	Module Type
182 mm	SWM11BN0XXX, SWM11BN2XXX, SWM11BN4XXX, SWM11BN6XXX, SWM11BN8XXX, SWM11BT0XXX, SWM11BT2XXX, SWM11BT4XXX, SWM11BT6XXX, SWM11BT8XXX, SWM11BB0XXX, SWM11BB2XXX, SWM11BB4XXX, SWM11BB6XXX, SWM11BB8XXX, SWT15BG0XXX, SWT15BG2XXX, SWT15BG4XXX, SWT15BG6XXX, SWT15BG8XXX

Table 1: MODULE TYPES AND CELL SIZE

Note: The information provided in this manual is subject to revision without prior notice for continual improvement

(Remarque : Les informations fournies dans ce manuel sont sujettes à révision sans préavis pour une amélioration continue.)

2.1. FIRE SAFETY

- The PV module is declared as non-explosion-protected equipment, and must not be installed near open flames, flammable materials and vapours.
  (Le module PV est déclaré comme équipement non protégé contre les explosions et ne doit pas être installé à proximité de flammes nues, de matériaux et de vapeurs inflammables.)

- SHPV Modules have a Class C fire resistance rating in accordance with UL 61730/ IEC 61730 certification. “The fire rating of this module is valid only when mounted in the manner specified in the mechanical mounting instructions.” Rooftop installations should be placed over fire resistant roof coverings only. Roof constructions and installations may affect the fire safety of a building; improper installation may create hazards in the event of a fire.
  (Les modules SHPV ont un indice de résistance au feu de classe C conformément à la certification UL 61730/IEC 61730. « Le classement au feu de ce module n'est valide que lorsqu'il est monté de la manière spécifiée dans les instructions de montage mécanique. » Les installations sur le toit doivent être placées uniquement sur des revêtements de toit résistants au feu. Les constructions et installations de toiture peuvent affecter la sécurité incendie d'un bâtiment ; une mauvaise installation peut créer des dangers en cas d’incendie.)

- Additional devices such as ground fault indicator, fuses etc., may be required.
  (Des dispositifs supplémentaires tels qu'un indicateur de défaut à la terre, des fusibles, etc. peuvent être nécessaires.)

- Unskilled installation procedure, using defective/worn out parts may result in an electrical hazard

during operation. In order to prevent the risk of fire in this case, SHPV modules should not be installed near highly inflammable liquids/gases, or locations with hazardous materials.
(Une procédure d'installation non qualifiée, l'utilisation de pièces défectueuses/usées peut entraîner un risque électrique pendant le fonctionnement. Afin d'éviter tout risque d'incendie dans ce cas, les modules SHPV ne doivent pas être installés à proximité de liquides/gaz hautement inflammables ou d'emplacements contenant des matières dangereuses.)

- In the case of a fire, SHPV 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
(En cas d'incendie, les modules SHPV peuvent produire une tension/surintensité dangereuse, même s'ils ont été déconnectés de l'onduleur, ou ont été partiellement ou entièrement détruits, ou le câblage nu détruit. En cas d'incendie, informez l'équipe d'incendie/de sécurité des dangers particuliers liés au système photovoltaïque et restez à l'écart de tous les éléments du système photovoltaïque pendant et après un incendie jusqu'à ce que les mesures nécessaires aient été prises pour atténuer le risque.)

3. STORAGE UNLOADING AND UNPACKING

- The PV module is declared as non-explosion-protected equipment, and must not be installed near open flames, flammable materials and vapours
- Modules should be stored in a dry and ventilated environment to avoid direct sunlight and moisture. If modules are stored in an uncontrolled environment, the storage time should be less than 1 month and extra precautions should be taken to prevent connectors from being exposed to moisture or sunlight
- Do not allow children and unauthorized persons near the installation site or storage area of modules

3.1. UNLOADING

- At receipt of PV modules, verify the product details as it had been ordered. Packing list pasted outside the box contains all details including the serial no of modules
- It is recommended to unload the packing box by using forklift only
- Always move the forklift or jack entering from the short side. In the process of loading and unloading, the forklift should be selected according to the size and weight of the goods. If the fork length is less than 3/4 of the size of the goods, extension sleeves should be fitted on the forks before the assembly is forked, in order to avoid the packing container dumping when moving the forklift
- When the forklift is loaded with modules, the spacing between the two forks should be adjusted as required to ensure the load of the two froks is balanced without deflection.
- Ensure while loading the module using forklift the frok lift arm should be covered with sponges

and minimum distance has to be maintained between frok lift arm and module pallet.

- When lifting the module with forklift ensure that it should not be lifted above 5 degrees

Attention in Loading and unloading with hoisting:

- During unloading, the hoisting rope of the crane should be a longer nylon sling. Wire rope is not allowed
- Before lifting, the length of the sling should be evenly distributed on both sides to avoid the case body tilting to one side during lifting, which causes the sling to be too tight and the assembly to explode
- When lifting, the box should be kept balanced to avoid tilting
- In order to minimize the impact of sling on the safety of goods in the process of hoisting, the box should be supported during loading and unloading. For example, wooden plank, boards or other fixtures of the same width as the outer packing cases should be used on the upper part of the box to reduce the pressure of the contact position on the box

3.2. UNPACKING

- Unpack module pallet with care and follow the unpacking steps marked on the pallet. Be careful when unpacking, transporting and storing the modules
- Unpacking of Module should always be done as shown in figure 1
- Unpacking of PV modules should always be done in the vertical manner by two persons. Care should be taken for falling over one module to the other inside the packing box

Figure 1: MODULE UNPACKING

Note: After Removing the Sleeve of packing box, support the modules using a support structure (L-Type stand (or) structure with counterweights (or) another pallet). Failure to do so would result in module breakage, and void of warranty

- Care should be taken while placing the module on support structure so that it does not fall off
- Do not carry the module by its wires or junction box. Carry the module by its frame, vertically, with two or more people

- Do not place the modules directly on top of each other
- Do not place excessive loads on the module or twist the module frame
- Do not stand, step, walk and/or jump on the module
- Do not carry the module on the head
- Do not drop or place objects on the modules (such as tools)
- Do not mark the modules with sharp instruments. Particular attention should be given to ensure that the module's back-sheet does not come in contact with Sharp objects, as scratches and holes will directly affect product safety
- Do not change the wiring of bypass diodes
- Keep all electrical contacts clean and dry
- Do not keep the modules on the field with backside facing sun/upside-down

3.3. MODULE IDENTIFICATION

- Each module has a unique serial number, which is laminated behind the glass. Please do not tamper with the serial number of the module and always record the serial numbers during an installation for your future records. A nameplate containing model name, electrical and safety characteristics of the module is also affixed to the back side

4. ENVIRONMENTAL CONSIDERATIONS

4.1. CLIMATE CONDITION

- All SHPV Solar modules are tested for IEC 61215, IEC 61730-I & II, UL 1703, IEC 61701, IEC 62716, IEC 62804. The modules are qualified for safety through IEC 61730 is considered to meet the requirements of Safety Class II
- SHPV modules meet the requirements of European Standards, and a certificate of Conformity (CE) is given as they are tested for Ammonia Fumes that may be present in Barns, Sheltering Cattle, Pigs, as well as sustainable for Installation in Humid (Coastal) areas with high Sand Storms. SHPV modules have passed Salt mist corrosion test (Severity VI), IEC 61701, with a salt concentration of 5% by weight. Galvanic corrosion can occur between the aluminium frame and ground mounting materials, if such materials are made of dissimilar metals. Stainless steel and Aluminium metal in direct contact is not recommended for seaside installations, so as to avoid metal corrosion
- Do not install modules near naked flames or flammable materials
- Do not expose modules to artificially concentrated light sources
- Do not immerse modules in water or constantly expose modules to water (either fresh or salt) (i.e. from fountains, sea spray)
- Exposing modules to salt (i.e. marine environments) and sulphur (i.e. sulphur sources, volcanoes) risks module corrosion
- To gain better output from rear side from bifacial modules prefer albedo table while installing PV modules

Surface Type	Typical Value	Surface Type	Typical Value
Fresh asphalt	0.03 - 0.04	Desert sand	0.30 – 0.40
Sand	0.15 – 0.18	Snow	0.40 – 0.90
Agricultural crop	0.18 – 0.25	Fresh snow	0.80 – 0.90
Bare soil	0.17	Ocean Ice	0.50 – 0.70
Green grass	0.20 – 0.25		

Table 2: ALBEDO RANGE FOR DIFFERENT SURFACE

4.2. ENVIRONMENTAL CONDITION

- Ambient temperature: -40°C to +50°C
- Storage temperature: -20°C to +50°C
- Operating temperature: -40°C to +70°C (Module [T98]max (°C): 70°C)
- Humidity: ≤ 85% RH
- Mechanical load pressure: 5400 Pa (112.8lb/ft2) on the front and 2400 Pa on the rear (50.12lb/ft2)
- Minimum Design Load (Pa): -1600 Pa, +3600 Pa
- BIS: front 1000 W/m2, rear 300 W/m2

Note: The mechanical load bearing (Including wind and snow loads) of the module is based on the approved mounting methods. The professional system installer must be responsible for mechanical Load calculation according to the system design

5. INSTALLATION CONDITION

5.1. SITE SELECTION

- In most applications, SHPV modules should be installed in a location where they will receive maximum sunlight throughout the year. Shading can be minimized by having the distance between the obstruction and solar array more than thrice the height of obstruction
- In the Northern Hemisphere, the module should typically face south, and in the Southern Hemisphere, the modules should typically face north. Modules facing 30° away from true South (or North) will lose approximately 10 to 15 percent of their power output. If the module faces 60° away from true South (or North), the power loss will be 20 to 30 percent
- When choosing a site, avoid trees, buildings or obstructions, which could cast shadows on the modules, especially during the winter months where the arc traced by the sun is lowest, above the horizon. Shading causes loss of output, but the bypass diodes in the PV module will minimize any such significant losses
- For optimum energy production, solar modules should normally be mounted facing the equator at

an angle to the horizontal plane, equivalent to the latitude of the installation. If the PV module is placed at a different angle or orientation, it could have a direct impact on the power output

- Any slope of less than 1:2.4 is required to maintain the fire class rating; Modules are Class C Fire Rated
- Avoid using mounting methods where drain holes are blocked
- PV modules should not be installed in such a way that it will be immersed in water under any circumstances, and also it should not be installed in a moving vehicle / vessel
- Minimum distance between each Solar PV Module should be 7.0 mm.
- A clearance of at least 115 mm (4.5 in) (recommended) is provided between modules and the surface of the wall or roof. If other mounting means are employed this may affect the UL Listing or the fire class ratings.
- The installation place should be less than 1,000 m (3,280 ft) above sea level. Above 1,000 m are allowed only if the wind pressure load for a module is less than 2,400 N/m2 (50.12 lb/ft2)

5.2. TILT ANGLE SELECTION

- The tilt angle of the PV module is measured between the surface of the PV module and the horizontal ground surface. The PV module generates maximum output power when it faces the sun directly
- If the tilt angle of the PV module is below 15 degree, it is recommended to use two water drain clips in the bottom edge of the module frame.

- For standalone systems with batteries where the PV modules are attached to a permanent structure, the tilt angle of the PV modules should be selected to optimize the performance, based on seasonal load and sunlight. In general, if the PV output is adequate when irradiance is low (e.g., winter), then the angle chosen should be adequate during the rest of the year
- For grid-connected installations where the PV modules are attached to a permanent structure, PV modules should be tilted so that the energy production from the PV modules will be maximized on an annual basis
- The System Fire Class Rating of a module in a roof mounted system should meet the local code requirements in order to achieve the specified System Fire Class Rating for a non-BIPV module
- Any module mounting system has limitations on inclination required to maintain a specific System Fire Class Rating

Note: The connection of the module to the racking system can be created with clamps, with frame, or an embedded system on the frame. If a different installation method is desired, please contact SHPV customer service or technical support team for consultation. Improperly mounted modules maybe damaged.

6. MOUNTING INSTRUCTIONS

- PV modules can be installed or fixed by clamp method

- While mounting the PV module, if the frame has a transparent plastic film, this film must be removed from all sides all sides of the frame before installing the modules.
- For bolts type fixing corrosion resistive M6/M8 bolts to be used, mounting methods should ensure following things

  a) Minimum clearance required between module edge and surface should also be considered according to the local regulation's requirements.

  b) Minimum distance between each PV module should be 10mm. c) Use durable, rust-proof and ultraviolet resistant materials to fabricate the modules support structure and use such support structure that are already tested, certified and approved.

  c) Use durable, rust-proof and ultraviolet resistant materials to fabricate the modules support structure and use such support structure that are already tested, certified and approved.

For Bifacial modules follow these instructions before installation

- For optimum generation from the back side, SHPV advises a minimum of 300mm of space between the modules and the ground surfaces
- Apply light – coloured, highly reflecting materials to the surfaces, like aluminium foil or white membrane
- The bifacial modules have the potential to generate 10% to 30% extra electricity from the back. For optimal ventilation and increased generation, there should be a minimum of 100mm space between the roof shed and the module on the rooftop

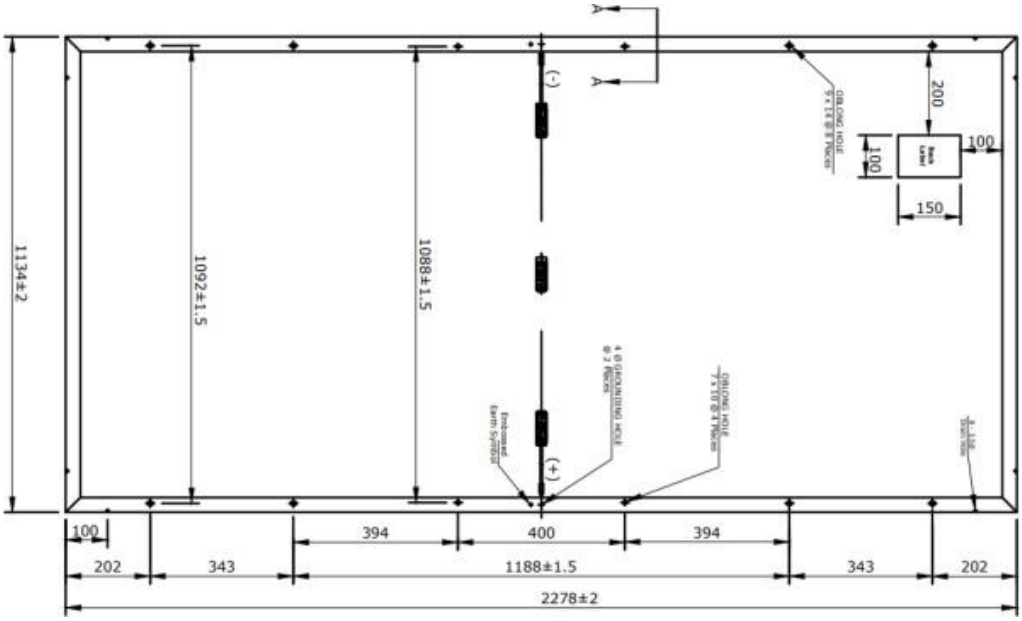

Figure 2: PV MODULE WITH MOUNTING HOLES (FOR REFERENCE)

6.1. MOUNTING METHODS

6.1.1. BOLT TYPE FIXING

- The frame of each module has 8 mounting holes (Length x Width: 12 mm x 8 mm) (or) (Length x Width: 14 mm x 9 mm) used to secure modules to the support structure. The module frame must be attached to a mounting rail using M6/M8 corrosion-proof bolts together with spring washers and flat washers in eight symmetrical locations on the PV module. The applied torque value should be high enough to fix the modules steadily. The reference value for M6/M8 bolt is 16 to 25 Nm. As to special support system or special installation requirement, please reconfirm with the support system supplier for torque value. Please find the mounting information image in **Figure 2** & **Figure 3**

Figure 3: BOLT TYPE FIXING

6.1.2. CLAMP TYPE FIXING

- The module clamps should 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 the below mentioned clamp-mounting method, make sure to use at least four clamps on each module, two clamps should be attached on each long side of the module. Depending on the local wind and snow loads, if excessive pressure load is expected, additional clamps or support is required to ensure that the module can bear the load
- The applied torque value should be big enough to fix the modules steadily (Please consult with the clamp or support structure supplier, for the specific torque value. For example: M6/M8 Screw torque reference value is 16 to 25 Nm)

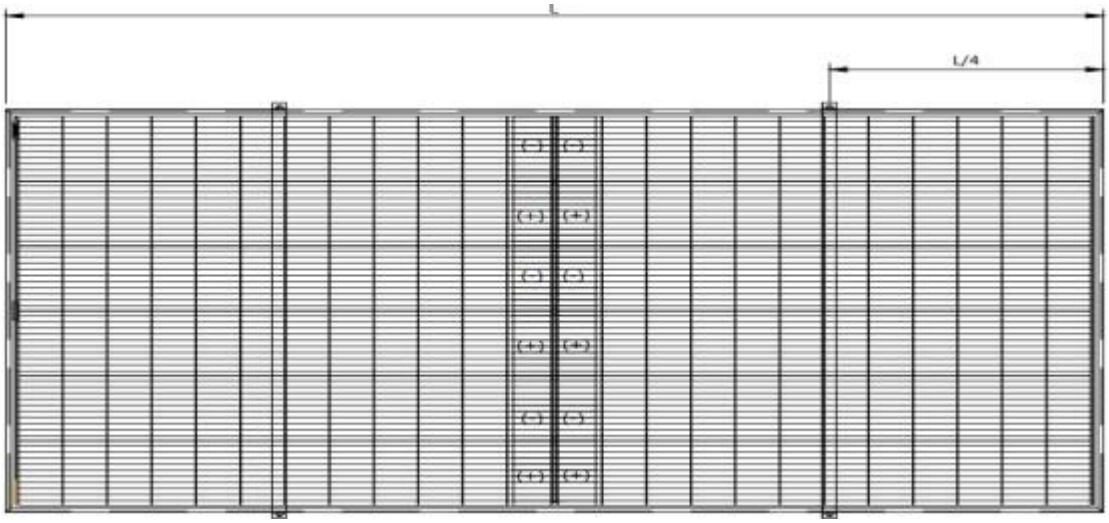

Figure 4: INSTALLATION WITH CLAMPS INTO 4 OUTER HOLES. BEAMS PERPENDICULAR TO LONG SIDES

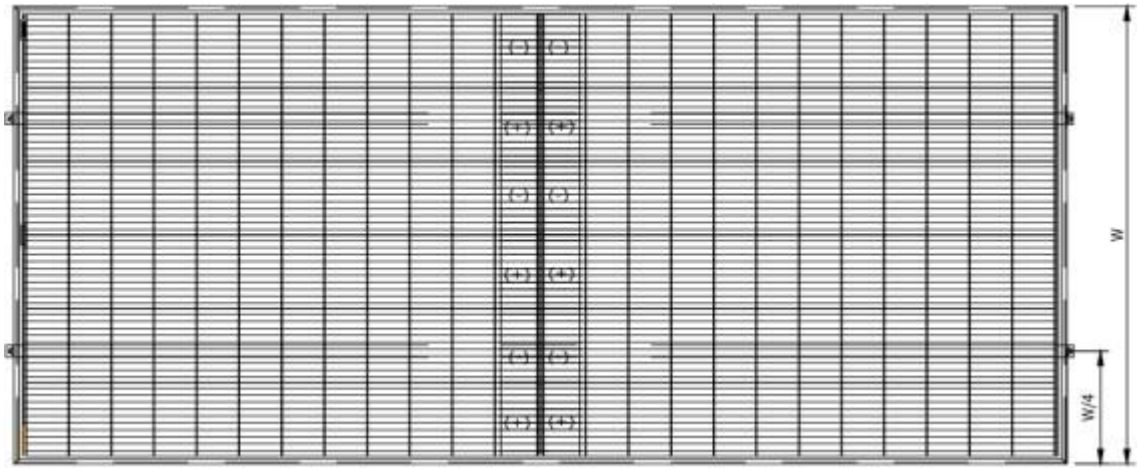

Figure 5: INSTALLATION WITH CLAMPS INTO 4 INNER HOLES. BEAMS PERPENDICULAR TO SHORTSIDES

- To fix the modules on the mounting rail, a minimum of 4 clamps need to be fixed
- The clamps should never touch the glass and cause any breakage, and also clamps should not cause any shadow effects on the module
- The customer should not do any modification to the frame under any circumstances
- SHPV Solar modules are certified for 2400 Pa (50.12 lb/ft^2) (Wind Load) and 5400 Pa (112.8 b/ft^2) (Snow Load) on the front side. Additional clamps can be used to ensure that the modules can bear the load
- Fringe Type Module Installation (**Figure 6**) and Middle Module Installation (**Figure 7**) Diagrams are given below.

FRINGE MODULE INSTALLATION

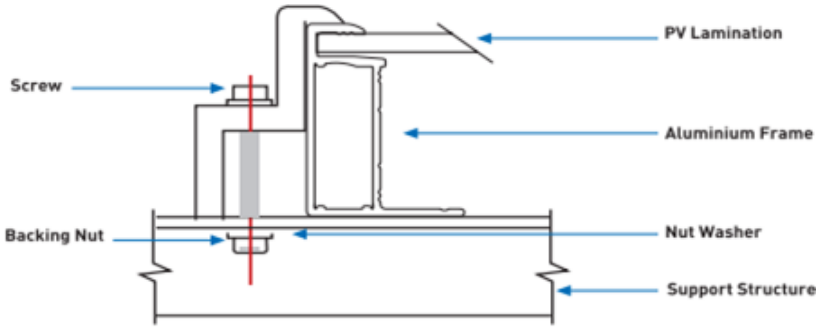

Figure 6: PV MODULES INSTALLES USING FRINGE CLAMPING METHOD

MIDDLE MODULE INSTALLATION

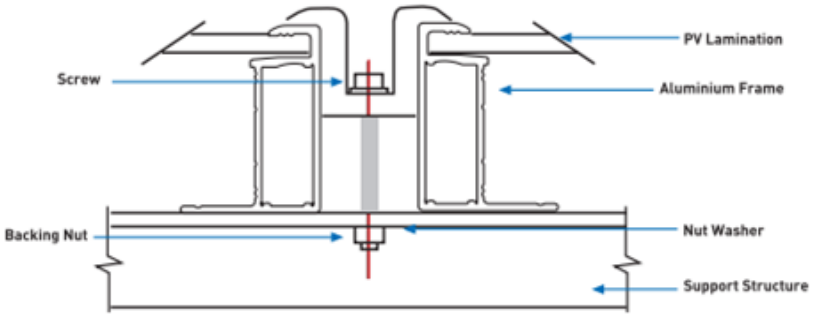

Figure 7: PV MODULES INSTALLED USING MIDDLE CLAMPING METHOD

6.1.3. BIFACIAL MODULE INSTALLATION AND MOUNTING

- Bifacial modules can be mounted by bolts or clamps
- Panels must not be subjected to wind or snow loads exceeding the maximum permissible loads, and must not be subjected to excessive forces due to the thermal expansion of the support structures
- There must be at least 4 to 7 inches of space between each row of solar panels, as the frame contracts and expands with the weather. Additionally, there must be at least 12 inches of space between the solar panels and the edge of the roof to comply with building codes and ensure the safety of the arrary
- While, mounting the bifacial module mount the Junction box to be back side of the module

(i.e. towards the roof floor/ ground facing). Attached images for reference

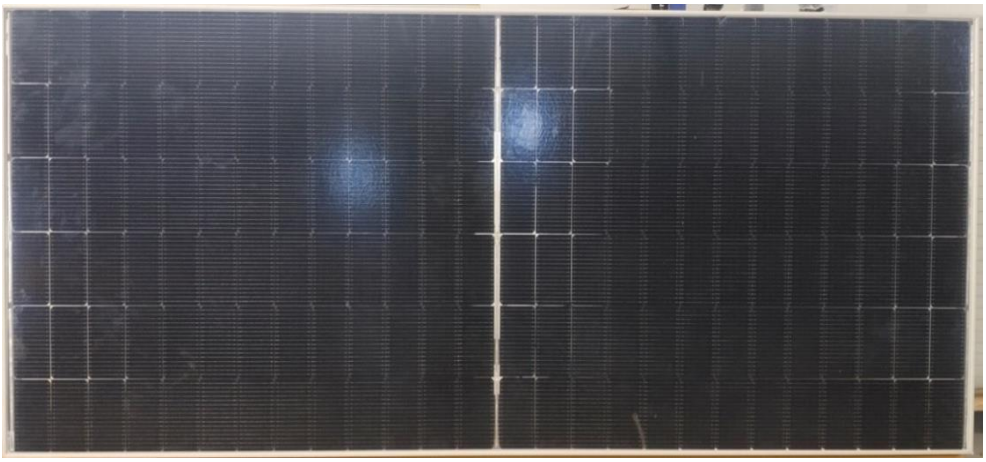

Figure 8: BIFACIAL MODULE FRONT SIDE

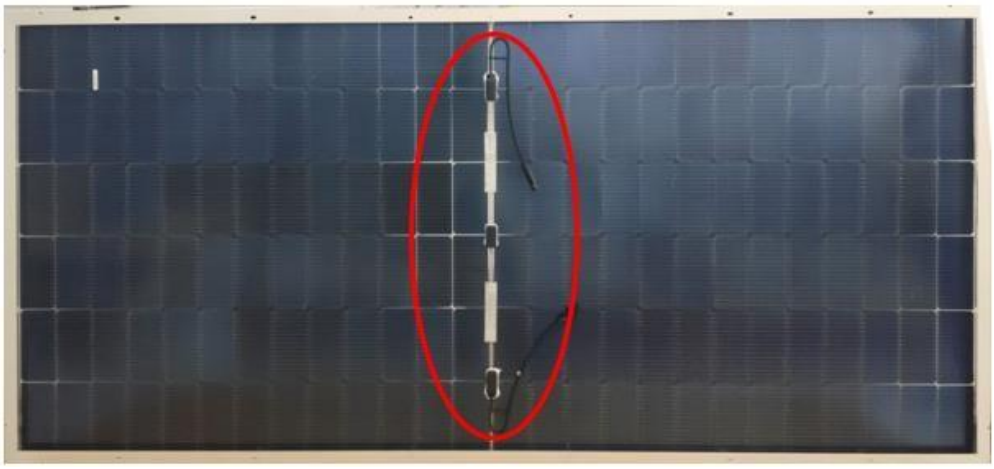

Figure 9: BACK SIDE OF BIFACIAL MODULE

6.1.4. MOUNTING WITH BOLTS 14 X 9 mm MOUNTING HOLES

- Modules can be attached using the mounting holes 14 X 9 mm on the back of the module frame, by fixing the module to the support rails with bolts. The frame of each module has 8 Nos. 14 X 9 mm mounting holes, ideally placed to optimize the load handling capability, and to secure the modules to the supporting structure
- To maximize mounting longevity, SHPV strongly recommends the use of corrosion proof (stainless steel) attachment fixings. Secure the module in each mounting location with an M8 bolt and a flat washer, spring washer and nut and tighten to a torque of 16 to 20 Nm (140 to 180 lbf.in.). All parts in contact with the modules should use flat stainless-steel washers of minimum

1.5 mm thickness with an outer diameter of 20 to 24 mm (0.79 - 0.94 in)

6.1.5. MOUNTING WITH SINGLE-AXIS TRACKING SYSTEM 10 X 7 mm MOUNTING HOLES

- It is a Single-axis Tracking System, the module is fixed on the axis by bolting long frame
- The frame of each module has 4 Nos. 10 X 7 mm mounting holes with specific location
- Module in each fixing location is fixed with an M6 bolt, two flat washers, a spring washer and nut
- If a different bolt similar to M6 is used, they need to be tightened to a torque of 16 Nm (140lbf.in)
- All parts in contact with the frame should use flat stainless-steel washers of minimum 1.5 mm thickness with an outer diameter of 16-20mm (0.63-0.79in.)
- The bolt should be made of stainless steel or the other anti-corrosion material
- Mechanical Load Pressure under this method: 30 lbs.ft2 max from the front side & 30 lbs.ft2 max from the rear according to UL1703

6.1.6. MOUNTING WITH CLAMPS

- SHPV has tested its modules with a number of clamps from different manufacturers, with a mounting bolt of at least M8
- The length of clamp ≥ 60 mm (2.36in), thickness ≥ 3 mm (0.12in), Material: 6005 T5 / T6 (Rm ≥ 255 M Pa, Rp 0.2 ≥ 230 M Pa)
- The clamp must overlap the module frame by at least 7 mm (0.28 in) but no more than 10 mm (0.39in)
- Use at minimum 4 clamps to attach modules to the mounting rails
- Modules clamps should not come into contact with the front glass and must not deform the frame
- Be sure to avoid shadowing effects on the solar cells from the module clamps
- The module frame is not to be modified under any circumstances
- When choosing this type of clamp-mounting method, use at least four clamps on each module, two clamps should be attached on each long sides of the module (for portrait orientation)
- Depending on local wind and snow loads, additional clamps may be required to ensure that modules can bear the load
- Applied torque should refer to mechanical design standard according to the bolt customer is using, ex: M8 – 16 to 20 N m (140-180 lbf.in

6.2. PV MODULE GROUNDING

- All modules have to be electrically grounded as per the National Electrical Code (USA) or in accordance with CSA C22.1, Safety Standard for Electrical Installations, Canadian Electrical Code, Part 1.Modules are provided with grounding holes at the back of the module frames and the

grounding symbol (embossed earth) has also been printed/marked near the hole for identification

- The module must be grounded using the Grounding hole
- The surface of the frame has been anodized. It is necessary to use tooth gasket or self-tapping screw for effective grounding
- Bimetallic Lug is required for effective grounding
- Every module must be grounded individually, only after all the modules in the system are connected properly
- Bracket must be checked before the event of a thunderstorm; it is necessary to carry out spot check on the underground component
- It is recommended to use grounding cable with cross-sectional area of 6 mm^2
- The Recommended Grounding method is given in below figure 10.

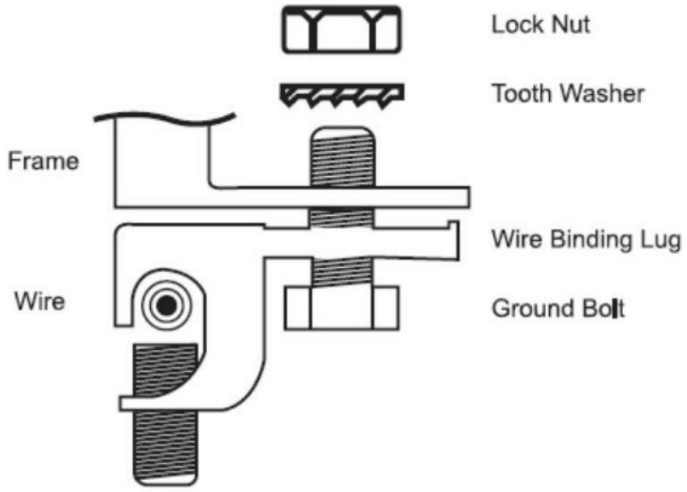

Figure 10: PV MODULES RECOMMENDED GROUNDING

6.2.1. ANTI THUNDER

- Anti-thunder measures must be taken for modules in series. Photovoltaic grounding and lightning protection must be implemented as per local government regulations.

Figure 11: PV MODULE GROUNDING ACCESSORIES

7. ELECTRICAL CONFIGURATION

- All wiring should be performed, by well-trained, qualified installers as per the local codes and regulations
- It is recommended to connect only such number of modules in series, such that the system voltage should not exceed the rated value at any time of the year. The EPC should choose the appropriate electrical design based on the Inverter MPPT ratings, operating voltage, and the environmental conditions, considering the lowest temperature recorded at the site
- PV modules can be connected in Series to increase the Operating Voltage (up to $1500V_{dc}$). The positive connector of module is connected to the negative connector of another module, and a click sound should be heard. Click sound ensures proper connectivity between the two terminals. Similarly, PV modules can be connected in Parallel to increase the overall current (up to Fuse Rating; 25A) at the terminals
- SHPV modules are provided with standard copper cables having 4 mm^2 cross-sectional area, and are rated for 1500V/1000V (IEC and UL) maximum system voltage, 90° C, and UV resistant. Ensure that the cables are not exposed to waterlogging
- The maximum voltage in the system should be lesser than the certified system voltage (typically 1500V) or the maximum input voltage of the inverter. Since V_{oc} α (1/T), the open circuit voltage of the array needs to be calculated at the lowest ambient temperature recorded at the location of power plant
- Below formula can be used for this calculation:

$$\textbf{System Voltage} = X * V_{oc} * [1 + ((T_{\alpha})_{Voc}\ (\%) \times (25 - T_{min}))]$$

Where;

X - No: modules which are connected in series

V_{oc} - Open circuit voltage of each module (Refer to the Data Sheet)

$(T_{\alpha})_{Voc}$ - Thermal coefficient of open circuit voltage for the module in Percentage

T_{min} - Minimum ambient temperature of the location of the plant

- Outer cable diameter maximum is 7 mm and minimum is 5 mm
- In field application it is recommended to use 4 mm^2 cables insulated for minimum of 90°C and designated as PV wire
- Bending radius of the Junction Box Cable should be ≥ 42 mm
- Under normal conditions, a photovoltaic module is likely to experience conditions that produce higher current and/or voltage than reported at standard test conditions. Accordingly, the values of *Isc and Voc* marked on this PV module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, and size of controls (e.g., inverter) connected

to the PV output.

7.1. ELECTRICAL WIRING

The reported performance measurements are subject to ±5% uncertainty at STC/BSTC (1000W/m² Irradiance, a cell temperature of 25°C and an AM1.5 spectrum) for voltage, current and 0-3% power, where standard test conditions (1000 W/m2, (25 ± 2) °C, AM 1.5 according to IEC 60904-3) and BSTC (AM 1.5, T = 25 °C, Irradiance = 1000W/m2 + φ•135W/m2)

Maximum allowable system voltage for SHPV modules is 1500V, Class for protection against electrical shock, in accordance with Clause 4 of IEC 61730-1:2016 is CLASS II.

When modules are in series connection, the string voltage is sum of individual module in one string. When modules are in parallel connection, the current is sum of the individual string current. Modules with different electric performance models cannot be connected in one string.

7.1.1. SERIES CONNECTION:

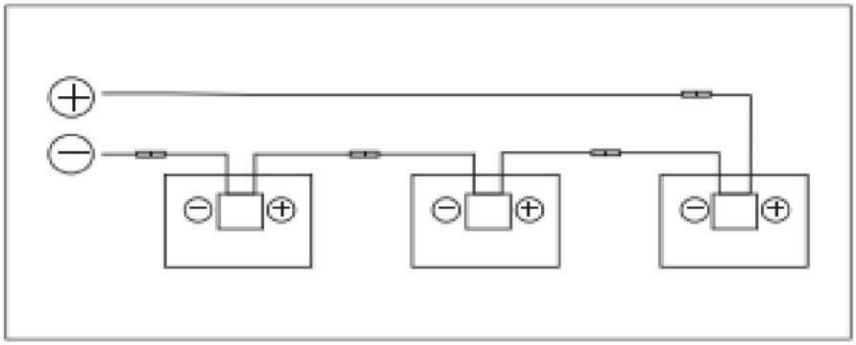

Figure 12: PV MODULES CONNECTED IN SERIES

7.1.2. PARALLEL CONNECTION:

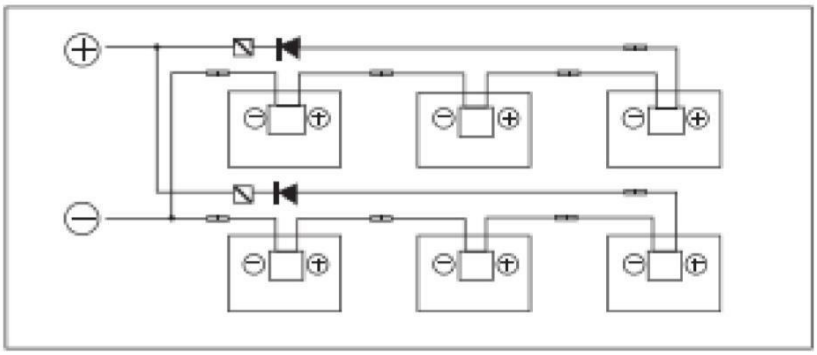

Figure 13: PV MODULES CONNECTED IN PARALLEL

7.2. CONNECTORS

- Protect unplugged connectors against moisture, dust and any environmental pollution. Only clean and dry plugged connectors fulfil their ingress protection (IP) class. Ensure that the connector caps are fastened before connecting the modules. Do not attempt to make an electrical connection with wet, soiled, or otherwise faulty connectors. Avoid sunlight exposure, and water immersion of the connectors. Avoid connectors resting on the ground or roof surface
- Faulty connections can result in arcs and electrical shock. Check all electrical connections are fastened and secured. Make sure all locking connectors are fully engaged and locked.
- Only compatible connectors can be mated, i.e., from the same vendor and model, shall be used. For approved connector make for each PV model as per IEC CDF kindly connect to SHPV technical team

Note: Please make sure to use specific Connector Crimping Tool

Figure 14: PV MODULES CONNECTORS

- The junction boxes used with SHPV modules contain bypass diodes wired in parallel with the PV cell strings. In the case of partial shading, the diodes bypass the current generated by the non-shaded cells, thereby limiting module heating and performance losses. Bypass diodes are not overcurrent protection devices
- Modules equipped with PV wiring connectors that comply with the Standard, "Connectors for Use in Photovoltaic Systems, UL 6703", shall have the specific, allowable, mating connector manufacturer(s) and model number(s) listed, as well as contact information and/or website of the PV connector manufacturer
- Cables should always be fastened on module frames or on mounting rails, in order to avoid shading on module rear side.
- For Connector Manufacturer and Model please refer below

Manufacturer	Model
Zhejiang Zhonghuan Sunter PV Technology Co., Ltd	PV-ZH202B
DhaSh PV Technologies Private Ltd	DS01
Stäubli Electrical Connectors AG	PVKST4-EVO2/xy_UR PVKBT4-EVO2/xy_UR

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7.3. FUSE RATING

- Please rate the fuses for maximum V_{dc} and connected in each, non-grounded pole of the Solar

Array. (If the system is a floating system then fuses should be connected in both positive and negative poles). The maximum Fuse Rating is usually 25 A for modules connected in series (String), but the actual module specific rating can be found on the module data sheet. The fuse rating also corresponds to maximum reverse current that a module will be able to withstand. 25 A Fuse per String is recommended.

- 1.5 /$Kf \cdot ISC \leq In \leq Max\ Series\ Fuse\ Rating$ $(IEC\ standard)$
- 1.56/ $Kf \cdot ISC \leq In \leq Max\ Series\ Fuse\ Rating$ $(NEC\ standard)$
- In - Fuse rated current [A]
- ISC - Short circuit current of the module [A]
- Kf Temperature correction factor [-]

7.4. TECHNICAL SPECIFICATION

- SHPV recommends to avoid using Y Connectors, although a maximum of 2 strings per Y Connector could to be connected in parallel, with appropriate string fuse for circuit protection
- SHPV recommends a maximum of 30 modules to be connected in series based on the Module's Maximum System Voltage

Note: The Recommended Maximum Series/Parallel Module Configuration is subjected to choose of Inverter (MPPT Range) and the Temperature Ranges recorded at the site

Type name or model no.	SWM11BN8xxx (xxx= 595-585 in step of 1)	SWM11BN6xxx (xxx= 550-540 in step of 1)	SWM11BN2xxx (xxx= 460-450 in step of 1)
Nominal short-circuit current at STC [A]	13.67 – 13.56	13.79 – 13.68	13.83 – 13.79
Nominal open-circuit voltage at STC [V]	55.02 – 54.58	50.25 – 49.82	41.74 – 41.30
Tolerance of rating at STC (Pmpp / Isc / Voc) [%]	0-3/±5/±5	0-3/±5/±5	0-3/±5/±5
Dimensions (L x W x H) [mm]	2465 x1134x35	2278x1134x35	1909 x1134x35
Module area [m²]	2.81	2.58	2.16
Class (IEC 61730-1:2016)	Class II	Class II	Class II
Maximum system voltage [V_{DC}]	1500	1500	1500
Pollution degree	PD 1	PD 1	PD 1
Over-current protection rating [A]	25	25	25
Defined min. creepage distance [mm]	14.0	14.0	14.0
Defined min. clearance distance [mm]	14.0	14.0	14.0
Max. operational altitude [masl]	≤2000	≤2000	≤2000
Design load – downwards [Pa]	3600	3600	3600
Design load – upwards [Pa]	1600	1600	1600
Safety factor for mechanical load	1.5	1.5	1.5
Number of solar cells	156	144	120
Connection of cells (S, SP, PS)	SP	SP	SP
Number of diodes	3	3	3
Cells per diode	52	48	40
Temperature Coefficient for V_{oc}	**-0.2741**		
Temperature Coefficient for I_{sc}	**0.0479**		
Temperature Coefficient for P_{max}	**-0.3621**		

Table 3: TECHNICAL SPECIFICATION FOR M10 PERC MODULES

Type name or model no.	SWM11BT8xxx (xxx= 595-585 in step of 1)	SWM11BT6xxx (xxx = 550-540, in steps of 1)	SWM11BT2xxx (xxx = 460-450, in steps of 1)
Nominal short-circuit current at STC [A]	13.67 – 13.56	13.79 – 13.68	13.83 – 13.79
Nominal open-circuit voltage at STC [V]	55.02 – 54.58	50.25 – 49.82	41.74 – 41.30
Tolerance of rating at STC (Pmpp / Isc / Voc) [%]	±3/±10/±10	±3/±10/±10	±3/±10/±10
Nominal maximum output power at BNPI [W]	655 – 644	606 – 595	506 – 497
Nominal short-circuit current at BNPI [A]	15.04 – 14.92	15.17 – 15.05	15.26 – 15.17
Nominal open-circuit voltage at BNPI [V]	55.02 – 54.58	50.25 – 49.82	41.47 – 41.30
Tolerance of rating at BNPI (Pmpp / Isc / Voc) [%]	±3/±10/±10	±3/±10/±10	±3/±10/±10
Bifaciality coefficient	70 ± 5 %	70 ± 5 %	70 ± 5 %
Dimensions (L x W x H) [mm]	2465x1134x35	2278 x 1134 x 35	1909 x 1134 x 35
Module area [m²]	2.81	2.58	2.16
Class (IEC 61730-1:2016)	Class II	Class II	Class II
Maximum system voltage [VDC]	1500	1500	1500
Pollution degree	PD 1	PD1	PD1
Qualified as cemented joint design	No	No	No
Over-current protection rating [A]	30.0	30	30
Defined min. creepage distance [mm]	14.0	14	14
Defined min. clearance distance [mm]	14.0	14	14
Max. operational altitude [masl]	≤2000	≤2000	≤2000
Design load – downwards [Pa]	3600	3600	3600
Design load – upwards [Pa]	1600	1600	1600
Safety factor for mechanical load	1.5	1.5	1.5
Number of solar cells	156	144	120
Connection of cells (S, SP, PS)	SP	SP	SP
Number of diodes	3	3	3
Cells per diode	52	48	40
Temperature Coefficient for V_{oc}	-0.2741		
Temperature Coefficient for I_{sc}	0.0479		
Temperature Coefficient for Pmax	-0.3621		

Table 4: TECHNICAL SPECIFICATION FOR M10 PERC BIFACIAL MODULE

Type name or model no.	SWM11BB8xxx (xxx= 590-580 in step of 1)	SWM11BB6xxx (xxx = 545 - 535, in steps of 1)	SWM11BB2xxx (xxx = 455-445, in steps of 1)
Nominal maximum output power at STC [W]	590-580 (in steps of 1)	545 - 535 (in step of 1W)	455-445 (in step of 1W)
Nominal short-circuit current at STC [A]	13.62 – 13.51	13.74 – 13.64	13.83 – 13.75
Nominal open-circuit voltage at STC [V]	54.80 – 54.36	50.04 – 49.61	41.52 – 41.08
Tolerance of rating at STC (Pmpp / Isc / Voc) [%]	±3/±5/±5	±3/±5/±5	±3/±5/±5
Dimensions (L x W x H) [mm]	2465x1134x35	2278 x 1134 x 35	1909 x 1134 x 35
Module area [m²]	2.81	2.58	2.16
Class (IEC 61730-1:2016)	Class II	Class II	Class II
Maximum system voltage [VDC]	1500	1500	1500
Pollution degree	PD 1	PD1	PD1
Qualified as cemented joint design	No	No	No
Over-current protection rating [A]	25.0	25	25
Defined min. creepage distance [mm]	14.0	14	14
Defined min. clearance distance [mm]	14.0	14	14
Max. operational altitude [masl]	≤2000	≤2000	≤2000
Design load – downwards [Pa]	3600	3600	3600
Design load – upwards [Pa]	1600	1600	1600
Safety factor for mechanical load	1.5	1.5	1.5
Number of solar cells	156	144	120
Connection of cells (S, SP, PS)	SP	SP	SP
Number of diodes	3	3	3
Cells per diode	52	48	40
Temperature Coefficient for V_{oc}	-0.2741		
Temperature Coefficient for I_{sc}	0.0479		
Temperature Coefficient for Pmax	-0.3621		

Table 5: TECHNICAL SPECIFICATION FOR M10 PERC BLACK MODULES

Type name or model no.	SWT15BG8xxx (xxx= 630-595, in step of 1)	SWT15BG6xxx (xxx= 580-550, in step of 1)	SWT15BG4xxx (xxx = 530-500, in steps of 1)	SWT15BG2xxx (xxx= 480- 450, in step of 1)	SWT15BG0xxx (xxx = 430-405, in steps of 1)
Nominal short-circuit current at STC [A]	14.27 – 13.85	14.28 – 13.92	14.43 – 14.07	14.30 – 13.94	13.97 – 13.67
Nominal open-circuit voltage at STC [V]	55.87 – 54.96	51.46 – 50.68	46.43 – 45.65	42.73 – 41.95	38.33 – 37.68
Tolerance of rating at STC (Pmpp / Isc / Voc) [%]	±3/±10/±10	±3/±10/±10	±3/±10/±10	±3/±10/±10	±3/±10/±10
Nominal maximum output power at BNPI [W]	693-654	638-605	583-550	528-495	473-445
Nominal short-circuit current at BNPI [A]	15.70 – 15.24	15.71 – 15.31	15.87 - 15.48	15.73 – 15.33	15.37- 15.04
Nominal open-circuit voltage at BNPI [V]	55.87 – 54.96	51.46 – 50.68	46.43 – 45.65	42.73 – 41.95	38.33 – 37.68
Tolerance of rating at BNPI (Pmpp / Isc / Voc) [%]	±3/±10/±10	±3/±10/±10	±3/±10/±10	±3/±10/±10	±3/±10/±10
Bifaciality coefficient	80 ± 5 %	80 ± 5 %	80 ± 5 %	80 ± 5 %	80 ± 5 %
Dimensions (L x W x H) [mm]	2465 x1134x35	2278x1134x35	2094 x 1134 x35	1909 x1134x35	1722 x 1134 x 35
Module area [m²]	2.80	2.58	2.37	2.16	1.95
Class (IEC 61730-1:2016)	Class II	Class II	Class II	Class II	Class II
Maximum system voltage [VDC]	1500	1500	1500	1500	1500
Pollution degree	PD 1	PD 1	PD 1	PD1	PD1
Qualified as cemented joint design	No	No	No	No	No
Over-current protection rating [A]	30	30	30	30	30
Defined min. creepage distance [mm]	12.5	12.5	12.5	12.5	12.5
Defined min. clearance distance [mm]	12.5	12.5	12.5	12.5	12.5
Max. operational altitude [masl]	≤2000	≤2000	≤2000	≤2000	≤2000
Design load – downwards [Pa]	3600	3600	3600	3600	3600
Design load – upwards [Pa]	1600	1600	1600	1600	1600
Safety factor for mechanical load	1.5	1.5	1.5	1.5	1.5
Number of solar cells	156	144	132	132	108
Connection of cells (S, SP, PS)	SP	SP	SP	SP	SP
Number of diodes	3	3	3	3	3
Cells per diode	52	48	44	40	36
Temperature Coefficient for V_{oc}	-0.216%/ C				
Temperature Coefficient for I_{sc}	+0.041%/ C				
Temperature Coefficient for Pmax	-0.291%/ C				

Table 6: TECHNICAL SPECIFICATION FOR M10 TOPCON BIFACIAL MODULES

7.5. BYPASS DIODES

- Bypass diodes divert current from the cell strings in the event of partial shading
- If hot spot occurred, the diode will come into operation to stop the main current from flowing through the hot spot cells in order to prevent module over-heated and performance loss
- In case of any failure, diode replacement of Potted Junction Box is not possible. If the bypass diode stops working, then the only way to correct the problem is to replace the complete Junction box with new one. To replace Junction Box SHPV recommends contacting the supplier

Note: The Warranty Claim is Void if the replacement of Junction Box is not done under the presence of SHPV Personnel

7.6. SELECTION OF INVERTER AND COMPATIBILITY

- Connect the required quantity of modules, which corresponds to the Voltage specifications of the Inverters used in the system. When installed as per IEC norms and regulations, SHPV modules normally do not need to be electrically connected to earth and can operate with either galvanically isolated (with transformer) and transformer less inverters. If the system is located in hot and very humid locations, then galvanically isolated Inverters with Transformers must be used and the negative pole of the array must be connected to earth. It is recommend to adopt inverter negatively-earthed-installation to avoid the PID effect. If a Transformer less Inverter is used in hot humid climatic locations, the Installer should ensure that the right active negative earthing kit is to be installed by consulting and having assurance from the Inverter supplier

8. MAINTENANCE AND CARE

All solar module types described in this manual are designed to operate in outdoor conditions for long periods. However, it is recommended to follow the basic procedures that are described below in order to obtain the best performance from the solar photovoltaic modules;

- Well-designed PV Plant requires minimum maintenance but however with further maintenance the performance and the reliability of the system can be improved
- Check that the mounting structures are properly laid and the modules are held tightly and are in accordance with the mounting instructions given in Section 6
- Ensure all the cable assembly is tight and no part of cable assembly will be exposed to water logging
- Do not open the junction box to change the diodes even if they are defective. Please contact with PV module manufacturer in case of known or suspected diode failure
- Do not make modifications to any component of the PV module (diode, junction box, connectors or others)
- Regular maintenance is required to keep modules clear of dust, bird droppings, seeds, pollen, leaves, branches, dirt spots and snow
- SHPV recommends cleaning the soft dirt (like dust) on modules just with air pressure. This technique can be applied as long as the method is efficient enough considering the existing

conditions

- If grease is present, an environmental friendly cleaning agent may be used with caution
- Snow should be removed using a soft brush
- Periodically inspect the system to check the integrity of all wiring and supports
- To protect against electric shock or injury, electrical or mechanical inspections and maintenance should be performed by qualified personnel only
- Product should be recycled in useful renewable method after end of its life cycle SHPV is recommending the installers to clean the modules as explained in the below procedure
- When there is a noticeable build-up of soiling deposits on the module surface, wash the PV array with water and a gentle cleaning implement (a sponge, or a non-conductive brush) during the cool part of the day. Dirt must never be scraped or rubbed away when dry, as this will cause micro-scratches
- Ensure that any brushes or agitating tools are constructed with non-conductive materials to minimize risk of electric shock and that they are not abrasive to the glass or the aluminium frame
- The power output from the module is strongly influenced by the transparency of the Cover/front glass. Over a period of time dust could accumulate on the glass and reduce the solar light passing through the glass which in turn reduces the performance of the module. In order to restore the module performance, clean the glass with plain water. In most cases plain water is adequate. However, if there are any hard stains, it could be removed by gently wiping/mopping with soft cotton/sponge
- Aluminium frames could get discoloured due to bird droppings. It is recommended to use mild soap or detergent to clean the Aluminium surface. Wear gloves while cleaning, as sharp edges on the Aluminium frame can cause injury
- While cleaning be careful not to drop any objects on the module surface. The module surface is made of glass and can get damaged easily. A damaged module increases the risk of electrical shock. Any damaged module must be immediately replaced by a new module
- Periodic inspection of the mounting structure and electrical connections must be carried out and any loose connections must be corrected immediately
- The module should be cleaned when the irradiance is lower than 200 W/m², suggested module cleaning time: In the summer, before 6 AM, and after 7 PM; In the winter before 7 AM, and after 6 PM
- Do not touch the surface of module with bare hands.
- Do not walk, stand or sit on the module while cleaning
- Do not clean the module which has cracked glass or damaged cable

8.1. CLEANING INSTRUCTION

- The module must not be covered by grass, animal droppings or other debris, otherwise it can cause decrease in power, hot spots, or combustion
- It is recommended to inspect modules for cracks, damage cable joints and loose connections before cleaning of the modules. It is also recommended that personnel shall wear appropriate Personal Protective Equipment (PPE) during cleaning

- Personal Protective Equipment (PPE) matrix is essential for ensuring the safety of workers during the installation and cleaning of solar modules the recommended PPE for various tasks associated with solar module installation and maintenance given in below table
- The specific PPE required can vary based on the job site risk assessment and local regulations ensure compliance with the latest local safety standards.

Task	PPE Required
General Installation	Safety helmet, safety glasses, gloves, high-visibility vest, steel-toed boots
Electrical Work	Insulated gloves, safety glasses, face shield
Working at Heights	Safety harness, fall arrest system, helmet with chin strap
Cleaning Modules	Electrically insulating gloves, non-conductive footwear, goggles

Table 7: LIST OF PPE MATRIX

- While cleaning rear side of bifacial module, avoid any sharp objects that may cause damage or penetrate the base material other cleaning requirements are same as front side.
- Modules that are mounted flat (0 tilt angle) should be cleaned more often, as they will not self clean as effectively as modules at a 10 tilt or greater
- 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 75mg/L. In case mineral content of water used is more than 75mg/L but less than 200mg/L, the water must be squeezed off to prevent scale build up over module surface. A long handle commercially available ‘squeeze’ may be used
- Do not use abrasive cleaners, de-greasers or any unauthorized chemical substance (e.g. oil, lubricant, pesticide, etc.) on the module
- Do not use cleaning corrosive solutions containing hydrofluoric acid, alkali, acetone, or industrial alcohol. Only substances explicitly approved by SHPV are allowed to be used for cleaning modules
- Noticeable dirt must be rubbed away by gentle cleaning implement (soft cloth, sponge or brush with soft bristles
- Cleaning Time: The recommended time for cleaning modules is during low light conditions when production is lowest. The best time to clean modules is from dusk to dawn when the plant is not in operation and risk of electrical shock hazard is minimum
- 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
- Removing Stubborn Marks: To remove stubborn dirt such as birds dropping, dead insects, tar etc., use a soft sponge, micro-fibre cloth or a non-conductive non-abrasive brush. It is recommended to soak the dirt point with water/water jet for some time before using the sponge/brush. Rinse the

module subsequently with plenty of water

- The back surface of the solar module doesn't require any specific cleaning unless any dirt or debris is stuck on the back sheet. While cleaning the dirt on the back sheet avoid any sharp object, which can damage the substrate material and cause a slit
- Module Safety Instructions: Ensure brushes or agitating tools are not abrasive to glass, EPDM, silicone, aluminium, or steel Ensure any brushes or agitating tools are constructed with non-conductive materials to minimize risk of electric shock
- However 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
- Once a year, or as required as per site conditions, check that growing foliage has not caused module shading. Correct if this condition has occurred
- As required, check that the system voltage and current output (or power output) is consistent with the expected output. Such a check will help to determine if array cleaning is needed, if there are loose or corroded connections, or if there is a component problem

8.2. MODULE APPERANCE INSPECTION

Check module cosmetic defects with naked eyes, especially:

- Module glass cracks.
- Corrosion at welding parts of the cell main grid (caused by moisture into the module due to damage of sealing materials during installation or transportation)
- Check whether there are traces of burning mark on the module back sheet
- Check PV modules if any signs of aging including rodent damage, climate aging, connector's tightness, corrosion and grounding condition.
- Check if any sharp objects in contact with PV modules' surface
- Check if any obstacles shading the PV modules
- Check if any loose or damage screws between the modules and mounting system. If so, adjust and fix in time

8.3. INSPECTION OF CONNECTORS AND CABLES

It is suggested to carry out the following preventive inspection twice a year:

- Check the tightness of the connectors and cables.
- Check if any crack or gap of silicone nearby the junction box

IMPORTANT: All cleaning and maintenance operations are to be done by trained personnel only. If the modules are mounted on high roof or on an area which is at a specific height from the ground level, the people involved in cleaning operations must wear appropriate safety harness.

8.4. OTHERS

Figure 15: PV MODULES UNDERGOING SHADING

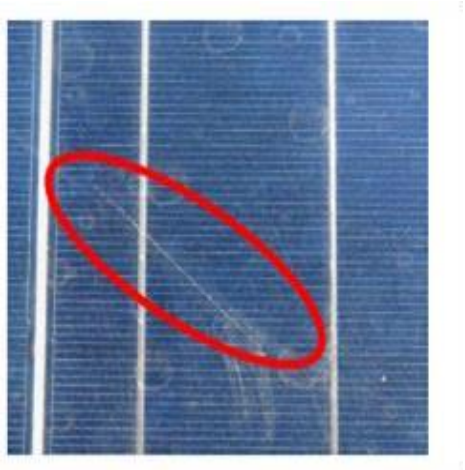

Figure 16: DAMAGED PV MODULES

- In order to maintain system security, and provide maximum efficiency, Electrical and Mechanical failures needs to be tested by an authorized personnel
- Check whether the module and the bracket is fixed firmly, if not, it may cause the module to be overturned by wind
- Check whether the grounding line, and modules are in good condition
- Check whether the cable or other components are on top of the module, this may cause cell cracks, decreased power, and in some cases hot spot

Figure 17: IMPROPER PV MODULES MOUNTING AND CONNECTION

9. DISPOSAL AND PRODUCT LIFE CYCLE

- If the modules need to be disposed off, kindly contact the manufacturer, or it can be done in accordance with the local laws for landfills. In either case, customer is requested to intimate the manufacturer
- Safe disposal of PV Modules suggests de-commissioning of the Modules, such that no harmful materials are released to the environment. At the end of the module's life cycle, the module and the various parts involved during manufacturing could be recycled. If the solar panels are not reused or recycled, there can be a significant wastage of raw materials
- PV Modules are made of various components, and each component has different properties (seen with respect to hazardous/non-hazardous, recyclable/non-recyclable). Most common recycled components of the PV modules are glass (front cover), aluminium frame and solar cells. Recycling these components, do not pose any threat to the surroundings. The Ethylene Vinyl Acetate (EVA) Encapsulant, and Polyvinyl Fluoride Substrate are typically not recoverable, but can be removed through thermal process. Junction boxes can be removed from the module manually. Dispose the module as per E-Waste Local Regulation and policy of that region (i.e. E-Waste Regulations of the Country) and dispose modules through authorized E-Waste management agencies. Furthermore, few components can be recovered, if the modules are defective, broken, or not needed by the customer. Some of these components are also used in electronic products. Therefore, Standard Recycling practices can be followed
- "Meaning of crossed–out wheeled dustbin: Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of inland fills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new ones, the retailer is legally obligated to take back your old appliance for disposal at least free of charge.

10. WARNING

- While performing any type of electrical maintenance, the system should be isolated / shutdown and maintenance should be performed by well trained professionals. Any failure to follow instructions may results in lethal electric shocks, burns, other injuries and sometimes death. SHPV is not responsible for any type of accident in Power Plants using SHPV Modules
  (Lors de l'exécution de tout type de maintenance électrique, le système doit être isolé/arrêté et la maintenance doit être effectuée par des professionnels bien formés. Tout non-respect des instructions peut entraîner des décharges électriques mortelles, des brûlures, d'autres blessures et parfois la mort. SHPV n'est responsable de tout type d'accident dans les centrales électriques utilisant des modules SHPV)
- This documentation includes a statement advising that artificially concentrated sunlight shall not be directed onto the front or back face of the PV module (if not qualified for)
  (Cette documentation comprend une déclaration indiquant que la lumière du soleil artificiellement concentrée ne doit pas être dirigée sur la face avant ou arrière du module PV (s'il n'est pas qualifié pour cela)

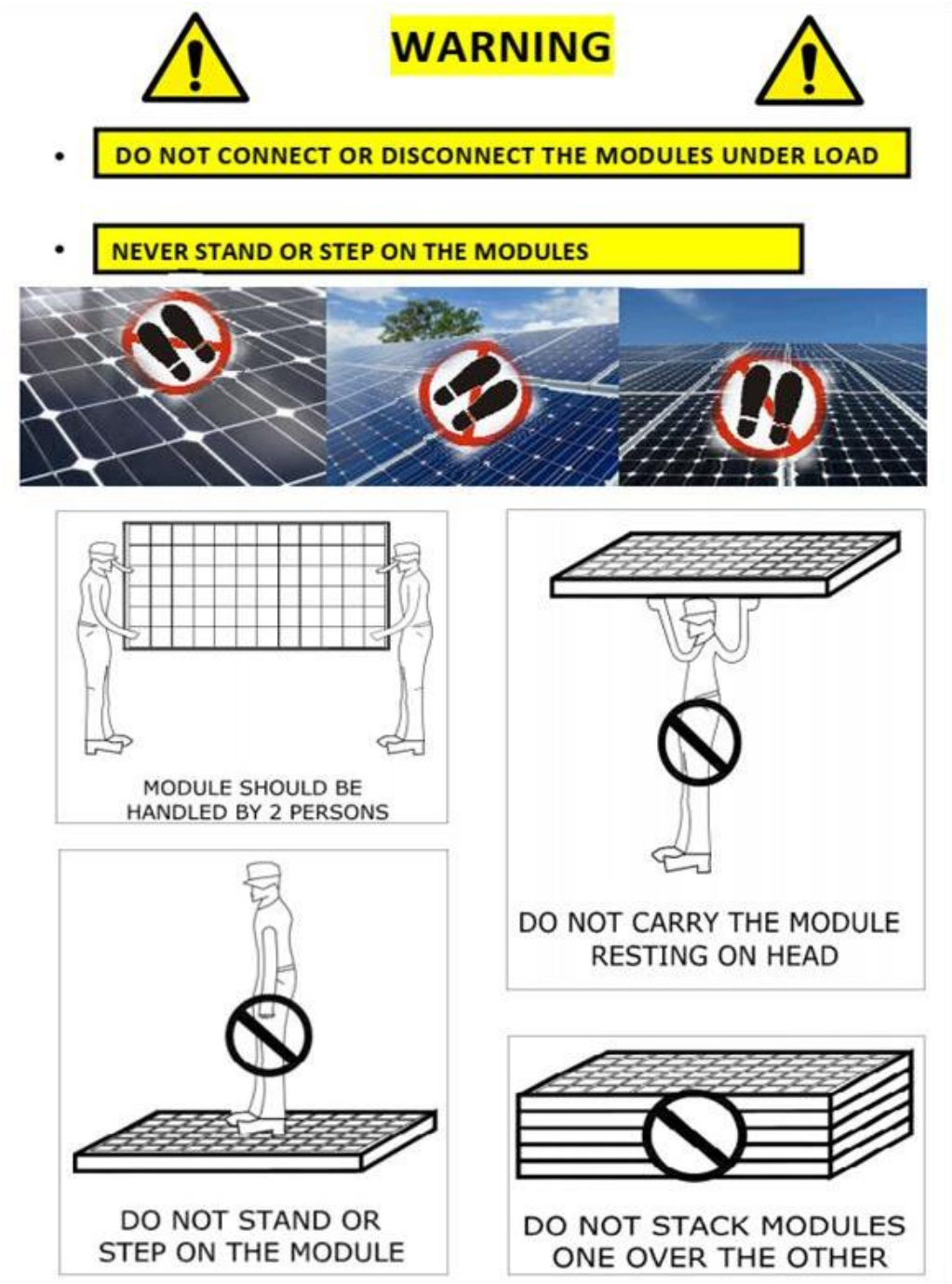

Figure 18: PV MODULES WARNINGS

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