

DENIM INSTALLATION MANUAL

This installation manual applies to modules manufactured by Denim as per type and power class outlined in the table on page 1 of this installation manual.

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www.denimsolar.com

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1. Introduction

This installation manual includes essential electrical and mechanical installation information which you must be aware of before handling and installing the Photovoltaic Modules (hereinafter “Modules”) manufactured by Denimsolar(hereinafter “Denim”). Key safety information is also included in this manual and you should get familiar with such information.

This installation manual does not constitute explicit or implicit quality warranty.

IMPORTANT NOTIFICATION :

- This manual contains important safety instructions for the installation, handling, maintenance of Modules. When installing Modules, please follow all safety precautions as well as local codes and regulations.
- Installing solar systems requires specialized skills and knowledge. Installation should only be performed by professional and qualified personnel.
- Before installing, installers should have a thorough understanding of this manual and keep this manual in safe place for further reference.
- If any questions, please contact Denim Customer Service Department (Email: support@solarclarity.nl) for further information.

2. Disclaimer of Liability

As the installation, handling and use of Denim PV modules are beyond company control, Denim shall not be liable for loss, damage, injury or expense resulting from the improper installation, handling, use or maintenance.

No responsibility is assumed by Denim 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 under any patent or patent rights.

Denim reserves the right to revise datasheets and installation manual without prior notice.

3. Codes and Regulations

The mechanical and electrical installation of PV Modules shall conform to relevant applicable laws, such as electrical codes, building codes and electric utility interconnect requirements. These requirements may differ for installation locations, such as building rooftop or motor vehicle applications. Requirements may also vary with system voltage, and for DC or AC application. Please contact local authorities for specific regulations.

4. Applied Products

This installation manual applies to modules manufactured by Denim as per type and power class outlined in the table as below. Please note: XXX in the column represents the relevant power classes. Module types not included in this table are not subject to this installation manual.

Type of Module	Power Class(XXX)
DENIM U MI XXX BB 144H DENIM U MI XXX BW 144H DENIM U MI XXX WW 144H	350 - 415
DENIM U MI XXX BB 120H DENIM U MI XXX BW 120H DENIM U MI XXX WW 120H	295 - 345
DENIM U M2 XXX BB 144H DENIM U M2 XXX BW 144H DENIM U M2 XXX WW 144H	410 - 460
DENIM U M2 XXX BB 120H DENIM U M2 XXX BW 120H DENIM U M2 XXX WW 120H	345 - 380

5. General Safety Precautions

5.1 Product Identification

Each module is labeled with nameplate and serial number to identify the product.

Nameplate: It’ s labeled on the back of each module and it describes module type, peak power, peak power current, peak power voltage, open circuit voltage, short circuit current under standard test conditions (STC), also includes weight, dimension and maximum system voltage of 1000V/1500V DC.

Serial number: Each module has a unique and traceable serial number when it’ s manufactured. Three serial number labels can be found for each module.

1. One is located below the nameplate on the back of modules.
2. You may also find such serial number solidified inside the module permanently and it can be seen from front of the module and be used to identify the module in the future.
3. You may find the third serial number label on the side of module frame.

5.2 General Safety

Denim modules are designed to meet the requirements of IEC 61215 and IEC 61730, application class A, safety class II. Modules rated in such application class can be used in system operating at greater than 50V DC or 240W, where general contact access is anticipated.

When PV Modules installed on rooftops, it’ s a must that the roof has a fire resistant covering suitable for such application. Before installing rooftop system, it’ s necessary to have construction experts or engineers run an assessment for the entire structure. The rooftop shall be proved to be capable of withstanding additional weight of PV system components, including PV Modules, rails etc.

For your safety, please ensure certain precautions are taken such as ladders, stairways & personal protective measures before performing the installation.

PV modules can produce DC current when exposed to illumination, thus leading to electrical shock or burn. Any contact with 30V or larger DC voltage is potentially lethal.

Important Notification:

- Do NOT install or handle modules in rainy, heavily windy or snowy days or on damp or sandy roofs. Please carry out installation in dry conditions with dry tools.
- Do NOT contact with electrically active parts of the modules, such as terminals, regardless of connection of the modules.
- Do NOT use or install a module with broken glass or torn back sheet.
- Do NOT concentrate sunlight onto the modules artificially.
- Do NOT make holes in the frame, do not reconnect or repair junction box cable.
- Do NOT try to disassemble the modules and do not remove the labels on the back sheet.
- Do NOT stand, step or walk on modules.
- Do NOT paint or write on the surface and the back sheet.
- Do NOT touch the module when it's energized.
- Do NOT bend cables. It may cause module damage.
- Please ensure that the polarity of each module or a string is not reversed considering the rest of the modules or strings.
- Please ensure that all connections are securely made with no gap between contacts. Any gap may result in electrical arcing that can cause a fire hazard and /or an electric shock.
- To avoid arcs and electrical shock, please do not break down electric connection under load.

5.3 Handling safety

- Please remove metallic jewelry, wear insulated gloves and use proper personal protective equipment when handling the modules.
- Do NOT lift or move the modules with the junction box or cable.
- Do NOT allow objects to fall on modules.
- Do NOT drop the modules.
- Do NOT allow any mechanical stress to the modules.

5.4 Fire Safety

Please consult your local authority for codes and regulations of building or structural fire safety before installation. For fire safety class, Denim Modules are rated as Class C according to UL790.

For rooftop installation, modules shall be installed over a fire resistant layer or materials and suitable for this application. Please ensure that the modules back sheet and mounting surface are adequately ventilated.

Roof constructions and installations may affect the fireproof performance of buildings. Improper installation may lead to hazards in the event of fire.

To guarantee the fire safety class, the distance between module frame and roof surface should be larger than 10cm.

Adopt appropriate components such as fuses, circuit breaker and grounding connector as required by local codes and regulations.

5.5 Storage and unpacking

- Modules should be stored in a ventilated, rain-proof and dry location. Please do not remove the original packing until installation.
- When storing the modules, pallets can be stacked but not exceeding two. If pallets are stored outside temporarily, a protective covering is required to protect pallets against direct weathering and do not stack more than one pallet.
- Do NOT place modules directly on top of each other.
- Two persons are required for unpacking, when handling modules, both hands are required.
- At the installation site, please keep modules and their electrical contact clean and dry before installation. Any modules with corrosive contacts should not be used.

6. Mechanical installation

6.1 Selection of installation site

- Modules can be mounted in landscape or portrait orientation.
- Do NOT install modules near flammable gas/vapors.
- Do NOT install modules in close proximity to air conditioning systems.
- Modules shall be installed in places free of shading to obtain the maximum yield of the PV system. The shading area may also increase the temperature of the shaded areas, resulting in power loss and a decrease of lifetime.
- Modules can be installed to withstand the extreme working temperature from -40 C to 85 C.
- Please ensure that installed modules do not suffer wind or snow pressure exceeding the permissible maximum load limit.

Please do not install PV modules in a location where they' ll be immersed in water or continually exposed to water from a sprinkler or fountain etc.

- Please ensure that lightning protection will be performed for modules installed in places with frequent lightning and thunder.
- Please carry out protective measures to ensure safe and reliable installation of modules in severe environment such as heavy snow, cold and strong wind or island close to water and salt mist or deserts.

Notes: Installing modules can accelerate the processes of electrical insulation losses and galvanic corrosion. Corrosion may happen when a frame is connected to the bracket or where grounding is connected. Denim PV Modules are applicable for installation 500m or more away from the coastline. If you want to install your system closer than 500m away from the coastline, please contact Denim technical department for installation guide.

6.2 Selection of installation tilt angles

Modules will obtain maximum power output if facing to the sunlight directly. Modules are preferred to face the south in the north hemisphere and face the north in the south hemisphere.

Modules connected in series shall be installed with same orientation and tilt angle. If difference occurs, it may result in different solar irradiation and output power loss.

A minimum tilt angle 10 degree is suggested so that dust on the surface can be washed away more easily. The mostly suitable installation tilt angle relies on the corresponding latitude. Professional PV system simulating software is recommended to obtain such data.

6.3 General requirements

- Please ensure installation methods and supporting system of modules is strong enough for modules to withstand expected load. The installer or supporting system supplier shall provide necessary guarantee. The installation supporting system must be tested by the third-party institute with static mechanical analysis capacity in comply with local national or international standards.
- Module mounting structure shall be made from durable, corrosion-resistant and UV-resistant material.
- Modules shall be securely attached to mounting structure.
- Select higher mounting structure where heavy snow may accumulate, preventing the lowest edge of modules from being covered by snow for a long time. In addition, ensure that the lowest edge of modules high enough to avoid shading by plants or trees or damage by sands and stones.
- When modules are installed on mounting structure parallel to the roof or wall, a minimum gap of 10cm between the modules frame and the surface of the wall or roof is required for air ventilation, so that to avoid wiring damage.
- The minimum gap between two adjoining modules frame is 10mm because the modules frame may experience thermal expansion.
- Ensure that back sheet of modules not be in contact with bracket or building structure that may damage the surface of back sheet, especially when the modules are under mechanical load.
- Modules have been certified for a maximum static load 5400 Pa on the front(snow load) and 2400 Pa on the back(wind load), these values can vary depending on installation method of the modules (please refer to following installation guide), the described load in this manual is for the test load. Note: According to IEC 61215-2016 installation requirements, the safety factor of 1.5 times needs to be taken into consideration when computing the relevant maximum design load.

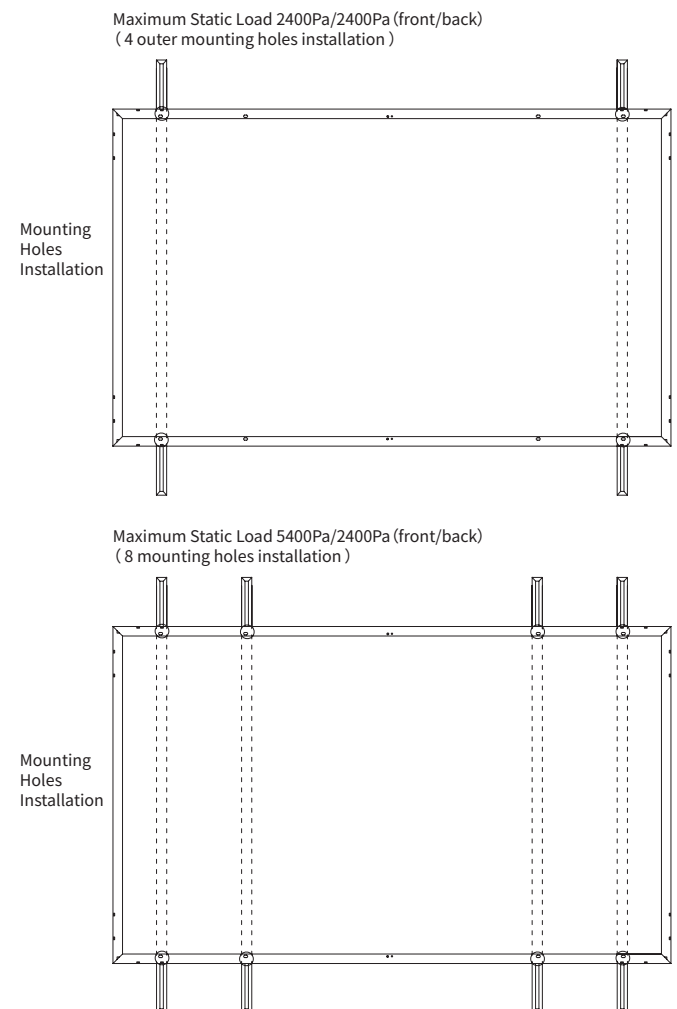
6.4 Installation methods

Denim solar panels can be installed with mounting holes or clamps. Suggested installation methods are as below:

6.4.1 Installation by mounting holes (Figure 1)

Each module has 8 mounting holes in the frame, and the numbers of usage of mounting holes depend on required mechanical load. Modules shall be bolted to mounting structure through mounting holes in the frame. Installers may use corrosion-resistant M8 bolt, a flat washer and a spring washer to fix modules on the bracket. The tightening torque range is 14~20N.M.

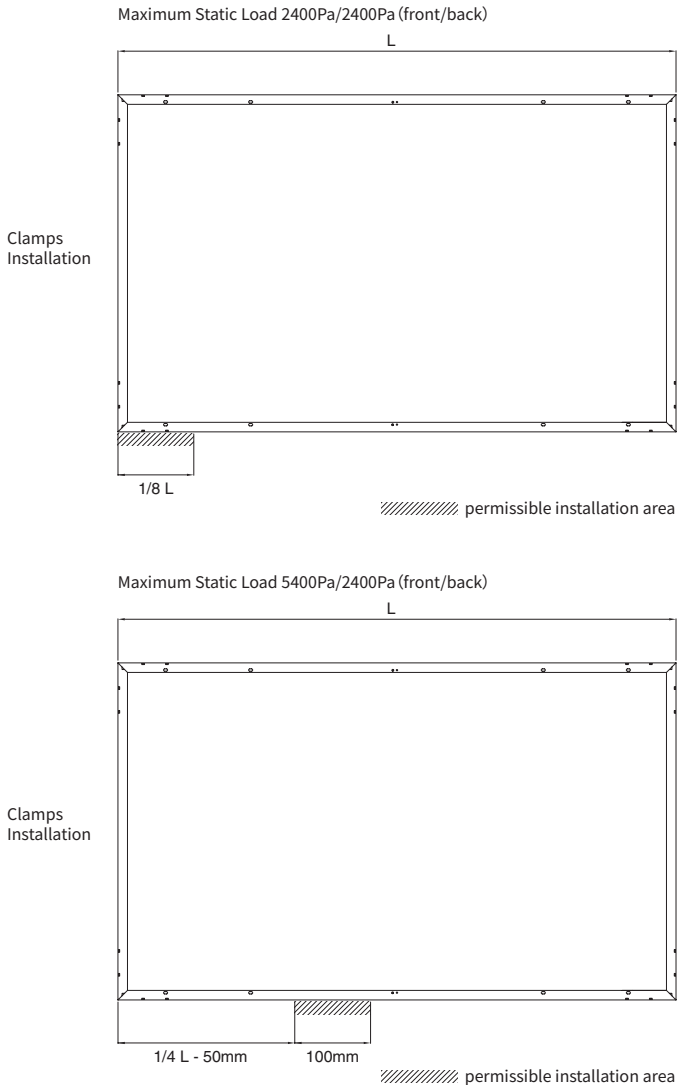
(Figure 1)



6.4.2 Installation by clamps (Figure 2)

Modules can be mounted with specialized clamps. Under no circumstances should the clamps touch the glass or deform the frame of the component. The surface of clamps which is in contact with the front of frame shall be smooth and flat, otherwise the frame will be damaged. The drainage holes shall not be blocked by clamps. Be sure to avoid shading effects from the clamps. It is suggested to use the clamps which are wider than 50mm and of aluminum alloy or approved by system installation. Recommended torque range is 18~24 N.M.

(Figure 2)



7. Electrical Installation

7.1 Electrical Performance

Module electric performance parameters such as I_{sc} , V_{oc} and P_{max} nominal values have $\pm 3\%$ tolerance under standard testing conditions of: irradiance of 1000 W/m^2 , cell temperature of 25°C and air mass of AM1.5. When modules are connected in series, the final voltage is sum of the single module. When modules are connected in parallel, the final current is sum of the single module. Modules with different electric performance models cannot be connected in series.

Under normal conditions, the modules may produce more current or voltage than reported at Standard Test Conditions. Accordingly, the values of short circuit current & open circuit voltage marked on modules shall be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fusing sizes, and size of controls connected to modules output.

The maximum number of modules that can be connected in one series string shall be calculated in comply with relevant regulations. The open circuit voltage value under the expected lowest temperature shall not exceed the maximum system voltage value stipulated for modules and other values required by DC electric parts. The maximum system voltage of Denim modules is DC 1000V/ 1500V based on IEC61730.

The maximum number of the modules can be installed in one series string can be calculated as below:

$$N = \frac{V_{MAX}}{V_{oc} [1 - \beta \times (25 - T)]}$$

N: The maximum number of modules in series;

V_{MAX} : Maximum system voltage;

V_{oc} : Open circuit voltage of single module;

β : Temperature coefficient of V_{oc} of the selected module;

T: The expected lowest temperature of the installation site.

Please use over-current protection device with the same specifications to protect the modules, if reverse current could exceed the value of the maximum fuse rating of the modules as shown on the label or datasheet. An over-current protection device is required if more than two strings are connected in parallel.

7.2 Bypass diodes

Junction boxes of Denim Modules contain bypass diodes wired in parallel with the PV cell strings. If hot spot occurs with the module, the bypass diodes start to work to prevent main current from flowing through the hot spot cells, so that module heating and power loss could be limited. Please notice that bypass diodes are not over-current protection devices.

If the diodes are found to be out of function, installers or maintenance providers should contact Denim. Please do not try to open the junction box by yourself.

8. Grounding

The modules use an anodized corrosion-resistant aluminum alloy frames as rigid support. The frame of modules should be grounded to prevent lightening and static damage. The grounding device should fully contact the aluminum alloy and should penetrate the oxide film on the surface of the frame.

Please do not drill additional grounding holes on the frame, otherwise the warranty will be void.

The grounding conductor or strap may be copper, copper alloy, or other material acceptable for use as an electrical conductor in accordance with National Electrical Codes. The grounding conductor must then connect to earth using a suitable earth ground electrode.

9. Operation and Maintenance

IMPORTANT NOTIFICATION: Before carrying out operation and maintenance, please shut down the system.

9.1 Visual Inspection

This is to check that if modules are of appearance defects. Normally we suggest to inspect items as below:

- whether the glass is broken or not;
- whether there's corrosion of the cells' bus-bar;
- whether there's burning traces on the modules' back sheet; whether there's any object on the surface of the modules.

9.2 Inspection of connectors and cables

It's recommended to carry out the preventive maintenance every six months as below:

- Check whether the encapsulation of the connector with the cable is intact;
- Check the junction box to make sure it's well sealed and there's no crack.

9.3 Cleaning

Modules perform the best with completely unobstructed access to sunlight for most or all of the day. Due to leaves, bird droppings and airborne particles (from dirt and pollen), PV modules can become dirty, leading to power loss of your solar system. The degree of influence is determined by the transparency of wastes/dust. In general, small amount of dust will not affect power output remarkably. While large amount of dust accumulated on the surface of the glass might reduce power output and even lead to regional hot spot.

When you clean the PV Modules, you are cleaning the glass and frames of the modules. You may clean the modules with soft sponge or cloth and clean water which is close to the temperature of the modules. Do not use acid and alkaline detergents to clean modules. Do not use tools with rough surface to clean the modules. Any tools which may scratch the modules or damage the coating of the glass and frames are not suggested. To avoid potential risk of electrical shock, do not try to clean the modules with broken glass or exposed wires.

We do not suggest to clean modules in the daytime. Cleaning is suggested at the beginning of early morning or evening with less sunlight. Denim suggests that there should be no obstructed objects on or over the surface of modules at any time.

The frequency of cleaning depends on dirt accumulating speed. In many cases, the glass of the modules might be cleaned by rain. It is recommended to clean once in six months or at least once in a year to ensure the best performance of the system.

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