

# UL Installation guide for solar photovoltaic module

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#### **Purpose of this guide**

This guide contains information regarding the installation and safe handling photovoltaic module (hereafter is referred to as “module”).

Installers must read and understand the guide before installation. Any questions, please contact our sales department for further explanations. The installer should conform to all safety precautions in the guide and local codes when installing a module.

Before installing a solar photovoltaic system, installers should become familiar with the mechanical and electrical requirement for such a system. Keep this guide in a safe place for future reference (care and maintenance) and in case of sale or disposal of the modules.

#### **General**

- Installing solar photovoltaic systems may require specialized skills and knowledge. Installation should be performed only by qualified persons.
- Each module comes with a permanently attached junction box and #12AWG wire terminated in connectors. Fitted cables can be provided to customers for ease of installation if desired.
- Installers should assume the risk of all injury that might occur during installation, including, without limitation, the risk of electric shock..
- One individual module may generate DC voltages greater than 30 volts when exposed to direct sunlight. Contact with a DC voltage of 30V or more is potentially hazardous.
- Do not disconnect under load.
- Photovoltaic solar modules change light energy to direct-current electrical energy. They are designed for outdoor use. Modules may be ground mounted, mounted on rooftops, vehicles or boats. Proper design of support structures is responsibility of the system designers and installers. Use of mounting holes is suggested in a following paragraph.
- Do not attempt to disassemble the modules, and do not remove any attached nameplates or components from the modules.



- Do not apply paint or adhesive to module top surface.
- Do not use mirrors or other magnifiers to artificially concentrate sunlight on the modules. Do not expose backsheet foils directly to sunlight.



When installing the system, abide with all local, regional and national statutory regulations. Obtain a building permit where necessary.

***Safety precaution for installing a solar photovoltaic system***

- Solar modules produce electrical energy when light shines on their front surface. The DC voltage may exceed 30V. If modules are connected in series, the total voltage is equal to the sum of the individual module voltages. If modules are connected in parallel, the total current is equal to the sum of individual module currents.
- Keep children well away from the system while transporting and installing mechanical and electrical components.
- Completely cover the module with an opaque material during installation to keep electricity from being generated.
- Do not wear metallic rings, watchbands, ear, nose, lip rings or other metallic devices while installing or troubleshooting photovoltaic systems.



- Use only insulated tools that are approved for working on electrical installations.
- Abide with the safety regulations for all other components used in the system, including wiring and cables, connectors, charging regulators, inverters, storage batteries and rechargeable batteries, etc.
- Use only equipment, connectors, wiring and support frames suitable for a solar electric system. Always use the same type of module within a particular photovoltaic system.
- The electrical characteristics are within  $\pm 10$  percent of the indicated values of  $I_{sc}$ ,  $V_{oc}$ , and  $P_{max}$  under standard test conditions (irradiance of  $100\text{mW}/\text{cm}^2$ , AM 1.5 spectrums, and a cell temperature of  $25^\circ\text{C}$  ( $77^\circ\text{F}$ ))
- Under normal outdoor conditions the module will produce current and voltages that are different than those listed in the data sheet. Data sheet values are values expected at standard test conditions. Accordingly, during system design, values of short-circuit current and open-circuit voltage should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor ampacity, fuse ratings and size of controls connected

- to the modules or system output.
- Refer to section 690-8 of the National Electrical Code for an additional multiplying factor of 125 percent (80 Percent derating) which may be applicable.

### **Product identification**

Each module has two labels on its rear side providing the following information:

- Nameplate: describes the product type; rated power, rated current, rated voltage, open circuit voltage, short circuit current, all as measured under standard test conditions; weight, dimension etc. The maximum system voltage for UL listed modules is 600 volts DC and is shown on the nameplate. Maximum fuse rating is also shown.
- Bar code: each individual module has a unique serial number. It is permanently attached to the interior of the module visible when viewing from the front of the module. This bar code is inserted at the beginning of laminating.

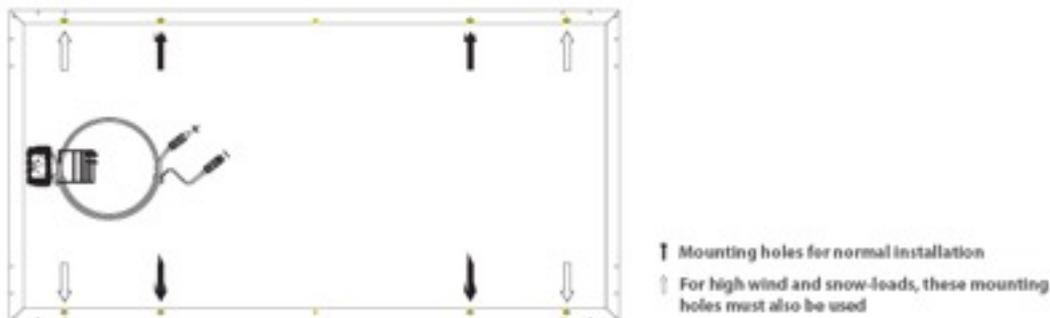
### **Mechanical Installation**

#### ● **Selecting the location**

- Select a suitable location for installing the modules.
- The modules should be facing south in northern latitudes and north in southern latitudes.
- For detailed information on the best elevation tilt angle for the installation, refer to standard solar photovoltaic installation guides or a reputable solar installer or systems integrator.
- The module should not be shaded at any time of the day.
- Do not use module near equipment or in locations where flammable gases can be generated or collected.

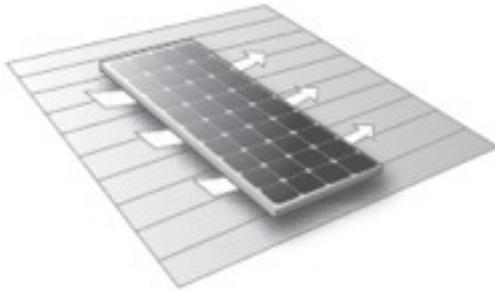
#### ● **Selecting the proper support frame**

- Always observe the instructions and safety precautions included with the support frames to be used with the modules.
- Do not attempt to drill holes in the glass surface of the modules. To do so will void the warranty.
- Do not drill additional mounting holes in the frame of the modules. Doing so will void the warranty.
- Modules must be securely attached to the mounting structure using four mounting points for normal installation. If additional wind or snowloads are anticipated for this installation, additional mounting points are also used. The details please see the below drawing. Load calculations are left to the system designers or installers.



- The support module mounting structure must be made of durable, corrosion-resistant and UV-resistant material.
- **Ground mount**
  - Select the height of the mounting system to prevent the lowest edge of the module from being covered by snow for a long time in winter in areas that experience heavy snowfalls. In addition, assure the lowest portion of the module is placed high enough so that it is not shaded by plants or trees or damaged by sand and stone driven by wind.
- **Roof mount**
  - When installing a module on a roof or building, ensure that it is securely fastened and cannot fall as a result of wind or snow loads.
  - Provide adequate ventilation under a module for cooling (10cm minimum air space)

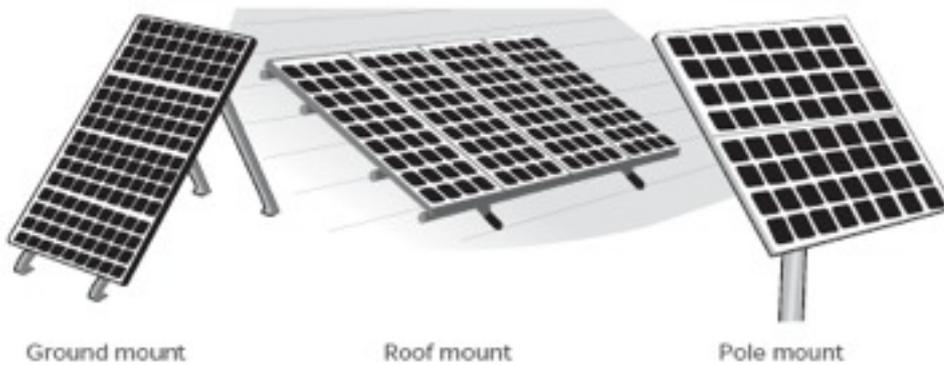
between module and mounting surface).



- When installing module on a roof, ensure that the roof construction is suitable. In addition, any roof penetration required to mount the module must be properly sealed to prevent leaks.
- In some cases, a special support frame may be necessary.
- The roof installation of solar modules may affect the fireproofing of the house construction.
- The modules are rated fire Class C, and are suitable for mounting over a class A roof. Do not install modules on a roof or building during strong winds in case of accidents.

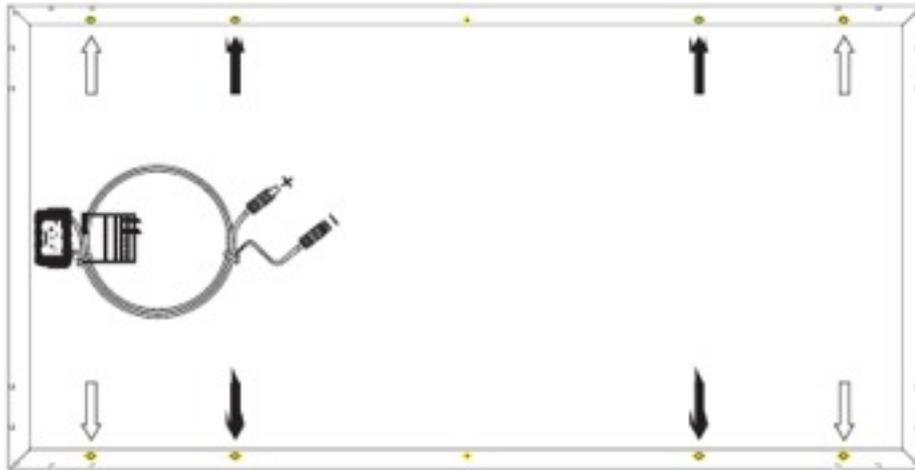
- **Pole mount**

- When installing a module on a pole, choose a pole and module mounting structure that will withstand anticipated winds for the area.



- **General installation**

- Module mounting must use the pre-drilled mounting holes in the frame.
- The most common mounting is achieved by mounting the module using the four symmetry points close to the inner side on module frames.
- If excessive wind or snow loads are expected, all eight mounting holes must be used.
- Do not lift the module by grasping the module's junction box or electrical leads.
- Do not stand or step on module.
- Do not drop module or allow objects to fall on module.
- To avoid glass breakage, do not place any heavy objects on the module.
- Do not set the module down hard on any surface.
- Inappropriate transport and installation may break module.



- ↑ Mounting holes for normal installation
- ↑ For high wind and snow-loads, these mounting holes must also be used

### ***Electrical Installation***

This guide describes some of the most important typical uses as representative examples.

- **Grid-connected electrical system**

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

- **Grounding**

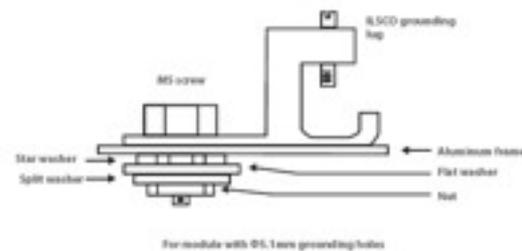
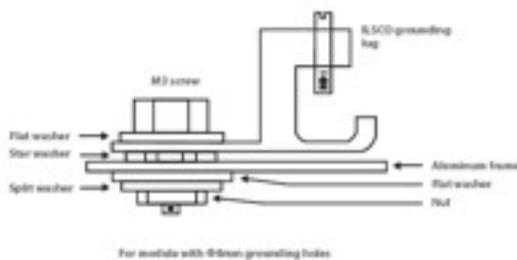
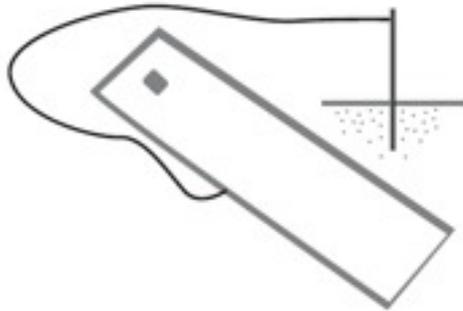
- The module frame must be properly grounded. The grounding wire must be properly fastened to the module frame to assure good electrical contact. Use the recommended type, or an equivalent, connector for this wire.
- If the support frame is made of metal, the surface of the frame must be electroplated and have excellent conductivity.
- We recommend the lay-in lug (Cat. No. GBL4-DBT, rated for 600Volts, company: ILSCO, UL number is E34440) when grounding. First strip 16mm insulating jacket from the end of the ground wire carefully to avoid nicking or cutting conductors, insert the wire to the feet of the lug (see the picture), and screw down the slotted screw. Be careful not to damage the wire core. And then tighten up the screw.



Insert ground wire here ↑

Next, assemble the recommended ILSCO grounding lug to the aluminum frame using stainless steel M3 or M5 screw and hardware as shown below. Note: there are two different size grounding

holes, the smaller of which is being phased out. Further, buildup of hardware for mounting the grounding lug are the same—except for the M3 screw, an added flat washer is mounted directly under the M3 screw head. The star washer is fitted directly under the grounding lug and makes electrical contact by penetrating the anodized coating of the aluminum frame. The screw assembly is further fitted with a flat washer, then a split lock washer and finally a nut to secure the entire assembly, as shown. Recommended torque of M3 or M5 screw assembly is 0.8NM or 1.5 NM.

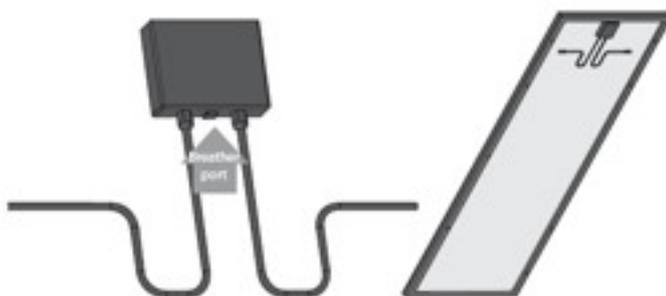


- **General installation**

- Do not use modules of different configurations in the same system. The max. number of module (N) =  $V_{max \text{ system}} / [V_{oc}(\text{at STC})]$ .
- Several modules are connected in series and then in parallel to form a PV array, especially for application with a high operation voltage. If modules are connected in series, the total voltage is equal to the sum of individual voltages.
- For applications requiring high currents, several photovoltaic modules can be connected in parallel; the total current is equal to the sum of individual currents.
- Module is supplied with connectors to use for system electrical connections.

Consult rated local wiring regulations to determine system wire size, type, and temperature.

- The cross section area of cable and the capacity of connector must be selected to suit the maximum system short circuit current (Recommended cross section area of cable is 12AWG for a single module and rated current of a connector is larger than 10A), otherwise the cable and connector will be overheated under large current. Please note that the upper limit temperature of cable is  $\geq 85^{\circ}\text{C}$ , and the connector is  $\geq 105^{\circ}\text{C}$ .
- The junction box has a breather port. The breather port must be mounted facing down and can not be exposed to rain. Therefore, the junction box must be on the higher side of the module when it is mounted.



### *Commission and Maintenance*

- **Blocking diodes and bypass diode**

- Blocking diodes prevent current flowing from the battery to the module when no electricity is being generated. It is recommended to use blocking diodes when a charging regulator is not used. Your specialist dealer can advise you the suitable types.
- In systems with more than two modules in series, high reverse current can flow through cells that are shaded partially or outright when part of a module is shaded and the rest is exposed to the sun. These currents can cause the affected cells to get very hot and could even damage the module. To protect module from such high reverse currents, by-pass diodes are used in module. All modules rated greater than 55 Watt have bypass diode already integrated in the junction box. In the unlikely event of diode failure, a replacement can easily be made.
- Protect yourself from electricity shocks while debugging or maintaining the solar power system.

#### ■ **Testing, commissioning and troubleshooting**

- Test all electrical and electronic components of the system before using it. Follow the instructions in the guides supplied with the components and equipment.

#### ■ **Testing modules connected in series before they are connected to system.**

- Check the open-circuit voltage of every series module by a digital multimeter (Fluke 170 series are recommended). The measured values should correspond to the sum of the open-circuit voltage of the individual module. You will find the rated voltage in the technical specifications of the type of the module used. If the measured value is significantly lower than the expected value, please proceed as described under “Troubleshooting an excessively low voltage”.
- Check the short-circuit current of every series circuit. It can be measured directly by a digital multimeter (Fluke 170 series are recommended) connected in the two terminals of series circuit or module, or with any load such as PV illumination to make a rough measurement. Attention, the rated scale of the ammeter or the rated current of load should more than 1.25 times of the rated short-circuit current of series module. You will find the rated current in the technical specifications of the type of module used. The measured value can vary significantly, depending on weather conditions, the time of day and shading of the module.

#### ■ **Troubleshooting low voltages**

Identify the commonly low voltage and excessively low voltage. Commonly the low voltage mentioned here is the decrease of open-circuit voltage of the module, which is caused by the temperature rising of solar cells or lower irradiance. Excessively low voltage is typically caused by improper connections at the terminals or defective bypass diodes.

- First, check all wiring connections to make sure it is not open-circuit or is not connection well.
- Check the open-circuit voltage of each module:
- Fully cover the modules with an opaque material.
- Disconnect the wiring at both terminals of the modules.
- Remove the opaque material from the module to be checked and measure the open-circuit voltage at its terminals.
- If the measured voltage is only half of the rated, this indicates a defective bypass diode. Refer to ‘Testing and replacing bypass diodes’.
- In the case of not very low irradiance, if the voltage across the terminals differs from the rated value by more than 5 percent, this indicates a bad electrical connection.

#### ● **Maintenance**

The following maintenance is recommended in order to ensure optimum performance of the module:

- Clean the glass surface of the module as necessary. Always use water and a soft sponge or cloth for cleaning. A mild, non-abrasive cleaning agent can be used to remove stubborn dirt.
- Check the electrical and mechanical connections every six months to verify that they are clean, secure and undamaged.
- If any problem arises, have them investigated by a competent specialist. Attention, observe the maintenance instructions for all components used in the system, such as support frames, charging regulators, inverters, batteries etc.