

# Photovoltaic Module Safety & Installation Manual

**NOTICE!** Please carefully read and understand the contents of this installation manual before installing, wiring, or operating Upsolar products in your PV system. Failure to follow all proceeding terms and conditions will void Upsolar's "Limited Warranty for PV Modules".

STC = 1000 W/m<sup>2</sup> AM 1.5 25°C

Always refer to your local regulations when sizing conductors, fuses, inverters, and other Balance of System (BOS) components.

## 1.0 INTRODUCTION

Thank you for choosing Upsolar photovoltaic (PV) modules. Our goal is to provide you with high quality PV modules to ensure a secure long-term investment.

This installation guide, provided by Upsolar Global Co., Ltd. and supplied with Upsolar products, contains information regarding proper handling, installation, and maintenance of Upsolar modules.

All instructions in this manual should be read and fully understood by all parties before any attempt to install Upsolar PV modules. PV project designers and installers should always comply with all safety precautions listed within this manual as well as with any local or jurisdictional codes that pertain to PV installations.

Upsolar reserves the right to make changes to its products and installation manual without prior notice to the customer.

Please contact [support@upsolar.com](mailto:support@upsolar.com) for any additional questions or explanations.

### 1.1 Liability Conditions

The installation techniques, handling and use of Upsolar's products are beyond Upsolar's control. Therefore, Upsolar does not assume responsibility for loss, damage or expenses resulting from improper installation, handling or use of its products.

### 1.2 Limited Warranty

All Upsolar product warranties are listed in the Upsolar warranty conditions which can be downloaded from the Upsolar global website: [www.upsolar.com](http://www.upsolar.com).

## 2.0 SAFETY PRECAUTIONS



Before installing or operating modules, please read and understand all safety instructions in this manual!

**Module Installation** should only be carried out by qualified individuals.

- **Always** follow and observe all appropriate regional and jurisdictional electric codes.
- **Always** use properly insulated and/or rated electrical and mechanical tools during installation of PV modules.
- **Always** mount PV modules over a fire resistant roof, when mounting on a roof (refer to IEC 61730-1 clause 12.4).
- **Always** ground all PV modules according to the local electrical codes.
- **Always** use only one type of PV module within a PV string.
- **Do not** step on or put heavy/sharp objects on PV modules.
- **Do not** disconnect modules under load.
- **Do not** use artificial methods, like applying water, to cool a PV module.
- **Do not** touch a PV module terminal box or the end of output cables. Avoid wearing metallic jewelry or devices attached to the body during installation.
- **Do not** install PV modules in wet or windy conditions.
- **Do not** drill extra holes in module frame or glass surface.
- **Do not** store or install PV modules in the vicinity of flammable gases or materials.
- **Do not** disassemble any part of the PV module.
- **Do not** expose the PV modules to artificially concentrated sunlight (refer to IEC 61730-1 clause 12.5).

## 3.0 ELECTRICAL CHARACTERISTICS OF A PV MODULE

It is very important to understand that a PV module can have electrical characteristics different from the Standard Test Conditions (STC) rating on its nameplate. Atmospheric conditions can increase the module's current and/or voltage to higher levels than those reported in STC.



## WARNING!



All installation and mounting instructions must be read and properly understood before attempting to install, wire, and/or operate PV modules. PV modules generate DC electricity when exposed to light. This can pose danger to the installer, user, and/or property. Any contact with electrically active module terminals can result in arcing, potentially leading to shocks, burns, fires, and/or death.

PV modules are electrically live when mounted and installed.

**Danger:** Electrical hazard increases with parallel connections (higher currents) and series connection (higher voltages) of PV modules.

The PV installer must assume all inherent risk of property damage and/or personal injury related to the mishandling of PV modules during installation and maintenance.

"Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of  $I_{sc}$  and  $V_{oc}$  marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output." (Extract from IEC 61730-1 clause 12.7 and UL1703 clause 48.9)

"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." (Extract from UL1703, clause 48.6)

## 4.0 ELECTRICAL CONFIGURATIONS

### 4.1 General Wiring

Please follow all module specification and jurisdictional laws regarding interconnection of PV modules. Modules can be connected in both series and parallel to attain the desired electrical output.

**Combined source circuits should contain only one type of PV module.**

Conductors must meet or exceed the following requirements (refer to IEC 61730-1 clause 12.3):

- Size: minimum 4.0 mm<sup>2</sup> (12 AWG) for modules connected in series
- Temperature rating (-40°C to +90°C)
- Type PV-wire, USE-2 or equivalent

### 4.2 Maximum Voltage (for series connections)



The maximum PV system voltage for a circuit should be calculated as the sum of the rated open circuit voltage of the series-connected PV modules (corrected for the lowest expected ambient temperature). Open Circuit Voltage should be used to determine the voltage rating of all other BOS (Balance of System) components in the system

The open voltage of each string must never exceed the maximum system voltage value defined by local regulation (refer to IEC 61730-1 clause 12.3). Refer to the Upsolar datasheets for PV module temperature coefficients and electrical values needed for this calculation.

### 4.3 PV Module and Equipment Grounding



Please refer to the applicable regional and local codes in regards to grounding PV modules and other PV system components.

If PV modules' individual grounding is required by local legislation, Upsolar PV modules should be grounded through the frames, using one of the provided grounding holes (Figure 1). Please refer to NEC Article 250, 690.41-690.49, and UL Standard 1703 for proper grounding procedures.

Example (refer to IEC61730-1 clause 12.3): remove any anodization or oxidation from the module frame at the grounding lug point of contact. Apply a thin coat of anti-oxidant film, then use a stainless steel M3.5 screw (with serrated screwhead to penetrate the frame anodized layer), nut, and lock washer to attach an outdoor rated tin-plated copper lug. Attach an equipment grounding conductor (4mm<sup>2</sup> -12AWG- not provided by Upsolar) to the installed grounding lug (not provided by Upsolar).

#### 4.4 Lightning Protection



PV systems do not generally increase the risk of buildings being struck by lightning. If a lightning protection system currently exists on the installation building, the PV system should be connected to it. To minimize risk in the event of lightning strike, avoid DC cable loops when designing the system.

Surge arrestors on the DC side of the PV system are recommended. If no lightning protection exists, all PV modules should be earth-grounded according to local technical regulations.

#### 4.5 Overcurrent Protection Device (OCPD)

When the potential reverse current of a PV string exceeds the rated Upsolar PV module series fuse rating (values indicated in the module datasheet) an overcurrent protection device (OCPD) must be used (IEC 61730-1 clause 12.3). One or two strings of PV modules in parallel do not require OCPD's, but 3 or more PV strings in parallel will usually require an OCPD. In this case, it is recommended to use one fuse per string rated at  $1.56 \times I_{sc}$  or higher ( $I_{sc}$  is the PV module's short circuit current at STC). Example of fuse types: DCM 600Vdc or PV Fuse 1000Vdc.

Each Upsolar module is equipped with 3 by-pass diodes (Schottky type) connected in parallel of the strings of cells to limit the cells heating up in conditions of partial shading (hot-spot effect). The characteristics of these diodes are:

- Voltage rating:  $V_{RRM} = 45 \text{ V}$
- Current rating:  $I_F = 15 \text{ A}$

### 5.0 MODULE CHARACTERISTICS

#### 5.1 Operating temperature



Always try to provide adequate ventilation around installed PV modules, especially in hot environments. High temperatures have a negative impact on cell performance.

Predetermined nominal temperatures for Upsolar modules:

Maximum Operating Temperature	+90° C	+194° F
Minimum Operating Temperature	-40° C	-40° F

Table 1: UPSOLAR MODULE OPERATING TEMPERATURES

- It is recommended that a space of at least 5cm (2 inches) is maintained between the mounting surface and the PV module.
- A gap larger than 5mm (3/16 inch) is recommended between adjoining modules to allow for thermal expansion.

#### 5.2 PV Module Design Strength

Upsolar PV modules have been tested according to IEC design qualification type EN 61215: 2005 and IEC safety standard EN 61730-1&2:2007 (Application class A, refer to clause 12.1).

Modules rated for use in the application class A may be used in systems operating at greater than 50V DC or 240W, where general contact access is anticipated. Modules qualified for safety through this part of the IEC 61730-1 and IEC 61730-2 safety standards and within this application class are considered to meet the requirements for safety class II.

Upsolar PV modules have passed the mechanical load test to 5400 Pa. This corresponds to a wind speed of approximately 200 km/h.

Upsolar PV modules comply with the test requirements for UL 1703 type 1 fire classification.

#### 5.3 Mounting Hardware

All hardware that comes into contact with the PV module frame should be corrosion and UV resistant. Damage to the module frame or structure could occur if improper materials are used.

To minimize galvanic corrosion, metals compatible with aluminum should be used when in contact with the PV module frame.

Always apply proper torque settings to all mounting hardware according to specifications (see section 6.1). Minimum mechanical means specified by the mounting solution supplier should be used.

#### 5.4 Operating Environments

Do not mount or operate Upsolar PV modules in the following environments:

- Extreme wind
- Extreme temperature (see Table 1)
- Near flammable gasses or materials

For installations on agricultural roofs or in coastal areas, refer to the instructions given in the documents "Upsolar declaration – Ammonia" and "Upsolar declaration – Coastal areas".

For installation in high moisture area (e.g. tropical climate), we strongly recommend to either connect the PV modules to an inverter with transformer and a proper grounding of the negative pole of each string or to confirm that the PV modules are belonging to the PID resistant Upsolar products range before proceeding to the installation.

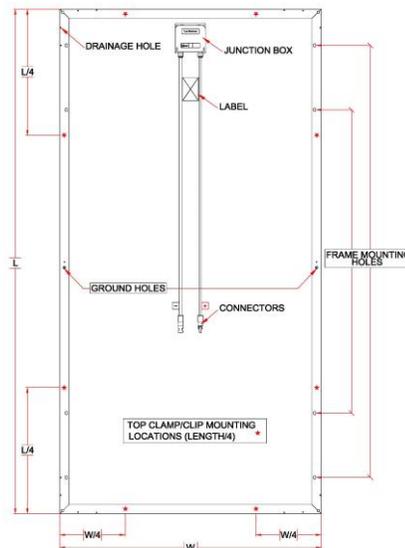


Figure 1 : Module mounting diagram

### 6.0 MOUNTING CONFIGURATION

Always try to select a suitable orientation to maximize the sunlight exposure to the PV module surface. Shading can significantly affect the module and string performance in a PV array.

Sufficient space between the module frame and mounting structure is required to prevent module damage and to reduce high operating temperatures due to poor air circulation.

#### 6.1 PV Module Mounting Techniques

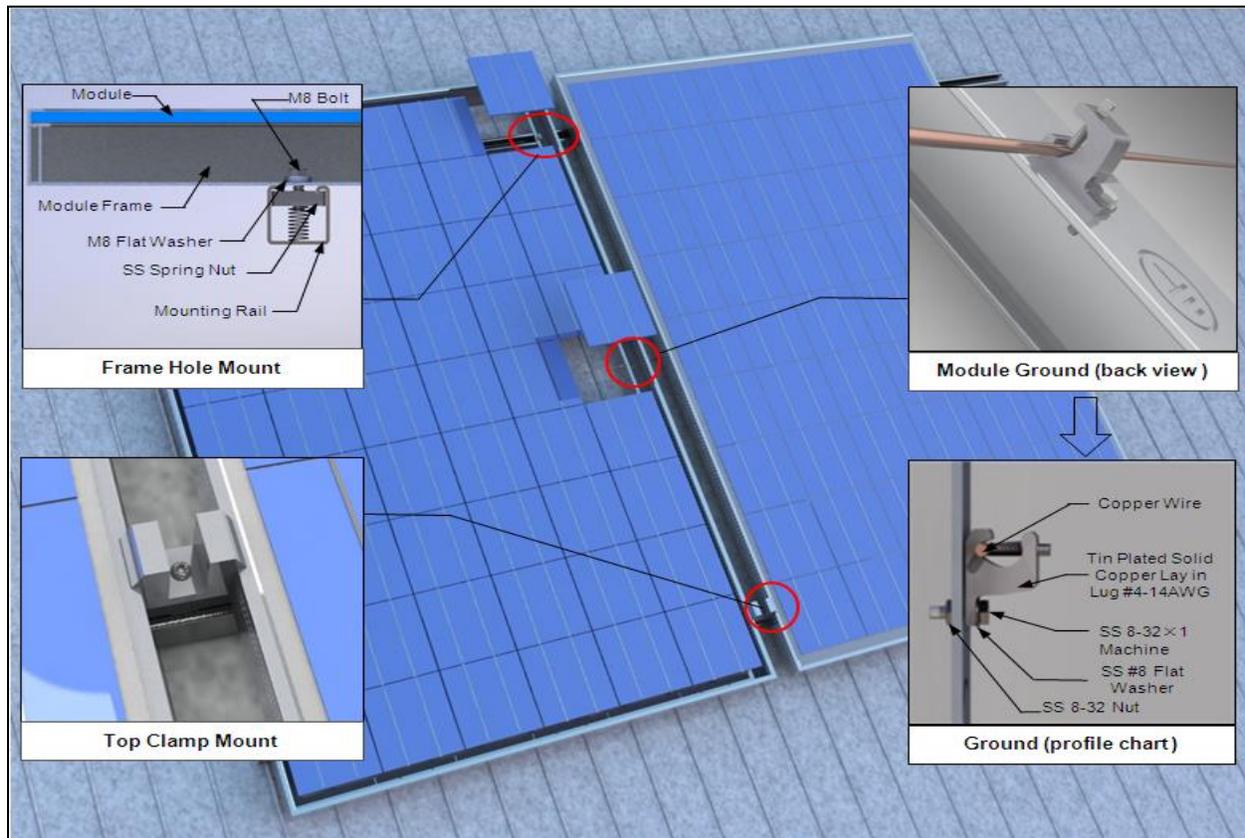


Upsolar PV modules can be mounted either in a vertical or landscape orientation as long as one of the following mounting procedures is followed (refer to IEC 61730-1 clause 12.4)

1. **Mounting Clamps (for open-rack and roof installations):** Attach the PV module to the mounting system using clamps or clips from a certified manufacturer according to their instructions. Clamps or clips should be spaced at  $\frac{1}{4}$  the length or width of the module from the frame ends ( $\pm 5 \text{ cm}$ ). Top mount clamps/clips should always be mounted symmetrically (see Figure 1). Upsolar recommends the following minimum dimensions for each clamp: catch length: 30mm, catch width: 5mm, thickness: 3mm. The torque recommended to fix the clamps is 15 N.m (11.1 lb.ft).
2. **Frame Holes (for open-rack systems):** Attach the PV module to the mounting system using the provided mounting holes. At least 4 points of connection are required between each module and the mounting surface. It is recommended that 4 M6 (1/4") SS bolts with nuts and washers be used on each module. The torque recommended to fix the bolts is 15 N.m (11.1 lb.ft).
3. **End Mount (for open-rack and roof installations):** End mounting implies mounting the length/width of the module's frame to a supporting rail. The end-mounting rail and clips or clamps must be of sufficient strength to allow for maximum design pressure of the module (see datasheet). Verify this capacity with the mounting system vendor before installation.
4. **Slope:** In general, modules should be installed with a slope greater than  $10^\circ$  in order to prevent water stagnation and dirt build-up. Consult local, regional and national building fire statutory regulations

- regarding mounting requirements. Upsolar PV modules have a type 1 fire rating and must be installed over a roof with appropriate fire resistance. A slope less than 5 in/ft (127 mm/305 mm) is required to maintain a fire class rating.
- The module is considered to be in compliance with UL 1703 only when the module is mounted in the manner specified by these mounting instructions.
  - A module with exposed conductive parts is considered to be in compliance with UL 1703 only when it is electrically grounded in accordance with the instructions presented below and the requirements of the National electrical Code
  - Any module without a frame (laminated) shall not be considered to comply with the requirements of UL 1703 unless the module is mounted with hardware that has been tested and evaluated with the module under this standard or by a field inspection certifying that the installed module complies with the requirements of UL 1703
  - The fire rating of this module is valid only when mounted in the manner specified in the mechanical mounting instructions."

Figure 2: Module installation diagram (recommended)



## 6.2 PV Module Handling

- Do not expose the PV module to excessive loads on the surface or bend the module frame. DANGER: Risk of broken glass!
- Do not stand or step on the PV module. The glass may be slippery. DANGER: Risk of injury and electric shock if glass is broken!
- PV modules are heavy, please handle them with care. It is recommended that two qualified personnel handle one PV module at a time.
- Do not hit or put excessive load on the glass or back sheet. PV cells may break.
- Do not twist the interconnect cables excessively. NEVER expose cables, wires, or other electrical parts to water. DANGER: risk of electric shock!
- Do not drill holes in the frame. Modifications to the frame will void the "Limited warranty for PV modules".
- Do not touch the PV module with bare hands. The frame of the PV module has sharp edges and may cause injury. Wear suitable gloves when handling the PV module.
- Do not drop the PV module or allow objects to fall on the PV module.
- The packaging is not resistant to weathering. Store PV modules in a dry place and NEVER expose them directly to water (eg. rain).
- Transport the PV modules to the installation site in the original packaging. Before installation, keep all modules and electrical contacts clean and dry.
- Protect the module cables from mechanical stress during transport and handling. BE CAREFUL: never pull on cables!
- Handle modules with care when lifting them from pallets. Never stack pallets, and stack a maximum of 23 modules per pallet only. Use appropriate Upsolar plastic corners when stacking PV modules.
- Check the PV modules for damage after unpacking.
- Do not install damaged PV modules. When in doubt about the condition of a PV module, please contact Upsolar customer service for advice.
- Always wear protective head gear, insulating gloves and safety shoes (with rubber soles) when installing PV modules.

## 7.0 MAINTENANCE

Annual inspection of the PV modules, array, and BOS is highly recommended. The following items (regarding the PV modules) should be checked periodically to keep the PV system functioning correctly for many years.

- Ensure there is no corrosion on the mechanical connections between the PV modules and the mounting structure. Tighten all loose components to specified torque settings.
- Check all electrical connections between PV modules for corrosion (connectors, cables, and grounds). **DANGER: never disconnect PV modules under load!**
- Make sure PV modules are **clean and free of dirt and dust**. Use water and a soft sponge or cloth for cleaning. A mild, non-abrasive cleaning agent can be used if necessary.
  - Critical cleaning liquid detergent is recommended. Do not use dishwasher detergent!
  - Use water pressure of 45 PSI (3 bar) or less.
  - De-ionized water is recommended if available.
  - Do not use cold water on hot modules.
- Make sure all maintenance work is executed by qualified personnel only.

## 8.0 PV MODULES ELECTRICAL DATA:

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 mW/cm<sup>2</sup>, AM 1.5 spectrum, and a cell temperature of 25°C (77°F)).

For a module or panel containing other than crystalline-silicon cells, the multiplying factor at conditions of an irradiance of 125 mW/cm<sup>2</sup>, AM 1.5 spectrum, and a cell temperature of minus 10°C (plus 14°F) for  $V_{oc}$  and plus 75°C (167°F) for  $I_{sc}$  is to be determined and this factor is to be indicated in the instructions."

Monocrystalline 6" – 60 cells White type	Modules rating at STC (Standard Test Conditions)				
	UP-M260M	UP-M265M	UP-M270M	UP-M275M	UP-M280M
Module type	UP-M260M	UP-M265M	UP-M270M	UP-M275M	UP-M280M
$P_m$ (W <sub>p</sub> )	260	265	270	275	280
$V_m$ (V)	30.4	30.6	30.8	31.0	31.2
$I_m$ (A)	8.55	8.66	8.77	8.87	8.97
$V_{oc}$ (V)	38.3	38.6	38.9	39.2	39.5
$I_{sc}$ (A)	8.96	9.04	9.12	9.20	9.28
Maximum System voltage (IEC)	1000V	1000V	1000V	1000V	1000V
Maximum System voltage (UL)	1000V	1000V	1000V	1000V	1000V
Maximum Reverse Current	20A	20A	20A	20A	20A

Polycrystalline 6" – 60 cells White type	Modules rating at STC (Standard Test Conditions)				
	UP-M250P	UP-M255P	UP-M260P	UP-M265P	UP-M270P
Module type	UP-M250P	UP-M255P	UP-M260P	UP-M265P	UP-M270P
$P_m$ (W <sub>p</sub> )	250	255	260	265	270
$V_m$ (V)	30.6	30.8	31.0	31.2	31.4
$I_m$ (A)	8.17	8.28	8.39	8.49	8.60
$V_{oc}$ (V)	38.0	38.2	38.3	38.5	38.6
$I_{sc}$ (A)	8.50	8.55	8.70	8.78	8.88
Maximum System voltage (IEC)	1000V	1000V	1000V	1000V	1000V
Maximum System voltage (UL)	1000V	1000V	1000V	1000V	1000V
Maximum Reverse Current	20A	20A	20A	20A	20A

Polycrystalline 6" – 72 cells White type	Modules rating at STC (Standard Test Conditions)				
	UP-M300P	UP-M305P	UP-M310P	UP-M315P	UP-M320P
Module type	UP-M300P	UP-M305P	UP-M310P	UP-M315P	UP-M320P
$P_m$ (W <sub>p</sub> )	300	305	310	315	320
$V_m$ (V)	35.9	36.1	36.3	36.5	36.7
$I_m$ (A)	8.36	8.45	8.54	8.63	8.72
$V_{oc}$ (V)	45.6	45.8	46.0	46.2	46.4
$I_{sc}$ (A)	8.66	8.74	8.82	8.90	8.98
Maximum System voltage (IEC)	1000V	1000V	1000V	1000V	1000V
Maximum System voltage (UL)	1000V	1000V	1000V	1000V	1000V
Maximum Reverse Current	20A	20A	20A	20A	20A

## 9.0 REVISIONS AND MODIFICATIONS

Revision #	Revision date	Revised by	Approved by	Modifications done
1.1.1	23-Mar-2008	Spring Yan	Eric Xu	First version of Upsolar manual
1.1.2	15-Jan-2009	Spring Yan	Eric Xu	Details about the 3 types of mounting solutions
1.1.3	13-Nov-2009	Adrien Pellarin	Bijay Lal Shrestha	Series fuses sizing recommendation
1.2.1	21-Jul-2010	Geof Moser	Bijay Lal Shrestha	Completion with UL standards requirements
1.2.2	5-Dec-2010	Geof Moser	Bijay Lal Shrestha	Grounding instruction, mounting structure example
1.3.2	7-Mar-2012	Juliet Gao	Adrien Pellarin	Completion with JET specific requirements
1.3.2	9-May-2013	David Barousse	Adrien Pellarin	PV modules slope specification
1.3.3	29-Aug-2014	David Barousse	Adrien Pellarin	Completion with UL standards requirements
1.3.4	20-Oct-2014	David Barousse	Adrien Pellarin	Completion with JET and MCS requirements
1.3.5	9-Jan-2015	Sam Cai	Adrien Pellarin	Update of products range
1.3.6	13-Nov-2015	Sam Cai	Adrien Pellarin	Update of products range

Further guidance for modules equipped with Tigo maximizer, SolarEdge power optimizer or Solrif framed modules installation can be found online on Upsolar's website; see following link (select "Special products"):

<http://www.upsolar.com/eu/products/>

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