

## Safety and Installation Manual (United States and Canada)

### 1.0 Overview

This manual provides information for the safe installation and operation of EPV SOLAR photovoltaic (PV) modules. Always contact the appropriate authorities to determine permissions, local permitting, installation, and inspection requirements before installation. EPV SOLAR recommends that installations in the United States be in compliance with the latest U.S. National Electrical Code (NEC), that installations in Canada be in compliance with the latest Canadian Electric Code, and that the appropriate national or international electrical standards be followed elsewhere. Retain this manual for future reference.

**Warning!** Carefully read this entire Safety and Installation Manual before attempting to install, wire, operate, and maintain this product. Contact with electrically active parts of the module such as terminals can result in burns, sparks, and lethal shock whether the module is connected or disconnected.

### Disclaimer of Liability

Since the use of this manual and the conditions or methods of system design, installation, operation, use, and maintenance of the module are beyond EPV SOLAR control, EPV SOLAR does not assume responsibility, and expressly disclaims liability, for loss, damage, or expense arising out of or in any way connected with such installation, operation, use, or maintenance. No responsibility is assumed by EPV SOLAR for any infringement of patents or other rights of third parties that may result from use of the module. Liability for defective product shall be limited to replacement of the defective product.

No license is granted by implication or otherwise under any patent or patent rights. The information in this manual is based on EPV SOLAR knowledge and experience and is believed to be reliable; but such information, including product specifications (without limitations) and suggestions, does not constitute a warranty, expressed or implied. EPV SOLAR reserves the right to make changes to the product, specifications, or manual without prior notice.

### 1.1 Underwriters Laboratories (UL) and Intertek (ETL) Listing Information

Please refer to the module's product information sheet for listing and certification details. A Nationally Recognized Testing Laboratory (NRTL) listing means the module meets or exceeds the requirements of UL 1703 for PV modules. The UL 1703 standard covers flat-plate photovoltaic modules and panels intended for installation on or integral with buildings, or to be freestanding.

### 1.2 Limited Warranty

Please refer to EPV SOLAR's General Terms and Conditions of Sale for complete details of the module's limited warranties. Failure to comply with this Safety and Installation Manual will invalidate the EPV SOLAR Limited Warranty for PV Modules as stated in EPV SOLAR's General Terms and Conditions of Sale.

## 2.0 Safety Precautions

Before installing or servicing the module, read and understand all safety and installation information contained in this manual.

**Danger! Electric Shock and Burn Hazard!** Module produces electrical energy when exposed to any light, either direct or diffuse. Extreme care should be taken to prevent electrical shock. Improper connection or disconnection of module leads or contact with damaged or exposed leads could cause injury or death.

*Specifications are subject to revisions without notice.  
20090305*

- 2.1 Modules must be installed in strict compliance with the latest U.S. National Electrical Code in the USA or with the latest Canadian Electric Code in Canada, and any applicable local codes and permitting and inspection requirements must be met.
- 2.2 Modules in the PV array should be completely shielded from exposure to light before making any electrical connection or disconnection.
- 2.3 When modules are connected in series, voltages are additive. When modules are connected in parallel, current is additive. Consequently, a multi-module system can produce high voltages and current that constitute an increased hazard and could cause serious injury or death.
- 2.4 Installation and maintenance of solar modules requires a great degree of skill and should only be performed by qualified licensed professionals, including, without limitation, licensed contractors and licensed electricians.
- 2.5 Modules have no serviceable parts. Damaged modules cannot be repaired and should be replaced.
- 2.6 Extreme caution and good safety practices such as, but not limited to, insulation, isolation, shorting of exposed current carrying parts, the use of properly insulated tools, wearing gloves and appropriate protective clothing, and removal of jewelry should be taken by all persons working with or installing modules to reduce the chance of injury or accidental exposure to live circuits.
- 2.7 Care should be taken to avoid impacting, scratching, dropping, or stepping on modules during installation.
- 2.8 Broken module glass is an electrical safety hazard, and contact with module surface or mounting frame may cause electric shock.
- 2.9 Avoid handling wet modules or installing during high wind periods. Only work in dry conditions, with dry modules and dry tools.
- 2.10 Module's surface may become hot enough to burn skin when in service.
- 2.11 Artificially concentrated sunlight should not be directed on the module.
- 2.12 To avoid the hazard of electrical shock and injury, children and unauthorized persons should not be allowed near the solar modules.
- 2.13 Since sparks may occur, do not install the module where flammable gases or vapors are present.

## 3.0 Module Specifications

For specific electrical performance and mechanical specifications, please refer to the module's product information sheet.

The module electrical ratings are rated at Standard Test Conditions (STC) of 1 kW/m<sup>2</sup> irradiance with AM 1.5 spectrum and a cell temperature of 25° C.

The photovoltaic module has a stabilization process that occurs during the first few months in service, where the power output characteristics are higher than the rated values at STC. During this stabilization period, the power may be between 12% and 20% higher than the rated value, operating voltage may be up to 8% higher, and operating current may be up to 14% higher.

Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at STC. Accordingly, the values of I<sub>sc</sub> and V<sub>oc</sub> marked on this module should be multiplied by a factor of 1.31 and 1.10, respectively, when determining component voltage ratings, conductor ampacities, fuse sizes, and size of controls connected to the PV output. Refer to NEC Section 690-8 for an additional multiplying factor of 1.25 that may be applicable.

Refer to NEC 690.7 for a V<sub>oc</sub> correction factor that is based on ambient air temperatures. If NEC 690.7 is not available, a factor of 1.25 should be used to adjust voltage.

The rated electrical characteristics are within  $\pm 10\%$  of the indicated values of  $I_{sc}$ ,  $V_{oc}$ , and  $P_{max}$  under STC of  $1 \text{ kW/m}^2$  irradiance with AM 1.5 spectrum and a cell temperature of  $25^\circ \text{C}$ .

### 3.1 Fire Rating

The module is Class C fire rated.

## 4.0 Electrical Specifications

With system design being the responsibility of the system designer, EPV SOLAR cannot assume liability for how the modules are installed. We do however provide the following guidance:

### 4.1 Electrical Connections

Modules may be connected in series, parallel, or in a combination of series-parallel to achieve the desired electrical output. Use the same type of modules in an installation.

**Series Connection:** Wire modules in series to produce the desired voltage output. Do not exceed the module's maximum system voltage as indicated in the module's product information sheet.

**Parallel Connection:** Wire modules in parallel to produce the desired current output. Series strings or modules may require fusing when combined with other strings. Please refer to the module's product information sheet for the module series fuse rating and to NEC Article 690 for additional fusing specifications.

### 4.2 Design and Code Compliance

Electrical installation and wiring methods should be in strict accordance with the latest U.S. National Electrical Code in the USA or with the latest Canadian Electric Code in Canada, and any applicable local codes and permitting and inspection requirements must be met.

In Canada the installation shall be in accordance with CSA C22.1, Safety Standard for Electrical Installations, Canadian Electric Code, Part 1.

System design should be done by qualified persons familiar with photovoltaic systems. Care should be taken to observe voltage limitations and over-current specifications. The performance and safety of the modules is dependent on sound electrical system design and installation. System wiring should be 600V, USE-2, and rated sunlight resistant.

### 4.3 Module Wiring with Quick Connect Connector

EPV SOLAR modules are equipped with factory installed wires and quick connectors, and no attempt should be made to modify them. There are no user-serviceable parts in the wiring boot on the back of the module, and it should not be opened.

The module wiring is typically 14 AWG gauge stranded copper wire, rated sunlight resistant with an operating range of  $-40$  to  $90^\circ \text{C}$ .

Observe proper precaution when connecting and disconnecting the quick connect connectors, since the modules produce electricity when exposed to light—both direct and diffuse. The quick connect connectors should never be connected or disconnected while the module is under load. The module may be connected or disconnected when shielded from exposure to light. Once mated for service, the connectors should be located in the array structure in a manner that will avoid casual contact and accidental disconnection.

### 4.4 Grounding

The metal brackets (if part of the modules) are electrically isolated from the current-carrying components of the modules and require no special grounding. The balance of the module contains no exposed conductive parts (except for the wire leads); therefore, grounding of each individual module is not required. Any non-current-carrying conductive parts of the mounting structure must be grounded by methods approved by local standards, as sited in article 690 of the U.S. National Electrical Code. Proper system grounding must be provided to minimize damage to the electrical system in the case of a lightning

*Specifications are subject to revisions without notice.  
20090305*

strike and to facilitate activation of over-current protective devices in the case of electrical faults.

The negative conductor of the module must be grounded. Incorporation of ground fault protection into the electrical system design is the responsibility of the system designer.

EPV SOLAR recommends that safety accomplished by good grounding practices be a high priority in system design. This design should include, but not be limited to, ample grounding electrodes to produce a grounding electrode system of low resistance and of sufficient capacity to carry fault currents that can potentially be developed by the entire electrical system.

### 4.5 Diodes

Amorphous silicon (a-Si) thin-film modules, due to their semiconductor composition, contain two diode structures in series. As a result, external bypass diodes are not provided. It is up to the discretion of the system designer to determine if external bypass diodes are necessary. Should the designer choose to use an external bypass diode, a FAGOR 1N5407 or equivalent diode should be used. This is a silicon rectifier with 800 volt blocking voltage and 3.0 amp continuous current capability.

### 4.6 Series Fuse

At the system designer's option, an external series connected fuse may be installed with a module or string. A four (4) amp fuse rated for 600 volts DC shall be used. Bussmann fuse No. DCM-4 or equivalent meets these requirements.

### 4.7 Reverse Current

Extreme conditions such as module shading or failure could yield temperatures that exceed the specified operation range of the module. This could result in cracking, brief arcing (as conductive material is destroyed), and smoke. It is advised that designers contact EPV SOLAR for design assistance if they are planning a design with a large number of parallel strings.

## 5.0 Handling and Use

EPV SOLAR modules are made with glass, and, although they are robust, they are subject to breakage if not properly handled and installed. Protective gloves should be worn when handling EPV SOLAR modules to protect against sharp glass and burns. Modules should be transported and stored in the shipping container provided. The modules are shipped with corner guards, which should remain on the module during all phases of handling and installation. The guards should be removed and discarded when installation is complete.

To prevent damage to the glass that later may result in cracking, the module should never be left unsupported or be set down on its corner, on concrete, or on any other hard or gritty surface. Suitable resting and inspection surfaces should be prepared before removing the module from the shipping container. Care should always be taken in removing or moving any module so that it does not hit another module or hard object. Do not allow the glass to come in contact with anything that may cause scratches. To avoid the hazard of electrical shock, injury, or damage to the module, never carry the module by its wires.

## 6.0 Module Mounting

The EPV SOLAR Limited Warranty for PV Modules is contingent upon the system designer's consideration of the following factors:

### 6.1 Site Considerations

**Fire Hazard:** In the case of roof mounting, an approved Class C (or better) Fire Rated roofing product must be installed on the roof deck before installation of the module. Refer to local building code requirements for proper selection of roofing product. The roof

construction and the mounting design have an impact on the fire resistance of a building. Improper installation may contribute to fire hazards.

**Ventilation:** A clearance of four inches or more behind the modules is recommended to provide adequate ventilation behind the modules, especially in hot environments. This clearance also allows any condensation or moisture to dissipate.

**Design Strength:** EPV SOLAR modules are designed and tested to a maximum loading of +/- 50 lb/ft<sup>2</sup>. This loading can be a combination of snow, ice, or wind. Care should be taken to mount the modules in a manner that provides sufficient design strength while meeting local code requirements. Design strength of 50 lb/ft<sup>2</sup> corresponds approximately to a wind speed of 125 mph.

**Building Construction:** The building construction or structure (roof, façade, etc.) where the modules are being installed should be of sufficient strength to support the solar installation. For modules mounted on roofs, special construction or structures may be required to provide proper installation support.

**Module Orientation:** EPV SOLAR modules may be mounted at any angle, from horizontal to vertical. Select the appropriate orientation to maximize module exposure to direct sunlight.

**Module Shading:** Shading should be avoided. Shading a portion of a module or one module in a series string significantly reduces the output of all modules in the string and may cause over-heating. Possible sources of shading are mounting hardware, modules in adjoining rows, vegetation, and nearby buildings.

## 6.2 Mounting Structures

Mounting structures should be substantial enough to safely support the weight of the module and any additional external forces such as wind, snow, or ice. As with any glass sheet product, the modules and supporting structures can be damaged by high winds. Therefore, support structures should be designed to hold the modules in maximum wind conditions (considering both uplift and downdraft forces) as well as to support their weight.

The mounting structure should be true and square and of sufficient strength to prevent the modules from warping or twisting when attached. It should also prevent excessive movement or vibration of the modules due to ambient conditions.

Clearance between the module and the mounting surface should be adequate to prevent the wiring boot from touching the surface and to prevent wire damage. The module is not designed for integral mounting as part of a roof or wall.

## 6.3 Attachment Methods

Modules may be mounted at any angle from horizontal to vertical. Select the appropriate orientation to maximize sunlight exposure. Care should be taken to avoid impacting, scratching, dropping, or stepping on the modules during installation. When using a third party Please follow installation instructions as supplied from the mounting structure. If using EPV back brackets the mounting bolts should not be over-tightened, since this could damage the mounting bracket and could compromise the integrity of the mounting. EPV SOLAR recommends tightening securely to a torque of 5 foot-pounds. Warranty against breakage is void if proper mounting practices are not used.

## 7.0 Maintenance

Modules do not require routine maintenance. However it is advisable to perform periodic inspection of modules for damage to glass and periodic inspection of electrical connections for any loose connections and/or corrosion.

## 7.1 Cleaning

Cleaning of modules is normally accomplished by their exposure to rain. The modules' ability to self-clean is facilitated by their frameless construction and by mounting them at a tilt. In extreme environments, dust and soil may accumulate on the module surface and affect performance. Module surfaces may be washed with water and a soft cloth or sponge. Do not use harsh chemicals that may damage the glass surface or leave a residue. Aggressive measures such as using an abrasive pad or scraper must not be used at any time. Please exercise extreme caution when working with water around any electrical apparatus.

## 7.2 Electrical

Associated electrical systems should be maintained in conformance with sound electrical practice. Inspect all modules and wires periodically for the general condition of the wire and to make sure connections are tight, free from corrosion, and free of infiltration from foreign substances.

## 7.3 Damage

Module glass can be damaged by vandalism, catastrophic weather, or accidents. Damaged modules cannot be repaired and should be replaced. The removed EPV SOLAR a-Si modules contain no chemically hazardous materials and should be disposed of properly. Please exercise extreme caution when handling broken or chipped glass.