



# **EVERGREEN SOLAR CEDAR PHOTOVOLTAIC MODULES EC-50 SERIES & EC-100 SERIES INSTALLATION AND OPERATION MANUAL**

Please read this manual completely before installing or using Evergreen Solar's Cedar photovoltaic (PV, solar electric) modules.

## **Safety Precautions**

Photovoltaic modules produce DC electricity when exposed to light and therefore can produce an electrical shock or burn. Modules produce voltage even when not connected to an electrical circuit or load. Modules produce nearly full voltage when exposed to as little as 5% of full sunlight, and both current and power increase with light intensity. Use insulated tools and rubber gloves when working with modules in sunlight.

PV modules have no on/off switch. Modules can be rendered inoperative only by removing them from sunlight, or by fully covering their front surface with cloth, cardboard, or other completely opaque material, or by working with modules face down on a smooth, flat surface.

Modules can produce higher output than the rated specifications. Industry standard ratings are made at conditions of 1000 watts/m<sup>2</sup> and 25°C cell temperature. Reflection from snow or water can increase sunlight and therefore boost current and power. In addition, colder temperatures can substantially increase voltage and power.

Evergreen Solar modules are constructed with tempered glass, but still must be handled with care. If the front glass is broken or if the polymer backskin is torn, contact with any module surface or the frame can produce electrical shock, particularly when the module is wet. Broken or damaged modules must be disposed of properly.

Cedar PV modules are intended for use in terrestrial applications only, thus excluding aerospace or maritime conditions or use with sunlight concentration.

## **Codes and Regulations**

The mechanical and electrical installation of PV systems should be performed in accordance with all applicable codes, including electrical codes, building codes, and electric utility interconnect requirements. Such requirements may vary for mounting location, such as building rooftop, marine, or motor vehicle applications. Requirements may also vary with system voltage, and for DC or AC application. Contact local authorities for governing regulations. In the U.S., all installations should conform to the National Electrical Code (NEC), including Article 690 on Solar Photovoltaic Systems and all other appropriate articles and sections.

## **Mechanical Installation**

Modules may be mounted at any angle from a vertical orientation to a horizontal one. The appropriate fixed tilt angle and azimuth orientation should be used in order to maximize the exposure to sunlight. If a variable-orientation tracking system is used, the modules must never be oriented beyond vertical (with the junction box up), even when stowed. Modules should be bolted to support structures through mounting holes located in the frame's back flanges only. Four 1/4-inch stainless steel bolts, with nuts, washers, and lock washers, are recommended for module mounting. Creation of additional holes for mounting is not recommended and will invalidate the warranty.

The modules are designed for a maximum allowable design pressure of 50 pounds per square foot, which may correspond to a nominal wind speed of approximately 125 mph in certain circumstances. Actual maximum allowable wind speed may be influenced by module type, mounting configuration, location, and other factors. In no case should modules be exposed

to pressures greater than 50 pounds per square foot of uniformly distributed wind, snow, or other loading. Care should be taken to avoid mounting modules in areas that are prone to drifting snow, icicle and/or ice dam formation. For example, a module mounted with its edge located directly above an overhanging roof eave is likely to be subjected to ice dam formation. The weight of an ice dam or icicle can easily exceed the allowable 50 pounds per square foot of uniformly distributed load.

A clearance of four inches or more behind the modules is recommended to permit air circulation and cooler module operation. Elevated temperatures lower operating voltage and shorten module lifetime. Clearance of 1/4 inch or more between modules is required to allow for thermal expansion of the frames.

## Electrical Installation

Modules should be mounted to maximize direct exposure to sunlight and to eliminate or minimize shadowing. Even partial shadowing can substantially reduce module and system output. Furthermore, partial shadowing can elevate the shaded portion's internal temperature, which may lower output and shorten module life. Bypass diodes should be installed according to the instructions in the following sections. Blocking diodes should be installed in series with each module or series string to prevent possible back flow of energy through the module(s) when modules or strings are connected in parallel or used in conjunction with a battery.

Whenever necessary to comply with local codes, use a listed fuse or circuit breaker, rated for the maximum series fuse rating of the module and the system voltage.

All electrical components should have ratings equal or greater to the system rating. Do not exceed the maximum allowable system voltage as listed on the module label.

All module frames should be grounded for safety. The module frame is provided with grounding holes that accommodate self-tapping screws. A #10 stainless steel tapping screw is recommended.

Under normal conditions, a photovoltaic module may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of short circuit current,  $I_{sc}$ , and open circuit voltage,  $V_{oc}$ , marked on

UL-listed modules should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fuse sizes, and size of controls connected to the module output. In the U.S., refer to Section 690-8 of the National Electric Code for an additional multiplying factor of 1.25, which may be applicable.

Rated electrical characteristics are within 10 percent of measured values at Standard Test Conditions of:  $1000 \text{ W/m}^2$ ,  $25^\circ\text{C}$  cell temperature and solar spectral irradiance per ASTM E 892.

### Modules with Quick Connectors

Cedar Line modules are optionally available with factory-installed wires and quick connectors. These modules have been designed to be easily interconnected in series. Each module has two single-conductor wires, one positive and one negative, that are pre-wired inside the junction box. The connectors at the opposite end of these wires allow easy series connection of adjacent modules by firmly inserting the male connector of a module into the female connector of an adjacent module until the connector is fully seated.

A separate return wire or wires may be required to run the positive and negative terminations of the series string of modules to the load. Male and/or female connectors pre-attached to wires may be used at the string terminations for return wire connections and/or for source circuit box terminations.

Modules with factory-installed quick connectors also have bypass diodes installed.

### Modules without Quick Connectors

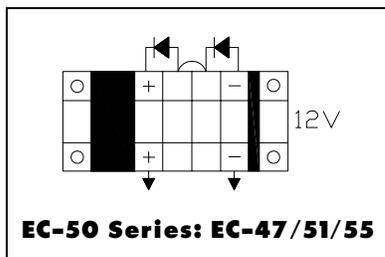
Alternatively, wiring can be done directly within the junction box. The junction box includes a wiring terminal strip with six terminals. In addition, each terminal includes two screws: top (toward the lid hinge) and bottom.

If wiring is to be done inside the junction box, open the lid of the junction box by loosening the single, captive screw. The lid is designed to remain open during wiring. The lid is not designed to be removed from the module, and does not require a gasket. Do not over-tighten the lid screw when securing.

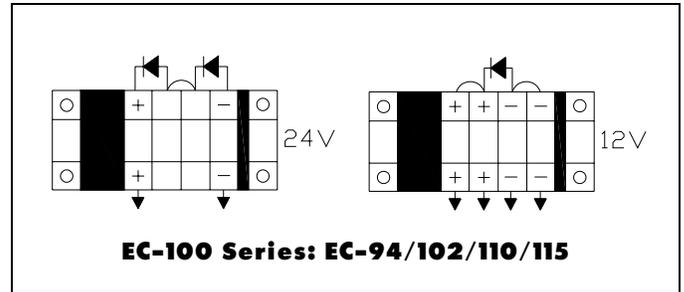
It is recommended that the top screws of the terminals be reserved for the flat jumpers, bypass diodes, or blocking diodes, and that the output wiring remain

attached to the terminal's bottom screws. In this way, the thin leads of the diodes will not be matched with the thicker power wiring, which might lead to poor electrical contact.

EC-50 Series modules, EC-47/51/55, are factory-wired for 12-volt nominal operation and are not intended to be reconfigured for other voltages. It is recommended that bypass diodes be installed, especially if the modules are connected in a series string. The diodes should be rated at 6 amps and at or above the system voltage rating. Such diodes should be installed one every 18 cells, as shown in the following diagram.



EC-100 Series modules, EC-94/102/110/115, can be wired for 12-volt or 24-volt operation by moving the jumpers and diodes, as shown in the following diagram. It is recommended that bypass diodes be installed, especially if the modules are connected in a series string. The diodes should be rated at or above the system voltage rating. Such diodes should be installed one every 36 cells, as shown in the following diagram.



In 12-volt mode, the six terminals include two positive terminals, two negative terminals, and two spare terminals. In the 12-volt configuration, the two positive terminals are electrically equivalent, and either one can be used for power wiring; similarly for the two negative terminals. In 24-volt mode (EC-100 Series modules only), the middle two terminals should not be used for power wiring, only for jumpers and diodes.

### Operation and Maintenance

Inspect the modules periodically for damage to glass, backskin, or frame. Check electrical connections for loose connections and corrosion.

PV modules can operate effectively without ever being washed, although removal of dirt from the front glass can increase output. The glass can be washed with a wet sponge or cloth. Wear rubber gloves for electrical insulation.

*Note: This document may be provided in multiple languages. If there is a conflict among versions, the English language version dominates.*

### Electrical Ratings

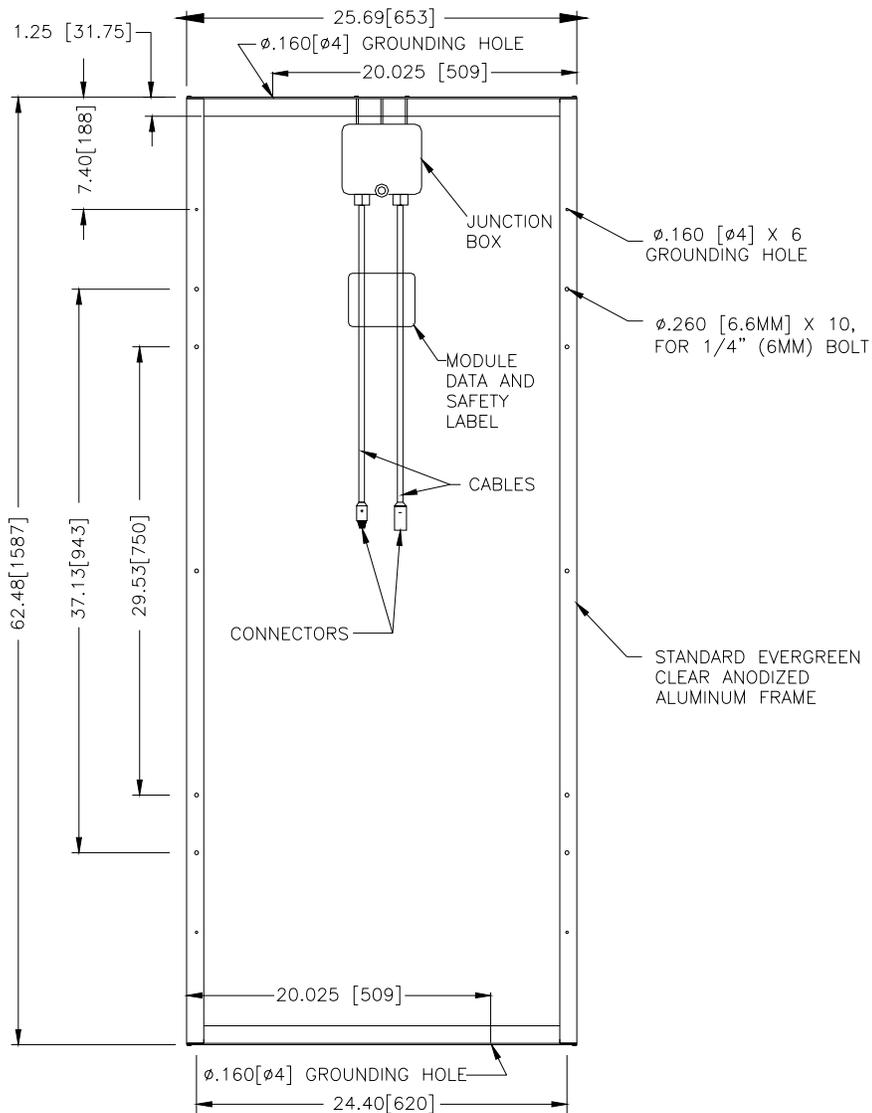
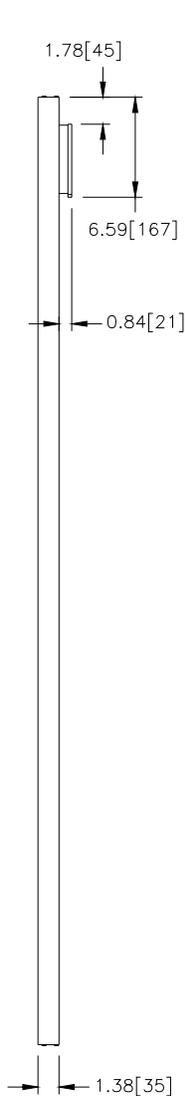
	<b>EC-47</b>	<b>EC-51</b>	<b>EC-55</b>	<b>EC-94</b>		<b>EC-102</b>		<b>EC-110</b>		<b>EC-115</b>	
Pp W	47	51	55	94		102		110		115	
Vp V	16.0	16.2	16.5	15.9	31.8	16.2	32.4	16.4	32.7	16.5	33.0
Ip A	2.94	3.15	3.33	5.91	2.96	6.30	3.15	6.72	3.36	6.97	3.48
Voc V	20.0	20.0	20.0	20.0	40.0	20.0	40.0	20.0	40.0	20.0	40.0
Isc A	3.58	3.70	3.79	7.29	3.65	7.49	3.75	7.67	3.84	7.71	3.86
Cells	36	36	36	72		72		72		72	
Max. Series Fuse	15 A										

Note: EC-94, EC-102, EC-110 and EC-115 have field-selectable voltage. Minimum Specified Power Rating is 90% of above power rating. All modules are factory-inspected to produce at least 96% of above power rating

**EC-94/102/110/115**  
**(Shown with optional quick connectors)**

**Weight:**  
**30 lb**  
**(13.64Kg)**

**Dimensions:**  
**Inches [mm]**



**EC-47/51/55**

**Weight:**  
**15 lb (6.8 kg)**

**Dimensions:**  
**Inches [mm]**

