



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

Warning!
**Electrical Shock and
Burn Hazard**

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/m² 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 extreme 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 minimum allowable design pressure of 50 pounds per square foot, which corresponds to a nominal wind speed of approximately 125 mph. Actual maximum allowable wind speed may be influenced by module type, mounting configuration, location, and other factors.

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

ALL CEDAR LINE MODULES

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.

Each junction box has four knockouts. Any number can be used, either with 1/2-inch conduit or with sunlight-resistant outdoor-rated wiring in conjunction with liquid-tight connectors. Use care removing the knockouts to avoid damaging the module.

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.

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 be 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.

Terminals will accommodate either wire lugs or stripped wire. Each terminal screw will accommodate two stripped wires, one on either side, but it is recommended that wires of different sizes not be mixed under the same terminal screw.

Use copper wiring only, 8-18 AWG, insulated for 90°C minimum, sunlight resistant, type USE, USE-2, TC, UF, SE or equivalent.

Use a listed fuse or circuit breaker, rated for the maximum series fuse rating of the module and the system voltage.

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.

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.

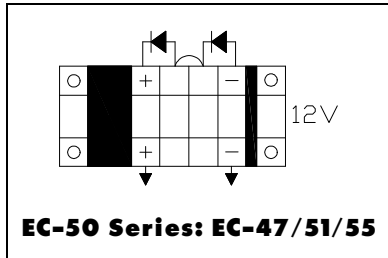
Under normal conditions, a photovoltaic module may experience conditions that produce more current and/or voltage than reported at Standard Test Conditions. Accordingly, the values of short circuit current, I_{sc} , and open circuit voltage, V_{oc} , marked on UL-listed modules should be multiplied by 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 W/m^2 , 25°C cell temperature and solar spectral irradiance per ASTM E 892.

EC-50 SERIES MODULES

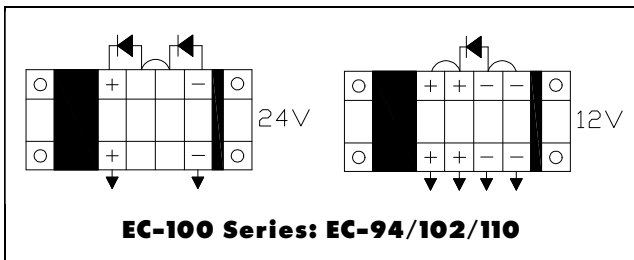
EC-50 Series Modules, EC-47/51/55, are factory-wired for 12-volt nominal operation and are not

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 600V or at least the system voltage rating. Such diodes should be installed one every 18 cells, as shown in the diagram, below.



EC-100 SERIES MODULES

EC-100 Series Modules, EC-94/102/110, can be wired for 12-volt or 24-volt operation by moving the jumpers and diodes, as shown in the diagram, below. It is recommended that bypass diodes be installed, especially if the modules are connected in a series string. The diodes should be rated at 600V or at least the system voltage rating. Such diodes should be installed one every 36 cells, as shown in the diagram, below.



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.

Limited Warranty

Evergreen Solar warrants Cedar photovoltaic modules to be free from defects in materials and workmanship under normal installation, application, and use for one (1) year from the date of manufacture. Evergreen Solar will, at its option, repair or replace the product, or refund the purchase price, if the product becomes inoperable due to a defect in material or workmanship during the warranty period.

Evergreen Solar further warrants for a period of ten (10) years from the date of manufacture that the power rating at Standard Test Conditions will remain at 90% or greater of Evergreen Solar's power rating specified on the label. Evergreen Solar further warrants for a period of twenty (20) years from the date of manufacture that the power rating at Standard Test Conditions will remain at 80% or greater of Evergreen Solar's power rating specified on the label. Evergreen Solar will, at its option, repair or replace the product, refund the purchase price, or provide the purchaser with additional modules to make up lost power, provided that such degradation is determined to be due to defects in materials and workmanship under normal installation, application, and use.

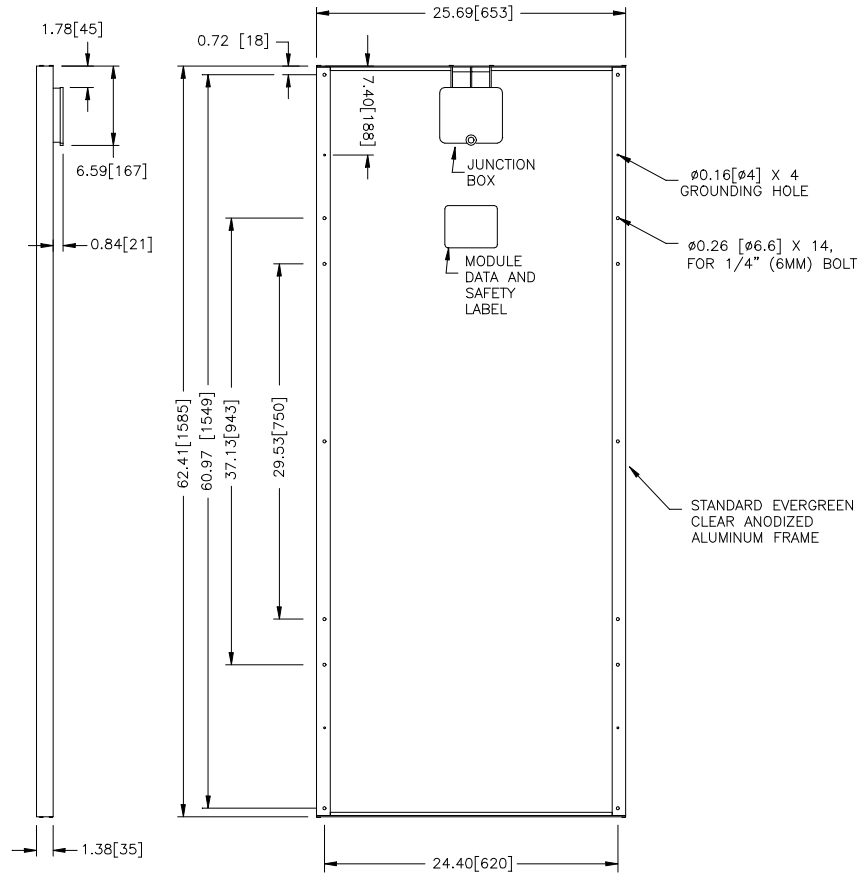
Evergreen Solar is not responsible for any incidental or consequential damages arising from the use or loss of use of the product. Evergreen Solar's maximum liability under any warranty is limited to the purchase price of the product.

For a warranty claim, contact your Evergreen Solar dealer or Evergreen Solar directly about appropriate procedures. This warranty does not cover transportation costs associated with the return of product or costs of installation, removal, or reinstallation.

EC-94/102/110

Weight:
27 lb (12.2kg)

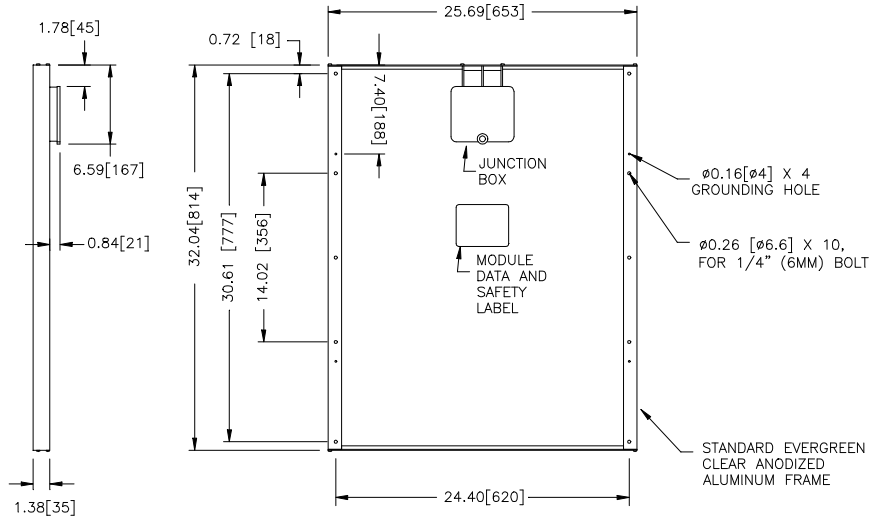
Dimensions:
Inches (mm)



EC-47/51/55

Weight:
15 lb (6.8 kg)

Dimensions:
Inches (mm)



Electrical Ratings

| | | EC-47 | EC-51 | EC-55 | EC-94 | | EC-102 | | EC-110 | |
|------------------|---|-------|-------|-------|-------|------|--------|------|--------|------|
| Pp | W | 47 | 51 | 55 | 94 | | 102 | | 110 | |
| Vp | V | 15.5 | 15.6 | 16.1 | 15.5 | 31.0 | 15.6 | 31.2 | 16.1 | 32.2 |
| Ip | A | 3.04 | 3.28 | 3.42 | 6.08 | 3.04 | 6.57 | 3.28 | 6.84 | 3.42 |
| Voc | V | 20.0 | 20.0 | 20.0 | 20.0 | 40.0 | 20.0 | 40.0 | 20.0 | 40.0 |
| Isc | A | 3.65 | 3.73 | 3.90 | 7.29 | 3.65 | 7.45 | 3.73 | 7.80 | 3.90 |
| Cells | | 36 | 36 | 36 | 72 | | 72 | | 72 | |
| Max. Series Fuse | | 15 A | | | | | | | | |

Note: See label for best estimate of actual electrical performance. EC-94, EC-102, and EC-110 have field-selectable voltage.