



EVERGREEN SOLAR SPRUCE LINE™ PHOTOVOLTAIC MODULES INSTALLATION AND OPERATION MANUAL



WARNING ELECTRICAL HAZARD



Please read this manual completely before installing or using an Evergreen Solar Spruce photovoltaic (PV, solar electric) module. This photovoltaic module produces electricity when exposed to light. Follow all applicable electrical safety precautions. Only qualified personnel should install or perform maintenance work on this module. Do not damage or scratch the rear surface of the module. Do not handle modules when they are wet.

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/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.

Spruce PV modules are intended for use in terrestrial applications only, thus excluding aerospace or maritime conditions or use with sunlight concentration. Excluded applications include, but are not limited to, installations where modules are likely to come in contact with any salt water or where likely to become partially or wholly submerged in fresh or salt water, examples of which include use on boats, docks and buoys.

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 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. They may be mounted in either orientation, in “landscape” or “portrait.” 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. Additional mounting configurations may also be utilized. Contact the factory for more information. 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 power 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 are factory installed (see Electrical Ratings table for details). Blocking diodes may be used where desired to prevent reverse current flows from external sources into the PV array in stand-alone PV systems when the charge controller does not

block such reverse currents. Blocking diodes, when used, may not be substituted for any required overcurrent device.

When reverse currents can exceed the value of the maximum protective fuse marked on the back of the module, a properly rated and certified overcurrent device (fuse or circuit breaker) must be connected in series with each module or string of modules. The rating shall not exceed the value of the maximum protective fuse marked on the back of the module.

All electrical components should have ratings equal to or greater than the system voltage. 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 #10-32 stainless steel thread cutting 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 Electrical 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.

Spruce Line modules are equipped 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.

Warning: Connecting Spruce modules in reverse polarity to a high current source such as a battery will destroy the bypass diodes and render the module inoperative. Bypass diodes are not user replaceable.

Operation and Maintenance

No routine maintenance is required. However it is advisable to perform periodic inspection of the modules 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.

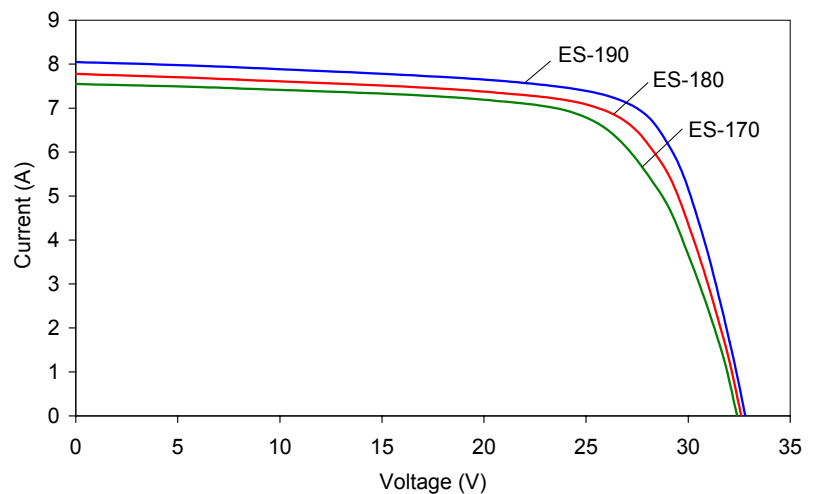
Electrical Specifications*

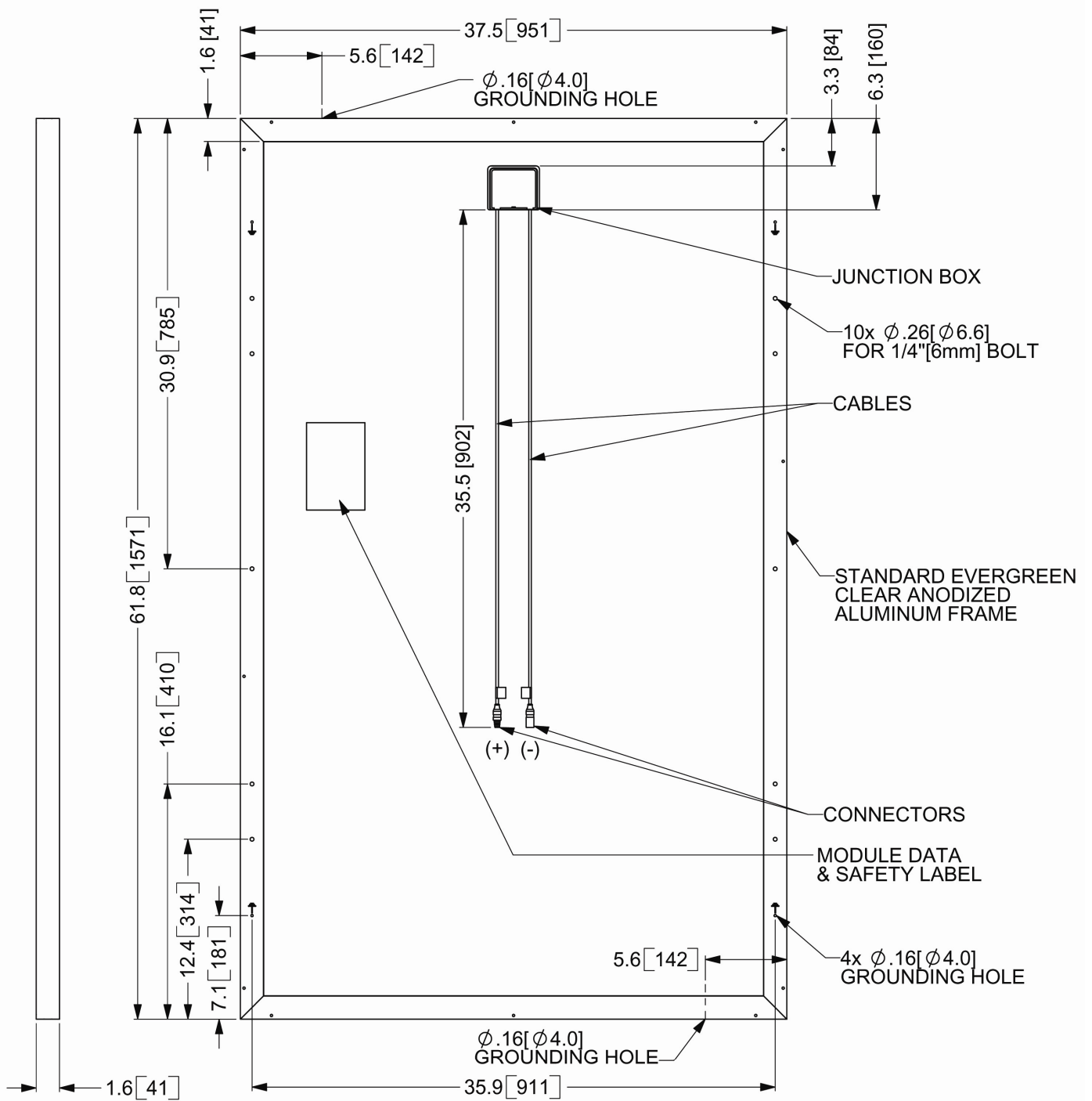
	ES-170-RL	ES-180-RL	ES-190-RL
P _p (W)	170	180	190
V _p (V)	25.3	25.9	26.7
I _p (A)	6.72	6.95	7.12
V _{oc} (V)	32.4	32.6	32.8
I _{sc} (A)	7.55	7.78	8.05
Cells	108		
Bypass Diodes	3 x Type AR2510, 1000V, 25A		
Maximum Series Fuse	15A		
UL Rated System Voltage	600V		
TÜV Rated System Voltage	1000V		
*At STC (Standard Test Conditions): 1000 W/m ² , 25° C cell temperature, AM 1.5 spectrum. Minimum Specified Power Rating is 2% below P _p ; other specifications are +/-10%. Specifications subject to change without notice. 25 year limited power warranty. Complete warranty available on request.			
Note: This document may be provided in multiple languages. If there is a conflict among versions, the English language version dominates.			

Temperature Effects

P _p	- 0.51%/°C
V _{oc}	- 0.35%/°C
I _{sc}	+ 0.05%/°C
NOCT	47°C

I-V Characteristics*





ES-170 / 180 / 190-RL

Weight: 40.1 lb [18.2 kg]