Instructions for Installation of Polysolar PS-CT-Series BIPV modules

Polysolar Limited

Aurora Cambridge, Madingley Road, Cambridge, CB3 0ET, UK

TEL：+44 (0)1223 911534
Email : info@polysolar.co.uk
WEB：www.polysolar.co.uk

1. Introduction

This instruction is provided for the installation and operation of Polysolar 's photovoltaic glazing modules. Before installation or operation, please read the general information and safety guidelines carefully. If any questions about installation and operation remain, please contact Polysolar or its sales agent. You should be aware that the warranty may be invalidated as a result of improper installation and operation. The information contained in this manual is intended to provide system designers, integrators, installers, and maintenance personnel with minimum requirements and recommendations for the deployment of a safe and approved solution for the installation of the PV modules.

The following are descriptions of sketches.

 **Attention!**

 **Please wear eye-safety protection.**

 **Please wear safety gloves**.

 **Beware of injury under operation.**

 **Beware of risk of electric shock.**

2. General instructions

Photovoltaic modules produce electricity when exposed to the sun or other light source. For users and installers' safety, please read the entire instructions carefully prior to installation and PV system operation. Also, carefully read the PV module data sheet provided with this product to understand the physical and electrical properties. It is the responsibility of the installer and/or system integrator to ensure that the installation and handling of PV modules are compliant with all local electrical regulations and codes, glazing and construction regulations. Determine local permits, installation and inspection requirements before installing PV module(s). Polysolar assumes no liability for damages incurred due to non-compliance with these instructions. Please also read the instructions for the other components which make up the whole PV system.

2.1 Special instructions

2.1.1 Do not attempt to disassemble the PV module, and do not remove any attached nameplates or components! Doing so will void the warranty.

2.1.2 Do not disconnect under load! Doing so may cause electric shock or the system to fail.

2.1.3 Do not use mirrors or other hardware to artificially concentrate sunlight on the PV module! This will damage the PV module and may be dangerous!

2.1.4 Do not use organic solvents to clean the surface and sides of the PV module.

2.1.5 Handle with care! Impact may break the PV modules and cause malfunction, electric shock and/or injury.

2.1.6 Beware of the risk of electric shock and short-circuits, as the PV modules generate high voltage and current when exposed to light.

2.1.7 If PV modules are installed above ground level, wear a safety belt and protection gloves when installing the PV modules to prevent the risk of falling and of electric shock.

2.1.8 CdTe modules are qualified for the Application Class A. Modules rated within this application class may be used in systems operating at greater than 50V DC or 240W, where general contact access is anticipated. Modules qualified for safety under IEC 61730-2 and within this application class are considered to meet the requirements for safety class II. (IEC Only)

2.1.9 In the UK, modules should be installed according to MIS3002 by MCS certified personnel.

2.1.10 Keep this instruction together with the documentations of the PV module.

2.2 Standard Operating Conditions

2.2.1 The module should be installed in a location where it should not be shaded during the normal daylight time and use the most suitable installation angle to ensure the maximum irradiance. For more detailed information on the installation angle for the selected location, consult an experienced solar installer or system integrator

2.2.2 Do NOT use modules near equipment or in a location where flammable gases may be generated or collected

2.2.3 Ensure that the module and connector will not be submerged in water or covered by snow for a long period of time.

2.2.4 Ambient temperature should be in the range between -20 °C and 50 °C, and PV module operating temperature should be in the range between -20 °C and 85 °C.

2.2.5 Shadow on PV modules should be prevented otherwise shading may cause power output decline and even fire hazard.

2.2.6 Water accumulating on the junction box or junction box being immersed in water should be avoided.

2.3 Maintenance

2.3.1 Under normal use maintenance is not necessary. The dirt on the surface of the PV modules will be washed away by rain.

2.3.2 A routine surface cleaning may be necessary for the PV modules used in particular conditions or environments, e.g. region of highly air polluted or dusty.

2.3.3 Use water and a soft sponge, brush or cloth for cleaning. A neutral, mild, and non-abrasive cleaning agent can be used to remove stubborn dirt.

2.3.4 Check the exposed electrical and mechanical connections every few months to verify that they are clean, secure and undamaged. The inspection and maintenance periods depend on the operation conditions and environment.

2.3.5 Installed modules may collect a light layer of dust and/or dirt over time. This may affect the output of the module. Clean the glass surface of modules periodically as required. Cracked or broken modules present a shock hazard due to leakage currents, and the risk of shock is increased when modules are wet. Before cleaning, thoroughly inspect modules for cracks, damage, and loose connections. Repair any ground faults. Broken modules should be replaced, and damaged wires must be replaced or repaired immediately

2.3.6. Modules should be cleaned only when in open circuit – either disconnected from load, or during times when inverter is turned off. Appropriate electrically insulating Personal Protective Equipment (PPE) must be worn during any cleaning or

inspection operations. Always use clean water and a soft sponge or cloth for cleaning. A mild, non-abrasive cleaning agent may be used to remove stubborn dirt

2.3.7 Modules should NOT operate in the open-circuit or short-circuit conditions for more than ninety (90) consecutive days to avoid a potential reduction of energy output of modules

The following lists a set of most common causes for PV system to produce low power output:

- Inverter failure
- Improper or faulty field wiring or connections
- Blown fuses or tripped circuit breakers
- Excessive amounts of dirt and dust on the modules
- Shading of modules by trees, poles, or buildings

CdTe modules are qualified for the Application Class A. Modules rated within this application class may be used in systems operating at greater than 50V DC or 240W, where general contact access is anticipated. Modules qualified for safety under IEC 61730-2 and within this application class are considered to meet the requirements for safety class II. (IEC Only)

3. Safety instructions

Be familiar with the basic principles of electricity and electrical equipment. Use properly insulated tools and appropriate protective equipment such as safety shoes, work gloves, and protection goggles. Use a properly and approved voltmeter for measuring the electrical properties of PV systems and single PV module.

3.1 PV modules produce DC electricity when they are exposed to light and therefore can incur an electrical shock or burn to the human body. Modules produce voltage even when they are not connected to an electrical circuit or under load. A single module could produce more than 36 V voltage when exposed to low irradiance of sunlight, and the danger increases as modules are connected in series and/or parallel. Both current and power will increase with higher light intensity. Use insulated tools and rubber gloves while working with modules in sunlight. Do NOT wear metallic rings, watchbands or other metallic objects while working with modules.

3.2 PV modules do NOT have 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. Follow the safety regulations for all other system components, including wires and cables, connectors, inverters, storage batteries, etc.

3.3 Rated electrical characteristics are within ±5 % of measured values at Standard Test Conditions of: 1000 W/m^2, 25°C cell temperature and solar spectral irradiation of AM1.5 spectrum. 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 value of I_{sc} and V_{oc} marked on this module should be multiplied by a factor of 1.25 when to determine the component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output.

3.4 To avoid electric shock when working on PV module wiring, covering faces of PV module completely with opaque materials is recommended to prevent electricity generation.

3.5 Isolate PV module(s) from other sources of electricity, such as batteries or inverters, before completing whole PV system wiring work.

3.6 Avoid contact terminals when PV modules are exposed to light.

3.7 Do not remove any parts originally installed or disassemble the PV module.

3.8 Exercise utmost caution when working on wiring up to and installing the inverter.

3.9 Do not attempt to install or use a PV module with broken or damaged front glass

or back glass.

3.10 Check PV modules for cracks, damage, or loose wires/connectors/junction boxes. Remove and do not try to clean or use cracked or damaged PV modules.

3.11 Do not use high pressure water spray or organic reagents to clean the PV modules.

3.12 To avoid risk of electric shock, the operator should wear insulated gloves and shoes to avoid direct contact with the cleaning solutions or PV modules.

The PV modules are qualified for application class A: Hazardous voltage (IEC EN 61730: higher than 50 V DC; EN 61730: higher than 120 V DC), hazardous power applications (higher than 240 W) where general contact access is anticipated (PV modules qualified for safety through IEC EN 61730-1 and -2 within this application class are considered to meet the requirements for safety class II).

4. Unpacking, Transportation and Storage

4.1 Unpacking the PV modules and storage: Utmost care is required when handling PV modules. Use care when unpacking, transporting, and storing the PV modules.

4.2 The PV module is frameless double-glass laminated configuration; any collision should be avoided during transport and installation. Any damage at the corners or boards caused by collision easily lead to future brakeage from these injured sites may be ignited by temperature, stress, or other factors. If a collision occurs, you must inspect whether damage caused at the edges or corners, no damage should be confirmed prior to installation.

4.3 If installed PV modules are broken, immediately replace to avoid risk of leakage and damage to personnel and PV system.

4.3.1 Transport PV modules in an upright position and carry PV modules with both hands.

4.3.2 Do not lift PV modules by grasping the PV module's junction box, cables or connectors.

4.3.3 Ensure PV modules are installed/stored without self-weight deflections. Do not stack PV modules on the top of other PV modules.

4.3.4 Don't mark using sharp tools and keep all electrical contacts clean and dry.

4.3.5 Avoid non-uniform mechanical load during installation, transportation and storage to prevent the risk of cracking the PV module.

4.3.6 After unpacking, please note the possibility of dirt getting into connectors.

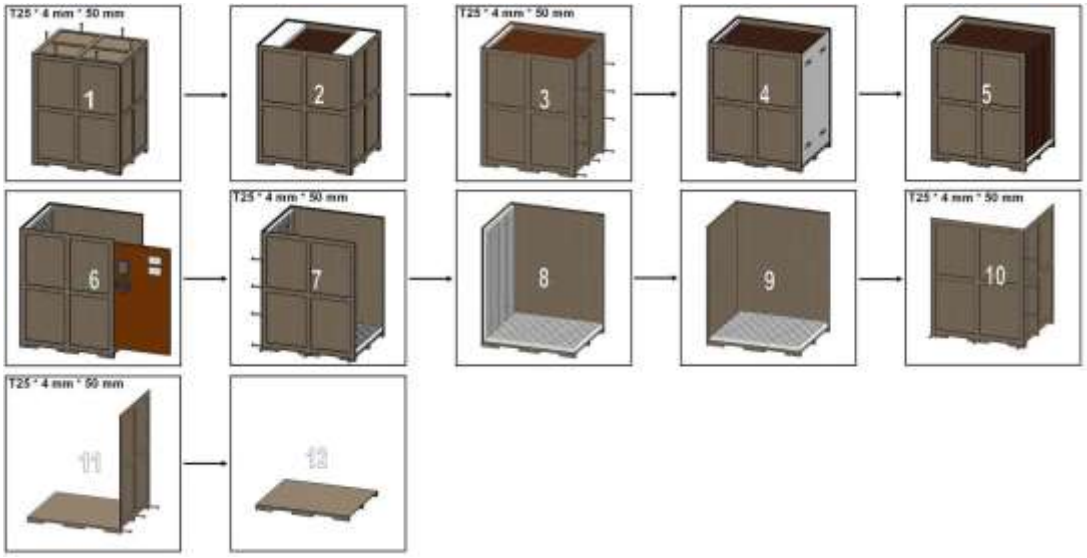

Figure 4-3. Unpacking steps for a 40-module crate.

5. Installation instructions (non BIPV applications)

5.1 The module should be installed in a location where it should not be shaded during the normal daylight time.

5.2 Determine and use the most suitable installation angle to ensure the maximum irradiance. For more detailed information on the installation angle for the selected location, consult an experienced solar installer or system integrator.

5.3 Do NOT use modules near equipment or in a location where flammable gases may be generated or collected.

5.4 Ensure that the module and connector will not be soaked in water or covered by snow for a long period of time.

5.5 Beware that PV modules exposed to a wide range of mechanical conditions may cause surface stress to appear.

5.6 Beware due to different thermal coefficients of glass and metal clamps/ support structure, Refer to MIS3002 (& DIN 1055) for basics for the planning of a structural framework regarding building structures which must be taken into account.

5.7 Structural strength of PV system must be sufficient, with no deformation caused by static load or dynamic load. Deformation of the support structure may pull PV modules to distortion and cause the damage of PV modules through to stress.

5.8 Mounting procedures (non BIPV roof mount and field mount)

5.8.1. For standard roof mounting modules should be secured to the support structure with appropriative clips at eight (8) symmetrical points (see Figure 2). The locations of clips shall be along the 1200 mm length of the module and outermost clips shall be located at 80±25mm from the module corner. The distance between clips on the same edge should be in a range of 215 mm to 265 mm

5.8.2 If the modules are to be tilted and mounted in portrait orientation, a slide-prevention feature is recommended to prevent the module from sliding out of the module clips. If the modules are to be tilted and mounted in landscape orientation, no additional slide-prevention features are necessary.

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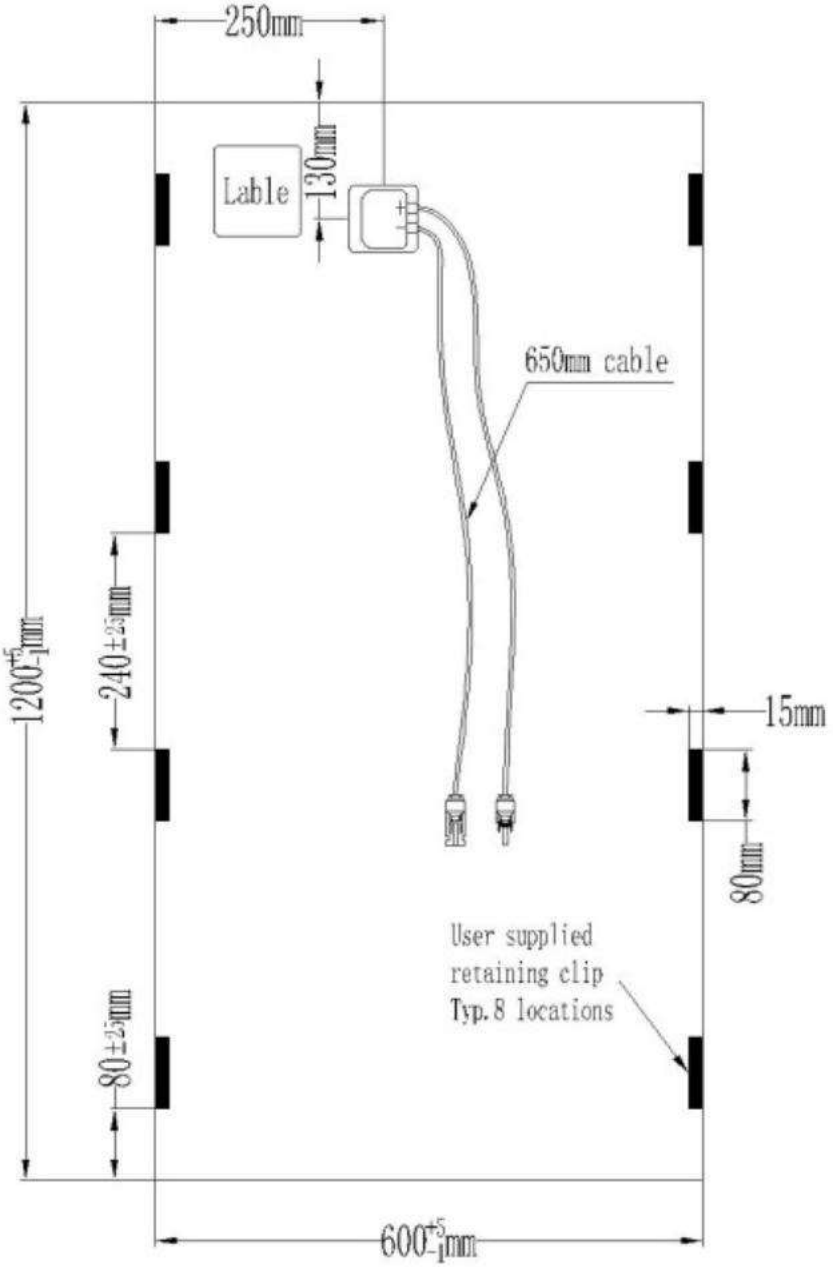
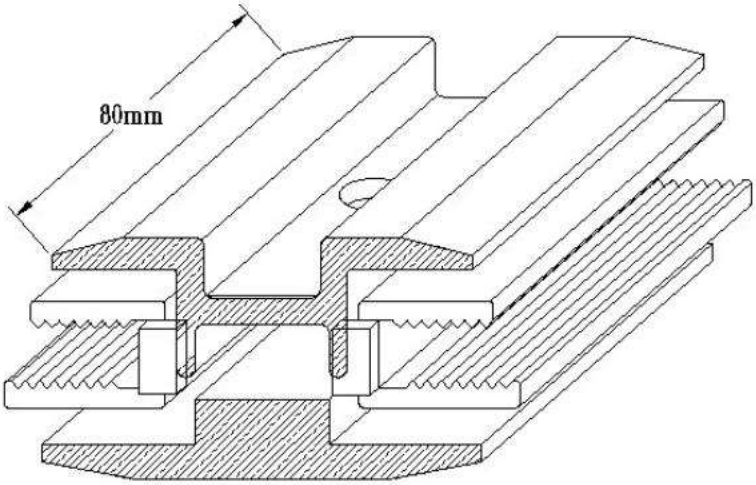


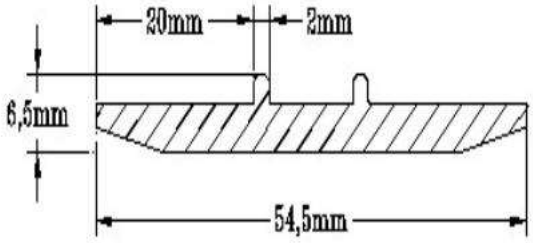
Figure 2: Recommended Location of Retaining Clips (Back Side)

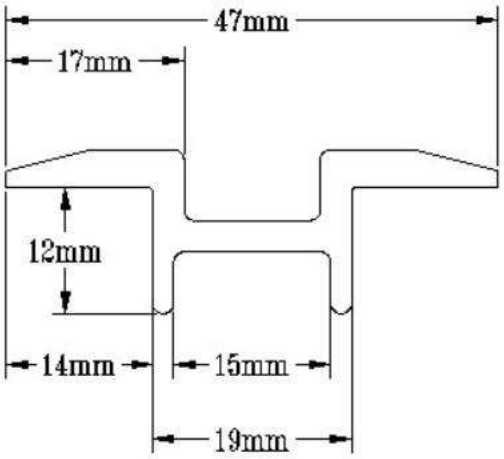
5.8.3 If standard retaining clip is used rather than BIPV glass mounting solutions, it is recommended by Polysolar that the clamping should meet the following specifications. see Figure 3):

- A module surface contact length of 80 mm.
- The upper clip must guarantee that the front side module contact width is in a range of 13 mm and 15 mm.
- The lower clip must guarantee that the back-side module contact width is aluminum of 15 mm.

- The retaining clip shall provide an appropriate gap to allow for the thickness of the module.







5.8.4 Rubber gasket, or equivalent materials, must be applied between the module and the clips (or the mounting structure) to provide adequate protection of the module surface. No direct contact of rigid structures is permitted against the surface or edges of the glass laminate

5.8.5 Clip insulator Must meet following requirements (see figure 4).

- Insulation and protective materials recommended by SF are Ethylene Propylene Diene Monomer (EPDM), silicone rubber formulation, or equivalent.
- Thickness of top section: 3 mm minimum (includes "teeth" or "ridges")
- Thickness of bottom section: 3 mm minimum (includes "teeth" or "ridges")
- Thickness of vertical edge: 2 mm minimum

5.8.6 For insulator Polysolar recommends choosing materials that are highly UV resistant

5.8.7 Retaining clips and support rails should be designed to facilitate good air circulation and drainage at the module interface.

5.6.8. It is important to ensure that the module clips are installed parallel to the supporting rails.

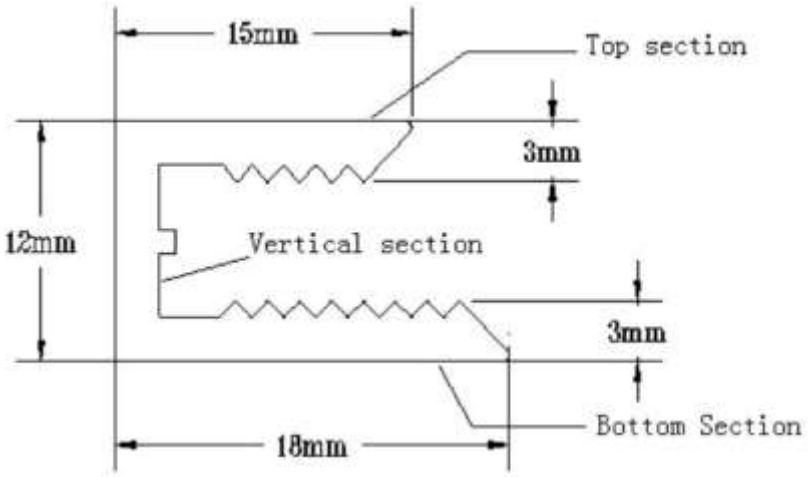


Figure 4. Insulator specification

5.9 Mounting procedures for BIPV structures

5.9.1 For BIPV applications the mounting instructions will vary by application. The principals of the PV installation remain the same but the mount procedures and components will vary by application. Polysolar modules are designed for BIPV applications and can be tailored to specific applications, too numerous to mention in this document. Equally the applications and mountings are too numerous to mention and each application mounting should be addressed directly by Polysolar or its sales agents.

5.9.2 Polysolar modules are glass glass laminates, that can be fabricated into double or triple glazed units. The mounting, in support frameworks, such as glazing bars, curtain walling profiles etc. should therefore adhere to the requirements of these mounting systems. The key factors to consider are avoiding covering the active areas of the modules. For further guidance read Polysolar's Guide to BIPV or contact Polysolar directly

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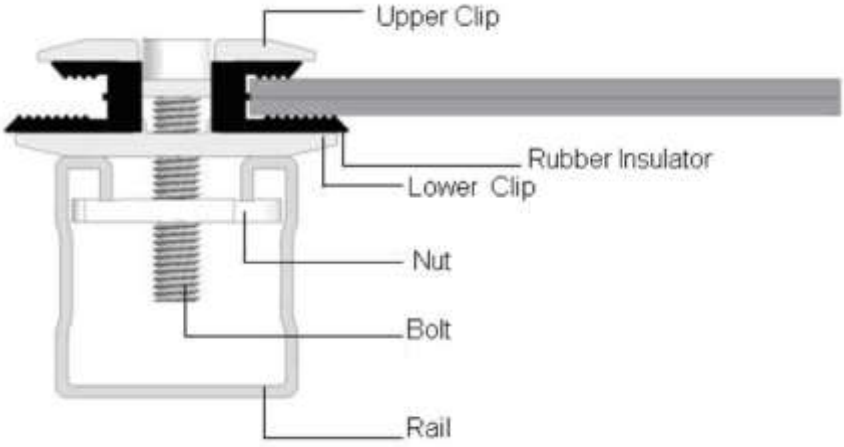
Standard Components		
Model name	Upper Clip	Lower Clip
		
Dimensions	80×47×15.2mm	80×54.5×6.5mm
Material	Aluminium alloy	Aluminium alloy
Model name	Rubber Insulator	Bolt
		
Dimensions	80×18×12mm	M8×40mm
Material	EPDM, silicone rubber formulation, or equivalent	Stainless steel
Model name	Nut	Rail
		
Dimensions	35×19.4×3.2mm	40×40mm (according to the array)
Material	Stainless steel	steel
Model name	Combination	
		
Dimensions	80×47×19mm	

Table 2: Standard Parts

Figure 5-4. A single module mounting configuration set up for UL and TUV certifications.



6. Physical Specifications and Electrical Characteristics

Product Specifications – see separate datasheets.

7. Electrical Instructions

To avoid electrical shock, ground the support structure of the PV system before wiring the circuit using a grounding method that meets appropriate local standard or directive requirements. Such grounding means should be isolated from live parts by reinforced insulation during the period of installation and subsequent system operation.

The output voltage and current will exceed the nominal output of the PV modules in the initial operation. You should be aware of the difference between initial and stabilized performances of the PV modules. Power output of the PV modules may also increase under different environments and should be taken into account.

All of the electrical connections should comply with IEC EN 61730, UL 1703, or CNS 15118, and/or applicable local codes/standards.
The system voltage of a PV array should not exceed maximum limit of applicable codes/standards, e.g.1000 V DC (IEC) or 600 V DC (UL), and inverter for serial connection during PV modules operating temperature.

Be aware that temperature coefficient and V_{oc} is negative correlation, V_{oc} of PV modules and voltage of PV array could be higher than magnitude of at STC when the PV modules are operating in cold environment (lower than 25 °C).

PV modules may be connected in series, parallel or in a combination of series-parallel to achieve the desired electrical output as long as certain conditions are met.

7.1 Connection in series

7.1.1 Connectors attached to Polysolar modules are MC4 compatible. When connected in series as shown in Figure 7-1, you should securely lock the male and female connectors together.

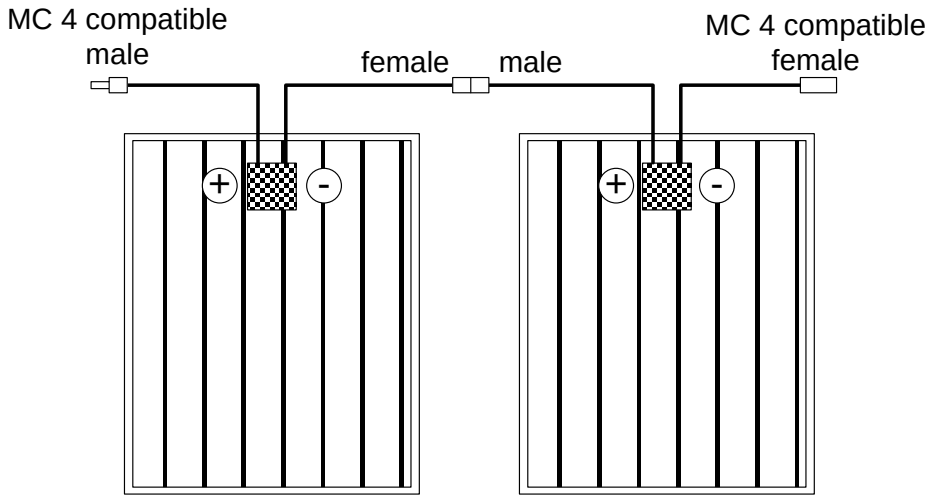


Figure 7-1. Connection in series

7.1.2 For a PV array (Figure 7-2), maximum number (N) of PV modules for each PV string can be calculated by the following formula, Eq(1):

$$N \times V_{oc} < V_{ms} \quad \text{.....Eq(1)}$$

where N is maximum numbers of the PV modules for a PV string

V_{oc} [V] is open circuit voltage of a PV module

V_{ms} [V] is maximum system voltage for a PV array

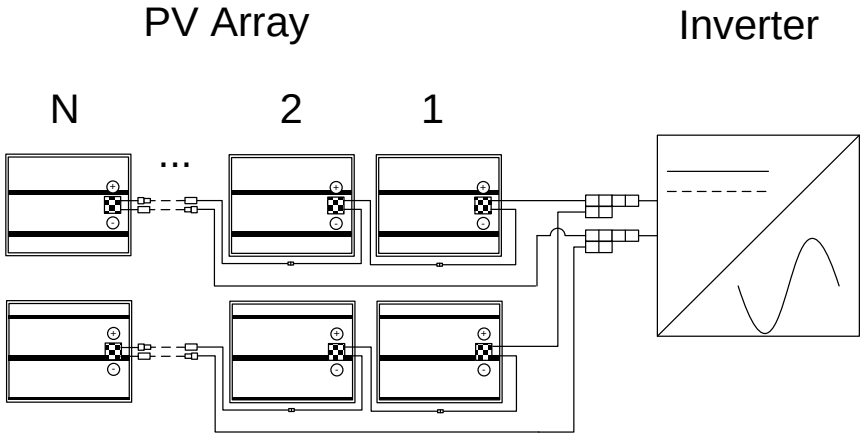
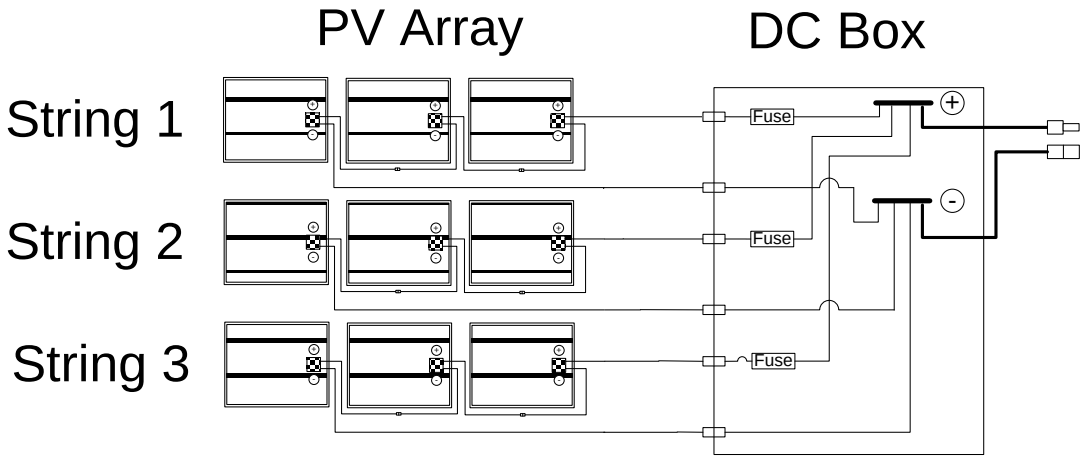


Figure 7-2. N PV modules forming a PV string

7.2 Connection in parallel

The PV strings can be connected in parallel to a DC box with fuse as shown in Figure 7-3:



7.3 Protection devices

7.3.1 One 2-Amp fuse can be installed at positive pole of every single string to prevent the PV modules from damage that might be caused by reverse current.

7.3.2 One 3-Amp fuse can be installed for two strings connected in parallel, as shown in Figure 7-4.

7.3.3 When two PV strings connected in parallel, the maximum reverse current from another string is 0.98A±10 % (at STC) for the case of using the PV module of PS-CT-85 (85Wp). However, the maximum reverse current is dependent upon temperature; if the PV system works in a high-temperature environment, the maximum reverse current usually would be increased.

7.3.4 For the PV array in Figure 7-4, if another string is added to the array, i.e. three strings in parallel, the maximum reverse current from another two strings applying to a single string would be 1.96 Amps. It means that the maximum reverse current to PV module will reached in relation to the over current protection rating of PV module, thus the strings with more than the permitted rating are at the risk of damage. For the maximum reverse current of array can be calculated by using the following formula, Eq(2).

The maximum reverse current (Amp) = (N-1) × I_{SC} .....Eq(2)

where N is the number of strings in parallel

Isc of PV module at STC (1.20 Amps, for PS-A-87B)

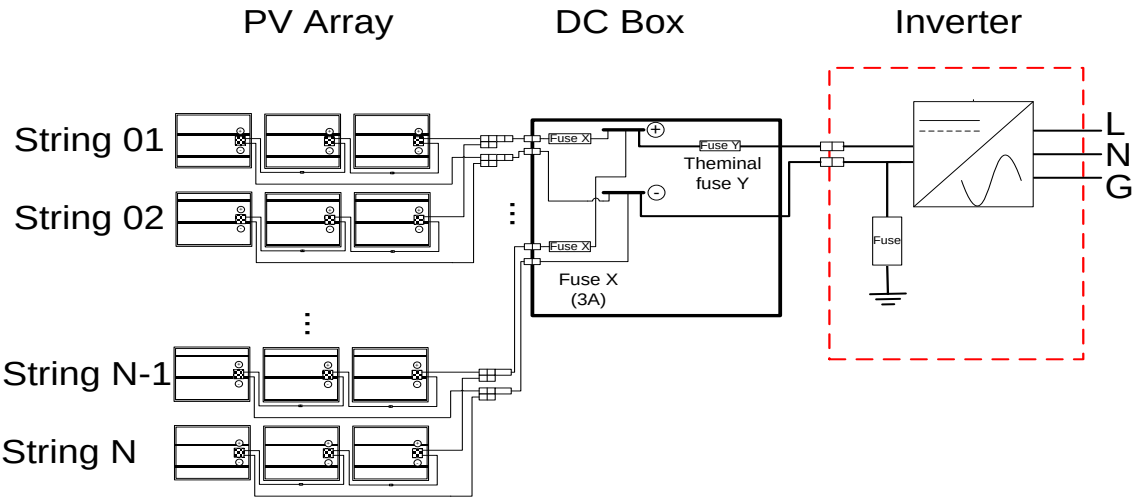


Figure 7-4. Fuse connection for PV array

7.3.5 For the PV system designed with multiple string arrays, "Fuse X" with 3 A rating is suggested, as shown in Figure 7-4. The protection current rating for "Terminal fuse Y" between the array and inverter is described as the following formula, Eq(3):

Fuse protection current rating of array = N × Isc × S.. .....Eq(3)

where N is the number of strings in parallel

I_{SC} is 1.20 A at STC (for model: PS-A-87B)

S is a safety factor of 1.25

For example, when N is 10, the fuse protection current rating is 15.0 Amps. The

protection current rating of common commercial fuses is usually available in a value of integer which may not exactly meet your need. If exactly the right fuse is not available, a fuse with slightly larger protection current rating can be use only if the rating as close as possible to the rating of originally required fuse.

7.3.6 If blocking diodes are required, please confirm that the current capacity and the voltage limit of the blocking diodes is suitable for the design of PV array.

7.3.7 For lightning protection please refer to MIS3002 or your local codes/regulations.

7.4 Grounding

7.4.1 Risks of fire and electrical shock

The grounding of the PV system is critical for the safety and performance. Failure or incomplete system grounding may cause fire/electrical shock or reduce the performance of PV system. The PV modules must only be used in configurations where the negative polarity of the PV module is connected to ground or connecting system to the negative terminal on the DC side of inverter. Details for the grounding should refer to the applicable local codes for electrical system on specific requirements.

7.4.2 Module grounding

Polysolar's PS-CT series do not require grounding, but the modules should in installed avoiding directly touching any metal surfaces. The Polysolar PS-CT series modules can use conventional transformer inverters. Grounding of the modules is also possible using grounding kits available with most transformer inverters. For further information see the specifications of the inverter manufacturer.

7.4.3 Warranty exclusion

Failure to comply with the requirement of the electrical connections will invalidate warranty for the PV modules. Contact your installer or Polysolar if any questions about grounding remain.

7.5 Wiring and connectors

7.5.1 Only connect PV modules in series with the same type and avoid using different power categories.

7.5.2 Don't open junction box or remove connectors from the solar cables.

7.5.3 The solar cables are equipped with the MC4 compatible solar-lock pin-and-socket connectors.

7.5.4 The connectors are marked with the respective polarity (see Figure 7-6).

Figure 7-6. Connectors: Minus (-) and Plus (+)

7.5.5 Be sure to observe the PV module's polarity. Reverse polarity might cause destruction of the protective diode in the junction box.

7.5.6 If additional cables are required, only use appropriate TUV or UL-certified PV cables containing at least 2.5 mm^2 cross-section wire.

7.5.7 If it is necessary to purchase MC4 compatible connectors from different manufactures or suppliers, be sure to have samples tested first and confirm that they are 100% compatible with the connectors of Polysolar PV modules.

7.5.8 During installation in the field, please pay special attentions to prevent dirt, foreign particles, or water from entering connectors. Poor electrical contact or poor water-proof resulting from loose contact will cause malfunction.

7.6 System commissioning

7.6.1 System should be commissioned by an MCS certified installer according to MIS3002.

7.6.2 There are no additional manufacturer recommendations or specifications for commissioning beyond what is contained elsewhere in this installation instruction document.

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Physical Specifications PS-CT Series

Active Material of Cell		Cadmium Telluride (CdTe)
Encapsulation Material		Polyvinyl butyrate (PVB) thickness 0.4 mm
Front Cover		Float Glass,thickness: 3.2 mm
Back Cover		Tempered Glass, thickness: 3.2 mm
Wiring Material		Tin & silver coated copper ribbon thickness 0.1 mm
Junction Box	**Bipass diode**	10 A
	IP Class	IP 65
Cable length		700 mm (+) 700 mm (-) side mounted junction box or 650 mm (+) 650 mm (-) back mounted junction box
Connecting Cable Plug		Rated voltage 1000 V D.C. Temperature range: -40 to 85 °C Plug/Socket MC4 compatible Ø 4 mm Cable cross section: 2.5 mm^2
Transparency		Variable 10-50%
Frame		Frameless
Dimensions	**Width**	600 mm +2/-1 mm
	Length	1200 mm +2/-1 mm
	Thickness	6.8 mm +2/-1 mm
Weight		11.8 kg
The module is tested under 2400 Pa (50 lb/$ft^{2)}$ mechanical load or approximately to a wind speed of 130 km/h (80 mph) with certified mounting solutions. Other mounting solutions for higher mechanical loads are also available and can be warranted by Polysolar.		

Polysolar Model	Class	Stabilized Performance STC				
		Transparency	V_{mpp} (V)	I_{mpp} (A)	V_{oc} (V)	I_{sc} (A)
		Electrical tolerance +5/-0%				
PS-CT-85	85W	5%	96.6	0.88	120.5	0.98
PS-CT-72	72 W	10%	87.0	0.82	116	0.88
PS-CT-64	64 W	20%	87.0	0.73	116	0.78
PS-CT-56	56 W	30%	87.0	0.64	116	0.68
PS-CT-48	48 W	40%	87.0	0.55	116	0.59
PS-CT-40	40 W	50%	87.0	0.46	116	0.49
Max over current rating	2.0 A					
Temperature Coefficient	I_{sc} + 0.06%/K V_{oc} – 0.32%/K P_{mpp} – 0.21%/K					
Max System Voltage	1000 V					

The unit's electrical ratings are measured under Standard Test Conditions (STC) and have been delivered on the specific table of electrical characteristics as shown above. A photovoltaic module may produce more current and/or voltage than reported at STC. Sunny, cool weather and reflection from snow or water can increase current and power output. Therefore, the values of I_{sc} and V_{oc} marked on the units should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, fuse sizes, and size of controls connected to PV output. [STC]: 1000 W/m^2 , AM 1.5, 25 .The exactly measured electrical characteristics are shown on the label of the units.

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Warranty

Warranty on Product (Workmanship & Materials)	Warranty on Performance (Power Grade Output)
10 years from date of shipment	90% of power grade output of the module for a 10 year period and then 80% of the power grade output of the module for a 25 year period from date of shipment
Certifications	IEC EN 61646 & 61730-1 & 61730-2 MCS 017 (BSI) Kitemark CE Mark