



TUNGHSU

INSTALLATION MANUAL

Suitable for:
Frameless M6 series mono bifacial double glass 440Wp



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1.- General requirements

Thank you for choosing TUNGHSU panels.

Please read this guide in its entirety before installation.

The purpose of this document is to provide the minimum requirements and recommendations for a safe and successful installation of TUNGHSU PV modules.

This document also contains the requirements necessary to maintain compliance of the TUNGHSU PV module with IEC 61215 and IEC 61730.

This guide contains basic information about the TUNGHSU series photovoltaic modules, their installation and safe handling. All instructions should be read and understood before attempting installation. If you have any questions, please contact your dealer or TUNGHSU " for more information.

This documentation refers to the PV modules themselves and is not intended to be a complete installation manual for personnel who have not received specific training on PV modules. It serves as a general but strictly mandatory reference for the Installer. Violation or inaccurate compliance with any provision of this documentation voids the warranty.

The installer must understand and follow all applicable local, state, and federal regulations and standards for building construction, electrical design, fire, and safety, and should consult with local authorities to determine applicable permit requirements before attempting to install or maintain PV modules and should become familiar with the mechanical and electrical requirements of PV systems.

Failure to follow the instructions in this guide may damage system components, endanger personnel, damage property, or void the panel warranty.

Rooftop PV systems should only be installed on homes that have been formally tested for structural integrity and confirmed by a certified building engineer or specialist to be capable of handling the additional weighted load of the PV system components, including the PV modules.

For your safety, do not attempt to work on a roof until safety precautions have been identified and taken, including but not limited to fall protection measures, ladders or stairs, and personal protective equipment (PPE).

For your safety, do not install or handle PV modules in adverse conditions, including, but not limited to, high or gusty winds and wet or icy roof surfaces.

The construction of the flat-plate PV module consists of a laminated assembly of solar cells encapsulated within an insulating material inside two sheets of glass.

Keep this documentation in a safe place for future reference.

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



2 Handling

TUNGHSU PV modules should only be transported in the supplied packaging and kept in the packaging until ready for installation. Protect the pallets from movement and exposure to damage during transport.

transport. Secure pallets against falling. Do not exceed the maximum height of pallets to be stacked, as indicated on the pallet packaging. Store the pallets in a cool, dry place until the modules are ready to be unpacked.

TUNGHSU photovoltaic modules are heavy and should be handled with care. Never use the junction box or cables as a grip. Do not exert mechanical stress on the cables. Never step on the PV modules, drop them or place heavy objects on them.

heavy objects on them. Be careful when placing PV modules on hard surfaces and secure them against falling. Broken glass can cause personal injury. PV modules with broken glass cannot be repaired and must not be used. Broken or damaged PV modules must be handled with care and disposed of properly.

3 Implementation

3.1 Restrictions

TUNGHSU PV modules must be mounted on suitable mounting structures located on suitable buildings, the ground or other structures suitable for PV modules (e.g. carports, building facades or PV trackers). PV modules must not be mounted on moving vehicles of any kind. Modules must not be installed where they can be submerged in water.

Artificially concentrated light must not be directed at the TUNGHSU PV modules.

3.2 Recommendations

TUNGHSU recommends mounting the PV modules at a minimum tilt angle of 10 degrees to allow adequate self-cleaning from rain.

Partial or complete shading of a PV module(s) can significantly reduce the performance of the system. TUNGHSU recommends minimising the amount of shading throughout the year to increase the amount of energy produced by the PV modules.

High system voltages could be induced in the event of an indirect lightning strike, which could cause damage to PV system components. The open area of the wire loops should be minimised; to reduce the risk of lightning-induced surges.

Better ventilation of the modules and shorter connection cables increase the electrical energy yield.



For bifacial modules:

It is recommended to increase the height of the PV panel from the ground so that more light can travel under the module and then be reflected.

The bifacial gain increases significantly if the modules are installed on white surfaces (high albedo value) that reflect light.

4 Electrical installation

4.1 Safety

Photovoltaic modules can produce current and voltage when exposed to light of any intensity. The electrical current increases with increasing light intensity. DC voltage of 50 volts or more is potentially lethal. Contact with the live circuits of a photovoltaic system operating under light can cause a lethal electric shock.

Disable PV modules by removing them completely from the light or by covering their front surface with an opaque material. Observe the safety regulations for live electrical equipment when working with modules that are exposed to any type of light. Use insulated tools and do not wear metal jewellery while working with PV modules.

working with photovoltaic modules.

To avoid electric arcs and electric shock, do not disconnect electrical connections under load. Faulty connections can also cause arcing and electric shock. Keep connectors dry and clean, and make sure they are in good working condition. Never insert metal objects into the connectors or modify them in any way to ensure an electrical connection.

Do not touch or handle PV modules with broken glass unless the PV modules are first disconnected and you are wearing appropriate personal protective equipment. Avoid handling PV modules when they are wet, unless you clean the PV modules as instructed in this manual. Never touch electrical connections that are wet without protecting yourself with insulating gloves.

The modules are rated for application class A: Hazardous voltage (IEC 61730: above 50 V DC; EN 61730: above 120 V), hazardous energy applications (above 240 W) where general contact access is anticipated.

The installation of solar photovoltaic systems requires specialised skills and knowledge. It should only be carried out by qualified and specially instructed personnel. The installer assumes all risk of injury, including the risk of electric shock.

Use only equipment, connectors, wiring and mounting accessories specifically designed for use in a PV system.

Before any manipulation on an installed PV system, switch it on first on the AC side and then on the DC side of the inverter or charge controller.

When disconnecting the cables connected to a PV module that is exposed to light, an electric arc can occur. Arcing can cause burns, start fires, or create safety problems (up to lethal electric shock).



Check the remaining voltage before starting and observe the relevant local safety regulations for such working conditions.

Under normal conditions, a PV module may produce more current and/or voltage (here: 30 V DC) than reported under standard test conditions.

Contact with a DC voltage of 30 V or more is potentially dangerous. Take care when wiring or handling modules exposed to sunlight.

Only connect modules with the same rated output current in series. If modules are connected in series, the total voltage is equal to the sum of the voltages of the individual modules.

Only connect modules or series combinations of modules with the same voltage in parallel. If modules are connected in parallel, the total current is equal to the sum of the combined currents of the individual modules or in series.

Always use the same module type within a particular PV system.

If the sum of the short-circuit currents of the parallel-connected modules passes through the reverse current string, diodes or fuses must be used in each string of parallel-connected modules. These string diodes or fuses must be rated for the maximum expected current and voltage. The fuse rating also corresponds to the maximum reverse current that a module can withstand. The reverse current value can be found on the product label, in the product data sheet or in SECTION 7 of the installation manual. Observe the safety instructions and precautions for all other components used in the system, including wiring and cables, connectors, DC circuit breakers, inverters, etc.

Use appropriate safety equipment (insulated tools, dielectric gloves and shoes, etc.) approved for use in electrical installations.

4.2 Configuration

Under normal conditions, a PV module is likely to experience conditions that produce more current and/or voltage than reported under standard test conditions (STC: 1000 W/m², AM 1,5 and cell temperature of 25 °C) or bifacial standard test conditions (BSTC: 1167 W/m², AM 1,5 and cell temperature of 25 °C). The short circuit current (ISC) shall be multiplied by a factor of 1.25 and the open circuit voltage (VOC) shall be multiplied by a factor of up to 1.25 depending on the lowest and highest ambient temperature recorded for the installation site when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output.

Voltages are additive when PV modules are connected directly in series, and module currents are additive when PV modules are connected directly in parallel. PV modules with different electrical characteristics should not be connected directly in series. The use of suitable third-party electronic devices connected to the PV modules may allow for different electrical connections and must be installed according to the instructions specified by the manufacturer.

The maximum series interconnection voltage of the modules must be lower than the maximum certified system voltage of the module. In addition, the maximum input voltage of the inverter and other electrical devices in the system must be taken into account. The open circuit voltage



of the array string shall be calculated at the lowest expected ambient temperature for the location. The maximum system voltage for the module is given in the module data sheet.

4.3 Over Current Protection Device (OCPD)

When the potential reverse current of a PV string exceeds the rated fuse rating of the TUNGHSU PV module series (values indicated in the module data sheet), an overcurrent protection device (OCPD) must be used (IEC 61730-1, clause 12.3). An overcurrent protection device is required for each string in series if more than two strings are connected in parallel. In this case, one fuse per string of $1.25 \times I_{sc}$ or higher (I_{sc} is the short-circuit current of the PV module at STC) is required. A PV fuse in each PV string will protect the PV modules and conductors from overcurrent faults and help minimise safety risks. The PV fuse will also isolate the faulty PV string so that the balance of the PV system can continue to generate electricity.

Clasificación de amperaje del fusible $\geq 1,25 \times I_{sc}$

Seleccione la siguiente clasificación estándar más alta en el catálogo de fusibles fotovoltaicos disponibles.

I_{sc} = Corriente de cortocircuito de un módulo en condiciones de prueba estándar (STC);

Taking into account the I_{sc} values of the TUNGHSU modules, the correct value of the PV fuses to be used in the installation is 20 A. TUNGHSU recommends using PV fuses on both the positive and negative conductors.

4.4 Cables and wiring

TUNGHSU PV modules are supplied with two standard sunlight-resistant output cables terminated with PV connectors ready for most installations. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector. The module wiring is designed for series connections [i.e. male (+) to female (-) interconnections], but can also be used to connect suitable third-party electrical devices that may have alternative wiring configurations, provided the manufacturer's instructions are followed.

Use field wiring with suitable cross-sectional areas that are approved for use with the maximum short-circuit current of the PV module. All wiring must be double insulated, cross wires with a minimum rating of 1.8 kV (over 1500 V voltage) and a minimum temperature rating of 90 °C applicable. Wire size not less than 4 mm². The type of insulation must be appropriate for the type of installation method used and must comply with the requirements of IEC 61730 and Safety Class II. instalación utilizado y debe cumplir con los requisitos de IEC 61730 y Clase de seguridad II.

- Insulation level: 1.8 kV (conductor-to-conductor);
- Temperature: -40°C to +90°C minimum;
- Conductor construction: tinned stranded copper wire with copper purity greater than 99.9%;
- Primary insulation: cross-linked polyethylene (XLPE), sunlight and moisture resistant, flame retardant. Suitable for ducts and conduits installed underground;
- Insulation (sheath): thermoplastic, sunlight resistant, flame retardant, water resistant.
- Minimum outer diameter of insulated cable - 5.2 mm.
- Minimum conductor cross-section: 4 mm².



TUNGHSU recommends installers to use only sunlight-resistant cables qualified for direct current (DC) wiring in photovoltaic systems. The cables must be secured to the mounting structure in such a way as to avoid mechanical damage to the cable and/or module. Do not apply tension to the cables. For fixing, use appropriate means such as sunlight-resistant cable ties and/or cable management clips. Although the cables are resistant to sunlight and water, where possible, avoid exposure to direct sunlight and immersion of the cables in water.

The standard length of cables from junction boxes is 0.35m. Two panels are intended to be interconnected in the system.

4.5 Earthing

Functional grounding is not foreseen for TUNGHSU modules. If it is carried out, local electrical codes and regulations must be observed and the grounding means used must be isolated from live parts by reinforced insulation. Safety earthing must be carried out accordingly.

4.5.1 Earthing of framed SOLID series modules

For the framed series of photovoltaic panels, grounding must be ensured by connecting the module frame to the grounding structure. Observe all local electrical codes and regulations. A bolted connection is required, incorporate: TUNGHSU

recommends that installers use only sunlight-resistant cables qualified for direct current (DC) wiring in photovoltaic systems. The cables must be secured to the mounting structure in such a way as to avoid mechanical damage to the cable and/or module. Do not apply tension to the cables. For fixing, use appropriate means such as sunlight-resistant cable ties and/or cable management clips. Although the cables are resistant to sunlight and water, where possible, avoid exposure to direct sunlight and immersion of the cables in water.

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- A screw size of M4 or larger;
- A star washer under the screw head or a serrated screw must penetrate non-conductive coatings such as anodised frame;
- The screw and star washer must be made of stainless steel;
- The grounding screw must pass through all connecting elements and protrude two threads to the outside.



The devices listed and identified for the grounding of metal frames of photovoltaic modules may ground the exposed metal frames of the module to grounded mounting structures.

In any case, grounding screws or other parts must be used separately from the module mounting parts.

The earthing resistance of the earthing structure shall be achieved in accordance with local standards, Eurocodes or other legal normative references.

4.5.2 Grounding TUNGHSU series glass-crystal bifacial grounding

Since the TUNGHSU Bifacial glass-crystal modules are frameless, no module grounding is required.

All other PV plant equipment must be grounded in accordance with local and national electrical codes.

4.6 Connectors

TUNGHSU PV panel connectors are MC4 compatible. Keep the MC4 compatible connectors dry and clean, and ensure that the connector caps are hand-tightened before connecting the modules. Do not attempt to make an electrical connection with wet, dirty, or defective connectors. Avoid exposure to sunlight and immersion of connectors in water. Do not allow the connectors to rest on the floor or ceiling surface. Do not disconnect under load. Faulty connections can cause arcing and electric shock. Check that all electrical connections are securely fastened. Make sure that all locking connectors are fully engaged and locked.

4.7 Bypass diodes

The PV module junction box contains 3 bypass diodes (one in each part of the split junction box; Schottky type) connected in parallel with the PV cell strings. In the case of partial shading (hot spot effect), the diodes divert the current generated by the unshaded cells, which limits module heating and yield losses.

Bypass diodes are not overcurrent protection devices. Bypass diodes divert the current of the cell strings in case of partial shading. The characteristics of these diodes:

Rated voltage: 50 V;

Current rating - 20 A.

5 Fire class classification

The TUNGHSU module has been approved by the IEC fire test and achieved the flammability class A. The fire test was performed with an inclination of 127 mm by 300 mm (as prescribed in point A.2.5 of IEC 61730-2).



6 Mechanical mounting

All mechanical pressure values stated in this manual are design figures, this means that the test values are 1.5 times higher, e.g. if the modules are declared to withstand a pressure of 1600 Pa, this means that they were tested at a pressure of 2400 Pa.

6.1 Mounting rails

Observe the safety regulations and installation instructions included with the mounting rail. If necessary, please contact the supplier directly for further information.

The modules must be securely positioned on the support profile. The entire rail supporting the PV system must be strong enough to withstand possible mechanical stresses caused by wind or snow, in accordance with local, regional and state (and other associated) safety regulations.

Ensure that the mounting rail does not deform or affect the modules when it expands as a result of thermal expansion.

The mounting rail must be made of durable, non-corrosive and UV-resistant materials.

6.2 Mounting with clamps

TUNGHSU has tested its modules with alumed C3systems 6/9 clamps Use at least 4 clamps to fix the modules on the mounting rails. The metal parts of the module clamps must not come into contact with the front or rear glass. When choosing this type of clamp mounting method, use at least four clamps on each module; two clamps should be placed on each long side. Depending on local wind and snow loads, additional clamps may be required to ensure that the modules can support the load.

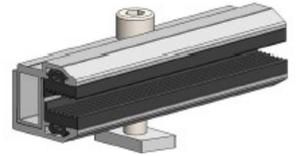
The applied torque must refer to the mechanical design standard according to the bolt used by the customer. It is recommended to use only certified equipment for the installation of the PV plant.

The tightening torque of the alumed C3systems 6/9 clamps should be at least 15 Nm, but not more than 20 Nm.

Normally 15 Nm is reached when two aluminium profiles touch each other. When using other mounting clamps, refer to the manufacturer's recommendations.

Table 1. Laminate, type alumed C3systems 6/9, clamp details Product



Product	Visual example	Length Options	Material finish
Intermediate Clamp MEDI 6/9		15MEDI 6/9 – 150mm 20MEDI 6/9 – 200mm	Anodized Aluminum Black Aluminum
End Clamp MEDF 6/9		15MEDF 6/9 – 150mm 20MEDF 6/9 – 200mm	Anodized Aluminum Black Aluminum

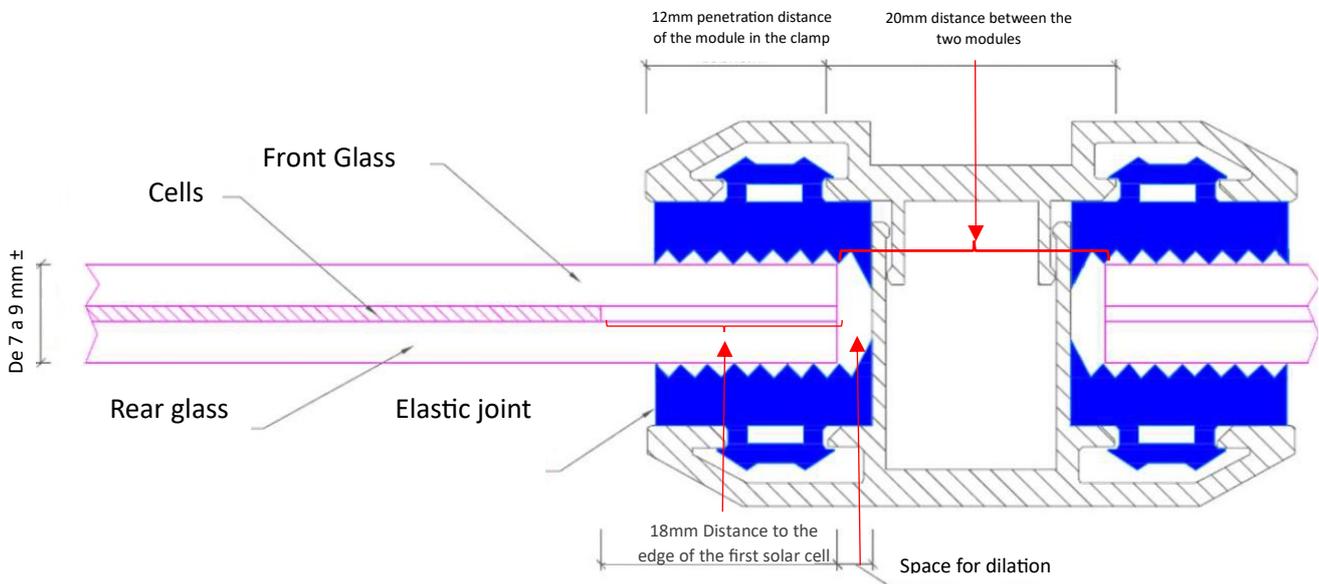


Figure 1.
Recommended Clamp Dimensions for TUNGHSU PV Glass-Glass Modules



6.3 Frameless TUNGHSU mounting

6.3.1 Cross sections

• 1600 Pa wind load/1600 Pa snow load

• 2400 Pa wind load/3600 Pa snow load

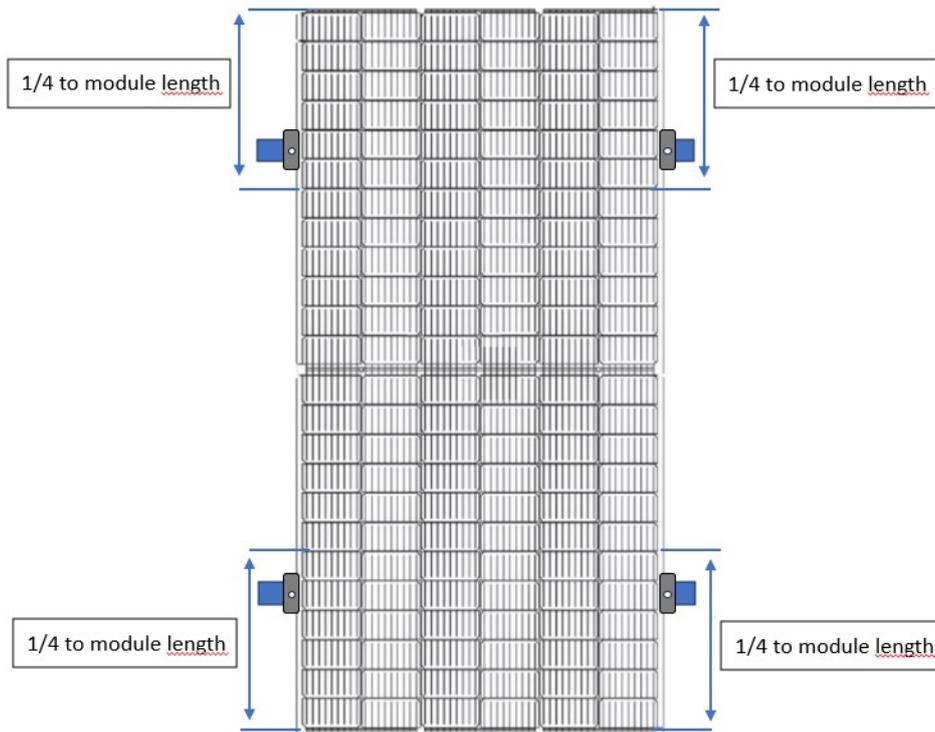


Figure 2. 6.3 Assembly of frameless TUNGHSU panels with four fixing points to cross rails.

If 100 mm clamps are used, 1600 Pa of wind and snow loads can be achieved. It is not recommended to use four fixing points with 100 mm long clamps in vertical configuration due to the risk of the panels sliding out of the clamp joints. It is normal that with loads above 1600 Pa the panels touch the cross rails. Please make sure that the rail surface is smooth, as even the smallest sharp edge can cause rapid mechanical failure. If the rail surface is not smooth and sharp edges occur, it is recommended to use rail joints to equalise the contact surface.



7 Exclusion of liability

Since it is impossible for SoliTek to control the installation, operation, application and maintenance of the PV system in accordance with this instruction. TUNGHSU accepts no responsibility and expressly disclaims any liability for any loss, damage or expense arising out of or in any way connected with such installation, operation, use or maintenance.

TUNGHSU shall not assume any liability for any possible infringement of patent rights and rights of third parties related to the application of the solar power system. No patent permission is granted by implication.

The information in this instruction comes from the knowledge and experience of TUNGHSU. However, the instructions and suggestions in this instruction do not constitute an external or internal guarantee. SoliTek reserves the right to revise this instruction, the products and all product information without prior notification to customers.