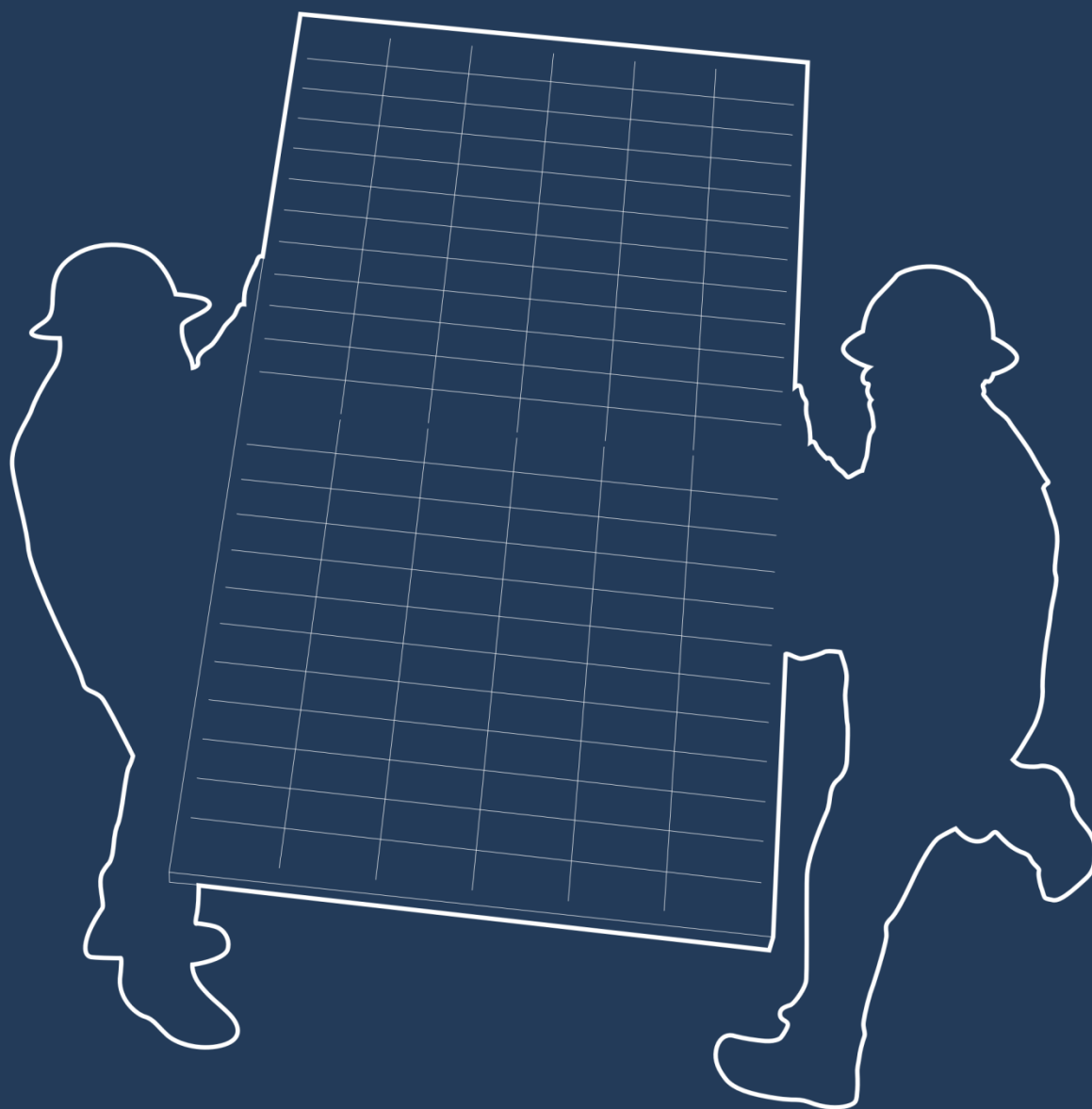


THORNOVA SOLAR

USER MANUAL



THORNOVA solar

APPLICABLE MODULE TYPE

This document is applicable to the series of PV modules as listed below:

With half-cut of mono c-Si cells 182mm cells:

type 1	TS -xxx78(xxx) /-G7/-G11
type 2	TS -xxx72(xxx) /-G7/-G9/-G10/G13
type 3	TS -xxx66(xxx) /-G9/-G10/-G11/G13
type 4	TS -xxx60(xxx) /-G7/-G9/-G10/-G11/G13
type 5	TS -xxx54(xxx) /- G9/G10/G11/G13
type 6	TS -xxx48(xxx)-G11
type 7	TS -xxx36(xxx)

With half-cut of mono c-Si cells 210mm cells:

type 8	TS -xxx66(xxx)-G12
type 9	TS -xxx60(xxx)-G12
type 10	TS -xxx36(xxx)-G12
type 11	TS -xxx32(xxx)-G12
type 12	TS -xxx28 (xxx)-G12

NOTE: Modules with 1500V; xxx: Module power

Contents of this document are subject to change without notice.

For the latest document please refer to Thornova Solar official website: www.thornovasolar.com

Yuncheng Solar Technology Co., Ltd

Contents

1.	INTRODUCTION.....	- 4 -
2.	SAFETY PRECAUTIONS.....	- 4 -
3.	SITE SELECTION AND ANGLE.....	- 6 -
	INSTALLATION ENVIRONMENT SELECTION.....	- 6 -
	INCLINATION SELECTION.....	- 6 -
4.	UNLOAD / TRANSPORTATION.....	- 7 -
5.	STORAGE.....	- 13 -
6.	UNPACKING INTRODUCTION.....	- 13 -
	UNPACKING SAFETY.....	- 13 -
	UNPACKING STEPS.....	- 15 -

1. INTRODUCTION

First, thank you for choosing our products. This manual shall only apply to the installation, maintenance and use of the Thornova Solar modules manufactured by Yuncheng Solar Technology Co., Ltd (hereinafter referred to as "Thornova Solar"). Failure to follow these safety instructions may result in personal injury or property damage.

The installation and operation of solar modules requires specialized skills and should only be performed by professionals. Please read the "Safety and Installation Instructions" carefully before using and operating the modules. The installer must inform the end customers (or consumers) of the above matters accordingly.

The term "Module" or "PV Module" in this manual refers to one or more Thornova Solar modules. Please retain this manual for future reference.

DISCLAIMER

Thornova solar reserves the rights to change this User Manual without noticing in advance. This User Manual is not a warranty document and does not have any warranty meaning. Failure of the customers to follow the requirements outlined in this User Manual during the handling (including without limitation to packing/unpacking, loading/unloading, transportation, storage, installation, use, operation or maintenance, etc.) of the products will result in the invalidity of product's limited warranty.

Thornova Solar is not responsible for any damages of any kind, including but not limited to any product damages, personal injury or any other property losses, as resulting from any improper operations or faults by the customers during the handling of the products as failure to follow the instructions in this User Manual.



Warning

Otherwise, the product may be damaged, or the user's personal safety may be endangered.



Prohibition

Otherwise, the product may be damaged, or the user's personal safety may be endangered.

2. SAFETY PRECAUTIONS

GENERAL SAFETY

Before attempting to install, wire, operate and maintain the modules, please read and understand all safety instructions. The module's solar cell will generate direct current (DC) when it is exposed to direct sunlight or other light sources, and direct contact with electricity live parts of the module, such as terminals, can result in injury or death, irrespective of whether the module and the other electrical equipment are connected or not.

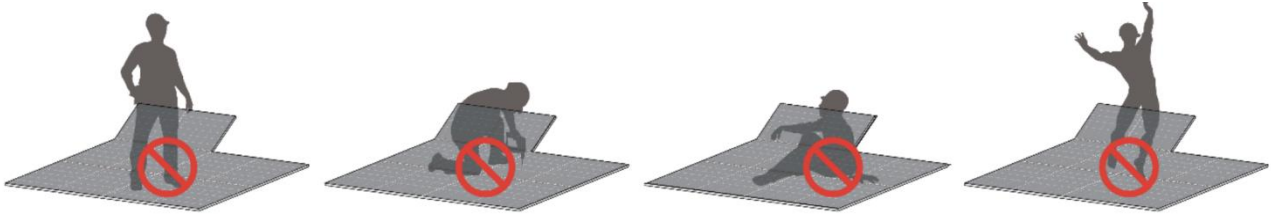
Regardless of whether the PV module is connected to the system or not, when conducting such as installation, grounding, wiring, or cleaning work, appropriate protective equipment such as insulation tools, hard hats, insulated gloves, safety belts and safety insulated shoes should always be used to avoid direct contact with the modules, reduce the risk of electric shock and protect your hands from sharp edges.



Under normal conditions, a solar photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. The requirement of National Electric Code (NEC) in Article 690 shall be following to address these increased outputs. In installation not under the requirement of the NEC, the values of I_{sc} and V_{oc} marked on this module should be multiplied by a factor of 1.25 when determining

component voltage ratings, conductor current ratings, fuse sizes and size of controls connected to the PV output.

Do not stand, sit, walk, or jump directly on the module package or the module itself.

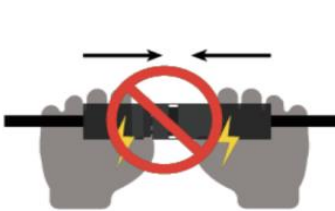


The PV module does not contain any serviceable parts.

Do not disassemble or move any part of the module.

Do not damage or scratch the front or backside surfaces of the module, as scratches may directly affect the product safety. If you detect any scratches or cuts on the module front or backside, please do not use the module at all.

Do not put heavy objects or sharp objects on modules.



Do not pull, scratch or bend the output cables with force. Otherwise, the insulation part of the output cables will be damaged, leading to current leakage or electric shock.



Do not insert any conductive material into the connectors attached to the module.



Do not connect or disconnect the module when there is a current flow or connected with any powered system.

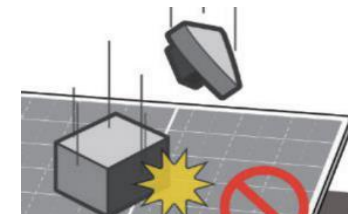
Do not use water to extinguish fires when the module is connected to any powered system.

Do not artificially concentrate sunlight on the module.

Do not drop PV modules or allow objects to hit or fall directly on the modules. Do not carry modules on your head.

Do not carry modules with ropes.

Do not carry modules on your back.



During the normal operation of modules, they should not be blocked by buildings, trees, chimneys, etc. at any time of the day.

Keep the junction box cover always closed.

FIRE SAFETY

When install modules on the rooftop, please refer to local laws and regulations before installation and abide by the requirements on building fire protection. The roof should be covered with a layer of fireproof materials with suitable fire protection rating and make sure that the backsheet and the mounting surface are fully ventilated. Different roof structures and installation methods will affect fireproof performance of buildings. Improper installation may lead to the risk of fire. Please use proper module accessories such as fuse, circuit breaker and grounding connector according to local regulations.



Do not install or use modules near open flames or flammable and explosive materials.

3. SITE SELECTION AND ANGLE

INSTALLATION ENVIRONMENT SELECTION

Thornova Solar recommends that the module should be installed in a working environment with an ambient temperature of -20°C to 50°C but not exceed the temperature limit of -40°C to 85°C . The modules shall be installed in shadow-free areas throughout the year. Do not install the PV modules at a place where water damage may occur.

When installing solar modules on the rooftop, a safe working area must be left between the roof edge and the outer edge of the PV array.

When stacking module on the rooftop, the rooftop should be tested for such loading and the installation plan must be developed in accordance with the specification requirements.

When using the modules in areas with high wind load and snow load, the supporting structure design should be carried out in strict accordance with the local design specifications, to ensure that the external load does not exceed the mechanical strength limit that the modules can withstand.

Salt spray corrosion tests conducted in accordance with IEC 61701 have shown that Thornova Solar's PV modules can be installed near offshore or in the corrosive environment. However, the modules shall not be immersed in water or in a permanently wet environment (e.g., fountains, spindrift, etc.).

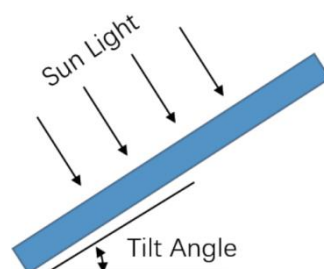
There is a risk of corrosion if the module is placed in a salt spray (i.e., a marine environment) or in an environment containing sulphur (e.g., volcanoes, etc.).

In the place, 50~500 m away from the sea, stainless steel or aluminium materials need to be used in where contacting PV modules, and the installation position must be processed with anticorrosion treatment.

INCLINATION SELECTION

The tilt angle of the PV module refers to the angle between the module and the horizontal ground.

The tilt angle shall be selected according to the local conditions for different projects. Thornova Solar recommends that the mounting tilt angle should not be less than 10° . For specific tilt angles, it shall be chosen in accordance with the local design procedures, specifications and regulations, or following the recommendations of the experienced PV module installers.



The PV modules is highly recommended facing south in the northern hemisphere and north in the southern hemisphere to get the best performance.

Following the local regulations, if PV modules are installed in North America and any other country or region comply to UL standard. A minimum of 155 mm (6.10 inch, recommended value) clearance shall be left between the PV module (backside) and the wall or roof surface. If other installation methods are used, the PV module's UL certification or fire class rating may get affected.

4. UNLOAD / TRANSPORTATION

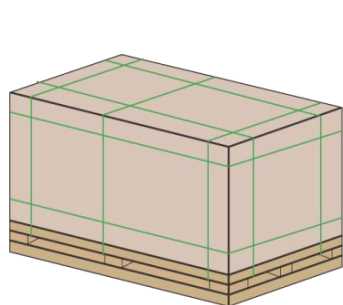
Please make sure to have sufficient safe distance during forklift operation to prevent people from standing or passing on both sides.

When unloading using a forklift, particular care should be taken to control the travel speed and prevent tilting during cornering.

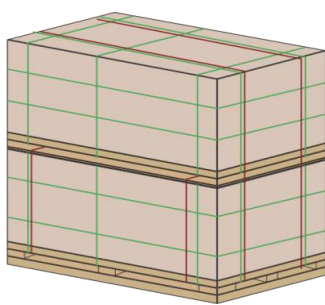
In any circumstances, for vertical landscape packages, it shall not be stacked more than two layers; for vertical portrait packages, stacking is not allowed.

The working ground needs to ensure that the packaging box can be placed horizontally and steadily to avoid tipping.

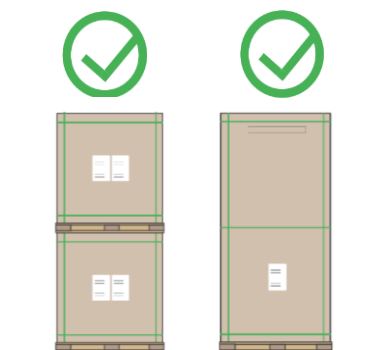
Example for vertical landscape package and vertical portrait package is shown as follows:



Vertical landscape package
(short-side vertically placed)



Vertical portrait package
(long-side vertically placed)



UNLOADING

Upon arrival of the modules, please check the packaging box is in good condition, and check whether the module type and quantity on the outer packaging are consistent with the delivery order, if anything is wrong, please contact Thornova Solar logistics and sales staff immediately.

1. Unloading with a crane

When crane is used to unload the modules, please choose and use specialized tooling according to the weight and size of the module. Please adjust the position of the sling to keep the modules steady.

To ensure the safety of the module, wooden sticks, boards or other fixtures of the same width as the outer packing cases should be used on the upper part of the box to prevent the sling from squeezing the pallet and damaging the modules. When placing the modules, do not lower the packing box too quickly and put it on a flat ground.



For vertical landscape packages, do not lift more than FOUR pallets of modules at once; for vertical portrait packages, do not lift more than TWO pallets of modules at once.

Do not unload modules under the weather conditions of wind more than 6 class (in Beaufort scale), heavy rain or heavy snow.



2. Unloading with a forklift

The loading dock should be as the same height as the underside of the carrier.

The forklift should be driven at a controlled speed of ≤ 5 km/h in straight, and ≤ 3 km/h for turning, to avoid sudden stop and rapid start.

Since the packing box will block the sight of the forklift driver, it is recommended to drive backwards during the forklifting and arrange for special supervision and command to prevent bumping into people or items causing personal injury or damage to the modules.

Please choose a flat and solid ground to place the module package after transportation to the installation site.

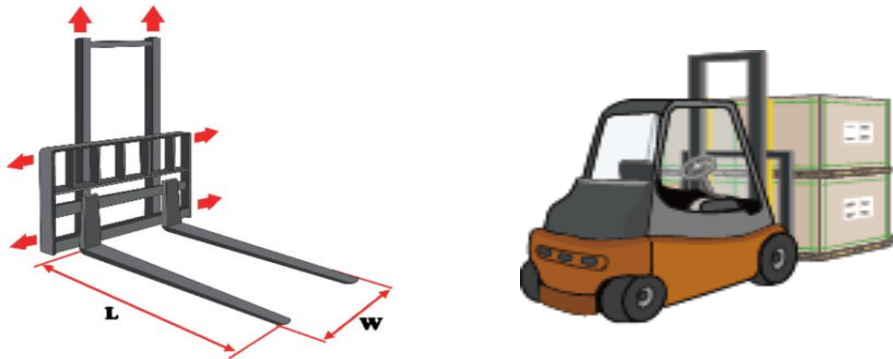
Forklift operation in warehouse

When using a forklift to unload the modules, please choose a forklift with suitable tonnage according to module weight. The forks should go into the pallet at least $3/4$ of the pallet depth during unloading (the forks length $L \geq 3/4$ of pallet length).

To ensure better stability during forklift transport, the forks distance (W) should be adjusted to the maximum position without any interference.

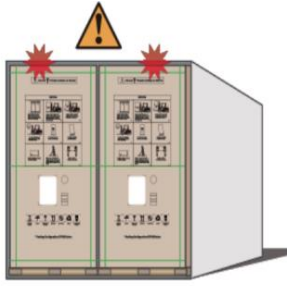
Please drive slowly and do not allow forks to hit the cartons or pallets. Please place buffer protection material (in yellow, preferably silicone, rubber, EPE) in advance to prevent the inside modules being damaged due to the external force.

It is recommended to extend the height or width of the forklift backrest to prevent directing touch with the module glass.

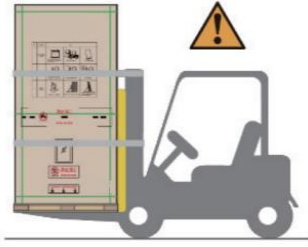


Please also pay attention to the following precautions when unloading

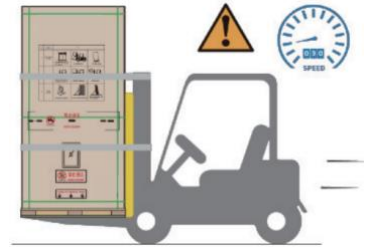
(taking vertical portrait packages as an example)



Prevent collision on the top when unloading from the container.



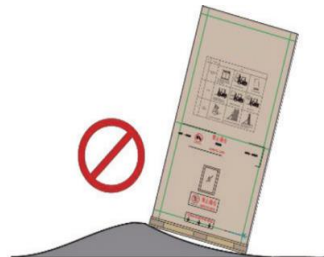
Recommend to secure the module package to the forklift with a safety rope, transport horizontally with no person standing on either side.



Control the speed to prevent tipping.



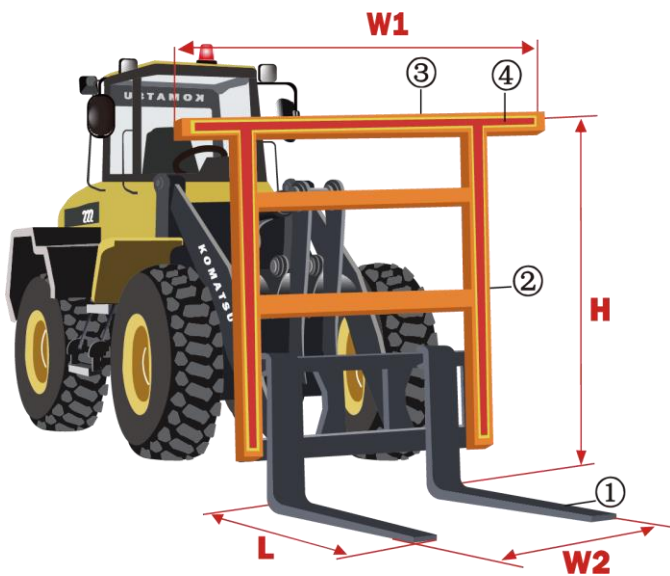
No collision on the module glass



No tilting storage.

Forklift operation at project site

The forklift operation at project site refers to the transportation of modules between the storage site and the installation site after they arrived at the project storage site.



Forklift requirements:

Vertical portrait package

Please use forklifts with a rated lifting capacity of ≥ 3.5 tons to load and transport the modules.



Do not allow the convex part of the fork to directly contact with the carton or modules to prevent damage to the modules.

① Forks

The fork length (L) should ≥ 1.0 m.

The forks distance (W2) should be adjusted to the maximum position without any interference to the pallet.

② Backrest

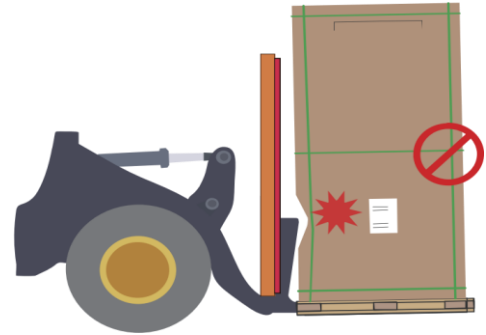
The backrest length (H) should ≥ 1.7 m; the backrest width (W1) should ≥ 1.5 m.

The backrest shall be perpendicular to the fork, and the structure must be firm (withstand pressure ≥ 15 kN). When the entire module package leans on the backrest, the backrest shall not be deformed due to pressure.

③ Beam

④ Buffer material

The contact position between the top beam and the module package should be fixed with a buffer material (preferably silicone, rubber, EPE) to prevent the forklift from damaging the modules.



Vertical landscape package

① Forks

The fork length (L) should ≥ 1.0 m.

The forks distance (W2) should be adjusted to the maximum position without any interference to the pallet.

② Backrest

The backrest length (H) should ≥ 1.5 m or the backrest width (W1) should ≥ 2.5 m.

The backrest shall be perpendicular to the fork, and the structure must be firm (withstand pressure ≥ 15 kN). When the entire module package leans on the backrest, the backrest shall not be deformed due to pressure.



③ Beam

④ Buffer material

The contact position between the top beam and the module package should be fixed with a buffer material (preferably silicone, rubber, EPE) to prevent the forklift from damaging the modules.

*Forklift specifications and operating practices include, but are not limited to, the above-mentioned matters.

Please also pay attention to the following precautions:

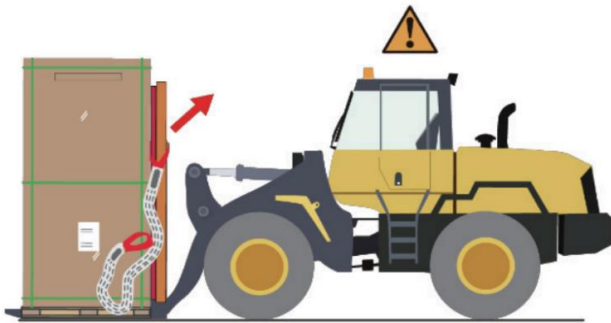


The forklift must be operated from the long side of the pallet (forks enter slowly into the pallet from the long side). Do not collide with the module.

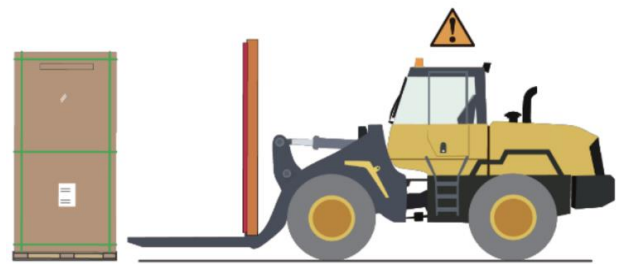
Both sides of the beam shall contact with the package at the same time.



The module package shall lean on the backrest, the package must be fixed using a safety rope with a tensile strength of ≥ 2000 kgf, and control the speed to prevent tip-off.



Place the module package smoothly on the ground, untie the safety rope after the confirmation of no risk of tilting.



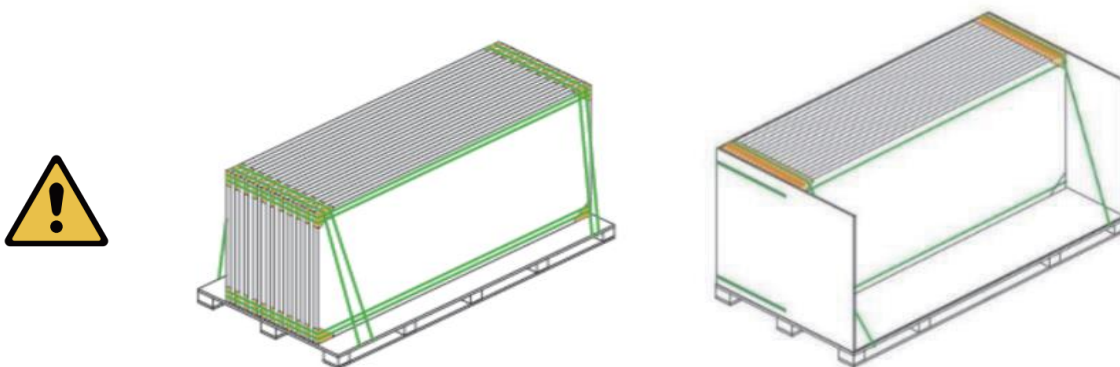
Exit the forklift slowly.

SECONDARY TRANSPORTATION

The packaged modules can be transported by land, sea or air. During transportation, make sure that the package is fixed with packing belts securely on the shipping platform without any movement.

If the unpacked modules need to be transported to other places, it is recommended to pack the single module together in a package to the maximum number allowed and fixed with inner packing belts (2100Nforce recommended). Finally, cover it with the packaging carton box and fix it with the same number of packing belts as before.

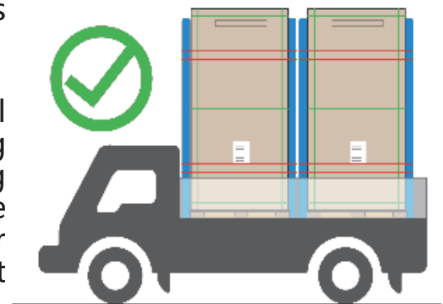
If the number of modules need to be packed is less than the maximum number allowed in a package, the modules need to be fixed and secured to the centre of the pallet for utility packaging (the following figure to the left) or on the side for distribution packaging (the following figure to the right), and fixed with inner packing belts (2100Nforce recommended). Finally, cover it with the packaging carton box and fix it with the same number of packing belts as before. Do not put the unfulfilled package on the lower layer when transported.



Please use appropriate means of transport to transport the modules. Do not use pedicab to transport or handle the modules.

Secondary transport is not allowed for the monofacial modules that are packaged horizontally.

There is no stacking of pallets allowed (for both vertical landscape and vertical portrait packages), when transporting with small trucks. Please fix the package to the vehicle using e.g. safety ropes and control the driving speed according to the road conditions. Please put paper corner support or other buffer material between safety rope and carbon box to protect modules from damage.



When using box trucker and flatbed trucker transport the modules, the module packages should be placed close to each other without any gap. The empty space needs to be filled to prevent the package moving backwards to the rear of the truck. Additionally, every package needs to be fixed using e.g. ropes to the vehicle when transporting with the flatbed trucker.

Do not allow pallets to exceed the loading area of the transport vehicle.

5. STORAGE

Modules should be stored in a dry and ventilated environment on a flat ground (for vertical portrait package, the inclination of ground need to be less than 4°), to avoid damage or dumping of the modules due to ground deformation or collapse.

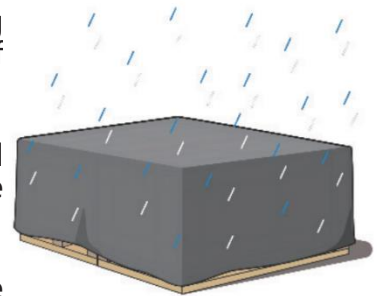
Storage requirements: relative humidity < 85% and temperature range of -40° C to 50° C.



Do not remove the original package and keep the wrapping film and carton box in a good condition, if the modules require long-distance transport or long-term storage.

For long-term storage, it is recommended to store the modules in a standard warehouse with regular inspection, and under confirming of your personal safety, reinforce the package in a timely manner if any anomalies are found.

The warehouse shelves should have sufficient carrying capacity and storage space, regular inspection is required to ensure the storage safety.



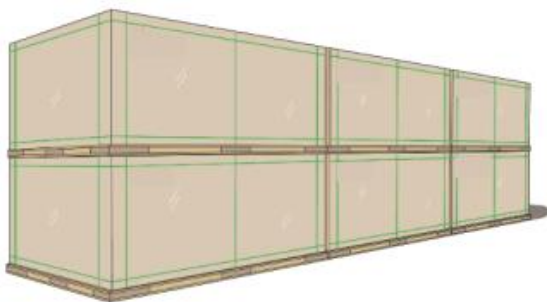
If you need to store the modules in the project site, do not choose soft ground and the ground that is easy to collapse, should choose a hard ground or a higher ground with flat surface to ensure the module packages not collapsing and tilting for long-term storage.

In rainy weather, please fully cover the modules and pallets with a rain protection and take moisture proof measures on pallets and cartons to prevent collapse and moisture ingress. Under sun or wind, remove the rain cloth to allow the package to dry as soon as possible, prevent package collapse caused by the rain.

Do not allow the pallets to soak in water. The ground drainage measures should be done previously for the storage site to prevent a large amount of water accumulation on the ground after rain, causing the ground to soften, sink, etc.

Do not allow unauthorized persons to access the module storage area.

The modules should be centrally stored.



6. UNPACKING INTRODUCTION

UNPACKING SAFETY

Before unpacking, please check the product type, power bins, serial number and relevant suggestions on the A4 paper of the packaging box and read the unpacking instructions carefully.

Custom unpacking methods are prohibited.

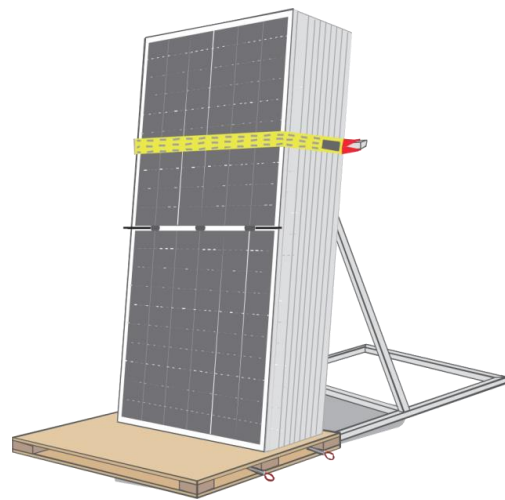
Before unpacking, please make sure that the packaging box is in good condition, it is recommended to use art knife to remove the packing belt and wrapping film. Violent removal is prohibited to avoid scratching the modules in the box.

Please check that the number of modules in the box and the barcode information on the module frame are consistent with the information on the A4 paper on the packaging box. Please follow the recommended unpacking steps to unpack the modules. When unpacking, it must be operated by two or more people at the same time. Always wear insulating gloves when handling the modules. If all the modules are not taken out after unpacking, the remaining modules shall be placed horizontally and repackaged to prevent them from tipping. When packaging, please note that the glass side of the bottom module should face up, the glass side of the middle modules should face down, and the glass side of the top module should face up. Stacks of modules should contain no more than 16 modules, and the frames should be aligned.

If the unpacked modules are not installed immediately, they should be fixed to the stand supporter with a safety rope under weather of 6 class wind (the modules should be less than 12 pieces).



Please fix the unpacked modules to the stand supporter with a safety rope.



For matters regarding the unpacking stand supporter, please contact Thornova Solar sales.



In windy weather, it is recommended not to carry the modules, and the unpacked modules should be properly secured.

Do not unpack the modules outside under rain and snow conditions.

Do not carry the module by one person to prevent the module from slipping and hitting other modules, causing scratches, cracks, or deformation on the modules.

Do not lift modules by their cables or junction box.

Before removing the inner packing belts, please take measures to protect the modules from dumping.

If unpacking the vertical landscape packages on non-horizontal ground, anti-tilting measures should be taken.

The vertical portrait packages have a high centre of gravity and are prohibited to unpack on nonhorizontal or soft grounds to avoid personal injury or even death.

When unpacking vertical portrait package, do not stand on the back of the stand supporter, please operate in strict accordance with the requirements of the unpacking instructions.

When removing the packing belts in vertical portrait package, take care not to hurt yourself (face, eyes, etc.).

Do not stand on the pallet during unpacking, please carry the modules from sides of the pallet. Do not move the stand supporter during unpacking to prevent the modules being tilted.

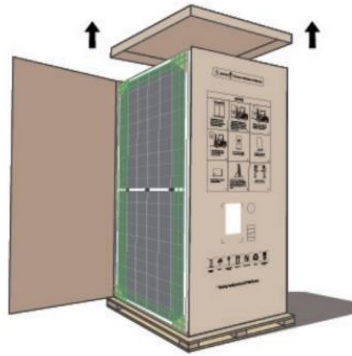
Do not lean the module on any instable objects, such as poles or mounting columns. Do not support the back of the modules directly with materials such as wooden strips.

UNPACKING STEPS

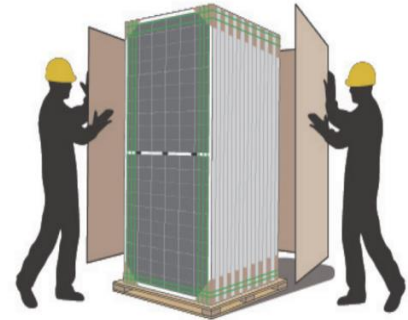
Method A: Unpacking for modules with vertical package.



1) Remove the wrapping film and packing belts.



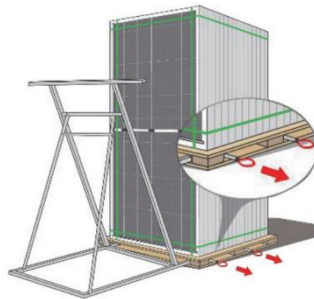
2) Remove the top cover and sealing tape.



3) Remove the carton box.



4) Place the stand supporter from the glass or backsheet side.



5) Pull out the 4 levers from both sides of the pallet.



6) Cut off all the horizontal packing belts.



7) When there are 1-2 vertical packing belts remaining, push the module gently to tilt toward the stand supporter.

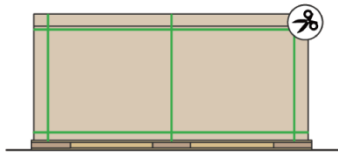


8) Cutoff the remaining packing belts so that the modules rest on the stand supporter.

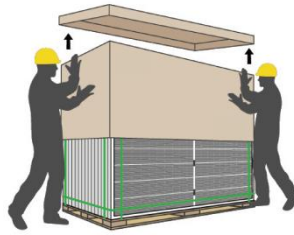


9) Take out the modules in order.

Method B: Unpacking for vertical landscape package



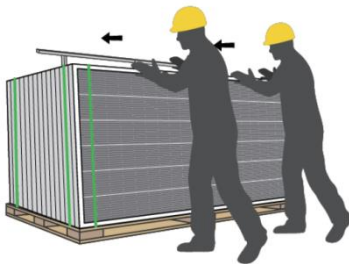
1) Remove the wrapping film and packing belts.



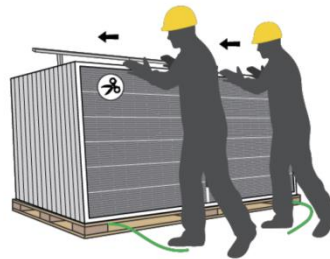
2) Remove the top cover and the cartons.



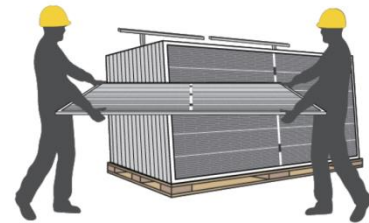
3) Place the stand supporter that higher or wider than the module in order to avoid hitting and damaging the glass.



4) Cut off all the horizontal packing belts; when there are 1 or 2 vertical packing belts remaining, push the module gently to tilt toward the stand supporter.



5) Cut off the remaining packing belts.



6) Take out the modules in order.

THORNOVA **Solar**



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