

LONGi

Module Product Manual



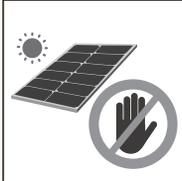
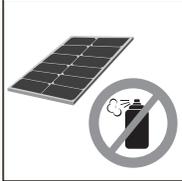
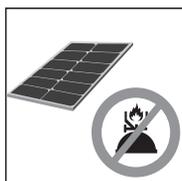
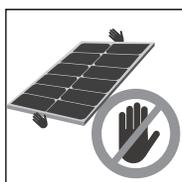
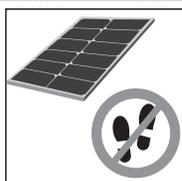
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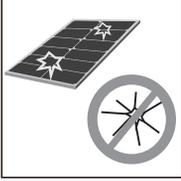
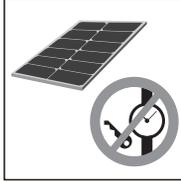
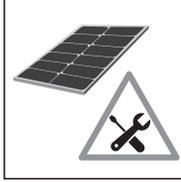
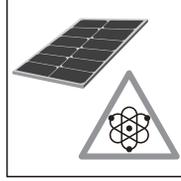
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1 Safety Precautions

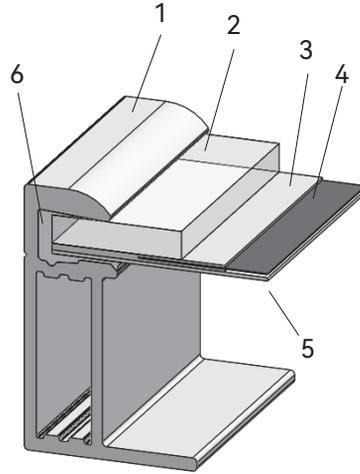
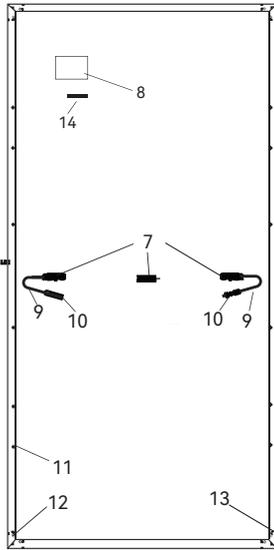
LONGi

<ul style="list-style-type: none">◆ Do not contact live parts of the module directly.	
<ul style="list-style-type: none">◆ Do not disassemble modules or remove the nameplate or any adhered parts.	
<ul style="list-style-type: none">◆ Do not paint or paste any object on the surface of the modules.	
<ul style="list-style-type: none">◆ Do not focus sunlight on the modules using mirrors or lenses.	
<ul style="list-style-type: none">◆ No unattended children allowed near the modules.	
<ul style="list-style-type: none">◆ Do not place modules in areas where combustible gases are likely to be generated or stored.	
<ul style="list-style-type: none">◆ Pulling on the junction box cable is strictly prohibited.	
<ul style="list-style-type: none">◆ No stepping on module.	

LONGI 1 Safety Precautions

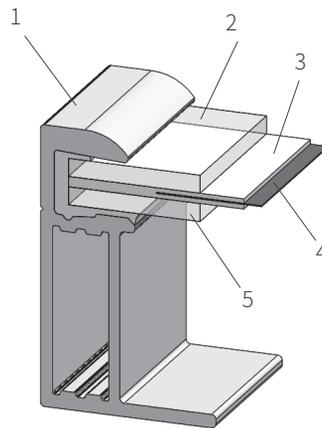
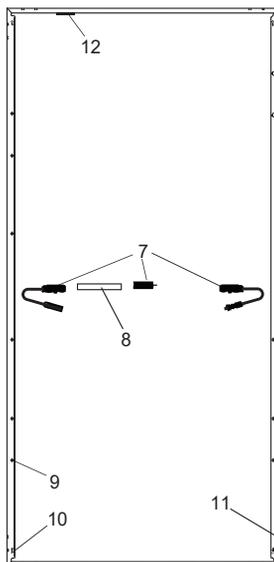
<ul style="list-style-type: none">◆ Do not place or throw weights on or onto the modules to avoid damaging the glass.	
<ul style="list-style-type: none">◆ No bumping of modules.	
<ul style="list-style-type: none">◆ Metal jewellery is prohibited near the modules.	
<ul style="list-style-type: none">◆ The use of non-insulated tools are prohibited.	
<ul style="list-style-type: none">◆ No installations in rain.	
<ul style="list-style-type: none">◆ The modules need to be reliably grounded. The PV array grounding should be continuous and reliable, and the grounding resistance should be less than 4Ω.	

2.1 Schematic diagram of the module structure



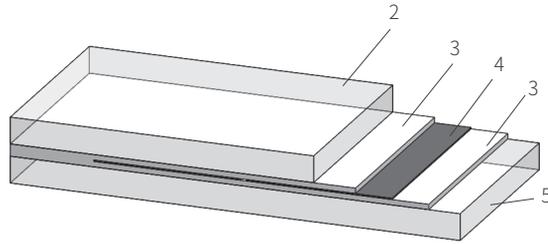
Schematic diagram of the monofacial module structure

1.Frame	2.Glass	3.EVA	4.Solar Cell
5.Back Sheet	6.Silica Gel	7.Junction Box	8.Nameplate
9.Cables	10.Connector	11.Mounting Hole	12.Grounding Holes
13.Drain Holes	14.Barcode		



Bifacial Modules (With Frame)

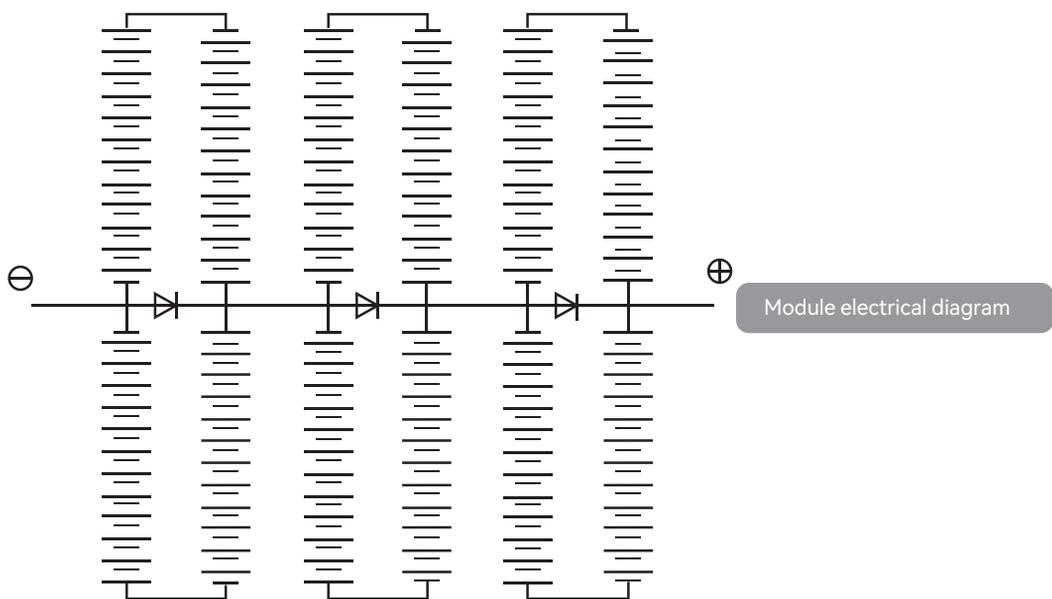
LONGI 2 Module Introduction



Bifacial Modules (Frameless)

Schematic diagram of the bifacial module structure

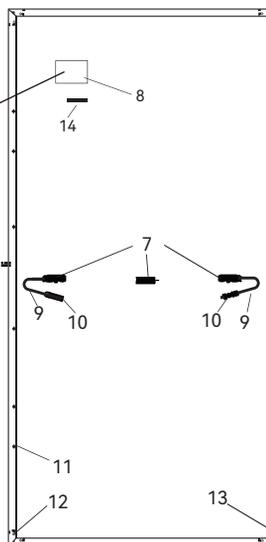
1.Frame	2.Front Glass	3.EVA/POE	4.Solar Cell
5.Back Glass	6.Sealant	7.Junction Box	8.Nameplate
9.Mounting Holes	10.Grounding Holes	11.Drain Holes	12.Barcode



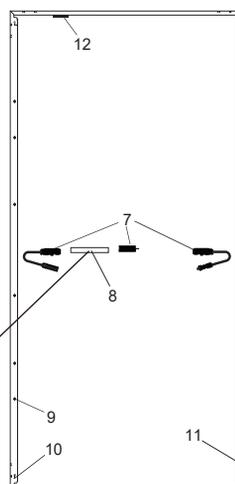
Module electrical diagram

2.2 Module identification

- ◆ Nameplate: Information on module parameters, including rated power, rated current, rated voltage, open-circuit voltage, short-circuit current under standard testing conditions, certification indicator, maximum system voltage, etc.



Monofacial Modules



Bifacial Modules



Diagram of nameplate location

LONGI 2 Module Introduction

- ◆ Current classification: The current is divided into 3 classes: H for the high class, M for the middle class and L for the low class. The best practice is to only use modules with the same power and current class within the same string during installation.

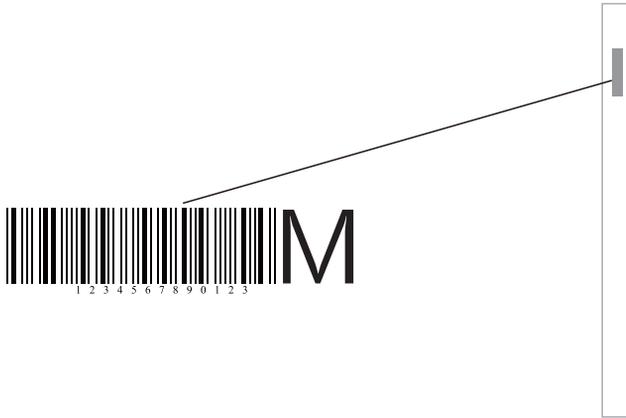


Diagram example of current classification

- ◆ Barcode: Every module is marked with an unique serial number for traceability.

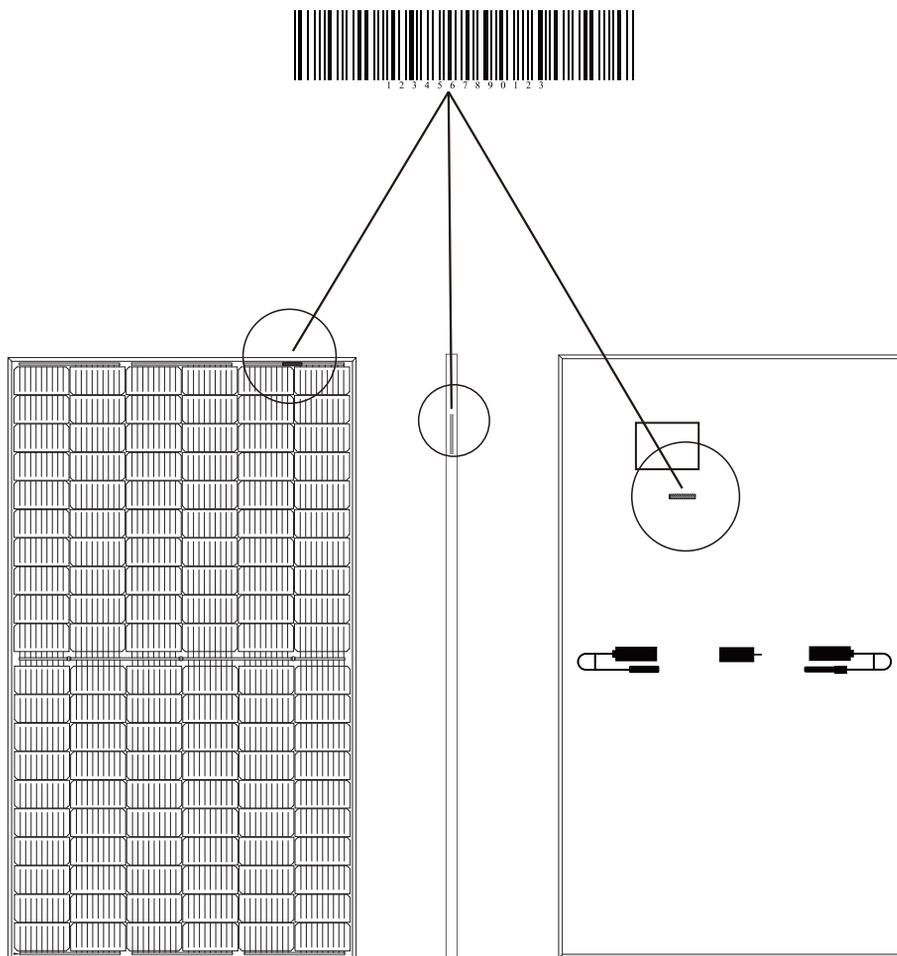


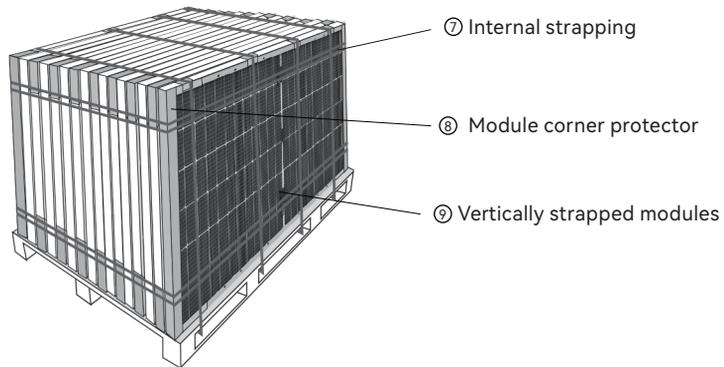
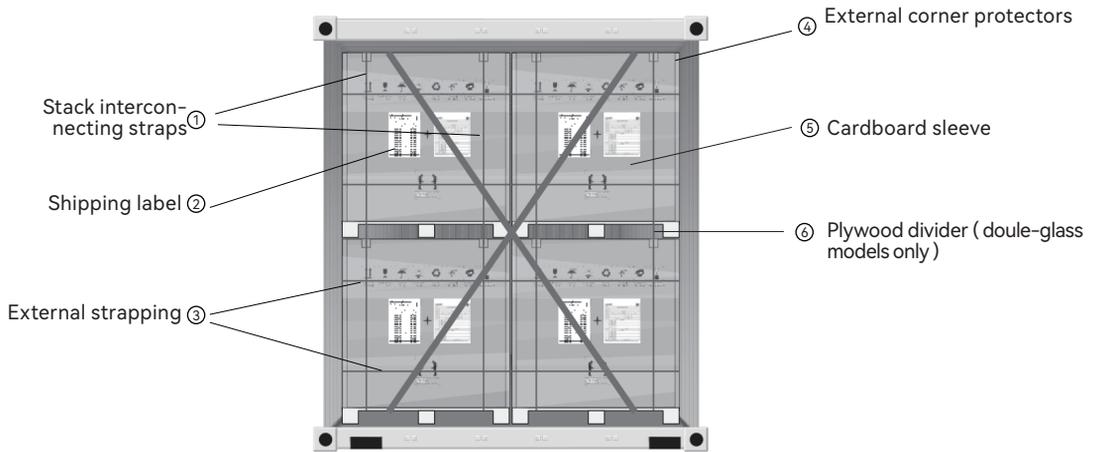
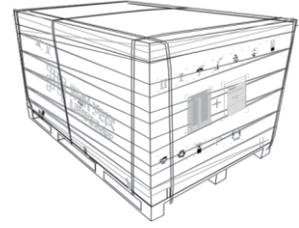
Diagram of barcode location

The patterns and contents of the above barcode and nameplate are for demonstration purpose only.

LONGi ■ 3 Module Transport and Storage

3.1 Transport and storage requirements

LONGi solar photovoltaic modules are packed with a layer of plastic film on the outside of the pallet, which provides basic dust and water protection for the modules. For long distance transport or long time site storage, do not unpack pallets. The diagram on the right shows the package detail.

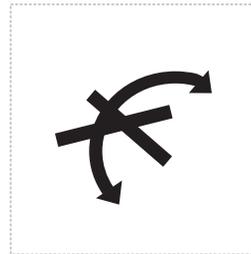
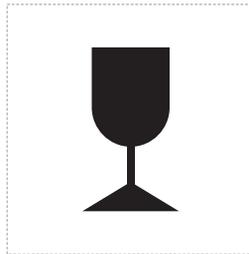
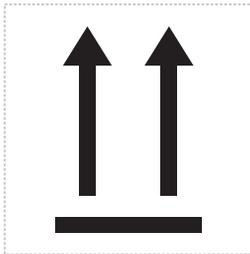


Packaging diagram

Note: the exterior pallet printing, labeling and the packing method may vary depending on the product type and batch. Images shown above are for reference only.

3 Module Transport and Storage **LONGi**

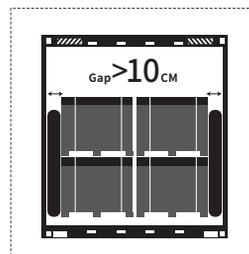
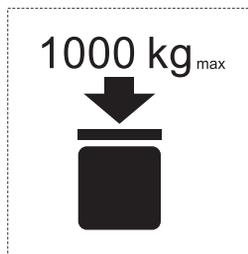
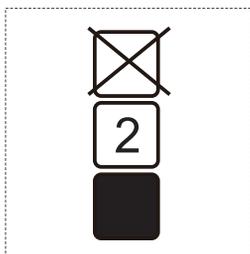
- ◆ The packed modules can be transported by road, sea or air. Please ensure that the packed modules do not roll or slide during transport. It is preferable to secure the pallets to the transport platform. The modules should be prevented from falling from higher ground. It is also necessary to avoid violent shocks and bumps to the packaged modules. The diagram below shows the upward, fragile, and no-rolling sign, respectively.



- ◆ The pallet is not completely moisture-proof and the structural integrity of the pallet will be reduced when exposed to moisture, which could be dangerous. During transport and storage, do not expose the modules to rain or moisture and keep them in a ventilated, water-proof and dry place.



- ◆ Packaged modules can be stacked together for transport or storage up to a maximum of one layer. When using non-factory vehicles or containers for intermediate transfers, secure the pallets with a flat support or rain cloth straps around the pallet and with additional paddings, such as airline inflatable bags, if the pallet is more than 10cm from the carriage wall to avoid skewing and damage to the pallets.

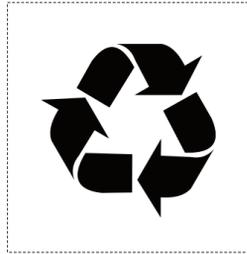
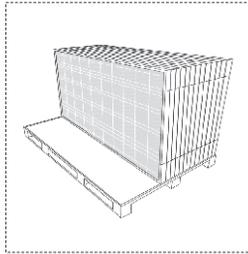


LONGI 3 Modules Transport and Storage

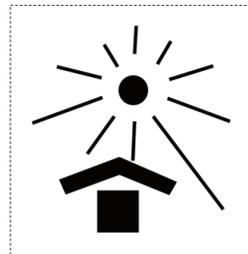
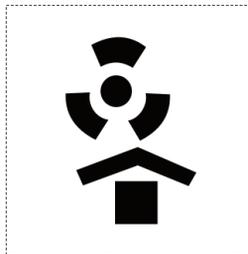
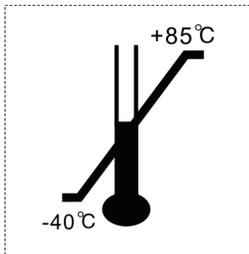
- ◆ Stepping on top of pallets and modules is prohibited.



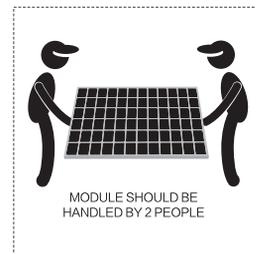
- ◆ To open the pallet, please follow the steps in 5.3 Unpacking steps. The packaging materials are recyclable.



- ◆ It is forbidden to store the modules together with corrosive chemicals or gases. Pay close attention to fire prevention and keep the storage temperature within $-40\sim+85\text{ }^{\circ}\text{C}$. Extended exposure to the sun is prohibited.



- ◆ If the pallet is found to be moist, carefully unpack and remove the modules from the pallet and place them in a ventilated area. Do not stack modules from more than one pallet in a single stack after unpacking. Module must be handled by two persons at the same time. The stacked modules must be aligned at the top and bottom of the frame and must not press on the connectors and cables.

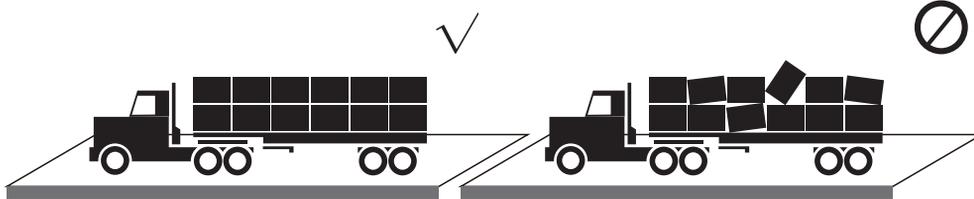


3.2 Notes on claims for cargo damage in transit

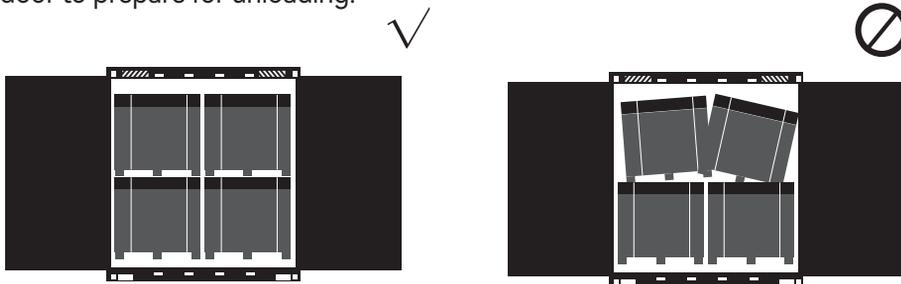
- ◆ Upon arrival of the module at its destination, the customer must promptly confirm whether the outer sleeve and the modules are damaged or abnormal in appearance. In the event of any damage to the outer packaging of the module, the customer must immediately take photographs of the whole vehicle and pallet upon arrival to record evidence of the damage, mark down the non-conformance on the delivery form, and inform the carrier and LONGi for inspection. Customers reserve the right to reject damaged pallets from the carrier. If signed with no damage notation, the pallet and modules shall be treated as undamaged. Any further damage found will be at responsibility of receiver.
- ◆ If the quantity of modules is found to be insufficient, the customer should immediately obtain proof of damage or discrepancy from the carrier, consignee or relevant agency and indicate the actual quantity received on the signed receipt. When making a claim to LONGi, the claimant needs to provide the following documents: waybill, invoice, packing list, signed receipt, valid photographic proof and claim list.
- ◆ If there is a delay between module delivery and unpacking, module damage found after unpacking can be proven to be caused by transit/handling upon presenting the combination of packing sheet, pallet ID, valid photographic evidence and/or inspection reports. Photos proving module damage from transportation should be taken as a whole pallet, prior to cutting individual modules loose. Note that the delay to unpack modules cannot exceed 10 days after arrival to project site.
- ◆ LONGi will not be liable for any damage to the modules due to irregular transfer, reversal or handling operations on site, but may provide replacement at the customer's cost.

- ◆ Upon arrival of the modules, check for the following items:
 - whether the rain cloth protection of the vehicle is in place
 - whether the appearance of the cardboard packaging is intact
 - whether there is rain damage on pallets
 - condition of the transport vessel is intact
 - position of ropes/straps are in place
 - whether full trays have shifted (skewed or broken pallets/parts)
 - any other abnormalities (please specify)

After confirming everything is normal, start preparing for unloading.



- ◆ Container transport: After the container arrives, first check externally whether there is serious deformation, holes on the container body, or any other abnormalities; then check whether the container had previously been opened. The door should be opened carefully in case of pallet collapse. Once confirmed everything is normal, carefully open the door to prepare for unloading.



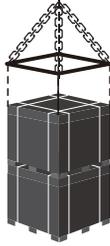
- ◆ Forklifts or cranes are recommended for unloading modules, and can be selected according to the actual situation on the power station site. The forklift must be operated by a qualified operator with appropriate license; otherwise, they must not operate the relevant vehicle to unload the modules to avoid causing damages to the modules or injuries to the personnel on site. When unloading, the fork must not hit the pallet. When lifting, ensure that the center of gravity of the entire box is stable and in the center of the box, and handled with caution.



4 Unloading and Storage LONGi



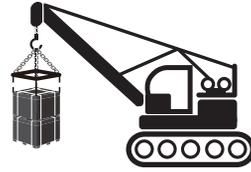
— Safety —



— Specialities —

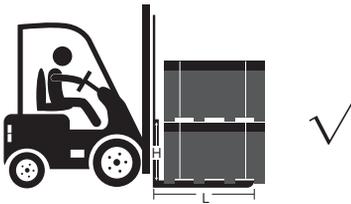


— Efficient —



— Intention —

- ◆ When unloading with a special forklift, select forklift fork length appropriately for pallet size. The fork must be at least 90% in contact with the pallet surface. When the forklift is running, please avoid fierce vibrations on rough terrain or backrest significant tilting at one end. Impact and collisions are strictly prohibited. The height of the forklift's backrest must be higher than the height of a single pallet, and the contact area between the backrest and the box must be padded.



Forklift tines inserted from the short side (recommended). $H >$ single trailer packing height, $L >$ 90% of pallet length.



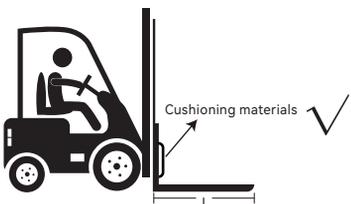
Forklift tines inserted from the long side (allowed, but not recommended). $H >$ single trailer packing height, $L >$ 90% of pallet length.



Fork tines need to be inserted centrally.



Inserted from the long side, the backrest is below the height of the package and there is no gap between it and the box, which can break the glass by pressing the internal modules.

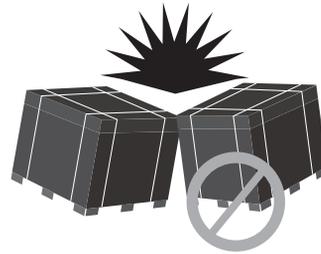
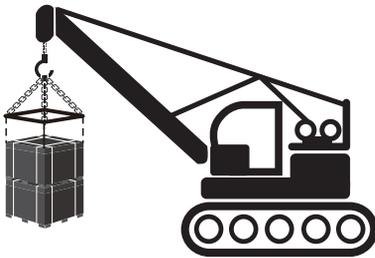


Additional cushioning material on forklift backrests.



Forklifts longer than the length of the pallet will hit adjacent pallets.

- ◆ When using a crane to unload the modules, special lifting tools must be used. The lower support bar of the sling must be rectangular steel, and the width of the rectangular steel must not be less than 8cm. Round steel is not allowed to be used to avoid stress concentration damage at the bottom of the pallet and the risk of tipping due to the rolling of the round steel. The upper part of the lifting assembly must have a crossbar, with internal dimensions corresponding to the dimensions of the pallet. The lifting point must be marked at the pallet's lifting point to prevent crushing stresses on the sides of the pallets during lifting, resulting in deformation or bursting of the internal module frame. Avoid shaking of the pallets against each other or sudden or jerking movement during lifting and landing.



- ◆ The area where the modules are to be unloaded must be flat and spacious. Avoid waterlogged, potholed or sloping areas. Keep pallets away from chemical corrosion, flooding, fire hazards, blasting and vibration sources, etc. Arrange the pallets in a neat and orderly manner with the top and bottom pallets aligned to avoid overhanging pallets, skewed pallets or misalignment of the top and bottom pallets. Do not exceed the maximum number of pallets (2) printed on the box when stacking the modules. Do not stack modules in areas of significant slope (stacking of two pallets).

4 Unloading and Storage LONGi

- ◆ If there is any damage to the packaging of the outer pallets, photos must be taken to retain evidence (damaged pallets, license plate number, container number). Inform the driver to confirm and note the damage details on the receipt, and provide relevant evidence photos to inform LONGi sales staff.



Package



Container



Overall photo of the defective packaging

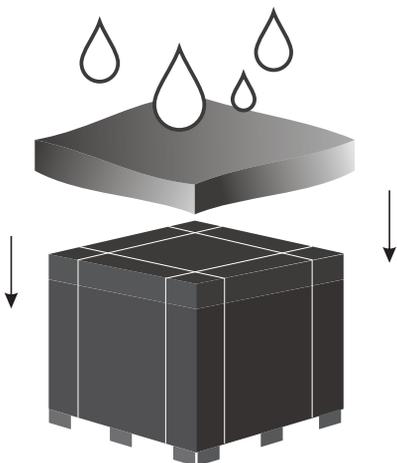


Close-up detailed photo of the defect

最大功率 Prime	545W	電壓分類 Current Class	M
托盤號 Pallet No.	LR990054210100009		
棧位型號 Module Type	LR5-72HPH-545M		
棧位盒型號(總長/總寬) Length/Connector			
PV-LR04A (+0.4m)-0.2m(PH-LRS) 三分體			
電池片顏色 Cell color	/	邊框顏色 Frame color	Test 銀白色
托托包總外尺 Total Size	2300*1120*1243	總淨重 Total N. W.	843.2KG
序號 No.	條形碼 BarCode	序號 No.	條形碼 BarCode
1		2	
4		5	
7		8	
10		11	
13		14	
16		17	
19		20	
22		23	
25		26	
28		29	
31		32	
34		35	
		36	

Shipping label

- ◆ If installation is not possible in time, a rainproof cloth or corresponding waterproofing measures should be used to prevent damage to the cardboard sleeve and pallet from weather, which may compromise the structural integrity of the packing materials during transfer or allow water ingress to the internal electrical connections of the modules.



5.1 Confirmation of mounting system before unpacking of modules

- ◆ The mounting system are installed in accordance with the construction specifications and drawings, and the beams and purlins must be securely connected and fixed.
- ◆ The PV racking should be installed neatly, aesthetically pleasing, and without distortion, which may affect the installation quality of the modules. All racking systems should be confirmed for module compatibility and checked for installation quality prior to module installation.

5.2 Unpacking requirements

- ◆ Equipment and tools : knives, gloves, forklift
- ◆ Personnel : At least four people

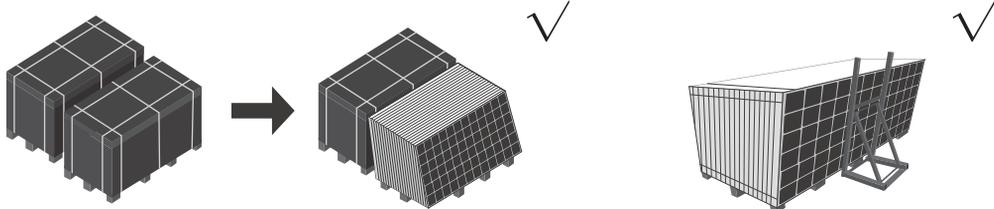
Caution:

- ◆ Before unpacking and transporting the modules, confirm the condition of each module. If abnormalities such as bursting or damage are found, stop transporting immediately and inform the customer service personnel, supervisor, general contractor and owner on site to take photos and confirm that the rest of the modules and packing boxes will not be moved on site.
- ◆ When unpacking outdoors, it is forbidden to work in rainy conditions. This is because the carton will soften and loosen when exposed to rain and the modules inside may fall out, causing damage to the modules or injury to people.
- ◆ If windy conditions prevail on site, special care should be taken to ensure safety. It is NOT recommended to unpack the modules in windy conditions. Unpacked modules should be properly secured.
- ◆ Place the pallets on flat ground to avoid tipping over.
- ◆ Use scissors or an utility knife to cut the outer packing straps short. Take care to avoid cutting into the backsheet or frame, and check the amount of modules inside the box in time after opening .
- ◆ When opening a full box of modules, hold the module to prevent it from falling, which may cause microcracks or burst of the modules.

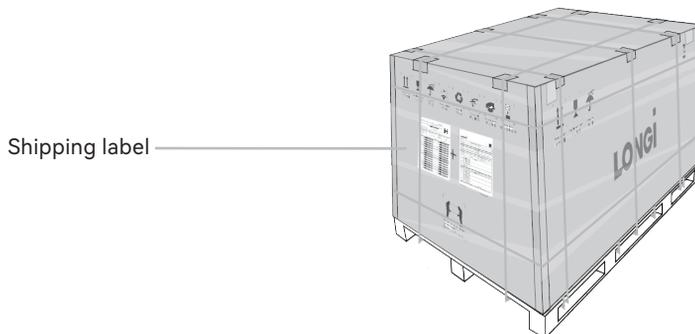
- ◆ Determine the current class shown on the module frame and install modules of the same current class in the same area (array, combiner box).
- ◆ When unpacking, be careful of edges of the frame, blades or other sharp objects to avoid cutting yourself or others.
- ◆ For safety reasons, it is forbidden to unpack the upper pallet while they are stacked.

5.3 Unpacking steps

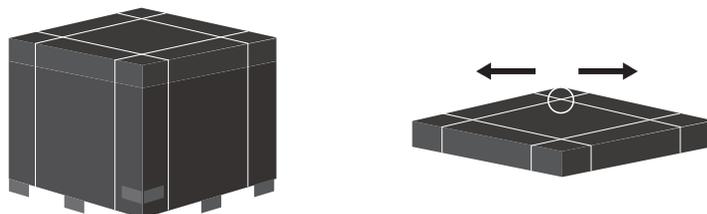
- ◆ Use a forklift to move the pallets to the working area (same requirements for forklift as in chapter 4), avoiding violent bumps and vibrations during the movement of the modules and avoiding the pallets from tipping backwards during transport. In the case of manual forklifts, it is best to insert the forks from the short side of the pallet. The long side of the unpacked modules needs to be placed close to a solid wall (15-20 cm distance), or on a supporting tool.



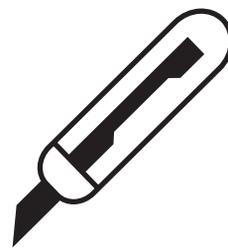
- ◆ Confirm the box is intact and that the relevant information on the shipping label, including product type, specification, number of modules in the pallet, barcode, electrical performance parameters and current rating of the corresponding modules, is correct and that the modules of the same current rating are installed in the same string. Avoid mismatching losses due to stringing modules with different current rating.



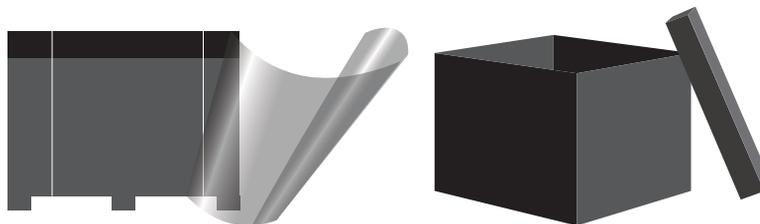
- ◆ Remove the external straps and shrink wrap. Find the joint of the strapping and easily separate it by tugging on each end of the joint with both hands and applying force in opposite directions (or use an utility knife).



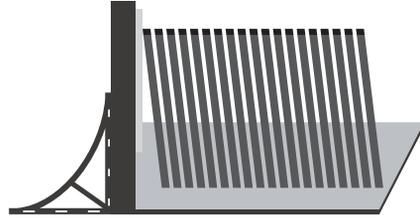
- ◆ Remove the protective film. Use an utility knife or other sharp object to cut through the protective film on the outside of the pallet. Be careful not to damage the cardboard sleeve.



- ◆ Remove the protective plastic cover from the top cover and open the top cover.



- ◆ With a team of four or more persons, position one person on each of the short side of the pallet (2 total) to prevent modules from tipping over. The other two persons will lift the cardboard sleeve from bottom to top. The cardboard sleeve is then flattened, and positioned between the modules and the support object. The modules are then gently leaned into the supporting object.

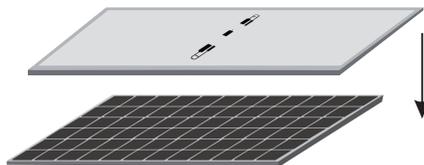


- ◆ Lift the modules: two persons hold the two short sides of the module and lift the to it designated place simultaneously. Protective gloves must be worn during the unpacking process to avoid cutting hands. Do not touch the glass surface with fingers to avoid leaving fingerprints on the glass surface.



- ◆ Gradually remove all modules. If the modules are not installed immediately after unpacking, it is recommended to lay the modules flat from their vertical position. First put a top cover from the packing box on an empty pallet, then place the first module front side up, and stack the modules with front side facing down. The maximum number of stacked pieces shall not exceed the number of modules in a pallet, and the module frame shall not press against the connector and cable.

Note: The modules must be aligned after stacking, otherwise they will tilt and fall during transport; be careful when lifting modules by hand, only the middle part of the frame should be lifted, not the four corners, and the modules should not be twisted or bumped.



6.1 Placement precautions before installing modules

- ◆ Slightly place the module on the brackets. Do not allow the back of the module to come into contact with the metal frame to avoid scratching of the backsheet. This may allow moisture ingress and compromise its insulation functions, or create micro-cracks on the module, affecting its power output and reliability. Also avoid scratching the module frame to prevent damage to its anti-corrosion anodized coating.

6.2 Precautions for handling of modules prior to installation

- ◆ Pay attention to the surrounding environment during the handling of pallets and module, and do not hit other objects. During the handling of the module, two people with gloves need to grasp the inner side of the frame with both hands to move the module. It is prohibited to carry with one hand, shoulder, reverse back and other non-standard actions that may directly cause micro cracks to the product. It is strictly prohibited to contact the glass surface or backsheet surface with fingers and other parts.



- ◆ Do not move or handle the modules by dragging the junction boxes or cables under any circumstances, to avoid loosening of the connector (causing electrical hazards) or dislodging (causing damage to the product or personal injury).

6.3 General safety

- ◆ Do not work on the roof without PPE (Personal Protective Equipment) which include but not limited to fall protection, ladders or stairs and other personal protective measures.
- ◆ Do not install or handle modules in unsafe conditions including but not limited to strong winds or gusts, damp or sandy roofs.

6.4 Electrical performance safety

- ◆ LONGi products can produce DC current under illumination, so there is a risk of electric shock or burns when touching the wiring metal of the module connections. Any contact of 30V or higher DC voltage can be fatal.
- ◆ To avoid electric arc or electric shock hazards, please do not break electric connection in loaded conditions. Incorrect connections will also lead to electric arc or shock. Keep connectors dry and clean and make sure that they are in good operating condition. Do not insert other metals into the connectors or carry out electric connection by improper means.
- ◆ Do not insert other metal objects into the connector or make electrical connections in any other way.
- ◆ If the module glass or other sealing materials are damaged, please wear PPE(personal protective equipment) and then isolate modules from the circuit. Work in dry conditions and use dry tools only. Do not work on the module when it is wet unless you are wearing suitable electric shock protection.

6.5 Operation safety

- ◆ It is forbidden to allow packed pallets to be dropped directly.
- ◆ Do not exceed the indicated maximum layer limit printed on the packing carton when stacking pallets up.
- ◆ Put packaging carton in a ventilated, water-proof and dry place before unpacking modules.
- ◆ Carrying modules using the junction box or wires are strictly forbidden.
- ◆ Do not step on the modules.
- ◆ To avoid glass damage, heavy objects are not allowed on modules.
- ◆ Do not dismantle the module, remove the nameplate or parts of the module.
- ◆ Avoid damage to the module backsheet and do not scratch or nick the module backsheet.
- ◆ Do not drill holes on the module frame, which may reduce frame loading capacity and lead to frame corrosion.
- ◆ Do not scratch the anodized coating of the aluminium alloy frame except for grounding connection. Scratching may lead to frame corrosion and reduce frame loading capacity.
- ◆ Do not repair modules with damaged glass or backsheet by yourself.

6.6 Installation conditions

6.6.1 Installation site and working environment

- ◆ The modules cannot be used in space.
- ◆ Do not manually focus sunlight with mirrors or magnifying glass onto modules.
- ◆ LONGi modules shall be installed on proper buildings or other appropriate places (such as ground, garage, building outer wall, roof, PV tracking system) but shall not be installed on any vehicles.
- ◆ Do not install modules at places that may be flooded.
- ◆ LONGi suggests installing the modules in the working environment where the monthly average highest and lowest temperature of the installation site is between -20°C to 50°C . The extreme working environment temperature of the modules is -40°C to 85°C .
- ◆ Make sure that installed modules do not suffer wind or snow pressure that exceeds the permissible maximum load limit.
- ◆ Modules shall be installed in places free from shadows throughout the year. Make sure there are no light-blocking obstacles in the installation sites.
- ◆ Carry out lightning protection for modules installed in places with frequent lightning. Do not install modules in places with flammable gases.
- ◆ The modules must not be installed or used in environments with excessive hail, snow, sand, soot, air pollution, etc.
- ◆ Modules cannot be installed or used in environments with strong corrosive substances such as salt, salt mist, saline, active chemical vapor, acid rain, or other substances that corrode modules, and affecting module's integrity and operator's safety.
- ◆ Please take protective measures to ensure reliable and safe installation of modules in severe environments such as heavy snow, extreme cold, strong wind, locations close to the ocean and salt mist, or deserts.
- ◆ LONGi modules passed the IEC61701 salt spray corrosion test, but the corrosion may still occur at where the module frame is connected to the mounting system or where the grounding is connected. In the event of LONGi modules are installed 50m –500m away from the ocean, stainless steel or aluminum materials should be used to contact the PV modules, and the connection point should be protected with anti-corrosion measures.



Chemical plant



Hail



Bituminous coal field



Sand dust



Seaside



Desert



6.6.2 Selection of tilt angle

- ◆ Tilt angle of the module is defined as the angle between module surface and horizontal surface.
- ◆ The module will obtain the maximum power output when directly facing sunlight.
- ◆ Modules are preferred to be south-facing in the north hemisphere and north-facing in the south hemisphere.
- ◆ Please refer to standard modules installation guideline or suggestions from experienced PV module installer for the specific installation angle.
- ◆ LONGi suggests that tilt angle of module installation should be no less than 10° , so dust on module surface can be washed away easily by rainfall and the frequency of cleaning can be reduced. A higher tilt angle allows surface precipitation to flow down and prevents standing water to form water mark on module surface, which may affect module appearance and performance.



6.7 Mechanical installation

- ◆ LONGi recommends that the lowest point of the module is at least 30 cm above the ground. In areas with heavy snow in winter, a higher mounting system is preferred, so the lowest point of the module will not be covered by accumulated snow for a long time. In addition, the lowest point of the module should be high enough so that it will not be shaded by vegetations or damaged by sand and rocks.
- ◆ If modules are installed parallel to the roof or wall, the minimum gap between the back of the module and the roof/wall surface shall be 10cm for air ventilation and to avoid impeding module performance by overheating.
- ◆ Drilling holes on module glass and frame is prohibited.
- ◆ Module frame can expand and contract due to temperature changes, so the frame interval between two adjoining modules shall be no less than 10mm.
- ◆ The module should be installed in such a way that it does not cause galvanic corrosion between the aluminum frame and other metallic components.

- ◆ The appendix of UL1703 "Flat Plate Photovoltaic Modules and Panels" recommends that the electrochemical potential difference between metals in contact should not exceed 0.6V.
- ◆ The modules can be installed in portrait or landscape orientations. When installing the modules, be cautious not to block the draining hole on the frame.

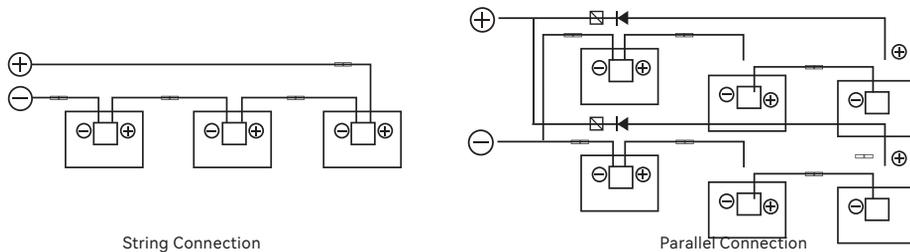
6.8 Installation method

- ◆ Modules can be mounted using mounting holes in frame, with clamps or other approved mounting systemd can be found in the LONGi Solar PV Module Installation

6.9 Electrical installation

6.9.1 Electrical performance

- ◆ When modules are in series connection, the string voltage is the sum of the voltage of each module in one string. When modules are in parallel connection, the current is the sum of the current of each module as shown in the following diagrams.



 Bypass diode
  Over current protection Device
  Connectors

Series Connection and Parallel Connection Circuit Diagram

- ◆ Modules with different electrical parameters can not be connected in one string.

- ◆ The electrical installation, cable wiring, grounding, commissioning and testing of the electrical system shall be in accordance with the relevant local electrical standards and regulations of the country / region of installation. For example, if installed in China, the electrical installation shall comply with the relevant requirements of GB/T50794-2012 code of practice for the construction of photovoltaic power plants, the cable wiring shall comply with the relevant requirements of GB501168 construction and acceptance of cable wiring for electrical installation works, and the grounding of the electrical system shall comply with the relevant requirements of GB50169 code of practice for the construction and acceptance of grounding devices for electrical equipment installation. The commissioning and testing shall comply with the relevant requirements of GB/T19939 "technical requirements for grid connection of photovoltaic systems".
- ◆ The maximum allowed quantity of modules in string connection shall be calculated according to relevant regulations. The open circuit voltage value under the expected lowest temperature shall not exceed the maximum system voltage value allowed by modules and other electrical equipment.

- ◆ The open-circuit voltage correction factor can be calculated according to the following formula: $C_{Voc} = 1 - \beta_{Voc} \times (25 - T)$. T is the minimum ambient temperature expected at the system installation location and β (%/°C) is the Voc temperature coefficient of the selected module (refer to the corresponding module datasheet).

- ◆ If there is reverse current in excess of the maximum fuse current flowing through the module, use overcurrent protection device with the same specifications to protect the module; if combining more than two strings, there must be an overcurrent protection device on each string of modules.

6.9.2 Cables and wiring

- ◆ The cables used to connect the modules on site must be able to withstand the maximum short-circuit current of the modules, using special anti-UV cables for photovoltaic systems.

- ◆ The minimum standards for cable used to connect modules on site are:

Testing Standard	Wire Size	Temperature Rating
TUV 2PFG 11694	≥4mm ²	-40°C to +90°C

- ◆ When cables are fixed to the mounting system, avoid mechanically damaging cables or modules. Do not press cables by force. Adopt UV resistant cable ties and clamps to fix cables on the bracket. Though cables are UV resistant and waterproof, it is still necessary to prevent cables from direct sunlight and water immersion.

6.9.3 Connectors

- ◆ Please keep connectors clean and dry. Make sure connector caps are fastened before connection. Do not connect connectors under improper conditions of damp, dirty or other extreme situations. Avoid connectors from direct sunlight and water immersion or falling onto ground or roof.
- ◆ Incorrect connection may lead to electric arc and electric shock. Please make sure that all electric connection is reliable. Make sure all connectors are fully locked.
- ◆ It is strictly forbidden to connect the connectors from different connector brands or models to avoid mismatching of the connectors, resulting in power generation loss or fire risk.

6.9.4 Bypass diodes

- ◆ LONGi solar module junction box contains bypass diode which is in parallel connection with the cell string. If hot spot occurs, the diode will come into operation to stop the main current from flowing through the hot spot cells in order to prevent module over-heat and performance loss. Please note that bypass diode is not the overcurrent protection device.
- ◆ If the diode is defective or suspected to be defective, the installer or system maintenance supplier shall contact LONGi. Please do not try to open the module junction box on your own.

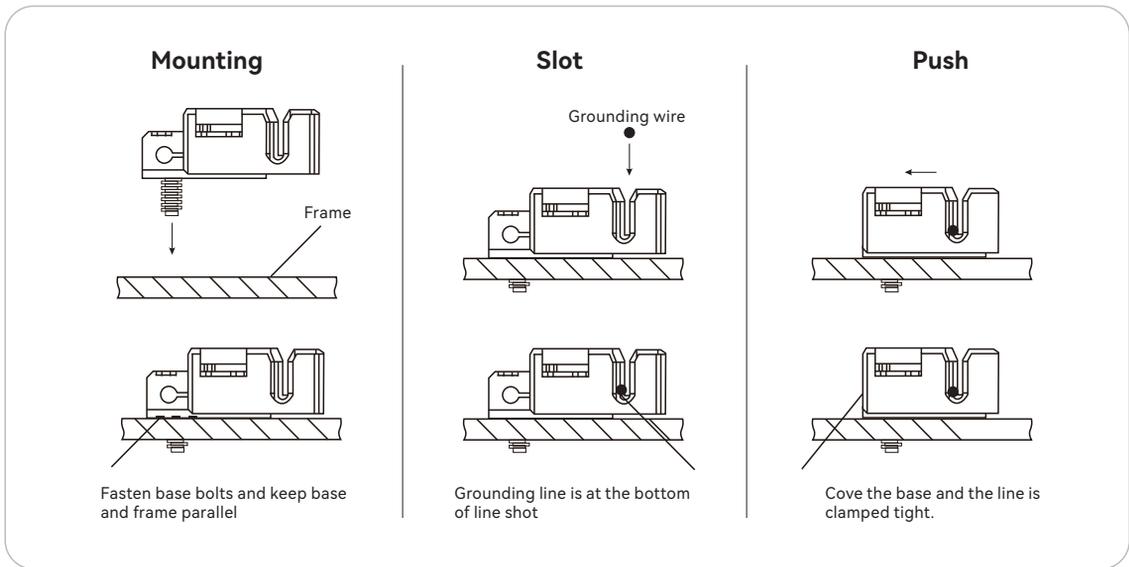
- 6.9.5 Notes on electrical connections
- ◆ PV modules are powered under illumination, which may cause injury with a voltage of 30VDC or more.
- ◆ Do not contact any metallic connector or internal components.
- ◆ To avoid arcing and electric shock hazards, do not disconnect the electrical connection under load. Incorrect connections can also lead to arcing and electric shocks.
- ◆ Wear electrical safety protection (insulated gloves, insulated shoes, etc.) when making electrical connections.
- ◆ Pay attention to each string number and positive and negative connection markings when making electrical connections, to facilitate electrical commissioning and O&M troubleshooting.
- ◆ The connectors should be plugged in place and a "click" sound should be heard as a confirmation to avoid false, misplaced or missed connections.

6.10 Grounding

- ◆ For safe operation and to protect modules from lightning and static-electricity damage, the module frame must be grounded.
- ◆ The grounding device must be in full contact with inner side of the aluminum alloy and penetrate anodized surface of the frame.
- ◆ Do not drill additional grounding holes on module frame.
- ◆ The grounding of the module must not lead to galvanic corrosion between the aluminum frame of the module and different metals, as recommended in the appendix of UL 1703 "Flat Plate Photovoltaic Modules and Panels".
- ◆ Holes marked with a grounding mark on the frame can only be used for grounding but not for mounting.

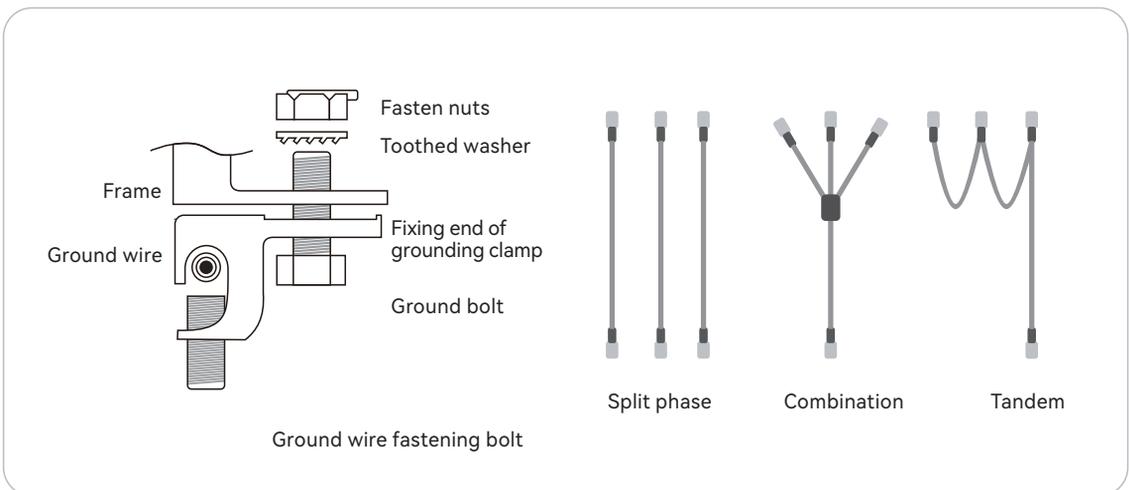
The following grounding methods have been permitted

- 6.10.1 Grounding by grounding clamp.
- ◆ There is a grounding hole with the diameter of $\varnothing 4.2$ mm at the edge of the module back frame. The central line of the grounding sign located on the edge of the module back frame also overlaps with that of the grounding hole.
- ◆ Grounding between modules shall be confirmed by qualified electricians and grounding devices shall be manufactured by qualified electric manufacturer. The copper core wire size used grounding should be 12AWG. The grounding clamp should be torqued at $2.3N \cdot m$.



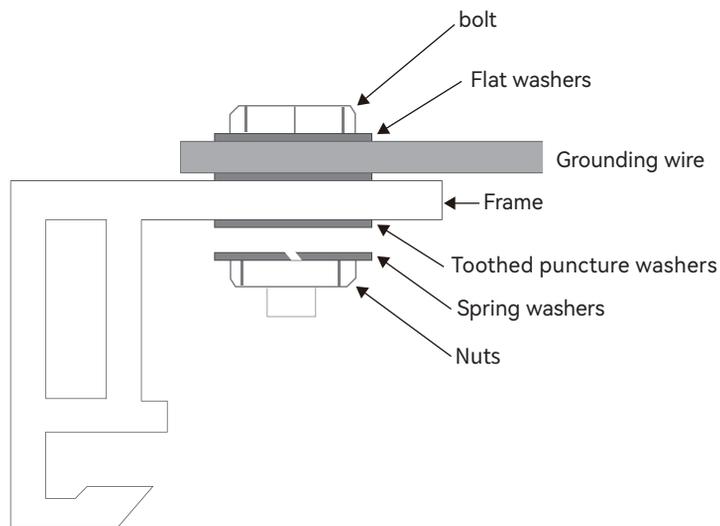
6.10.2 Grounding by unoccupied mounting holes

- ◆ Mounting holes on modules that are not occupied can be used for grounding modules.
- ◆ Align grounding clamp to the frame mounting hole. Use grounding bolt to go through the grounding clamp and frame.
- ◆ Put the tooth side of the washer on the other side and fasten the nuts with the recommended tightening torque of: 2.0N•m to 2.3N•m.
- ◆ Pass the grounding wire through the grounding clamp.
- ◆ Fasten bolts grounding wires and complete installation.



6.10.3 Bolt grounding (recommended torque 3-5N•m for installation)

Item	Four holes inside and outside	400 holes	Grounding holes
Bolts	M8 (full thread recommended)	M6 (full thread recommended)	M4 (full thread recommended)
Toothed puncture washers	8	6	4
Flat washers	8	6	4
Spring washers	8	6	4
Nuts	M8	M6	M4



- 6.10.4 Self-tapping and self-drilling screws may be used for grounding, if and only if applied through the grounding holes. Screw size between ST4.8 ~ 6.3.

6.10.5 Other third party grounding devices

- Third party grounding device can be used for grounding of LONGi modules but such grounding shall be proved to be reliable. Grounding device shall be operated in line with stipulations of the manufacturer.
- Grounding installation considerations:

- ◆ Do not drill additional grounding holes on module frame, only existing holes may be used for grounding operations.
- ◆ Material selection: bolts, nuts, screws, washers or other related parts made from stainless steel.

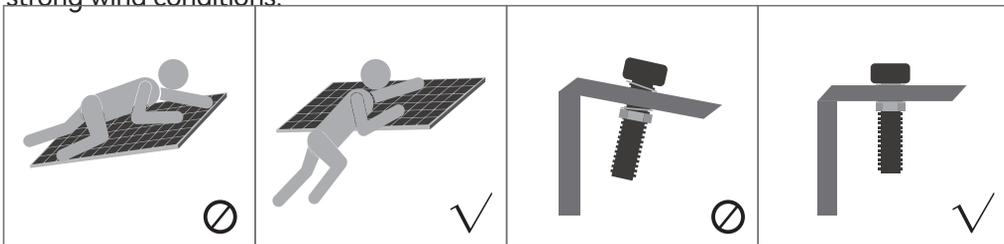
6.10.6 Mounting and fixing precautions

- ◆ Install strictly in accordance with the design drawings, and confirm with the design institute if there is unclear information.
- ◆ It is recommended to use a torque wrench to tighten the bolts, with a recommended torque range of 14N•m to 20N•m. Avoid applying too much torque, which may deform or damage the module profile; or applying too little torque, which may result in poor clamping and loosening of the nuts, and long-term wind load vibration may cause the modules to slide off. The position of the pressure block should not be moved or distorted to avoid changing the mechanical loading conditions of the module.

The tilting angle of the module is adjusted according to the design requirements to

- ◆ avoid the impact of power generation loss due to angle deviations.

Take the necessary safety precautions when working at height and prohibit work in strong wind conditions.

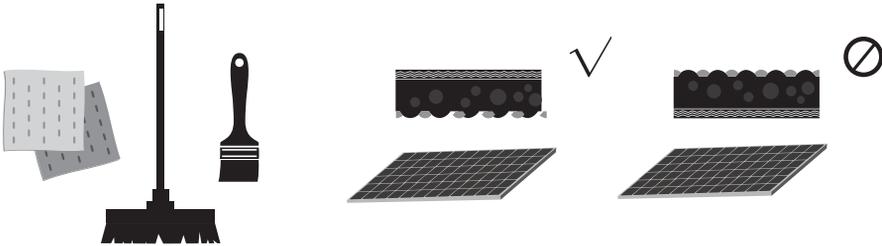


7.1 Cleaning requirements

- ◆ The cleaning process must be carried out only after the PV module has been disconnected and cooled down. All operational steps must be subject to the necessary electrical protective measures. Ensure that the cleaned modules are connected after they have been fully dried.

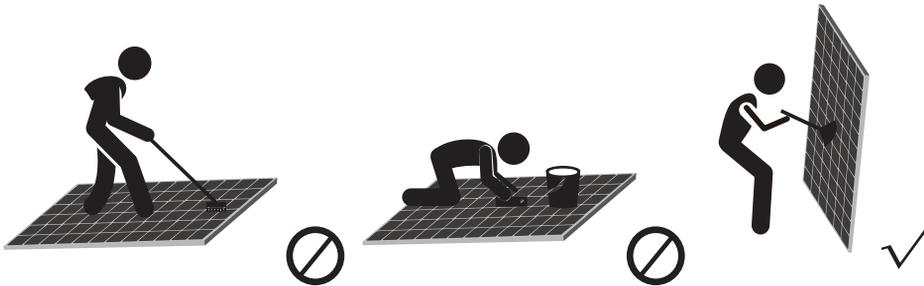
7.2 General description

- ◆ Never touch or handle the surface of the module glass with bare fingers or hands without gloves. The use of clean gloves will prevent fingerprints or dirt being left on the glass.
- ◆ The use of metal tools such as pocket knives, razor blades, bakelite or other abrasive materials is strictly prohibited.
- ◆ Various soft foam materials, non-woven fabrics, dusters, brooms, soft sponges, soft brushes and bristle brushes can be used. The hard side of the sponge as shown in the diagram only allows cleaning of the aluminium frame of the module. Using the hard side to clean the glass can cause scratches to the coated glass.



- ◆ The brushes are recommended to use nylon wire with a diameter of 0.06-0.1 mm and nylon wire 1010 for brushes.
- ◆ Some commercial glass cleaners, alcohol, ethyl alcohol, methanol should only be used if water can not clean it.
- ◆ Abrasive powders, abrasive cleaners, washing and cleaning agents, polishers, sodium hydroxide, benzene, petrol, nitro thinners, acids or alkalis and other chemicals are strictly prohibited.
- ◆ Cleaning water pressure must be below 690KPa. Most municipal water can be used for cleaning. It is not recommended to use water with a high mineral content, as this can lead to mineral deposits on the glass surface when the water dries out.

- ◆ The difference in water and module temperatures must be between -5°C and 10°C , while the water pH value should be between 6 and 8.
- ◆ The use of steam or corrosive chemicals to accelerate cleaning is strictly forbidden.
- ◆ Attempting to clean glass or modules with broken or damaged wires is strictly forbidden, as it may result in electric shock.
- ◆ It is strictly forbidden to walk, stand or sit on the modules to clean them.



7.3 Selection of cleaning time

- ◆ Cleaning of module glass should be carried out in the early morning, late evening, at night or on rainy days. Early morning or late evening should be carried out at a time period when the sun is not shining.

7.4 Planning of cleaning cycles and areas

- ◆ Since large photovoltaic power stations cover a large area, have a large number of modules and have a short time frame for cleaning operations each day, the cleaning of photovoltaic power stations should be planned and carried out according to the specific zone division area of the power station, so that the cleaning of photovoltaic power stations can be completed with minimal labor.
- ◆ The zoning of the cleaning work should be in accordance with the electrical structure of the PV plant and should ensure that all modules connected to several combiner boxes and inverters are covered in each cleaning phase.

7.5 Routine cleaning

◆ Step 1: Dusting

- ◆ Dust the surface of the module with a dry duster or rag to remove any adhering material such as dry dust, leaves, etc. If the surface of the module is clean and has been cleaned by this step, the following steps can be disregarded. If the module is installed in deserts where there is little water and a lot of dust, it is recommended to use air to blow and remove most of the sand and dust from the module surface.

◆ Step 2: Wiping

- ◆ If there are hard foreign objects such as mud, bird droppings, plant branches and leaves adhering to the modules, they should be wiped off with a non-woven fabric or brush, not with hard objects. Do not wipe areas without hard foreign objects.
- ◆ Vegetations grown near the PV modules should be trimmed or removed if they shade the modules.

◆ Step 3: Cleaning

- ◆ If there are staining substances on the surface of the modules such as bird droppings, plant sap, etc., or if the air is too humid for dust to be removed, they need to be removed by cleaning. This is usually done with water, which is sprayed onto the contaminated area and then wiped off with a brush.
- ◆ In case of oily substances, apply water mixed with alcohol to the stained area, wait for the solution to penetrate the contaminant and then wipe it off with a brush.
- ◆ If necessary, use a commercial glass cleaner together with a non-woven or glass scraper for final cleaning of the modules.

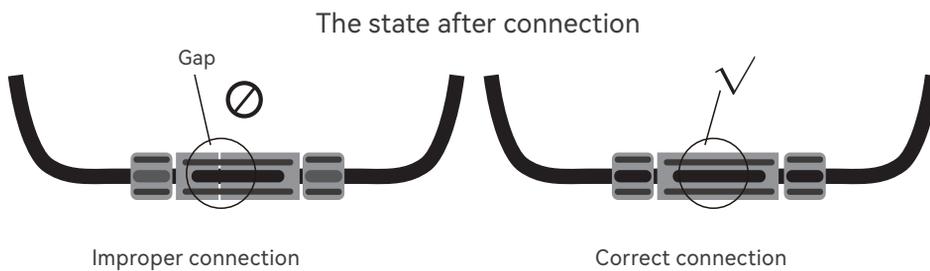
8.1 Module appearance inspection

- ◆ Visually inspect the modules for cosmetic defects, specifically:
- ◆ Cracks on module glass.
- ◆ Corrosion on PV cell soldering joints (caused by moisture in the module due to damaged sealing materials during installation or transportation).

8.2 Inspection of connectors and cables

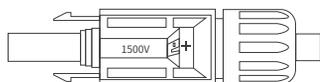
- ◆ It is suggested to carry out the following preventive inspection twice a year:
- ◆ Check the tightness of the connectors and cables.
- ◆ Check if there are any sealant cracks or gaps near the junction box.

8.2.1 Connector installation

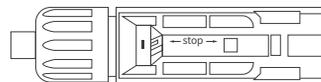


8.2.2 Connector assembly requirements

Connector assembly instructions (PV-LR5 as an example)



PV-Positive Connector



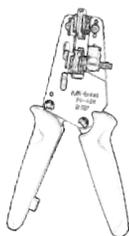
PV-Negative Connector

- ◆ We do not guarantee product safety and technical conformity if the parts and tools used are not specified by LONGi or if preparation and installation operations are neglected when installing the modules yourself.
- ◆ To prevent electric shock, the connectors must be disconnected from the power supply when disassembling and assembling.
- ◆ The end product must provide protection against electric shocks.
- ◆ PVC cables are not recommended.
- ◆ Unplugging with load connected: the connectors of the modules cannot be unplugged with load connected; they can only be plugged in and out with power after the DC-AC inverter has been switched off or the combiner in which the string is located has been disconnected from the system so that the modules are under unloaded condition.
- ◆ It is not recommended to use the H07RN-F tinned cable since the contact resistance of the crimped area may exceed the permitted value when the copper wire is oxidised.

- ◆ Tools for connector assembly



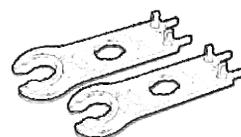
Toolbox



Wire cutter

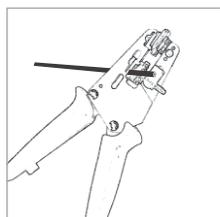


Crimping pliers

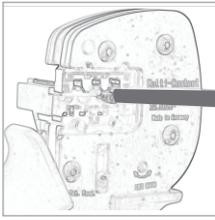


A set of open-end plastic wrenches

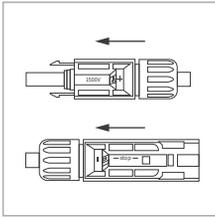
- ◆ Connector assembly steps



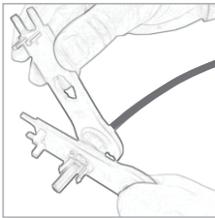
Strip the cable insulation layer, $L=7\pm 0.5$ mm, be careful not to cut the core beneath the insulation layer.



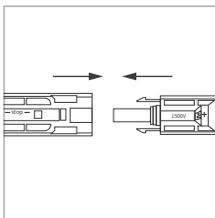
Crimping of the pin bushing is only necessary to ensure that the metal part is concentric with the cable. After crimping, the tension between the cable and the metal part must be $\geq 310\%$.



Insert the crimped plug into the insulating sleeve of the socket or plug. Check that the metal parts are secure by gently pulling on the wires until they engage.

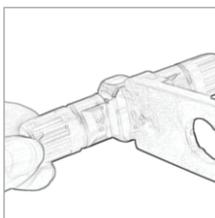


To install the cable hood, pre-tighten by hand then tighten the cable hood with a plastic spanner (for clearance refer to the clearance table on page 1). When screwing the rear cover, ensure that the cable wires are concentric with the rear cover. The original plastic wrench can be used for assembly on site and is not suitable for mass assembly in the factory.



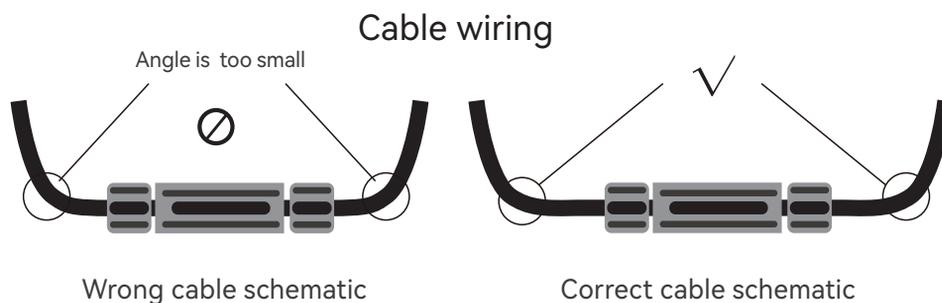
Test the connection

Plug in: insert the male and female heads in pairs until they engage, pulling gently to check.



Plug out: after connecting the PV-LR5 plug, it can only be unlocked with a plastic tool spanner.

▪ Cable connection



- ◆ The minimum bend radius of the cable is 43mm.

8.3 Operation and maintenance considerations

- ◆ Check the module cable connection and the grounding wire are in good connection and not dislodged.
- ◆ Check if there is any hot spot along the combiner box wiring.
- ◆ Check the module mounting system and clips for looseness and breakage.
- ◆ Check and clear any vegetations blocking or shading the panels.
- ◆ Check that the surface of the panel is free from obstructions.
- ◆ Check for bird droppings on the surface of the panels and clean them if necessary.
- ◆ Check the panel for hot spots, discoloured or broken internal solder wires.
- ◆ The cleanliness of the panels is maintained.
- ◆ In windy conditions, the panels and mounting system should be inspected as a priority.
- ◆ The panels should be cleaned in time to avoid snow and ice accumulation on the panel surface during heavy snowfall.
- ◆ All watertight seals should be checked for integrity during heavy rain.
- ◆ Ensure no animal entrance to the power station to damage the panels.
- ◆ The surface of the panels should be inspected after hailstorms.
- ◆ The panel temperature should be measured, checked and compared to the ambient temperature for analysis.
- ◆ The problems identified must be dealt with, analyzed and summarized in a timely manner.
- ◆ A detailed record of each inspection should be kept to facilitate future analysis.

- ◆ Regular and special inspections:
- ◆ The PV modules should be inspected once every quarter. During the inspection, the main checklists should include whether the module connectors are loose, whether the cable fixing is off or loose, and whether there are hot spots on the PV modules. In addition, the monitoring system in the main control room should be used to check whether the current is generally consistent, and for strings where the voltage and current are significantly low. A comprehensive check is carried out to analyze whether there are bulges in the module junction box, whether the appearance of the module is good, and whether there are any heat discolorations.
- ◆ In the event of high winds, a full inspection (special inspection) should be carried out, focusing on whether the PV modules have fallen off or been damaged, and whether there are any heat discolorations.
- ◆ After thunderstorms focus on inspecting PV modules for lightning damage.
- ◆ After hailstorms focus on inspecting module glass damage.
- ◆ After heavy rain or flood, focus on inspecting modules for dislodgement, damage, and module connectors soaking or rusting.

9 Technical problems or after-sales service

- ◆ For technical inquiries or after-sales supports, contact LONGi through the following channels:
- ◆ Contact the installer.
- ◆ Contact LONGi through the LONGi unified service hotline 4008-601012.
- ◆ Contact a LONGi sales representative.
- ◆ Submit inquiries via the LONGi website > service support > service inquiry and one of our technical representatives will contact you within 5 working days.

Disclaimer

- ◆ Published in November 2021, this document is managed by the technical services department. Its final interpretation is at the sole discretion of LONGi Solar Technology Co.Ltd.



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