1. User Manual

This manual contains information about the installation and safe operation of PV modules (hereinafter referred to as "modules") of Shandong CAS Future Energy Photoelectric Technology Co., Ltd. Shandong CAS Future Energy Photoelectric Technology Co., Ltd. is hereinafter referred to as "ZKFN". Failure to follow these safety guidelines could result in injury or property damage.

The installer must read and understand this guideline before installation. If you have any questions, please contact ZKFN customer service or our local representative for more detailed information. The installer must follow all safety precautions, local requirements and legal or authorized authorities as described in this guideline. Before installing a solar PV system, the installer shall be familiar with the mechanical and electrical requirements. The operation of a PV system requires relevant expertise, and the system must be installed and maintained by qualified personnel with specialised knowledge. Please store this guideline in a safe place. It shall be used during operation and maintenance of the modules or sales and handling of the modules. Please feel free to use it on the premise of following the requirements of this installation manual.

The module installer must inform the end customer (or consumer) of the above contents accordingly.

1.1 Disclaimer

ZKFN reserves the right to change this installation manual without prior notice. ZKFN makes no warranty of any kind, express or implied, with respect to any of the information contained in this manual. Failure of the customer to follow the requirements outlined in this manual during installation of the modules will void the limited warranty on the product provided to the customer.

1.2 Scope of Responsibilities

ZKFN is not responsible for any of the following forms of injury and damage, including, but not limited to, bodily injury and property damage resulting from module operation, system installation errors, and failure to follow the instructions in this manual.

2. Product Introduction

ZKFN's lightweight modules are flexible & lightweight products. The lightweight series of PV modules are suitable for photovoltaic building-integrated installations on commercial roofing systems.

Advantages of lightweight modules: They are lightweight and bendable, thus simplifying the installation process, and reducing installation time, the labour intensity and the number of perforations on the roof.

Features of lightweight modules:

□ The fluorocarbon composite front panel is of glassless structure, reducing 70% module weight

□ Lightweight modules are bendable up to 30°

□ Quick installation, curved, with irregular roofs, suitable for installation on roofs with insufficient load-bearing relative to conventional modules, with wide range of application scenarios

□ Reduction of shading losses in PV systems by means of bypass diodes

3. Safety Measures

3.1 Warnings

Please read and understand all safety rules before installing, wiring, operating or servicing the modules. PV modules may generate electricity when exposed to a light source. The PV arrays with multiple modules may pose a risk of fatal electric shock and/or burns. Unauthorized or untrained personnel shall not touch the PV modules and wiring terminals.

3.2 General Safety

A. The installer must follow all safety precautions, local requirements and legal or authorized authorities as described in this guideline. The operation of a PV system requires relevant expertise, and the system must be installed and maintained by qualified personnel with specialised knowledge. Unauthorized or untrained personnel shall not touch the PV modules and shall not approach the installation area or the module storage area.

B. Do not use the damaged modules. The damaged modules must not be repaired, Contact with the module surface may result in an electric shock hazard. Do not disassemble the assembly or remove any part of the module. Do not artificially gather sunlight on these solar modules.

C. Do not connect the positive end of an individual PV module from the positive end of the cable. Ensure that the polarity of each module or string of modules is not reversed from the other modules or strings of modules. Ensure that there are no gaps between the insulating gaskets of the connectors. Gaps between insulating gaskets may lead to a risk of fire and/or electric shock.

D. The maximum system voltage shall not exceed the certified maximum system voltage of the module being used according to the National Electrical Code.

E. Do not install or operate the module when the area where the module is to be installed is wet or when the weather is windy. The modules are fixed with structural adhesive so that it is necessary to ensure that modules are installed in a sunny day.

F. The damaged junction box and connectors may impose a potential electrical hazard and a scratching hazard. Do not use the damaged modules and do not disassemble the modules.

G. Please remember that PV modules generate electricity and that certain safety measures must be taken to avdid danger.

Electrical protection class: Class II

3.3 Operating Safety

A. To avoid damaging the modules, do not scratch or hit the modules, and do not use paint or adhesives on the front or back of the modules. To prevent degradation of module insulation, avoid scratching, cutting cables and connectors or exposing them under sunlight for a long time. Do not drop the module or allow objects to fall on the module. Do not place any heavy or sharp objects on the module.

B. In the event of a fire, disconnect the power supply before extinguishing the fire in accordance with fire safety requirements.

C. Work only in a dry environment and use only dry tools. Do not work in a wet environment without wearing any PPEs. Do not touch the junction boxes, connectors, cables and other charged bodies of the modules directly with your hands without wearing any PPEs under sunlight, regardless of whether the PV module is connected to the system or not.

D. Do not climb, step, stand, walk or jump directly on the packaging or modules.

E. Do not place the modules frontally on any platform for dragging.

4. Unloading, Transport and Storage

Preventive measures and general safety rules:

A. Modules shall be stored in their original boxes prior to installation. Please protect the packages from damage. Transport the modules and unpack the modules according to the recommended mode of transportation and unpacking procedures. To avoid damaging the modules, do not scratch or hit the modules. Do not apply direct pressure to the modules during transport. Improper transport or installation may damage the modules and void the warranty. Do not step on or stand over the module box and modules.

B. Work only in dry environments. Ensure that all modules and electrical contacts are clean and dry before installation. If it is necessary to store uninstalled modules outdoors for a period of time, always cover the modules and ensure that they are face down on a soft flat surface to prevent water from accumulating inside the modules and damage to the connectors;

C. Unpacking must be operated by 2 or more persons at the same time. Do not lift the module by the module terminal box or lead wires. Use both hands to carry the modules and do not overlap them. Do not place the module in an environment where it is not reliably supported or secured. Do not place any heavy or sharp objects on the module.

4.1 Packaging Labelling Instructions

4.1.1 Do not discard the modules at will, and the modules need to be specifically recycled 	4.1.2 Do not expose modules to rain or moisture 
4.1.3 The modules in the carton are fragile and shall be handled with care 	4.1.4 The package shall be kept vertical and upward during transport 
4.1.5 Do not step on packing boxes and modules	4.1.6 Do not exceed the max. number of layers when stacking modules as indicated by the printed symbols on the outer packing box

4.2 Unloading Precautions

A. When unloading the modules from the transport vehicle, an appropriate lifting fixture shall be used. A maximum of 2 pallets of modules could be lifted at one time. Before lifting, please ensure that the pallets and cartons are not damaged or skewed and that the ropes for lifting are strong and secure. When the lifting is almost on the ground, two people, one on each side, hold up the carton and gently place it on a relatively flat position on the project site. Or a forklift truck is used to unload the modules from the lorry. The unloaded modules shall be placed on a level surface.

B. When the modules are temporarily stored at the project site, they shall be placed in a ventilated & dry place without water accumulation. Do not stack the modules at the project site. The modules shall be covered with a tarpaulins, which shall be reinforced by curtains or mesh belt to prevent the modules from being exposed to moisture and rain

4.3 Secondary Transport and Precautions

A. Do not remove the original packaging if the module is to be transported a second time over long distances or stored for long periods of time. The finished products packaged in modules can be shipped by road, sea or air. During the transport, the packing box shall be secured to the transport platform to ensure that the package will not roll over. In the case of road transport, for example, the maximum 2 layers are stacked for normal truck transport. Do not cut the baling straps.

B. The original packaging shall not be removed for consignments at the project site. Only one layer is allowed for transport. During transport, the box shall be secured to the transport platform to ensure that the packaging will not roll over. Do not use tricycles to transport the modules; Do not use ropes to bind & carry the modules; Do not carry the modules by a person; Do not carry or drag the modules through the wires or junction box of the modules.

4.4 Storage

A. Do not expose modules to rain or moisture. If it is necessary to store uninstalled modules outdoors for a period of time, always cover the modules and ensure that the back sides are down and they are placed on a soft flat surface to prevent water from accumulating inside the modules and damage to the connectors.

A. Do not remove the original packaging if the module is to be transported over long distances or stored for long periods of time.

C. Stored in the warehouse at project site (humidity: <70%; temperature: -20°C~+50°C): Lightweight modules are stacked up to 2 pallets at static piling; Stored in the normal warehouse: (humidity: <70%; temperature: -20°C~+50°C): Lightweight modules are stacked up to 2 pallets.

5. Unpacking Instructions

5.1 Unpacking Safety:

A. When unpacking outdoors, do not work in rainy conditions. Because cartons will soften and fall apart when they get wet. The lightweight modules inside may come out causing damage to the modules or injury to personnel. If the site is windy, special care needs to be taken to ensure safety. Especially in windy conditions, it is recommended not to handle the modules and to secure the unpacked modules properly.

B. The working floor needs to ensure that the packing box can be placed horizontally and stably. A supportive removal tool shall be used when removing the carton to prevent the modules from tipping sideways and falling down.

C. Protective gloves shall be worn during unpacking to avoid hand injuries and fingerprints on the front of the modules.

D. Information of modules can be found on the outer packaging. Please read the information carefully before unpacking.

E. Each module shall be carried by two persons. Do not lift the module by grasping the module junction box or lead wires. Use hands to carry the long side of the module, the backside must not face up, and do not place modules on top of each other.

F. Unpacked modules must be completely assembled. Do not pile them on the project site.

5.2 Unpacking Steps:

A. Before unpacking, please check the product name and serial number on the outer A4 sheet. Custom-style unpacking methods are not allowed.

B. When removing the module from the packing box, two persons shall stand on either side of the box and lift the module at the same time, with one hand grasping the corner of the module and the other hand grasping the short side while removing the module. If unpacking on a horizontal surface, take out the module in turn from one side of the package towards the other and then carry the module by the two persons. If unpacking on a horizontal surface, a supportive removal tool shall be used when removing the carton to prevent the modules from tipping sideways and falling down.

C. The modules removed from the packing box must not be leaned against the mounting posts or placed in an unsupported or unsecured environment.

6. Mounting

6.1 Mounting Safety

A. ZKFN solar modules can be mounted horizontally or vertically. However, the mounting method used shall ensure that obstacles on the mounting surface minimize the effect of shading on the module.

B. Do not unpack the modules prior to installation, ad leave the modules in the carton.

C. When installing the modules, work only in a dry environment and use only dry tools. Do not work in a wet environment without wearing any PPEs. Do not install modules in rainy, snowy or windy conditions. Keep connectors dry and clean when installing the modules to avoid risk of electric shock. If the terminals of the modules are wet, the work shall not be conducted to avoid electric shock. Please install the modules immediately upon unpacking.

D. Do not wear metal rings, wristwatches or other metal objects when installing or

repairing the PV system.

E. Do not disconnect electrical connections or unplug the connectors while the circuit is loaded. Do not touch the modules unnecessarily after completing the installation; High temperature may be generated on module surface, thus resulting in burning and electric shock hazards.

F. Do not install the modules alone. Please always keep a team of 2 or more persons for working.

G. The cables shall be secured or tied off upon the installation of the module so that they are not exposed to direct sunlight upon the installation, which prevents deterioration of the cables. Low-hanging cables may cause many problems, such as current leakage and fire at the place where water accumulates.

H. The application class of ZKFN lightweight module is class A.

6.2 Installation Methods

6.2.1 Installation Requirements

Modules shall be installed in accordance with the examples and recommendations. If the installation method is different from that announced by ZKFN, please consult the local technical support or after-sales service of ZKFN and obtain the agreement of ZKFN. Failure to do so will damage the modules and void the warranty.

A. The ability of the module to be mechanically loaded (including snowfall and wind loads) depends on how the ZKFN module is mounted. Mechanical loads shall be calculated by a professional system designer based on actual and environmental conditions.

B. The drain holes must not be blocked under any circumstances during installation or use.

C. The inclination angle of the colour steel tile roof shall be 0° ≤ and ≤25° when installing ZKFN Lightweight Module. When the angle is >25°, foam tape is required to assist the structural adhesive for positioning to prevent slippery.

D. Lightweight modules shall not be exposed to sunlight until they are installed.

E. According to the mounting surface corrugated evenly arranged, the connectors should be reserved on the side of the channel. The distance between the protruding corrugations on both sides of the modules installed shall be equally divided, and the maximum support spacing shall be ≤480mm.

F. Gluing requirements: Glue type: the structural adhesive with a width of 6~10 mm and a height of 2~5mm.

6.2.2 Environmental Requirements

ZKFN lightweight series modules shall be installed in locations that meet the following requirements

A. The modules must not be exposed to strongly corrosive chemicals or flammable vapours or gases (e.g. emission areas of pollutants such as factories)

B. Installation positions shall be planned according to design requirements. Corners, roof edges and other positions with the maximum wind buoyancy shall be avoided

C. The ambient temperature at the time of installation shall be within 4.4°C~35°C

(40°F~95°F). The recommended min. installation temperature is ≥40°F (4.4°C). When install the modules in hot environment, they shall be stored in a cool area.

6.2.3 Roofing Requirements

ZKFN lightweight series modules shall be installed in locations that meet the following requirements

A. ZKFN lightweight modules shall not be installed if the building and other systems or modules would have a damaging mechanical or electrical effect on the PV modules

B. The fire rating and slope limitations of the roofing system shall not be exceeded when installing ZKFN lightweight modules

C. ZKFN lightweight module product warranty does not cover the lightweight modules installed in waterlogged location

1. To ensure effective drainage, the installation roof must be the sloping roof
2. Lightweight modules shall not be installed within 2m of roof drainage outlets, in low lying areas, or in any low lying areas of the roof
3. Lightweight modules shall not be submerged in water or subjected to water spray at all times

D. Lightweight modules shall not be installed directly over links between existing roofs.

6.2.4 Installation of Lightweight Modules

6.2.4.1 Conditions and preparation of roof substrates

A. The designed lightweight modules are suitable for bonded to clean, dry, unweathered colourful steel tiles and roofs. The min. requirements for direct bonding shall be met

B. Roofs on which lightweight modules are placed shall be flat, smooth and free of wrinkles. Avoid irregularities and depressions in the roof that may cause deformation of the surface of the lightweight module during bonding to the roof

C. Clean the mounting substrate to be bonded using a cleaning solvent before bonding the module. After cleaning, wipe the roof with a clean, fibre-free rag or paper towel so that the roof will be dried completely. Ensure that there is no debris such as crumbs, talc, dust, oil, ice, snow & moisture. These debris may reduce bonding effectiveness and shorten the service life of structural adhesives.

D. Rust stains on the mounting surface shall be removed with a steel brush or sandpaper. The industrial antirust paint must be dried before the installation;

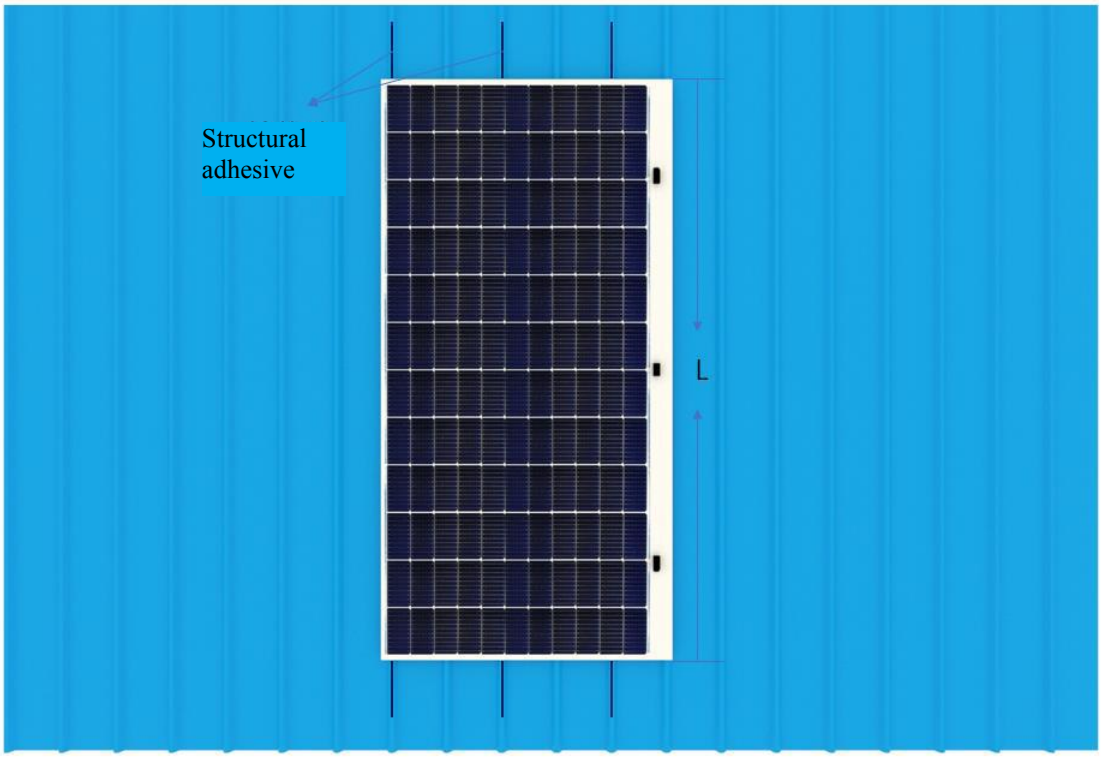
E. Remove debris from the roofing substrate. The roof substrate shall be cleaned with a specified or approved cleaning agent (Annex 1). If the roofing substrate is very dirty, it shall be cleaned with a low-pressure water jet or power washer before applying the cleaner (1/4 cup of trisodium phosphate, 1/2 cup of liquid detergent (optional) and 5 gallons of water).

6.2.4.2 Introduction to Lightweight Module Installation

A. Lightweight modules are installed vertically on a coloured steel tile roof

Three strips of structural glue with length of L, width of 6 ~ 10mm and height of 2 ~ 5mm shall be applied to the corrugated part of T-shaped coloured steel tile. Modules

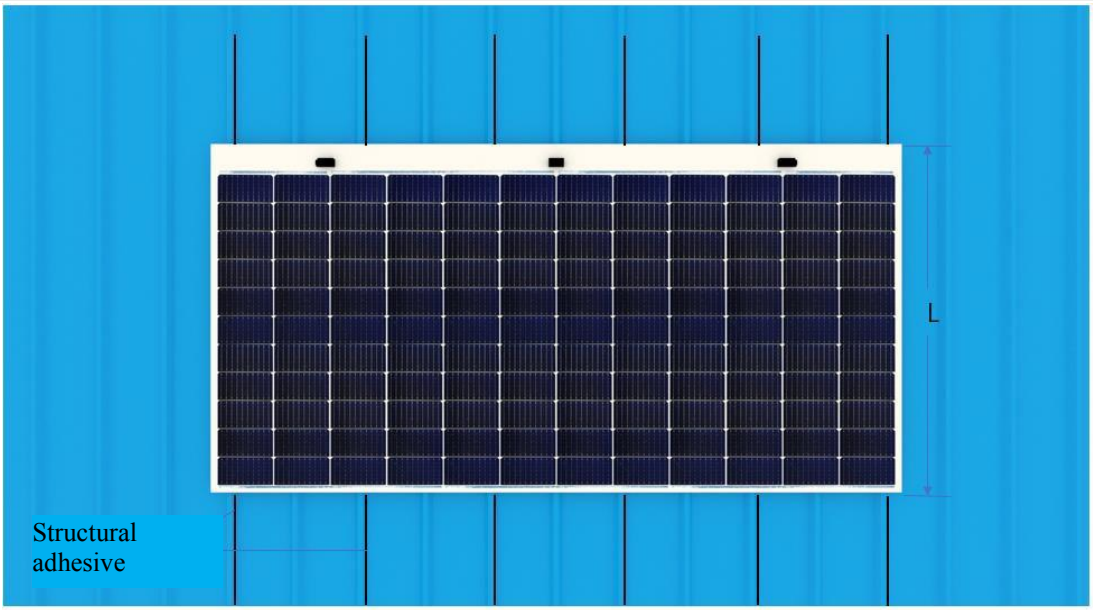
need to be installed within 5min after applying structural adhesive. Otherwise, the bonding performance may be affected. After installation, a roller brush shall be used to gently roll the surface of the module so that the module is firmly bonded to the coloured steel tiles. The distance of protruding corrugations on both sides of the module installed shall be equally divided into rows. The schematic diagram is as follows:



Model	L
ZKFN-182M(PD)-xxx (xxx = 445-480, in increment of 5)	2250
Bonding requirements	The total area of structural adhesive bonding shall be ≥ 405cm²;

B. Lightweight modules are installed horizontally on a coloured steel tile roof

Six strips of structural glue with length of L, width of 6 ~ 10mm and height of 2 ~ 5mm shall be applied to the corrugated part of T-shaped coloured steel tile. Modules need to be installed within 5min after applying structural adhesive. Otherwise, the bonding performance may be affected. After installation, a roller brush shall be used to gently roll the surface of the module so that the module is firmly bonded to the coloured steel tiles. The distance of protruding corrugations on both sides of the module installed shall be equally divided into rows. The schematic diagram is as follows:



Model	L
ZKFN-182M(PD)-xxx (xxx = 445-480, in increment of 5)	1130
Bonding requirements	The total area of structural adhesive bonding shall be ≥ 406cm²;

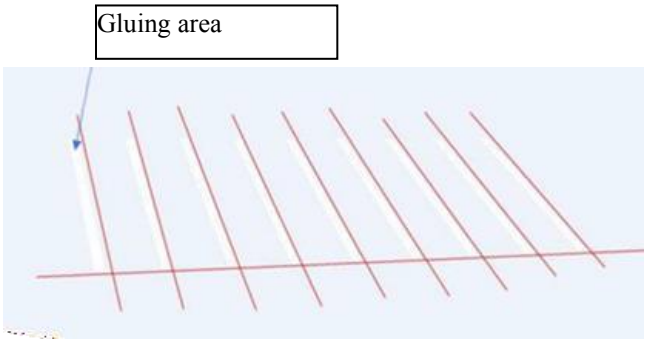
C. Lightweight modules are installed horizontally on a coloured steel tile roof

- **Positioning and setting-out:** The spacing of the aluminium square tubes shall be determined according to the design drawings (please contact ZKFN for the design drawings);
- **Substrate primer** (This step can be ignored if the substrate does not require a primer)

i. The gluing area for the module shall be determined on the cleaned roof (please refer to the design drawings for exact dimensions);

ii. Secondary cleaning of the gluing area shall be conducted. Wipe the area with the special cleaner specified in Annex 1;

iii. In the gluing area, a primer is applied before the structural adhesive is applied to increase adhesion (see table below for different roof primer models).



Adhesive mounting for different substrate types

Types of Roofing Substrates	Whether the Roofing Substrate Requires a Primer	Primer Model	Types of Structural Adhesives

TPO	Yes	Please contact ZKFN	Tianshan 1527
Concrete roofing	Yes	Please contact ZKFN	Tianshan 1527
tempered glass	No	\	Tianshan 1527
PVC	No	\	MS8201

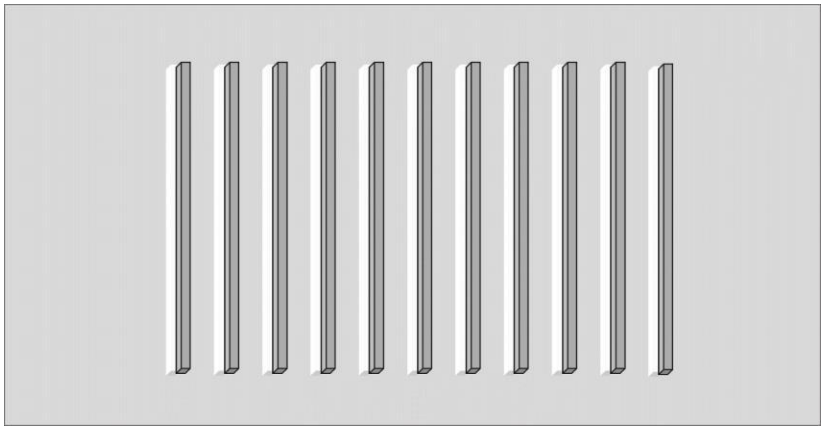
● **Sticking square tube**

i. Perform gluing operations in gluing areas as required by gluing specification;

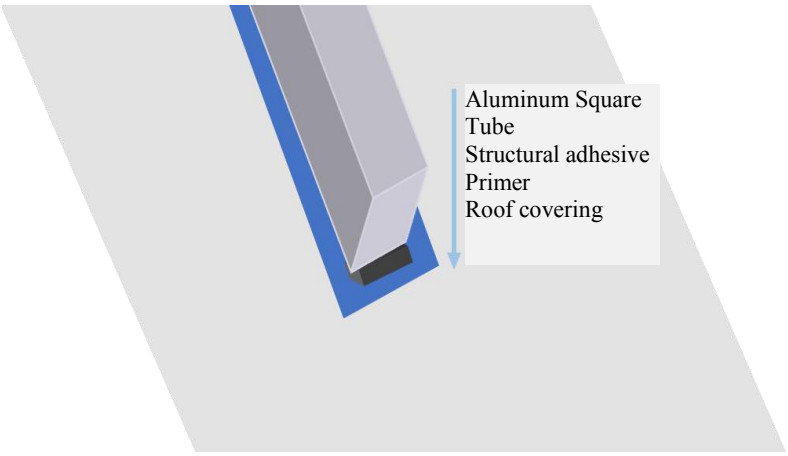
ii. The two ends of a single PV module are continuously glued, and the middle sticking area is glued in sections with a glue length of 200mm.

Segment distance and glue length can be adjusted according to the actual situation on site;

iii. Bonding square tube: Bond the square tube along the gluing path, and gently



compact it to keep the thickness of the glue not less than 3mm;

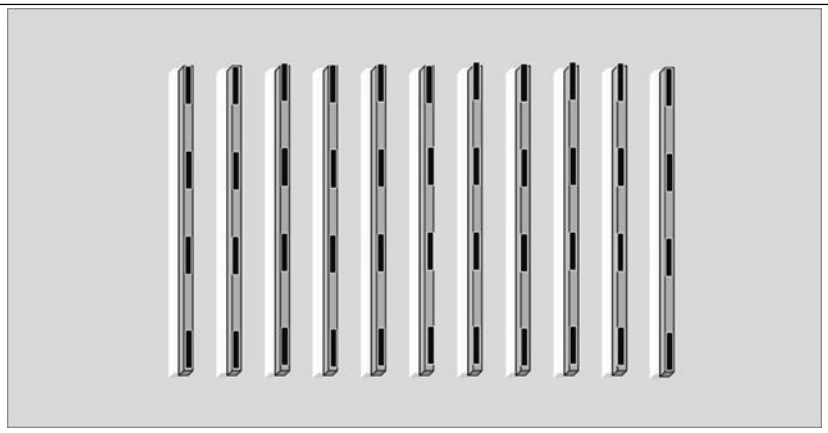


● Module bonding

i. Perform gluing operations on the upper surface of the square tube in accordance with the gluing specification;

ii. The two ends of a single PV module are continuously glued, and the middle sticking area is glued in sections with a glue length of 200mm. Segment distance and glue length can be adjusted according to the actual situation on site;

iii. Excessive distortion of module is not allowed when installing it. Two persons shall grasp the white edge of the module and put it into the gluing area slowly. The modules shall be bonded horizontally and vertically, and a secondary bonding is not allowed;

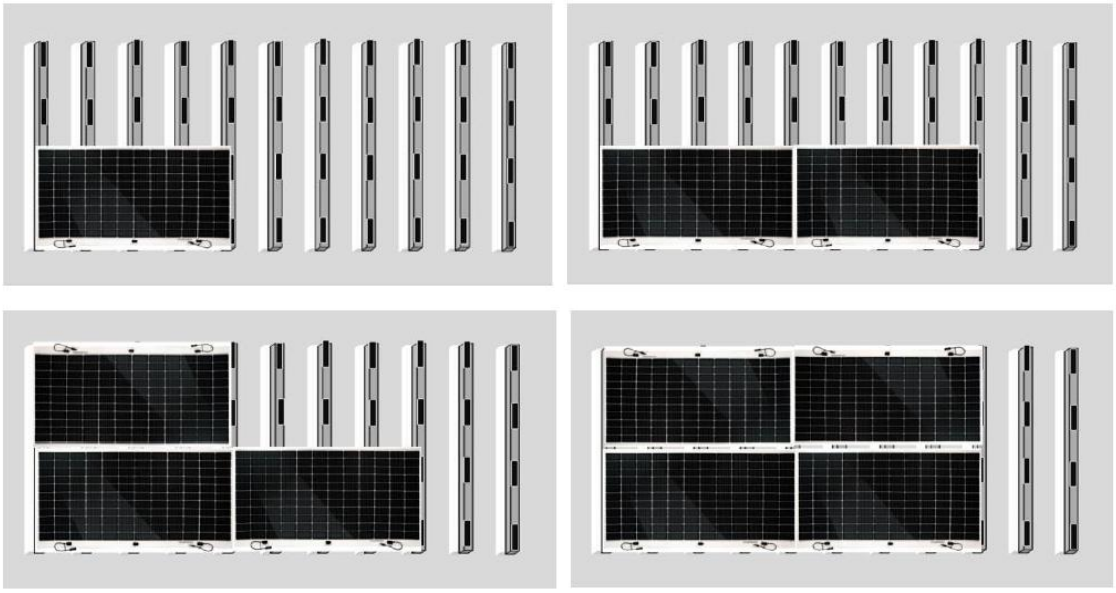


iv. After the module is affixed in level, do not press the cell by hand for stabilization. The non-cell area of the module needs to be compacted with crimping rollers. A plastic roller shall be used to roll over the surface of the module to ensure a good bonding between the module and the roof;

v. The min. distance between modules is 5mm, and a distance of 500~800mm is kept between arrays for construction and maintenance access (this spacing is for reference only);

vi. When the junction box is in the direction of the long side of the PV module, the side of the junction box is placed at the edge position, which is convenient for string wiring and maintenance inspection;

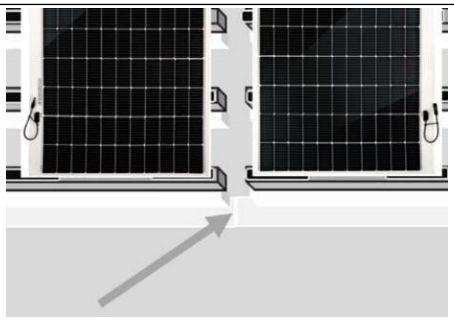
vii. The above mentioned steps shall be followed to install the other modules.



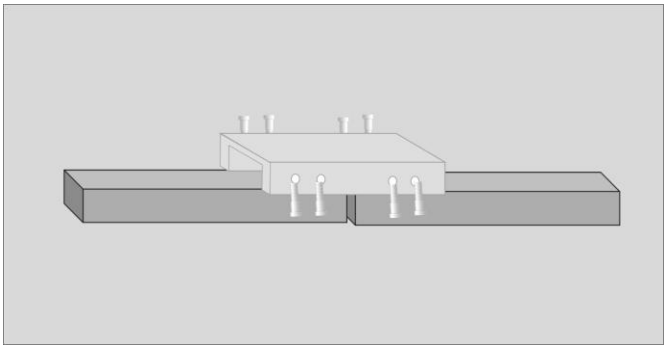
● Square tube splicing

During the installation of the project, the square tubes need to be assembled into a longer square tube by splicing them together. Please follow the two modes below strictly;

i. Mode 1: Splicing is handled at the gap between neighbouring modules

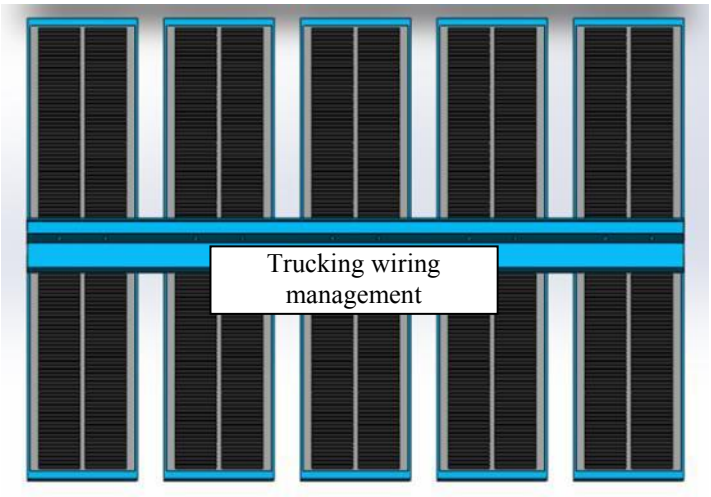


ii. Mode 2: Splices are connected by means of connectors and fasteners, the pattern of which is for reference only. Adaptive connectors can be customized according to the actual situation of the project



6.2.4.3 Connection and Wiring

Each lightweight module comes with two cables and a pair of connectors, making it easy for you to make positive and negative connections using MC connectors. The following mounting slots are recommended for connections and wiring



Attention:

All installation modes described here are for reference only. ZKFN is not responsible for the provision of related installation modules, design and installation of module system. Mechanical loads and security must be carried out by a professional system installer or an experienced person.

Before the installation, the following important items must be verified:

a) Check for bugs or other debris prior to installation. If yes, they shall be wiped off.

b) Check that the serial number of the module is correct.

c) During installation and arrangement design, a channel with arrangement spacing of 400-800mm shall be reserved for operation and maintenance. The end of junction box shall be close to the channel side. In case of shading shadow, it shall be arranged and reserved according to the actual shadow length;

6.2.5 Grounding

ZKFN lightweight PV modules are not equipped with metal frames, so that the equipment shall not be grounded. The electrical grounding point for the PV circuit may be located within the static inverter.

6.2.6 Electrical Installation

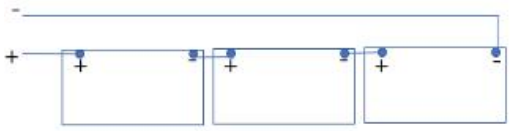
All wiring shall be performed by a qualified & professionally trained installer in accordance with local codes and procedures. The modules can be connected in series. The operating voltage can be increased by inserting the positive plug of one module into the negative socket of the next module. Always ensure that the contacts are corrosion-free, clean and dry before connecting the modules. If a set of arrays is connected to another with opposite polarity, the irreparable damage may be caused to the product. Be sure to check the voltage and polarity of each column before making parallel connections. If measurements reveal reversed polarity or a voltage difference greater than 10V between arrays, check the structural configuration before making connections.

A. All other cables used to connect to the DC system, including the connectors, shall be of similar (or higher) specifications. ZKFN recommends that all cables be routed in suitable ducting and away from areas prone to waterlogging.

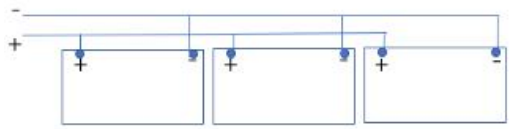
B. Each module has two standard output cables and plug-and-play connectors on each terminal. ZKFN module is equipped with a DC copper stranded cable with a cross-sectional area of 4mm², rated at 1000 VDC & UV-resistant. All cables used to connect DC systems must have similar or better parameters as described above. We require that all wiring and electrical connections meet the requirements of the appropriate National Electrical Code.

6.2.6.1 Wiring

To ensure proper system operation, when connecting modules or connecting loads (e.g., inverters & batteries), observations shall be made to ensure that the cables are connected with the correct polarity (as shown in Figures 1 and 2). The bypass diode may be damaged if the modules are not connected correctly. The modules can be wired in series to increase voltage. Series connections are made by connecting wiring from the positive terminal of a module to the negative terminal of the next module. Fig. 1 shows how the modules are connected in series. Modules can be connected in parallel to increase the current (as shown in Fig. 2). Parallel connections are made by connecting wiring from the positive terminal of a module to the positive terminal of the next module. The number of modules connected in series and in parallel shall be reasonably designed according to the system configuration. All of the above instructions must be observed in order to fulfil the conditions of the ZKFN warranty.

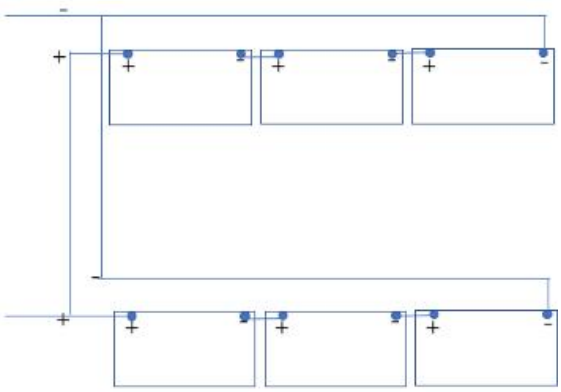


Connect in series



Connect in parallel

Figure 1



Connect in series and then in parallel

Figure 2

6.2.6.2 Fuse

When installing fuses, they shall be rated for max. DC voltage and connected to each ungrounded pole of the array (In other words, if the system is not grounded, the fuses shall be connected to the positive and negative terminals.).

A. Normally, the max. rating of fuses connected in series with the array is 20A. However, the actual module-specific ratings are available on product labels and product data sheets.

B. The rating of this fuse also corresponds to the max. reverse current value that the module can withstand (When an array is masked, the array is loaded to generate current to other module arrays connected in parallel). Thus, there will be an impact on the number of arrays connected in parallel.

C. Do not connect two or more strings in parallel before connecting the fuse.

7. Maintenance of Modules

7.1 Appearance Check and Replacement of Modules

The modules in the PV array shall be regularly inspected for any damage. If any damage is found, the modules shall be replaced with the same model. Factors such as cracked modules, broken cables & damaged junction boxes may lead to functional and safety failures of the modules.

A well-designed solar system requires very little maintenance. However, there are some simple steps that can be taken to improve system performance and reliability.

A. It shall be maintained at least once a year by the trained personnel; The maintenance personnel shall wear rubber gloves and insulated boots at all times during work to remove any obstructions that may obscure the solar module and thus affect its performance.

B. Check that the mounted hardware is tightened properly.

C. Check that all array fuses in each ungrounded pole are functioning properly.

D. If the module is damaged, it must be replaced. The module must be replaced with the

same model. Do not touch the live parts of cables and connectors when replacing the modules. Appropriate PPEs (insulating tools, insulating gloves & insulating boots) shall be used when handling the modules.

E. When replacing the module, tear off from the position where structural glue has not been applied, clean the bonding places with cleaning solvent, and then re-install and connect the lines according to the module installation method.

F. For repair, an opaque material is applied to the front surface of the module. Modules exposed to sunlight will generate high voltages and are extremely dangerous.

G. ZKFN PV module junction boxes are equipped with bypass diodes that will minimize module heating and current loss.

7.2 Inspection of Connector and Cable

A. Check all cables to verify that they are securely connected; ZKFN recommends that all cables shall be run in appropriate conduits and sited away from areas prone to waterlogging.

B. It is recommended that electrical, earthing and mechanical connections be checked every 6 months to ensure that they are clean, secure, undamaged and free from rust; that mountings are properly tightened; and that all cables are checked to ensure that connectors are tight.

7.3 Cleaning

The power generated by solar modules is proportional to the light falling on them. The modules whose batteries are shaded produce relatively little power. Thus, it is important to keep the modules clean.

A. The PV module shall be cleaned at an irradiance of less than 200W/m², avoiding large differences between the temperature of the water used for cleaning and the air temperature, which may cause lobes; Hard water needs to be softened for module cleaning and any water left on the surface of the module shall be wiped.

B. Do not clean the PV modules under meteorological conditions of wind greater than level 4, heavy rain or snow.

C. When a pressurized water stream is used to clean the surface of the module, the water pressure used shall not exceed 70kPa. The module shall not subject to additional external forces.

D. During the cleaning of PV modules, do not step on the modules, do not splash water on the back of the modules and on the cables, and ensure that the connectors are clean and dry, in order to prevent electric shocks and fire hazards; Do not use the steam cleaner; A soft cloth or a soft roller and water shall be used to clean the modules; Do not place the modules directly into water. Take care to avoid severe thermal shock that could damage the modules.

E. Frictionless & neutral liquid cleaner shall be used when there are difficult-to-clean substances such as oil on the surface of the PV module. Organic solvents containing alkalis and acids shall not be used to clean the modules. Do not use corrosive solvents or hard objects to wipe the PV module.

F. If you are unsure whether an array or section needs to be cleared, a particularly dirty array shall be selected first to start clearing. If the percentage improvement is less than 5&, cleaning is usually not required. The above validation shall only be carried out

under constant insolation rates (sunny, strong sunshine & cloud-free).

G. Usually, the backside of the module is not required to be cleaned; If the backside of the module is to be cleaned, cares shall be taken to avoid the cleaning solution seeping through to the bottom of the material.

H. Vegetation shall be removed regularly to avoid shading of PV modules by vegetation.

7.4 Water Quality Requirements

PH:5~7

Chloride or salt content: 0-3,000mg/L

Turbidity: 0-30NTU

Conductivity: 1500~3000μs/cm

Total dissolved solids: ≤1000mg/L7

Water hardness: 0-40mg/L

Non-alkaline water must be used, and softened water is used when available.

7.5 Inspection after Cleaning the Modules

A. The overall appearance of the module is clean, bright and free of stains through visual inspection; Whether there is any dust accumulation on the surface of the module through sampling inspection; There are no visible modules; No unintentional rupture on the surface of the module.

B. Whether the cleaned modules are free from tilting and bending; Whether the module terminals are disconnected.

C. After the PV modules are cleaned, the PV module cleaning record shall be completed.

Annex 1

Primer Cleaner

Roof Type	Recommended Cleaning Agents
Plastic roofs such as TPO, PVC, asphalt & EPDM	Plastic cleaner China: RA-1033 Overseas: The cleaning agent recommended by the roofing material supplier shall be used
Roofs such as coloured steel tiles, glass roofs & metal roofs	90% isopropyl alcohol + 10% water

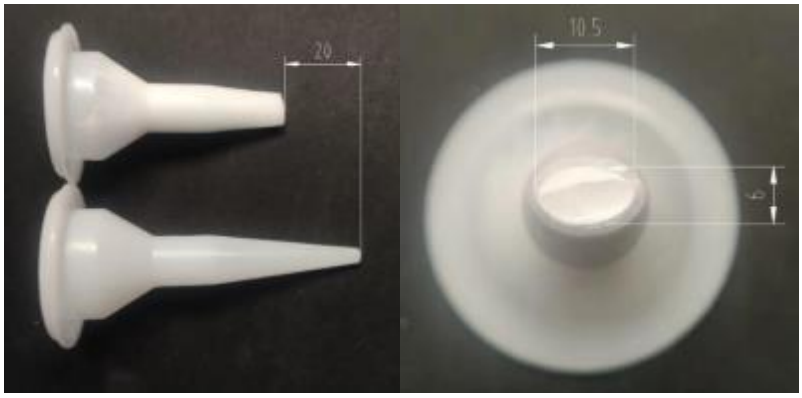
The above cleaners or those recommended by roofing contractor shall be used;

Annex 2:

Gluing Operation Specification

1. Nozzle Cutting

The internal dimension of the standard nozzle cut is 10.5mm×6mm. To make the nozzle, cut a length of about 20mm from the original nozzle and flatten it to the required size, as shown in the figure below:



Please strictly observe the following operation modes for cutting the nozzle;

1. Measure the 20mm length of the head of the nozzle with a ruler or tape measure to confirm the cutting position, and then use the tool for cutting;

2. It is recommended to heat the tip of the nozzle with a lighter for about 2s to prevent it from springing back after being flattened;

3. The nozzle is compacted to the required size using the flattening die cut by the tool;