# FLEXIBLE SOLAR PV

## Operation and maintenance guide

**INSTALLATION / ENGINEERING REFERENCE**

Read the complete instructions before installation or service. Retain the safety warnings, configuration limits, handling methods and inspection requirements with the selected equipment.

Prepared for professional equipment selection and project coordination.

WAYTON document edition | 25 November 2026

Product requirements remain model-specific. Confirm the selected module, mounting or bonding method, project conditions and current document revision before work begins.

For documentation and supply coordination: tech@waytonenergy.com

## Table of Contents

1. Manual Overview, Rights and Responsibilities ..... - 3 -
**1.1 Scope of Application ..... - 3 -**
**1.2 Disclaimer ..... - 3 -**
**1.3 Scope of Liability ..... - 3 -**
**1.4 Warranty Terms ..... - 4 -**
**1.5 Technical Support Information ..... - 4 -**
2. O&M Safety Operating Procedures ..... - 4 -
**2.1 General Safety Warnings ..... - 4 -**
**2.2 O&M Personnel Safety Requirements..... - 5 -**
**2.3 Equipment Safety Requirements ..... - 6 -**
**2.4 Prohibited O&M Activities ..... - 6 -**
3. O&M Inspection Specifications ..... - 7 -
**3.1 General O&M Requirements ..... - 7 -**
**3.2 Inspection Frequency and Items ..... - 9 -**
**3.3 Special Inspections ..... - 10 -**
4. PV Module Cleaning ..... - 10 -
**4.1 Basic Cleaning Requirements ..... - 10 -**
**4.2 Cleaning Methods ..... - 10 -**
**4.3 Cleaning Timing ..... - 11 -**
**4.5 Cleaning Precautions ..... - 11 -**
**4.6 Post-Cleaning Inspection ..... - 11 -**
5. Module Repair and Replacement ..... - 12 -
**5.1 General Replacement Requirements ..... - 12 -**
**5.2 Adhesive-Mount Module Replacement Procedure (flexible modules Series) ..... - 12 -**
**5.3 Clamp-Fixed Module Replacement Procedure (detachable modules Series) ..... - 13 -**
**5.4 System Verification After Module Replacement ..... - 14 -**
6. Common Fault Diagnosis and Troubleshooting..... - 14 -

6.1 Abnormal Module Power Degradation ..... - 14 -
6.2 Module Hot Spot Effect ..... - 15 -
6.3 Module Wiring and Connector Faults ..... - 16 -
6.4 Inverter-Side and String-Level Fault Diagnosis ..... - 16 -
7.1 Emergency Response to Module Electrical Leakage ..... - 17 -
7.2 Emergency Response to Module Fire ..... - 17 -
7.3 Emergency Response to Extreme Weather ..... - 18 -
7.4 Lightning Strike Emergency Response ..... - 19 -
8. O&M Records and Archive Management ..... - 19 -
8.1 O&M Records Management System ..... - 19 -
8.2 Archive Classification and Filing System ..... - 20 -
8.3 Annual O&M Report ..... - 20 -
9.1 Frequently Asked Questions (FAQ)..... - 21 -
9.2 Common O&M Tools and Instruments Checklist ..... - 22 -
9.3 Technical Support and Contact Information ..... - 22 -
9.4 Manual Revision Notes ..... - 23 -

1. Manual Overview, Rights and Responsibilities

## 1.1 Scope of Application

This O&M manual (hereinafter referred to as "this Manual") is issued by Shandong the module manufacturer Solar Technology Co., Ltd. (hereinafter referred to as "the module manufacturer") and applies to all operational aspects throughout the full lifecycle of flexible modules series and detachable modules series lightweight PV modules (hereinafter collectively referred to as "Modules"), covering: routine inspection and specialized testing, module cleaning, fault diagnosis and troubleshooting, module repair and replacement, emergency response, and O&M records and archive management. The flexible modules series consists of flexible conformable modules installed using structural adhesive direct bonding without the need for mounting rails or brackets, suitable for T-type and corrugated color steel tile roofs and flat roof waterproof membrane surfaces. The detachable modules series consists of lightweight rigid back-frame modules installed using the Quick-Clamp rapid fixing system, supporting non-destructive removal, suitable for various color steel tile roofs (including standing seam and trapezoidal seam types) and flat roof scenarios. Both series are equipped with the module manufacturer's exclusive TSR-Armor ™ Anti-Micro-Crack Technology. This Manual is intended for qualified O&M entities and O&M personnel. The aforementioned entities and their operating personnel are obligated to read, fully understand, and strictly comply with all provisions of this Manual before commencing work, and shall provide written disclosure of relevant safety and maintenance essentials to the end owner.

## 1.2 Disclaimer

the module manufacturer reserves the right to modify this Manual without prior notice due to product technology upgrades, process improvements, or standards updates. The latest version of this

center. Customers and O&M parties are responsible for proactively checking and ensuring the use of the latest version. Any operational deviations resulting from the use of an outdated version of this Manual shall be the sole responsibility of the user. Failure by the customer to follow the requirements set forth in the O&M manual (including

operation and maintenance will result in the voiding of the limited product warranty provided to the customer. the module manufacturer makes no warranty, express or implied, with respect to any information contained in this Manual. Users and O&M personnel must conduct on-site technical surveys of the project to ensure that the O&M methods adopted comply with local laws, regulations, and building codes.

## 1.3 Scope of Liability

Regardless of whether module O&M is performed in accordance with the instructions in this Manual, the module manufacturer assumes no legal liability for any damage arising during the O&M process (including but not limited to personal injury and property damage resulting from module handling and system maintenance). In the event of any discrepancy between different language versions of this Manual, the Chinese version shall prevail.

This Manual is provided solely for O&M operational guidance. No statement in this Manual, whether express or implied, shall constitute a warranty certificate.

## 1.4 Warranty Terms

All the module manufacturer flexible modules and detachable modules series products are covered by a 12-year product warranty and a 25-year linear power warranty. The specific warranty coverage, claim procedures, and exclusion clauses shall be governed by the official warranty document provided at the time of product purchase. Key auxiliary materials replaced during O&M, including modules, clamps, structural adhesives, and connectors, must use specification models recommended or certified by the module manufacturer to ensure overall system compatibility, reliability, and safety. Product or system damage caused by the use of non-certified hardware is not covered under warranty.

## 1.5 Technical Support Information

For product documentation, project requirements and coordination of manufacturer technical support, contact WAYTON at tech@waytonenergy.com. or assistance with abnormal O&M issues, please contact the module manufacturer through the following official channels:

2. O&M Safety Operating Procedures

## 2.1 General Safety Warnings

1. All O&M work must be performed in full compliance with local and regional regulations as well as applicable national or international electrical standards.

2. Electric Shock and Burn Hazard: PV modules are DC power generating devices. When their surfaces are exposed to light, DC voltage will be present at the positive and negative terminals and connectors even if they are not connected to a circuit. The voltage of a PV array consisting of multiple modules connected in series can reach levels that endanger personal safety. Personnel who have not received professional training or authorization are prohibited from contacting the module's terminals, connectors, or exposed live parts in any manner. Contact with live components may result in severe burns or fatal electric shock.

3. Prohibition of Load-Break Operations: Before performing any module replacement, wiring, or system modification work, it is essential to first ensure that both the DC-side and AC-side systems are completely de-energized, and to implement strict anti-reclosure and de-energization verification measures. It is prohibited under any circumstances to disconnect connectors or electrical connections under load. Load-break disconnection will generate a hazardous and destructive DC arc, which may cause fire, equipment damage, and serious personal injury.

4. Handling of Damaged Modules: Modules found with appearance damage during O&M inspections (including but not limited to surface penetration, cracking, backsheet scratches with penetration, junction box cracking, or internal water ingress) shall be immediately isolated and scheduled for replacement. Damaged modules are irreparable

and pose an extremely high risk of electrical leakage and electric shock, as their insulation performance has completely failed. It is prohibited for any reason to disassemble modules, remove module components, or modify the wiring of bypass diodes. Module junction box covers must remain securely closed at all times.

5. Positive-Negative Short Circuit Risk: It is prohibited to directly connect the positive and negative connectors of a single module, as this will cause a module short circuit. Before performing O&M work, all connector insulation plugs or sealing rings must be inspected and confirmed to be intact and properly seated, to prevent short circuits caused by insulation failure, which could lead to fire or electric shock hazards.

6. Environmental and Electrical Parameter Limits: The designed stable operating ambient temperature range for the modules is -40C to +85C. The maximum system open-circuit voltage under any expected minimum ambient temperature must not exceed the maximum system voltage of DC 1500V indicated on the module product label. Operation beyond rated parameters is prohibited during O&M.

7. Fire Safety: If a fire occurs at the O&M site, under conditions where it is safe to do so and without risk to personnel, the power supply of the entire PV system (including both DC and AC sides) must first be disconnected. Subsequently, firefighting shall be conducted in accordance with electrical fire codes using non-conductive extinguishing agents such as dry powder or carbon dioxide. It is prohibited to directly spray water or foam onto the modules and electrical system without first disconnecting the power supply.

8. Application Class and Warning: This series of modules is Application Class A (equivalent to IEC 61730-1 Safety Class II), suitable for systems accessible to the public. When the system open-circuit voltage exceeds 50V, according to safety regulations, prominent "Danger: Electric Shock" warning signs must be posted near string connection devices and at easily accessible locations such as inverters.

## 2.2 O&M Personnel Safety Requirements

1. Qualification Requirements: All personnel responsible for O&M of PV systems must have completed professional PV system O&M training, hold valid relevant qualification certificates (including but not limited to low-voltage electrician certificate, high-voltage electrician certificate, work-at-height certificate), and be thoroughly familiar with all safety specifications in this Manual and relevant local government regulations before commencing O&M work.

2. Two-Person Work Rule: To minimize risks associated with solo operations (such as accidental electric shock, falls from height, etc.), all on-site O&M, handling, and wiring work must be performed by at least two persons working together. Solo high-risk operations are prohibited.

3. Personal Protective Equipment (PPE): O&M personnel must correctly wear certified personal protective equipment during operations, including but not limited to: anti-slip protective gloves, long-sleeved insulated work clothing, and anti-smash insulated shoes. When working at roof edges or in any area where a fall hazard exists (height difference exceeding 2 meters), a dual-hook shock-absorbing safety harness must be worn at all times and securely attached to an independently installed lifeline or anchor point. Additionally, guardrails or safety nets should be installed below the work surface.

4. Tools and Jewelry: Only tools that meet safety standards and are properly insulated may be used during work. Wearing any metal jewelry (such as watches, rings, necklaces,

bracelets, etc.) is prohibited while on duty. Such items may cause unintended current conduction leading to short circuit risks, or may scratch the module surface during work.

5. Adverse Weather: Outdoor inspections, cleaning, or repair work of any kind are prohibited under rainy, snowy, foggy, or thunderstorm conditions, or when the on-site instantaneous wind speed reaches or exceeds Force 4 (approximately 7.9 m/s). Humid environments significantly increase the risk of electric shock. O&M personnel must ensure that all modules, tools, and electrical connection points are in a clean and dry condition before commencing work.

6. Safety Awareness: O&M personnel must establish a "Safety First" mindset. It is strictly prohibited to contact the metal live parts of modules without disconnecting the power supply. It is strictly prohibited to smoke or use open flames near the module array. If safety hazards such as module electrical leakage or fire are discovered, work must be immediately stopped, the power supply disconnected, and the corresponding emergency procedures initiated.

## 2.3 Equipment Safety Requirements

1. Circuit Safety: The wiring of the PV module array must comply with electrical safety specifications. Terminals must be securely connected to avoid loosening and oxidation. The main switch, circuit breakers, fuses, and other protection devices of the module array must be included in the periodic inspection scope to ensure they function correctly and can promptly disconnect the power supply in the event of circuit short circuit or overload. Unauthorized modification of the module circuit connection method or addition of extra loads is strictly prohibited.

2. Fire Safety: The area surrounding the module array must remain unobstructed. Storage of flammable and explosive materials (such as gasoline, diesel, cardboard boxes, chemical solvents, etc.) is strictly prohibited. The power station must be equipped with an adequate quantity of appropriate types of fire extinguishing equipment (dry powder extinguishers, carbon dioxide extinguishers). Fire extinguishing equipment must be included in the periodic inspection plan to ensure it remains within the validity period and in a usable condition. O&M personnel must master the basic method of PV power station firefighting: first disconnect the power supply, then use appropriate fire extinguishing equipment for suppression.

3. Module Grounding Exemption Statement: Given that the design of all flexible modules and detachable modules series modules does not incorporate any non-insulated external metal frame (border), the module itself constitutes a complete Class II insulation structure (equivalent to IEC 61730-1 Safety Class II). Therefore, explicit grounding treatment of any part of the module body is not required. This exemption statement does not alter the overall lightning protection grounding and electrical protective grounding requirements of the PV system.

## 2.4 Prohibited O&M Activities

To ensure module performance, personal safety, and warranty validity, the following activities are strictly prohibited during O&M operations:

1. Physical Damage and Coatings: It is prohibited to use sharp objects to scratch, strike, bend, or impact the front and back surfaces of modules. It is prohibited to apply paint, adhesives, tape, or any type of coating to any area of the module surface. It is prohibited to drill holes, cut, or grind any part of the module (unless prior written confirmation is obtained from the module manufacturer professional technical personnel).

2. Cable and Connector Damage: It is prohibited to scratch, cut, crush, or pull the module's factory-installed cables and connectors in any manner. It is prohibited to expose cables and connectors to direct sunlight or water for extended periods without adequate protection.

3. Improper Handling and Pressure: It is prohibited to lift, carry, or drag modules by gripping the junction box, output leads, or connectors. Modules must be carried with both hands supporting the bottom. It is prohibited to apply improper pressure, stand, walk, climb, or jump on the module surface. It is prohibited to allow modules to collide, rub against, or impact any hard or sharp objects.

4. Artificial Light Concentration: It is prohibited to use mirrors, magnifying glasses, lenses, or other optical devices to concentrate additional sunlight or artificial light onto the module surface.

5. Water Immersion and Stacking: It is prohibited to place modules for extended periods or permanently in environments where water may accumulate or where they are continuously exposed to moisture. During all stages of storage, handling, and O&M, it is prohibited to place modules face-down, stack modules on top of each other, or apply compressive loads to modules.

6. Surface Foreign Matter and Shading: It is prohibited to apply structural adhesive, sealant, or any foreign substance onto the effective light-receiving area of the module cells during O&M. After O&M is completed, all output lines and jumper cables must be routed clearly and secured reliably. It is prohibited for conductors, clamps, or other objects to shade the effective light-receiving area of the cells.

7. Pollution Sources and Ignition Sources: It is prohibited to install continuous emission outlets or exhaust vents for oil fumes, dust, or chemically corrosive gases around the modules. It is prohibited to store open flame sources or flammable and explosive materials near the modules.

8. Improper Loading: After completing O&M inspections, it is prohibited to place any heavy objects, tools, or objects with sharp fulcrums on the module surface, to prevent long-term stress-induced damage.

9. Preventing Loosening: Modules must always remain in a securely fastened condition to withstand all potential loads (including wind and snow loads). Module loosening that pulls on connecting cables, leading to insulation failure, electrical leakage, and arcing, is a significant risk source for distributed PV systems.

10. Disassembly Prohibition: It is prohibited to disassemble modules or remove any component parts of modules. Damaged junction boxes and damaged connectors both pose potential electrical hazards and laceration hazards.

3. O&M Inspection Specifications

## 3.1 General O&M Requirements

### 3.1.1 Shading Prevention Management

During the installation and operation of lightweight PV modules, local or overall shadow shading (including but not limited to cables, terminals, vent caps, monitoring equipment, inverters, tree shadows, parapet walls, guardrails, etc.) is strictly prohibited. During inspections, newly emerging shading sources must be thoroughly investigated and promptly removed.

After rain or snow events, the module surface must be inspected within 24 hours, and accumulated dust on the module surface should be rinsed off to prevent dust from mixing with rainwater to form mud stains that remain on the module surface, causing severe localized shading. Adhere to a combination of routine inspection and specialized testing. Periodically conduct visual screening for debris shading, module appearance integrity, and junction box condition. Promptly remove localized shading objects such as surface dust and bird droppings. Implement effective shading prevention and dust accumulation prevention measures for the power station.

### 3.1.2 Mounting Structure Safety Inspection

1. Structural Adhesive Bonding Method (flexible modules Series): At each inspection, the condition of the bonded areas must be checked to determine whether there is adhesive opening, debonding, corner lifting, or edge lifting. Focus inspection on the bonding quality at the four corners and edge areas of the modules. Any anomalies found should be promptly recorded and scheduled for repair.

2. Clamp/Fixture Fixing Method (detachable modules Series): At each inspection, the firmness of clamps and fixtures and the tightness of bolts must be checked. At the same time, the safety status of the building's relevant supporting structures must be examined. For M8 bolts used for clamp fastening, the tightening torque should be maintained within the range of 15~20 N·m.

### 3.1.3 Electrical Safety Inspection

Focus on inspecting the connection sealing integrity and fastening of PV connectors, and investigate whether DC cables show signs of damage, aging, compression, or tension. Verify the specification and model consistency of PV connectors. If the PV connectors used do not match the original connectors of the PV modules in specification or model, this can easily cause excessive interface fit clearance and seal structure failure, allowing external moisture and dust to invade the connector cavity, causing internal pin oxidation and corrosion, increased contact resistance, leading to abnormal connector heating, arc burn-through, and posing serious safety hazards. Warning: Throughout the DC side of the entire PV system - from the module factory-installed output cables, field-fabricated jumpers (string extension cables), to the input terminals of combiner boxes and inverters - at any position where plug connections are required, it must be ensured that the male and female connectors originate from the same manufacturer and belong to the same product model series.

### 3.1.4 Hot Spot Prevention

Conduct infrared thermal imaging inspections on a periodic basis. For minor hot spots (temperature difference < 20°C), perform tracking monitoring and record the trend of change. Modules with severe high- temperature hot spots (temperature difference ≥ 20°C) must be immediately taken out of service and scheduled for replacement. Eliminate module operation with faults, prevent high-temperature fire risks, and ensure safe and stable power generation of the array.

### 3.1.5 Module Disassembly Prohibition

PV modules are hermetically integrated electrical equipment, and on-site disassembly poses multiple uncontrollable risks. It is strictly prohibited for any personnel to disassemble module face panels, junction boxes, backsheets, internal cells, or other components at the

O&M site or during repair processes. Unauthorized removal of the module's factory-installed sealing structures and electrical connection points is not permitted.

## 3.2 Inspection Frequency and Items

### 3.2.1 Routine Inspection (Monthly)

A comprehensive equipment inspection of the distributed PV power generation system shall be conducted at least once per month by trained professional O&M personnel. During operations, inspection personnel must wear rubber-insulated gloves and insulated boots at all times. PV module inspection and examination shall include the following items:

• Whether the PV module light -receiving surface is clean, and whether there is dust accumulation, bird droppings, oil stains, or other contaminants and new shading

• Whether inter -module connecting wires are loose, burnt, or aged, and whether cable tie-downs are in good condition

• Whether PV module junction boxes are secure, box covers are tightly closed, and connectors are fully plugged in

• Whether PV modules show deformation, cracks, breakage, discoloration, delamination, bubbles, or other abnormal conditions

• Whether module mounting fasteners (clamps, fixtures) are loose, and whether the bonded areas of adhesive-mounted modules are intact

• Whether connections between array mounting brackets are secure, and whether the connection between brackets and the grounding system is reliable

• Verify through the monitoring system whether current, voltage, and power data of each string are within normal ranges

### 3.2.2 Additional Quarterly Inspection Items

In addition to completing all monthly inspection items, the following specialized inspections shall be added each quarter:

• Use an infrared thermal imaging camera to perform hot spot scanning on all modules block by block, establishing a module temperature archive

• Check whether array fuses, circuit breakers, disconnect switches, and other protection devices are functioning normally

• Check whether the roof drainage system is unobstructed and whether there are water accumulation hazards around the modules

• Inspect the lightning protection and grounding system, measuring whether grounding resistance values are within the specified range (generally required to be ≤ 4Ω)

• Conduct torque re -inspection of at least 10% of electrical connection points

### 3.2.3 Additional Annual Inspection Items

In addition to completing all monthly and quarterly inspection items, a comprehensive in-depth inspection shall be conducted once per year:

• Use an IV curve tracer to perform power characteristic testing on each string or at least 30% of modules

• Perform EL inspection (electroluminescence imaging) on modules with abnormal power degradation to detect internal defects

• Conduct comprehensive fastening torque re -inspection of all DC-side electrical connection points

• Conduct a comprehensive safety assessment of the roof support structure (load -bearing structure, anchor points, rust inspection)

• Use an insulation resistance tester (DC 500V/1000V) to measure string -to-ground insulation resistance

• Issue an annual O&M analysis report, summarizing the year's operational data and performance change trends

## 3.3 Special Inspections

Special inspections must be organized immediately after extreme weather events or special operating conditions:

• After Thunderstorm Weather: Use a thermal imaging camera to check whether junction box temperatures of modules in lightning strike risk areas are abnormally elevated; check whether lightning protection devices have activated

• After High Wind Weather: Check whether PV module clamps and fixtures have come off or loosened; whether modules have been flipped or displaced by strong wind; whether the roof remains stable

• After Hail/Snow Weather: Inspect PV module face panels block by block for cracks or breakage; check for module deformation caused by snow load

• After Sandstorm Weather: Check whether there are sand impact marks on module surfaces; promptly arrange cleaning operations to remove accumulated dust from the surface

4. PV Module Cleaning

## 4.1 Basic Cleaning Requirements

PV modules should be kept with clean surfaces during operation. In general, cleaning should be performed at least once per month, with frequency appropriately increased under harsh natural environmental conditions. In areas with severe dust (within a 50-meter radius), such as cement plants, mining areas, and along dusty roads, cleaning frequency should be increased to at least once every half month. PV modules must be cleaned promptly when visibly soiled to ensure module photoelectric conversion efficiency. Cleaning should be scheduled when any of the following conditions are met:

• Visual inspection shows the module light -receiving surface is noticeably dirty with a visible dust layer

• Using a high -precision DC watt-hour meter to simultaneously measure in real time the energy output of 2 strings to be cleaned and 2 cleaned strings, the comparison value differs by ≥ 4%

• The PV array power output falls below 85% of the initial state (output at the conclusion of the last cleaning)

• Power station monitoring data shows generation output has dropped by more than 5% from normal levels, and equipment faults and meteorological factors have been ruled out

## 4.2 Cleaning Methods

It is recommended to use a damp soft cloth, sponge, or soft roller to remove surface stains from the module manufacturer lightweight PV modules. For stubborn stains, a neutral wiping agent (such as glass cleaner, neutral detergent, dishwashing liquid) or surfactant (degreaser, stain remover) may be used to assist cleaning. The use of steel wire brushes, steel wool, metal scrapers, hard-bristle brushes, or similar tools as cleaning implements is prohibited. Standard Cleaning Sequence: First rinse from top to bottom with clean water to remove loose dust, then gently wipe with a soft cloth dampened with clean water or neutral cleaning solution, and finally thoroughly rinse with ample clean water and wipe dry with a clean soft

cloth. The use of corrosive solvents for cleaning or hard objects for wiping PV modules is prohibited.

## 4.3 Cleaning Timing

To avoid artificial shading during cleaning operations that could cause hot spot effects, reduce PV power station generation losses, and ensure the safety of cleaning personnel, cleaning should be performed avoiding periods of high temperature, strong irradiance, and optimal PV generation time. To avoid electric shock injury to cleaning personnel and damage to PV modules caused by the high voltage and high current of the PV power station, cleaning should be performed during periods when irradiance is below 200 W/m², typically choosing early morning, late afternoon, nighttime, or overcast days.

## 4.4 Cleaning Water Quality Requirements

Cleaning water must meet the following standards to avoid scale formation or corrosion on the module surface:

• Total Hardness (as CaCO□): ≤ 200 mg/L

• Total Dissolved Solids (TDS): ≤ 500 mg/L

• pH Value: 6.5 ~ 8.5

• Suspended Solids: ≤ 50 mg/L Note: Where conditions permit, softened water or deionized water should be used preferentially to avoid scale deposits forming on the module surface.

## 4.5 Cleaning Precautions

The following safety and operational specifications must be strictly observed during cleaning operations:

• It is strictly prohibited to step on flexible modules series flexible modules (frameless) for cleaning operations

• It is strictly prohibited for water flow to splash onto the module back side and cable wiring areas

• Cleaning operations are prohibited under severe weather conditions such as heavy rain, heavy snow, blowing sand, and hail

• Prevent external forces and other mechanical impact or compression on modules

• It is prohibited to use high -pressure gas or compressed air to blow-clean module surfaces, to prevent wind pressure from causing module damage

• Avoid significant temperature differences between the cleaning water temperature and the module surface temperature (temperature difference is recommended not to exceed 10°C)

• If cleaned with pressurized water flow, the recommended water pressure is 0.1~0.2 MPa

• It is strictly prohibited at all times to use a high -pressure water jet at close range aimed at the junction box seams and connectors for flushing

• It is prohibited to walk, stand, or sit on modules while performing module cleaning

• The junction box of flexible modules series modules is located on the front side of the module; during cleaning, tools must avoid the junction box area to prevent sealing strip detachment or housing damage

## 4.6 Post-Cleaning Inspection

After completing cleaning operations, the following inspections shall be performed and documented in writing:

• The overall appearance of the modules should be visually clean and bright, free of residual stains and water marks

• There are no new scratch marks or human -caused cracking on the module surface

• Modules show no tilting or bending, and terminals show no detachment or loosening

• Connectors remain dry and clean, with sealing rings intact

• Record cleaning date, cleaning personnel, cleaning scope, cleaning method, and pre/post -cleaning string power comparison data

5. Module Repair and Replacement

## 5.1 General Replacement Requirements

Before module replacement operations, potential risks during the operation process must be comprehensively identified (including but not limited to: personnel lacerations from tool handling, falls from height, electric shock hazards during circuit disconnection/restoration, and debris splashing during old module removal, etc.), and specific mitigation measures must be developed for each risk. A "Pre-Work Safety Briefing" must be conducted before each operation. The work supervisor shall explain the day's work content, specific task assignments, safety precautions, and emergency response procedures to all participating personnel. Written records shall be made and signed by all personnel before work may commence. Before replacement, each new module must be individually inspected for appearance (confirming no surface scratches, cracks, deformation, and that terminals are intact without defects). The module model, rated power, electrical parameters, and other nameplate information must be checked against the old module for consistency, ensuring electrical compatibility between old and new modules before they can be put into service. It is prohibited to use excessive force to pry modules, to avoid causing module breakage or personnel injury. During the removal process, care must be taken to protect adjacent module surfaces and electrical connections from damage. Waste modules, glass fragments, damaged accessories, and other items must be collected separately and stored centrally. Damaged modules shall be professionally disposed of in accordance with hazardous waste management requirements. Random disposal or mixing with ordinary construction waste is prohibited. Warning: When replacing modules, the front surface of the module to be replaced must be completely covered with opaque material (such as black light-blocking cloth or thick cardboard). Modules exposed to sunlight will generate high voltage, which is extremely dangerous.

## 5.2 Adhesive-Mount Module Replacement Procedure (flexible modules Series)

Applicable to flexible modules series flexible conformable modules. The replacement steps are as follows:

3. Plan Preparation: Before module replacement, a Lightweight Module Replacement Implementation Plan shall be prepared, defining the operational process, personnel assignments, safety measures, and quality acceptance criteria

4. De-energization Confirmation: Before commencing work, the corresponding combiner box and inverter power supply for the module must be disconnected. A "Do Not Close,

Personnel at Work" warning sign shall be hung at the disconnection point. After a certified electrician confirms de-energization using a multimeter, subsequent work may begin

5. Module Covering: Completely cover the front surface of the module to be replaced with opaque material to block light

6. Electrical Disconnection: Use specialized unlocking tools to separate the module's positive and negative connectors; make cable number markings

7. Old Module Removal: Use tools such as utility knives and scrapers to carefully cut the PV-specific structural adhesive along the bonding interface, gradually separating the old module from the roof substrate. During the operation, control force and cutting angle to avoid damaging surrounding modules and the roof waterproofing layer

8. Substrate Cleaning: Thoroughly remove residual structural adhesive and debris from the roof substrate, ensuring the bonding surface is dry, clean, and flat. If necessary, perform light sanding on the substrate surface to restore surface roughness

9. New Module Installation: Strictly follow the standardized procedures in the module manufacturer flexible modules & detachable modules Series PV Module Installation Manual for adhesive application, module placement, roller pressing, and positioning

10. Curing Protection: During the structural adhesive curing period (reference curing times: 24 hours at 25°C~40°C, 48 hours at 10°C~25°C, 72 hours at 0°C~10°C), it is strictly prohibited to apply any disturbance to the module. Protective

barriers and warning signs shall be installed in the replacement area

11. Electrical Connections: After the structural adhesive has fully cured, re-connect the connectors according to the marked positive/negative polarity correspondence, ensuring an audible "click" locking sound is heard

12. Power-On Testing: Remove the covering material, close the switch to restore power supply. Measure the output parameters of the new module, confirming compatibility with other modules in the same string

13. Records and Filing: Record in detail all information about the replacement process, including replacement date, replacement reason, old and new module serial numbers and test data, operating personnel, etc.; update the power station O&M archive

## 5.3 Clamp-Fixed Module Replacement Procedure (detachable modules Series)

Applicable to detachable modules series rigid back-frame modules. The replacement steps are as follows:

1. Plan Preparation: Before module replacement, a Clamp-Fixed Module Replacement Implementation Plan shall be prepared, defining the operational process and safety measures

2. De-energization Confirmation: Same as Requirement 2 of the Adhesive-Mount Replacement Procedure

3. Module Covering: Same as Requirement 3 of the Adhesive-Mount Replacement Procedure

4. Electrical Disconnection: Same as Requirement 4 of the Adhesive-Mount Replacement Procedure

5. Old Module Removal: Use a torque wrench to loosen and remove the clamp fastening bolts to the specified torque, remove the clamps in sequence, and carefully move the old module out from the installation surface. During the operation, be careful to avoid colliding with surrounding modules

6. Installation Surface Inspection: Clean debris and rust from the installation surface; check whether clamps/brackets show deformation, rust, or looseness. If anomalies are found, the damaged accessories must first be repaired or replaced

7. New Module Installation: Position the new module at the designated location, adjusting peripheral gaps to be uniform and consistent. Install clamps in sequence, uniformly tightening M8 bolts to a torque of 15~20 N·m. Clamps must press on the designated load-bearing area of the module back-frame and must not press on the effective cell area above

8. Electrical Connections: Same as Requirement 9 of the Adhesive-Mount Replacement Procedure

9. Power-On Testing: Same as Requirement 10 of the Adhesive-Mount Replacement Procedure

10. Records and Filing: Same as Requirement 11 of the Adhesive-Mount Replacement Procedure

## 5.4 System Verification After Module Replacement

After completing module replacement, in addition to individual testing of the new module, the overall performance of the affected string shall also be verified:

• Measure the string open -circuit voltage (Voc) and short-circuit current (Isc), comparing with the string design values and normal strings in the same array

• Monitor the string operating current to confirm good current matching between the new module and existing modules in the string

• Observe power generation data over at least one full sunshine day to confirm that string power has recovered to normal levels

• Perform infrared thermal imaging scanning of the newly replaced module area to confirm the absence of abnormal heating points

6. Common Fault Diagnosis and Troubleshooting

## 6.1 Abnormal Module Power Degradation

### Fault Symptoms

Module output power is significantly lower than rated power, and the power degradation rate exceeds the normal range, or unexpected rapid power decline occurs within a short period.

### Fault Cause Analysis

• Modules operating long -term in high-temperature, high-humidity environments, leading to accelerated aging of cells and encapsulation materials

• Long -term uncleaned dust and dirt accumulation on the module surface, resulting in continuous decline of light transmittance

• Internal cell micro -cracks and broken grid fingers within the module, affecting the effective collection of photo-generated current

• Bypass diode failure within the junction box (short -circuit or open-circuit failure), causing partial cell strings within the module to cease operation

• Persistent localized shading on the module surface, triggering long -term hot spot effects causing permanent cell degradation

• Poor connector contact or cable aging, resulting in abnormal increase of series resistance

### Diagnosis and Troubleshooting Methods

• Use a professional IV curve tracer to measure the actual output power of the module, confirming the degree of power degradation and the abnormal IV curve pattern

• Carefully inspect the module surface for dust, dirt, scratches, cracks, etc.; check whether the junction box is intact

• Use an infrared thermal imaging camera to detect whether hot spot effects and abnormal heating points exist

• Conduct EL inspection on modules suspected of having internal defects to confirm the presence of micro-cracks, broken grid fingers, cold soldering, etc.

• If caused by surface dust/dirt accumulation → Clean the module promptly

• If caused by localized shading → Remove the shading source and optimize the module's surrounding environment

• If the junction box internal diode is damaged → Replace with the same model junction box (must be performed by the module manufacturer authorized personnel)

• If the module has severe aging (power degradation exceeding 20%) or irreversible internal defects → Replace the module

• If the module is still within the warranty period and confirmed to be a product quality issue → Apply for after -sales service in accordance with warranty procedures

## 6.2 Module Hot Spot Effect

### Fault Symptoms

Infrared thermal imaging inspection reveals localized areas of the module with significantly higher temperatures than surrounding normal areas (temperature difference ≥ 20°C). Severe hot spots can cause discoloration and bubbling of module surface encapsulation materials, backsheet burn-through, junction box melting and deformation, and in extreme cases may trigger fire.

### Fault Cause Analysis

• Localized shading objects present on the module surface (leaves, bird droppings, dust clumps, building shadows, etc.); shaded cells transition from power generation units to power-consuming loads, consuming the electrical energy generated by adjacent normal cells and forming localized high temperatures

• Performance degradation of individual cells within the module (efficiency decline, increased series resistance), creating electrical mismatch with other normal cells in the same string

• Cells exhibiting micro -defects such as micro-cracks and broken grid fingers, where obstructed local current flow leads to concentrated heating

• Bypass diode failure, unable to bypass and protect the shaded cell string when shading occurs

### Treatment and Preventive Measures

Immediate Treatment: Immediately remove shading objects from the module surface; de-energize and isolate modules with severe hot spots to prevent fault escalation. Graded Disposition:

• Minor hot spots (temperature difference < 20°C) with no visible internal damage → Continue tracking and monitoring after removing shading objects

• Moderate hot spots (temperature difference 20 ~ 40°C) → Recommend developing a replacement plan and completing replacement during the next scheduled downtime

• Severe hot spots (temperature difference ≥ 40°C) or modules already showing visible damage on appearance → Must be immediately taken out of service and replaced Preventive Measures: During the module array design and installation phase, layouts should be rationally planned to avoid inter-module shading. Periodically clear vegetation and debris

around modules that could form shading sources. Conduct comprehensive infrared thermal imaging inspections on a quarterly basis, establishing a module temperature baseline archive.

## 6.3 Module Wiring and Connector Faults

### Fault Symptoms

Unstable or completely absent module output voltage and current; abnormally elevated temperatures at terminals and connectors (hot to the touch or hot spots visible in infrared thermography); oxidation discoloration and arc burn marks appearing on terminal surfaces; in severe cases, melting and deformation of connector plastic housings with a burnt odor.

### Fault Cause Analysis

• Connectors not fully plugged into position, resulting in increased contact resistance and localized heating

• Connector seal failure (sealing ring aging, damage, or detachment), with moisture and dust intrusion causing pin oxidation and corrosion

• Male and female connectors originating from different manufacturers or different model series, resulting in large interface fit tolerances and unreliable contact

• Output cables with insulation layer aging, cracking, and damage due to long -term exposure, causing electrical leakage or short circuits

• Wiring errors (such as reversed positive and negative polarity) or incorrect string wiring topology

• Connectors under prolonged cable tension, causing internal pin loosening

### Troubleshooting Procedure

• Safe De -energization: First disconnect the corresponding combiner box and inverter power supply, confirm de-energization using a multimeter, and hang "Do Not Close" warning signs

• Fault Location: Use a multimeter to sequentially test continuity, voltage, and contact resistance values at each terminal, locating the fault point

• Loose Terminal → Re -tighten to specified torque using specialized tools

• Terminal Oxidation/Corrosion → Cut off the damaged section and replace with a new connector of the same model and specification

• Connector Model Mismatch → Replace all connectors with certified matching models

• Cable Damage → Replace with PV -specific DC cable of the same specification, ensuring wire gauge and voltage rating match the original

• Wiring Error → Rewire according to the correct positive/negative polarity markings and string wiring diagram

• Restoration and Verification: After completing wiring, restore power, measure string open -circuit voltage, short-circuit current, and operating current, confirming the fault has been eliminated and parameters are normal

## 6.4 Inverter-Side and String-Level Fault Diagnosis

### Fault Symptoms

Monitoring system shows persistently low or zero output power for a particular string; inverter reports insulation resistance too low fault, DC over-voltage/under-voltage alarms; string current significantly deviates from the average level of other strings in the same array.

### Diagnostic Steps

• Step 1: Identify the fault string number and corresponding physical location through the monitoring platform

• Step 2: Under safe de -energized conditions, measure the open-circuit voltage (Voc) of the string and compare with normal strings in the same array. If Voc is significantly lower, this indicates module short circuit, bypass diode short circuit, or severe module damage within the string

• Step 3: Measure the string short -circuit current (Isc). If Isc is significantly lower, there may be severe module dust accumulation, shading, aging, or poor connector contact

• Step 4: Measure the string segment by segment, progressively narrowing the fault range until the specific problematic module is located

• Step 5: Perform further diagnostics such as IV curve testing and EL inspection on the identified problematic module, determine the fault type, and take corresponding treatment measures

7. Emergency Response Measures

## 7.1 Emergency Response to Module Electrical Leakage

Upon discovery of a module electrical leakage alarm or suspected leakage situation, O&M personnel must immediately execute the following handling procedures:

• Personnel Emergency Evacuation: Immediately move away from the leakage area; do not touch the leaking module and its surrounding metal components; simultaneously prevent other personnel from entering

• Safe De -energization: Certified professionals wearing insulating gloves rated for the appropriate voltage level shall use an insulated operating rod to disconnect the corresponding combiner box and inverter power supply, and hang warning signs

• Fault Detection: Use an insulation resistance tester to measure the insulation resistance to ground of the leaking string segment by segment, using the sectional elimination method to locate the leaking module

• Cause Investigation: Inspect the leaking module for conditions such as water ingress in the junction box, connector seal failure, cable insulation damage, and backsheet penetration damage

• Repair Disposition: Replace the faulty module, damaged cables, or connectors based on the cause of leakage. After repair is complete, re-test insulation resistance to confirm restoration to acceptable levels

• Power Restoration: Only after all tests are passed may warning signs be removed and power be restored. After power restoration, continuous monitoring shall be conducted for at least 1 hour to confirm the absence of anomalies

## 7.2 Emergency Response to Module Fire

The fire performance of the module manufacturer flexible modules and detachable modules series lightweight PV modules have passed UL790 Class C standard testing and certification for fire performance, demonstrating good fire resistance. If a module fire incident occurs at the O&M site, the following procedures shall be followed:

• Immediately disconnect the main power supply of the PV module array (including both DC-side and AC-side power supplies) to prevent fire spread and electric shock incidents

• If the fire is small and safe conditions permit, use a dry powder extinguisher or carbon dioxide extinguisher to suppress the fire at the source. It is strictly prohibited to use water or foam for direct firefighting to avoid electric shock risk

• If the fire is too large to extinguish independently, immediately call 119 to report the fire, clearly communicating to the fire department key information such as "PV power station fire, DC high voltage hazard," and organize all personnel to evacuate to a safe area

• After the fire is extinguished, conduct a systematic investigation of the fire cause, assess the damage level of each module and electrical equipment, and prepare the Fire Incident Analysis and Restoration Plan

• Only after confirming that all safety hazards have been eliminated (structural safety, electrical insulation, and module integrity) may the power station be gradually restored to operation according to the restoration plan

## 7.3 Emergency Response to Extreme Weather

### 7.3.1 Rainstorm/Flooding

• Before a rainstorm arrives, inspect whether the drainage system of the module array is unobstructed, and clear debris from drainage outlets

• Relocate important equipment within the power station (such as monitoring hosts, inverters) to higher ground or implement waterproof protection measures

• During the rainstorm, cease all outdoor O&M operations. If flooding occurs at the power station, immediately disconnect all power supplies

• After floodwaters recede, perform drying treatment, cleaning, and insulation testing on all water-affected modules, cables, connectors, and electrical equipment. Only after confirming the absence of safety hazards may operations be gradually restored

### 7.3.2 High Wind/Typhoon

• Before high winds arrive, comprehensively inspect the fastening condition of module clamps and fixtures, and reinforce any loose bolts

• Clear loose objects around the module array that could be easily picked up by wind

• During the typhoon, shut down the power station power supply and evacuate all personnel to a safe area

• After the wind event, comprehensively inspect whether brackets and modules show deformation, displacement, damage, or other conditions. Repair damaged areas and only restart the power station after passing comprehensive inspection

### 7.3.3 Blizzard/Low Temperature

• During a blizzard, periodically use a soft snow pusher (silicone or rubber material) to clear accumulated snow from module surfaces, preventing snow shading or module deformation due to excessive snow load

• In low -temperature environments, check whether connectors and terminals show signs of icing. If icing has occurred, wait for natural thawing and complete drying before performing operations, to avoid poor contact or operational damage caused by icing

• It is strictly prohibited to step on flexible modules series flexible modules when clearing snow. Stepping on flexible modules flexible modules can easily cause irreversible damage such as backsheet rupture and cell micro-cracking, and will simultaneously compromise the module's sealing performance, triggering subsequent faults such as moisture ingress and circuit short circuit

• Cleaning tools must not make contact with junction boxes. The junction box of flexible modules series modules is located on the front side of the module. If tools make contact with the junction box during cleaning, this can easily cause sealing strip detachment, housing damage, or internal terminal loosening and poor line contact, which may in turn lead to safety hazards such as electrical leakage and circuit breakage. During operations, the tool cleaning range must be controlled to avoid the junction box area. If necessary, a small soft-bristle brush may be used to separately clean a small amount of snow around the junction box

## 7.4 Lightning Strike Emergency Response

The thunderstorm season is a high-risk period for PV power stations suffering lightning strikes. If the monitoring system shows widespread module communication interruption, inverter tripping, or on-site inspection reveals obvious lightning strike marks on modules (such as junction box puncture, module surface arc burn spots), the following handling procedures shall be immediately initiated:

• Immediately disconnect all power supplies to the power station; personnel shall promptly evacuate to a safe indoor area

• After the thunderstorm passes, comprehensively inspect the lightning protection and grounding system: check grounding down-conductors for breakage or fusing; measure whether grounding resistance still meets design requirements (generally required to be ≤ 4Ω)

• Inspect the appearance of modules block by block; use an infrared thermal imaging camera to scan for abnormal heating points

• Measure insulation resistance and IV characteristics of strings affected by lightning strikes; replace modules that have been punctured or have severely degraded performance

• Inspect whether surge protective devices (SPDs) inside inverters and combiner boxes have activated or been damaged; if damaged, they must be promptly replaced

8. O&M Records and Archive Management

## 8.1 O&M Records Management System

The completeness and accuracy of O&M records form the foundation for power station asset management, warranty claims, performance assessment, and fault tracing. It is recommended to establish archive management principles of "full lifecycle coverage, dual-track electronic and paper systems, equal emphasis on safety and utilization." Through standardized record collection and regulated archive management, achieve O&M process traceability, problem locatability, and decision supportability, forming a closed management loop of "Record - Archive - Utilize - Optimize." O&M personnel shall record in detail the relevant information for each O&M activity, covering the following categories:

• Inspection Records: Record inspection date, inspection personnel, inspection scope, inspection results (module appearance condition, operating parameter data, problems identified and on-site handling), tracking of unresolved issues

• Cleaning Records: Record cleaning date, cleaning personnel, cleaning scope, cleaning method, water consumption and quality, representative string power comparison data before and after cleaning

• Fault Handling Records: Record fault occurrence date, fault module serial number and location, fault symptom description, fault cause analysis, specific handling methods and steps, handling results, repair personnel signature, list of materials and spare parts used for repair

• Module Replacement Records: Record replacement date, information on old module (serial number, model, years in service, fault type), information on new module (serial number, model, initial electrical performance test data), replacement operating personnel

• Emergency Response Records: Record the time and location of the emergency incident, incident type and severity, specific emergency response measures and execution process, response results and subsequent impact assessment, personnel involved in the response

• Specialized Testing Records: Record the date, scope, method, raw data, and analysis conclusions of specialized tests such as IV curve testing, EL inspection, infrared thermal imaging scanning, and insulation resistance testing

## 8.2 Archive Classification and Filing System

Archive management is recommended to adopt a four-level classification system of "Primary Classification - Secondary Classification - File Group - Document":

• Basic Archive Category: Includes module factory documentation (certificate of conformity, factory test report, technical parameter list), procurement contracts, warranty agreements, system as-built drawings, completion acceptance reports, etc.

• O&M Process Archive Category: Compiles the various O&M records mentioned above, with file groups organized by "Year - O&M Type - Area." Inspection records shall be summarized daily and bound monthly; fault handling records shall be separately established as "one case, one file," including supporting materials such as test reports, pre- and post-repair comparison photographs

• Performance Monitoring Archive Category: Separately stores professional testing data such as IV curve tests, EL inspections, and hot spot scans. Establish a "Module-Specific Performance Ledger" indexed by module serial number, recording key performance data at each testing node throughout the full lifecycle, and annually compile the Module Performance Degradation Analysis Report

• Compliance Management Archive Category: Includes copies of O&M personnel qualification certificates, testing instrument calibration certificates, waste module recycling and disposal certificates, industry regulatory inspection records, safety training records, etc., ensuring that O&M activities are fully compliant and traceable throughout the entire process

## 8.3 Annual O&M Report

A comprehensive Annual PV Power Station O&M Analysis Report shall be prepared and submitted each year. The report shall contain at least the following content:

• Annual power generation statistics and comparative analysis against design values and the same period of the previous year

• Annual inspection and cleaning operation summary statistics (number of inspections, number of cleanings, number and type distribution of problems identified and resolved)

• Module performance degradation trend analysis (based on IV curve and EL inspection data)

• Fault statistical analysis (fault type distribution, fault rate, mean time to repair, impact assessment on power generation)

• Annual O&M cost statistics, and O&M plan and budget recommendations for the following year

• Key focus areas and improvement recommendations for the following year

## 9.1 Frequently Asked Questions (FAQ)

### Q1: What is the maintenance interval for the module manufacturer lightweight PV module products?

### What are the main items to check?

A: It is recommended to conduct comprehensive inspection and maintenance at least once per month, checking the operational performance of all modules and the safety and reliability of the electrical system. Modules should be cleaned at least once per month to ensure PV power generation efficiency. Main inspection items include: whether module appearance has any damage; whether electrical connections are secure; whether junction boxes and connectors are intact; whether module surfaces are clean and free of shading; whether mounting support structures are stable; whether the lightning protection and grounding system is normal; whether the monitoring system is operating normally; and whether the PV system has any abnormal power output.

### Q2: If a small amount of dust appears on the module surface but hasn't reached the cleaning trigger threshold of a 5% power drop, is cleaning necessary?

A: If the dust layer is thin and rainfall is forecasted in the short term, cleaning can be postponed while continuously monitoring power trends through the monitoring system. However, if local air pollution is severe, the dust contains sticky substances prone to caking, or no effective precipitation is forecasted within the next week, it is recommended to schedule cleaning in advance to prevent long-term dust accumulation from hardening into a crust, which would increase subsequent cleaning difficulty and continuously affect light transmittance.

### Q3: If modules ice over in winter, can hot water be used directly to melt the ice?

A: It is strictly prohibited to use hot water for direct rinsing or pouring onto ice-covered modules. Severe temperature differentials between cold and hot will cause thermal shock stress to the module panel and encapsulation materials, potentially leading to module breakage or encapsulation layer failure. It is recommended to wait for ambient temperature to rise to allow the ice to melt naturally, or to use a silicone/plastic dedicated de-icing scraper (metal tools are strictly prohibited) to gently remove surface ice. After the ice has completely melted and the module surface is dry, inspect the module for signs of water ingress or damage.

### Q4: Can flexible modules & detachable modules series flexible modules be stepped on for cleaning or maintenance?

A: No. The flexible modules and detachable modules series are flexible solar modules. Any form of stepping on them may cause irreversible damage such as backsheet rupture and micro-cracks in solar cells. It will also compromise the module's sealing performance, leading to subsequent faults including moisture ingress and electrical short circuits. For cleaning and maintenance operations, dedicated walkway brackets must be used, and access shall only be made around the perimeter of the modules.

### Q5: If module power degradation exceeds the normal range but the module is still within the warranty period, how do I apply for after-sales service?

A: First organize the complete O&M archive for the module (including inspection data, IV curve power test reports, fault photographs, EL inspection images, etc.), contact the module manufacturer SOLAR after-sales service department, and submit the Warranty Period After-Sales Service Application Form with relevant supporting materials. the module manufacturer will arrange for authorized technical personnel to conduct on-site verification and testing. Upon confirmation that the issue is a product quality problem, corresponding repair or replacement services will be provided in accordance with the warranty policy.

### Q6: The flexible modules series module junction box is located on the front side of the module. What are the special precautions during cleaning?

A: The junction box of flexible modules series modules is located on the front side (light-receiving surface) of the module, which is a structural feature of its flexible encapsulation design. During cleaning operations, special attention must be paid to: cleaning tools (soft cloth, roller, water squeegee) must avoid the junction box area to prevent tool impact from causing junction box sealing strip detachment, housing damage, or internal terminal loosening. A small soft-bristle brush is recommended for separately cleaning a small amount of dust around the junction box. It is strictly prohibited at all times to use a high-pressure water jet aimed at the junction box and its seams for flushing.

## 9.2 Common O&M Tools and Instruments Checklist

The following are recommended common tools and testing instruments for PV power station O&M:

• Digital Multimeter (CAT III 1500V rating) - Measuring DC voltage, current, and continuity

• Clamp -Type DC Ammeter - Measuring string operating current without breaking the circuit

• IV Curve Tracer - Measuring the current-voltage characteristic curve of modules/strings; diagnosing performance degradation

• Infrared Thermal Imaging Camera - Hot spot detection, connector and terminal heating point investigation

• Insulation Resistance Tester (DC 500V/1000V) - String-to-ground insulation resistance measurement

• EL Inspection Equipment - Detecting internal defects such as cell micro-cracks, broken grid fingers, and cold soldering

• Torque Wrench (0~30 N·m) - Electrical connection and clamp bolt fastening torque verification

• MC4 Connector Specialized Disassembly/Assembly Tools - Safe connector separation and mating

• Grounding Resistance Tester - Periodic testing of lightning protection and grounding systems

• PV -Specific Cleaning Toolkit (soft roller, microfiber cloth, soft water squeegee, soft-bristle brush, etc.)

## 9.3 Technical Support and Contact Information

## 9.4 Manual Revision Notes

This manual is Version A01, released on May 09, 2026. the module manufacturer will periodically revise and improve the manual content based on module technology upgrades, industry standards

download center and notified to registered users through email and other channels. Users may obtain the latest version free of charge. If users discover any issues or have suggestions for improvement while using this manual, they may send an email to tech-support@the module manufacturer.com, and we will promptly evaluate and incorporate them into the revision plan.

# A CLEARER PROJECT BRIEF.

Start with the equipment and installation requirements.

| Tell WAYTON | Useful project inputs |
| --- | --- |
| Location and application | Project country, site type and intended operating use |
| Equipment configuration | Module model, rated capacity and inverter specification |
| Installation conditions | Roof or mounting type, drawings and known constraints |
| Supply scope | Quantity, destination, schedule and required documentation |

## tech@waytonenergy.com

www.waytonenergy.com/products/solar-panels/

WAYTON supports product matching, documentation and supply coordination. Installation and final engineering must follow the project requirements and the applicable equipment instructions.