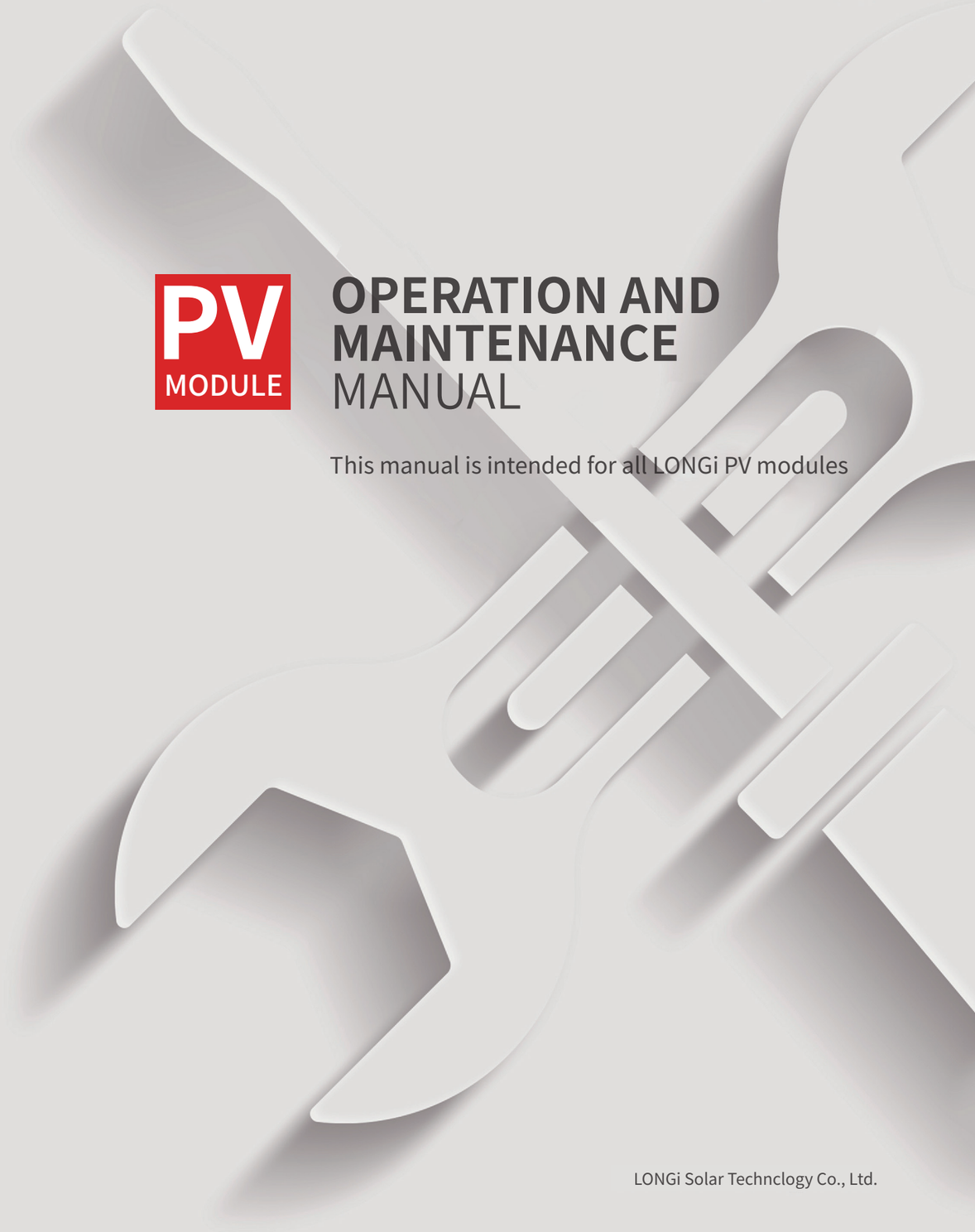
LONGi

PV MODULE

OPERATION AND MAINTENANCE MANUAL

This manual is intended for all LONGi PV modules



LONGi

LONGi Solar Technclogy Co., Ltd.

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Introduction

First, thank you very much for choosing LONGi PV modules.

This manual states a detailed description of the operation and maintenance (hereinafter referred to as O&M) of LONGi PV modules. This manual can be used by the owners and operation and maintenance people of PV systems. Please refer to the relevant information and requirements in this manual carefully when maintaining LONGi modules. The content of this manual includes the daily inspection of on-site modules during the operation of the PV power station, cleaning of modules, cleaning of obstructions, and handling of normal problems and other requirements and suggestions. The suggestions in this manual are to improve the safety of modules in the O&M process, and they have been tested and verified in practice.

All contents in this manual are intellectual properties of LONGi which originates from long term of technical exploration and experience accumulation of LONGi. The final interpretation right of this manual belongs to LONGi. LONGi reserves the rights for modifying product manual without noticing in advance. It is recommended to visit our website regularly at www.longi.com for the latest version of this installation manual.

Disclaimer

This manual does not perform as any warranty terms and conditions, neither explicit description nor implications. Compensation strategy is not provided for any losses, module damaging and any other expenses incurred which are directly caused by the module installation, operation, utilization and maintenance. LONGi Solar is neither responsible for any infringement of patent rights nor the third parties rights, which may caused by module operation and maintenance.

01

PV Module

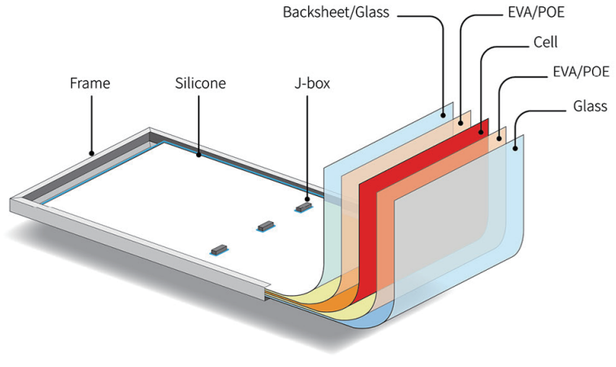
PV Module Basic Knowledge and O&M Safety Notes

1.1 Significance of O&M

In a PV power station, PV modules are the core power generation units, which is the device that directly converts solar energy into electrical energy. The operation of PV modules has a significant impact on the power generation and revenue of the entire power station. The proper operation and maintenance methodology of solar modules could diagnose potential failures and slowdown risk expansion promptly, thus to keep the steady power generation performance within full lifetime. In addition, after each O&M operation, it is recommended to keep O&M records to provide historical data support for the long-term operation of the power station.

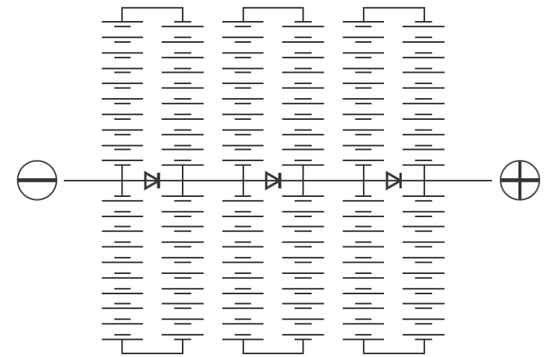
1.2 Basic Introduction to PV Modules

PV modules are mainly composed of eight materials: solar cells, packaging film, back sheet (mono-facial), glass, ribbon/bus bar, frame, junction box, and silicone.



Components of PV Module

The internal circuit of half-cut modules can be simplified as follows:

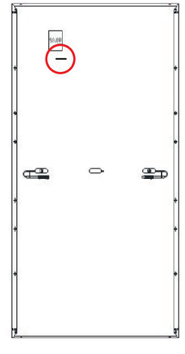


Module Electrical Connection Diagram

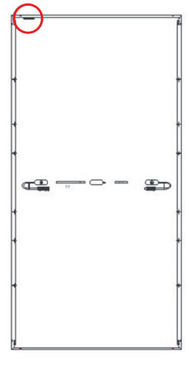
There are 3 types of labels affixed to each module, nameplate, current classification label and barcode, providing the following information:

(1) Nameplate: Generally affixed to the back of the module, the mono-facial module nameplate is rectangular, and the bifacial module nameplate is long; it displays module parameter, including product type, rated power, rated current, rated voltage, open circuit voltage, short circuit current under standard test conditions, certification mark, maximum system voltage and other information.

Example of Nameplate



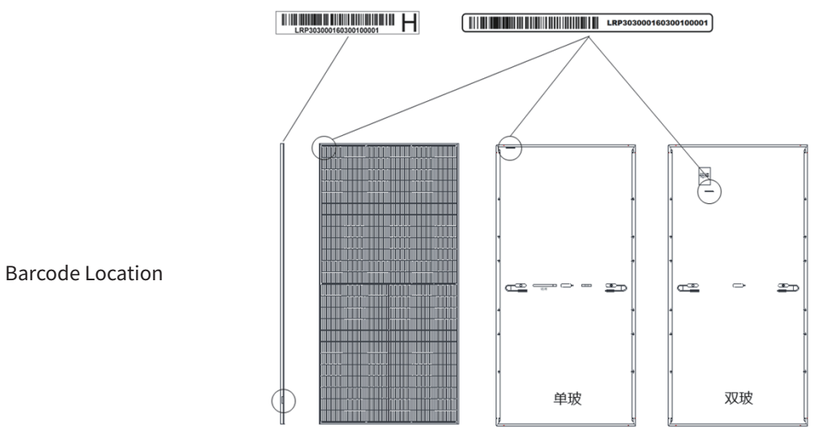
Mono facial Nameplate position



Bifacial Nameplate position

(**(2) Current classification label:** generally affixed to the side of the long frame of the module; the power of module take 5W as an interval. For each power interval module, the current is divided into 3 levels, H represents the high-range current, M represents the middle-range current, and L represents the low-range current. The best working state of modules is that modules of the same power and the same current level are connected in the same string.

(3) Barcode: Each module has a unique serial number. This serial number is printed on the barcode and placed in the module before lamination, and cannot be torn or smeared after lamination. In addition, the same serial number can be found on the side of the module nameplate or the rear of the module and the side of the long frame.



1.3 Q&M Safety Notes

The O&M of PV modules should be based on the installation manual, warranty, the datasheet of the module, PV module certification standards, etc. Please follow the national and local regulation, compliance and industry standards, including the safety production law, environmental protection law, national standards and electricity specifications. Please ensure the safety of labors and photovoltaic module systems.

1.3.1 Electrical Safety of PV Modules

(1) Photovoltaic modules are DC power devices, which will generate direct current under the condition of light, and the voltage of each module is usually greater than 36V. The max. voltage would reach hundreds till 1,500 volts after series and parallel connection, as well as accompanied by a large current. Even in the case of dim sunlight, the array still has a very high voltage, and any device which may be connected to the wire has a potential for electric leakage. Therefore, before module O&M, you should check whether there are abnormal records on the system side and analyze whether there is a potential electric leakage hazard. Before the O&M, a test pen is also needed to detect the module frame, bracket and the surface of the module to eliminate the potential electric leakage hazard. It is supposed to take appropriate protective measures (insulated gloves, insulated shoes, etc.) to avoid direct contact with 30V or higher DC voltage (30V or higher DC voltage may be fatal) to ensure personal safety.

(2) PV modules do not have a switch, and modules can only be stopped by avoiding sunlight or shielding them with cloth, cardboard or completely opaque materials.

(3) In order to avoid the danger of arcing and electric shock, please do not disconnect the electrical connection when there is a load. Incorrect connections can also cause arcing and electric shock. The connectors must be kept dry and clean to ensure that they are in good working conditions. Do not insert other conductive objects into the connector or make electrical connections in any other way.

(4) If the module glass or other packaging materials are damaged, please wear PPE(Personal Protective Equipment) to separate the module from the circuit. It is strictly forbidden to touch wet modules, unless you are wearing an electric shock-proof equipment that meets the requirements.

1.3.2 Operational Safety of PV Modules

(1) There are edges in the bracket or module' s frame. Therefore, O&M people should wear corresponding protective clothing and helmets to avoid injury. Avoid hooks, straps, thread ends and other parts that can easily cause entanglement on the clothing or tools you are wearing.

(2) Carrying modules with the junction box or wires are strictly forbidden.

(3) Do not stand or walk on modules.

(4) Do not try to dismantle the module or remove nameplate or parts of modules.

(5) Do not paint or apply any other adhesive on modules.

(6) Do not damage or scratch back sheet/rear glass of modules.

(7) Do not drill holes on the frame of module without permission. This will weaken corrosion protection and mechanical load resistance of the frame, which the limited warranty of LONGi Solar Module will be invalid.

(8) Do not repair problematic modules without being permitted.

(9) The modules need to be connected as soon as possible after the installation, or at least appropriate actions should be taken to protect from foreign object entities. Such as, moisture, dust, and organisms invasion of the connector, which may cause the connector to fail to work properly or be damaged.

02

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O&M Work Guidance for PV Modules

2.1 Inspection of PV Modules

The PV array should be inspected regularly to check whether PV modules are abnormal, and the abnormality should be dealt with in time. If the power station is equipped with an intelligent monitoring platform, it is recommended to conduct intelligent inspections from the system side every day to focus on analyzing the operating state of modules. If there is an abnormality in branch voltage, current, or output power (The deviation between the current or voltage of a branch and the average current or voltage of other branches in the same combining manifolds exceeds 5%; Under the same conditions, the output power/energy yield of a combining manifold is less than 15% of other combining manifolds in the same inverter), it must be inspected and dealt with in time.

It is recommended to complete a comprehensive inspection of modules in the first month of trial operation, and at least one comprehensive inspection every other 6 months afterwards. If abnormal conditions (such as abnormal weather or human activities, etc.) occur, modules need to be inspected in time. If the power station O&M party and the system integrator have relevant regulations on professional power station O&M management, it is recommended to strictly comply with them.

2.1.1 Regular Inspection of PV Modules

Before the inspection, safety protection devices such as insulating gloves and insulating boots should be worn. The recommended regular inspection items are listed as follows. If other related defects are found in the early inspection, they should also be included in the inspection scope.

(1) Regular inspection items are listed as follows.

a.The appearance inspection of PV modules: Through visual inspection, the recommended inspection cycle is 1 time/month (the inspection frequency can be increased according to the project situation).

Abnormal items	Prevention & Treatment Measure
Shadow on the surface of module	Regular inspection and cleaning. When the dirt on the surface of the module covers the primary color of cells, the module must be cleaned according to Section 2.2. If there are obstructions around the module, the obstruction must be cleaned according to Section 2.3.
Losing electric shock warning sign	Check regularly, and paste the sign again if it is lost.
Damage or soaking of cable	1. Regularly check and connect the cables according to the drawings, should fix the cables to the frame or bracket with cable ties, so as to prevent the cables from falling into the water accumulation area, and avoid animal bites, and cable squeezing and pulling. 2. In general, if the cable is damaged, there will be insulation or current and voltage faults. The monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection. 3. If the module cable is damaged, mark the abnormal module, and promptly consult LONGi customer service for assistance.
Heating, damage, pollution, soaking or corrosion of connectors	1. During O&M, if it is found that the connectors are loose, it may be that the modules were not connected at the site immediately after unpackaging, so that the connectors invaded impurities or sediment, water and other pollutants. 2. The cables should be fixed to the frame or bracket by cable ties to prevent the connectors from falling into the water accumulation areas. 3. Substances containing alkanes, such as gasoline, cleaning lubricants, electronic revitalizers, etc., are prohibited from contacting the connectors. 4. Regularly check the connectors. If they are loose, please restore them to a good connection; if the connectors are polluted, corroded, or damaged, they should be replaced in time. 5. In general, there will be insulation or current and voltage faults in connector failure, and the monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection.
Deformation, twist, crack or burn of Junction box	1. Regularly check junction boxes to eliminate direct exposure under sunlight and avoid soaking in waterlogged areas such as puddles, avoid squeezing and pulling junction boxes; check the lightning protection facilities and grounding connection to ensure that there is no abnormality. 2. Check the surface of modules to ensure that there is no dirt covering the primary color of the cells. Long-term shading will cause abnormality of the junction box. 3. Substances containing alkanes, such as gasoline, cleaning lubricants, electronic revitalizers, etc., are prohibited from contacting junction boxes. 4. In general, there will be insulation or current and voltage faults in junction box failure, and the monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection. 5. If the junction box is damaged, mark the abnormal components and promptly consult LONGi customer service for assistance.
Fasteners loosening	1. During the installation of modules, follow the relevant recommendations in the installation manual. 2. Regularly check whether the bolts and clamps are tightened. Before and after extreme weather, it is recommended to check loose bolts/clamps. 3. For high-frequency wind shock areas, anti-loosening bolts should be used to prevent loosening.
Deformation of frame	1. Adopt the appropriate installation method according to the actual load on the project site; strengthen the project site management to prevent the modules from bumping. 2. Slight deformation does not affect the installation and use of modules; mark them and continued to use; serious deformation may affects installation, safety and output, please mark abnormal modules, and promptly consult LONGi customer service for assistance.
Tearing of frame	1. Check the modules are installed according to the relevant recommendations in the installation manual. 2. Regularly check whether the bolts and clamps are tightened. Before and after abnormal weather, it is recommended to check whether there are any problems such as loosening of bolts/clamps, deformation of modules, and tearing of frames. 3. For projects with strong wind, the installation of modules can be further reinforced by using clamps and bolts at the same time. 4. If the frames are torn and the modules cannot be used, mark the abnormal modules and consult LONGi customer service for assistance.
Corrosion of frame	1. For projects prone to corrosion such as seaside and water surface, during the installation, use equipotential metals or rubber washers to avoid electrochemical corrosion between different metals. 2. If the frame is corroded, mark the abnormal modules and consult LONGi customer service for assistance.
Breakage of glass	1. Strengthen the project site management to prevent the modules from bumping. If the glass is broken, the modules must be replaced. 2. Special attention after installation: Avoid potential glass cracking risk which caused by rolling up sand and gravel during inspection, operation and maintenance vehicles; as well as to avoid splashing of hard objects such as sand and gravel when using a lawn mower for weeding. 3. If there are frequent bird activity areas around the project, it is necessary to prevent birds from throwing objects from high altitude and breaking the glass 4. If the glass is broken but no obvious impact indication, mark the abnormal modules and consult LONGi customer service for assistance.
Scratch of backsheet	Strengthen the project site management to prevent the modules from bumping. If the backsheet is scratched, the modules must be replaced or consult LONGi customer service for assistance.

b.Other inspection of PV modules: the inspection frequency can be increased according to the project situation.

Inspection Item	Inspection Method	Inspection Cycle	Abnormal Description	Prevention & Treatment Measure
Troubleshooting of modules	Warning of monitoring platform	Real-time viewing and timely processing	Under the same conditions, the deviation between the current or voltage of a branch and the average current or voltage of other branches in the same combining manifolds exceeds 5%; the output power/energy yield of a combining manifold is less than 15% of other combining manifolds in the same inverter.	1. In general, if the current or voltage are abnormal , the monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection. 2. If it is the problem in (a), handle it according to the description; if it is any other problem, mark the abnormal modules, and promptly consult LONGi customer service for assistance.

2.1.2 Regular Test of PV Modules

Conditional power stations can be equipped with professional test equipment such as PV module characteristic tester, DC clamp meter, multimeter, insulation resistance tester, infrared thermometer, infrared thermal imager, etc. Generally advise to schedule regular sampling test on the operating temperature and insulation tests of PV modules.

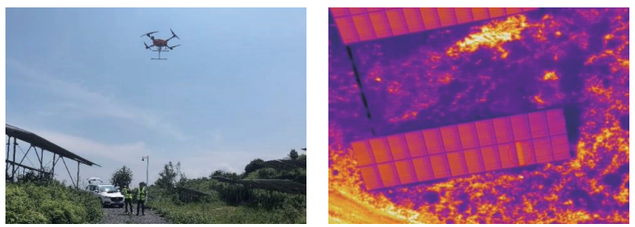
Inspection Item	Inspection Method	Inspection Cycle	Abnormal Description	Prevention & Treatment Measure
Working temperature	Infrared thermal imager	1 time half a year	The irradiation must be ⩾600W/m2, the wind speed ⩽2m/s. The difference between the high and low temperature of the cells in the same module is ⩾30°C	1. Check whether there is any shadow on the surface of the modules. When the dirt on the surface of the module covers the primary color of cells, the module must be cleaned according to Section 2.2. If there are obstructions around the module, the obstruction must be cleaned according to Section 2.3. 2. If there is still overheating after removing the shadow of the module, mark the abnormal module, and consult LONGi customer service for assistance.
Insulation test	Insulation resistance tester	1 time half a year	The test voltage is the system voltage. If the test object is a string, when the positive and negative electrodes are short-circuited, the insulation resistance to ground, positive to ground and negative to ground is less than 1MΩ; if the test object is a single module, for modules with an area of less than 0.1m2 , the insulation resistance is less than 400MΩ; for modules with an area of larger than 0.1m2 , the measured insulation resistance times the area of the module is less than 40MΩ.㎡	1. In general, if the current or voltage are abnormal, the monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection. 2. Confirm the measurement accuracy of the tester and whether it is calibrated; confirm the connection (the high-voltage terminal is connected to the internal circuit of the module, and the low-voltage terminal is connected to the frame). 3. If the module has insulation failure, mark the abnormal module and consult LONGi customer service for assistance. 4. Check whether it is caused by system failure such as whether there is direct contact between the broken cable and the bracket, whether the initial value of the insulation resistance of the inverter is too high, etc.

(1) Description of Working Temperature Test

The infrared thermal imaging test is usually used to troubleshoot whether modules have local hot spots and high temperature problems. If the power stations use handheld infrared thermal imager, according to the scale of the projects, it is recommended that the sampling ratio is: Household distributed systems can be fully inspected; 30MW and below can be sampled according to 1%; 30MW above to 100MW can be sampled according to 0.5%; 100MW and above can be sampled according to 0.2%; Expand the sampling ratio when a large number of defective modules are found in random inspection. For large-scale projects, professional UAV with infrared thermal imaging functions can also be purchased to speed up the inspection.

Handheld Infrared Thermal Imaging Test

UAV Infrared Thermal Imaging Test



The following requirements need to be complied during the test:

(a) Test conditions: The power station must be connected to the grid, and the irradiation must be ⩾600W/m2, the wind speed ⩽2m/s.

(b) Test method: the lens is aimed at the module under test; the dynamic high and low temperature capture points must all fall on the cell area of the same module.

(c) Judgment of results:

① For UAV infrared thermal imaging test, at this stage, only the determination of the abnormal high temperature of the module can be obtained, and the temperature difference cannot be further determined. It is necessary to further find the problem module, and use a handheld infrared thermal imager to further accurately test the temperature difference at a short distance.

② If the difference between the high and low temperature of the cells is ⩾30°C, it is deemed to have hot spots.

③ If there is abnormal heating in the junction box and connector, it is necessary to check whether the junction box and connector are bulged or poor connected.

④ If the whole series of modules generate heat, a multi-meter can be used to test the open voltage of modules to further confirm whether modules are abnormal.

(2) Description of Insulation test

Insulation resistance tester is usually used to troubleshoot whether modules have any insulation failure. In general, if the current or voltage are abnormal, the monitoring platform can be used to lock the position of the substring/area and conduct on-site inspection.

(a) Test method:

① Circuit connection: Terminate meter "E" to the frame or ground; terminate meter "L" to the circuit under test; terminate meter "G" to the guard ring which was used to eliminate the effects of leakage from the surface resistance of the loop under test.

②Select the measuring scale of tester: Switch the resistance range to the desired range, or step from the MΩ range to the GΩ range. If the meter continuously alarms, it means that the measured resistance is too low and should be measured in a lower range.

③Record the resistance value: Record the resistance value according to the display. After the high voltage output, reported the time at 15 seconds, 60 seconds and every 60 seconds, which is convenient for the operator to record.

(b) Judgment of results:

The test voltage is the system voltage. If the test object is a string, when the positive and negative electrodes are short-circuited, the insulation resistance to ground, positive to ground and negative to ground shall not be less than 1MΩ; if the test object is a single module, for modules with an area of less than 0.1m2 , the insulation resistance shall not be less than 400MΩ; for modules with an area of larger than 0.1m2 , the measured insulation resistance times the area of the module shall not be less than 40MΩ.㎡.

Insulation Resistance Tester

2.1.3 Key Inspection Items for Different Installation Environments

For different installation environments, it is necessary to focus on the following inspections. For the specific prevention & treatment measure of inspection items, please refer to the table above:

Type of Project	Characteristic of Project	Key Inspection Item	Inspection Method	Inspection Cycle
Roof distributed project	Due to the low height of the module from the roof, the space between modules and the roof is limited, and modules' ability to ventilate and dissipate heat is limited.	Shadow on the surface of module	visual inspection	1 time/month
		Abnormalities of cables, connectors and junction boxes	visual inspection	1 time/month
		Working temperature	Infrared thermal imager	1 time half a year
		Insulation test	Insulation resistance tester	1 time half a year
		Troubleshooting of modules	Warning of monitoring platform	Real-time viewing and timely processing
mountain, seaside	Modules are exposed to strong winds.	Shadow on the surface of module	visual inspection	1 time/month
		Fasteners loosening	visual inspection	1 time/month
		Deformation or tearing of frame	visual inspection	1 time/month
		whether the cable fixed securely	visual inspection	1 time/month
		breakage of glass, scratch of backsheet	visual inspection	1 time/month
		Working temperature	Infrared thermal imager	1 time half a year
		Troubleshooting of modules	Warning of monitoring platform	Real-time viewing and timely processing
Water surface, floating, seaside	The ambient humidity is high, and the metal parts are susceptible to corrosion.	Shadow on the surface of module	visual inspection	1 time/month
		Abnormalities of cables, connectors and junction boxes	visual inspection	1 time/month
		Corrosion of frame	visual inspection	1 time/month
		Insulation test	Insulation resistance tester	1 time half a year
		Troubleshooting of modules	Warning of monitoring platform	Real-time viewing and timely processing
Areas with frequent thunder and lightning activities	Thunder and lightning activities are frequent.	Abnormalities of junction boxes	visual inspection	1 time/month
		Insulation test	Insulation resistance tester	1 time half a year
		Troubleshooting of modules	Warning of monitoring platform	Real-time viewing and timely processing
Frequent sand and dust floating areas	Frequent sand and dust floating areas.	Fasteners loosening	visual inspection	1 time/month
		Deformation or tearing of frame	visual inspection	1 time/month
		Whether the cable fixed securely	visual inspection	1 time/month
		Breakage of glass, Scratching of Backsheet	visual inspection	1 time/month
		Insulation test	Insulation resistance tester	1 time half a year
		Troubleshooting of modules	visual inspection	Real-time viewing and timely processing

2.2 Cleaning of PV Modules

During the operation of the module, the obstruction of dust, bird droppings, ice and snow will reduce the output power, and partial obstruction may even cause hot spots. Therefore, modules need to be cleaned regularly.

2.2.1 Requirements of Cleaning Water and Detergent

(1) Municipal domestic water can be used for the cleaning of PV modules. If other water sources are used, the following requirements shall be met:

(a) PH：6 ~8

(b) Chloride or salinity: 0-1000 mg/L

(c) Turbidity: 0-30 NTU

(d) Specific conductance: ⩽3000 μs/cm

(e) Total dissolved solids: ⩽1000 mg/L

(f) Water Hardness: 0-450 mg/L

It is not recommended to use water with high mineral content, because the minerals in the water will deposit on the glass surface after long-term use, which will gradually accumulate and cause the change of the appearance of glasses and the decrease of glass transmittance which may further reduce the power generation of the module.

(2) The temperature difference between water and module cannot exceed 10°C. Do not clean the module when ambient temperature is lower than 5°C to avoid freezing and cracking of the glass.

(3) When using pressure water flow for cleaning, the water pressure on the surface of the module shall not exceed 0.7Mpa.

(4) Detergents, such as commercial glass cleaning agents, alcohol, and methanol, can only be used when the module cannot be cleaned with water. Do not use abrasive powder, abrasive cleaning agent, washing cleaning agent, polishing agent, sodium hydroxide, benzene, nitro thinner, acid or alkali and other chemical substances. The cleaning area needs to be rinsed by above required water when using a detergent agent.

(5) Do not use steam or corrosive chemical reagents to accelerate cleaning.

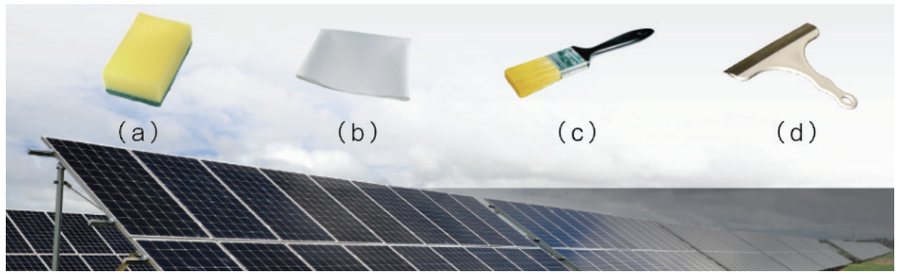
(6) Please contact Longi post-sales service team if required to use chemicals cleaning under extreme weather or/and complex environments.

2.2.2 Requirements of Cleaning Tools or Equipment

(1) During the cleaning process, it is recommended to wear cleaning gloves to avoid fingerprints or other dirt remaining on the glass. Do not touch the surface of the glass with bare hands without gloves.

(2) Do not use tools and materials that will scratch the surface of modules, such as blades, scouring wire and other metal tools or other abrasive materials.

(3) Various soft foam materials, non-woven fabrics, brooms, soft sponges, soft brushes and brushes whose diameter of nylon thread is 0.06-0.1mm can be used. If the sponge shown in the following figure (a) is used to clean modules, avoid using the hard surface of the sponge for cleaning.



(4) LONGi modules can be cleaned with automatic cleaning equipment. During the cleaning process, the requirements for the use of automatic cleaning equipment must be followed, and modules must be protected from damage. If you are not sure whether the automatic cleaning equipment will cause damage to modules, you can consult the customer service personnel of LONGi.

2.2.3 Notes for Cleaning Process

(1) The back of the bifacial module needs to be cleaned, and the back of the mono-facial module is not recommended to be cleaned.

(2) During the cleaning of PV modules, do not splash water on the cables. Ensure that the connectors are clean and dry to prevent electric shock and fire hazards.

(3) To prevent the risk of electric shock, do not clean PV modules with broken glass or exposed cables.

(4) Do not step on modules when cleaning.

(5) It is strictly forbidden to clean the obstruction under the extreme weather conditions of strong wind, heavy rain or heavy snow, and it is necessary to eliminate that modules may damaged by tools or improper operations.

(6) When removing the snow on the surface of the PV module, use a mop to gently remove all the snow. Avoid the phenomenon of "partly with snow and partly without snow" on PV modules. Do not forcibly clean up frost and snow to prevent damage to the surface glass of the module.

(7) After cleaning, the glass surface of the PV module shall be free of dust and dirt.

2.2.4 Recommended Cleaning Methods

(1) Cleaning Time

The cleaning of modules should be carried out in the early morning, dust, night or rainy day (recommended irradiation ≤200W/m2). The cleaning in the morning or dust should be carried out at a time when the sun is dim (it is recommended to clean modules when the inverter is not started). Prevent man-made shadows from causing hot spots on the PV array.

On cloudy or rainy days, sunlight will penetrate the thin cloud layer, and modules will generate voltage. It is necessary to pay attention to the safety of personnel to prevent danger.

(2) Cleaning Cycle and Area

As large-scale PV power stations occupies a large area, the number of modules is huge, and every day the suitable time for cleaning operations is short, the cleaning work of PV power stations should be planned and carried out according to the specific area, so as to use the least manpower to complete cleaning work of PV power station. The area division of the cleaning work should be carried out in accordance with the electrical structure of the PV power station, and at the same time, it should be ensured that each cleaning work can cover all modules connected to several combiner boxes and inverters.

For the cleaning cycle, the customer should evaluate the module cleaning frequency according to the actual situation of the project:

a) In rainy areas, it is recommended to clean at least once in 40-50 days; in dry areas with little rain, it is recommended to clean at least once in 20-30 days.

b) It is recommended to clean the back of the bifacial module at least once per half a year.

c) When the module/cell is partially obscured by dirt, the module must be cleaned.

(3) Cleaning Process

Routine cleaning work is recommended to be completed through three processes: first sweep, second scraping, and third washing.

Step 1: Sweep

A dry duster (without hard objects) or a soft and clean cloth should be used to remove the deposited dust and fallen leaves on the surface of the module. If there are no other deposits on the surface of the module and the module has been cleaned up according to this step, the following steps are not necessary.

Step 2: Scrape

If modules are closely attached hard foreign objects such as soil, bird droppings, plant branches and leaves, etc., they need to be cleaned with non-woven cloth or brush and do not use hard objects to scrape this area. Do not easily scrape the area without attaching hard foreign objects, just removed foreign objects.

Step 3: Cleaning

If there are stains on the surface of modules, such as bird droppings, plant juices, etc., or the air humidity is too high so that the dust is difficult to remove, modules need cleaning. After spraying the cleaning water to the contaminated area, use a brush to clean at the same time. If there are oily substances, alcohol can be applied to the contaminated area, and a brush is needed after the solution penetrates the contaminants. If there is still dirt that cannot be removed, you can use a commercial glass detergent and use a non-woven cloth to clean it.

Frameless bifacial modules generally use the same cleaning methods as common modules. However, because there is no frame around them, it is necessary to fully consider the deformation caused by external stress during the cleaning process, and try to avoid large-scale actions to prevent module damage or occurrence of security incident.

Because the back of the bifacial PV module can also generate power, the back of the module also is also suggested to be cleaned, and the cleaning method is the same as that of the front. From the perspective of safety, it is recommended to complete the power-off operation before cleaning the back of the bifacial module; when cleaning the back of the bifacial module, do not directly wash the junction box with water, and ensure that the connector is clean and dry.

2.2.5 Special Environmental Cleaning Requirements

(1) Accumulated Snow

LONGi Modules can withstand high snow loads (refer to the installation manual). If you need to remove snow to increase output power, please use tools that will not damage the surface of the module, such as a brush, mop, or blower, and gently remove all snow to avoid the appearance of "partly snow and part no snow" on the PV module. "The patchy phenomenon." Do not use hot water to pour PV modules, as uneven heat and cold will seriously damage PV modules. Please do not try to remove the frozen snow or ice on the module to prevent damage to the surface glass of the module.

(2) Arid and Rainless Areas

In arid and rainless areas, sand and dust are likely to accumulate on the entire surface of the module, as shown in the figure below. The frequency of cleaning needs to be judged according to the dust accumulation. If the module/cell is partially obscured by dirt, the module must be cleaned. For small power stations, manual cleaning can be used to clean according to the above cleaning steps. For large-scale power stations, high-pressure cleaning vehicles can be used to tangentially or positively impact PV modules to achieve the effect of dust removal, or automatic cleaning equipment approved by LONGi can be used for cleaning.

(3) Humid and Rainy Areas

In humid and rainy areas, the upper surface of the module can be kept clean to a certain extent by washing with rainwater, but a small amount of water and dirt are likely to remain on the lower edge of the module. This phenomenon is particularly obvious in the installation of the roof/factory distributed scene with a small inclination angle, as shown in the figure below. In this case, long-term accumulation of water on the bottom edge of the module will corrode the glass surface, and the uneven shielding of the bottom edge of the module will cause abnormal heating in the area. Please increase the cleaning frequency appropriately according to the actual situation. If the module/cell is partially obscured by dirt, the module must be cleaned.

2.2.6 Inspection after Cleaning

(1) Visually, the overall appearance of modules is clean, bright, and free of stains.

(2) There is no obvious scratch on the surface of the module.

(3) There is no manned cracking on the surface of the module.

(4) There is no tilt or bending of the module bracket after cleaning.

(5) There is no damage to modules, such as broken glass, broken back sheet, twisted or deformed frame, damaged cables, disconnected or broken connectors, and damaged junction boxes.

(6) Check the cleaning quality by power generation monitor.

2.3 Cleaning of Obstruction of PV Modules

2.3.1 Requirements of Obstruction Cleaning

(1) During the operation of modules, there should be no environmental factors that cast shadows on the module and block modules, otherwise it will cause hot spots on the module, which will cause the output power to be significantly reduced. Long-term shielding will causing safety hazards and damage the module and cells by permanent hot spots. Generally, there are many vegetation in the mountain power stations, and vegetation blocking modules are prone to appear. If such situation is found during the O&M process, please clean it up in time.

Shade of Vegetation

Drying of Crops

(2) In the process of cleaning the obstruction, it is necessary to comply with national laws, local regulations and industry standards, including the safety production law, environmental protection law, national standards and power codes, etc., to ensure the safety of people and photovoltaic module systems, and protect the environment.

(3) If vegetation inhibitors are used for spraying, the drugs should not contain corrosive or oxidizing components to modules and the system, and the drugs should avoid contact with the module.

(4) It is strictly forbidden to clean the obstruction under the extreme weather conditions of strong wind, heavy rain or heavy snow, and it is necessary to eliminate that modules may damaged by tools or improper operations.

(5) The cleared obstructions should be taken away from the PV array area for disposal.

(6) In the process of cleaning up the shelter or vegetation, it is necessary to avoid module smashing which may affected by the stability of the pile foundation and column.

2.3.2 Inspection after Obstructions Cleaning

(1) Visually, the light-receiving surface of the module is not blocked, and the bifacial module should be paid attention to ensuring that the back is not blocked.

(2) The vegetation needs to be 5cm below the lowest edge of the module.

(3) The obstructions on site are cleaned up, and PV modules are not damaged.

03 Handling of Module Problems

During the operation of the PV module, if the module fails, it is classified according to the fault responsibility, and the following two methods can be referred to:

3.1 Module Defect Failure

During the warranty period of modules, for problems caused by the defects of modules, before disassembling and handing, you need to take pictures of the problems, module barcodes and nameplates, and then immediately contact LONGi or the distributor who purchased modules to provide the following information to obtain after-sales service:

(a) Customer name

(b) Detailed description

(c) Proof materials, including photos or data

(d) The serial number of the relevant module

(e) Proof of purchase

(f) Module type

(g) The location of the module

LONGi will provide suggestions and solutions in accordance with the corresponding limited warranty.

3.2 Non-module Defect Failure

When modules cannot be used normally due to external force or external electric shock, you should stop using these modules immediately, and then consult your system installation engineer to replace them with similar performance modules. You can dispose of these modules yourself in these ways:

(a) Follow the requirements of local laws and regulations, and contact an organization that has the qualifications for harmless treatment to recycle and handle these modules.

(b) If your area has been covered by PV Cycle's business scope, you can contact them for handling.

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