



OPERATION AND MAINTENANCE MANUAL

This manual is intended for all LONGi PV modules

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Introduction

Thank you for choosing LONGi PV module.

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

This manual does not perform any warranty, whether express or implied. There is no provision on the compensation plan for the loss, module damage or other expenses directly caused or related to the installation, operation, or maintenance of modules. LONGi will not take any responsibility if the patent rights or the third party rights are infringed by the O&M of modules. All contents in this manual are intellectual properties of LONGi which originates from the long term technical exploration and experience accumulation. The final interpretation right of this manual belongs to LONGi. LONGi reserves the right for modifying the manual without noticing in advance. It is recommended to visit our website at www.longi.com for the latest version of this manual.

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PV Module

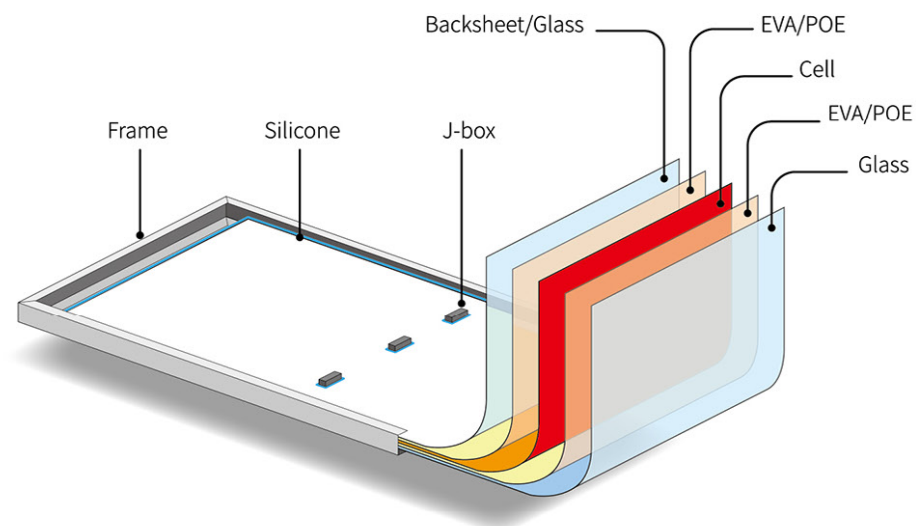
Basic Knowledge and O&M Safety Notes

1.1 Importance of O&M

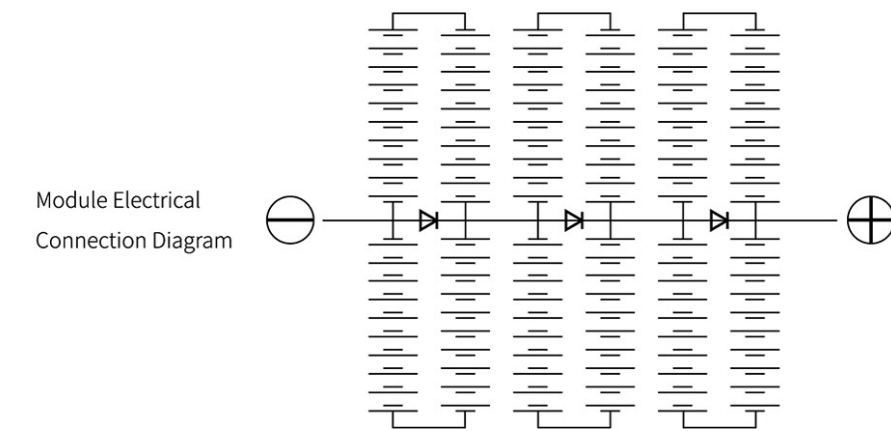
In PV power stations, PV modules are the core power generation units, which directly convert solar energy into electrical energy. The operation of PV modules impacts a lot on the power generation and revenue of the entire power station. Regular maintenance of PV modules will reduce dirt deposition on the module, avoid the hot spot problem, expose problems in time, avoid accidents and expansion to a certain extent, thereby improving the power generation and extending the lifecycle of PV modules. In addition, after daily O&M operation, it is recommended to keep the O&M records to provide historical data support for the long-term operation of the power station.

1.2 Introduction of PV Module

PV module is mainly composed of eight materials: solar cells, encapsulation film, backsheet (for mono-facial), glass, ribbon/bus bar, frame, junction box, and silicone.

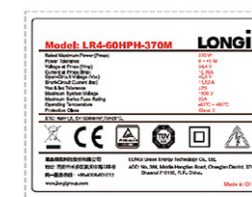


The internal circuit of half-cut modules could be simplified as follows:

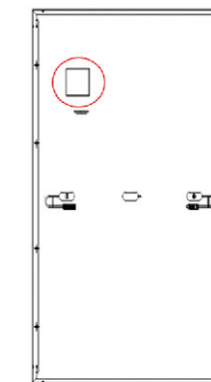


There are 3 types of labels affixed to each module: nameplate, current grading label and barcode, providing the following information:

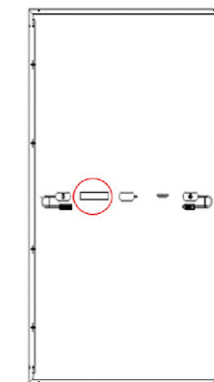
- 1. Nameplate:** Affixed to the back of the module, the mono-facial module nameplate is rectangular, while the bifacial module nameplate is long; The nameplate displays module parameters, including product type, rated power, rated current, rated voltage, open-circuit voltage, short circuit current under Standard Test Conditions (STC), certification mark, maximum system voltage and other information.



Example of Nameplate

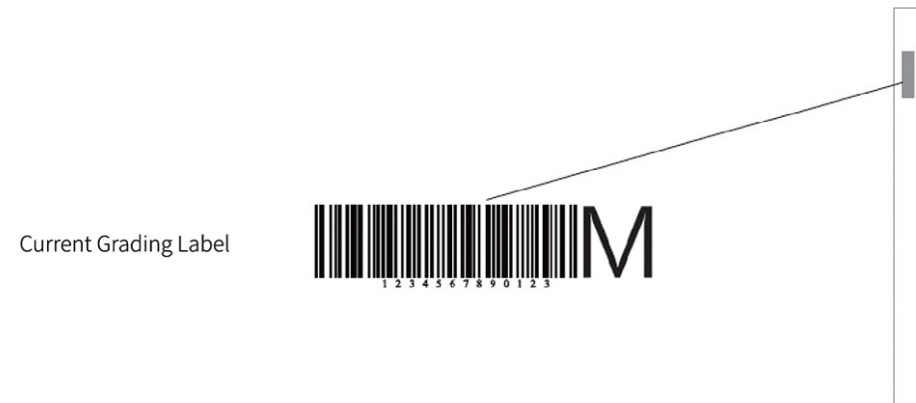


Mono-facial Module

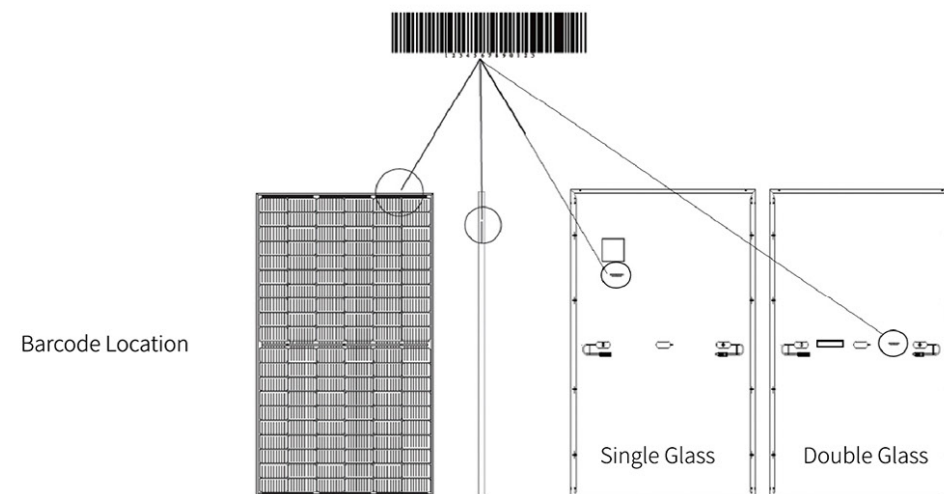


Bifacial Module

2. Current grading label: Affixed to the side of the long frame of the module; LONGi takes every 5W as one power grade. For modules in each power grade, 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 grade and the same current level are connected in the same string.



3. Barcode: Each module has a unique serial number. The serial number is printed on the barcode and placed in the module before lamination, so that the barcode could avoid being torn or smeared. In addition, the same serial number can be found both on the rear side of the module and the side of the long frame.



1.3 O&M Safety

The O&M is based on the installation manual, warranty, datasheet, and certification standards of the module, beside the O&M should also follow the corresponding regulations, including electrical code, construction code, and electrical connection requirements. These regulations vary with the installation site, the installation system voltage and current properties (DC or AC). For specific terms, please contact the local authority.

1.3.1 Electrical Safety of PV Modules

1. In PV power stations, PV modules will generate direct current under sunlight. After electrical connecting, there will be hundreds of volts of high voltage. Even in the case of dim sunlight, the module strings still have a high voltage, and any device that may be connected to the wire has the hidden danger of electric leakage. Therefore, you should first check whether there are abnormal records on the system side and make sure there is no danger of electric leakage before the O&M. A test pencil is needed to confirm whether the frame, the holder and the surface of the module have electric leakage. It is suggested to take appropriate protective measures (insulated gloves, insulated shoes, etc.) to avoid direct contact with 30V or higher voltage (30V or higher DC voltage may be fatal) to ensure personal safety.
2. PV modules do not have a switch, which means the module can only be stopped by avoiding sunlight or being shielded with cloth, cardboard or other completely opaque materials.
3. To avoid the risk of arcing and electric shock, please do not disconnect the electrical connection electrical 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 glass or other encapsulating material of the PV module is damaged, please wear PPE(Personal Protective Equipment) and separate the module from the circuit. Do not touch the wet module unless you are wearing appropriate anti-shock equipment.

1.3.2 Operational Safety of PV Modules

1. There are edges in the bracket or module's frame. Therefore, O&M personnel should wear corresponding protective clothing and helmets to avoid bumps or cuts. Avoid items such as hooks, straps, threads, etc. that can easily cause entanglement on clothing or tools.
2. Do not carry the module by grasping the junction box or the cable.
3. Do not stand or walk on the module.
4. Do not try to disassemble the module, do not remove the nameplate or any other part of the module.
5. Do not paint or apply any other adhesive on the module.
6. Avoid damaging or scratching the backsheet of the module.
7. Do not drill holes on the frame of the module without permission from LONGi.
8. Do not repair the module without permission from LONGi.

2

O&M Guidance of PV Modules

2.1 Inspection of PV Modules

In the PV power station, O&M personnel should inspect the PV modules regularly to check whether PV modules are in good condition, and the abnormality should be handled in time. If the power station is equipped with an intelligent monitoring platform, it is recommended to conduct a daily intelligent inspection with the system to confirm the operating state of modules. If there is any abnormality in voltage, current, or the output (The deviation between the current or voltage of a string and the average current or voltage of other strings in the same combiner box exceeds 5%; Under the same conditions, the output power/energy yield of a combiner box is 15% less than another combiner box in the same inverter), it should be inspected and handled in time.

Generally, it is recommended to conduct a comprehensive inspection of modules in the first month of trial operation, and at least once every other 6 months thereafter. If abnormal condition (such as abnormal weather, human factors, etc.) occurs, modules need to be inspected in time. If the power station or the system integrator has relevant regulations on PV power station O&M management, it is recommended to strictly follow them.

2.1.1 Regular Inspection of PV Modules

Before the inspection, the O&M personnel should wear PPE(Personal Protective Equipment), such as insulating gloves, and insulating boots. The recommended 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 is Once a month (the inspection frequency could be increased according to the project situation).

Abnormalities	Control Measures
Shelter on the module	Regular inspection and cleaning are needed. When the dirt on the surface of the module could cover the original color of cells, the module needs to be cleaned according to Section 2.2. If there are shelters around the module, the shelters must be cleaned according to Section 2.3.
Losing warning sign	Check regularly, and paste a new one in case it is lost.
Damage or soaking of cable	<ol style="list-style-type: none"> 1. Regularly check the circuit according to the drawings, and fix the cables to the frame or holder with cable ties. Avoid the cables from falling into the water, being damaged by an animal, squeezing and pulling. 2. If the cable is damaged, usually there will be insulation or current and voltage errors. The monitoring platform can locate the position of the string/area and then conduct an on-site inspection according to the location. 3. If the cable is damaged, mark the damaged module and consult LONGi customer service for assistance.

Hot, damaged, polluted, soaking or corrosion of connectors	<ol style="list-style-type: none"> 1. During the O&M, if the connector is loose, the module may not be well connected at the installation, therefore the connector may be invaded by impurities, sediment, water or other pollutants. 2. For the water area, the cables should be fixed to the frame or holder by cable ties to prevent the connectors from falling. 3. Keep the connectors away from substances containing alkanes, such as gasoline, lubricants, surfactant, etc. 4. Inspect connectors regularly. Reconnect the connector in case of loosening; If the connector has been polluted, corroded, or damaged, replacement should be taken in time. 5. If the connector is in failure, usually there will be insulation or current and voltage errors. The monitoring platform can locate the position of the string/area and then conduct an on-site inspection according to the location.
Deformation, twist, crack or burnt of the junction box	<ol style="list-style-type: none"> 1. Inspect junction boxes regularly and do not squeeze and pull junction boxes, keep the lightning protection facilities and grounding connection function well. 2. Check the surface of modules to ensure that there is no dirt covering the original color of the cells. A long time being sheltered will cause abnormality of the junction box. 3. Keep the junction box away from substances containing alkanes, such as gasoline, lubricants, surfactant, etc. 4. If the junction box is in failure, usually there will be insulation or current and voltage errors. The monitoring platform can locate the position of the string/area and then conduct an on-site inspection according to the location. 5. If the junction box is damaged, please mark the damaged module and consult LONGi customer service for assistance.
Fasteners loosening	<ol style="list-style-type: none"> 1. The module should be installed according to the relevant recommendations in the installation manual. 2. Inspect the bolts and clamps regularly to ensure they are tightened, especially for the case that before and after extreme weather, it is recommended to conduct the inspection. 3. For high-frequency wind areas, anti-loosening bolts should be used to prevent loosening.
Deformation of frame	<ol style="list-style-type: none"> 1. It is suggested to adopt the appropriate installation method of a module according to the actual load requirement on the site; Keep the modules from bumping by strengthening the site management. 2. Slight deformation does not affect installation and normal use of modules while serious deformation may affect installation, safety and power output, please mark the abnormal modules, and consult LONGi customer service for assistance.
Tear of frame	<ol style="list-style-type: none"> 1. Modules should be installed under the installation manual. 2. Inspect the bolts and clamps regularly to ensure they are tightened, especially for the case that before and after extreme weather, it is recommended to conduct the inspection. 3. For projects with high wind load requirements, the installation of modules could be further reinforced by using both clamps and bolts at the same time. 4. If the frame has been torn and the modules cannot be used, please mark the abnormal modules and consult LONGi customer service for assistance.
Corrosion of frame	<ol style="list-style-type: none"> 1. For projects prone to corrosion such as seaside and water, it is recommended to use equipotential metals or rubber gaskets for connection to avoid electrochemical corrosion between different metals. 2. If the frame has been corroded, please mark the abnormal modules and consult LONGi customer service for assistance.
Breakage of glass	<ol style="list-style-type: none"> 1. Strengthen the site management to prevent the modules from bumping. The modules must be replaced in case the glass is broken. 2. After the installation, the O&M should avoid rolling up sand or stones to break the glass of the module during the daily inspection. 3. If there is a frequent bird activity area around the station, it is necessary to take bird prevention measures to prevent birds from damaging the glass of the module. 4. If the glass is broken with no obvious impact, please mark the abnormal module and consult LONGi customer service for assistance.
Scratch of backsheets	Strengthen the 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: The frequency could be increased according to the project.

Inspection Item	Inspection Method	Inspection Frequency	Abnormalities	Control Measures
Troubleshooting of modules	Monitoring platform	Real-time monitoring and timely handling	The deviation between the current or voltage of a string and the average current or voltage of other strings in the same combiner box exceeds 5%; Under the same conditions, the output power/energy yield of a combiner box is 15% less than another combiner box in the same inverter.	<ol style="list-style-type: none"> The monitoring platform could locate the position of the string/area where the abnormal current or voltage occurs, and O&M personnel could conduct an on-site inspection according to the location. If the problem is in blank a, please handle it according to the measures; For any other problem, please mark the abnormal module, and consult LONGi customer service for assistance.

2.1.2 Regular Test of PV Modules

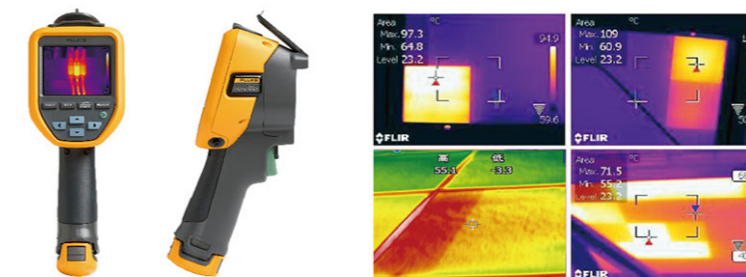
It is suggested that the power stations should be equipped with professional test equipment such as PV electrical tester, clamp meter, multimeter, insulation resistance tester, infrared thermometer, infrared thermal imager, etc., and the working temperature and insulation test of PV modules should be conducted regularly.

Inspection Item	Inspection Method	Inspection Frequency	Abnormalities	Control Measures
Working temperature	Infrared thermal imager	1 time half a year	Under the conditions that the irradiation is $\geq 600\text{W}/\text{m}^2$, and the wind speed is $\leq 2\text{m}/\text{s}$, the difference between the highest and lowest temperatures of the cells in the same module is $\geq 30^\circ\text{C}$	<ol style="list-style-type: none"> Check whether there is any shelter on the surface of the modules. When the dirt on the surface of the module could cover the original color of cells, the module needs to be cleaned according to Section 2.2. If there are shelters around the module, the shelters must be cleaned according to Section 2.3. If it is still hot 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 follows the system voltage. For testing a string, when the positive and negative electrodes are short-circuited, the measured insulation resistance to ground, positive to the ground or negative to the ground is less than $1\text{M}\Omega$; For testing a single module, the measured insulation resistance of the module with the area less than 0.1m^2 is less than $400\text{M}\Omega$, or the measured insulation resistance of module with the area more than 0.1m^2 is less than $40\text{M}\Omega$.	<ol style="list-style-type: none"> The monitoring platform could locate the position of the string/area where the abnormal current or voltage occurs, and O&M personnel should conduct an on-site inspection according to the location. Check the measurement accuracy of the tester and whether it has been calibrated; Check the connection (the high-voltage terminal is connected to the internal circuit of the module, while the low-voltage terminal is connected to the frame). If the module is in insulation failure, mark the abnormal module and consult LONGi customer service for assistance. Check whether the insulation failure is caused by an electrical system, such as direct contact between the damaged cable and the bracket, the high initial value of the insulation resistance of the inverter, etc.

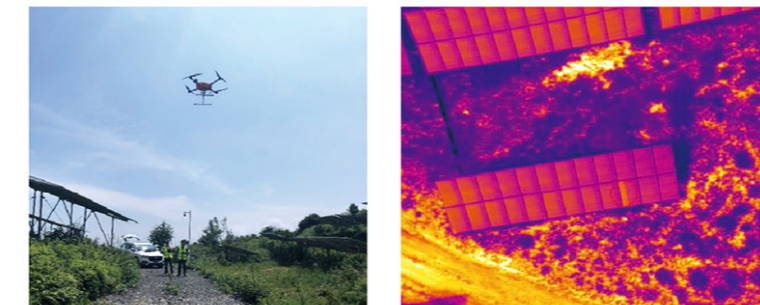
1. Working Temperature Test

The infrared imager is usually used to troubleshoot whether the module has a hot spot or abnormal heating problems. If the power stations use handheld infrared thermal imager, according to the scale of the PV power station, The recommended sampling ratio is: Household distributed station can be fully inspected; Capacity of 30MW or less can be sampled at 1%; Capacity of 30MW or up to 100MW can be sampled at 0.5%; Capacity of 100MW and above can be sampled at 0.2%; Improve the sampling ratio too many defective modules are found in the random inspection. For a large-scale PV power station, a professional UAV(Unmanned Aerial Vehicle) with an infrared thermal imager is a better choice which can speed up the inspection.

Handheld Infrared Thermal Imaging Test



UAV Infrared Thermal Imaging Test



The test should be complied following the requirements below:

- Test conditions: The power station is in operation, with the irradiation $\geq 600\text{W}/\text{m}^2$ and the wind speed $\leq 2\text{m}/\text{s}$.
- Test method: Aim at the module under test; The high and low-temperature capture points must fall on the cell area in the same module.
- Judgment:
 - For UAV infrared thermal imaging test now, only the abnormal high temperature of the module could be obtained with no data of the temperature difference. And using a handheld infrared thermal imager closely could get the data of temperature difference accurately.
 - If the difference between the highest and lowest temperature of the cells in the same module is $\geq 30^\circ\text{C}$, the module is deemed to have a hot spot.
 - If there is abnormal heating in the junction box or connector, it is necessary to check whether the junction box and connector are bulged or under poor connection.
 - If the modules of the whole string go hot abnormally, a multi-meter is needed to test the open voltage of modules to have a further confirm whether modules are abnormal.

2. Insulation test

An insulation resistance tester is usually used to troubleshoot whether the module is in insulation failure. The monitoring platform could locate the position of the string/area where the abnormal current or voltage occurs, and O&M personnel should conduct an on-site inspection according to the location.

The test should be complied following the requirements below:

a. Test method:

- ① Circuit connection: Connect pole "E" to the frame or ground; "L" to the circuit under test; "G" to the guard ring which was used to eliminate the effects of leakage current from the surface.
- ② Select the measuring range: Switch the resistance range to the required 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.
- ③ Record the resistance value: Record the 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:

The test voltage follows the system voltage. For testing a string, when the positive and negative electrodes are short-circuited, the measured insulation resistance to ground, positive to the ground or negative to ground is less than 1MΩ; For testing a single module, the measured insulation resistance of the module with the area less than 0.1m² is less than 400MΩ, or the measured insulation resistance of module with the area more than 0.1m² is less than 40MΩ.



Insulation Resistance Tester

2.1.3 Key Inspection Items for Different Stations

For different kinds of stations, it is necessary to conduct the following inspections, and refer to the table above for control measures:

Type of Project	Characteristics of Project	Key Inspection Item	Inspection Method	Inspection Frequency
Roof distributed project	Due to the low height of the module from the roof, the space between modules and the roof is limited, and the modules' ability to ventilate and dissipate heat is limited.	Shadow on the surface of the 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 the 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 is fixed securely	Visual inspection	1 time/month
		Breakage of glass, the 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 the 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

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 for 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: $\leq 3000 \mu\text{s}/\text{cm}$
 - e. Total dissolved solids: $\leq 1000 \text{ mg}/\text{L}$
 - 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 a change of the appearance of glasses and a decrease of glass transmittance which may further reduce the power generation of the module.

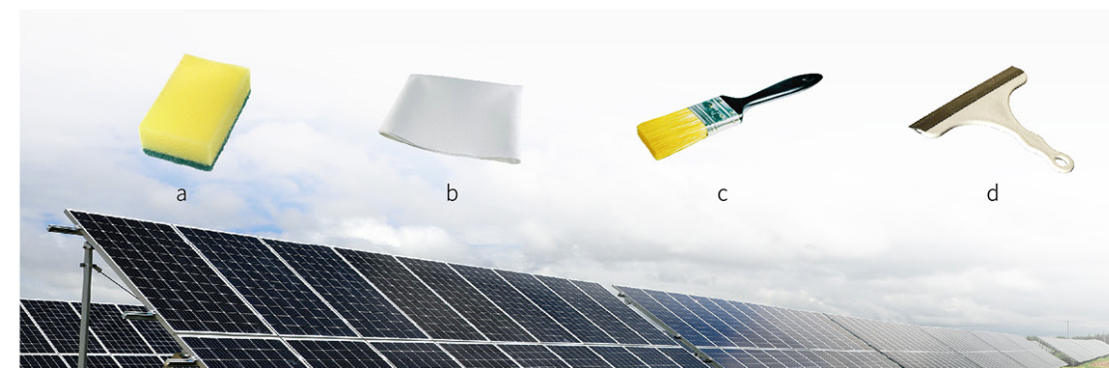
2. The temperature difference between water and module cannot exceed 10°C. Do not clean the module when the ambient temperature is lower than 5°C to avoid freezing and cracking of the glass.
3. When using pressure water flow for cleaning, the water pressure on the surface of the module shall not exceed 0.69Mpa.
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 machine, sodium hydroxide, benzene, nitro thinner, acid or alkali and other chemical substances.
5. Do not use steam or corrosive chemical reagents to accelerate cleaning.

2.2.2 Requirements for 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. If the PV module is cleaned under strong wind, heavy rain or heavy snow weather conditions, avoid cleaning tools or operation damage to the module.
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, dusk, night or on rainy day (recommended irradiation $\leq 200\text{W}/\text{m}^2$). The cleaning in the morning or dusk 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 occupy 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, 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 to hard foreign objects such as soil, bird droppings, plant branches and leaves, etc., they need to be cleaned with a 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 on 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 the occurrence of a security incident.

Because the back of the bifacial PV module can also generate power, the back of the module also needs 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.



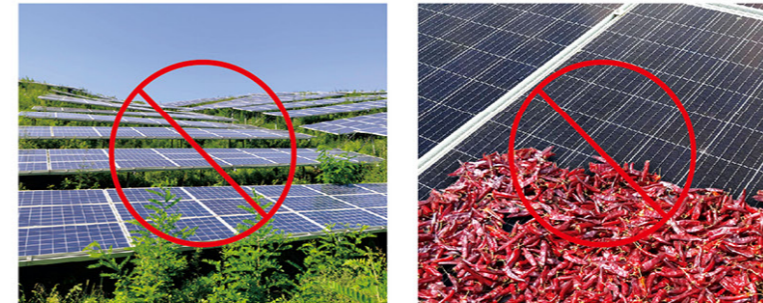
2.2.6 Inspection after Cleaning

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 matted 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.

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. Generally, there is much vegetation in the mountain power stations, and vegetation blocking modules are prone to appear. If such a 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 the corresponding local regulations, including the electrical law, construction law and electrical connection requirements, to ensure the safety of the person and the PV module system, and to 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. If the cleaning is carried out under strong wind, heavy rain, or heavy snow, it is necessary to avoid cleaning tools or operating damaged modules.
5. The cleared obstructions should be taken away from the PV array area for disposal.
6. In the process of clearing obstructions or vegetation, avoid affecting the stability of pile foundations and columns.

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.

3

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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