



PV MODULE

OPERATION & MAINTENANCE MANUAL



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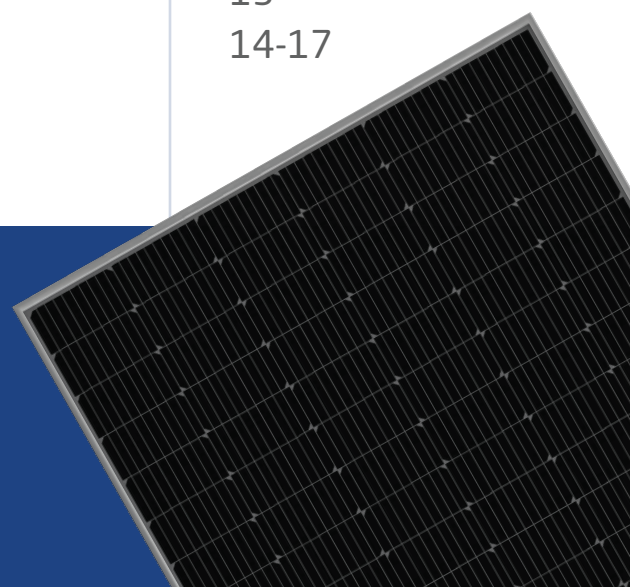
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**SMART MAINTENANCE.
MAXIMUM OUTPUT.**



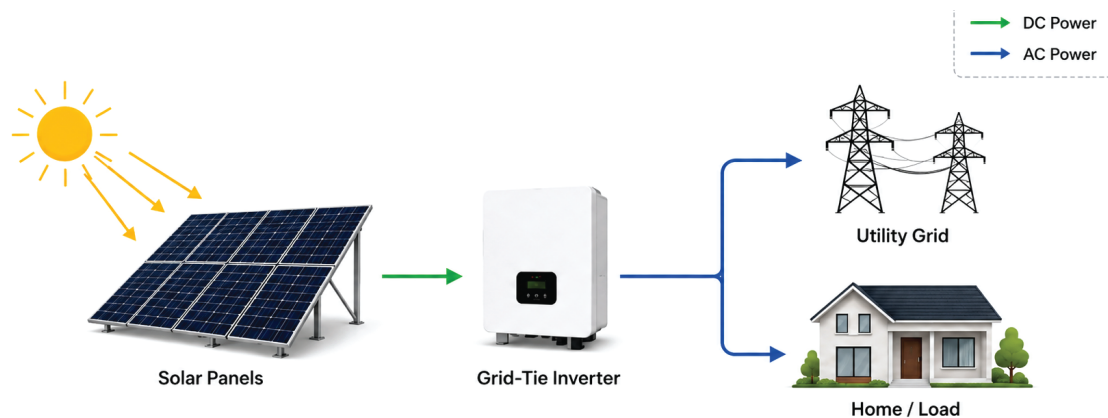
ABOUT SOLAR POWER SYSTEM

A. OVERVIEW OF SOLAR POWER SYSTEMS

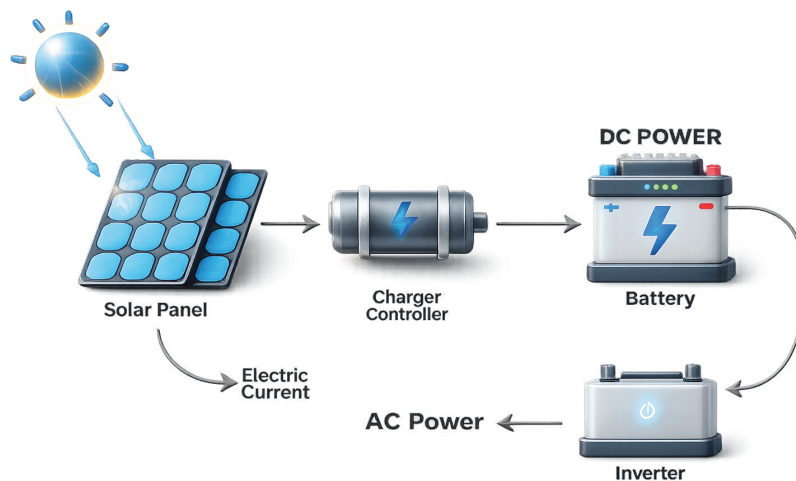
- A solar power system harnesses sunlight to generate electricity, offering a clean, renewable, and sustainable energy solution. At its core, the system relies on photovoltaic (PV) modules that convert sunlight into direct current (DC) electricity. This energy is then processed through inverters, which transform it into alternating current (AC) compatible with utility grids and household appliances.

Solar power systems are versatile and can be deployed in various configurations:

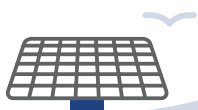
- **Grid-Tied Systems:** Connected to the utility grid, these systems allow users to consume solar energy and export excess power to the grid, often reducing electricity bills.



- **Off-Grid Systems:** Equipped with battery storage, these systems operate independently off the grid, providing reliable power in remote locations.



- **Hybrid Systems:** Combining features of both grid-tied and off-grid setups, these systems include battery storage for enhanced energy independence and backup power during outages. Solar power systems are not only environmentally friendly but also cost-effective in the long run, making them an ideal solution for residential, commercial, and industrial energy needs. With technological advancements, these systems continue to offer improved efficiency, durability, and affordability.



B. SYSTEM WORKING PRINCIPLE

- Solar Photovoltaic (PV) systems operate similarly to other electrical power-generating systems with the primary difference being the type of equipment used. In a Solar PV system, the unique components replace those found in traditional electromechanical Power generation. Despite this, the fundamental principles of operation and integration with other electrical systems remain consistent.
- While a Solar PV array generates Power when exposed to sunlight, and additional components are essential for conducting, controlling, converting and distributing the energy produced by the Solar panels effectively.

HEALTH, SAFETY & ENVIRONMENT

A. INTRODUCTION

Important Information

This product/system meets the specifications outlined by ISH Solar when used under normal conditions and in accordance with this instruction manual

- Disclaimer: ISH Solar is not liable for any damage resulting from improper use or use contrary to the instructions provided.
- Risk Awareness: Solar Electric/Photovoltaic (PV) Power Systems may be unfamiliar to many users, maintenance personnel, come with a unique set of residual risks and associated hazards.
- Safety Precaution: Do not attempt to install, operate, switch, control or maintain the system without thoroughly reading this section.

Important Pre-Installation Instructions

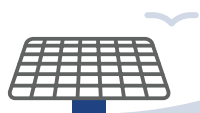
Before beginning the installation or working with Solar PV system components, ensure the following:

All personnel involved in the installation, commissioning and usage of the system/product have thoroughly read this document and are familiar with the health and safety aspects of Solar PV systems/products. Please keep this manual in an easily accessible place.

All products conform to the specifications stated by ISH Solar.

ISH Solar disclaims any liability for damages resulting from:

1. Lack of familiarity with the cautionary/informative symbols used in the products/system/user manual.
2. improper use or use contrary to the instructions contained herein.
3. Any attempts to service or modify the product/system by the user.
4. Any service/repair of the product/system by the user or any other unauthorized person, either during or outside the warranty period and other than by factory-trained personnel.



B. HEALTH AND SAFETY NOTICE

Warning!

Solar electric systems contain hazardous materials and high voltages. For your protection and the safety of others, please read these instructions carefully:

1. Ensure that everyone involved with your system reads and understands the safety requirements.
2. Remove all metallic ornaments such as wristwatches and jewellery, use insulated tools and wear appropriate Personal Protective Equipment (PPE) for the relevant installations.
3. Follow the correct sequence for connecting and disconnecting cables, interconnecting the inverter, ACDB and grid.
4. Do not short the output terminals of the Solar PV components.

C. DESCRIPTION AND SUMMARY OF HAZARDS

DANGER:

When connecting the AC Distribution Board (ACDB) to the Low Tension (LT) system, ensure it is done correctly. It always carries high AC voltage which can be dangerous to anyone who is not an expert in making system connections. Before making any changes, always safely switch off the grid input to avoid potential harm.



ORIENTATION SYMBOL:

Items marked with symbol must be stored in the orientation shown.



LETTER CONNECTION:

- Ensure proper colour coding of cables when connecting to the LT panel.
- Always switch off the grid before making any connections.
- If colour coding is not available, then carefully check the phase angles to ensure correct connections.



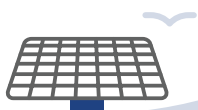
Protective clothing must be worn in this area

Protective footwear must be worn in this area

Protective Gloves must be worn

Eye protection must be worn

Safety helmets must be worn in this area at all



D. SPECIFIC HEALTH & SAFETY INSTRUCTIONS

Photovoltaic systems/products generally consist of the following major components:

- A. Solar PV Module
- B. Control Electronics (Inverters)
- C. Earthing & Lightning Protection
- D. Structural Assembly

A. SOLAR PV MODULE

Solar modules generate DC electricity whenever Sunlight shines on the Solar cells. Follow these guidelines to ensure safe handling:

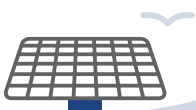
1. Firmly mount the Solar modules onto the structure.
2. To prevent dangerous voltages, cover the modules with opaque sheeting to block sunlight before making any electrical connections.

B. CONTROL ELECTRONICS (INVERTERS)

- Control Electronics Safety Guidelines
- Use only insulated tools and meters during installation and periodic maintenance to avoid electric shock.
- Do not interfere with any electronic components while they are in operation, as they may contain dangerous voltages.
- Ensure all electronic equipment is properly earthed as applicable.
- Do not attempt to service the unit yourself.
- During normal operation, do not disconnect the input cable connected to the inverter. If necessary, then follow the specified connection and disconnection sequence in the manual point 3.3 for the safety of both the operator and equipment.

C. EARTHING & LIGHTNING PROTECTION

- Lightning is a remarkable natural phenomenon that generates both electric and magnetic fields which vary in distance, frequency and time. Due to the low maintenance requirements of Solar Power arrays and autonomous operation, they are often installed in diverse, isolated and extreme locations worldwide. While protection against direct lightning strikes is crucial for critical applications or areas with a high probability of strikes. Generally, effective earthing of Solar array structures and associated equipment provides adequate protection in the field.
- **Lightning Protection and Earthing Guidelines.**
- Follow the recommendations for lightning protection components and install them at the locations specified in the installation/user manual.



- Earthing the Solar PV system is crucial for both safety and protection against lightning. Proper earthing ensures that the system voltage remains close to ground potential hereby reducing the risk of electric shocks.
- Adequate earthing also provides a path for fault currents induced by lightning.
- To ensure the safety and security of the Solar Power system and all exposed metal parts (e.g., Solar array structure, inverter/panel enclosure, metal cable conduits etc.) should be properly earthed.

D. STRUCTURAL ASSEMBLY

- Do not attempt to construct the structure in high winds.
- Exercise caution when lifting structural members and when working at elevated levels.
- Wear protective headgear.
- Refer to relevant drawings for structural and foundation details. Follow the specified installation sequence.

E. EMERGENCY RESPONSE GUIDELINES

- Switch off the circuit breakers immediately.
- Administer first aid to the patient and seek immediate medical attention.
- Do not switch the unit back on until it has been thoroughly checked and the cause of the electric shock has been diagnosed.



F. ENVIRONMENT RELATED GUIDELINES

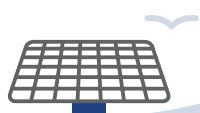
At ISH Solar, our commitment to the environment is a key priority. All activities are conducted with the utmost respect for the environment and ensuring efficient control of atmospheric emissions, effluents, residues etc. to guarantee the least possible environmental impact before the sale of our products.

To uphold this commitment, we hope that end-users will cooperate with us by adhering to local statutory norms for the disposal of products at the end of their life cycle after decades of operation.

If safe disposal of the product proves challenging, ISH Solar accepts returned equipment to our premises for recycling or disposal in accordance with best environmental practices.

Please follow these instructions to prevent environmental damage:

- Discard used Solar modules, electronics, mechanical and electrical accessories in compliance with local environmental legislation.
- If safe disposal is not possible, ensure the products are sent back to ISH Solar with adequate packing.



COMMISSIONING OF SOLAR PV SYSTEM

A. SPECIAL HEALTH SAFETY GUIDELINES



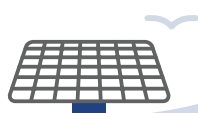
A. ELECTRIC SHOCK

- Photovoltaic (PV) modules generate electricity when exposed to light even if they are not connected to a circuit. Contact with module output wiring can result in shocks and burns. These hazards are heightened when multiple modules are interconnected to increase the array's output voltage.
- To ensure safety, cover the front surface (glass side) of the Solar module completely with an opaque cloth or other opaque material before performing any operation involving the module or system electrical connections. The module packing carton can also be used for covering the modules.



B. CAUTION

- Only use insulated tools when making electrical connections.
- Do not attempt to commission the system without the connection diagram, measuring tools, crimping tools and other mandatory items required for system commissioning.
- Switch off all circuit breakers and switches if they are provided in the system components.
- Midday or bright sunny days with no clouds are ideal for commissioning testing.



B. COMMISSIONING

- System commissioning is the process of ensuring that systems are designed, installed, functionally tested, capable of being operated and maintained to perform in accordance with the design objectives. In essence, commissioning ensures that the system meets the expected performance standards.

Pre-Commissioning Checklist

Before commissioning the system, verify and ensure the following:

- (A) The installation and pre-commissioning checks have been completed.
- (B) The polarity of the cables has been checked and marked. All cables connected to the positive terminal of the equipment should be marked as "+" and those connected to the negative terminal should be marked as "-".
- (C) The equipment is installed according to the manufacturer's specifications and standards.
- (D) Operational checkouts have been completed and the system operating personnel are trained.

C. SYSTEM CONNECTION & DIS-CONNECTION SEQUENCE

Important Note on Connection and Disconnection.

Depending on the system capacity/type, circuit breakers or switches may be provided in Solar PV components such as inverters and ACDB. Before connecting these components, switch off the circuit breakers or switches. If circuit breakers/switches are not provided (e.g., for 12/24V DC operating voltage equipment) then the cable must be terminated to the respective terminal following the specified sequence.

The connection and disconnection (switch on and switch off) sequence of the Solar PV system is crucial and must be strictly followed to ensure proper functioning, usage and maintenance of the Solar PV equipment. Incorrect connection or disconnection sequences can damage the Solar PV components.

SWITCHING SEQUENCE

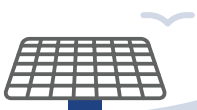
A. Module Covering Instructions

- Completely cover the front surface (glass side) of the Solar module with an opaque cloth or other opaque material before terminating the array cable to any Solar PV equipment.
- Remove the opaque material after connecting the array cable.



B. CAUTION

- If circuit breakers (MCBs) or switches are provided in Solar PV equipment, switch them off before terminating the electrically live cables.
- Treat the DC array terminals as "electrically live" cables.



MAINTENANCE OF SOLAR PV SYSTEM

A. GENERAL INFORMATION

A. MAINTENANCE WORK GUIDELINES

- Maintenance work must be carried out only by authorized and trained personnel.



B. ELECTRIC SHOCK HAZARD WARNING FOR PHOTOVOLTAIC (PV) MODULES

- Photovoltaic (PV) modules generate electricity when exposed to light and even when not connected to a circuit. Contact with module output wiring can result in shocks and burns. These hazards are amplified when multiple modules are interconnected to increase array output current or voltage.
- Cover the front surface (glass side) of the Solar module completely with an opaque cloth or other opaque material before performing any operation involving module or system electrical connections. The module packing carton can be used for covering the modules.



C. MAINTENANCE SAFETY WARNING

- Do not undertake maintenance work without proper personal protective equipment (PPE) and without being fully aware of Health, Safety and Environment (HSE) guidelines.



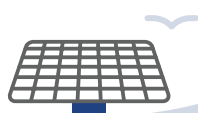
D. CAUTION

- Only use insulated tools when making electrical connections.
- Turn off all the circuit breakers and disconnect switches during maintenance work. Keep the switches in the open position during maintenance. The turn-off sequence must be strictly followed as specified in the "Switching On & Off the System" section of this manual.



E. MAINTENANCE SAFETY WARNING

- Turn off all the circuit breakers and disconnect switches during maintenance work. Keep the switches in the open position during maintenance. The turn-off sequence must be strictly followed as specified in the "Switching On & Off the System" section of this manual.



B. MAINTENANCE PROCEDURE FOR SOLAR ARRAY & MOUNTING STRUCTURE

A. MAINTENANCE AND INSPECTION OF SOLAR ARRAYS

Solar arrays comprising multiple Solar modules are often considered maintenance-free. This can be true in many cases. However, occasional maintenance and inspection ensure optimal performance of all the Solar modules in the array.

- The most common maintenance task is cleaning the glass area of the module to remove excessive dirt. This is usually only necessary during long dry periods without rain.
- To remove dust and dirt, simply wash the panel with water. For thicker dirt or grime, wash with soft water and a sponge.
- After cleaning, visually inspect the panels for defects such as cracks, chips and discoloration. Note any obvious defects in the system logbook to monitor for future deterioration, although in most cases panel output will not be affected.
- Regular observation of Solar array output voltage and current can help detect any loss of performance. Variations in current may occur due to changes in ambient temperature, season, angle of the sun and Solar radiation levels. For accurate observation, check on fine and cloud-free days around noon.
- Significant changes in output should be investigated. The most common causes for loss of output are excessive dirt on the modules or partial shading of the array. Other potential causes include wiring problems or issues with system regulators. If these problems are suspected, refer to authorized personnel for advice.

B. CLEANING WARNING FOR PV MODULES

- Under no circumstances should abrasively cleaning products, scrubbers, scourers, acids, alkaline cleaners or solvents be used to clean the front or rear surfaces of the modules.

C. INSPECTION OF ARRAY FRAMES

- When inspecting the Solar modules, note the condition of the array mounting frame.

D. INSPECTION OF ARRAY WIRING AND CONDUIT

- Inspect the condition of any conduit and wiring associated with the array and regulator.
- Pay particular attention to any breaks or deterioration in exposed conduit and wiring.
- During routine maintenance operations, check the support structures for any loose screws and bolts.
- Touch up any damaged areas of the structure with suitable paint.
- Ensure that the earth connection to the structures is intact.



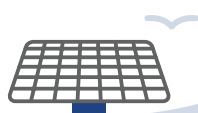
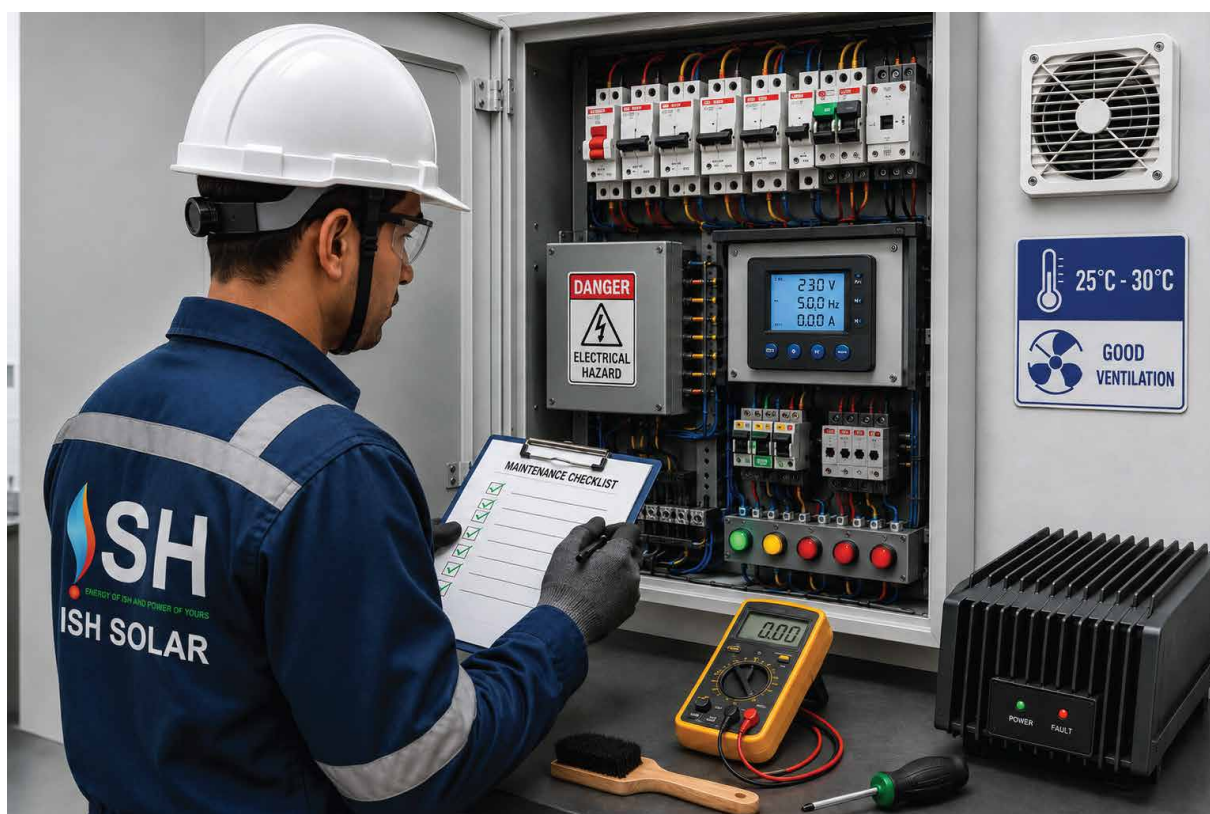
C. MAINTENANCE OF ELECTRONIC & ELECTRICAL EQUIPMENTS & WIRING

CAUTION

- Before commencing maintenance on any equipment, switch off all circuit breakers and switches if provided in the equipment.

MAINTENANCE CHECKLIST FOR EQUIPMENT

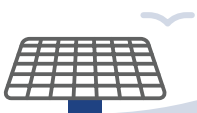
- Ensure the area around the equipment is clean.
- Check the room temperature. It is recommended to maintain the room temperature at about 25°C to 30°C for the longer service life of the equipment (not applicable for outdoor type equipment).
- Verify the correct functioning of the equipment by observing the indicators, metering and other displays in the equipment.
- When inspecting the equipment, remove any excess dust from the unit and especially from the heat sinks. Use only a dry cloth or brush for this task.
- Check all electrical power connections for tightness
- Verify control functions such as Inverter OFF, Array ON etc.
- Correctly installed switchboards and wiring should require no maintenance. As part of your system inspection, visually inspect the switchboards and wiring for any signs of corrosion or burning. If present, consult an authorized agent to identify and rectify possible faults.



DO'S & DON'TS

A. SOLAR PHOTOVOLTAIC POWER GENERATING SYSTEM

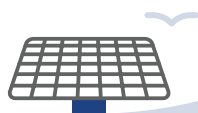
DO'S	DON'TS
Solar energy is precious. Always ensure that the Loads are switched off when not in use.	Do not switch on the loads when not required.
Maintain minimum gap between the -ve & +ve terminals.	Do not make closer connections.
Periodically check for operation of protective devices like MCB, switches etc. by switching ON/OFF manually,	Do not bypass any of the protective devices. If gone bad, replace with identical new piece.
Always ensure that the Solar module surface (glass side) is free from dust and are cleaned using normal soft water.	Do not allow dust to accumulate on the glass side of module & Do not use salt water (sea water) or detergents to clean the modules.
Ensure that no shadow falls on the Solar module. Shadows will reduce module performance.	Do not keep any object on the Solar module and do not allow any kind of shadow to fall on module.
Remove all metallic ornaments like Wrist watch, Jewellery etc. Wear PPE's like goggles, protective clothing, hard hat, gloves, gum boots etc. and use insulated tools during Installation, commissioning & maintenance of system.	Do not work with the system without PPE's and without reading this document.
Ensure that Electrical room window is always kept open for good ventilation and free from smoke, naked flame and other heat generating Equipments.	Do not keep the windows of Electrical room closed or block any of ventilation. Natural ventilation is a must
Maintenance of Solar PV system and system components must be carried out as per the schedule.	Do not forget to maintain the system as per schedule.



B. SOLAR PHOTOVOLTAIC POWER GENERATING SYSTEM COMPONENTS

SOLAR MODULE / SOLAR ARRAY

DO'S	DON'TS
Installation & commissioning to be done by trained and authorized persons only.	Do not try to install or commission the modules on your own. Only authorized personnel are eligible for Installation & commissioning of Solar module.
Solar panel wiring has to be done using proper PPE's like insulated tools, gloves etc.	Do not touch the module terminal by bare hands. Use proper PPE's during installation and commissioning.
Cover module front surface completely with an opaque material before performing any operation involving module or system electrical connections	Do not expose the module front surface (glass side) while performing any operation involving module or system electrical connections.
Ensure that no artificial light is focused on Solar module.	Do not attempt to increase module output by concentrating light on its surface.
Solar modules shall be fixed at tilt angle as specified for the location.	Don't fix the module in any other tilt angle than the specified range.
Ensure that the modules installed are free from all kinds of shadow.	Do not allow any kind of shadow to fall on the modules once the system is commissioned. Shadows limit the module output power.
Ensure that the module surface is cleaned using normal water.	Do not use salt water (sea water) or detergents for cleaning the module.
Module interconnection must be done as per the connection diagram.	Do not make wrong connection or short the module output terminal.
High voltage DC will be present at the time of module interconnection. Extreme care must be taken.	Do not make connection without necessary PPE's.
Disconnect DC connection only when system is in OFF condition.	Do not disconnect DC cables during system operation.

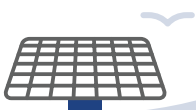


SOLAR MODULE / SOLAR ARRAY

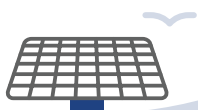
DO'S	DON'TS
Ensure that the structure is properly grouted to the surface.	Do not forget to grout the structure legs either by fixing bolts or welding.
Handle the structure using proper PPE's like gloves, goggles, safety shoes etc.	Do not lift/handle the structure without PPE's.
While handling/installation ensure that the structure galvanized surface does not get damaged and are free from deep scratches.	Do not leave the exposed structure surface as it is. Touch up as required using recommended paint.
Minimum 2 persons may be required to lift or assemble structure. The number of personnel required depends on the weight of the structure..	Do not try to lift structure single-handedly if found heavy.
Assembly of structure must be done during low winds.	Do not attempt to carry out the assembly of structures during high winds.
Ensure that all fasteners are firmly tightened.	Do not let loose the fasteners. Module frame or structure members may get damaged if fasteners are not firmly tightened.

ELECTRICAL EQUIPMENTS

DO'S	DON'TS
Install, operate and maintain the electrical equipment's in a dry place.	Do not install the Inverter, JB and ITB equipment's in the location which is exposed to direct Sunlight and water.
Ensure that Electrical room window is always kept open for good ventilation and free from smoke, naked flame and other heat generating Equipments.	Do not keep the windows of Electrical room closed or block any of ventilation. Natural ventilation is a must.
Installation and commissioning of electrical Equipments must be done by trained & authorized personnel's only.	Do not try to install or switch on the electrical Equipments on your own. This may cause injury to personnel or damage to equipment.

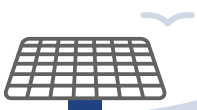


Check polarity using multimeter before terminating the cable end to the electrical Equipments.	Do not make wrong connections. (Wrong polarity)
Terminate the cables to electrical Equipments terminals with circuit breaker/switch in OFF position.	Do not connect any cable to the electrical Equipments with protective devices like MCB /MCCB's in ON position.
Electrical Equipments must be switched ON /OFF as per the switching sequence mentioned in manual.	Do not switch ON in wrong sequence. Wrong switching may cause injury to personnel or damage the equipment.
Completely isolate the electrical equipment while working with these Equipments.	Do not interfere with any electronic components while it is operating. It may contain dangerous voltages.
If any of the electrical equipment tripped, check the array, grid voltage and refer fault finding section before re-setting or re-starting the equipment.	Do not re-set or re-start the system without analysing the problem.
Ensure that the pre-sets on any of the cards are not tampered.	Do not re-set or re-start the system without analysing the problem.
Ensure proper earthing of electronic/electrical equipment is done wherever specified.	Do not forget to earth electronic/electrical Equipments, if required.



CABLE

DO'S	DON'TS
Do conduct a megger test for insulation resistance.	Do not lay or install a cable until the insulation test has been completed.
Inspect the cable thoroughly before laying/installing it.	Do not lay/install the cable before checking.
Use proper cable ties when laying cables.	Do not try to install or switch on the electrical Equipments by your own. This may cause injury to personnel or damage to equipment.
Use proper cable lugs for termination.	Do not terminate cables directly without lugs.
Maintain minimum safety clearances between phase to phase & phase to neutral.	Do not terminate the cables very closely.
Bending radius of the cable should be considered while bending the cable.	Do not bend the cable more than that of the given radius in technical specs.
Use the proper full-length cable for connecting two equipments.	Do not inter-connect two pieces of cables for connection between two Equipments.



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