Installation Manual: Solar Panels

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1.0 Read This First

Thank you for choosing RSPL's Photovoltaic (PV) module.

These modules are certified with IEC standards. The modules are designed to provide one of the longest lifespan in the industry. With over 30 years of experience in the world of solar, RSPL's solar modules are guaranteed to perfection.

This manual describes the installation and maintenance instructions for the RSPL photovoltaic modules.

Before wiring, installing or using a PV module, it is important to read this manual and understand the instructions. Installers should understand the basic principles of electricity, electric appliances and article 690 of the National Electric Code and local Electric Codes for your area (see Section 3 of this document). Special attention should be given to the safety instructions.

Specific attention is drawn to the hazard warning label and the notification mentioned on the cable tags, safety practices to be followed etc.

1.1 Disclaimer of Liability

Since the use of this manual and the conditions or methods of installation, operation, use, and maintenance of the module are beyond the control of RSPL, RSPL does not assume responsibility and expressly disclaims liability for loss, damage, or expense arising out of or in any way connected with such installation, operation, use, or maintenance.

No responsibility is assumed by RSPL for any infringement of patents or other rights of third parties which may result from use of the modules. No license is granted by implication or otherwise under any patent or patent rights.

1.2 Handling of the Modules

The PV modules are well packed and palettes as per the customer requirements and shipped for damage-free transit. If any de-stuffing operations of the container are involved at the customs/port of entry the same is to be monitored by the customer for safe handling of the pallets. A certificate to this effect with evidence of photos shall be submitted in any case of transit damage to the pallets at any stage.

Customer shall unload the heavy pallets using suitable material handling equipment for safe receipt from the containers. Unpacking the pallet shall be carried out using suitable tools without damaging the PV modules inside the pallet. Removal of the modules from the pallet and relocation or reloading/unloading etc., or any movement of each module from one place to other shall always be handled by two able bodied persons (and suitable pallet trucks) who could comfortably carry the heavy modules with all safety practices.

RSPL is not responsible for any mishandling of the equipment and the damages caused thereby by the customer.

1.3 Cleaning of the Modules

The modules before packing are well cleaned and sent in ready to use condition. It is very unlikely that the modules gather dust in the transit and thus doesn't require any further cleaning except when they are stored in dusty environment.

CUSTOMERS SHALL MAKE SURE NOT TO STORE ANY CHEMICALS OR REACTING AGENTS IN THE VISCINITY OF THE MODULES TO AVOID THE DAMAGE DUE TO INADVERTENT SPILLAGE OR VAPOURS EFECTING THE MODULES.

At any time, if end user needs to clean the modules to remove the dust or stains that can't be removed with simple water wash (spraying gently through a hose is acceptable) and drying with soft cloth the following methodology is recommended to clean the modules to achieve optimum performance.

1. Place the SPV module glass surface up on the cleaning table.
2. The module prior to commencement of cleaning shall be thoroughly blown with a blower or any pneumatic hose to clear any dust or hard particles such as sand grains that could possibly make a scratch during the cleaning process.
3. In-case of hard stains Clean by using a soft cloth and a diluted (90% pure) Isopropyl Alcohol (IPA)—(100 ml of potable water in 1000 ml of 99.9% pure Isopropyl Alcohol).
4. Once all the smears/stains are removed, clean once again with potable water or wash it with clean water hose to wash out the IPA.
5. Dry the module by absorbing the water with a clean sponge and dry soft cloth or medium heat hot air blower.

Never use any abrasive cleaner or hard bristle brush to clean the modules which would ruin the glass surface resulting in lower Pmp.

2.0 Safety Instructions

Read this section carefully before installing, using, repairing, or performing maintenance on your PV modules or PV power system.

WARNING

Lethal voltages and/or shock hazard may be present in modules and arrays during sunlight hours, even at low light levels. This hazard increases when multiple modules are connected together to provide higher system voltage or current levels. Dangerous voltages may also be present at night from connections to batteries and feedback from inverters or other parts of the system.

2.1 DON'Ts

※ **DO NOT** attempt to service any portion of the PV system unless you understand the electrical operation and are fully qualified to do so. Warranty of the RSPL modules would be null and void if any repair or servicing is attempted by any person whether qualified or not.

※ **DO NOT** disassembles the module.

Danger

※ **DO NOT** connect or disconnect a module unless the array string is open circuited and all of the modules in the string are well covered and not receiving any irradiance.

※ **DO NOT** install modules during high winds.

※ **DO NOT** drop, allow objects to fall on, or stand or step on modules.

※ **DO NOT** work on modules when modules are wet. If a wet module is cracked or broken the full system voltage may be present in the water. It would be hazardous for the persons working in such condition.

※ **DO NOT** attempt to remove snow or ice from the module. One has to wait till it melts.

※ **DO NOT** concentrate sunlight on modules. Artificially concentrated sunlight shall not be directed on the module/panel/array supplied by RSPL.

※ **DO NOT** wear jewelry on your body while working on the modules. This might jeopardize your safety as well as causing scratches and damage to the back sheet.

※ **DO NOT** touch terminals while the module is exposed to light without wearing electrical insulating gloves.

※ **DO NOT** install module where flammable gasses or vapors are present to reduce spark hazard.

※ **DO NOT** connect the modules in series in large numbers that result in the System Voltage of >600 V in case of UL 1703 certified modules (customers in USA & Canada) and >1000V in case of EN 61215 & EN 61730 certified modules (customers in Europe & those that follow IEC standards. There is no limitation on the number of modules that can be connected in parallel as long as the system voltages are maintained within the 600/1000V as per the applicable standards while sizing the cables as per local NEC codes. Modules that have multiple certifications are be connected as per the local applicable standards **not exceeding the System Voltage mentioned in the data label** of the module.

Danger!

The module interconnects supply direct current (DC) and are sources of voltage when the module is under load and when it is exposed to light. ***Direct current can arc across gaps and may cause injury or death if improper connection or disconnection is made, or if contact is made with module leads that are frayed or torn.***

Do not connect or disconnect modules under load i.e., when current from the modules or an external source is present or when it is exposed to light.

If the front glass is broken, or the back sheet is torn, contact with any module surface or module

frame can cause electrical shock.

2.2 DOs

- ✓ A two-person ("buddy") system is recommended while performing field work on all energized equipment where the system open circuit voltage is 30 volts or greater.
- ✓ Wear electrical insulating gloves rated at 1000 volts and suitable eye protection when working on systems where the system open circuit voltage is 30 volts or greater.
- ✓ Have a fire extinguisher, first aid kit, and electrical hook or cane available when performing field work on all energized equipment where the system open circuit voltage is 30 volts or greater.
- ✓ Series / parallel module configurations shall be restricted to the maximum system voltage of 600 VDC for UL listed modules and 1000 VDC for UL(IEC AND BIS) Certified modules.
- ✓ Use only insulated tools to reduce risk of electric shock.
- ✓ Use modules for their intended use only. Follow all module manufacturers' instructions.

3.0 Codes

3.1 National Electrical Code (NEC)

The National Electrical Code (NEC) covers the installation of photovoltaic systems that should be adhered to when systems are designed and installed. Article 690, *Solar Photovoltaic Systems*, of the NEC applies "to solar photovoltaic electrical energy systems including the array circuit(s), power conditioning unit(s), and controller(s) for such systems".

3.2 Local Codes and Regulations

In addition to the above the user is advised to refer to the local applicable safety and electrical codes apart from statutory and regulatory requirements pertaining to the PV Solar Module installations and commissioning.

4.0 Theory - How Photovoltaic's Work & How they are Made!

4.1 Modules and Type identification

Solar cell groups are packaged into standard "modules" to provide useful output voltages and currents and to protect the electrical circuit from the environment. RSPL PV Modules are made up of high efficiency Multi/mono crystalline Solar cells connected in series to increase the Voltage and output Power of the module as a unit. The module type indicates

the basic details such as cell type used and number of cells. It is quite easy to get to know this once the coding is known. This coding is different for BIS/UL Certified for IEC standards 61215 & 61730

The alphanumeric characters followed by RSPL (Ritika Systems Pvt Ltd) represent the suitable battery voltage and type of cell technology used and the next group of digits separated by space indicates the wattage of the module. Ex: RSPL indicates that Ritika Systems Private Limited and 12 Volts, Multi crystalline cells are used and the module will labeled as 160Wp. So such a module that is IEC/BIS certified is marked as PV Module Type: RSPL12P160.

For Indian Cells, J is added at the end, ie RSPL12P160J
For Mono Cells, M is added after RSPL, is RPSLM12P160
The cells and cell interconnects are completely sealed in a glass and foil laminate to exclude moisture ingress and provide electrical insulation. In field installation the modules can be connected together in series/parallel to form sub-array/array. A PV System may contain one module or several sub-arrays/arrays comprising thousands of modules.
Serial Nos have to be read as follows: RSPL Followed by letter A-L for Jan-Dec followed by two digit year followed by 6 digit serial number ie RSPLE20-XXXXXX where E stands for May, 20 stands for 2020 and XXXXXX stands for the serial no.

4.2 Shadow Effect & Bypass Diodes

Each PV cell (and of course, the module or panel consisting of several cells in series) is either a power producer when it is exposed to sunlight or a power consumer if it is not exposed to sunlight i.e. in a shadow. Power consumption by a solar cell is detrimental and has to be avoided. To facilitate this Bypass diodes are installed in the Junction Box of each module so that given number of PV cells are bypassed whenever required (during shadowing). Internal resistance of a diode is greater than that of a PV cell or string of PV cells when exposed to sunlight. So, the current flows through each consecutive cell following the path of least resistance. When a cell in the series string is shadowed the resistance of the string increases tremendously thus making the bypass diode the path of least resistance. Hence the current flows through the diode shunting the power through the alternate path around the PV cell or string to the next power producing cell/string. The only Voltage loss is limited to the loss due to inactive (shadowed) cells. RSPL modules have three strings each string being a series connection of 20 cells. All the three strings are brought in to the Junction Box and each string is bypassed by a diode. The Junction Box is a 4 contact type and the 4 bussing strings are terminated maintaining correct polarity. Two cables with connectors, one marked positive and one marked negative, are brought out of the Junction Box for external connection.

Please refer the attached string drawing for bypass diode configuration and diode ratings.

4.3 Certifications

RSPL PV modules '**RSPL- family series'** are also tested and qualified to meet IEC/IS 14286 61215:2005 Ed 2 and IEC/IS 61730-1/2:2004/2007 by UL(IEC and BIS). These modules carry the UL(IEC AND BIS) mark on the Data Label affixed to the substrate/back sheet along with the Class A, Safety Class II marking. The UL(IEC AND BIS) Certification includes the Trade Mark of RSPL for the Product Directories that cover UL(IEC AND BIS) certified products.

5.0 Installation Instructions

PLEASE REFER TO DOs AND DON'Ts GIVEN IN 2.0 SAFETY INSTRUCTIONS

5.1 Site Considerations

RSPL modules should be mounted in locations that meet the following requirements:

Standard Operating Condition [SOC]:

It should be ensured that RSPL PV modules will operate within the following temperature range:

Maximum Operating Temperature	+85°Celsius / +185°Fahrenheit
Minimum Operating Temperature	-40°Celsius / -40°Fahrenheit

Care should be taken to provide adequate ventilation behind the modules, especially in hot environments.

Excluded Operating Environments:

No RSPL module should be mounted at any site where it may be subject to any one of following ambient:

1. The ambient temperature is different from the SOC.
2. The ambient has excessive salt content to cause corrosive effects.
3. The hail and snow loads are out of bounds of the IEC standards.
4. The sand and dust damages are heavy.
5. Other special conditions include presence of chemically active vapour/gas and ambient that are not covered in IEC standards.

These operating environments are not recommended for standard RSPL modules and are excluded from the RSPL Limited Warranty for these modules.

5.2 Mounting the Module

- The RSPL module has 2 or 4 sets of mounting holes, holes through the bottom flanges on the frame side rails as per the relevant drawing of the module.
- Mounting the modules using both side rails and end rails could impose significant stress on the module and possibly damage it.
- It is recommended that either galvanized or stainless steel bolts, nuts and washers be used to mitigate corrosion.

5.3 Clearance between Modules

A clearance of 10 to 15 mm between any two modules on all sides is sufficient in most installations. However, the appropriate clearance is dependent upon many installation specific factors including the support structure, the temperatures at the site, and the maximum operating temperature of the module.

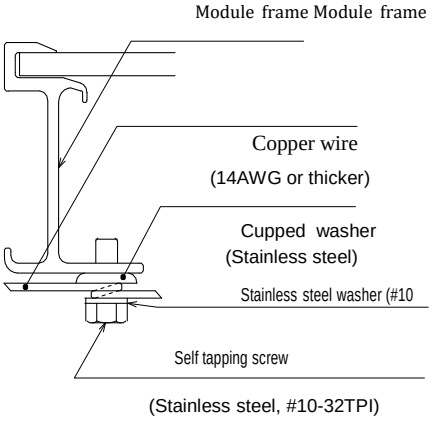
- Spacing between different modules in an array is the responsibility of System Integrator based on ambient temperature and site conditions. RSPL is not responsible for the damage to modules due to improper and unscientific installation of its modules.

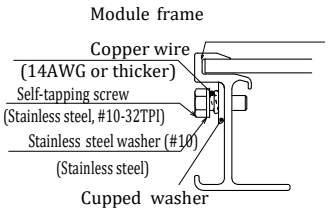
5.4 Grounding Scheme

- **Method1 (Self Tapping Screw)**

  - Secure the stainless steel screw of M5 or No 10, with 32 threads per inch to grounding hole by 2.3 Nm (20lbf-in). Ensure that two threads are engaged in the module frame. Stainless still washer with appropriate corrosion resistance coating should be inserted between copper wire & screw head.

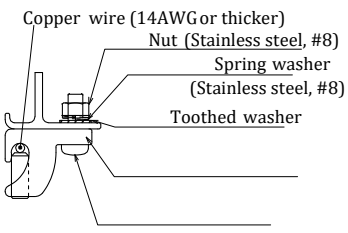
  - Proper cupped washer should be inserted between copper wire and frame to avoid galvanic corrosion Copper wire must have the thickness of #12 AWG or thicker, and be secured with the module frame





- **Method 2 (Bolt and Nut)**

The stainless bolt and nut of No.8 with 32 threads per inch Can be used instead of No.10 self tapping screw iron method #2 under following condition.
-Torque to secure bolt: 1.8 Nm (16LB-in)
-Lock or spring washer shall be inserted between nut & toothed washer.



(Stainless steel, #8)
Grounding lug
(ex. ILSCO GBL4-DBT)
Bolt
(Stainless steel, #8)

- **Grounding the Array:**

All the grounding wires from the modules/sub-arrays/arrays are brought over and terminated on the grounding points of the AJB (Array Junction Box). A single final Grounding Electrode Conductor connects these ground points of the AJB to the Earth Pit within a distance of 2 to 3 m from the AJB. The routing of the earth wire, its termination, Array Junction Box and earth pit of each array shall be made in accordance with the local NEC. Adequate maintenance practices shall be ensured to maintain the earth resistance well within the value specified by local NEC. RSPL as module supplier is not responsible for any of these activities.

- RSPL modules must be used only with galvanic insulated inverters by connecting either the positive (+) or negative (-) polarity of the PV array to ground protected by a fuse based on the system configuration. **Failure to comply with this requirement will invalidate the Limited Power Warranty for PV modules.**

CAUTION※

Never leave a module unsupported or unsecured. If a module should fall, the glass could break. A module with broken glass cannot be repaired and must not be used. Any damage reported after installation is viewed as that caused by mishandling and is not covered by the Warranty.

5.5 Orientation, Tilt Angle, & Shading

Photovoltaic modules generate maximum power when facing directly towards the sun. PV systems can track the sun or remain in a fixed tilt position. The tracking systems should produce more energy but are more costly and require more maintenance. PV systems are predominantly set at a tilt. Since applications and needs are different it is recommended that you consult a PV system integrator or use a commercially available software program to determine the expected energy output. The following paragraphs list some general rules of thumb.

To maximize annual energy output, point the array south in the northern hemisphere and north in the southern hemisphere. Tilt the array from horizontal equal to site latitude. Your direction and tilt can vary depending on at what time of the day you wish to maximize power output. Note that these orientations are **true, not magnetic** North and South.

It is not recommended to set the tilt angle below 10-15 degrees. Dirt tends to accumulate on modules installed at flatter angles and does not wash off as readily during rainfall. Dirt accumulation on the module will reduce its energy output.

Modules should be located in an un-shadowed location where they will receive maximum exposure to the sunlight for the longest possible time during the day. Shadowing caused by buildings, trees, utility poles, and other obstructions, may significantly reduce the module energy output.

If it is not possible to place the array in a shadow-free location, a location should be selected where there is no shading between the hours of 9 AM and 4 PM. This is the most energy-productive part of the day.

In systems that are configured with multiple rows of modules, the rows should be spaced far enough apart to minimize the impact of rows shading other rows. This distance is very dependent on the latitude at which the system is installed. The closer to the equator, the smaller this distance; farther from the equator, the greater is this distance.

If there are questions regarding the optimum configuration for the field installation, it is recommended that you obtain assistance from RSPL or its dealer or distributor or retain an engineer qualified with the design of PV systems.

5.6 Module to Module Interconnection

RSPL modules have been designed to be easily interconnected. Each RSPL module has a junction box is designed with appropriate diameter concentric nested, plugged holes. When opened, they will accept size electrical conduit and some smaller sized strain relief fittings.

Inside the junction box is a terminal strip, with the positive and negative wire connections clearly marked. The wires (not provided with module) are inserted into the terminal block and then the terminal block screws are tightened

5.7 Connecting Modules in Series or Parallel – Module Arrays

In photovoltaic arrays, the modules may be connected in series or parallel to achieve the required voltage and current levels. If modules are connected in series, with the positive terminal of one module connected to the negative terminal of another; the voltage level of the module string will be the sum of the voltages of the modules connected. It is to be noted that the modules in the series connection are to be matched to derive optimum power output. The current for the module string will be equal to that of any one module.

If modules are connected in parallel, with the positive terminal of each module connected together, and the negative terminals similarly connected to each other, the voltage level will be equal to that of any one module. The current for the module string will be the sum of the currents of the total modules connected in parallel.

For the maximum series/parallel module configurations, the values of Isc (Short circuit current) and Voc (Open circuit voltage) marked on the modules must be referred to.

Each module (or series string of modules so connected) connected in the array shall be provided with the maximum over current protection as specified.

The over current protection shall be either a Listed Circuit Breaker or Listed Fuse in accordance with local standards and NEC code.

Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/ or voltage than reported at standard test conditions. Accordingly, the values of Isc and Voc marked on the module should be multiplied by a

factor of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes and size of controls connected to the PV output.

5.8 System Wiring & Requirement of Fuse in array

All system wiring shall be in accordance with Article 690 of the National Electrical Code (NEC). Suitable cable types include SE, UF and USE. Where exposed to direct sunlight, type UF identified as sunlight resistant or type USE cable shall be used. Wire size 16 AWG and larger is recommended. The wires used should have a Temperature rating of 90 oC or higher.

Under Normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of Isc & Voc marked on this module should be multiplied by a factor 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes and size of control components to the PV output.

Fuses may be required in many places in a photovoltaic power system, both on the ac side and the dc side, depending on its complexity and size. This section will deal with the need for over current devices in the photovoltaic array portion of the system only - that is between the modules and the array dc combiner box. The values of all over current devices in the system are the responsibility of the system installer. The installer must install the module protective fuses described below and any other over current devices required by the NEC.
In order to protect the internal current paths of the module, an external module protective fuse must be installed in series with each module or string of series connected modules. The series fuse may have a maximum value up to 5 amps as marked on the back of the module. If multiple modules are connected in series only one fuse is required for each string of series connected modules. When the fuses are located in the multiple string/module combining box where the separate modules or strings of modules are connected in parallel, then these fuses may also be used to provide the over current protection for the module interconnection cables required by the NEC.

The NEC requires that every ungrounded conductor be protected by an over current device (fuse or circuit breaker). In a photovoltaic system with multiple sources of power (modules, batteries, battery chargers, generators, power conditioning systems, inverters, etc.) the over current devices must protect the conductor from over current from any source connected to that conductor. Blocking diodes, charge controllers, and inverters are NOT considered as over current devices and must be considered as zero-resistance wires.

If the photovoltaic system is directly connected to the load without battery storage or other source of power, then no over current protection is required if the conductors are sized at 156% of the array short-circuit current where there are no parallel-connected modules or strings of modules.

5.9 Blocking Diodes (Recommended for the provision of electronics in the systems)

Blocking Diodes (also known as series or isolation diodes) are placed in series with a module, or string of series-wired modules, to prevent current from flowing backwards

through the modules. This is particularly important in systems with battery storage. At night or during inclement weather the batteries could otherwise be drained by current flowing into the modules and dissipating as heat. A blocking diode will stop this. Blocking diodes in series are required to protect the weak strings (low current generating strings due to shadow effects or short circuit) against the reverse current flow from strong strings. The number, capacity / ratings, and installation of the blocking diodes are the responsibility of installer. RSPL modules do not come with blocking diodes.

5.10 Batteries

PV arrays are useful energy producers only when the sun is shining on the modules. Unless the use of electricity is programmed to match those times that power is flowing from the PV source, some sort of energy storage medium is needed. The most widely used method of storing electrical energy in association with photovoltaic applications, is batteries.

The design of battery storage systems to satisfy the voltage, current, current draw rates, and capacity requirements is beyond the scope of this manual. However, you can obtain assistance from your RSPL dealer or distributor or retain an engineer familiar with the design of PV systems to help you in designing battery storage.

6.0 Maintenance, Trouble-Shooting, & Repair

6.1 Maintenance

The maintenance requirements for the modules are minimal. If the modules become dirty they should be washed off, as the dirt reduces the power produced. The suggested method is to use the force of the water from a hose to remove the dirt. A mild nonabrasive detergent can be used but through cleaning of the module to remove the slats and stain markings of detergent is a must.

Finger prints may be removed with standard glass cleaner. Do not use harsh cleaning materials such as scouring powder, steel wool, scrapers, blades or other sharp instruments to clean the glass surface of the module. **Use of such materials will invalidate the product warranty.**

There is no need to clean back sheet and JB shall not be tampered with.

Periodic visual inspection of the PV modules and their interconnections is recommended. Modules should be inspected for broken glass, soundness of junction box, connectors & by-pass diodes and wire damage. Damaged components should be repaired and broken modules replaced.

A DC voltmeter is highly recommended for verifying that the system is operating properly and for checking system components.

6.2 Troubleshooting

A photovoltaic module will produce electricity when illuminated. Treat solar modules in the same way you would treat any electrical device. Only personnel trained in the use and handling of PV modules should attempt any diagnostic work.

WARNING

※Consult all Safety Instructions (see Important Safeguards section) and WARNINGS in this document before doing any work with the photovoltaic modules.

Photovoltaic system malfunctions in rare cases can be caused by module failures, therefore it may become necessary to field check modules for proper operation. Field conditions vary widely. Since the module output is a function of sunlight and temperature it can be difficult to determine what an appropriate field electrical reading should be. Subtle problems are not likely to be determined in the field; however gross ones should be detectable.

One of the best ways to determine if a module is malfunctioning is to compare the readings between the modules. Similar readings would indicate that the module in question is within specifications. Wide differences, >20%, would most likely indicate a module problem.

There are two module electrical parameters that can be readily measured in the field that will give a good indication if the module is functioning properly. These two parameters are the short circuit current (I_{sc}) and the open circuit voltage (V_{oc}). They are typically measured with a DC multi meter (an instrument that is able to measure current, voltage, and resistance in circuits).

Reading the voltage across the positive (+) and the negative (-) terminal/leads of the disconnected module will give the V_{oc}. Shorting the leads together and placing an ammeter in the circuit will give you the I_{sc}. Compare these readings to other modules and, if similar, the module is not defective.

6.3 Repair/Claims

With the exception of the module-to-module cabling and connections, all module repairs must take place in the factory. Before sending a module back, contact the module seller for authorization and return. The module serial number is laminated on the front left hand top corner. All claims and assistance for repair or replacement of modules shall contain complete information such as the module serial number, Invoice against which the modules are supplied, supporting photographs, description of the problem noticed etc., The modules shall not be sent back without clearance from RSPL. Please contact your authorized RSPL distributor or dealer first with claim details and supporting evidence.

Damages, if there are any, noticed upon receipt of goods shall be registered immediately and in any case not later than 3 days in case of packaging or pallets and within 15 days in case of modules. Special approval is required if this period has to be extended by RSPL due to specific reasons. **Damages caused due to mishandling of the pallets or modules are not covered in the warranty – please file those claims with your freight company**.

WARNING

Consult all Safety Instructions (see Important Safeguard section) and WARNINGS in this document before doing any work with the photovoltaic modules.

NOTE:
It should be noted that most problems that occur in a photovoltaic power system are not caused by the photovoltaic modules. The most common problem is a bad or improper connection. Before considering returning a suspect module to the seller, check the tightness of the connection to adjacent modules. Make sure that the terminal posts are clean and free from dirt and corrosion. Look for signs of arcing. If the connector or wiring appears to be damaged, a trained technician should be able to repair the module at the site. If connections and wiring look good, but the module does not seem to be working properly, contact the seller.

For additional information:
Contact Your Authorized RSPL Distributor
Or
Ritika Systems Pvt Ltd
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