

INSTALLATION MANUAL

Effective February 1, 2014

1. Introduction

- This Installation manual contains information regarding the installation and the safe handling method of the photovoltaic module (hereafter referred to as “module”) supplied by Hyundai Heavy Industries Co., Ltd. (hereafter referred to as “HHI”).
- System Users and Installers should read and understand this manual before handling, installing the module. For any questions, please contact Customer Support department or our local representatives for more detailed information.
- Before installing a solar photovoltaic system, mechanical and electrical requirements for the total system should be checked as well. Keep this manual in a safe place for future reference.
- The installer should conform to every safety precautions specified in this manual and local codes when installing a module.
- HHI modules are tested and certified for installation worldwide. Different regions may have different regulations for solar PV installations. In this manual, hereafter “IEC only” is used to refer to regions where IEC standard applies, e.g. Europe, Middle East, most of Asia Pacific countries; “UL only” is used to refer to regions where UL standard applies, e.g. United States, Canada; all other references are global.

2. General Information

This manual provides the installation information for HHI modules. Each individual module has a unique serial number.

Serial number : YYMMDD-XX-SxxxRG-0001(~9999) (Ex. 140317-21-S260RG-0001)

- YYMMDD : Production date
- XX : Production line
- SxxxRG : Model (xxx : module power range)
- 0001(~9999) : Production number

2.1 Disclaimer of Liability

- The information in this manual is based on HHI’s knowledge and experience and is believed to be reliable; but any information including product specification (without limitations) and descriptions do not constitute over a warranty.
- HHI reserves the rights for any change the technical specification including the PV production, the specifications, or the product information sheets without prior notice.
- The installation techniques, handling and use of this product are beyond company control.
- HHI does not have any responsibility and the liability for loss, damage, injury or expense resulting from improper installation, handling or use.

2.2 Notice

- Installing solar photovoltaic systems requires specialized skills and knowledge, and should only be performed by qualified persons.
- Each module has a junction box for permanent cable connection. HHI can provide customers with fitted cables for easy installation. Installers should secure the safe installation status including all electrical hazards.
- PID (Potential Induced Degradation) is not covered by Hyundai Limited Warranty for PV Modules. To prevent the PID phenomena, it is recommended to design the system to avoid PID or use the PID-free products.

2.3 DANGER

- Installers should secure the installation status, without limitation, including the risk of electric shock.
- Back sheet of PV module should be kept safe from any damage or scratch to prevent mechanical or electric shock.
- Do not disassemble or remove any part of a PV module or such actions may cause electric shock, fire or damage.
- Keep safety regulations for all components used in the system, including wiring and cables, connectors, charging regulators, inverters, storage batteries and rechargeable batteries, etc.

2.4 WARNING

- Before installation, prevent the module from exposure to direct sunlight or other light source. (If modules are exposed directly to sunlight without connection, each module generates over DC 30V, which is potentially hazardous.)
- Modules are heavy. Be sure to have more than two persons with anti-slip gloves on carry each PV module. Do not throw and drop PV modules.
- Do not sit, stand, step, walk and/or jump on the module, including the frames.
- Do not drop or place objects on the modules. Do not place excessive loads on the modules or twist the module frame.
- All installation equipment and PV modules must be kept in dry condition during installation.
- Check the current and the voltage before connecting the line. There is potential hazard in case of higher voltage in series connection and higher current in parallel connection.
- All PV modules must be earthed by using earth device. Safety check for all other parts of systems should be finished before installation to prevent any electric hazard.
- Do not use any damaged PV module, where it may cause fire, electric shock or injury.
- Do not focus light on a PV module, where it may cause fire and damage.
- Do not touch live parts of wires, cables, connectors, or junction boxes, in order to prevent electric shock and injury. Be sure the circuit breaker is off if it's applicable. Always use appropriate safety equipment. (insulated tools, insulating gloves, etc.)
- Do not re-arrange bypass diodes, where it may cause electric shock and injury.
- Do not disconnect the cable when the load to module is engaged.
- Check applied Class for module after installing the module.
- Do not use mirrors or other magnifiers to artificially concentrate sunlight on the modules.
- Do not remove any labels.

2.5

- In order to prevent any performance drop, damage, or incapability, do not use paint and adhesive material to the module surface.
- Do not leave modules in places where flammable gases can be generated or collected.
- Do not leave un-fixed and unsafe PV modules unattended.
- Do not wear metallic rings, watchbands, ear, nose, lip rings or other metallic devices while installing photovoltaic systems.

2.6 General Safety

The following requirements should be kept during installation and inspection.

- Check the inspection requirements by authorized personnel.
- All PV module system must be earthed. When installing the system, abide by all local, regional and national statutory regulations.
- System designer and installers should secure safe installation of PV modules. All installation must be conformed to all fire safety regulations. Additional structures can be applied for installation. If additional equipment is applied, it is necessary to check the fuse status, earth error and system isolation.
- Do not use different types of PV module in a same module array.
- Abide by the safety regulations for all other components within the total system.

2.7 UL Listing Information

The following requirements should be considered carefully during installation to meet UL requirements.

- It is necessary to use single or non-hollowed copper wire. For module connection, it is necessary to use irradiation-proof cables.
- It is necessary to read carefully all technical requirements for installation and specifications specified in this installation manual.
- All module frames must be earthed over 6 mm²(10 AWG) cable with adequate terminal connectors.

3. Installation

3.1 General

- Before installing and operating HHI PV system, installer and operator should follow the requirements specified in this manual.
- Do not drill additional holes in the frame of the modules. This additional hole will void the warranty. Refer to the mounting profile in Picture1, Picture2.
- Secure the module using mounting holes provided and ¼inch (6mm), stainless corrosion resistant material. Locking washers should be used for long-term security.
- Appropriate materials should be used for mounting structure in order to prevent the module frame, mounting structure from corrosion.
- Installation materials must be resisted against any corrosion of module frame, installation structures.
- When installing the system, it is necessary to avoid any shade caused by buildings or trees nearby.
- For more information about the installation, please contact local representatives for more detailed information.

3.2 Notes on Installation

- Space between PV module frames and installation objects is necessary for cooling air circulation. Do not seal this space.
- Minimum 4 inch (10.14cm) of standoff height is necessary based on UL Fire Class C.
- The minimum distance between two fixed modules for linear thermal expansion of the module frame supports should be 5mm. Nevertheless, the recommended distance between two modules is 20mm to allow wind circulation, in order to reduce pressure loads and improve module ventilation.
- The minimum distance between a module frame and a sidewall of clamp for linear thermal expansion of the module frame supports should be 2.5mm, in order to reduce pressure loads.
- All the junctions on the conductive connection must be fixed. Metal containing iron in the conductive connection should be made with stainless steel or be treated against corrosion by anodizing, spray-painting, or galvanization to prevent rusting and corrosion.
- Modules that feature antireflective coated glass are prone to visible finger print marks if touched on the front glass surface. HHI recommends handling modules with anti-reflective glass with gloves or limiting touching of the front surface. Any finger print marks resulting from installation will naturally disappear over time or can be reduced by following the washing guidelines in Section 7.1.

3.3 General Operation Condition

PV modules will be operated under General Operation Condition (GOC). Do not install PV module at site beyond General Operation Conditions or under specific condition.

1) General Operation Conditions

The site condition for the sea level and wind load should be matched the following requirements.

- (1) Sea level of site : Below 1,000m (3,280ft)
- (2) Maximum Instantaneous wind Speed
 - Below 5,400Pa (5,400N/m², 550kg/m², 112lb/ft²) on the front module surface
 - Below 2,400Pa (2,400N/m², 225kg/m², 46lb/ft²) on the back module surface
 - ※ If the wind strength is not over than 2,400Pa (2,400N/m², 225kg/m², 4 lb/ft²), the installation site over 1,000m (3,280ft) above sea level is permitted.
 - ※ Installations under the condition of wind strength specified above are allowed only when the methods of installations comply with Module Installation Instruction (Appendix 1.)

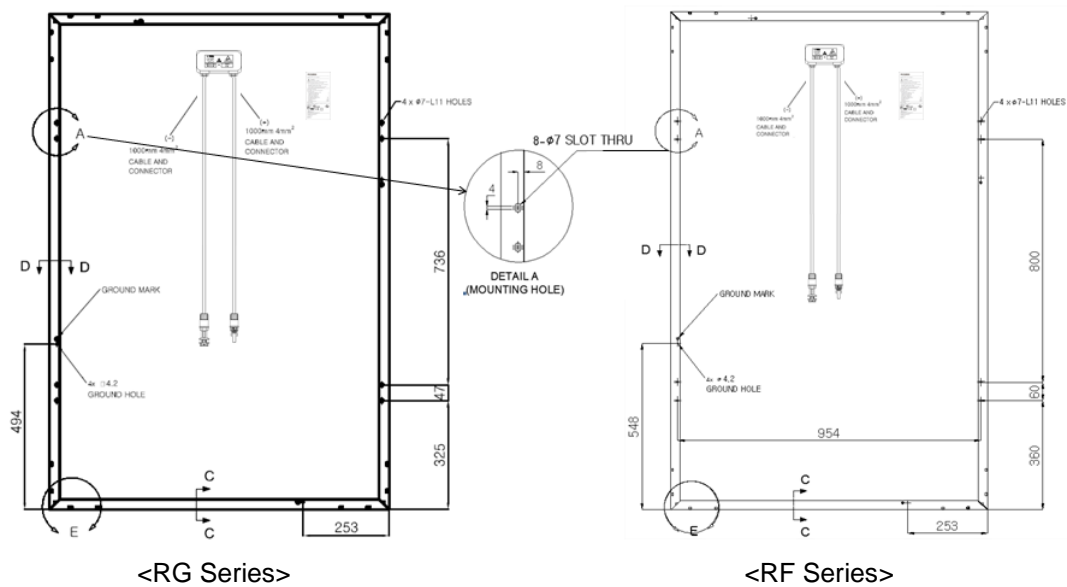
2) Specific Site Condition

- (1) Actual site condition should be checked for adequate installations.
 - 1) Chloride is an important factor to be considered.
 - 2) Hail, heavy snow, and sand are important factors to be considered.
 - 3) Air pollution, chemical gas, acid rain, and smoke are important factors to be considered.
- (2) Environmental conditions.
 - 1) PV modules shall not be installed in salty area within 500m from a body of salt water and/or area where salty wind hit directly.
 - ※ HYUNDAI modules have passed the IEC61701 test (Salt Mist Corrosion Test)
 - 2) PV modules shall not be immersed in water and shall not be continually exposure to Water from a sprinkler, fountain, etc.
 - 3) PV modules shall not be installed in sulfurous area near sulfurous volcano and sulfurous spring.

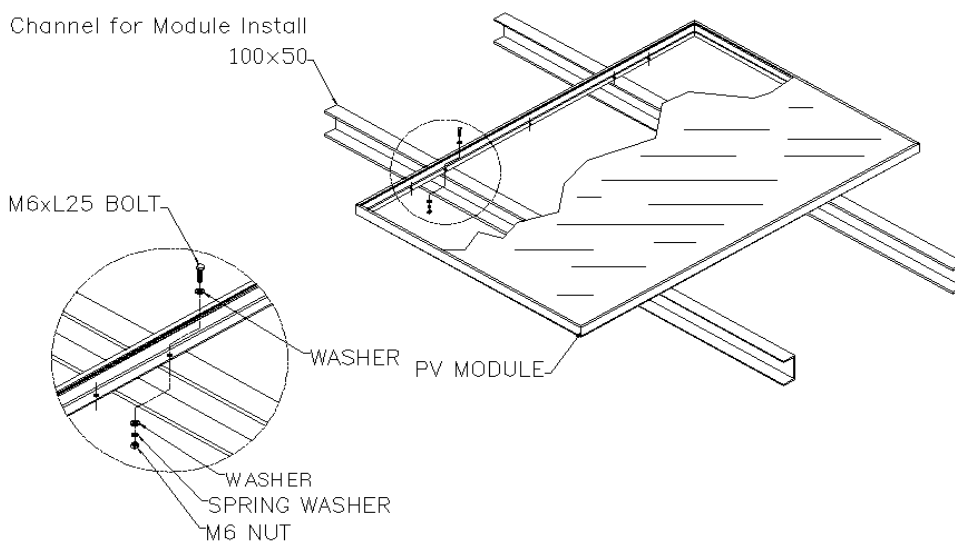
3.4 Mounting Method

- All modules are fixed using mounting holes of long frame.
- Each module must securely fastened at a minimum of 4 points on two opposite sides, using the most outer mounting holes.
- If additional wind loads are anticipated for this installation, additional mounting points should be used. System designer and installer are responsible for load calculations and for proper design of support structure.
- When installing modules in snowy area, additional clamping or supporting parts should be attached to the middle of the lower long side frame to prevent possible damages from slipping snow.

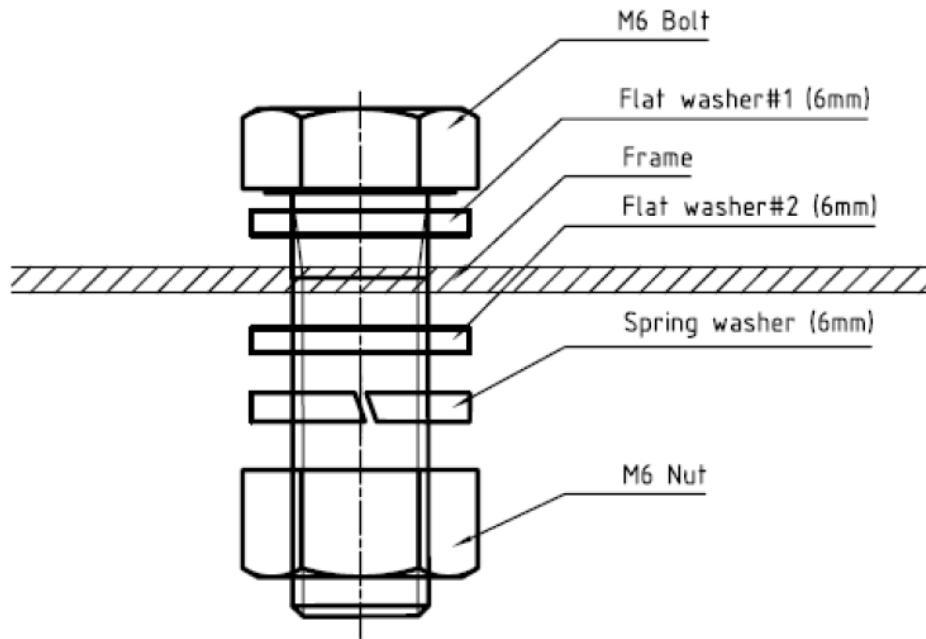
Detailed mounting method is described in 'module installation instruction' in the appendix.



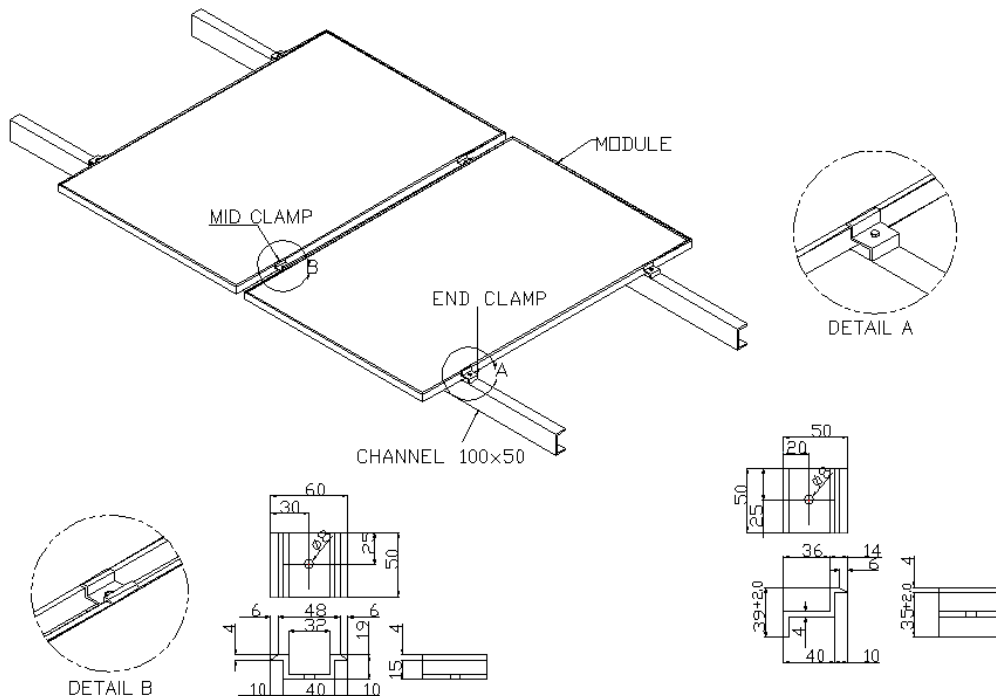
Picture 1. HiS-SxxxRF /-MxxxRF/ -SxxxRG/ -MxxxRG Hole Position



Picture 2. Installation Method using bolt & nut



Picture 3. Mounting Hardware



Picture 4. Installation Method using clamping

4. Specifications

4.1 Notes on Specification

- The electrical characteristics are within $\pm 10\%$ of the indicated values of I_{sc} , V_{oc} , I_{mpp} , V_{mpp} .
- Standard Test Condition (STC): Irradiation 1,000 W/m², Cell Temperature 25 °C, 1.5 AM.
- Electrical Characteristics : HiS-MxxxRF (Multi-Crystalline Si Type, 3 Bus Bar Type, 54 Cells)

Item	HiS-MxxxRF (xxx;Normal Power Value)						
Normal Power (Pmax)	215	220	225	230	235	240	245
Voltage at Pmax (Vmpp)	27.5	27.6	27.8	27.9	28.0	28.2	28.3
Current at Pmax (Impp)	7.8	8.0	8.1	8.2	8.4	8.5	8.7
Open circuit voltage (Voc)	33.4	33.5	33.7	33.8	34.0	34.1	34.3
Short circuit current (Isc)	8.4	8.5	8.7	8.8	8.9	9.1	9.2
Module efficiency	14.6	14.9	15.2	15.6	15.9	16.3	16.6
Temp. coefficient of Pmpp [%/K]	-0.43						
Temp. coefficient of Voc [%/K]	-0.32						
Temp. coefficient of Isc [%/K]	0.056						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000(IEC) / 600(UL)						
Cell quantity in series [pcs]	54						
Bypass diodes [pcs]	3						
Cell Type	6inches, Multi-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215, UL1703 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

- Electrical Characteristics : HiS-SxxxRF (Mono-Crystalline Si Type, 3 Bus Bar Type, 54 Cells)

Item	HiS-SxxxRF (xxx;Normal Power Value)						
Normal Power (Pmax)	225	230	235	240	245	250	255
Voltage at Pmax (Vmpp)	27.8	27.9	28.0	28.2	28.3	28.5	28.6
Current at Pmax (Impp)	8.1	8.2	8.4	8.5	8.6	8.8	8.9
Open circuit voltage (Voc)	33.9	34.0	34.2	34.3	34.5	34.6	34.7
Short circuit current (Isc)	8.7	8.8	8.9	9.1	9.2	9.4	9.5
Module efficiency	15.2	15.6	15.9	16.2	16.6	16.9	17.2
Temp. coefficient of Pmpp [%/K]	-0.44						
Temp. coefficient of Voc [%/K]	-0.34						
Temp. coefficient of Isc [%/K]	0.052						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000(IEC) / 600(UL)						
Cell quantity in series [pcs]	54						
Bypass diodes [pcs]	3						
Cell Type	6inches, Mono-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Electrical Characteristics : HiS-MxxxRG (Multi-Crystalline Si Type, 3 Bus Bar Type, 60 Cells)

Item	HiS-MxxxRG (xxx;Normal Power Value)						
Normal Power (Pmax)	240	245	250	255	260	265	270
Voltage at Pmax (Vmpp)	30.6	30.7	30.9	31.0	31.1	31.3	31.4
Current at Pmax (Impp)	7.9	8.0	8.1	8.2	8.4	8.5	8.6
Open circuit voltage (Voc)	37.1	37.3	37.4	37.6	37.7	37.9	38.0
Short circuit current (Isc)	8.4	8.5	8.7	8.8	8.9	9.1	9.2
Module efficiency	14.7	15.0	15.3	15.6	15.9	16.2	16.5
Temp. coefficient of Pmpp [%/K]	-0.43						
Temp. coefficient of Voc [%/K]	-0.32						
Temp. coefficient of Isc [%/K]	0.056						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000(IEC) / 600(UL)						
Cell quantity in series [pcs]	60						
Bypass diodes [pcs]	3						
Cell Type	6inches, Multi-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215, UL1703 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

· Electrical Characteristics : HiS-SxxxRG (Mono-Crystalline Si Type, 3 Bus Bar Type, 60 Cells)

Item	HiS-SxxxRG (xxx;Normal Power Value)						
Normal Power (Pmax)	250	255	260	265	270	275	280
Voltage at Pmax (Vmpp)	30.9	31.0	31.1	31.3	31.4	31.6	31.7
Current at Pmax (Impp)	8.1	8.2	8.4	8.5	8.6	8.7	8.8
Open circuit voltage (Voc)	37.6	37.8	37.9	38.1	38.2	38.4	38.5
Short circuit current (Isc)	8.7	8.8	8.9	9.0	9.2	9.3	9.4
Module efficiency	15.3	15.6	15.9	16.2	16.5	16.8	17.1
Temp. coefficient of Pmpp [%/K]	-0.44						
Temp. coefficient of Voc [%/K]	-0.34						
Temp. coefficient of Isc [%/K]	0.052						
Output tolerance [%]	+3/-0						
Maximum system voltage [Vdc]	1,000(IEC) / 600(UL)						
Cell quantity in series [pcs]	60						
Bypass diodes [pcs]	3						
Cell Type	6inches, Mono-crystalline Silicon Cell						
Safety Qualification & Class	IEC 61215, UL1703 & Class II						
Maximum Series Fuse Rating [A]	15						
Fire Class rating	Class C						

- Mechanical Characteristics (HiS-MxxxRF/HiS-SxxxRF)

Description	HiS-MxxxMF/HiS-SxxxMF
Length, mm(inches)	1,480(64.6)
Width, mm(inches)	998(39.3)
Depth, mm(inches)	35 (1.38)
Weight, kg(pounds)	15.4(34.0)

- Mechanical Characteristics (HiS-MxxxRG/HiS-SxxxRG)

Description	HiS-MxxxMG/HiS-SxxxMG
Length, mm(inches)	1,640(64.6)
Width, mm(inches)	998(39.3)
Depth, mm(inches)	35 (1.38)
Weight, kg(pounds)	17.2(37.9)

- The specifications in the datasheet is tested under STC conditions.
- In ambient condition, PV modules may have higher levels of voltage and current comparing with the data in STC conditions. According to IEC61730-1, all electrical characteristics such as Isc, Voc must be considered 25% more at the design stage for the nominal voltage, the conduction capacity, the fuse size, the controller capacity, etc.

Ambient Temperature		Correction Factor
Celsius (°C)	Fahrenheit (°F)	
25 ~ 10	77 ~ 50	1.06
9 ~ 0	49 ~ 32	1.10
-1 ~ -10	31 ~ 14	1.14
-11 ~ -20	13 ~ -4	1.18
-21 ~ -40	-5 ~ -40	1.25

4.2 Mechanical Loading

As the picture1, picture2 shows, a PV module has 2 mounting holes and 2 NOT USED HOLE at each side, a total of 8 holes. Please select outside mounting holes at each side. This can resist nominal load on the module surface of 5,400Pa (5,400N/m², 550kg/m², 112lb/ft²) at maximum.

5. Wiring

5.1 General

- All wiring should be matched with proper electrical codes, NEC (USA) or CEC (Canada).
- All wiring work should be done by a certified and authorized engineer.
- All wiring should be connected safely in order to prevent any hazard.
- All PV modules for one serial connection must be identical in terms of output, in types and manufacturer of solar cells.
- Do not connect PV modules directly in parallel without the junction box.

5.2 Module Wiring

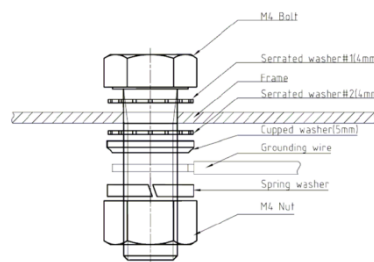
- Maximum system voltage should not exceed 1000[V] for IEC & 600[V] for UL.
- The maximum number of modules in parallel connection depends on inverter's capacity.
- PV modules are not designed to be connected to load directly. Therefore, a proper inverter must be connected.
- Bypass diodes are installed on the modules at the factory. Wrong connection may cause damage to the bypass diodes, cable and junction box.
- Fuse rating : Use 15A max series fuse. Fuse capacitance is calculated by using $I_{sc} \times 1.56$.

5.3 Array Wiring

'Array' is defined as a module arrangement with combined electrical connection. The array must be insulated to resist against the possible maximum open-circuit voltage. Also, solar irradiation-proof copper wires must be used for array wiring. Installers must check the local electrical specifications. In order to prevent cable drooping, installers should fix cable using wire or duct.

5.4 Earth Ground Wiring

To prevent electric shock and fire, an earthing must be done on the frames of PV modules and array. The array frame must be earthed according to NEC Article 250 (USA) or CEC (Canada). There is an earthing hole in the module frame; by using these holes, an earth conductor and the module frame must be connected and earthed. (See picture 6)

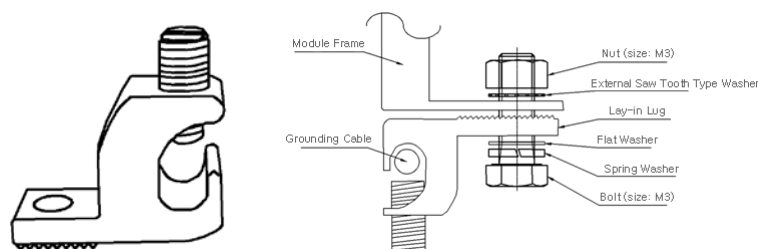


Picture 5. Grounding Hardware

1) Grounding using Lay-in Lug

It is necessary to ground module at earth hole (4.2mm / all frame) using GBL-4DBT Lay-in lug of ILSCO or a product certified of quality above. In order to connect module frame and Lay-in-lug electric more effectively, installers should use external saw tooth type washer or saw tooth type Lug and torque wrench(Torque level: 1.5 N-M).

The material for bolt, nut, washer and lug should be stainless steel.



Picture 6. Lay in Ground Lug

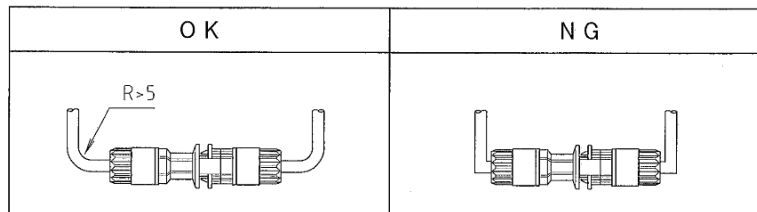
5.5 Module Terminations

The installer should connect cables using the same cable connector equipped in Each PV module. For more information about electrical connection, contact an authorized engineer of HHI.

5.6 Junction Box & Terminals

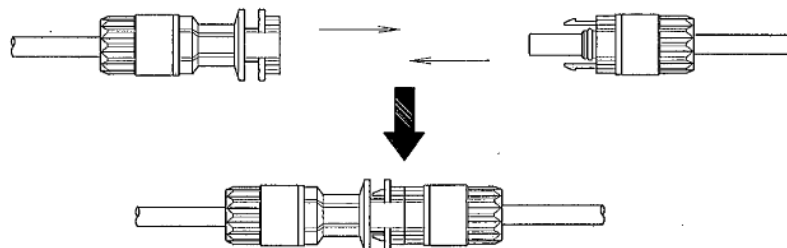
A PV module has the plus and minus connectors and a junction box with bypass diodes. On the junction box, the polarity is clearly marked (See the picture 12).

- 1) Protection Degree : IP65
- 2) Temperature Range : -40°C ~ +85°C
- 3) Wire Size : 4.0mm² (AWG 12)
- 4) The cable must not be bent or crushed on the direct exit of the cable screw joint. A minimum bending radius $R \geq 5$ x cable diameter must be maintained. The cable must be routed in a way that tensile stress on the conductor or connections is prevented.



Picture 7. Cable Routing

- 5) When connect connectors, insert connector until locking hook catches the holder and clicks. Pull each connector gently and make sure connectors are not disconnected.



Picture 8. Connect connectors

- 6) Do not give between the connector and cable a strong pull(over 10kg).
- 7) Do not apply external stress to the body of connector.

5.7 Conduit

For conduit application, it is necessary to follow the regulation for outdoor installation of conduit. All fixing parts should be protected from any damage and moisture.

6. Diodes

When there is partial shade on a PV module, reverse-voltage can circulate inside PV module. In order to protect this phenomenon, the diodes are normally installed in a Junction Box. HHI PV modules are equipped with bypass diodes. If installer wishes to apply additional diode, he or she should inform an authorized engineer of HHI.

7. Operation and Maintenance

It is required to perform regular inspection and maintenance of the modules, especially within warranty scope. It is the user's responsibility to report to the supplier regarding the damages found.

7.1 Cleaning

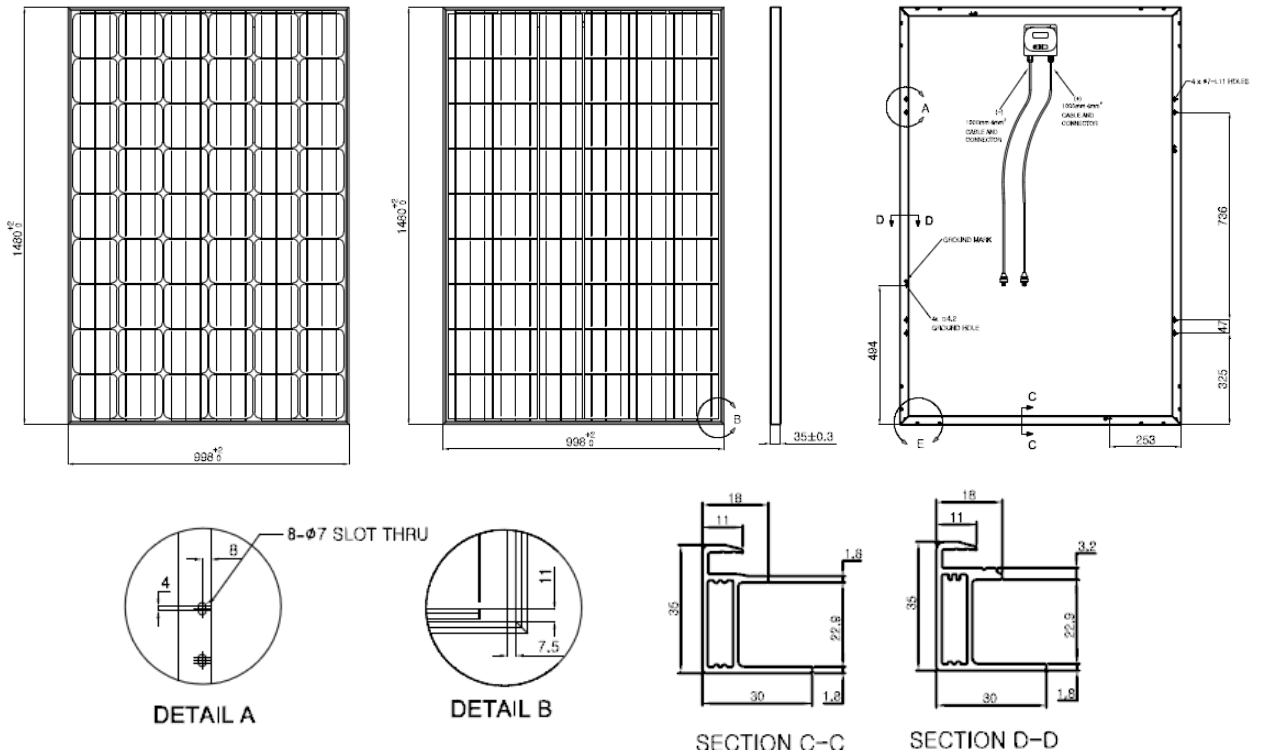
- HHI modules are designed for long life and require very little maintenance. Under most weather conditions, normal rainfall is sufficient to keep the module glass surface clean.
- Do not touch the glass since finger prints or stains will easily mark the glass.
- For AR coating HHI modules utilize special materials to increase energy harvest. Always use gloves when handling the module, never touch the glass with bare hands. If dirt build-up becomes excessive, clean the glass surface only with no heated water only. Normal water pressure is more than adequate.
- 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 or cleaning without consultation will invalidate the product warranty.
- PV modules that are mounted flat should be cleaned more often, as they will not "self-clean" as effectively as modules mounted at a 15° tilt or greater.
- Do not clean the back of the module. If cleaning the back of the module is required, please contact local representatives for more detailed information.

7.2 Visual Inspection of Modules

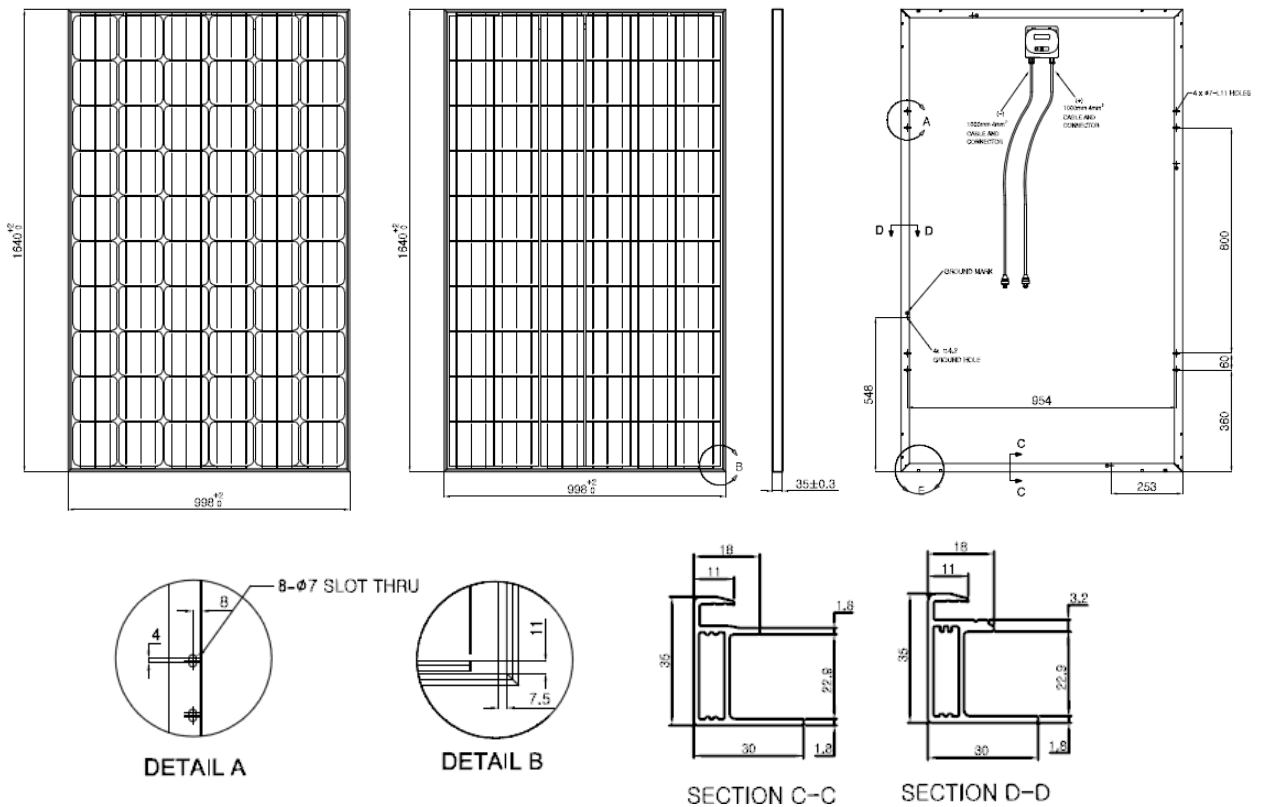
- Inspect the Modules visually to find whether there are appearance defects, the following need to be paid more attention especially:
 - 1) Whether the glass is broken
 - 2) Corrosion along the cells' bus-bar
 - 3) Whether there is burning vestige on the back-sheet.

7.3 Inspection of connector and Cable

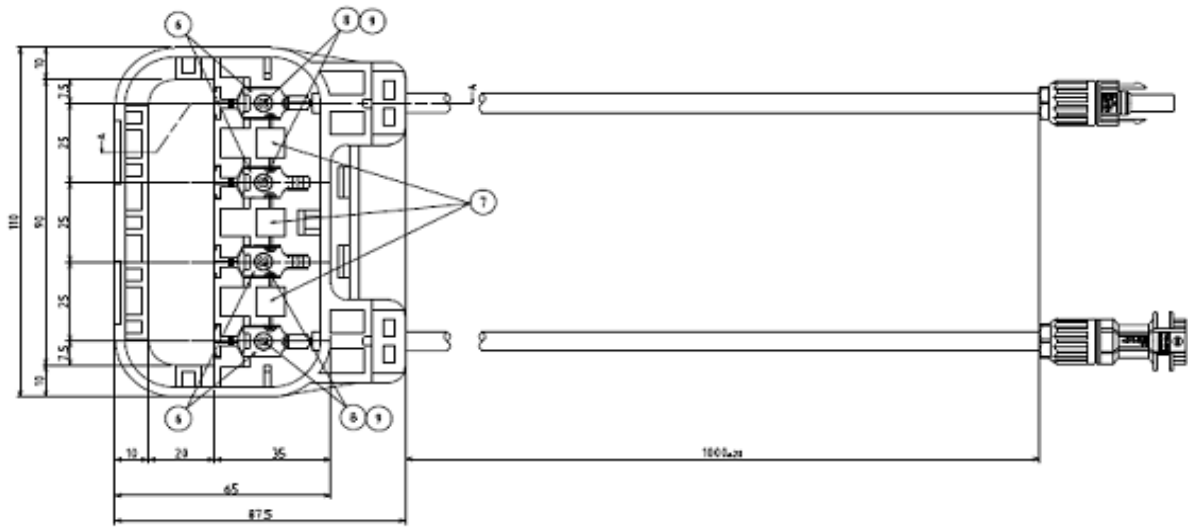
In order to ensure proper operation of the system, please check all wiring connections and the condition of the wire insulation periodically.



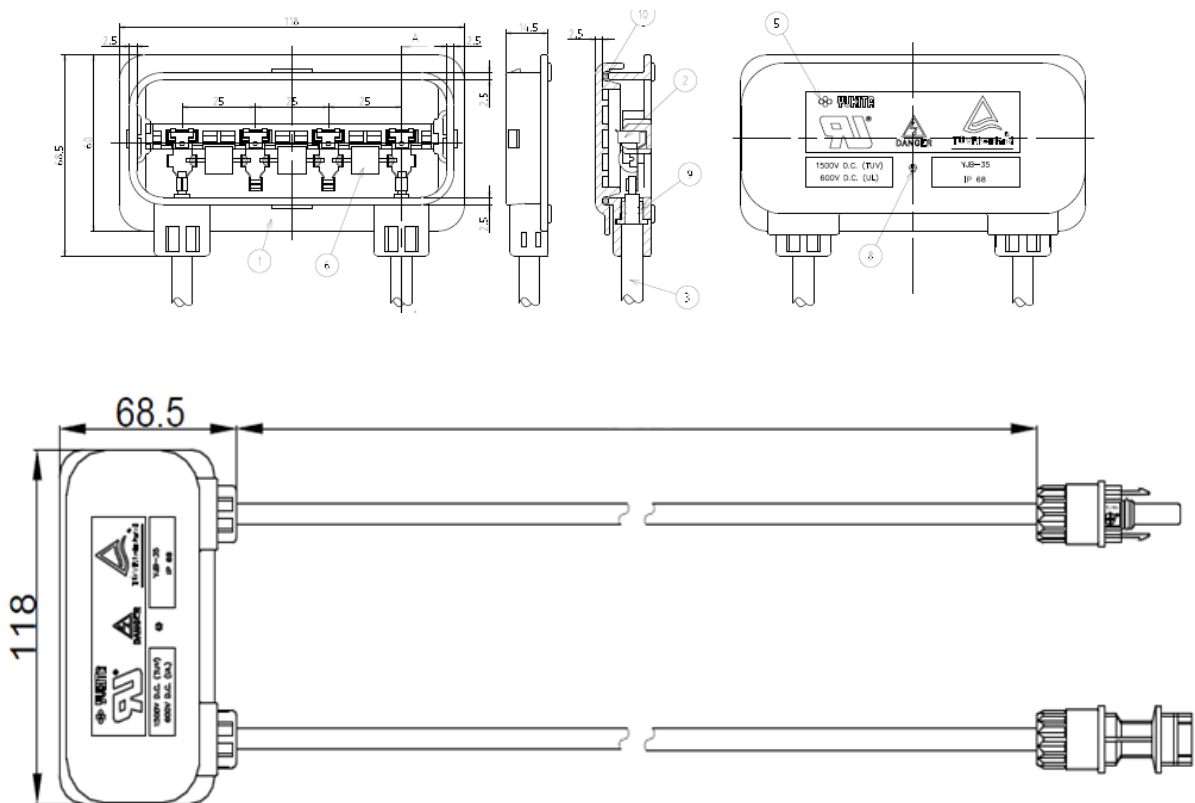
Picture 9. Standard module Layout & Ground position (HiS-MxxxRF/SxxxRF)



Picture 10. Standard module Layout & Ground position (HiS-MxxxRG/MxxxRG)



Picture 11. YJB-16 Junction box



Picture 12. YJB-35 Junction box

Appendix) Module Installation Instruction (HIS-MxxxRF, HIS-MxxxRG, HIS-SxxxRF, HIS-SxxxRG)

The installation methods which are described in Hyundai Heavy Industries installation Manual are covered by 2,400Pa Warranty.

Method		2400 Pa	5400 Pa
Bolting	Long Bar		
	Clamping	Long Bar	<p>Clamping Area $\leq L/4$</p>
Short Bar		<p>Clamping Area $\leq S/4$</p>	<p>$S/8 \leq$ Clamping Area $\leq S/4$</p>

Note 1) The certified mounting method is bolting method by TÜV Rheinland.

2) The Mounting method has been qualified by Hyundai Heavy Industries, and the mechanical load tests are based on IEC61215 ed.2.