

# INSTALLATION MANUAL

Effective April 4, 2017

## 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 Green Energy Co., Ltd. (hereafter referred to as “HHIGE”).
- 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.
- HHIGE 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 HHIGE modules. Each individual module has a unique serial number.

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

- YYMMDD : Production date
- XX : Internal admin number
- M(S)xxxXX : Model (xxx : Peak power at STC(Pmax)[W], XX : RF/RG/RI/TF/TG/TI)
- 0001(~9999) : Serial number

### 2.1 Disclaimer of Liability

- 1) HHIGE does not have any responsibility and liability for clause as below.
  - Loss, damage, injury or expense resulting from improper installation, handling or use. The installation techniques, handling and use of this product are beyond company control.
  - Infringement of any third party’s patent or right that is caused by using HHIGE modules.
  - Loss, damage, injury or expense resulting from any factor that is unsuspected the module was produced or shipped.
- 2) HHIGE reserves the rights for any change the technical specification including the PV production, the specifications, or the product information sheets without prior notice.

## 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. HHIGE can provide customers with fitted cables for easy installation. Installers should secure the safe installation status including all electrical hazards.

## 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 remove any labels.

## 2.5 CAUTION

- 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.
- Installers should be careful of module's sharp parts(ex: the edges of module)

## 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 by 4~6 mm<sup>2</sup>(10~12AWG) cable with adequate terminal connectors.

# 3. Installation

## 3.1 General

- Before installing and operating HHIGE 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, and Picture3.
- 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.
- 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 Performance Type1 or Type2.
- 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. HHIGE recommends handling modules 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.
- Do not install PV modules horizontally. Horizontal installation can cause performance drop of PV modules. HHIGE recommends mounting modules at a 12.5° tilt or greater.

### 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/m<sup>2</sup>, 550kg/m<sup>2</sup>, 112lb/ft<sup>2</sup>) on the front module surface
  - Below 2,400Pa (2,400N/m<sup>2</sup>, 244kg/m<sup>2</sup>, 50lb/ft<sup>2</sup>) on the back module surface
  - ※ If the wind strength is not over than 2,400Pa (2,400N/m<sup>2</sup>, 244kg/m<sup>2</sup>, 50lb/ft<sup>2</sup>), 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

The following actual site condition should be checked for adequate installations.

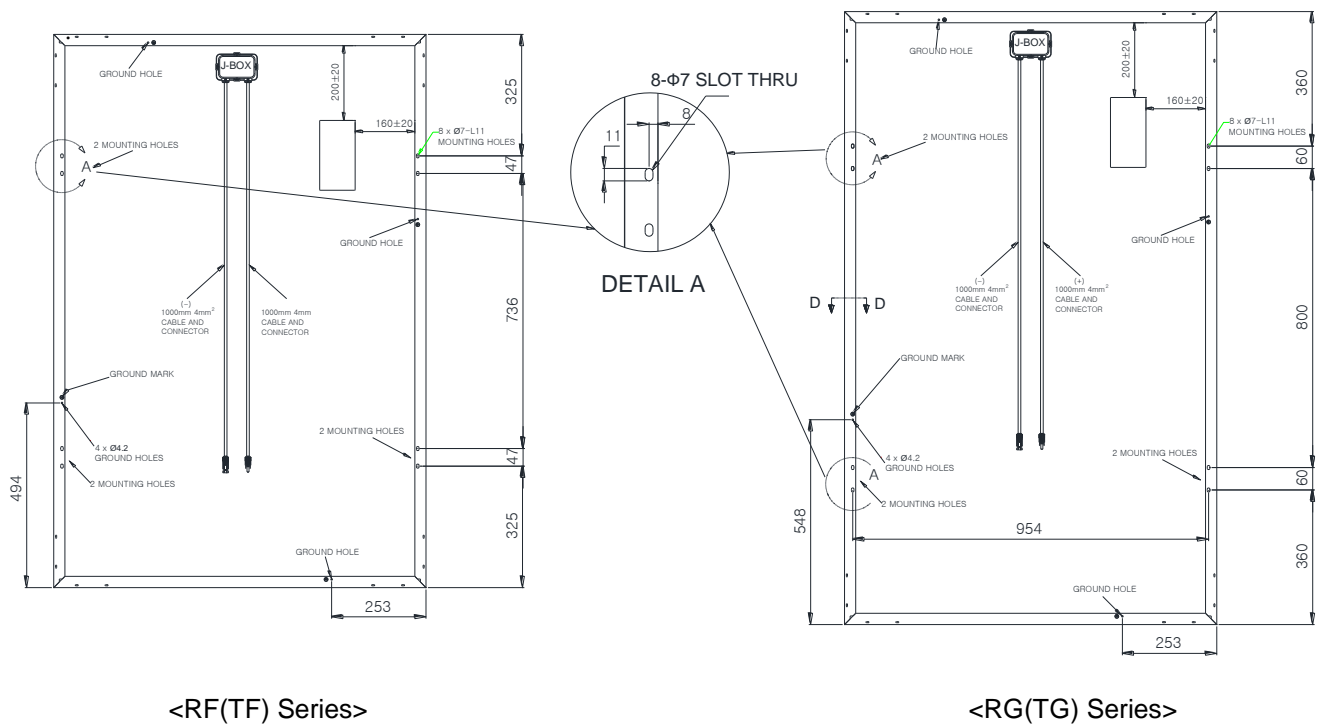
- Chloride is an important factor to be considered.
- Hail, heavy snow, and sand are important factors to be considered.
- Air pollution, chemical gas, acid rain, and smoke are important factors to be considered.
- PV modules shall not be installed in salty area within 500m from a body of salt water and/or area where salty wind hit directly. When PV modules are installed in 7km from a body of salt water, the

installer should check salt damage of the installed area.

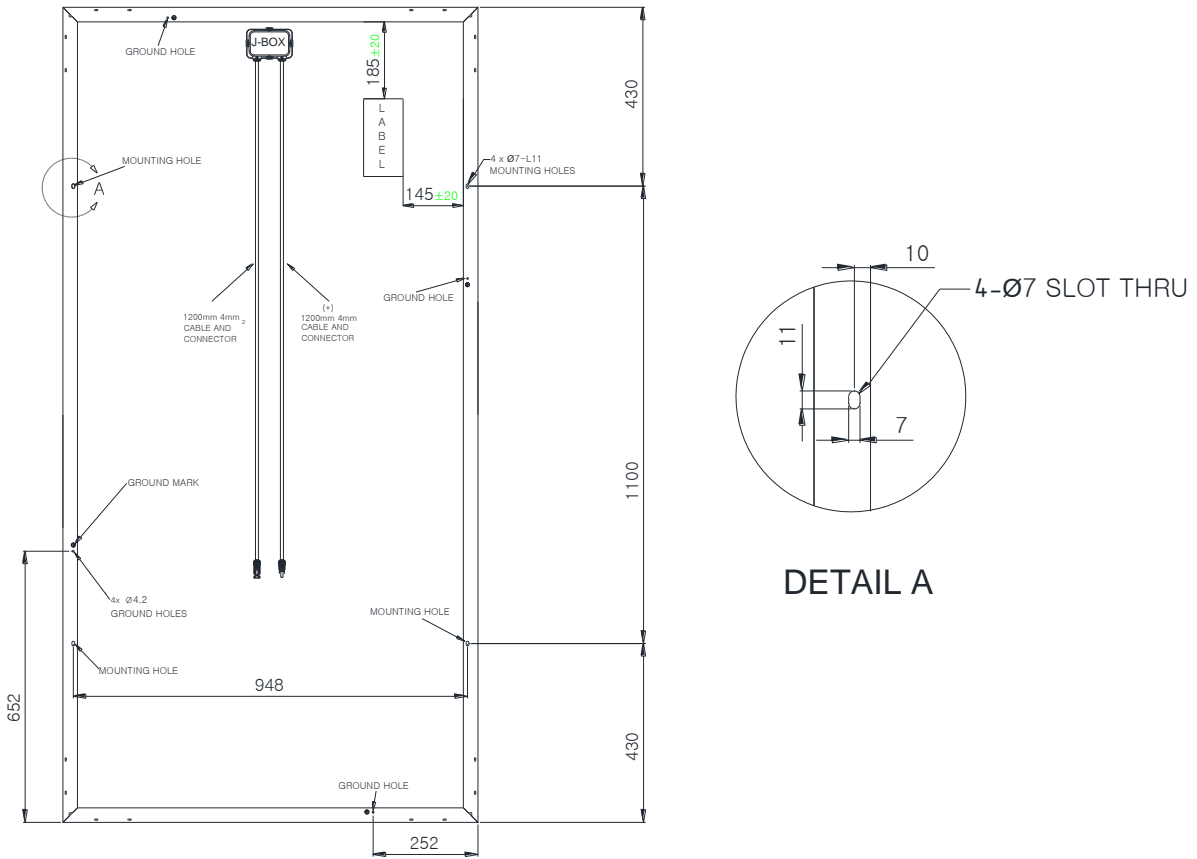
- PV modules shall not be immersed in water and shall not be continually exposure to Water from a sprinkler, fountain, etc.
- PV modules shall not be installed in sulfurous area near sulfurous volcano and sulfurous spring.
- If PV modules are installed near factory or plant area, they can be polluted by fumes and the pollution may not be cleaned. Thus the installer should consider and check the installation area and the distance from factory or plant area.
- If PV modules are installed in damp environments, the installer should check the installation area to see if there is a possibility that moss grows in PV modules.

### 3.4 Mounting Method

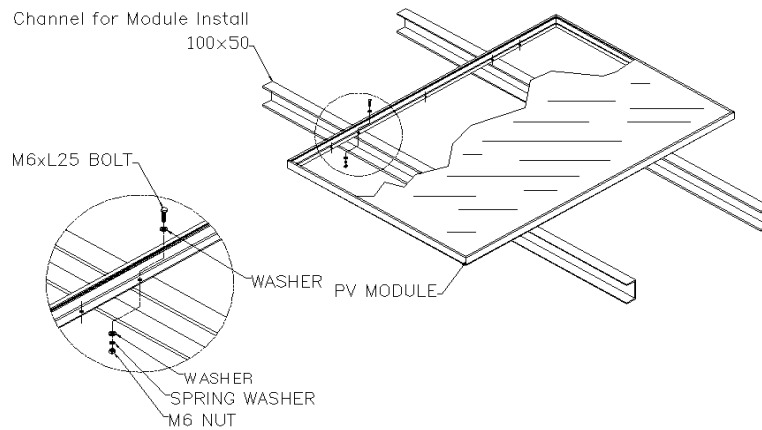
- Generally modules are fixed using mounting holes of long frame.
- Each module must be securely fixed at a minimum of 4 points on two each side of long frame or short frame.
- The mounting design must be certified by a registered professional engineer. The mounting design and procedures shall comply with local electrical and building codes.
- Mounting hardware is not provided by HHIGE.
- Mounting hardware like Picture 4. is highly recommended by clamping or bolt & nut mounting(Torque level: 4~5 N·M, M6 Bolt/Nut).
- Detailed mounting method is described in 'module installation instruction' in the appendix.



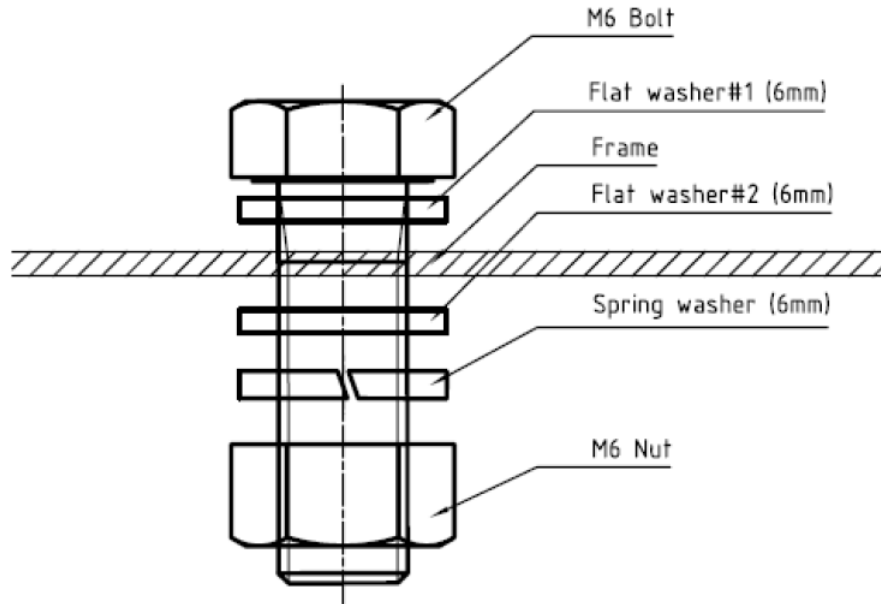
Picture 1. HiS-SxxxRF(TF) / -MxxxRF(TF) / -SxxxRG(TG) / -MxxxRG(TG) Hole Position



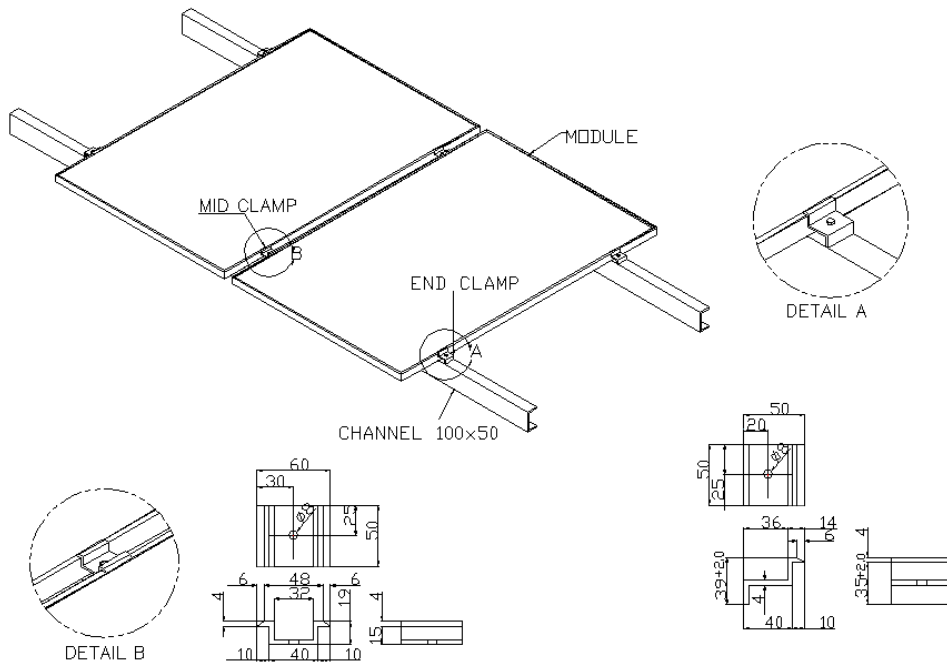
**Picture 2. HiS-SxxxRI(TI) / -MxxxRI(TI) Hole Position**



**Picture 3. Installation Method using bolt & nut**



**Picture 4. Mounting Hardware**



**Picture 5. Installation Method using clamping**

## 4. Specifications

### 4.1 Notes on Specification

- Electrical Characteristics : HiS-MxxxRF(TF) (Poly-Crystalline Si Type, 3/4 Bus Bar Type, 54 Cells)

Item	HiS-MxxxRF(TF) (xxx;Maximum Power Value)									
Maximum Power at STC(Pmax) [W]	210	215	220	225	230	235	240	245	250	255
Voltage at Pmax (Vmpp) [V]	27.4	27.5	27.6	27.8	27.9	28.0	28.2	28.3	28.4	28.6
Current at Pmax (Impp) [A]	7.7	7.8	8.0	8.1	8.2	8.4	8.5	8.7	8.8	8.9
Open circuit voltage (Voc) [V]	33.3	33.4	33.5	33.7	33.8	34.0	34.1	34.3	34.4	34.6
Short circuit current (Isc) [A]	8.2	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.4	9.5
Module efficiency [%]	14.2	14.6	14.9	15.2	15.6	15.9	16.3	16.6	16.9	17.2
Maximum Series Fuse Rating [A]	15									
Temp. coefficient of Pmpp [%/K]	-0.41									
Temp. coefficient of Voc [%/K]	-0.31									
Temp. coefficient of Isc [%/K]	0.039									
Output tolerance [%]	+3/-0									
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500									
Cell quantity in series [pcs]	54									
Bypass diodes [pcs]	3									
Cell Type	Poly-crystalline Silicon Cell									
Application & Safety Class	Class A & Class II									
Fire rating	Class C(IEC) / Type 1 or Type 2(UL)									

- Electrical Characteristics : HiS-SxxxRF(TF) (Mono-Crystalline Si Type, 3/4 Bus Bar Type, 54 Cells)

Item	HiS-SxxxRF(TF) (xxx;Maximum Power Value)											
Maximum Power at STC(Pmax) [W]	225	230	235	240	245	250	255	260	265	270	275	280
Voltage at Pmax (Vmpp) [V]	27.8	27.9	28.0	28.2	28.3	28.5	28.6	28.7	28.9	29.0	29.2	29.3
Current at Pmax (Impp) [A]	8.1	8.2	8.4	8.5	8.6	8.8	8.9	9.0	9.2	9.3	9.4	9.6
Open circuit voltage (Voc) [V]	33.9	34.0	34.2	34.3	34.5	34.6	34.7	34.9	35.0	35.2	35.3	35.5
Short circuit current (Isc) [A]	8.7	8.8	8.9	9.1	9.2	9.4	9.5	9.6	9.8	9.9	10.0	10.2
Module efficiency [%]	15.2	15.6	15.9	16.2	16.6	16.9	17.2	17.6	17.9	18.3	18.6	19.0
Maximum Series Fuse Rating [A]	15						20					
Temp. coefficient of Pmpp [%/K]	-0.40											
Temp. coefficient of Voc [%/K]	-0.29											
Temp. coefficient of Isc [%/K]	0.039											
Output tolerance [%]	+3/-0											
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500											
Cell quantity in series [pcs]	54											
Bypass diodes [pcs]	3											
Cell Type	Mono-crystalline Silicon Cell											
Application & Safety Class	Class A & Class II											
Fire rating	Class C(IEC) / Type 1 or Type 2(UL)											



· Electrical Characteristics : HiS-MxxxRG(TG) (Poly-Crystalline Si Type, 3/4 Bus Bar Type, 60 Cells)

Item	HiS-MxxxRG(TG) (xxx;Maximum Power Value)										
Maximum Power at STC(Pmax) [W]	235	240	245	250	255	260	265	270	275	280	285
Voltage at Pmax (Vmpp) [V]	30.5	30.6	30.7	30.9	31.0	31.1	31.3	31.4	31.5	31.7	31.8
Current at Pmax (Impp) [A]	7.8	7.9	8.0	8.1	8.2	8.4	8.5	8.6	8.7	8.8	9.0
Open circuit voltage (Voc) [V]	37.1	37.1	37.3	37.4	37.6	37.7	37.9	38.0	38.2	38.3	38.5
Short circuit current (Isc) [A]	8.3	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.5
Module efficiency [%]	14.4	14.7	15.0	15.3	15.6	15.9	16.2	16.5	16.8	17.1	17.4
Maximum Series Fuse Rating [A]	15										
Temp. coefficient of Pmpp [%/K]	-0.41										
Temp. coefficient of Voc [%/K]	-0.31										
Temp. coefficient of Isc [%/K]	0.039										
Output tolerance [%]	+3/-0										
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500										
Cell quantity in series [pcs]	60										
Bypass diodes [pcs]	3										
Cell Type	Poly-crystalline Silicon Cell										
Application & Safety Class	Class A & Class II										
Fire rating	Class C(IEC) / Type 1 or Type 2(UL)										

· Electrical Characteristics : HiS-SxxxRG(TG) (Mono-Crystalline Si Type, 3/4 Bus Bar Type, 60 Cells)

Item	HiS-SxxxRG(TG) (xxx;Maximum Power Value)										
Maximum Power at STC(Pmax) [W]	265	270	275	280	285	290	295	300	305	310	315
Voltage at Pmax (Vmpp) [V]	31.3	31.4	31.6	31.7	31.8	32.0	32.1	32.3	32.4	32.5	32.7
Current at Pmax (Impp) [A]	8.5	8.6	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.5	9.7
Open circuit voltage (Voc) [V]	38.1	38.2	38.4	38.5	38.7	38.8	39.0	39.1	39.2	39.4	39.5
Short circuit current (Isc) [A]	9.0	9.2	9.3	9.4	9.5	9.7	9.8	9.9	10.0	10.2	10.3
Module efficiency [%]	16.2	16.5	16.8	17.1	17.4	17.7	18.0	18.3	18.6	18.9	19.2
Maximum Series Fuse Rating [A]	15					20					
Temp. coefficient of Pmpp [%/K]	-0.40										
Temp. coefficient of Voc [%/K]	-0.29										
Temp. coefficient of Isc [%/K]	0.039										
Output tolerance [%]	+3/-0										
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500										
Cell quantity in series [pcs]	60										
Bypass diodes [pcs]	3										
Cell Type	Mono-crystalline Silicon Cell										
Application & Safety Class	Class A & Class II										
Fire rating	Class C(IEC) / Type 1 or Type 2(UL)										

· Electrical Characteristics : HiS-MxxxRI(TI) (Poly-Crystalline Si Type, 3/4 Bus Bar Type, 72 Cells)

Item	HiS-MxxxRI(TI) (xxx;Maximum Power Value)										
Maximum Power at STC(Pmax) [W]	290	295	300	305	310	315	320	325	330	335	340
Voltage at Pmax (Vmpp) [V]	35.4	35.6	35.8	36.0	36.0	36.2	36.4	36.6	36.8	37.1	37.4
Current at Pmax (Impp) [A]	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.8	8.9	9.0	9.1
Open circuit voltage (Voc) [V]	44.5	44.7	44.9	45.1	45.3	45.5	45.7	45.9	46.1	46.3	46.5
Short circuit current (Isc) [A]	8.5	8.6	8.7	8.8	8.9	9.0	9.0	9.1	9.2	9.3	9.4
Module efficiency [%]	14.8	15.1	15.3	15.6	15.8	16.1	16.4	16.6	16.9	17.1	17.4
Maximum Series Fuse Rating [A]	15										
Temp. coefficient of Pmpp [%/K]	-0.41										
Temp. coefficient of Voc [%/K]	-0.31										
Temp. coefficient of Isc [%/K]	0.039										
Output tolerance [%]	+3/-0										
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500										
Cell quantity in series [pcs]	72										
Bypass diodes [pcs]	3										
Cell Type	Poly-crystalline Silicon Cell										
Application & Safety Class	Class A & Class II										
Fire rating	Class C(IEC) / Type 1 or Type 2(UL)										

· Electrical Characteristics : HiS-SxxxRI(TI) (Mono-Crystalline Si Type, 3/4 Bus Bar Type, 72 Cells)

Item	HiS-SxxxRI(TI) (xxx;Maximum Power Value)										
Maximum Power at STC(Pmax) [W]	325	330	335	340	345	350	355	360	365	370	375
Voltage at Pmax (Vmpp) [V]	37.8	38.0	38.2	38.4	38.6	38.7	38.9	39.1	39.3	39.5	39.7
Current at Pmax (Impp) [A]	8.6	8.7	8.8	8.9	9.0	9.0	9.1	9.2	9.3	9.4	9.4
Open circuit voltage (Voc) [V]	46.1	46.3	46.5	46.7	46.9	47.1	47.3	47.4	47.6	47.8	48.0
Short circuit current (Isc) [A]	9.2	9.3	9.4	9.5	9.6	9.6	9.7	9.8	9.9	9.9	10.0
Module efficiency [%]	16.6	16.9	17.1	17.4	17.6	17.9	18.1	18.4	18.7	18.9	19.2
Maximum Series Fuse Rating [A]	15						20				
Temp. coefficient of Pmpp [%/K]	-0.40										
Temp. coefficient of Voc [%/K]	-0.29										
Temp. coefficient of Isc [%/K]	0.039										
Output tolerance [%]	+3/-0										
Maximum system voltage [Vdc]	IEC: 1,000 / UL: 600 or 1,000 or 1,500										
Cell quantity in series [pcs]	72										
Bypass diodes [pcs]	3										
Cell Type	Mono-crystalline Silicon Cell										
Application & Safety Class	Class A & Class II										
Fire rating	Class C(IEC) / Type 1 or Type 2 (UL)										

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

Description	HiS-MxxxRF(TF)/HiS-SxxxRF(TF)
Length, mm(inches)	1,480(58.3) +2/-0
Width, mm(inches)	998(39.3) +2/-0
Depth, mm(inches)	35 (1.38) ± 0.3
Weight, kg(pounds)	17.4(38.4)

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

Description	HiS-MxxxRG(TG)/HiS-SxxxRG(TG)
Length, mm(inches)	1,640(64.6) +2/-0
Width, mm(inches)	998(39.3) +2/-0
Depth, mm(inches)	35 (1.38) ± 0.3
Weight, kg(pounds)	18.7(41.2)

· Mechanical Characteristics (HiS-MxxxRI(TI)/HiS-SxxxRI(TI))

Description	HiS-MxxxRI/HiS-SxxxRI
Length, mm(inches)	1,960 (77.2) +2/-0
Width, mm(inches)	998 (39.3) +2/-0
Depth, mm(inches)	50 (1.97) / 40 (1.57) ± 0.3
Weight, kg(pounds)	23.2 (51.1) / 23.0 (50.7)

- The specifications in the datasheet are tested under STC. Under actual(field) conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. There are different standards of electric/safety, HHIGE recommend that customers follow applied standards depending on their certification and country. For the case of under UL standard, the requirements of the National Electrical Code (NEC) in Article 690 shall be followed to address these increased outputs. In installations not under the requirements of the NEC(According to IEC61730-1), the values of ISC and VOC marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor capacities, overcurrent device ratings, and size of controls connected to the PV output.

### ※ UL Fire Rating

The modules in the specified construction site shown by table below, when used with a listed mounting system that has been rated as a Class A System or when installed with type 1 or type2 modules, is suitable to maintain the System Class A Fire Rating.

Module model	Specific construction	Marking
HiS-SXXXRF(TF) HiS-MXXXRF(TF) HiS-SXXXRG(TG)	Superstrate: 3.2 ~ 4.0 mm thick; EVA: 0.25 ~ 0.45mm thick; Substrate: 0.3 mm ~ 0.64 mm thick;	Module Fire Performance: Type 1
HiS-MXXXRG(TG) HiS-SXXXRI(TI) HiS-MXXXRI(TI)	Superstrate: 3.2 ~ 4.0 mm thick; EVA: 0.25 ~ 0.45mm thick; Substrate: 0.253mm ~ 0.3 mm thick;	Module Fire Performance: Type 2

## 5. Wiring

### 5.1 General

- All wiring should be matched with acceptable regional and local electrical codes. (Ex: NEC (USA), 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 and in types.
- Do not connect PV modules directly in parallel without the combine box.

### 5.2 Module Wiring

- System voltage should not exceed the maximum system voltage of module. Refer to the table of clause 4.1 Notes on specification.
- 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: Fuse capacitance is calculated by using  $I_{sc} \times 1.56$  according to NEC. Refer to the table of clause 4.1 Notes on specification.

### 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

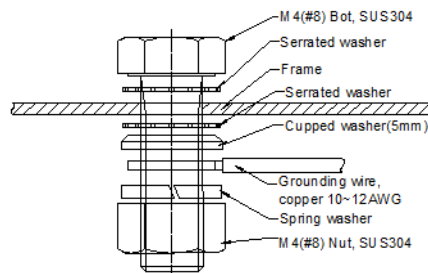
To prevent electric shock and fire, an earthing must be done on the frames of PV modules and array. The array frame must be earthed according to NEC Article 250 (USA) or CEC (Canada).

### 1) Grounding hardware

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)

Common grounding hardware (nuts, bolts, star washers, spilt-ring lock washer, flat washers and the like) is used to attach a listed grounding/bonding device. The attachment must be made in conformance with the grounding device manufacturer's instructions.

Common hardware items such as nuts, bolts, star washers, lock washers and the like have not been evaluated for electrical conductivity or for use as grounding devices and should be used only for maintaining mechanical connections and holding electrical grounding devices in the proper position for electrical conductivity. Such device, where supplied with the module and evaluated through the requirements in UL 1703, may be used for grounding connections in accordance with the instructions provided with the module.

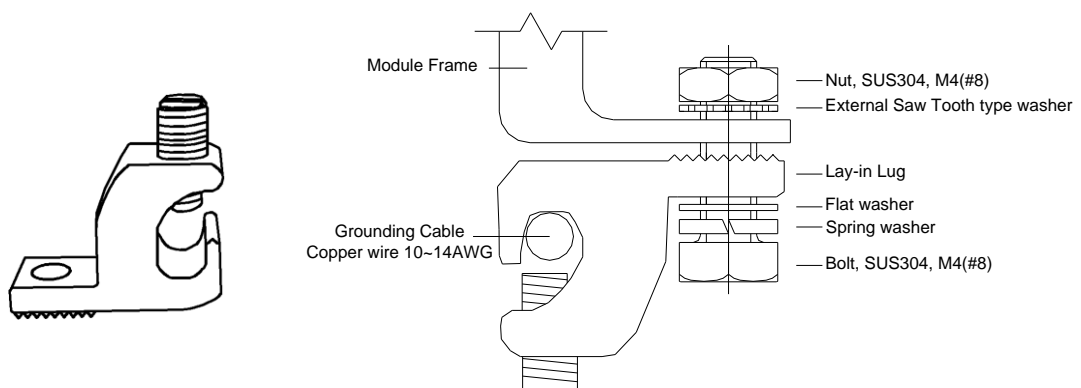


Picture 6. Grounding Hardware(Torque level: 4~5N·m)

### 2) 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.

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



Picture 7. Lay in Ground Lug(Torque level: 1.5N·m)

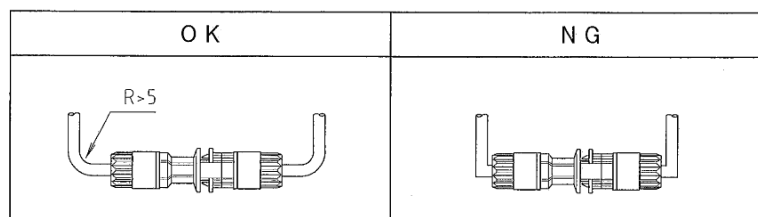
## 5.5 Module Terminations

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 HHIGE.

## 5.6 Junction Box & Terminals

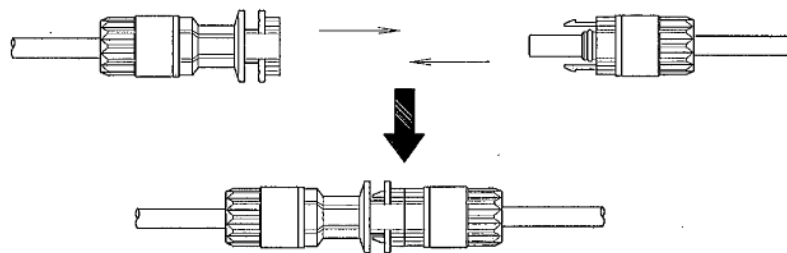
A PV module has the plus and minus connectors and a junction box with bypass diodes. On the junction box, the polarity is clearly marked.

- 1) Protection Degree : IP67 or greater
- 2) Temperature Range : -40°C ~ +85°C
- 3) Wire Size : 4.0mm<sup>2</sup> (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 8. 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 9. 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.
- 8) Do not place the connector in water.
- 9) If the connectors need to be disconnected, installer should use the exclusive tool to disconnect them after safety measure such as cut-off of connection band.
- 10) Connected cables and connectors should be fixed.
- 11) Action against contamination or corrosion should be enacted on disconnected connectors.

## 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 occur inside PV module. In order to protect this phenomenon, the diodes are normally installed in a Junction Box. HHIGE PV modules are equipped with bypass diodes. If installer wishes to change into other diodes, the installer should inform an authorized engineer of HHIGE.

## 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

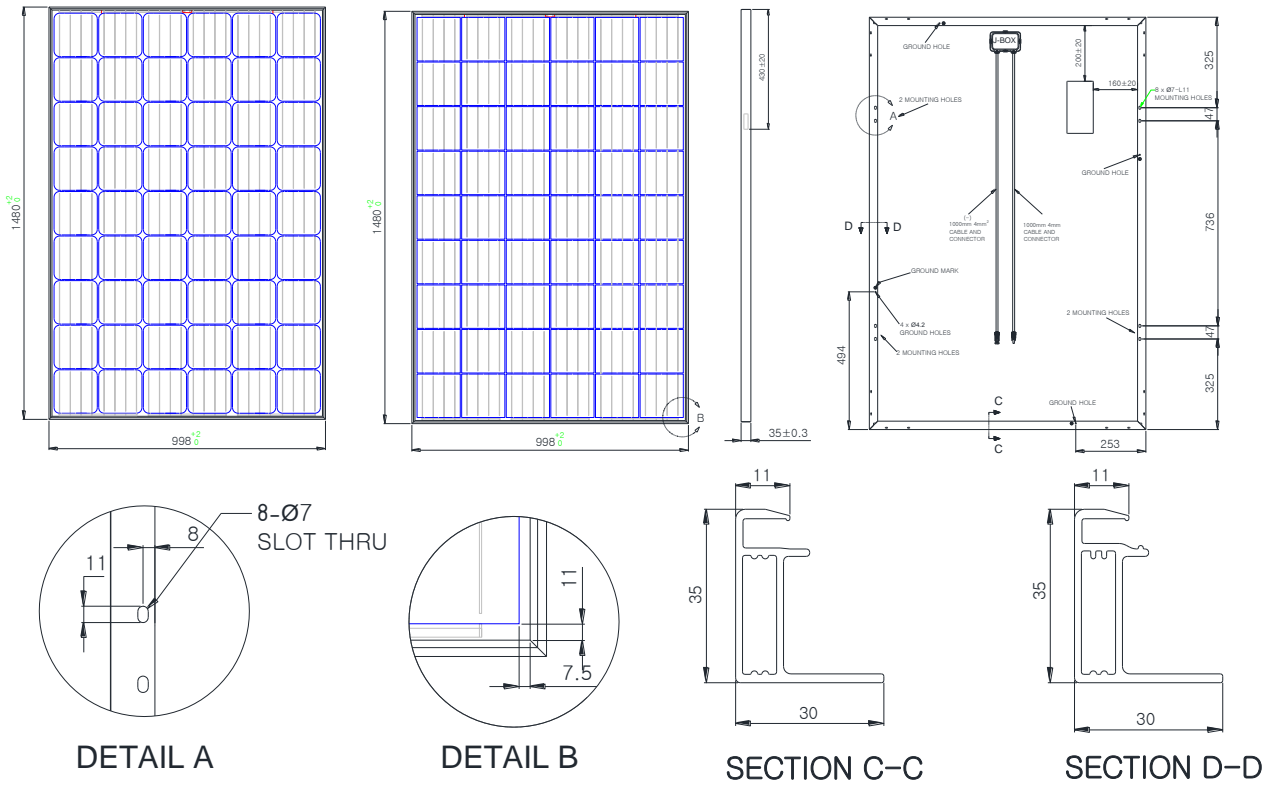
- HHIGE modules are designed for long life and require very little maintenance. Under most weather conditions, normal rainfall is sufficient to keep the module glass surface clean.
- For AR coating HHIGE modules utilize special materials to increase energy harvest. Always use clean gloves when handling the module, never touch the glass with bare hands.
- If dirt build-up becomes excessive, clean the glass surface with room temperature water. Do not use water with high pressure for cleaning. 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 will invalidate the product warranty.
- 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.
- PV modules will be "self-clean" as effectively as modules mounted at a 15° tilt or greater.

### 7.2 Visual Inspection of Modules

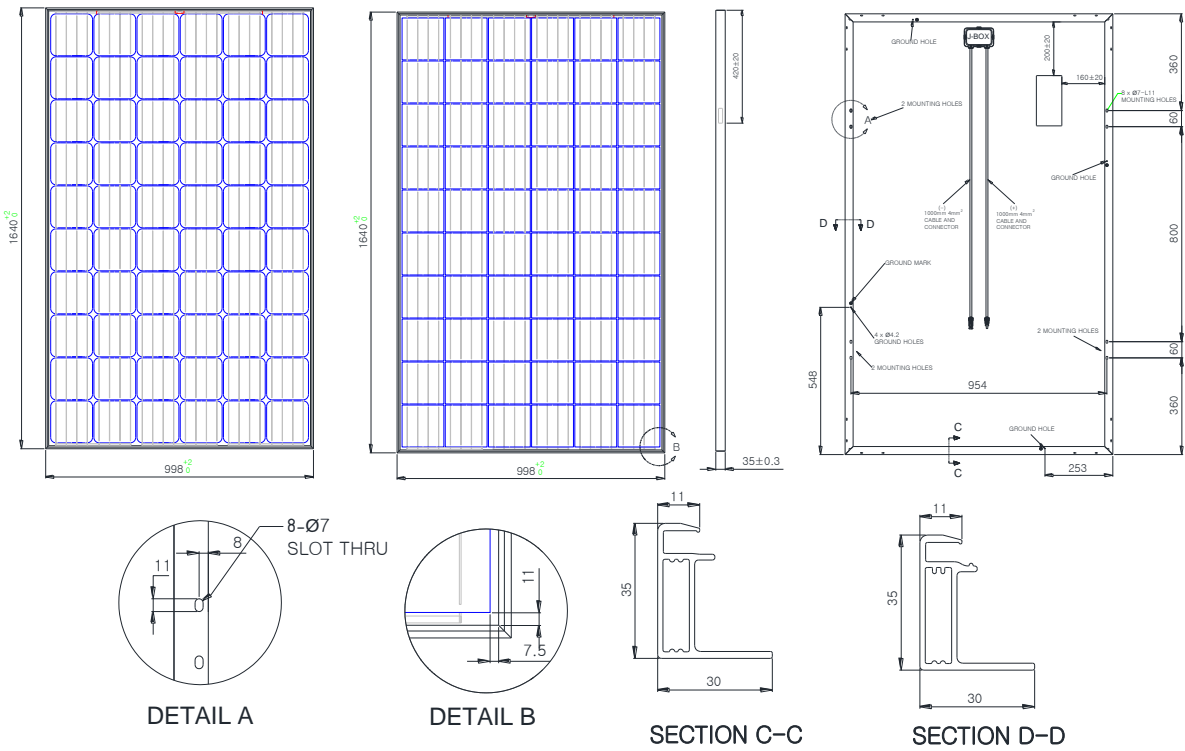
- Inspect the Modules visually to find whether there are appearance defects, the following need to be paid more attention especially:
  - 1) Whether the glass is broken
  - 2) Corrosion along the cells' bus-bar
  - 3) Whether there is burning vestige on the back-sheet.

### 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.

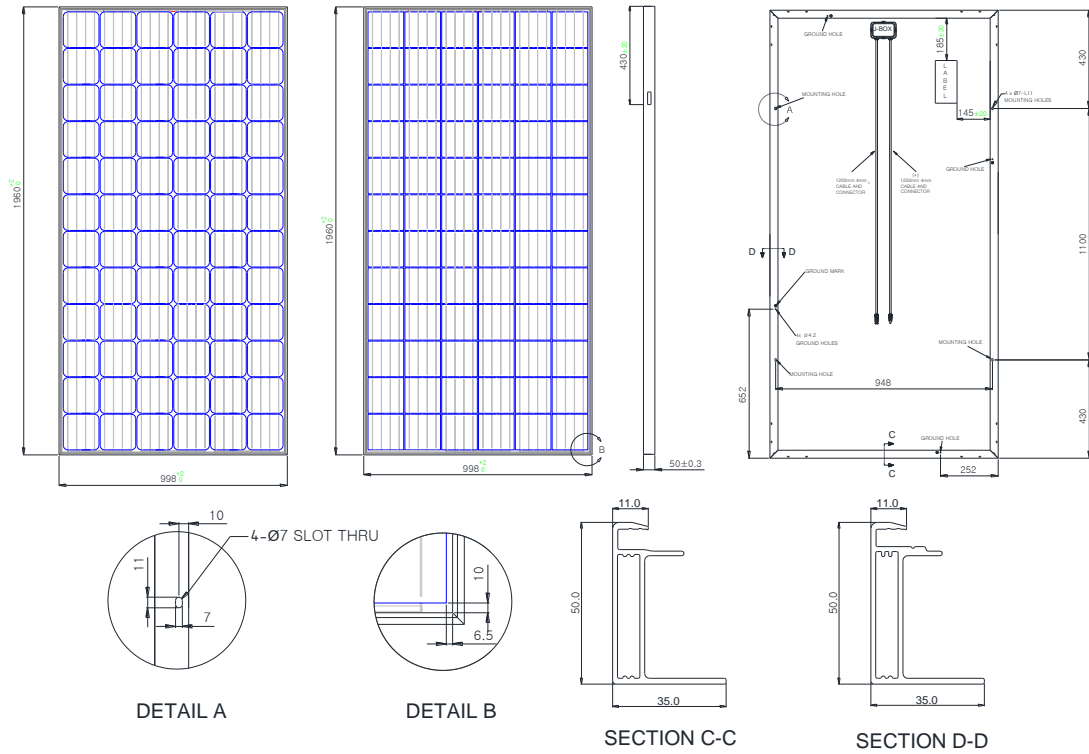


Picture 10. Layout & Ground position (HiS-SxxxRF(TF)/MxxxRF(TF))

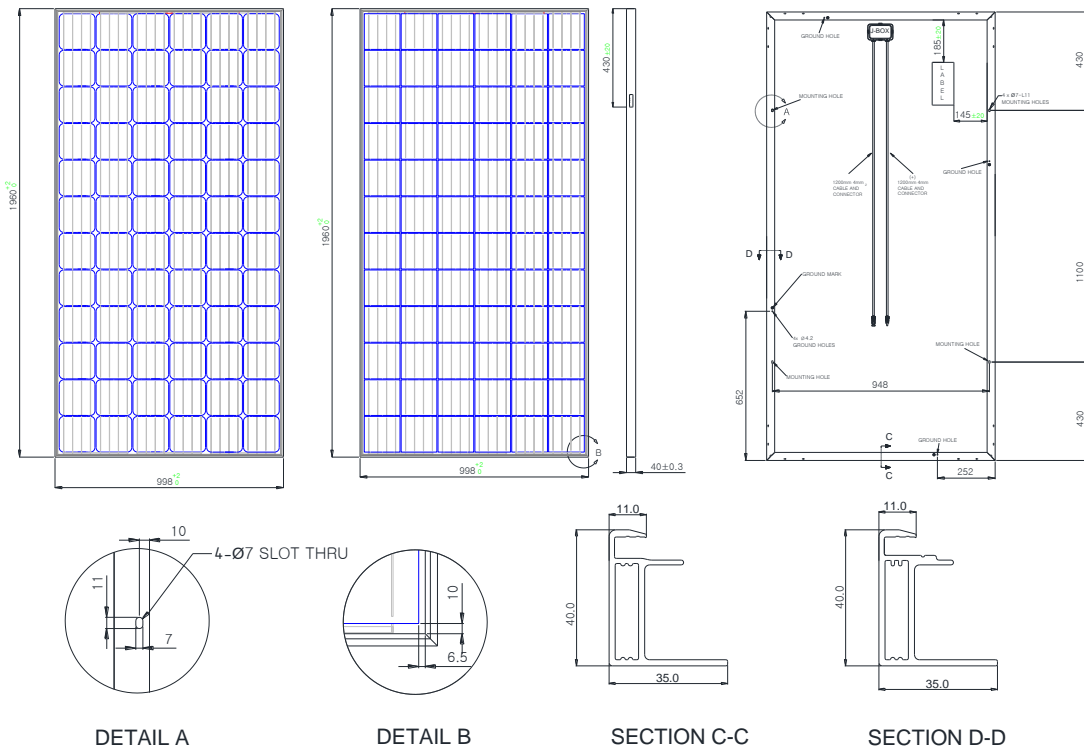


Picture 11. Layout & Ground position (HiS-SxxxRG(TG)/MxxxRG(TG))





**Picture 12. Layout & Ground position (HiS-SxxxRI(TI)/HiS-MxxxRI(TI), 50mm frame)**



**Picture 13. Layout & Ground position (HiS-SxxxRI(TI)/HiS-MxxxRI(TI), 40mm frame)**

**Appendix) Module Installation Instruction (HIS-M/SxxxRF(TF), HIS-M/SxxxRG(TG), HIS-M/SxxxRI(TI))**

Method		2400 Pa	5400 Pa
<b>Bolting</b>	Long Bar		
	<b>Clamping</b>	<p>Clamping Area <math>\leq L/4</math></p>	<p><math>L/8 \leq</math> Clamping Area <math>\leq L/4</math></p>
※ Min. clamping width: 2"(50mm)		<p>Clamping Area <math>\leq S/4</math></p>	<p><math>S/8 \leq</math> Clamping Area <math>\leq S/4</math></p>

Note 1) The certified mounting method is bolting method by VDE  
 2) The Mounting method has been qualified by Hyundai Heavy Industries Green Energy, and the mechanical load tests are based on IEC61215 ed.2.