

# HES INSTALLATION MANUAL (IEC)

Issued on Apr. 18<sup>th</sup>, 2022

## 1. General Information

- This Installation manual contains information regarding the installation and the safe handling method of the photovoltaic shingled module (hereafter referred to as “**module**”) supplied by Hyundai Energy Solutions Co., Ltd. (hereafter referred to as “**HES**”) which is as follows,
  - HiE-SxxxSG: 340 pieces, 325-360W, 1500V / HiE-SxxxSI: 408 pieces, 395-435W, 1500V
  - HiE-SxxxUG: 340 pieces, 350-380W, 1500V / HiE-SxxxUI: 408 pieces, 420-455W, 1500V
  - HiE-SxxxUF: 360 pieces, 370-400W, 1500V / HiE-SxxxUH: 432 pieces, 455-480W, 1500V
  - HiE-SxxxVG: 340 pieces, 380-415W, 1500V / HiE-SxxxVI: 408 pieces, 460-500W, 1500V
- System users and installers should read and understand this manual before handling, installing the module. Please contact Customer Support department or our local representatives for more detailed information.
- Before installing solar photovoltaic systems, 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 consider every safety precautions specified in this manual and local codes when installing a module.
- HES 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.

### 1.1

#### NOTICE

- Installing solar photovoltaic systems requires specialized skills and knowledge. Thus, before installation, wiring, and operation of photovoltaic modules, system users and installer should understand and conform to this manual.
- Installation and wiring should only be performed and supervised by qualified persons.
- Each module has a junction box for permanent cable connection. HES can provide customers with

fitted cables for easy installation. Installers should secure the safe installation status including all electrical hazards.

## 1.2



- Installers should secure the installation status, without limitation, including the risk of electric shock.
- Backsheet 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. 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.

## 1.3



- Before installation, recommend preventing 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.

#### 1.4



- 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)

### 1.5 General Safety

The following requirements should be kept during installation and inspection.

- Check the inspection requirements by authorized personnel.
- 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. Transportation, Storage and Unpacking

- Modules are packaged vertically. They should also be vertical during transportation.
- Check tension of banding tapes before transportation. Be cautious of abnormal shock for vehicles and modules which might cause module damage and cell crack during transportation. Store the modules safely in a dry and cool environment.

- Do not stack or move more than two packages of modules which are stacked vertically.
- Workers are recommended to keep some distance from the package when one worker cuts banding tapes. Don't lift the package after removing banding tapes.
- After unpacking, please visually check if there is no problem on modules. Install modules and components without any defect.
- When carrying modules, do not hold cables or junction box. Carry by holding frames with two hands.
- Carry one module at one time.

### 3. Installation Environment

#### 3.1 General

- Before installing and operating HES 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 Picture 1.
- Secure the module using mounting holes provided and 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 HES or 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 50mm of standoff height is necessary.
- The minimum distance between two fixed modules for linear thermal expansion of the module frame supports should be 10 mm. Nevertheless, the recommended distance between two modules is 30 mm 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 1.5 mm, 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. HES 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 6.2.
- Do not install PV modules horizontally. Horizontal installation can cause performance drop of PV modules. HES recommends mounting modules at a 10° tilt or greater.

### 3.3 Installation Site

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 Site Conditions

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

(1) Sea level of site : Below 1,000 m (3,280 ft)

(2) Maximum Instantaneous wind Speed (design load, safety factor = 1.5)

- Below 2,400Pa or 3,600Pa on the front module surface
- Below 1,600Pa or 2,400Pa on the back module surface
- ※ If the wind strength is not over than 2,400Pa (2,400 N/m<sup>2</sup>, 245 kg/m<sup>2</sup>, 50 lb/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

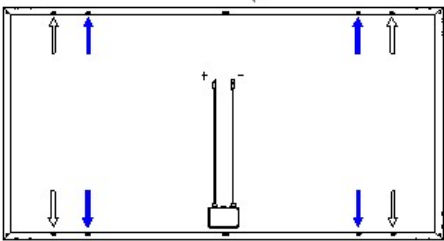


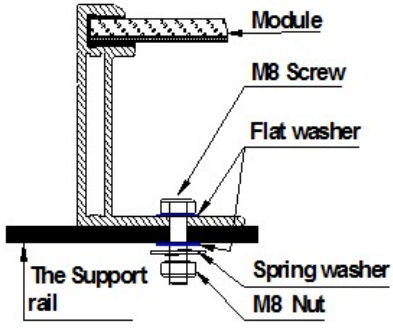
The following actual site condition should be checked for adequate installations.

- Hail, heavy snow, and sand are to be considered as important factors related to module damage and power output decline.
- HES recommend installing lightning rods in lightning-expected areas and SPD (Surge Protection Device) for surge.
- Air pollution, chemical gas, acid rain, and smoke are important factors to be considered.
- Do not use PV modules in place of normal roofing.

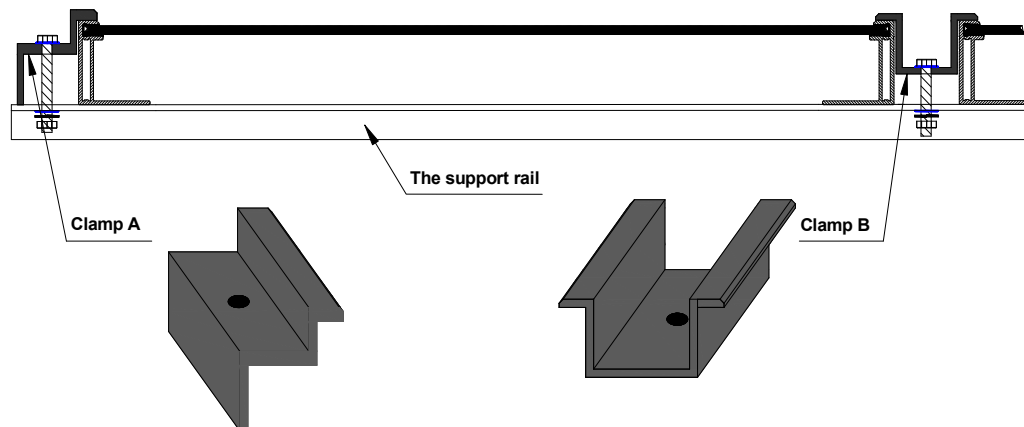
- PV modules are not recommended to be installed where salt-mist will hit directly. HES PV modules have passed IEC61701 salt-mist, but galvanic corrosion can occur between the aluminum frame of the modules and mounting or grounding hardware if such hardware is comprised of dissimilar metals. Tongwei modules can be installed at seaside locations 50m to 500m from the sea, but the modules should be protected against corrosion. For locations  $\geq 500\text{m}$  from the sea, it is low risk with salt-mist corrosion, only annual preventive maintenance is required. When PV modules are installed within 7km from a body of salt water, the installer should check for salt damage at the proposed install location and implement salt-mist corrosion preventive measures, which are not scratching the corrosion-resistant coating of the modules and mounting system, installing modules at a minimum tilt of 10 degrees.
- 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.
- In a harsh, hot, and humid environment, HES recommends using (-) grounding to inverters.
- Do not install PV modules indoors or on moving objects.

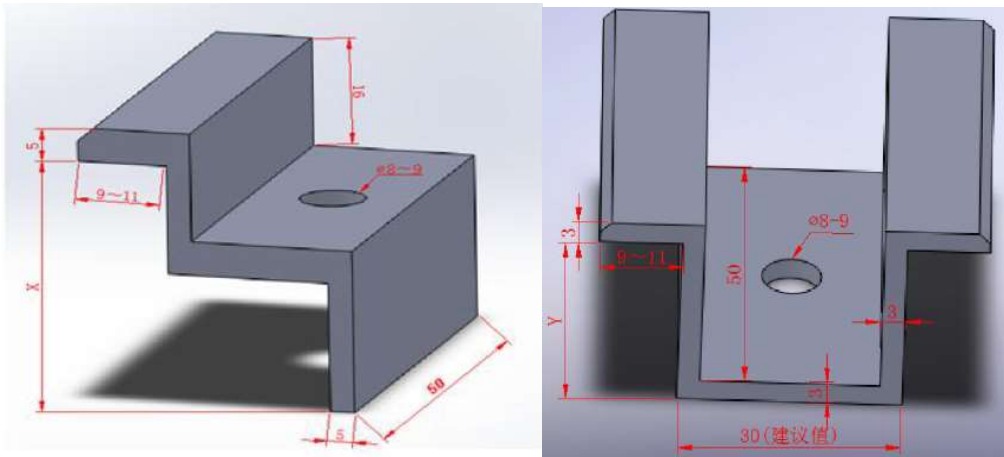
## 4. Installation

- Generally modules are fixed using mounting holes or clamp hardware.
- Each module must be securely fixed at a minimum of 4 – 8 points on two each side of long 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 HES.
- Mounting hardware like those in Picture 1 & 2 is highly recommended by clamping or bolt & nut mounting (Torque level: 16 N·m for bolting method, 8 N·m for clamping). The material of bolts and nuts are recommended as stainless steel.
- Area of module frame fastened by each clamp shall be no less than 400 mm<sup>2</sup>. (*clamp length  $\geq 50\text{mm}$ , the clamped width of module frame shall be in this area: 8-11mm*)
- Detailed mounting method is described in 'module installation instruction' in the Appendix 1.

Mounting holes location <sup>Ⓢ</sup>	Screw bolts fasten method <sup>Ⓢ</sup>	Recommend accessories <sup>Ⓢ</sup>		
		Part name <sup>Ⓢ</sup>	material <sup>Ⓢ</sup>	dimension <sup>Ⓢ</sup>
 <p>  Under low wind pressure and snow load conditions, these mounting holes should be used.   Under high wind pressure and snow load conditions, these mounting holes must also be used.         </p>		screw <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8×16mm <sup>Ⓢ</sup>
		spring washer <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>
		flat washer <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>
		Nut <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>

Picture 1. Installation Method using stainless steel bolt & nut





Fixture A: Fixture for edge module Fixture

B: Fixture for intermediate modules

For the 35\*35 frame, the recommended value of X is 34mm

For the 35\*35 frame, the recommended value of X is 25mm

For the 40\*35 frame, the recommended value of X is 39mm

For the 40\*35 frame, the recommended value of X is 30mm

**Picture 2. Mounting Hardware (Clamp)**

## 5. Wiring

### 5.1 General

- All wiring should be matched with acceptable regional and local electrical codes.
- All wiring work should be done by certified and authorized engineers.
- 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.

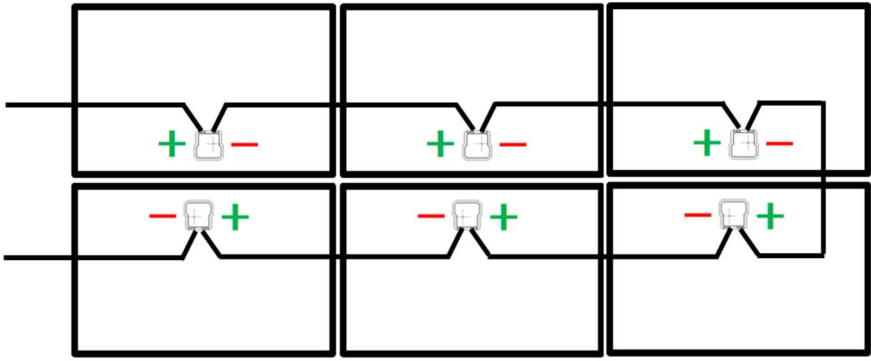
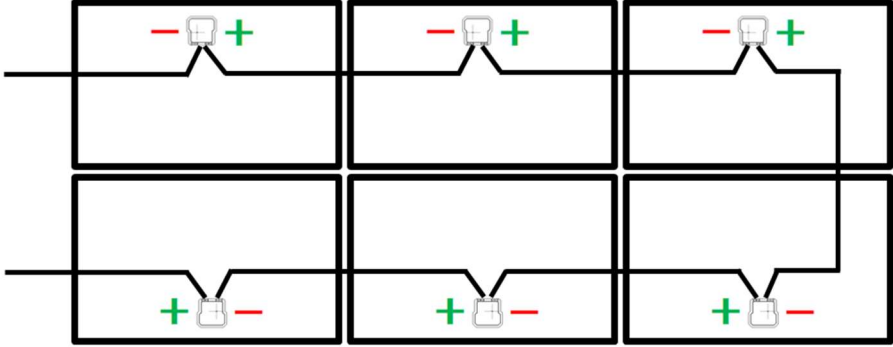
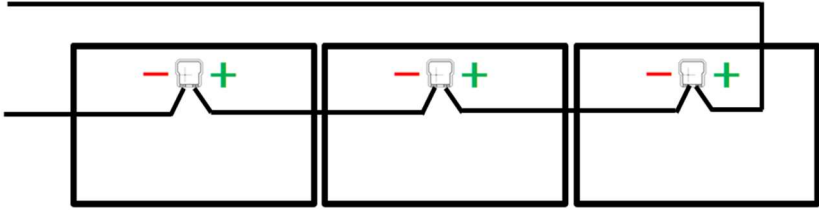
### 5.2 Module Wiring

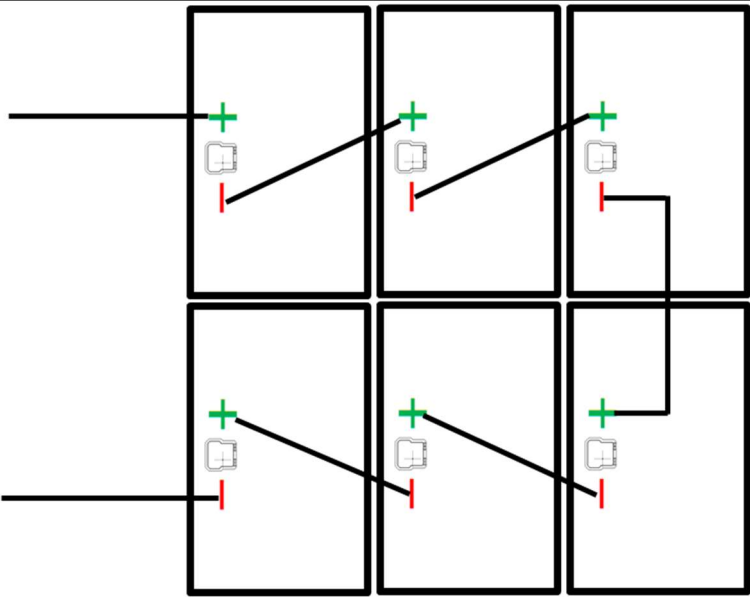
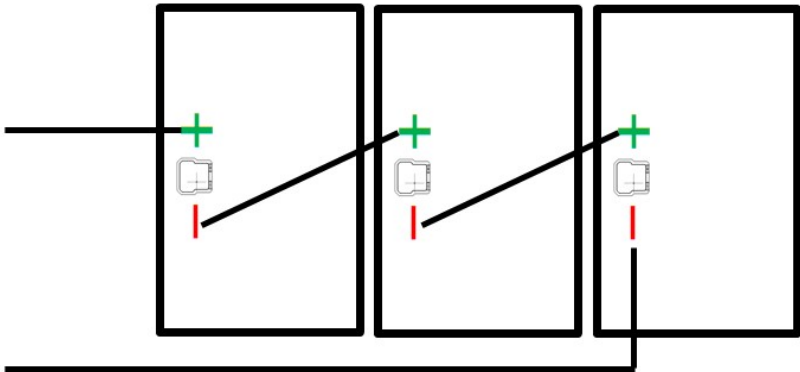
- System voltage should not exceed the maximum system voltage of module.
- The maximum number of modules in parallel connection depends on inverter's capacity.
- PV modules are not designed to be connected to load directly. Therefore, a proper inverter must be connected.
- Bypass diodes are installed on the modules at the factory. Wrong connection may cause damage to the bypass diodes, cable and junction box.
- The value of  $I_{sc}$  and  $V_{oc}$  marked on modules should be multiplied by 1.25 when determining module voltage ratings, conductor current ratings, fuse size and the size of controls to the PV output



### 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.

<p><b>Horizontal Installation</b> (Double row, The junction box is inside)</p>	
<p><b>Horizontal Installation</b> (Double row, The junction box is outside)</p>	
<p><b>Horizontal Installation</b> (Single row)</p>	

<p><b>Vertical Installation (Double row)</b></p>	
<p><b>Vertical Installation (Single row)</b></p>	

## 5.4 Earth Ground Wiring

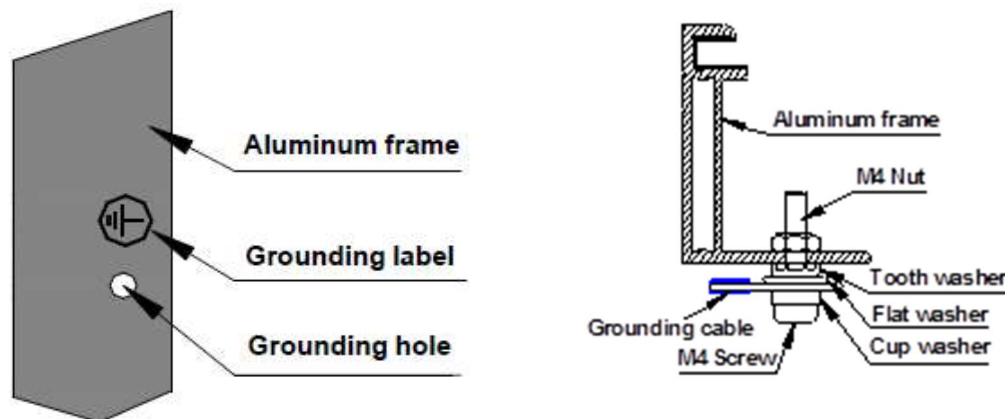
To prevent electric shock and fire, an earthing must be done on the frames of PV modules and array. The array frame must be earthed according to local codes.

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. Use 12 AWG copper wire for the grounding wire. (See picture 3)

Common grounding hardware (nuts, bolts, star washers, split-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 3. Grounding Hardware(Torque level: 2-3 N·m)**

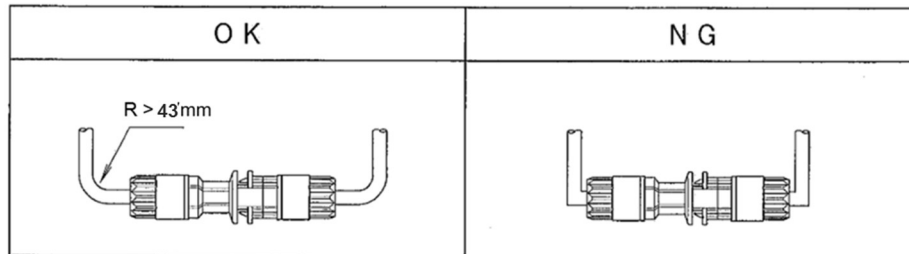
## 5.5 Module Terminations

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 HES. HES does not give warranty for the case of using connectors which are not approved by HES.

## 5.6 Junction Box & Terminals

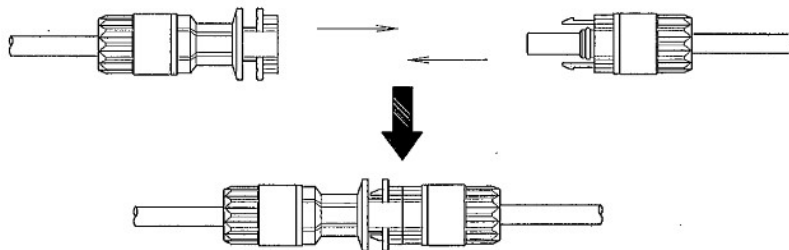
A PV module has the plus and minus connectors and a junction box with bypass diodes. On the junction box, the polarity is clearly marked.

- 1) Protection Degree : IP67
- 2) Temperature Range : -40°C ~ +90°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 43mm must be maintained. The cable must be routed in a way that tensile stress on the conductor or connections is prevented. (Picture 4)



**Picture 4. 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 5)
- 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. Do not place the connectors in water.
- 8) When same series modules with different connectors are installed together, make sure those two connectors are compatible.



**Picture 5. Connect connectors**

- 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.

## 5.8 Diode

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 the Junction Box. HES PV modules are equipped with bypass diodes. If installer wishes to change into other diodes, the installer should inform an authorized engineer of HES.

Object	Manufacturer	Type	Technical Data
Junction Box	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	GF26xy	Max. Voltage=1500 V (DC) Rated current = 13 A for GF26xy(x=1) Rated current = 15 A for GF26xy(x=2) Rated current = 20 A for GF26xy(x=3) RTI = 110 °C Number of diodes: 2
Bypass diodes	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST6020	Tj max = 200°C If = 20A for GF26xy(x=2)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST4530/T	Tj max = 200°C If = 30A for GF26xy(x=2)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST4520	Tj max = 200°C If = 20A for GF26xy(x=1)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST5040D	Tj max = 200°C If = 40A for GF26xy(x=3)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	PanJit International Inc		
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K 1 x4.0	Rated voltage = 1500VDC

		mm <sup>2</sup>	
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated voltage = 1500VDC Rated current = 30A
	Staubli Electrical Connectors AG	PV-KST4-EVO 2/xy_UR PV-KBT4-EVO 2/xy_UR	Rated Voltage = 1500VDC Rated Current = 45A (4.0mm <sup>2</sup> )
	Amphenol Technology (Shenzhen) Co., Ltd.	UTXCFabcd UTXCMabcd	Rated voltage = 1500VDC Rated current = 35A
	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	RHC2xyzu	Rated voltage = 1500VDC Rated current = 35A

Object	Manufacturer	Type	Technical Data
Junction Box	Tongwei solar(Hefei) Co., Ltd.	PVJB-TW-S/001	Max. Voltage=1500 V (DC) Rated current = 15 A RTI = 110 °C
Bypass diodes	Changzhou Starsea Electronics	PST6020	Tj max = 200°C If = 20A
	Yangzhou Yangjie Electronic Technology	GF3045MG	Tj max = 200°C If = 30A
	Changzhou Starsea Electronics Co., Ltd.	PV4045D	Tj max = 200°C If = 40A for PVJB-TW-S/00A (A=2)
	Hangzhou Lion Microelectronics Co., Ltd.	THY2550	Tj max = 200°C If = 25A for PVJB-TW-S/00A (A=1)
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K 1 x4.0 mm <sup>2</sup>	Rated voltage = 1500VDC
	Zhejiang Zhonghuan Sunter PV Technology Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
	Ningbo Kibor Wire&Cable Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC

	Wuxi Xinhongye Wire&Cable Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated voltage = 1500VDC Rated current = 30A
	Staubli	PV-KST4-EVO 2/xy_UR PV-KBT4-EVO 2/xy_UR	Rated Voltage = 1500VDC Rated Current = 45A (4.0mm <sup>2</sup> )

## 6. Electrical Installations

### 6.1 General With Regard to Electrical Installation

6.1.1 Under normal outdoor conditions, a module is likely to produce different current and voltage than the values measured under STC in the specification of HES solar's module. Therefore, when determining the parameters (for example, nominal voltage, conductor capacity, fuse capacity and controller capacity, etc.) related to the power output of the PV system, the values of short-circuit current and open circuit voltage of the modules should be multiplied by a factor of 125% during design and installation.

6.1.2 Try to use the modules with the same configuration in the same PV system. If the modules are connected in series, the total voltage is the sum of voltages of all the modules. The maximum voltage of string does not exceed the maximum system voltage of the modules (the maximum system voltage of HES solar's modules is 1500V), the maximum number of modules that can be connected in a series string must be calculated in accordance with applicable regulations, make sure the open circuit voltage of string does not exceed the maximum system voltage of the modules and the other electrical DC components required at the minimum temperature at the PV system location. Using the following formula:

$$\text{System voltage} = N \times V_{oc} \times [1 + \lambda_{voc} (25 - T_{min})]$$

N      number of modules in series

V<sub>oc</sub>    open circuit voltage at STC (refer to product label or data sheet)

λ<sub>voc</sub>    Thermal coefficient of V<sub>oc</sub> of each module (refer to product data sheet)

T<sub>min</sub>    Minimum ambient temperature at the PV system location

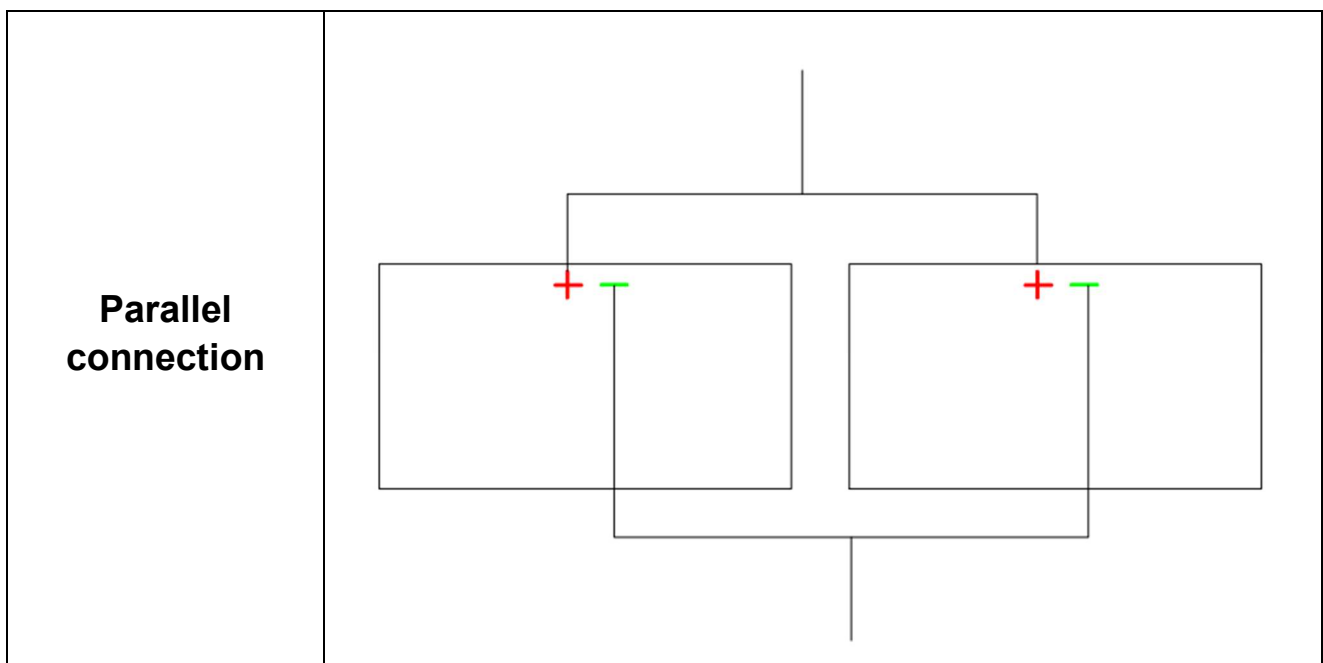
6.1.3 If the PV system requires the installation of high current, several PV modules can be connected in

parallel, and total current is the sum of current of all the modules. The maximum parallel number of the modules  $N = I_{\text{max}} (\text{fuse rating}) / I_{\text{sc}}$ ,

6.1.4 An over-current protection device with appropriately rated must be used when reverse current could exceed the value of the maximum fuse rating of the module, an over-current protection devices is required for each series string if more than two series strings are connected in parallel.

6.1.5 When installing the module, place the end with the junction box up and try to avoid the rain.

6.1.6 Do not carry out installation in rainy weather, because humidity will void the insulation protection, Thus cause safety accidents.





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## 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 Cautions

- Do not conduct electrical work such as opening junction boxes or separation of connectors without a qualified expert.
- Before electrical work, remove any metal material from body and wear protection equipment for insulation.
- To minimize output decline, remove any substance near the PV modules such as grass, moss, and vine.
- Any chemical which is not approved by HES shall not contact PV modules.

### 7.2 Cleaning

- Recommend maintaining module glass surface clean as possible to improve module power efficiency and long life.
- HES 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 HES 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 and soft materials without potential risks of scratch. 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 backside of the module. If backside cleaning is necessary, 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.

### 7.3 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 Backsheet.

#### **7.4 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.

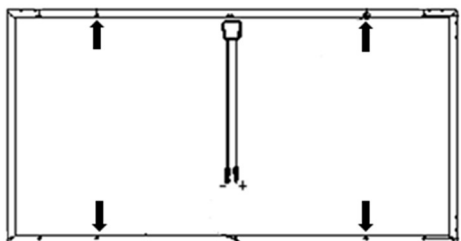
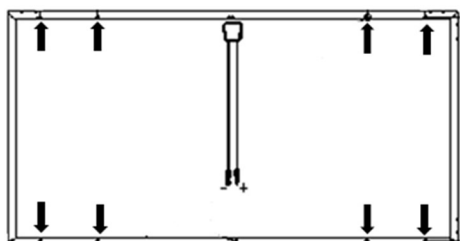
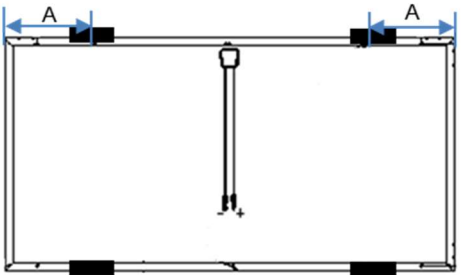
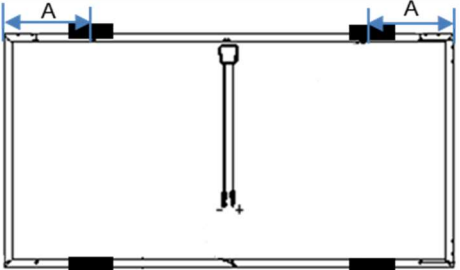
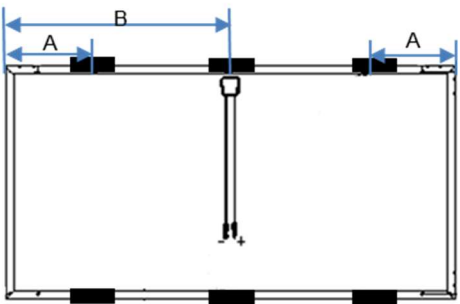
### **8. Disposal**

- Users shall dispose of modules according to local disposal regulations.
- Contact HES for more detailed information related to disposal and recycling.




### **9. Disclaimer of Liability**

- 1) HES do 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 HES modules.
  - Loss, damage, injury or expense resulting from any factor that is unsuspected the module was produced or shipped.
- 2) HES reserves the rights for any change the technical specification including the PV production, the specifications, or the product information sheets without prior notice.

## Appendix 1) Module Installation Instruction (Front / Back Design Load, Safety factor = 1.5)

Method		SG / UG / UF / VG	SI / UI / UH / VI
<b>Bolting</b>	on Long Bar	 <b>4 Bolts : 3600/1600 Pa</b>	 <b>8 Bolts : 3600/1600 Pa</b>
<b>Clamping</b>  ■ :Clamping area ※ Min. Clamp Width: 50mm	on Long Bar	  A: 160~560mm <b>Design load 3600/1600Pa</b>  Overlap of Clamp with Al frame : 9-11mm	  A: 390±50mm (SI) 395±50mm (UI/UH) 410±50mm (VI) <b>Design load 2400/1066Pa</b> Overlap of Clamp with Al frame : 9-11mm
			  A: 390±50mm, B: 970±50mm (SI) A: 395±50mm, B: 985±50mm (UI/UH) A: 410±50mm, B: 1028±50mm (VI) <b>Design load 3600/1600Pa</b>  Overlap of Clamp with Al frame : 9-11mm

## Appendix 2) Module Installation Instruction with none mounting rails

	<p>Use four clamps on the corner of short side frame, abreast with the long side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 1200\text{pa}</math> Downforce <math>\leq 1600\text{pa}</math></p>
	<p>Use four clamps on the corner of long side frame, abreast with the short side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 2000\text{pa}</math> Downforce <math>\leq 2000\text{pa}</math></p>
	<p>Use four clamps on the corner of short side frame, abreast with the short side frame, and two clamps on the middle of long side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 2400\text{pa}</math> Downforce <math>\leq 3600\text{pa}</math></p>

## Appendix 3) Module Electrical Performance

### · Electrical Characteristics : HiE-SxxxSG

Item	HiE-SxxxSG (xxx: Maximum Power Value)							
Maximum Power at STC(P <sub>max</sub> ) [W]	360	355	350	345	340	335	330	325
Voltage at P <sub>max</sub> (V <sub>mpp</sub> ) [V]	37.8	37.7	37.6	37.5	37.4	37.3	37.2	37.1
Current at P <sub>max</sub> (I <sub>mpp</sub> ) [A]	9.52	9.42	9.31	9.20	9.09	8.98	8.87	8.76
Open circuit voltage (V <sub>oc</sub> ) [V]	45.80	45.60	45.40	45.3	45.2	45.2	45.1	45.1
Short circuit current (I <sub>sc</sub> ) [A]	9.70	9.65	9.60	9.55	9.51	9.49	9.45	9.42
Module efficiency [%]	20.8	20.5	20.2	19.9	19.6	19.3	19.0	18.8
Maximum Series Fuse Rating [A]	20							
Temp. coefficient of P <sub>mpp</sub> [%/K]	-0.34							
Temp. coefficient of V <sub>oc</sub> [%/K]	-0.27							
Temp. coefficient of I <sub>sc</sub> [%/K]	0.04							
Output tolerance [W]	+5 / 0							
Maximum system voltage [Vdc]	IEC 1,500 / UL 1,500							
Cell quantity in series [pcs]	340							
Bypass diodes [pcs]	2							
Cell Type	Mono-crystalline Silicon Cell							
Application & Safety Class	Class A & Class II							
Fire rating	Class C (IEC) / Type 1 (UL)							

· **Electrical Characteristics : HiE-SxxxSI**

Item	HiE-SxxxSI (xxx: Maximum Power Value)								
Maximum Power at STC(P <sub>max</sub> ) [W]	435	430	425	420	415	410	405	400	395
Voltage at P <sub>max</sub> (V <sub>mpp</sub> ) [V]	38.0	37.9	37.8	37.7	37.6	37.5	37.4	37.3	37.2
Current at P <sub>max</sub> (I <sub>mpp</sub> ) [A]	11.45	11.35	11.24	11.14	11.04	10.93	10.83	10.72	10.62
Open circuit voltage (V <sub>oc</sub> ) [V]	46.20	46.00	45.80	45.50	45.40	45.30	45.30	45.20	45.20
Short circuit current (I <sub>sc</sub> ) [A]	11.71	11.65	11.59	11.53	11.47	11.43	11.39	11.35	11.31
Module efficiency [%]	21.0	20.7	20.5	20.2	20.0	19.7	19.5	19.3	19.0
Maximum Series Fuse Rating [A]	20								
Temp. coefficient of P <sub>mpp</sub> [%/K]	-0.34								
Temp. coefficient of V <sub>oc</sub> [%/K]	-0.27								
Temp. coefficient of I <sub>sc</sub> [%/K]	0.04								
Output tolerance [W]	+5 / 0								
Maximum system voltage [V <sub>dc</sub> ]	IEC 1,500 / UL 1,500								
Cell quantity in series [pcs]	408								
Bypass diodes [pcs]	2								
Cell Type	Mono-crystalline Silicon Cell								
Application & Safety Class	Class A & Class II								
Fire rating	Class C (IEC) / Type 1 (UL)								

· **Electrical Characteristics : HiE-SxxxUG**

Item	HiE-SxxxUG (xxx: Maximum Power Value)						
Maximum Power at STC(Pmax) [W]	350	355	360	365	370	375	380
Voltage at Pmax (Vmpp) [V]	37.5	37.6	37.7	37.8	37.9	38.0	38.1
Current at Pmax (Impp) [A]	9.33	9.44	9.55	9.66	9.76	9.87	9.97
Open circuit voltage (Voc) [V]	45.90	46.00	46.10	46.20	46.30	46.40	46.50
Short circuit current (Isc) [A]	9.98	10.04	10.10	10.16	10.22	10.28	10.34
Module efficiency [%]	19.6	19.9	20.2	20.5	20.7	21.0	21.3
Maximum Series Fuse Rating [A]	20						
Temp. coefficient of Pmpp [%/°C]	-0.34						
Temp. coefficient of Voc [%/°C]	-0.27						
Temp. coefficient of Isc [%/°C]	0.04						
Output tolerance [W]	+5 / 0						
Maximum system voltage [Vdc]	1,500 (IEC)						
Cell quantity in series [pcs]	340						
Bypass diodes [pcs]	2						
Cell Type	Mono-crystalline Silicon Cell						
Electrical protection class	Class II						
Fire rating	Class C (IEC)						

# Electrical Characteristics : HiE-SxxxUI

Item	HiE-SxxxUI (xxx: Maximum Power Value)							
Maximum Power at STC(Pmax) [W]	420	425	430	435	440	445	450	455
Voltage at Pmax (Vmpp) [V]	37.4	37.6	37.7	37.8	37.9	38.0	38.1	38.2
Current at Pmax (Impp) [A]	11.23	11.30	11.41	11.51	11.61	11.71	11.81	11.91
Open circuit voltage (Voc) [V]	46.0	46.0	46.10	46.20	46.30	46.40	46.50	46.60
Short circuit current (Isc) [A]	11.93	11.98	12.03	12.08	12.12	12.16	12.20	12.24
Module efficiency [%]	19.7	19.9	20.1	20.4	20.6	20.8	21.1	21.3
Maximum Series Fuse Rating [A]	20							
Temp. coefficient of Pmpp [%/°C]	-0.34							
Temp. coefficient of Voc [%/°C]	-0.27							
Temp. coefficient of Isc [%/°C]	0.04							
Output tolerance [W]	+5 / 0							
Maximum system voltage [Vdc]	1,500 (IEC)							
Cell quantity in series [pcs]	408							
Bypass diodes [pcs]	2							
Cell Type	Mono-crystalline Silicon Cell							
Electrical protection class	Class II							
Fire rating	Class C (IEC)							



· **Electrical Characteristics : HiE-SxxxUF**

Item	HiE-SxxxUF (xxx: Maximum Power Value)						
Maximum Power at STC(Pmax) [W]	370	375	380	385	390	395	400
Voltage at Pmax (Vmpp) [V]	40.2	40.40	40.60	40.80	40.80	40.90	41.0
Current at Pmax (Impp) [A]	9.20	9.28	9.36	9.44	9.56	9.66	9.76
Open circuit voltage (Voc) [V]	48.7	48.90	49.10	49.30	49.30	49.40	49.50
Short circuit current (Isc) [A]	9.85	9.89	9.93	9.98	10.03	10.07	10.12
Module efficiency [%]	19.7	20.0	20.3	20.5	20.8	21.1	21.3
Maximum Series Fuse Rating [A]	20						
Temp. coefficient of Pmpp [%/°C]	-0.34						
Temp. coefficient of Voc [%/°C]	-0.27						
Temp. coefficient of Isc [%/°C]	0.04						
Output tolerance [W]	+5 / 0						
Maximum system voltage [Vdc]	1,500 (IEC)						
Cell quantity in series [pcs]	360						
Bypass diodes [pcs]	2						
Cell Type	Mono-crystalline Silicon Cell						
Electrical protection class	Class II						
Fire rating	Class C (IEC)						

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· **Electrical Characteristics : HiE-SxxxUH**

Item	HiE-SxxxUH (xxx: Maximum Power Value)							
Maximum Power at STC(Pmax) [W]	445	450	455	460	465	470	475	480
Voltage at Pmax (Vmpp) [V]	40.1	11.17	11.23	11.30	11.37	11.49	11.59	11.68
Current at Pmax (Impp) [A]	11.10	40.3	40.5	40.7	40.9	40.9	41.0	41.1
Open circuit voltage (Voc) [V]	11.85	11.90	11.95	11.99	12.03	12.07	12.12	12.17
Short circuit current (Isc) [A]	48.6	48.8	49.0	49.2	49.4	49.4	49.5	49.6
Module efficiency [%]	19.8	20.0	20.3	20.5	20.7	20.9	21.2	21.4
Maximum Series Fuse Rating [A]	20							
Temp. coefficient of Pmpp [%/°C]	-0.34							
Temp. coefficient of Voc [%/°C]	-0.27							
Temp. coefficient of Isc [%/°C]	0.04							
Output tolerance [W]	+5 / 0							
Maximum system voltage [Vdc]	1,500 (IEC)							
Cell quantity in series [pcs]	432							
Bypass diodes [pcs]	2							
Cell Type	Mono-crystalline Silicon Cell							
Electrical protection class	Class II							
Fire rating	Class C (IEC)							

# Electrical Characteristics : HiE-SxxxVG

Item	HiE-SxxxVG (xxx: Maximum Power Value)							
Maximum Power at STC(Pmax) [W]	380	385	390	395	400	405	410	415
Voltage at Pmax (Vmpp) [V]	38.3	38.4	38.5	38.5	38.6	38.7	38.8	38.9
Current at Pmax (Impp) [A]	9.92	10.03	10.13	10.26	10.36	10.47	10.57	10.67
Open circuit voltage (Voc) [V]	46.1	46.2	46.3	46.3	46.4	46.5	46.6	46.7
Short circuit current (Isc) [A]	10.77	10.82	10.87	10.92	10.97	11.02	11.07	11.12
Module efficiency [%]	19.4	19.6	19.9	20.2	20.4	20.7	20.9	21.2
Maximum Series Fuse Rating [A]	20							
Temp. coefficient of Pmpp [%/°C]	-0.34							
Temp. coefficient of Voc [%/°C]	-0.27							
Temp. coefficient of Isc [%/°C]	0.04							
Output tolerance [W]	+5 / 0							
Maximum system voltage [Vdc]	1,500 (IEC)							
Cell quantity in series [pcs]	340							
Bypass diodes [pcs]	2							
Cell Type	Mono-crystalline Silicon Cell							
Electrical protection class	Class II							
Fire rating	Class C (IEC)							

· **Electrical Characteristics : HiE-SxxxVI**

Item	HiE-SxxxVI (xxx: Maximum Power Value)								
Maximum Power at STC(Pmax) [W]	460	465	470	475	480	485	490	495	500
Voltage at Pmax (Vmpp) [V]	38.5	38.5	38.6	38.7	38.8	38.8	38.9	39.0	39.0
Current at Pmax (Impp) [A]	11.95	12.08	12.18	12.27	12.37	12.50	12.60	12.69	12.82
Open circuit voltage (Voc) [V]	46.3	46.3	46.4	46.5	46.6	46.6	46.7	46.8	46.8
Short circuit current (Isc) [A]	12.81	12.85	13.04	13.10	13.16	13.22	13.28	13.34	13.40
Module efficiency [%]	19.6	19.8	20.1	20.3	20.5	20.7	20.9	21.1	21.3
Maximum Series Fuse Rating [A]	20								
Temp. coefficient of Pmpp [%/°C]	-0.34								
Temp. coefficient of Voc [%/°C]	-0.27								
Temp. coefficient of Isc [%/°C]	0.04								
Output tolerance [W]	+5 / 0								
Maximum system voltage [Vdc]	1,500 (IEC)								
Cell quantity in series [pcs]	408								
Bypass diodes [pcs]	2								
Cell Type	Mono-crystalline Silicon Cell								
Electrical protection class	Class II								
Fire rating	Class C (IEC)								

# HES INSTALLATION MANUAL (IEC)

Issued on Jul. 12<sup>nd</sup>, 2021

## 1. General Information

- This Installation manual contains information regarding the installation and the safe handling method of the photovoltaic shingled module (hereafter referred to as “**module**”) supplied by Hyundai Energy Solutions Co., Ltd. (hereafter referred to as “**HES**”) which is as follows,
  - HiE-SxxxKG: 340 pieces, 530~545W, 1500V / HiE-SxxxKI: 408 pieces, 635~655W, 1500V
  - HiE-SxxxKJ: 414 pieces, 645~655W, 1500V / HiE-SxxxKM: 390 pieces, 605~625W, 1500V
  - HiE-SxxxKN: 345 pieces, 535~550W, 1500V / HiE-SxxxKL: 325 pieces, 505~520W, 1500V
- System users and installers should read and understand this manual before handling, installing the module. Please contact Customer Support department or our local representatives for more detailed information.
- Before installing solar photovoltaic systems, 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 consider every safety precautions specified in this manual and local codes when installing a module.
- HES 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.

### 1.1

#### NOTICE

- Installing solar photovoltaic systems requires specialized skills and knowledge. Thus, before installation, wiring, and operation of photovoltaic modules, system users and installer should understand and conform to this manual.
- Installation and wiring should only be performed and supervised by qualified persons.
- Each module has a junction box for permanent cable connection. HES can provide customers with fitted cables for easy installation. Installers should secure the safe installation status including all electrical hazards.

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**1.2**

- Installers should secure the installation status, without limitation, including the risk of electric shock.
- Backsheet 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. 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.

**1.3**

- Before installation, recommend preventing 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.

#### 1.4



- 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)

#### 1.5 General Safety

The following requirements should be kept during installation and inspection.

- Check the inspection requirements by authorized personnel.
- 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. Transportation, Storage and Unpacking

- Modules are packaged vertically. They should also be vertical during transportation.
- Check tension of banding tapes before transportation. Be cautious of abnormal shock for vehicles and modules which might cause module damage and cell crack during transportation. Store the modules safely in a dry and cool environment.
- Do not stack or move more than two packages of modules which are stacked vertically.
- Workers are recommended to keep some distance from the package when one worker cuts banding tapes. Don't lift the package after removing banding tapes.

- After unpacking, please visually check if there is no problem on modules. Install modules and components without any defect.
- When carrying modules, do not hold cables or junction box. Carry by holding frames with two hands.
- Carry one module at one time.

### 3. Installation Environment

#### 3.1 General

- Before installing and operating HES 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 Picture 1.
- Secure the module using mounting holes provided and 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 HES or 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 50mm of standoff height is necessary.
- The minimum distance between two fixed modules for linear thermal expansion of the module frame supports should be 10 mm. Nevertheless, the recommended distance between two modules is 30 mm 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 1.5 mm, 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. HES 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 6.2.

- Do not install PV modules horizontally. Horizontal installation can cause performance drop of PV modules. HES recommends mounting modules at a 10° tilt or greater.

### 3.3 Installation Site

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 Site Conditions

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

(1) Sea level of site : Below 1,000 m (3,280 ft)

(2) Maximum Instantaneous wind Speed (design load, safety factor = 1.5)

- Below 2,400Pa or 3,600Pa on the front module surface
- Below 1,600Pa or 2,400Pa on the back module surface
- ※ If the wind strength is not over than 2,400Pa (2,400 N/m<sup>2</sup>, 245 kg/m<sup>2</sup>, 50 lb/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.

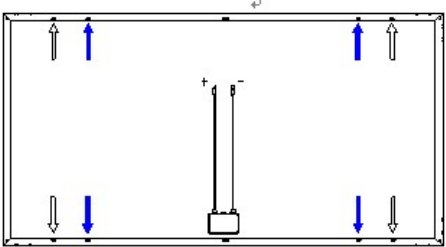


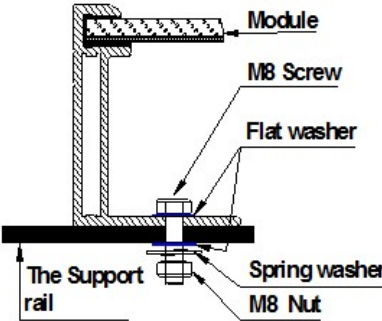
- Hail, heavy snow, and sand are to be considered as important factors related to module damage and power output decline.
- HES recommend installing lightning rods in lightning-expected areas and SPD (Surge Protection Device) for surge.
- Air pollution, chemical gas, acid rain, and smoke are important factors to be considered.
- Do not use PV modules in place of normal roofing.
- PV modules are not recommended to be installed where salt-mist will hit directly. HES PV modules have passed IEC61701 salt-mist, but galvanic corrosion can occur between the aluminum frame of the modules and mounting or grounding hardware if such hardware is comprised of dissimilar metals. Tongwei modules can be installed at seaside locations 50m to 500m from the sea, but the modules should be protected against corrosion. For locations  $\geq 500$ m from the sea, it is low risk with salt-mist

corrosion, only annual preventive maintenance is required. When PV modules are installed within 7km from a body of salt water, the installer should check for salt damage at the proposed install location and implement salt-mist corrosion preventive measures, which are not scratching the corrosion-resistant coating of the modules and mounting system, installing modules at a minimum tilt of 10 degrees.

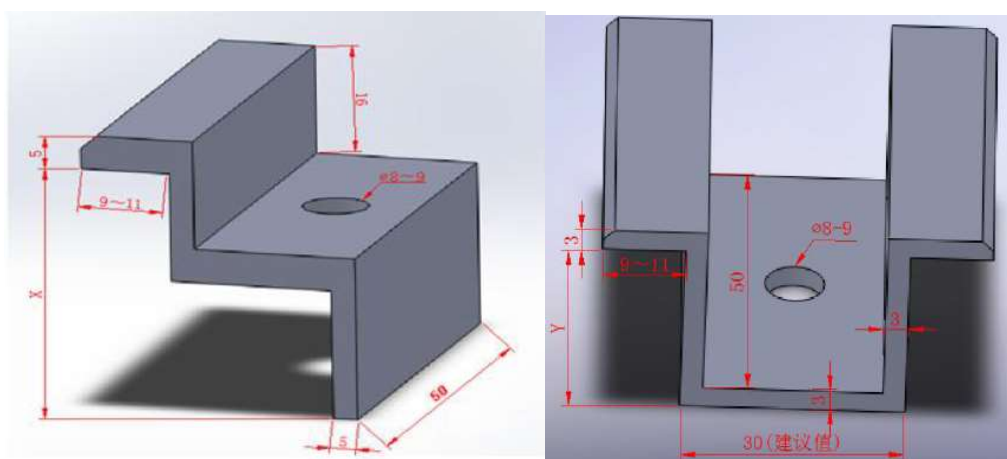
- PV modules shall not be immersed in water and shall not be continually exposure to water from a sprinkler, fountain, etc.
- PV modules shall not be installed in sulfurous area near sulfurous volcano and sulfurous spring.
- If PV modules are installed near factory or plant area, they can be polluted 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.
- In a harsh, hot, and humid environment, HES recommends using (-) grounding to inverters.
- Do not install PV modules indoors or on moving objects.

## 4. Installation

- Generally modules are fixed using mounting holes or clamp hardware.
- Each module must be securely fixed at a minimum of 4 – 8 points on two each side of long 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 HES.
- Mounting hardware like those in Picture 1 & 2 is highly recommended by clamping or bolt & nut mounting (Torque level: 16 N·m for bolting method, 8 N·m for clamping). The material of bolts and nuts are recommended as stainless steel.
- Area of module frame fastened by each clamp shall be no less than 400 mm<sup>2</sup>. (*clamp length ≥ 50mm, the clamped width of module frame shall be in this area: 8-11mm*)
- Detailed mounting method is described in 'module installation instruction' in the Appendix 1.

Mounting holes location <sup>Ⓢ</sup>	Screw bolts fasten method <sup>Ⓢ</sup>	Recommend accessories <sup>Ⓢ</sup>		
 <p>  Under low wind pressure and snow load conditions, these mounting holes should be used.   Under high wind pressure and snow load conditions, these mounting holes must also be used.         </p>		Part name <sup>Ⓢ</sup>	material <sup>Ⓢ</sup>	dimension <sup>Ⓢ</sup>
		screw <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8×16mm <sup>Ⓢ</sup>
		spring washer <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>
		flat washer <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>
		Nut <sup>Ⓢ</sup>	Stainless steel <sup>Ⓢ</sup>	M8 <sup>Ⓢ</sup>

Picture 1. Installation Method using stainless steel bolt & nut



### B: Fixture for intermediate modules

For the 35\*35 frame, the recommended value of X is 25mm

For the 40\*35 frame, the recommended value of X is 30mm

### Picture 2. Mounting Hardware (Clamp)

## 5. Wiring

## 5.1 General

- All wiring should be matched with acceptable regional and local electrical codes.
- All wiring work should be done by certified and authorized engineers.
- All wiring should be connected safely in order to prevent any hazard.

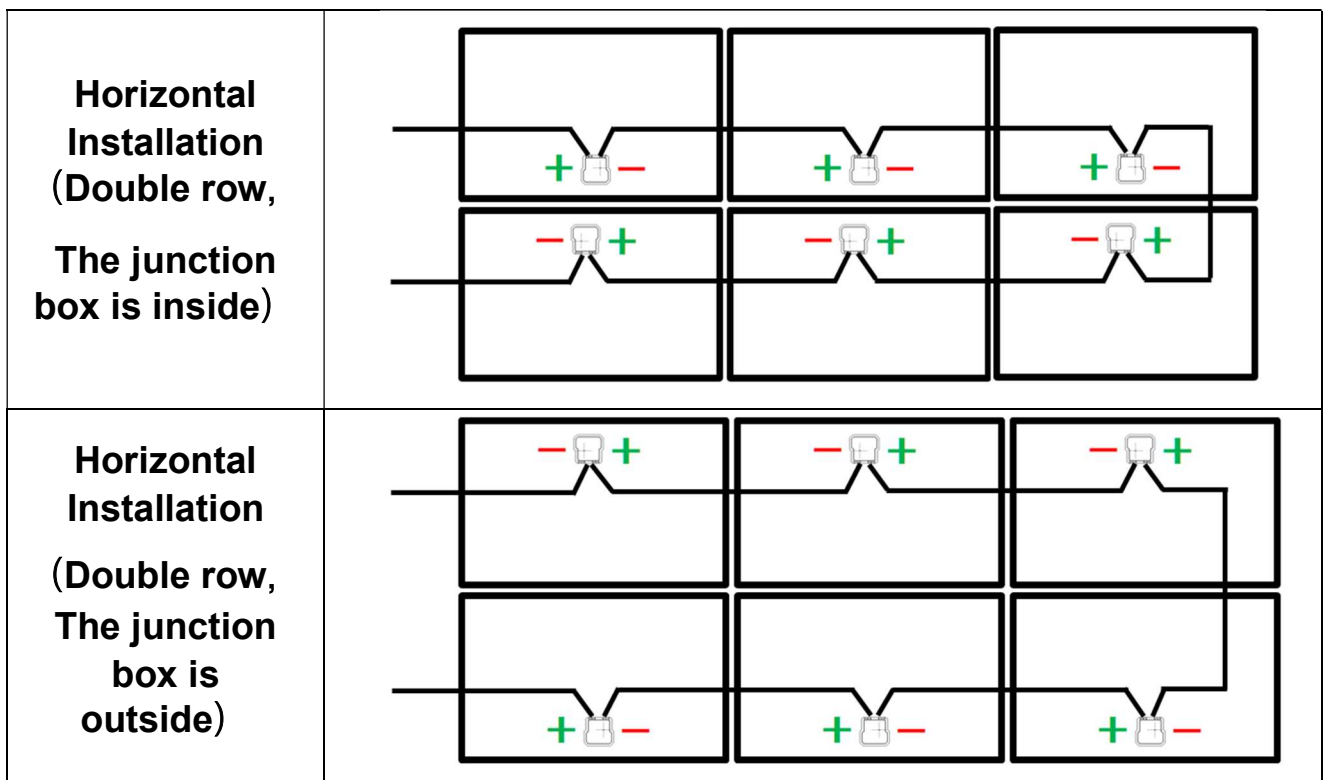
- All PV modules for one serial connection must be identical in terms of output and in types.
- Do not connect PV modules directly in parallel without the combine box.

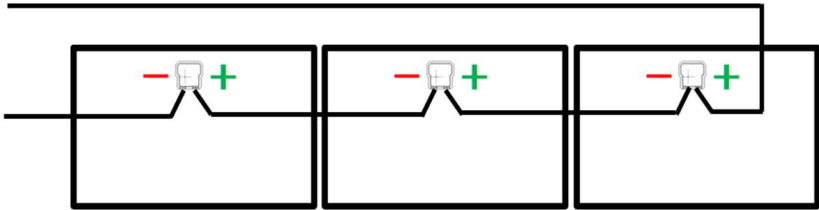
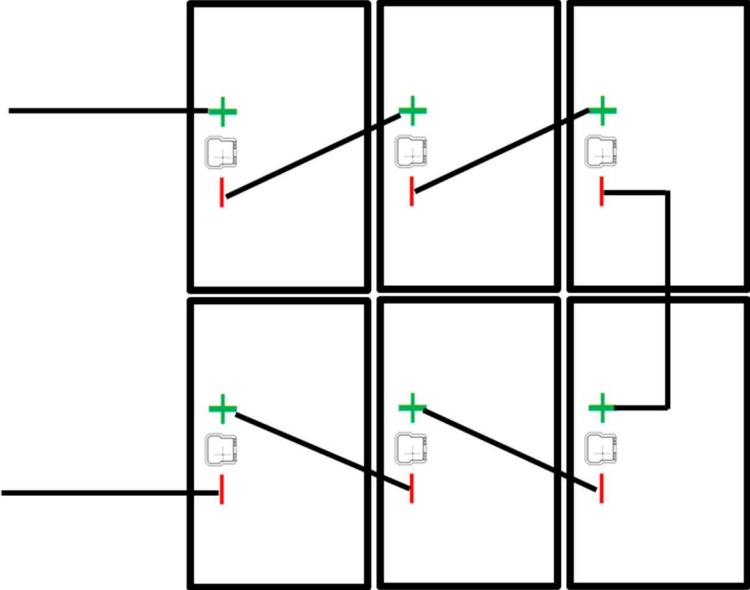
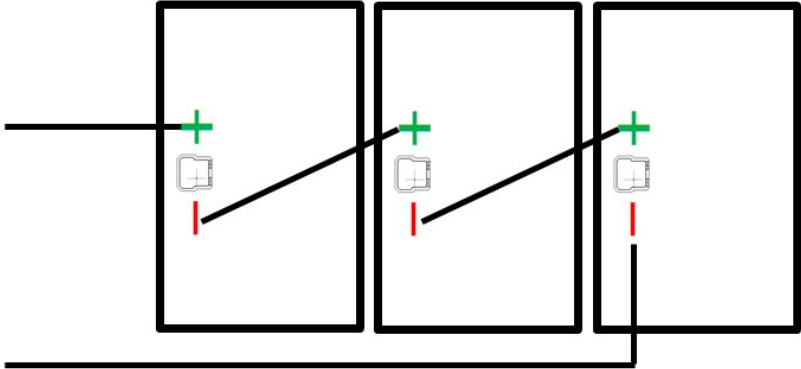
## 5.2 Module Wiring

- System voltage should not exceed the maximum system voltage of module.
- 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.
- The value of Isc and Voc marked on modules should be multiplied by 1.25 when determining module voltage ratings, conductor current ratings, fuse size and the size of controls to the PV output

## 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.



<p><b>Horizontal Installation</b> (Single row)</p>	
<p><b>Vertical Installation</b> (Double row)</p>	
<p><b>Vertical Installation</b> (Single row)</p>	

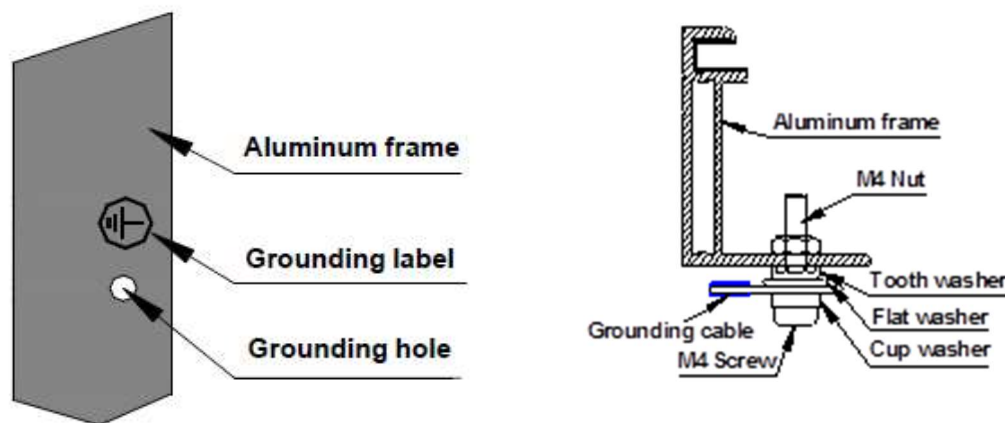
## 5.4 Earth Ground Wiring

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 local codes.

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. Use 12 AWG copper wire for the grounding wire. (See picture 3)

Common grounding hardware (nuts, bolts, star washers, split-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 3. Grounding Hardware(Torque level: 2-3 N·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 HES. HES does not give warranty for the case of using connectors which are not approved by HES.

## 5.6 Junction Box & Terminals

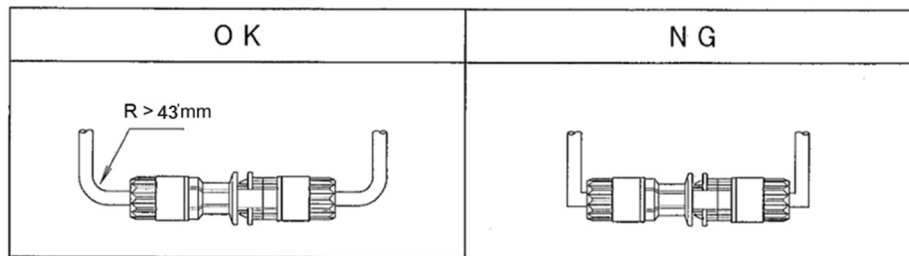
A PV module has the plus and minus connectors and a junction box with bypass diodes. On the junction box, the polarity is clearly marked.

12) Protection Degree : IP67

13) Temperature Range : -40°C ~ +90°C

14) Wire Size : 4.0mm<sup>2</sup> (AWG 12)

15) The cable must not be bent or crushed on the direct exit of the cable screw joint. A minimum bending radius 43mm must be maintained. The cable must be routed in a way that tensile stress on the conductor or connections is prevented. (Picture 4)



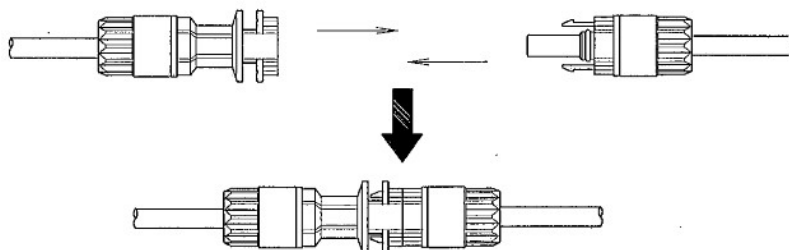
**Picture 4. Cable Routing**

16) 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 5)

17) Do not give between the connector and cable a strong pull (over 10kg).

18) Do not apply external stress to the body of connector. Do not place the connectors in water.

19) When same series modules with different connectors are installed together, make sure those two connectors are compatible.



**Picture 5. Connect connectors**



- 20) 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.
- 21) Connected cables and connectors should be fixed.
- 22) 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.

## 5.8 Diode

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 the Junction Box. HES PV modules are equipped with bypass diodes. If installer wishes to change into other diodes, the installer should inform an authorized engineer of HES.

Object	Manufacturer	Type	Technical Data
Junction Box	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	GF26xy	Max. Voltage=1500 V (DC) Rated current = 13 A for GF26xy(x=1) Rated current = 15 A for GF26xy(x=2) Rated current = 20 A for GF26xy(x=3) RTI = 110 °C Number of diodes: 2
Bypass diodes	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST6020	Tj max = 200°C If = 20A for GF26xy(x=2)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST4530/T	Tj max = 200°C If = 30A for GF26xy(x=2)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST4520	Tj max = 200°C If = 20A
	Yangzhou HY Technology Development Co., Ltd.		

	ChangZhou StarSea Electronics Co., Ltd.		for GF26xy(x=1)
	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST5040D	Tj max = 200°C If = 40A for GF26xy(x=3)
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou StarSea Electronics Co., Ltd.		
	PanJit International Inc		
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K 1 x4.0 mm <sup>2</sup>	Rated voltage = 1500VDC
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated voltage = 1500VDC Rated current = 30A
	Staubli Electrical Connectors AG	PV-KST4-EVO 2/xy_UR  PV-KBT4-EVO 2/xy_UR	Rated Voltage = 1500VDC Rated Current = 45A (4.0mm <sup>2</sup> )
	Amphenol Technology (Shenzhen) Co., Ltd.	UTXCFabcd  UTXCMabcd	Rated voltage = 1500VDC Rated current = 35A
	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	RHC2xyzu	Rated voltage = 1500VDC Rated current = 35A

Object	Manufacturer	Type	Technical Data
Junction Box	Tongwei solar(Hefei) Co., Ltd.	PVJB-TW-S/001	Max. Voltage=1500 V (DC) Rated current = 15 A RTI = 110 °C
Bypass diodes	Changzhou Starsea Electronics	PST6020	Tj max = 200°C If = 20A
	Yangzhou Yangjie Electronic Technology	GF3045MG	Tj max = 200°C If = 30A
	Changzhou Starsea Electronics Co., Ltd.	PV4045D	Tj max = 200°C If = 40A for PVJB-TW-S/00A (A=2)
	Hangzhou Lion Microelectronics Co., Ltd.	THY2550	Tj max = 200°C If = 25A for PVJB-TW-S/00A (A=1)
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K 1 x4.0 mm <sup>2</sup>	Rated voltage = 1500VDC
	Zhejiang Zhonghuan Sunter	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC

	PV Technology Co., Ltd.		
	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
	Ningbo Kibor Wire&Cable Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
	Wuxi Xinhongye Wire&Cable Co., Ltd.	H1Z2Z2-K 1 x 4.0 mm 2	Rated voltage = 1500VDC
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated voltage = 1500VDC Rated current = 30A
	Staubli	PV-KST4-EVO 2/xy_UR PV-KBT4-EVO 2/xy_UR	Rated Voltage = 1500VDC Rated Current = 45A (4.0mm <sup>2</sup> )

Object	Manufacturer	Type	Technical Data
Junction Box	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	FT20xv (x = 1, 2, 3 or A; v = W)	Rated Voltage = 1500VDC Rated current = 25A Reverse current = 41A RTI = 125°C Number of diodes: 3
Bypass diodes	Yangzhou Yangjie Electronic Technology Co., Ltd.	PST5040D	Tj max = 200°C If = 40A
	Yangzhou HY Technology Development Co., Ltd.		
	ChangZhou Star Sea Electronics Co., Ltd.		
Cable	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	H1Z2Z2-K	Rated voltage = 1500VDC
	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	62930 IEC 131 1x4.0 mm2	Rated voltage = 1500VDC
Connectors	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	05-8	Rated current = 30 A
	Amphenol Technology (Shenzhen) Co., Ltd.	H4CFC4DMS; H4CMC4DMS	Rated current = 35 A

	Amphenol Technology (Shenzhen) Co., Ltd.	UTXCFabcd; UTXCMabcd	Rated current = 35 A
	Stäubli Electrical Connectors AG	PV-KST4-EVO 2/xy_UR; PV-KBT4-EVO 2/xy_UR	Rated current = 45A (4.0mm <sup>2</sup> )
	Tyco Electronics (Shanghai) Co., Ltd.	PV4-S1yx (y=F or M; x=2.5 or 4.0)	Rated current = 40A (x=2.5); 40A (x=4.0)
	Hanwha Q CELLS (Qidong) Co., Ltd.	HQC4	Rated current = 30A
	Zhejiang Renhe Photovoltaic Technology Co., Ltd.	RHC2xyzu	Rated current = 35A (4.0mm <sup>2</sup> )

Object	Manufacturer	Type	Technical Data
Junction Box	SUZHOU UKT NEW ENERGY TECHNOLOGY CO., LTD	JB12x (x=A-25)	Rated Voltage = 1500VDC Rated Current = 25A Reverse Current = 54A RTI = 110°C Number of diodes: 3
Bypass diodes	SUZHOU UKT NEW ENERGY TECHNOLOGY CO., LTD	UKTH4545-12/ TM3045-25	Tj max = 200°C If = 30A
Cable	Ningbo Kibor Wire & Cable Co., Ltd.	H1Z2Z2-K 1x4.0mm <sup>2</sup>	Rated voltage = 1500VDC
	Wuxi Xinhongye Wire & Cable Co., Ltd.	H1Z2Z2-K 1x4.0mm <sup>2</sup>	
	Trina Solar Co., Ltd.	62930 IEC 131 1x4.0mm <sup>2</sup> HALOGEN FREE LOW SMOKE	
	Trina Solar Co., Ltd.	H1Z2Z2-K 1x4.0mm <sup>2</sup>	
	Changshu JHOSIN Communication Technology Co., Ltd.	62930 IEC 131 1x4.0mm <sup>2</sup> HALOGEN FREE LOW SMOKE	
Connectors	SUZHOU UKT NEW ENERGY TECHNOLOGY	PV-CO02-xy	Rated voltage = 1500VDC

**Sales Office**

4th Fl., First Tower,  
55, Bundang-ro, Bundang-gu,  
Seongnam-si, Gyeonggi-do,  
13591 Korea

**Factory**

NO.888 Changning Road, High-tech District,  
Hefei, Anhui, P.R. China

	CO., LTD		Rated current = 45A
	Jiangxi Jinko PV Material Co., Ltd.	PV-JK03M-2	Rated voltage = 1500VDC Rated current = 30A
	Stäubli Electrical Connectors AG	PV-KST4-EVO 2/xy_UR PV-KBT4-EVO 2/xy_UR	Rated voltage = 1500VDC Rated current = 45A
	Trina Solar Co., Ltd.	TS4-xz (z=2)	Rated voltage = 1500VDC Rated current = 41A
	Trina Solar Co., Ltd.	TS4	Rated voltage = 1500VDC Rated current = 41A

Object	Manufacturer	Type	Technical Data
Junction Box	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	JM37xy (x=A, y=B)	Rated Voltage = 1500VDC Rated Current = 25A Reverse Current = 41A RTI = 110°C Number of diodes: 3
Bypass diodes	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	MK4050	Tj max = 200°C If = 40A
Cable	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	H1Z2Z2-K 1x4.0mm <sup>2</sup>	Rated Voltage = 1500VDC
Connectors	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	PV-JM601A	Rated Current = 30A
	Stäubli Electrical Connectors AG	PV-KST4-EVO2/xy_UR (male); PV-KBT4-EVO2/xy_UR (female)	Rated Current = 45A (4mm <sup>2</sup> )
	Zhejiang Jiaming Tianheyuan Photovoltaics Technology Co., Ltd.	PV-JM608	Rated Current = 30A
	Amphenol Technology (Shenzhen) Co., Ltd.	H4Cabcdef(c=4)(b=B, M or N)	Rated Current = 30A

## 6. 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.

### 6.1 Cautions

- Do not conduct electrical work such as opening junction boxes or separation of connectors without a qualified expert.
- Before electrical work, remove any metal material from body and wear protection equipment for insulation.
- To minimize output decline, remove any substance near the PV modules such as grass, moss, and vine.
- Any chemical which is not approved by HES shall not contact PV modules.

### 6.2 Cleaning

- Recommend maintaining module glass surface clean as possible to improve module power efficiency and long life.
- HES 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 HES 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 and soft materials without potential risks of scratch. 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 backside of the module. If backside cleaning is necessary, 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.

### 6.3 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 Backsheet.

## 6.4 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.

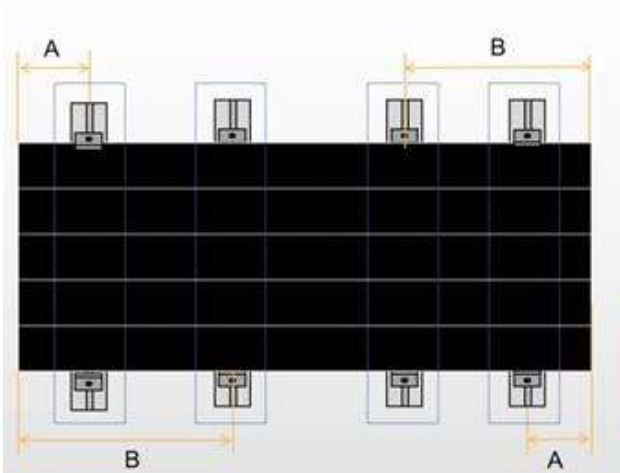
## 7. Disposal

- Users shall dispose of modules according to local disposal regulations.
- Contact HES for more detailed information related to disposal and recycling.

## 8. Disclaimer of Liability




- 3) HES do 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 HES modules.
  - Loss, damage, injury or expense resulting from any factor that is unsuspected the module was produced or shipped.
- 4) HES reserves the rights for any change the technical specification including the PV production, the specifications, or the product information sheets without prior notice.

## Appendix 1) Module Installation Instruction (Front / Back Design Load, Safety factor = 1.5)

Method		KL / KG / KN / KM / KI / KJ						
<div>Clamping</div> <div>■:Clamping area</div> <div>※ Min. Clamp Width: 50mm</div>	on Long Bar							
		Module Type	Installation method	Design load*safety factor(1.5)/Pa	Long side/mm	Short side/mm	A/mm	B/mm
		KL	Long side Installation	1096	2253	1096	405±50	545±50
		KG	Long side Installation	1096	2355	1096	425±50	570±50
		KN	Long side Installation	1096	2384	1096	430±50	575±50
		KM	Long side Installation	1303	2253	1303	405±50	545±50
		KI	Long side Installation	1303	2355	1303	425±50	570±50
		KJ	Long side Installation	1303	2384	1303	430±50	575±50
		Design load 5400/2400Pa						



## Appendix 2) Module Installation Instruction with none mounting rails

	<p>Use four clamps on the corner of short side frame, abreast with the long side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 1200\text{pa}</math> Downforce <math>\leq 1600\text{pa}</math></p>
	<p>Use four clamps on the corner of long side frame, abreast with the short side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 2000\text{pa}</math> Downforce <math>\leq 2000\text{pa}</math></p>
	<p>Use four clamps on the corner of short side frame, abreast with the short side frame, and two clamps on the middle of long side frame, none mounting rails used.</p> <p>Maximun load: Uplift load <math>\leq 2400\text{pa}</math> Downforce <math>\leq 3600\text{pa}</math></p>

## Appendix 3) Module Electrical Performance

### · Electrical Characteristics : HiE-SxxxKG

Item	HiE-SxxxKG (xxx: Maximum Power Value)			
Maximum Power at STC(Pmax) [W]	530	535	540	545
Voltage at Pmax (Vmpp) [V]	38.2	38.3	38.3	38.4
Current at Pmax (Impp) [A]	13.88	13.98	14.08	14.18
Open circuit voltage (Voc) [V]	46.0	46.1	46.2	46.3
Short circuit current (Isc) [A]	14.77	14.87	14.98	15.09
Module efficiency [%]	20.6	20.8	21.0	21.2
Maximum Series Fuse Rating [A]	25			
Temp. coefficient of Pmpp [%/°C]	-0.34			
Temp. coefficient of Voc [%/°C]	-0.27			
Temp. coefficient of Isc [%/°C]	0.04			
Output tolerance [W]	+5 / 0			
Maximum system voltage [Vdc]	1,500 (IEC)			
Cell quantity in series [pcs]	340			
Bypass diodes [pcs]	3			
Cell Type	Mono-crystalline Silicon Cell			
Electrical protection class	Class II			
Fire rating	Class C (IEC)			

· **Electrical Characteristics : HiE-SxxxKI**

Item	HiE-SxxxKI (xxx: Maximum Power Value)				
Maximum Power at STC(Pmax) [W]	635	640	645	650	655
Voltage at Pmax (Vmpp) [V]	38.1	38.18	38.26	38.38	38.43
Current at Pmax (Impp) [A]	16.67	16.76	16.86	16.94	17.04
Open circuit voltage (Voc) [V]	45.9	46.0	46.1	46.2	46.3
Short circuit current (Isc) [A]	17.73	17.83	17.93	18.02	18.13
Module efficiency [%]	20.7	20.9	21.0	21.2	21.3
Maximum Series Fuse Rating [A]	25				
Temp. coefficient of Pmpp [%/°C]	-0.34				
Temp. coefficient of Voc [%/°C]	-0.27				
Temp. coefficient of Isc [%/°C]	0.04				
Output tolerance [W]	+5 / 0				
Maximum system voltage [Vdc]	1,500 (IEC)				
Cell quantity in series [pcs]	408				
Bypass diodes [pcs]	3				
Cell Type	Mono-crystalline Silicon Cell				
Electrical protection class	Class II				
Fire rating	Class C (IEC)				

· **Electrical Characteristics : HiE-SxxxKL**

Item	HiE-SxxxKL (xxx: Maximum Power Value)			
Maximum Power at STC(P <sub>max</sub> ) [W]	505	510	515	520
Voltage at P <sub>max</sub> (V <sub>mpp</sub> ) [V]	36.6	36.7	36.8	36.9
Current at P <sub>max</sub> (I <sub>mpp</sub> ) [A]	13.80	13.90	14.01	14.11
Open circuit voltage (V <sub>oc</sub> ) [V]	44.1	44.2	44.3	44.4
Short circuit current (I <sub>sc</sub> ) [A]	14.68	14.79	14.90	15.01
Module efficiency [%]	20.5	20.7	20.9	21.1
Maximum Series Fuse Rating [A]	25			
Temp. coefficient of P <sub>mpp</sub> [%/°C]	-0.34			
Temp. coefficient of V <sub>oc</sub> [%/°C]	-0.27			
Temp. coefficient of I <sub>sc</sub> [%/°C]	0.04			
Output tolerance [W]	+5 / 0			
Maximum system voltage [V <sub>dc</sub> ]	1,500 (IEC)			
Cell quantity in series [pcs]	325			
Bypass diodes [pcs]	3			
Cell Type	Mono-crystalline Silicon Cell			
Electrical protection class	Class II			
Fire rating	Class C (IEC)			

· **Electrical Characteristics : HiE-SxxxKN**

Item	HiE-SxxxKN (xxx: Maximum Power Value)			
Maximum Power at STC(Pmax) [W]	535	540	545	550
Voltage at Pmax (Vmpp) [V]	38.8	38.9	39.0	39.1
Current at Pmax (Impp) [A]	13.77	13.87	13.97	14.07
Open circuit voltage (Voc) [V]	46.8	46.9	47.0	47.1
Short circuit current (Isc) [A]	14.65	14.76	14.86	14.97
Module efficiency [%]	20.5	20.7	20.9	21.0
Maximum Series Fuse Rating [A]	25			
Temp. coefficient of Pmpp [%/°C]	-0.34			
Temp. coefficient of Voc [%/°C]	-0.27			
Temp. coefficient of Isc [%/°C]	0.04			
Output tolerance [W]	+5 / 0			
Maximum system voltage [Vdc]	1,500 (IEC)			
Cell quantity in series [pcs]	345			
Bypass diodes [pcs]	3			
Cell Type	Mono-crystalline Silicon Cell			
Electrical protection class	Class II			
Fire rating	Class C (IEC)			

· **Electrical Characteristics : HiE-SxxxKM**

Item	HiE-SxxxKM (xxx: Maximum Power Value)				
Maximum Power at STC(Pmax) [W]	605	610	615	620	625
Voltage at Pmax (Vmpp) [V]	36.4	36.5	36.6	36.7	36.8
Current at Pmax (Impp) [A]	16.60	16.70	16.80	16.90	17.00
Open circuit voltage (Voc) [V]	43.9	44.0	44.1	44.2	44.3
Short circuit current (Isc) [A]	17.66	17.77	17.87	17.98	18.08
Module efficiency [%]	20.6	20.8	20.9	21.1	21.3
Maximum Series Fuse Rating [A]	30				
Temp. coefficient of Pmpp [%/°C]	-0.34				
Temp. coefficient of Voc [%/°C]	-0.27				
Temp. coefficient of Isc [%/°C]	0.04				
Output tolerance [W]	+5 / 0				
Maximum system voltage [Vdc]	1,500 (IEC)				
Cell quantity in series [pcs]	390				
Bypass diodes [pcs]	3				
Cell Type	Mono-crystalline Silicon Cell				
Electrical protection class	Class II				
Fire rating	Class C (IEC)				

· **Electrical Characteristics : HiE-SxxxKJ**

Item	HiE-SxxxKJ (xxx: Maximum Power Value)		
Maximum Power at STC(Pmax) [W]	645	650	655
Voltage at Pmax (Vmpp) [V]	38.7	38.8	38.8
Current at Pmax (Impp) [A]	16.68	16.77	16.86
Open circuit voltage (Voc) [V]	46.6	46.7	46.8
Short circuit current (Isc) [A]	17.74	17.84	17.94
Module efficiency [%]	20.8	20.9	21.1
Maximum Series Fuse Rating [A]	30		
Temp. coefficient of Pmpp [%/°C]	-0.34		
Temp. coefficient of Voc [%/°C]	-0.27		
Temp. coefficient of Isc [%/°C]	0.04		
Output tolerance [W]	+5 / 0		
Maximum system voltage [Vdc]	1,500 (IEC)		
Cell quantity in series [pcs]	414		
Bypass diodes [pcs]	3		
Cell Type	Mono-crystalline Silicon Cell		
Electrical protection class	Class II		
Fire rating	Class C (IEC)		