

**ROSS COUNTY SOLAR, LLC'S DECEMBER 24, 2020 RESPONSES
TO STAFF'S DECEMBER 15, 2020 DATA REQUESTS**

In the Matter of the Application of)	
Ross County Solar, LLC for a)	
Certificate of Environmental)	Case No. 20-1380-EL-BGN
Compatibility and Public Need)	

1. In accordance with Ohio Admin.Code 4906-4-8(A)(1)(c) please provide the generation equipment manufacturer's safety standards. Include a complete copy of the manufacturer's safety manual or similar document and any recommended setbacks from the manufacturer.

Ross County Solar has provided manufacturer specifications that are representative of what will be used for the Project as Exhibit B of the certificate application. Attached is Exhibit B from the certificate application for your reference. As stated in the application, technology is constantly improving, and panels will continue to be evaluated until a selection is made prior to construction. Attached is an installation manual (Exhibit I) that is representative of what manufacturers provide to ensure proper and safe installation onsite. Unlike wind turbines, panel manufacturers do not include specific manufacturer safety manuals with their products, but rather the products comply with specific industry accepted standards and criteria:

Ross County Solar will only utilize panels that are Underwriters Laboratories (UL) Certified. Specifically, UL 1703 is now harmonized with International Electric Commission (IEC) 61730 to ensure that panels meet specific safety and use criteria. An overview of the UL and IEC safety standards is attached (Exhibit II). The standard was also updated in 2017 to address rear-side quality and safety standards with the proliferation of bifacial modules in the market. UL/IEC certification is a standard requirement to obtain non-recourse project financing, as it demonstrates to lenders and investors that they will not be exposed to risk of premature failure or unexpected performance degradation.

2. Please provide the following information for the 69 kV gen-tie line:
 - a. Tower designs, pole structures, conductor size and number per phase, and insulator arrangement.

The attached PDF shows a representative tower design and pole structure for the gen-tie line (Exhibit III). It is anticipated that the gen-tie line will leave the collector substation via a dead-end structure, and cross Lower Twin Road. A second structure is anticipated to be placed North of Lower Twin Road to accommodate the gen-tie line turning and interconnecting with the existing substation. The conductor size is anticipated to consist of Kiwi 2167 AWG with 1 conductor per phase, and insulators are anticipated to be arranged per the attached drawing. The layout of the gen-tie line is subject to additional ongoing coordination with AEP but is generally representative of what is anticipated.

b. Base and foundation design.

The base and foundation are anticipated to utilize direct embedded poles with a minimum depth of 10% of the pole height plus 2 feet. The design will follow Rural Utility Service (RUS) standards for 69 kV transmission lines.

c. Cable type and size, where underground.

No underground cable is planned or anticipated; thus this is not applicable to the proposed gentle route.

d. Other major equipment or special structures.

No other equipment or special structures are anticipated at this time.

3. Please explain what possible mitigation measures Ross County Solar will employ for water well locations, as mentioned on page 60 of the application.

Ross County Solar will continue to work closely with landowners to ensure that wells are identified across the site. All wells identified will be marked on final construction drawings. For water wells located near residences, it is anticipated that no additional mitigation other than avoidance is necessary, as panels and associated construction equipment are significantly set back from those well locations. For any wells identified that will be impacted by construction or operation of the facility, the wells would be decommissioned prior to impacts to the area. The wells would be cut and capped, and any necessary documentation would be completed per local and state law.

4. What is the distance between solar farm equipment and the two water wells discussed on page 60 and Figure 08-1 of the Application?

Based on the preliminary layout, and water well data from the Ohio DNR, water well ID 211507 is located approximately 30 feet from the nearest solar panel. However, investigation of aerial photography shows the well location shown in the DNR database as active agricultural land with no indication of a well. Based on investigation of aerial photography, and google street view, the well appears to be sited at a location approximately 110 feet northeast of the DNR listed location and approximately 135 feet from the panel location in the preliminary facility layout. The exact well location will be confirmed via additional survey work to ensure avoidance avoided during construction.

The second well located within the Project Area is well ID 350988. This is located within the farmstead of a participating landowner. As the farmstead will continued to be maintained by the landowner for the life of the Project, no impacts to the well are anticipated. Based on the location listed in the DNR database, the well is approximately 520 feet from solar panels in the preliminary Facility layout.

5. From non-participating residences there is a 50 foot setback from PV panels, and 300 feet from non-participating residences to inverters and the substation, correct?

A 300-foot setback will apply to solar panel placement and inverters from non-participating residences. Additionally, a 50-foot setback will generally be applied from non-participating parcel boundaries and from road centerlines.

6. For the architecture and archaeological reviews:

a. You have concurrence with SHPO, correct?

See full response below.

b. Is anymore field work left to be done?

See full response below.

c. Once a final design is developed, an MOU for mitigation worked out with SHPO, correct?

Concurrence from the OSHPO has been obtained for both the Phase 1 Architectural Reconnaissance Survey Report and for the Phase 1 Archaeological Reconnaissance Report. Concurrence letters obtained from the OSHPO are provided as the first page of Exhibit T and Exhibit U of the application. Avoidance measures and mitigation have preliminarily been agreed to with OSHPO. No additional field work is anticipated or requested by the OSHPO. Ross County Solar will continue to work with the OSHPO to establish an MOU for the Project prior to the commencement of construction.

Solar Ware Ninja™

TMEiC
We drive industry

Multiple Configurations for Maximum Flexibility

TMEiC's Solar Ware Ninja is the latest evolution of the highly successful Solar Ware family of inverters, joining over 20GW of TMEiC's globally installed photovoltaic inverters. Continuing the legacy of high efficiency, cutting-edge features, and unmatched reliability, the new Ninja modular inverter system is the culmination of input from utilities, developers, and technicians.

The Ninja is a global product, performing the duties of both generation and energy storage. The modular system introduces multiple layers of flexibility to allow designers an almost unlimited number of options for every project. The advanced controls system is packed with features to meet not only today's smart inverter requirements, but also new requirements as they are introduced. Like the award-winning Samurai series of inverters, the Ninja utilizes the same highly reliable IGBT based power conversion system.



Customizable Block

Up to 6 Ninja units on the same skid. Able to combine PV and ESS inverters in the same lineup. A skid controller will manage output of the Ninja power station.

- Fully Modular design means:
 - Completely independent inverters for increased availability
 - Individual MPPT for greater energy yield
 - Latest generation of Smart Inverter controls platform
 - Multiple output options with various MPPT ranges
- DC Zone monitoring is standard
- UL or IEC certified global design
- PV or Energy Storage (bi-directional)
- Outdoor rated enclosure

TMEiC is Bankable

- Stable, with multi billion \$USD revenue
- Diversified, with decades of power electronics experience in a variety of heavy industries, including metals, oil & gas, mining, and container cranes industries
- Manufacturing in the US and several other locations

TMEiC is Reliable

- Over 20GW of PV and ESS inverters globally
- Own exclusive use of Mitsubishi Electric's 3 level NPS technology
- Industry leading fleet availability

TMEiC is Support

- Award winning service
- 24/7 US based hot line
- Over 30 years PV inverter manufacturing and R&D experience
- Comprehensive customer training programs
- Authorized Service Provider program available

		PV-PCS				ESS-PCS		
Type		PVU-L0800GR	PVU-L0840GR	PVU-L0880GR	PVU-L0920GR	BSU-L0640GR	BSU-L0800GR	BSU-L0840GR
Output side (AC)	Rated Power@25°C	800kW	840kW	880kW	920kW	640kW	800kW	840kW
	Rated Power@50°C	730kW	765kW	800kW	840kW	550kW	730kW	765kW
	Rated Voltage	600V +10%, -12%	630V +10%, -12%	660V +10%, -12%	690V +10%, -12%	480VAC	600VAC	630VAC
	Rated Frequency	50Hz / 60Hz (+0.5Hz, -0.7Hz)						
	Rated Power Factor	>0.99						
	Reactive Capability	±421 kVAR	±442 kVAR	±464 kVAR	±485 kVAR	-512to+640 kVAR	-640to+800 kVAR	-672to+840 kVAR
	Rated Current	702 Arms @50 °C						
	Maxium Current	770 Arms @25 °C						
	Maximum Efficiency	98.8%						
	CEC Efficiency	98.5%						
Input side (DC)	Maximum Voltage	1500 Vdc						
	MPPT Operation Range	875-1300VDC	915-1300VDC	960-1300VDC	1005-1300VDC	710-1100VDC	875-1300VDC	915-1300VDC
Environ. Conditions	Ingress Protection Ratings	IP54 / NEMA3R						
	Installation	Outdoor						
	Ambient Temperature Range	-25° to 50°C						
	Maximum Altitude	>2000 m power derating (Max. 4000m)						
Protective Functions	Input (DC) Side	DC Protection: Fuses Ground Fault, DC Reverse Current, Over Voltage, Over Current						
	Grid (AC) Side	AC Protection: Disconnect Switch and Fuse, Anti-islanding, Over/Under Voltage, Over/Under Frequency, Over Current						
	Grid Assistance	Reactive/Active Power Control, Power Factor Control, Fault Ride Through (optional)						
Harmonic Distortion of AC Current		≤ 3% THD (at rated power)				≤ 5% THD (at rated power)		
Communication		Modbus/TCP						
Fault Analysis		Fault Event Log, Waveform Acquisition via memory card						
Compliance		UL1741, UL1745A / IEEE1547 / NEC2017 / IEC62109-1,2 / IEC61000-6-2,4 / IEC61727, IEC62116 / IEC61400, BDEW / IEC61683 / IEC60068						
Cooling Method		Heat Pipes and Forced Air Cooling						
Number of Inputs		Standard 6 inputs for PV (maximum 8 per inverter)				1 per Inverter		
Standard Control Power Supply		Control Power Supply from Inverter output and Capacitor backup circuit (3 sec. compensation)						
Weight		<1000kgs						
Dimensions (H x W x D)		1100 X 1100 X 1900 mm (L x W x H)						
Floor Space		1875.5 sq. in. (1.21 m²)						
Color		Cabinet: Sand White #Dic583						

Note: Standard configuration not limited configuration. Contact TMEIC for detailed information.

WWW.TMEIC.COM

SC 4000 UP / SC 4200 UP / SC 4400 UP / SC 4600 UP



Efficient

- Up to 4 inverters can be transported in one standard shipping container
- Overdimensioning up to 150% is possible
- Full power at ambient temperatures of up to 25 °C

Robust

- Intelligent air cooling system OptiCool for efficient cooling
- Suitable for outdoor use in all climatic ambient conditions worldwide

Flexible

- One device for all applications
- PV application, optionally available with DC-coupled storage system

Easy to Use

- Improved DC connection area
- Connection area for customer equipment
- Integrated voltage support for internal and external loads

SUNNY CENTRAL UP

The new Sunny Central: more power per cubic meter

With an output of up to 4600 kVA and system voltages of 1500 V DC, the SMA central inverter allows for more efficient system design and a reduction in specific costs for PV and battery power plants. A separate voltage supply and additional space are available for the installation of customer equipment. True 1500 V technology and the intelligent cooling system OptiCool ensure smooth operation even in extreme ambient temperature as well as a long service life of 25 years.

SUNNY CENTRAL UP

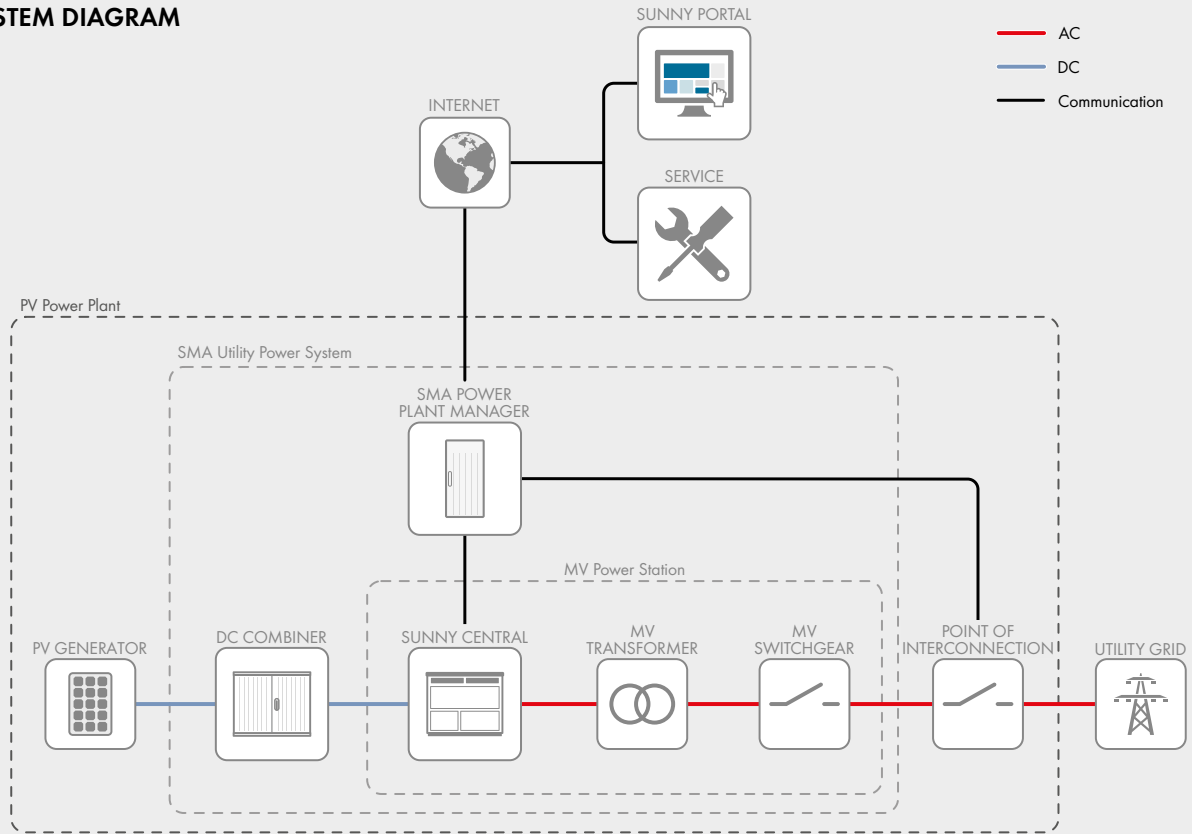
Technical Data	SC 4000 UP	SC 4200 UP
DC side		
MPP voltage range V_{DC} (at 25 °C / at 50 °C)	880 to 1325 V / 1100 V	921 to 1325 V / 1100 V
Min. DC voltage $V_{DC, min}$ / Start voltage $V_{DC, Start}$	849 V / 1030 V	891 V / 1071 V
Max. DC voltage $V_{DC, max}$	1500 V	1500 V
Max. DC current $I_{DC, max}$	4750 A	4750 A
Max. short-circuit current $I_{DC, SC}$	6400 A	6400 A
Number of DC inputs	Busbar with 26 connections per terminal, 24 double pole fused (32 single pole fused)	
Number of DC inputs with optional DC coupled storage	18 double pole fused (36 single pole fused) for PV and 6 double pole fused for batteries	
Max. number of DC cables per DC input (for each polarity)	2 x 800 kcmil, 2 x 400 mm ²	
Integrated zone monitoring	○	
Available PV fuse sizes (per input)	200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A	
Available battery fuse size (per input)	750 A	
AC side		
Nominal AC power at $\cos \varphi = 1$ (at 25 °C / at 50 °C)	4000 kVA / 3400 kVA	4200 kVA / 3570 kVA
Nominal AC power at $\cos \varphi = 0.8$ (at 25 °C / at 50 °C)	3200 kW / 2720 kW	3360 kW / 2856 kW
Nominal AC current $I_{AC, nom}$ (at 25 °C / at 50 °C)	3850 A / 3273 A	3850 A / 3273 A
Max. total harmonic distortion	< 3% at nominal power	< 3% at nominal power
Nominal AC voltage / nominal AC voltage range ^{1) 8)}	600 V / 480 V to 720 V	630 V / 504 V to 756 V
AC power frequency / range	50 Hz / 47 Hz to 53 Hz 60 Hz / 57 Hz to 63 Hz > 2	
Min. short-circuit ratio at the AC terminals ⁹⁾	1 / 0.8 overexcited to 0.8 underexcited	
Power factor at rated power / displacement power factor adjustable ^{8) 10)}		
Efficiency		
Max. efficiency ²⁾ / European efficiency ²⁾ / CEC efficiency ³⁾	98.8% / 98.6% / 98.5%	98.8% / 98.7% / 98.5%
Protective Devices		
Input-side disconnection point	DC load break switch	
Output-side disconnection point	AC circuit breaker	
DC overvoltage protection	Surge arrester, type I & II	
AC overvoltage protection (optional)	Surge arrester, class I & II	
Lightning protection (according to IEC 62305-1)	Lightning Protection Level III	
Ground-fault monitoring / remote ground-fault monitoring	○ / ○	
Insulation monitoring	○	
Degree of protection: electronics / air duct / connection area (as per IEC 60529)	IP54 / IP34 / IP34	
General Data		
Dimensions (W / H / D)	2815 / 2318 / 1588 mm (110.8 / 91.3 / 62.5 inch)	
Weight	< 4000 kg / < 8818.5 lb	
Self-consumption (max. ⁴⁾ / partial load ⁵⁾ / average ⁶⁾	< 8100 W / < 1800 W / < 2000 W	
Self-consumption (standby)	< 370 W	
Internal auxiliary power supply	○ Integrated 8.4 kVA transformer	
Operating temperature range ⁸⁾	-25 °C to 60 °C / -13 °F to 140 °F	
Noise emission ⁷⁾	63.0 dB(A)*	
Temperature range (standby)	-40 °C to 60 °C / -40 °F to 140 °F	
Temperature range (storage)	-40 °C to 70 °C / -40 °F to 158 °F	
Max. permissible value for relative humidity (condensing / non-condensing)	95% to 100% (2 month/year) / 0% to 95%	
Maximum operating altitude above MSL ⁸⁾ 1000 m / 2000 m ¹¹⁾ / 3000 m ¹¹⁾	● / ○ / ○	● / ○ / -
Fresh air consumption	6500 m ³ /h	
Features		
DC connection	Terminal lug on each input (without fuse)	
AC connection	With busbar system (three busbars, one per line conductor)	
Communication	Ethernet, Modbus Master, Modbus Slave	
Enclosure / roof color	RAL 9016 / RAL 7004	
Supply for external loads	○ (2.5 kVA)	
Standards and directives complied with	CE, IEC / EN 62109-1, IEC / EN 62109-2, AR-N 4110, IEEE1547, UL 840 Cat. IV, Arrêté du 23/04/08	
EMC standards	IEC 55011, FCC Part 15 Class A	
Quality standards and directives complied with	VDI/VDE 2862 page 2, DIN EN ISO 9001	
● Standard features ○ Optional – not available * preliminary		
Type designation	SC 4000 UP	SC 4200 UP

- 1) At nominal AC voltage, nominal AC power decreases in the same proportion
- 2) Efficiency measured without internal power supply
- 3) Efficiency measured with internal power supply
- 4) Self-consumption at rated operation
- 5) Self-consumption at < 75% P_n at 25 °C
- 6) Self-consumption averaged out from 5% to 100% P_n at 25 °C

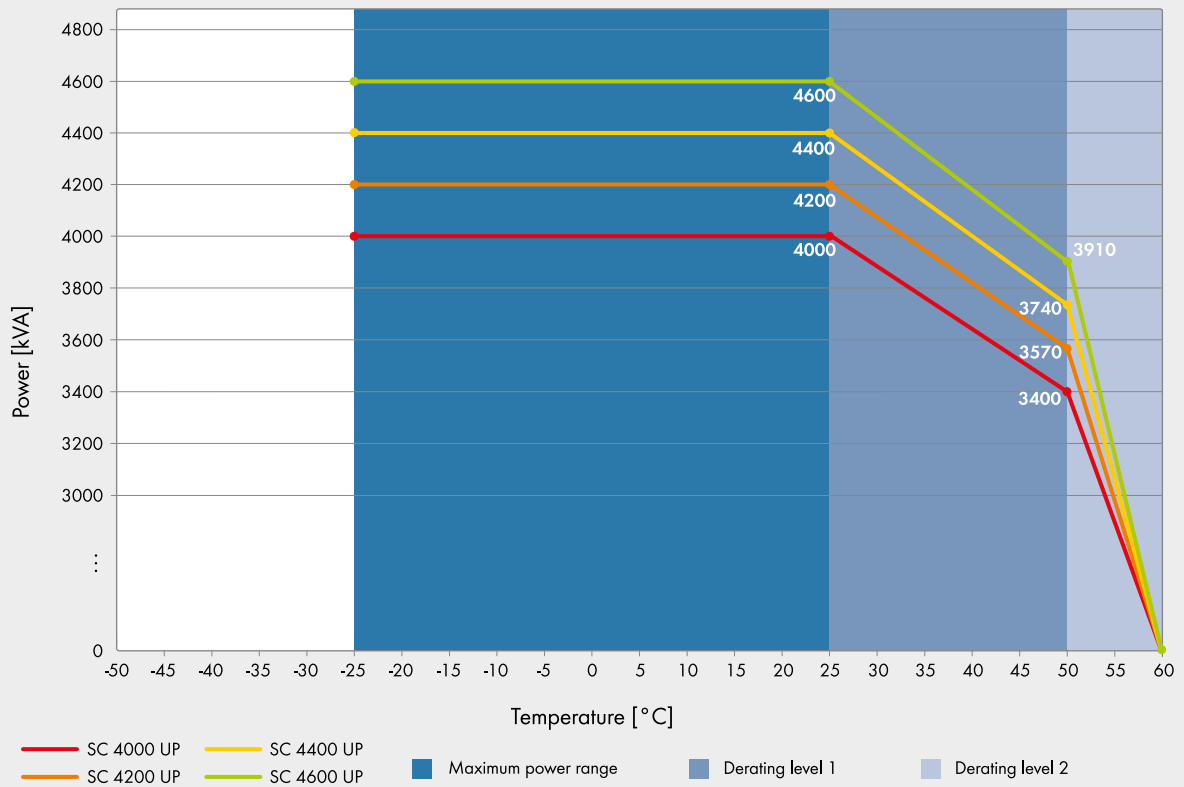
- 7) Sound pressure level at a distance of 10 m
- 8) Values apply only to inverters. Permissible values for SMA MV solutions from SMA can be found in the corresponding data sheets.
- 9) A short-circuit ratio of < 2 requires a special approval from SMA
- 10) Depending on the DC voltage
- 11) Earlier temperature-dependent de-rating and reduction of DC open-circuit voltage

Technical Data	SC 4400 UP	SC 4600 UP
DC side		
MPP voltage range V _{DC} (at 25 °C / at 50 °C)	962 to 1325 V / 1100 V	1003 to 1325 V / 1100 V
Min. DC voltage V _{DC, min} / Start voltage V _{DC, Start}	934 V / 1112 V	976 V / 1153 V
Max. DC voltage V _{DC, max}	1500 V	1500 V
Max. DC current I _{DC, max}	4750 A	4750 A
Max. short-circuit current I _{DC, SC}	6400 A	6400 A
Number of DC inputs	Busbar with 26 connections per terminal, 24 double pole fused (32 single pole fused)	
Number of DC inputs with optional DC coupled storage	18 double pole fused (36 single pole fused) for PV and 6 double pole fused for batteries	
Max. number of DC cables per DC input (for each polarity)	2 x 800 kcmil, 2 x 400 mm ²	
Integrated zone monitoring	○	
Available PV fuse sizes (per input)	200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A	
Available battery fuse size (per input)	750 A	
AC side		
Nominal AC power at cos φ = 1 (at 25 °C / at 50 °C)	4400 kVA / 3740 kVA	4600 kVA / 3910 kVA
Nominal AC power at cos φ = 0.8 (at 25 °C / at 50 °C)	3520 kW / 2992 kW	3680 kW / 3128 kW
Nominal AC current I _{AC, nom} (at 25 °C / at 50 °C)	3850 A / 3273 A	3850 A / 3273 A
Max. total harmonic distortion	< 3% at nominal power	< 3% at nominal power
Nominal AC voltage / nominal AC voltage range ^{1) 8)}	660 V / 528 V to 759 V	690 V / 552 V to 759 V
AC power frequency / range	50 Hz / 47 Hz to 53 Hz 60 Hz / 57 Hz to 63 Hz > 2	
Min. short-circuit ratio at the AC terminals ⁹⁾	● 1 / 0.8 overexcited to 0.8 underexcited	
Power factor at rated power / displacement power factor adjustable ^{8) 10)}		
Efficiency		
Max. efficiency ²⁾ / European efficiency ²⁾ / CEC efficiency ³⁾	98.8% / 98.7% / 98.5%	98.9% / 98.7% / 98.5%
Protective Devices		
Input-side disconnection point	DC load break switch	
Output-side disconnection point	AC circuit breaker	
DC overvoltage protection	Surge arrester, type I & II	
AC overvoltage protection (optional)	Surge arrester, class I & II	
Lightning protection (according to IEC 62305-1)	Lightning Protection Level III	
Ground-fault monitoring / remote ground-fault monitoring	○ / ○	
Insulation monitoring	○	
Degree of protection: electronics / air duct / connection area (as per IEC 60529)	IP54 / IP34 / IP34	
General Data		
Dimensions (W / H / D)	2815 / 2318 / 1588 mm (110.8 / 91.3 / 62.5 inch)	
Weight	< 4000 kg / < 8818.5 lb	
Self-consumption (max. ⁴⁾ / partial load ⁵⁾ / average ⁶⁾	< 8100 W / < 1800 W / < 2000 W	
Self-consumption (standby)	< 370 W	
Internal auxiliary power supply	○ Integrated 8.4 kVA transformer	
Operating temperature range ⁸⁾	-25 °C to 60 °C / -13 °F to 140 °F	
Noise emission ⁷⁾	63.0 dB(A)*	
Temperature range (standby)	-40 °C to 60 °C / -40 °F to 140 °F	
Temperature range (storage)	-40 °C to 70 °C / -40 °F to 158 °F	
Max. permissible value for relative humidity (condensing / non-condensing)	95% to 100% (2 month/year) / 0% to 95%	
Maximum operating altitude above MSL ⁸⁾ 1000 m / 2000 m ¹¹⁾ / 3000 m ¹¹⁾	● / ○ / -	
Fresh air consumption	6500 m ³ /h	
Features		
DC connection	Terminal lug on each input (without fuse)	
AC connection	With busbar system (three busbars, one per line conductor)	
Communication	Ethernet, Modbus Master, Modbus Slave	
Enclosure / roof color	RAL 9016 / RAL 7004	
Supply for external loads	○ (2.5 kVA)	
Standards and directives complied with	CE, IEC / EN 62109-1, IEC / EN 62109-2, AR-N 4110, IEEE1547, UL 840 Cat. IV, Arrêté du 23/04/08	
EMC standards	IEC 55011, FCC Part 15 Class A	
Quality standards and directives complied with	VDI/VDE 2862 page 2, DIN EN ISO 9001	
● Standard features ○ Optional – not available * preliminary		
Type designation	SC 4400 UP	SC 4600 UP

SYSTEM DIAGRAM



TEMPERATURE BEHAVIOR (at 1000 m)



SG3150U/SG2500U New

SUNGROW
Clean power for all

SG3150U/SG2500U

Turnkey Station for North America 1500 Vdc System



HIGH YIELD

- Advanced three-level technology, max. efficiency 98.8%, CEC efficiency 98.5 %
- Max. DC/AC ratio more than 1.5



EASY O&M

- Integrated current and voltage monitoring function for online analysis and fast trouble shooting
- Modular design, easy for maintenance
- Convenient external LCD



SAVED INVESTMENT

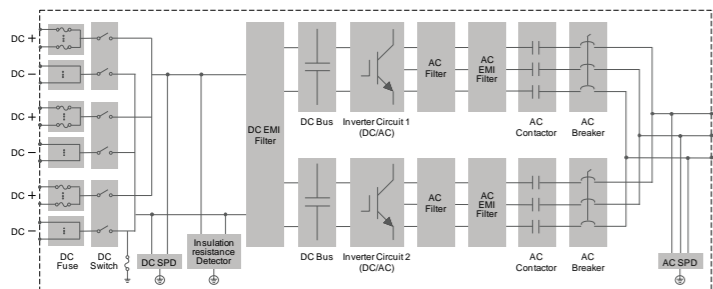
- Low transportation and installation cost due to 10-foot container design
- 1500V DC system, low system cost
- Integrated LV auxiliary power supply



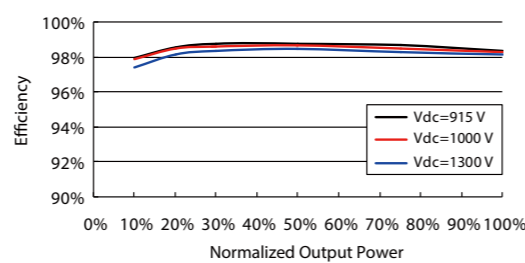
GRID SUPPORT

- Complies with UL 1741, UL 1741 SA, IEEE 1547, Rule 21 and NEC 2014/2017
- Grid support including L/HVRT, L/HFRT, power ramp rate control, active and reactive power support

CIRCUIT DIAGRAM



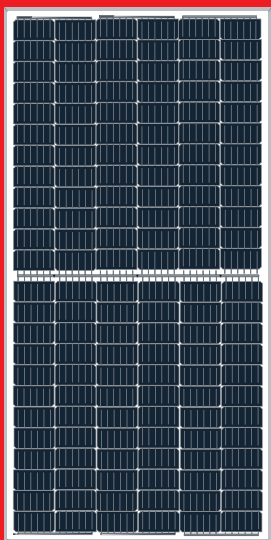
EFFICIENCY CURVE (SG3150U)



Type designation	SG3150U		SG2500U
Input (DC)			
Max. PV input voltage	1500V		
Min. PV input voltage / Startup input voltage	915 V / 955 V		800 V / 840 V
MPP voltage range for nominal power	940 – 1300 V		800 – 1300 V
No. of independent MPP inputs	1		
No. of DC inputs	18 – 24		18 – 21
Max. PV input current	3420 A		3508 A
Max. DC short-circuit current	4800 A		
Output (AC)			
AC output power	3150 kVA @ 45 °C (113 °F)		2750 kVA @ 45 °C (113 °F) / 2500 kVA @ 50 °C (122 °F)
Max. AC output current	2886 A		
Nominal AC voltage	630 V		550 V
AC voltage range	554 - 690 V	554 - 690 V	484 - 605 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 – 65 Hz		
THD	< 3 % (at nominal power)		
DC current injection	< 0.5 % of nominal output current		
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading – 0.8 lagging		
Feed-in phases / Connection phases	3 / 3		
Efficiency			
Max. efficiency	98.8%		
CEC efficiency	98.5 %		
Protection			
DC input protection	Load break switch + fuse		
AC output protection	Circuit breaker		
Overvoltage protection	DC Type II / AC Type II		
Grid monitoring / Ground fault monitoring	Yes / Yes		
Insulation monitoring	Optional		
Q at night function	Optional		
Overheat protection	Yes		
General Data			
Dimensions (W*H*D)	2991*2896*2438 mm (117.8"*114.0"*96.0")		
Weight	6.9 T (15211.9 lbs)		
Isolation method	Transformerless		
Degree of protection	NEMA 3R		
Auxiliary power supply	120 Vac, 5 kVA / Optional: 480 Vac, 30 kVA		
Operating ambient temperature range	-30 to 60 °C (> 45 °C derating) (-22 to 140 °F (> 113 °F derating))		-30 to 60 °C (> 50 °C derating) (-22 to 140 °F (> 122 °F derating))
Allowable relative humidity range (non-condensing)	0 – 95 %		
Cooling method	Temperature controlled forced air cooling		
Max. operating altitude	4000 m (> 2000 m derating) (13123 ft (> 6561 ft derating))		
Display	Touch screen		
Communication	Standard: RS485, Ethernet; Optional: optical fiber		
Compliance	UL 1741, IEEE 1547, UL1741 SA, NEC 2014 / 2017, CSA C22.2 No.107.1-01		
Grid support	L/HVRT, L/HFRT, active & reactive power control and power ramp rate control, Volt-var, Frequency-watt		



Representative Solar PV Panels

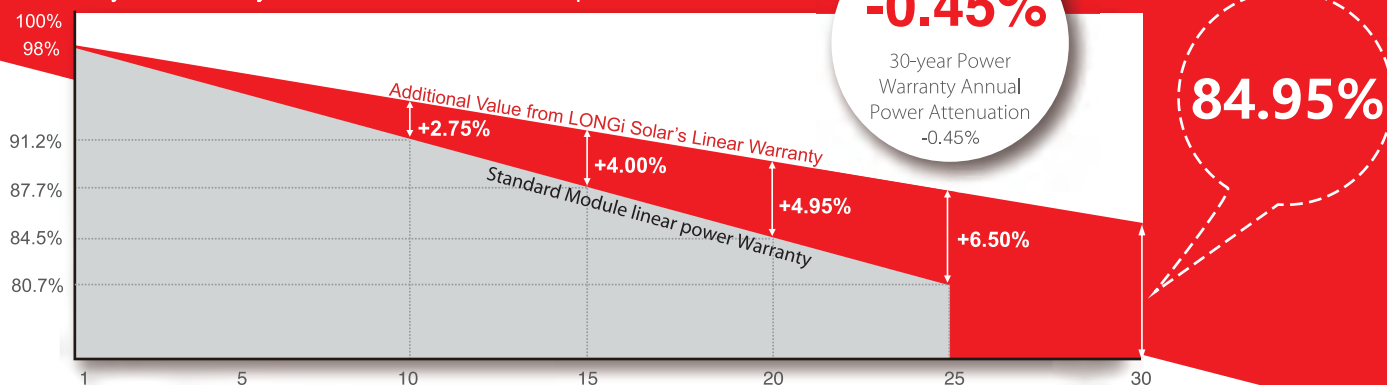


LR4-72HBD 425~445M

Hi-M04

**High Efficiency
Low LID Bifacial PERC with
Half-cut Technology**

10-year Warranty for Materials and Processing;
30-year Warranty for Extra Linear Power Output



Complete System and Product Certifications

IEC 61215, IEC61730, UL1703

ISO 9001:2008: ISO Quality Management System

ISO 14001: 2004: ISO Environment Management System

TS62941: Guideline for module design qualification and type approval

OHSAS 18001: 2007 Occupational Health and Safety



* Specifications subject to technical changes and tests. LONGi Solar reserves the right of interpretation.

Front side performance equivalent to conventional low LID mono PERC:

- High module conversion efficiency (up to 19.9%)
- Better energy yield with excellent low irradiance performance and temperature coefficient
- First year power degradation <2%

Bifacial technology enables additional energy harvesting from rear side (up to 25%)

Glass/glass lamination ensures 30 year product lifetime, with annual power degradation < 0.45%, 1500V compatible to reduce BOS cost

Solid PID resistance ensured by solar cell process optimization and careful module BOM selection

Reduced resistive loss with lower operating current

Higher energy yield with lower operating temperature

Reduced hot spot risk with optimized electrical design and lower operating current

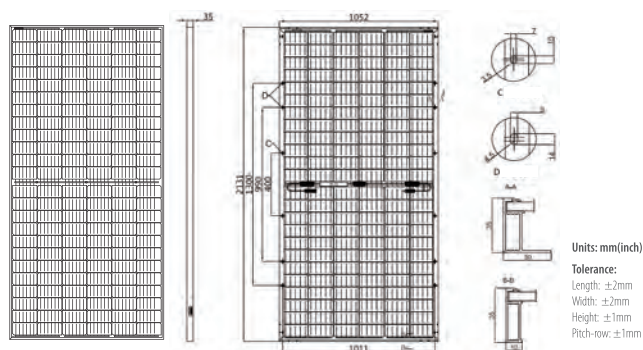
LONGi

Room 801, Tower 3, Lujiazui Financial Plaza, No.826 Century Avenue, Pudong Shanghai, 200120, China
Tel: +86-21-80162606 E-mail: module@longi-silicon.com Facebook: www.facebook.com/LONGi Solar

Note: Due to continuous technical innovation, R&D and improvement, technical data above mentioned may be of modification accordingly. LONGi Solar have the sole right to make such modification at anytime without further notice; Demanding party shall request for the latest datasheet for such as contract need, and make it a consisting and binding part of lawful documentation duly signed by both parties.

LR4-72HBD 425~445M

Design (mm)



Mechanical Parameters

Cell Orientation: 144 (6×24)
 Junction Box: IP68, three diodes
 Output Cable: 4mm², 300mm in length,
 length can be customized
 Glass: Dual glass
 2.0mm tempered glass
 Frame: Anodized aluminum alloy frame
 Weight: 29.5kg
 Dimension: 2131×1052×35mm
 Packaging: 30pcs per pallet
 150pcs per 20'GP
 600pcs per 40'HC

Operating Parameters

Operational Temperature: -40℃ ~ +85℃
 Power Output Tolerance: 0 ~ +5 W
 Voc and Isc Tolerance: ±3%
 Maximum System Voltage: DC1500V (IEC / UL)
 Maximum Series Fuse Rating: 20A
 Nominal Operating Cell Temperature: 45±2℃
 Safety Class: Class II
 Fire Rating: UL type 3
 Bifaciality: Glazing≥70%

Electrical Characteristics

Test uncertainty for Pmax: ±3%

Model Number	LR4-72HBD-425M		LR4-72HBD-430M		LR4-72HBD-435M		LR4-72HBD-440M		LR4-72HBD-445M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	425	316.0	430	319.7	435	323.5	440	327.2	445	331
Open Circuit Voltage (Voc/V)	49.4	46.0	49.6	46.2	49.8	46.4	49.9	46.5	50.1	46.7
Short Circuit Current (Isc/A)	11.02	8.93	11.09	8.98	11.16	9.04	11.25	9.11	11.32	9.16
Voltage at Maximum Power (Vmp/V)	41.0	38.1	41.2	38.2	41.4	38.4	41.5	38.5	41.7	38.7
Current at Maximum Power (Imp/A)	10.37	8.30	10.44	8.36	10.51	8.42	10.61	8.50	10.68	8.55
Module Efficiency(%)	19.0		19.2		19.4		19.6		19.9	

STC (Standard Testing Conditions): Irradiance 1000W/m², Cell Temperature 25℃, Spectra at AM1.5

NOCT (Nominal Operating Cell Temperature): Irradiance 800W/m², Ambient Temperature 20℃, Spectra at AM1.5, Wind at 1m/s

Electrical characteristics with different rear side power gain (reference to 425W front)

Pmax /W	Voc/V	Isc /A	Vmp/V	Imp /A	Pmax gain
446	49.4	11.58	41.0	10.88	5%
468	49.4	12.13	41.0	11.40	10%
489	49.5	12.68	41.1	11.92	15%
510	49.5	13.23	41.1	12.44	20%
531	49.5	13.78	41.1	12.96	25%

Temperature Ratings (STC)

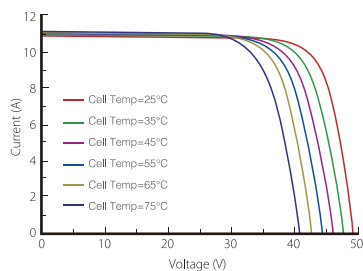
Temperature Coefficient of Isc	+0.060%/℃
Temperature Coefficient of Voc	-0.300%/℃
Temperature Coefficient of Pmax	-0.370%/℃

Mechanical Loading

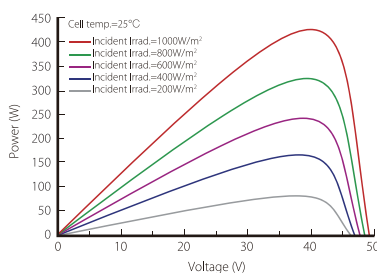
Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

I-V Curve

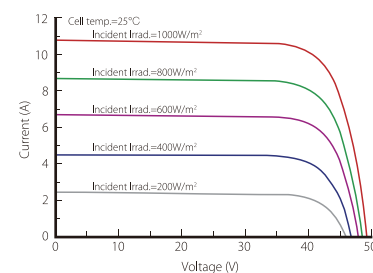
Current-Voltage Curve (LR4-72HBD-425M)



Power-Voltage Curve (LR4-72HBD-425M)



Current-Voltage Curve (LR4-72HBD-425M)



LONGi

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Note: Due to continuous technical innovation, R&D and improvement, technical data above mentioned may be of modification accordingly. LONGi Solar have the sole right to make such modification at anytime without further notice; Demanding party shall request for the latest datasheet for such as contract need, and make it a consisting and binding part of lawful documentation duly signed by both parties.



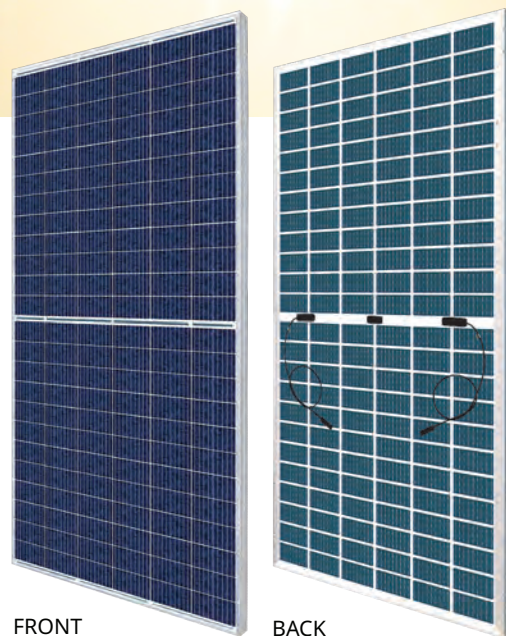
BiHiKu

SUPER HIGH POWER BIFACIAL POLY PERC MODULE

390 W ~ 410 W

UP TO 30% MORE POWER FROM THE BACK SIDE

CS3W-390 | 395 | 400 | 405 | 410PB-AG



MORE POWER



Up to 30% more power from the back side



24 % more front side power than conventional modules



Low NMOT: 41 ± 3 °C
Low temperature coefficient (Pmax):
-0.37 % / °C



Better shading tolerance

MORE RELIABLE



Lower internal current,
lower hot spot temperature



Minimizes micro-cracks and
snail trails



Heavy snow load up to 5400 Pa,
wind load up to 2400 Pa *



Fire Class A and Type 3 / Type 13



linear power output warranty*



**enhanced product warranty on
materials and workmanship***

*According to the applicable Canadian Solar Limited Warranty Statement.

MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2015 / Quality management system
ISO 14001:2015 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / CE / MCS / INMETRO
UL 1703 / IEC 61215 performance: CEC listed (US)
UL 1703: CSA / IEC 61701 ED2: VDE / IEC 62716: VDE / IEC 60068-2-68: SGS
Take-e-way



* As there are different certification requirements in different markets, please contact your local Canadian Solar sales representative for the specific certificates applicable to the products in the region in which the products are to be used.

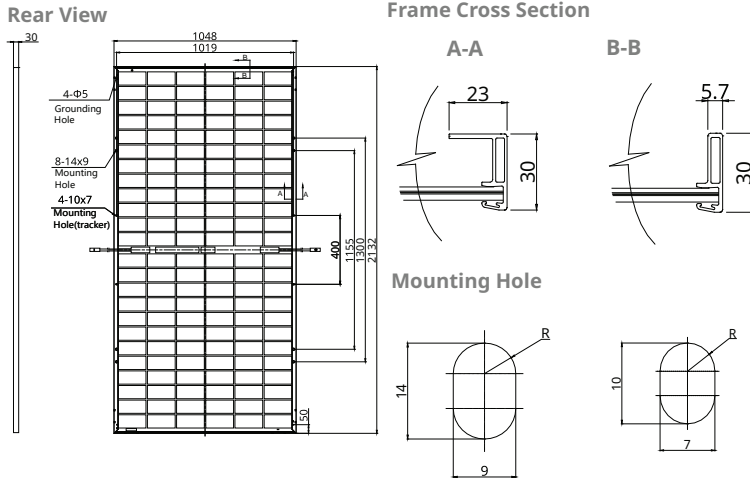
CANADIAN SOLAR (USA), INC. is committed to providing high quality solar products, solar system solutions and services to customers around the world. No. 1 module supplier for quality and performance/price ratio in IHS Module Customer Insight Survey. As a leading PV project developer and manufacturer of solar modules with over 36 GW deployed around the world since 2001.

* For detailed information, please refer to Installation Manual.

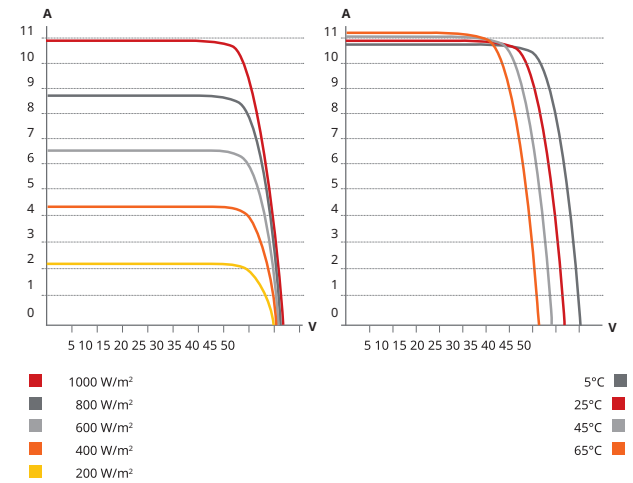
CANADIAN SOLAR (USA), INC.

3000 Oak Road, Suite 400, Walnut Creek, CA 94597, USA | www.canadiansolar.com/na | sales.us@canadiansolar.com

ENGINEERING DRAWING (mm)



CS3W-400PB-AG / I-V CURVES



ELECTRICAL DATA | STC*

	Nominal Max. Power (Pmax)	Opt. Operating Voltage (Vmp)	Opt. Operating Current (Imp)	Open Circuit Voltage (Voc)	Short Circuit Current (Isc)	Module Efficiency
CS3W-390PB-AG	390 W	38.3 V	10.19 A	46.8 V	10.74 A	17.45%
Bifacial Gain**	5% 410 W	38.3 V	10.71 A	46.8 V	11.28 A	18.35%
	10% 429 W	38.3 V	11.21 A	46.8 V	11.81 A	19.20%
	20% 468 W	38.3 V	12.23 A	46.8 V	12.89 A	20.95%
	30% 507 W	38.3 V	13.25 A	46.8 V	13.96 A	22.69%
CS3W-395PB-AG	395 W	38.5 V	10.26 A	47 V	10.82 A	17.68%
Bifacial Gain**	5% 415 W	38.5 V	10.78 A	47 V	11.36 A	18.57%
	10% 435 W	38.5 V	11.3 A	47 V	11.9 A	19.47%
	20% 474 W	38.5 V	12.31 A	47 V	12.98 A	21.21%
	30% 513 W	38.5 V	13.34 A	47 V	14.07 A	22.96%
CS3W-400PB-AG	400 W	38.7 V	10.34 A	47.2 V	10.9 A	17.90%
Bifacial Gain**	5% 420 W	38.7 V	10.86 A	47.2 V	11.45 A	18.80%
	10% 440 W	38.7 V	11.37 A	47.2 V	11.99 A	19.69%
	20% 480 W	38.7 V	12.41 A	47.2 V	13.08 A	21.48%
	30% 520 W	38.7 V	13.44 A	47.2 V	14.17 A	23.27%
CS3W-405PB-AG	405 W	38.9 V	10.42 A	47.4 V	10.98 A	18.13%
Bifacial Gain**	5% 425 W	38.9 V	10.94 A	47.4 V	11.53 A	19.02%
	10% 445 W	38.9 V	11.46 A	47.4 V	12.08 A	19.92%
	20% 486 W	38.9 V	12.5 A	47.4 V	13.18 A	21.75%
	30% 527 W	38.9 V	13.56 A	47.4 V	14.27 A	23.59%
CS3W-410PB-AG	410 W	39.1 V	10.49 A	47.6 V	11.06 A	18.35%
Bifacial Gain**	5% 431 W	39.1 V	11.03 A	47.6 V	11.61 A	19.29%
	10% 451 W	39.1 V	11.54 A	47.6 V	12.17 A	20.18%
	20% 492 W	39.1 V	12.59 A	47.6 V	13.27 A	22.02%
	30% 533 W	39.1 V	13.64 A	47.6 V	14.38 A	23.85%

* Under Standard Test Conditions (STC) of irradiance of 1000 W/m², spectrum AM 1.5 and cell temperature of 25°C.

** Bifacial Gain: The additional gain from the back side compared to the power of the front side at the standard test condition. It depends on mounting (structure, height, tilt angle etc.) and albedo of the ground.

ELECTRICAL DATA

Operating Temperature	-40°C ~ +85°C
Max. System Voltage	1500 V (IEC/UL) or 1000 V (IEC/UL)
Module Fire Performance	TYPE 3 / Type 13 (UL 1703) or CLASS A (IEC61730)
Max. Series Fuse Rating	25 A
Application Classification	Class A
Power Tolerance	0 ~ + 5 W
Power Bifaciality*	70 %

* Power Bifaciality = $\frac{P_{max, rear}}{P_{max, front}}$ both $P_{max, rear}$ and $P_{max, front}$ are tested under STC, Bifaciality Tolerance: ± 5 %

* The specifications and key features contained in this datasheet may deviate slightly from our actual products due to the on-going innovation and product enhancement. Canadian Solar Inc. reserves the right to make necessary adjustment to the information described herein at any time without further notice.
Please be kindly advised that PV modules should be handled and installed by qualified people who have professional skills and please carefully read the safety and installation instructions before using our PV modules.

ELECTRICAL DATA | NMOT*

	Nominal Max. Power (Pmax)	Opt. Operating Voltage (Vmp)	Opt. Operating Current (Imp)	Open Circuit Voltage (Voc)	Short Circuit Current (Isc)
CS3W-390PB-AG	291 W	35.7 V	8.15 A	44.0 V	8.66 A
CS3W-395PB-AG	295 W	35.9 V	8.21 A	44.2 V	8.72 A
CS3W-400PB-AG	299 W	36.1 V	8.27 A	44.4 V	8.79 A
CS3W-405PB-AG	302 W	36.3 V	8.33 A	44.6 V	8.85 A
CS3W-410PB-AG	306 W	36.5 V	8.39 A	44.8 V	8.92 A

* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

MECHANICAL DATA

Specification	Data
Cell Type	Poly-crystalline
Cell Arrangement	144 [2X (12 X6)]
Dimensions	2132 × 1048 × 30 mm (83.9 × 41.3 × 1.2 in)
Weight	28.2 kg (62.2 lbs)
Front / Back Glass	2.0 mm heat strengthened glass
Frame	Anodized aluminium alloy
J-Box	IP68, 3 diodes
Cable	4.0 mm ² (IEC), 12 AWG (UL)
Cable Length (Including Connector)	Portrait: 400 mm (15.7 in) (+) / 280 mm (11.0 in) (-); landscape: 1400 mm (55.1 in); leap-frog connection: 1850 mm (72.8 in)*
Connector	T4 series
Per Pallet	35 pieces

Per Container (40' HQ) 700 pieces or 560 pieces (only for US and Canada)

* For detailed information, please contact your local Canadian Solar sales and technical representatives.

TEMPERATURE CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.37 % / °C
Temperature Coefficient (Voc)	-0.29 % / °C
Temperature Coefficient (Isc)	0.05 % / °C
Nominal Module Operating Temperature	41 ± 3°C

PARTNER SECTION



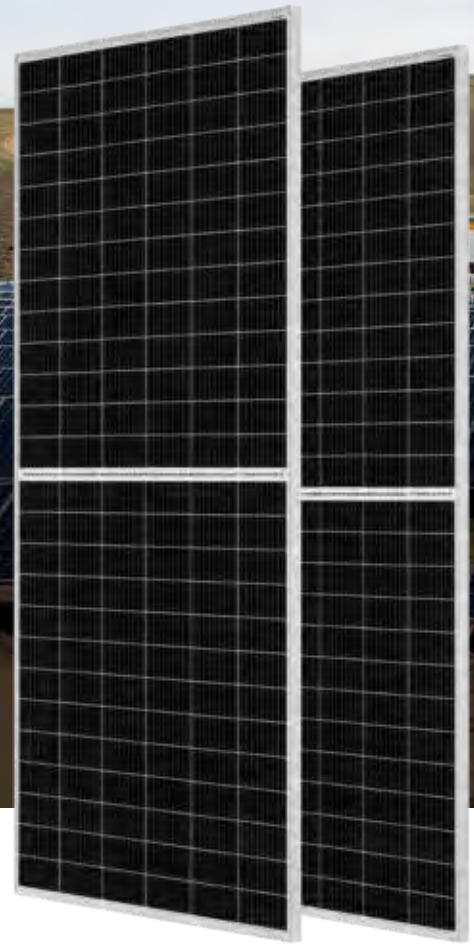
Mono

450W MBB Bifacial Mono PERC Half-cell Double Glass Module

JAM78D10 430-450/MB Series

Introduction

Assembled with MBB bifacial PERC cells and half-cell configuration, these double glass modules have the capability of converting the incident light from the rear side together with the front side into electricity, providing higher output power, lower temperature coefficient, less shading loss, as well as enhanced tolerance for mechanical loading.



Higher output power



More reliable, more stable
power generation



Less shading effect

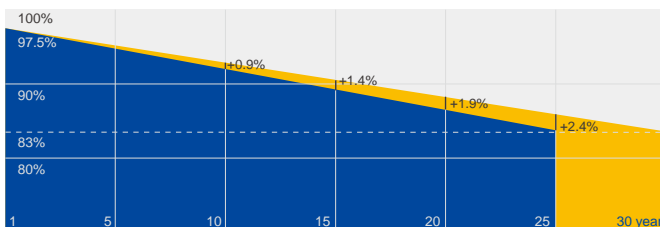


Lower temperature coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

0.5% Annual Degradation
Over 30 years



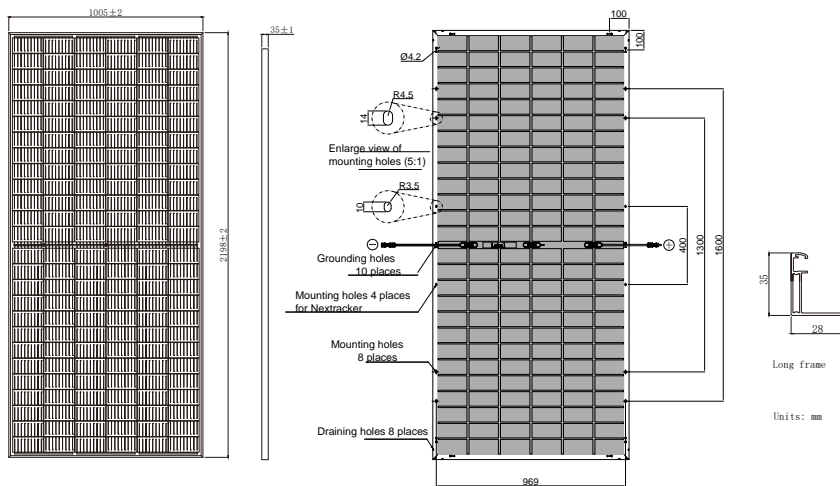
■ Additional Value From 30-Year Warranty ■ JA Standard

Comprehensive Certificates

- IEC 61215, IEC 61730, UL 61215, UL 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- OHSAS 18001: 2007 Occupational health and safety management systems
- IEC TS 62941: 2016 Terrestrial photovoltaic (PV) modules – Guidelines for increased confidence in PV module design qualification and type approval



MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono
Weight	29.0kg±3%
Dimensions	2198±2mm×1005±2mm×35±1mm
Cable Cross Section Size	4mm²(12 AWG)
No. of cells	156 (6×26)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35
Cable Length (Including Connector)	Portrait:300mm(+)/400mm(-); Landscape:1200mm(+)/1200mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	30 Per Pallet

ELECTRICAL PARAMETERS AT STC

TYPE	JAM78D10 -430/MB	JAM78D10 -435/MB	JAM78D10 -440/MB	JAM78D10 -445/MB	JAM78D10 -450/MB
Rated Maximum Power(Pmax) [W]	430	435	440	445	450
Open Circuit Voltage(Voc) [V]	52.46	52.74	53.01	53.29	53.58
Maximum Power Voltage(Vmp) [V]	43.93	44.31	44.68	44.96	45.28
Short Circuit Current(Isc) [A]	10.28	10.32	10.37	10.42	10.46
Maximum Power Current(Imp) [A]	9.79	9.82	9.85	9.90	9.94
Module Efficiency [%]	19.5	19.7	19.9	20.1	20.4
Power Tolerance	0~+5W				
Temperature Coefficient of Isc(α_{Isc})	+0.044%/°C				
Temperature Coefficient of Voc(β_{Voc})	-0.272%/°C				
Temperature Coefficient of Pmax(γ_{Pmp})	-0.354%/°C				
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G				

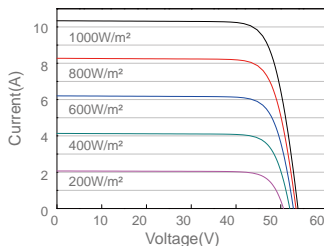
Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH DIFFERENT REAR SIDE POWER GAIN(REFERENCE TO 435W FRONT)

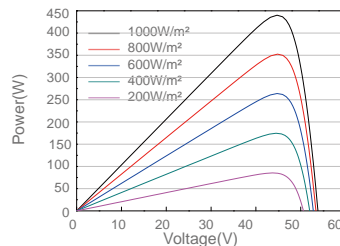
Backside Power Gain	5%	10%	15%	20%	25%	Maximum System Voltage	1500V DC(UL)
Rated Max Power(Pmax) [W]	457	479	500	522	544	Operating Temperature	-40°C~+85°C
Open Circuit Voltage(Voc) [V]	53.60	53.60	53.60	53.70	53.70	Maximum Series Fuse	20A
Max Power Voltage(Vmp) [V]	44.35	44.35	44.35	44.45	44.45	Maximum Static Load,Front*	5400Pa(112 lb/ft²)
Short Circuit Current(Isc) [A]	10.82	11.33	11.85	12.36	12.88	Maximum Static Load,Back*	2400Pa(50 lb/ft²)
Max Power Current(Imp) [A]	10.30	10.79	11.28	11.74	12.23	NOCT	45±2°C
*For NexTracker installations, Maximum Static Load,Front is 1800Pa while Maximum Static Load,Back is 1800Pa.						Bifaciality**	70%±5%
**Bifaciality=Pmax,rear/Rated Pmax,front						Fire Performance	UL Type 29

CHARACTERISTICS

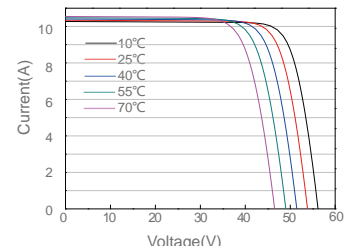
Current-Voltage Curve JAM78D10-440/MB



Power-Voltage Curve JAM78D10-440/MB



Current-Voltage Curve JAM78D10-440/MB



THE

DUOMAX^{twin}

BIFACIAL DUAL GLASS 144 CELL MULTI BUSBAR MODULE

144-Cell

MONOCRYSTALLINE MODULE

390-410W

POWER OUTPUT RANGE

20.2%

MAXIMUM EFFICIENCY

0~+5W

POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading total solution provider for solar energy. With local presence around the globe, Trina Solar is able to provide exceptional service to each customer in each market and deliver our innovative, reliable products with the backing of Trina as a strong, bankable brand. Trina Solar now distributes its PV products to over 100 countries all over the world. We are committed to building strategic, mutually beneficial collaborations with installers, developers, distributors and other partners in driving smart energy together.

Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716

ISO 9001: Quality Management System

ISO 14001: Environmental Management System

ISO14064: Greenhouse Gases Emissions Verification

OHSAS 18001: Occupation Health and Safety Management System

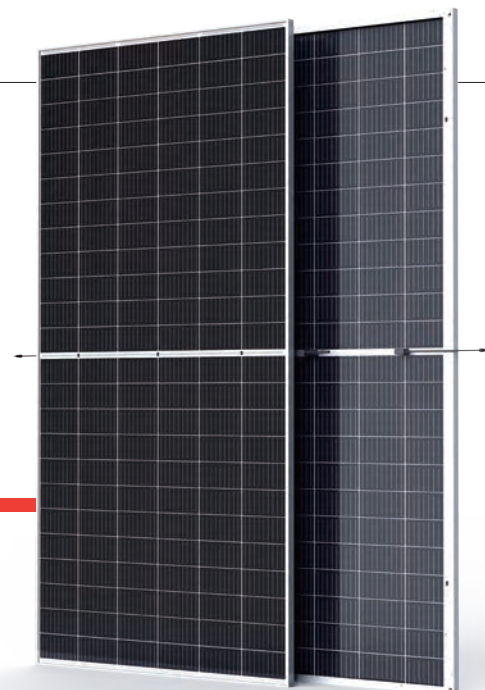


PRODUCTS

TSM-DEG15MC.20(II)

POWER RANGE

390-410W



High power output

- Up to 410W front power and 20.2% module efficiency with half-cut and MBB (Multi Busbar) technology enabling higher BOS savings
- Lower resistance of half-cut cells ensures higher power



Certified to perform in highly challenging environments

- High PID resistance through cell process and module material control
- Resistant to salt, acid, sand, and ammonia
- Proven to be reliable in high temperature and humidity areas
- Certified to the best fire class A
- Minimizes micro-crack and snail trails
- Certified to 5400 Pa positive load and 2400 Pa negative load



High energy generation, low LCOE

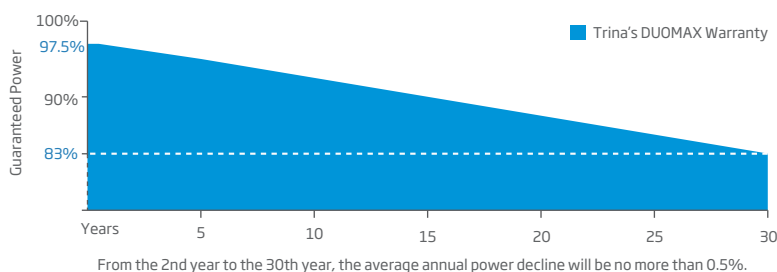
- Up to 25% additional power gain from back side, depending on the albedo
- Excellent 3rd party validated IAM and low light performance with cell process and module material optimization
- Low temp coefficient (-0.35%) and NMOT increases energy production
- Better anti-shading performance and lower operating temperature
- Higher power from same installation footprint as standard modules



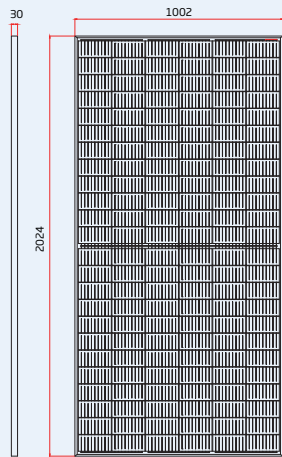
Easy to install, wide application

- Frame design enables compatibility with standard installation methods
- Deployable for ground mounted utility, carports, and agricultural projects
- Safe and easy to transport, handle, and install like normal framed modules

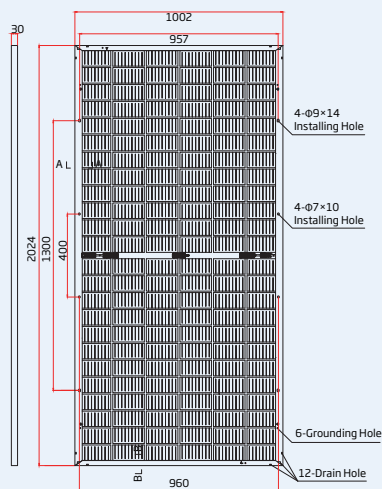
Trina Solar's DUOMAX Performance Warranty



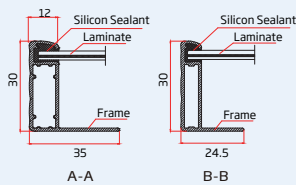
DIMENSIONS OF PV MODULE (mm)



Front View



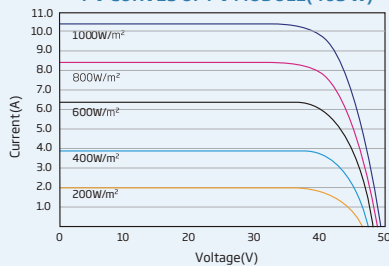
Back View



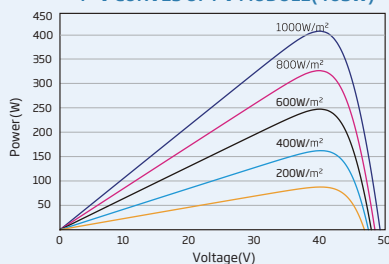
A-A

B-B

I-V CURVES OF PV MODULE(405W)



P-V CURVES OF PV MODULE(405W)



ELECTRICAL DATA (STC)

Peak Power Watts- P_{MAX} (Wp)*	390	395	400	405	410
Power Output Tolerance- P_{MAX} (W)	0 ~ +5				
Maximum Power Voltage- V_{MPP} (V)	40.2	40.5	40.8	41.1	41.4
Maximum Power Current- I_{MPP} (A)	9.71	9.76	9.81	9.86	9.91
Open Circuit Voltage- V_{OC} (V)	48.5	48.7	48.9	49.1	49.3
Short Circuit Current- I_{SC} (A)	10.25	10.29	10.33	10.37	10.41
Module Efficiency η_m (%)	19.2	19.5	19.7	20.0	20.2

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.

*Measuring tolerance: $\pm 3\%$.

ELECTRICAL DATA (NMOT)

Maximum Power- P_{MAX} (Wp)	295	299	302	306	310
Maximum Power Voltage- V_{MPP} (V)	37.7	38.0	38.3	38.6	38.9
Maximum Power Current- I_{MPP} (A)	7.82	7.86	7.90	7.93	7.97
Open Circuit Voltage- V_{OC} (V)	45.7	45.9	46.1	46.3	46.5
Short Circuit Current- I_{SC} (A)	8.26	8.29	8.33	8.36	8.39

NMOT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

Electrical characteristics with different rear side power gains (referenced specifically to 405 Wp front)**

Maximum Power- P_{MAX} (Wp)	425	446	466	486	506
Maximum Power Voltage- V_{MPP} (V)	41.1	41.1	41.1	41.1	41.1
Maximum Power Current- I_{MPP} (A)	10.35	10.85	11.34	11.83	12.33
Open Circuit Voltage- V_{OC} (V)	49.2	49.3	49.4	49.5	49.6
Short Circuit Current- I_{SC} (A)	10.89	11.41	11.93	12.44	12.96
Pmax gain	5%	10%	15%	20%	25%

Power Bifaciality: 70 \pm 5%.

MECHANICAL DATA

Solar Cells	Monocrystalline
Cell Orientation	144 cells (6 \times 24)
Module Dimensions	2024 \times 1002 \times 30 mm (79.69 \times 39.45 \times 1.18 inches)
Weight	26.0 kg (57.3 lb)
Front Glass	2.0 mm (0.08 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant material	POE/EVA
Back Glass	2.0 mm (0.08 inches), Heat Strengthened Glass (White Grid Glass)
Frame	30mm (1.18 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0 mm ² (0.006 inches ²) Portrait: 280/280 mm (11.02/11.02 inches) Landscape: 1900/1900 mm (74.80/74.80 inches)
Connector	Trina TS4

TEMPERATURE RATINGS

NMOT (Nominal Module Operating Temperature)	41°C ($\pm 3^\circ\text{C}$)
Temperature Coefficient of P_{MAX}	- 0.35%/°C
Temperature Coefficient of V_{OC}	- 0.25%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

WARRANTY

10 year Product Workmanship Warranty
30 year Power Warranty

(Please refer to product warranty for details)

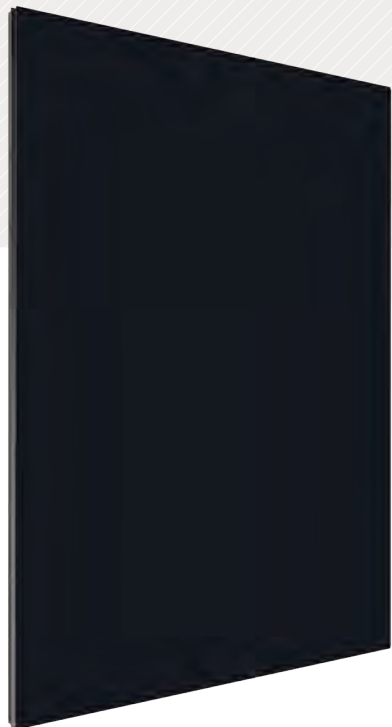
** Back-side power gain varies depending upon the specific project albedo

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	20A

PACKAGING CONFIGURATION

Modules per box: 35 pieces
Modules per 40' container: 770 pieces



420-445 Watts
17%+ Efficiency

HIGH-POWER PV MODULES

First Solar Series 6™ photovoltaic (PV) module sets a new industry benchmark for reliable energy production, optimized design and environmental performance. Series 6 modules are optimized for every stage of your application, significantly reducing balance of system, shipping, and operating costs.



MORE ENERGY PER MODULE

- More watts per connection and per lift (420+ watts) than 72-cell silicon modules
- With superior temperature coefficient, spectral response and shading behavior, Series 6 modules generate up to 8% more energy per watt than conventional crystalline silicon solar modules
- Anti-reflective coated glass enhances energy production



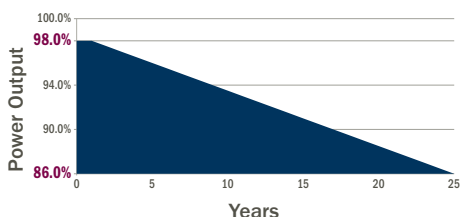
INNOVATIVE MODULE DESIGN

- Under-mount frame allows for simple and fast installation
- SpeedSlots™ combine the robustness of bottom mounting with the speed of top clamping while utilizing fewer fasteners
- Dual junction box optimizes module-to-module connections
- Under-mount frame provides the cleaning and snow-shedding benefits of a frameless module, protects edges against breakage and enables horizontal stacking

INDUSTRY-LEADING MODULE WARRANTY¹

98% WARRANTY START POINT

0.5% WARRANTED ANNUAL DEGRADATION RATE



- 25-Year Linear Performance Warranty
- 10-Year Limited Product Warranty



PROVEN LONG-TERM RELIABILITY

- Manufactured using methods and process adapted from Series 4 modules – the most tested solar modules in the industry
- Independently tested and certified for reliable performance that exceeds IEC standards in high temperature, high humidity, extreme desert and coastal applications



BEST ENVIRONMENTAL PROFILE

- Fastest energy payback time and smallest carbon and water footprint in the industry
- Global PV collection and recycling services available through First Solar or customer-selected third-party

FIRST SOLAR SERIES 6™

MODEL TYPES AND RATINGS AT STANDARD TEST CONDITIONS (1000W/m², AM 1.5, 25°C)²

NOMINAL VALUES		FS-6420 FS-6420A	FS-6425 FS-6425A	FS-6430 FS-6430A	FS-6435 FS-6435A	FS-6440 FS-6440A	FS-6445 FS-6445A
Nominal Power ³ (-0/+5%)	P _{MAX} (W)	420.0	425.0	430.0	435.0	440.0	445.0
Efficiency (%)	%	17.0	17.2	17.4	17.6	17.8	18.0
Voltage at P _{MAX}	V _{MAX} (V)	180.4	181.5	182.6	183.6	184.7	185.7
Current at P _{MAX}	I _{MAX} (A)	2.33	2.34	2.36	2.37	2.38	2.40
Open Circuit Voltage	V _{OC} (V)	218.5	218.9	219.2	219.6	220.0	220.4
Short Circuit Current	I _{SC} (A)	2.54	2.54	2.54	2.55	2.55	2.56
Maximum System Voltage	V _{SYS} (V)	1500 ⁵					
Limiting Reverse Current	I _R (A)	6.0					
Maximum Series Fuse	I _{CF} (A)	6.0					

RATINGS AT NOMINAL OPERATING CELL TEMPERATURE OF 45°C (800W/m², 20°C air temperature, AM 1.5, 1m/s wind speed)²

Nominal Power	P _{MAX} (W)	317.2	320.9	324.7	328.5	332.4	336.0
Voltage at P _{MAX}	V _{MAX} (V)	168.7	169.8	170.9	172.0	173.1	174.1
Current at P _{MAX}	I _{MAX} (A)	1.88	1.89	1.90	1.91	1.92	1.93
Open Circuit Voltage	V _{OC} (V)	206.3	206.6	207.0	207.3	207.7	208.0
Short Circuit Current	I _{SC} (A)	2.04	2.05	2.05	2.06	2.06	2.06

TEMPERATURE CHARACTERISTICS

Module Operating Temperature Range	(°C)	-40 to +85
Temperature Coefficient of P _{MAX}	T _K (P _{MAX})	-0.32%/°C [Temperature Range: 25°C to 75°C]
Temperature Coefficient of V _{OC}	T _K (V _{OC})	-0.28%/°C
Temperature Coefficient of I _{SC}	T _K (I _{SC})	+0.04%/°C

MECHANICAL DESCRIPTION

Length	2009mm
Width	1232mm
Thickness	49mm
Area	2.47m ²
Module Weight	36kg
Leadwire ⁶	2.5mm ² , 720mm (+) & Bulkhead (-)
Connectors	MC4-EVO 2
Bypass Diode	N/A
Cell Type	Thin film CdTe semiconductor, up to 264 cells
Frame Material	Anodized Aluminum
Front Glass	2.8mm heat strengthened Series 6A™ includes anti-reflective coating
Back Glass	2.2mm heat strengthened
Encapsulation	Laminate material with edge seal
Frame to Glass Adhesive	Silicone
Load Rating ⁷	2400Pa

PACKAGING INFORMATION

Modules Per Pallet	26	Pallet Dimensions (L x W x H)	2200 x 1300 x 1150mm (86 x 51 x 45in)
Pallet Weight	1051kg	Pallets per 40' Container	18

Disclaimer

The information included in this Module Datasheet is subject to change without notice and is provided for informational purposes only. No contractual rights are established or should be inferred because of user's reliance on the information contained in this Module Datasheet. Please refer to the appropriate Module User Guide and Module Product Specification document for more detailed technical information regarding module performance, installation and use.

The First Solar logo, First Solar™, and all products denoted with ® are registered trademarks, and those denoted with a ™ are trademarks of First Solar, Inc.

CERTIFICATIONS AND TESTS

IEC

61215 & 61730 1500V⁵, CE
61701 Salt Mist Corrosion
60068-2-68 Dust and Sand Resistance

UL

UL 1703 1500V Listed⁵

REGIONAL CERTIFICATIONS

CSI Eligible JET⁴
MCS SII
InMetro⁴

EXTENDED DURABILITY TESTS

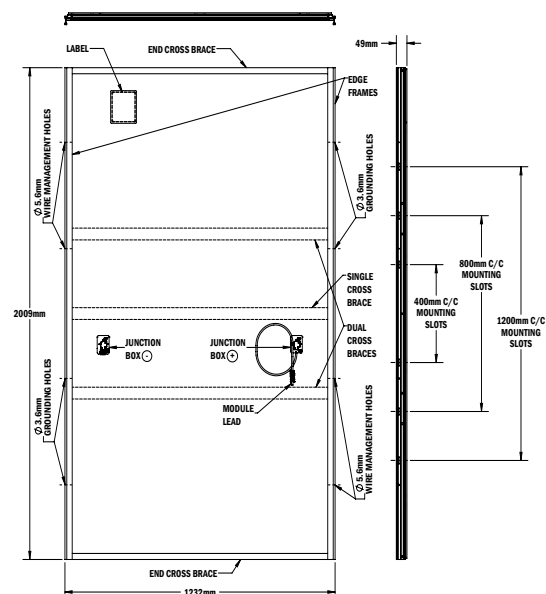
ANSI/CAN/CSA-C450-18
Long-Term Sequential
Thresher Test
PID Resistant

QUALITY & EHS

ISO 9001:2015 & 14001:2015
OHSAS 18001:2007
ISO 45001:2018



MECHANICAL DRAWING



Install in portrait only

- Limited power output and product warranties subject to warranty terms and conditions
- All ratings ±10%, unless specified otherwise. Specifications are subject to change
- Measurement uncertainty applies
- Testing Certifications/Listings pending
- IEC 61730-1: 2016 Class II | ULC 1703 1000V listed
- Leadwire length from junction box exit to connector mating surface
- Higher load ratings can be met with additional support, subject to testing

powered by

Q. ANTUM DUO

Q. PEAK DUO L-G8.2

415-430

ENDURING HIGH
PERFORMANCE



QUANTUM TECHNOLOGY: LOW LEVELISED COST OF ELECTRICITY

Higher yield per surface area, lower BOS costs, higher power classes, and an efficiency rate of up to 20.3%.



INNOVATIVE ALL-WEATHER TECHNOLOGY

Optimal yields, whatever the weather with excellent low-light and temperature behaviour.



ENDURING HIGH PERFORMANCE

Long-term yield security with Anti LID Technology, Anti PID Technology¹, Hot-Spot Protect and Traceable Quality Tm Q™.



EXTREME WEATHER RATING

High-tech aluminium alloy frame, certified for high snow (5400 Pa) and wind loads (2400 Pa).



A RELIABLE INVESTMENT

Inclusive 12-year product warranty and 25-year linear performance warranty².



STATE OF THE ART MODULE TECHNOLOGY

QUANTUM DUO combines cutting edge cell separation and innovative 12-busbar design with Q. ANTUM Technology.

¹ I-VT test conditions according to IEC 61215-2:2016, method B (-1000V, 168h)

² See data sheet on-line for further information.

THE IDEAL SOLUTION FOR:



Roofing arrays on
commercial/industrial
buildings



Ground-mounted
solar power plants

Engineered in Germany

Q CELLS

Representative Tracking Systems



DuraTrack® HZ v3

RELIABILITY IS POWER.

167×

fewer components than
competitive trackers

25,000+

Megawatt Years of Operation

ARRAY TECHNOLOGIES, INC.

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+1 505.881.7572

sales@arraytechinc.com

arraytechinc.com

THE MOST RELIABLE TRACKER UNDER THE SUN

HIGHEST POWER DENSITY.

Higher density means more power and more profit. DuraTrack HZ v3 offers the unique ability to maximize the power density of each site, boasting 6% more density than our closest competitor.

LEADING TERRAIN ADAPTABILITY.

Uneven terrain? Hill yes! Our flexibly linked architecture, with articulating driveline joints and forgiving tolerances, create the most adaptable system in market for following natural land contours and creates the greatest power generation potential from every site.

FEWER COMPONENTS. GREATER RELIABILITY.

Less is more. Array was founded on a philosophy of engineered simplicity. Minimizing potential failure points (167 times fewer components than competitors), DuraTrack HZ v3 consistently delivers higher reliability and superior uptime.

FAILURE-FREE WIND DESIGN.

DuraTrack HZ v3 was designed and field tested to withstand some of the harshest conditions on the planet. It is the only tracker on the market that reliably handles wind events with a fully integrated, fully automatic wind-load mitigation system.

ZERO SCHEDULED MAINTENANCE.

Three decades of solar tracker system design, engineering and testing has resulted in uncompromising reliability. Maintenance-free motors and gears, fewer moving parts, and industrial-grade components means maintenance-free energy generation.



DuraTrack® HZ v3

COST VERSUS VALUE

We believe value is more than the cost of a tracking system. It's about building with forgiving tolerances and fewer parts so construction crews can work efficiently. It means protecting your investment with a failure-free wind management system. It also includes increasing power density. But most of all, value is measured in operational uptime, or reliability.

THE GLOBAL LEADER IN RELIABILITY

Array has spent decades designing and perfecting the most reliable tracker on the planet. Fewer moving parts, stronger components and intelligent design that protects your investment in the harshest weather are but a few of the innovative differences that keep your system running flawlessly all day and you resting easy at night.



STRUCTURAL & MECHANICAL FEATURES/SPECIFICATIONS	
Tracking Type	Horizontal single axis
MW per Drive Motor	Up to 1.036800 MW DC using 360W crystalline
String Voltage	Up to 1,500V DC
Maximum Linked Rows	32
Maximum Row Size	90 modules crystalline, glass-on-glass, and bifacial; 240 modules First Solar 4; 72 modules First Solar 6
Drive Type	Rotating gear drive
Motor Type	2 HP, 3 PH, 480V AC
Motors per 1 MW DC	Less than 1
East-West / North-South Dimensions	Site / module specific
Array Height	54" standard, adjustable [48" min height above grade]
Ground Coverage Ratio (GCR)	Flexible, 28–45% typical, others supported on request
Terrain Flexibility	N-S tolerance: 0° - 8.5° standard, 15° optional Driveline: 40° in all directions
Modules Supported	Most commercially available, including frameless crystalline, thin film, and bifacial
Tracking Range of Motion	± 52° standard, ± 62° optional
Operating Temperature Range	-30°F to 140°F [-34°C to 55°C]
Module Configuration	Single-in-portrait standard, including bifacial. Two-or-three in landscape (framed or frameless), four-in-landscape (thin film) also available.
Module Attachment	Single fastener, high-speed mounting clamps with integrated grounding. Traditional rails for crystalline in landscape, custom racking for thin film and frameless crystalline and bifacial per manufacturer specs.
Materials	HDG steel and aluminum structural members
Allowable Wind Load (IBC 2012)	135 mph, 3-second gust exposure C
Wind Protection	Passive mechanical system relieves wind and obstruction damage — no power required
ELECTRONIC CONTROLLER FEATURES/SPECIFICATIONS	
Solar Tracking Method	Algorithm with GPS input
Control Electronics	MCU plus Central Controller
Data Feed	MODBUS over Ethernet to SCADA system
Night-time Stow	Yes
Tracking Accuracy	± 2° standard, field adjustable
Backtracking	Yes
INSTALLATION, OPERATION & MAINTENANCE	
PE Stamped Structural Calculations & Drawings	Yes
On-site Training & System Commissioning	Yes
Connection Type	Fully bolted connections, no welding
In-field Fabrication Required	No
Dry Slide Bearings & Articulating Driveline Connections	No lubrication required
Scheduled Maintenance	None required
Module Cleaning Compatibility	Robotic, Tractor, Manual
GENERAL	
Annual Power Consumption (kWh per 1 MW)	400 kWh per MW per year, estimated
Land Area Required per 1 MW	Approx. 4 to 4.5 acres per MW @ 33% GCR (site and design specific)
Energy Gain vs. Fixed-Tilt	Up to 25%, site specific
Warranty	10 year structural, 5 year drive & control components
Patent Numbers	US patent 8,459,249 US patent 9,281,778 US patent 9,581,678 B2 and patents pending
Codes and Standards	UL Certified [3703 & 2703]; IEC 62817

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From both
sides now

The next-generation-now horizontal single-axis solar tracker





Single-Axis Tracker

The SF7 standard configuration enables cost-effective installation, operation, and innovation such as the bifacial tracking solution.

The BiTEC data indicates that individual bifacial modules on SF7 Bifacial Solar Tracker achieve **+19.2%** Bifacial Gain under high albedos.

+19%

Bifacial Gain under high albedo compared to monofacial trackers

+12%

Bifacial Gain under medium albedo compared to monofacial trackers



3rd party independent engineering B&V data-validation letter available upon request.

Bifacial Tracker Evaluation Center (BiTEC) real data

+2.4%

Bifacial Gain compared to trackers in 1P

Higher output

Bifacial PV modules on SF7 2P bifacial trackers have higher Bifacial Gain than on 1P trackers.

No hanging wires

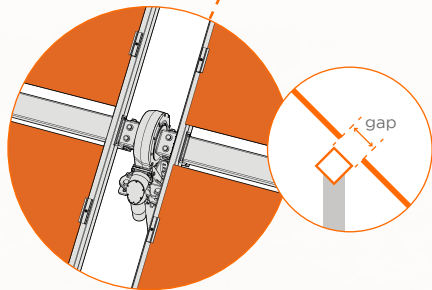
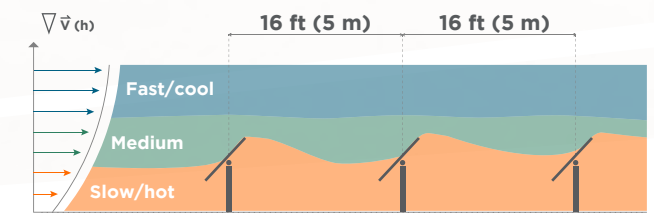
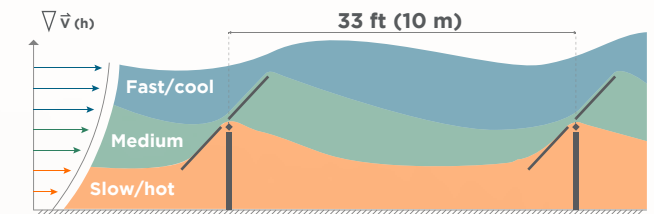
Manages DC cable through torque-tube with no shading interference over the back-side of the panels.

- ✓ **83% Total wire reduction**
- ✓ **75% Installation labor reduction**

Cooler Modules

Tracker design improves airflow. Modules operate at lower temperatures than regular 1P trackers, resulting in higher module energy output.

2P Vs 1P tracker Cooling



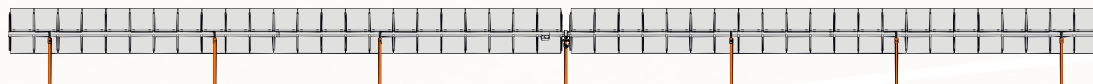
15 cm gap (6 inches) between modules and torque-tube

No Shading

2P module mounting: no backside shading from torque tube.

Only 7 piles every 90 modules

46% fewer piles per MW than 1P trackers, and no dampers, the SF7 minimizes the number of objects shading the rear side of the panels.



Taller Tracker

Higher modules position increase diffuse and reflected irradiance. Panels operate at lower temperatures, leading to higher module power output.

VOYAGER



Engineering | Software | Tracker

The Next Evolution In Tracker Design From FTC Solar

Lowest Installed Cost

- Up to to 60% less posts
- Up to 20% less DC BOS cost
- Less than 300 man hrs/ MW to install

Optimized Bi-facial Performance

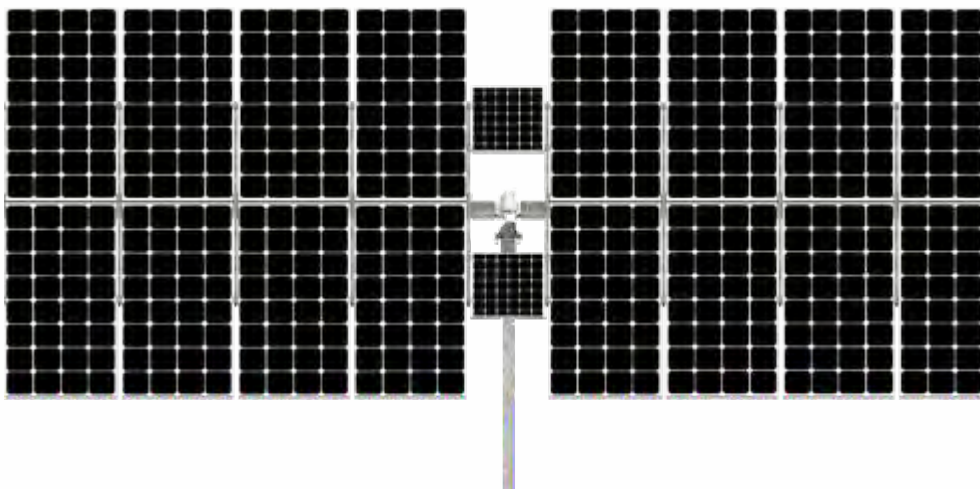
- Up to 0.5% yield improvement due to less backside shading and better albedo capture

Superior Design Flexibility

- 20%-60% GCR support
- 60m row provides layout compaction with more MWs/site

Designed for Reliability

- Hierarchy of row zone and site controllers provides communication and data redundancy
- Self-powered drive and control system with 3 day autonomy mitigates interruptions



Engineering | Software | Tracker

FTC Inc. (HQ), USA, 11801 Domain Blvd., 3rd Floor, Austin, Texas 7875
FTC San Francisco, USA, 44 Montgomery St., 3rd Floor, San Francisco, CA 94104

www.ftcsolar.com

FTC SOLAR VOYAGER TRACKER

PRODUCT

Module Configuration	<ul style="list-style-type: none"> - 104, 108, 112, 116 or 120 modules/row (C-Si or Bifacial) - 96 modules/row (FSLR Series 6) - 240 modules/ row (FSLR Series 4)
Tracking Range	-60° to +60° range of motion with backtracking
Tracking Drive Unit	24V DC self powered drive system with battery backup
Foundations	<ul style="list-style-type: none"> - 7 (std) or 9 posts per row, project-specific - W8 posts, length and weight project-specific
Certifications	UL 2703, 3703 and IEC EC 62817

CONDITIONS

Maximum Wind Speed	105 mph (std); 135 mph (configurable), per ASCE7-10
Maximum Snow Load	5 psf (std); 40 psf (configurable), per ASCE 7-10
Site Slope	Tolerances: N/S = 17.5% terrain following; E/W = no limit / customer defined
Operating Temperature	- 20° to +60° C
Ground Coverage ratio	20-60% GCR supported with adequate access pathways



VOYAGER CONTROLLER: PRECISE CONTROL, ADVANCED ALGORITHMS, SECURE DATA

ROW-LEVEL
CONTROL

ZONE-LEVEL
CONTROL

SITE-LEVEL
CONTROL



IN THE PALM OF
YOUR HAND



The Voyager Smart Control System features:

Wireless mesh network offers communication redundancy

Bi-directional communication between row and zone controllers

Advanced performance analytics available

Site wind and temperature data available for site monitoring. Additional environmental sensors available.

A photograph of the NX Horizon Self-Powered Tracker, showing two rows of blue solar panels mounted on a silver metal tracking system. The panels are tilted at an angle, and the tracking mechanism is visible in the center. The background is a clear blue sky and green grass.

NX Horizon Self-Powered Tracker

Our most amazing tracker yet.

In our mission to make solar a mainstream energy source, NEXTracker has engineered the most intelligent and flexible tracking technology yet. Using sustainable design methods with outcomes that benefit people and the planet, we bring you: NX Horizon™.

NX Horizon (formerly referred to as the Self-Powered Tracker or SPT), brings self-contained motor power to each row, eliminating power wiring and trenching. Our advanced horizontal tracker has the widest rotational range available, lowest O&M costs, and requires far less power to operate than other trackers. By offering more powerful systems at a greater value, NEXTracker enables greater deployment of renewable energy worldwide.

NX Horizon key features and benefits include:

- Self-powered system with smart performance communications: Self-contained units on each row include a dedicated PV panel to provide power to the controller which drives the motor and hosts intelligent control electronics to position each tracker. With smart communications built in, NX Horizon systems can be accessed remotely, providing customers with a granular view to optimize tracker performance, operations and maintenance.
- Independent balanced rows with 120 degree rotational range: Each NX Horizon row has its own controlled motor with rotational range that delivers up to 2% more energy than typical linked row trackers. These agile, independent rows stop in less than 90 seconds to reduce wind forces

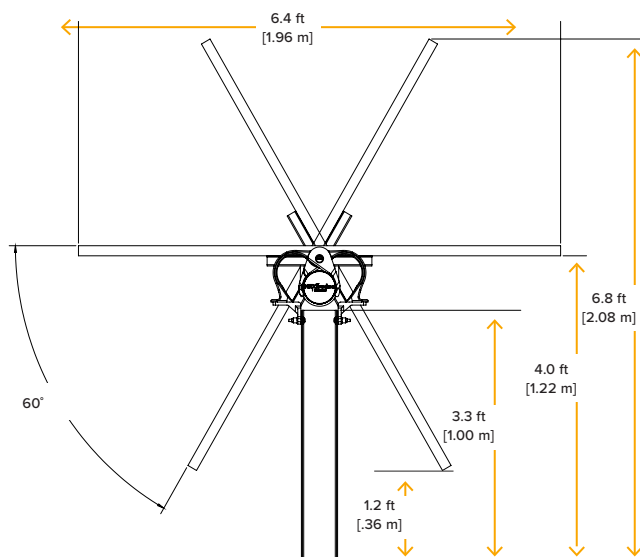
on the array, protecting the PV modules in harsh environments. NX Horizon solar trackers also have a mechanically balanced row design that aligns PV panels with the tracker's axis of rotation – which greatly reduces row torque, using less energy from the motor to track throughout the day.

- Self-grounded system with theft-proof fasteners: NX Horizon is the world's first horizontal tracker with an entirely self-grounded design. This means no separate bonding hardware is required. You save on material and associated costs by eliminating grounding washers, braided straps, bare copper wire, and grounding rods. What's more, we've designed our own fasteners that can only be removed with special tools – deterring PV theft.

NX Horizon Specifications

Tracking Technology	Horizontal single-axis balanced-mass tracker with independently-driven rows
Tracking Range	Up to 120° ($\pm 60^\circ$)
Control System	1 Self-Powered Controller (SPC) per tracker; 1 Network Control Unit (NCU) per 100 SPCs
Communications	Wireless ZigBee® mesh network/SCADA; no communication wiring required
Drive System	One slew gear, 24 VDC motor and self-powered controller w/dedicated solar panel per row
DC Capacity	23-35kWp per tracker row, depending on panel type. Row length up to 90 panels.
System Voltage	1,500 volt or 1,500 volt
Power Consumption	No grid power required
Ground Coverage Ratio	Fully configurable by customer; typical range 33%-50%
Installation Method	Rapid field assembly, no welding required
Foundation Types	Compatible with all major foundation types (driven pier, concrete foundation, ground screw)
Standard Wind Design	100 mph/161 kph, 3 second gust per ASCE7-10; configurable for higher wind speeds
Safety Stowing	Automated wind and snow stowing with self-contained backup power; no external power required
Torsional Limiter	Included at each foundation/bearing for additional wind and snow load protection
Principal Materials	Galvanized and stainless steel
Grounding Method	Self-grounding structure; separate materials and labor not required
Compliance	Grounding/bonding: UL2703; structural design: ASCE7-10
Other Available Options	Snow and flood sensors
Warranty	10 years on structural components; 5 years on drive and control systems
Typical Dimensions	Height 2.1 m/6.8 ft (@ 60°), Width 2.0 m/6.4 ft, Length 85 m/283 ft

Typical 72-cell c-Si configuration: 85 m row with 80 panels mounted in portrait:



NEXTracker

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1.0 GENERAL INFORMATION

This general manual provides important safety information relating to the installation, maintenance and handling of bifacial double glass solar modules. Professional installer must read these guidelines carefully and strictly follow these instructions. Failure to follow these instructions may result in death, injury or property damage. The installation and handling of PV modules requires professional skills and should only be performed by qualified professionals. Installers must inform end-users (consumers) about the aforesaid information accordingly.

The word "module" or "PV module" used in this manual refers to one or more double glass solar modules. This manual is only valid for the bifacial double glass module types CS3W-PB-AG, CS3W-MB-AG, CS3U-MB-AG, CS3K-MB-AG, CS3U-PB-AG, CS3K-PB-AG, CS3Y-MB-AG, CS3Y-PB-AG, CS6W-MB-AG, CS7N-MB-AG and CS7L-MB-AG. Please retain this manual for future reference.

We recommend visiting www.canadiansolar.com regularly for the most updated version of bifacial module installation manual.

1.1 INSTALLATION MANUAL DISCLAIMER

The information contained in this manual is subject to change by Canadian Solar Inc. without prior notice. Canadian Solar Inc. gives no warranty of any kind whatsoever, either explicitly or implicitly, with respect to the information contained herein.

In the event of any inconsistency among different language versions of this document, the English version shall prevail. Please refer to our product lists and documents published on our website at:

<http://www.canadiansolar.com> as these lists are updated on a regular basis.

1.2 LIMITATION OF LIABILITY

Canadian Solar Inc. shall not be held responsible for damages of any kind, including – without limitation – bodily harm, injury or damage to property, in connection with handling PV modules, system installation, or compliance or non-compliance with the instructions set forth in this manual.

2.0 SAFETY PRECAUTIONS



Warning: Before attempting to install, wire, operate and/or service the module and other electrical equipment, all instructions should be read and understood. PV module connectors pass direct current (DC) when exposed to sunlight or other light sources. Contact with electrically active parts of the module, such as terminals, can result in injury or death, irrespective of whether or not the module and the other electrical equipment have been connected.



Avertissement: Toutes les instructions devront être lues et comprises avant de procéder à l'installation, le câblage, l'exploitation et/ou l'entretien des panneaux. Les interconnexions des panneaux conduisent du courant continu (CC) lorsque le panneau est exposé à la lumière du soleil ou à d'autres sources lumineuses. Tout contact avec des éléments sous

tension du panneau tels que ses bornes de sortie peut entraîner des blessures ou la mort, que le panneau soit connecté ou non.

General Safety

- All Modules must be installed by licensed electricians in accordance with the applicable electrical codes such as, the latest National Electrical Code (USA) or Canadian Electric Code (Canada) or other national or international electrical codes.
- Protective clothing (non-slip gloves, clothes, etc.) must be worn during installation to prevent direct contact with 30 V_{DC} or greater, and to protect hands from sharp edges.
- Use electrically insulated tools to reduce the risk of electric shock.
- Prior to installation, remove all metallic jewelry to prevent accidental exposure to live circuits.
- If the disconnects and over current protective devices (OCPD) cannot be opened or the inverter cannot be powered down, cover the fronts and backs of modules in the PV array with an opaque material to stop the production of electricity when installing or working on a module or wiring.
- When installing modules in light rain, morning dew, take appropriate measures to prevent water ingress into the connectors, f. e. using connector endcaps.
- **Do not** install modules in strong wind.
- **Do not** use or install broken modules.
- **Do not** contact module surface if the front or rear glass is broken. This may cause electric shock.
- **Do not** open the cover of the junction box at any time.
- **Do not** attempt to repair any part of the PV module. The module does not contain any serviceable parts.
- **Do not** disassemble a module or remove any module part.
- **Do not** artificially concentrate sunlight on a module.
- **Do not** connect or disconnect modules when current from the modules or an external source is present.
- **Do not** allow children or unauthorized persons near the installation site or module storage area.

3.0 MECHANICAL / ELECTRICAL SPECIFICATIONS

Module electrical ratings are measured under Standard Test Conditions (STC) of 1000 W/m² irradiance, with an AM 1.5 spectrum, and a cell temperature of 25°C. Detailed electrical and mechanical characteristics of Canadian Solar Inc. crystalline silicon PV modules can be found in Annex A (Mechanical And Electrical Ratings) of this Installation Manual. Main electrical characteristics under STC are also stated on each module label. Please refer to the datasheet or the product nameplate for the maximum system voltage.

Under certain conditions, a module may produce more current or voltage than its Standard Test Conditions rated power. For Bifacial modules particularly, the operating current is related to specific system mounting and design conditions, and will vary under different module mounting height and albedo of ground surface. As a result, correction factors should be applied to the module short-circuit current and the open-circuit voltage under STC, when determining component ratings and capacities.

For open-circuit voltage, the most conservative correction factors presented in Table 1 below generally applies.

Table 1: Low temperature correction factors for open-circuit voltage

Lowest Expected Ambient Temperature (°C/°F)	Correction Factor
24 to 20 / 76 to 68	1.02
19 to 15 / 67 to 59	1.04
14 to 10 / 58 to 50	1.06
9 to 5 / 49 to 41	1.08
4 to 0 / 40 to 32	1.10
-1 to -5 / 31 to 23	1.12
-6 to -10 / 22 to 14	1.14
-11 to -15 / 13 to 5	1.16
-16 to -20 / 4 to -4	1.18
-21 to -25 / -5 to -13	1.20
-26 to -30 / -14 to -22	1.21
-31 to -35 / -23 to -31	1.23
-36 to -40 / -32 to -40	1.25

Alternatively, a more accurate correction factor for the open-circuit voltage can be calculated using the following formula:

$$C_{Voc} = 1 - \alpha_{Voc} \times (25 - T) \quad C_{Voc} = 1 - \alpha_{Voc} \times (25 - T)$$

T (°C) is the lowest expected ambient temperature at the system installation site

α_{Voc} (%/°C) is the voltage temperature coefficient of the selected module (refer to corresponding datasheet)

OCPD rating selection should be done per the following guidance, where the minimum OCPD rating possible is determined by calculating the expected maximum circuit current for the PV system, and the maximum OCPD rating constrained by the IEC 61215:2016 and UL 1703:2018 standard requirements for the certified PV modules.

$$\text{Minimum string fuse rating} < X \leq \text{Maximum string fuse rating}$$

The maximum string fuse ratings can be found in ANNEX A: Mechanical And Electrical Ratings for all the certified Canadian Solar bifacial module types.

The minimum string fuse rating for compliance with NEC:2017 code and IEC62548:2016 requirement is suggested to be determined as follows:

$$\text{Minimum string fuse rating} = I_{scSTC} \times 1.25 \times \text{Max}(1.175, I_{mpp\alpha} \div I_{mppSTC})$$

$I_{mpp\alpha}$ = the highest 3-hour current average resulting from the simulated local simultaneous irradiances on the front and rear sides of the PV array accounting for elevation and orientation

I_{scSTC} = the listed short circuit current at 0% bifacial gain on the PV module datasheet or nameplate label

I_{mppSTC} = the listed MPP operating current at 0% bifacial gain on the PV module datasheet or nameplate label

An assembly, together with its overcurrent device(s), that is listed for continuous operation at 100 percent of its rating shall be permitted to be used at 100 percent of its rating, and therefore shall not require the additional 1.25 multiplier

Appropriate correction factors should be selected by licensed professional electrical engineers according to relevant design codes and system simulation results. Canadian Solar does not take responsibility for the determination of the minimum series fuse rating.

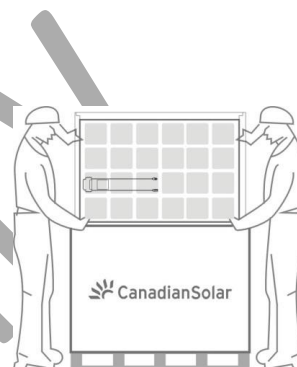
Please contact Canadian Solar's technical support team for additional information pertaining to engineering optimization and approval of project specific module string lengths.

4.0 UNPACKING AND STORAGE

NOTICE

PRECAUTIONS

- Modules should be stored in a dry and ventilated environment to avoid direct sunlight and moisture. If modules are stored in an uncontrolled environment, the storage time should be less than 3 months and extra precautions should be taken to prevent connectors from being exposed to moisture or sunlight, like using connector endcaps. Connector endcaps are available upon request.
- Unpack module pallets carefully, following the steps shown on the pallet. Unpack, transport and store the modules with care.
- Modules must always be unpacked and installed by at least two people. Always use both hands when handling modules with gloves.
- Do not lift modules by their wires or junction box.
- Do not stack the framed modules.
- Do not place excessive loads on the module or twist the module.
- Do not stand, step, walk and/or jump on modules under any circumstances. Localized heavy loads may cause severe micro-cracks at cell level, which in turn may compromise module reliability and void Canadian Solar Inc's warranty.
- Do not carry modules on your head.
- Do not drop or place objects (such as tools) on the modules.
- Do not use sharp instruments on the modules.
- Do not leave modules unsupported or unsecured.
- Do not change the wiring of bypass diodes.
- Keep all electrical contacts clean and dry at all times.
- Do not expose the modules and its electrical contacts to any unauthorized chemical substance (e.g. oil, lubricant, pesticide, etc.).



Product identification

- Each module has two identical barcodes (one in the laminate under the front glass, the second on the rear side of the module) that act as a unique identifier. Each module has a unique serial number containing 14 digits.
- A nameplate is also affixed to the rear glass of each module. This nameplate specifies the model type, as well as the main electrical and safety characteristics of the module.



5.0 MODULE INSTALLATION



Precautionary Measures and General Safety

- Prior to installing modules please obtain information about any requirements and necessary approvals for the site, installation and inspection from the relevant authorities.
- Check applicable building codes to ensure that the construction or structure (roof, facade, support, etc.) can bear the module system load.
- Canadian Solar Inc. bifacial double glass solar modules have been qualified for Application Class A (equivalent to Safety Class II requirements). Modules rated under this class should be used in systems operating at voltage above 50 V or power above 240 W, where general contact access is anticipated.
- Canadian Solar Inc. bifacial double glass modules have been certified as Type 3 or Type 13 according to UL 1703, Type 29 according to UL 61730 and as Class A or Class C for fire performance according to IEC 61730-2, please refer to the datasheet or the product nameplate for the detailed types.
- Consult your local authority for guidelines and requirements for building or structural fire safety.

UL 1703 system fire rating requirements

- The fire rating of this module is only valid when the product is installed as specified in the mechanical mounting instructions.
- When installing the modules, ensure the assembly is mounted over a fire resistant roof covering rated for the application.
- A photovoltaic system composed of UL 1703 or UL 61730 certified modules mounted on a UL 2703 certified mounting system should be evaluated in combination with roof coverings in accordance with UL 1703 or UL 61730 standard, with respect to meeting the same fire classification as the roof assembly.
- Mounting systems with a System Fire Class Rating (Class A, B or C), tested in conjunction with fire rated “Type 3” rated modules, are considered acceptable for use with Canadian Solar Inc. modules, provided the mounting system does not violate any other requirement of this manual.
- Any mounting system limitation on inclination or accessory required to maintain a specific System Fire Class Rating should be clearly specified in the installation instructions and UL 2703 certification of the mounting system supplier.

Environmental conditions

- The module is intended for use in general open-air climates, as defined in IEC 60721-2-1: Classification of environmental conditions Part 2-1: Environmental conditions appearing in nature - temperature and humidity.
- Please consult the Canadian Solar Inc. technical support department for more information on the use of modules in special climates, such as an altitude greater than 2000 m, heavy snow, severe hail storm, hurricane etc.
- Do not install modules near open flames or flammable materials.
- Do not immerse modules in water or constantly expose modules to water (either fresh or salt) (i.e. from fountains, sea spray).
- Exposing modules to salt (i.e. marine environments) or sulfur (i.e. sulfur sources, volcanoes) incurs the risk of module corrosion.

- Do not expose modules and their electrical contacts to any unauthorized chemical substances (e.g. oil, lubricant, pesticide, etc.), as modules may incur damages.
- Failure to comply with these instructions will void Canadian Solar Inc. warranty.

Installation Requirements

- Ensure that the module meets the general technical system requirements.
- Ensure that other systems components do not damage modules mechanically or electrically.
- Modules can be wired in series to increase voltage or in parallel to increase current. To connect modules in series, connect the positive terminal of one module to the negative terminal of the next module. To connect in parallel, connect the positive terminal of one module to the positive terminal of the next module.
- Only connect the quantity of modules that corresponds to the voltage specifications of the inverters used in the system. In addition modules must **NOT** be connected together to create a voltage higher than the maximum permitted system voltage stated on the module nameplate, even under the worst local temperature conditions (see Table 1 for the correction coefficients that apply to open-circuit voltage).
- A maximum of two strings can be connected in parallel without using an over-current protection device (fuse, etc.) incorporated in series within each string. Three or more strings can be connected in parallel if an appropriate and certified over-current protection device is installed in series within each string. And it shall be ensured in the PV system design that the reverse current of any particular string is lower than the module maximum fuse rating under any circumstances.
- Only modules with similar electrical parameters should be connected in the same string to avoid or minimize mismatch effects in arrays.
- To minimize risk in the event of an indirect lightning strike, avoid forming loops with the wiring when designing the system.
- The recommended maximum series fuse rating is stated in table 1 in the Annex A.
- Modules should be safely fixed to bear all expected loads, including wind and snow loads.
- After the installation of double glass modules, a 30 mm deflection for framed module is allowed.
- For framed modules, a minimum clearance of 6.5 mm (0.25 in) between modules is required to allow thermal expansion of the frames and modules.

Optimum orientation and tilt

- To maximize the annual yield, please calculate the optimum orientation and tilt for PV modules in that specific installation site. The highest yields are achieved when sunlight shines perpendicularly onto the PV modules.

Avoid shading

- Even minor partial shading (e.g. from dirt deposits) reduces the yield. A module can be considered to be unshaded if its entire surface is free from shading all year round. Sunlight should be able to reach at least the front side of the module even on the shortest day of the year.
- For optimizing the power generation of the rear side of bifacial modules, obstacles between modules and the mounting ground should be avoided as much as possible.
- Constant shading conditions can affect module service lifetime, due to accelerated ageing of the encapsulation material and thermal stress on the bypass diodes.

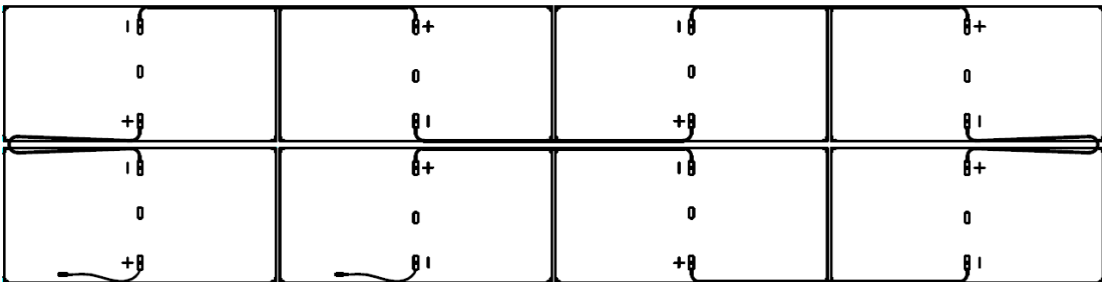
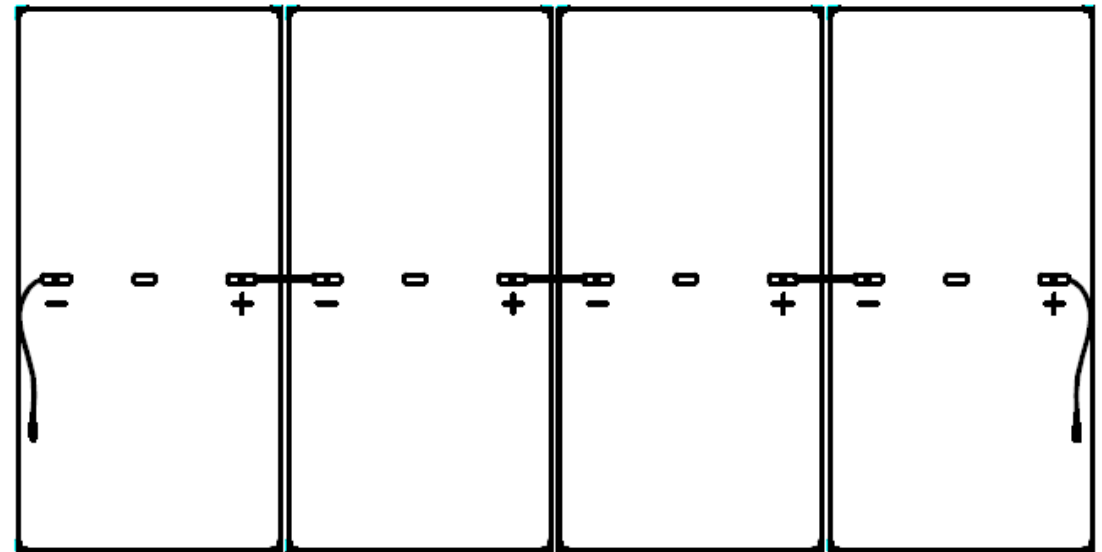
Reliable ventilation

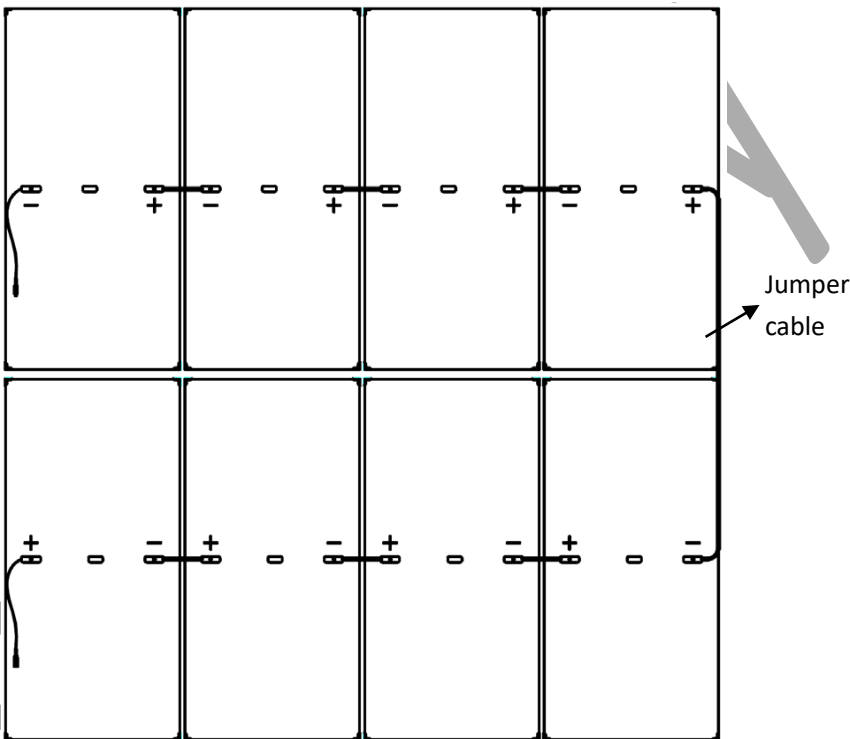
- Bifacial modules use direct, reflected, or diffuse sunlight on the backside to generate additional power. Therefore, bifacial modules are not suggested to be used in building attached photovoltaic systems (BAPV). If BAPV, or similar mounting is still required, sufficient clearance of at least 10 cm (3.94 in) between the module and the mounting surface needs to be provided to allow cooling air to circulate around the back of the module. This also allows condensation or moisture to dissipate.
- According to UL 1703, if any other specific clearance required for maintaining a system fire rating should prevail. Detailed clearance requirements pertaining to system fire ratings must be provided by your racking supplier.

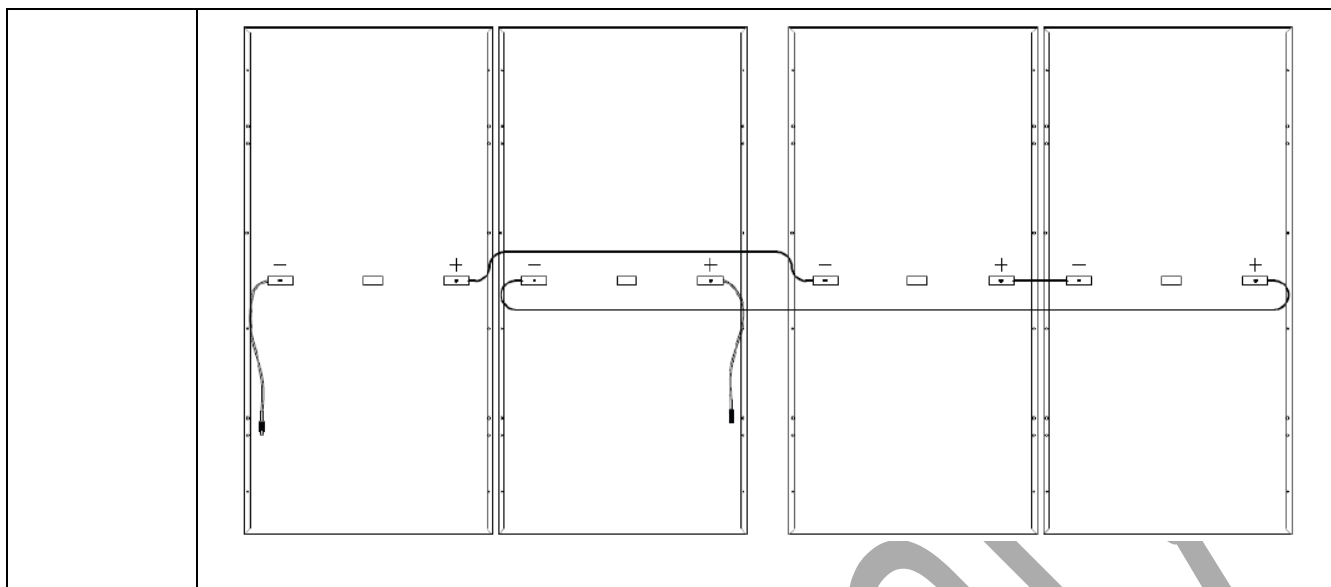
5.1 MODULE WIRING**Correct wiring scheme**

- Ensure that the wiring is correct before starting up the system. If the measured open circuit voltage (V_{oc}) and short-circuit current (I_{sc}) differ substantially from the specifications, this indicates that there is a wiring fault.
- Do not connect different connectors (brand and model) together.
- When modules have been pre-installed but the system has not been connected to the grid yet, each module string should be kept under open-circuit conditions and proper actions should be taken to avoid dust and moisture penetration inside the connectors.
- For CS3W, CS3U, CS3Y, CS3K, CS6W, CS7N and CS7L series modules, Canadian Solar Inc. offers several cable length options to match various system configurations, which are shown in table 2:
- On below figures, bold lines represent cable installation pathways, while + and - connector correspond to positive and negative module terminals respectively.
- Cables should always be fastened on module frames or mounting rails, in order to avoid shading on module rear side.
- In case where a cable connection method not included in below table is used, please confirm suitable cable length with Canadian Solar's sales representative.

Table 2: System Cable configuration for CS3W, CS3U, CS3Y, CS3K, CS6W, CS7N and CS7L modules

Module types	Recommended wiring configurations
CS3U-MB-AG CS3K-MB-AG CS3U-PB-AG CS3K-PB-AG CS3W-PB-AG CS3W-MB-AG CS3Y-PB-AG CS3Y-MB-AG CS6W-MB-AG CS7N-MB-AG CS7L-MB-AG	Landscape installation two rows: CS3U/CS3W/CS3Y/CS6W/CS7N/CS7L Cable length per lead = 1400 mm CS3K Cable length per lead = 1250 mm
	
	Note: Adjacent modules in the same row need to be rotated 180 degrees for proper installation.
	Portrait installation one row: CS3U/CS3K/CS3W Cable length per lead = 400 mm (+), 280 mm (-) CS3Y/CS6W Cable length per lead = 410 mm (+), 290 mm (-) CS7N/CS7L Cable length per lead = 460 mm (+), 340 mm (-)
	

Module types	Recommended wiring configurations (continued)
CS3U-MB-AG CS3K-MB-AG CS3U-PB-AG CS3K-PB-AG CS3W-PB-AG CS3W-MB-AG CS3Y-PB-AG CS3Y-MB-AG CS6W-MB-AG CS7N-MB-AG CS7L-MB-AG	<p>Portrait installation two rows:</p> <p>CS3U/CS3W Cable length = 400 mm (+), 280 mm (-) & 1800 mm jumper cable</p> <p>CS3K Cable length = 400 mm (+), 280 mm (-) & 1400 mm jumper cable</p> <p>CS3Y/CS6W Cable length = 410 mm (+), 290 mm (-) & 2000 mm jumper cable</p> <p>CS7N Cable length = 460 mm (+), 340 mm (-) & 2150 mm jumper cable</p> <p>CS7L Cable length = 460 mm (+), 340 mm (-) & 2000 mm jumper cable</p>
	
	<p>Note: Modules in adjacent rows need to be rotated 180 degrees for proper installation.</p>
	<p>Portrait installation one row: (Leap-frog for single-axis tracker)</p> <p>CS3U Cable length = 1670 mm (+), 1670 mm (-)</p> <p>CS3W/CS3Y Cable length = 1850 mm (+), 1850 mm (-)</p> <p>CS6W Cable length = 2000 mm (+), 2000 mm (-)</p>



The maximum distance between two adjacent modules should be within 50 mm (1.96 in) for side with mounting clamps, and within 25 mm (0.98 in) for side without mounting clamps, in order to meet system cable scheme.

Correct connection of plug connectors

- Make sure that all connections are safe and properly mated. The PV connectors should not be subjected to stress from the exterior. Connectors should only be used to connect the circuit. They should never be used to turn the circuit on and off.
- Connectors are not waterproof when unmated. When installing modules, connectors should be connected to each other as soon as possible or appropriate measures (like using connector endcaps) should be taken to avoid moisture and dust penetrating into the connector.
- Do not clean or precondition the connectors using lubricants or any unauthorized chemical substances.

Use of suitable materials

- Only use dedicated solar cable and suitable plugs (wiring should be sheathed in a sunlight-resistant conduit or, if exposed, should itself be sunlight-resistant) that meet local fire, building and electrical regulations. Please ensure that all wiring is in perfect electrical and mechanical condition.
- Installers may only use single-conductor cable listed and labeled as USE-2 or PV wire which is 90°C wet rated in North America, and single conductor cable, 4-16 mm² (5-12 AWG), 90°C wet rated in other areas (i.e. TUV 2PFG1169 or EN50618 approved), with proper insulation which is able to withstand the maximum possible system open-circuit voltage. Only copper conductor material should be used. Select a suitable conductor gauge to minimize voltage drop and ensure that the conductor ampacity complies with local regulations (i.e. NEC 690.8(D)).


Cable and connector protection

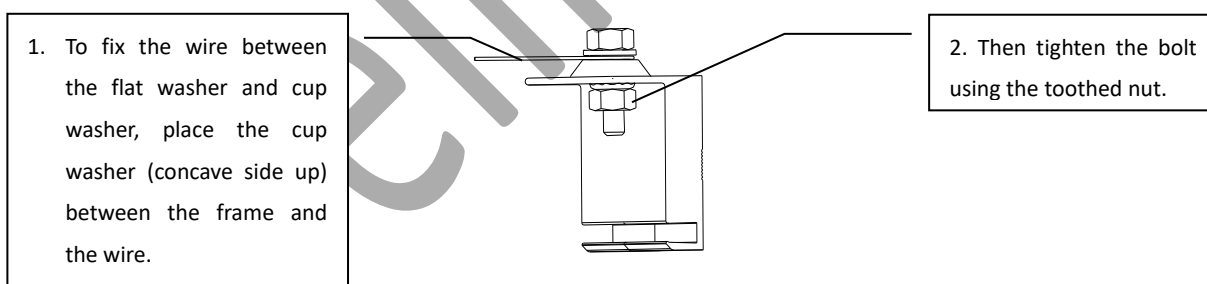
- Secure the cables to the mounting system using UV-resistant cable ties. Protect exposed cables from damage by taking appropriate precautions (e.g. placing them inside a metallic raceway like EMT conduit).

Avoid exposure to direct sunlight.

- A minimum bending radius of 60mm (2.36 in) is required when securing the junction box cables to the racking system.
- Protect exposed connectors from weathering damage by taking appropriate precautions. Avoid exposure to direct sunlight.
- Do not place connectors in locations where water could easily accumulate.

5.2 GROUNDING

- For grounding requirements in North America, a module with exposed conductive parts is considered to comply with UL 1703 only when it is electrically grounded in accordance with both the instructions presented below and the requirements of the National Electrical Code. Any grounding means used with Canadian Solar Inc. modules should be NRTL certified to UL 467 and UL 2703 standards. Please consult our technical service team for the formal approval process.
 - For grounding requirements in other areas, although the modules are certified to Safety Class II, we recommend them to be grounded and that module installation should comply with all applicable local electrical codes and regulations. Grounding connections should be installed by a qualified electrician. Connect module frames together using adequate grounding cables: we recommend using 4-14 mm² (AWG 6-12) copper wire. Holes provided for this purpose are identified with a grounding symbol  (IEC 61730-1). All conductive connection junctions must be firmly fixed.
 - Do not drill any extra ground holes for convenience as this will void the modules warranty.
 - All bolts, nuts, flat washers, lock washers and other relevant hardware should be made of stainless steel, unless otherwise specified.
 - Canadian Solar Inc. does not provide grounding hardware.
- One grounding method is recommended for Canadian Solar Inc. framed modules, as described below.
- **Grounding Method: Bolt + Toothed Nut + Cup washer**



- A grounding kit containing an M5 (3/16") SS cap bolt, an M5 (3/16") SS flat washer, an M5 (3/16") SS cup washer, and an M5 (3/16") SS nut (with teeth) should be used to attach copper grounding wire to a pre-drilled grounding hole on the frame (see image above). The grounding holes are located at the upper and lower edges of the long side frame, close to the module short sides.
- Mounting rail designs should be such to allow easy access to the grounding holes located on the long side of the frame, in order to enable the equipment grounding function when required.
- Place the wire between the flat washer and the cup washer. Ensure that the cup washer is positioned between the frame and the wire with the concave side up to prevent galvanic corrosion. Tighten the bolt securely using the SS toothed nut. A wrench may be used to do this. The tightening torque is 3-7 Nm (2.2-5.2 ft-lbs).

6.0 MOUNTING INSTRUCTIONS



The applicable regulations pertaining to work safety, accident prevention and securing the construction site must be observed. Workers and third party personnel shall wear or install fall arrest equipment. Any third party need to be protected against injuries and damages.

- The mounting design must be certified by a registered professional engineer. The mounting design and procedures must comply with local codes and requirements from all relevant authorities.
- Canadian Solar Inc. does not provide mounting hardware.
- The system designer and installer are responsible for load calculations and for proper design of support structure.
- The loads described in this manual correspond to test loads. For installations complying with UL 1703 or UL 61730 and IEC 61215-2:2016, a safety factor of 1.5 should be applied for calculating the equivalent maximum authorized design loads. Project design loads depend on construction, applicable standards, location and local climate. Determination of the design loads is the responsibility of the racking suppliers and/or professional engineers. For detailed information, please follow local structural code or contact your professional structural engineer.
- Use appropriate corrosion-proof fastening materials. All mounting hardware (bolts, spring washers, flat washers, nuts) should be hot dip galvanized or stainless steel.
- Use a torque wrench for installation.
- Do not drill additional holes or modify the module frame. Doing so will void the warranty.

WHEN CLAMPS ARE USED AS FIXING MATERIAL

- Install and tighten the module clamps to the mounting rails using the torque stated by the mounting hardware manufacturer. System designer and installer are responsible for load calculations and for proper design of support structure. It is recommended to use a torque wrench for installation. Tightening torques must respectively be within 17-23 Nm (12.5-17.0 ft-lb) for M8 x 1.25-Grade 8.8 (5/16"-18 Grade B7) galvanized or A2-70 stainless steel coarse thread bolts, depending on bolt class. The yield strength of bolt and nut should not be less than 450 MPa.
- Clamp material should be anodized aluminum alloy or steel of appropriate grade.
- Clamp positions are of crucial importance for the reliability of the installation, the clamp centerline must only be positioned within the authorized position ranges indicated below, depending on the configuration and load.

6.1 MOUNTING METHODS FOR FRAMED BIFACIAL MODULE (Bolting)

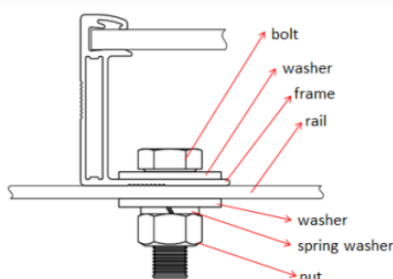
- This mounting method has been qualified by Canadian Solar Inc., as well as certified by VDE and CSA.
- Modules should be bolted to support structures through the mounting holes in the rear frame flanges only.
- Each module must be securely fastened at a minimum of 4 points on two opposite sides.
 - M8x 1.25 (5/16") bolt and nut should be used.
 - Plain washer size should be M8 with outer diameter 16 mm.

- The yield strength of bolt and nut should not be less than 450 MPa.

NOTICE

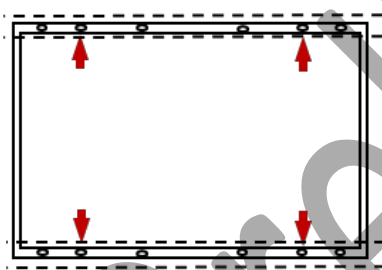
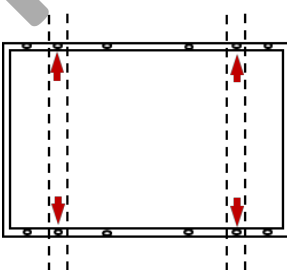
Suitable bolt length should be chosen based on actual module frame height. For bifacial module with 30 mm frame height, our recommended maximum bolt length is 20 mm in order to properly insert the bolts through the mounting hole. The system designer is responsible to check that the racking supplier specified bolt length comply with above requirement and will not affect installation.

- Tightening torque should be within 17-23 Nm (12.5-17.0 ft-lbs) for M8 (5/16") coarse thread bolts, depending on bolt class.
- In areas with heavy wind loads, additional mounting points should be used. The system designer and the installer are responsible for calculating the load and ensuring that the support structure meets the requirements.

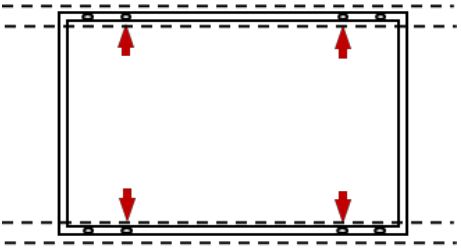
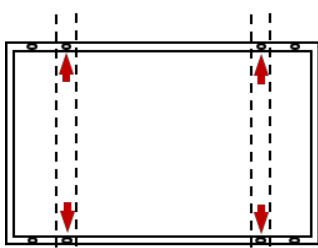


- Modules should be bolted at the following hole locations depending on the configuration and load:

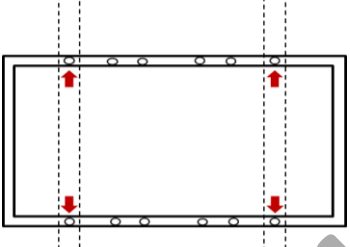
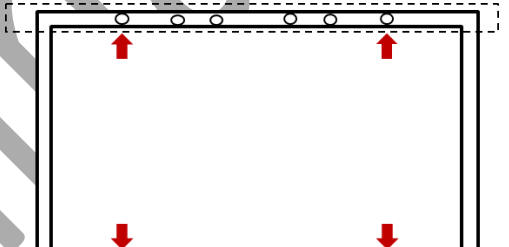
CS3U-MB-AG, CS3U-PB-AG, CS3W-PB-AG, CS3W-MB-AG

 <p>Bolting on long frame side using four middle mounting holes. Mounting rails run parallel to the long frame side.</p>	 <p>Bolting on long frame side using four middle mounting holes. Mounting rails run perpendicularly to the long frame side.</p>
<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 3600 Pa</p>	<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 5400 Pa</p>

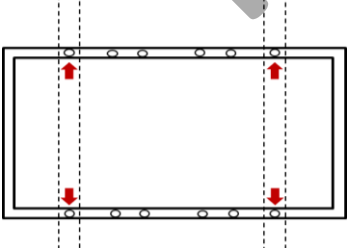
CS3K-MB-AG, CS3K-PB-AG

 <p>Bolting on long frame side using four innermost mounting holes. Mounting rails run parallel to the long frame side.</p>	 <p>Bolting on long frame side using four innermost mounting holes. Mounting rails run perpendicularly to the long frame side.</p>
<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 3600 Pa</p>	<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 5400 Pa</p>

CS3Y-MB-AG, CS3Y-PB-AG

 <p>Bolting on long frame side using four outermost mounting holes. Mounting rails run perpendicularly to the long frame side.</p>	 <p>Bolting on long frame side using four outermost mounting holes. Mounting rails run parallel to the long frame side.</p>
<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 5400 Pa</p>	<p>Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 3600 Pa</p>

CS6W-MB-AG

 <p>Bolting on long frame side using four outermost mounting</p>

holes.

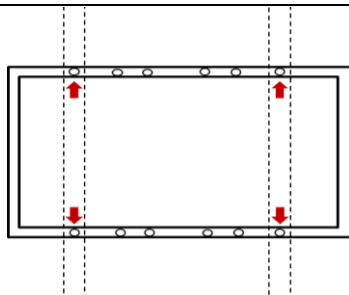
Mounting rails run perpendicularly to the long frame side.

Maximum Load:

Uplift load ≤ 2400 Pa

Downforce load ≤ 3600 Pa

CS7N-MB-AG



Bolting on long frame side using four outermost mounting holes.

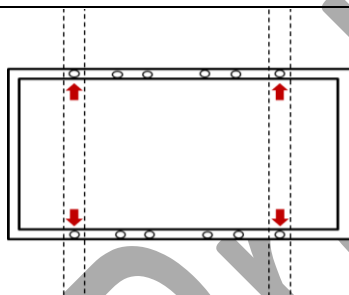
Mounting rails run perpendicularly to the long frame side.

Maximum Load:

Uplift load ≤ 2400 Pa

Downforce load ≤ 4400 Pa

CS7L-MB-AG



Bolting on long frame side using four outermost mounting holes.

Mounting rails run perpendicularly to the long frame side.

Maximum Load:

Uplift load ≤ 2600 Pa

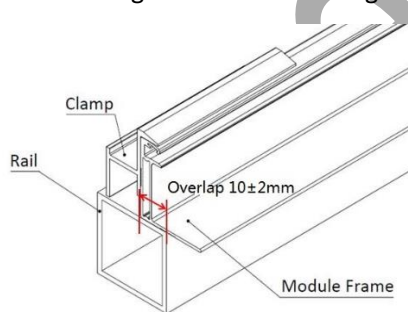
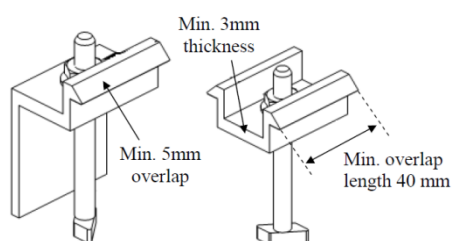
Downforce load ≤ 4600 Pa

6.2 MOUNTING METHODS FOR FRAMED BIFACIAL MODULE (Clamping)

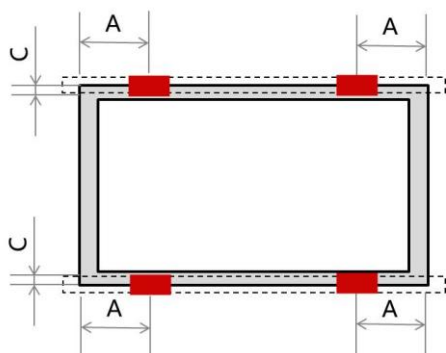
- This mounting method has been qualified by Canadian Solar Inc. as well as certified by VDE and CSA.
- Each module must be securely fastened at a minimum of four points on two opposite sides. The clamps should be positioned symmetrically. The clamps should be positioned according to the authorized position ranges defined in table below. Install and tighten the module clamps to the mounting rails using the torque

stated by the mounting hardware manufacturer. M8 x 1.25 (5/16") bolt and nut are used for this clamping method. The yield strength of bolt and nut should not be less than 450 MPa.

- Tightening torques should be within 17-23 Nm (12.5-17.0 ft-lbs) for M8 (5/16"-18 Grade B7) coarse thread bolts, depending on the bolt class. For the bolt grade, the technical guideline from the fastener suppliers should be followed. Different recommendations from specific clamping hardware suppliers should prevail.
- The system designer and installer are responsible for load calculations and for proper design of support structure.
- The mounting rails shall be designed to limit as much as possible shade on module rear side cells.
- Canadian Solar Inc.'s warranty may be void in cases where improper clamps or unsuitable installation methods are found. When installing inter-modules or end-type clamps, the clamps must:
 1. **Not** bend the module frame
 2. **Not** touch or cast shadows on the front glass
 3. **Not** damage the surface of the frame (to the exception of the clamps with bonding pins)
 4. Overlap the module frame by at least 5 mm (0.2 in)
 5. Overlap in length by at least
 - a) 80 mm (3.15 in) when $2400 \text{ Pa} < \text{uplift load} \leq 4000 \text{ Pa}$ is required.
 - b) 40 mm (1.57 in) when uplift load $\leq 2400 \text{ Pa}$ is required.
 6. Clamps have to have a thickness of at least 3 mm (0.12 in)
- Clamp material should be anodized aluminum alloy or stainless steel.
- Clamp positions are of crucial importance for the reliability of the installation. The clamp centerlines must only be positioned within the ranges indicated in table below, depending on the configuration and load.
- For configurations where the mounting rails run parallel to the frame, precautions should be taken to ensure the bottom flange of the module frame overlaps the rail by $10 \pm 2 \text{ mm}$ (0.39 in) or more, without creating undesirable shading on the rear side of the cells.

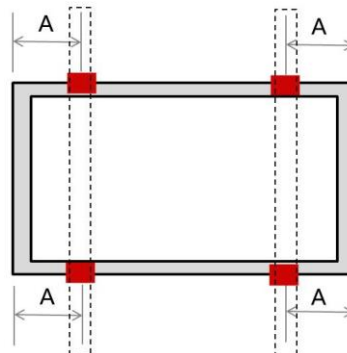


CS3W-PB-AG, CS3W-MB-AG



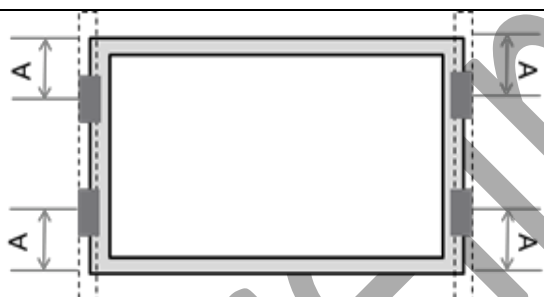
Use 4 clamps on the long side.
Mounting rails run parallel to the long side frame.

Clamp length ≥ 40 mm
A=410-490 mm
C=10 \pm 2mm (overlap between the rail and module frame)
Maximum Load:
Uplift load ≤ 2400 Pa
Downforce load ≤ 3600 Pa



Use 4 clamps on the long side.
Mounting rails run perpendicular to the long side frame.

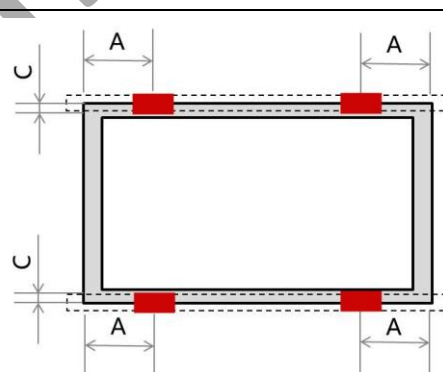
Clamp length ≥ 80 mm
A=410-490 mm
Maximum Load:
Uplift load ≤ 3600 Pa
Downforce load ≤ 5400 Pa



Use 4 clamps on the short side.
Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 40 mm
A range =200-250mm
C=10 \pm 2mm (overlap between the rail and module frame)
Maximum Load:
Uplift load ≤ 1000 Pa
Downforce load ≤ 1000 Pa

Clamp length ≥ 40 mm
A range =0-200mm
C=10 \pm 2mm (overlap between the rail and module frame)



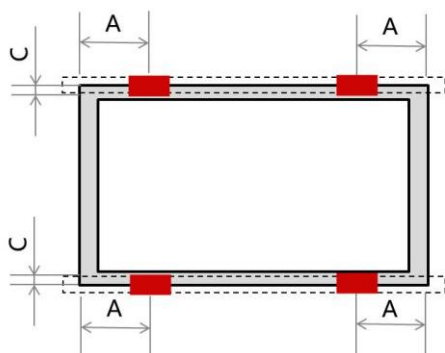
Use 4 clamps on the long side.
Mounting rails run parallel to the long side frame

Clamp length ≥ 80 mm
A=410-490 mm
C=10 \pm 2mm (overlap between the rail and module frame)
Maximum Load:
Uplift load ≤ 3600 Pa
Downforce load ≤ 4400 Pa

Notice: Only applicable to modules with matching frame profiles on both the long and short sides

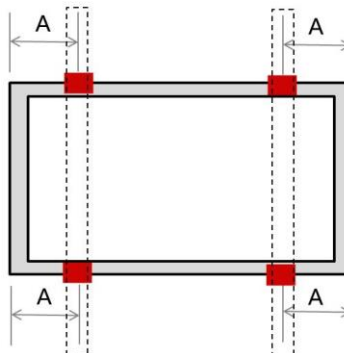
frame)
 Maximum Load:
 Uplift load ≤ 800 Pa
 Downforce load ≤ 800 Pa

CS3U-MB-AG and CS3U-PB-AG



Use 4 clamps on the long side.
 Mounting rails run parallel to the long side frame.

Clamp length ≥ 40 mm
 A=410-490 mm
 C=10 \pm 2mm (overlap between the rail and module frame)
 Maximum Load:
 Uplift load ≤ 2400 Pa
 Downforce load ≤ 3600 Pa



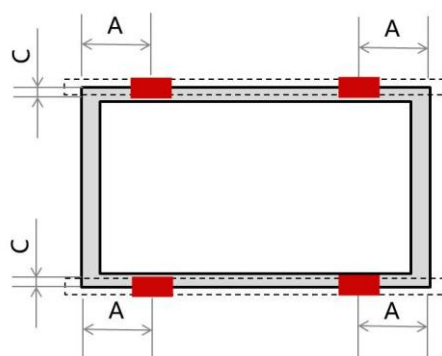
Use 4 clamps on the long side.
 Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 80 mm
 A=410-490 mm
 Maximum Load:
 Uplift load ≤ 3600 Pa
 Downforce load ≤ 5400 Pa



Use 4 clamps on the short side.
 Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 40 mm
 A range =200-250mm
 C=10 \pm 2mm (overlap between the rail and module frame)

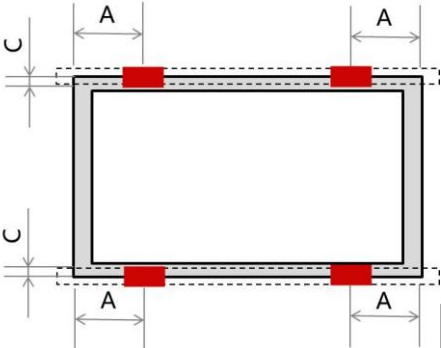
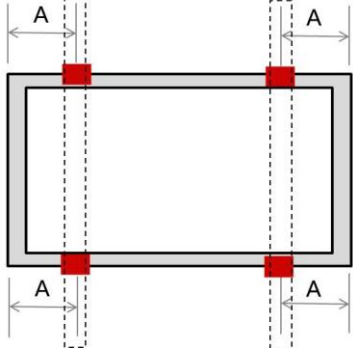


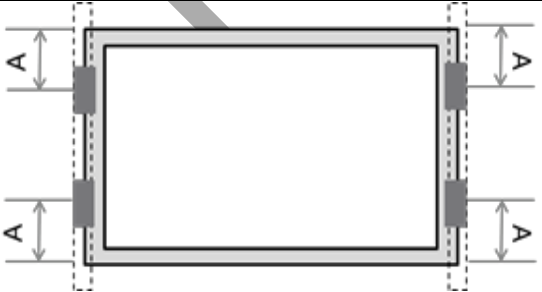
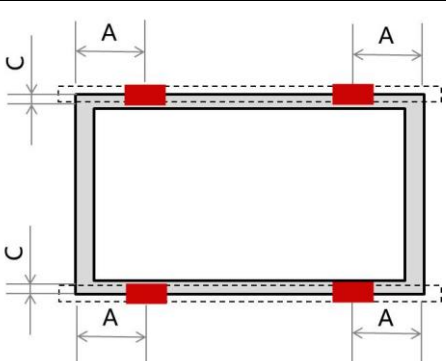
Use 4 clamps on the long side.
 Mounting rails run parallel to the long side frame

Clamp length ≥ 80 mm
 A=410-490 mm
 C=10 \pm 2mm (overlap between the rail and module frame)

<p>Maximum Load: Uplift load ≤ 1000 Pa Downforce load ≤ 1000 Pa</p>	<p>Maximum Load: Uplift load ≤ 3200 Pa Downforce load ≤ 3800 Pa Notice: Only applicable to modules with matching frame profiles on both the long and short sides</p>
<p>Clamp length ≥ 40 mm A range = 0-200mm C=10\pm2mm (overlap between the rail and module frame) Maximum Load: Uplift load ≤ 800 Pa Downforce load ≤ 800 Pa</p>	

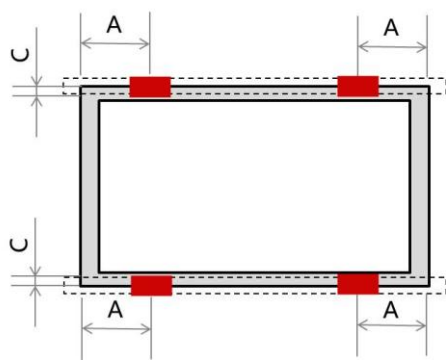
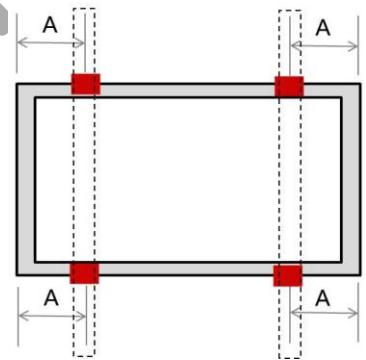
CS3K-MB-AG and CS3K-PB-AG

 <p>Use 4 clamps on the long side. Mounting rails run parallel to the long side frame.</p>	 <p>Use 4 clamps on the long side. Mounting rails run perpendicular to the long side frame.</p>
<p>Clamp length ≥ 40 mm A=270 – 380 mm C=10\pm2mm (overlap between the rail and module frame) Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 3600 Pa</p>	<p>Clamp length ≥ 80 mm A=270 – 380 mm Maximum Load: Uplift load ≤ 3600 Pa Downforce load ≤ 5400 Pa</p>

 <p>Use 4 clamps on the short side. Mounting rails run perpendicular to the long side</p>	
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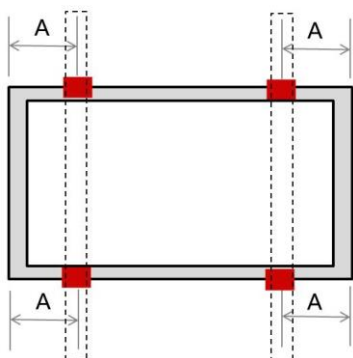
frame.	Use 4 clamps on the long side. Mounting rails run parallel to the long side frame.
Clamp length ≥ 40 mm A=200 – 250 mm C=10 \pm 2 mm Maximum Load: Uplift load ≤ 2000 Pa Downforce load ≤ 2400 Pa Notice: Only applicable to modules with matching frame profiles on both the long and short sides	Clamp length ≥ 80 mm A=270 – 380 mm C=10 \pm 2 mm Maximum Load: Uplift load ≤ 3200 Pa Downforce load ≤ 3800 Pa Notice: Only applicable to modules with matching frame profiles on both the long and short sides
Clamp length ≥ 40 mm A=0 – 200 mm C=10 \pm 2 mm Maximum Load: Uplift load ≤ 1800 Pa Downforce load ≤ 2200 Pa Notice: Only applicable to modules with matching frame profiles on both the long and short sides	

CS3Y-MB-AG and CS3Y-PB-AG

 <p>Use 4 clamps on the long side. Mounting rails run parallel to the long side frame.</p>	 <p>Use 4 clamps on the long side. Mounting rails run perpendicular to the long side frame.</p>
Clamp length ≥ 80 mm A=400-550 mm C=10 \pm 2mm (overlap between the rail and module frame) Maximum Load: Uplift load ≤ 3200 Pa Downforce load ≤ 4400 Pa	Clamp length ≥ 40 mm A=300-600 mm Maximum Load: Uplift load ≤ 2400 Pa Downforce load ≤ 3600 Pa
	Clamp length ≥ 80 mm A=400-550 mm Maximum Load: Uplift load ≤ 3600 Pa

Downforce load ≤ 5400 Pa

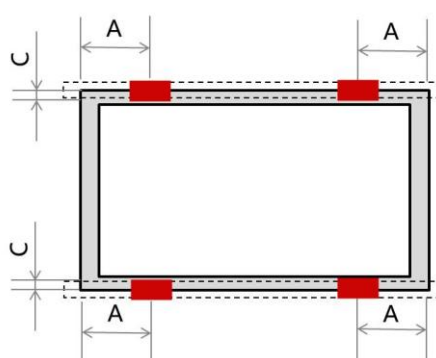
CS6W-MB-AG



Use 4 clamps on the long side.
Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 40 mm
A=300-600 mm
Maximum Load:
Uplift load ≤ 2400 Pa
Downforce load ≤ 2400 Pa

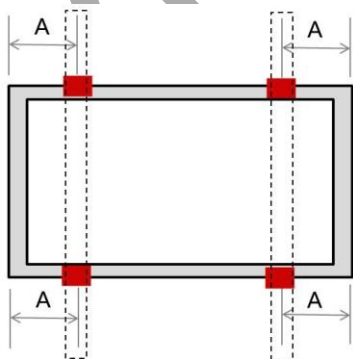
Clamp length ≥ 80 mm
A=400-500 mm
Maximum Load:
Uplift load ≤ 3600 Pa
Downforce load ≤ 4200 Pa



Use 4 clamps on the long side.
Mounting rails run parallel to the long side frame.

Clamp length ≥ 80 mm
A=400-500 mm
C=10 \pm 2mm (overlap between the rail and module frame)
Maximum Load:
Uplift load ≤ 3600 Pa
Downforce load ≤ 4000 Pa

CS7N-MB-AG



Use 4 clamps on the long side.
Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 40 mm

A=300-600 mm

Maximum Load:

Uplift load ≤ 2400 Pa

Downforce load ≤ 2400 Pa

Clamp length ≥ 80 mm

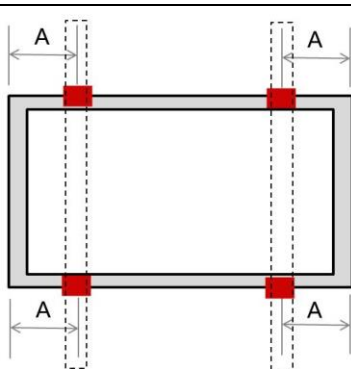
A=480-520 mm

Maximum Load:

Uplift load ≤ 3000 Pa

Downforce load ≤ 3600 Pa

CS7L-MB-AG



Use 4 clamps on the long side.

Mounting rails run perpendicular to the long side frame.

Clamp length ≥ 80 mm

A=300-600 mm

Maximum Load:

Uplift load ≤ 2600 Pa

Downforce load ≤ 2600 Pa

Clamp length ≥ 80 mm

A=400-500 mm

Maximum Load:

Uplift load ≤ 3200 Pa

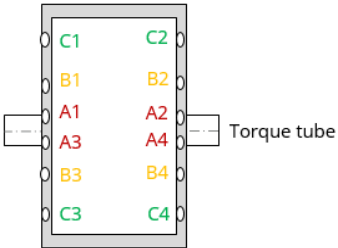
Downforce load ≤ 3800 Pa

6.3 MOUNTING METHODS FOR FRAMED BIFACIAL MODULE (Single-axis tracker)

- The bolts and clamps used in this section should follow the requirements in 6.3 and 6.4.
- Under any conditions the junction box should not become in contact with the subjacent racking structure. If any racking structures, especially bearing house, have to be located under the modules, the gap between the junction box and the racking structure should be at least 30 mm (CS3W) and 50 mm (CS3Y / CS6W / CS7N / CS7L).

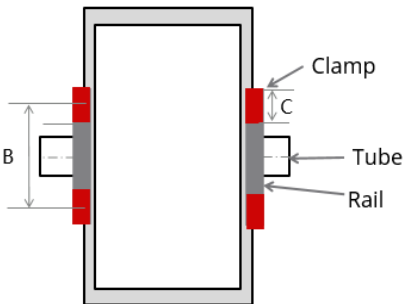
- If your tracker design cannot meet the above distance requirement, please contact Canadian Solar Inc technical support department in writing for advices.

Tracker 1P Bolting method



Module type	Mounting hole space (mm)	Fixed mounting hole location	Plain washer outer diameter (mm)	Test load (Pa)
CS3W-PB	A1-A3: 400	A1, A2, A3, A4	16	+2400/-2200
CS3W-MB	B1-B3: 1155	A1, A2, A3, A4 B1, B2, B3, B4	16	+3000/-2800
CS3Y-PB	A1-A3: 400	A1, A2, A3, A4	16	+2400/-1800
CS3Y-MB	B1-B3: 790	A1, A2, A3, A4 B1, B2, B3, B4	16	+2800/-2800
CS6W-MB	A1-A3: 400 B1-B3: 790	A1,A2,A3,A4	16	+2400/-2200
		A1,A2,A3,A4 B1,B2,B3,B4	16	+2800/-2800
CS7L-MB	A1-A3: 400	A1,A2,A3,A4	16	+1800/-1600
		B1,B2,B3,B4	16	+2400/-1800
CS7N-MB	B1-B3: 790	A1,A2,A3,A4	16	+1600/-1400
		B1,B2,B3,B4	16	+2200/-1600

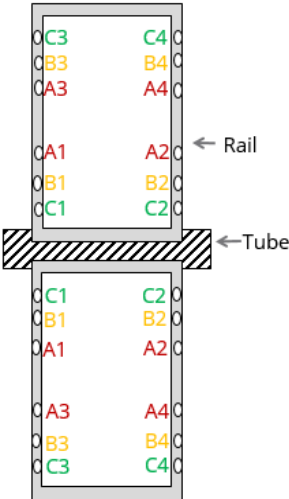
Tracker 1P Clamping method



Overlap width between clamp and frame:
Frame top side $\geq 10\text{mm}$
Frame bottom side $\geq 15\text{mm}$

Module type	B Value (mm)	Test load(Pa)	Clamp length C
CS3W-PB CS3W-MB	400	+2400/-1800	$\geq 40\text{mm}$
CS3Y-MB CS3Y-PB	300	± 1600	
	400	± 1800	
CS6W-MB	600	± 2400	$\geq 40\text{mm}$
	400	± 1900	$\geq 80\text{mm}$
CS7L-MB	600	+2100/-1800	$\geq 40\text{mm}$
CS7N-MB	400	+1600/-1600	$\geq 40\text{mm}$
	400	+1500/-1500	$\geq 40\text{mm}$

Tracker 2P Bolting method

	Module type	Mounting hole space (mm)	Mounting hole location	Plain washer outer diameter (mm)	Test load(Pa)
	CS3W-PB CS3W-MB	A1-A3: 400 B1-B3: 1155 C1-C3: 1300	C1, C2, A3, A4	16	±1800
			B1, B2, B3, B4	16	+2600/-2400
	CS3Y-PB CS3Y-MB	A1-A3: 400 B1-B3: 790	B1, B2, A3, A4 B1, B2, B3, B4	16	+1800/-1200 +2400/-1400
	CS6W-MB	A1-A3: 400 B1-B3: 790	B1,B2,A3,A4 B1,B2,B3,B4	16	+1800/-1600 +2400/-2400
	CS7L-MB	A1-A3: 400	B1,B2,A3,A4 B1,B2,B3,B4	16	+1200/-1000 +1800/-1200
	CS7N-MB	B1-B3: 790	B1,B2,A3,A4 B1,B2,B3,B4	16	+1000/-800 +1600/-1000

The following tracker manufacturers and types are approved with Canadian Solar framed bifacial modules.

Module Type	Compatible Tracker	Mounting Hardware	Maximum Load (Pa)	Reference Manual (Version No.)
CS3U-MB-AG CS3U-PB-AG	ATI DuraTrack™H Z Tracking System(V3)	Standard 300mm clamp 20563/20751 Hi-rise 300mm clamp-20822 Hi-rise 400mm clamp-20834	Uplift load \leq 2400 Pa Downforce load \leq 2400 Pa	DuraTrack HZ Solar Tracker Installation Guide
CS3Y-MB-AG CS3Y-PB-AG	ATI DuraTrack™H Z Tracking System(V3)	Hi-rise 400 mm clamp-20857 Clamp Ear 80 mm	+1800/-1800Pa	DuraTrack HZ Solar Tracker Installation Guide
CS3U-MB-AG CS3U-PB-AG	NEXTracker NX Horizon	Short Rail V2.4.9 (400 mounting holes position) Rail part No: 21190, 21191	Uplift load \leq 2 400 Pa Downforce load \leq 2400 Pa	NEXTracker NX Horizon 2.4 Short Rail Installation Manual
CS3Y-MB-AG CS3Y-PB-AG	NEXTracker NX Horizon	400 mm frame hole attachment. Uses V2.4.10 rail + 4x bobtails (head O.D. 16.8 mm)	+2000/-1800Pa	NEXTracker NX Horizon 2.4 Rail Installation Manual
CS3U-MB-AG CS3U-PB-AG	Arctech single-axis tracker Portrait one portrait	440mm rail (bolting method/ M6 bolt+M6 spring washer+M6 plain washer(O.D.=18m m)/400mm holes position) Drawing No: CS2018013	Uplift load \leq 2400 Pa Downforce load \leq 2400 Pa	Skyline-Module Fixing Installation Manual
CS3U-MB-AG CS3U-PB-AG	Arctech single-axis tracker Portrait two rows	3572mm rail (bolting method/ M8 bolt+M8 plain washer(O.D.=16m m)/1155mm holes position) Drawing No:	Uplift load \leq 2400 Pa Downforce load \leq 2400 Pa	SkySmart-Module Fixing Installation Manual

		CS2018012B		
CS3U-MB-AG CS3U-PB-AG	Soltec SF7 Single-Axis Tracker Portrait two rows	2556mm rail (Bolting method/ M6 bolt+M6 plain washer(O.D.=18mm)/1300mm+400 mm holes position) Drawing No: SF7-MR-04-039_Dr biku-1800Pa-30m m	Uplift load \leq 1800 Pa Downforce load \leq 1800 Pa	SF7QG-1500V-en
CS3U-MB-AG CS3U-PB-AG	Soltec SF7 Single-Axis Tracker Portrait two rows	3311 mm long rail (bolting method/ M6 bolt+M6 plain washer(O.D.=18mm)/ 1155mm holes position)Rail Drawing No: SF7-MR-04-040_Dr biku-2400Pa-30m m	Uplift load \leq 2400 Pa Downforce load \leq 2400 Pa	SF7QG-1500V-en
CS3W-PB-AG CS3W-MB-AG	ATI DuraTrack™H Z Tracking System	Standard 300mm clamp 20563/20751 Hi-rise 300mm clamp-20822	Uplift load \leq 1200 Pa Downforce load \leq 1500 Pa	DuraTrack HZ Solar Tracker Installation Guide
		Hi-rise 400mm clamp-20834	Uplift load \leq 1800 Pa Downforce load \leq 2400 Pa	
		Hi-rise 400mm clamp-20857 Clamp Ear 80mm	Uplift load \leq 2400 Pa Downforce load \leq 2400 Pa	

CS3W-PB-AG CS3W-MB-AG	Arctech single-axis tracker Portrait one row	730mm rail 80mm clamp Drawing No: CS2018014/ CS2018015/ CS2018016	Uplift load ≤ 2400 Pa Downforce load ≤ 2400 Pa	Skyline-Module Fixing Installation Manual DuraTrack HZ Solar Tracker Installation Guide
CS3W-MB-AG CS3W-PB-AG	Arctech single-axis tracker Portrait one portrait	440mm rail (bolting method/ M6 bolt+M6 spring washer+M6 plain washer(O.D.=16mm)/400mm holes position) Drawing No: LT9003540	Uplift load ≤ 1800 Pa Downforce load ≤ 1800 Pa	Skyline-Module Fixing Installation Manual
		1200mm rail (bolting method/ M8 bolt+M8 plain washer(O.D.=16mm)/1155mm holes position) Drawing No: LT9015540	Uplift load ≤ 2800 Pa Downforce load ≤ 3000 Pa	
CS3W-PB-AG CS3W-MB-AG	NEXTracker NX Horizon	400mm frame hole attachment. Uses V2.4.10 rail + 4x bobtails (head O.D. 16.8mm)	Uplift load ≤ 1800 Pa Downforce load ≤ 1800 Pa	NEXTracker NX Horizon 2.4 Short Rail Installation Manual
		400mm + 1155mm frame hole attachment. Uses V2.4.10 rail + 1,180mm supplemental rail + 8x bobtails (head O.D. 16.8mm)	Uplift load ≤ 2800 Pa Downforce load ≤ 3000 Pa	
CS3W-PB-AG CS3W-MB-AG	Arctech single-axis tracker Portrait two	3482mm rail (bolting method/ M8 bolt+M8 plain washer(O.D.=16mm)	Uplift load ≤ 2400 Pa Downforce load ≤ 2400 Pa	SkySmart-Module Fixing Installation Manual

	rows	m)/1155mm holes position) Drawing No: CS2018011		
CS3W-PB-AG CS3W-MB-AG	Soltec SF7 Single-Axis Tracker Portrait two rows	3421 mm long rail (bolting method/ M6 bolt+M6 plain washer(O.D.=18m m)/ 1155mm holes position)Rail Drawing No: SF7-MR-04-041_Dr -bihiku-2400Pa-30 mmframe	Uplift load ≤ 2400 Pa Downforce load ≤ 2400 Pa	SF7QG-1500V-en

The allowable maximum twist angle of the module is 0.5 degrees.

Please contact the tracker manufacturer and Canadian Solar Inc. technical support department for details in regard to specific projects.

7.0 MAINTENANCE

- **Do not** make modifications to any component of the PV module (diode, junction box, connectors or others).
- Regular maintenance is required to keep modules clear of snow, bird droppings, seeds, pollen, leaves, branches, dirt spots, and dust.
- Modules with sufficient tilt (at least 15°), generally do not require cleaning (rain will have a self-cleaning effect). If the module has become soiled, it shall be washed with water and a non-abrasive cleaning brush or sponge during the cool part of the day. Do not scrape or rub dry dirt away, as this may cause micro scratches.
- Snow should be removed using a soft brush.
- Periodically inspect the system to check the integrity of all wiring and supports.
- To protect against electric shock or injury, electrical or mechanical inspections and maintenance should be performed by qualified personnel only.
- Please refer to Annex B (Module Cleaning Guide) for more information on module cleaning.

AMENDED EDITIONS AND DATES

- Rev 1.0 is released in June, 2018.
- Rev 1.1 is released in March, 2019.
- Rev 1.2 is released in June, 2019.
- Rev 1.21 is released in July, 2019.
- Rev 1.3 is released in September, 2019.
- Rev 1.4 is released in December, 2019.

- Rev 1.5 is released in April, 2020.
- Rev 1.6 is released in May, 2020.
- Rev 1.61 is released in July, 2020.
- Rev 1.62 is released in December, 2020.

Preliminary

ANNEX A: Mechanical And Electrical Ratings

Standard Test Conditions are: irradiance of 1 kW/m², air mass (AM) spectrum of 1.5, and cell temperature of 25°C. The electrical characteristics are respectively within ±10 percent or [0; +5W] of the indicated values for Isc, Voc and Pmax. Specifications are subject to change without notice.

Table 1: Mechanical and Electrical Ratings under STC

Model Type	Maximum power Pmax<W>	Operating voltage Vmp <V>	Operating current Imp <A>	Open Circuit Voltage Voc <V>	Short Circuit Current Isc <A>	Max. Series Fuse Rating <A>	Overall Dimension <mm>	Weight <Kg>
CS3U-350MB-AG	350	38.8	9.03	46.6	9.53	25	2022 * 992 * 30 mm (79.6 * 39.1 * 1.18 in)	25.7 kg (56.7 lbs)
CS3U-355MB-AG	355	39.0	9.11	46.8	9.61	25		
CS3U-360MB-AG	360	39.2	9.19	47.0	9.69	25		
CS3U-365MB-AG	365	39.4	9.27	47.2	9.77	25		
CS3U-370MB-AG	370	39.6	9.35	47.4	9.85	25		
CS3U-375MB-AG	375	39.8	9.43	47.6	9.93	25		
CS3U-380MB-AG	380	40.0	9.50	47.8	10.01	25		
CS3U-385MB-AG	385	40.2	9.58	48.0	10.09	25		
CS3U-390MB-AG	390	40.4	9.66	48.2	10.17	25		
CS3U-395MB-AG	395	40.6	9.73	48.4	10.25	25		
CS3U-400MB-AG	400	40.8	9.81	48.6	10.33	25		
CS3U-405MB-AG	405	41.0	9.88	49.3	10.44	25		
CS3U-410MB-AG	410	41.2	9.96	49.5	10.52	25		
CS3K-280MB-AG	280	31.7	8.84	38.5	9.49	25	1696 * 992 * 30 mm (66.8 * 39.1 * 1.18 in)	22.1kg (48.7 lbs)
CS3K-285MB-AG	285	31.9	8.94	38.7	9.57	25		
CS3K-290MB-AG	290	32.1	9.04	38.9	9.65	25		
CS3K-295MB-AG	295	32.3	9.14	39.1	9.73	25		
CS3K-300MB-AG	300	32.5	9.24	39.3	9.82	25		
CS3K-305MB-AG	305	32.7	9.33	39.5	9.90	25		
CS3K-310MB-AG	310	32.9	9.43	39.7	9.98	25		
CS3K-315MB-AG	315	33.1	9.52	39.9	10.06	25		
CS3K-320MB-AG	320	33.3	9.61	40.1	10.14	25		
CS3K-325MB-AG	325	33.5	9.71	40.3	10.22	25		
CS3K-330MB-AG	330	33.7	9.80	40.5	10.30	25	2022 * 992 * 30 mm (79.6 * 39.1 * 1.18 in)	25.7 kg (56.7 lbs)
CS3U-350PB-AG	350	39.2	8.94	46.6	9.51	25		
CS3U-355PB-AG	355	39.4	9.02	46.8	9.59	25		
CS3U-360PB-AG	360	39.6	9.10	47.0	9.67	25		
CS3U-365PB-AG	365	39.8	9.18	47.2	9.75	25		
CS3U-370PB-AG	370	40.0	9.26	47.4	9.83	25		
CS3U-375PB-AG	375	40.2	9.34	47.6	9.91	25		

Model Type	Maximum power P _{max} <W>	Operating voltage V _{mp} <V>	Operating current I _{mp} <A>	Open Circuit Voltage V _{oc} <V>	Short Circuit Current I _{sc} <A>	Max. Series Fuse Rating <A>	Overall Dimension <mm>	Weight <Kg>
CS3U-380PB-AG	380	40.4	9.42	47.8	9.99	25	1696 * 992 * 30 mm (66.8 * 39.1 * 1.18 in)	22.1kg (48.7 lbs)
CS3U-385PB-AG	385	40.6	9.50	48.0	10.07	25		
CS3U-390PB-AG	390	40.8	9.56	48.6	10.17	25		
CS3U-395PB-AG	395	41.0	9.64	48.8	10.24	25		
CS3U-400PB-AG	400	41.2	9.71	49.0	10.30	25		
CS3U-405PB-AG	405	41.4	9.79	49.2	10.37	25		
CS3U-410PB-AG	410	41.6	9.86	49.4	10.43	25		
CS3U-415PB-AG	415	41.8	9.93	49.6	10.49	25		
CS3U-420PB-AG	420	42.0	10.00	49.8	10.55	25		
CS3K-265PB- AG	265	30.6	8.66	37.3	9.22	25	1696 * 992 * 30 mm (66.8 * 39.1 * 1.18 in)	22.1kg (48.7 lbs)
CS3K-270PB- AG	270	30.8	8.77	37.5	9.30	25		
CS3K-275PB- AG	275	31.0	8.88	37.7	9.38	25		
CS3K-280PB- AG	280	31.2	8.98	37.9	9.47	25		
CS3K-285PB- AG	285	31.4	9.08	38.1	9.56	25		
CS3K-290PB- AG	290	32.3	8.98	38.9	9.49	25		
CS3K-295PB- AG	295	32.5	9.08	39.1	9.57	25		
CS3K-300PB- AG	300	32.7	9.18	39.3	9.65	25		
CS3K-305PB- AG	305	32.9	9.28	39.5	9.73	25		
CS3K-310PB- AG	310	33.1	9.37	39.7	9.81	25		
CS3K-315PB- AG	315	33.3	9.46	39.9	9.89	25		
CS3K-320PB- AG	320	33.5	9.56	40.1	9.97	25		
CS3K-325PB- AG	325	33.7	9.65	40.9	10.21	25		
CS3K-330PB- AG	330	33.9	9.74	41.1	10.29	25		
CS3K-335PB- AG	335	34.1	9.83	41.3	10.37	25		
CS3K-340PB-AG	340	34.3	9.92	41.5	10.45	25		
CS3K-345PB-AG	345	34.5	10.00	41.7	10.52	25		
CS3K-350PB-AG	350	34.7	10.09	41.9	10.60	25		
CS3W-380PB-AG	380	37.9	10.03	46.4	10.58	25	2132 * 1048 * 30 mm (83.9 * 41.3 * 1.18 in)	28.2kg (62.2 lbs)
CS3W-385PB-AG	385	38.1	10.11	46.6	10.66	25		
CS3W-390PB-AG	390	38.3	10.19	46.8	10.74	25		
CS3W-395PB-AG	395	38.5	10.26	47.0	10.82	25		
CS3W-400PB-AG	400	38.7	10.34	47.2	10.9	25		
CS3W-405PB-AG	405	38.9	10.42	47.4	10.98	25		
CS3W-410PB-AG	410	39.1	10.49	47.6	11.06	25		
CS3W-415PB-AG	415	39.3	10.56	47.8	11.14	25		
CS3W-420PB-AG	420	39.5	10.64	48.0	11.26	25		

Model Type	Maximum power P _{max} <W>	Operating voltage V _{mp} <V>	Operating current I _{mp} <A>	Open Circuit Voltage V _{oc} <V>	Short Circuit Current I _{sc} <A>	Max. Series Fuse Rating <A>	Overall Dimension <mm>	Weight <Kg>
CS3W-425PB-AG	425	39.7	10.71	48.2	11.29	25		
CS3W-430PB-AG	430	39.9	10.78	48.4	11.32	25		
CS3W-435PB-AG	435	40.1	10.85	48.6	11.35	25		
CS3W-440PB-AG	440	40.3	10.92	48.7	11.40	25		
CS3W-445PB-AG	445	40.5	10.99	48.8	11.45	25		
CS3W-415MB-AG	415	39.1	10.62	47.3	11.28	25	2132 × 1048 × 30 mm (83.9 × 41.3 × 1.18 in)	28.4kg (62.6 lbs)
CS3W-420MB-AG	420	39.3	10.69	47.5	11.33	25		
CS3W-425MB-AG	425	39.5	10.76	47.7	11.37	25		
CS3W-430MB-AG	430	39.7	10.84	47.9	11.42	25		
CS3W-435MB-AG	435	39.9	10.91	48.1	11.47	25		
CS3W-440MB-AG	440	40.1	10.98	48.3	11.53	25		
CS3W-445MB-AG	445	40.3	11.05	48.5	11.59	25		
CS3W-450MB-AG	450	40.5	11.12	48.7	11.65	25		
CS3W-455MB-AG	455	40.7	11.18	48.9	11.71	25		
CS3W-460MB-AG	460	40.9	11.25	49.1	11.77	25		
CS3W-465MB-AG	465	41.1	11.32	49.3	11.83	25	2260 × 1048 × 32 mm (89.0 × 41.3 × 1.26 in)	29.9 kg (65.9 lbs)
CS3Y-465MB-AG	465	43.6	10.67	52.3	11.42	25		
CS3Y-470MB-AG	470	43.8	10.74	52.5	11.47	25		
CS3Y-475MB-AG	475	44.0	10.81	52.7	11.52	25		
CS3Y-480MB-AG	480	44.2	10.87	52.9	11.57	25		
CS3Y-485MB-AG	485	44.4	10.94	53.1	11.62	25		
CS3Y-490MB-AG	490	44.6	11.00	53.3	11.67	25	2260 1048 × 32 mm (89.0 × 41.3 × 1.26 in)	29.9 kg (65.9 lbs)
CS3Y-430PB-AG	430	41.6	10.34	50.8	11.08	25		
CS3Y-435PB-AG	435	41.8	10.41	51.0	11.13	25		
CS3Y-440PB-AG	440	42.0	10.48	51.2	11.18	25		
CS3Y-445PB-AG	445	42.2	10.55	51.4	11.23	25		
CS3Y-450PB-AG	450	42.4	10.62	51.6	11.28	25		
CS3Y-455PB-AG	455	42.6	10.69	51.8	11.33	25		
CS3Y-460PB-AG	460	42.8	10.75	52.0	11.38	25		
CS3Y-465PB-AG	465	43.0	10.82	52.2	11.43	25		
CS3Y-470PB-AG	470	43.2	10.88	52.4	11.48	25	2266 × 1134 × 35 mm(89.2 × 44.6 × 1.38 in)	29.9 kg (71.4 lbs)
CS3Y-475PB-AG	475	43.4	10.95	52.6	11.53	25		
CS6W-510MB-AG	510	40.1	12.72	48.0	13.60	30		
CS6W-515MB-AG	515	40.3	12.78	48.2	13.65	30		
CS6W-520MB-AG	520	40.5	12.84	48.4	13.70	30		
CS6W-525MB-AG	525	40.7	12.90	48.6	13.75	30		

Model Type	Maximum power P _{max} <W>	Operating voltage V _{mp} <V>	Operating current I _{mp} <A>	Open Circuit Voltage V _{oc} <V>	Short Circuit Current I _{sc} <A>	Max. Series Fuse Rating <A>	Overall Dimension <mm>	Weight <Kg>
CS6W-530MB-AG	530	40.9	12.96	48.8	13.80	30		
CS6W-535MB-AG	535	41.1	13.02	49.0	13.85	30		
CS6W-540MB-AG	540	41.3	13.08	49.2	13.90	30		
CS6W-545MB-AG	545	41.5	13.14	49.4	13.95	30		
CS6W-550MB-AG	550	41.7	13.20	49.6	14.00	30		
CS6W-555MB-AG	555	41.9	13.25	49.8	14.05	30		
CS7L-570MB-AG	570	33.7	16.93	40.1	18.17	35	2172*1303*35 mm (85.5 * 51.3 * 1.38 in)	35.9 kg (79.1 lbs)
CS7L-575MB-AG	575	33.9	16.97	40.3	18.22	35		
CS7L-580MB-AG	580	34.1	17.02	40.5	18.27	35		
CS7L-585MB-AG	585	34.3	17.06	40.7	18.32	35		
CS7L-590MB-AG	590	34.5	17.11	40.9	18.37	35		
CS7L-595MB-AG	595	34.7	17.15	41.1	18.42	35		
CS7L-600MB-AG	600	34.9	17.20	41.3	18.47	35	2384*1303*35 mm (93.9 * 51.3 * 1.38 in)	39.4 kg (86.9 lbs)
CS7N-630MB-AG	630	37.1	16.99	44.2	18.23	35		
CS7N-635MB-AG	635	37.3	17.03	44.4	18.27	35		
CS7N-640MB-AG	640	37.5	17.07	44.6	18.31	35		
CS7N-645MB-AG	645	37.7	17.11	44.8	18.35	35		
CS7N-650MB-AG	650	37.9	17.16	45.0	18.39	35		
CS7N-655MB-AG	655	38.1	17.20	45.2	18.43	35		
CS7N-660MB-AG	660	38.3	17.24	45.4	18.47	35		

ANNEX B: Module Cleaning Guidelines

This manual covers the requirements for the cleaning procedure of Canadian Solar Inc.'s photovoltaic modules. The purpose of these cleaning guidelines is to provide general information for cleaning Canadian Solar modules. System users and professional installers should read these guidelines carefully and strictly follow these instructions.

Failure to follow these instructions may result in death, injury or damage to the photovoltaic modules. Damages induced by inappropriate cleaning procedures will void Canadian Solar Inc. warranty.

Safety Warning



- Cleaning activities create risk of damaging the modules and array components, as well as increasing the potential electric shock hazard.
- Cracked or broken modules represent an electric shock hazard due to leakage currents, and the risk of shock is increased when modules are wet. Before cleaning, thoroughly

inspect modules for cracks, damage, and loose connections.

- The voltage and current present in an array during daylight hours are sufficient to cause a lethal electrical shock.
- Ensure that the circuit is disconnected before starting the cleaning procedure as contact with leakage of electrically active parts can result in injury.
- Ensure that the array has been disconnected to other active components (such as inverter or combiner boxes) before starting with the cleaning.
- Wear suitable protection (clothes, insulated gloves, etc.).
- Do not immerse the module, partially or totally, in water or any other cleaning solution.

Handling Notice

NOTICE

- Use a proper cleaning solution and suitable cleaning equipment.
- Do not use abrasive or electric cleaners on the module.
- Particular attention should be taken to avoid the module backsheet or frame to come in contact with sharp objects, as scratches may directly affect product safety.
- Do not use abrasive cleaners, de-greasers or any unauthorized chemical substance (e.g. oil, lubricant, pesticide, etc.) on the module..
- Do not use cleaning corrosive solutions containing hydrofluoric acid, alkali, acetone, or industrial alcohol. Only substances explicitly approved by Canadian Solar are allowed to be used for cleaning modules.
- Canadian Solar Inc. recommends to avoid rotating brush cleaning methods, as they could create micro-cracks in the PV modules.
- Dirt must never be scraped or rubbed away when dry, as this will cause micro-scratches on the glass surface.

Operation Preparation

- Noticeable dirt must be rubbed away by gentle cleaning implement (soft cloth, sponge or brush with soft bristles).
 - Ensure that brushes or agitating tools are not abrasive to glass, EPDM, silicone, aluminum, or steel.
 - Conduct the cleaning activities avoiding the hottest hours of the day, in order to avoid thermal stress on the module.
- ✓ **We recommend the following to be used:**
- ✓ Water with low mineral content
 - ✓ Near neutral pH water
 - ✓ The maximum water pressure recommended is 4 MPa (40 bar)

Cleaning Methods

Method A: Compressed Air

Canadian Solar Inc. recommends cleaning the soft dirt (like dust) on modules just with air pressure. This technique can be applied as long as the method is efficient enough considering the existing conditions.

Method B: Wet cleaning

If excessive soiling is present on the module surface, a non-conductive brush, sponge, or other mild agitating method may be used with caution.

- Ensure that any brushes or agitating tools are constructed with non-conductive materials to minimize risk of electric shock and that they are not abrasive to the glass or the aluminum frame.
- If grease is present, an environmental friendly cleaning agent may be used with caution.

Preliminary



IEC / UL 61730 - The New Harmonized Standard for Safety

USA and International Access in One Standard

On December 4, 2017, the long-term effort to harmonize the UL1703 PV module safety standard was completed with the publication of UL 61730-1 and UL 61730-2.

A New UL Safety Standard

The new harmonized standard included the updates in IEC 61730, published August 2016, as the basis for harmonization with UL 1703 and resulted in UL 61730-1 and UL 61730-2. Advances in materials, increasing system voltages and innovative designs are addressed with new and updated construction and testing requirements. The new PV module standard further enables reduction in product cost, increases in performance and broadens access to markets with continued confidence in their safe operation.

While the publication of the harmonized standard does not immediately replace UL 1703, it is important to know how the changes will impact your current PV module or system design. Whether you're a manufacturer, developer or financier of PV systems, you can benefit from the updates.

The UL 61730 consists of 2 parts:

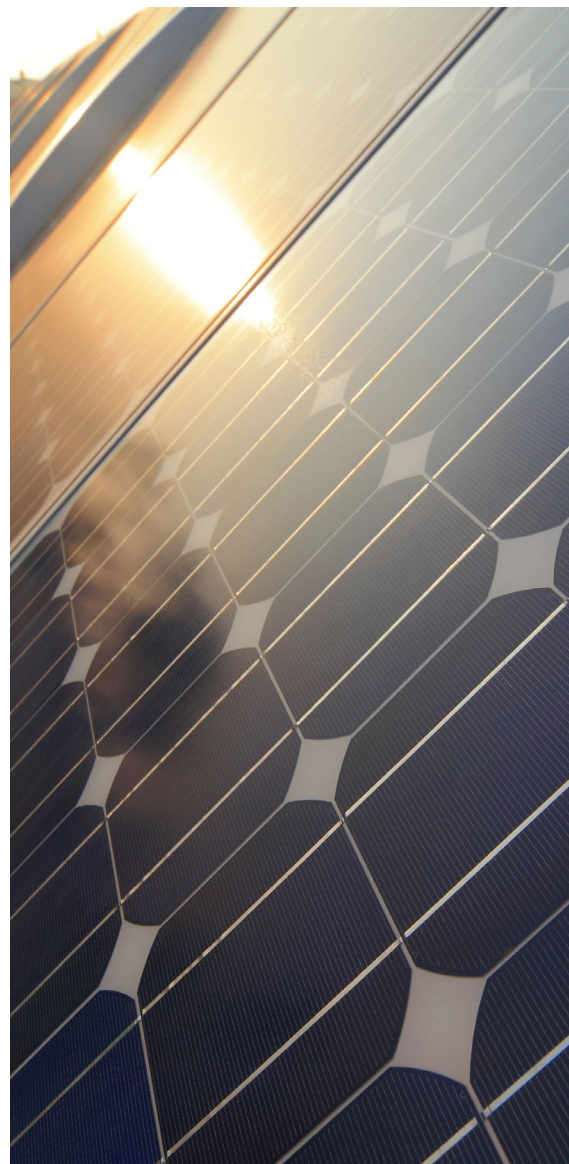
Part 1: Describes the construction requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation during their expected lifetime. Key updates include:

- Clearly defined Insulation requirements based on material properties, material groups, location of installation and installation type
- Cemented joints concept for maintaining insulation requirements
- Overvoltage categories, system voltage classes and protective means
- Requirements for component approvals

Part 2: Provides the testing sequence intended to verify the safety of PV modules whose construction has been assessed by UL 61730 part 1.

- This edition of the standard contains over 20 significant technical changes relative to the previous edition
- A minimum of nine PV modules and one unframed PV module now required for the updated test sequences

Evaluation and testing of a PV module for certification involves both part 1 and part 2 of the new standard.

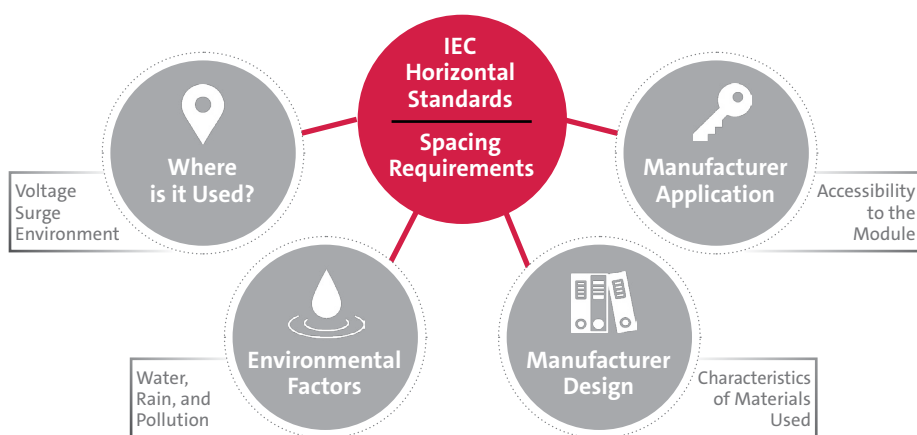


For more information on UL services for the PV industry please contact ULHELPS@ul.com or call 1.877.ULHELPS (1.877.854.3577)



Harmonized standards enable access to global markets. Global commerce depends on the use of technically valid standards to facilitate international trade in products such as those in PV systems. The UL 61730 harmonized safety standard enables cost savings for manufacturers by testing once and leveraging the UL “record of test” for access to other markets. Since regional regulations for installation of electrical products must be considered, additional requirements called national differences or deviations also apply and incremental testing may be necessary depending where the product is installed.

New construction and testing requirements aimed at innovation. Since publication in 1986 of the first PV standard, UL has been in lockstep with the evolution of PV module technology and understands the relationship between their operation in the field and testing in the lab.



Construction requirements in UL 61730-1 are specific to PV module materials, equipment application, accessibility and environmental factors; when applied correctly they reduce the likelihood of technical error in the design stage. Applying the concepts of insulation coordination and getting the spacing's right increases confidence of a compliant result when testing for safety certification, reducing the cost of rework.

Testing requirements in UL 61730-2 reflect lessons learned from the field across a variety of technologies, materials, installation types and climates. Most notable is the B Sequence which does a more thorough job of weather testing of the module construction and is intended to simulate a stressor scenario for adhesion at multiple material interfaces. Also, the test method looks at weathering of the front side as well as the back side of the module.

UL's Continuing Certification program supports coexisting safety standards. Safety certification to UL1703 for existing products and the use of UL61730 for certification of new products provides the least disruptive path for the PV industry. The aim of the standards technical panel (STP) decision is to allow manufacturers to continue to apply the UL mark on established products to show safety compliance. New products or changes to existing products must comply with UL61730 by the transition date of December 4, 2019.

Why UL?

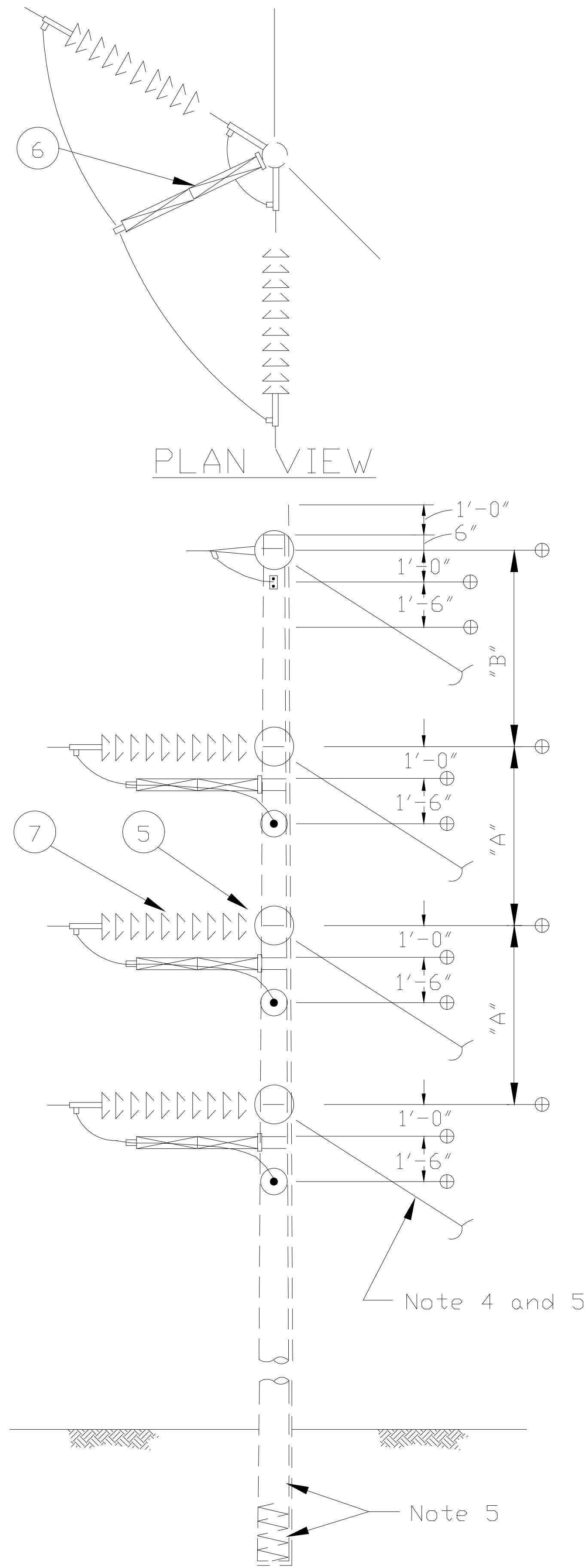
UL drives global research and standards to continually advance and meet ever-evolving product safety, performance and interoperability needs. We partner with businesses, manufacturers, trade associations and international regulatory authorities to bring solutions to a more complex global supply chain.

Knowledge & Experience – As a contributing member of the IEC TC2 Working Group 2, North America code making panels and convener of the International Harmonization Committee we have deep understanding of the new requirements in UL 61730-1 and 61730-2 for specific market applications.

Speed & Efficiency – Our globally located state-of-the-art labs and combined testing for UL 61730, IEC 61730 and IEC 61215-series reduce turnaround time.

Single Source Services – Combine your testing to IEC and UL standards to save you valuable time and money and expand market access.

For more information on UL services for the PV industry please contact ULHELPS@ul.com or call 1.877.ULHELPS (1.877.854.3577)




PLAN VIEW

TS-5AA


TS-5			LIST OF MATERIALS			
DWG. REF.	AA	A	DESCRIPTION	ITEM	DET.	CODE No.
1	6	-	3/4" Bolt, Machine, by req'd length	c		
2	6	-	Washer, Curved,4"sq x1/4",13/16" hole	d		
3	3	-	Washer, Spring, 13/16" hole	aw		
4	6	-	3/4" Locknut, MF Type	ek		
5	8	8	GUY ATTACHMENT, ____ DUTY	-	TG-__D	
6	3	-	INSULATOR,HORIZONTAL POST, w/CLAMP	-	TM-3__	
7	6	6	INSULATOR ASSEMBLY, DEADEND	-	TM-__	
8	2	2	OHGW ASSEMBLY, DEADEND	-	TM-4__	

- NOTES:
1. Metal shims should be used to adjust post insulators when brackets are located on uneven pole surfaces.
 2. Minimum line angle for TS-5AA is 40 degrees.
 3. Drawing TE-1 gives guidance to subassembly alternatives.
 4. For guying arrangements, see drawing TMG-2.
 5. The following materials are to be specified on plan and profile drawings and staking sheets: POLES, POLE GROUNDING ASSEMBLY, GUYING ASSEMBLIES, ANCHORS AND ANY ADDITIONAL GROUNDING OR POLE FOUNDATION UNITS.

TS-5AA		
DIMENSIONS A & B		
VOLTAGE	A	B
72kv	7'-0"	7'-0"



THIS DRAWING PREPARED AT THE
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PRELIMINARY
NOT FOR CONSTRUCTION

**ROSS COUNTY SOLAR, LLC'S FEBRUARY 16, 2021 RESPONSE
TO STAFF'S FEBRUARY 3, 2021 DATA REQUEST**

**In the Matter of the Application of Ross)
County Solar, LLC for a Certificate of)
Environmental Compatibility and Public)
Need)**

Case No. 20-1380-EL-BGN

1. Are you considering using solar panels that contain cadmium telluride (CdTe) or copper indium gallium deselenide (CIGS)? And if so, is it possible for the panels to leach those chemicals into the ground water?

Response: Ross County Solar is considering panels that contain trace amounts of cadmium telluride for the Project. First Solar, a reputable and Ohio based solar panel manufacturer, produces thin film panels containing this element. Ross County Solar continues to consider these for the Project, and a decision for a panel will be made based on various factors such as costs, panel efficiency, and overall availability based on construction timing. Panels containing CIGS are not being considered for the Project.

The EPA-approved method for determining whether a hazardous substance is likely to leach into the ground and ground water is the Toxicity Characteristic Leaching Procedure ("TCLP"). The panel manufacturers being considered by the Applicant complete TCLP testing as part of the product development process and have determined that all existing products passed TCLP testing. In other words, no hazardous materials, including arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver, leached from the tested products resulting in leachate concentrations above the EPA's regulatory thresholds. In light of the panels being fully encapsulated, unlikely to shatter, and not expected to leach hazardous materials into the environment, the risk to the environment from the contents of the PV panels will be minimal. If a PV panel is broken at the Project, the broken pieces and the remainder of the panel will be recycled or disposed of and replaced, thereby further reducing the risk for hazardous materials contained in the panel to leach into the environment.

**ROSS COUNTY SOLAR, LLC'S MARCH 3, 2021 RESPONSES
TO STAFF'S FEBRUARY 19, 2021 DATA REQUESTS**

**In the Matter of the Application of Ross)
County Solar, LLC for a Certificate of)
Environmental Compatibility and Public)
Need)**

Case No. 20-1380-EL-BGN

1. Does Ross County Solar anticipate cleaning of the solar panels with water? If so, how often would these be cleaned on an annual basis?

Response: As noted in page 12 of the certificate application filed on October 30, 2020, Ross County Solar does not anticipate the need to clean solar panels with water. Precipitation in Ohio occurs regularly enough that no panel cleaning is anticipated to be necessary.

2. What is the approximate volume of water that would be required to clean the solar farm?

Response: As noted above, no cleaning of panels is anticipated to be necessary, and thus no volume of water is required.

3. Where will the waste materials and debris from the removal of the residence and shed located on Rolfe Road be disposed?

Response: Since the submittal of the application, the owner of the trailer home that was anticipated to be removed by Ross County Solar has elected to remove the trailer to a location outside of the Project Area. Exact timing of the removal by the owner is to-be-determined. Ross County Solar no longer anticipates that it will have the responsibility to remove the structure.

Ross County Solar will continue to coordinate with the landowner on removal of the structure. Should the landowner not follow through on removal of the structure prior to construction and Ross County Solar is required to remove it, the waste materials would be transported to a licensed solid waste disposal facility. Waste materials will be sorted and applicable materials such as metals are anticipated to be recycled. The contractor selected for the Project will identify the best option for disposal of the materials prior to their removal.

4. Please provide a copy of the landowner's authorization/approval to remove the residence and shed located on Rolfe Road?

Response: Ross County Solar's lease agreements provide for explicit rights to develop the areas designated within the lease agreements for solar energy development. The area that the structure is located is one such location. While Ross County Solar's lease agreements are confidential, through this response, Ross County Solar confirms that it

has authorization pursuant to the lease with participating landowner in question to remove the residence and shed. Also, please note that the landowner has indicated an intent to move the structures prior to construction.

5. Please explain how Ross County Solar will, during the detailed engineering phase, minimize any potential damage from high wind velocities by proper structural design of the Project support equipment at sufficient depths based on the site-specific soil conditions to preclude any adverse influence from high wind velocities

Response: Ross County Solar has completed test borings of the site, previously provided with the Certificate Application as Exhibit C, to determine overall suitability and anticipated range in pile depths for the Project. Prior to construction, Ross County Solar anticipates the completion of a final geotechnical evaluation and pull-testing to ensure that more localized soil conditions within the Project Area are accounted for. Pull testing evaluates the lateral and vertical loading to identify soils strength and the pile depth necessary to withstand high wind events. Final geotechnical borings and further pile testing will support a site-specific structural design analysis that incorporates specific wind, snow, seismic, frost and corrosion inputs that will be utilized to complete the engineering requirements and pile design criteria.

6. Please indicate any wind loading precautions (e.g. stowing) or wind equipment ratings that will be included in the final project design.

Response: Ross County Solar's final project design will identify the necessary pile type and pile depth across the Project Area to ensure that site specific structural loading requirements and inputs (wind, snow, seismic, frost and corrosion) are accounted for.

7. Have the solar panels under consideration by Ross County Solar passed the US EPA's Toxicity Characteristic Leaching Procedure (TCLP) test?

Response: Vendors under consideration for the Project have historically certified their modules in compliance with the EPA TCLP, and expect to continue to do so once the modules under consideration begin serial production.

8. According to page 3 of the Decommissioning Plan, "waste materials that hold no value will be recycled or disposed of via a licensed solid waste disposal facility." Will the solar panels be checked for toxicity or hazardous materials (e.g. RCRA listing), or acceptability of the solid waste facility prior to decommissioning?

Response: As noted above, the panels under consideration have historically been in compliance with the US EPA's TCLP test, and meet the US EPA definition of non-hazardous waste. Should the panels be landfilled, Ross County Solar would ensure that they meet all disposal requirements related to the panels and would work with the selected disposal facility to ensure compliance. However, the panels are still anticipated to hold value at the end of the Project's life. Many solar panel manufacturers either have programs or are developing programs to accept panels back to their facility to recycle and reuse most of the components. Various recycling programs are under development that are likely to accept panels at the end of the Project's life.

9. Lighting at the inverters will be motion and switch activated. This means lights at the inverters will be off at night unless someone approaches the inverter, correct?

Response: Unless maintenance activities are underway at an inverter location, or the lighting is activated by nearby motion, the lighting will be off at inverter locations during nighttime hours.

10. Please provide a photo or drawing showing what the facility perimeter fence would look like.

Response: Below is a photo of a National Grid Renewables project in Minnesota with similar fencing to the proposed Project (Refer to Photo 1). Please note that the vegetative screening showing in photo 1 is not necessarily indicative of screening at the Ross County Solar Project. In the case of Ross County Solar, and for enhanced security, the fencing will be topped with straight strands of barbed wiring. Fencing is also generally shown in the Exhibit V, Appendix D of Ross County Solar's Certificate Application. A photo representation from the appendix is included below as Photo 2.

Photo 1: Fencing at an existing National Grid Renewables project in Minnesota.



Photo 2: Visual Representation of Fencing at the Ross County Solar Site (Refer to Exhibit V, Appendix D of application)



11. Will the Project include meteorological towers or pyrometers? If so, how many will there be and what are the locations?

Response: Per Page 16 and 17 of the certificate application, up to nine weather stations are anticipated throughout the site:

The Facility will include up to nine weather stations, which will be mounted adjacent to the inverters. These weather stations will be up to 20 feet in height. See Inset 03-7 for a photograph of a weather station that is representative of what will be installed for the Facility. These weather stations measure various aspects of the weather such as solar irradiance and wind speed.

Inset 03-7. Representative Weather Station



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6/25/2021 1:47:08 PM

in

Case No(s). 20-1380-EL-BGN

Summary: Exhibit Company Exhibit 2 electronically filed by Mr. Ken Spencer on behalf of Armstrong & Okey, Inc. and Burke, Carolyn