

Confidential Release

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Reviewing Attorney Examiner's Signature

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PUCO



Ross County Solar

Exhibit B

Manufacturer's Equipment Specifications

CONFIDENTIAL

Case No. 20-1380-EL-BGN

Representative Inverters

CONFIDENTIAL

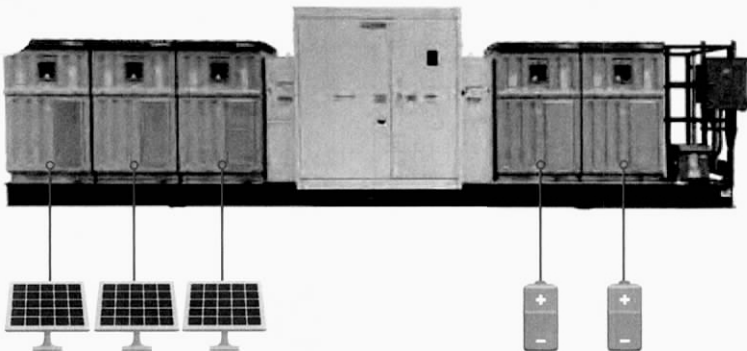
Solar Ware Ninja™

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.

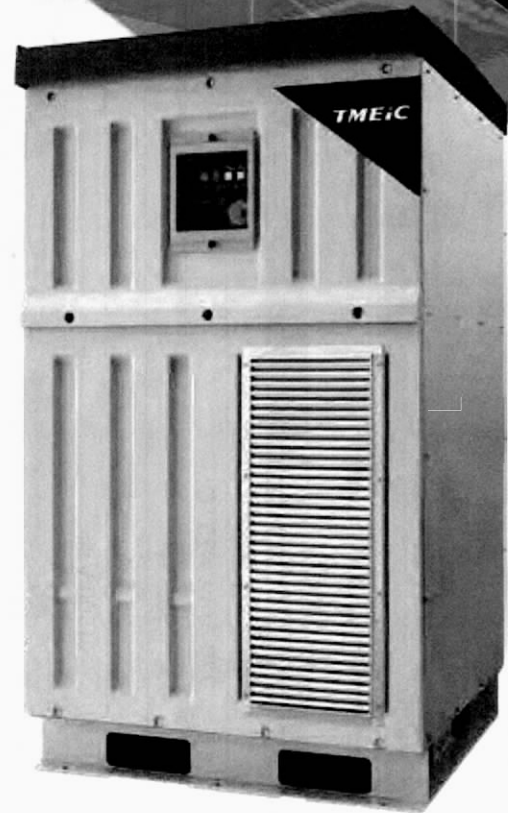
The Ninja is a global product, performing the duties of both generation and energy storage. The modular system introduces multiple layers of flexibility to allow designers an almost unlimited number of options for every project. The advanced controls system is packed with features to meet not only today's 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

Type		PV-PCS				ESS-PCS		
		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)						
Output side (AC)	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%						
	Maximum Voltage	1500 Vdc						
	MPPT Operation Range	875-1300VDC	915-1300VDC	960-1300VDC	1005-1300VDC	710-1100VDC	875-1300VDC	915-1300VDC
Input side (DC)	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 / IEE1547 / 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							

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 $\cos \phi = 1$ (at 25 °C / at 50 °C)	4000 kVA / 3400 kVA	4200 kVA / 3570 kVA
Nominal AC power at $\cos \phi = 0.8$ (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

DC side

MPP voltage range V_{DC} (at 25 °C / at 50 °C)

Min. DC voltage V_{DC, min} / Start voltage V_{DC, Start}

Max. DC voltage V_{DC, max}

Max. DC current I_{DC, max}

Max. short-circuit current I_{DC, SC}

Number of DC inputs

Number of DC inputs with optional DC coupled storage

Max. number of DC cables per DC input (for each polarity)

Integrated zone monitoring

Available PV fuse sizes (per input)

Available battery fuse size (per input)

AC side

Nominal AC power at cos φ = 1 (at 25 °C / at 50 °C)

Nominal AC power at cos φ = 0.8 (at 25 °C / at 50 °C)

Nominal AC current I_{AC, nom} (at 25 °C / at 50 °C)

Max. total harmonic distortion

Nominal AC voltage / nominal AC voltage range^{1) 8)}

AC power frequency / range

Min. short-circuit ratio at the AC terminals⁹⁾

Power factor at rated power / displacement power factor adjustable^{8) 10)}

Efficiency

Max. efficiency²⁾ / European efficiency²⁾ / CEC efficiency²⁾

Protective Devices

Input-side disconnection point

Output-side disconnection point

DC overvoltage protection

AC overvoltage protection (optional)

Lightning protection (according to IEC 62305-1)

Ground-fault monitoring / remote ground-fault monitoring

Insulation monitoring

Degree of protection: electronics / air duct / connection area (as per IEC 60529)

General Data

Dimensions (W / H / D)

Weight

Self-consumption (max.⁴⁾ / partial load⁵⁾ / average⁶⁾

Self-consumption (standby)

Internal auxiliary power supply

Operating temperature range⁸⁾

Noise emission⁷⁾

Temperature range (standby)

Temperature range (storage)

Max. permissible value for relative humidity (condensing / non-condensing)

Maximum operating altitude above MSL⁸⁾ 1000 m / 2000 m¹¹⁾ / 3000 m¹¹⁾

Fresh air consumption

Features

DC connection

AC connection

Communication

Enclosure / roof color

Supply for external loads

Standards and directives complied with

EMC standards

Quality standards and directives complied with

● Standard features ○ Optional – not available * preliminary

Type designation

SC 4400 UP

SC 4600 UP

962 to 1325 V / 1100 V

934 V / 1112 V

1500 V

4750 A

6400 A

Busbar with 26 connections per terminal, 24 double pole fused (32 single pole fused)

18 double pole fused (36 single pole fused) for PV and 6 double pole fused for batteries

2 x 800 kcmil, 2 x 400 mm²

○

200 A, 250 A, 315 A, 350 A, 400 A, 450 A, 500 A

750 A

4400 kVA / 3740 kVA

3520 kW / 2992 kW

3850 A / 3273 A

< 3% at nominal power

660 V / 528 V to 759 V

50 Hz / 47 Hz to 53 Hz

60 Hz / 57 Hz to 63 Hz

> 2

● 1 / 0.8 overexcited to 0.8 underexcited

98.8% / 98.7% / 98.5%

98.9% / 98.7% / 98.5%

DC load break switch

AC circuit breaker

Surge arrester, type I & II

Surge arrester, class I & II

Lightning Protection Level III

○ / ○

○

IP54 / IP34 / IP34

2815 / 2318 / 1588 mm (110.8 / 91.3 / 62.5 inch)

< 4000 kg / < 8818.5 lb

< 8100 W / < 1800 W / < 2000 W

< 370 W

○ Integrated 8.4 kVA transformer

–25 °C to 60 °C / –13 °F to 140 °F

63.0 dB(A)*

–40 °C to 60 °C / –40 °F to 140 °F

–40 °C to 70 °C / –40 °F to 158 °F

95% to 100% (2 month/year) / 0% to 95%

● / ○ / –

6500 m³/h

Terminal lug on each input (without fuse)

With busbar system (three busbars, one per line conductor)

Ethernet, Modbus Master, Modbus Slave

RAL 9016 / RAL 7004

○ (2.5 kVA)

CE, IEC / EN 62109-1, IEC / EN 62109-2, AR-N 4110, IEEE1547,

UL 840 Cat. IV, Arrêté du 23/04/08

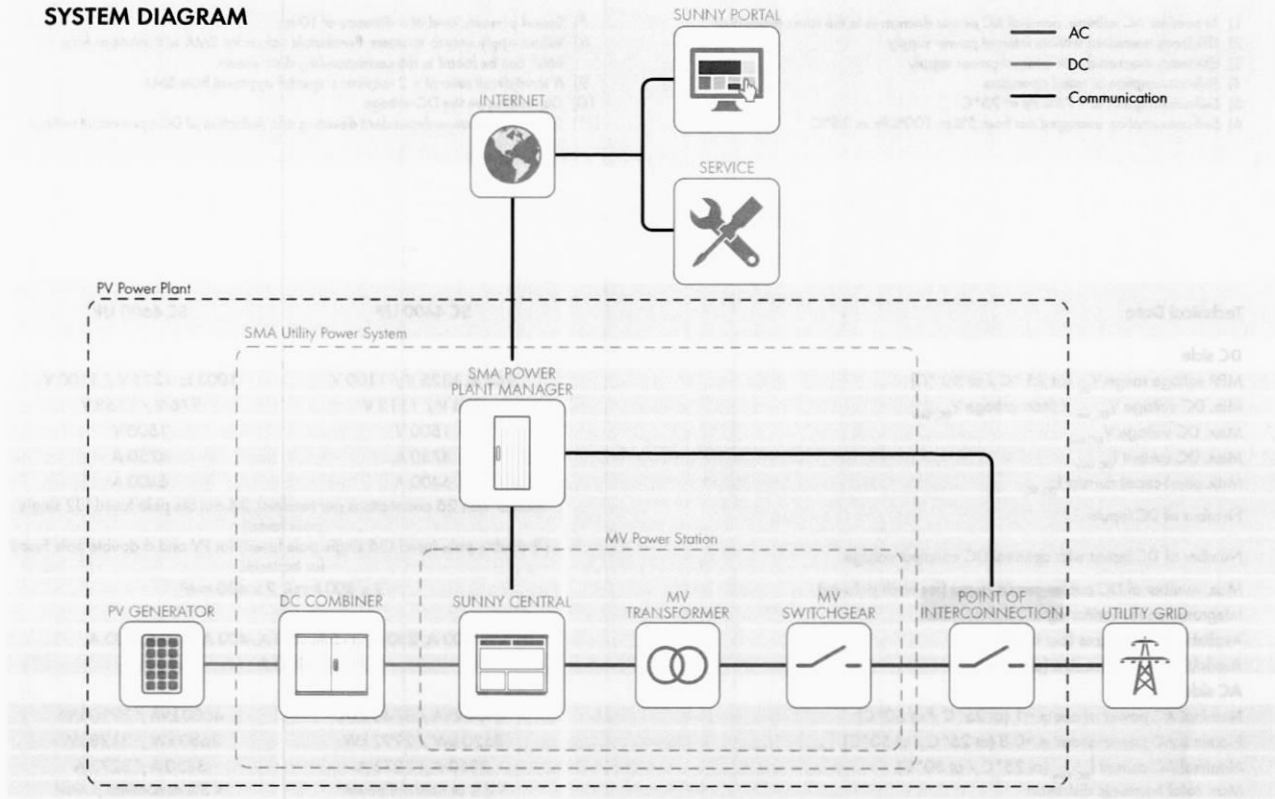
IEC 55011, FCC Part 15 Class A

VDI/VDE 2862 page 2, DIN EN ISO 9001

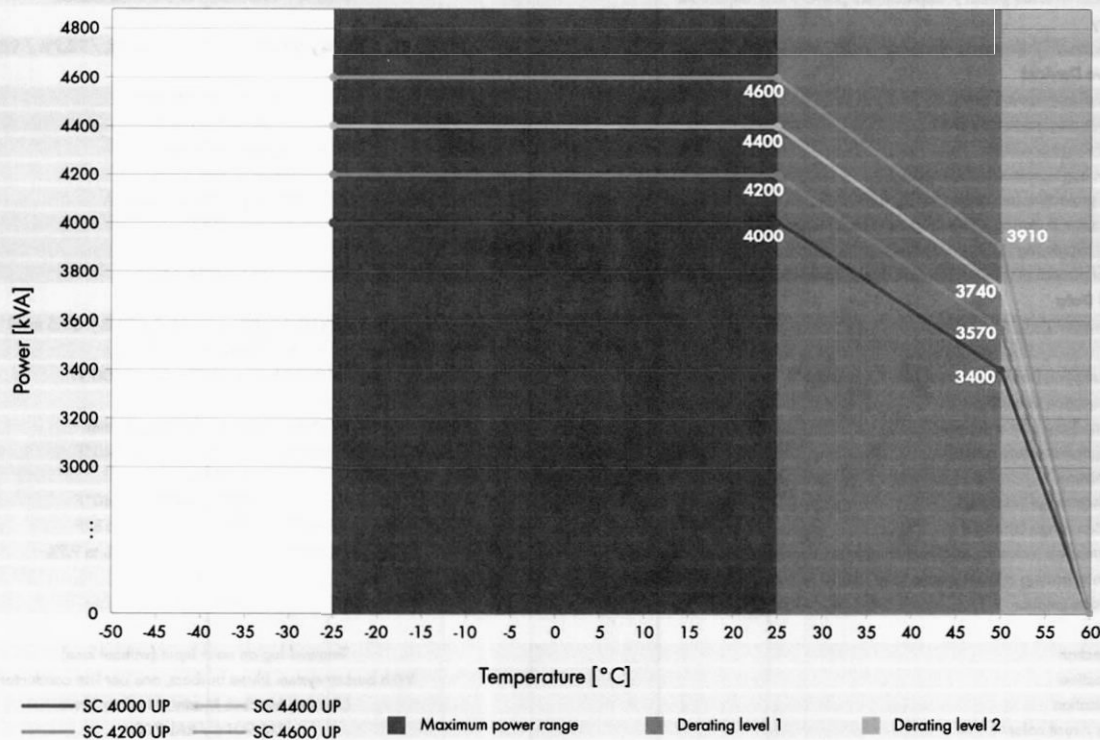
SC 4400 UP

SC 4600 UP

SYSTEM DIAGRAM

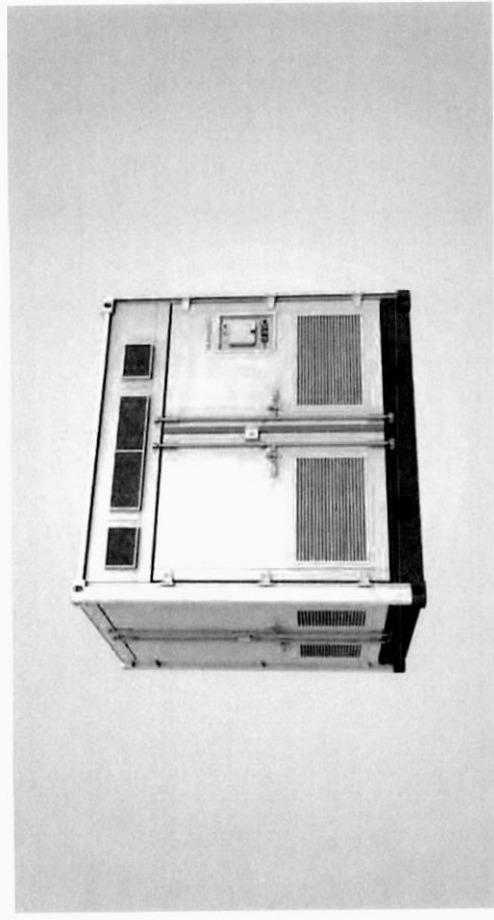


TEMPERATURE BEHAVIOR (at 1000 m)



SG3150U/SG2500U New

Turnkey Station for North America 1500 Vdc System



EASY O&M

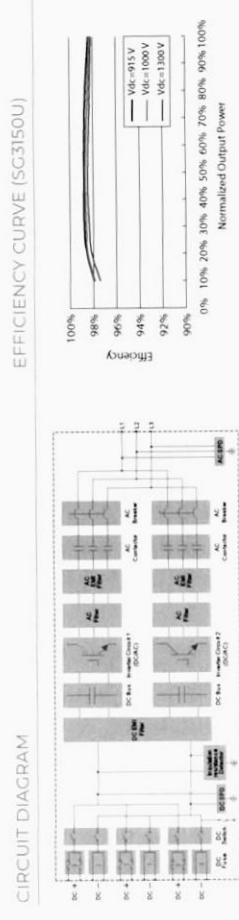
- Integrated current and voltage monitoring function for online analysis and fast trouble shooting
- Modular design, easy for maintenance
- Convenient external LCD

SAVED INVESTMENT

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

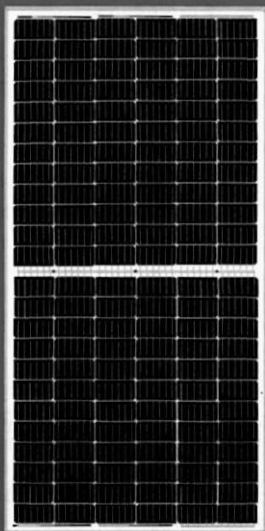
GRID SUPPORT

- 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



Type designation	SG3150U	SG2500U
Input (DC)		
Max. PV input voltage	1500V	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	1
No. of DC inputs	18 ~ 24	18 ~ 21
Max. PV input current	3420 A	3508 A
Max. DC short-circuit current	4800 A	4800 A
Output (AC)		
AC output power	3150 kVA @ 45 °C (115 °F)	2750 kVA @ 45 °C (115 °F) / 2500 kVA @ 50 °C (122 °F)
Max. AC output current	2886 A	2886 A
Nominal AC voltage	630 V	550 V
AC voltage range	554 ~ 690 V	484 ~ 605 V
Nominal grid frequency / Grid frequency range	60 Hz / 55 ~ 65 Hz	60 Hz / 55 ~ 65 Hz
THD	< 3 % (at nominal power)	< 3 % (at nominal power)
DC current injection	< 0.5 % of nominal output current	< 0.5 % of nominal output current
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading	> 0.99 / 0.8 leading
Feed in phases / Connection phases	3 / 3	3 / 3
Efficiency		
Max. efficiency	98.8 %	98.8 %
CEC efficiency	98.5 %	98.5 %
Protection		
DC input protection	Load break switch + fuse	Load break switch + fuse
AC output protection	Circuit breaker	Circuit breaker
Overvoltage protection	DC Type II / AC Type II	DC Type II / AC Type II
Grid monitoring / Ground fault monitoring	Yes / Yes	Yes / Yes
Insulation monitoring	Optional	Optional
Q at night function	Optional	Optional
Overheat protection	Yes	Yes
General Data		
Dimensions (W*H*D)	2991*2896*7438 mm (117.8" * 114.0" * 96.0")	2991*2896*7438 mm (117.8" * 114.0" * 96.0")
Weight	6.9 t (15219 lbs)	6.9 t (15219 lbs)
Isolation method	Transformerless	Transformerless
Degree of protection	NEMA 3R	NEMA 3R
Auxiliary power supply	120 Vac, 5 kVA / Optional 480 Vac, 30 kVA	120 Vac, 5 kVA / Optional 480 Vac, 30 kVA
Operating ambient temperature range	30 to 60 °C (> 45 °C derating) / 22 to 140 °F (> 122 °F derating)	30 to 60 °C (> 50 °C derating) / 22 to 140 °F (> 122 °F derating)
Allowable relative humidity range (non-condensing)	0 ~ 95 %	0 ~ 95 %
Cooling method	Temperature controlled forced air cooling	Temperature controlled forced air cooling
Max. operating altitude	4000 m (> 2000 m derating) (13123 ft (> 6563 ft derating))	4000 m (> 2000 m derating) (13123 ft (> 6563 ft derating))
Display	Touch screen	Touch screen
Communication	Standard RS485, Ethernet, Optional optical fiber	Standard RS485, Ethernet, Optional optical fiber
Compliance	UL 1741, IEEE 1547, UL 1741 SA, NEC 2014 / 2017, CSA C22.2 No.107.1.01	UL 1741, IEEE 1547, UL 1741 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	L/HVRT, L/HFRT, active & reactive power control and power ramp rate control
	Volt. var. / Frequency watt	Volt. var. / Frequency watt

Representative Solar PV Panels

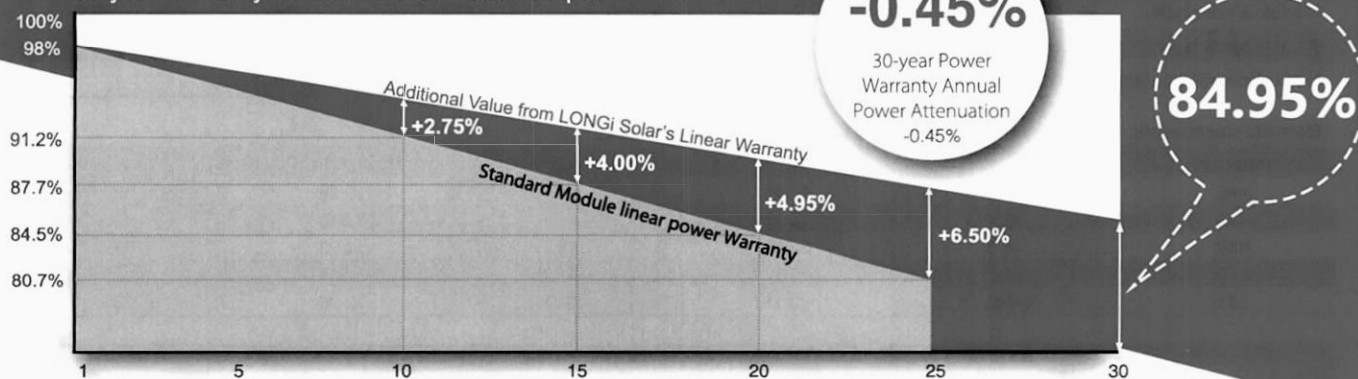


LR4-72HBD 425~445M

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

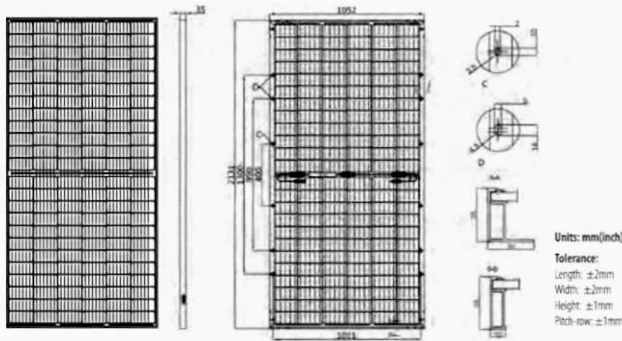
LONGi

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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.

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°C ~ +85°C
 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°C
 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°C, Spectra at AM1.5

NOCT (Nominal Operating Cell Temperature): Irradiance 800W/m², Ambient Temperature 20°C, 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)

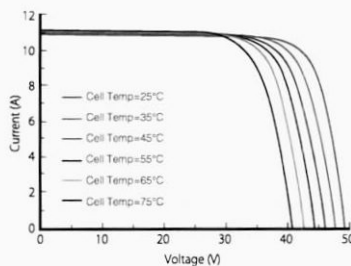
Temperature Coefficient of Isc	+0.060%/°C
Temperature Coefficient of Voc	-0.300%/°C
Temperature Coefficient of Pmax	-0.370%/°C

Mechanical Loading

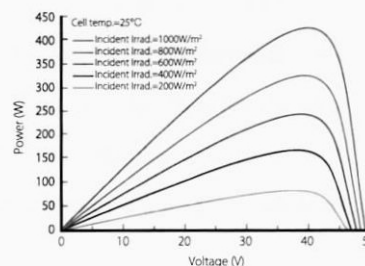
Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

I-V Curve

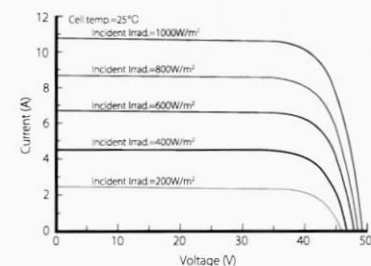
Current-Voltage Curve (LR4-72HBD-425M)



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



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



LONGI

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.



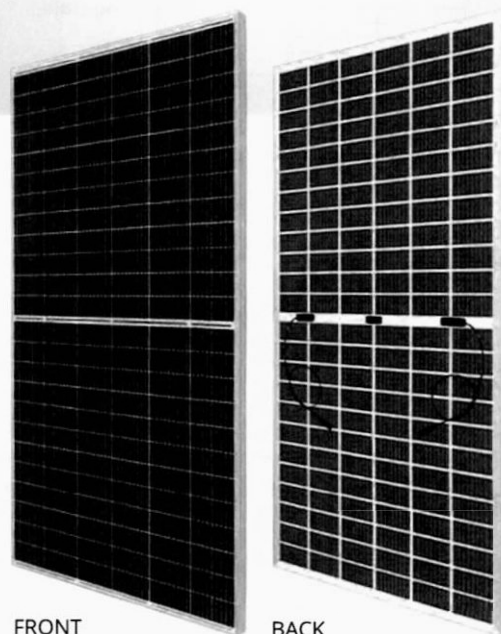
BiHiKu

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



FRONT

BACK

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.

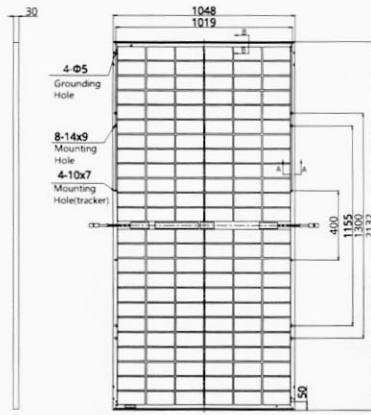
* For detailed information, please refer to Installation Manual.

CANADIAN SOLAR (USA), INC.

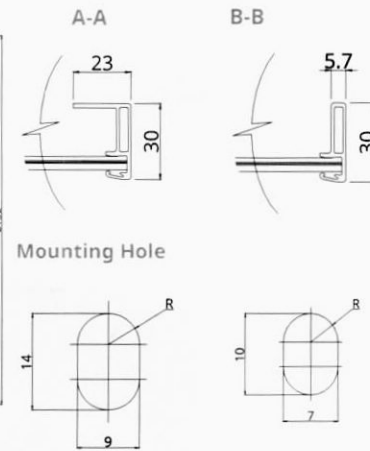
3000 Oak Road, Suite 400, Walnut Creek, CA 94597, USA | www.canadiansolar.com/na | sales.us@canadiansolar.com

ENGINEERING DRAWING (mm)

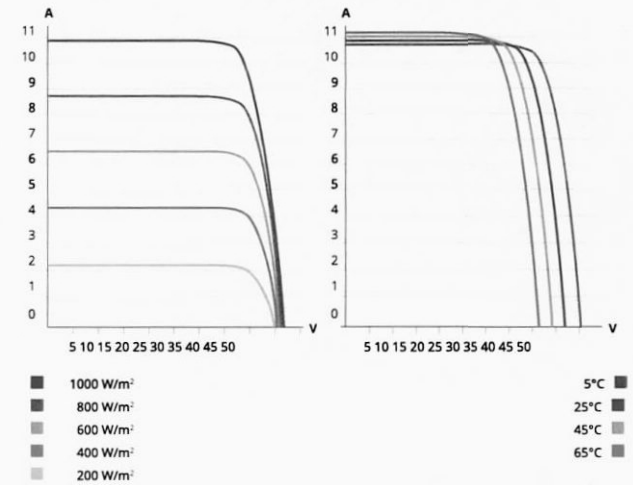
Rear View



Frame Cross Section



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 = $P_{max, rear} / P_{max, front}$ both $P_{max, rear}$ and $P_{max, front}$ are tested under STC, Bifaciality Tolerance: $\pm 5 \%$

* 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 x 1048 x 30 mm (83.9 x 41.3 x 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 mm² (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



Harvest the Sunshine

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

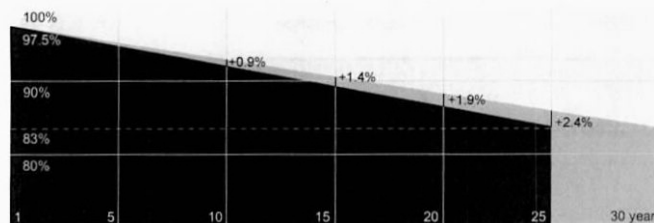


Lower temperature coefficient

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



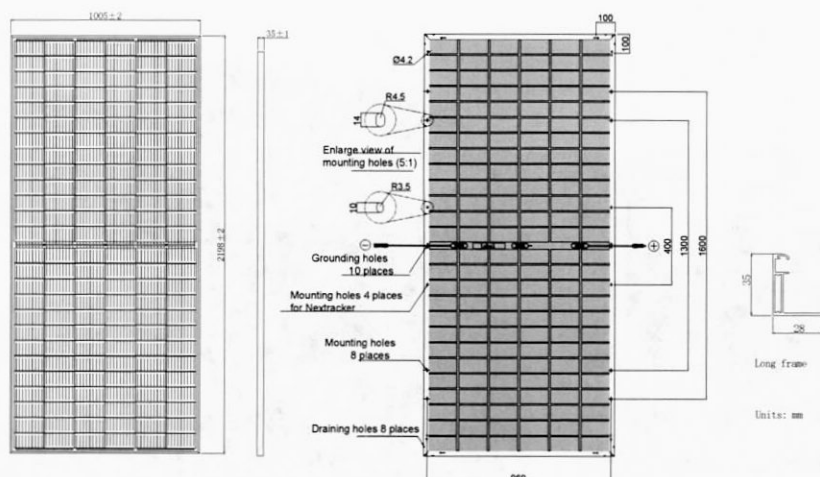
JASOLAR

www.jasolar.com

Specifications subject to technical changes and tests.
JA Solar reserves the right of final interpretation.



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(REFRENCE TO 435W FRONT)

Backside Power Gain	5%	10%	15%	20%	25%
Rated Max Power(Pmax) [W]	457	479	500	522	544
Open Circuit Voltage(Voc) [V]	53.60	53.60	53.60	53.70	53.70
Max Power Voltage(Vmp) [V]	44.35	44.35	44.35	44.45	44.45
Short Circuit Current(Isc) [A]	10.82	11.33	11.85	12.36	12.88
Max Power Current(Imp) [A]	10.30	10.79	11.28	11.74	12.23

*For NexTracker installations, Maximum Static Load.Front is 1800Pa while Maximum Static Load.Back is 1800Pa

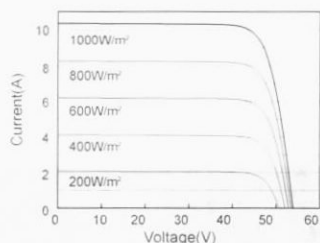
$$^{**}\text{Bifaciality} = P_{\text{max, rear}} / \text{Rated } P_{\text{max, front}}$$

OPERATING CONDITIONS

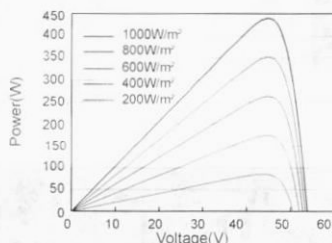
Maximum System Voltage	1500V DC(UL)
Operating Temperature	-40℃~+85℃
Maximum Series Fuse	20A
Maximum Static Load, Front*	5400Pa(112 lb/ft²)
Maximum Static Load, Back*	2400Pa(50 lb/ft²)
NOCT	45±2℃
Bifaciality**	70%±5%
Fire Performance	UL Type 29

CHARACTERISTICS

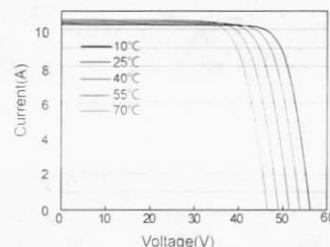
Current-Voltage Curve JAM78D10-440/MB



Power-Voltage Curve JAM78D10-440/MB



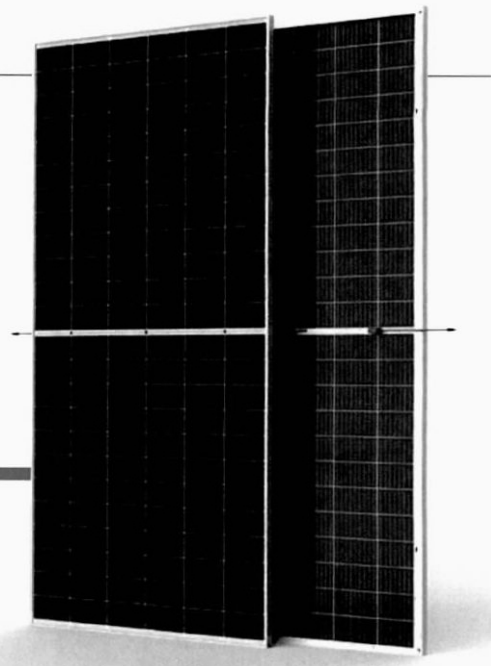
Current-Voltage Curve JAM78D10-440/MB



THE DRAFT

DUOMAX^{tw}

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

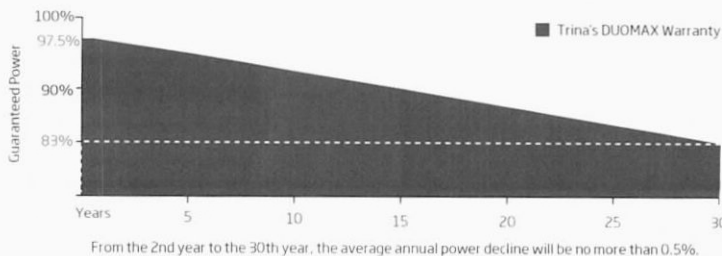
- Up to 25% additional power gain from back side, depending on the albedo
- Excellent 3rd party validated IAM and low light performance with cell process and module material optimization
- Low temp coefficient (-0.35%) and NMOT increases energy production
- Better anti-shading performance and lower operating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



Easy to install, wide application

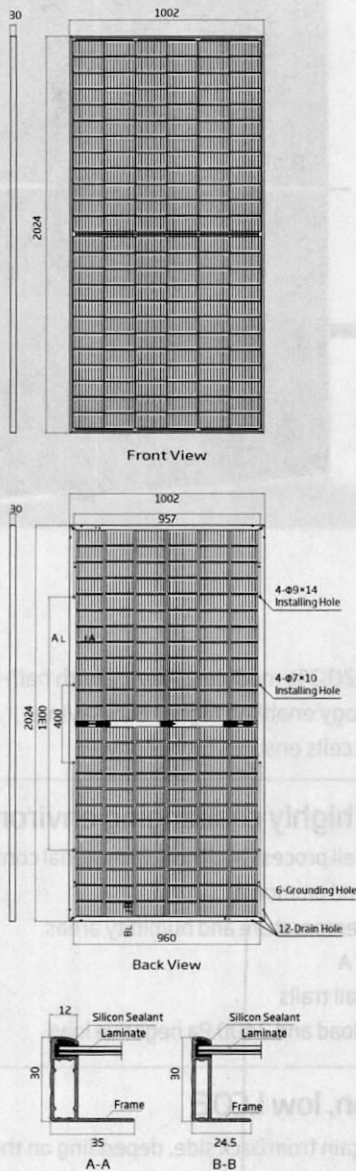
- Frame design enables compatibility with standard installation methods
- Deployable for ground mounted utility, carports, and agricultural projects
- Safe and easy to transport, handle, and install like normal framed modules

Trina Solar's DUOMAX Performance Warranty

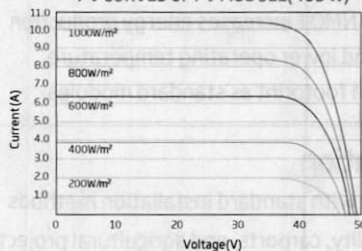


Trina solar

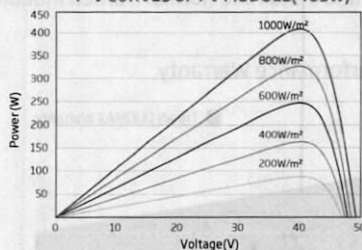
DIMENSIONS OF PV MODULE (mm)



I-V CURVES OF PV MODULE(405 W)



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 mm² (0.006 inches²) 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)

MAXIMUM RATINGS

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

WARRANTY

10 year Product Workmanship Warranty
 30 year Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

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

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



First Solar Series 6™

NEXT GENERATION THIN FILM SOLAR TECHNOLOGY

MODULE DATASHEET

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.



420-445 Watts
17%+ Efficiency



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



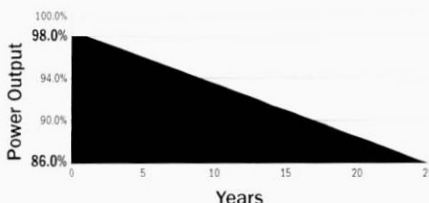
INNOVATIVE MODULE DESIGN

- 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)†

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 Power³ (-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)	1500⁵					
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)†

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

MECHANICAL DESCRIPTION

Length	2009mm
Width	1232mm
Thickness	49mm
Area	2.47m²
Module Weight	36kg
Leadwire⁶	2.5mm², 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 Rating⁷	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

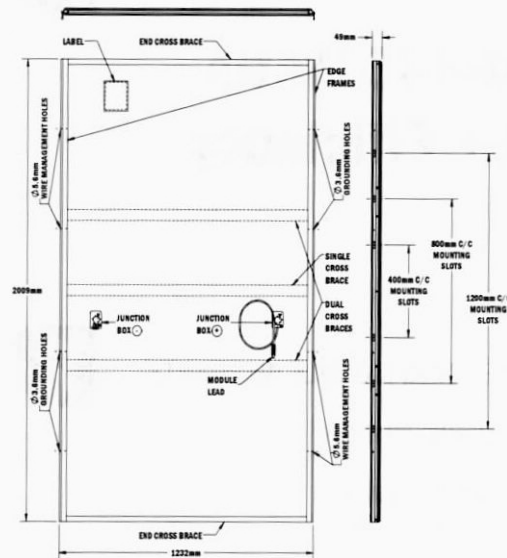
ANSI/CAN/CSA-C450-18
Long-Term Sequential
Thresher Test
PID Resistant

QUALITY & EHS

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



MECHANICAL DRAWING



Install in portrait only

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

QUANTUM DUO

Q.PEAK DUO L-G8.2

415-430

ENDURING HIGH
PERFORMANCE



QUANTUM TECHNOLOGY: LOW WASTE AND 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 TESSING & DYEING
Optima yields, whatever the weather with excellent
low light and temperature behaviour.



ENCLOSING HIGH PERFORMANCE
Long-term yield security with Axi UO Technology, Axi R.O.
Technology, Hot-Spot Protect and Texas Instruments Quality. The QM



EXTREME WEATHER RATED
High-tech aluminum alloy frame, certified for
high winds (5400fpm) and wind loads (24.00psf)

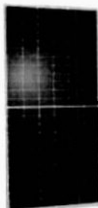


A **WILLIAMS** commitment
includes 12-year product warranty and 20-year
linear performance warranty*



STATE OF THE ART IN COOL TECHNOLOGY
Q-ANTUM DUO combines cutting edge cell separation
and innovative 12-tubular design with Q-ANTUM Technology.

² See also <http://www.fishbase.org> for further information.



THE IDEAL SOLUTION FOR:



Learning objectives
comprehensive individual
feedback

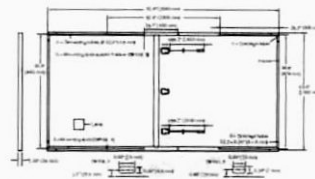


100% **RECYCLED**
 WITH **NO ADDED**
 CHEMICALS

Engineered in Germany

MECHANICAL SPECIFICATION

Format	81.9in x 60.6in x 1.38in (including frame) (2080mm x 1539mm x 35mm)
Weight	55.1lbs (25.0kg)
Front Cover	0.13in (3.2mm) thermally pre-stressed glass with anti-reflection technology
Back Cover	Composite film
Frame	Anodized aluminum
Cell	6 x 24 monocrystalline Q.ANTUM solar half cells
Junction Box	2.09 x 9.6in x 1.26 x 3.36in x 0.59 x 0.71in (53.10mm x 30.60mm x 15.18mm, IP67 with bypass diodes)
Cable	4mm ² Solar cable (V) x 55.1in (1.400mm) (V) x 55.1in (1.400mm)
Connector	Stäubli MC4-Evo2, Harsco Q CELLS HQ04, Amphion UTX, Seattle OS-B, JMT-HY, AMGLA, Tongsheng Cables 7-IP68 or French PV26-IP67



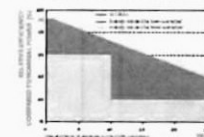
ELECTRICAL CHARACTERISTICS

POWER CLASS	415	420	425	430
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC* (POWER TOLERANCE: ±5W/-0W)				
Power at MPP	P_{MPP} [W]	415	420	425
Short Circuit Current ¹	I_{SC} [A]	10.69	10.74	10.83
Open Circuit Voltage ¹	V_{OC} [V]	48.59	48.64	49.09
Current at MPP	I_{MPP} [A]	10.16	10.22	10.31
Voltage at MPP	V_{MPP} [V]	40.77	41.68	41.38
Efficiency ¹	η [%]	≥19.4	≥19.6	≥19.6
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT ²				
Power at MPP	P_{MPP} [W]	310.8	314.5	318.3
Short Circuit Current ¹	I_{SC} [A]	8.61	8.65	8.72
Open Circuit Voltage ¹	V_{OC} [V]	45.82	46.05	46.29
Current at MPP	I_{MPP} [A]	8.01	8.05	8.08
Voltage at MPP	V_{MPP} [V]	38.79	39.09	39.38

*Measurements conducted at $P_{MPP} \pm 2\%$, $I_{SC} \pm 5\%$ at STC 1000W/m², 25±2°C, AM1.5 according to IEC 60904-3 + 1000W/m², NMOT: minimum AM1.5

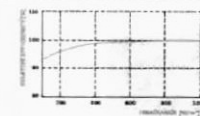
Q CELLS PERFORMANCE WARRANTY

PERFORMANCE AT LOW IRRADIANCE



At least 95% of nominal power during two year. Therefore max. 0.24% degradation per year. At least 90% of nominal power up to 10 years. At least 85% of nominal power up to 25 years.

All data within measurement tolerance. Full warranty in accordance with the warranty terms of the Q CELLS sales organization of your respective country.



Typical module performance under the irradiance conditions in comparison to STC conditions (25°C, 1000W/m²)

TEMPERATURE COEFFICIENTS

Temperature Coefficient of I_{SC}	β [%/K]	-0.04	Temperature Coefficient of V_{OC}	β [%/K]	-0.27
Temperature Coefficient of P_{MPP}	γ [%/K]	-0.35	Normal Module Operating Temperature	NMOT [°C]	109±5.4 (K ₅ ± 3°C)

PROPERTIES FOR SYSTEM DESIGN

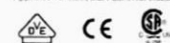
Maximum System Voltage V_{sys}	[V]	1500 (IEC) / 1500 (UL)	Safety Class	II
Maximum Series Fuse Rating	[A DC]	20	Fine Rating based on IEC 60361 / UL 1703	C (IEC) / TYPE I (UL)
Max. Design Load, Pull/Push ¹	[N]	75 (9600lb) / 75 (1600lb)	Permitted Module Temperature on Continuous Duty	-40°F up to +145°F (-40°C up to +65°C)
Max. Tensile Load, Pull/Push ¹	[N]	113 (2500lb) / 50 (1100lb)		

¹See installation manual.

QUALIFICATIONS AND CERTIFICATES

PACKAGING INFORMATION

UL 1703, CE-compliant, IEC 61215/IEC 61730-2016, Approbation Class II, U.S. Patent No. 9,893,215 (solar only)



Number of Modules per Pallet	29
Number of Pallets per 53'FT Trailer	26
Number of Pallets per 40'HC Container	22
Pallet Dimensions (L x W x H)	84.6 x 45.5 x 48.0 in (2150 x 1150 x 1200mm)
Pallet Weight	1717lbs (779kg)

Note: Installation instructions must be followed. See the installation and operating manual or contact our technical service department for further information on approved installation and use of this product.

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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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+1 855.TRACKPV (872.2578)
+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.

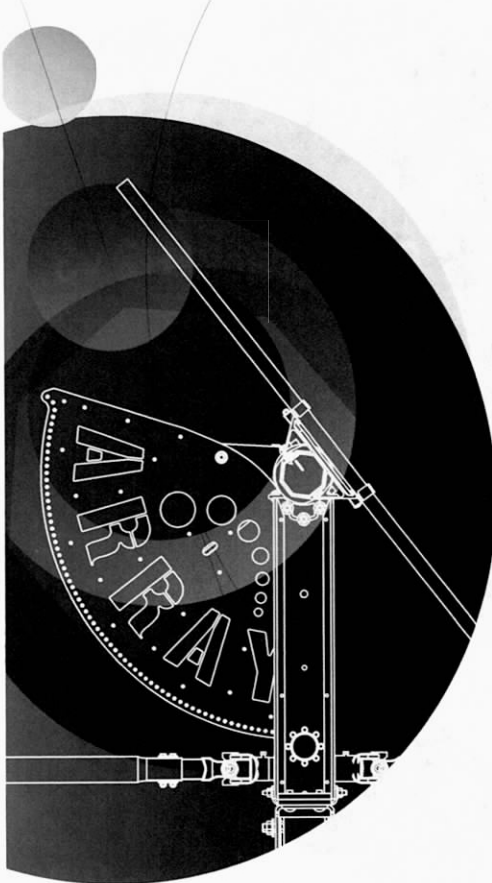
Less is more. Array was founded on a philosophy of engineered simplicity. Minimizing potential failure points (167 times fewer components than competitors), DuraTrack HZ v3 consistently delivers higher reliability and superior uptime.

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





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 Bi-facial 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



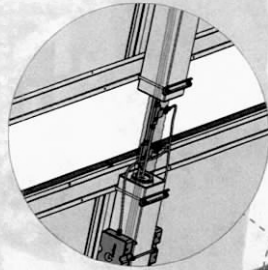
3rd party independent engineering B&V data-validation letter available upon request.

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.

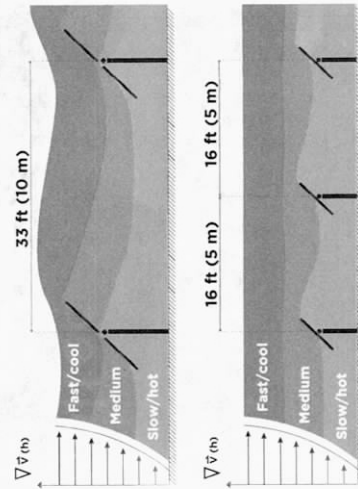
✓ **83% Total wire reduction**

✓ **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



Taller Tracker

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

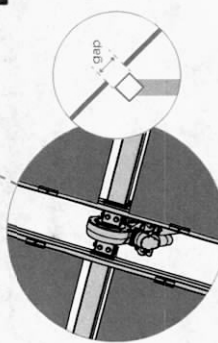
Only 7 piles every 90 modules

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.

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



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



VOYAGER

FTCSOLAR
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

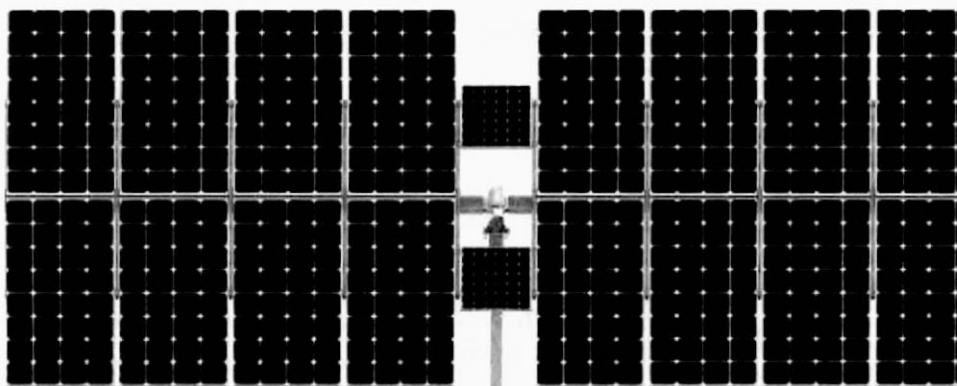
- Up to 0.5% yield improvement due to less backside shading and better albedo capture

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



FTCSOLAR
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

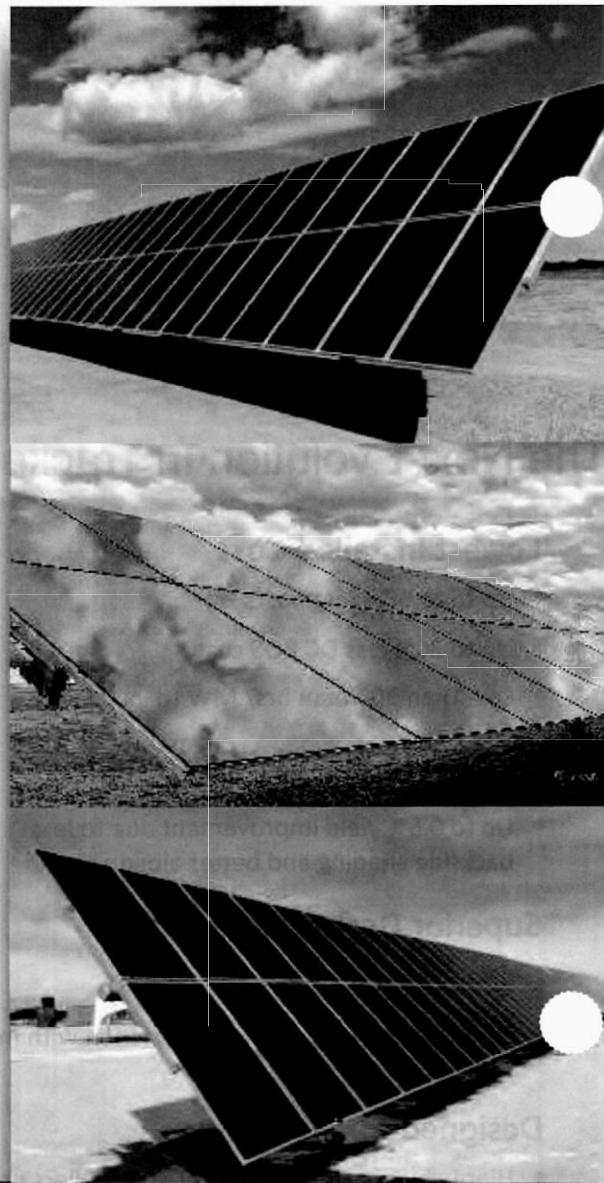
VOYAGER TRACKER

PRODUCT

Module Configuration	- 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	- 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



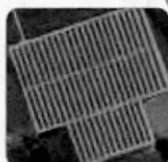
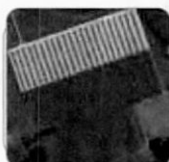
VOYAGER CONTROLLER:

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

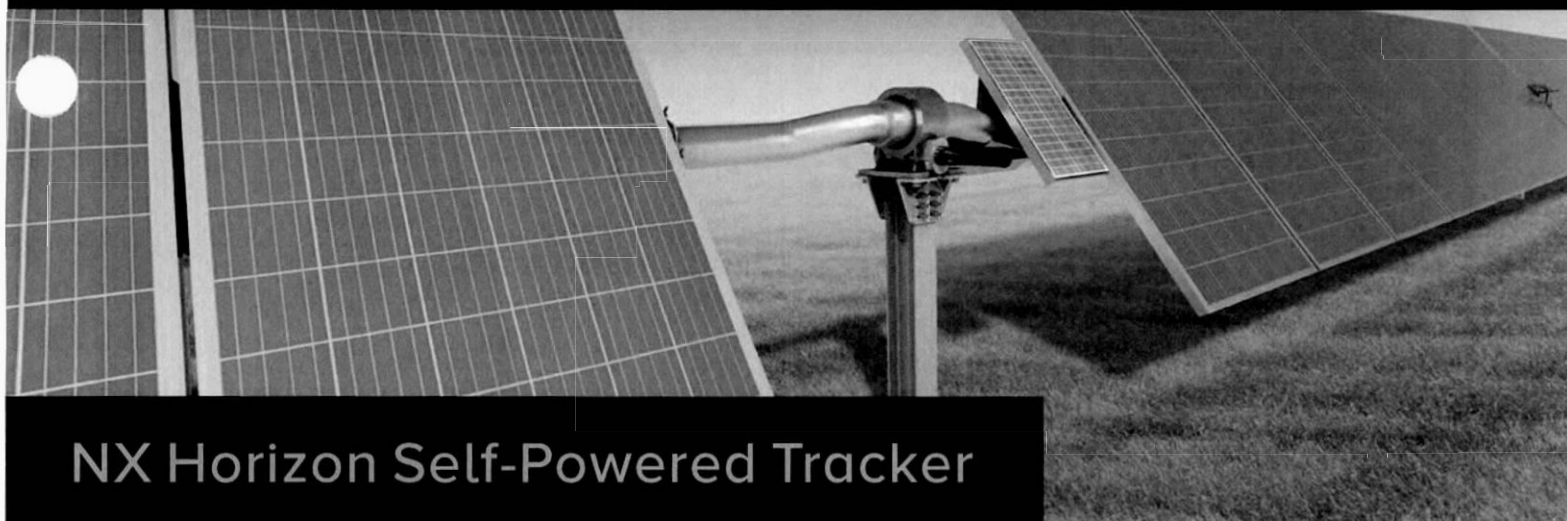
Site wind and temperature data available for site monitoring. Additional environmental sensors available.

FTC SOLAR

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



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

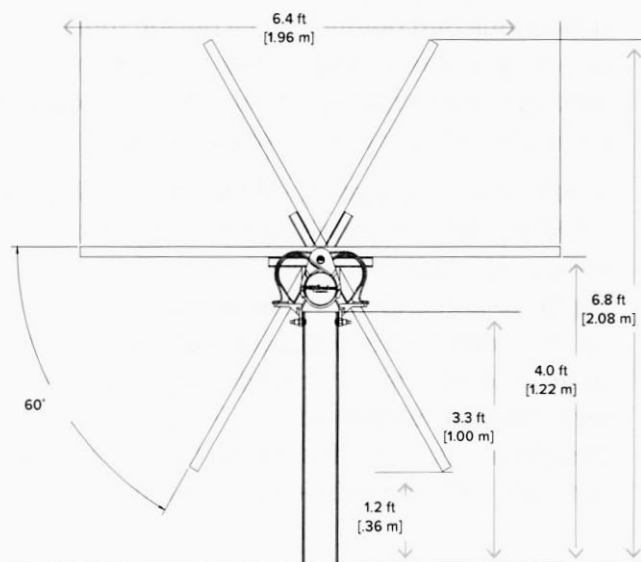
on the array, protecting the PV modules in harsh environments. NX Horizon solar trackers also have a mechanically balanced row design that aligns PV panels with the tracker's axis of rotation – which greatly reduces row torque, using less energy from the motor to track throughout the day.

- 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° (± 60°)
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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