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CHRISTINE M.T. PIRIK
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July 31, 2018

Ms. Barcy F. McNeal, Secretary
Ohio Power Siting Board
Docketing Division
180 East Broad Street, 11th Floor
Columbus, Ohio 43215-3793

**Re: Case No. 17-774-EL-BGN, In the Matter of the Application of Vinton Solar Energy LLC for a Certificate of Environmental Compatibility and Public Need to Construct a Solar-Powered Electric Generation Facility in Vinton County, Ohio.**

**Release of Exhibit A, and Portions of Exhibits B and J to the Public Record**

Dear Ms. McNeal:

On July 5, 2017, Vinton Solar Energy LLC ("Applicant") filed an application for a certificate to construct a solar-powered electric generation facility in Vinton County, Ohio ("Application"). In addition, the Applicant filed a motion requesting a protective order covering the following: the financial narrative at pages 29-31 of the Application; Exhibits A and B containing the module and inverter specifications; and Exhibit J, the Certificate of Insurance Liability.

Subsequently, it was determined that Exhibit A, the vast majority of Exhibit B, and portions of Exhibit J should be released into the public record. Therefore, consistent with the amended motion of protective order filed today in this docket, the Applicant is now filing in the open record: Exhibit A; the vast majority of the documents in Exhibit B, with the exception of Item 5; and Exhibit J, with the policy numbers and certificate number redacted.

We are available, at your convenience, to answer any questions you may have.

Respectfully submitted,

/s/ *Christine M.T. Pirik*
Christine M.T. Pirik
William V. Vorys
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215

***Attorneys for Applicant Vinton Solar Energy LLC***

Enclosure

**CERTIFICATE OF SERVICE**

The Ohio Power Siting Board's e-filing system will electronically serve notice of the filing of this document on the parties referenced in the service list of the docket card who have electronically subscribed to this case. In addition, the undersigned certifies that a copy of the foregoing document is also being served upon the person below via electronic mail this 31st day of July, 2018.

*/s/ Christine M.T. Pirik*
Christine M.T. Pirik (0029759)

Counsel:

john.jones@ohioattorneygeneral.gov
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lcurtis@ofbf.org
amilam@ofbf.org

Administrative Law Judge:

Jay.agranoff@puco.ohio.gov

COLUMBUS 39579-29 94607v2

# Exhibit A

# 1) Jinko Solar Multi Module

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
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***Attorneys for Vinton Solar Energy LLC***

www.jinkosolar.com

Building Your Trust in Solar

# EAGLE 72

## *310-330 Watt*

POLYCRYSTALLINE MODULE

***1500V Available**

Positive power tolerance of 0/+3%

## KEY FEATURES

**High Voltage**
1000V standard; 1500V option lowers BOS costs and yields better LCOE

**Innovative Solar Cells**
Four busbar cell technology improves module efficiency

**PID-Free**
World's 1st PID-Free module at 85℃/85%RH

**Low-Light Performance**
New glass technology improves light absorption and retention

**Strength and Durability**
Certified for high snow (5400Pa) and wind (2400Pa) loads

**Weather Resistance**
Certified for salt mist and ammonia resistance

- ISO9001:2008 Quality Standards
- ISO14001:2004 Environmental Standards
- OHSAS18001 Occupational Health & Safety Standards

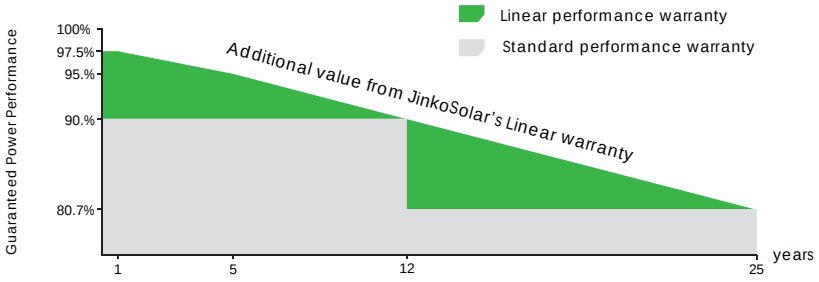
Nomenclature:

JKM320PP - 72 -

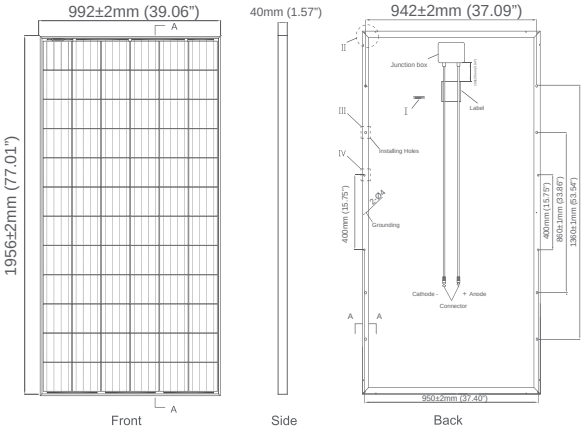
| Code | Certification |
|---|---|
| null | 1000V |
| V | 1500V |

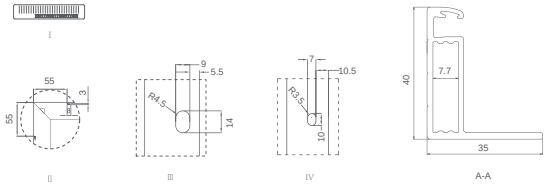
## LINEAR PERFORMANCE WARRANTY

**10 Year Product Warranty • 25 Year Linear Power Warranty**



## Engineering Drawings



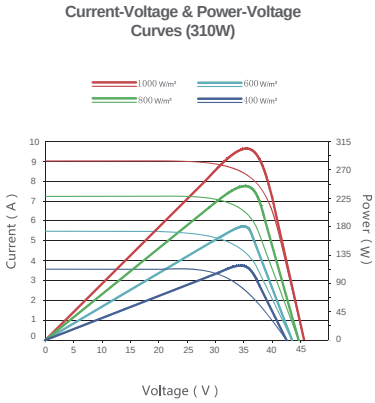



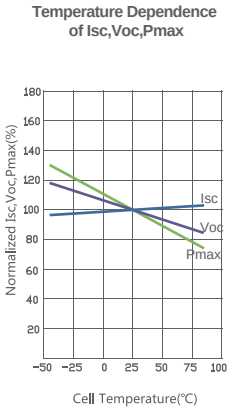
## Packaging Configuration

( Two boxes =One pallet )

25pcs/ box, 50pcs/pallet, 600pcs/40'HQ Container

## Electrical Performance & Temperature Dependence




## Mechanical Characteristics

| | |
|---|---|
| Cell Type | Poly-crystalline 156×156mm (6 inch) |
| No.of cells | 72 (6×12) |
| Dimensions | 1956×992×40mm (64.97×39.06×1.57 inch) |
| Weight | 26.5 kg (58.4 lbs.) |
| Front Glass | 4.0mm, High Transmission, Low Iron, Tempered Glass |
| Frame | Anodized Aluminium Alloy |
| Junction Box | IP67 Rated |
| Output Cables | 12 AWG, Length:1200mm (47.24 inch) |
| Fire Type | Type 1 |

## SPECIFICATIONS

| Module Type | JKM310PP-V | | JKM315PP-V | | JKM320PP-V | | JKM325PP-V | | JKM330PP-V | |
|---|---|---|---|---|---|---|---|---|---|---|
| | STC | NOCT | STC | NOCT | STC | NOCT | STC | NOCT | STC | NOCT |
| Maximum Power (Pmax) | 310Wp | 231Wp | 315Wp | 235Wp | 320Wp | 238Wp | 325Wp | 242Wp | 330Wp | 246Wp |
| Maximum Power Voltage (Vmp) | 37.0V | 33.9V | 37.2V | 34.3V | 37.4V | 34.7V | 37.6V | 35.0V | 37.8V | 35.3V |
| Maximum Power Current (Imp) | 8.38A | 6.81A | 8.48A | 6.84A | 8.56A | 6.86A | 8.66A | 6.91A | 8.74A | 6.97A |
| Open-circuit Voltage (Voc) | 45.9V | 42.7V | 46.2V | 43.2V | 46.4V | 43.7V | 46.7V | 44.0V | 46.9V | 44.2V |
| Short-circuit Current (Isc) | 8.96A | 7.26A | 9.01A | 7.29A | 9.05A | 7.30A | 9.1A | 7.34A | 9.14A | 7.38A |
| Module Efficiency STC (%) | 15.98% | | 16.23% | | 16.49% | | 16.75% | | 17.01% | |
| Operating Temperature(℃) | -40℃~+85℃ | | | | | | | | | |
| Maximum system voltage | 1500VDC (UL) | | | | | | | | | |
| Maximum series fuse rating | 15A | | | | | | | | | |
| Power tolerance | 0~+3% | | | | | | | | | |
| Temperature coefficients of Pmax | -0.40%/℃ | | | | | | | | | |
| Temperature coefficients of Voc | -0.30%/℃ | | | | | | | | | |
| Temperature coefficients of Isc | 0.06%/℃ | | | | | | | | | |
| Nominal operating cell temperature (NOCT) | 45±2℃ | | | | | | | | | |

STC: Irradiance 1000W/m² Cell Temperature 25°C AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM=1.5 Wind Speed 1m/s

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

# Exhibit A

# 2) Jinko Solar Mono Module

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
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wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

www.jinkosolar.com

(PRELIMINARY VERSION)

# Eagle PERC 72

## *335-355 Watt*

MONO CRYSTALLINE MODULE

Positive power tolerance of 0 ~+3%

PERC

(4BB)

## KEY FEATURES

**High Efficiency:**
Higher module conversion efficiency(up to 18.30%) benefit from Passivated Emmiter Rear Contact (PERC) technology

**High Voltage**
1000V standard; 1500V option lowers BOS costs and yields better LCOE

**PID-Free**
World's 1st PID-Free module at 85℃/85%RH

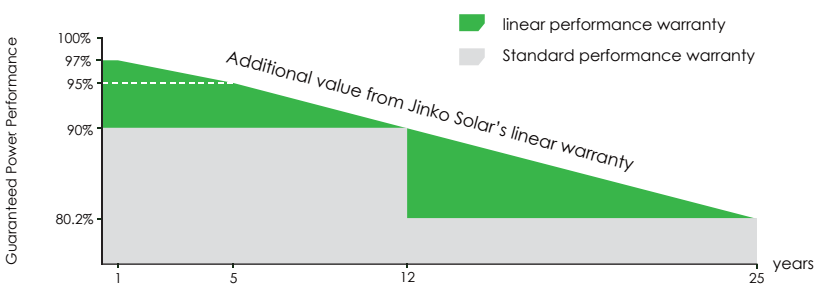
**Low-light Performance:**
Advanced glass and solar cell surface texturing allow for excellent performance in low-light environments

**Strength and Durability**
Certified for high snow (5400Pa) and wind (2400Pa) loads

**Weather Resistance**
Certified for salt mist and ammonia resistance

## LINEAR PERFORMANCE WARRANTY

**10 Year Product Warranty • 25 Year Linear Power Warranty**




- ISO9001:2008 Quality Standards
- ISO14001:2004 Environmental Standards
- OHSAS18001 Occupational Health & Safety Standards

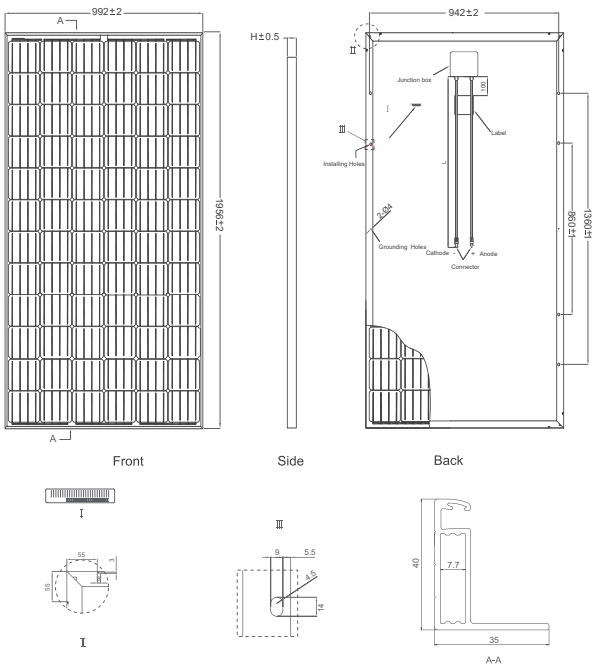
Nomenclature:

JKM355M - 72 - T

| Code | Certification |
|---|---|
| null | 1000V |
| V | 1500V |

(PRELIMINARY VERSION)

## Engineering Drawings

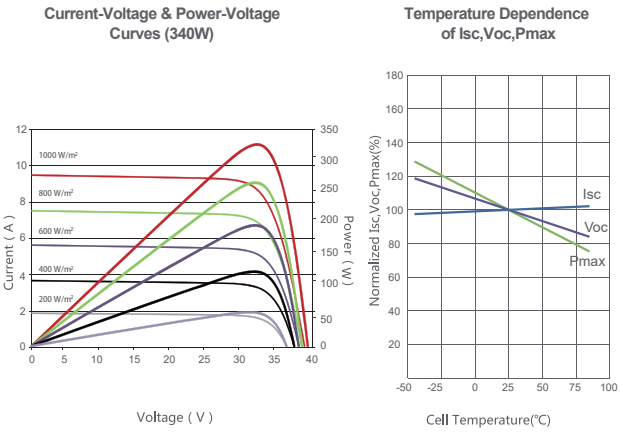



## Packaging Configuration

( Two boxes =One pallet )

25pcs/ box, 50pcs/pallet, 600pcs/40'HQ Container

## Electrical Performance & Temperature Dependence




## Mechanical Characteristics

| | |
|---|---|
| Cell Type | Mono-crystalline PERC 156×156mm (6 inch) |
| No.of cells | 72 (6×12) |
| Dimensions | 1956×992×40mm (64.97×39.06×1.57 inch) |
| Weight | 26.5 kg (58.4 lbs.) |
| Front Glass | 4.0mm, High Transmission, Low Iron, Tempered Glass |
| Frame | Anodized Aluminium Alloy |
| Junction Box | IP67 Rated |
| Output Cables | 12 AWG, Length:1200mm (47.24 inch) |
| Fire Type | Type 1 |

## SPECIFICATIONS

| Module Type | JKM335M-V | | JKM340M-V | | JKM345M-V | | JKM350M-V | | JKM355M-V | |
|---|---|---|---|---|---|---|---|---|---|---|
| | STC | NOCT | STC | NOCT | STC | NOCT | STC | NOCT | STC | NOCT |
| Maximum Power (Pmax) | 335Wp | 250Wp | 340Wp | 254Wp | 345Wp | 258Wp | 350Wp | 262Wp | 355Wp | 266Wp |
| Maximum Power Voltage (Vmp) | 38.1V | 35.8V | 38.3V | 36.0V | 38.5V | 36.2V | 38.7V | 36.4V | 38.9V | 36.6V |
| Maximum Power Current (Imp) | 8.80A | 6.99A | 8.88A | 7.06A | 8.97A | 7.13A | 9.05A | 7.20A | 9.13A | 7.27A |
| Open-circuit Voltage (Voc) | 46.6V | 43.4V | 46.8V | 43.6V | 47.0V | 43.8V | 47.2V | 44.0V | 47.5V | 44.2V |
| Short-circuit Current (Isc) | 9.31A | 7.61A | 9.38A | 7.68A | 9.45A | 7.75A | 9.51A | 7.82A | 9.57A | 7.88A |
| Module Efficiency STC (%) | 17.27% | | 17.52% | | 17.78% | | 18.04% | | 18.30% | |
| Operating Temperature(℃) | -40℃~+85℃ | | | | | | | | | |
| Maximum system voltage | 1500VDC (UL) | | | | | | | | | |
| Maximum series fuse rating | 15A | | | | | | | | | |
| Power tolerance | 0~+3% | | | | | | | | | |
| Temperature coefficients of Pmax | -0.39%/℃ | | | | | | | | | |
| Temperature coefficients of Voc | -0.29%/℃ | | | | | | | | | |
| Temperature coefficients of Isc | 0.05%/℃ | | | | | | | | | |
| Nominal operating cell temperature (NOCT) | 45±2℃ | | | | | | | | | |

STC: Irradiance 1000W/m² Cell Temperature 25°C AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM=1.5 Wind Speed 1m/s

* Power measurement tolerance: ± 3%

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

# Exhibit A

# 3) Hanwha Q Cell Multi Module

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

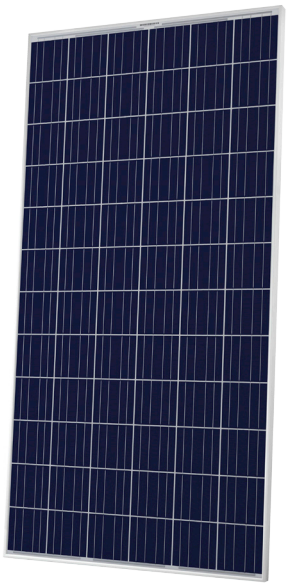
***Attorneys for Vinton Solar Energy LLC***

powered by Q.ANTUM

# Q.PLUS L-G4.2 345-355

## Q.ANTUM SOLAR MODULE

**The Q.ANTUM solar module Q.PLUS L-G4.2 with power classes up to 355 Wp is the strongest module of its type on the market globally. Powered by 72 Q CELLS solar cells Q.PLUS L-G4.2 was specially designed for large solar power plants to reduce BOS costs. Only Q CELLS offers German engineering quality with our unique triple Yield Security.**



### LOW ELECTRICITY GENERATION COSTS

Higher yield per surface area and lower BOS costs thanks to higher power classes and an efficiency rate of up to 18.1 %.

### INNOVATIVE ALL-WEATHER TECHNOLOGY

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

### ENDURING HIGH PERFORMANCE

Long-term yield security with Anti-PID Technology[1], Hot-Spot-Protect and Traceable Quality Tra.Q™.

### EXTREME WEATHER RATING

High-tech aluminum 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 guarantee[2].

EUPD RESEARCH TOP BRAND PV MODULES USA 2016

Q CELLS YIELD SECURITY
- ANTI PID TECHNOLOGY (APT)
- HOT-SPOT PROTECT (HSP)
- TRACEABLE QUALITY (TRA.Q™)

Photon
Q CELLS
Best polycrystalline solar module 2014
Q.PRO-G2 235
174 modules tested

[1] APT test conditions: Cells at -1500 V against grounded, with conductive metal foil covered module surface, 25 °C, 168 h

[2] See data sheet on rear for further information.

### THE IDEAL SOLUTION FOR:

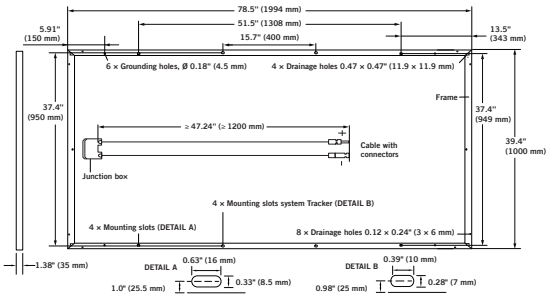
Ground-mounted solar power plants

Engineered in **Germany**

Q CELLS

## MECHANICAL SPECIFICATION

| | |
|---|---|
| **Format** | 78.5 in × 39.4 in × 1.38 in (including frame)<br>(1994 mm × 1000 mm × 35 mm) |
| **Weight** | 52.9 lbs (24 kg) |
| **Front Cover** | 0.13 in (3.2 mm) thermally pre-stressed glass with anti-reflection technology |
| **Back Cover** | Composite film |
| **Frame** | Anodized aluminum |
| **Cell** | 6 × 12 Q.ANTUM solar cells |
| **Junction box** | 3.35-4.37 in × 2.36-3.15 in × 0.59-0.75 in (85-111 × 60-80 × 15-19 mm),<br>Protection class ≥ IP67, with bypass diodes |
| **Cable** | 4 mm² Solar cable; (+) ≥ 47.24 in (1200 mm), (-) ≥ 47.24 in (1200 mm) |
| **Connector** | Amphenol UTX, IP68 |

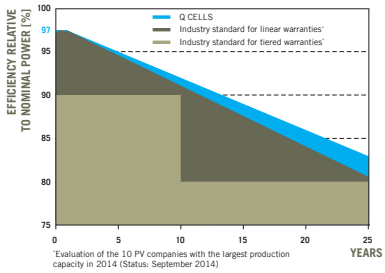



## ELECTRICAL CHARACTERISTICS

| POWER CLASS | | | | 345 | 350 | 355 |
|---|---|---|---|---|---|---|
| **MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / -0 W)** | | | | | | |
| Minimum | **Power at MPP[2]** | $P_{MPP}$ | [W] | 345 | 350 | 355 |
| | **Short Circuit Current*** | $I_{SC}$ | [A] | 9.64 | 9.69 | 9.74 |
| | **Open Circuit Voltage*** | $V_{OC}$ | [V] | 47.46 | 47.71 | 47.97 |
| | **Current at MPP*** | $I_{MPP}$ | [A] | 9.09 | 9.15 | 9.21 |
| | **Voltage at MPP*** | $V_{MPP}$ | [V] | 37.93 | 38.23 | 38.52 |
| | **Efficiency[2]** | η | [%] | ≥ 17.3 | ≥ 17.6 | ≥ 17.8 |
| **MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NOC[3]** | | | | | | |
| Minimum | **Power at MPP[2]** | $P_{MPP}$ | [W] | 255.8 | 259.5 | 263.2 |
| | **Short Circuit Current*** | $I_{SC}$ | [A] | 7.77 | 7.81 | 7.85 |
| | **Open Circuit Voltage*** | $V_{OC}$ | [V] | 44.29 | 44.53 | 44.77 |
| | **Current at MPP*** | $I_{MPP}$ | [A] | 7.14 | 7.19 | 7.24 |
| | **Voltage at MPP*** | $V_{MPP}$ | [V] | 35.83 | 36.10 | 36.36 |

[1] 1000 W/m², 25 °C, spectrum AM 1.5 G [2] Measurement tolerances STC ±3%; NOC ±5% [3] 800 W/m², NOCT, spectrum AM 1.5 G * typical values, actual values may differ

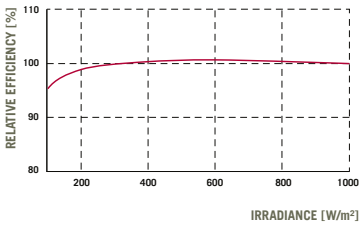
### Q CELLS PERFORMANCE WARRANTY




At least 97 % of nominal power during first year. Thereafter max. 0.6 % degradation per year.
At least 92 % of nominal power up to 10 years.
At least 83 % of nominal power up to 25 years.

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

### PERFORMANCE AT LOW IRRADIANCE




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

### TEMPERATURE COEFFICIENTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Temperature Coefficient of $I_{SC}$** | α | [%/K] | +0.04 | **Temperature Coefficient of $V_{OC}$** | β | [%/K] | −0.29 |
| **Temperature Coefficient of $P_{MPP}$** | γ | [%/K] | −0.40 | **Normal Operating Cell Temperature** | NOCT | [°F] | 113 ± 5.4 (45 ± 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] | 15 | **Fire Rating** | C (IEC) / TYPE 1 (UL) |
| **Design load, push (UL)[2]** | [lbs/ft²] | 75 (3600 Pa) | **Permitted module temperature on continuous duty** | -40 °F up to +185 °F<br>(-40 °C up to +85 °C) |
| **Design load, pull (UL)[2]** | [lbs/ft²] | 33 (1600 Pa) | [2] safety factor of 1.5 included, see installation manual | |

## QUALIFICATIONS AND CERTIFICATES

IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A
This data sheet complies with DIN EN 50380.

C Certified US
UL 1703
(254141)

## PACKAGING INFORMATION

| | |
|---|---|
| **Number of Modules per Pallet** | 29 |
| **Number of Pallets per 53' Container** | 26 |
| **Number of Pallets per 40' Container** | 22 |
| **Pallet Dimensions ( L × W × H )** | 81.3 × 45.3 × 46.9 in<br>(2065 × 1150 × 1190 mm) |
| **Pallet Weight** | 1671 lbs (758 kg) |

**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.

**Hanwha Q CELLS America Inc.**
300 Spectrum Center Drive, Suite 1250, Irvine, CA 92618, USA | **TEL** +1 949 748 59 96 | **EMAIL** inquiry@us.q-cells.com | **WEB** www.q-cells.us

Engineered in **Germany**

# Exhibit A

# 4) Hanwha Q Cell Mono Module

Christine M.T. Pirik (0029759)
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William V. Vorys (0093479)
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Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

Exhibit A 4

DRAFT

# Q.PEAK L-G4.2 360-370

## Q.ANTUM SOLAR MODULE

**The Q.ANTUM solar module Q.PEAK L-G4.2 with power classes up to 370 Wp is the strongest module of its type on the market globally. Powered by 72 Q CELLS solar cells Q.PEAK L-G4.2 was specially designed for large solar power plants to reduce BOS costs. Only Q CELLS offers German engineering quality with our unique Q CELLS Yield Security.**

### LOW ELECTRICITY GENERATION COSTS

Higher yield per surface area and lower BOS costs thanks to higher power classes and an efficiency rate of up to 18.8 %.

### INNOVATIVE ALL-WEATHER TECHNOLOGY

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

### ENDURING HIGH PERFORMANCE

Long-term yield security with Anti-PID Technology[1], Hot-Spot-Protect and Traceable Quality Tra.Q™.

### LIGHT-WEIGHT QUALITY FRAME

High-tech aluminum 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 guarantee[2].

EUPD RESEARCH TOP BRAND PV MODULES EUROPE 2016

Q CELLS YIELD SECURITY
- ANTI PID TECHNOLOGY (APT)
- HOT-SPOT PROTECT (HSP)
- TRACEABLE QUALITY (TRA.Q™)

Photon
Q CELLS
Best polycrystalline solar module 2013
Q.PRO-G2 235
151 modules tested

[1] APT test conditions: Cells at -1500 V against grounded, with conductive metal foil covered module surface, 25 °C, 168 h

[2] See data sheet on rear for further information.

### THE IDEAL SOLUTION FOR:

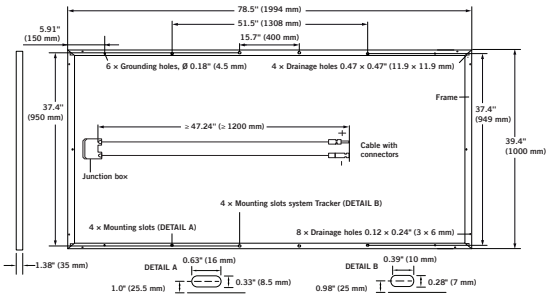
Ground-mounted solar power plants

Engineered in **Germany**

Q CELLS

## MECHANICAL SPECIFICATION

| | |
|---|---|
| **Format** | 78.5 in × 39.4 in × 1.38 in (including frame)<br>(1994 mm × 1000 mm × 35 mm) |
| **Weight** | 52.9 lb (24 kg) |
| **Front Cover** | 0.13 in (3.2 mm) thermally pre-stressed glass with anti-reflection technology |
| **Back Cover** | Composite film |
| **Frame** | Anodised aluminum |
| **Cell** | 6 × 12 Q.ANTUM monocrystalline solar cells |
| **Junction box** | 2.59-3.03 in × 4.37-3.54 in × 0.59-0.71 in (66-77 mm × 111-90 mm × 15-18 mm), Protection class IP67, with bypass diodes |
| **Cable** | 4 mm² Solar cable; (+) ≥ 47.24 in (1200 mm), (-) ≥ 47.24 in (1200 mm) |
| **Connector** | MC4 or MC4 intermateable, IP68 |

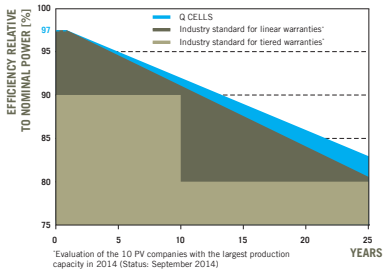



## ELECTRICAL CHARACTERISTICS

| POWER CLASS | | | | 360 | 365 | 370 |
|---|---|---|---|---|---|---|
| **MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / -0 W)** | | | | | | |
| Minimum | **Power at MPP[2]** | $P_{MPP}$ | [W] | 360 | 365 | 370 |
| | **Short Circuit Current*** | $I_{SC}$ | [A] | 9.77 | 9.83 | 9.89 |
| | **Open Circuit Voltage*** | $V_{OC}$ | [V] | 47.71 | 48.00 | 48.28 |
| | **Current at MPP*** | $I_{MPP}$ | [A] | 9.26 | 9.33 | 9.41 |
| | **Voltage at MPP*** | $V_{MPP}$ | [V] | 38.89 | 39.10 | 39.32 |
| | **Efficiency[2]** | η | [%] | ≥ 18.1 | ≥ 18.3 | ≥ 18.6 |
| **MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NOC[3]** | | | | | | |
| Minimum | **Power at MPP[2]** | $P_{MPP}$ | [W] | 266.1 | 269.8 | 273.5 |
| | **Short Circuit Current*** | $I_{SC}$ | [A] | 7.88 | 7.93 | 7.97 |
| | **Open Circuit Voltage*** | $V_{OC}$ | [V] | 44.63 | 44.90 | 45.17 |
| | **Current at MPP*** | $I_{MPP}$ | [A] | 7.27 | 7.34 | 7.40 |
| | **Voltage at MPP*** | $V_{MPP}$ | [V] | 36.59 | 36.77 | 36.94 |

[1] 1000 W/m², 25°C, spectrum AM 1.5 G  [2] Measurement tolerances STC ±3%; NOC ±5%  [3] 800 W/m², NOCT, spectrum AM 1.5 G  * typical values, actual values may differ

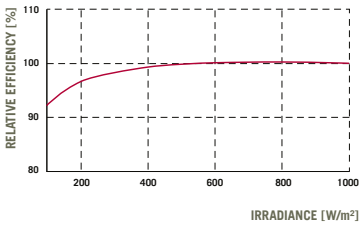
### Q CELLS PERFORMANCE WARRANTY




At least 97 % of nominal power during first year. Thereafter max. 0.6 % degradation per year.
At least 92 % of nominal power after 10 years.
At least 83 % of nominal power after 25 years.

All data within measurement tolerances. Full warranties in accordance with the warranty terms of the Q CELLS sales organisation of your respective country.

### PERFORMANCE AT LOW IRRADIANCE




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

### TEMPERATURE COEFFICIENTS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Temperature Coefficient of $I_{SC}$** | α | [%/K] | +0.04 | **Temperature Coefficient of $V_{OC}$** | β | [%/K] | −0.28 |
| **Temperature Coefficient of $P_{MPP}$** | γ | [%/K] | −0.39 | **Normal Operating Cell Temperature** | NOCT | [°F] | 113 ± 5.4 (45 ± 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] | 15 | **Fire Rating** | C (IEC) / TYPE 1 (UL) |
| **Max Load (UL)[2]** | [lbs/ft²] | 75 (3600 Pa) | **Permitted module temperature on continuous duty** | -40 °F up to +185 °F<br>(-40 °C up to +85 °C) |
| **Load Rating (UL)[2]** | [lbs/ft²] | 33 (1600 Pa) | [2] see installation manual | |

## QUALIFICATIONS AND CERTIFICATES

IEC 61215 (Ed. 2); IEC 61730 (Ed. 1), Application class A
This data sheet complies with DIN EN 50380.

C Certified US
UL 1703
(254141)

## PACKAGING INFORMATION

| | |
|---|---|
| **Number of Modules per Pallet** | 29 |
| **Number of Pallets per 40' Container** | 22 |
| **Pallet Dimensions ( L × W × H )** | 81.3 × 45.3 × 46.9 in<br>(2065 × 1150 × 1190 mm) |
| **Pallet Weight** | 1671 lbs (758 kg) |

**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.

**Hanwha Q CELLS America Inc.**
300 Spectrum Center Drive, Suite 1250, Irvine, CA 92618, USA | **TEL** +1 949 748 59 96 | **EMAIL** inquiry@us.q-cells.com | **WEB** www.q-cells.us

Engineered in **Germany**

# Exhibit A

# 5) Trina Solar Multi Module

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Dickinson Wright PLLC
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Phone: (614) 591-5461
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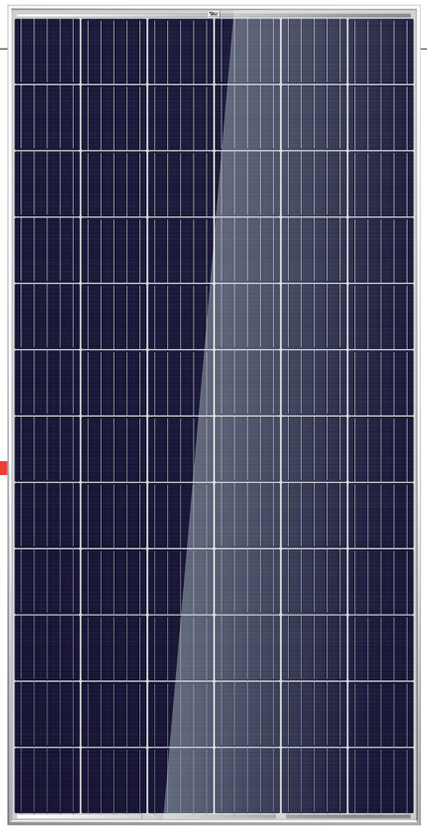
***Attorneys for Vinton Solar Energy LLC***

Mono Multi Solutions



# THE TALLMAX

## FRAMED 72-CELL MODULE (1500V)

**72 CELL**
MULTICRYSTALLINE MODULE

**320-335W**
POWER OUTPUT RANGE

**17.3%**
MAXIMUM EFFICIENCY

**0~+5W**
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading comprehensive solutions provider for solar energy. we believe close cooperation with our partners is critical to success. Trina Solar now distributes its PV products to over 60 countries all over the world. Trina is able to provide exceptional service to each customer in each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners.

### Comprehensive Products And System Certificates

IEC61215/IEC61730/UL1703/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

Trinasolar

### Ideal for large scale installations

- Reduce BOS cost by connecting more modules in a string
- 1500V UL/1500V IEC certified

### One of the industry's most trusted modules

- Field proven performance

### Highly reliable due to stringent quality control

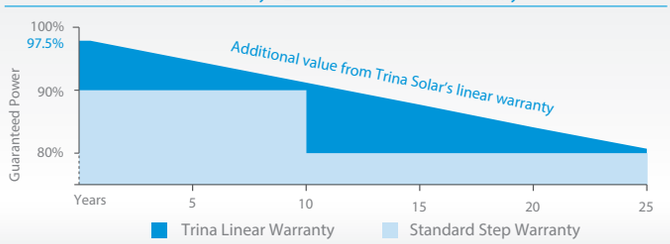
- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- PID resistant
- 100% EL double inspection

### Certified to withstand the most challenging environmental conditions

- 2400 Pa wind load
- 5400 Pa snow load
- 35 mm hail stones at 97 km/h

### LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty · 25 Year Linear Power Warranty

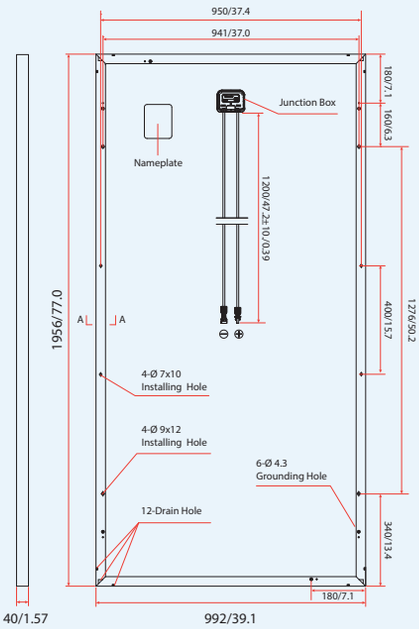


# TALLMAX

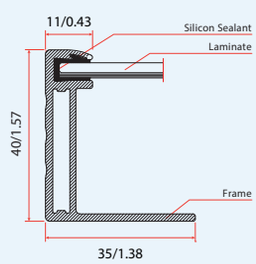
## FRAMED 72-CELL MODULE (1500V)

| PRODUCTS | POWER RANGE |
|---|---|
| TSM-PE14A | 320-335W |

### DIMENSIONS OF PV MODULE (mm/inch)

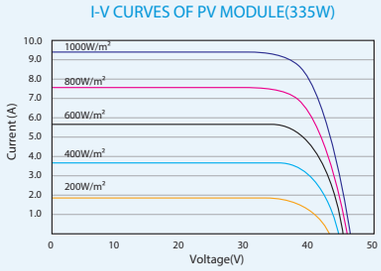



Back View

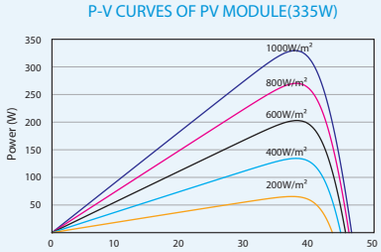



(A-A)

### I-V CURVES OF PV MODULE(335W)




### P-V CURVES OF PV MODULE(335W)




### ELECTRICAL DATA (STC)

| | | | | |
|---|---|---|---|---|
| Peak Power Watts-$P_{MAX}$ (Wp)* | 320 | 325 | 330 | 335 |
| Power Output Tolerance-$P_{MAX}$ (W) | 0 ~ +5 | | | |
| Maximum Power Voltage-$V_{MPP}$ (V) | 37.1 | 37.2 | 37.3 | 37.6 |
| Maximum Power Current-$I_{MPP}$ (A) | 8.63 | 8.76 | 8.87 | 8.91 |
| Open Circuit Voltage-$V_{OC}$ (V) | 45.8 | 45.9 | 46.1 | 46.3 |
| Short Circuit Current-$I_{SC}$ (A) | 9.10 | 9.25 | 9.38 | 9.39 |
| Module Efficiency $\eta_m$ (%) | 16.5 | 16.8 | 17.0 | 17.3 |

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

### ELECTRICAL DATA (NOCT)

| | | | | |
|---|---|---|---|---|
| Maximum Power-$P_{MAX}$ (Wp) | 238 | 242 | 246 | 249 |
| Maximum Power Voltage-$V_{MPP}$ (V) | 34.4 | 34.5 | 34.6 | 34.9 |
| Maximum Power Current-$I_{MPP}$ (A) | 6.91 | 7.02 | 7.11 | 7.14 |
| Open Circuit Voltage-$V_{OC}$ (V) | 42.5 | 42.6 | 42.7 | 42.9 |
| Short Circuit Current-$I_{SC}$ (A) | 7.35 | 7.47 | 7.57 | 7.58 |

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

### MECHANICAL DATA

| | |
|---|---|
| Solar Cells | Multicrystalline 156.75 × 156.75 mm (6 inches) |
| Cell Orientation | 72 cells (6 × 12) |
| Module Dimensions | 1956 × 992 × 40 mm (77.0 × 39.1 × 1.57 inches) |
| Weight | 22.5 kg (49.6 lb) |
| Glass | 3.2 mm (0.13 inches), High Transmission, AR Coated Tempered Glass |
| Backsheet | White |
| Frame | Silver Anodized Aluminium Alloy |
| J-Box | IP 67 or IP 68 rated |
| Cables | Photovoltaic Technology Cable 4.0mm² (0.006 inches²), 1200 mm (47.2 inches) |
| Connector | MC4 or Amphenol H4/UTX (1500V) |
| Fire Type | Type 1 or Type 2 |

### TEMPERATURE RATINGS

| | |
|---|---|
| NOCT(Nominal Operating Cell Temperature) | 44°C (±2°C) |
| Temperature Coefficient of $P_{MAX}$ | - 0.41%/°C |
| Temperature Coefficient of $V_{OC}$ | - 0.32%/°C |
| Temperature Coefficient of $I_{SC}$ | 0.05%/°C |

### MAXIMUM RATINGS

| | |
|---|---|
| Operational Temperature | -40~+85°C |
| Maximum System Voltage | 1500V DC (IEC) |
| | 1500V DC (UL) |
| Max Series Fuse Rating | 15A |

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

### WARRANTY

| |
|---|
| 10 year Product Workmanship Warranty |
| 25 year Linear Power Warranty |

(Please refer to product warranty for details)

### PACKAGING CONFIGURATION

| |
|---|
| Modules per box: 27 pieces |
| Modules per 40' container: 648 pieces |

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

# Exhibit A

# 6) Trina Solar Mono Module

Christine M.T. Pirik (0029759)
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Dickinson Wright PLLC
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Columbus, Ohio 43215
Phone: (614) 591-5461
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wvorys@dickinsonwright.com

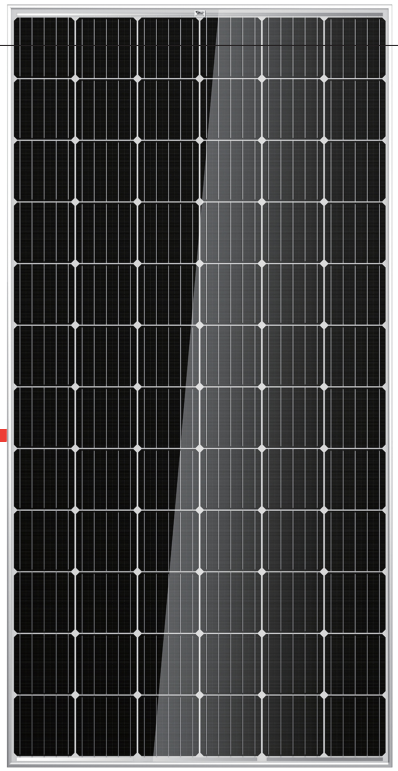
***Attorneys for Vinton Solar Energy LLC***

Mono Multi Solutions

THE

# TALLMAX M PLUS

## FRAMED 72-CELL MODULE (1500V)



**72 CELL**
MONOCRYSTALLINE MODULE

**335-365W**
POWER OUTPUT RANGE

**18.8%**
MAXIMUM EFFICIENCY

**0~+5W**
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading comprehensive solutions provider for solar energy. we believe close cooperation with our partners is critical to success. Trina Solar now distributes its PV products to over 60 countries all over the world. Trina is able to provide exceptional service to each customer in each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners.

### Comprehensive Products And System Certificates

IEC61215/IEC61730/UL1703/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

Trinasolar

### Ideal for large scale installations

- Reduce BOS cost by connecting more modules in a string
- 1500V UL/1500V IEC certified

### Maximize limited space with top-end efficiency

- Up to 188 W/m$^2$ power density
- Low thermal coefficients for greater energy production at high operating temperatures

### Highly reliable due to stringent quality control

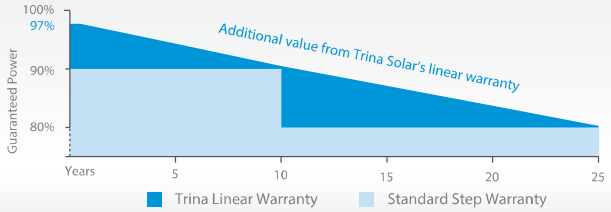
- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- 100% EL double inspection
- PID Resistant

### Certified to withstand the most challenging environmental conditions

- 2400 Pa wind load
- 5400 Pa snow load
- 35 mm hail stones at 97 km/h

### LINEAR PERFORMANCE WARRANTY

10 Year Product Warranty · 25 Year Linear Power Warranty

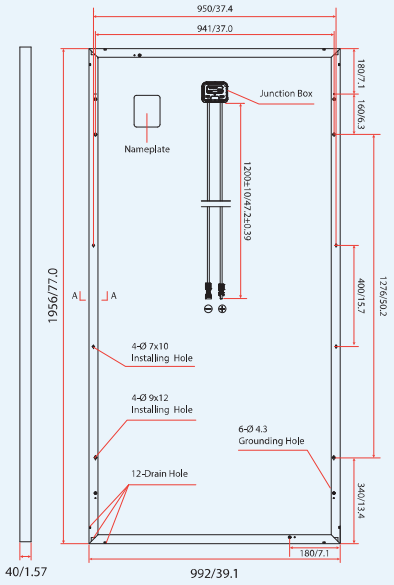


# TALLMAX M PLUS

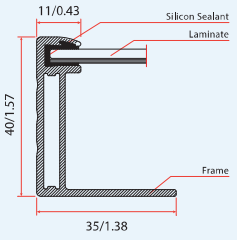
## FRAMED 72-CELL MODULE (1500V)

| PRODUCTS | POWER RANGE |
|---|---|
| TSM-DE14A(II) | 335-365W |

### DIMENSIONS OF PV MODULE (mm/inch)

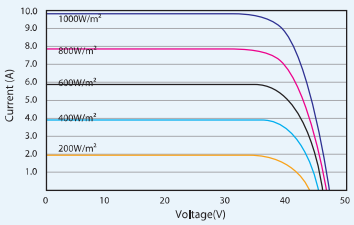



Back View

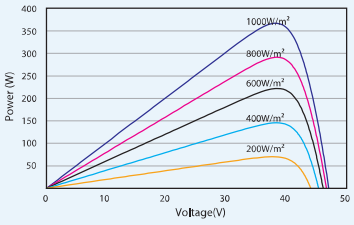



(A-A)

### I-V CURVES OF PV MODULE(365W)




### P-V CURVES OF PV MODULE(365W)




### ELECTRICAL DATA (STC)

| Peak Power Watts-$P_{MAX}$ (Wp)* | 335 | 340 | 345 | 350 | 355 | 360 | 365 |
|---|---|---|---|---|---|---|---|
| Power Output Tolerance-$P_{MAX}$ (W) | 0 ~ +5 | | | | | | |
| Maximum Power Voltage-$V_{MPP}$ (V) | 37.9 | 38.2 | 38.4 | 38.5 | 38.7 | 38.9 | 39.1 |
| Maximum Power Current-$I_{MPP}$ (A) | 8.84 | 8.90 | 9.00 | 9.09 | 9.17 | 9.26 | 9.35 |
| Open Circuit Voltage-$V_{OC}$ (V) | 46.3 | 46.5 | 46.7 | 46.9 | 47.0 | 47.2 | 47.3 |
| Short Circuit Current-$I_{SC}$ (A) | 9.36 | 9.45 | 9.50 | 9.60 | 9.69 | 9.79 | 9.88 |
| Module Efficiency $\eta_m$ (%) | 17.3 | 17.5 | 17.8 | 18.0 | 18.3 | 18.5 | 18.8 |

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

### ELECTRICAL DATA (NOCT)

| Maximum Power-$P_{MAX}$ (Wp) | 250 | 253 | 257 | 261 | 264 | 268 | 272 |
|---|---|---|---|---|---|---|---|
| Maximum Power Voltage-$V_{MPP}$ (V) | 35.1 | 35.2 | 35.5 | 35.6 | 35.8 | 35.9 | 36.1 |
| Maximum Power Current-$I_{MPP}$ (A) | 7.12 | 7.19 | 7.25 | 7.33 | 7.40 | 7.47 | 7.54 |
| Open Circuit Voltage-$V_{OC}$ (V) | 43.1 | 43.2 | 43.4 | 43.5 | 43.7 | 43.8 | 43.9 |
| Short Circuit Current-$I_{SC}$ (A) | 7.56 | 7.63 | 7.67 | 7.75 | 7.82 | 7.88 | 7.95 |

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

### MECHANICAL DATA

| Solar Cells | Monocrystalline 156.75 × 156.75 mm (6 inches) |
|---|---|
| Cell Orientation | 72 cells (6 × 12) |
| Module Dimensions | 1956 × 992 × 40 mm (77.0 × 39.1 × 1.57 inches) |
| Weight | 26.0 kg (57.3 lb) with 4.0 mm glass |
| Glass | 4.0 mm (0.16 inches) High Transmission, AR Coated Tempered Glass |
| Backsheet | White |
| Frame | Silver Anodized Aluminium Alloy |
| J-Box | IP 67 or IP 68 rated |
| Cables | Photovoltaic Technology Cable 4.0mm² (0.006 inches²), 1200 mm (47.2 inches) |
| Connector | MC4 or Amphenol H4/UTX (1500V) |
| Fire Type | Type 1 or Type 2 |

### TEMPERATURE RATINGS

| NOCT(Nominal Operating Cell Temperature) | 44°C (±2°C) |
|---|---|
| Temperature Coefficient of $P_{MAX}$ | - 0.39%/°C |
| Temperature Coefficient of $V_{OC}$ | - 0.29%/°C |
| Temperature Coefficient of $I_{SC}$ | 0.05%/°C |

### MAXIMUM RATINGS

| Operational Temperature | -40~+85°C |
|---|---|
| Maximum System Voltage | 1500V DC (IEC)<br>1500V DC (UL) |
| Max Series Fuse Rating | 15A |

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

### WARRANTY

| 10 year Product Workmanship Warranty |
|---|
| 25 year Linear Power Warranty |

(Please refer to product warranty for details)

### PACKAGING CONFIGURATION

| Modules per box: 27 pieces |
|---|
| Modules per 40' container: 648 pieces |

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

# Exhibit A

# 7) JA Solar Multi Module

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wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

JA SOLAR

# JAP6(K)

## -72/310-330/4BB
## F 40-35

MULTICRYSTALLINE SILICON MODULE

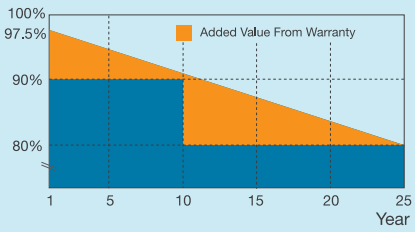
## JA Solar Holdings Co., Ltd.

JA Solar Holdings Co., Ltd. is a world-leading manufacturer of high-performance photovoltaic products that convert sunlight into electricity for residential, commercial, and utility-scale power generation. The company was founded on May 18, 2005, and was publicly listed on NASDAQ on February 7, 2007. JA Solar is one of the world's largest producers of solar cells and modules. Its standard and high-efficiency product offerings are among the most powerful and cost-effective in the industry.

A d d : Building No.8, Nuode Center, Automobile Museum East Road, Fengtai District, Beijing
T e l : +86 (10) 63611888
F a x : +86 (10) 63611999
Email: sales@jasolar.com market@jasolar.com

## Superior Warranty

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




## Key Features

- JA 4BB design module reduce cell series resistance and stress between cell interconnectors improves module reliability and module conversion efficiency
- High output, 16.99% highest conversion efficiency
- Designed for DC IEC 1000V applications
- Anti-reflective and anti-soiling surface reduces power loss from dirt and dust
- Outstanding performance in low-light irradiance environments
- Excellent mechanical load resistance: Certified to withstand high wind loads (2400Pa) and snow loads (5400Pa)
- High salt and ammonia resistance certified by TÜV NORD

## Reliable Quality

- Positive power tolerance: 0~+5W
- 100% EL double-inspection ensures modules are defects free
- Modules binned by current to improve system performance
- Potential Induced Degradation (PID) Resistant

## Comprehensive Certificates

- IEC 61215, IEC 61730, UL1703, CEC Listed, MCS and CE
- ISO 9001: 2008: Quality management systems
- ISO 14001: 2004: Environmental management systems
- BS OHSAS 18001: 2007: Occupational health and safety management systems
- Environmental policy: The first solar company in China to complete Intertek's carbon footprint evaluation program and receive green leaf mark verification for our products

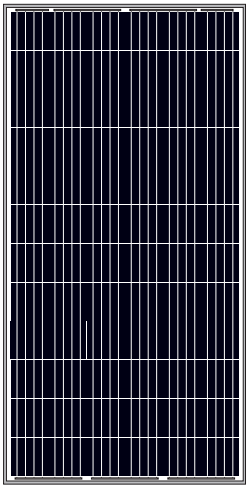
Specifications subject to technical changes and tests. JA Solar reserves the right of final interpretation.

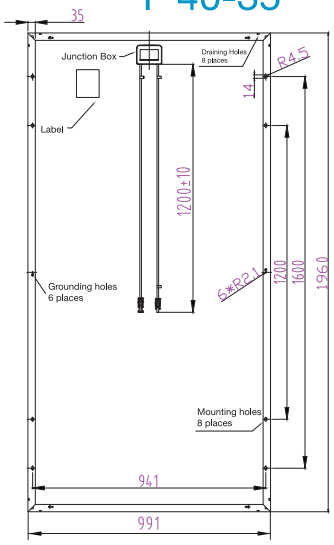
# JAP6(K)-72/310-330/4BB

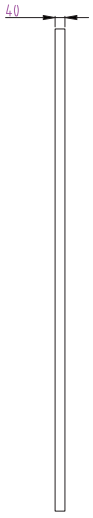
JA SOLAR

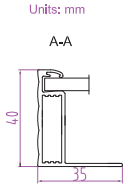
## Engineering Drawings

F 40-35






■ customized cable length available upon request

## MECHANICAL PARAMETERS

| | |
|---|---|
| Cell (mm) | Poly 156.75x156.75 |
| Weight (kg) | 23 (approx) |
| Dimensions (L×W×H) (mm) | 1960×991×40 |
| Cable Cross Section Size ($mm^2$) | 4 |
| No. of Cells and Connections | 72 (6×12) |
| Junction Box | IP67, 3 diodes |
| Connector | MC4 Compatible |
| Packaging Configuration | 27 Per Pallet |

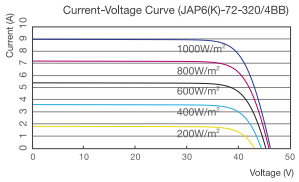
## WORKING CONDITIONS

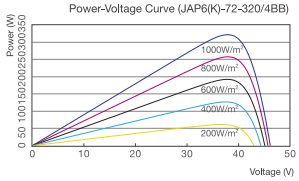
| | |
|---|---|
| Maximum System Voltage | DC 1000V (IEC) |
| Operating Temperature | -40℃~+85℃ |
| Maximum Series Fuse | 15A |
| Maximum Static Load, Front (e.g., snow and wind)<br>Maximum Static Load, Back (e.g., wind) | 5400Pa (112 lb/$ft^2$)<br>2400Pa (50 lb/$ft^2$) |
| NOCT | 45±2℃ |
| Application Class | Class A |

## ELECTRICAL PARAMETERS

| TYPE | JAP6(K)-72-310/4BB | JAP6(K)-72-315/4BB | JAP6(K)-72-320/4BB | JAP6(K)-72-325/4BB | JAP6(K)-72-330/4BB |
|---|---|---|---|---|---|
| Rated Maximum Power at STC (W) | 310 | 315 | 320 | 325 | 330 |
| Open Circuit Voltage (Voc/V) | 45.56 | 45.85 | 46.12 | 46.38 | 46.40 |
| Maximum Power Voltage (Vmp/V) | 36.89 | 37.09 | 37.28 | 37.39 | 37.65 |
| Short Circuit Current (Isc/A) | 8.92 | 9.01 | 9.09 | 9.17 | 9.28 |
| Maximum Power Current (Imp/A) | 8.40 | 8.49 | 8.58 | 8.69 | 8.77 |
| Module Efficiency [%] | 15.96 | 16.22 | 16.48 | 16.73 | 16.99 |
| Power Tolerance (W) | -0~+5W | | | | |
| Temperature Coefficient of Isc (αIsc) | +0.058%/℃ | | | | |
| Temperature Coefficient of Voc (βVoc) | -0.330%/℃ | | | | |
| Temperature Coefficient of Pmax (γPmp) | -0.410%/℃ | | | | |
| STC | Irradiance 1000W/$m^2$, Cell Temperature 25℃, Air Mass 1.5 | | | | |

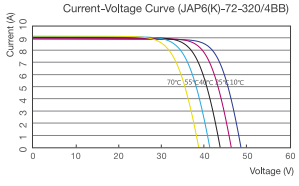
## I-V CURVE




## NOCT

| TYPE | JAP6(K)-72-310/4BB | JAP6(K)-72-315/4BB | JAP6(K)-72-320/4BB | JAP6(K)-72-325/4BB | JAP6(K)-72-330/4BB |
|---|---|---|---|---|---|
| Max Power (Pmax) [W] | 225.06 | 228.69 | 232.32 | 235.95 | 239.58 |
| Open Circuit Voltage (Voc) [V] | 41.63 | 41.84 | 42.04 | 42.24 | 42.41 |
| Max Power Voltage (Vmp) [V] | 33.87 | 34.00 | 34.19 | 34.37 | 34.58 |
| Short Circuit Current (Isc) [A] | 7.03 | 7.08 | 7.14 | 7.20 | 7.25 |
| Max Power Current (Imp) [A] | 6.65 | 6.73 | 6.80 | 6.87 | 6.93 |
| Condition | Under Normal Operating Cell Temperature, Irradiance of 800 W/$m^2$, spectrum AM 1.5, ambient temperature 20℃, wind speed 1 m/s | | | | |




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.

# Exhibit A

# 8) JA Solar Mono Module

Christine M.T. Pirik (0029759)
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wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

JA SOLAR

# JAM6(K)

## -72/320-340/4BB
## F 40-35
MONOCRYSTALLINE SILICON MODULE

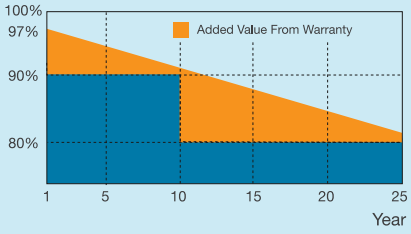
## JA Solar Holdings Co., Ltd.

JA Solar Holdings Co., Ltd. is a world-leading manufacturer of high-performance photovoltaic products that convert sunlight into electricity for residential, commercial, and utility-scale power generation. The company was founded on May 18, 2005, and was publicly listed on NASDAQ on February 7, 2007. JA Solar is one of the world's largest producers of solar cells and modules. Its standard and high-efficiency product offerings are among the most powerful and cost-effective in the industry.

A d d : Building No.8, Nuode Center, Automobile Museum East Road, Fengtai District, Beijing
T e l : +86 (10) 63611888
F a x : +86 (10) 63611999
Email: sales@jasolar.com market@jasolar.com

## Superior Warranty

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




## Key Features

- JA 4BB design module reduce cell series resistance and stress between cell interconnectors improves module reliability and module conversion efficiency
- High power output of more than 330W and module efficiency up to 16.99% which has been verified by TÜV Rheinland
- Anti-reflective and anti-soiling surface reduces power loss from dirt and dust
- Outstanding performance in low-light irradiance environments
- Excellent mechanical load resistance: Certified to withstand high wind loads (2400Pa) and snow loads (5400Pa)
- High salt and ammonia resistance certified by TÜV NORD

## Reliable Quality

- Positive power tolerance: 0~+5W
- 100% EL double-inspection ensures modules are defects free
- Modules binned by current to improve system performance
- Potential Induced Degradation (PID) Resistant

## Comprehensive Certificates

- IEC 61215, IEC 61730, UL1703, CEC Listed, MCS and CE
- ISO 9001: 2008: Quality management systems
- ISO 14001: 2004: Environmental management systems
- BS OHSAS 18001: 2007: Occupational health and safety management systems
- Environmental policy: The first solar company in China to complete Intertek's carbon footprint evaluation program and receive green leaf mark verification for our products

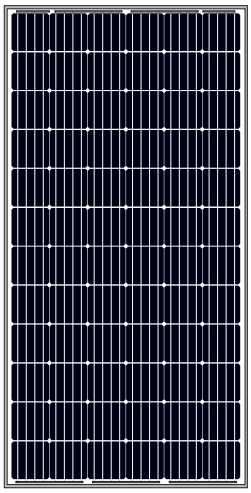
Specifications subject to technical changes and tests. JA Solar reserves the right of final interpretation.

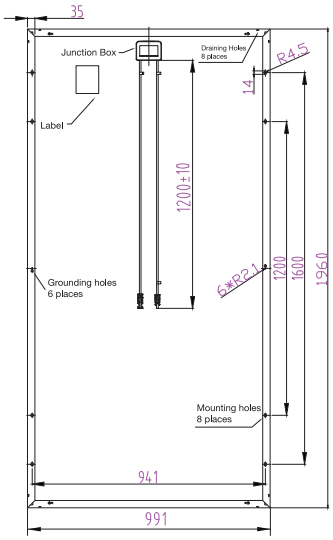
# JAM6(K)-72/320-340/4BB

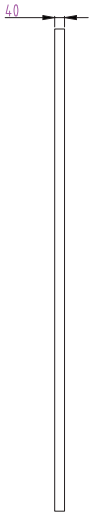
JA SOLAR

F 40-35

## Engineering Drawings

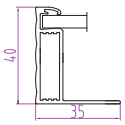





Units: mm

A-A




■ customized cable length available upon request

## MECHANICAL PARAMETERS

| | |
|---|---|
| Cell (mm) | Almost Full Square Mono 156.75x156.75 |
| Weight (kg) | 23 (approx) |
| Dimensions (L×W×H) (mm) | 1960×991×40 |
| Cable Cross Section Size ($mm^2$) | 4 |
| No. of Cells and Connections | 72 (6×12) |
| Junction Box | IP67, 3 diodes |
| Connector | MC4 Compatible |
| Packaging Configuration | 27 Per Pallet |

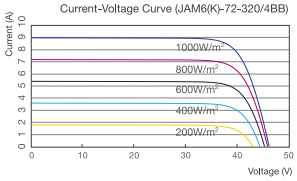
## WORKING CONDITIONS

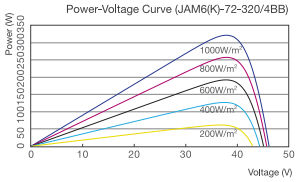
| | |
|---|---|
| Maximum System Voltage | DC 1000V (IEC) |
| Operating Temperature | -40℃~+85℃ |
| Maximum Series Fuse | 15A |
| Maximum Static Load, Front (e.g., snow and wind)<br>Maximum Static Load, Back (e.g., wind) | 5400Pa (112 lb/$ft^2$)<br>2400Pa (50 lb/$ft^2$) |
| NOCT | 45±2℃ |
| Application Class | Class A |

## ELECTRICAL PARAMETERS

| TYPE | JAM6(K)-72 -320/4BB | JAM6(K)-72 -325/4BB | JAM6(K)-72 -330/4BB | JAM6(K)-72 -335/4BB | JAM6(K)-72 -340/4BB |
|---|---|---|---|---|---|
| Rated Maximum Power at STC (W) | 320 | 325 | 330 | 335 | 340 |
| Open Circuit Voltage (Voc/V) | 45.32 | 45.60 | 45.85 | 46.09 | 46.32 |
| Maximum Power Voltage (Vmp/V) | 36.96 | 37.15 | 37.38 | 37.60 | 37.87 |
| Short Circuit Current (Isc/A) | 9.25 | 9.33 | 9.42 | 9.51 | 9.60 |
| Maximum Power Current (Imp/A) | 8.66 | 8.75 | 8.83 | 8.91 | 8.98 |
| Module Efficiency [%] | 16.48 | 16.73 | 16.99 | 17.25 | 17.50 |
| Power Tolerance (W) | -0~+5W | | | | |
| Temperature Coefficient of Isc (αIsc) | +0.059%/℃ | | | | |
| Temperature Coefficient of Voc (βVoc) | -0.330%/℃ | | | | |
| Temperature Coefficient of Pmax (γPmp) | -0.410%/℃ | | | | |
| STC | Irradiance 1000W/$m^2$, Cell Temperature 25℃, Air Mass 1.5 | | | | |

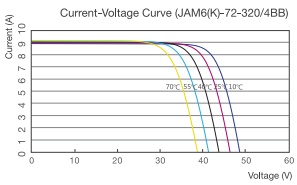
## I-V CURVE




## NOCT

| TYPE | JAM6(K)-72 -320/4BB | JAM6(K)-72 -325/4BB | JAM6(K)-72 -330/4BB | JAM6(K)-72 -335/4BB | JAM6(K)-72 -340/4BB |
|---|---|---|---|---|---|
| Max Power (Pmax) [W] | 233.92 | 237.58 | 241.23 | 244.89 | 248.54 |
| Open Circuit Voltage (Voc) [V] | 42.24 | 42.46 | 42.68 | 42.89 | 43.11 |
| Max Power Voltage (Vmp) [V] | 34.00 | 34.18 | 34.31 | 34.44 | 34.57 |
| Short Circuit Current (Isc) [A] | 7.28 | 7.30 | 7.38 | 7.45 | 7.52 |
| Max Power Current (Imp) [A] | 6.88 | 6.95 | 7.03 | 7.11 | 7.19 |
| Condition | Under Normal Operating Cell Temperature, Irradiance of 800 W/$m^2$, spectrum AM 1.5, ambient temperature 20℃, wind speed 1 m/s | | | | |




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.

# Exhibit A

# 9) First Solar Series 4 PV Module

Christine M.T. Pirik (0029759)
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William V. Vorys (0093479)
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wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

# First Solar Series 4™ PV Module

ADVANCED THIN FILM SOLAR TECHNOLOGY

**122.5 WATT MODULE EFFICIENCY OF 17.0%**

## INDUSTRY BENCHMARK SOLAR MODULES

As a global leader in PV energy, First Solar's advanced thin film solar modules have set the industry benchmark with over 10 gigawatts (GW) installed worldwide and a proven performance advantage over conventional crystalline silicon solar modules. Generating more energy than competing modules with the same power rating, First Solar's Series 4™ and Series 4A™ PV Modules deliver superior performance and reliability to our customers.

## PROVEN ENERGY YIELD ADVANTAGE

- Generates more energy than conventional crystalline silicon solar modules with the same power due to superior temperature coefficient and superior spectral response
- Anti-reflective coated glass (Series 4A™) enhances energy production

## ADVANCED PERFORMANCE & RELIABILITY

- Compatible with advanced 1500V plant architectures
- Highly predictable energy in all climates and applications
- Independently certified for reliable performance in high temperature, high humidity, extreme desert and coastal environments

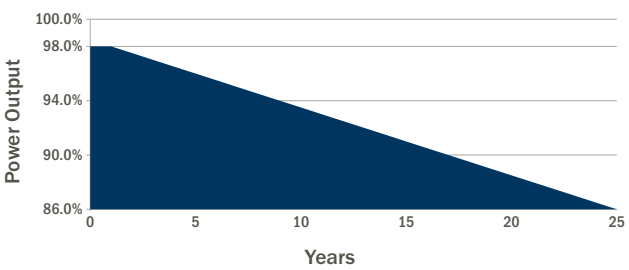
## CERTIFICATIONS & TESTS

- PID-Free, Thresher Test[1], Long-Term Sequential Test[1], and ATLAS 25+[1]
- IEC 61646 1500V, IEC 61730 1500V, CE
- IEC 61701 Salt Mist Corrosion, IEC 60068-2-68 Dust and Sand Resistance
- ISO 9001:2008 and ISO 14001:2004
- UL 1703 Listed Fire Performance PV Module Type 10[2]
- CSI Eligible, FSEC, MCS, CEC Listed (Australia), SII[1], InMetro

## END-OF-LIFE RECYCLING

- Recycling services available through First Solar's industry-leading recycling program or customer-selected third party.

## MODULE WARRANTY[3]



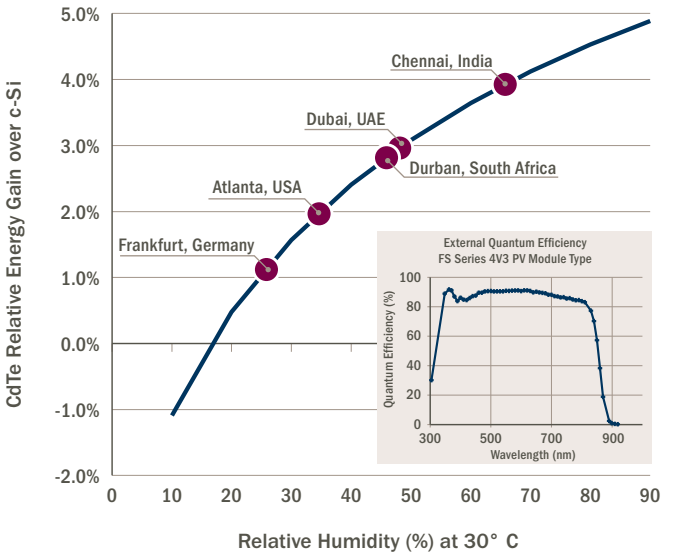

- 25-Year Linear Performance Warranty[4]
- 10-Year Limited Product Warranty

# FIRST SOLAR SERIES 4™ PV MODULE

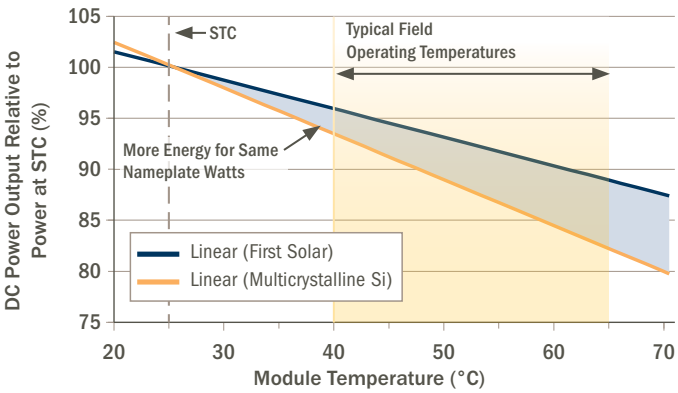
| MECHANICAL DESCRIPTION | |
|---|---|
| Length | 1200mm |
| Width | 600mm |
| Weight | 12kg |
| Thickness | 6.8mm |
| Area | 0.72m² |
| Leadwire | 2.5mm², 610mm |
| Connectors | MC4[9] |
| Bypass Diode | None |
| Cell Type | Thin-film CdTe semiconductor, up to 216 cells |
| Frame Material | None |
| Front Glass | 3.2mm heat strengthened<br>Series 4A™ includes anti-reflective coating |
| Back Glass | 3.2mm tempered |
| Encapsulation | Laminate material with edge seal |
| Load Rating | 2400Pa[10] |

| MODULE NUMBERS AND RATINGS AT STANDARD TEST CONDITIONS (1000W/m², AM 1.5, 25°C)[5] | | | | | | | |
|---|---|---|---|---|---|---|---|
| NOMINAL VALUES | | FS-4110-3<br>FS-4110A-3 | FS-4112-3<br>FS-4112A-3 | FS-4115-3<br>FS-4115A-3 | FS-4117-3<br>FS-4117A-3 | FS-4120-3<br>FS-4120A-3 | FS-4122-3<br>FS-4122A-3 |
| Nominal Power[6] (-0/+5W) | $P_{MPP}$ (W) | 110.0 | 112.5 | 115.0 | 117.5 | 120.0 | 122.5 |
| Voltage at $P_{MAX}$ | $V_{MPP}$ (V) | 67.8 | 68.5 | 69.3 | 70.1 | 70.8 | 71.5 |
| Current at $P_{MAX}$ | $I_{MPP}$ (A) | 1.62 | 1.64 | 1.66 | 1.68 | 1.70 | 1.71 |
| Open Circuit Voltage | $V_{OC}$ (V) | 86.4 | 87.0 | 87.6 | 88.1 | 88.7 | 88.7 |
| Short Circuit Current | $I_{SC}$ (A) | 1.82 | 1.83 | 1.83 | 1.83 | 1.84 | 1.85 |
| Module Efficiency | % | 15.3 | 15.6 | 16.0 | 16.3 | 16.7 | 17.0 |
| Maximum System Voltage | $V_{SYS}$ (V) | 1500 [7,8] | | | | | |
| Limiting Reverse Current | $I_R$ (A) | 4.0 | | | | | |
| Maximum Series Fuse | $I_{CF}$ (A) | 4.0 | | | | | |
| **RATINGS AT NOMINAL OPERATING CELL TEMPERATURE OF 45°C (800W/m², 20°C air temperature, AM 1.5, 1m/s wind speed)[5]** | | | | | | | |
| Nominal Power | $P_{MPP}$ (W) | 83.2 | 85.1 | 87.0 | 89.0 | 90.8 | 92.7 |
| Voltage at $P_{MAX}$ | $V_{MPP}$ (V) | 63.5 | 64.5 | 64.9 | 65.9 | 66.3 | 67.2 |
| Current at $P_{MAX}$ | $I_{MPP}$ (A) | 1.31 | 1.32 | 1.34 | 1.35 | 1.37 | 1.38 |
| Open Circuit Voltage | $V_{OC}$ (V) | 81.6 | 82.1 | 82.7 | 83.2 | 83.7 | 83.7 |
| Short Circuit Current | $I_{SC}$ (A) | 1.47 | 1.47 | 1.48 | 1.48 | 1.48 | 1.49 |
| **TEMPERATURE CHARACTERISTICS** | | | | | | | |
| Module Operating Temperature Range | (°C) | -40 to +85 | | | | | |
| Temperature Coefficient of $P_{MPP}$ | $T_K$ ($P_{MPP}$) | -0.28%/°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 | | | | | |

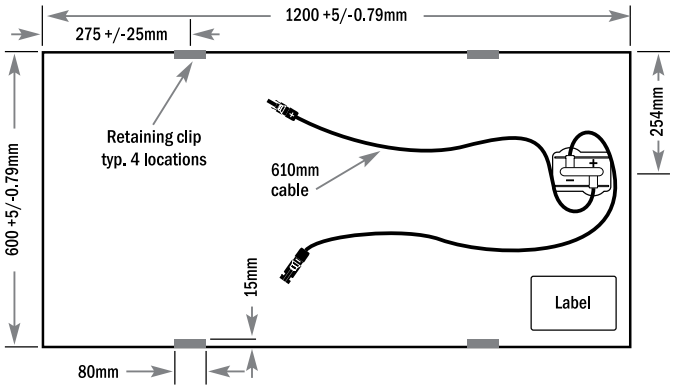
## SUPERIOR SPECTRAL RESPONSE




## SUPERIOR TEMPERATURE COEFFICIENT




## MECHANICAL DRAWING




1 Testing Certifications/Listings pending
2 Class A Spread of Flame / Class B Burning Brand. Roof mounted fire rating is established by assessing rack and solar module as a unit
3 Limited power output and product warranties subject to warranty terms and conditions
4 Ensures 98% rated power in first year, -0.5%/year through year 25
5 All ratings ± 10%, unless specified otherwise. Specifications are subject to change
6 Measurement uncertainty applies
7 UL 1703 1500V Listed / ULC 1703 1000V Listed
8 Application Class A for 1000V (class II), Application Class B for 1500V (class 0)
9 Multi-Contact MC4 (PV-KST4/PV-KBT4)
10 Higher load ratings can be met with additional clips or wider clips, subject to testing

# Exhibit A

# 10) Canadian Solar Multi Module

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wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

CanadianSolar

# MAXPOWER (1500 V)
# CS6U-315|320|325|330P

Canadian Solar's new 1500 V module is a product for high voltage systems, which can increase the string length of solar systems by up to 50%, saving BOS cost.

## KEY FEATURES

- 1500 V — Designed for high voltage systems of up to 1500 $V_{DC}$, saving on BoS cost
- Excellent module efficiency of up to 16.97 %
- Outstanding low irradiance performance: 96.0 %
- No. 1 PTC — High PTC rating of up to 92.15 %
- IP67 — IP67 junction box for long-term weather endurance
- Heavy snow load up to 5400 Pa, wind load up to 2400 Pa

**25 years** linear power output warranty

**10 years** product warranty on materials and workmanship

## MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2008 / Quality management system
ISO 14001:2004 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

## PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / MCS / CE
UL 1703 / IEC 61215 performance: CEC listed (US)
UL 1703: CSA / IEC 61701 ED2: VDE / IEC 62716: VDE
UNI 9177 Reaction to Fire: Class 1
Take-e-way

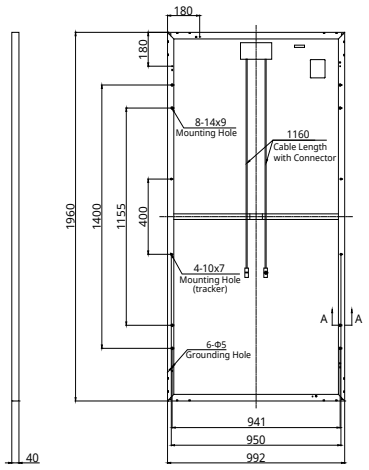
* Please contact your local Canadian Solar sales representative for the specific product certificates applicable in your market.

**CANADIAN SOLAR INC.** is committed to providing high quality solar products, solar system solutions and services to customers around the world. As a leading PV project developer and manufacturer of solar modules with over 20 GW deployed around the world since 2001, Canadian Solar Inc. (NASDAQ: CSIQ) is one of the most bankable solar companies worldwide.

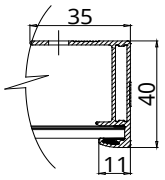
**CANADIAN SOLAR INC.**
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

## ENGINEERING DRAWING (mm)

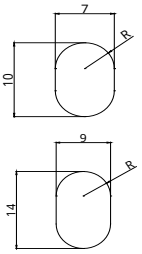
### Rear View



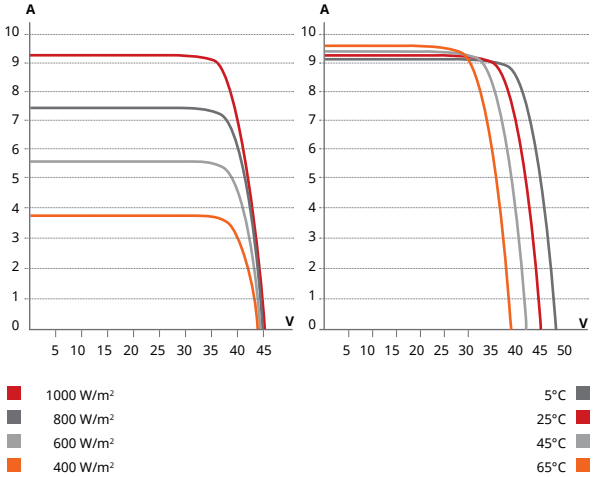

### Frame Cross Section A-A




### Mounting Hole




## CS6U-320P / I-V CURVES




## ELECTRICAL DATA | STC*

| CS6U | 315P | 320P | 325P | 330P |
|---|---|---|---|---|
| Nominal Max. Power (Pmax) | 315 W | 320 W | 325 W | 330 W |
| Opt. Operating Voltage (Vmp) | 36.6 V | 36.8 V | 37.0 V | 37.2 V |
| Opt. Operating Current (Imp) | 8.61 A | 8.69 A | 8.78 A | 8.88 A |
| Open Circuit Voltage (Voc) | 45.1 V | 45.3 V | 45.5 V | 45.6 V |
| Short Circuit Current (Isc) | 9.18 A | 9.26 A | 9.34 A | 9.45 A |
| Module Efficiency | 16.20% | 16.46% | 16.72% | 16.97% |
| Operating Temperature | -40°C ~ +85°C | | | |
| Max. System Voltage | 1500 V (IEC) or 1500 V (UL) | | | |
| Module Fire Performance | TYPE 1 (UL 1703) or CLASS C (IEC 61730) | | | |
| Max. Series Fuse Rating | 15 A | | | |
| Application Classification | Class A | | | |
| Power Tolerance | 0 ~ + 5 W | | | |

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

## MECHANICAL DATA

| Specification | Data |
|---|---|
| Cell Type | Poly-crystalline, 6 inch |
| Cell Arrangement | 72 (6×12) |
| Dimensions | 1960×992×40 mm (77.2×39.1×1.57 in) |
| Weight | 22.4 kg (49.4 lbs) |
| Front Cover | 3.2 mm tempered glass |
| Frame Material | Anodized aluminium alloy |
| J-Box | IP67, 3 diodes |
| Cable | PV1500DC-F1 4 mm² (IEC) & 12 AWG 2000 V (UL), 1160 mm (45.7 in) |
| Connector | T4 series or UTX or MC4 series |
| Per Pallet | 26 pieces, 635 kg (1400 lbs) |
| Per Container (40' HQ) | 624 pieces |

## ELECTRICAL DATA | NMOT*

| CS6U | 315P | 320P | 325P | 330P |
|---|---|---|---|---|
| Nominal Max. Power (Pmax) | 231 W | 235 W | 239 W | 242 W |
| Opt. Operating Voltage (Vmp) | 33.7 V | 33.9 V | 34.0 V | 34.2 V |
| Opt. Operating Current (Imp) | 6.87 A | 6.94 A | 7.01 A | 7.08 A |
| Open Circuit Voltage (Voc) | 42.0 V | 42.2 V | 42.4 V | 42.5 V |
| Short Circuit Current (Isc) | 7.41 A | 7.48 A | 7.54 A | 7.63 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.

## TEMPERATURE CHARACTERISTICS

| Specification | Data |
|---|---|
| Temperature Coefficient (Pmax) | -0.41 % / °C |
| Temperature Coefficient (Voc) | -0.31 % / °C |
| Temperature Coefficient (Isc) | 0.053 % / °C |
| Nominal Module Operating Temperature (NMOT) | 43±2 °C |

## PERFORMANCE AT LOW IRRADIANCE

Outstanding performance at low irradiance, with an average relative efficiency of 96.0 % for irradiances between 200 W/m² and 1000 W/m² (AM 1.5, 25°C).

## PARTNER SECTION

The aforesaid datasheet only provides the general information on Canadian Solar products and, due to the on-going innovation and improvement, please always contact your local Canadian Solar sales representative for the updated information on specifications, key features and certification requirements of Canadian Solar products in your region.

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.

# Exhibit A

# 11) Canadian Solar Mono Module

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***Attorneys for Vinton Solar Energy LLC***

CanadianSolar

# MAXPOWER (1500 V)
# CS6U-325|330|335|340M

Canadian Solar's new 1500 V module is a product for high voltage systems, which can increase the string length of solar systems by up to 50%, saving BOS cost.

## KEY FEATURES

- 1500 V — Designed for high voltage systems of up to 1500 $V_{DC}$, saving on BoS cost
- Outstanding low irradiance performance of up to 96.5 %
- No. 1 PTC — High PTC rating of up to 92.17 %
- IP67 — IP67 junction box for long-term weather endurance
- Heavy snow load up to 5400 Pa, wind load up to 2400 Pa

**25 years** linear power output warranty

**10 years** product warranty on materials and workmanship

## MANAGEMENT SYSTEM CERTIFICATES*

ISO 9001:2008 / Quality management system
ISO 14001:2004 / Standards for environmental management system
OHSAS 18001:2007 / International standards for occupational health & safety

## PRODUCT CERTIFICATES*

IEC 61215 / IEC 61730: VDE / MCS / CE
UL 1703 / IEC 61215 performance: CEC listed (US)
UL 1703: CSA / IEC 61701 ED2: VDE / IEC 62716: VDE
UNI 9177 Reaction to Fire: Class 1
Take-e-way

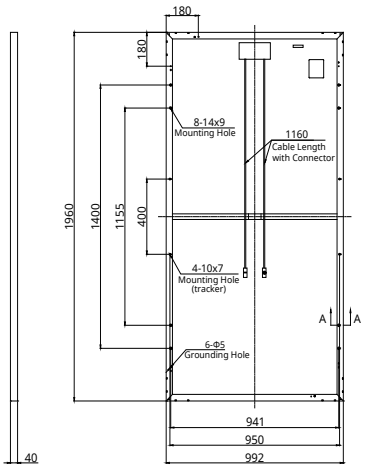
* Please contact your local Canadian Solar sales representative for the specific product certificates applicable in your market.

**CANADIAN SOLAR INC.** is committed to providing high quality solar products, solar system solutions and services to customers around the world. As a leading PV project developer and manufacturer of solar modules with over 20 GW deployed around the world since 2001, Canadian Solar Inc. (NASDAQ: CSIQ) is one of the most bankable solar companies worldwide.

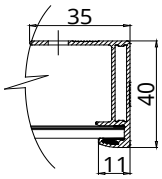
**CANADIAN SOLAR INC.**
545 Speedvale Avenue West, Guelph, Ontario N1K 1E6, Canada, www.canadiansolar.com, support@canadiansolar.com

## ENGINEERING DRAWING (mm)

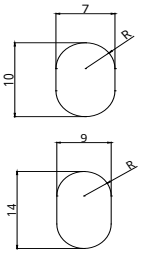
### Rear View



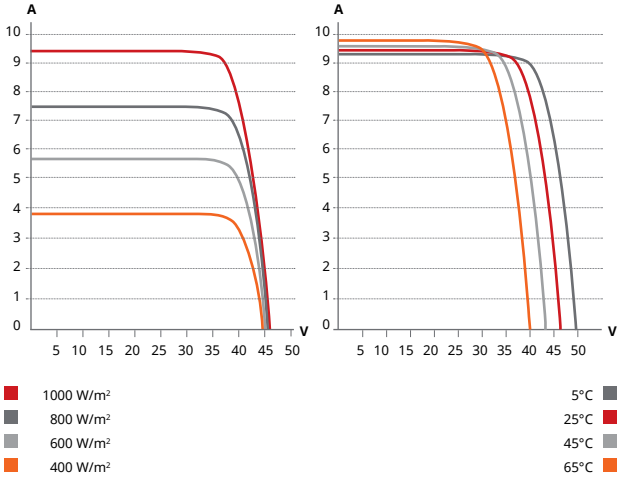

### Frame Cross Section A-A




### Mounting Hole




## CS6U-335M / I-V CURVES




## ELECTRICAL DATA | STC*

| CS6U | 325M | 330M | 335M | 340M |
|---|---|---|---|---|
| Nominal Max. Power (Pmax) | 325 W | 330 W | 335 W | 340 W |
| Opt. Operating Voltage (Vmp) | 37.4 V | 37.5 V | 37.8 V | 37.9 V |
| Opt. Operating Current (Imp) | 8.69 A | 8.80 A | 8.87 A | 8.97 A |
| Open Circuit Voltage (Voc) | 45.8 V | 45.9 V | 46.1 V | 46.2 V |
| Short Circuit Current (Isc) | 9.21 A | 9.31 A | 9.41 A | 9.48 A |
| Module Efficiency | 16.72% | 16.97% | 17.23% | 17.49% |
| Operating Temperature | -40°C ~ +85°C | | | |
| Max. System Voltage | 1500 V (IEC) or 1500 V (UL) | | | |
| Module Fire Performance | TYPE 1 (UL 1703) or CLASS C (IEC 61730) | | | |
| Max. Series Fuse Rating | 15 A | | | |
| Application Classification | Class A | | | |
| Power Tolerance | 0 ~ + 5 W | | | |

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

## MECHANICAL DATA

| Specification | Data |
|---|---|
| Cell Type | Mono-crystalline, 6 inch |
| Cell Arrangement | 72 (6×12) |
| Dimensions | 1960×992×40 mm (77.2×39.1×1.57 in) |
| Weight | 22.4 kg (49.4 lbs) |
| Front Cover | 3.2 mm tempered glass |
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| J-Box | IP67, 3 diodes |
| Cable | PV1500DC-F1 4 mm2 (IEC) & 12 AWG 2000 V (UL), 1160 mm (45.7 in) |
| Connector | T4 series or UTX or MC4 series |
| Per Pallet | 26 pieces, 635 kg (1400 lbs) |
| Per Container (40' HQ) | 624 pieces |

## ELECTRICAL DATA | NMOT*

| CS6U | 325M | 330M | 335M | 340M |
|---|---|---|---|---|
| Nominal Max. Power (Pmax) | 239 W | 242 W | 246 W | 250 W |
| Opt. Operating Voltage (Vmp) | 34.4 V | 34.5 V | 34.8 V | 34.9 V |
| Opt. Operating Current (Imp) | 6.94 A | 7.03 A | 7.08 A | 7.16 A |
| Open Circuit Voltage (Voc) | 42.6 V | 42.7 V | 42.9 V | 43.0 V |
| Short Circuit Current (Isc) | 7.44 A | 7.52 A | 7.60 A | 7.66 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.

## TEMPERATURE CHARACTERISTICS

| Specification | Data |
|---|---|
| Temperature Coefficient (Pmax) | -0.41 % / °C |
| Temperature Coefficient (Voc) | -0.31 % / °C |
| Temperature Coefficient (Isc) | 0.053 % / °C |
| Nominal Module Operating Temperature (NMOT) | 43±2 °C |

## PERFORMANCE AT LOW IRRADIANCE

Outstanding performance at low irradiance, with an average relative efficiency of 96.5 % for irradiances between 200 W/m² and 1000 W/m² (AM 1.5, 25°C).

## PARTNER SECTION

The aforesaid datasheet only provides the general information on Canadian Solar products and, due to the on-going innovation and improvement, please always contact your local Canadian Solar sales representative for the updated information on specifications, key features and certification requirements of Canadian Solar products in your region.

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# Exhibit B

# 1) SMA SC2500 Inverter

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FIGURE B 1

# SUNNY CENTRAL 2500


**Economic**

- Highest power density
- Market leading efficiency
- Provides ancillary services with Q-on-Demand
- Reduce installation and transportation costs with up to four inverters in a standard shipping container or a flat-bed truck

**Robust**

- Proven and intelligent precision air-cooling technology
- Durably built for outdoor installation in harsh environmental conditions
- Robust and redundant fiber optic communication network configurations

**Flexible**

- Operation up to 1,500 V DC
- Highest DC:AC design ratio in the industry
- Nominal power operation from -25 °C to 50 °C

**Highly integrated**

- Area for customer SCADA equipment
- Integrated zone monitoring
- LOTO DC and AC disconnects
- On-board 120V AC Power Outlet

## SUNNY CENTRAL 2500

The new Sunny Central: maximum power density and integration

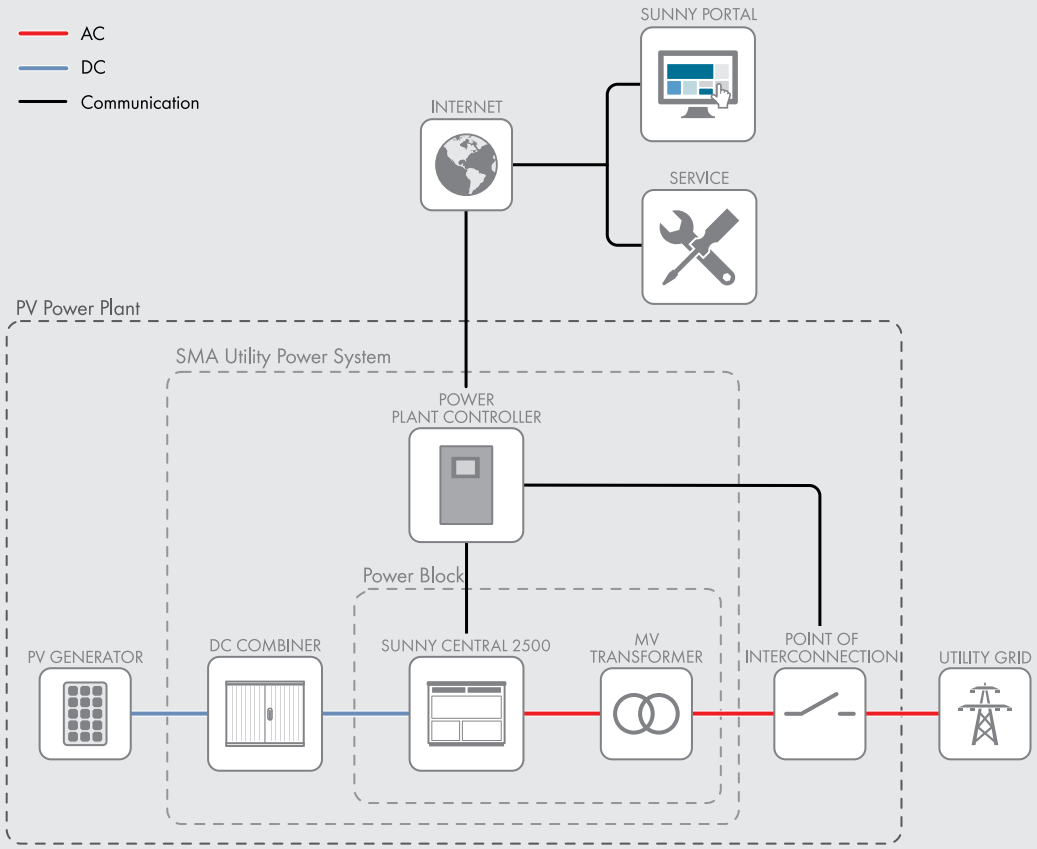
The Sunny Central 2500 inverter (2,475 kVA for 1,500 V DC at 25 °C) minimizes the total installed cost while maximizing the energy production of the photovoltaic power plant. Integrated control power, convenience power, network switch, DC recombiner and DC disconnect dramatically increase the speed to energization. The new Sunny Central can connect to virtually any grid in the harshest conditions. It is suitable for global outdoor installation with its proven OptiCool™ precision air cooling technology ensuring smooth operation even under extreme environmental conditions.

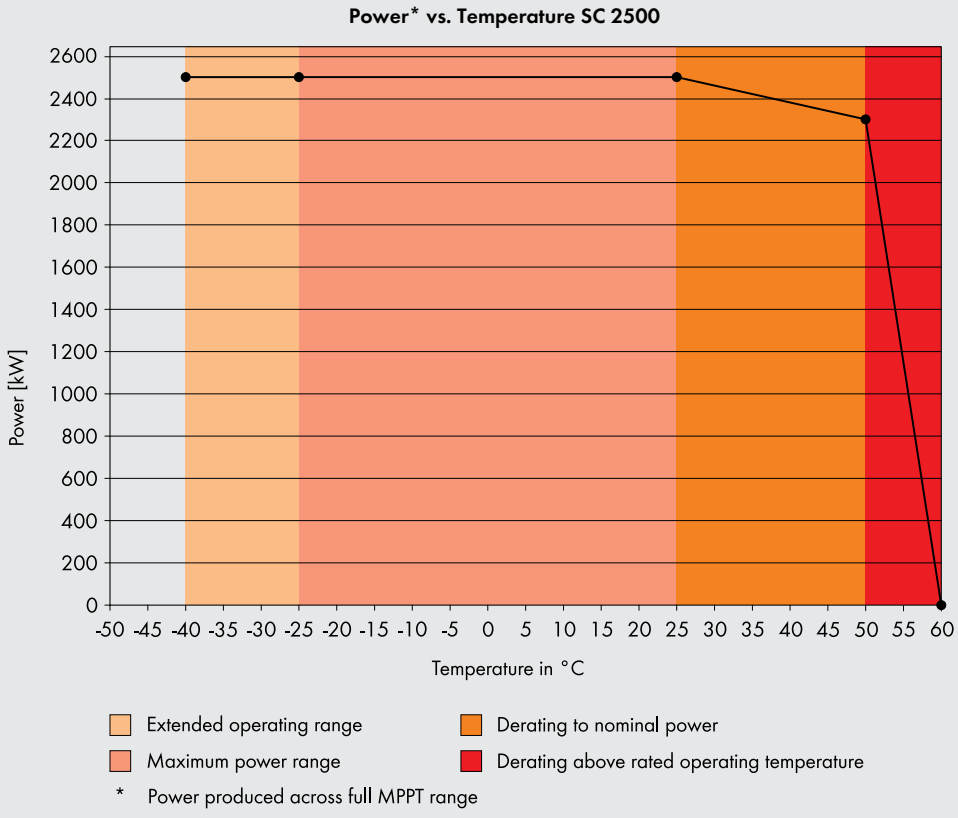
# SUNNY CENTRAL 2500

1) Preliminary values
2) CEC efficiency includes all control power
3) Power derated above 50°C, 0 KVA above 60°C

| Technical data | SC 2500 |
|---|---|
| **Input (DC)** | |
| MPP voltage range $V_{DC}$ | 840 V to 1,500 V |
| Max. input voltage $V_{DC, max}$ | 1,500 V |
| Max. input current $I_{DC, max}$ (@ 25°C / @ 50°C) | 3,000 A / 2,700 A |
| Number of DC inputs | 24 |
| Max. number of DC cables per DC input (for each polarity) | 2 x 800 kcmil, 2 x 400 mm² |
| Integrated zone monitoring (±0.5% shunt resistors) | o |
| Available DC fuse sizes (per input) | 200 A, 250 A, 315 A, 350 A, 400 A, 450 A |
| **Output (AC)** | |
| Nominal AC power (@ 25°C / @ 40°C / @ 50°C) | 2,475 kVA / 2,340 kVA / 2,250 kVA |
| Nominal AC power at cos ϕ =0.9 (@ 25°C / @ 40°C / @ 50°C) | 2,227 kW / 2,106 kW / 2,025 kW |
| Max. output current $I_{AC, max}$ | 2,598 A |
| Nominal AC current $I_{AC, nom}$ | 2,362 A |
| Max. total harmonic distortion | < 3% at nominal power |
| Nominal AC voltage / nominal AC voltage range | 550 V / 440 to 660 V |
| AC power frequency | 50 Hz, 60 Hz |
| Power factor at rated power/displacement power factor adjustable | 1 / 0.8 leading to 0.8 lagging |
| **Efficiency** [1] | |
| Max. efficiency / European weighted efficiency / CEC weighted efficiency[2] | 98.4% / 98.1% / 98.0% |
| **Protective and disconnection devices** | |
| Input-side disconnection point | DC load-break switch |
| Output-side disconnection point | AC circuit breaker |
| DC overvoltage protection | Surge arrester, type II |
| Ground-fault monitoring / remote ground-fault monitoring | o / o |
| Insulation monitoring | o |
| Degree of protection (as per IEC 60529) | IP54 |
| Degree of protection (as per NEMA) | 3R |
| **General data** | |
| Dimensions (W / H / D) | 2,761 mm / 2,300 mm / 1,668 mm (108.7 inch / 90.5 inch / 65.7 inch) |
| Weight | < 4,000 kg / < 8,819 lb |
| Max. self-consumption (operation) / self-consumption (stand-by) | < 8,100 W / < 300 W |
| Internal auxiliary power supply | Integrated 8.4 kVA transformer |
| Operating temperature range [3] | -25°C to 60°C / -13°F to 140°F |
| Extended operating temperature range | o (-40°C to 60°C / -40°F to 140°F) |
| Temperature range (stand-by) | -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) | 0% to 100% |
| Maximum operating altitude above MSL 2,000 m / 4,000 m | ● / o (with power reduction) |
| Fresh air consumption | 5,500 m³/h |
| **Features** | |
| DC connection | Terminal lug on each input or one busbar (without fuse) |
| AC connection | with busbar system (three busbars, one per line conductor) |
| Communication | Ethernet, Ethernet/IP, Modbus Master, Modbus Slave |
| Communication with SMA String-Monitor | Ethernet (optical fiber), Modbus |
| Enclosure / roof color | RAL 9016 / RAL 7004 |
| Display | HMI touchscreen (10.1") |
| Convenience power supply transformer | o (2.5 kVA) |
| Certificates and approvals | BDEW, EMC FCC Part 15 Class A, IEEE 1547, CE, UL 840 Category IV |
| | |
| | |
| | |
| | |
| ● Standard feature o Optional feature | |
| Type designation | SC-2500-EV-10 |

## PLANT DIAGRAM



# Exhibit B

# 2) ABB PVS980 Inverter

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***Attorneys for Vinton Solar Energy LLC***

Solar inverters

# ABB central inverters
# PVS980
# 1818 to 2000 kVA


**ABB central inverters raise reliability, efficiency and ease of installation to new levels. The inverters are aimed at system integrators and end users who require high-performance solar inverters for large photovoltaic (PV) power plants. PVS980 central inverters are available from 1818 kVA up to 2000 kVA, and are optimized for cost-effective, multi-megawatt power plants.**

## World's leading inverter platform

Like other ABB central inverters, the PVS980 has been developed on the basis of decades of experience in the industry and proven technology platform. Unrivalled expertise from the world's market and technology leader in frequency converters is the hallmark of this solar inverter series.

The PVS980 inverter is one of the most efficient and cost-effective ways of converting the direct current (DC) generated by solar modules into high-quality and $CO_2$-free alternating current (AC) that can be fed into the power distribution network.

## PVS980 central inverters from ABB

ABB PVS980 central inverters are ideal for large PV power plants. The high DC input voltage, high efficiency, proven components, compact and modular design and a host of life cycle services ensure ABB PVS980 central inverters provide a rapid return on investment.

## Highlights

- High total performance
- Outstanding endurance for outdoor use
- Compact, modular product design
- High DC input voltage up to 1500 $V_{DC}$
- Extensive DC and AC side protection
- Self-contained cooling system with high efficiency
- Versatile design for large-scale PV plants to minimize system costs
- Complete range of industrial data communication options, including remote monitoring
- Life cycle service and support through ABB's extensive global service network

# Maximum energy revenues

### Maximum energy revenues

ABB central inverters have a high total efficiency. Precise, optimized system control and maximum power point tracking (MPPT) combine with the unit's highly efficient power converter design to deliver the maximum energy from the PV modules to the power distribution network. For end users, this generates the highest possible revenues from the energy sales.

### Self-contained, low-maintenance cooling system

PVS980 inverters feature a proven closed loop cooling system used in other ABB industrial applications. This innovative, truly low-maintenance cooling solution is designed for demanding applications and harsh environments, cutting maintenance costs and ensuring outstanding endurance.

### Compact and modular design

PVS980 inverters are designed for fast and easy installation. The industrial design and modular platform provide a wide range of options, such as remote monitoring, fieldbus connection and modular and flexible DC input connections. The integrated DC saves space and costs as the solar array junction boxes can be connected directly to the fused busbars in the DC cabinet. PVS980 inverters are customized for the needs of end users and will be available with short delivery times.

### Versatile design for large-scale PV plants to minimize system costs

ABB's PVS980 central inverter enables system integrators to design PV power plants that use the optimum combination of inverters with different power ratings. Equipped with extensive electrical and mechanical protection, the inverters are engineered to provide a long and reliable service life of at least 25 years.

### Advanced grid support features

The PVS980 software includes all the latest grid support and monitoring features, including active power limitation, fault ride through (FRT) with current feed-in and reactive power control. Active and reactive power output can be controlled by an external control system or automatically by the inverter.

All grid support functions are parameterized, allowing easy adjusting for local utility requirements. ABB central inverters are also able to support grid stability at night by providing reactive power with the DC input disconnected.

# ABB central inverters

## PVS980

## 1818 to 2000 kVA


## High total performance

- High efficiency
- Low auxiliary power consumption
- Innovative controlled cooling
- Efficient maximum power point tracking
- Long and reliable service life of at least 25 years

## ABB self-contained cooling system

- Closed loop cooling system based on phase transition and thermosiphon technology
- Liquid-cooled inverter power ratings with the simplicity of air cooling
- No fillable liquids, pumps, valves, inhibitors or leaks
- Low maintenance

## Outstanding endurance for outdoor use

- Water- and dustproof outdoor enclosure
- Designed to withstand the toughest environments
- Long and reliable service life following the ABB life cycle model

## Versatile design for large-scale PV plants

- Integrated DC connection with variable number of inputs
- Wide standard option palette for tailoring
- Versatile AC connection methods

## Modular industrial design

- Compact and easy-to-maintain product design
- Fast and easy installation
- Integrated and flexible DC input section

## Minimizes system costs

- 1500 $V_{DC}$ system voltage
- Wide ranged and highly efficient MPPT algorithm
- Integrated protection to minimize external components
- Fast and easy installation and commissioning

## Life cycle service and support

- ABB's extensive global service network
- Extended warranties
- Service contracts
- Technical support throughout the service life

## Wide communication options

- Complete range of industrial data communication options for SCADA connections
- Ethernet/Internet Protocol
- Remote monitoring

# ABB central inverters

## PVS980

## 1818 to 2000 kVA

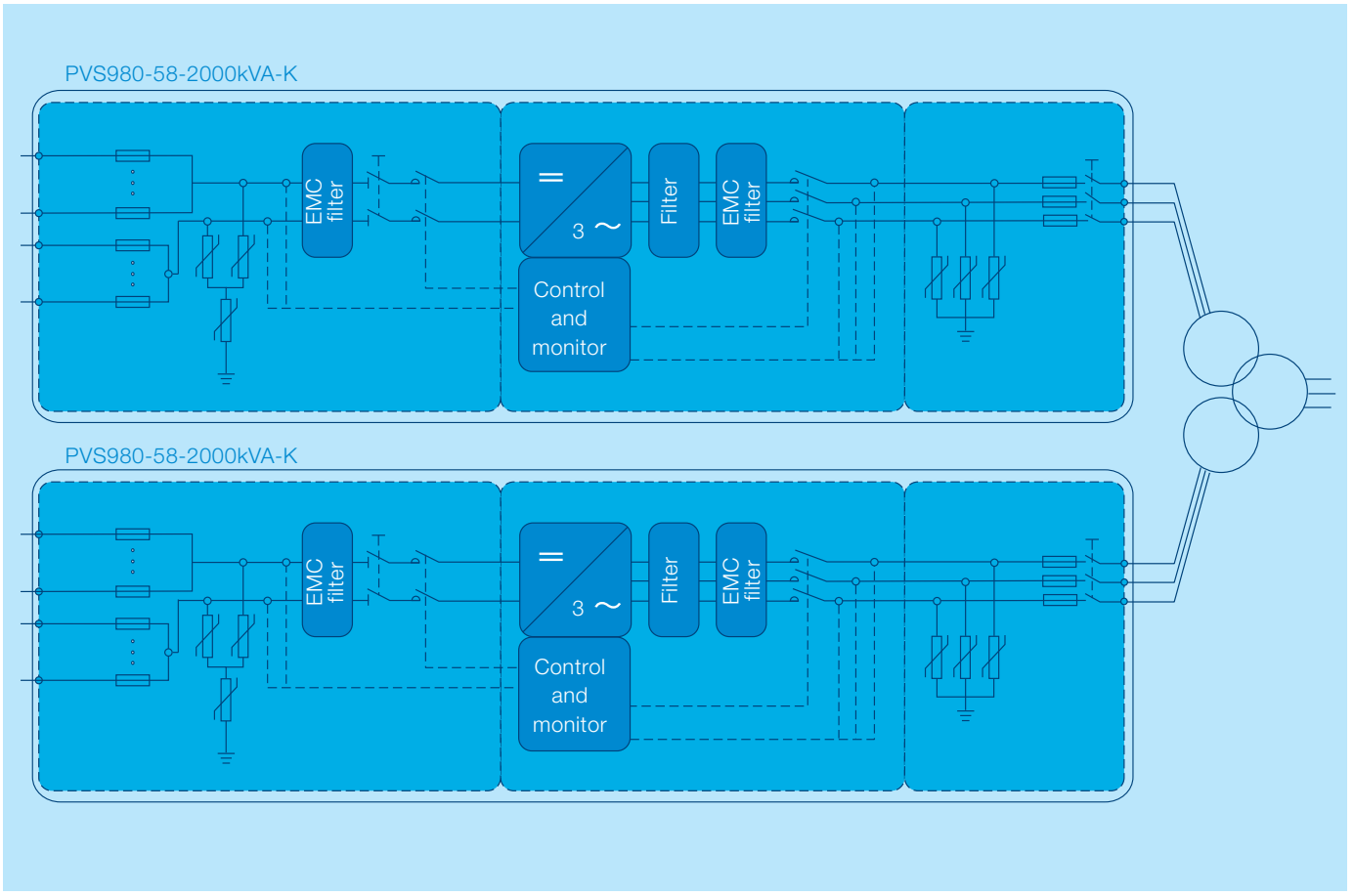


### Technical data and types

| Type designation<br>PVS980-58 | -1818kVA-I<br>1818 kVA | -1909kVA-J<br>1909 kVA | -2000kVA-K<br>2000 kVA |
|---|---|---|---|
| **Input (DC)** | | | |
| Maximum input power ($P_{PV,max}$) [1] | 2910 kWp | 3055 kWp | 3200 kWp |
| DC voltage range, mpp ($U_{DC, mpp}$) at 50 °C | 850 to 1100 V | 893 to 1100 V | 935 to 1100 V |
| DC voltage range, mpp ($U_{DC, mpp}$) at 35 °C | 850 to 1500 V | 893 to 1500 V | 935 to 1500 V |
| Maximum DC voltage ($U_{max (DC)}$) | 1500 V | 1500 V | 1500 V |
| Number of MPPT trackers | 1 | 1 | 1 |
| Number of protected DC inputs | 8 [2] to 24 (+/-) | 8 [2] to 24 (+/-) | 8 [2] to 24 (+/-) |
| **Output (AC)** | | | |
| Nominal power ($S_{N(AC)}$) [3] | 1818 kVA | 1909 kVA | 2000 kVA |
| Maximum output power ($S_{max (AC)}$) [4] | 2000 kVA | 2100 kVA | 2200 kVA |
| Nominal AC current ($I_{N(AC)}$) | 1750 A | 1750 A | 1750 A |
| Nominal output voltage ($U_{N(AC)}$) [5] | 600 V | 630 V | 660 V |
| Output frequency | 50/60 Hz | 50/60 Hz | 50/60 Hz |
| Harmonic distortion, current [6] | < 3% | < 3% | < 3% |
| Distribution network type [7] | TN and IT | TN and IT | TN and IT |
| **Efficiency** | | | |
| Maximum [8] | 98.8% | 98.8 % | 98.8% |
| Euro-eta [8] | 98.6% | 98.6 % | 98.6% |
| **Power consumption** | | | |
| Own consumption in operation | 2500 W | 2500 W | 2500 W |
| Standby operation consumption | 225 W | 225 W | 225 W |
| Auxiliary voltage type | internal | internal | internal |
| **Dimensions and weight** | | | |
| Width/Height/Depth, mm (W/H/D) | 3180/2366/1522 | 3180/2366/1522 | 3180/2366/1522 |
| Weight appr. | 3850 kg | 3850 kg | 3850 kg |

[1] DC/AC ratio over 1.6 might decrease time between maintenance intervals
[2] As standard
[3] At 50 °C
[4] At 35 °C
[5] ±10%
[6] At nominal power
[7] Inverter side must be IT type
[8] Without auxiliary power consumption at min $U_{DC}$

## ABB PVS980 central inverter design and power network connection

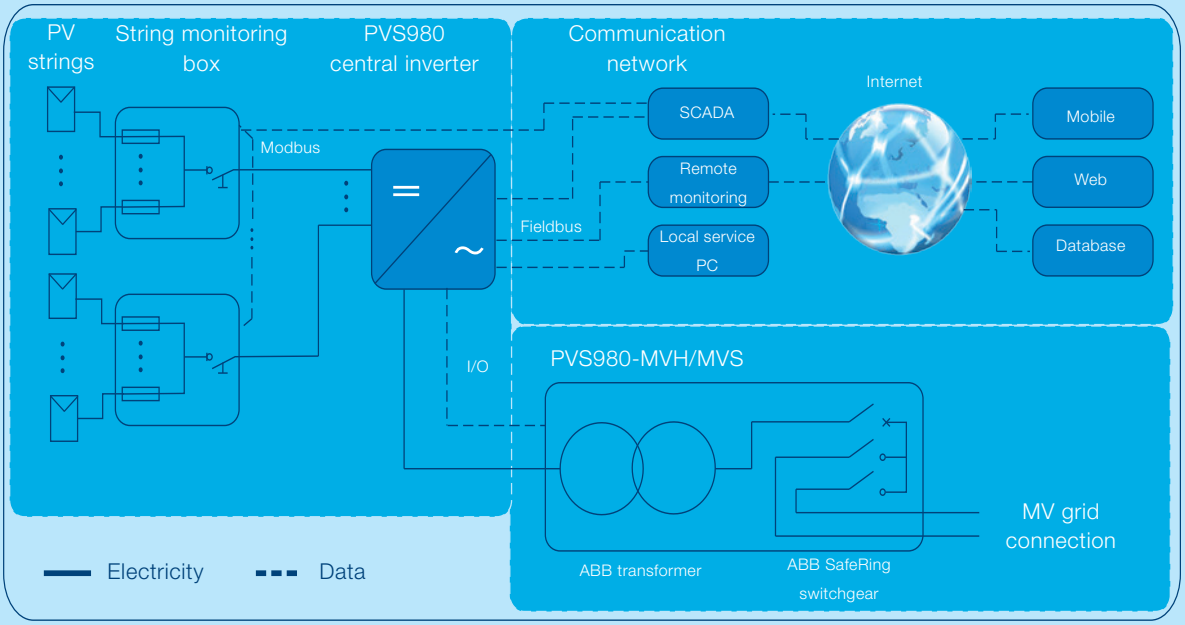



## Technical data and types

| Type designation<br>PVS980-58 | -1818kVA-I<br>1818 kVA | -1909kVA-J<br>1909 kVA | -2000kVA-K<br>2000 kVA |
|---|---|---|---|
| **Environmental limits** | | | |
| Degree of protection | IP65 [9]/Type 4X | | |
| Ambient temp. range (nom. ratings) [10] | -20 °C to +50 °C | | |
| Maximum ambient temperature [11] | +60°C | | |
| Relative humidity | 5% to 100% | | |
| Maximum altitude (above sea level) | 4000 m [12] | | |
| Maximum noise level | 85 dBA [13] | | |
| **Protection** | | | |
| Ground fault monitoring [14] | Yes | | |
| Grid monitoring | Yes | | |
| Anti-islanding | Yes | | |
| DC reverse polarity | Yes | | |
| AC and DC short circuit and overcurrent | Yes | | |
| AC and DC overvoltage and temperature | Yes | | |
| **User interface and communications** | | | |
| Local user interface | ABB local control panel | | |
| Analog inputs/outputs | Extendable as option | | |
| Digital inputs/relay outputs | Extendable as option | | |
| Fieldbus connectivity | Modbus, Profinet, Ethernet [14] | | |
| **Product compliance** | | | |
| Safety and EMC [15] | CE conformity according to LV and EMC directives | | |
| Certifications and approvals [15] | IEC, UL, CEI, RD, EDF, P.O. 12.3, BDEW, GOST, AS | | |
| Grid support and grid functions | Reactive power compensation [16], Power reduction, LVRT, Anti-islanding | | |

[9] Excluding underpressure testing
[10] -40 °C as option
[11] Power derating after 50 °C
[12] Derating above 1000 m
[13] At partial power typically < 75 dBA
[14] More communication options as engineered option
[15] Approvals pending, contact ABB for more information
[16] Also at night

## Data communication principle for ABB PVS980 central inverters




### Options

- Integrated and flexible DC input extension
- AC breaker
- AC busbar interface
- DC grounding (negative and positive)
- Fieldbus and Ethernet connections
- Current measurement to each DC input
- High altitude version
- Warranty extensions
- Solar inverter care contracts

### Related products

- Medium voltage station (transformer and switchgear) as outdoor or containerised solution
- String monitoring junction boxes
- Remote monitoring solutions

### Support and service

ABB supports its customers with a dedicated service network in more than 60 countries and provides a complete range of life cycle services from installation and commissioning to preventative maintenance, spare parts, repairs and recycling.

For more information please contact your local ABB representative or visit:

**www.abb.com/solarinverters**
**www.abb.com**



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Power and productivity for a better world™

# Exhibit B

# 3) Power Electric Inverter

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***Attorneys for Vinton Solar Energy LLC***

# HEC-US V1500

## UTILITY SCALE SOLAR INVERTER


EXTENDED MPPT
MPPt

AUTOMATIC REDUNDANT POWER MODULE SYSTEM
ARPMS

iCOOL V

ADJUSTABLE POWER
DAY
NIGHT

OUTDOOR DURABILITY

INGRESS PROTECTION

ACTIVE HEATING

3 LEVEL TOPOLOGY

## HEC-US V1500

The new Power Electronics HEC-US V1500 outdoor inverters are powerful and reliable 1500Vdc utility scale PV units for the US market. The HEC-US V1500 inverter family has 20 different UL-1741 certified models ranging from 1MW to 3MW with no derating at 50°C and a 98.5% CEC rated efficiency.

Power Electronics designs and manufactures 1700Vdc power converters for market leading customers in the mining, oil & gas and water industries and for the most demanding environments. With up to 7 425KW power modules connected in parallel, the HEC-US V1500 is a multilevel 1500Vdc system built on the Power Electronics expertise in >1,000Vdc systems and the proven Freesun HEC modular topology. The HEC-US V1500 has a standard stainless steel enclosure and best-in-class cooling at 50°C without derating to ensure reliable performance in the most demanding conditions.

Power Electronics offers customized NEC2014 compliant FSDK15 external DC Recombiner cabinets. The FSDK15 includes user specified overcurrent protection up to 400 Amps with 16 or 32 inputs to support higher ratio DC:AC PV designs. FSDK15 cabinets include current monitoring.

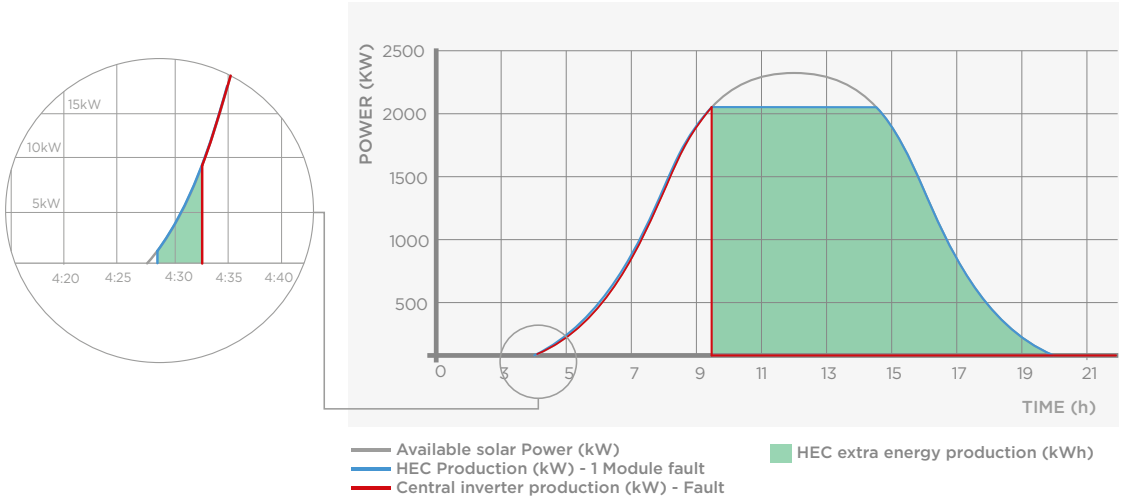
Power Electronics continues to evolve with the solar industry and the HEC-US V1500 is designed specifically to meet the new demand for 1500Vdc PV systems.

THE MOST POWERFUL AND RELIABLE 1500VDC UL-1741 CERTIFIED UTILITY-SCALE PV INVERTER IN THE MARKET

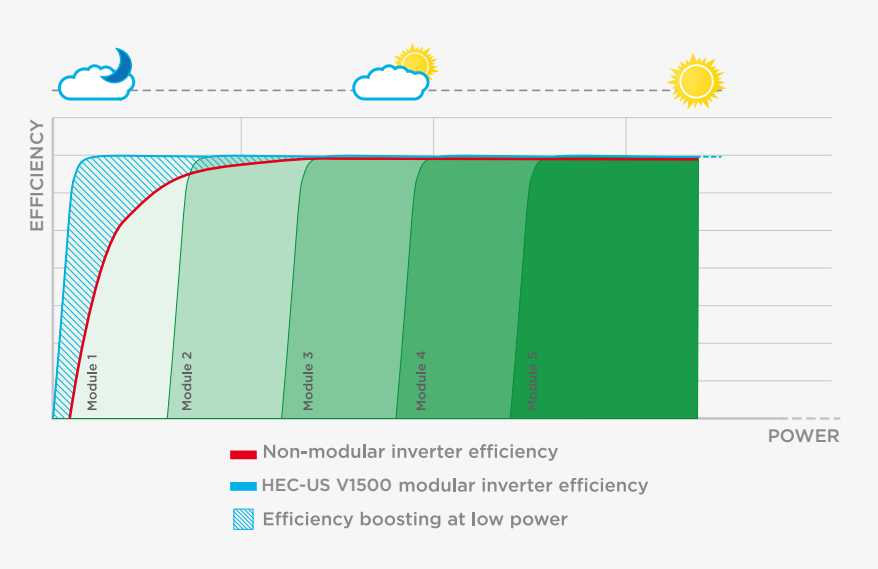
# AUTOMATIC REDUNDANT POWER MODULE SYSTEM (ARPMS)

The HEC-US V1500 topology combines the advantages of a central inverter with the availability of string inverters. HEC-US V1500 is a modular central inverter based on an Automatic Redundant Power Module (350kVA to 500kVA per stage).

If there is a fault in one power module, it is taken off-line and its output power is distributed evenly among the remaining functioning modules. All power modules work in parallel controlled by a dual redundant main control. As the main governor of the system it is responsible for the MPPt tracking, synchronization sequence and overall protection. The automatic redundant capability based on our industrial systems is able to shift the main control in the event of a fault, restoring the backup control and restarting the station to guarantee high availability. (patent pending)




A modular inverter is more efficient than a standard central inverter. During low radiation conditions, a modular architecture uses the correct number of power modules to provide power, while a central inverter must consume power internally to support the entire system. With lower losses, a modular inverter can provide power earlier in the morning and stop later at the end of the day. As a result, throughout the entire service life of the PV plant, the HEC-US V1500 inverter generates higher yields than a standard central inverter with a higher reliability than string inverters.



## REVOLUTIONARY COOLING SYSTEM

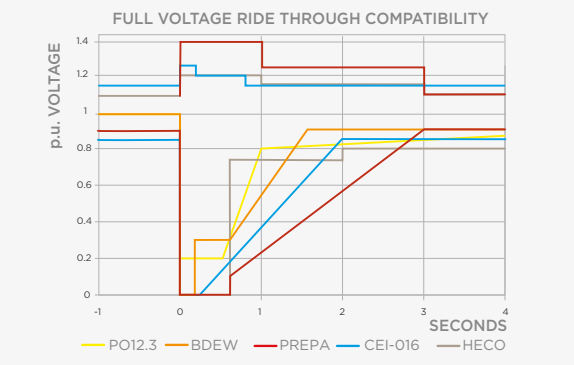
The Power Electronics HEC-US V1500 series includes the innovative and sophisticated iCOOL V performance that allows HEC-US V1500 to work up to 140°F (60°C) at nominal power. The cooling system iCOOL V smartly cools the inverter, regulating the cooling system capacity depending on data from the temperature sensors.

HEC-US V1500 modules are divided into two main areas: clean area (electronics) and hot area (heat sink). The electronics are totally sealed in a NEMA4 area and use a temperature control low flow cooling system that reduces filters clogging and maintenance intervals. The hot area integrates a speed controlled fan for each module, simplifying the cooling system and reducing the maintenance tasks.

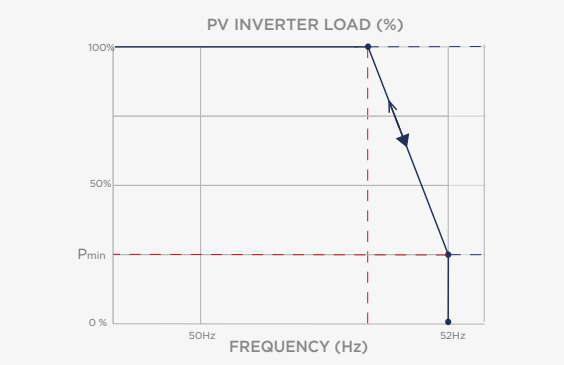
Furthermore, due to the modular topology, the iCOOL V reduces the Stand-by consumption at low capacity to the maximum, boosting the cooling capacity for photovoltaic installations situated up to 4000 meters above sea level. (patent pending)

# DYNAMIC GRID SUPPORT

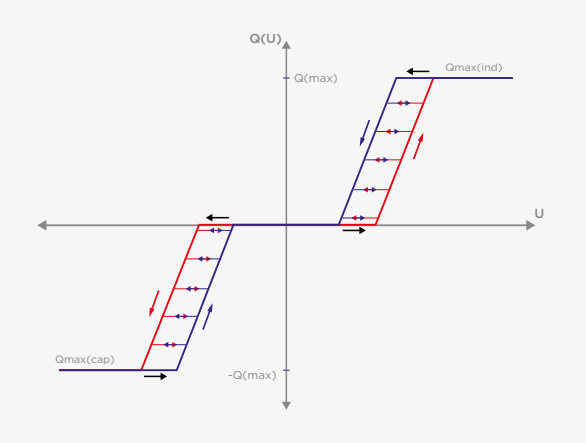
HEC-US V1500 firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment...), and is compatible with all the specific requirements of the utilities.

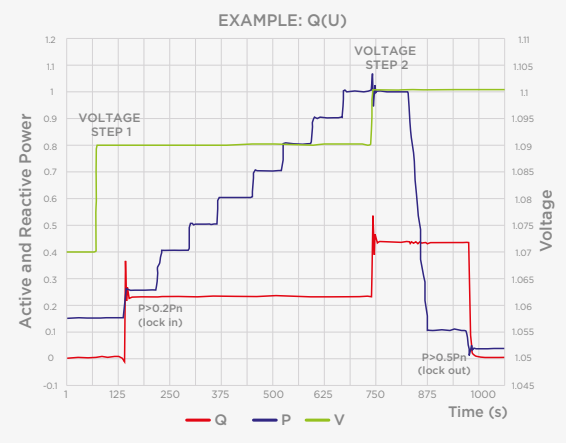



▲ **LVRT or ZVRT (Low Voltage Ride Through).** Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive power, as long as the protection limits are not exceeded.

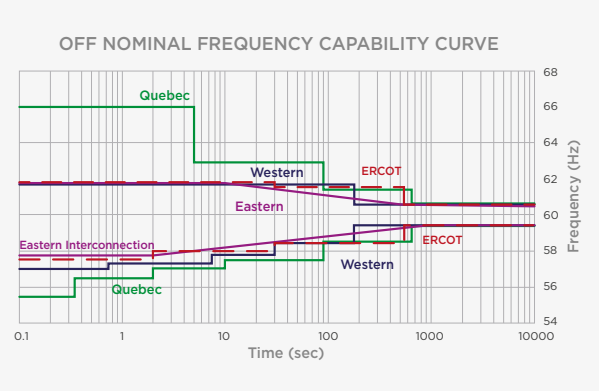



▲ **FRS (Frequency Regulation System).** Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

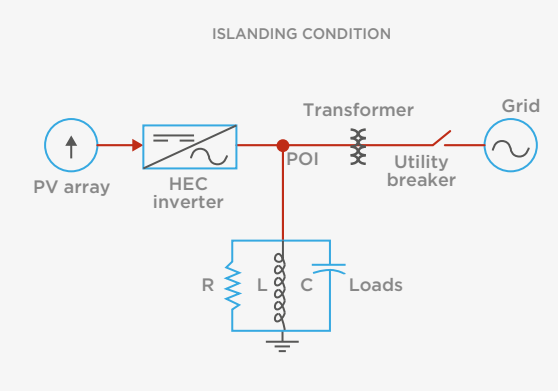



▲ **Q(V) curve:** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.




▲ **FRT (Frequency Ride Through):** Freesun solar inverters have flexible frequency protection settings, and can be easily adjusted to comply with future requirements.




▲ **Anti-islanding:** This protection combines passive and active methods that eliminates nuisance tripping and reduces grid distortion according to IEC 62116 and IEEE1547.


## VAR AT NIGHT

At night, the HEC-US V1500 inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).


## EASY TO MONITOR

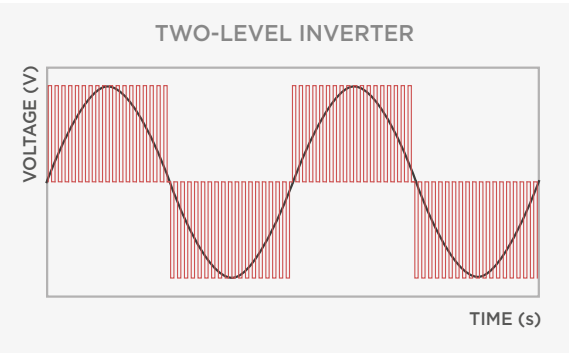
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors. The app user friendly interface allows quick and easy access to critical information (energy registers, production and events).

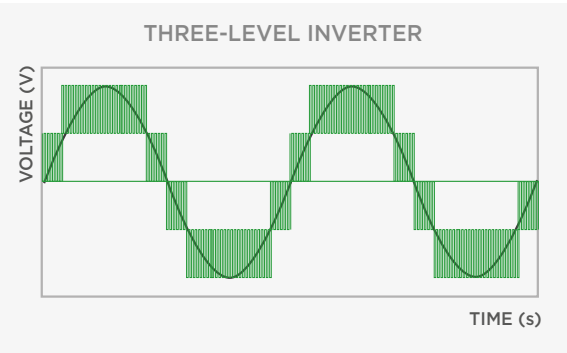

## ACTIVE HEATING

At night, when the unit is not actively exporting power, the inverter can import a small amount of power to keep the inverter internal ambient temperature above -20°C, without using external resistors. This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing the inverters availability and reducing the maintenance. (patent pending)


## MULTILEVEL TOPOLOGY

The multilevel IGBT topology makes the difference in the 1500Vdc technology, being the most efficient way to manage high DC link voltages. Based in our long IGBT experience components used in the HEC PLUS series, the HEC-US V1500 takes profit of the three level IGBT topology reducing the power stage losses, increasing the efficiency and offering a very low total harmonic distortion.



# HEC-US V1500

## TECHNICAL CHARACTERISTICS

| | | 690VAC - MPPt Window 976V-1310V | | | | |
|---|---|---|---|---|---|---|
| | | FRAME 3 | FRAME 4 | FRAME 5 | FRAME 6 | FRAME 7 |
| NUMBER OF MODULES | | 3 | 4 | 5 | 6 | 7 |
| REFERENCE | | FS1275CU15 | FS1700CU15 | FS2125CU15 | FS2550CU15 | FS3000CU15 |
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 1275 | 1700 | 2125 | 2550 | 3000 |
| | AC Output Power(kVA/kW) @25°C [1] | 1530 | 2040 | 2550 | 3060 | 3500 |
| | AC Output Power(kW) @50°C; PF=0.9 | 1150 | 1530 | 1910 | 2250 | 2700 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 690V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 60Hz | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | |
| | Power Factor (cosine phi) [2] | 0.0 leading ... 0.0 lagging / Reactive Power injection at night | | | | |
| | Power Curtailment (kVA) | 0...100% / 0.1% Steps | | | | |
| INPUT | MPPt @full power (VDC) [1] | 976V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Minimum Start Voltage | 1100V - User configurable | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| EFFICIENCY & AUX. SUPPLY | Efficiency (Max) (η) | 98.5% | 98.7% | 98.7% | 98.7% | 98.7% |
| | CEC (η) | 98.0% | 98.5% | 98.5% | 98.5% | 98.5% |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 120V / 208VAC–6kVA power supply available for external equipment (optional) | | | | |
| CABINET | Dimensions [WxDxH] [inches] | 119.6"x37.2"x86.5" | 147.6"x37.2"x86.5" | 175.7"x37.2"x86.5" | 203.8"x37.2"x86.5" | 231.9"x37.2"x86.5" |
| | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Weight (lbs) | 5809 | 7253 | 8697 | 10141 | 11585 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| ENVIRON-MENT | Degree of protection | NEMA 3R | | | | |
| | Permissible Ambient Temperature | -31°F to +140°F, -35°C[3] to +60°C / Active Power derating >50°C/122°F | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | |
| | Max. Altitude (above sea level) | 2000m / >2000m power derating (Max. 4000m) | | | | |
| | Noise level [4] | < 79 dBA | | | | |
| CONTROL INTERFACE | Interface | Graphic Display (inside cabinet) / Optional Freesun App | | | | |
| | Communication protocol | Modbus TCP | | | | |
| | Power Plant Controller | Optional | | | | |
| | Keyed ON/OFF switch | Standard | | | | |
| | Digital I/O | User configurable | | | | |
| | Analog I/O | User configurable | | | | |
| PROTECTIONS | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>NEC2014 Grounded PV Array: GFDI protection<br>Optional PV Array transfer kit: GFDI and Isolation monitoring device | | | | |
| | Humidity control | Active Heating | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | |
| | General DC Protection & Disconn. | External Disconnecting Unit Cabinet | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | |
| | Module DC Protection | DC fuses | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | |
| CERTI-FICA-TIONS | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | |

NOTES [1] Values at 1.00•Vac nom and cos Φ= 1. Consult Power Electronics for derating curves.
[2] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$
[3] Heating kit option required below -20°C.
[4] Sound pressure level at a distance of 1m from the rear part.

# HEC-US V1500

## TECHNICAL CHARACTERISTICS

| | | 645VAC - MPPt Window 913V-1310V | | | | |
|---|---|---|---|---|---|---|
| | | FRAME 3 | FRAME 4 | FRAME 5 | FRAME 6 | FRAME 7 |
| NUMBER OF MODULES | | 3 | 4 | 5 | 6 | 7 |
| REFERENCE | | FS1200CU15 | FS1600CU15 | FS2000CU15 | FS2400CU15 | FS2800CU15 |
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 1200 | 1600 | 2000 | 2400 | 2800 |
| | AC Output Power(kVA/kW) @25°C [1] | 1430 | 1910 | 2390 | 2860 | 3345 |
| | AC Output Power(kW) @50°C; PF=0.9 | 1080 | 1440 | 1800 | 2160 | 2520 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 645V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 60Hz | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | |
| | Power Factor (cosine phi) [2] | 0.0 leading ... 0.0 lagging / Reactive Power injection at night | | | | |
| | Power Curtailment (kVA) | 0...100% / 0.1% Steps | | | | |
| INPUT | MPPt @full power (VDC) [1] | 913V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Minimum Start Voltage | 1075V - User configurable | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| EFFICIENCY & AUX. SUPPLY | Efficiency (Max) (η) | 98.4% | 98.5% | 98.6% | 98.6% | 98.6% |
| | CEC (η) | 98.0% | 98.0% | 98.5% | 98.5% | 98.5% |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 120V / 208VAC–6kVA power supply available for external equipment (optional) | | | | |
| CABINET | Dimensions [WxDxH] [inches] | 119.6"x37.2"x86.5" | 147.6"x37.2"x86.5" | 175.7"x37.2"x86.5" | 203.8"x37.2"x86.5" | 231.9"x37.2"x86.5" |
| | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Weight (lbs) | 5809 | 7253 | 8697 | 10141 | 11585 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| ENVIRON-MENT | Degree of protection | NEMA 3R | | | | |
| | Permissible Ambient Temperature | -31°F to +140°F, -35°C[3] to +60°C / Active Power derating >50°C/122°F | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | |
| | Max. Altitude (above sea level) | 2000m / >2000m power derating (Max. 4000m) | | | | |
| | Noise level [4] | < 79 dBA | | | | |
| CONTROL INTERFACE | Interface | Graphic Display (inside cabinet) / Optional Freesun App display | | | | |
| | Communication protocol | Modbus TCP | | | | |
| | Power Plant Controller | Optional | | | | |
| | Keyed ON/OFF switch | Standard | | | | |
| | Digital I/O | User configurable | | | | |
| | Analog I/O | User configurable | | | | |
| PROTECTIONS | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>NEC2014 Grounded PV Array: GFDI protection<br>Optional PV Array transfer kit: GFDI and Isolation monitoring device | | | | |
| | Humidity control | Active Heating | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | |
| | General DC Protection & Disconn. | External Disconnecting Unit Cabinet | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | |
| | Module DC Protection | DC fuses | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | |
| CERTI-FICA-TIONS | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | |

NOTES [1] Values at 1.00•Vac nom and cos Φ= 1. Consult Power Electronics for derating curves.
[2] Consult P-Q charts available: Q(kVAr)=√(S(kVA)²-P(kW)²)
[3] Heating kit option required below -20°C.
[4] Sound pressure level at a distance of 1m from the rear part.

# HEC-US V1500

## TECHNICAL CHARACTERISTICS

| | | 600VAC - MPPt Window 849V-1310V | | | | |
|---|---|---|---|---|---|---|
| | | FRAME 3 | FRAME 4 | FRAME 5 | FRAME 6 | FRAME 7 |
| NUMBER OF MODULES | | 3 | 4 | 5 | 6 | 7 |
| REFERENCE | | FS1100CU15 | FS1475CU15 | FS1850CU15 | FS2225CU15 | FS2600CU15 |
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 1100 | 1475 | 1850 | 2225 | 2600 |
| | AC Output Power(kVA/kW) @25°C [1] | 1335 | 1780 | 2225 | 2660 | 3110 |
| | AC Output Power(kW) @50°C; PF=0.9 | 990 | 1325 | 1665 | 2000 | 2340 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 600V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 60Hz | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | |
| | Power Factor (cosine phi) [2] | 0.0 leading ... 0.0 lagging / Reactive Power injection at night | | | | |
| | Power Curtailment (kVA) | 0...100% / 0.1% Steps | | | | |
| INPUT | MPPt @full power (VDC) [1] | 849V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Minimum Start Voltage | 1050V - User configurable | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| EFFICIENCY & AUX. SUPPLY | Efficiency (Max) (η) | 98.4% | 98.5% | 98.6% | 98.6% | 98.6% |
| | CEC (η) | 98.0% | 98.0% | 98.5% | 98.5% | 98.5% |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 120V / 208VAC–6kVA power supply available for external equipment (optional) | | | | |
| CABINET | Dimensions [WxDxH] [inches] | 119.6"x37.2"x86.5" | 147.6"x37.2"x86.5" | 175.7"x37.2"x86.5" | 203.8"x37.2"x86.5" | 231.9"x37.2"x86.5" |
| | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Weight (lbs) | 5809 | 7253 | 8697 | 10141 | 11585 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| ENVIRON-MENT | Degree of protection | NEMA 3R | | | | |
| | Permissible Ambient Temperature | -31°F to +140°F, -35°C[3] to +60°C / Active Power derating >50°C/122°F | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | |
| | Max. Altitude (above sea level) | 2000m / >2000m power derating (Max. 4000m) | | | | |
| | Noise level [4] | < 79 dBA | | | | |
| CONTROL INTERFACE | Interface | Graphic Display (inside cabinet) / Optional Freesun App | | | | |
| | Communication protocol | Modbus TCP | | | | |
| | Power Plant Controller | Optional | | | | |
| | Keyed ON/OFF switch | Standard | | | | |
| | Digital I/O | User configurable | | | | |
| | Analog I/O | User configurable | | | | |
| PROTECTIONS | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>NEC2014 Grounded PV Array: GFDI protection<br>Optional PV Array transfer kit: GFDI and Isolation monitoring device | | | | |
| | Humidity control | Active Heating | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | |
| | General DC Protection & Disconn. | External Disconnecting Unit Cabinet | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | |
| | Module DC Protection | DC fuses | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | |
| CERTI-FICA-TIONS | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | |

NOTES [1] Values at 1.00•Vac nom and cos Φ= 1. Consult Power Electronics for derating curves.
[2] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$
[3] Heating kit option required below -20°C.
[4] Sound pressure level at a distance of 1m from the rear part.

# HEC-US V1500

## TECHNICAL CHARACTERISTICS

| | | 565VAC - MPPt Window 800V-1310V | | | | |
|---|---|---|---|---|---|---|
| | | FRAME 3 | FRAME 4 | FRAME 5 | FRAME 6 | FRAME 7 |
| NUMBER OF MODULES | | 3 | 4 | 5 | 6 | 7 |
| REFERENCE | | FS1050CU15 | FS1400CU15 | FS1750CU15 | FS2100CU15 | FS2450CU15 |
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 1050 | 1400 | 1750 | 2100 | 2450 |
| | AC Output Power(kVA/kW) @25°C [1] | 1250 | 1675 | 2090 | 2510 | 2930 |
| | AC Output Power(kW) @50°C; PF=0.9 | 945 | 1260 | 1575 | 1890 | 2205 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 565V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 60Hz | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | |
| | Power Factor (cosine phi) [2] | 0.0 leading ... 0.0 lagging / Reactive Power injection at night | | | | |
| | Power Curtailment (kVA) | 0...100% / 0.1% Steps | | | | |
| INPUT | MPPt @full power (VDC) [1] | 800V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Minimum Start Voltage | 1050V - User configurable | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| EFFICIENCY & AUX. SUPPLY | Efficiency (Max) (η) | 98.2% | 98.4% | 98.5% | 98.5% | 98.5% |
| | CEC (η) | 98.0% | 98.0% | 98.0% | 98.5% | 98.5% |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 120V / 208VAC–6kVA power supply available for external equipment (optional) | | | | |
| CABINET | Dimensions [WxDxH] [inches] | 119.6"x37.2"x86.5" | 147.6"x37.2"x86.5" | 175.7"x37.2"x86.5" | 203.8"x37.2"x86.5" | 231.9"x37.2"x86.5" |
| | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Weight (lbs) | 5809 | 7253 | 8697 | 10141 | 11585 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| ENVIRON-MENT | Degree of protection | NEMA 3R | | | | |
| | Permissible Ambient Temperature | -31°F to +140°F, -35°C[3] to +60°C / Active Power derating >50°C/122°F | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | |
| | Max. Altitude (above sea level) | 2000m / >2000m power derating (Max. 4000m) | | | | |
| | Noise level [4] | < 79 dBA | | | | |
| CONTROL INTERFACE | Interface | Graphic Display (inside cabinet) / Optional Freesun App | | | | |
| | Communication protocol | Modbus TCP | | | | |
| | Power Plant Controller | Optional | | | | |
| | Keyed ON/OFF switch | Standard | | | | |
| | Digital I/O | User configurable | | | | |
| | Analog I/O | User configurable | | | | |
| PROTECTIONS | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>NEC2014 Grounded PV Array: GFDI protection<br>Optional PV Array transfer kit: GFDI and Isolation monitoring device | | | | |
| | Humidity control | Active Heating | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | |
| | General DC Protection & Disconn. | External Disconnecting Unit Cabinet | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | |
| | Module DC Protection | DC fuses | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | |
| CERTI-FICA-TIONS | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | |

NOTES [1] Values at 1.00•Vac nom and cos Φ= 1. Consult Power Electronics for derating curves.
[2] Consult P-Q charts available: Q(kVAr)=√(S(kVA)²-P(kW)²)
[3] Heating kit option required below -20°C.
[4] Sound pressure level at a distance of 1m from the rear part.

# Exhibit B

# 4) Ingecon SUN Inverter

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

INGECON SUN

PowerMax B Series
1,500 Vdc

# 1170TL U B450 / 1400TL U B540 / 1500TL U B578 / 1560TL U B600 / 1600TL U B615 / 1640TL U B630

## TRANSFORMERLESS CENTRAL INVERTERS WITH A SINGLE POWER BLOCK

**Maximum power density**
These PV central inverters feature more power per cubic foot. Thanks to the use of high-quality components, this inverter series performs at the highest possible level.

**Latest generation electronics**
The B Series inverters integrate an innovative control unit that runs faster and performs a more efficient and sophisticated inverter control, as it uses a last-generation digital signal processor. Furthermore, the hardware of the control unit allows some more accurate measurements and very reliable protections.

These inverters feature a low voltage ride-through capability and also a lower power consumption thanks to a more efficient power supply electronic board.

**Integrated DC and AC connections**
The input and output connections are integrated into the same cabinet, facilitating connection, maintenance and repair work.

**Maximum protection**
These three phase inverters are equipped with a motorized DC switch to decouple the PV generator from the inverter.

These inverters are supplied with an AC circuit breaker. Optionally, they can be supplied with DC fuses, grounding kit and input current monitoring.

**Maximum efficiency values**
Through the use of innovative electronic conversion topologies, efficiency values of up to 98.9% can be achieved.

**A complete range of equipment for all types of projects**
Versions available:

- Indoor inverters.
- Outdoor inverters.
- Symmetrical inverters, with the connection cabinet on the opposite side, to make it possible to install two inverters facing each other, with a common power supply point.

**Enhanced functionality**
This new INGECON® SUN PowerMax range features a revamped, improved enclosure which, together with its innovative air cooling system, makes it possible to increase the ambient operating temperature.

UL 1741 COMPLIANT

www.ingeteam.com
solar.us@ingeteam.com

Ingeteam

# 1170TL U B450 / 1400TL U B540 / 1500TL U B578 / 1560TL U B600 / 1600TL U B615 / 1640TL U B630

**Long-lasting design**
These inverters have been designed to guarantee a long life expectancy. Standard 5 year warranty, extendable for up to 25 years.

**Grid support**
The INGECON® SUN PowerMax B Series has been designed to comply with the grid connection requirements UL1741, IEEE1547 and RULE21, contributing to the quality and stability of the electric system. These inverters therefore feature a low voltage ride-through capability, and can deliver reactive power and control the active power delivered to the grid.

**Ease of maintenance**
All the elements can be removed or replaced directly from the inverter's front side, thanks to its new design.

**Easy to operate**
The INGECON® SUN PowerMax inverters feature an LCD screen for the simple and convenient monitoring of the inverter status and a range of internal variables. The display also includes a number of LEDs to show the inverter operating status with warning lights to indicate any incidents. All this helps to simplify and facilitate maintenance tasks.

**Monitoring and communication**
Ethernet communications supplied as standard. The following applications are included at no extra cost: INGECON® SUN Manager, INGECON® SUN Monitor and its Smartphone version Web Monitor, available on the App Store. These applications are used for monitoring and recording the inverter's internal operating variables through the Internet (alarms, real time production, etc.), in addition to the historical production data.

Two communication ports available (one for monitoring and one for plant controlling), allowing fast and simultaneous plant control.

PROTECTIONS

- DC Reverse polarity.
- Short-circuits and overloads at the output.
- Anti-islanding with automatic disconnection.
- Insulation failure DC.
- Up to 15 pairs of fuse holders.
- Lightning induced DC and AC surge arrestors, type 2 (type 1 also available for the DC side).
- Motorized DC switch to automatically disconnect the inverter from the PV array.
- Low voltage ride-through capability.
- AC circuit breaker.
- Hardware protection via firmware.
- NEMA 4 / IP66 protection class for the electronics.

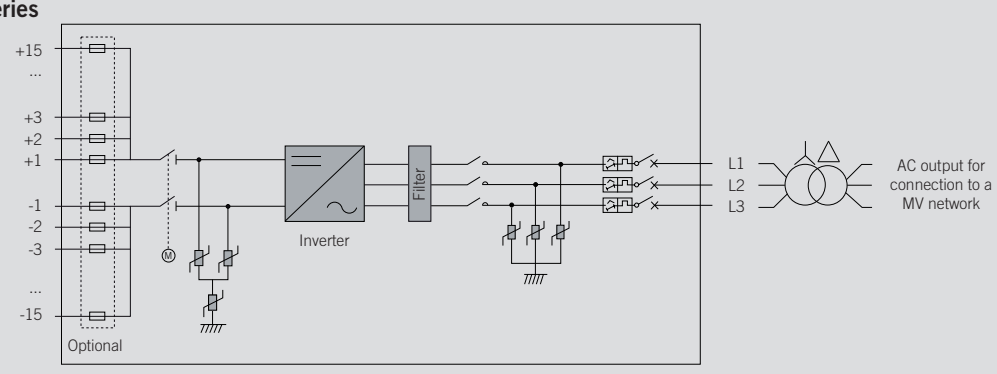
OPTIONAL ACCESSORIES

- Motorization kit for the AC circuit breaker.
- Insulation failure AC.
- Grounding kit.
- Heating kit, for operating at an ambient temperature of down to -22 ºF.
- DC fuses.
- Monitoring of the group currents at the DC input.
- Remote tripping of the AC circuit breaker.
- Wattmeter on the AC side.
- Extendable up to 15 fuse holders per inverter.
- PID prevention kit (PID: Potential Induced Degradation).
- Night time reactive power injection.

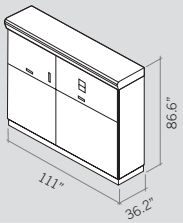
ADVANTAGES OF THE MONOBLOCK VERSION

- Higher power density.
- Latest generation electronics.
- More efficient electronic protection.
- Night time supply to communicate with the inverter at night.
- Enhanced performance.
- Easier maintenance thanks to its new design and enclosure.
- Lightweight spares.
- It allows to ground the PV array.
- Components easily replaceable.

**PowerMax B Series**




**Size and weight** (inches and lbs)




**1170TL U B450 / 1400TL U B540 / 1500TL U B578 / 1560TL U B600 / 1600TL U B615 / 1640TL U B630**
3,572 pounds

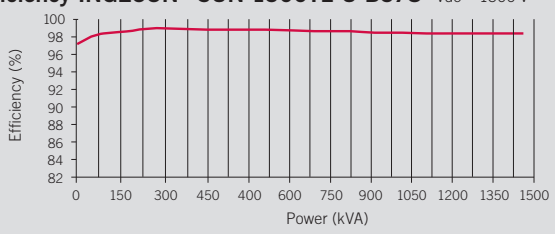
INGECON SUN

# PowerMax B Series 1,500 Vdc

| | 1170TL U B450 | 1400TL U B540 | 1500TL U B578 |
|---|---|---|---|
| **Input (DC)** | | | |
| Recommended PV array power range[1] | 1,072 - 1,469 kWp | 1,286 - 1,763 kWp | 1,377 - 1,887 kWp |
| Voltage Range MPP[2] | 660 - 1,300 V | 786 - 1,300 V | 840 - 1,300 V |
| Maximum voltage[3] | 1,500 V | | |
| Maximum current | 2,000 A | | |
| N° inputs with fuse-holders | 6 up to 15 | | |
| Fuse dimensions | 63 A / 1,500 V to 400 A / 1,500 V fuses (optional) | | |
| Type of connection | Connection to copper bars | | |
| Power blocks | 1 | | |
| MPPT | 1 | | |
| **Input protections** | | | |
| Overvoltage protections | Type 2 surge arresters (type 1 optional) | | |
| DC switch | Motorized DC load break disconnect | | |
| Other protections | Up to 15 pairs of DC fuses (optional) / Reverse polarity / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton | | |
| **Output (AC)** | | | |
| Power @77 °F / @122 °F[4] | 1,169 kVA / 975 kVA | 1,403 kVA / 1,169 kVA | 1,502 kVA / 1,251 kVA |
| Current @77 °F / @122 °F | 1,500 A / 1,250 A | | |
| Rated voltage | 450 V IT System | 540 V IT System | 578 V IT System |
| Frequency | 50 / 60 Hz | | |
| Power Factor[5] | 1 | | |
| Power Factor adjustable | Yes. Smax=1,169 kVA | Yes. Smax=1,403 kVA | Yes. Smax=1,502 kVA |
| THD (Total Harmonic Distortion)[6] | <3% | | |
| **Output protections** | | | |
| Overvoltage protections | Type 2 surge arresters | | |
| AC breaker | AC circuit breaker with door control, remote trip or motorized | | |
| Anti-islanding protection | Yes, with automatic disconnection | | |
| Other protections | AC short-circuits and overloads | | |
| **Features** | | | |
| Maximum efficiency | 98.9% | | |
| CEC | 98.5% | | |
| Max. consumption aux. services | 2,500 VA | | |
| Stand-by or night consumption[7] | < 90 W | | |
| Average energy consumption per day | 18 kWh | | |
| **General Information** | | | |
| Ambient temperature | -4 °F to +131 °F | | |
| Relative humidity (non-condensing) | 0-95% (Indoor) / 0-100% (Outdoor) | | |
| Protection class | NEMA12 (Indoor) / NEMA3 (Outdoor) | | |
| Max. altitude[8] | 6,562 ft (2,000 m) | | |
| Cooling system | Air forced with temperature control (230 V phase+ neutral power supply) | | |
| Air flow | 66.77 $ft^3/s$ (6,200 $m^3/h$) | | |
| Acoustic emission | <77 dB | | |
| Marking | CE, ETL | | |
| EMC and security standards | UL1741, FCC Part 15, IEEE C37.90.1, IEEE C37.90.2, CSA22.2 No107 | | |
| Grid connection standards | IEC 62116, UL1741, IEEE1547, IEEE1547.1, NEC CODE, Electric Rule 21: 2015, CSA22.2 No107 | | |

**Notes:** [1] Depending on the type of installation and geographical location. Data for STC conditions [2] Vmpp.min is for rated conditions (Vac=1 p.u. and Power Factor=1) [3] Consider the voltage increase of the 'Voc' at low temperatures [4] For each degree of increase between 77 °F and 122 °F, the output power will be reduced at the rate of 0.37%. Over 122 °F, the output power will be reduced at the rate of 1% for each degree of increase [5] For $P_{out}$>25% of the rated power [6] For $P_{out}$>25% of the rated power and voltage in accordance with IEC 61000-3-4 [7] Consumption from PV field when there is PV power available [8] Over 3,300 ft, temperature for rated power is reduced at the rate of 2.42 °F for each 3,300 ft. For installations beyond the maximum altitude, please contact Ingeteam's solar sales department.

**Efficiency INGECON® SUN 1500TL U B578** Vdc = 1500 V



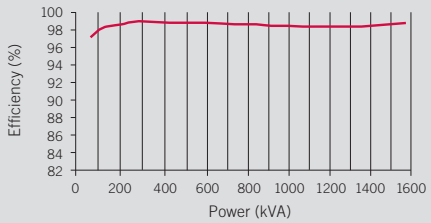
INGECON SUN

# PowerMax B Series 1,500 Vdc

| | 1560TL U B600 | 1600TL U B615 | 1640TL U B630 |
|---|---|---|---|
| **Input (DC)** | | | |
| Recommended PV array power range[1] | 1,429 - 1,959 kWp | 1,465 - 2,008 kWp | 1,500 - 2,057 kWp |
| Voltage Range MPP[2] | 870 - 1,300 V | 889 - 1,300 V | 915 - 1,300 V |
| Maximum voltage[3] | 1,500 V | | |
| Maximum current | 2,000 A | | |
| N° inputs with fuse-holders | 6 up to 15 | | |
| Fuse dimensions | 63 A / 1,500 V to 400 A / 1,500 V fuses (optional) | | |
| Type of connection | Connection to copper bars | | |
| Power blocks | 1 | | |
| MPPT | 1 | | |
| **Input protections** | | | |
| Overvoltage protections | Type 2 surge arresters (type 1 optional) | | |
| DC switch | Motorized DC load break disconnect | | |
| Other protections | Up to 15 pairs of DC fuses (optional) / Reverse polarity / Insulation failure monitoring / Anti-islanding protection / Emergency pushbutton | | |
| **Output (AC)** | | | |
| Power @77 °F / @122 °F[4] | 1,559 kVA / 1,299 kVA | 1,598 kVA / 1,332 kVA | 1,637 kVA / 1,364 kVA |
| Current @77 °F / @122 °F | 1,500 A / 1,250 A | | |
| Rated voltage | 600 V IT System | 615 V IT System | 630 V IT System |
| Frequency | 50 / 60 Hz | | |
| Power Factor[5] | 1 | | |
| Power Factor adjustable | Yes. Smax=1,559 kVA | Yes. Smax=1,598 kVA | Yes. Smax=1,637 kVA |
| THD (Total Harmonic Distortion)[6] | <3% | | |
| **Output protections** | | | |
| Overvoltage protections | Type 2 surge arresters (type 1 optional) | | |
| AC breaker | AC circuit breaker with door control, remote trip or motorized | | |
| Anti-islanding protection | Yes, with automatic disconnection | | |
| Other protections | AC short-circuits and overloads | | |
| **Features** | | | |
| Maximum efficiency | 98.9% | | |
| CEC | 98.5% | | |
| Max. consumption aux. services | 2,500 VA | | |
| Stand-by or night consumption[7] | < 90 W | | |
| Average energy consumption per day | 18 kWh | | |
| **General Information** | | | |
| Ambient temperature | -4 °F to +131 °F | | |
| Relative humidity (non-condensing) | 0-95% (Indoor) / 0-100% (Outdoor) | | |
| Protection class | NEMA12 (Indoor) / NEMA3 (Outdoor) | | |
| Max. altitude[8] | 6,562 ft (2,000 m) | | |
| Cooling system | Air forced with temperature control (230 V phase+ neutral power supply) | | |
| Air flow | 66.77 $ft^3/s$ (6,200 $m^3/h$) | | |
| Acoustic emission | <77 dB | | |
| Marking | CE, ETL | | |
| EMC and security standards | UL1741, FCC Part 15, IEEE C37.90.1, IEEE C37.90.2, CSA22.2 No107 | | |
| Grid connection standards | IEC 62116, UL1741, IEEE1547, IEEE1547.1, NEC CODE, Electric Rule 21: 2015, CSA22.2 No107 | | |

**Notes:** [1] Depending on the type of installation and geographical location. Data for STC conditions [2] Vmpp.min is for rated conditions (Vac=1 p.u. and Power Factor=1) [3] Consider the voltage increase of the 'Voc' at low temperatures [4] For each degree of increase between 77 °F and 122 °F, the output power will be reduced at the rate of 0.37%. Over 122 °F, the output power will be reduced at the rate of 1% for each degree of increase [5] For $P_{out}$>25% of the rated power [6] For $P_{out}$>25% of the rated power and voltage in accordance with IEC 61000-3-4 [7] Consumption from PV field when there is PV power available [8] Over 3,300 ft, temperature for rated power is reduced at the rate of 2.42 °F for each 3,300 ft. For installations beyond the maximum altitude, please contact Ingeteam's solar sales department.

## Efficiency INGECON® SUN 1640TL U B630 Vdc = 650 V



# Exhibit J

# Certificate of Liability Insurance

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

***Attorneys for Vinton Solar Energy LLC***

Exhibit J
Supplemented 7/31/18

# CERTIFICATE OF LIABILITY INSURANCE

DATE(MM/DD/YYYY)
06/06/2017

**THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.**

**IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).**

**PRODUCER**
Aon Risk Services Central, Inc.
Chicago IL Office
200 East Randolph
Chicago IL 60601 USA

**CONTACT NAME:**
**PHONE (A/C. No. Ext):** (866) 283-7122 **FAX (A/C. No.):** (800) 363-0105
**E-MAIL ADDRESS:**

| INSURER(S) AFFORDING COVERAGE | NAIC # |
|---|---|
| INSURER A: Federal Insurance Company | 20281 |
| INSURER B: | |
| INSURER C: | |
| INSURER D: | |
| INSURER E: | |
| INSURER F: | |

**INSURED**
Vinton Solar Energy LLC
One South Wacker
Suite 1900
Chicago IL 60606 USA

**COVERAGES** **CERTIFICATE NUMBER:** [redacted] **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS. **Limits shown are as requested**

| INSR LTR | TYPE OF INSURANCE | ADDL INSD | SUBR WVD | POLICY NUMBER | POLICY EFF (MM/DD/YYYY) | POLICY EXP (MM/DD/YYYY) | LIMITS | |
|---|---|---|---|---|---|---|---|---|
| A | X **COMMERCIAL GENERAL LIABILITY**<br>CLAIMS-MADE X OCCUR<br>GEN'L AGGREGATE LIMIT APPLIES PER:<br>POLICY X PRO-JECT X LOC<br>OTHER: | | | [redacted] | 06/01/2017 | 06/01/2018 | EACH OCCURRENCE<br>DAMAGE TO RENTED PREMISES (Ea occurrence)<br>MED EXP (Any one person)<br>PERSONAL & ADV INJURY<br>GENERAL AGGREGATE<br>PRODUCTS - COMP/OP AGG | $1,000,000<br>$1,000,000<br>$25,000<br>$2,000,000<br>$2,000,000<br>Included |
| A | **AUTOMOBILE LIABILITY**<br>X ANY AUTO<br>OWNED AUTOS ONLY<br>HIRED AUTOS ONLY<br>SCHEDULED AUTOS<br>NON-OWNED AUTOS ONLY | | | [redacted] | 06/01/2017 | 06/01/2018 | COMBINED SINGLE LIMIT (Ea accident)<br>BODILY INJURY ( Per person)<br>BODILY INJURY (Per accident)<br>PROPERTY DAMAGE (Per accident) | $1,000,000 |
| A | X **UMBRELLA LIAB** X OCCUR<br>**EXCESS LIAB** CLAIMS-MADE<br>DED RETENTION | | | [redacted] | 06/01/2017 | 06/01/2018 | EACH OCCURRENCE<br>AGGREGATE | $25,000,000<br>$25,000,000 |
| A | **WORKERS COMPENSATION AND EMPLOYERS' LIABILITY**<br>ANY PROPRIETOR / PARTNER / EXECUTIVE OFFICER/MEMBER EXCLUDED? Y/N: N<br>**(Mandatory in NH)**<br>If yes, describe under DESCRIPTION OF OPERATIONS below | N / A | | [redacted] | 06/01/2017 | 06/01/2018 | X PER STATUTE OTH-ER<br>E.L. EACH ACCIDENT<br>E.L. DISEASE-EA EMPLOYEE<br>E.L. DISEASE-POLICY LIMIT | <br>$1,000,000<br>$1,000,000<br>$1,000,000 |

**DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)**

Location: Vinton County, OH
Evidence of Insurance

**CERTIFICATE HOLDER**

Vinton Solar Energy LLC
One South Wacker
Suite 1900
Chicago IL 60606 USA

**CANCELLATION**

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

**AUTHORIZED REPRESENTATIVE**

Aon Risk Services Central, Inc.

Holder Identifier :

Certificate No : 570066705236

Summary: Notification of Release of Exhibit A, and Portions of Exhibits B and J to the Public Record electronically filed by Christine M.T. Pirik on behalf of Vinton Solar Energy LLC