FIELD
ENGINEERING CO., INC.
CONSULTING ENGINEERS

11D Industrial Drive, P.O. Box 1178
Mattapoisett, Massachusetts 02739
Telephone: (508) 758-2749
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March 17, 2021
Project No. 2312

Mr. Stephen Seredynski, Chair
Northfield Planning Board
69 Main Street
Northfield, MA 01360

**RE: Response to Consultant Comments**
**Proposed Pine Meadow Road Solar Array "A"**
**BWC Pine Meadow Brook LLC**
**Off Pine Meadow Road, Northfield, Massachusetts**

Dear Board Members:

Field Engineering Co., Inc. ("FEC") and BWC Pine Meadow Brook LLC ("BWC") has received the review comment letter dated February 8, 2021 prepared by Beacon Integrated Solutions related to the above referenced project and has prepared the following response narrative and supporting documentation for consideration by the Board. Section headings and numbering correspond to the numbering in the Beacon Letter.

BEACON COMMENT: Agricultural Covenant-Beacon recommends that in connection with its application for a Building Permit, the Planning Board should require The Applicant to provide proof of release of the parcels under review in this application.

**FEC/BWC RESPONSE: The Agricultural Covenant was released on February 15th, 2021, please see Exhibit A for the recorded release.**

BEACON COMMENT: Building Permit-Section 11.08.03.02 Beacon recommends that The Applicant provide final construction drawings to the Planning Board, stamped by a licensed professional engineer register in MA prior to seeking a Building Permit.

**FEC/BWC RESPONSE: The Applicant agrees to provide to the Planning Board final construction drawings, stamped by a licensed professional engineer registered in MA prior to submitting and application for a Building Permit.**

BEACON COMMENT: Site Plan Review - (2) Required Documents - (a) Site Plan showing - ii. Proposed changes to the landscape- Beacon recommends that the Planning Board require additional information on the design, use and operation of the Hoop Houses.

**FEC/BWC RESPONSE: Jesse Robertson-Dubois has provided an overview of the use and operation and Hoop Houses at the public hearing on February 18th, 2021. Please see Exhibit B – Hoop House Bedded Pack Roof Example for more information.**

BEACON COMMENT: Site Plan Review - (2) Required Documents - (a) Site Plan showing – iii. Locations of wetlands and Priority Habitat Areas. - Beacon recommends that The Applicant file a Notice of Intent with NHESP to confirm the non-existence of native species listed as endangered, threatened or of special concern.

**FEC/BWC RESPONSE: Based on the MA OLIVER GIS analysis, the project area is not within the NHESP Priority Habitats of Rare Species or NHESP Estimated Habitats of Rare Wildlife. Please see Exhibit C – NHESP Endangered Species Analysis.**

BEACON COMMENT: Site Plan Review - (2) Required Documents - (a) Site Plan showing – vi. List of hazardous materials:

(1) Beacon recommends that The Applicant provide detailed operations, maintenance and remedial procedures to address issues pertaining to fluid release and impact on vegetation and stormwater.

**FEC/BWC RESPONSE: See response below to: BEACON COMMENT Site Plan Review - (5) Design and Performance Standards - (g) Hazardous Materials.**

(2) Further, Beacon recommends that The Applicant provide more detailed information on the proposed battery storage and containment equipment, in addition to the HVAC equipment. Specifically, The Applicant should provide documentation on the fluids contained in these systems in addition to the fire suppression systems to be used.

**FEC/BWC RESPONSE: The Applicant provides Exhibit D- Sungrow ST3727kWh Energy Storage Systems Specifications, which details the proposed Samsung battery storage system and HVAC containment equipment. The Sungrow HVAC system proposed is a forced air cooling system that utilizes air conditioning units located on the ends of the container, with a total of 4 units per container, as seen in Exhibit E- ST3727kWh system noise test report.**

**This HVAC system is used to maintain consistent temperatures, and is similar to the heating and cooling equipment used for a typical building. Historically, HVAC systems used the Freon (R-22) refrigerant fluid to cool, but this was banned as of January 1, 2020. R-22 has now been replaced by a R-410A (also called Puron), which is an Alkyl Halide refrigerant that does not contribute to ozone depletion.**

**The containment system also includes a FM-200 fire suppression system. FM-200 (HFC-227ea) leaves no residue and does not require clean up after deployment. FM-200 is a liquified gas stored on as a liquid on site in a container and turns to a vapor when discharged to disrupt the combustion reaction to extinguish the fire. More information on FM-200 is provided in Exhibit F- FM-200 Material Safety Data Sheet.**

BEACON COMMENT Site Plan Review -(2) Required Documents - (a) Site Plan showing – v. Electrical diagram- Beacon recommends that The Applicant provide additional detail as to its approach to locating underground conduit through the wooded and sloped topography to Pine Meadow Road for the utility interconnection. Such detail should include the impact on existing trees and vegetation.

**FEC/BWC RESPONSE: The Applicant has revised the interconnection access for Array A to follow the existing driveway onto the site. This revised interconnection approach was provided in the updated plan submitted to the Planning Board on March 9th, 2021.**

BEACON COMMENT Site Plan Review - (2) Required Documents - (a) Site Plan showing – x. Name, address and contact information of the installer- Beacon recommends that The Applicant identify and provide all required information to the Planning Board in connection with its application for a Building Permit.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Planning Board with all required information in connection with its application for a Building Permit**

BEACON COMMENT Site Plan Review – (2) Required Documents - (c) – O & M Plan

(1) Beacon recommends that the Planning Board Condition the Special Permit with the requirement that The Applicant provide year-round access to the concrete equipment pad and the overall system, including providing the Town on an annual basis with adequate documentation addressing snow removal services on the gravel access road.

**FEC/BWC RESPONSE: The Applicant agrees to clear any snow from roads within 24 hours of a snow event exceeding 4".**

(2) Beacon further recommends that in connection with its jurisdictional review of the Notice of Intent to be filed with the Northfield Conservation Commission, a review of the proposed annual O&M Stormwater Management Systems plan should be evaluated for best management practices.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Planning Board with the proposed O&M Stormwater Management System plans for Best Management Practices.**

BEACON COMMENT Site Plan Review – (2) Required Documents - (f) – Proof of Liability Insurance: Beacon recommends that the Planning Board seek guidance from the Town's insurance agent with regards to the limits of coverage.

**FEC/BWC RESPONSE: The Applicant awaits feedback from the Town's insurance agent.**

BEACON COMMENT Site Plan Review - (2) Required Documents – (g) – Financial Surety:

(1) Beacon recommends that the Planning Board request The Applicant to reconsider its projected cost estimate and provide supporting documentation of actual decommissioning costs for projects owned by The Applicant of similar size.

**FEC/BWC RESPONSE: The Applicant has provided a decommissioning summary by Field Engineering, which has been signed and stamped. This calculation to determine removal costs has been broadly accepted across Massachusetts for solar projects. Please see table below for examples of previously approved solar projects decommissioning estimates.**

| Project | Total Bond Amount (Present) | System Size (MWDC) | Cost/MW (Present) |
|---|---|---|---|
| Town of Palmer Sykes Solar Project | $187,500 | 8.561 | $21,902 |
| Town of Mattapoisett Solar Project | $142,500 | 6.56 | $21,723 |
| Town of Wilbraham Solar Project | $94,900 | 4.4 | $21,568 |

(2) Beacon recommends that the form of Financial Surety be an annual renewing irrevocable Bond with the Town of Northfield as the named bond holder.

**FEC/BWC RESPONSE: The Applicant requests for the Planning Board not to specify the form of financial surety as a condition. The Applicant is willing to provide to the Planning Board the form of financial surety before a building permit is requested for the Board's approval.**

BEACON COMMENT Site Plan Review (4) Appurtenant Structures :

(1) Beacon recommends that the Planning Board require additional information on the design, use and operation of the Hoop Houses.

**FEC/BWC RESPONSE: Jesse Robertson-Dubois has provided an overview of the use and operation and Hoop Houses at the public hearing on February 18th, 2021. Please see Exhibit B – Calhoun Bedded Pack Roof Example for Hoop Houses.**

(2) Beacon recommends that the Planning Board condition the Special Permit to require The Applicant to conduct a "balloon test" from the highest point expected of the equipment on the concrete pad at a time when any deciduous trees have lost its leaves.

**FEC/BWC RESPONSE: The Applicant believes a balloon test should not be required as the proposed site plan complies with the maximum structure height of 20'. The Applicant also notes that the height requirements from the solar by-law would not apply to the agricultural structures.**

(3) Beacon recommends that this review further consider any visual impacts associated with the utility interconnection, particularly as it relates to any tree removal requirements in connection with siting the underground conduit run from the concrete equipment pad to Pine Meadow Road.

**FEC/BWC RESPONSE: As a result of the redesign of the interconnection route for Array A, The Applicant has eliminated the need to remove trees for interconnection of this site.**

BEACON COMMENT Site Plan Review - (5) Design and Performance Standards - (c) Signage Beacon recommends that The Applicant or its Asset Manager/Operator provide a number that is available 24/7/365 to address emergency concerns. This is particularly important for Public Safety personnel.

**FEC/BWC RESPONSE: The Applicant agrees to provide its Asset Manager/ Operator a number that is 24/7/365 available to address emergency concerns.**

BEACON COMMENT Site Plan Review - (5) Design and Performance Standards - (f) Control of Vegetation. Beacon recommends that the Planning Board Condition the Special Permit by prohibiting the use of any chemicals, herbicides or pesticides within Array A and in all portions of the parcels under the Applicant's control.

**FEC/BWC RESPONSE: The Applicant requests that the Board provide further detail as to its concerns regarding use of common chemicals, herbicides, or pesticides. The Applicant will only use agricultural materials (fertilizers and pesticides) for the agricultural use in compliance with applicable laws.**

BEACON COMMENT Site Plan Review - (5) Design and Performance Standards - (g) Hazardous Materials

(1) Beacon recommends that The Applicant provide detailed operations, maintenance and remedial procedures to address issues pertaining to fluid release and impact on vegetation and stormwater.

**FEC/BWC RESPONSE: In the event of fluid release of hazardous material during the construction, operation, or decommissioning of the solar project, The Applicant shall notify MassDEP in accordance with Massachusetts Contingency Plan (310 CMR 40.00), retain a Licensed Site Professional (LSP) and work with MassDEP officials for guidance. A contingency plan shall be implemented in the event of the release of hazardous materials under the following measures:**

**a. Equipment necessary to attend to inadvertent spills or leaks shall be stored on site in a secure and accessible location. Such equipment shall include, but not limited to: safety goggles, protective gloves, water and chemical fire extinguishers, sand, shovels, suitable absorbent materials, storage containers, and first aid equipment.**

**b. Hazardous fluid releases shall be treated properly according to material type, volume of spill and location of spill to prevent further spillage and containment to the smallest area possible. Removal of the release fluid shall be done in an environmentally friendly manner and any damaged environment shall be remediated.**

**c. For large spills Mass DEP Hazardous Waste Incident Response Group will be notified immediately at 617-792-7653 and an emergency contractor shall be engaged.**

**Additionally, any procedures to address issues related to impacts on vegetation and stormwater will be detailed in the Stormwater Pollution Prevention Plan (SWPPP) filed prior to construction.**

(2) Further, Beacon recommends that The Applicant provide more detailed information on the proposed battery storage and containment equipment, in addition to the HVAC equipment. Specifically, The Applicant should provide documentation on the fluids contained in these systems in addition to the fire suppression systems to be used.

**FEC/BWC RESPONSE: Materials in the lithium-ion battery storage component include Cobalt Oxide, Manganese dioxide, Nickel oxide, Carbon, Polyvinylidene fluoride, and aluminum foil. Quantity and first aid measures are provided in Exhibit G- Samsung Materials specifications, to this response.**

BEACON COMMENT Site Plan Review - (5) Design and Performance Standards - (h) Noise.
Beacon recommends that the Planning Board require The Applicant to provide a noise study of the combined solar photovoltaic array equipment and associated battery storage system demonstrating dBA levels at the boundary of the property.

**FEC/BWC RESPONSE: Noise levels from the battery storage system will be generated by the HVAC system to heat and cool the storage container. Sungrow conducted a noise study for the ST3727kWh battery storage system proposed, and the study and results are provided in Exhibit G- Sungrow Noise Study. Noise volumes are the greatest at the end of the container, where the air conditioning systems are located. Maximum noise levels are 63.8 dBA at a distance of 1 meter and 56.4 dBA at a distance of 5 meters at each end of the system. From the side of the system, maximum noise levels are 56.3 dBA from a 5-meter distance, and 51.7 dBA at a 1-meter distance. The battery storage system is located approximately 115 Feet from the nearest property line and 330 Feet from the nearest residence. The solar system will produce noise from its inverters at a noise level of 73 dBA from 10 feet away from the inverters and 43 dBA 100 feet away from the inverters. Please see Exhibit H and Exhibit I for inverter specifics. For reference, a noise level of 60-70 dBA is the equivalent of a business office environment, or a normal conversation, and a noise level of 55 dBA is equivalent to a household refrigerator.**

BEACON COMMENT Site Plan Review - (6) Safety and Environmental Standards - (a) Emergency Services

(1) Beacon recommends that prior to commissioning, The Applicant should provide the Town with a Safety Manual describing the components of Array A and detailing safe de-energizing procedures of all major components including inverters, battery systems and modules. While it is not expected such detailed de-energizing procedures will be required, such information would prove beneficial in the event of a significant emergency.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Town with a Safety manual detailing the safe de-energization of all major components prior to commissioning. The Applicant requests the Board's guidance as to which Town department should receive the manual.**

(2) Beacon recommends that the Planning Board Condition the Special Permit with the requirement that the Town be noticed on any assignment, transfer or sale of BWC Pine Meadow Brook LLC.

**FEC/BWC RESPONSE: The Applicant agrees to provide notice to the Town of any assignment, transfer, or sale of BWC Pine Meadow Brook LLC.**

BEACON COMMENT Monitoring, Maintenance and Reporting – Solar Photovoltaic Installation Conditions

(1) Beacon recommends that the Planning Board Condition the Special Permit with the requirement that The Applicant provide year-round access to the entire gravel access road, concrete equipment pad and the overall system, including providing the Town on an annual basis with adequate documentation demonstrating the provision for snow removal services on the gravel access road.

**FEC/BWC RESPONSE: The Applicant agrees to provide year-round access to the entire gravel assess road and will perform snow clearing operations after any snow event of 4" or more.**

(2) Beacon further recommends that in connection with its jurisdictional review of the Notice of Intent to be filed with the Northfield Conservation Commission, a review of the proposed annual O&M Stormwater Management Systems plan should be evaluated for best management practices.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Planning Board with the proposed annual O&M Stormwater Management Systems plan to confirm that best management practices as described by the DEP Stormwater Management Handbook are included prior to construction. The Applicant notices the obligation of the Northfield Conservation Commission to review and approve the Stormwater Management System plan as part of the Notice of Intent filing.**

BEACON COMMENT Monitoring, Maintenance and Reporting – Modifications. Beacon recommends that the Planning Board Condition the Special Permit to require that any material modifications to Array, specifically as it relates to Array DC capacity, battery storage, changes to the size or location of the concrete equipment pad, and/or changes to the design of the utility interconnection as shown in the Site Drawings dated 12/28/2020, pages SP-1 and SP-2, among others, be immediately provided to the Planning Board for approval.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Planning Board with any material modifications to the final site drawings approved by the Board for approval as an amendment to this permit, prior to receiving building permit.**

BEACON COMMENT Monitoring, Maintenance and Reporting – Annual Reporting Beacon recommends that the Planning Board require The Applicant to provide copies of any annual reports filed with the Massachusetts Department of Agriculture and Massachusetts Department of Energy Resources in compliance with SMART Program qualifications.

**FEC/BWC RESPONSE: The Applicant agrees to provide the Planning Board with copies of annual reports filed with Massachusetts Department of Agriculture and Massachusetts Department of Energy Resources in compliance with SMART program regulations.**

BEACON COMMENT Abandonment or Decommissioning – Abandonment Beacon recommends that the Planning Board require The Applicant and property owner to address Decommissioning Requirements in its Lease agreements and provide evidence of such obligations.

**FEC/BWC RESPONSE: The decommissioning requirements of the Northfield Zoning By law supersede any requirement The Applicant has with the property owner to decommission the project at the end of its useful life or termination of the project. Due to the obligation from the town required decommissioning surety, The Applicant respectfully requests that the contract between The Applicant and landowners remains private.**

BEACON COMMENT Financial Surety:

(1) Beacon recommends that the Planning Board request The Applicant to reconsider its projected cost estimate and provide supporting documentation of actual decommissioning costs for projects owned by The Applicant of similar size.

**FEC/BWC RESPONSE: The Applicant has used industry accepted standards to determine decommissioning costs and does not recommend increasing the cost estimate. Please see FEC/BWC Response above to BEACON COMMENT Site Plan Review - (2) Required Documents – (g) – Financial Surety: (1)- for more details**.

(2) Beacon recommends that the form of Financial Surety be an annual renewing irrevocable Bond with the Town of Northfield as the named bond holder.

**FEC/BWC RESPONSE: The Applicant requests for the Town not to specify the form of financial surety for decommissioning. The Applicant agrees to provide the final form of financial surety to the Planning Board for approval before a Building Permit is requested.**

We feel that we have adequately addressed the Consultant's comments with this letter and the attached documentation and look forward to further discussing this project with the Board at the next Hearing on March 18. Please do not hesitate to contact me should you have any questions or require any additional information.

Sincerely,
**Field Engineering Co., Inc.**


Richard R. Riccio III, P.E.
Project Manager

cc: Beacon Integrated Solutions

Attachments

1. **Exhibit A-Agricultural Covenant Release**
2. **Exhibit B-Hoop House Bedded Pack Roof Example**
3. **Exhibit C-NHESP Mapping**
4. **Exhibit D-Sungrow ST37272kWh Energy Storage System Specifications**
5. **Exhibit E-ST37272kWh system noise test report**
6. **Exhibit F-FM-200 Material Safety Data Sheet**
7. **Exhibit G-Samsung Battery Specifications**
8. **Exhibit H-Power Electronics Solar Inverter (HEC1500V) Information**
9. **Exhibit I-Power Electronics Solar Inverter (HEMK600V) Information**

# Exhibit A-Agricultural Covenant Release

Bk: 7715 Pg: 266 Franklin County
Page: 1 of 3 03/01/2021 10:02 AM

**RELEASE OF LAND from a NON-DEVELOPMENT COVENANT held by THE COMMONWEALTH OF MASSACHUSETTS**

Whereas the Commonwealth is the holder of a Non-Development Covenant dated March 8, 2016, recorded in the Franklin County Registry of Deeds in Book 6863, Page 183 ("Covenant"), on land located in the Town of Northfield owned by Hopping Ahead, LLC;

Property Address: Pine Meadow Road, Northfield, MA

Whereas, the Senate and House of Representatives in the General Court assembled, by Chapter 224 of the Acts of 2018 ("Act"), which was duly enacted and approved on August 9, 2018, a copy of which is attached hereto as Exhibit A, authorized the Commissioner of the Department of Agricultural Resources to execute a certificate releasing to Hopping Ahead, LLC the land from the Covenant;

Now, therefore, all of the parcels included in the Covenant are hereby released of record from the Covenant by the Commissioner of the Department of Agricultural Resources.

As a condition of the Release, Hopping Ahead LLC has paid to the Department of Agricultural Resources the sum of $100,000.00. Money received by the Commonwealth for release of the Covenant under this section shall be held in trust by the Department, to be expended only to acquire new agricultural covenants.

Executed under seal this 11th day of February 2021.

THE COMMONWEALTH OF MASSACHUSETTS

BY: _____
John Lebeaux
Commissioner
Department of Agricultural Resources

**COMMONWEALTH OF MASSACHUSETTS**

Norfolk, ss. Feb. 15, 2021

On this 15 day of February, 2021, before me, the undersigned notary public, John Lebeaux, personally appeared, proved to me through satisfactory evidence of identification, which was personal knowledge, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose as Commissioner of the Department of Agricultural Resources of the Commonwealth of Massachusetts, as the voluntary act of the said Commonwealth. This document was notarized remotely utilizing electronic video conferencing in real time pursuant to Chapter 71 of the Acts of 2021.

(official signature and seal of notary public)


Notary Public: _____

Print Name: Christine M Smith

My commission expires: 7/26/24

# EXHIBIT A

## Acts (2018)

## Chapter 224

AN ACT RELEASING CERTAIN LAND IN NORTHFIELD FROM THE OPERATION OF AN AGRICULTURAL COVENANT.

*Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:*

SECTION 1. Notwithstanding any general or special law to the contrary, under section 22 of chapter 20 of the General Laws, the commissioner of agricultural resources shall execute a release of the agricultural covenant held by the commonwealth, acting on its behalf, on certain land in the town of Northfield owned currently by Hopping Ahead LLC, ("Landowner"). Title was acquired by a covenant recorded in Book 6863, Page 183, at the Greenfield Registry of Deeds

SECTION 2. As a condition precedent to the release authorized in section 1, the current landowner shall pay to the department of agricultural resources a monetary amount as determined by the commissioner, provided such sum shall not exceed the funds the landowner originally received as consideration for said covenant. Monies received by the commonwealth for said release under this section, shall be held in trust by the department, to be expended only for acquiring new agricultural covenants.

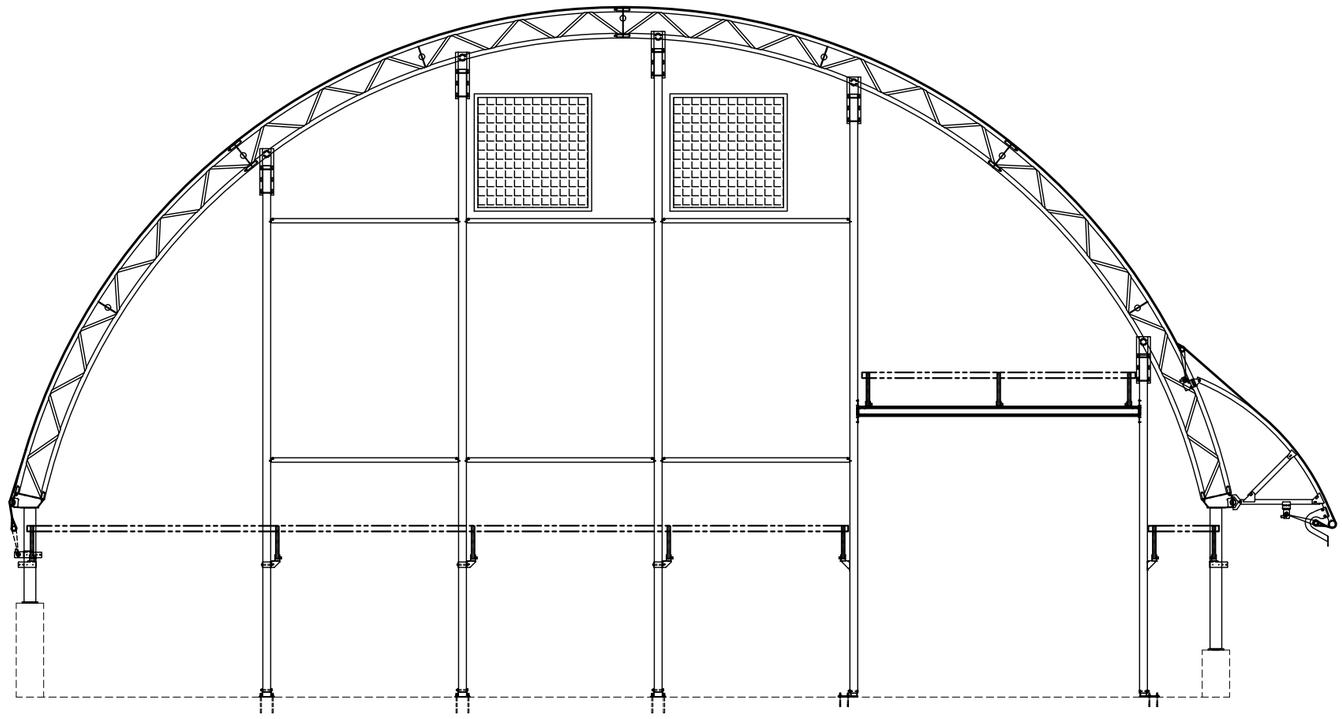
*Approved, August 9, 2018.*

## Exhibit B-Hoop House Bedded Pack Roof Example

P:\CC\2018 CC\405144 52x88x8 IHS 4&6HSS FC- Desousa & Sons Dairy, Rehoboth MA\Engineering\405144 CC52x88 R0.dwg
8/24/2018 12:43 PM

# 52' CC SUPERSTRUCTURE

| BASIS FOR DESIGN | | |
|---|---|---|
| SITE LOCATION | LATITUDE / LONGITUDE | APPROX. 41°48'37.45"N, 71°17'43.71"W |
| | ADDRESS | 305 PROVIDENCE STREET |
| | CITY/TOWN | REHOBOTH |
| | STATE | MASSACHUSETTS |
| | COUNTRY | USA |
| PROJECT DESCRIPTION | | |
| DEALER | LUSSIER BARN BUILDERS | |
| OWNER'S NAME | DESOUSA & SONS DAIRY | |
| STRUCTURE TYPE | MODEL | CC52 - BAG COVER |
| | WIDTH X LENGTH | 52' x 88' |
| | TRUSS SPACING | 8' o/c |
| | FABRIC TYPE | 12.1 oz/yd² PE NON-FR |
| DESIGN CRITERIA | GOVERNING BUILDING CODE | 780 CMR 9TH EDITION |
| ROOF LOADS | USE AND OCCUPANCY | AGRICULTURAL - LOW HAZARD |
| | DEAD LOAD | XXX |
| | COLLATERAL LOAD | 0.25 PSF |
| | LIVE LOAD | 12 PSF |
| | SNOW LOAD | 30 PSF |
| | IMPORTANCE FACTOR | 1 |
| | Ct | 1.2 |
| | Ce | 0.9 |
| | pf | XXX |
| WIND DESIGN | BASIC ULTIMATE WIND SPEED | 124 MPH |
| | WIND EXPOSURE | C |
| | BASIC/CLADDING (EXCLUDING GCp FIG 6-11) | XXX / XXX PSF |
| | IMPORTANCE FACTOR | 1 |
| | ROOF HEIGHT | 29'-5" |
| | DESIGN ENCLOSURE | FULLY ENCLOSED |
| SEISMIC DESIGN | Ss | XXX |
| | S1 | XXX |
| | IMPORTANCE FACTOR | 1 |
| | SITE CLASS | D |
| | USE GROUP | 1 |
| | R LONGITUDINAL | *3.0 |
| | R TRANSVERSE | *3.0 |
| | OCCUPANCY STANDARD - SEISMIC | I |
| | | |
| *CONSERVATIVELY TAKEN SMALLER THAN REQUIRED PER 12.2-1 | | |




## REVISION TABLE

| No. | DESCRIPTION | DATE |
|---|---|---|
| 0 | ENGINEER APPROVAL AND INITIAL RELEASE | XX/XX/XXXX |

## DRAWING INDEX

| SHEET NAME | SHEET No. | TITLE |
|---|---|---|
| TS | 1 OF 12 | TITLE SHEET |
| GSN | 2 OF 12 | GENERAL STRUCTURAL NOTES |
| REA | 3 OF 12 | DETAILED REACTIONS |
| FOU | 4 OF 12 | FOUNDATION PLAN |
| FRA | 5 OF 12 | FRAMING PLAN |
| EL-A | 6 OF 12 | ELEVATION A |
| EL-B | 7 OF 12 | ELEVATION B |
| EL-C | 8 OF 12 | ELEVATION C |
| DET1 | 9 OF 12 | DETAILS |
| DET2 | 10 OF 12 | DETAILS |
| DET3 | 11 OF 12 | DETAILS |
| DET4 | 12 OF 12 | DETAILS |

Calhoun Super Structures Ltd.
3702 Bruce Rd #10
Tara, Ontario, Canada
N0H 2N0
1-800-265-3894
www.calhoun.ca
www.calhounsuperstructure.com

CALHOUN

| | NAME | DATE dd/mm/yyyy |
|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |



TITLE SHEET
52' CC SERIES
405144 CC52x88 R0

SIZE D | SHEET NAME TS
SCALE: N T S | SHEET 1 OF 11

# GENERAL

## 1. DESIGN STANDARDS

The following standards are used in addition to the governing code which is noted on the Title Sheet of this drawing set. All referenced standards refer to the most recent revision unless noted otherwise.

AISC–Steel–Construction–Manual–13th Edition
Hollow Structural Sections, Connections and Trusses
North American Specification for the Design of Cold–Formed Steel Structural Members
CSA S16–09, Limit States design of Steel Structures
CSA S136–07, Cold Formed Steel Structural Members
ULC S109, Flame Tests of Flame Resistant Fabrics and Films

## 2. MANUFACTURING STANDARDS

a. Fabrication in accordance with CSA S16 and CSA S136 (as applicable).
b. Welding in accordance with CSA W59 and CSA S136 (as applicable).
c. Calhoun Super Structures is certified in accordance with CSA W47.1 Division 2
d. All Welders have been qualified in accordance with CSA W47.1

e. These drawings have been prepared by the EOS primarily to safeguard against major structural damage and loss of life, not to limit damage or maintain function as per requirements of the current accepted building code as listed in the basis for design.

f. Professional standards of care normally exercised under similar circumstances by reputable engineers in this area or similar localities have been used or exceeded in these drawings.

g. Design of non–structural elements, (such as stairs, railings, non–load bearing walls, veneers, curtain walls, etc) and their attachments, are not included and must be provided by others unless specifically noted on these drawings.

h. Design of prefabricated structural products, (such as wood trusses, steel joists, or concrete pre–cast elements, etc) is not included, and must be provided by others unless specifically noted on these drawings.

i. Specification references, (such as ASTM, AISI, AWS, CCI, CISC, CSA, CWB etc) shall be the latest accepted version where noted on these drawings.

# CONSTRUCTION

a. An experienced licensed contractor with a working knowledge of applicable codes and industry accepted standard practices shall perform the work depicted in these drawings.

b. All work shall conform to the minimum standards of the current accepted building code found in the basis for design and other codes, industry specific specifications, and standards listed herein. The contractor shall comply with requirements of all regulatory agencies with authority over any portion of the work. Work not explicitly shown on these drawings shall conform to all applicable codes and accepted standard practices.

c. The contractor shall verify all dimensions, elevations, and conditions on these drawings with all other relevant construction discipline drawings prior to the start of construction. Notify the EOS in writing before the start of construction regarding discrepancies, omissions or variations, or they shall become the sole responsibility of the contractor. Notes and the specific details on these drawings take precedence over general structural notes and typical details.

d. Construction methods are not explicitly included on these drawings. General sequences are shown for reference only. The contractor shall be solely responsible for all methods, sequences, and procedures of construction. The contractor shall provide adequate shoring, bracing, framework, etc. as required for the protection of life and property during construction.

e. Excavation procedures including shoring and protection of adjacent property, structures, streets, and utilities shall be performed in compliance with local building codes, regulations, and safety requirements, and shall be the contractor's responsibility.

f. Construction materials shall be spread out uniformly on structural systems such that design live loads are not exceeded.

g. Openings, pockets, etc. shall not be placed in structural members unless specifically detailed on these drawings. When drawings by others show items in structural members not shown on the structural drawings, notify the EOS in writing to determine correct deposition.

h. Site visits by the EOS are a resource for the contractor and shall not be considered as special inspections. Contractor and/or customer will be responsible for all costs incurred when requesting site visits by the EOS.

i. As per CSA–S16–09, Section 29, Sub–section 29.7.2, Plumbness of Columns, (c): Column verticality shall not exceed 1/500 and shall be measured from the actual column centerline at the base of the column.

STRUCTURAL BOLT TORQUE VALUES

| SIZE | | GR 5/A325 | | | | |
|---|---|---|---|---|---|---|
| DIA. (inch) | THREADS PER INCH | TENSILE ksi (min.) | PROOF LOAD (lbs) | CLAMP LOAD (lbs) | TORQUE DRY (ft–lbs) | TORQUE LUBE (ft–lbs) |
| 3/8 | 16 | 120 | 6600 | 4950 | 30 | 23 |
| 7/16 | 14 | 120 | 9050 | 6780 | 50 | 35 |
| 1/2 | 13 | 120 | 12100 | 9050 | 75 | 55 |
| 5/8 | 11 | 120 | 19200 | 14400 | 150 | 110 |
| 3/4 | 10 | 120 | 28400 | 21300 | 260 | 200 |
| 1–1/4 | 7 | 105 | 71700 | 53800 | 1120 | 840 |

NOTE: TORQUE VALUES FOR REFERENCE ONLY. TURN OF THE NUT, CALIBRATED WRENCH OR OTHER APPROVED METHOD REQUIRED TO ENSURE BOLT TENSION.

# STRUCTURAL STEEL

## 1.0 MATERIALS

a. Structural steel members shall conform to the following ASTM (CSA G–40.21) with the following grades and material properties U.N.O.

| SHAPE | CSA G40.21 DESIGNATION | ASTM DESIGNATION (SAE GRADE) | YEILD STRENGTH MPa (ksi) | TENSILE STRENGTH MPa (ksi) |
|---|---|---|---|---|
| STANDARD STEEL SHAPES | 300 W | A36/44W | 300 (44) | 450–620 (65–80) |
| ROLLED WIDE FLANGE SECTIONS | 350 W | A992 | 350 (50) | 450 (65) |
| BARS AND PLATES | 300 W | A36/44W | 300 (44) | 450–620 (65–80) |
| HSS – ROUND | 350 W | G40.21 350W | 350 (50) | 450–650 |
| HSS – SQ./REC. | 350 W | A500 GRADE C | 350 (50) | 450–650 |
| MECHANICAL TUBING | --- | 787–05 | 380 (55) | --- |
| STRUCTURAL BOLTS | --- | GRADE 5 | --- | 724–827 (60) |
| | --- | A325 | --- | 724–827 (105–120) |
| | --- | GRADE 8 | --- | 827 (120) |
| | --- | A490 | --- | 1034 (150) |
| ANCHOR BOLTS | --- | F1554 GR 36 | 248 (36) | 400–558 (58–80) |
| | --- | F1554 GR 55 | 380 (55) | 517–655 (75–95) |
| | --- | F1554 GR 105 | 724 (105) | 125–150 (125–150) |

b. Structural steel shall be fabricated and erected in accordance with AISC/CISC specifications for the design fabrication and erection of structural steel buildings.

## 2.0 INSTALLATION

a. Welders shall be AWS/CWB certified where required by jurisdictional authority. All welding shall use E70 series low hydrogen electrodes. All welding shall conform to the latest American Welding Society standards; welds on drawings are shown as shop welds. Contractor may shop weld or field weld at his discretion. All full penetration welds shall be tested and certified by an independent testing laboratory.

b. All bolts shall be installed as bearing–type connections with threads excluded from shear plane (type "x" connection), UNO. High–strength bolts shall be snug tightened using any AISC/CISC approved method and do not require special inspections unless noted otherwise. All bolts in slotted or oversize holes and all high–strength bolts shall be installed with washers.

c. All expansion or epoxy bolts shall have current approved rating (ICC–ES or equivalent) for material into which installation occurs. Headed studs shall conform to all requirements of the latest edition of the "recommended practices for stud welding" and the "structural welding code" published by AWS. All bolts, anchor bolts, expansion bolts, etc. shall be installed with steel washers at face of wood.

d. Grout beneath column bases or bearing plates shall be 5000psi (35MPa) minimum non–shrink flow–able grout or dry–pack. Install grout under bearing plates before framing member is installed. At columns, install grout under base plates after column has been plumbed but prior to floor or roof installation. Grout depth shall be sufficient to allow grout or dry pack to be placed beneath plate without voids.

e. All misc. welds not noted, including stiffeners, misc. plates, etc. shall be per AISC/CISC manual table J2.4 or in an AWS/CWB certified shop.

# LIGHT GAUGE STEEL FRAMING

## 1.0 MATERIALS

a. All products to be manufactured by the current members of the steel stud manufacturers association. All galvanized studs and joist shall be formed from steel that corresponds to the minimum requirements of the latest addition of the AISA or CSA–S136. All structural members shall be designed in accordance with the Canadian Institute of Steel Construction (CISC) or American Iron and Steel Institute (AISI) specification for the design of cold–formed steel structural members (latest edition).

b. Structural drawings show only the primary structural framing elements of the system, and the contractor shall provide all accessories required for the complete and proper installation, as recommended by the manufacturer for the steel members used.

c. All welding shall be performed by welders experienced in light gauge structural steel framing work. All welds per AWS D1.3 or AWS D1.3 as applicable.

## 2.0 FRAMING

a. Prior to fabrication of framing, that is designed and supplied by others, the contractor shall submit shop drawings to the EOS to obtain approval.

b. All framing components shall be cut squarely for attachment to perpendicular members or as required for an angular fit against abutting members.

c. Temporary bracing where required, shall be provided until erection is complete.

d. Fastening of the components shall be with self–drilling screws or welding. Screws or welds shall be of sufficient size to insure the strength of the connection. All welds of galvanized steel shall be touched up with paint. Wire tying of components shall not be permitted.

e. Screws shall be self–tapping pan head, hex head, or wafer head sheet metal screws. Screws which are removed shall be replaced by a screw of a larger diameter where the replacement is made into an existing hole. Replace all screws which strip out material. Screws shall be spaced no closer than 5/8" o/c and with a minimum free edge distance of 1/2". Screws No. 8 and larger shall have a minimum head size of 5/16".

f. Any on–site welding during structure erection shall be performed by welders experienced in light gauge structural steel framing work.

STANDARD ABBREVIATIONS

| ABBREVIATION | DEFINITION |
|---|---|
| ACI | AMERICAN CONCRETE INSTITUTE |
| AITC | AMERICAN INSTITUTE OF TIMBER CONSTRUCTION |
| AISC | AMERICAN INSTITUTE OF STEEL CONSTRUCTION |
| AISI | AMERICAN IRON AND STEEL INSTITUTE |
| ANSI | AMERICAN NATIONAL STANDARDS INSTITUTE |
| ALT | ALTERNATIVE |
| ASTM | AMERICAN SOCIETY FOR TESTING AND MATERIALS |
| AWPA | AMERICAN WOOD PRESERVERS ASSOCIATION |
| AWS | AMERICAN WELDERS SOCIETY |
| BOF | BOTTOM OF FOOTING |
| CAN | CANADIAN |
| CWS | CANADIAN WELDERS SOCIETY |
| CWB | CANADIAN WELDING BUREAU |
| CONT. | CONTINUOUS |
| DIA. | DIAMETER |
| EF | EACH FACE |
| EOS | ENGINEER OF STRUCTURE |
| EW | EACH WAY |
| FFE | FINISH FLOOR ELEVATION |
| FT | FOOT |
| GA | GAUGE |
| GLB | GLUE LAMINATED BEAM |
| GSN | GENERAL STRUCTURAL NOTES |
| HSS | HOLLOW STRUCTURAL SECTION |
| HORIZ | HORIZONTAL |
| IBC | INTERNATIONAL BUILDING CODE |
| ICC–ES | INTERNATIONAL CODE COUNCIL – EVALUATION SERVICES |
| KIP | KILOPOUND (1,000 LB) |
| kPa | KILOPASCAL |
| ksi | KIPS PER SQUARE INCH |
| MFR | MANFACTURER |
| MAX | MAXIMUM |
| MIN | MINIMUM |
| MPa | MEGAPASCALS |
| MSC | MISCELLANEOUS |
| NBCC | NATIONAL BUILDING CODE OF CANADA |
| NFBC | NATIONAL FARM BUILDING CODE |
| NTS | NOT TO SCALE |
| o/c | ON CENTER |
| OBC | ONTARIO BUILDING CODE |
| PA | PASCAL |
| psf | POUNDS PER SQUARE FOOT |
| psi | POUNDS PER SQUARE INCH |
| SAE | SOCIETY OF AUTOMOTIVE ENGINEERS |
| STD | STANDARD |
| TOF | TOP OF FOOTING / FOUNDATION |
| TOL | TOP OF LEG |
| TOS | TOP OF STEEL |
| TOW | TOP OF WALL |
| TYP. | TYPICAL |
| UBC | UNIFORM BUILDING CODE |
| ULC | UNDERWRITERS LABORATORIES OF CANADA |
| UNO | UNLESS NOTED OTHERWISE |
| VERT | VERTICAL |
| WCLIB | WEST COAST LUMBER INSPECTION BUREAU |
| WWPA | WESTERN WOOD PRODUCTS ASSOCIATION |

# FRAMING NOTES

1. DOOR DESIGNED & SUPPLIED BY OTHERS. DOOR MUST BE DESIGNED TO HANDLE SITE WIND LOADS. STRUCTURE HAS BEEN DESIGNED SUCH THAT THE DOOR IS CLOSED IN THE EVENT OF HIGH WIND (EXCEEDING 70 KPH OR 44 MPH).
2. ENDWALL STRAPPING AND HARDWALL CLADDING DESIGNED AND SUPPLIED BY OTHERS (CLADDING TO 8', FABRIC ABOVE).
3. ALL STRAPPING AND HARDWALL CLADDING MUST BE DESIGNED TO MEET SITE WIND LOADS.

# GENERAL NOTES

1. VERIFY ALL DIMENSIONS PRIOR TO CONSTRUCTION. RESOLVE DISCREPANCIES WITH THE BUILDING SUPPLIER.
2. FINISHED FLOOR ELEVATION = 100'–0" U.N.O.
3. ALL CONCRETE COMPONENTS ARE SUPPLIED BY OTHERS.

NOTE:
BUILDING IS DESIGNED TO BE FREE STANDING.

**ANY MODIFICATIONS OR DAMAGE TO STRUCTURE OR COMPONENTS MUST BE REPORTED IMMEDIATELY TO CALHOUN SUPER STRUCTURES. ALL REPAIRS MUST BE APPROVED BY EOS IN WRITING.**

**FOUNDATION DESIGNED AND SUPPLIED BY OTHERS**

Calhoun Super Structures Ltd.
3702 Bruce Rd #10
Tara, Ontario, Canada
N0H 2N0
1–800–265–3694
www.calhoun.ca
www.calhounsuperstructure.com

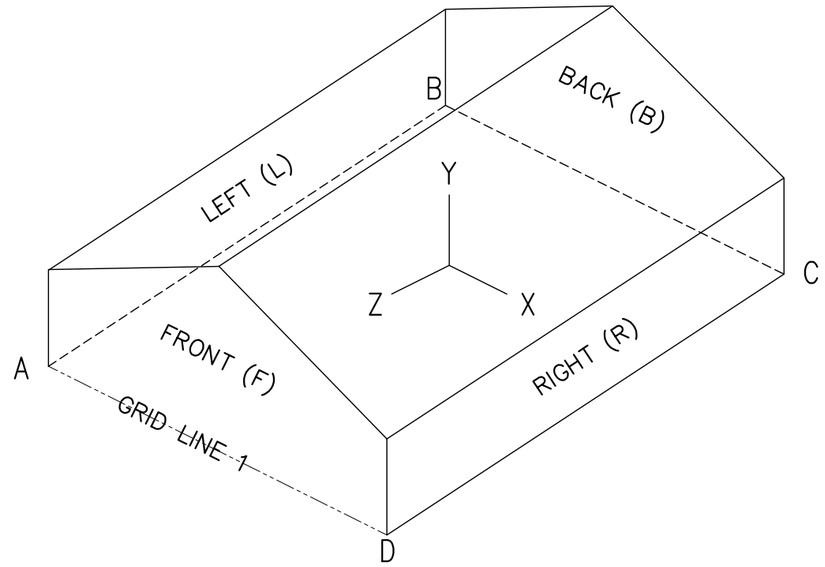
CALHOUN

| | NAME | DATE dd/mm/yyyy |
|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |



GSN
52' CC SERIES
405144 CC52x88 R0

SIZE: D | SHEET NAME: GSN | SCALE: N T S | SHEET 2 OF 11

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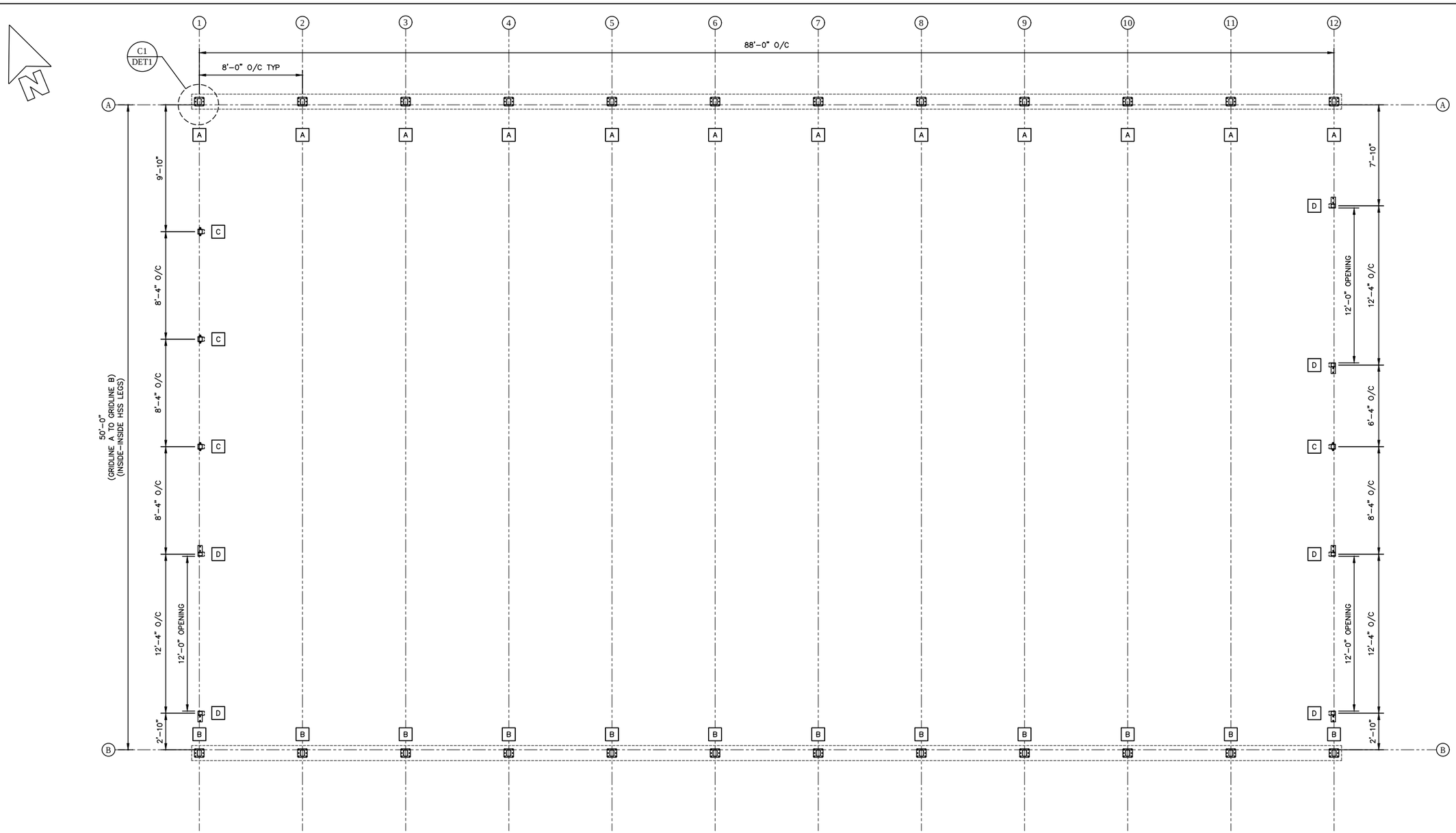
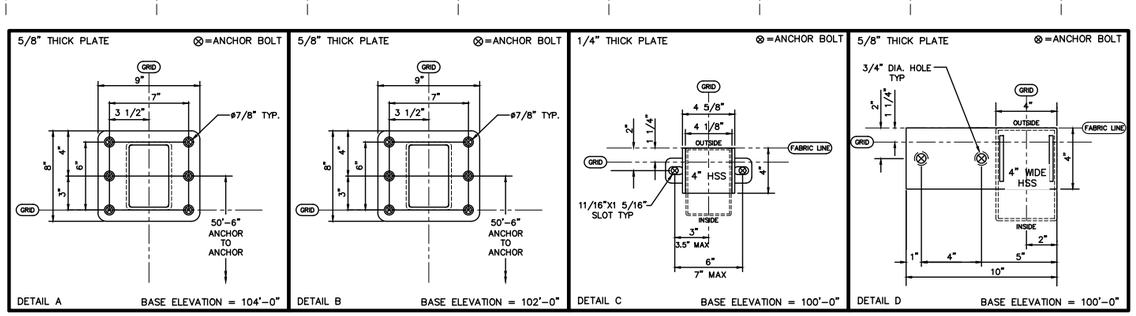
REACTIONS
52' CC SERIES
405144 CC52x88 R0

SIZE: D
SHEET NAME: REA
SCALE: N T S




NOTE:
THE FOUNDATION DESIGNER MAY CHOSE ANCHORS OF VARIOUS DIAMETERS WHERE APPROPRIATE. IF THE ANCHOR IS MORE THAN 1/16" SMALLER THAN THE PROVIDED HOLE, THE CONTRACTOR SHALL USE A MINIMUM 2" DIAMETER, 1/4" THICK WASHER WITH A STANDARD HOLE.

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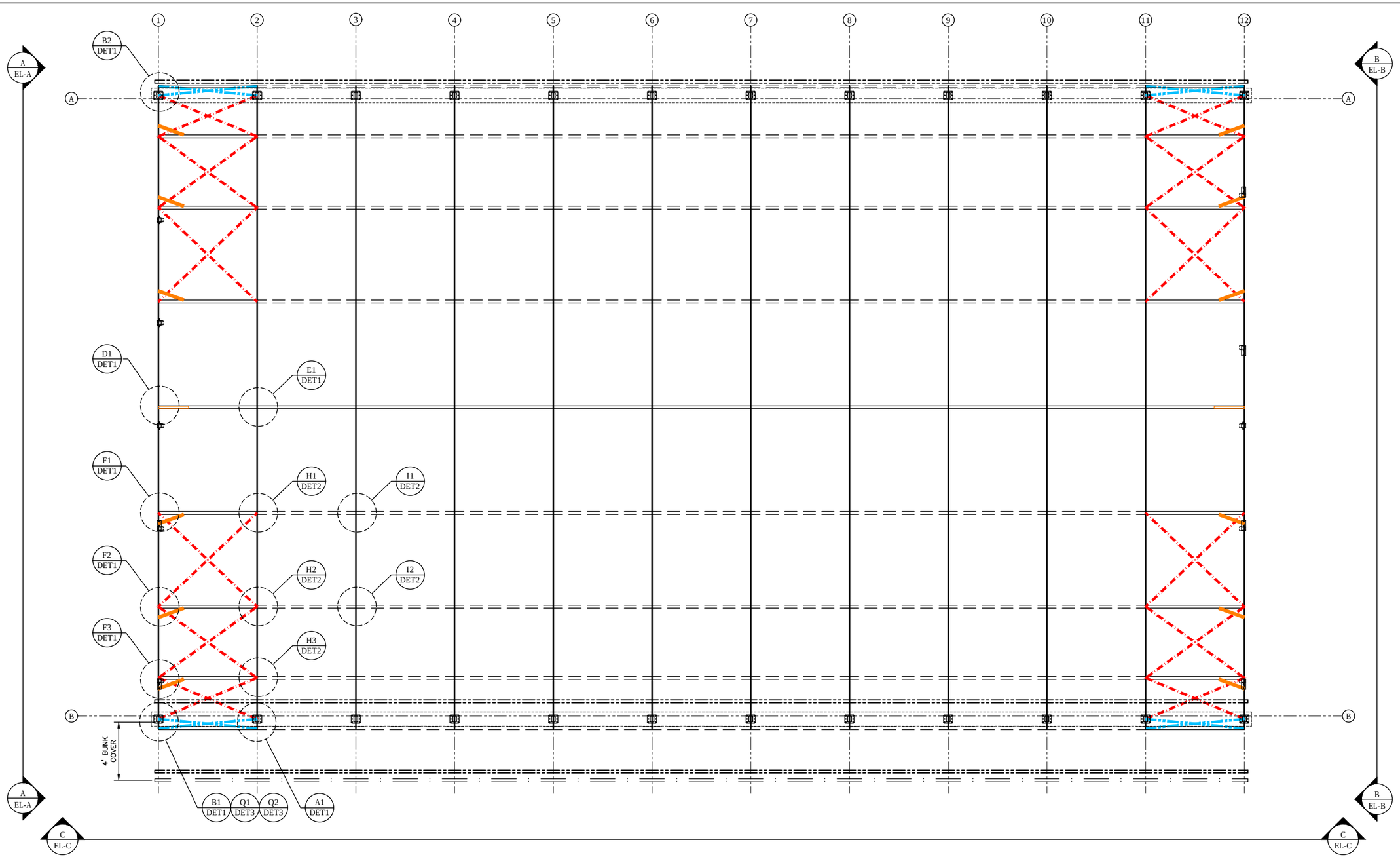
| CHECKED | A G B | 23/08/2018 |

# FOUNDATION PLAN

52' CC SERIES
405144 CC52x88 R0



SIZE: D
SHEET NAME: FOU
SCALE: 1/4"=1'-0"
SHEET 4 OF 11




## FRAMING SCHEDULE

| LEGEND | DESCRIPTION | SECTION | GA/LOAD | COMMENTS |
|---|---|---|---|---|
| | TYPICAL PURLIN | 2-3/8"ø | 13 | UNBRACED BAYS |
| | TYPICAL PURLIN | 2-7/8"ø | 14 | BRACED BAYS / RIDGE |
| | BUNK EAVE TUBE | 3-1/2"ø | 14 | BUNK COVER EAVE TUBE |
| | BRACE PURLIN | U 2"X2" | 11 | END BAYS ONLY |
| | TENSION TUBE | 2-3/8"ø | 13 | ALL BAYS |

CABLE SCHEDULE

| LEGEND | DESCRIPTION | SECTION | GA/LOAD | PROOF TURNS | PRE-TENSION TURNS |
|---|---|---|---|---|---|
| | ROOF TRUSS | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | WALL | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | | | | | |
| | | | | | |

CABLE TENSIONING SEQUENCE:

1. HAND TIGHT
2. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (TO STRETCH CABLE)
3. LOOSEN TO SLACK
4. HAND TIGHT
5. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (FINAL TENSIONING 600 LBS UNO)

## MAIN BUILDING COVER INFORMATION

| FABRIC TYPE | COVER INFORMATION |
|---|---|
| BAG COVER | 1 PIECE BAG COVER, TENSION AS PER DETAILS |

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|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |



# FRAMING PLAN
52' CC SERIES
405144 CC52x88 R0

SIZE: D
SHEET NAME: FRA
SCALE: 1/4"=1'-0"
SHEET 5 OF 11

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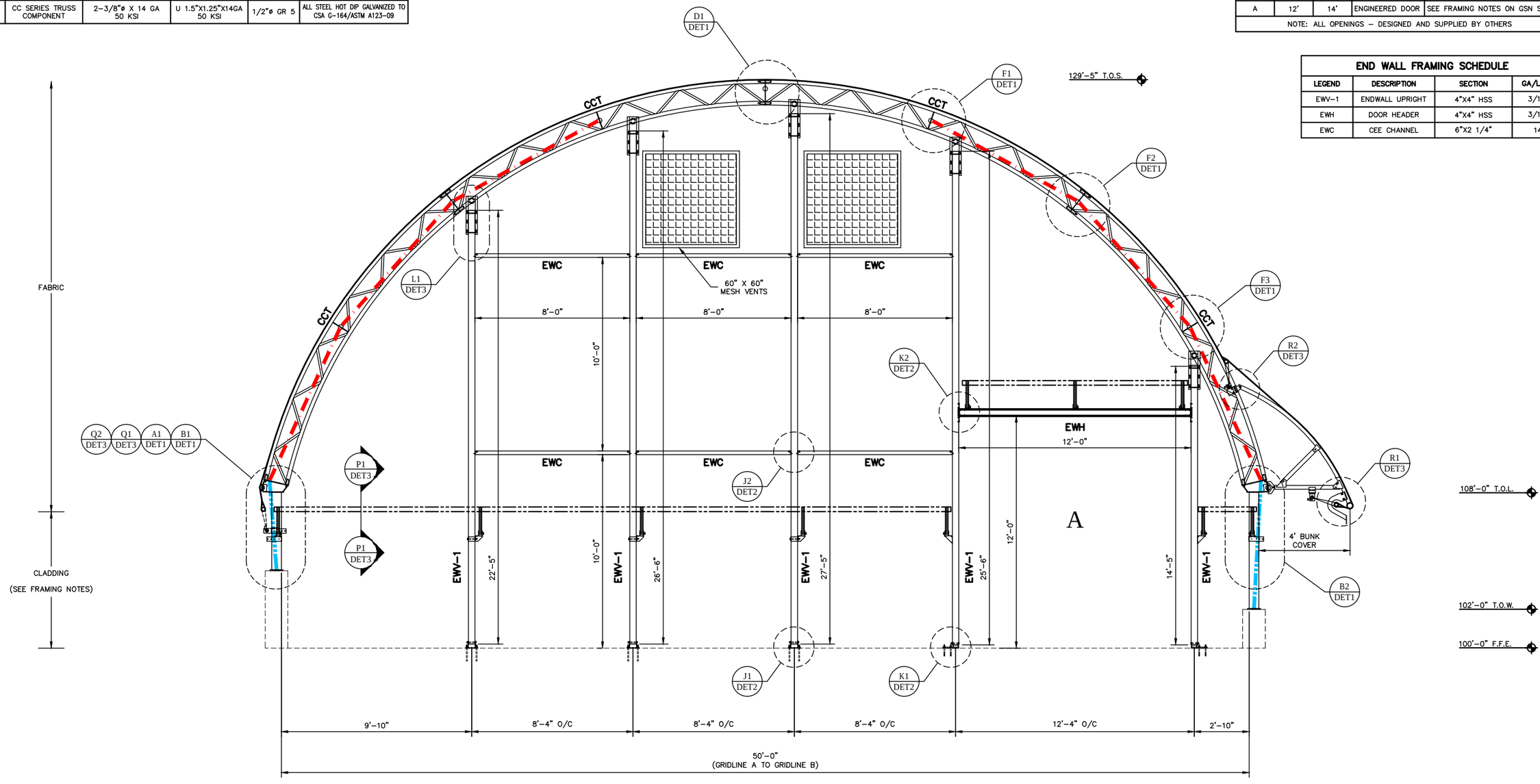
| COMPONENT SCHEDULE | | | | | |
|---|---|---|---|---|---|
| MARK | DESCRIPTION | CHORDS | WEBS | BOLTS | COMMENTS |
| CCT | CC SERIES TRUSS COMPONENT | 2-3/8"ø X 14 GA 50 KSI | U 1.5"X1.25"X14GA 50 KSI | 1/2"ø GR 5 | ALL STEEL HOT DIP GALVANIZED TO CSA G-164/ASTM A123-09 |

| DOOR SCHEDULE | | | | |
|---|---|---|---|---|
| MARK | WIDTH | HEIGHT | TYPE | COMMENTS |
| A | 12' | 14' | ENGINEERED DOOR | SEE FRAMING NOTES ON GSN SHEET |
| NOTE: ALL OPENINGS – DESIGNED AND SUPPLIED BY OTHERS | | | | |

| END WALL FRAMING SCHEDULE | | | |
|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD |
| EWV-1 | ENDWALL UPRIGHT | 4"X4" HSS | 3/16" |
| EWH | DOOR HEADER | 4"X4" HSS | 3/16" |
| EWC | CEE CHANNEL | 6"X2 1/4" | 14 |




END 1–GRIDLINE 1

| FRAMING SCHEDULE | | | | |
|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | COMMENTS |
| | TYPICAL PURLIN | 2-3/8"ø | 13 | UNBRACED BAYS |
| | TYPICAL PURLIN | 2-7/8"ø | 14 | BRACED BAYS / RIDGE |
| | BUNK EAVE TUBE | 3-1/2"ø | 14 | BUNK COVER EAVE TUBE |
| | BRACE PURLIN | U 2"X2" | 11 | END BAYS ONLY |
| | TENSION TUBE | 2-3/8"ø | 13 | ALL BAYS |

| CABLE SCHEDULE | | | | | |
|---|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | PROOF TURNS | PRE-TENSION TURNS |
| | ROOF TRUSS | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | WALL | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | | | | | |
| | | | | | |

CABLE TENSIONING SEQUENCE:

1. HAND TIGHT
2. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (TO STRETCH CABLE)
3. LOOSEN TO SLACK
4. HAND TIGHT
5. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (FINAL TENSIONING 600 LBS UNO)

| END WALL FABRIC INFORMATION | |
|---|---|
| FABRIC TYPE | FABRIC INFORMATION |
| 1 PIECE END PANEL | CONNECTED TO OUTER CHORD USING SCHEDULE 80 PVC WITH CAMBUCKLES @ 20" o/c. TENSION AS PER DETAILS. |

**FOUNDATION DESIGNED AND SUPPLIED BY OTHERS**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ELEVATION A
52' CC SERIES
405144 CC52x88 R0

SIZE D | SHEET NAME EL-A
SCALE: 3/8"=1'-0" | SHEET 6 OF 11

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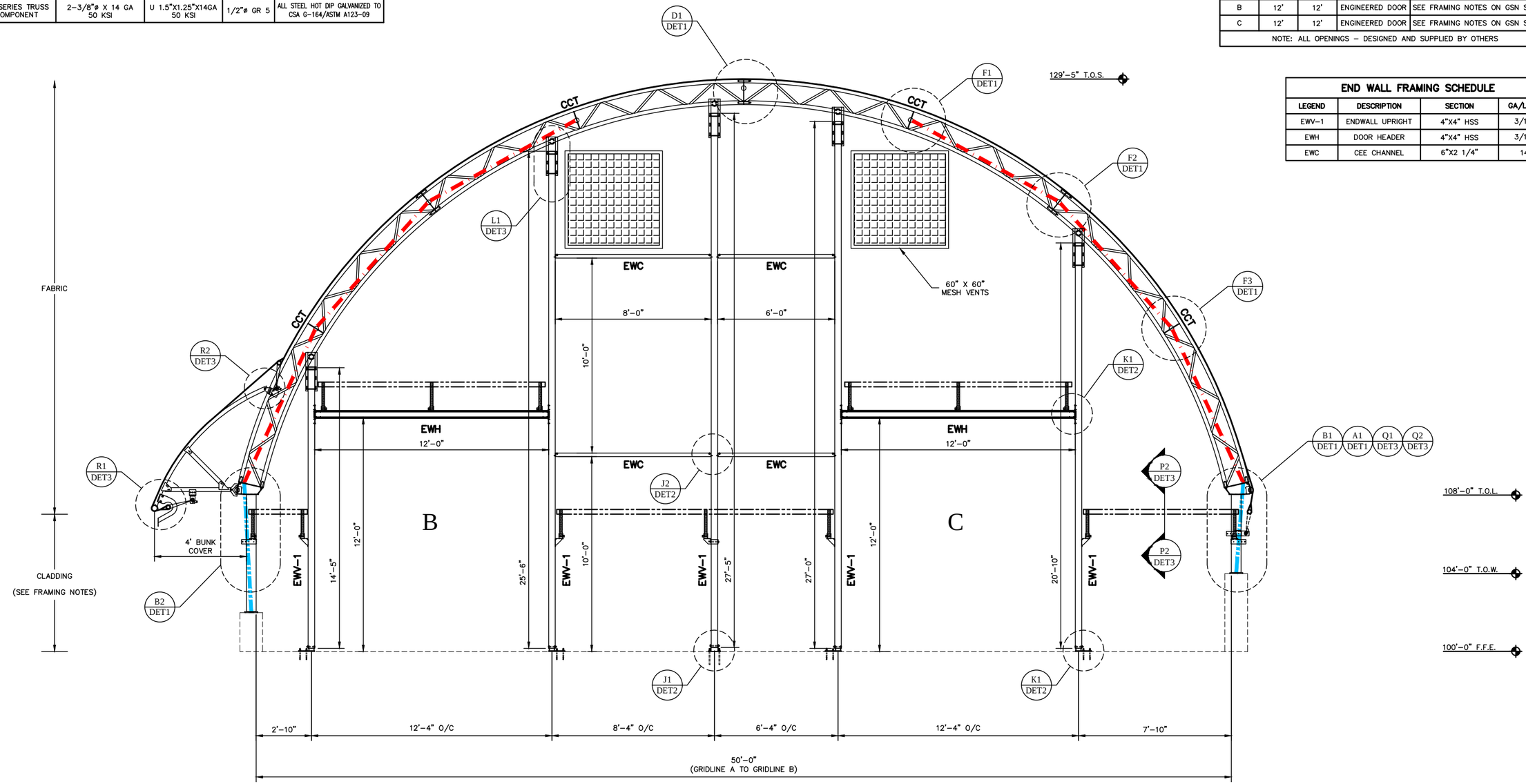
| COMPONENT SCHEDULE | | | | | |
|---|---|---|---|---|---|
| MARK | DESCRIPTION | CHORDS | WEBS | BOLTS | COMMENTS |
| CCT | CC SERIES TRUSS COMPONENT | 2-3/8"ø X 14 GA 50 KSI | U 1.5"X1.25"X14GA 50 KSI | 1/2"ø GR 5 | ALL STEEL HOT DIP GALVANIZED TO CSA G-164/ASTM A123-09 |

| DOOR SCHEDULE | | | | |
|---|---|---|---|---|
| MARK | WIDTH | HEIGHT | TYPE | COMMENTS |
| B | 12' | 12' | ENGINEERED DOOR | SEE FRAMING NOTES ON GSN SHEET |
| C | 12' | 12' | ENGINEERED DOOR | SEE FRAMING NOTES ON GSN SHEET |
| NOTE: ALL OPENINGS – DESIGNED AND SUPPLIED BY OTHERS | | | | |

| END WALL FRAMING SCHEDULE | | | |
|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD |
| EWV-1 | ENDWALL UPRIGHT | 4"X4" HSS | 3/16" |
| EWH | DOOR HEADER | 4"X4" HSS | 3/16" |
| EWC | CEE CHANNEL | 6"X2 1/4" | 14 |




**END 2–GRIDLINE 12**

| FRAMING SCHEDULE | | | | |
|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | COMMENTS |
| | TYPICAL PURLIN | 2-3/8"ø | 13 | UNBRACED BAYS |
| | TYPICAL PURLIN | 2-7/8"ø | 14 | BRACED BAYS / RIDGE |
| | BUNK EAVE TUBE | 3-1/2"ø | 14 | BUNK COVER EAVE TUBE |
| | BRACE PURLIN | U 2"X2" | 11 | END BAYS ONLY |
| | TENSION TUBE | 2-3/8"ø | 13 | ALL BAYS |

| CABLE SCHEDULE | | | | | |
|---|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | PROOF TURNS | PRE-TENSION TURNS |
| | ROOF TRUSS | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | WALL | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | | | | | |
| | | | | | |

CABLE TENSIONING SEQUENCE:

1. HAND TIGHT
2. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (TO STRETCH CABLE)
3. LOOSEN TO SLACK
4. HAND TIGHT
5. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (FINAL TENSIONING 600 LBS UNO)

| END WALL FABRIC INFORMATION | |
|---|---|
| FABRIC TYPE | FABRIC INFORMATION |
| 1 PIECE END PANEL | CONNECTED TO OUTER CHORD USING SCHEDULE 80 PVC WITH CAMBUCKLES @ 20" o/c. TENSION AS PER DETAILS. |

**FOUNDATION DESIGNED AND SUPPLIED BY OTHERS**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Tara, Ontario, Canada
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| | NAME | DATE dd/mm/yyyy |
|---|---|---|
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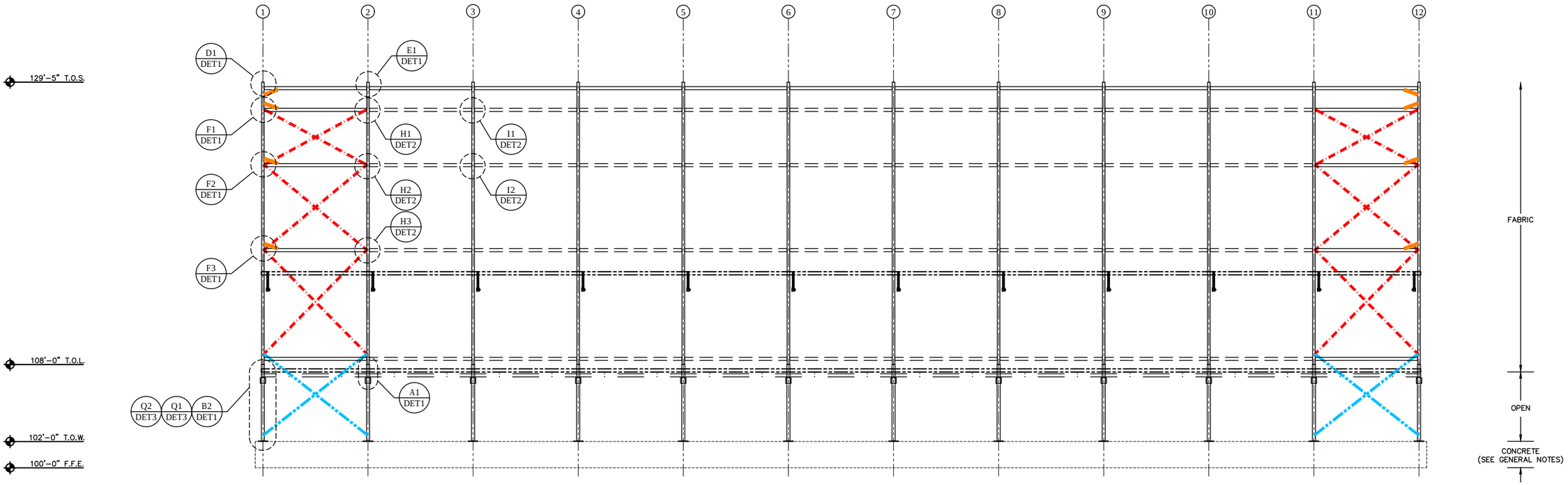
| CHECKED | A G B | 23/08/2018 |



ELEVATION B
52' CC SERIES
405144 CC52x88 R0

SIZE: D | SHEET NAME: EL-B
SCALE: 3/8"=1'-0" | SHEET 7 OF 11




**GRIDLINE B**

| FRAMING SCHEDULE | | | | |
|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | COMMENTS |
| | TYPICAL PURLIN | 2-3/8"ø | 13 | UNBRACED BAYS |
| | TYPICAL PURLIN | 2-7/8"ø | 14 | BRACED BAYS / RIDGE |
| | BUNK EAVE TUBE | 3-1/2"ø | 14 | BUNK COVER EAVE TUBE |
| | BRACE PURLIN | U 2"X2" | 11 | END BAYS ONLY |
| | TENSION TUBE | 2-3/8"ø | 13 | ALL BAYS |

| CABLE SCHEDULE | | | | | |
|---|---|---|---|---|---|
| LEGEND | DESCRIPTION | SECTION | GA/LOAD | PROOF TURNS | PRE-TENSION TURNS |
| | ROOF TRUSS | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | WALL | 3/16" DIA 7X19 | 600 | XXX | XXX |
| | | | | | |
| | | | | | |

CABLE TENSIONING SEQUENCE:

1. HAND TIGHT
2. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (TO STRETCH CABLE)
3. LOOSEN TO SLACK
4. HAND TIGHT
5. PLUS SPECIFIED TURNS, AS ABOVE, USING A CHEATER BAR OR WRENCH (FINAL TENSIONING 600 LBS UNO)

| MAIN BUILDING COVER INFORMATION | |
|---|---|
| FABRIC TYPE | COVER INFORMATION |
| BAG COVER | 1 PIECE BAG COVER, TENSION AS PER DETAILS |

**FOUNDATION DESIGNED AND SUPPLIED BY OTHERS**

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|---|---|---|
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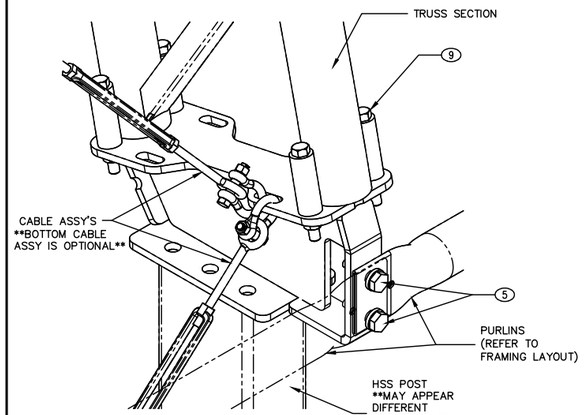
| CHECKED | A G B | 23/08/2018 |

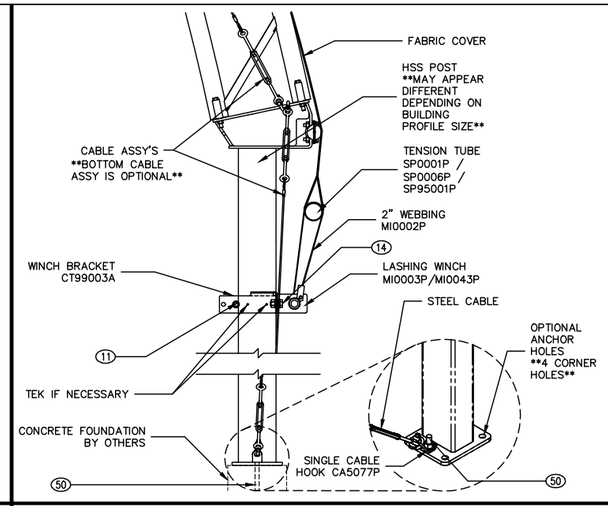


ELEVATION C
52' CC SERIES
405144 CC52x88 R0

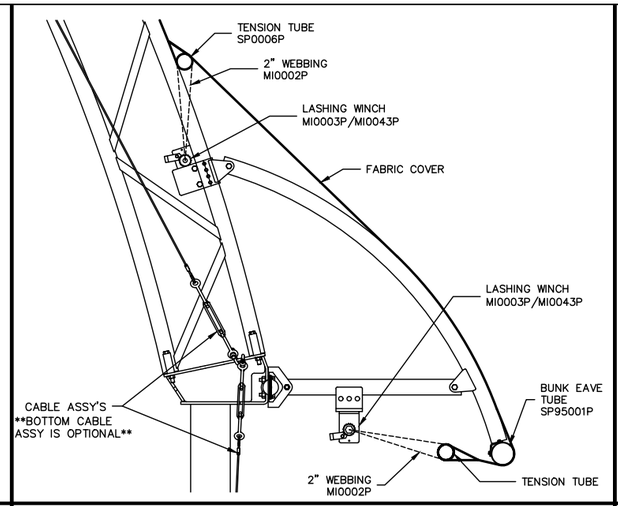
SIZE: D
SHEET NAME: EL-C
SCALE: 1/4=1'-0"
SHEET 8 OF 11



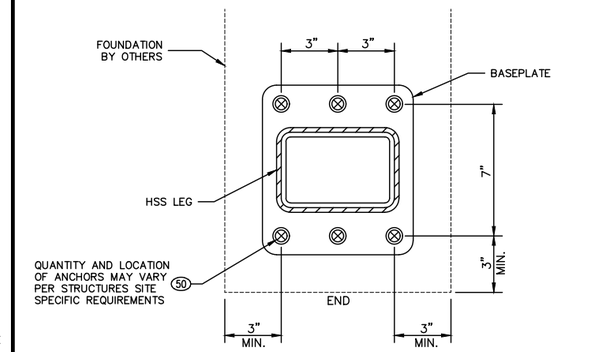

DETAIL A1 HSS POST – BAG COVER




DETAIL B1 BAG COVER STANDARD FABRIC TERMINATION

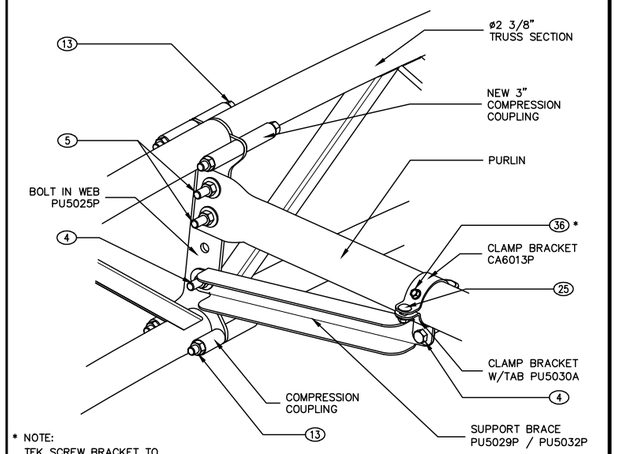



DETAIL B2 – BUNK COVER FABRIC TERMINATION



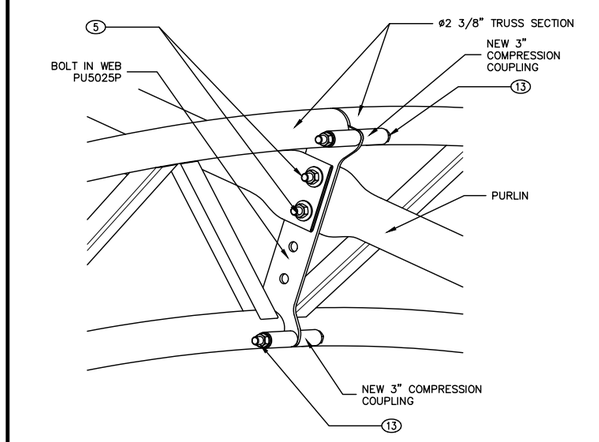

NOTE: MINIMUM DIMENSIONS ARE RECOMMENDATIONS ONLY BASED ON INDUSTRY STANDARDS

DETAIL C1 – HSS LEG FOUNDATION MOUNT

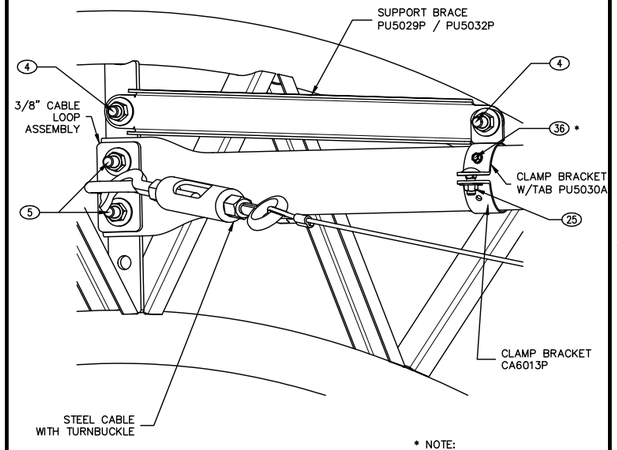



* NOTE:
TEK SCREW BRACKET TO
PURLIN (2 MINIMUM)

DETAIL D1 RIDGE PURLIN AT END AT BOLT IN WEB

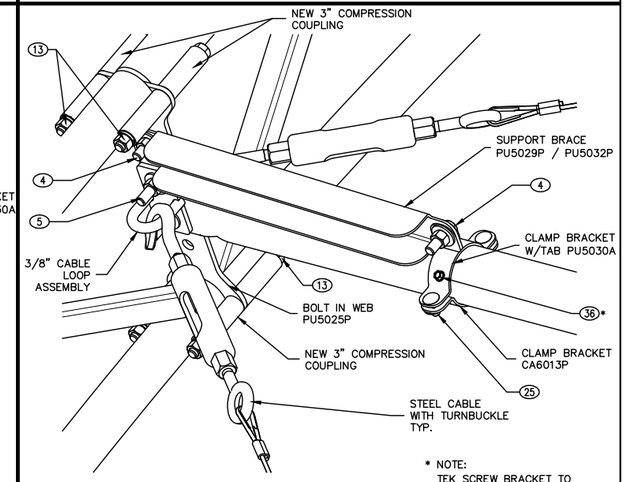



DETAIL E1 RIDGE PURLIN AT BOLT IN WEB



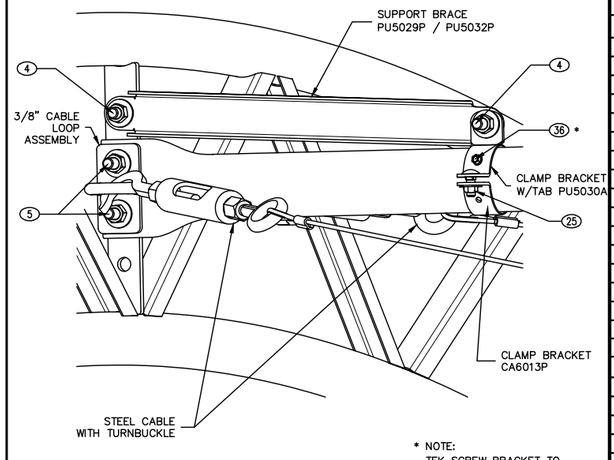

* NOTE:
TEK SCREW BRACKET TO
PURLIN BOTH SIDES (2 MINIMUM)

DETAIL F1 PURLIN AT END AT WELD IN WEB – ONE CABLE




* NOTE:
TEK SCREW BRACKET TO
PURLIN BOTH SIDES (2 MINIMUM)

DETAIL F2 PURLIN AT END AT BOLT IN WEB




* NOTE:
TEK SCREW BRACKET TO
PURLIN BOTH SIDES (2 MINIMUM)

DETAIL F3 PURLIN AT END AT WELD IN WEB – TWO CABLES

## HARDWARE SCHEDULE (AS OCCURS)

| ITEM No. | DESCRIPTION | PART No. | ITEM No. | DESCRIPTION | PART No. |
|---|---|---|---|---|---|
| 1 | HEX BOLT 3/8 X 1–1/2 | FA0029P | 25 | CARRIAGE BOLT 3/8 X 1–1/2 | FC060150G5G |
| 2 | --- | --- | 26 | CARRIAGE BOLT 3/8 X 4 | FA0103P |
| 3 | --- | --- | 27 | CARRIAGE BOLT 3/8 X 4–1/2 | FA0102P |
| 4 | HEX BOLT 1/2 X 1–1/2 | FA0011P | 28 | CARRIAGE BOLT 1/2 X 2 | FA0146P |
| 5 | HEX BOLT 1/2 X 2–1/2 | FA0151P | 29 | CARRIAGE BOLT 1/2 X 4–1/2 | FA0138P |
| 6 | HEX BOLT 1/2 X 2–1/2 GR8 | FA7021P | 30 | CARRIAGE BOLT 1/2 X 5 | FA0127P |
| 7 | HEX BOLT 1/2 X 3–1/2 | FA0006P | 31 | CARRIAGE BOLT 1/2 X 5–1/2 | FA7010P |
| 8 | HEX BOLT 1/2 X 4 | FA0009P | 32 | CARRIAGE BOLT 5/8 X 1–1/2 | FA0142P |
| 9 | HEX BOLT 1/2 X 4–1/2 | FA0076P | 33 | CARRIAGE BOLT 5/8 X 6 | FA7017P |
| 10 | HEX BOLT 1/2 X 5 | FA0010P | 34 | LAG BOLT 3/8 X 1–1/2 | FA0030P |
| 11 | HEX BOLT 1/2 X 5–1/2 | FA0080P | 35 | LAG BOLT 1/2 X 3–1/2 | FA0007P |
| 12 | HEX BOLT 1/2 X 6–1/2 | FH080650G5G | 36 | TEK SCREWS 1/4 X 1 | FA2201P |
| 13 | HEX BOLT 1/2 X 7–1/2 | FH080750G5G | 37 | TEK SCREWS 1/4 X 1–1/4 GASK | FA2204P |
| 14 | HEX BOLT 5/8 X 1–1/2 | FA0059P | 38 | TEK SCREWS 1/4 X 1 WHITE | FA2202P |
| 15 | HEX BOLT 5/8 X 2 | FA0061P | 39 | TEK SCREWS 12–24 X 1–1/4 | FA0147P |
| 16 | HEX BOLT 5/8 X 2–1/2 | FA0062P | 40 | TEK SCREWS 1/4 X 2–1/2 | FA0089P |
| 17 | HEX BOLT 5/8 X 3 | FA0063P | 41 | TEK SCREWS 1/4 X 1–1/2 | FA2203P |
| 18 | HEX BOLT 5/8 X 4 | FA0055P | 42 | THREADED ROD 5/8 X 5 | FR100500G2G |
| 19 | HEX BOLT 5/8 X 5 | FA0074P | 43 | CARRIAGE BOLT 5/8 X 2 | FC100200G5G |
| 20 | HEX BOLT 5/8 X 6 | FA7016P | 44 | HEX BOLT 1/2 X 1 | FH080100G5G |
| 21 | HEX BOLT 3/4 X 3 | FA0077P | 45 | LAG BOLT 3/4 X 3–1/2 | FG120350G2G |
| 22 | HEX BOLT 3/4 X 5 | FA6005P | 48 | BLIND BOLT 1/2 | FA1053P |
| 23 | HEX BOLT 7/8 X 2–1/2 | FA0120P | 49 | BLIND BOLT 5/16" X 2" | FA1054P |
| 24 | HEX BOLT 1–1/4 X 4–1/2 | FA7015P | 50 | CONNECTION BY OTHERS | |

NOTES: REFERENCE TO BOLTS AND/OR U–BOLTS INCLUDES ASSOCIATED NUT AND WASHER
ALWAYS INSTALL WASHER ON TURN SIDE OF BOLT – UNO

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www.calhoun.ca
www.calhounsuperstructure.com

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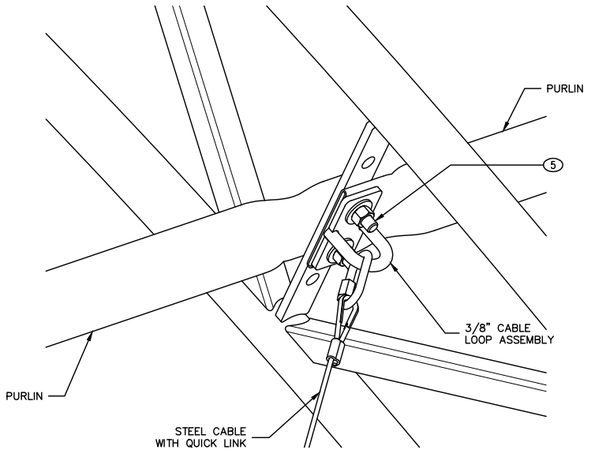
| | NAME | DATE dd/mm/yyyy |
|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |

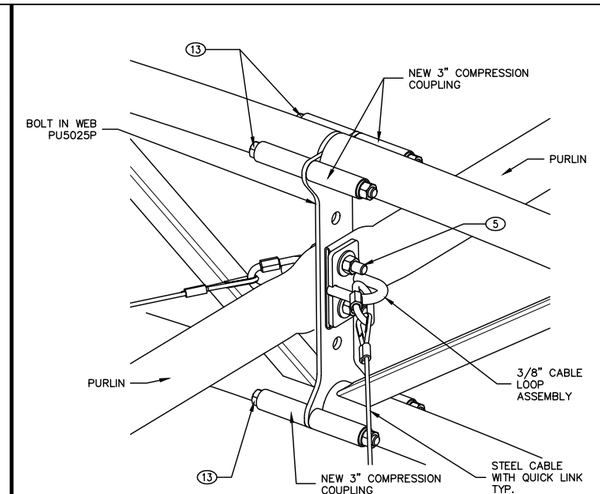


DETAILS
52' CC SERIES
405144 CC52x88 R0

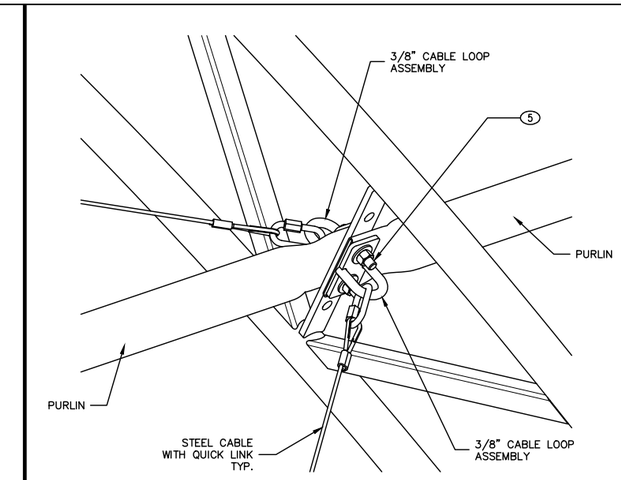
SIZE: D
SHEET NAME: DET1
SCALE: N T S
SHEET 9 OF 11



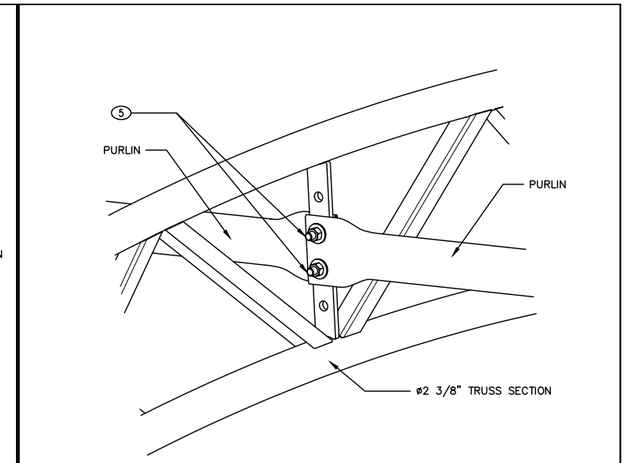

DETAIL H1 BRACED BAY TO UNBRACED BAY AT WELD IN WEB



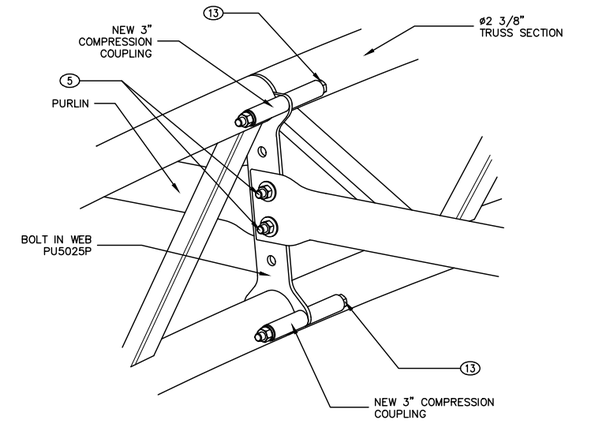

DETAIL H2 BRACED BAY TO UNBRACED BAY AT BOLT IN WEB



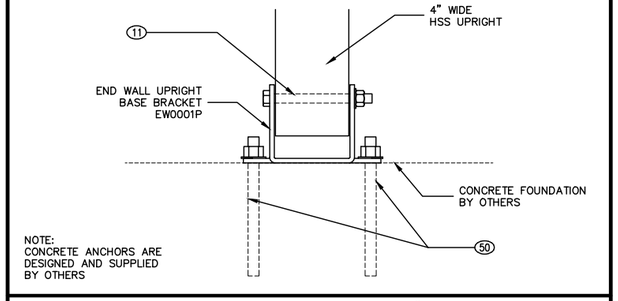

DETAIL H3 BRACED BAY TO UNBRACED BAY AT WELD IN WEB – TWO CABLES



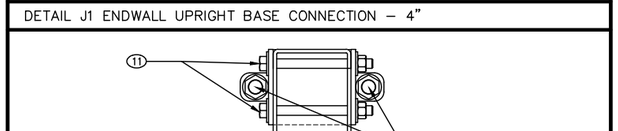

DETAIL I1 UNBRACED BAY TO UNBRACED BAY AT WELD IN WEB



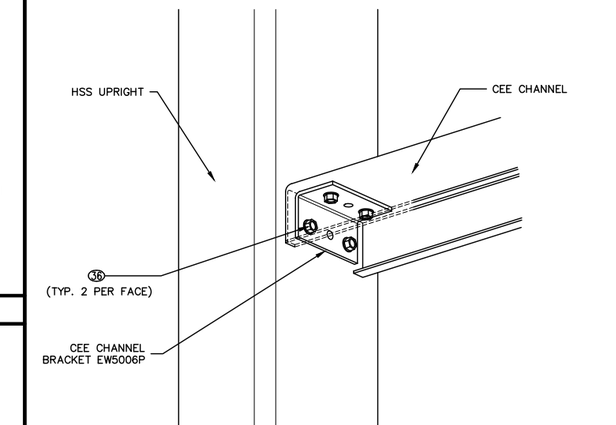

DETAIL I2 UNBRACED BAY TO UNBRACED BAY AT BOLT IN WEB



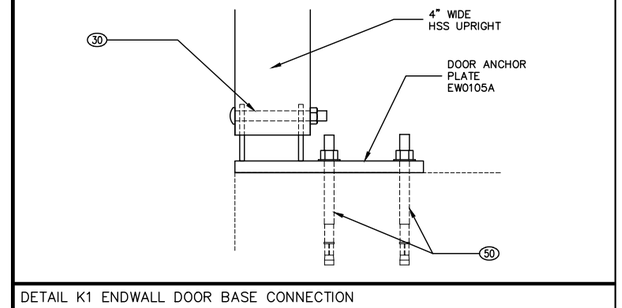

DETAIL J1 ENDWALL UPRIGHT BASE CONNECTION – 4"



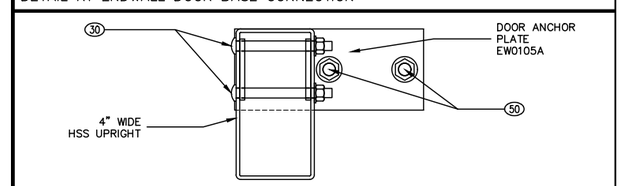

PLAN VIEW J1



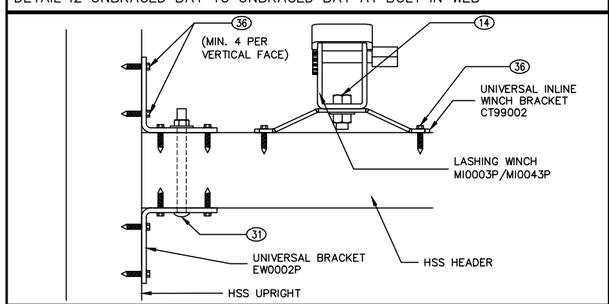

DETAIL J2 ENDWALL UPRIGHT TO CEE CHANNEL CONNECTION



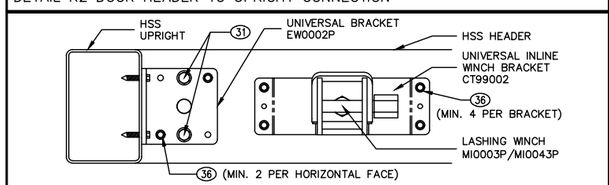

DETAIL K1 ENDWALL DOOR BASE CONNECTION




PLAN VIEW K1




DETAIL K2 DOOR HEADER TO UPRIGHT CONNECTION




PLAN VIEW K2

## HARDWARE SCHEDULE (AS OCCURS)

| ITEM No. | DESCRIPTION | PART No. | ITEM No. | DESCRIPTION | PART No. |
|---|---|---|---|---|---|
| 1 | HEX BOLT 3/8 X 1–1/2 | FA0029P | 25 | CARRIAGE BOLT 3/8 X 1–1/2 | FC060150G5G |
| 2 | --- | --- | 26 | CARRIAGE BOLT 3/8 X 4 | FA0103P |
| 3 | --- | --- | 27 | CARRIAGE BOLT 3/8 X 4–1/2 | FA0102P |
| 4 | HEX BOLT 1/2 X 1–1/2 | FA0011P | 28 | CARRIAGE BOLT 1/2 X 2 | FA0146P |
| 5 | HEX BOLT 1/2 X 2–1/2 | FA0151P | 29 | CARRIAGE BOLT 1/2 X 4–1/2 | FA0138P |
| 6 | HEX BOLT 1/2 X 2–1/2 GR8 | FA7021P | 30 | CARRIAGE BOLT 1/2 X 5 | FA0127P |
| 7 | HEX BOLT 1/2 X 3–1/2 | FA0006P | 31 | CARRIAGE BOLT 1/2 X 5–1/2 | FA7010P |
| 8 | HEX BOLT 1/2 X 4 | FA0009P | 32 | CARRIAGE BOLT 5/8 X 1–1/2 | FA0142P |
| 9 | HEX BOLT 1/2 X 4–1/2 | FA0076P | 33 | CARRIAGE BOLT 5/8 X 6 | FA7017P |
| 10 | HEX BOLT 1/2 X 5 | FA0010P | 34 | LAG BOLT 3/8 X 1–1/2 | FA0030P |
| 11 | HEX BOLT 1/2 X 5–1/2 | FA0080P | 35 | LAG BOLT 1/2 X 3–1/2 | FA0007P |
| 12 | HEX BOLT 1/2 X 6–1/2 | FH080650G5G | 36 | TEK SCREWS 1/4 X 1 | FA2201P |
| 13 | HEX BOLT 1/2 X 7–1/2 | FH080750G5G | 37 | TEK SCREWS 1/4 X 1–1/4 GASK | FA2204P |
| 14 | HEX BOLT 5/8 X 1–1/2 | FA0059P | 38 | TEK SCREWS 1/4 X 1 WHITE | FA2202P |
| 15 | HEX BOLT 5/8 X 2 | FA0061P | 39 | TEK SCREWS 12–24 X 1–1/4 | FA0147P |
| 16 | HEX BOLT 5/8 X 2–1/2 | FA0062P | 40 | TEK SCREWS 1/4 X 2–1/2 | FA0089P |
| 17 | HEX BOLT 5/8 X 3 | FA0063P | 41 | TEK SCREWS 1/4 X 1–1/2 | FA2203P |
| 18 | HEX BOLT 5/8 X 4 | FA0055P | 42 | THREADED ROD 5/8 X 5 | FR100500G2G |
| 19 | HEX BOLT 5/8 X 5 | FA0074P | 43 | CARRIAGE BOLT 5/8 X 2 | FC100200G5G |
| 20 | HEX BOLT 5/8 X 6 | FA7016P | 44 | HEX BOLT 1/2 X 1 | FH080100G5G |
| 21 | HEX BOLT 3/4 X 3 | FA0077P | 45 | LAG BOLT 3/4 X 3–1/2 | FG120350G2G |
| 22 | HEX BOLT 3/4 X 5 | FA6005P | 48 | BLIND BOLT 1/2 | FA1053P |
| 23 | HEX BOLT 7/8 X 2–1/2 | FA0120P | 49 | BLIND BOLT 5/16" X 2" | FA1054P |
| 24 | HEX BOLT 1–1/4 X 4–1/2 | FA7015P | 50 | CONNECTION BY OTHERS | |

NOTES: REFERENCE TO BOLTS AND/OR U–BOLTS INCLUDES ASSOCIATED NUT AND WASHER
ALWAYS INSTALL WASHER ON TURN SIDE OF BOLT – UNO

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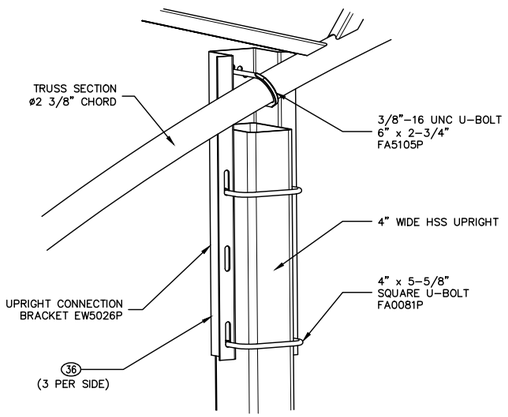
| | NAME | DATE dd/mm/yyyy |
|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |

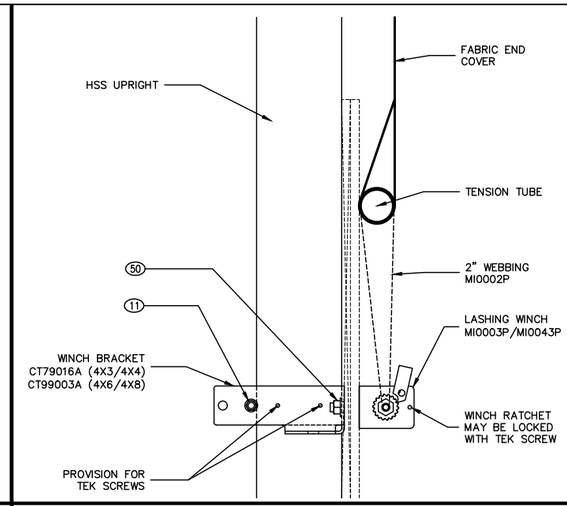


DETAILS
52' CC SERIES
405144 CC52x88 R0

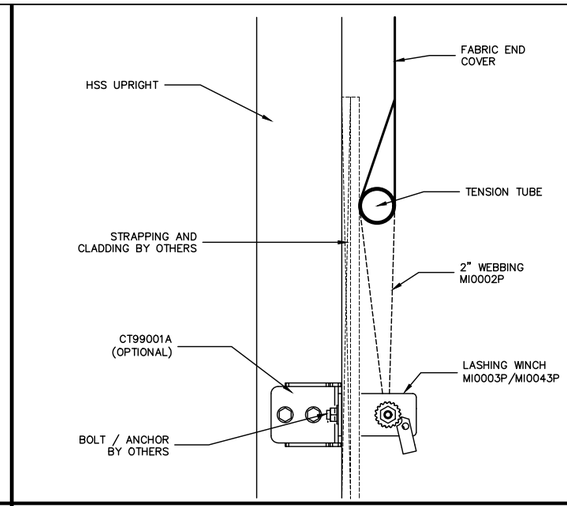
SIZE: D
SHEET NAME: DET2
SCALE: N T S
SHEET: 10 OF 11



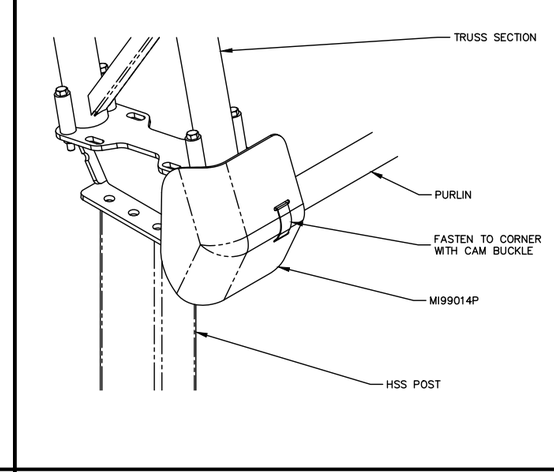

DETAIL L1 ENDWALL HSS UPRIGHT CONNECTION AT TRUSS – 4X4 HSS



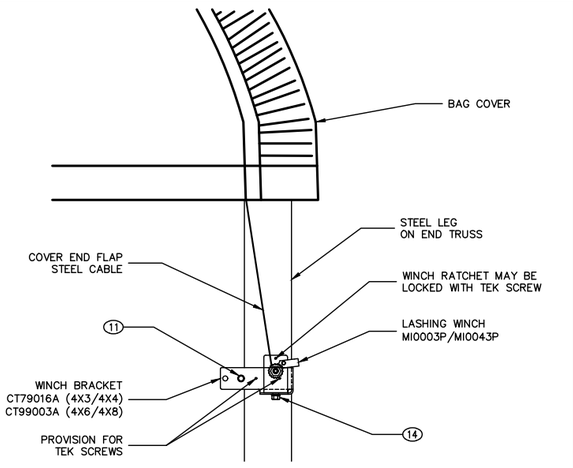

DETAIL P1 – END WALL FABRIC ON HSS WITH CLADDING BY OTHERS



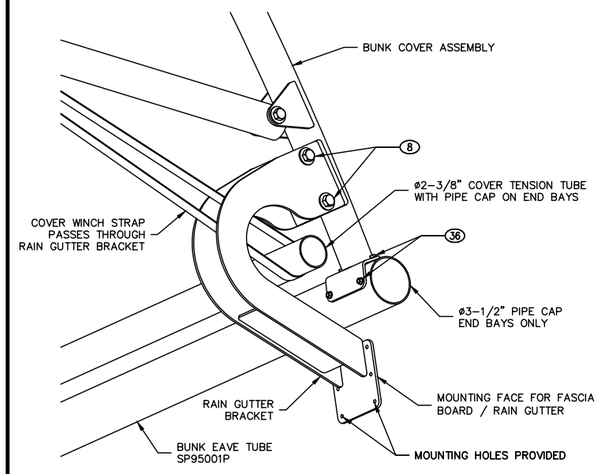

DETAIL P2 – END WALL FABRIC ON HSS WITH CLADDING BY OTHERS



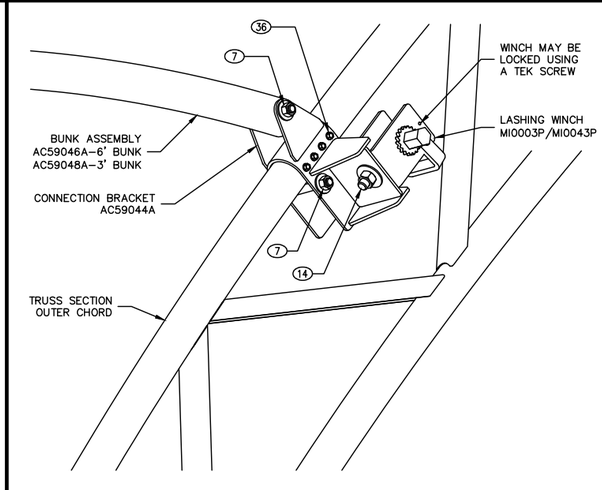

DETAIL Q1 – COVER GUARD – HSS POST (END FRAMES ONLY)




DETAIL Q2 – END FLAP CABLE WINCH MOUNTING – BAG COVER – HSS LEG




DETAIL R1 – BUNK EAVE CONNECTION WITH RAIN GUTTER




DETAIL R2 – BUNK TANGENT PIPE CONNECTION AT TRUSS

## HARDWARE SCHEDULE (AS OCCURS)

| ITEM No. | DESCRIPTION | PART No. | ITEM No. | DESCRIPTION | PART No. |
|---|---|---|---|---|---|
| 1 | HEX BOLT 3/8 X 1-1/2 | FA0029P | 25 | CARRIAGE BOLT 3/8 X 1-1/2 | FC060150G5G |
| 2 | --- | --- | 26 | CARRIAGE BOLT 3/8 X 4 | FA0103P |
| 3 | --- | --- | 27 | CARRIAGE BOLT 3/8 X 4-1/2 | FA0102P |
| 4 | HEX BOLT 1/2 X 1-1/2 | FA0011P | 28 | CARRIAGE BOLT 1/2 X 2 | FA0146P |
| 5 | HEX BOLT 1/2 X 2-1/2 | FA0151P | 29 | CARRIAGE BOLT 1/2 X 4-1/2 | FA0138P |
| 6 | HEX BOLT 1/2 X 2-1/2 GR8 | FA7021P | 30 | CARRIAGE BOLT 1/2 X 5 | FA0127P |
| 7 | HEX BOLT 1/2 X 3-1/2 | FA0006P | 31 | CARRIAGE BOLT 1/2 X 5-1/2 | FA7010P |
| 8 | HEX BOLT 1/2 X 4 | FA0009P | 32 | CARRIAGE BOLT 5/8 X 1-1/2 | FA0142P |
| 9 | HEX BOLT 1/2 X 4-1/2 | FA0076P | 33 | CARRIAGE BOLT 5/8 X 6 | FA7017P |
| 10 | HEX BOLT 1/2 X 5 | FA0010P | 34 | LAG BOLT 3/8 X 1-1/2 | FA0030P |
| 11 | HEX BOLT 1/2 X 5-1/2 | FA0080P | 35 | LAG BOLT 1/2 X 3-1/2 | FA0007P |
| 12 | HEX BOLT 1/2 X 6-1/2 | FH080650G5G | 36 | TEK SCREWS 1/4 X 1 | FA2201P |
| 13 | HEX BOLT 1/2 X 7-1/2 | FH080750G5G | 37 | TEK SCREWS 1/4 X 1-1/4 GASK | FA2204P |
| 14 | HEX BOLT 5/8 X 1-1/2 | FA0059P | 38 | TEK SCREWS 1/4 X 1 WHITE | FA2202P |
| 15 | HEX BOLT 5/8 X 2 | FA0061P | 39 | TEK SCREWS 12-24 X 1-1/4 | FA0147P |
| 16 | HEX BOLT 5/8 X 2-1/2 | FA0062P | 40 | TEK SCREWS 1/4 X 2-1/2 | FA0089P |
| 17 | HEX BOLT 5/8 X 3 | FA0063P | 41 | TEK SCREWS 1/4 X 1-1/2 | FA2203P |
| 18 | HEX BOLT 5/8 X 4 | FA0055P | 42 | THREADED ROD 5/8 X 5 | FR100500G2G |
| 19 | HEX BOLT 5/8 X 5 | FA0074P | 43 | CARRIAGE BOLT 5/8 X 2 | FC100200G5G |
| 20 | HEX BOLT 5/8 X 6 | FA7016P | 44 | HEX BOLT 1/2 X 1 | FH080100G5G |
| 21 | HEX BOLT 3/4 X 3 | FA0077P | 45 | LAG BOLT 3/4 X 3-1/2 | FG120350G2G |
| 22 | HEX BOLT 3/4 X 5 | FA6005P | 48 | BLIND BOLT 1/2 | FA1053P |
| 23 | HEX BOLT 7/8 X 2-1/2 | FA0120P | 49 | BLIND BOLT 5/16" X 2" | FA1054P |
| 24 | HEX BOLT 1-1/4 X 4-1/2 | FA7015P | 50 | CONNECTION BY OTHERS | |

NOTES: REFERENCE TO BOLTS AND/OR U-BOLTS INCLUDES ASSOCIATED NUT AND WASHER
ALWAYS INSTALL WASHER ON TURN SIDE OF BOLT – UNO

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| | NAME | DATE dd/mm/yyyy |
|---|---|---|
| DRAWN | L T C | 23/08/2018 |
| CHECKED | A G B | 23/08/2018 |

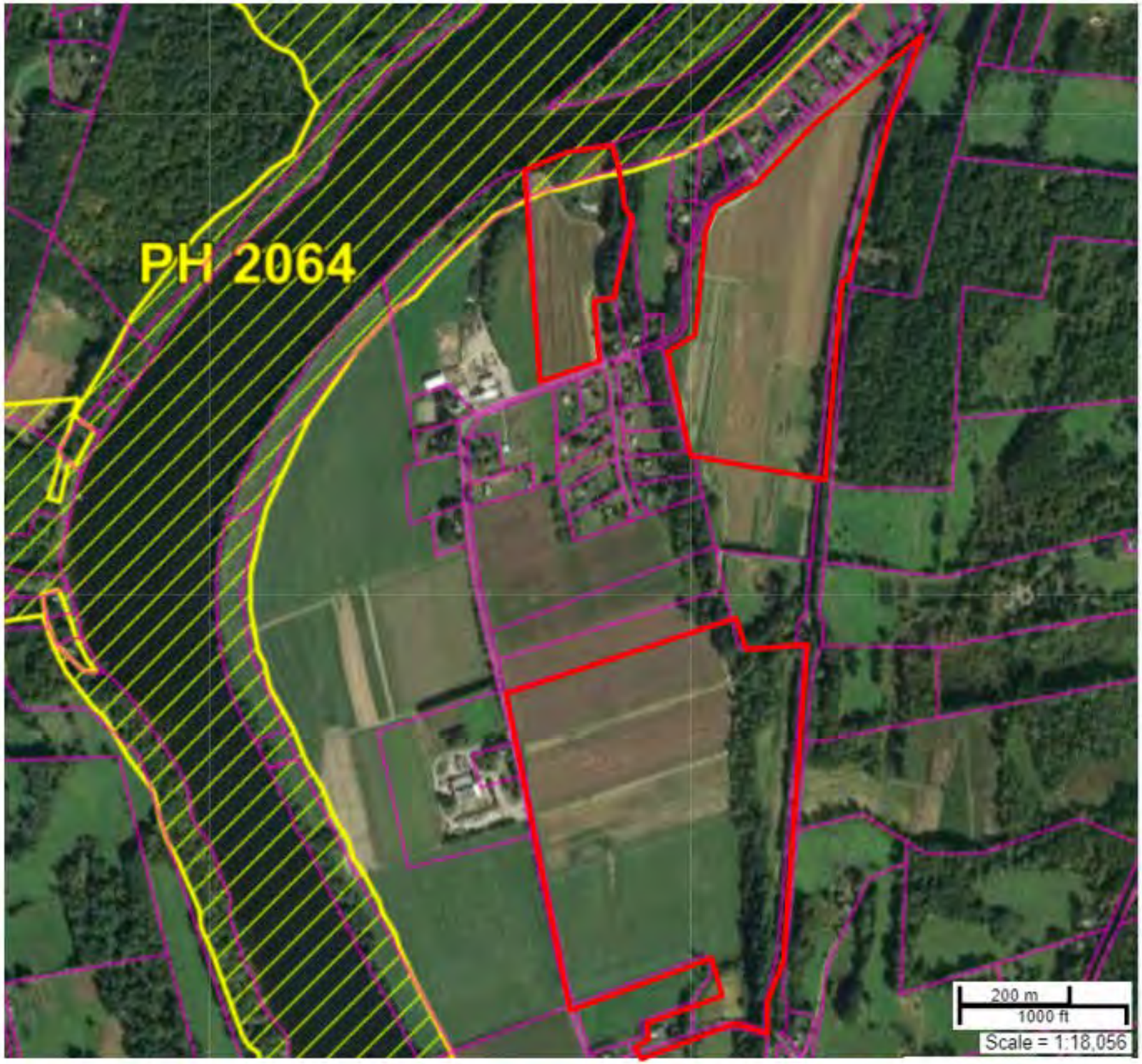


DETAILS
52' CC SERIES
405144 CC52x88 R0

SIZE: D
SHEET NAME: DET3
SCALE: N T S
SHEET: 11 OF 11

# Exhibit C-NHESP Mapping

# NHESP Endangered Species Analysis




NHESP Priority Habitats of Rare Species

NHESP Estimated Habitats of Rare Wildlife

# Exhibit D-Sungrow ST37272kWh Energy Storage System Specifications

SUNGROW

# ST3727KWH(L)-D1250HV+ SG3600UD-MV Preliminary

Energy Storage System

## HIGH INTEGRATION

- DC coupled energy storage system integrated with PV inverter
- Advanced integration technology ensures optimal system performance and lower cost

## SAFE AND RELIABLE

- DC electric circuit safety management includes fast breaking and anti-arc protection
- Multi-state monitoring and linkage actions ensure battery system safety

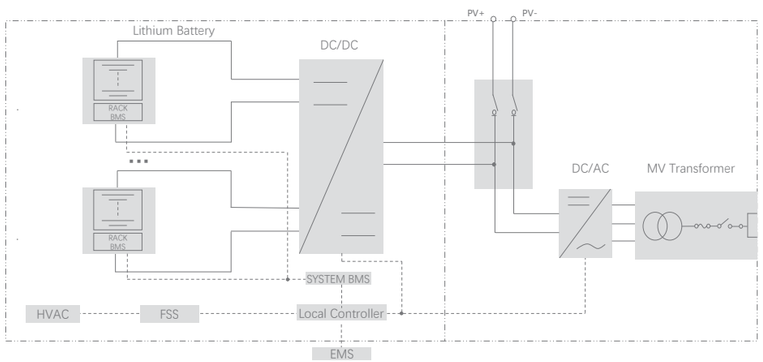
## EFFICIENT AND FLEXIBLE

- Intelligent cell-level temperature control ensures higher efficiency and longer battery cycle life
- Modular design supports parallel connection and easy system expansion

## SMART AND FRIENDLY

- Integrated local controller enables single point of communication interface
- Fast state monitoring and faults record enables pre-alarm and faults location

## CIRCUIT DIAGRAM










**Battery capacity will be configurable as client requirement**

| System Type | ST3727KWH(L)-D1250HV+SG3600UD-MV |
|---|---|
| **PV Data** | |
| Max. PV input voltage | 1,500 V |
| MPPT voltage range for nominal power | 915 ~ 1,300 V |
| Number of PV inputs | 20(optional:22/24/26/28) |
| Max. PV input current | 5,415 A |
| **Battery Data** | |
| Cell type | LFP , 280 AH |
| Configuration of system | 416S10P |
| Battery capacity (BOL) | 3,727 kWh |
| Battery voltage range | 1,123.2 ~ 1,497.6 V |
| BMS communication interfaces | RS485, Ethernet |
| BMS communication protocols | Modbus RTU, Modbus TCP |
| **DCDC Data** | |
| Working voltage range | 500 ~ 1,500 V |
| Nominal power | 1,250 kW |
| Max. current | 1,400 A |
| **AC Data** | |
| Nominal AC power | 3,600 kW @ 45 ℃ (113 ℉) / 3,240 kW @ 50 ℃ (122 ℉) |
| Max.THD of current | < 3 % (at nominal power) |
| DC component | < 0.5 % In |
| Grid voltage range | 12 – 35 kV |
| Power factor | > 0.99 (at nominal power) |
| Adjustable power factor | 0.8 leading – 0.8 lagging |
| Nominal grid frequency | 50 Hz /60 Hz |
| Grid frequency range | 50 Hz / 45 – 55 Hz, 60 Hz / 50 – 65 Hz |
| Isolation method | Transformer |
| **Transformer** | |
| Transformer rated power | 3,600 kVA |
| LV/MV voltage | 0.63 kV / 12 ~ 35 kV |
| Transformer vector | Dy1 or Dy11 |
| Transformer cooling type | ONAN (Optional: KNAN) |
| Oil type | Mineral oil (PCB free) or degradable oil on request |
| **General Data** | |
| Dimensions of PCS unit (W * H * D) | 6,058*2,896*2,438 mm / 238.5"*114.0"*96.0" |
| Dimensions of battery unit (W * H * D) | 12,192*2,896*2,438 mm / 480.0"*114.0"*96.0" |
| Weight of PCS unit | 18,000 kg / 39,683.2 lbs |
| Weight of battery unit (with / without battery) | 46,300 kg 102,074.0 lbs / 16,300 kg 35,935.3 lbs |
| Degree of protection | NEMA 3R |
| Operating temperature range | -30 to 50 ℃ / -22 to 122 ℉ (> 45 ℃ / 113 ℉ derating) |
| Relative humidity | 0 – 95 % (non-condensing) |
| Max. working altitude | 1000 m (standard) / > 1000 m (optional) (3280.8 ft (standard) / > 3280.8 ft (optional)) |
| Cooling concept of battery chamber | Heating, Ventilation and Air Conditioning |
| Cooling concept of PCS chamber | Temperature controlled forced air cooling |
| Fire suppression system of battery unit | FM200 extinguishment system |
| Communication interfaces | RS485, Ethernet |
| Communication protocols | Modbus RTU, Modbus TCP, IEC 104 |
| Compliance | UL9540, UL9540A, UL1973, UL1741+SA, IEEE1547 |

# Exhibit E-ST37272kWh system noise test report

# ST3727KWH（L）Container noise test report

## 1. Test overview and results

The ST3727KWH(L) container has a total length of 12.2m, a width of 2.3m, and a height of 2.8m. The container contains 4 air conditioners with a cooling capacity of 30kW, which are distributed at both ends of the container and are the main noise source of the system. In this test, three points 1m, 3m, and 5m away from the container and a vertical height of 1.5m were selected for testing. The environmental noise was 49.7dB. The specific test results are shown in the figure below.

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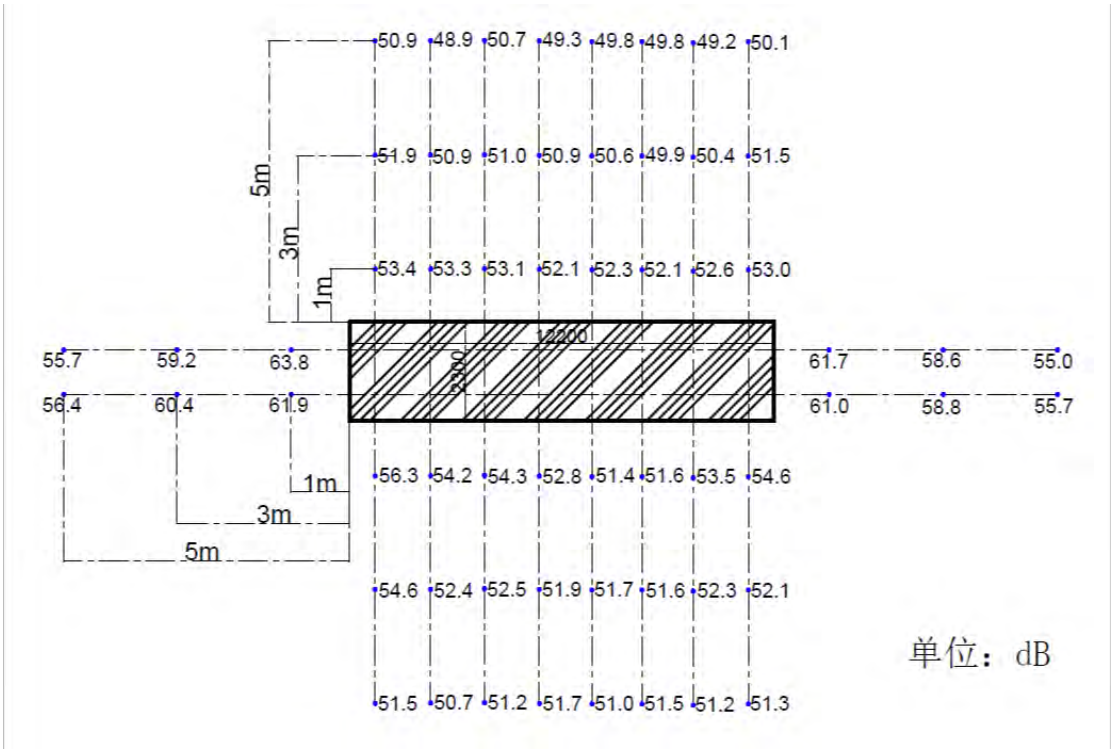



Fig 1. Test result graph

## 2. Test details

1m

3m



5m



1m


3m



5m



1m


3m


5m


1m

3m



5m



1m

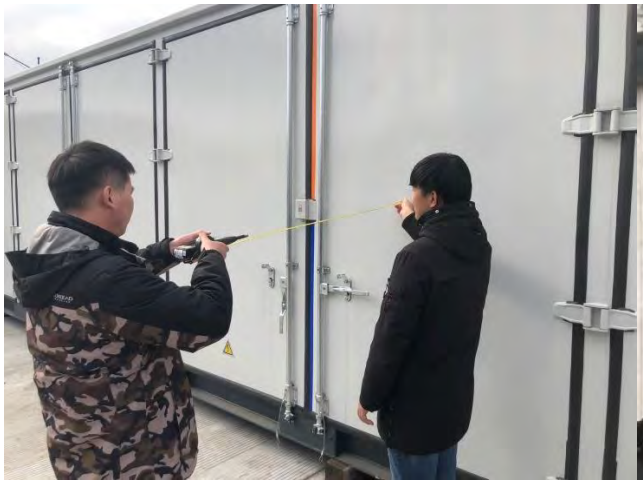

3m



5m



1m




3m


5m


1m

3m


5m


1m

3m



5m



1m

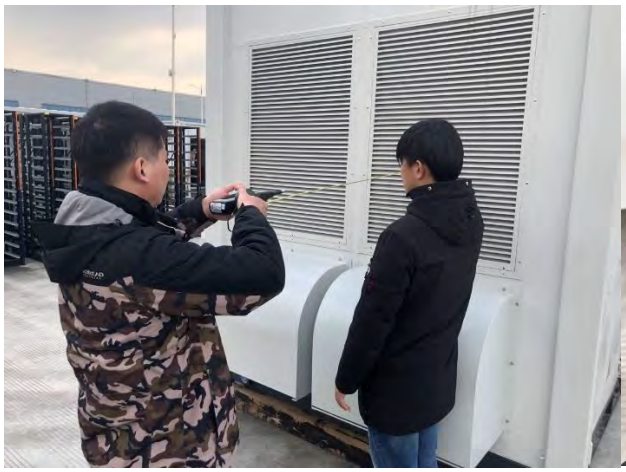
3m



5m



1m



3m

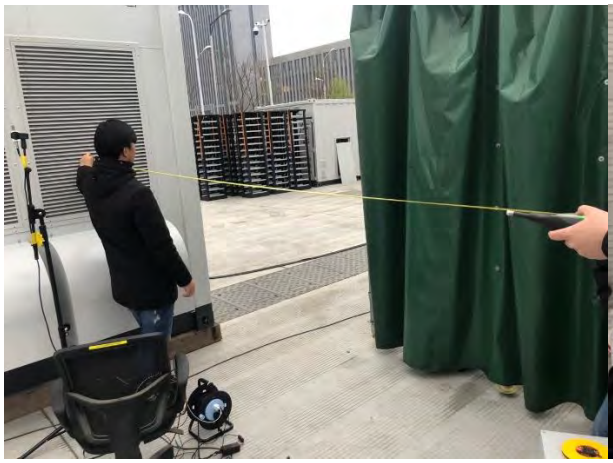


5m

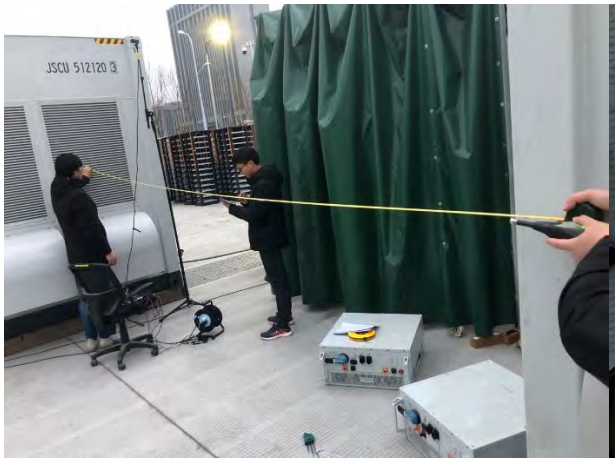


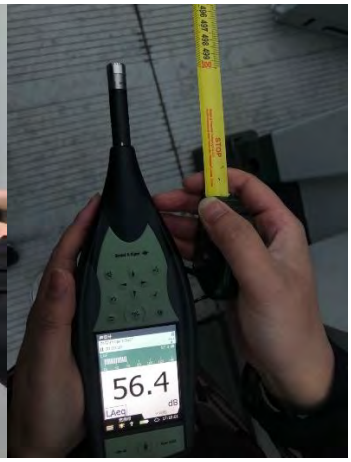
1m

3m




5m




1m

3m



5m



1m

3m



5m



1m

3m



5m



1m


3m



5m



1m


3m



5m



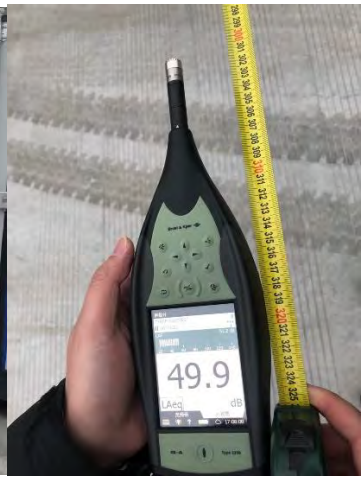
1m


3m


5m


1m

3m


5m

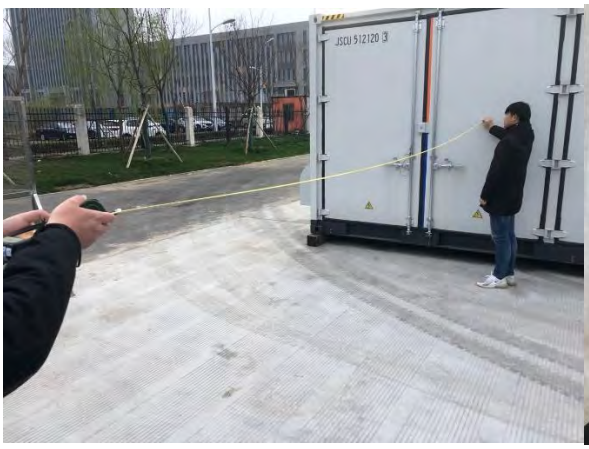


1m


3m



5m





1m

3m


5m


# Exhibit F-FM-200 Material Safety Data Sheet

Material Safety Data Sheet

# *FM-200®*

Version 2.1

Revision Date 07/11/2011 Ref. 130000036866

This SDS adheres to the standards and regulatory requirements of the United States and may not meet the regulatory requirements in other countries.

## SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

| | | |
|---|---|---|
| Product name | : | FM-200® |
| Tradename/Synonym | : | FE-227<br>2-Hydroperfluoropropane<br>Propane, 1,1,1,2,3,3,3-Heptafluoro-<br>HFC-227eaHP<br>2-Hydroheptafluoropropane<br>Heptafluoropropane<br>2-H-heptafluoropropane<br>1,1,1,2,3,3,3-Heptafluoropropane<br>R-227<br>R227<br>HFC-227ea |
| MSDS Number | : | 130000036866 |
| Product Use | : | Fire extinguishing agent |
| Manufacturer | : | DuPont<br>1007 Market Street<br>Wilmington, DE 19898 |
| Product Information | : | 1-800-441-7515 (outside the U.S. 1-302-774-1000) |
| Medical Emergency | : | 1-800-441-3637 (outside the U.S. 1-302-774-1139) |
| Transport Emergency | : | CHEMTREC: 1-800-424-9300 (outside the U.S. 1-703-527-3887) |

## SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Misuse or intentional inhalation abuse may lead to death without warning.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.
Rapid evaporation of the liquid may cause frostbite.

Potential Health Effects

Skin : Contact with liquid or refrigerated gas can cause cold burns and frostbite.

| | | |
|---|---|---|
| Eyes | : | Contact with liquid or refrigerated gas can cause cold burns and frostbite. |
| Inhalation | : | Misuse or intentional inhalation abuse may cause death without warning symptoms, due to cardiac effects.<br>Other symptoms potentially related to misuse or inhalation abuse are: Anaesthetic effects, Light-headedness, dizziness, confusion, incoordination, drowsiness, or unconsciousness, irregular heartbeat with a strange sensation in the chest, heart thumping, apprehension, feeling of fainting, dizziness or weakness.<br>Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing. |

Carcinogenicity

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, or OSHA, as a carcinogen.

## SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

| Component | CAS-No. | Concentration |
|---|---|---|
| 1,1,1,2,3,3,3-Heptafluoropropane | 431-89-0 | 100 % |

## SECTION 4. FIRST AID MEASURES

| | | |
|---|---|---|
| Skin contact | : | In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Take off all contaminated clothing immediately. Consult a physician. Wash contaminated clothing before re-use. Treat for frostbite if necessary by gently warming affected area. |
| Eye contact | : | In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Consult a physician if necessary. |
| Inhalation | : | Remove from exposure, lie down. Move to fresh air. Keep patient warm and at rest. Artificial respiration and/or oxygen may be necessary. Consult a physician. |

| | | |
|---|---|---|
| Ingestion | : | Is not considered a potential route of exposure. |
| General advice | : | Never give anything by mouth to an unconscious person. When symptoms persist or in all cases of doubt seek medical advice. |
| Notes to physician | : | Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, that may be used in situations of emergency life support should be used with special caution. |

## SECTION 5. FIREFIGHTING MEASURES

| | | |
|---|---|---|
| Fire and Explosion Hazard | : | The product is not flammable. Hazardous decomposition products : Hydrogen fluoride, Carbonyl fluoride |
| Suitable extinguishing media | : | This material is a fire extinguishing agent. |

## SECTION 6. ACCIDENTAL RELEASE MEASURES

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

| | | |
|---|---|---|
| Safeguards (Personnel) | : | Evacuate personnel, thoroughly ventilate area, use self-contained breathing apparatus. Keep upwind of leak - evacuate until gas has dispersed. |
| Spill Cleanup | : | Ventilate area using forced ventilation, especially low or enclosed places where heavy vapors might collect. |

## SECTION 7. HANDLING AND STORAGE

| | | |
|---|---|---|
| Handling (Personnel) | : | Do not breathe gas. Avoid contact with skin, eyes and clothing. Provide sufficient air exchange and/or exhaust in work rooms. For personal protection see section 8. Wash hands thoroughly after handling. Wash clothing after use. Decomposition will occur when product comes in contact with open flame or electrical heating elements.<br>Handle in accordance with good industrial hygiene and safety practice. |

| | | |
|---|---|---|
| Storage | : | Valve protection caps and valve cutlet threaded plugs must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Never attempt to lift cylinder by its cap. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder. Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Separate full containers from empty containers. Keep at temperature not exceeding 52°C. Do not store near combustible materials. Keep container tightly closed in a dry and well-ventilated place. Store in original container. Protect from contamination. Avoid area where salt or other corrosive materials are present. |
| Storage temperature | : | < 52 °C (< 126 °F) |

## SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

| | | |
|---|---|---|
| Engineering controls | : | Use only with adequate ventilation. Keep container tightly closed. |
| Personal protective equipment | | |
| Respiratory protection | : | Wear NIOSH approved respiratory protection as appropriate. |
| Hand protection | : | Additional protection: Impervious gloves |
| Eye protection | : | Safety glasses with side-shields Additionally wear a face shield where the possibility exists for face contact due to splashing, spraying or airborne contact with this material. |
| Skin and body protection | : | Where there is potential for skin contact, have available and wear as appropriate, impervious gloves, apron, pants, jacket, hood and boots. |
| Protective measures | : | Self-contained breathing apparatus (SCBA) is required if a large release occurs. |

Exposure Guidelines

Exposure Limit Values

1,1,1,2,3,3,3-Heptafluoropropane

| | | | |
|---|---|---|---|
| AEL * | (DUPONT) | 1,000 ppm | 8 & 12 hr. TWA |

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

## SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

| | | |
|---|---|---|
| Form | : | Liquefied gas |
| Odor | : | none |
| Melting point/range | : | -131 °C (-204 °F) |
| Boiling point | : | -16.3 °C (2.7 °F) |
| Vapour Pressure | : | 4,547 hPa at 25 °C (77 °F) |
| Density | : | 1.388 g/cm3 at 25 °C (77 °F)<br>(as liquid) |

## SECTION 10. STABILITY AND REACTIVITY

| | | |
|---|---|---|
| Stability | : | Stable at normal temperatures and storage conditions. |
| Incompatibility | : | Alkali metals Alkaline earth metals, Powdered metals, Powdered metal salts |
| Hazardous decomposition products | : | Hazardous decomposition products , Hydrogen fluoride , Carbonyl fluoride, Carbon monoxide, Carbon dioxide |
| Hazardous reactions | : | Polymerization will not occur. |

## SECTION 11. TOXICOLOGICAL INFORMATION

FM-200®

| | | |
|---|---|---|
| Inhalation 4 h LC50 | : | > 788698 ppm , rat |
| Inhalation | : | dog<br>Cardiac sensitization |
| Dermal | : | not applicable |
| Oral | : | not applicable |
| Skin irritation | : | No skin irritation, Not tested on animals |

Not expected to cause skin irritation based on expert review of the properties of the substance.

| | | |
|---|---|---|
| Eye irritation | : | No eye irritation, Not tested on animals<br>Not expected to cause eye irritation based on expert review of the properties of the substance. |
| Sensitisation | : | Does not cause skin sensitization., Not tested on animals<br>Not expected to cause sensitization based on expert review of the properties of the substance. |
| | | Did not cause sensitization on laboratory animals. There are no reports of human respiratory sensitization. |
| Repeated dose toxicity | : | Inhalation<br>rat<br>No toxicologically significant effects were found. |
| Carcinogenicity | : | Overall weight of evidence indicates that the substance is not carcinogenic. |
| Mutagenicity | : | Did not cause genetic damage in animals.<br>Did not cause genetic damage in cultured mammalian cells.<br>Did not cause genetic damage in cultured bacterial cells. |
| Reproductive toxicity | : | Animal testing showed no reproductive toxicity.<br>Information given is based on data obtained from similar substances. |
| Teratogenicity | : | Animal testing showed no developmental toxicity. |
| Further information | : | Cardiac sensitisation threshold limit : 730190 mg/m3 |

## SECTION 12. ECOLOGICAL INFORMATION

Aquatic Toxicity
FM-200®

| | | |
|---|---|---|
| 96 h LC50 | : | Danio rerio (zebra fish) > 200 mg/l<br>Information given is based on data obtained from similar substances. |
| 96 h LC50 | : | Oncorhynchus mykiss (rainbow trout) > 81.8 mg/l |

Information given is based on data obtained from similar substances.

| | | |
|---|---|---|
| 72 h EC50 | : | Pseudokirchneriella subcapitata > 114 mg/l<br>Information given is based on data obtained from similar substances. |
| 72 h EC50 | : | Pseudokirchneriella subcapitata > 118 mg/l<br>Information given is based on data obtained from similar substances. |
| 48 h EC50 | : | Daphnia magna (Water flea) > 200 mg/l<br>Information given is based on data obtained from similar substances. |
| 48 h EC50 | : | Daphnia magna (Water flea) > 97.9 mg/l<br>Information given is based on data obtained from similar substances. |

Environmental Fate
FM-200®

| | | |
|---|---|---|
| Biodegradability aerobic | : | 1 % OECD Test Guideline 301<br>Not readily biodegradable. |
| Biodegradability aerobic | : | 5 % OECD Test Guideline 301<br>Not readily biodegradable. |

## SECTION 13. DISPOSAL CONSIDERATIONS

| | | |
|---|---|---|
| Waste Disposal | : | Can be used after re-conditioning. Recover by distillation or remove to a permitted waste disposal facility. Comply with applicable Federal, State/Provincial and Local Regulations. |
| Environmental Hazards | : | Empty pressure vessels should be returned to the supplier. |

## SECTION 14. TRANSPORT INFORMATION

| | | | |
|---|---|---|---|
| DOT | UN number | : | 3296 |
| | Proper shipping name | : | Heptafluoropropane |
| | Class | : | 2.2 |
| | Labelling No. | : | 2.2 |
| IATA_C | UN number | : | 3296 |

| | | | |
|---|---|---|---|
| | Proper shipping name | : | Heptafluoropropane |
| | Class | : | 2.2 |
| | Labelling No. | : | 2.2 |
| IMDG | UN number | : | 3296 |
| | Proper shipping name | : | Heptafluoropropane |
| | Class | : | 2.2 |
| | Labelling No. | : | 2.2 |

## SECTION 15. REGULATORY INFORMATION

| | | |
|---|---|---|
| SARA 313 Regulated Chemical(s) | : | SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313. |
| California Prop. 65 | : | Chemicals known to the State of California to cause cancer, birth defects or any other harm: none known |

## SECTION 16. OTHER INFORMATION

| | | HMIS |
|---|---|---|
| Health | : | 1 |
| Flammability | : | 0 |
| Reactivity/Physical hazard | : | 0 |
| PPE | : | Personal Protection rating to be supplied by user depending on use conditions. |

FM-200 is a registered trademark of E. I. du Pont de Nemours and Company
Before use read DuPont's safety information.
For further information contact the local DuPont office or DuPont's nominated distributors.
® DuPont's registered trademark

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing,

storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Significant change from previous version is denoted with a double bar.

# Exhibit G-Samsung Battery Specifications

## 1. Product and Company Identification USA, EU

***Important Note:*** As a solid, manufactured article, exposure to hazardous ingredients is not expected with normal use. This battery is an article pursuant to 29 CFR 1910.1200 and, as such, is not subject to the OSHA Hazard Communication Standard requirement. The information contained in this Material Safety Data Sheet contains valuable information critical to the safe handling and proper use of the product. This MSDS should be retained and available for employees and other users of this product.

**Commercial product name**
MODEL CM0940R0003A (94Ah capacity)

**Use of the substance/preparation**
Lithium-Ion battery

**Company/undertaking identification**

**Manufacturer**
SAMSUNG SDI Co. LTD
428-5 Gongse-dong, Giheung-gu, Yongin-si,
Gyeonggi-do, 446-577 Korea
Telephone: ++82 31 210 8535
Telefax: ++82 31 210 8289

Contact person: Euiryong Bang

Telephone:

**Responsible Department:** Development Team
Responsible for the safety data sheet: er.bang@samsung.com

**Further Information**
Battery-System: Lithium-Ion (Li-ion)
Voltage: 3.68V
Anode (negative electrode): based on intercalation graphite
Cathode (positive electrode): based on lithiated metal oxide (Cobalt, Nickel, Manganese)

***Remark:***

The information and recommendations set forth are made in good faith and believed to be accurate as of the date of preparation. SAMSUNG SDI Co., Ltd. makes no warranty, expressed or implied, with respect to this information and disclaims all liabilities from reliance on it.

## 2. Hazards Identification USA

**Route(s) of Entry**
There is no hazard when the measures for handling and storage are followed.

**Signs and Symptoms of Exposure**
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

OSHA Hazard Communication: This material is not considered hazardous by the OSHA Hazard Communication Standard 29CFR 1910.1200.

Carcinogenicity (NTP): Not listed
Carcinogenicity (IARC): Not listed
Carcinogenicity (OSHA): Not listed

**Special hazards for human health and environment**
There is no hazard when the measures for handling and storage are followed.
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

## 2. Hazards Identification USA, EU

**Explication of special hazards for human health and environment**
Not classified as dangerous according to directive 1999/45/EEC
There is no hazard when the measures for handling and storage are followed.
In case of cell damage, possible release of dangerous substances and a flammable gas mixture.

## 3. Composition/information on ingredients USA, EU

**Hazardous components**

| EC-No. | CAS-No. | Chemical name | Quantity | EU-Classification |
|---|---|---|---|---|
| 215-154-6 | 1307-96-6 | Cobalt oxide | < 30 % | Xn, N R22435053 |
| 215-202-6 | 1313-13-9 | Manganese dioxide | < 30 % | Xn R20/22 |
| 215-215-7 | 1313-99-1 | Nickel oxide | < 30 % | Carc. Cat. 1, T R49-43-48/23--53 |
| 231-153-3 | 7440-44-0 | Carbon | 10 - 30 % | |
| | | Electrolyte (*) | 10 - 20 % | Carc. Cat. 3, C, R10-34-40-43 |
| | 24937-79-9 | Polyvinylidene fluoride (PVdF) | < 10 % | |
| 231-072-3 | 7429-90-5 | Aluminium foil | 2 - 10 % | |

| | | | | |
|---|---|---|---|---|
| 231-159-6 | 7440-50-8 | Copper foil | 2 - 10 % | |
| | | Aluminium and inert materials | 5 - 10 % | |

Full text of each relevant R phrase can be found in heading 16.

**Further Information**
For information purposes:
(*) Main ingredients: Lithium hexafluorophosphate, organic carbonates

Because of the cell structure the dangerous ingredients will not be available if used properly.
During charge process a lithium graphite intercalation phase is formed.

Mercury content: Hg < 0.1mg/kg

Cadmium content: Cd < 1mg/kg

Lead content: Pb: < 10mg/kg

## 4. First Aid Measures USA, EU

**General information**
The following first aid measures are required only in case of exposure to interior battery components after damage of the external battery casing.
Undamaged, closed cells do not represent a danger to the health.

**After inhalation**
Ensure of fresh air. Consult a physician.

**After contact with skin**
In case of contact with skin wash off immediately with plenty of water. Consult a physician.

**After contact with eyes**
Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Seek medical treatment by eye specialist.

**After ingestion**
Drink plenty of water.
Call a physician immediately.

## 5. Fire Fighting Measures USA, EU

**Suitable extinguishing media**
Cold water and dry powder in large amount are applicable.
Use metal fire extinction powder or dry sand if only few cells are involved.

**Special hazards arising from the chemical**
May form hydrofluoric acid if electrolyte comes into contact with water.
In case of fire, the formation of the following flue gases cannot be excluded:
Hydrogen fluoride (HF), Carbon monoxide and carbon dioxide.

**Protective equipment and precautions for firefighters**
Wear self-contained breathing apparatus and protective suit.
Additional information
If possible, remove cell(s) from fire fighting area. If heated above 125°C, cell(s) can explode/vent. Cell is not flammable but internal organic material will burn if the cell is incinerated.

## 6. Accidental Release Measures USA, EU

**Personal precautions**
Use personal protective clothing.
Avoid contact with skin, eyes and clothing.
Avoid breathing fume and gas.

**Environmental precautions**
Do not discharge into the drains/surface waters/groundwater.
Methods for cleaning up/taking up
Take up mechanically and send for disposal.

## 7. Handling and Storage USA, EU

### Handling

**Advice on safe handling**
Avoid short circuiting the cell. Avoid mechanical damage of the cell. Do not open or disassemble.
Advice on protection against fire and explosion
Keep away from open flames, hot surfaces and sources of ignition.

### Storage

**Requirements for storage rooms and vessels**
Storage at room temperature (approx. 20°C) at approx. 20-50% of the nominal capacity
(OCV approx. 3.5-3.7 V).
Keep in closed original container.

## 8. Exposure Controls/Personal Protection Exposure limit values Exposure limits USA

## 8. Exposure controls/personal protection Exposure limit values Exposure limits (EH40) EU

| CAS-No. | Chemical name | ml/m³ | mg/m³ | F/ml | Category | Origin |
|---|---|---|---|---|---|---|
| 7440-44-0 | Graphite, respirable | <br>- | 4<br>- | | TWA (8 h)<br>STEL (15 min) | WEL<br>WEL |

**Additional advice on limit values**
During normal charging and discharging there is no release of product.

**Occupational exposure controls**
No specific precautions necessary.

**Protective and hygiene measures**
When using do not eat, drink or smoke. Wash hands before breaks and after work.

**Respiratory protection**
No specific precautions necessary.

**Hand protection**
No specific precautions necessary.

**Eye protection**
No specific precautions necessary.

**Skin protection**
No specific precautions necessary.

.

## 9. Physical and Chemical Properties USA, EU

**Appearance**

| | |
|---|---|
| Form: | Solid |
| Color: | Various |
| Odor: | Odorless |

**Important health, safety and environmental information**

| Test method | |
|---|---|
| pHValue: | n.a. |
| Flash point: | n.a |
| Lower explosion limits: | n.a. |
| Vapour pressure: | n.a. |
| Density: | n.a. |
| Water solubility: | Insoluble |
| Ignition temperature: | n.a. |

## 10. Stability and Reactivity USA, EU

**Stability**
Stable

**Conditions to avoid**
Keep away from open flames, hot surfaces and sources of ignition. Do not puncture, crush or incinerate.

**Materials to avoid**
No materials to be especially mentioned.

**Hazardous decomposition products**
In case of open cells, there is the possibility of hydrofluoric acid and carbon monoxide release.

**Possibility of Hazardous Reactions**
Will not occur

**Additional information**
No decomposition if stored and applied as directed.

## 11. Toxicological Information USA, EU

**Empirical data on effects on humans**
If appropriately handled and if in accordance with the general hygienic rules, no damages to health have become known.

## 12. Ecological Information USA, EU

**Further information**
Ecological injuries are not known or expected under normal use. Do not flush into surface water or sanitary sewer system.

## 13. Disposal Considerations USA, EU

**Advice on disposal**
For recycling consult manufacturer.

**Contaminated packaging**
Disposal in accordance with local regulations.

## 14. Transport Information USA, EU

**US DOT 49 CFR 172.101**

Proper shipping name
Lithium-ion batteries

| | |
|---|---|
| ID Number: | UN3480 |
| Hazard Class or Division: | 9 |
| Packing group: | II |
| Label: | 9 |

**Land transport (ADR/RID)**

| | |
|---|---|
| UN number: | 3480 |
| ADR/RID class: | 9 |
| Classification code: | M4 |
| Warning plate | |
| Hazard label: | 9 |


| | |
|---|---|
| ADR/RID packing group: | II |
| Limited quantity: | LQ 0 |
| Tunnel restriction code: | E |
| Description of the goods | Lithium-ion batteries |

**Other applicable information (land)**
LQ 0: No exemption under the conditions of 3.4.2.
Transport category: 2

**Marine transport**

| | |
|---|---|
| UN number: | 3480 |
| IMDG code: | 9 |
| Marine pollutant: | No |
| Hazard label: | 9 |


| | |
|---|---|
| IMDG packing group: | II |
| EmS: | F-A, S-I |
| Limited quantity: | None |
| Description of the goods | Lithium-ion batteries |

**Air transport**

| | |
|---|---|
| UN/ID number: | 3480 |
| ICAO/IATA-DGR: | 9 |
| Hazard label: | 9 |


| | |
|---|---|
| ICAO packing group: | II |
| Limited quantity Passenger: | - |
| IATA-packing instructions - Passenger: | 965 |

| | |
|---|---|
| IATA-max. quantity - Passenger: | 5 kg G |
| IATA-packing instructions - Cargo: | 965 |
| IATA-max. quantity - Cargo: | 35 kg G |
| Description of the goods | Lithium-ion batteries |

**Other applicable information**

| | |
|---|---|
| Lithium equivalent: | 29.6g |
| Wh-rating per cell: | 346 Wh |

## 15. Regulatory Information USA

### U.S. Regulations

**National Inventory TSCA**
SAMSUNG SDI certifies that all chemical components of the Model CS0600R0005B ( 60 Ah capacity) Lithium-Ion Battery are listed on the US EPA TSCA 8(b) Inventory or are exempt from listing.

**SARA**
To the best of our knowledge this product contains no toxic chemicals subject to the supplier notification requirements of Section 313 of the Superfund Amendments and Reauthorization Act (SARA/EPCRA) and the requirements of 40 CFR Part 372.

## 15. Regulatory information EU

### Labeling

**Hazardous components which must be listed on the label**
As an article the product does not need to be labeled in accordance with EC directives or respective national laws.

**EU regulatory information**
1999/13/EC (VOC): 0 %

## 16. Other Information USA

**Hazardous Materials Information Label (HMIS)**
Health: 0
Flammability: 0
Physical Hazard: 0

**NFPA Hazard Ratings**
Health: 0
Flammability: 0
Reactivity: 0
Unique Hazard:

## 16. Other Information EU

**Full text of R-phrases referred to under sections 2 and 3**
R10 Flammable.

| | |
|---|---|
| R20/22 | Harmful by inhalation and if swallowed. |
| R22 | Harmful if swallowed. |
| R34 | Causes burns. |
| R40 | Limited evidence of a carcinogenic effect. |
| R43 | May cause sensitization by skin contact. |
| R48/23 | Toxic: danger of serious damage to health by prolonged exposure through inhalation. |
| R49 | May cause cancer by inhalation. |
| R50 | Very toxic to aquatic organisms. |
| R53 | May cause long-term adverse effects in the aquatic environment. |

**Further Information USA, EU**

Data of sections 4 to 8, as well as 10 to 12, do not necessarily refer to the use and the regular handling of the product (in this sense consult package leaflet and expert information), but to release of major amounts in case of accidents and irregularities. The information describes exclusively the safety requirements for the product
(s) and is based on the present level of our knowledge. This data does not constitute a guarantee for the characteristics of the product(s) as defined by the legal warranty regulations. "(n.a. = not applicable; n.d. = not determined)"

The data for the hazardous ingredients were taken respectively from the last version of the sub-contractor's safety data sheet.

# Exhibit H-Power Electronics Solar Inverter (HEC1500V) Information

# HEC V1500

## *UTILITY SCALE SOLAR INVERTER*

The Power Electronics HEC V1500 are reliable 1500Vdc outdoor utility-scale inverters, with more than 2.5GW already installed worldwide. The HEC V1500 inverter family has 25 different models ranging from 1MW to 3.5MW, and it is available for the IEC and UL market.

With up to seven 500kW power modules connected in parallel, the HEC V1500 is a multi-level 1500Vdc system built on the Power Electronics expertise in >1,000Vdc systems and in the proven Freesun HEC modular topology.

The HEC V1500 power stage is based on a multi-level IGBT topology, which makes the difference in the 1500Vdc technology. Power Electronics takes advantage of the three-level topology, reducing the power stage losses, and increasing the inverter efficiency.

## THE MOST RELIABLE 1500VDC UTILITY-SCALE PV INVERTER IN THE MARKET


NEXT GENERATION

1500 VDC

EXTENDED MPPT
MPPt

AUTOMATIC REDUNDANT POWER MODULE SYSTEM
ARPMS

iCOOL V

ADJUSTABLE POWER
DAY
NIGHT

OUTDOOR DURABILITY

INGRESS PROTECTION

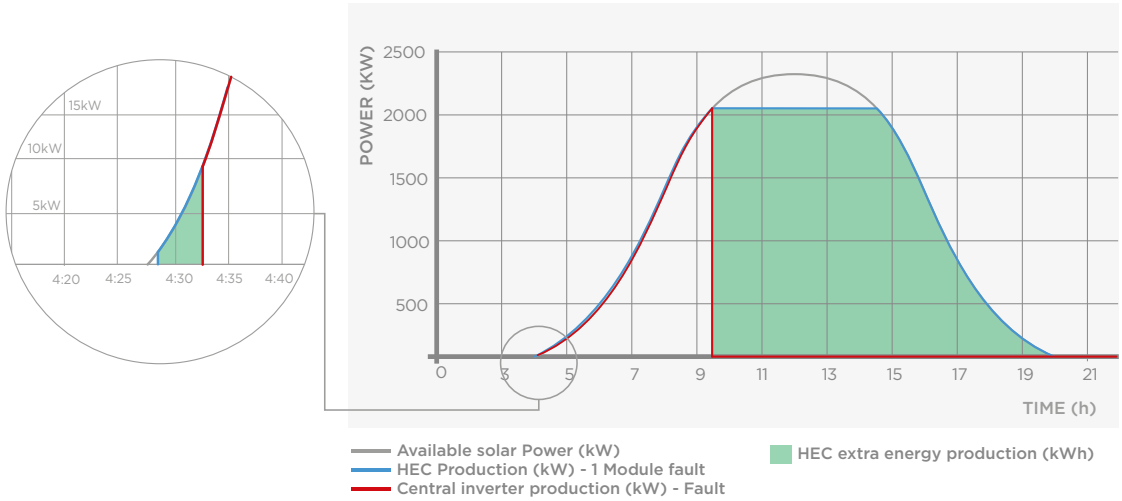
ACTIVE HEATING

3 LEVEL TOPOLOGY

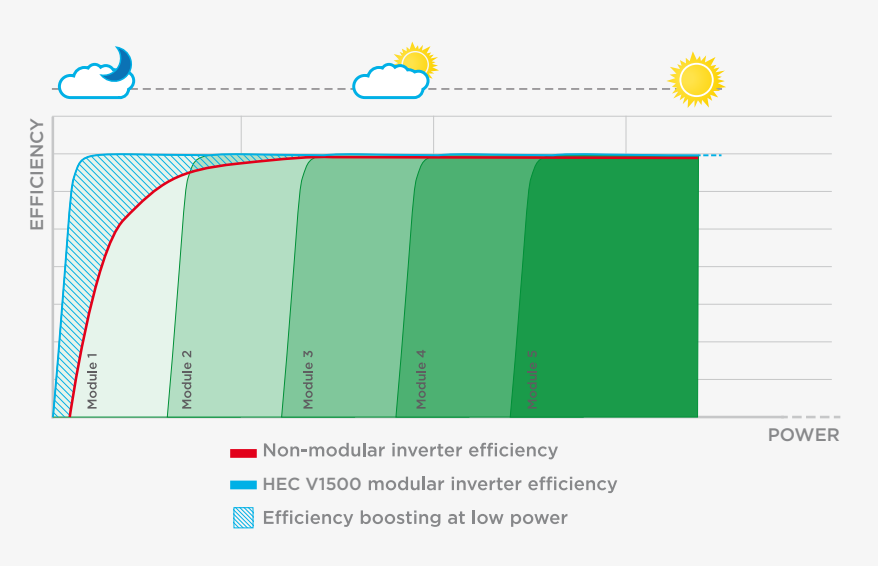
# AUTOMATIC REDUNDANT POWER MODULE SYSTEM (ARPMS)

The HEC V1500 topology combines the advantages of a central inverter with the availability of string inverters. HEC 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)



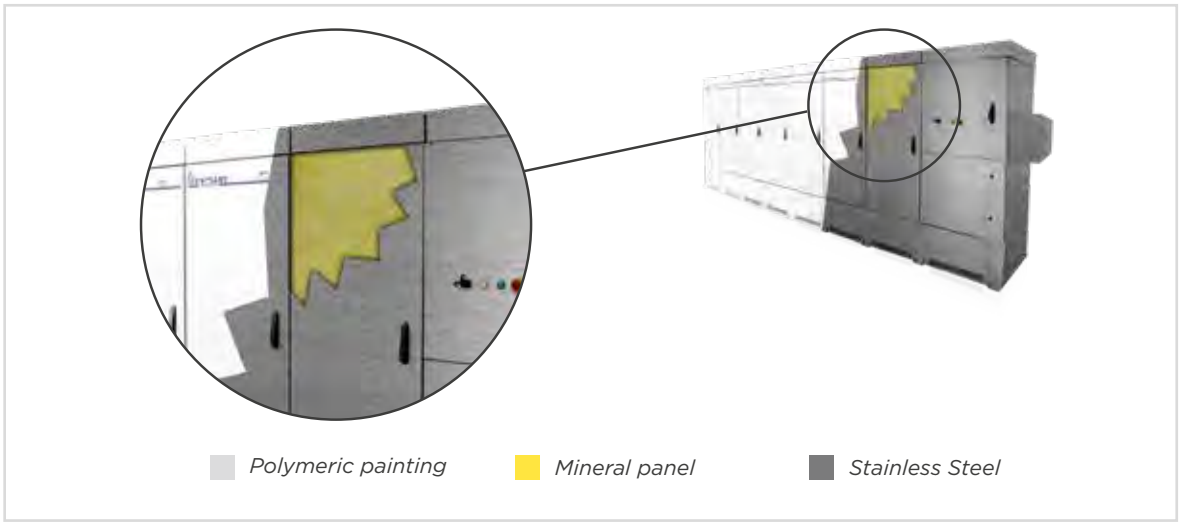

A modular inverter is more efficient than a standard central inverter. During low radiation conditions, a modular architecture uses the correct number of power modules to provide power, while a central inverter must consume power internally to support the entire system. With lower losses, a modular inverter 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 V1500 inverter generates higher yields than a standard central inverter with a higher reliability than string inverters.




## ROBUST DESIGN

HEC V1500 inverters have been designed to last for more than 25 years of operation in harsh environments and extreme weather conditions. HEC V1500 units are tested and ready to withstand conditions from the frozen siberian tundra to the californian Death Valley, featuring:

- Totally sealed cabin for protecting electronics against dust and moisture.
- Conformal coating on electronic boards shields PCBs from harsh atmospheres.
- Temperature and humidity controlled active heating prevents internal water condensation.
- Stainless Steel construction with 2mm thickness for maximum enclosure longevity.
- The HEC V1500 has a C5-M degree of protection according to ISO 12944.
- 50mm mineral panel isolates the cabinet from solar heat gains.
- Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages. The solid HEC V1500 structure avoids the need of additional external structures.
- Random units selected to pass a Factory Water Tightness Test ensuring product quality.

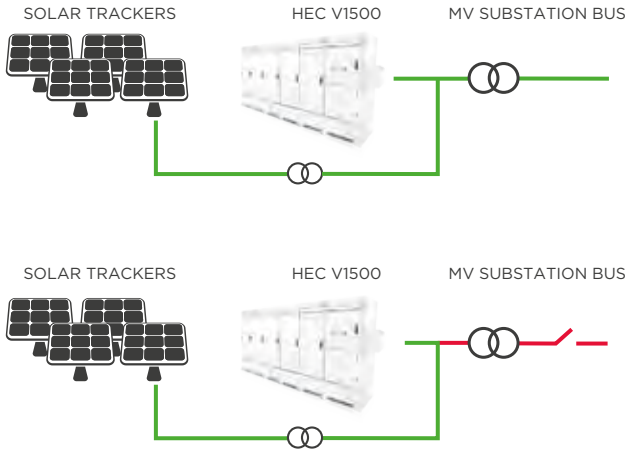




## BACK FEED TRACKER SUPPLY

During solar power plant normal operation, the solar trackers are powered by the grid via the auxiliary service transformer. In case of a loss of mains, a UPS with battery systems is needed for powering the solar trackers and ensures achieving the safety position.

Battery systems increase the CAPEX and the OPEX of the project, due to a high maintenance requirement, extra energy consumption and battery replacement. In order to avoid these disadvantages, HEC V1500 inverter is able to provide the safety power supply required without using battery systems, taking profit of the energy available in the PV field, and therefore offering the most cost-effective solution in the market.

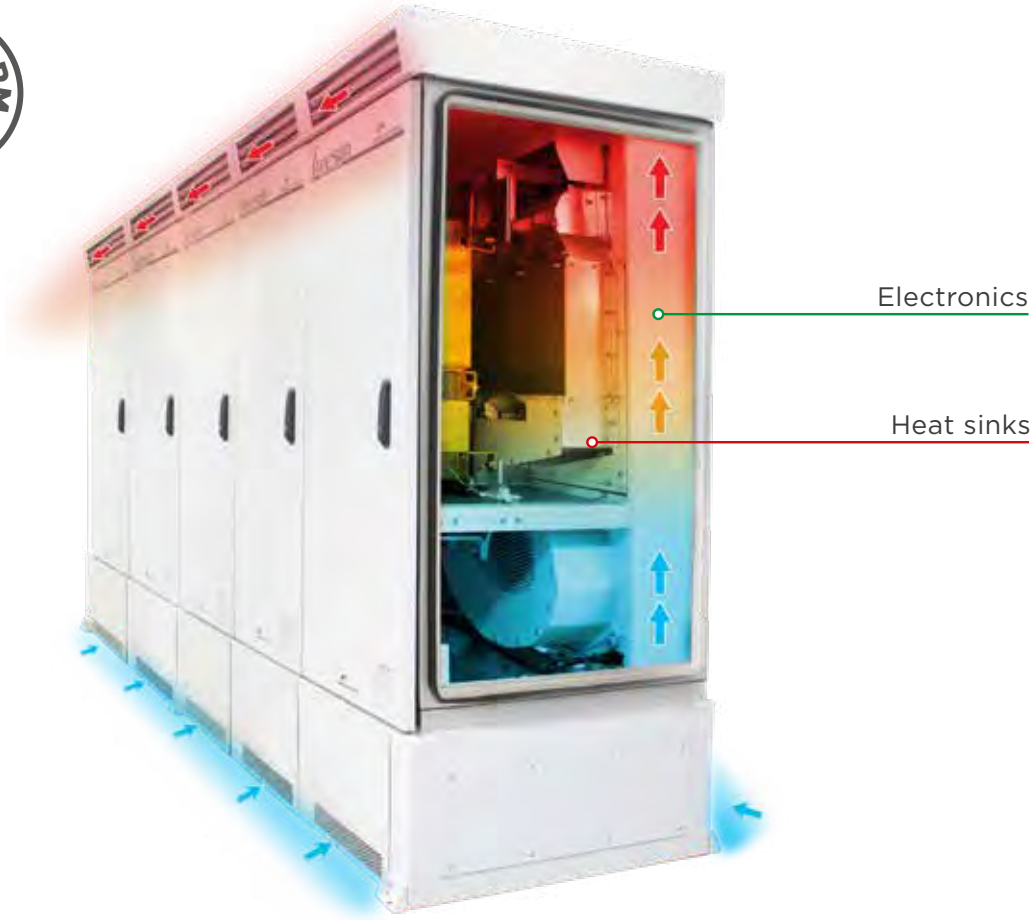


## REVOLUTIONARY COOLING SYSTEM

The Power Electronics HEC V1500 series includes the innovative and sophisticated iCOOL V performance that allows HEC V1500 to work up to 50°C at nominal power. The cooling system iCOOL V smartly cools the inverter, regulating the cooling system capacity depending on the data from the temperature sensors.

HEC V1500 modules are divided into two main areas: clean area (electronics) and hot area (heat sink). The electronics are totally sealed 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)




## VAR AT NIGHT

At night, the HEC 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

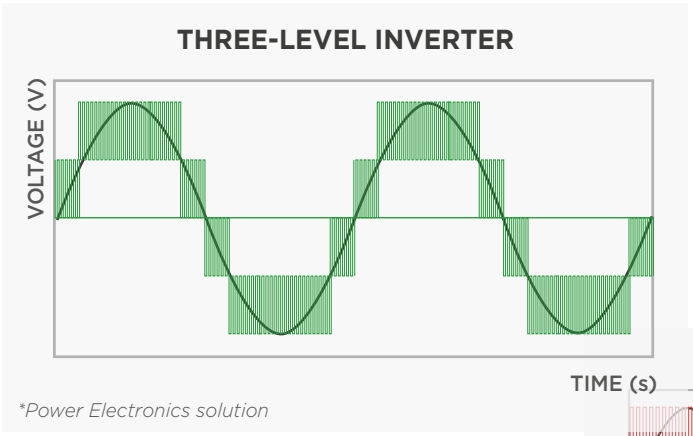
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors. The app user friendly interface allows quick and easy access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

## ACTIVE HEATING

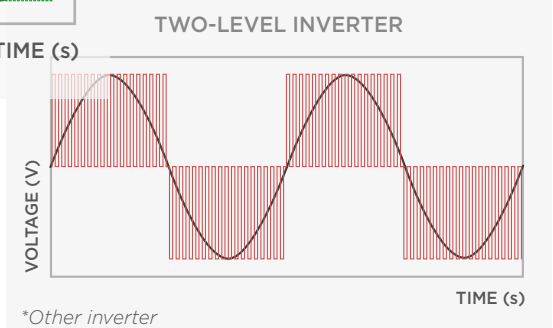
At night, when the unit is not actively exporting power, the inverter can import a small amount of power to keep the inverter internal ambient temperature above -20°C, without using external resistors. This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing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

## 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 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.



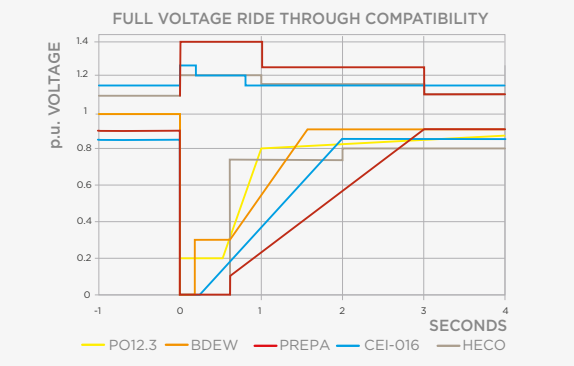

*Power Electronics solution



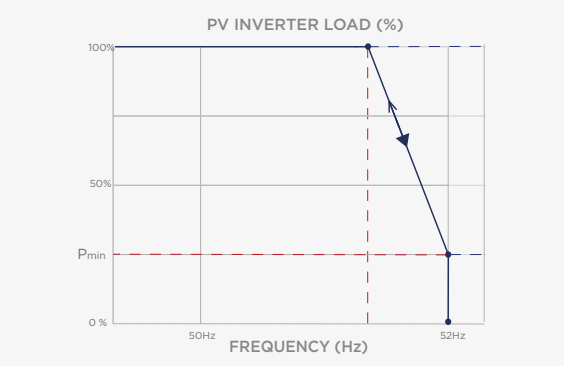

*Other inverter

# DYNAMIC GRID SUPPORT

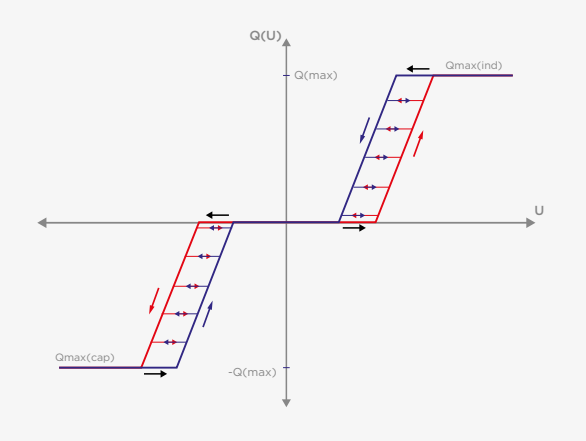
HEC V1500 firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment...), and can be configured to meet specific utility requirements.

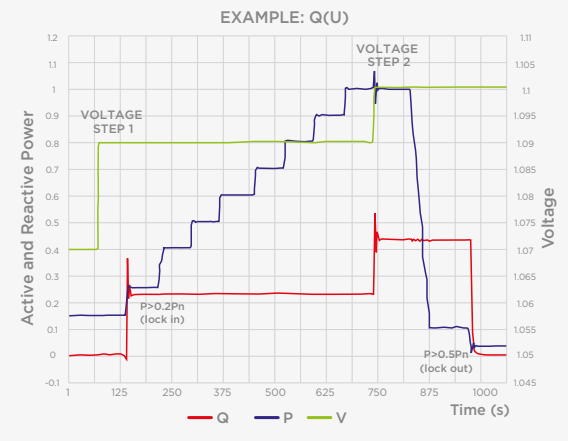



▲ **LVRT or ZVRT (Low Voltage Ride Through).** Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive power, as long as the protection limits are not exceeded.



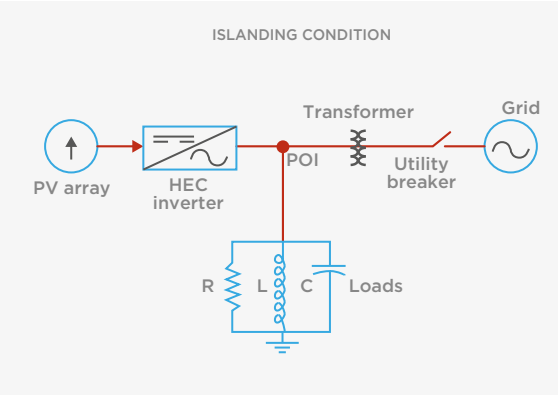

▲ **FRS (Frequency Regulation System).** Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.




▲ **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.

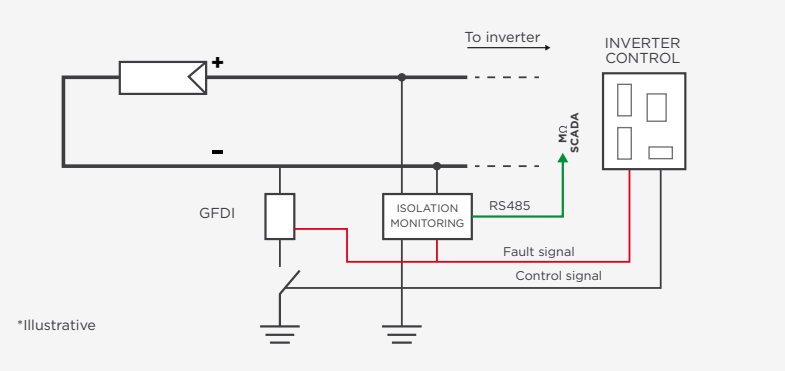

▲ **FRT (Frequency Ride Through):** Freesun solar inverters have flexible frequency protection settings and can be easily adjusted to comply with future requirements.




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

## PV ARRAY TRANSFER KIT

By mounting this kit, the inverter and the PV plant will be able to shift its running conditions from negative grounded array to floating array and viceversa. Under regular conditions the inverter will be running with a negative pole grounded and therefore, a GDFI will provide protection against unlikely ground fault defects and the solar cells will not suffer a negative voltage relative to their surroundings at any time. This running mode can be transfered to a floating array configuration enabling an isolation monitoring device that the O&M can use for: regular PV plant isolation control, identification of the array affected by a ground fault defect and most important, increase the operator safety under O&M service activities.




## DC DISCONNECTION & PROTECTION

HEC V1500 is available with an external DC disconnection and protection unit (DU unit) that will be coupled together with the inverter by a mounting kit. The DC subsystems are fully customizable and can be featured with up to 32 inputs.

The disconnecting unit goes one step further by improving the PV plant safety and operation for those who apply the best engineering.

## EXTENDED MPPT

Using the latest modulation techniques, inspired by the most accurate and powerful motor control applications, has lead to the widest MPPt full power window in the solar market. It allows optimal PV plant design and boosted performance rates.

## EASY TO SERVICE

By providing full front and rear access the HEC series simplifies the maintenance tasks improving the MTTR (achieving a lower OPEX). The frontal access allows the checking of the whole electronic cabinet (electronics boards, semiconductors, power supply, contactors...) while the rear access permits the revision of AC fuses and LCL filter.

# HEC-US V1500 690VAC

## TECHNICAL CHARACTERISTICS

NORTH AMERICA

| | | 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 | 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, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

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 645VAC

## TECHNICAL CHARACTERISTICS

NORTH AMERICA

| | | 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 | 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, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

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 630VAC

## TECHNICAL CHARACTERISTICS

NORTH AMERICA

| | | 630VAC - MPPt Window 891V-1310V | | | | |
|---|---|---|---|---|---|---|
| | | FRAME 3 | FRAME 4 | FRAME 5 | FRAME 6 | FRAME 7 |
| NUMBER OF MODULES | | 3 | 4 | 5 | 6 | 7 |
| REFERENCE | | FS1270CU15 | FS1695CU15 | FS2120CU15 | FS2540CU15 | FS3001CU15 |
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 1180 | 1570 | 1965 | 2360 | 2750 |
| | AC Output Power(kVA/kW) @40°C [1] | 1270 | 1695 | 2120 | 2540 | 3000 |
| | AC Output Power(kVA/kW) @25°C [1] | 1400 | 1870 | 2340 | 2800 | 3275 |
| | Max. AC Output Current (A) @50°C | 1080 | 1440 | 1800 | 2160 | 2520 |
| | Max. AC Output Current (A) @40°C | 1165 | 1550 | 1940 | 2330 | 2715 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 630V ±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 | 0...100% / 0.1% Steps | | | | |
| INPUT | MPPt @full power (VDC) | @50°C 891V-1310V / @40°C 891V-1285V / @25°C 891V-1250V | | | | |
| | 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) Preliminary | 98.5% | | | | |
| | CEC (η) Preliminary | 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 / Power derating >40°C/104°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 | Compatible with third party SCADA controls | | | | |
| | 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, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

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 600VAC

## TECHNICAL CHARACTERISTICS

NORTH AMERICA

| | | 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 | 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, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

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 565VAC

## TECHNICAL CHARACTERISTICS

NORTH AMERICA

| | | 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 | 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, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

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.

# Exhibit I-Power Electronics Solar Inverter (HEMK600V) Information

POWER ELECTRONICS

PURE ENERGY

# SOLAR SOLUTIONS

INVERTERS | STATIONS

# PURE ENERGY

**Pure Energy** is our motivation for leading the renewable energy generation, it is the search for product and service perfection, it is our vision of a world, clean and sustainable for our children and future generations.

## CONTENTS


CAUTION
PRÉCAUTION


**Since 1987** Power Electronics Industrial division has been producing high power variable speed drives and soft starters for low and medium voltage AC motor applications. This experience has allowed Power Electronics to position itself as the leading manufacturer of utility scale solar inverters thanks to our unique product features, patented designs, fastest global delivery times and unbeatable 24/7 Power on Support. Power Electronics fully designs and manufactures its Freesun inverters in Valencia, Spain and is proud to have some of the most advanced R&D laboratories and factories in the industry.

**30 YEARS OF PRODUCT EXCELLENCE**

**24/7 POWER ON SUPPORT**

**INTERNATIONAL PRESENCE**

**FINANCIAL STABILITY AND STRENGTH**

**INDEPENDENT REPORTS AND CERTIFICATIONS**

**SUSTAINABLE GROWTH**

## ENGINEERING & CONSULTING

**Energy projects** often require customer specific solutions, for this reason our clients also have our Engineering and Consulting department at their disposal, which is comprised of a wide number of highly skilled and experienced engineers that are available to modify our standard product to suit customer demands and ensure our clients get the product they need.

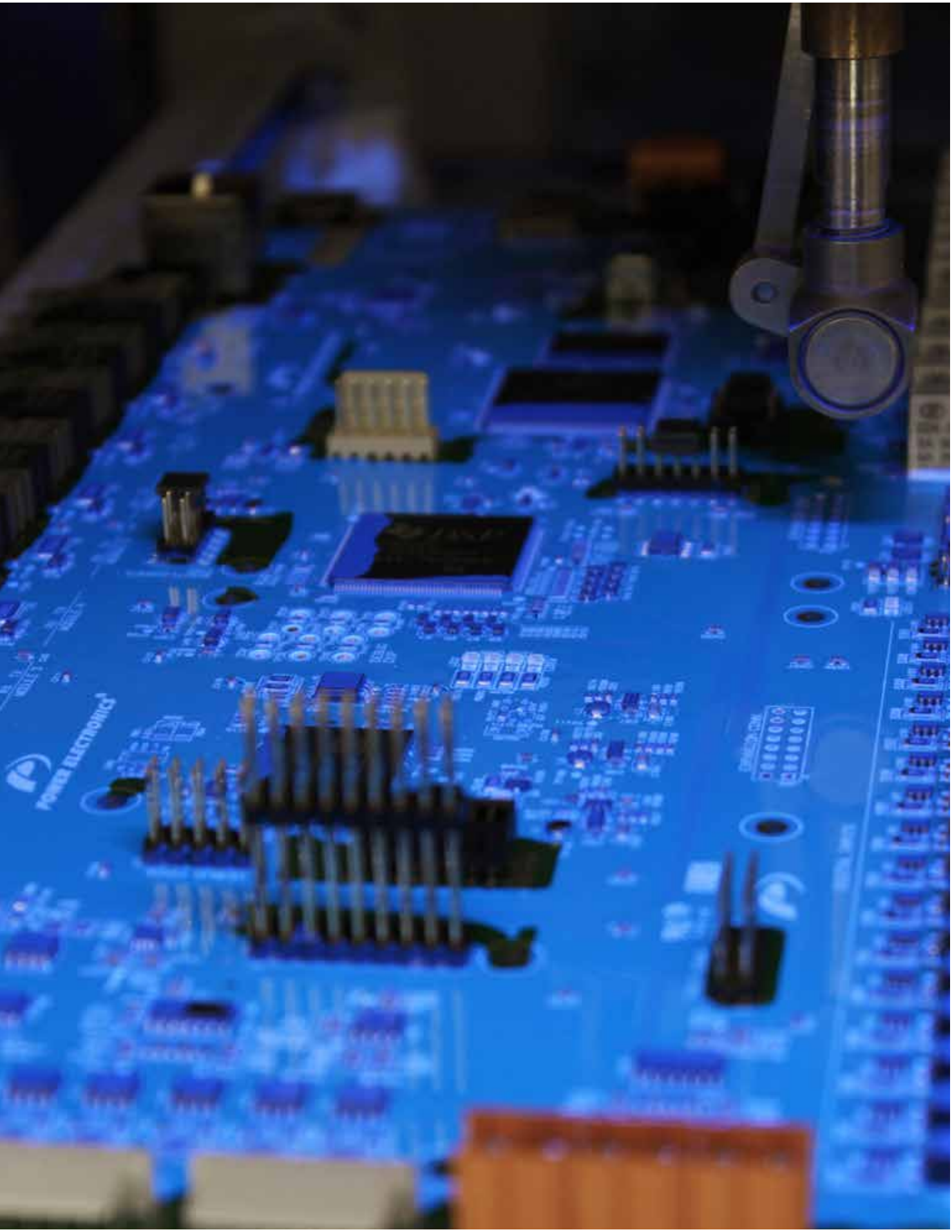
TECHNICAL ADVICE
ENGINEERING
CUSTOMIZED SOLUTIONS
PROJECT MANAGEMENT
COMMISSIONING
24/7 SERVICE

## VERTICAL INTEGRATION

**Flexibility and specialization** play a key role in the manufacture of standard products, but even more so in personalized products. We design and manufacture integrally the mechanics of our equipment. Vertical integration gives us the flexibility to adapt to customer requirements and still provide very short delivery times.

INNOVATION & DESIGN FLEXIBILITY
HIGH QUALITY COMPONENTS
RELIABLE ENGINEERING
FACTORY TESTED
VALUE CHAIN SUPERVISION
IMMEDIATE DELIVERY

*"We design, manufacture and test the electronic boards of all our products"*



**AVAILABILITY**

**COMMISSIONING**

**CUSTOMER SUPPORT**

**ONSITE ASSISTANCE**

**SPARE PARTS WARRANTY**

**TRAINING SEMINARS**

**WARRANTY**

## POWER ON SUPPORT

**Power on Support is the concept** of a customer oriented strategy implemented by Power Electronics since its origins more than 30 years ago with 24/7 after sales service available for all our customers and end users without the need of signing an O&M contract.

Customer Oriented Strategy.

## WORLDWIDE PRESENCE

From the beginning, customer service and internationalization have been key elements for the development of the company. Thanks to the global expansion in the five continents, today we have presence and provide technical service throughout the world.

● HEADQUARTERS


**+20**
DELEGATIONS

**+100**
SALES COUNTRIES

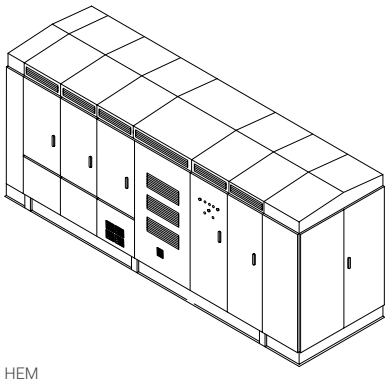
**+12GW**
SOLAR INVERTERS INSTALLED

**+12GW**
ANNUAL CAPACITY PRODUCTION

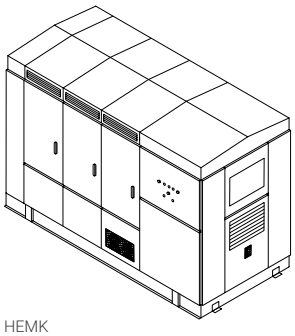

UNITED KINGDOM
POLAND
GERMANY
FRANCE
ITALY
SPAIN
PORTUGAL
TURKEY
MOROCCO
CHINA
JAPAN
S. KOREA
DUBAI
INDIA
SINGAPORE
SOUTH AFRICA
AUSTRALIA
NEW ZEALAND

# PRODUCT RANGE

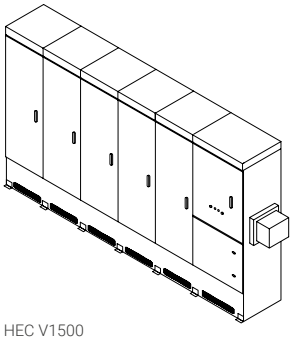
## SOLAR INVERTERS



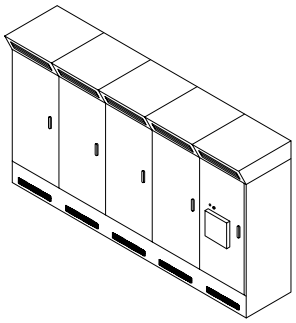
HEM
3000 kVA - 3630 kVA
34.5V
1500 Vdc
P. 15



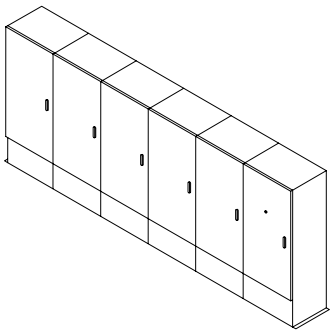
HEMK
2000 kVA - 3800 kVA
600 Vac - 690 Vac
1500 Vdc
P. 29



HEC V1500
1050 kVA - 3500 kVA
565 Vac - 690 Vac
P. 43

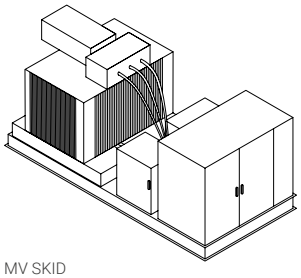


HEC PLUS
1000 kVA - 2550 kVA
400 Vac - 460 Vac
1000 Vdc
P. 65

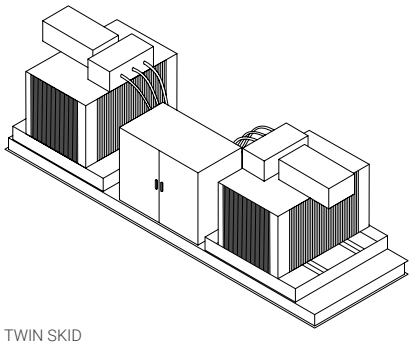


HE PLUS
1000 kVA - 2550 kVA
400 Vac - 460 Vac
1000 Vdc
P. 85

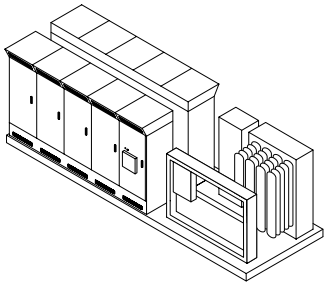
**SOLAR STATIONS**



MV SKID
1050 kVA - 3800 kVA
12 kV - 36 kVac
Oil Transformer
2L+P/V Switchgear
P. 99

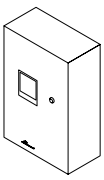


TWIN SKID
3000 kVA - 7600 kVA
12 kV - 36 kVac
Oil Transformer
2L+ 2P/2V Switchgear
P. 103

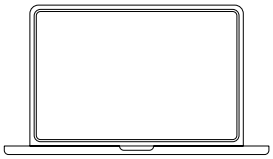


HEK
1000 kVA - 7000 kVA
12.47 kV - 34.5 kV
1000 Vdc - 1500 Vdc
Open Skid Station
P. 107

**CONTROL AND MONITORING SOLUTIONS**



FREESUN PPC
P. 113



FREESUN PORTAL
P. 117

FREESUN APP
P. 119

# SOLAR INVERTERS

## UTILITY SCALE
## OUTDOOR AND INDOOR INVERTERS


HEM Solar inverter

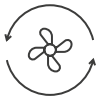
# HEM

UTILITY SCALE MV CENTRAL STRING INVERTER


**FIELD REPLACEABLE UNITS**

**OUTDOOR DURABILITY**


**IP65 AVAILABLE**



**ICOOL 3**

**ACTIVE HEATING**

**3 LEVEL TOPOLOGY**

**ECON MODE**


**MULTI MPPT AVAILABLE**

## THE INNOVATIVE MEDIUM VOLTAGE CENTRAL STRING INVERTER

The Power Electronics HEM medium voltage inverter is designed for utility scale solar applications, that require the advantages of a central inverter solution but also the modularity of a string architecture. The HEM can reach up to a nominal power of 3.6MVA, and offers a wide MPPT window. It also has the added advantage of having an integrated medium voltage transformer and switchgear.

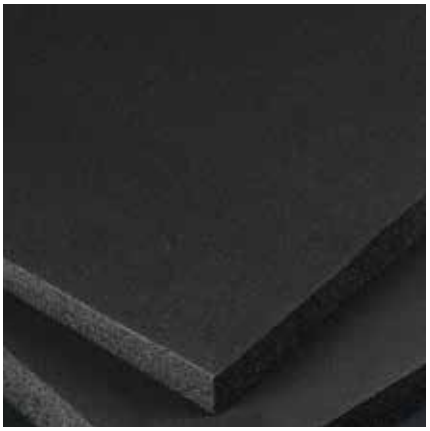
Its architecture, composed of six field replaceable units (FRU), is designed to provide the highest availability and optimize yield production. Its use in Utility Scale PV plants provides considerable savings in CAPEX, since having an integrated MV transformer and switchgear reduces the need of additional connections between the LV and MV sides.

Thanks to the Power Electronics iCOOL3 cooling system, the HEM is the first inverter able to provide IP65 degree of protection with an air cooling system, and as a result reducing OPEX costs.

## ROBUST DESIGN




Polymeric Painting



Closed-Cell Insulation

Galvanized Steel | Stainless Steel (Optional)

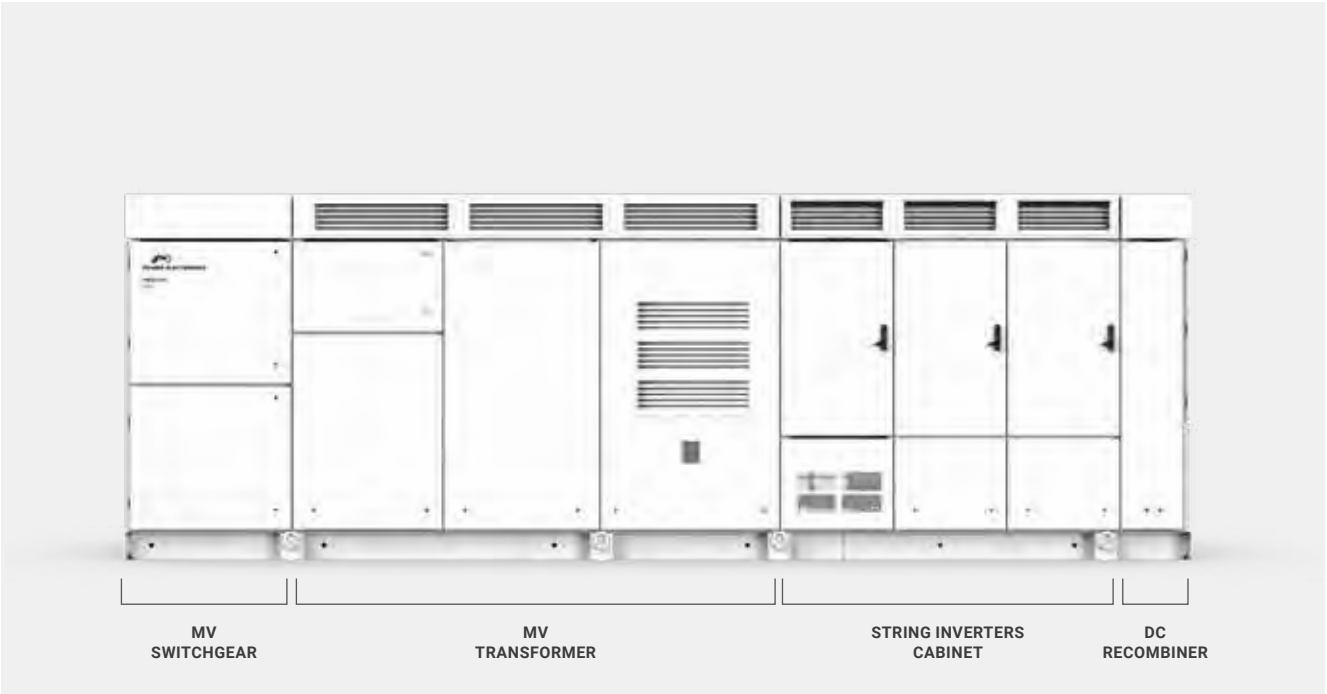
HEM inverter modules have a design life of greater than 30 years of operation in harsh environments and extreme weather conditions. HEM units are tested and ready to withstand conditions from the frozen Siberian tundra to the Californian Death Valley, featuring:

| |
|---|
| Totally sealed electronics cabinet protects electronics against dust and moisture. |
| Conformal coating on electronic boards shields PCBs from harsh atmospheres. |
| Temperature and humidity controlled active heating prevents internal water condensation. |
| C4 degree of protection according to ISO 12944.<br>Up to C5-M optional. |
| Closed-Cell insulation panel isolates the cabinet from solar heat gains. |
| Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages. |
| The solid HEM structure avoids the need of additional external structures. |
| Random units selected to pass a Factory Water Tightness Test ensuring product quality. |
| IP65 Available. |

## REAL TURN-KEY SOLUTION - EASY TO SERVICE

With the HEM, Power Electronics offers a real turn-key solution, including the MV transformer and switchgear fully assembled and tested at the factory. The HEM is a compact turn-key solution that will reduce site design, installation and connection costs.

By providing full front access the HEM series simplifies the maintenance tasks, reducing the MTTR (and achieving a lower OPEX). The total access allows a fast swap of the FRUs without the need of qualified technical personnel.



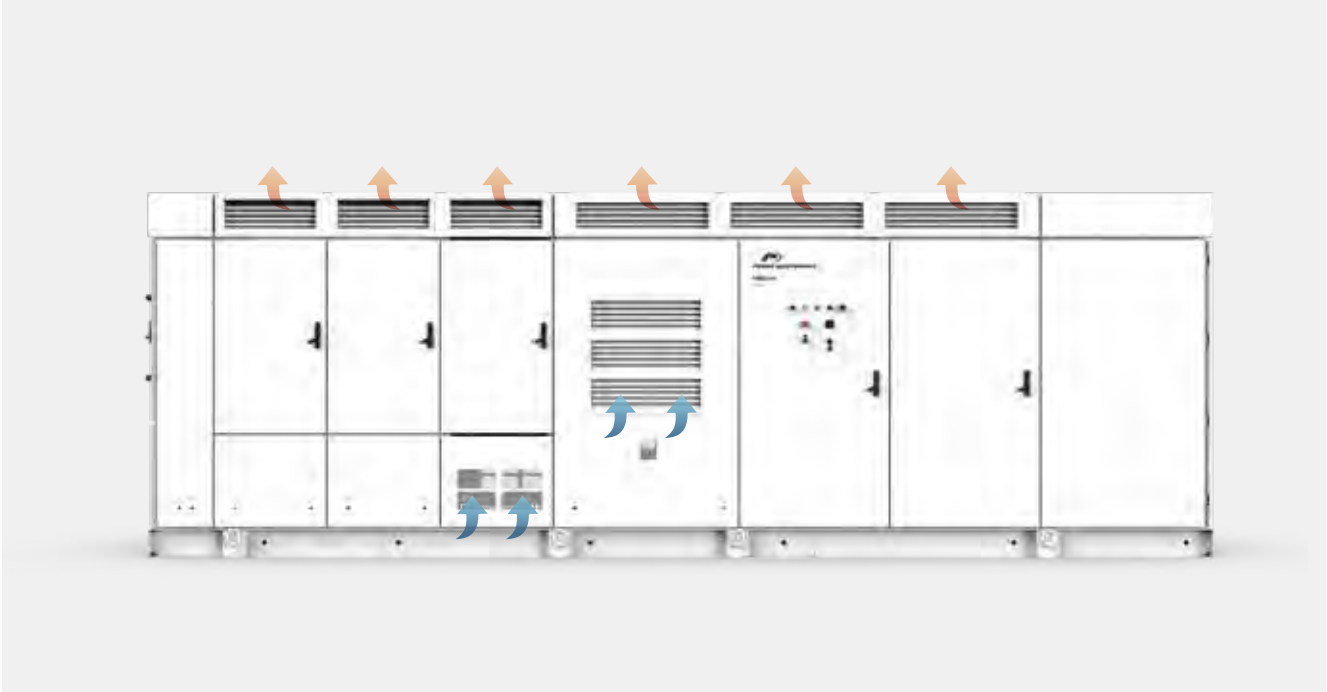

## STRING CONCEPT POWER STAGES

The HEM combines the advantages of a central inverter with the modularity of the string inverters. Its power stages are designed to be easily replaceable on the field without the need of advanced technical service personnel, providing a safe, reliable and fast Plug&Play assembly system.

Following the modular philosophy of the Freesun series, the HEM is composed of 6 FRUs (field replaceable units), being able to work with up to 6 different MPPts, providing a perfect solution for irregular locations, where each area of the PV plant has a different production curve. HEM is also available with a single MPPt, where all the power stages are physically joined in the DC side and therefore, in the event of a fault, the faulty module is taken off-line and its power is distributed evenly among the remaining functioning FRUs.

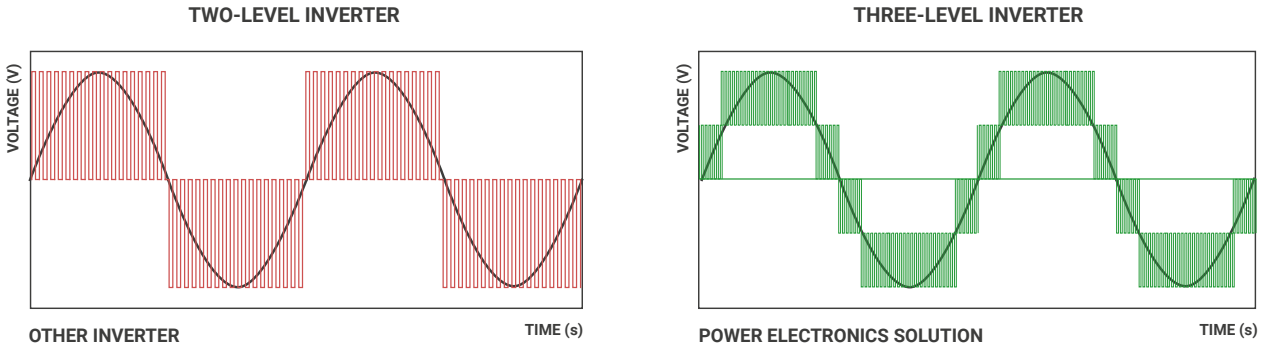
## INNOVATIVE COOLING SYSTEM

Based on more than 3 years of experience with our MV Variable Speed Drive, the iCOOL3 is the first air-cooling system allowing IP65 degree of protection in an outdoor solar inverter. iCOOL3 delivers a constant stream of clean air to the FRUs and the MV transformer, being the most effective way of reaching up to IP65 degree of protection, without having to maintain cumbersome dust filters or having to use liquid-cooling systems, avoiding the commonly known inconveniences of it (complex maintenance, risk of leaks, higher number of components…), therefore resulting in an OPEX cost reduction.



## MULTILEVEL TOPOLOGY

The multilevel IGBT topology is the most efficient approach to manage high DC link voltages and makes the difference in the 1,500 Vdc design. Power Electronics has many years of power design in both inverters and MV drives and the HEMK design is the result of our experience with 3 level topologies. The 3 level IGBT topology reduces stage losses, increases inverter efficiency and minimizes total harmonic distortion.



## VAR AT NIGHT

At night, the HEM 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).

## 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 maintenance. **PATENTED**

## ECON MODE

This innovative control mode allows increasing the efficiency of the MV transformer up to 25%, reducing the power consumption of the plant and therefore providing considerable savings. Available as an optional kit, this feature has a payback time of less than a few years, therefore resulting in the increase of the plant lifetime overall revenue.

## EASY TO MONITOR

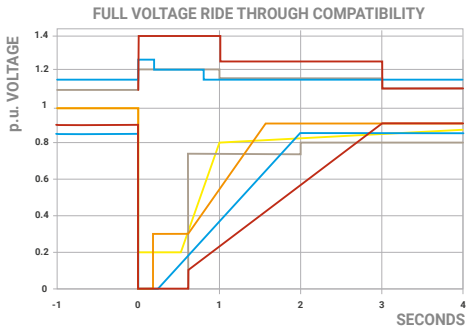
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors.

The app user-friendly interface allows quick and easy access to critical information (energy registers, production and events).

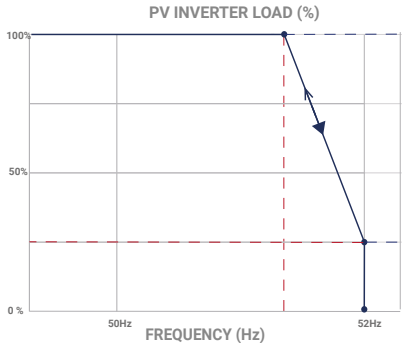
| | |
|---|---|
| **AVAILABLE INFORMATION** | Grid and PV field data.<br>Inverter and Power module data (Voltages, currents, power, temperatures, I/O status...).<br>Weather conditions.<br>Alarms and warnings events.<br>Energy registers.<br>Others. |
| **FEATURES** | Easy Wireless connection.<br>Comprehensive interface.<br>Real time data.<br>Save and copy settings. |
| **LANGUAGE** | English, Spanish. |
| **SYSTEM REQUIREMENTS** | iOS or Android devices. |
| **SETTINGS CONTROL** | Yes |

## DYNAMIC GRID SUPPORT

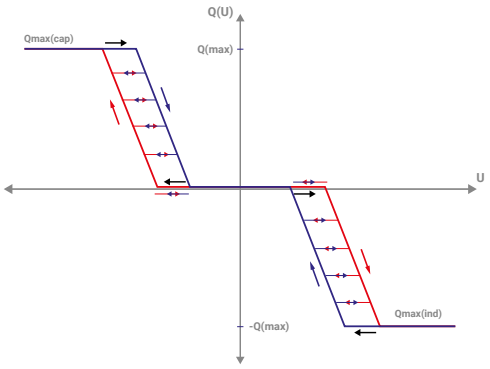
HEM firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

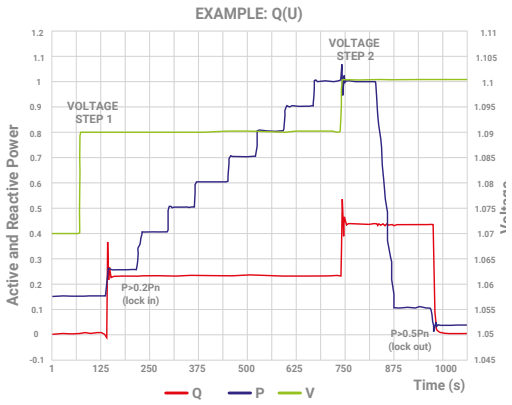



**Low Voltage Ride Through** (LVRT or ZVRT ). Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive current, as long as the protection limits are not exceeded.

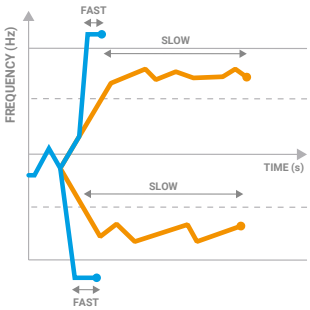



**Frequency Regulation System** (FRS). Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

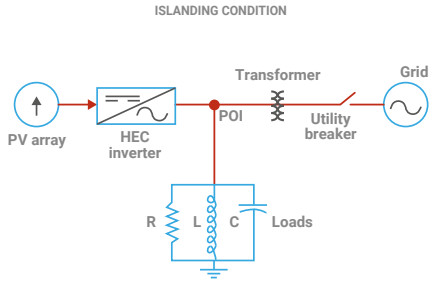



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.




**Frequency Ride Through** (FRT). 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.

FRONT VIEW

BACK VIEW

# TECHNICAL CHARACTERISTICS HEM

| REFERENCE | | FS3300M |
|---|---|---|
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 3300 |
| | AC Output Power(kVA/kW) @25°C [1] | 3630 |
| | Operating Grid Voltage(VAC) [2] | 34.5kV ±10% |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night |
| **INPUT** | MPPt @full power (VDC) | 934V-1310V |
| | Maximum DC voltage | 1500V |
| | Number of inputs [2] | Up to 36 |
| | Max. DC continuous current (A) | 3970 |
| | Max. DC short circuit current (A) | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98% including MV transformer (preliminary) |
| | Max. Power Consumption (KVA) | 20 |
| **CABINET** | Dimensions [WxDxH] (ft) | 21.7 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 6.6 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating |
| | Relative Humidity | 4% to 100% non condensing |
| | Max. Altitude (above sea level) [4] | 2000m |
| | Noise level [5] | < 79 dBA |
| **CONTROL INTERFACE** | Interface | Graphic Display |
| | Communication protocol | Modbus TCP |
| | Plant Controller Communication | Optional |
| | Keyed ON/OFF switch | Standard |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device |
| | General AC Protection | MV Switchgear (configurable) |
| | General DC Protection | Fuses |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 |
| | Compliance | NEC 2014 / NEC 2017 (optional) |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003. |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Consult Power Electronics for other altitudes.
[5] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEM

| REFERENCE | | FS3225M |
|---|---|---|
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 3225 |
| | AC Output Power(kVA/kW) @25°C [1] | 3550 |
| | Operating Grid Voltage(VAC) [2] | 34.5kV ±10% |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night |
| **INPUT** | MPPt @full power (VDC) | 913V-1310V |
| | Maximum DC voltage | 1500V |
| | Number of inputs [2] | Up to 36 |
| | Max. DC continuous current (A) | 3970 |
| | Max. DC short circuit current (A) | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98% including MV transformer (preliminary) |
| | Max. Power Consumption (KVA) | 20 |
| **CABINET** | Dimensions [WxDxH] (ft) | 21.7 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 6.6 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating |
| | Relative Humidity | 4% to 100% non condensing |
| | Max. Altitude (above sea level) [4] | 2000m |
| | Noise level [5] | < 79 dBA |
| **CONTROL INTERFACE** | Interface | Graphic Display |
| | Communication protocol | Modbus TCP |
| | Plant Controller Communication | Optional |
| | Keyed ON/OFF switch | Standard |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device |
| | General AC Protection | MV Switchgear (configurable) |
| | General DC Protection | Fuses |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 |
| | Compliance | NEC 2014 / NEC 2017 (optional) |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003. |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Consult Power Electronics for other altitudes.
[5] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEM

| REFERENCE | | FS3150M |
|---|---|---|
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 3150 |
| | AC Output Power(kVA/kW) @25°C [1] | 3465 |
| | Operating Grid Voltage(VAC) [2] | 34.5kV ±10% |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night |
| **INPUT** | MPPt @full power (VDC) | 891V-1310V |
| | Maximum DC voltage | 1500V |
| | Number of inputs [2] | Up to 36 |
| | Max. DC continuous current (A) | 3970 |
| | Max. DC short circuit current (A) | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98% including MV transformer (preliminary) |
| | Max. Power Consumption (KVA) | 20 |
| **CABINET** | Dimensions [WxDxH] (ft) | 21.7 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 6.6 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating |
| | Relative Humidity | 4% to 100% non condensing |
| | Max. Altitude (above sea level) [4] | 2000m |
| | Noise level [5] | < 79 dBA |
| **CONTROL INTERFACE** | Interface | Graphic Display |
| | Communication protocol | Modbus TCP |
| | Plant Controller Communication | Optional |
| | Keyed ON/OFF switch | Standard |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device |
| | General AC Protection | MV Switchgear (configurable) |
| | General DC Protection | Fuses |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 |
| | Compliance | NEC 2014 / NEC 2017 (optional) |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003. |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Consult Power Electronics for other altitudes.
[5] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEM

| REFERENCE | | FS3075M |
|---|---|---|
| OUTPUT | AC Output Power(kVA/kW) @50°C [1] | 3075 |
| | AC Output Power(kVA/kW) @25°C [1] | 3380 |
| | Operating Grid Voltage(VAC) [2] | 34.5kV ±10% |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night |
| INPUT | MPPt @full power (VDC) | 870V-1310V |
| | Maximum DC voltage | 1500V |
| | Number of inputs [2] | Up to 36 |
| | Max. DC continuous current (A) | 3970 |
| | Max. DC short circuit current (A) | 6000 |
| EFFICIENCY & AUXILIARY SUPPLY | Max. Efficiency PAC, nom (η) | 98% including MV transformer (preliminary) |
| | Max. Power Consumption (KVA) | 20 |
| CABINET | Dimensions [WxDxH] (ft) | 21.7 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 6.6 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling |
| ENVIRONMENT | Degree of protection | NEMA3R - IP54 / IP65 available |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating |
| | Relative Humidity | 4% to 100% non condensing |
| | Max. Altitude (above sea level) [4] | 2000m |
| | Noise level [5] | < 79 dBA |
| CONTROL INTERFACE | Interface | Graphic Display |
| | Communication protocol | Modbus TCP |
| | Plant Controller Communication | Optional |
| | Keyed ON/OFF switch | Standard |
| PROTECTIONS | Ground Fault Protection | GFDI and Isolation monitoring device |
| | General AC Protection | MV Switchgear (configurable) |
| | General DC Protection | Fuses |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 |
| CERTIFICATIONS | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 |
| | Compliance | NEC 2014 / NEC 2017 (optional) |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003. |

[1] Values at 1.00•Vac nom and cos Φ= 1.
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[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[4] Consult Power Electronics for other altitudes.
[5] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEM

| REFERENCE | | FS3000M |
|---|---|---|
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 3000 |
| | AC Output Power(kVA/kW) @25°C [1] | 3300 |
| | Operating Grid Voltage(VAC) [2] | 34.5kV ±10% |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night |
| **INPUT** | MPPt @full power (VDC) | 849V-1310V |
| | Maximum DC voltage | 1500V |
| | Number of inputs [2] | Up to 36 |
| | Max. DC continuous current (A) | 3970 |
| | Max. DC short circuit current (A) | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98% including MV transformer (preliminary) |
| | Max. Power Consumption (KVA) | 20 |
| **CABINET** | Dimensions [WxDxH] (ft) | 21.7 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 6.6 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating |
| | Relative Humidity | 4% to 100% non condensing |
| | Max. Altitude (above sea level) [4] | 2000m |
| | Noise level [5] | < 79 dBA |
| **CONTROL INTERFACE** | Interface | Graphic Display |
| | Communication protocol | Modbus TCP |
| | Plant Controller Communication | Optional |
| | Keyed ON/OFF switch | Standard |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device |
| | General AC Protection | MV Switchgear (configurable) |
| | General DC Protection | Fuses |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 |
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[4] Consult Power Electronics for other altitudes.
[5] Readings taken 1 meter from the back of the unit.

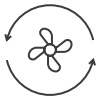
# HEMK

UTILITY SCALE CENTRAL STRING INVERTER


**FIELD REPLACEABLE UNITS**

**OUTDOOR DURABILITY**


**IP65 AVAILABLE**



**ICOOL 3**

**ACTIVE HEATING**

**3 LEVEL TOPOLOGY**


**MULTI MPPT AVAILABLE**

## COMBINING THE BENEFITS OF CENTRAL AND STRING INVERTERS

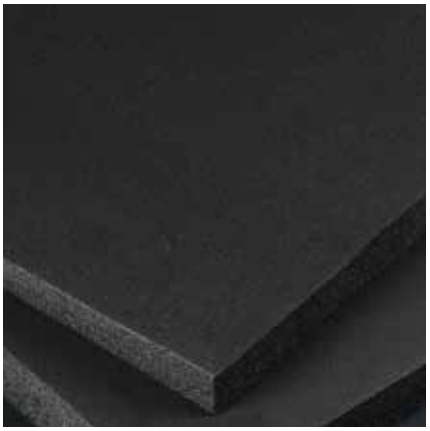
The HEMK is the second generation 1500V inverter, based on the more than proven HEC V1500. This modular solar inverter offers the advantages of both central and string inverters. Reaching a very high power density, and an output power of 3.8MW, it is available in 6 different AC voltages, providing the flexibility to choose the best solution for each PV plant. The power stage architecture, composed of six field replaceable units (FRU), is designed to provide the highest availability and optimize yield production.

The innovative iCOOL3 cooling system allows the HEMK to be installed in the harshest environments, thanks to a degree of protection of up to IP65. This advanced air-cooling system, reduces the OPEX cost compared to other cooling solutions, that need the use of complex liquid-cooling systems.

## ROBUST DESIGN




Polymeric Painting



Closed-Cell Insulation

Galvanized Steel | Stainless Steel (Optional)

HEMK inverter modules have a design life of greater than 30 years of operation in harsh environments and extreme weather conditions. HEMK units are tested and ready to withstand conditions from the frozen Siberian tundra to the Californian Death Valley, featuring:

| |
|---|
| Totally sealed electronics cabinet protects electronics against dust and moisture. |
| Conformal coating on electronic boards shields PCBs from harsh atmospheres. |
| Temperature and humidity controlled active heating prevents internal water condensation. |
| C4 degree of protection according to ISO 12944.<br>Up to C5-M optional. |
| Closed-Cell insulation panel isolates the cabinet from solar heat gains. |
| Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages. |
| The solid HEMK structure avoids the need of additional external structures. |
| Random units selected to pass a Factory Water Tightness Test ensuring product quality. |
| IP65 available. |

## COMPACT DESIGN - EASY TO SERVICE

By providing full front access the HEMK series simplifies the maintenance tasks, reducing the MTTR (and achieving a lower OPEX). The total access allows a fast swap of the FRUs without the need of qualified technical personnel.

With the HEMK, Power Electronics offers its most compact solution, achieving 3.8MW in just 12ft long, reducing installation costs and labor time.


## STRING CONCEPT POWER STAGES

The HEMK combines the advantages of a central inverter with the modularity of the string inverters. Its power stages are designed to be easily replaceable on the field without the need of advanced technical service personnel, providing a safe, reliable and fast Plug&Play assembly system.

Following the modular philosophy of the Freesun series, the HEMK is composed of 6 FRUs (field replaceable units), being able to work with up to 6 different MPPTs, providing a perfect solution for irregular locations, where each area of the PV plant has a different production curve.

HEMK is also available with a single MPPt, where all the power stages are physically joined in the DC side and therefore, in the event of a fault, the faulty module is taken off-line and its power is distributed evenly among the remaining functioning FRUs.

## INNOVATIVE COOLING SYSTEM

Based on more than 3 years of experience with our MV Variable Speed Drive, the iCOOL3 is the first air-cooling system allowing IP65 degree of protection in an outdoor solar inverter. iCOOL3 delivers a constant stream of clean air to the FRUs, being the most effective way of reaching up to IP65 degree of protection, without having to maintain cumbersome dust filters or having to use liquid-cooling systems, avoiding the commonly known inconveniences of it (complex maintenance, risk of leaks, higher number of components…), therefore resulting in an OPEX cost reduction.

## VAR AT NIGHT

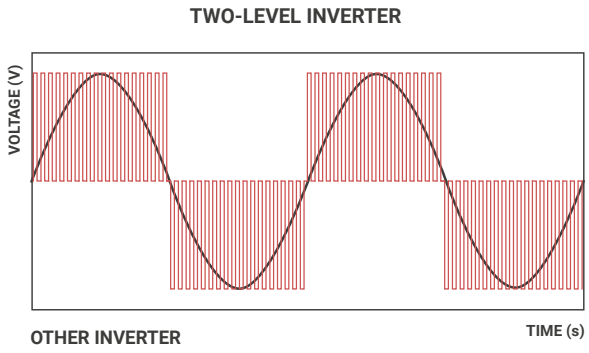
At night, the HEMK inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).

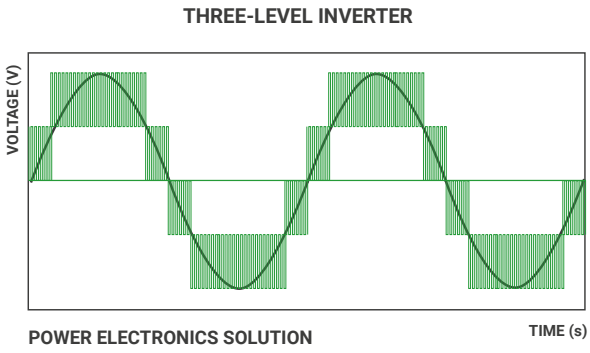
## ACTIVE HEATING

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. **PATENTED**

## MULTILEVEL TOPOLOGY

The multilevel IGBT topology is the most efficient approach to manage high DC link voltages and makes the difference in the 1,500 Vdc design. Power Electronics has many years of power design in both inverters and MV drives and the HEMK design is the result of our experience with 3 level topologies. The 3 level IGBT topology reduces stage losses, increases inverter efficiency and minimizes total harmonic distortion.




## EASY TO MONITOR

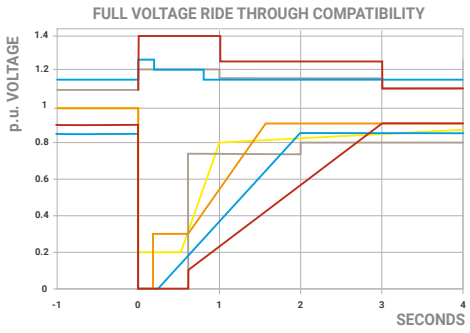
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors.

The app user friendly interface allows quick and easy access to critical information (energy registers, production and events).

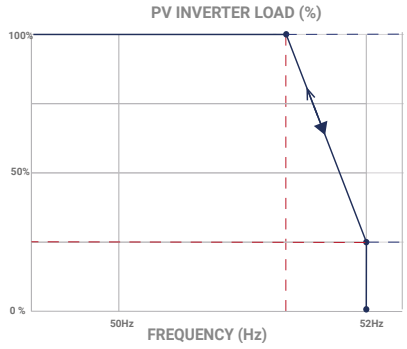
| | |
|---|---|
| **AVAILABLE INFORMATION** | Grid and PV field data.<br>Inverter and Power module data (Voltages, currents, power, temperatures, I/O status...).<br>Weather conditions.<br>Alarms and warnings events.<br>Energy registers.<br>Others. |
| **FEATURES** | Easy Wireless connection.<br>Comprehensive interface.<br>Real time data.<br>Save and copy settings. |
| **LANGUAGE** | English, Spanish. |
| **SYSTEM REQUIREMENTS** | iOS or Android devices. |
| **SETTINGS CONTROL** | Yes |

## DYNAMIC GRID SUPPORT

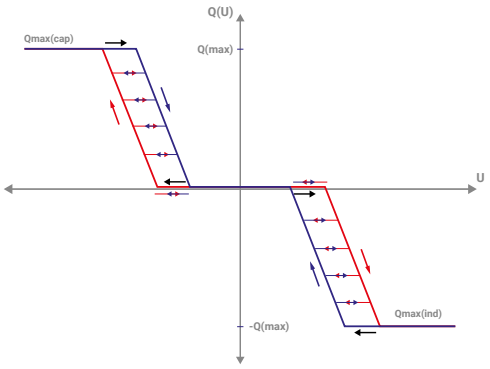
HEMK firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

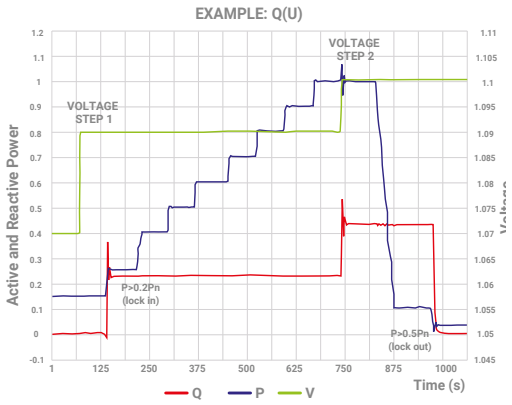



**Low Voltage Ride Through** (LVRT or ZVRT ). Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive current, as long as the protection limits are not exceeded.

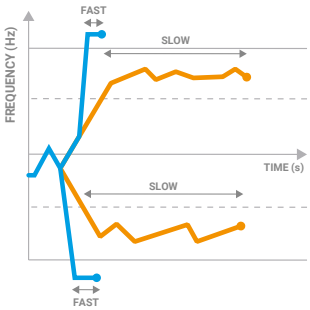



**Frequency Regulation System** (FRS). Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

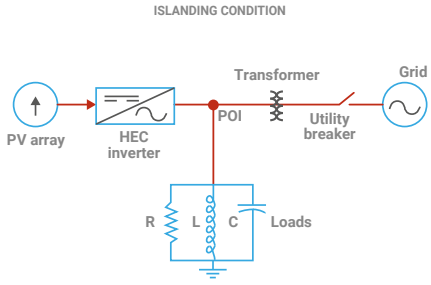



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.




**Frequency Ride Through** (FRT). 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.

# TECHNICAL CHARACTERISTICS HEMK 690V

| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2300K** | **FS3450K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2300 | 3450 |
| | AC Output Power(kVA/kW) @25°C [1] | 2530 | 3800 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 690V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 976V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.9 | 98.9 |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12.3 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEMK 660V

| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2200K** | **FS3300K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2200 | 3300 |
| | AC Output Power(kVA/kW) @25°C [1] | 2420 | 3630 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 660V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 934V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.8% | 98.9% |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEMK 645V

| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2150K** | **FS3225K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2150 | 3225 |
| | AC Output Power(kVA/kW) @25°C [1] | 2365 | 3550 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 645V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 913V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.8% | 98.9% |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEMK 630V

| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2100K** | **FS3150K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2100 | 3150 |
| | AC Output Power(kVA/kW) @25°C [1] | 2310 | 3465 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 630V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 891V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.8% | 98.8% |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEMK 615V

| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2050K** | **FS3075K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2050 | 3075 |
| | AC Output Power(kVA/kW) @25°C [1] | 2225 | 3380 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 615V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 870V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.8% | 98.8% |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEMK 600V

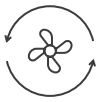
| | | FRAME 1 | FRAME 2 |
|---|---|---|---|
| **REFERENCE** | | **FS2000K** | **FS3000K** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 2000 | 3000 |
| | AC Output Power(kVA/kW) @25°C [1] | 2200 | 3300 |
| | Max. AC Output Current (A) @25°C | 2120 | 3175 |
| | Operating Grid Voltage(VAC) [2] | 600V ±10% | |
| | Operating Grid Frequency(Hz) | 50Hz/60Hz | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | |
| | Power Factor (cosine phi) [3] | 0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night | |
| **INPUT** | MPPt @full power (VDC) | 849V-1310V | |
| | Maximum DC voltage | 1500V | |
| | Number of inputs [2] | Up to 36 | |
| | Number of MPPts | Up to 4 | Up to 6 |
| | Max. DC continuous current (A) | 2645 | 3970 |
| | Max. DC short circuit current (A) | 4000 | 6000 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.8% | 98.8% |
| | Max. Power Consumption (KVA) | 8 | 10 |
| **CABINET** | Dimensions [WxDxH] (ft) | 9 x 7 x 7 | 12 x 7 x 7 |
| | Dimensions [WxDxH] (m) | 2.7 x 2.2 x 2.2 | 3.7 x 2.2 x 2.2 |
| | Type of ventilation | Forced air cooling | |
| **ENVIRONMENT** | Degree of protection | NEMA3R - IP54 / IP65 available | |
| | Permissible Ambient Temperature | -35°C to +60°C / >50°C Active Power derating | |
| | Relative Humidity | 4% 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 | |
| | Communication protocol | Modbus TCP | |
| | Plant Controller Communication | Optional | |
| | Keyed ON/OFF switch | Standard | |
| **PROTECTIONS** | Ground Fault Protection | GFDI and Isolation monitoring device | |
| | General AC Protection | Circuit Breaker | |
| | General DC Protection | Fuses | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 | |
| **CERTIFICATIONS** | Safety | UL1741, CSA 22.2 No.107.1-01, UL62109-1, IEC62109-1, IEC62109-2 | |
| | Compliance | NEC 2014 / NEC 2017 (optional) | |
| | Utility interconnect | UL 1741SA-Sept.2016, IEEE 1547-2003 | |

[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult Power Electronics for other configurations.
[3] Consult P-Q charts available: Q(kVAr)=√(S(kVA)2-P(kW)2).
[4] Readings taken 1 meter from the back of the unit.

# HEC V1500

UTILITY SCALE SOLAR INVERTER

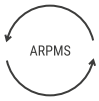
**OUTDOOR DURABILITY**



**ICOOL V**

**ACTIVE HEATING**

**3 LEVEL TOPOLOGY**




**AUTOMATIC REDUNDANT POWER MODULE SYSTEM**

## THE MOST RELIABLE 1500VDC UTILITY-SCALE PV INVERTER IN THE MARKET

The Power Electronics HEC V1500 are reliable 1500Vdc outdoor utility-scale inverters, with more than 4GW already installed worldwide. The HEC V1500 inverter family has 25 different models ranging from 1MW to 3.5MW, and it is available for the IEC and UL market. With up to seven 500kW power modules connected in parallel, the HEC V1500 is a multilevel 1500Vdc system built on the Power Electronics expertise in >1,000Vdc systems and in the proven Freesun HEC modular topology.The HEC V1500 power stage is based on a multi-level IGBT topology, which makes the difference in the 1500Vdc technology. Power Electronics takes advantage of the three-level topology, reducing the power stage losses, and increasing the inverter efficiency

## ROBUST DESIGN




Polymeric Painting

Mineral Panel

Galvanized Steel | Stainless Steel (Optional)

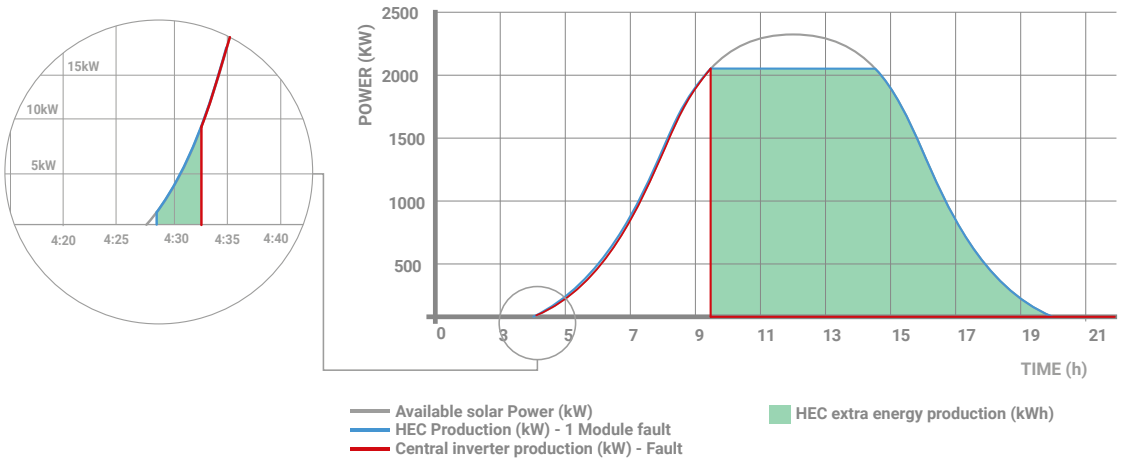
HEC V1500 inverters have been designed to last for more than 25 years of operation in harsh environments and extreme weather conditions. HEC V1500 units are tested and ready to withstand conditions from the frozen siberian tundra to the californian Death Valley, featuring:

- Totally sealed electronics cabinet protects electronics against dust and moisture.
- Conformal coating on electronic boards shields PCBs from harsh atmospheres.
- Temperature and humidity controlled active heating prevents internal water condensation.
- Galvanized Steel construction with 2mm thickness for maximum enclosure longevity.
- 50mm mineral panel isolates the cabinet from solar heat gains.
- Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages.
- The solid HEC V1500 structure avoids the need of additional external structures.
- Random units selected to pass a Factory Water Tightness Test ensuring product quality.
- C5-M degree of protection according to ISO 12944.

## AUTOMATIC REDUNDANT POWER MODULE SYSTEM

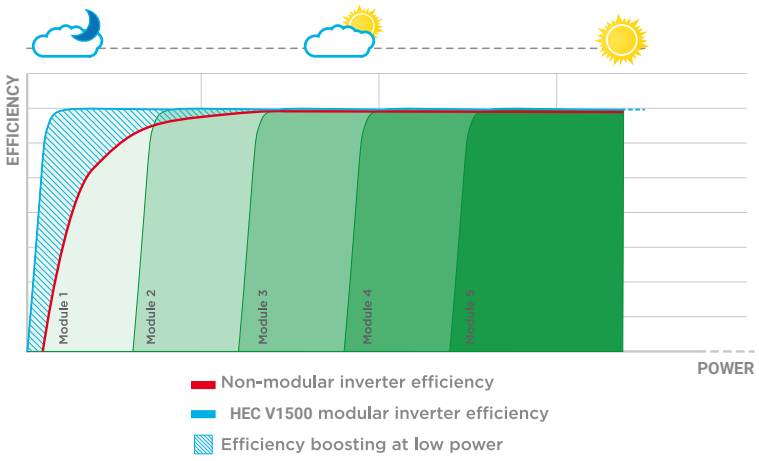
The HEC V1500 topology combines the advantages of a central inverter with the availability of string inverters. HEC V1500 is a modular central inverter based on an Automatic Redundant Power Module (350kVA to 500kVA per stage).

If there is a fault in one power module, it is taken off-line and its 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.

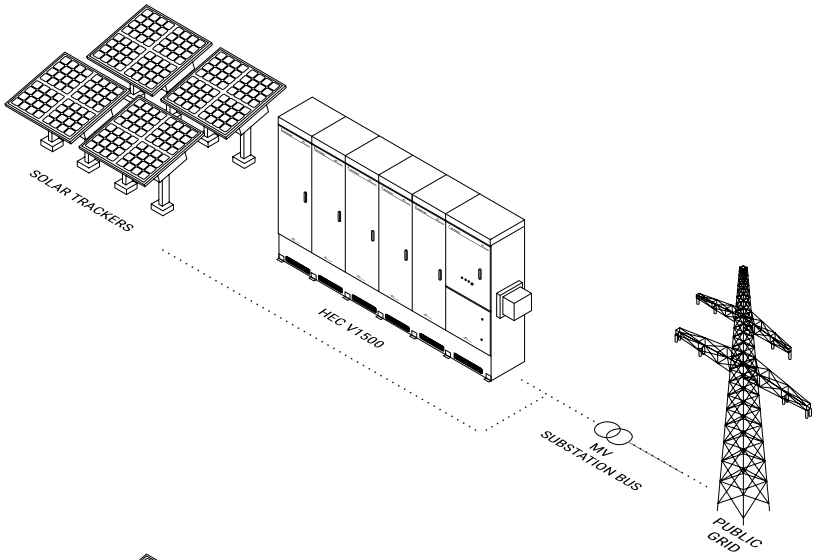
With lower losses, a modular inverter can provide power earlier in the morning and stop later at the end of the day. As a result, throughout the entire service life of the PV plant, the HEC V1500 inverter generates higher yields than a standard central inverter with a higher reliability than string inverters.



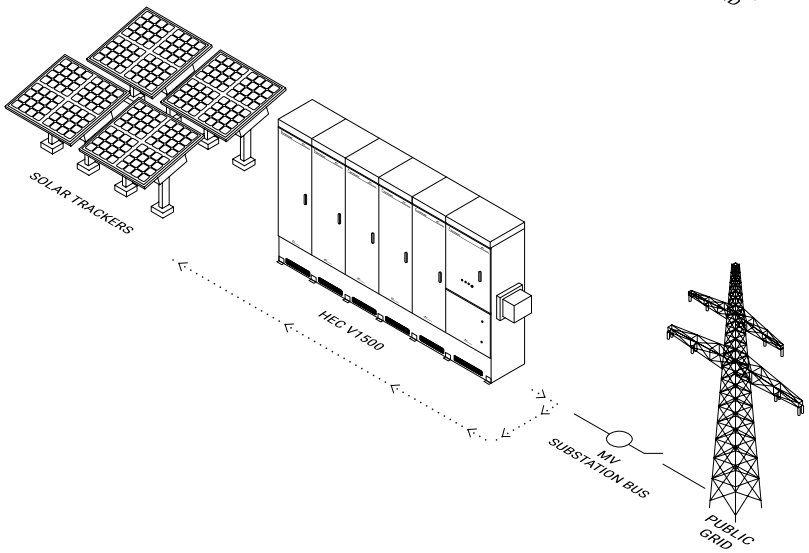
## BACK FEED TRACKER SUPPLY

During solar power plant normal operation, the solar trackers are powered by the grid via the auxiliary service transformer. In case of a loss of mains, a UPS with battery systems is needed for powering the solar trackers and ensures achieving the safety position. Battery systems increase the CAPEX and the OPEX of the project, due to a high maintenance requirement, extra energy consumption and battery replacement. In order to avoid these disadvantages, HEC V1500 inverter is able to provide the safety power supply required without using battery systems, taking profit of the energy available in the PV field, and therefore offering the most cost-effective solution in the market.

**PLANT UNDER OPERATION**




**BLACKOUT EVENT**

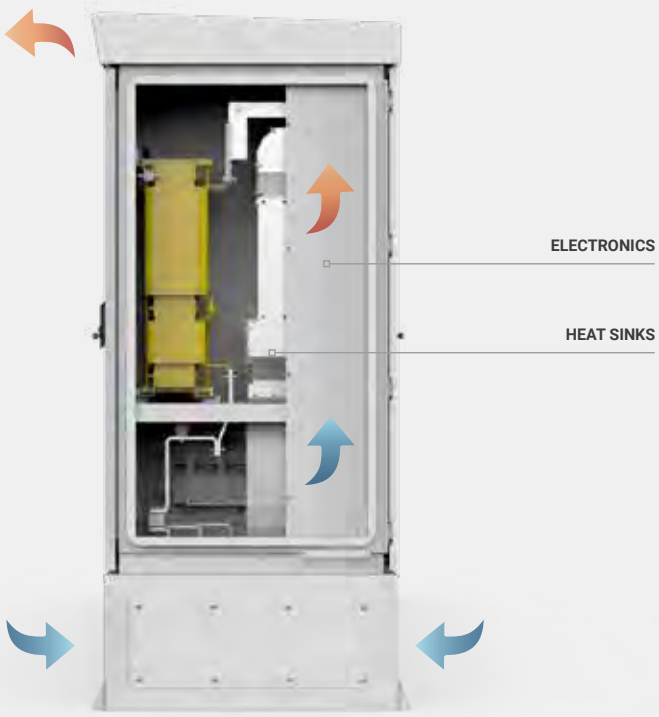



..... **Energy Flow**

## REVOLUTIONARY COOLING SYSTEM

The Power Electronics HEC V1500 series includes the innovative and sophisticated iCOOL V performance that allows HEC V1500 to work up to 50°C at nominal power. The cooling system, iCOOL V, smartly cools the inverter, regulating the cooling system capacity depending on the data from the temperature sensors. HEC V1500 modules are divided into two main areas: clean area (electronics) and hot area (heat sink). The electronics are totally sealed 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**




## VAR AT NIGHT

At night, the HEC 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).

## HIGH MODULARITY SYSTEM

The HEC V1500 inverter family is a high modularity solution with its 25 different models based on 5 frames, from 3 up to 7 power modules. With its modular and flexible design, Power Electronic offers a smart solution for meeting all our clients' needs, providing high modularity and redundancy to any solar power plant.

Its extensive product range, a wide power and voltage range and a redundant control system, makes the HEC V1500 inverter family an optimal solution to guarantee high availability in every small-medium utility scale project.

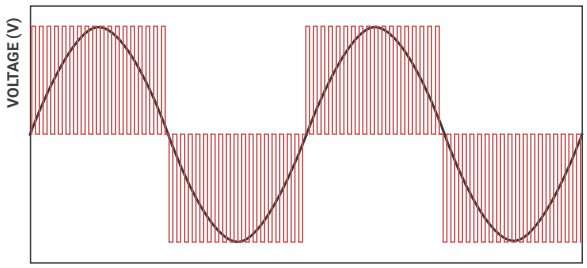
**FROM 1MW**

**UP TO 3.5MW**

## MULTILEVEL TOPOLOGY

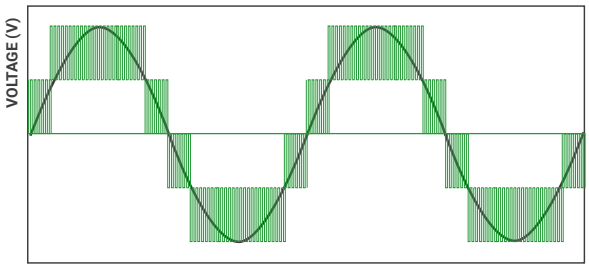
The multilevel IGBT topology makes the difference when the DC voltage is above 1000V, being the most efficient way to manage high DC link voltages. Based in our long IGBT experience components used in our Solar and Industrial division, the HEC V1500 takes profit of the three level IGBT topology reducing the power stage losses, increasing the efficiency and offering a very low total harmonic distortion.

**TWO-LEVEL INVERTER**




**OTHER INVERTER**

**THREE-LEVEL INVERTER**




**POWER ELECTRONICS SOLUTION**

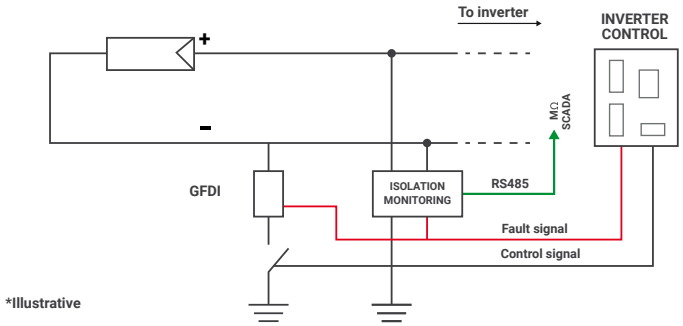
## ACTIVE HEATING

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. **PATENTED**

## PV ARRAY TRANSFER KIT

By mounting this kit, the inverter and the PV plant will be able to shift its running conditions from negative grounded array to floating array and viceversa. Under regular conditions the inverter will be running with a negative pole grounded and therefore, a GDFI will provide protection against unlikely ground fault defects and the solar cells will not suffer a negative voltage relative to their surroundings at any time. This running mode can be transfered to a floating array configuration enabling an isolation monitoring device that the O&M can use for: regular PV plant isolation control, identification of the array affected by a ground fault defect and most important, increase the operator safety under O&M service activities.




## EASY TO MONITOR

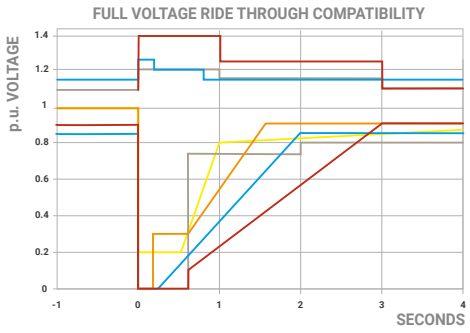
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors.

The app user friendly interface allows quick and easy access to critical information (energy registers, production and events).

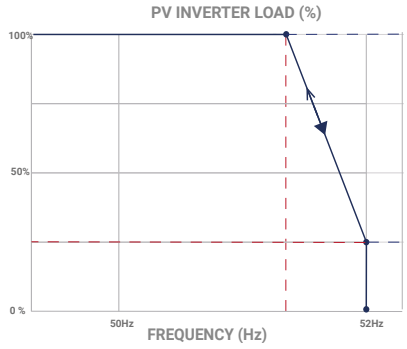
| | |
|---|---|
| **AVAILABLE INFORMATION** | Grid and PV field data.<br>Inverter and Power module data (Voltages, currents, power, temperatures, I/O status...).<br>Weather conditions.<br>Alarms and warnings events.<br>Energy registers.<br>Others. |
| **FEATURES** | Easy Wireless connection.<br>Comprehensive interface.<br>Real time data.<br>Save and copy settings. |
| **LANGUAGE** | English, Spanish. |
| **SYSTEM REQUIREMENTS** | iOS or Android devices. |
| **SETTINGS CONTROL** | Yes |

## DYNAMIC GRID SUPPORT

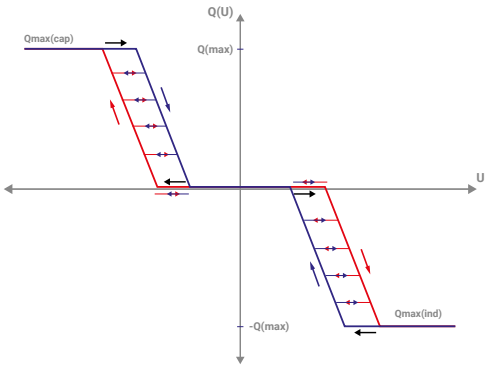
HEC V1500 firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

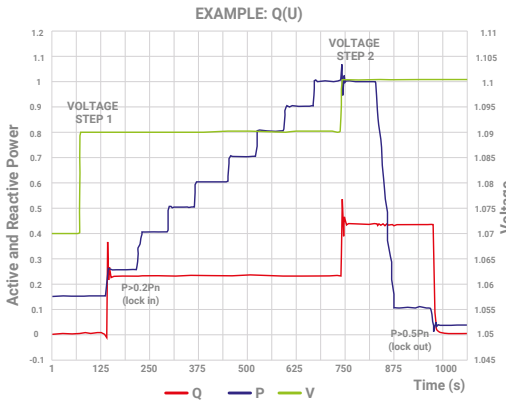



**Low Voltage Ride Through** (LVRT or ZVRT ). Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive current, as long as the protection limits are not exceeded.

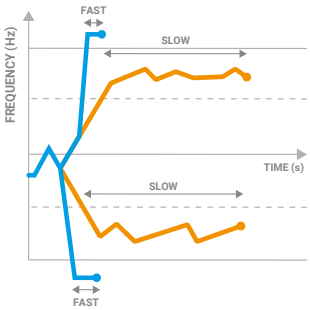



**Frequency Regulation System** (FRS). Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

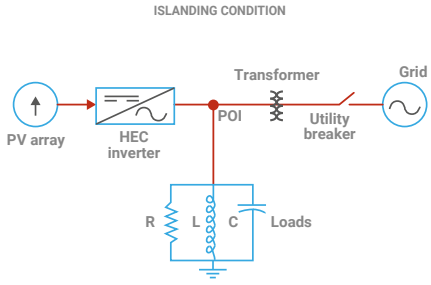



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.



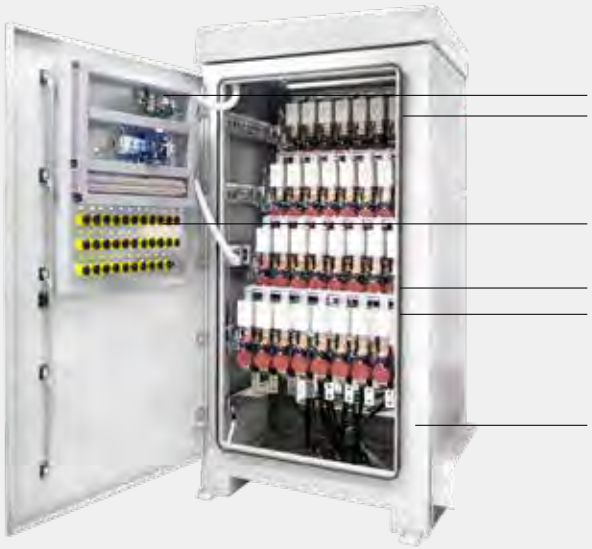

**Frequency Ride Through** (FRT). Freesun solar inverters have flexible frequency protection settings and can be easily adjusted to comply with future requirements.




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

## DISCONNECTION AND PROTECTION

HEC V1500 is available with an external DC disconnection and protection unit (DU unit) that will be coupled together with the inverter by a mounting kit. The DC subsystems are fully customizable and can be featured with up to 32 inputs. The disconnecting unit goes one step further by improving the PV plant safety and operation for those who apply the best engineering.




## TECHNICAL INFORMATION

| | |
|---|---|
| **Voltage rating** | 1500 Vdc |
| **Maximum number of inputs** | Frame 1: 16 inputs<br>Frame 2: 32 inputs |
| **Maximum DC continuous current** | 3745A |
| **Maximum DC short circuit current** | 5450A |
| **Maximum fuse size per input** | 400A |
| **Max. positive and negative input wire size** | 2 x 750 kcmil - 380mm2 (Check Installation Manual for further information) |
| **Terminals** | 2 holes - 1.75" hole spacing |
| **String configuration** | Floating array / Possitive or negative pole grounded |
| **Floating array protection** | Insulation monitoring device |
| **Grounded array protection** | GFDI / GFDI + Insulation monitoring device (NEC 2014) optional |
| **Operating temperature** | -35°C to 60°C |
| **Zone monitoring** | Optional (Voltage and current monitoring) |
| **DC disconnect** | 400A DC contactor |
| **Input disable capability** | 2 push buttons in Frame 1<br>4 push buttons in Frame 2<br>Other confi gurations optional |
| **Fuse mounting** | Up to 32 x Busbar bolted |
| **Cooling** | Forced air cooling, temperature controlled |
| **Heating** | Heating resistor |
| **Type** | IEC / UL |

# CONFIGURATION TABLE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **FAMILY** | | Freesun Disconnnecting Unit | | | | | | | |
| **SERIES** | **C** | HEC Series | | | | | | | |
| **TYPE** | **U** | UL | **H** | IEC | | | | | |
| **MAXIMUN VOLTAGE** | **15** | 1500V | | | | | | | |
| **INPUTS PER POLE** | **01** | 1 Input | **...** | ... | **32** | 32 Inputs | | | |
| **STRING LOCKOUT AND TAGOUT** | **A** | Standard (1 input per tray) | **B** | 3 Push buttons | **C** | 4 Push buttons | **...** | ... | **Z** 1 Pushbutton per Input |
| **LIGHTNING AND OVERVOLTAGE PROTECTIONS** | **O** | Type 2 | **L** | Type 1 | | | | | |
| **ZONE MONITORING** | **N** | Not included | **C** | Current Monitoring | | | | | |
| **INSULATION MONITORING** | **I** | Insulation Monitoring (Floating Array) | **G** | GFDI + Insulation Monitoring (negative pole grounded) | | | | | |
| **PAINT AND CORROSION PROTECTION** | **A** | C4 | **M** | C5M | | | | | |

**INSULATION MONITORING DEVICE**

Insulation monitoring can detect cable insulation issues in the PV array. If low insulation resistance is detected between the array and ground, the device disconnects the inverter and writes a fault message in the system fault log. In grounded systems, an additional contactor connected in series with the GFDI disconnects the pole from the ground every morning, prior to the startup sequence of the inverter, in order to allow the monitoring device to check the insulation between both poles and ground.

**VOLTAGE AND CURRENT MONITORING**

The FSDK Voltage and Current monitoring option provides data for zone current values, as well as the open circuit voltage for every DC input. DC Voltage and current monitoring allows an operator to safely check the PV array operation without opening the DC cabinet. With the Voltage and Current monitoring option, a remote SCADA operator will be able to receive fault messages like “unbalanced currents”, “unbalanced voltages” or “blown fuse” and take appropriate action based on the status of the PV field.

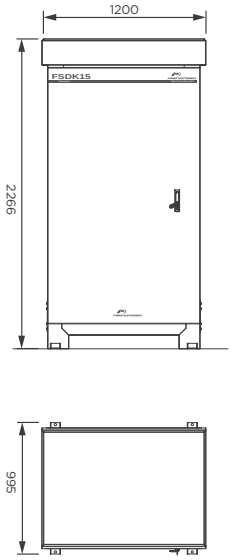
**LOW STRING INSULATION DETECTOR**

Using the individual DC contactors and the Insulation Monitoring option, the FSDK unit can automatically identify which input has low insulation and isolate it from the rest of the PV field. After the faulted line is disconnected, the inverter will log the error and send a warning to the O&M team to provide information about the faulty input. Detailed troubleshooting information will reduce service time and quickly get a system back on-line.

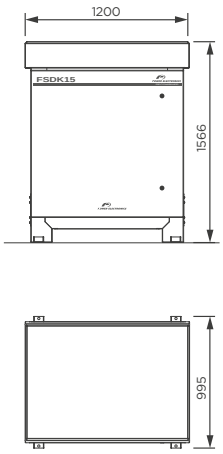
**PATENTED**

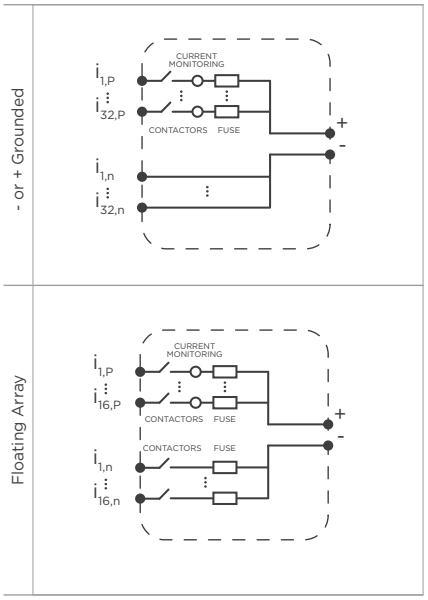
# DIMENSIONS & DIAGRAM

**FRAME 2**




**FRAME 1**



# TECHNICAL CHARACTERISTICS

# HEC V1500 - 690V

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1275CH15** | **FS1700CH15** | **FS2125CH15** | **FS2550CH15** | **FS3000CH15** |
| **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 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 690V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 50Hz/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 | 0...100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) [1] | 976V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Efficiency (Max) (η) | 98.8% | | | | |
| | Euroeta (η) | 98.7% | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 400V / 230VAC–6kVA power supply available for external equipment (optional) | | | | |
| **CABINET** | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | |
| | Permissible Ambient Temperature | -35°C[3] to 60°C / Active Power derating >50°C | | | | |
| | 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/IP | | | | |
| | 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>Grounded PV Array (Positive pole and negative pole): 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) | | | | |
| **CERTIFICATIONS** | Safety | IEC62109-1, IEC62109-2 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC V1500 - 645V

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1200CH15** | **FS1600CH15** | **FS2000CH15** | **FS2400CH15** | **FS2800CH15** |
| **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 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 645V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 50Hz/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 | 0...100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) [1] | 913V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Efficiency (Max) (η) | 98.7% | | | | |
| | Euroeta (η) | 98.6% | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 400V / 230VAC–6kVA power supply available for external equipment (optional) | | | | |
| **CABINET** | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | |
| | Permissible Ambient Temperature | -35°C[3] to 60°C / Active Power derating >50°C | | | | |
| | 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/IP | | | | |
| | 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>Grounded PV Array (Positive pole and negative pole): 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) | | | | |
| **CERTIFICATIONS** | Safety | IEC62109-1, IEC62109-2 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC V1500 - 630V

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1270CH15** | **FS1695CH15** | **FS2120CH15** | **FS2540CH15** | **FS3001CH15** |
| **OUTPUT** | AC Output Power (kVA/kW) @50°C [1] | 1180 | 1570 | 1965 | 2360 | 2750 |
| | AC Output Power (kVA/kW) @40°C [1] | 1270 | 1695 | 2120 | 2540 | 3000 |
| | AC Output Power (kVA/kW) @25°C [1] | 1400 | 1870 | 2340 | 2800 | 3275 |
| | Max. AC Output Current (A) @50°C | 1080 | 1440 | 1800 | 2160 | 2520 |
| | Max. AC Output Current (A) @40°C | 1165 | 1550 | 1940 | 2330 | 2715 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 630V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 50Hz/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 | 0…100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) | @50°C 891V-1310V / @40°C 891V-1285V / @25°C 891V-1250V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Efficiency (Max) (η) Preliminary | 98.6% | | | | |
| | Euroeta (η) Preliminary | 98.6% | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 400V / 230VAC–6kVA power supply available for external equipment (optional) | | | | |
| **CABINET** | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | |
| | Permissible Ambient Temperature | -35°C[3] to +60°C / Power derating >40°C | | | | |
| | 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>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) | | | | |
| **CERTIFICATIONS** | Safety | IEC62109-1, IEC62109-2 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC V1500 - 600V

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1100CH15** | **FS1475CH15** | **FS1850CH15** | **FS2225CH15** | **FS2600CH15** |
| **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 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 600V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 50Hz/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 | 0...100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) [1] | 849V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Efficiency (Max) (η) | 98.6% | | | | |
| | Euroeta (η) | 98.6% | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 400V / 230VAC–6kVA power supply available for external equipment (optional) | | | | |
| **CABINET** | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | |
| | Permissible Ambient Temperature | -35°C[3] to 60°C / Active Power derating >50°C | | | | |
| | 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/IP | | | | |
| | 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>Grounded PV Array (Positive pole and negative pole): 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) | | | | |
| **CERTIFICATIONS** | Safety | IEC62109-1, IEC62109-2 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC V1500 - 565V

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1050CH15** | **FS1400CH15** | **FS1750CH15** | **FS2100CH15** | **FS2450CH15** |
| **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 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 565V ±10% | | | | |
| | Operating Grid Frequency (Hz) | 50Hz/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 | 0...100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) [1] | 800V - 1310V | | | | |
| | Maximum DC voltage | 1500V | | | | |
| | Max. DC continuous current (A) | 1600 | 2140 | 2675 | 3210 | 3745 |
| | Max. DC short circuit current (A) | 2320 | 3100 | 3880 | 4650 | 5450 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Efficiency (Max) (η) | 98.5% | | | | |
| | Euroeta (η) | 98.4% | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 50W/per module | | | | |
| | Control Power Supply | 400V / 230VAC–6kVA power supply available for external equipment (optional) | | | | |
| **CABINET** | Dimensions [WxDxH] [mm] | 3038x945x2198 | 3751x945x2198 | 4464x945x2198 | 5177x945x2198 | 5890x945x2198 |
| | Weight (kg) | 2635 | 3290 | 3945 | 4600 | 5255 |
| | Air Flow | Bottom intake. Exhaust top rear vent. | | | | |
| | Type of ventilation | Forced air cooling | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | |
| | Permissible Ambient Temperature | -35°C[3] to 60°C / Active Power derating >50°C | | | | |
| | 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/IP | | | | |
| | 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>Grounded PV Array (Positive pole and negative pole): 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) | | | | |
| **CERTIFICATIONS** | Safety | IEC62109-1, IEC62109-2 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US V1500 - 690V

**NORTH AMERICA**

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **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 | 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 & AUXILIARY 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 | | | | |
| **ENVIRONMENT** | 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) | | | | |
| **CERTIFICATIONS** | Safety | UL 1741, CSA 22.2 No.107.1-01, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US V1500 - 645V

**NORTH AMERICA**

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **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 | 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 & AUXILIARY 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 | | | | |
| **ENVIRONMENT** | 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) | | | | |
| **CERTIFICATIONS** | Safety | UL 1741, CSA 22.2 No.107.1-01, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US V1500 - 630V

**NORTH AMERICA**

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **3** | **4** | **5** | **6** | **7** |
| **REFERENCE** | | **FS1270CU15** | **FS1695CU15** | **FS2120CU15** | **FS2540CU15** | **FS3001CU15** |
| **OUTPUT** | AC Output Power (kVA/kW) @50°C [1] | 1180 | 1570 | 1965 | 2360 | 2750 |
| | AC Output Power (kVA/kW) @40°C [1] | 1270 | 1695 | 2120 | 2540 | 3000 |
| | AC Output Power (kVA/kW) @25°C [1] | 1400 | 1870 | 2340 | 2800 | 3275 |
| | Max. AC Output Current (A) @50°C | 1080 | 1440 | 1800 | 2160 | 2520 |
| | Max. AC Output Current (A) @40°C | 1165 | 1550 | 1940 | 2330 | 2715 |
| | Max. AC Output Current (A) @25°C | 1285 | 1710 | 2140 | 2570 | 3000 |
| | Operating Grid Voltage (VAC) | 630V ±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 | 0…100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) | @50°C 891V-1310V / @40°C 891V-1285V / @25°C 891V-1250V | | | | |
| | 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 & AUXILIARY SUPPLY** | Efficiency (Max) (η) Preliminary | 98.5% | | | | |
| | CEC (η) Preliminary | 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 | | | | |
| **ENVIRONMENT** | Degree of protection | NEMA 3R | | | | |
| | Permissible Ambient Temperature | -31°F to +140°F, -35°C[3] to +60°C / Power derating >40°C/104°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 | Compatible with third party SCADA controls | | | | |
| | 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) | | | | |
| **CERTIFICATIONS** | Safety | UL 1741, CSA 22.2 No.107.1-01, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US V1500 - 600V

**NORTH AMERICA**

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **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 | 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 & AUXILIARY 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 | | | | |
| **ENVIRONMENT** | 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) | | | | |
| **CERTIFICATIONS** | Safety | UL 1741, CSA 22.2 No.107.1-01, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US V1500 - 565V

**NORTH AMERICA**

| | | FRAME 1 | FRAME 2 | FRAME 3 | FRAME 4 | FRAME 5 |
|---|---|---|---|---|---|---|
| **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 | 0...100% / 0.1% Steps | | | | |
| **INPUT** | MPPt @full power (VDC) [1] | 800V - 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 & AUXILIARY 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 | | | | |
| **ENVIRONMENT** | 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) | | | | |
| **CERTIFICATIONS** | Safety | UL 1741, CSA 22.2 No.107.1-01, UL62109-1 | | | | |
| | Utility interconnect | UL 1741SA-Sept. 2016 / IEEE 1547.1-2005 | | | | |

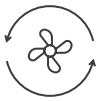
[1] Values at 1.00•Vac nom and cos Φ= 1.
Consult Power Electronics for derating curves.
[2] Consult P-Q charts available: $Q(kVAr)=\sqrt{(S(kVA)^2-P(kW)^2)}$.
[3] Heating resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.


POWER ELECTRONICS

# HEC PLUS

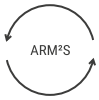
UTILITY SCALE SOLAR INVERTER

**OUTDOOR DURABILITY**



**ICOOL**

**ACTIVE HEATING**




**AUTOMATIC REDUNDANT**
**MODULAR MULTI-MASTER SYSTEM**

## THE MOST POWERFUL AND RELIABLE UTILITY-SCALE PV INVERTER ON THE MARKET

Power Electronics' HEC PLUS outdoor modular and redundant inverters are the most powerful and reliable Utility Scale PV Inverters on the market. The upgraded 1000Vdc class inverters offer an extended MPPt voltage range and maximum efficiency in AC output voltages ranging from 400Vac to 460Vac, covering all commercial and utility-scale PV facilities.

The HEC PLUS is based on a modular & redundant topology with up to 10 modules that provide the competitiveness of central inverters and the availability of string inverters. The HEC PLUS is featured with an outdoor stainless steel enclosure, 50mm mineral isolation panel and the most advanced iCOOL filter-less system that makes it suitable for the most demanding conditions.

## ROBUST DESIGN




Polymeric Painting

Mineral Panel

Galvanized Steel | Stainless Steel (Optional)

HEC PLUS inverters have been designed to last for more than 25 years of operation in harsh environments and extreme weather conditions. HEC PLUS units are tested and ready to withstand conditions from the frozen siberian tundra to the californian Death Valley, featuring:

- Totally sealed electronics cabinet protects electronics against dust and moisture.
- Conformal coating on electronic boards shields PCBs from harsh atmospheres.
- Temperature and humidity controlled active heating prevents internal water condensation.
- Galvanized Steel construction with 2mm thickness for maximum enclosure longevity.
- 50mm mineral panel isolates the cabinet from solar heat gains.
- Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages.
- The solid HEC PLUS structure avoids the need of additional external structures.
- Random units selected to pass a Factory Water Tightness Test ensuring product quality.
- Anti-corrosive polymeric C4 paint coat according to ISO 9223 used in the most unforgiving environments. The HEC PLUS is also available in a C5-M degree of protection by request.

# TOPOLOGY

**NO CONDENSATION**

The active cabinet heating regulates temperature and prevents internal water condensation.

**DOUBLE GASKETED DOORS**

IP54 rated electronic area, protected from dust and moisture.

**STAINLESS STEEL ENCLOSURE**

Inox construction with 2mm thickness for maximum enclosure longevity.

**SPECIAL PAINT**

Anti-corrosive polymeric paint (C4) ISO-9223 is used on all HEC inverters.

**INSULATION**

50mm of insulation material protects internal components from external solar heat gains.

**FSDK Recombiner**

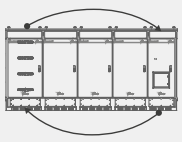
· Up to 32 fuse protected inputs.
· Zone monitoring. CT's in each input.
· Up to 32 contactors with lockout/ tagout safety features.

**DC CABINET**


**TESTS**
Random units are batch tested at the Factory for IP compliance.

**CONFORMAL COATING**
Conformal coating on electronic board shields PCBs from harsh environments.

**MIRROR UNITS**
Shift AC and DC modules to improve power station layout.



**INVERTER MODULES**

**AC CABINET**

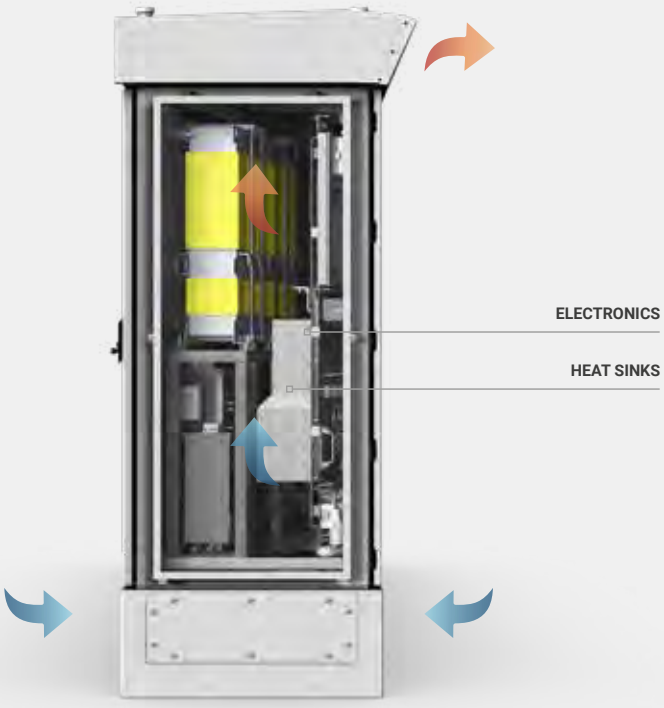
## AUTOMATIC REDUNDANT MODULAR MULTI-MASTER SYSTEM

The HEC PLUS is a central inverter based on an Automatic Redundant Modular Multi-Master System (200kVA to 250kVA per module). The unit's redundant multi-master capability translates into more availability and therefore more power production. Modularity allows for the use of fewer type of components throughout the product range, reducing maintenance costs and simplifying the stock of spare parts.

## INNOVATIVE COOLING SYSTEM

In Power Electronics we don't believe in cost cutting when it affects the quality of the product and that's why we oversize sensitive components and improve the sophisticated iCOOL performance that allow HEC PLUS to work at 50°C. Our know how in mining, water treatment plants and CSP facilities located in the most demanding locations all over the world have given us the necessary experience to develop the perfect technical solution for our outdoor solar inverters.

HEC PLUS modules are divided into two main areas: clean area (electronics) and hot area (filters and heat sink). The electronics are totally sealed and use a temperature control low flow cooling system that reduces filters clogging and maintenance intervals. The hot area integrates independent and speed controlled fans per each module, reducing to the maximum the Stand-by consumption at low capacity and boosting the cooling capacity for PV installation situated at higher altitudes than 3000 meters above sea level.

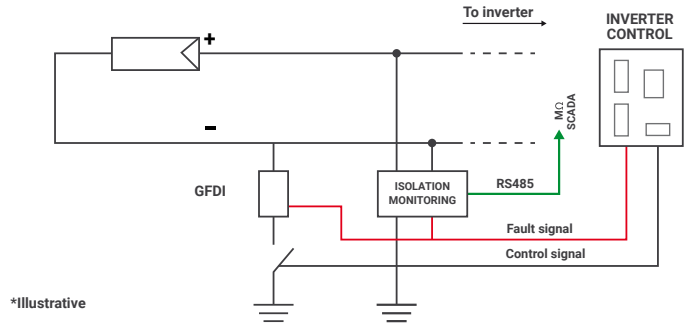


## EASY TO SERVICE

By providing full front and rear access the HEC series simplifies the maintenance tasks. The frontal access allows the checking of the whole electronic cabinet (electronics boards, semiconductors, power supply, contactors... ) while the rear access permits the revision of AC fuses and LCL filter.

## PV ARRAY TRANSFER KIT

By mounting this kit, the inverter and the PV plant will be able to shift its running conditions from negative grounded array to floating array and viceversa. Under regular conditions the inverter will be running with a negative pole grounded and therefore, a GDFI will provide protection against unlikely ground fault defects and the solar cells will not suffer a negative voltage relative to their surroundings at any time. This running mode can be transfered to a floating array configuration enabling an isolation monitoring device that the O&M can use for: regular PV plant isolation control, identification of the array affected by a ground fault defect and most important, increase the operator safety under O&M service activities.




## EXTENDED MPPT

Using the latest modulation techniques, inspired by the most accurate and powerful motor control applications, has lead to the widest MPPt full power window in the solar market. It allows optimal PV plant design and boosted performance rates.

## ACTIVE HEATING

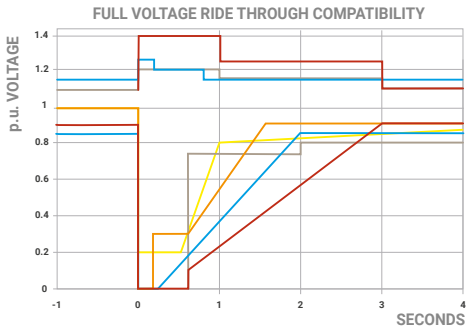
At night, when the unit is not actively exporting power, the inverter can import a small amount of power to keep the inverter internal ambient temperature above -20°C, without using external resistors. This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing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

## VAR AT NIGHT

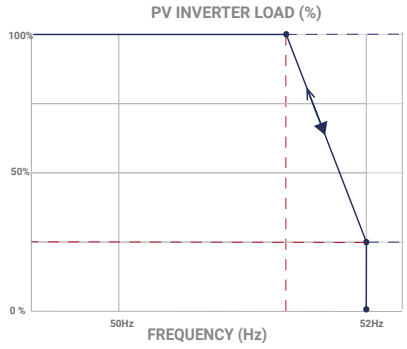
At night, the HEC PLUS inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).

## DYNAMIC GRID SUPPORT

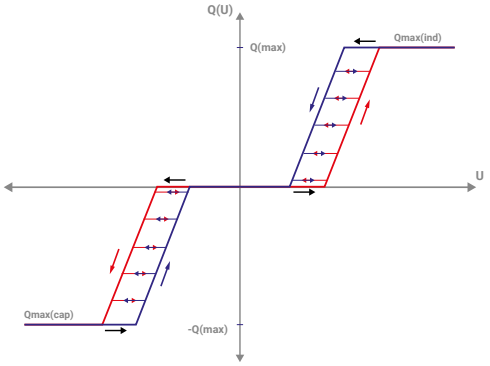
HEC PLUS firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

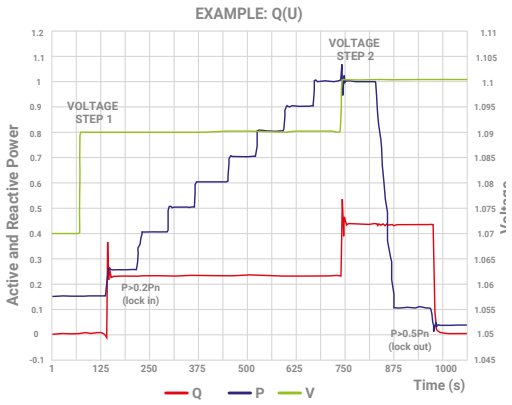



**Low Voltage Ride Through** (LVRT or ZVRT ). Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive current, as long as the protection limits are not exceeded.

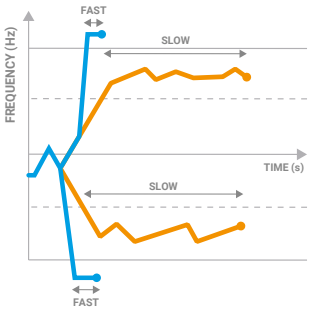



**Frequency Regulation System** (FRS). Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

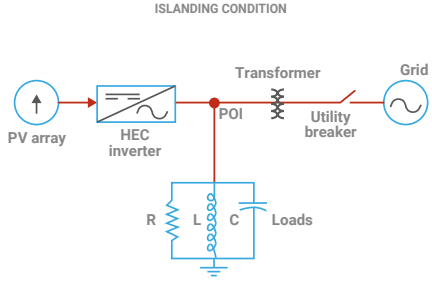



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.




**Frequency Ride Through** (FRT). 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.

## DISCONNECTION AND PROTECTION

HEC PLUS is available with an external DC disconnection and protection unit (DU unit) that will be coupled together with the inverter by a mounting kit. The DC subsystems are fully customizable and can be featured with up to 40 inputs. The disconnecting unit goes one step further by improving the PV plant safety and operation for those who apply the best engineering.


## TECHNICAL INFORMATION

| | |
|---|---|
| **Maximum DC Current (A):** | According to fuse rating |
| **Maximum Continuous current (A)** | According to fuse rating |
| **Max. Possitive and Negative input Wire size** | 600kcmil / 300mm2 |
| **Max. Input wires** | 2 x 600kcmil per input |
| **Operating Temperature** | -20°C to 60°C |
| **Zone Monitoring** | Optional in each positive input |
| **Lockout-tagout** | One general as standard, other confi gurations optional |
| **Fuse mounting** | 40xBusbar Bolted (US), 32xNH fuse base (IEC) |
| **Terminals** | Lugs Rated 90°C with 2 holes – 1.75” hole spacing |
| **Cooling** | Forced air cooling, temperature controlled, optional heating resistors |
| **Avg. Consumption** | 82W (230Vac) |

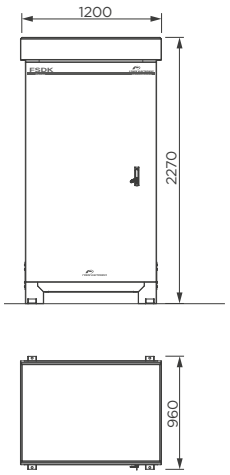
## CONFIGURATION TABLE

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **FAMILY** | | FSDK Recombiner | | | | | | | | | |
| **SERIES** | **C** | HEC Series | | | | | | | | | |
| **TYPE** | **U** | UL | **J** | JAPAN | **H** | IEC | | | | | |
| **MAXIMUM VOLTAGE** | **10** | 1000V | | | | | | | | | |
| **FRAME** | **1** | Frame 1 | **2** | Frame 2 | | | | | | | |
| **INPUTS PER POLE** | **01** | 1 Input | **...** | ... | **40** | 40 Inputs | | | | | |
| **STRING LOCKOUT AND TAGOUT** | **A** | Standard (1 input per tray) | **B** | 3 Push buttons | **C** | 4 Push buttons | **...** | ... | **Z** | 1 Push button per Input | |
| **LIGHTNING AND OVERVOLTAGE PROTECTIONS** | **O** | Type 2 | **L** | Type 1 + Type 2 | | | | | | | |
| **ZONE MONITORING** | **N** | Not included | **C** | Voltage and Current Monitoring | **I** | Voltage and Current Monitoring + Low String Insulation Detector | | | | | |
| **INSULATION MONITORING** | **I** | Basic Insulation Monitoring Device | **M** | Insulation Monitoring and Measurement Device | **G** | GFDI | **N** | GFDI + Insulation Monitoring and Measurment Device | | | |
| | Floating array | | | | Negative grounding | | | | | | |
| **PAINT AND CORROSION PROTECTION** | **A** | C4 - RAL7035 | **B** | C4 - RAL6013 | **C** | C4 - RAL6005 | **M** | C5M - RAL7035 | **N** | C5M - RAL6013 | **O** C5M - RAL6005 |
| **INVERTER CONNECTION** | **S** | Standard | **Y** | Symmetrical | | | | | | | |
| **EXTERNAL METERING** | **N** | Not Included | **I** | Included | | | | | | | |

## DIMENSIONS & DIAGRAM

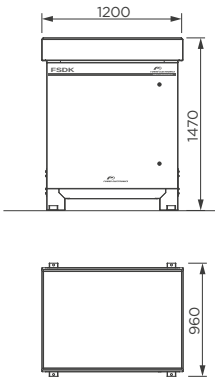
**FRAME 2**

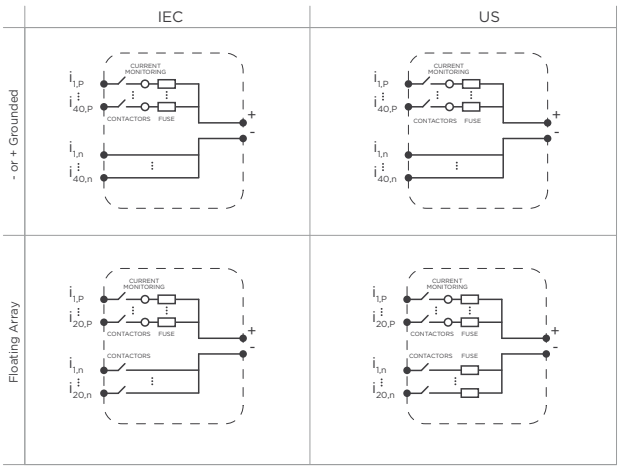
(21 to 40 fuse protected input)




**FRAME 1**

(1 to 20 fuse protected input)

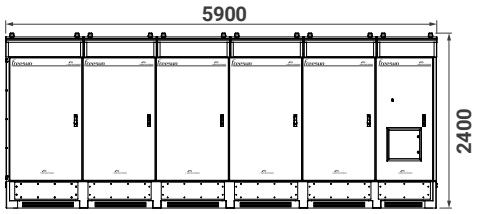


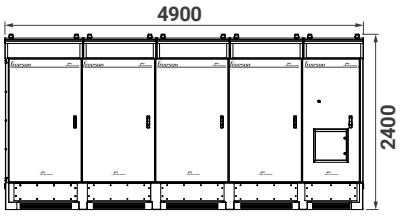
# FRAMES AND DIMENSIONS

## HEC PLUS

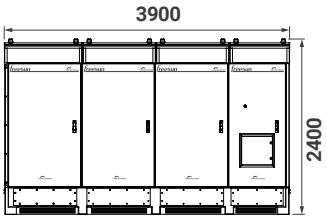
### FRAME 4



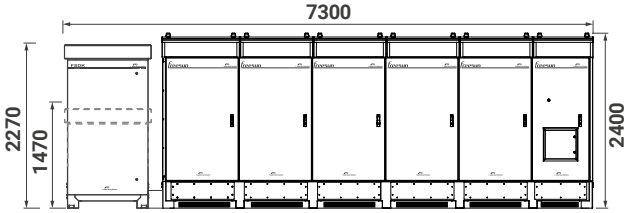

### FRAME 3

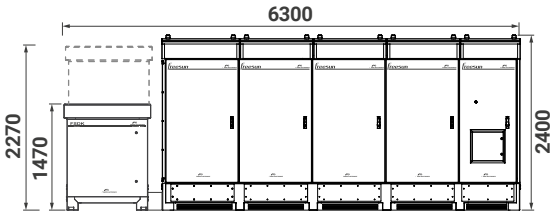


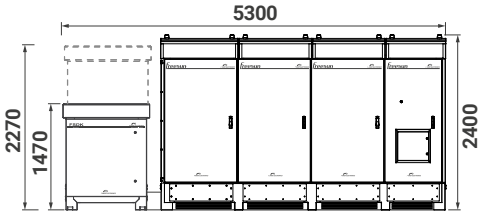

### FRAME 2




## HEC PLUS + FSDK




Depth of all units is 1020mm.

# TECHNICAL CHARACTERISTICS

# HEC PLUS - 460V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1162CH** | **FS1391CH** | **FS1620CH** | **FS1850CH** | **FS2081CH** | **FS2300CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 1160 | 1390 | 1620 | 1850 | 2080 | 2300 |
| | AC Output Power(kVA/kW) @25°C [1] | 1270 | 1530 | 1780 | 2040 | 2290 | 2550 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 460Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion(THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi) [2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC) [1] | 651V-900V | | | | | |
| | MPPt window @full power (VDC) [1] | 671V–820V @50°C / 744V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 400V/230VAC–1kVA user power supply available, Optional 6kVA | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Intake through lower part blown out through upper side | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | | |
| | Permissible Ambient Temperature | -30°C [3] to +60°C / >50°C Active Power derating | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC PLUS - 440V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1112CH** | **FS1331CH** | **FS1550CH** | **FS1770CH** | **FS1991CH** | **FS2200CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 1110 | 1330 | 1550 | 1770 | 1990 | 2200 |
| | AC Output Power(kVA/kW) @25°C [1] | 1220 | 1460 | 1710 | 1950 | 2190 | 2440 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 440Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi) [2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC) [1] | 623V-900V | | | | | |
| | MPPt window @full power (VDC) [1] | 642V–820V @50°C / 712V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 400V/230VAC–1kVA user power supply available, Optional 6kVA | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Intake through lower part blown out through upper side | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | | |
| | Permissible Ambient Temperature | -30°C [3] to +60°C / >50°C Active Power derating | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDI and Isolation monitoring device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC PLUS - 420V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1051CH** | **FS1271CH** | **FS1480CH** | **FS1690CH** | **FS1901CH** | **FS2200CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 1050 | 1270 | 1480 | 1690 | 1900 | 2110 |
| | AC Output Power(kVA/kW) @25°C [1] | 1160 | 1400 | 1630 | 1860 | 2100 | 2330 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 420Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi) [2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC) [1] | 623V-900V | | | | | |
| | MPPt window @full power (VDC) [1] | 616V–820V @50°C / 680V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 400V/230VAC–1kVA user power supply available, Optional 6kVA | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Intake through lower part blown out through upper side | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | | |
| | Permissible Ambient Temperature | -30°C [3] to +60°C / >50°C Active Power derating | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDI and Isolation monitoring device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS HEC PLUS - 400V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1003CH** | **FS1201CH** | **FS1401CH** | **FS1600CH** | **FS1800CH** | **FS2000CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C [1] | 1000 | 1200 | 1400 | 1600 | 1800 | 2000 |
| | AC Output Power(kVA/kW) @25°C [1] | 1110 | 1330 | 1550 | 1770 | 2000 | 2220 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 400Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi) [2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC) [1] | 566V-900V | | | | | |
| | MPPt window @full power (VDC) [1] | 584V–820V @50°C / 648V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 400V/230VAC–1kVA user power supply available, Optional 6kVA | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Intake through lower part blown out through upper side | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | IP54 | | | | | |
| | Permissible Ambient Temperature | -30°C [3] to +60°C / >50°C Active Power derating | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDI and Isolation monitoring device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US PLUS - 440V

**NORTH AMERICA**

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1112CU** | **FS1331CU** | **FS1550CU** | **FS1770CU** | **FS1991CU** | **FS2200CU** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C | 1110 | 1330 | 1550 | 1770 | 1990 | 2200 |
| | AC Output Power(kVA/kW) @25°C | 1220 | 1460 | 1710 | 1950 | 2190 | 2440 |
| | Max. Power (kW@PF=0.9, @50°C) | 1000 | 1190 | 1390 | 1590 | 1790 | 1980 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 440Vac ±10% | | | | | |
| | Operating Grid Frequency | 60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | | |
| | Power Factor (cosine phi) [1] | 0.00 leading … 0.00 lagging adjustable/ Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC) [2] | 623V-900V | | | | | |
| | MPPt window @full power (VDC) [2] | 642V–820V @50°C / 712V–820V @25°C | | | | | |
| | Maximum DC Voltage | 1000V | | | | | |
| | Minimum Start Voltage | 700V - User configurable | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency / CEC (η) | 98.6% / 98.0% | | | | | |
| | Euroeta (η) | 98.3% | | 98.4% | | | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 120V / 208VAC–1kVA power supply available for external equipment | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| **CABINET** | Dimensions [WxDxH] [ft] | 153.5"x40.12"x94.5" | | 192.9"x40.12"x94.5" | | 232.3"x40.12"x94.5" | |
| | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (lbs) | 7804 | 8487 | 10119 | 10802 | 12434 | 13117 |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Bottom intake. Exhaust top vent (Front or Rear option) | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | NEMA 3R | | | | | |
| | Permissible Ambient Temperature | -22°F to +122°F, -30°C[3] to +50°C / Active Power derating >50°C/122°F | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 1000m; >1000m power derating 1% Sn (kVA) per 100m | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display (inside cabinet) / Optional Freesun App | | | | | |
| | Communication Protocol | RS232 / RS485 / USB / Ethernet, (Modbus RTU, Modbus TCP/IP) | | | | | |
| | Power Plant Controller | Optional | | | | | |
| | Keyed ON/OFF switch | Standard | | | | | |
| **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 (FSDK) | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | | |
| **CERTIFICATIONS** | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US PLUS - 420V

**NORTH AMERICA**

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1051CU** | **FS1271CU** | **FS1480CU** | **FS1690CU** | **FS1901CU** | **FS2110CU** |
| OUTPUT | AC Output Power(kVA/kW) @50°C | 1050 | 1270 | 1480 | 1690 | 1900 | 2110 |
| | AC Output Power(kVA/kW) @25°C | 1160 | 1400 | 1630 | 1860 | 2100 | 2330 |
| | Max. Power (kW@PF=0.9, @50°C) | 940 | 1140 | 1330 | 1520 | 1710 | 1900 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 420Vac ±10% | | | | | |
| | Operating Grid Frequency | 60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | | |
| | Power Factor (cosine phi)[1] | 0.00 leading … 0.00 lagging adjustable/ Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[2] | 594V-900V | | | | | |
| | MPPt window @full power (VDC)[2] | 616V–820V @50°C / 680V–820V @25°C | | | | | |
| | Maximum DC Voltage | 1000V | | | | | |
| | Minimum Start Voltage | 700V - User configurable | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency / CEC (η) | 98.6% / 98.0% | | | | | |
| | Euroeta (η) | 98.3% | | 98.4% | | | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 120V / 208VAC–1kVA power supply available for external equipment | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| **CABINET** | Dimensions [WxDxH] [inches] | 153.5”x40.12”x94.5” | | 192.9”x40.12”x94.5” | | 232.3”x40.12”x94.5” | |
| | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (lbs) | 7804 | 8487 | 10119 | 10802 | 12434 | 13117 |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Bottom intake. Exhaust top vent (Front or Rear option) | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | NEMA 3R | | | | | |
| | Permissible Ambient Temperature | -22°F to +122°F, -30°C[3] to +50°C / Active Power derating >50°C/122°F | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 1000m; >1000m power derating 1% Sn (kVA) per 100m | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display (inside cabinet) / Optional Freesun App | | | | | |
| | Communication Protocol | RS232 / RS485 / USB / Ethernet, (Modbus RTU, Modbus TCP/IP) | | | | | |
| | Power Plant Controller | Optional | | | | | |
| | Keyed ON/OFF switch | Standard | | | | | |
| **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 (FSDK) | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | | |
| **CERTIFICATIONS** | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HEC-US PLUS - 400V

**NORTH AMERICA**

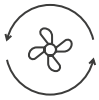
| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1004CU** | **FS1201CU** | **FS1401CU** | **FS1600CU** | **FS1801CU** | **FS2000CU** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C | 1000 | 1200 | 1400 | 1600 | 1800 | 2000 |
| | AC Output Power(kVA/kW) @25°C | 1110 | 1330 | 1550 | 1770 | 2000 | 2220 |
| | Max. Power (kW@PF=0.9, @50°C) | 900 | 1080 | 1260 | 1440 | 1620 | 1800 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 400Vac ±10% | | | | | |
| | Operating Grid Frequency | 60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% per IEEE519 | | | | | |
| | Power Factor (cosine phi)[1] | 0.00 leading … 0.00 lagging adjustable/ Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[2] | 566V-900V | | | | | |
| | MPPt window @full power (VDC)[2] | 584V–820V @50°C / 648V–820V @25°C | | | | | |
| | Maximum DC Voltage | 1000V | | | | | |
| | Minimum Start Voltage | 700V - User configurable | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency / CEC (η) | 98.6% / 98.0% | | | | | |
| | Euroeta (η) | 98.3% | | 98.4% | | | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Control Power Supply | 120V / 208VAC–1kVA power supply available for external equipment | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| **CABINET** | Max. Power Consumption | 153.5"x40.12"x94.5" | | 192.9"x40.12"x94.5" | | 232.3"x40.12"x94.5" | |
| | Dimensions [WxDxH] [mm] | 3900x1050x2400 | | 4900x1050x2400 | | 5900x1050x2400 | |
| | Weight (lbs) | 7804 | 8487 | 10119 | 10802 | 12434 | 13117 |
| | Weight (kg) | 3540 | 3850 | 4590 | 4900 | 5640 | 5950 |
| | Air Flow | Bottom intake. Exhaust top vent (Front or Rear option) | | | | | |
| | Type of ventilation | Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | NEMA 3R | | | | | |
| | Permissible Ambient Temperature | -22°F to +122°F, -30°C[3] to +50°C / Active Power derating >50°C/122°F | | | | | |
| | Relative Humidity | 0% to 100% non condensing | | | | | |
| | Max. Altitude (above sea level) | 1000m; >1000m power derating 1% Sn (kVA) per 100m | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display (inside cabinet) / Optional Freesun App | | | | | |
| | Communication Protocol | RS232 / RS485 / USB / Ethernet, (Modbus RTU, Modbus TCP/IP) | | | | | |
| | Power Plant Controller | Optional | | | | | |
| | Keyed ON/OFF switch | Standard | | | | | |
| **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 (FSDK) | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC and DC protection (type 2) | | | | | |
| **CERTIFICATIONS** | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | | |
| | Utility interconnect | IEEE 1547 with Utility Interactive Control functions | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# HE PLUS

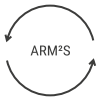
UTILITY SCALE SOLAR INVERTER


**MULTI MPPT**



**ICOOL**

**ACTIVE HEATING**




**AUTOMATIC REDUNDANT**
**MODULAR MULTI-MASTER SYSTEM**

**INDOOR**


**PROACTIVE ATTITUDE**

## THE TRULY MODULAR INVERTER, WITH ALL SYSTEMS REPEATED IN EACH MODULE

The Power Electronics HE PLUS solar inverter is the best choice in quality and reliability. It is available in four output voltages from 400Vac to 460Vac, covering a power range from 1000kVA to 2550kVA. It is a truly redundant multi-master inverter. Designed for indoor applications, it simplifies maintenance tasks due to its extractable modules.

With the best in class topology and unique after-sales service in the market the HE PLUS represents the best guarantee for your investment.

# TOPOLOGY

**NO CONDENSATION**

The Active cabinet heating regulates temperature and prevents internal water condensation.

**WITHDRAWABLE MODULES**

Withdrawable modules allow easy front access to all components reducing service time.

**DC CLOSE COUPLING**

Positive and negative terminals are ready for busbar or wiring connection


**CONFORMAL COATING**

Conformal coating on electronic board shields PCBs from harsh environments.

**AC CLOSE COUPLING**

The inverter can be easily connected to the transformer using an efficient busbar connection.

**WIFI ROUTER**

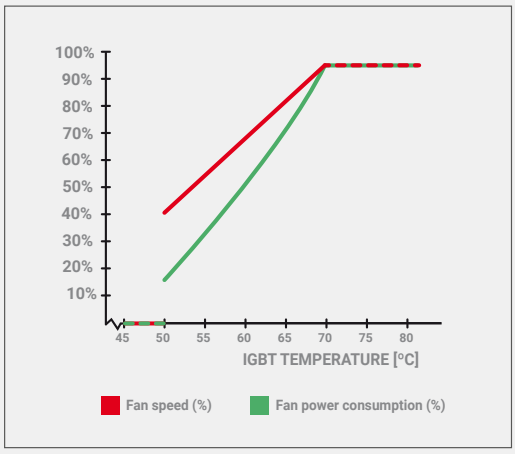
Wifi router allows the operator to connect remotely to the unit without entering the station.

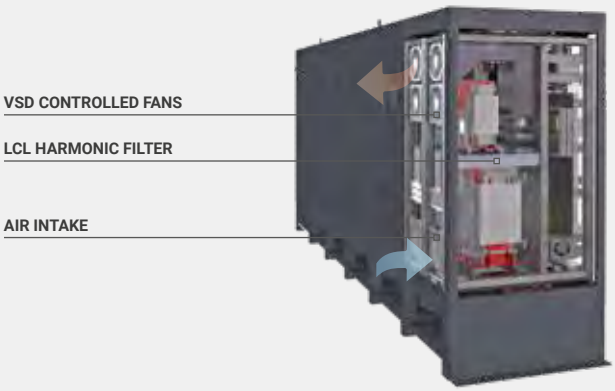
## AUTOMATIC REDUNDANT MODULAR MULTI-MASTER SYSTEM

The HE PLUS is a central inverter based on an Automatic Redundant Modular Multi-Master System (200kVA to 250kVA per module). The unit's redundant multi-master capability translates into more availability and therefore more power production. Modularity allows for the use of fewer type of components throughout the product range, reducing maintenance costs and simplifying the stock of spare parts.

## REVOLUTIONARY DIRECT REAR COOLING

Independent and temperature controlled VSD fans reduce significantly the auxiliary power consumption. A direct cooling flow to the outside reduce the station temperature.




## 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.

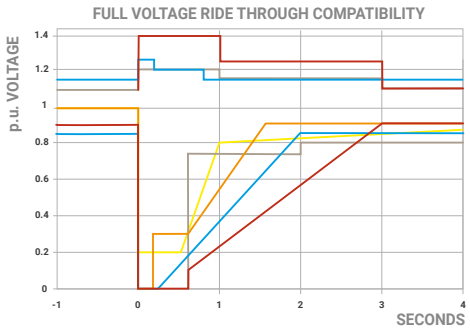
This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing the inverters availability and reducing the maintenance. **PATENTED**

## VAR AT NIGHT

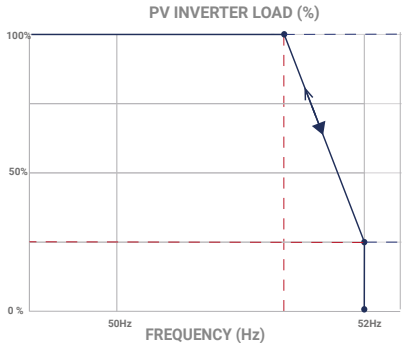
At night, the HE PLUS inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).

## DYNAMIC GRID SUPPORT

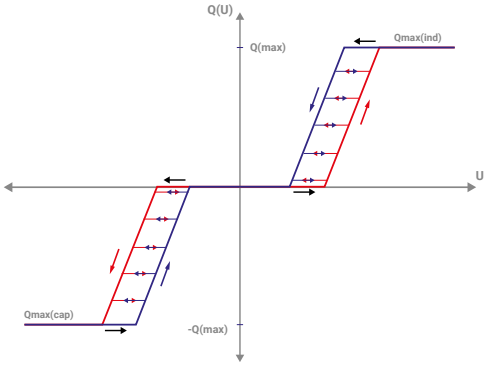
HE PLUS firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

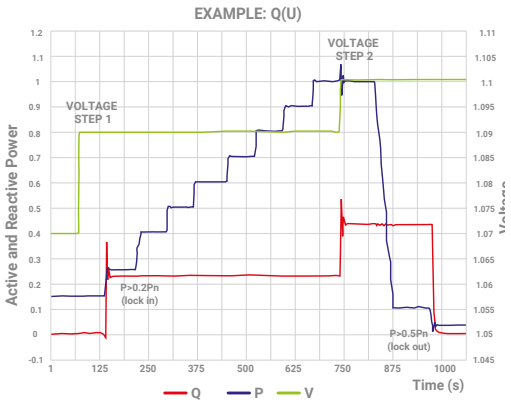



**Low Voltage Ride Through** (LVRT or ZVRT ). Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive current, as long as the protection limits are not exceeded.

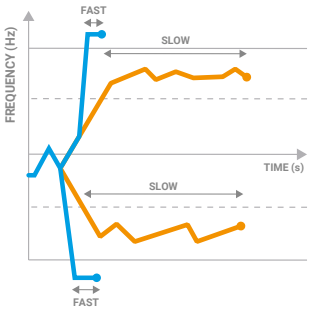



**Frequency Regulation System** (FRS). Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

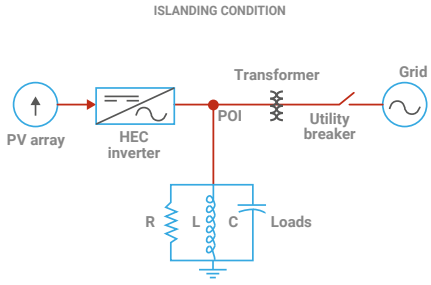



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.




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



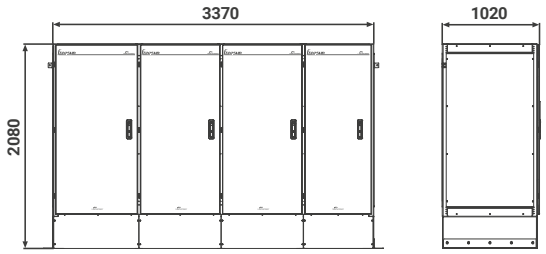

**Anti-islanding.** This protection combines passive and active methods that eliminates nuisance tripping and reduces grid distortion according to IEC 62116 and IEEE1547.

## EASY TO SERVICE

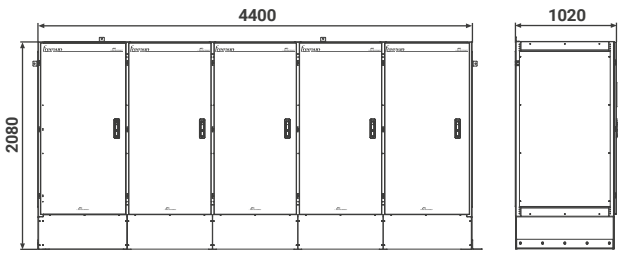
Its modular design allows for isolation and replacement of all the components with no effort, saving time and money during routine inspections. Each module is equipped with guided wheels that enable an easy frontal extraction only with the aid of the delivered trolley.

## FRAMES AND DIMENSIONS

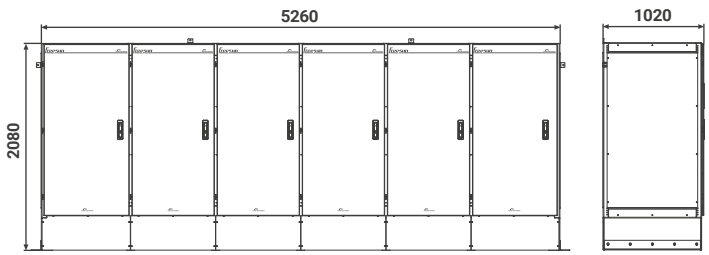
**FRAME 2**




**FRAME 3**




**FRAME 4**



# TECHNICAL CHARACTERISTICS

# HE PLUS - 460V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1162CH** | **FS1391CH** | **FS1620CH** | **FS1850CH** | **FS2081CH** | **FS2300CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C[1] | 1160 | 1390 | 1620 | 1850 | 2080 | 2300 |
| | AC Output Power(kVA/kW) @25°C[1] | 1270 | 1530 | 1780 | 2040 | 2290 | 2550 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 460Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion(THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi)[2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[1] | 651V-900V | | | | | |
| | MPPt window @full power (VDC)[1] | 671V–820V @50°C / 744V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Max. Power Consumption (W) | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3370x1020x2080 | | 4400x1020x2080 | | 5260x1020x2080 | |
| | Weight (kg) | 2500 | 2900 | 3300 | 3700 | 4100 | 4500 |
| | Air Flow | Intake through rear lower part blown out through upper side | | | | | |
| | Type of ventilation | VSD Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | Indoor IP21 | | | | | |
| | Permissible Ambient Temperature | -20°C to +60°C | | | | | |
| | Relative Humidity | 10% to 95% Non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level[4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App display or Web display | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDi and Isolation Monitoring Device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON/OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Wall mounted cabinets | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HE PLUS - 440V

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1112CH** | **FS1331CH** | **FS1550CH** | **FS1770CH** | **FS1991CH** | **FS2200CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C[1] | 1110 | 1330 | 1550 | 1770 | 1990 | 2200 |
| | AC Output Power(kVA/kW) @25°C[1] | 1220 | 1460 | 1710 | 1950 | 2190 | 2440 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 440Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi)[2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[1] | 623V-900V | | | | | |
| | MPPt window @full power (VDC)[1] | 642V–820V @50°C / 712V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Max. Power Consumption (W) | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3370x1020x2080 | | 4400x1020x2080 | | 5260x1020x2080 | |
| | Weight (kg) | 2500 | 2900 | 3300 | 3700 | 4100 | 4500 |
| | Air Flow | Intake through rear lower part blown out through upper side | | | | | |
| | Type of ventilation | VSD Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | Indoor IP21 | | | | | |
| | Permissible Ambient Temperature | -20°C to +60°C | | | | | |
| | Relative Humidity | 10% to 95% Non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App display or Web display | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDi and Isolation Monitoring Device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Wall mounted cabinets | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HE PLUS - 420V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1051CH** | **FS1271CH** | **FS1480CH** | **FS1690CH** | **FS1901CH** | **FS2110CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C[1] | 1050 | 1270 | 1480 | 1690 | 1900 | 2110 |
| | AC Output Power(kVA/kW) @25°C[1] | 1160 | 1400 | 1630 | 1860 | 2100 | 2330 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 420Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion(THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi)[2] | 0.00 leading ... 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[1] | 594V-900V | | | | | |
| | MPPt window @full power (VDC)[1] | 616V–820V @50°C / 680V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800W | 5600W | 6500W | 7300W | 8200W | 9000W |
| **CABINET** | Dimensions [WxDxH] [mm] | 3370x1020x2080 | | 4400x1020x2080 | | 5260x1020x2080 | |
| | Weight (kg) | 2500 | 2900 | 3300 | 3700 | 4100 | 4500 |
| | Air Flow | Intake through rear lower part blown out through upper side | | | | | |
| | Type of ventilation | VSD Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | Indoor IP21 | | | | | |
| | Permissible Ambient Temperature | -20°C to +60°C | | | | | |
| | Relative Humidity | 10% to 95% Non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDI and Isolation monitoring device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# TECHNICAL CHARACTERISTICS

# HE PLUS - 400V

| | | FRAME 2 | | FRAME 3 | | FRAME 4 | |
|---|---|---|---|---|---|---|---|
| **NUMBER OF MODULES** | | **5** | **6** | **7** | **8** | **9** | **10** |
| **REFERENCE** | | **FS1003CH** | **FS1201CH** | **FS1401CH** | **FS1600CH** | **FS1800CH** | **FS2000CH** |
| **OUTPUT** | AC Output Power(kVA/kW) @50°C[1] | 1000 | 1200 | 1400 | 1600 | 1800 | 2000 |
| | AC Output Power(kVA/kW) @25°C[1] | 1110 | 1330 | 1550 | 1770 | 2000 | 2220 |
| | Max. AC Output Current (A) @25°C | 1600 | 1920 | 2240 | 2560 | 2880 | 3200 |
| | Operating Grid Voltage(VAC) | 400Vac | | | | | |
| | Operating Range, Grid Frequency | 50Hz/60Hz | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at any load condition | | | | | |
| | Power Factor (cosine phi)[2] | 0.00 leading … 0.00 lagging adjustable / Reactive Power injection at night | | | | | |
| | Power Curtailment | 0...100%/0.1% Steps | | | | | |
| **INPUT** | MPPt Voltage Window (VDC)[1] | 566V-900V | | | | | |
| | MPPt window @full power (VDC)[1] | 584V–820V @50°C / 648V–820V @25°C | | | | | |
| | Maximum DC and Starting voltage | 1000V | | | | | |
| | Max. DC continuous current (A) | 1750 | 2100 | 2450 | 2800 | 3150 | 3500 |
| | Max. DC short circuit current (A) | 2275 | 2730 | 3185 | 3640 | 4095 | 4550 |
| **EFFICIENCY & AUXILIARY SUPPLY** | Max. Efficiency PAC, nom (η) | 98.6% | | 98.6% | | 98.6% | |
| | Euroeta (η) | 98.3% | | 98.4% | | 98.4% | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | |
| | Max. Power Consumption | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| | Max. Apparent Power (VA) | 4800VA | 5600VA | 6500VA | 7300VA | 8200VA | 9000VA |
| **CABINET** | Dimensions [WxDxH] [mm] | 3370x1020x2080 | | 4400x1020x2080 | | 5260x1020x2080 | |
| | Weight (kg) | 2500 | 2900 | 3300 | 3700 | 4100 | 4500 |
| | Air Flow | Intake through rear lower part blown out through upper side | | | | | |
| | Type of ventilation | VSD Forced air cooling | | | | | |
| **ENVIRONMENT** | Degree of protection | Indoor IP21 | | | | | |
| | Permissible Ambient Temperature | -20°C to +60°C | | | | | |
| | Relative Humidity | 10% to 95% Non condensing | | | | | |
| | Max. Altitude (above sea level) | 4000m; >1000m power derating | | | | | |
| | Noise level [4] | < 79 dBA | | | | | |
| **CONTROL INTERFACE** | Interface | Alphanumeric Display / Optional Freesun App | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | |
| | String Supervisor Communication | RS485 / Modbus RTU | | | | | |
| | Plant Controller Communication | Ethernet / Modbus TCP/IP | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30VDC, 8A) | | | | | |
| **PROTECTIONS** | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>Grounded PV array (Positive pole and negative pole): GFDI protection<br>PV Array transfer kit: GFDI and Isolation monitoring device (requires 1 Digital Output) | | | | | |
| | Humidity control | Active Heating | | | | | |
| | ON / OFF Pushbutton | Standard | | | | | |
| | General AC Protection & Disconn. | Circuit Breaker | | | | | |
| | General DC Protection & Disconn. | Optional External Disconnecting Unit Cabinet | | | | | |
| | Module AC Protection & Disconn. | AC contactor & fuses | | | | | |
| | Module DC Protection & Disconn. | DC contactor & DC fuses | | | | | |
| | Overvoltage Protection | AC, DC Inverter and auxiliary supply type 2 - Internal Standard | | | | | |
| | DC Lightning Protections | Optional (Integrated in the inverter) | | | | | |

[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 resistors kit option below -20°C.
[4] Readings taken 1 meter from the back of the unit.

# SOLAR STATIONS

## UTILITY SCALE
## OUTDOOR AND INDOOR INVERTERS


HEM Solar inverter

# MV SKID

UTILITY SCALE SOLAR STATION

**TURN-KEY SOLUTION**

**HIGH RELIABILITY**

**EASY TO INSTALL**

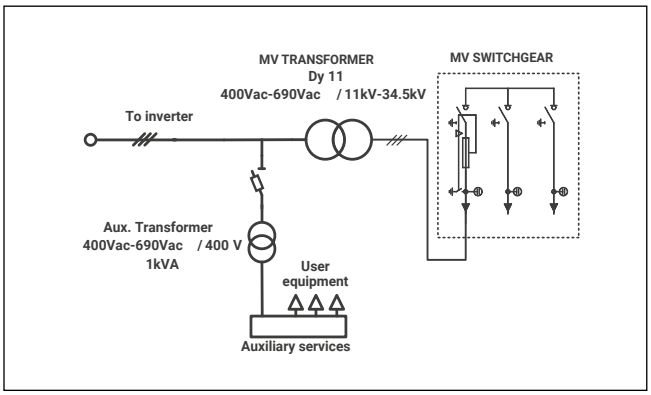
**OUTDOOR DURABILITY**

## SIMPLIFY YOUR COMMISSIONING WITH THE MOST COMPETITIVE SOLUTION INTEGRATED WITH ALL THE MEDIUM VOLTAGE EQUIPMENT

The MV Skid is a compact turnkey outdoor platform made from high resistance galvanized steel with all the medium voltage equipment integrated, including an outdoor power transformer, MV switchgear, oil tank, filter and built in fast power connection to any HEC and HEMK solar inverter. With between 400V-460V and 565V-690V in the low voltage range and 12kV to 36kV in the high voltage range, this compact platform achieves power outputs between 1050kVA and 3800kVA when combined with the HEC and HEMK solar inverter series. This compact solution also allows the installation of a low voltage cabinet that is fully configurable to the customer needs as well as different types of cells and even an enclosure fence among other options. The MV SKID simplifies the project design of the PV plant, reducing installation costs and the amount of resources needed. The benefits of the MV Skid and the fact that it is also easier to transport and deliver into remote sites makes it the optimal solution for EPC`s (engineering, procurement and construction).

## MODEL NUMBERS AND OPERATIONAL DIAGRAM

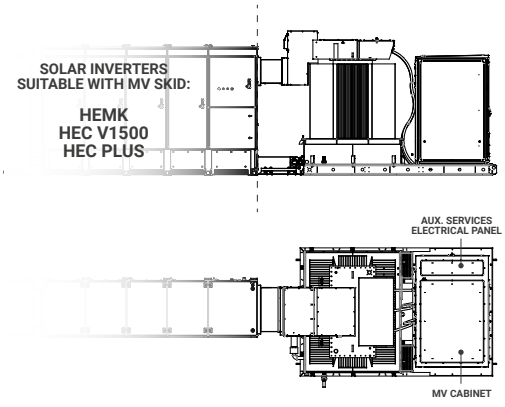
| REFERENCE | | RATED POWER (kVA) |
|---|---|---|
| FRAME 1 AND FRAME 2 [1] | MVS1050[ ] | 1050 |
| | MVS1100[ ] | 1110 |
| | MVS1220[ ] | 1220 |
| | MVS1335[ ] | 1335 |
| | MVS1440[ ] | 1440 |
| | MVS1550[ ] | 1550 |
| | MVS1630[ ] | 1630 |
| | MVS1710[ ] | 1710 |
| | MVS1800[ ] | 1800 |
| | MVS1900[ ] | 1900 |
| | MVS2000[ ] | 2000 |
| | MVS2110[ ] | 2110 |
| FRAME 2 | MVS2225[L] | 2225 |
| | MVS2330[L] | 2330 |
| | MVS2440[L] | 2440 |
| | MVS2550[L] | 2550 |
| | MVS2660[L] | 2660 |
| | MVS2860[L] | 2860 |
| | MVS3000[L] | 3000 |
| | MVS3110[L] | 3110 |
| | MVS3345[L] | 3345 |
| | MVS3500[L] | 3500 |
| | MVS3630[L] | 3630 |
| | MVS3800[L] | 3800 |



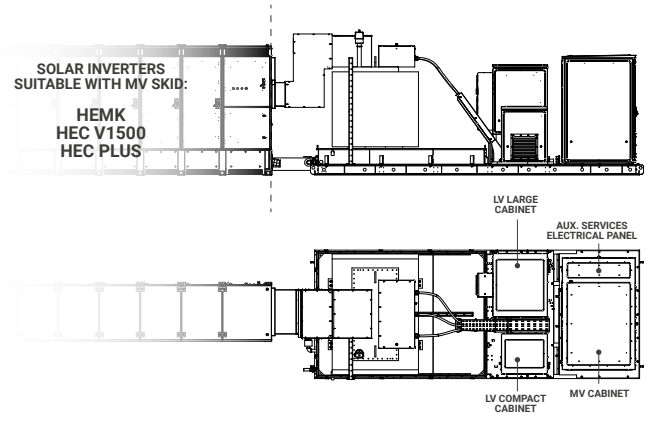

[1] Example: MVS1050S for Frame 1 / MVS10050L for Frame 2

## SECTIONS

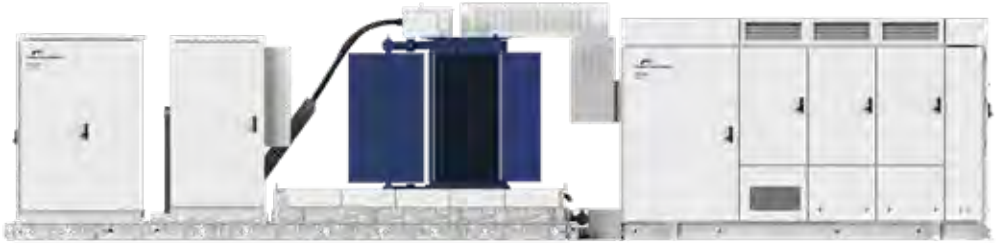
FRAME 1




FRAME 2




For customized solutions, contact Power Electronics.



# TECHNICAL CHARACTERISTICS MV SKID

| MV SKID | | FRAME 1 | |
|---|---|---|---|
| | | FRAME 2 | |
| **MEDIUM VOLTAGE EQUIPMENT** | Rated Power range | 1050kVA - 2110kVA | 2220kVA - 3800kVA |
| | MV Voltage range | 11kV / 20kV / 22kV / 23kV / 33kV / 34.5kV | |
| | LV Voltage range | 400V / 420V / 440V / 460V - HEC PLUS inverters<br>565V / 600V / 615V / 630V / 645V / 660V / 690V - HEC V1500 and HEMK inverters | |
| | Type of tank | Oil-sealed | |
| | Cooling | ONAN (KNAN optional) | |
| | Vector Group | Dy11 | |
| | Transformer protection | DGPT-2 (PT100 optional) | |
| | Oil tank | Integrated with valve and filter | |
| | Transformer protection rate | IP54 | |
| | Switchgear configuration | Single feeder (L) or Double feeder (2L) | |
| | Switchgear protection[1] | Fuses (P) / Automatic circuit breaker (V) | |
| **CONNECTIONS** | Inverter AC connection | Close couple solution (Plug & Play) | |
| | LV protection | Circuit breaker included in the inverter | |
| | HV AC wiring | MV Bridge between transformer and protection switchgear prewired | |
| **ENVIROMENT** | Ambient Temperature | -20°C…+50°C (t>50°C power derating) | |
| | Extended Temperature[2] [3] | -35°C…+50°C (t>50°C power derating) | |
| | Max. Altitude (above sea level) | >2000m power derating | |
| | Relative Humidity | 4% to 95% Non condensing | |
| **MECHANICAL CHARACTERISTICS** | Skid Dimensions (WxHxD) mm | 3690x2340x2235 | 5640x2340x2235 |
| | Skid weight with MV equipment[1] | < 8 Tn | |
| | Oil tank material | Galvanized Steel | |
| | Skid Body material | Galvanized Steel | |
| | Cabinet type | Outdoor | |
| | Anti-rodent protection | ✔ | |
| **AUXILIARY SERVICES ELECTRICAL PANEL** | Auxiliary supply | 3x400V, 50/60Hz | |
| | User power supply available | 1kVA or 6kVA | |
| | Additional auxiliary transformer[4] | 10kVA / 15kVA / 25kVA | |
| | Cooling | Air | |
| | Auxiliary supply protection | ✔ | |
| | Communication[4] | Ethernet (Fiber optic or RJ45) | |
| | UPS system for monitoring[4] | 1kVA / 3kVA, 10 minutes | |
| **AUXILIARY OUTDOOR TRANSFORMER** | Rated Power (Voltage) | - | 30kVA / 40kVA / 50kVA (3x400V) |
| | Cooling | - | Air |
| | Protection | - | Circuit breaker |
| | Cabinet type | - | Outdoor |
| **LV COMPACT CABINET** | Additional indoor auxiliary transf.[4] | - | 10kVA / 25kVA / 40kVA / 50kVA (3x400V) |
| | UPS system for monitoring[4] | - | 1kVA / 3kVA, 10 minutes |
| | Cooling | - | Air forced |
| | Auxiliary supply protection | - | ✔ |
| | Cabinet type | - | Outdoor |
| **LV LARGE CABINET** | Additional indoor auxiliary transf.[4] | - | 25kVA / 40kVA / 50kVA (3x400V) |
| | UPS for trackers[4] | - | 20kVA / 40kVA, 10 minutes |
| | Cooling | - | Air forced |
| | Auxiliary supply protection | - | ✔ |
| | Cabinet type | - | Outdoor |
| **OTHER EQUIPMENT** | Safety mechanism | Trapped key safety interlock | |
| | Safety perimeter | Transformer access protection fence | |
| | Cabinet heating | Heating resistors | |
| | Interior lighting | Fluorescent lamp | |
| | Emergency lighting | Electronic supplier for emergency lighting (1h autonomy) | |
| | Air conditioner | UPS batteries cooling | |
| | Communication[4] | Splice box / MV Switchgear monitoring | |
| **STANDARDS** | Medium Voltage | IEC 62271-202, IEC 62271-200, IEC 60076, IEC 61439-1 | |

[1] Depending on customer configuration.
[2] Optional. For additional information or available configurations, please consult Power Electronics.
[3] Other temperature range, consult Power Electronics.
[4] By demand.

# TWIN SKID

UTILITY SCALE SOLAR STATION

**TURN-KEY SOLUTION**

**HIGH RELIABILITY**

**EASY TO INSTALL**

**OUTDOOR DURABILITY**

## THE MOST POWER DENSE TURN-KEY STATION FOR LARGE SCALE PV PLANTS

The Twin Skid has been designed to meet the requirements of large scale PV power plants.

The solar station is a compact outdoor skid made of high resistance galvanized steel with all the medium voltage equipment integrated and acco panied by a solar inverter: protection cell, outdoor power transformer, oil tank and filter. This turnkey solution achieves power outputs between 3000kVA and 7600kVA with the HEC and HEMK solar inverter series. The Twin Skid simplifies the project design of the PV plant, reducing the cost of installation and the amount of resources needed thanks to its extra high power density.

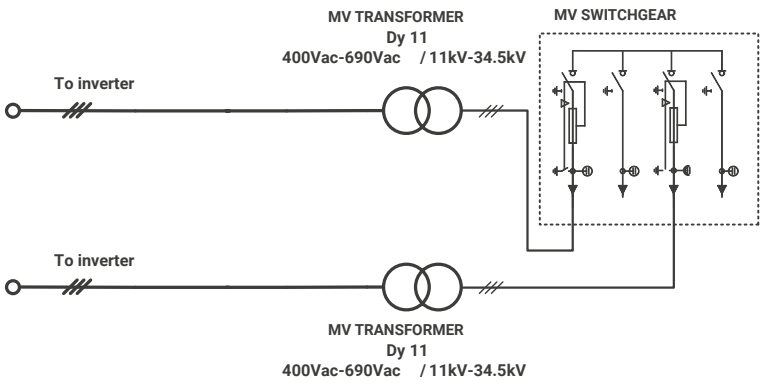
## CUSTOMIZED SOLUTIONS

High value power plant projects often require customer specific solutions. Our team of highly experienced engineers are available to modify our standard solution to suit your specific demands to ensure you get the product you need.

I-TWIN SKID

U-TWIN SKID

## OPERATIONAL DIAGRAM



# TECHNICAL CHARACTERISTICS TWIN SKID

| | | |
|---|---|---|
| **MEDIUM VOLTAGE EQUIPMENT** | Rated Power range [1] | 3000kVA - 7600kVA |
| | MV Voltage range | 11kV / 20kV / 22kV / 23kV / 33kV / 34.5kV |
| | LV Voltage range | 400V / 420V / 440V / 460V - HEC PLUS inverters<br>565V / 600V / 615V / 630V / 645V / 660V / 690V - HEC V1500 and HEMK inverters |
| | Type of tank | Oil-sealed |
| | Cooling | ONAN (KNAN optional) |
| | Vector Group | Dy11 |
| | Transformer protection | DGPT-2 (PT100 optional) |
| | Oil tank | Integrated with valve and filter |
| | Transformer protection rate | IP54 |
| | Switchgear configuration | Single feeder (L) or Double feeder (2L) |
| | Switchgear protection[1] | Fuses (2P) / Automatic circuit breaker (2V) |
| **CONNECTIONS** | Inverter AC connection | Close couple solution (Plug & Play) |
| | LV protection | Circuit breaker included in the inverter |
| | HV AC wiring | MV Bridge between transformer and protection switchgear prewired |
| **ENVIROMENT** | Ambient Temperature | -20°C...+50°C (t>50°C power derating) |
| | Extended Temperature[2] [3] | -35°C...+50°C (t>50°C power derating) |
| | Max. Altitude (above sea level) | >2000m power derating |
| | Relative Humidity | 4% to 95% Non condensing |
| **MECHANICAL CHARACTERISTICS** | Skid Dimensions (WxHxD) mm [1] | 8000x2340x2235 - 11000x2340x2235 |
| | Skid weight with MV equipment [1] | < 21 Tn |
| | Oil tank material | Galvanized Steel |
| | Skid Body material | Galvanized Steel |
| | Cabinet type | Outdoor |
| | Anti-rodent protection | ✔ |
| **AUXILIARY SERVICES** | Rated Power (Voltage) | 30kVA / 40kVA / 50kVA (3x400V) |
| **ELECTRICAL PANEL** | Cooling | Air |
| | Protection | Circuit breaker |
| | Cabinet type | Outdoor |
| **AUXILIARY OUTDOOR TRANSFORMER** | Rated Power (Voltage) | 30kVA / 40kVA / 50kVA (3x400V) |
| | Cooling | Air |
| | Protection | Circuit breaker |
| | Cabinet type | Outdoor |
| **LV COMPACT CABINET** | Additional indoor auxiliary transf.[4] | 10kVA / 25kVA / 40kVA / 50kVA (3x400V) |
| | UPS system for monitoring[4] | 1kVA / 3kVA, 10 minutes |
| | Cooling | Air forced |
| | Auxiliary supply protection | ✔ |
| | Cabinet type | Outdoor |
| **LV LARGE CABINET** | Additional indoor auxiliary transf.[4] | 25kVA / 40kVA / 50kVA (3x400V) |
| | UPS for trackers[4] | 20kVA / 40kVA, 10 minutes |
| | Cooling | Air forced |
| | Auxiliary supply protection | ✔ |
| | Cabinet type | Outdoor |
| **OTHER EQUIPMENT** | Safety mechanism | Trapped key safety interlock |
| | Safety perimeter | Transformer access protection fence |
| | Cabinet heating | Heating resistors |
| | Interior lighting | Fluorescent lamp |
| | Emergency lighting | Electronic supplier for emergency lighting (1h autonomy) |
| | Air conditioner | UPS batteries cooling |
| | Communication[4] | Splice box / MV Switchgear monitoring |
| **STANDARDS** | Medium Voltage | IEC 62271-202, IEC 62271-200, IEC 60076, IEC 61439-1 |

[1] Depending on customer configuration.
[2] Optional. For additional information or available configurations, please consult Power Electronics.
[3] Other temperature range, consult Power Electronics.
[4] By demand.

# HEK

UTILITY SCALE SOLAR STATION

**TURN-KEY SOLUTION**

**HIGH RELIABILITY**

**EASY TO INSTALL**

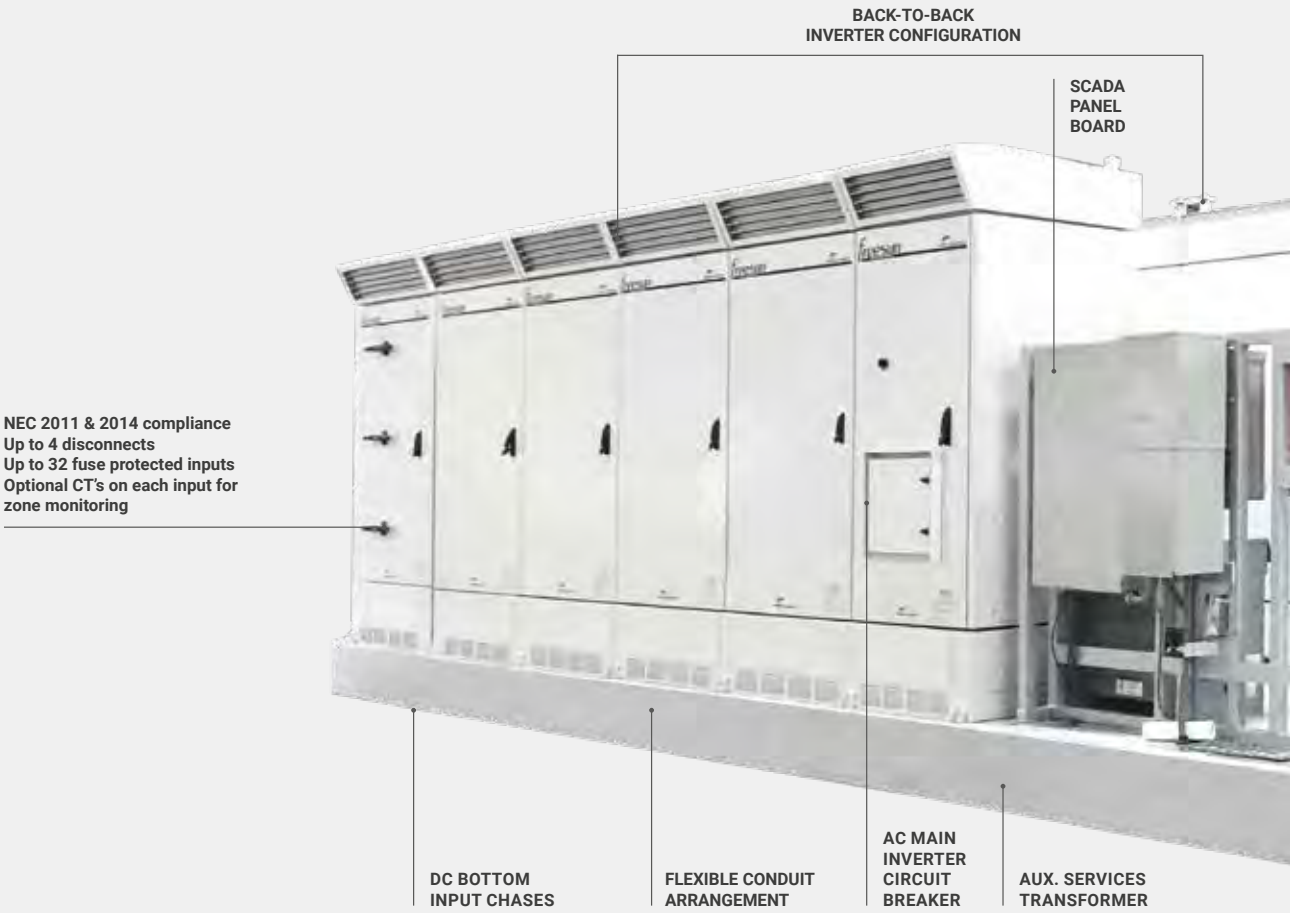
**OUTDOOR DURABILITY**

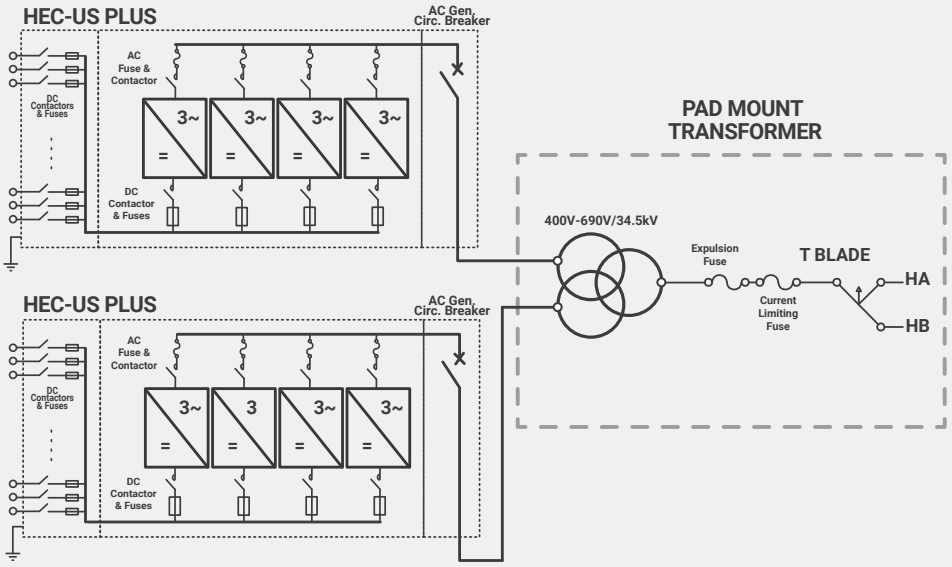
## THE OPEN SKID PLATFORM OFFERS MAXIMUM YIELD AND RELIABILITY FOR SYSTEMS FROM 1MW TO 7MW

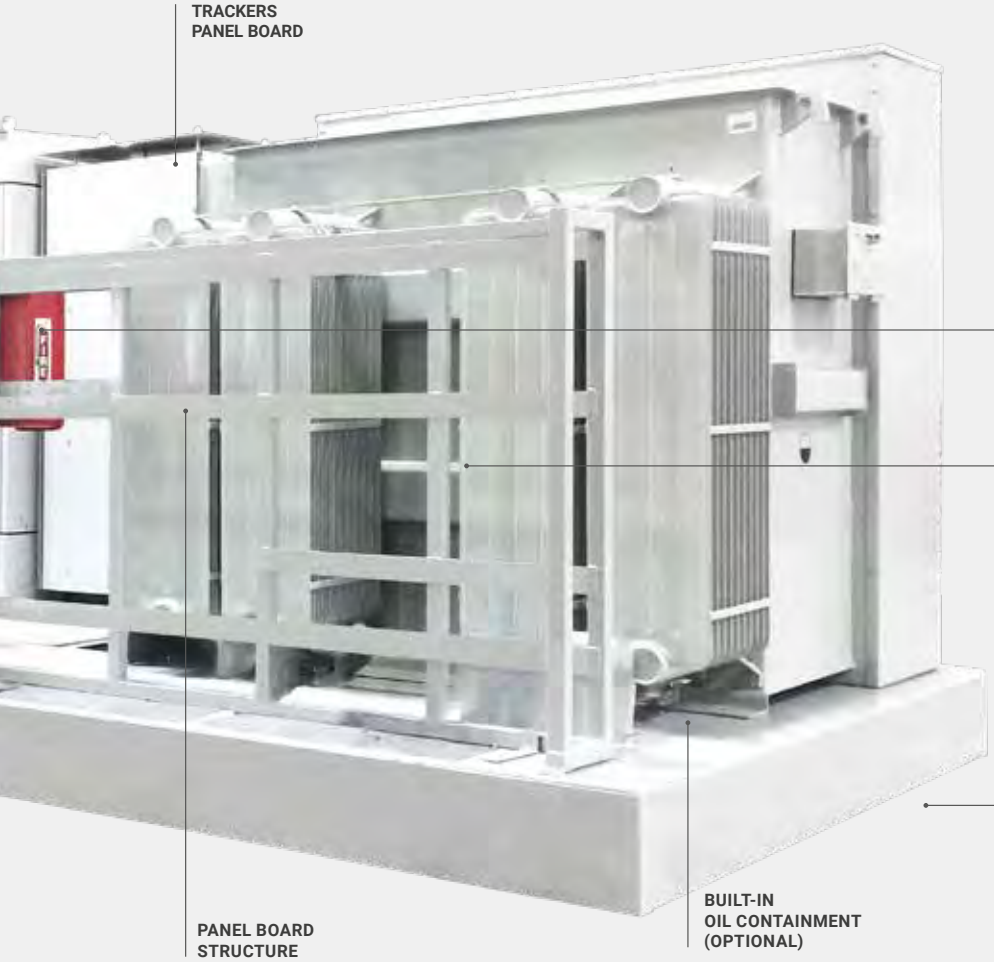
The HEK Open Skid Platforms is designed for large scale utility PV plants, with complete factory integrated DC & AC disconnects and protection, HEC-US solar inverters, step-up pad-mount transformer and auxiliary equipment. Critical power connections are completed and tested in a factory environment and the pre-tested unit is shipped to the field ready for the final connection. Standard MV skid platforms can reduce installation and commissioning time.

HEC-US inverters are equipped with the latest proven technologies which offer the maximum yield and proven reliability for utility scale projects.

# TOPOLOGY

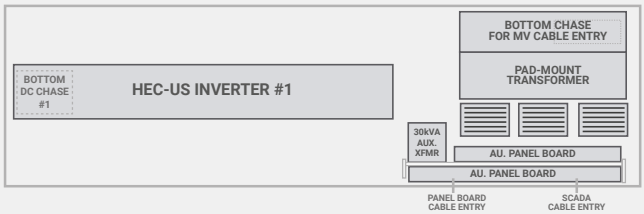

BACK-TO-BACK
INVERTER CONFIGURATION
SCADA
PANEL
BOARD
NEC 2011 & 2014 compliance
Up to 4 disconnects
Up to 32 fuse protected inputs
Optional CT's on each input for
zone monitoring
DC BOTTOM
INPUT CHASES
FLEXIBLE CONDUIT
ARRANGEMENT
AC MAIN
INVERTER
CIRCUIT
BREAKER
AUX. SERVICES
TRANSFORMER


HEC-US PLUS
AC Gen.
Circ. Breaker
AC
Fuse &
Contactor
DC
Contactors
& Fuses
3~
=
DC
Contactor
& Fuses
PAD MOUNT
TRANSFORMER
400V-690V/34.5kV
Expulsion
Fuse
T BLADE
HA
HB
Current
Limiting
Fuse
HEC-US PLUS
AC Gen.
Circ. Breaker
AC
Fuse &
Contactor
DC
Contactors
& Fuses
3
DC
Contactor
& Fuses

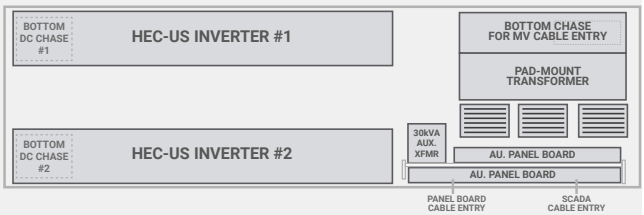



## CONFIGURATIONS

**1MW - 3.5MW**




**2MW - 7MW**




[1] Other configurations, please consult Power Electronics. Some HEK units may differ from the concept shown in the images.

# CONTROL AND MONITORING SOLUTIONS

**FREESUN PPC**
**FREESUN APP**
**FREESUN PORTAL**

# PPC

UTILITY SCALE POWER PLANT CONTROLLER

Power Electronics experience in integrating its products into different global electrical networks enables us to offer a set of solutions that can be customized to your requirements to control different sources of energy into the same grid. The integration of an alternative power source creates an unprecedented opportunity to reduce operational costs to off-grid industrial and commercial facilities.


## TECHNICAL CHARACTERISTICS

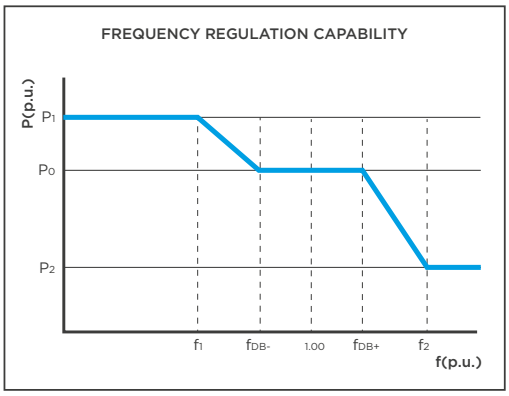
| | | |
|---|---|---|
| **GENERAL DATA** | Dimensions (WxDxH) mm | 415 x 230 x 515 |
| | Weight (kg) | 10 |
| | Mounting system | Wall mounted |
| | Compatible Inverters | HE, HEC, HEM, HEMK and Freemaq PCS |
| | Power Supply | 250W |
| **I/O and COMMUNICATIONS** [1] | 4 x Digital Inputs | Programmable inputs and active high (24Vdc). Optically isolated. |
| | 1 x RS485 Port | 3 wires (GND,A,B), Modbus RTU |
| | 1 x USB Port | PC connectable using a master.Modbus configurator (ModScan or similar). Reserved for TS. |
| | 1 x CAN Port | 3 wires (LO, GND, HI), Modbus RTU |
| | 1 x Ethernet Port (RJ45) | Modbus TCP/IP |
| **ENVIRONMENTAL CONDITIONS** | Operation Temperature | 0~50°C (32°~122°F) |
| | Storage temperature | -20~80°C (-4°~176°F) |
| | Humidity | 5-95% non-condensing |
| | Degree of protection | IP42 |
| **CERTIFICATIONS** | CE | |
| **OTHERS** | Web interface for local and remote monitoring | |
| | Customized solution | |

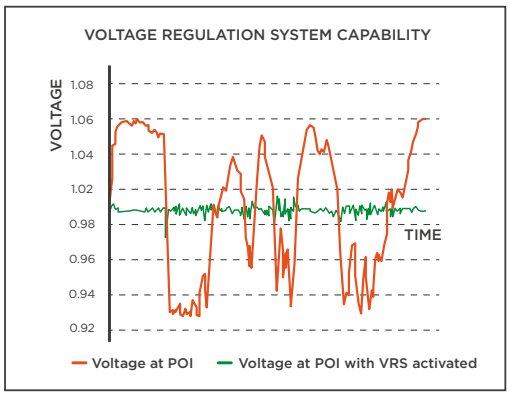
[1] Communication ports can be customised depending on PV plant design without prior notice.

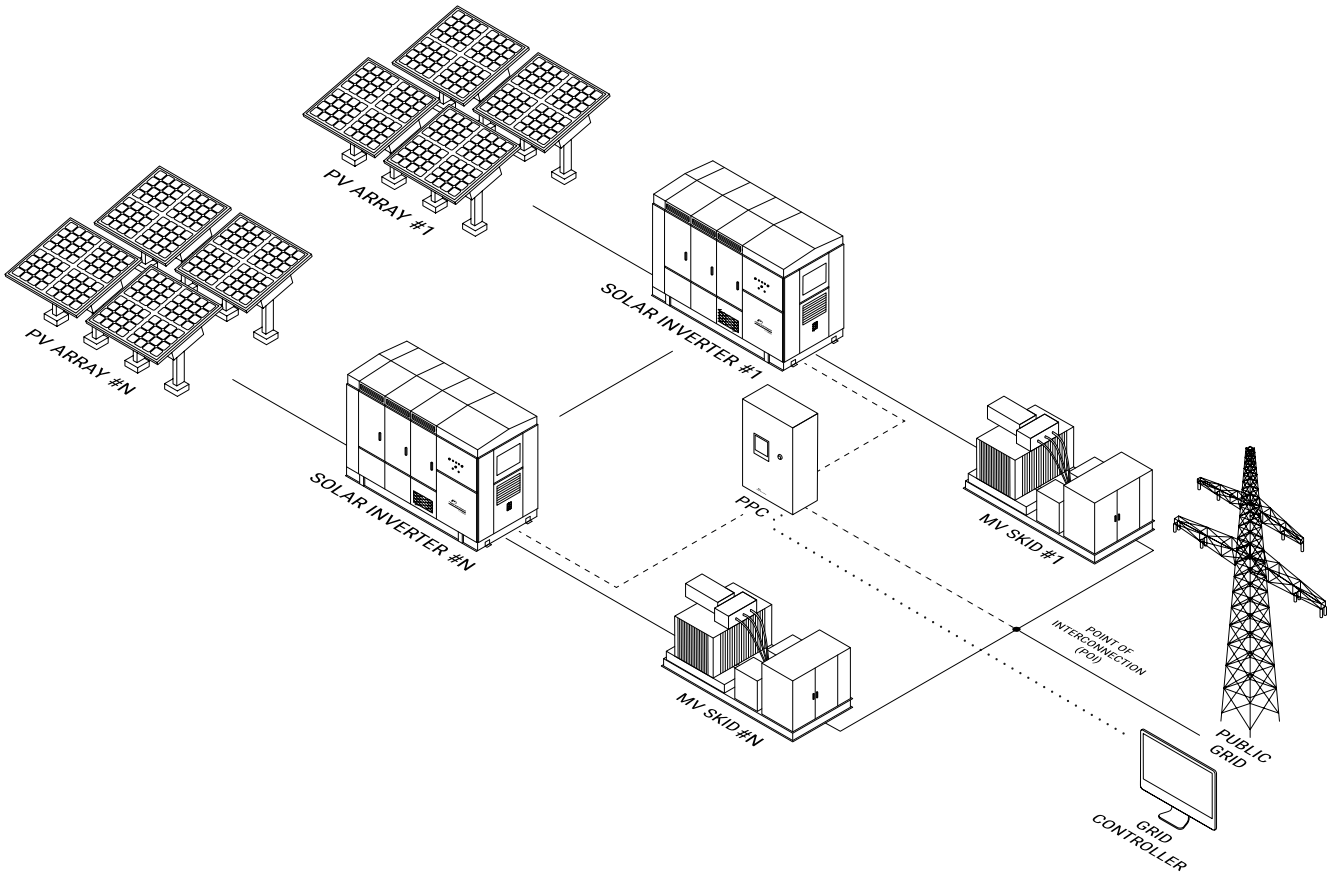
## DYNAMIC GRID SUPPORT

The Power Electronics Power Plant Controller is a device used to manage PV plants in order to comply with all the utility and customer requirements, thanks to its fast and flexible control algorithms. The PPC helps the grid controller to manage the performance of the PV plant, guaranteeing grid quality requirements.

The PPC includes the latest utility interactive specifications to support the grid, by controlling the reactive and active power at the POI with a fast response time. This flexible plant control device allows the user to customize the unit, in order to comply with any grid code standards and regulations.



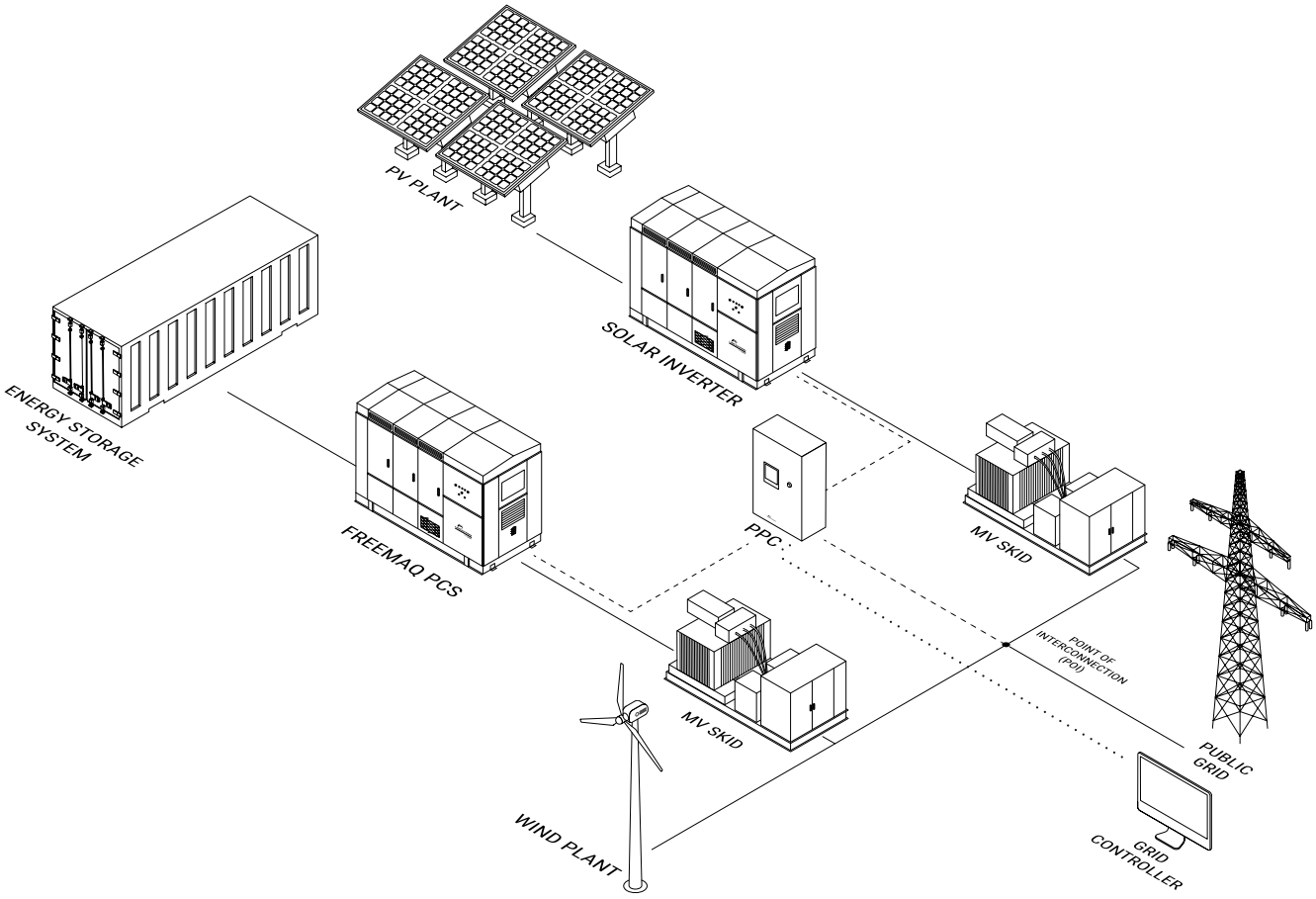



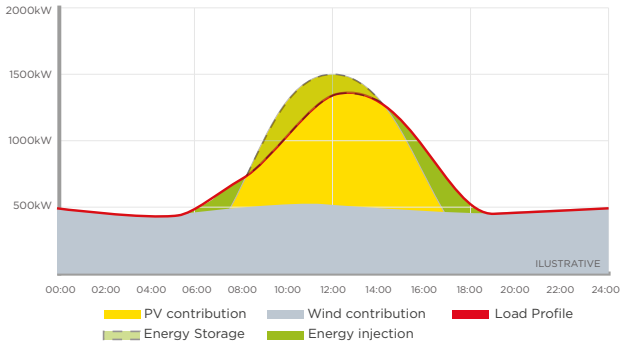
## POWER PLANT CONTROLLER

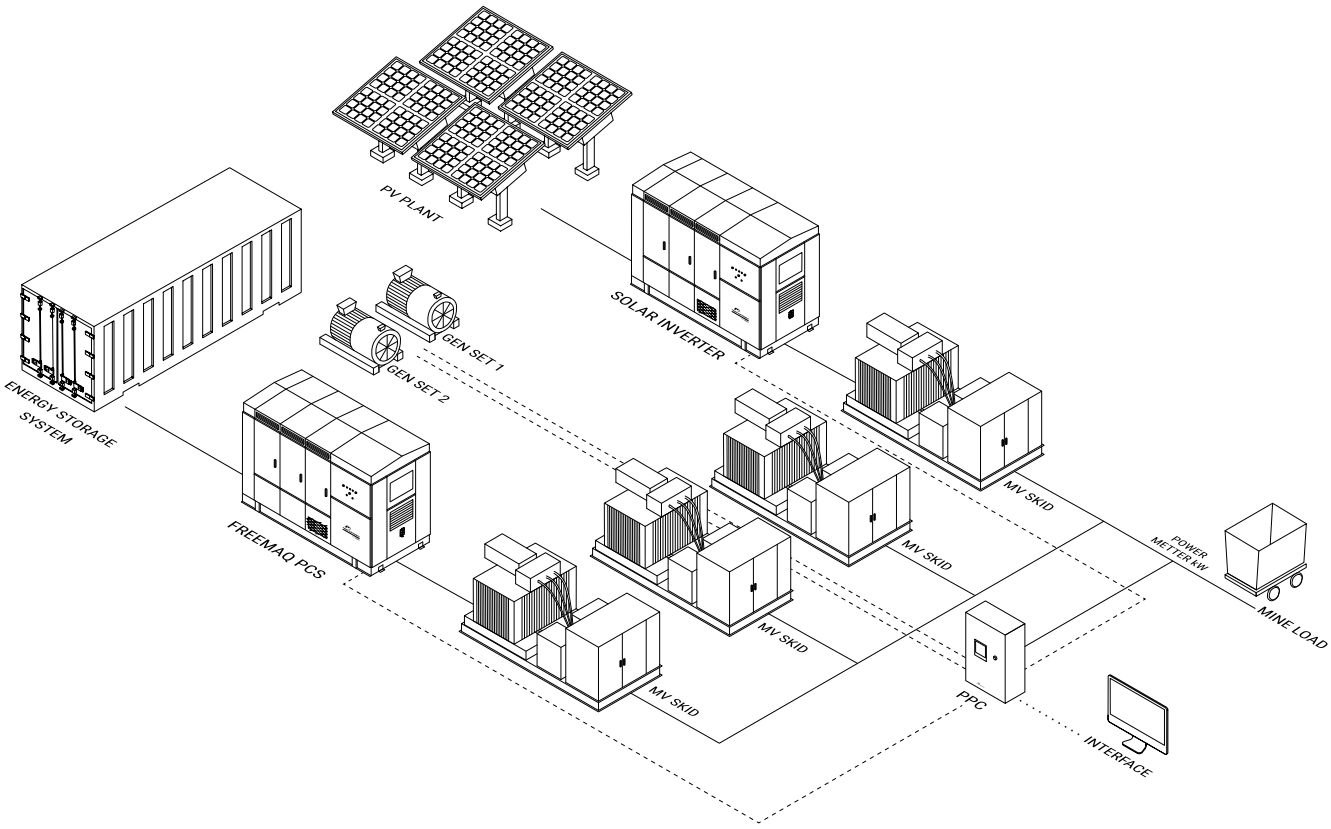
The Power Plant Controller (PPC) can be the main governor of the most complex Multi PCS systems by monitoring the point of interconnection (POI) and at the same time controlling the power generation and storage equipment.

The PPC is equipped with the latest PLC based microprocessor that interacts through the programmable digital/analogue signals and communication ports (Modbus TCP). The PPC together with the Freesun solar inverter or the Freemaq series can be customized for those countries (Puerto Rico, Hawaii….) that require full compliance to stringent dynamic grid support response at POI.

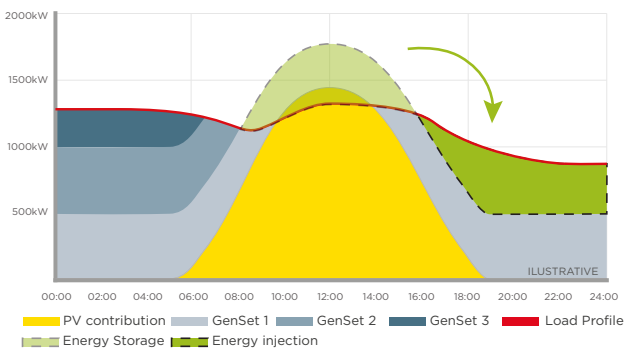



- PPC main governor and interface of the system.
- Multiple renewable power sources: solar, wind, etc.
- Centralized dynamic grid support at POI.
- Power smoothing – Enable ramp rate control.
- Storage equipment control.






- PPC main governor and interface of the system.
- Multiple GenSets and storage equipment control.
- Centralized dynamic grid support at POI.
- Power shaping - Enhanced broad implementation of decentralized PV.
- Power smoothing – Enable ramp rate control.



# FREESUN PORTAL

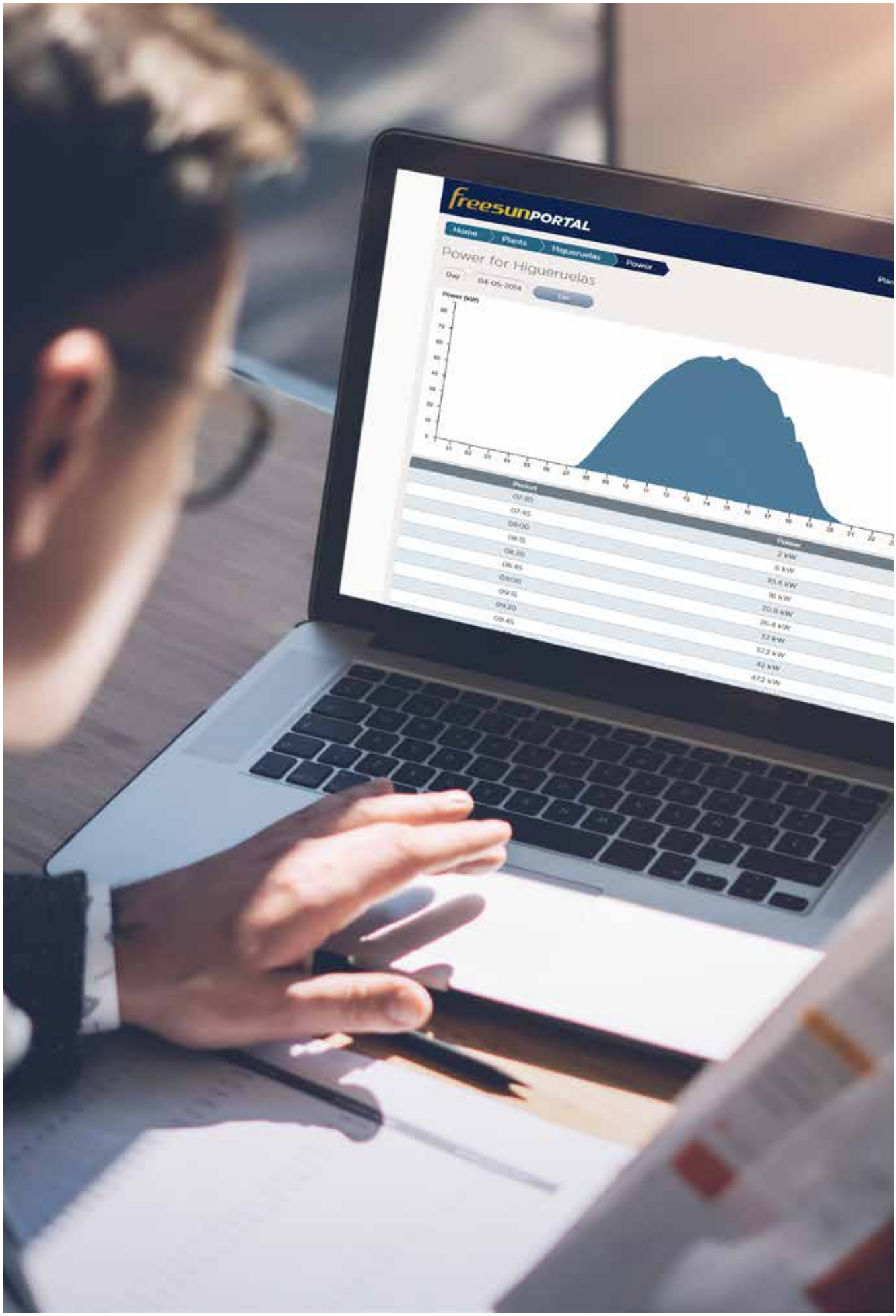
GO ONLINE

The Freesun Portal is an attractive and comprehensive monitoring tool available in one click through a free web service. The data sent by the Datalogger is stored in the Power Electronics Database and meaningfully plotted or exported. EPC´s or end user can easily check all the data retrieved from the inverter, in real time, anywhere in the world and on any device.

The system refreshes the data every minute showing an accurate and comprehensive status of your PV facilities.

The data is stored in a secure database where multiple PV plants can be monitored at the same time by multiple users in multiple locations. The web application allows you to introduce plant information, to select multiple charts or plot intervals for the creation of daily, monthly or annual reports, and to export data in xls and pdf files.

| | |
|---|---|
| **WEBSITE ACCESS** | www.freesunportal.com |
| **AVAILABLE INFORMATION** | Inverter and module status.<br>Inverter and module Power (kW).<br>Daily Energy (kWh).<br>Total Energy (MWh).<br>Inverter current (A).<br>Inverter and Module faults.<br>Others available. |
| **FEATURES** | Comprehensive and flexible charts<br>Annual, Monthly, daily reports.<br>Generation of historic data tables<br>Historic data exportation XLS. Files<br>Multiple user licences and administrator capabilities |
| **LANGUAGE** | English, Spanish. |
| **SYSTEM REQUIREMENTS** | Internet Explorer 8.<br>Firefox 5.<br>Google Chrome 14.<br>Safari 5.<br>Opera 11.<br>Java Script.<br>Cookies Activated. |


freesunPORTAL
Home
Plants
Higueruelas
Power
Power for Higueruelas
04-05-2014
Power (kW)

# FREESUN APP

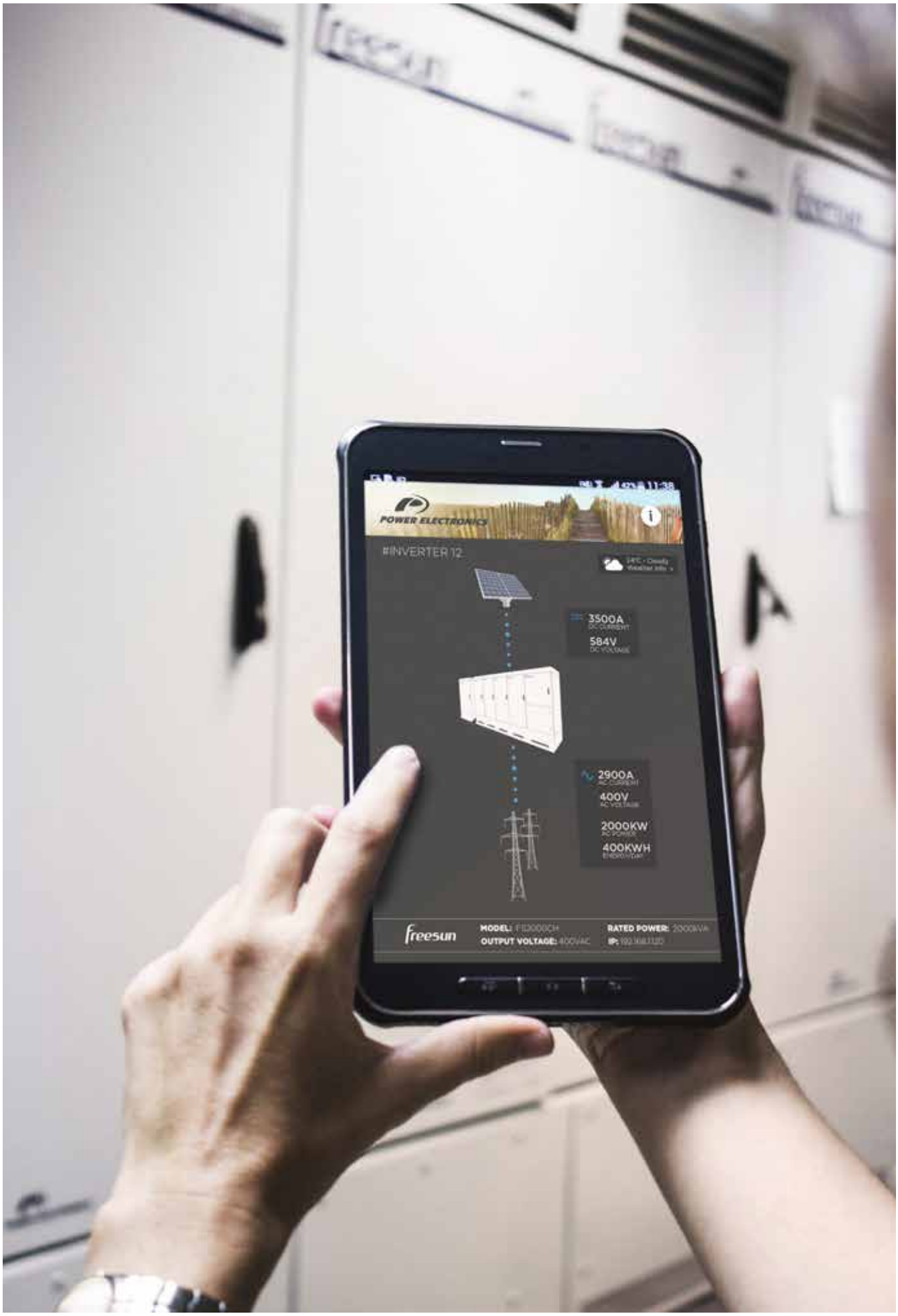
GO WIRELESS

The ultimate APP display application will play a key role in your Plant Service and Management. Any Android or iOS device can easily wirelessly connect to the inverter for a comprehensive and user friendly interface. Forget about using built-in displays with tiny screens or tedious menus, and allow your field technicians to service outdoor units in rain, snow or sun scorching conditions, without opening or standing in front of the unit. In its bid to create an application for mobile devices Power Electronics presents our Freesun app for monitoring our solar inverters. It is available on Android and iOS operating systems and can be used on both smartphones and tablets.

The Freesun application makes it easy to connect to our modular solar inverters via wifi. It is possible to perform the following tasks: monitor the key performance parameters of equipment, monitor operating statuses of diagnostics, module comparisons, values of incidents and many more.

The application, through a careful and simple interface, displays data graphically and numerically. It also provides comparative information at the level of modules as well as showing detailed information of the entire system. Easy and intuitive to use; with this application you can automatically identify Freesun solar inverters available on the local network and store information from inverters to communicate with them at any time.

| | |
|---|---|
| **AVAILABLE INFORMATION** | Grid and PV field data.<br>Inverter and Power module data (Voltages, currents, power, temperatures, I/O status...).<br>Weather conditions.<br>Alarms and warnings events.<br>Energy registers.<br>Others. |
| **FEATURES** | Easy Wireless connection.<br>Comprehensive interface.<br>Real time data.<br>Save and copy settings. |
| **LANGUAGE** | English, Spanish. |
| **SYSTEM REQUIREMENTS** | iOS or Android devices. |
| **SETTINGS CONTROL** | Yes |


POWER ELECTRONICS
#INVERTER 12
3500A
584V
2900A
400V
2000KW
400KWH
freesun
MODEL:
OUTPUT VOLTAGE:
RATED POWER:

# REFERENCES

**More than 12GW installed around the world.**

**BRAZIL**

**BRAZIL´S 1ST 1500V INVERTER**

**Sobral and Sertao, 30+30MW**

**HEC V1500 + MV SKID**

**ARGENTINA**

**ARGENTINA'S 1ST 1500V INVERTER**

**Nonogasta, 42MW**

**HEC V1500 + TWIN SKID**

**CHILE**

**Santiago Solar, 115MV**

**HEC PLUS + MV SKID**

**UNITED STATES**

**Selmer I-II, 14MW**

**HEC-US V1500**

**UNITED STATES**

**Maverick, 8.5MW**

**HEC-US V1500**

**UNITED STATES**

**Roserock, 157MW**

**HEC-US**

**MEXICO**

**Santiago & Hermosillo, 170+100MW**

**HEC V1500 + MV SKID**

**IRELAND**

**Dale Farm, 4MW**

**HEV 1500 + MV SKID**

**UNITED KINGDOM**

**Eveley, 49MW**

**HEC PLUS**

**UNITED STATES**

**Huzlehurst, 52MW**

**HEC-US V1500**

**JAPAN**

**Tano Ike, 2.5MW**

**HEC V1500**

**JAPAN 1ST 1500V INVERTER**

**UNITED KINGDOM**

**Lyneham, 51MW**

**HEC PLUS**


**UNITED STATES**

**Payne, 105MW**

**HEM**

**PANAMA**

**Chiriqui, 10.5MW**

**HEC PLUS**

**MAURITANIA**

**Zouerate, 3MW**

**HET**

**JORDAN**

**Al Mafraq, 61MW**

**HEC V1500 + MV SKID**

**JORDAN´S 1ST 1500V INVERTER**

**CHILE**

**Uribe, 50MW**

**HEC PLUS + MV SKID**

**UNITED STATES**

**San Bernardino, 30MW**

**HEK**

**UNITED KINGDOM**

**West Raynham, 44MW**

**HEC PLUS**

**PORTUGAL**

**Ourique, 46MW**

**HEC V1500**

**PORTUGAL'S 1ST 1500V INVERTER**

**BOLIVIA**

**Uyuni & Yunchara, 60+5MW**

**HEC V1500 + MV SKID**

**BOLIVIA 1ST 1500V INVERTER**

**CHILE**

**Los Andes, 24 MW**

**HEC PLUS**

**URUGUAY**

**Alto Cielo, 26MW**

**HEC PLUS**

**BARBADOS**

**St. Lucy, 9MW**

**HEC PLUS**

UNITED STATES

Gala, 56MW

HEC-US V1500

UNITED STATES

Calflats, 280MW

HEC-US

MEXICO

Solem I & II, 175 + 165 MV

HEC V1500 + MV SKID

**UNITED STATES**

**Oak Solar, 180MW**

**HEC-US V1500**

**AUSTRALIA**

**Barcaldine, 20MW**

**HEC PLUS + MV SKID**

**UNITED STATES**

**Portal Ridge, 32MW**

**HEC-US V1500**

## WARRANTY


Power Electronics (the Seller) warrants that their SOLAR INVERTER Products are free of faults and defects for a period of 5 years, valid from the date of delivery to the Buyer. It shall be understood that a product is free of faults and defects when its condition and performance is in compliance with its specification.

The warranty shall not extend to any Products whose defects are due to (i) careless or improper use, (ii) failure to observe the Seller's instructions regarding the transport, installation, functioning, maintenance and the storage of the Products, (iii) repairs or modifications made by the Buyer or third party without prior written authorization of the Seller, (iv) negligence during the implementation of authorized repairs or modifications, (v) if serial numbers are modified or illegible, (vi) anomalies caused by, or connected to, the elements coupled directly by the Buyer or by the final customer, (vii) accidents or events that place the Product outside its storage and operational specification, (viii) continued use of the Products after identification of a fault or defect.

The warranty excludes components that must be replaced periodically such as fuses, lamps & air filters or consumable materials subject to normal wear and tear.

The warranty excludes external parts that are not manufactured by the Seller under the brand of Power Electronics.

The Seller undertakes to replace or to repair, himself, at their discretion, any Product or its part that demonstrates a fault or defect, which is in conformance with the aforementioned terms of the warranty. Reasonable costs associated with the disassembly/assembly, transport and customs of equipment will also be undertaken by the Seller except in cases of approved intervention by the Buyer and/or their representative where cost allocation has been previously agreed. In case of fault or defect, the Buyer shall notify the Seller in writing by using the following contact email: quality@powerelectronics. com, of the presence of any fault or defect within 15 days of the fault or defect event. The serial number of the defective product plus a brief description of the fault must be included in the email. Failure to notify the Seller of fault or defect within this time period may result in the warranty becoming invalid.

In the event of replacement of defective Product or part thereof, the property of the Product or part shall be transferred to the Seller.

The Seller shall bear no liability for damages to property or third persons, even as manufacturer of the Products, other than that expressly provided by virtue of applicable mandatory law provisions. In any case, the Seller shall not be liable for indirect or consequential damages of whatsoever nature as, by way of example, production losses or unearned profits.

The Seller shall, at their discretion, forfeit all warranty rights of the Buyer if the total sum of the contract and payment has not been reached in accordance with the agreed conditions of the contract.

No other warranties, express or implied, are made with respect to the Products including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose.

In any case, the Buyer's right to damages shall be limited to a maximum amount equal to no more than the price obtained by the Seller of the faulty or defective Products.

These conditions shall apply to any repaired or replacement products. Not withstanding the above, the replacement of a Product does not imply an extension of the term of warranty outside that of the original term.

## ADDITIONAL WARRANTY


Power Electronics stands by the quality and durability of our inverters. That is why we offer a comprehensive 5 year warranty on our equipment. As the inverter is the critical component of the installation, it must not shutdown.

This is why we have made it our top priority to create a robust and reliable product and give the best service and warranty along with it. To boost your confidence further in our products, Extended Warranty packages up to 20 years are also available.

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