



## Design and Operations Report

In support of an application for a  
**Renewable Energy Approval (REA)**  
Pursuant to Ontario Regulation 359/09

For the

### **Penn Energy – Brantgate**

### **SOLAR ENERGY FACILITY**

FIT Contract No. F-001576- SPV-130-505

FIT Application No. FIT-FCELIHJ



In the  
**County of Brant**  
**ONTARIO, CANADA**

May 25, 2012

***(Revised December 11, 2013)***



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### **A note regarding REA application requirements and additional Project Information:**

This document is one component of a series of reports and other related documents that, collectively, constitute a complete Renewable Energy Approval (REA) application package which will be submitted to the Ministry of the Environment (MOE) for review and approval. As such, this report is intended to compliment the other documents and may reference and/or rely upon information contained in them; therefore, the contents herein should not be considered independently.

## **Table of Contents**

<b>1.0 INTRODUCTION</b>	<b>4</b>
<b>2.0 SITE PLANS</b> (refer to Appendix 'A' for drawings)	<b>5</b>
<b>3.0 FACILITY DESIGN</b>	<b>5</b>
3.1 General Description of REGF's Design	7
3.2 Potential Negative Environmental Effects attributable to Facility Design	7
<b>4.0 FACILITY OPERATION</b>	<b>8</b>
4.1 Daily Function	9
4.2 Planned Maintenance	9
4.3 Ancillary Activities	9
4.4 Potential Negative Environmental Effects	10
4.4.1 Significant Natural Heritage Features <b>(according to the NHA/EIS)</b>	10
4.4.2 Water Bodies <b>(according to the WA)</b>	10
4.4.3 Archeological and Cultural Heritage Features <b>(according to the AA and CHS)</b>	10
4.4.4 Acoustic Receptors <b>(according to the AAR)</b>	10
<b>5.0 ENVIRONMENTAL EFFECTS MONITORING PLAN (EEMP)</b>	<b>11</b>
5.1 An Excerpt from the Project Description Report (PDR)	12
5.2 EEMP for Facility Design	13
5.3 EEMP for Facility Operation phase	13
<b>6.0 RESPONSE AND COMMUNICATIONS PLAN</b>	<b>13</b>
6.1 Communication Methods	14
6.2 Contact Details	14
6.3 Response Procedures	15
<b>7.0 CONSIDERATION OF OTHER LAND USE PLANNING LAWS</b>	<b>18</b>
7.1 Niagara Escarpment (not applicable)	15
7.2 Lake Simcoe Watershed (not applicable)	15
7.3 Oak Ridges Moraine (not applicable)	15
7.4 Greenbelt (not applicable)	15
<b>8.0 ADDITIONAL REPORTS</b>	<b>16</b>
8.1 Effluent Management Plan Report (not applicable)	16



<b>8.2</b>	Emission Summary & Dispersion Monitoring Report (not applicable) .....	<b>16</b>
<b>8.3</b>	Environmental Impact Study Reports .....	<b>16</b>
<b>8.4</b>	Hydro-geological Assessment Report (not applicable) .....	<b>16</b>
<b>8.5</b>	Odour Study Report (not applicable) .....	<b>16</b>
<b>8.6</b>	Noise Study Report .....	<b>16</b>
<b>8.7</b>	Property Line Setback Assessment Report (not applicable) .....	<b>16</b>
<b>8.8</b>	Surface Water Assessment Report (not applicable) .....	<b>16</b>
<b>8.8.9</b>	Water Bodies Assessment Report .....	<b>16</b>
<b>APPENDICES</b> .....		<b>17</b>
A.	Site Plans	
B.	Solar Photovoltaic (PV) Modules	
C.	Array Racking	
D.	Array Foundations	
E.	Collection Houses and Low-Voltage (DC) Accessories	
F.	Inverters	
G.	Secondary Transformers (at collection houses)	

## List of Tables

<b>Table 1.</b>	Description of the Major Equipment and Components of the REGF .....	<b>6</b>
<b>Table 2.</b>	An Excerpt from the Project Description Report (PDR) .....	<b>12</b>
<b>Table 3.</b>	EEMP for all identified Potential Negative Environmental Effects .....	<b>13</b>

### Notice:

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## 1.0 INTRODUCTION

Penn Energy Renewables, Ltd. (Penn) has executed a FIT contract with the Ontario Power Authority (OPA) for the construction of an 8 MW, ground-mounted, Class 3 solar energy facility approximately 14 kilometres southwest of the City of Brantford, in the County of Brant, Ontario. The subject lands are located in part of Lots 1 and 2 Concession 11, in the County of Brant, geographic rural community of Burford. The proposed Renewable Energy Generation Facility (REGF) would consist of a collection of solar photovoltaic (PV) modules (each approximately 1.00 m x 1.67 m or 1.00 m x 2.00 m in dimension) that are grouped into arrays tilted and facing south. These stationary arrays are strung together forming a series of rows oriented east to west. The Environmental Protection Act (EPA) administered by the Ministry of the Environment (MOE) regulates Renewable Energy Approvals (REAs) under Part V.0.1 of the act, pursuant to Ontario Regulation 359/09 (O.Reg. 359/09). A proponent of a renewable energy project is required to submit numerous reports as part of an REA application; one of which is a Design and Operations Report (DOR).

According to the MOE's publication "Technical Guide to Renewable Energy Approvals Chapter 6: Guidance for preparing the Design and Operations Report" (2011)...

*The Design and Operations Report is the principal document where the details of a renewable energy project are presented. It builds on the Project Description Report by defining:*

- *the exact site plan;*
- *the design of the facility and the equipment to be used;*
- *how the facility will be operated;*
- *how environmental effects will be monitored and mitigated; and*
- *how emergencies and communications will be managed.*

This report begins with a description of the various items illustrated in the Site Plan drawings (see Appendix 'A') and then discusses Design of the proposed REGF, including specifications of its primary components (see Appendices). It continues by outlining the scope of work and detailing specific tasks for the Operations phase of this project. The potential for any negative environmental effects due to the REGF design or operational activities are examined and any mitigation or monitoring is proposed in the Environmental Effects Monitoring Plan (EEMP). Next is a description of the Response plan which lists contact information and procedures for both emergency and non-emergency communications. Finally are references to any other land use planning laws or additional reports that may apply.



Because of its low-impact nature in comparison to other forms of power generation, many DOR items listed in O.Reg. 359/09 (Table 1, Item 4) are not applicable to solar PV facilities; accordingly, these items are not included in this report (e.g. sewage, air contaminants, organic and other waste). It should also be noted that this project is not located within the Oak Ridges Moraine Conservation Plan Area, the Niagara Escarpment Plan Area, the Greenbelt's Protected Countryside or the Lake Simcoe Watershed.

## 2.0 SITE PLANS (refer to Appendix 'A' for drawings)

## 3.0 FACILITY DESIGN

Pursuant to Item 2 for DOR in Table 1 of O.Reg. 359/09, proponents shall set out conceptual plans, specifications and descriptions related to the **Design** of the REGF, including descriptions of:

- i. Sewage (n/a) There will be no works for the collection, transmission, treatment and disposal of sewage (including sediment control features and storm water management facilities).
- ii. Air contaminants (n/a) There will be no things that discharge contaminants into the air.
- iii. Other Waste (n/a) There will be no systems, facilities and equipment for receiving, handling, storing and processing any waste, biomass, source separated organics, farm material and biogas.

The MOE's publication "Technical Guide to Renewable Energy Approvals" (2011) suggests that the Design Plan should:

*"Describe the types, sizes, and design of proposed facility components. The focus...should be to detail attributes of the project that have the potential to cause negative environmental effects...For environmental effects that have been addressed by adhering to setback distances (for instance, avoiding development within 120 metres of a significant natural feature), this mitigation approach should be noted."*

It also advises that applicants should include the following technology-specific items to describe the Design of solar projects:

- *Make and Model of Solar Module (see Table 1, below, and Appendices)*
- *Diagram of the dimensions of each solar module (see Table 1 and Appendices)*
- *Diagram and specifications of how the solar modules are mounted (see Table 1 and Appendices)*
- *Description of the mechanism and range of motion if solar modules track the sun (n/a: fixed racking)*
- *Description of how power is inverted, transformed and transmitted, including specifications of all power conversion equipment (see Table 1 and Appendices)*
- *Description of any treatments to land on which the solar modules are proposed, particularly with regard to soil permeability and the potential for negative environmental effects related to stormwater runoff from the facility*
  - Although the solar panels are themselves impervious, the design and placement of the solar panels promotes the flow of rainwater to the ground surface beneath and surrounding the panels. Grasses



and/or alternative species of groundcover will be planted in these areas. As a result, runoff from these solar panels will travel predominantly along the surface of the ground, maintaining the opportunity to infiltrate in a manner similar to pre-development conditions.

- The foundation system is relatively minimal and consists of generously spaced posts or piers (only one per every 6-15 modules, depending on final engineering), which amounts to a very small footprint on the soil itself. These posts are the only point of contact between the arrays and the ground. The posts occupy substantially less than one percent (1%) of the site area. Accordingly, any change to stormwater runoff will be diminimus.
- There will be no paving. The access lanes are farm lanes; if required, they will be stabilized with gravel, which is typically considered a pervious surface.
- Limited impervious surfaces (e.g., inverter, transformer and substation pads) will be constructed for this development. The site access lanes and a small parking area would be constructed of gravel and would, as a consequence, maintain some level of stormwater infiltration.
- Although some grading is anticipated to smooth contours of the site, the Solar Farm will generally follow the existing topography. There is no planned import or export of fill or other material to or from the site. The anticipated grading is not expected to significantly increase the rate and/or flow of stormwater discharge from the site and may, in fact, increase stormwater infiltration by slightly reducing the average pitch of the site.
- Together these factors will avoid concentration of runoff and significantly decrease (if not eliminate altogether) the amount of precipitation that will not be absorbed by the soils in the immediate vicinity. It is anticipated that there will be little, if any, change to the quantities or rates of stormwater runoff. Compared to the pre-development condition, any impact is too negligible to warrant stormwater management controls.

**Table 1.** Description of the Major Equipment and Components of the REGF:

Major Equipment and Components	Description* (per subparagraph ii)	Notes*
Solar Photovoltaic (PV) Modules	<b>MaxPower CS6X</b> by Canadian Solar, or similar: 265-295 watts each (+5w tolerance); nominal dimensions: 1.0 m x 2.0 m; Poly- crystalline or Mono-crystalline silicon; aluminum frame; tempered glass cover	<i>See Appendix 'B'</i>
Array Racking	<b>ISYS Ground-Mount</b> by UniRac; <b>Solar Flexrack™</b> by NSM; or similar Aluminum or galvanized steel members	<i>See Appendix 'C'</i>
Array Foundations	<b>Driven piers or ground screws</b> by TerraFix, Krinner or similar (galvanized steel)	<i>See Appendix 'D'</i>
Collection Houses (see Inverters and Secondary Transformers, below)	<b>PV Box</b> by Schneider Electric, or similar	<i>See Appendix 'E'</i>
Low-Voltage (DC) Accessories into and within collection houses	Low-Voltage wiring strings, combiners, junction boxes, collection cabling, surge arrestors & related protection equipment, security & communications accessories, etc. by Schneider Electric or similar	<i>See Appendix 'E'</i>



Inverters (DC to AC)	<b>SC800CP-US</b> (800 kW each) by SMA, or similar	1-2 per collection house <i>See Appendix 'F'</i>
Interface Transformers (1 mVA)	<b>Class 7230 Pad-Mounted</b> Small Power transformer (208 V to 27.6 kV) by Schneider Electric, or similar	1 per collection house <i>See Appendix 'G'</i>
Medium-Voltage (AC) electrical equipment from collection houses to Project Switchyard and interconnection point	Medium-Voltage conductors, switchgear, disconnects, SCADA, meter, etc. <i>Currently being determined through ongoing coordination and negotiations with Hydro One Networks (HONI).</i>	to be determined

\* Specifications for major equipment and components are subject to change.

### 3.1 General Description of REGF's Design

The proposed REGF consists of a collection of solar photovoltaic (PV) modules (each approximately 1.0 m x 2.0 m in dimension) that are grouped into arrays, tilted and facing south. These stationary arrays are strung together forming a series of rows oriented east to west. Electricity collection and distribution lines link the PV modules to a collection house with inverter and transformer equipment. Penn anticipates selecting transformers that utilize biodegradable transformer oil(s), such as, by way of example, vegetable-based FR-3. Such transformer oils are non-toxic and readily biodegradable. They are less volatile than petroleum-based oils and have higher flash points for improved safety. They are known to quickly and thoroughly degrade in both soil and aquatic environments. For this size of operation 8-15 collection houses are anticipated. Laneways provide access to each collection house. The entire operation (solar modules, collection houses and access lanes) will be fenced in order to provide for safety and security, in accordance with applicable requirements. The fence is designed according to applicable legislations (such as Ontario Electric Safety Board). A perimeter lane would be constructed immediately inside of the fence. The access lanes (perimeter lane and laneways to collection houses) would be typical farm lanes. If necessary, they will be stabilized with gravel. The solar modules are placed above the ground and as such allow for grass to be established underneath. The foundation system for the arrays would be completed by pile driving or core drilling pipes into the ground. The exact methods will be decided during final project engineering.

### 3.2 Potential Negative Environmental Effects attributable to Facility Design (according to the NHA/EIS, AA and WA) <sup>a</sup>

NHA - The records review and site investigation confirmed that *"there are no natural features within the project location nor the adjacent lands."*

AA - A Stage 1 and 2 Archaeological Assessment found: *"...intensified pedestrian survey/Stage 2 excavation of the fields within the subject property did not result in the recovery of sufficient material to be considered a site, nor to proceed to Stage 3 assessment (Stand. 1. a. i, (1), (3), Sect. 2.2, MTC, 2011).*

<sup>a</sup> Much of the information in Subsections 3.2, 4.4 and Section 5 is taken from other reports prepared for this REA application, for example, the Natural Heritage Assessment and Environmental Impact Study Report by Savanta, Inc. (NHA/EIS), the Cultural Heritage Screening Results by Unterman McPhail Associates (CHS), the Archaeological Assessment (Stages 1 and 2) Report by Northeastern Archaeological Associates (AA), the Water Assessment Report by Savanta, Inc. (WA) and the Acoustic Assessment Report by HGC Engineering (AAR). Please refer to these companion reports for more detailed information..



*It is therefore the recommendation of this report that no further archaeological work is required within the development area.”* The Ministry of Tourism and Culture has reviewed the assessment and has concurred with the findings therein.

The *Cultural Heritage Screening* by Unterman McPhail Associates found that the proposed REGF is neither located on nor abuts any Protected Properties (as listed in the Table for section 19 of O.Reg. 359/09). It also confirmed there are no heritage resources – other than those described in the section. 19 Table – at the project location.

WA - The Water Assessment found: that there are “*no water bodies present on, or within 120 metres of the Project Location. In addition, no seepage areas were observed on or within 120 metres of the Project Location.*”

**Conclusion:** No negative environmental effects attributable to the Design of the REGF are anticipated as a result of findings from the required studies under O.Reg 359/09; therefore, neither mitigation measures nor monitoring are necessary.

## 4.0 FACILITY OPERATION

Pursuant to Item 3 for DOR in Table 1 of O.Reg. 359/09, proponents shall set out conceptual plans, specifications and descriptions related to the **Operation** of the REGF, including descriptions of:

- i. Water Taking (n/a) No water takings associated with the operation of the facility are planned. During the operations phase of the project, Penn anticipates that it will clean the modules twice per year. The duration of the module cleaning scope of work is approximately one week. It is anticipated that the module cleaning process will use not more than 30,240 liters of water per day on any day.
- ii. Sewage (n/a) No sewage will be produced.
- iii. Air contaminants (n/a) No air contaminants are expected to be discharged from the REGF.
- iv. Bio/Organic Waste (n/a) No biomass, source separated organics or farm material will be accepted or used at the facility.
- v. Other Waste (n/a) No waste will be generated as a result of the solar power generation process.

The MOE’s publication “Technical Guide to Renewable Energy Approvals” (2011) states that with respect to Solar Projects

*“Solar energy projects may have unique considerations that should be discussed in the Operational Plan. Some examples include (amongst others determined by the applicant):*

- *How the land upon which the solar modules are mounted will be managed to maintain specified land use conditions. This could include procedures to limit the growth of vegetation. This should be described if such activities have the potential to cause negative environmental effects; and*





- *How solar modules will be maintained including a description of all maintenance activities, their frequency, and any operational details that contribute to the evaluation of negative environmental effects.*

#### 4.1 Daily Function

One of the attributes of solar PV generation that sets it apart from other power sources is the passive nature of the system components. Coupled with monitoring and communications technology/SCADA, this passive nature allows for remote operations support. With that said, a caretaker (possibly living onsite) will regularly attend to the facility, albeit primarily for non-operations related purposes (see Ancillary Activities, below). No negative environmental effects attributable to the Daily Function of the REGF are anticipated pursuant to the requirements of O.Reg 359/09; therefore, neither mitigation measures nor monitoring are necessary.

#### 4.2 Planned Maintenance

Regularly scheduled service activities will be conducted at the proposed REGF throughout the operational phase, the majority of which will occur once or twice per year. Due to the scarcity of moving parts in solar PV generation components – in comparison to other forms of power generation – maintenance work will consist primarily of visual inspection of equipment & accessories to verify they are functioning properly and to ensure all connections (structural and electrical) are secure. It also entails cleaning or replacing filters and managing spare parts and consumables. On a related note, the need for un-planned maintenance may arise (e.g. due to failure of equipment/accessories or weather-related issues). Once a problem is identified – most likely via the remote monitoring and support system – a properly trained individual or team will be dispatched to diagnose and address the issue.

#### 4.3 Ancillary Activities

Activities that are supplementary to the operational portions of the facility include: grass maintenance; removal of invasive vegetation, debris and combustible materials; snow removal; monitoring for animal activity and related damage. During the operations phase of the REGF, grass maintenance will include regular mowing, within the facility and the landscaped areas outside the perimeter fence along the southern boundary. An area that is a maximum of 5 m wide on the outside of the perimeter fence will also be mowed regularly to ensure that no woody vegetation would become established where it could cause damage to the fence or shade the solar modules. Additionally, there is a possibility that fencing, security & communications systems, internal lane-ways, site entrance drive, collection houses, HVAC equipment, etc. may occasionally need repairs. This work will be implemented as necessary by an individual or team properly trained to address the issue.



#### 4.4 Potential Negative Environmental Effects<sup>b</sup>

As noted earlier, no negative environmental effects are expected from the Daily Function of the REGF and no monitoring or mitigation is warranted.

##### 4.4.1 Significant Natural Heritage Features (according to the NHA/EIS)

No negative environmental effects are anticipated as a result of findings from studies required pursuant to O.Reg 359/09. The records review and site investigation confirmed that *“there are no natural features within the project location nor the adjacent lands.”* The closest natural features are the Fairfield Plain Wetland (not provincially significant) which is approximately 140 metres from the Project Location. The next closest natural feature appears to be woodlands approximately 0.5km to the east.

Mitigation was employed by avoiding disturbance within 120 metres of any natural features.

##### 4.4.2 Water Bodies

No negative environmental effects are anticipated as a result of findings from studies required pursuant to O.Reg 359/09. The *Water Assessment Report* by Savanta, Inc. found: that there are *“no water bodies present on, or within 120 metres of the Project Location. In addition, no seepage areas were observed on or within 120 metres of the Project Location.”*

##### 4.4.3 Archeological and Cultural Heritage Features (according to the AA and CHS)

No negative environmental effects are anticipated as a result of findings from studies required pursuant to O.Reg 359/09. A Stage 1 and 2 Archaeological Assessment found: *“...intensified pedestrian survey/Stage 2 excavation of the fields within the subject property did not result in the recovery of sufficient material to be considered a site, nor to proceed to Stage 3 assessment (Stand. 1. a. i, (1), (3), Sect. 2.2, MTC, 2011). It is therefore the recommendation of this report that no further archaeological work is required within the development area.”* The Ministry of Tourism and Culture has reviewed the assessment and has concurred with the findings therein.

Mitigation was employed to address archaeological finds by creating a 70 metre buffer from found European items.

The *Cultural Heritage Screening* by Unterman McPhail Associates found that the proposed REGF is neither located on nor abuts any Protected Properties (as listed in the Table for section 19 of O.Reg. 359/09). It also confirmed there are no heritage resources – other than those described in the s. 19 Table – at the project location.

##### 4.4.4 Acoustic Receptors (according to the AAR)

No negative environmental effects are anticipated as a result of findings from studies required pursuant to O.Reg 359/09. The *Acoustic Assessment Report* by HGC Engineering concluded the following...

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<sup>b</sup> Much of the information in Subsections 3.2, 4.4 and Section 5 is taken from other reports prepared for this REA application, for example, the *Natural Heritage Assessment and Environmental Impact Study Report* by Savanta, Inc. (NHA/EIS), the *Cultural Heritage Screening Results* by Unterman McPhail Associates (CHS), the *Archaeological Assessment (Stages 1 and 2) Report* by Northeastern Archaeological Associates (AA), the *Water Assessment Report* by Savanta, Inc. (WA) and the *Acoustic Assessment Report* by HGC Engineering (AAR). Please refer to these companion reports for more detailed information.



*“The acoustic analysis indicates that the predicted sound levels of the facility will be within the applicable sound level limits specified in MOE guidelines NPC-232, during all hours of the day and night, under typical ‘predictable worst case’ operating conditions at all identified existing off-site receptor locations.*

**Conclusion:** Through mitigation by avoidance, no negative environmental effects attributable to the Daily Function of the REGF are anticipated.

## **5.0 ENVIRONMENTAL EFFECTS MONITORING PLAN (EEMP)**

Pursuant to Item 4 for DOR in Table 1 of O.Reg. 359/09, proponents shall include an **Environmental Effects Monitoring Plan (EEMP)** in respect of any negative environmental effects that may result from engaging in the renewable energy project, setting out

- i. Performance objectives in respect of the negative environmental effects,
- ii. Mitigation measures to assist in achieving the performance objectives mentioned in subparagraph i,
- iii. A program for monitoring negative environmental effects for the duration of the time that the project is engaged in, including a contingency plan to be implemented if any mitigation measures fail.

The MOE’s publication “Technical Guide to Renewable Energy Approvals” (2011) suggests that the EEMP should include the following, using summary tables and text descriptions as well as references to other reports as required:

- *A summary of all potential negative environmental effects caused by the project as given in the description of negative environmental effects in the Project Description Report. This summary is included for context.*
- *Performance objectives in respect of each potential negative effect. Performance should be defined such that in achieving the objective the negative effect will be mitigated.*
- *A description of all mitigation strategies planned to achieve performance objectives.*
- *Where there is an ongoing risk of potential negative environmental effects, description of how the project will be monitored to ensure that mitigation strategies are meeting performance objectives.*



## 5.1 An Excerpt from the Project Description Report (PDR)

**Table 2.** Section 4 – Potential (Negative) Environmental Effects:

Cultural Heritage & Archeological (MTC) [5.1]	In respect of Protected Properties, Unterman McPhail Associates (UMA) of Toronto, ON has screened the property and verified that the proposed project is <b>not</b> located on <b>nor</b> does it abut any protected properties as described in Column 1 of the Table to section 19 of O.Reg. 359/09. UMA also verified there are <b>no</b> other heritage resources at the project location (in addition to defined protected properties). A Stage 1 and 2 Archaeological Assessment Report was prepared by Northeastern Archaeological Associates of Port Hope, ON. A small number of European artifact fragments were found in an area near the existing house and the project was subsequently modified to avoid this area. Four isolated chert flakes and one base were found in separate locations onsite but did not result in the recovery of sufficient material to be considered a site, nor to proceed to Stage 3 assessment. MTC issued concurrence with these findings on September 25, 2012.
Natural Heritage (MNR) [5.2] <i>Woodlots, valleylands, wildlife habitat, provincial parks, conservation areas &amp; reserves, flora/fauna species of concern &amp; habitat, protected natural areas (e.g. ANSI), and locally important or valued ecosystems or vegetation...within 300m of RE project</i>	The REGF is not located within 120m of a Provincial Park or Conservation Reserve, nor is it within 50m of an ANSI-earth science. A Natural Heritage Assessment (NHA) as prescribed by O.Reg. 359/09 has been prepared by Savanta, Inc finding no natural features within the Project Location nor within a 120m boundary. The NHA reports' findings have been confirmed by the MNR. No negative environmental impacts pursuant to O.Reg 359/09 are anticipated.
Water Bodies (CA, MNR) [5.3]	A Water Assessment has been prepared by Savanta, Inc. There are no water bodies within the Project Location or an adjacent property.
Air, Odour, Dust [5.4]	No odors or dust emissions are produced from the solar power generation process.
Noise [5.5]	Minimal sound is emitted by the solar power generation process. The panels, racking and wiring – which comprise the majority of the REGF – produce virtually no sound. The inverter and transformer, however, do produce some noise – which will be studied in accordance with O.Reg. 359/09. It is anticipated that the prescribed noise limits will be adhered to via careful positioning of the suspect equipment, adequately distanced from any receptors.
Land Uses [5.6] (past & present; onsite & nearby)	According to the current zoning bylaw, this parcel is zoned "Extractive Industrial" but it has been farmed for ginseng following the completion of extraction activities. It is surrounded by agriculturally zoned land that is currently being used for various farming operations, except for land to the north of this site that is being used for aggregate purposes (also zoned Extractive Industrial).
Provincial & Local Infrastructure [5.6]	No negative environmental effect is anticipated on provincial and local services and infrastructure. The REGF requires no public water, sewer or gas services. While there will be a temporary increase of truck traffic on local roads during the few months of construction, there will be almost no traffic generated by this REGF once construction is complete
Livestock Impacts [5.6]	Per Ontario Energy Board standards, the project perimeter will be fences limiting potential for livestock to enter the facility
Public Health & Safety [5.8]	No negative environmental effect on public health and safety is anticipated. In fact, <b>there are numerous benefits provided by generating solar power</b> , which is why the provincial government is encouraging it. The facility will be surrounded by a fence for safety and security.



<b>Provincial Plan Areas</b> [5.9] <i>(Greenbelt, Oak Ridge Moraine, Niagara Escarpment, Lake Simcoe Watershed)</i>	Not Applicable, since project is not within any known PPA.
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## 5.2 EEMP for Facility Design

Subsequent to significant site plan modifications throughout the design phase, no negative environmental effects are attributable to the Design of the REGF pursuant to O.Reg 359/09. Therefore, neither mitigation measures nor monitoring are necessary.

## 5.3 EEMP for Facility Operation phase

As noted earlier, no negative environmental effects are expected from the Daily Function of the REGF pursuant to O.Reg 359/09.

**Table 3.** EEMP for all identified Potential Negative Environmental Effects:

None. Mo monitoring program is proposed as no Potential Negative Environmental Effects were found in the NHA/EIS, AA or WA pursuant to O.Reg 359/09.

## 6.0 RESPONSE AND COMMUNICATIONS PLAN

Pursuant to Item 5 for DOR in Table 1 of O.Reg. 359/09, proponents shall include a **Response Plan** setting out a description of the actions to be taken while engaging in the renewable energy project to inform the public, aboriginal communities and municipalities (Township and County)<sup>c</sup> with respect to the project, including

- i. Communication Methods: Measures to provide information regarding the activities occurring at the project location, including emergencies **(see 6.1, below)**
- ii. Contact Details: Means by which persons responsible for engaging in the project may be contacted **(see 6.2)**, and
- iii. Response Procedures: Means by which correspondence directed to the persons responsible for engaging in the project will be recorded and addressed. **(see 6.3)**

The MOE's publication "Technical Guide to Renewable Energy Approvals" suggests that the Response Plan should include the following components:

*c The proposed REGF is not located within the jurisdiction of a local roads board or a local services board, but both the upper-tier and lower-tier municipal bodies were consulted throughout the due diligence and design phases of this project. Feedback received from the Township and County representatives is documented in the Draft Consultation Report which is another component of the complete REA application package which will be submitted to the Ministry of the Environment (MOE) for review and approval.*



- **Contact Details:** A plan for communications in the event of an emergency including key contact information and a description of the chain of communications between the proponent and relevant responders under emergency scenarios applicable to the project. **(see 6.2, below)**
- **Communication Methods:** Description of how the information will be disseminated to all relevant responders such as the local fire department. **(see 6.1)**
- **Non-Emergencies:** A plan for non-emergency communications related to the project. This should describe how the public and other organizations will be provided information about the project. This could include notification of any project changes, results of the ongoing project monitoring, or other matters considered relevant by the applicant. **(see 6.1 thru 6.3)**
- **Response Procedures:** A plan for receiving communications from the public and any stakeholder. This should describe how the public and any stakeholders will be directed to correspond with the proponent, how correspondence will be recorded, how the proponent will address any concerns raised, and the communications plan for the response. This should also describe if/how correspondence will be shared with other stakeholders such as the Ministry of the Environment. The procedure for recording any complaints from the public should include the following: **(see 6.3)**
  - (a) Recording each complaint in a log book or in an electronic file. The information recorded shall include name, address and the telephone number of the complainant; time and date of the complaint, details of the complaint; actions taken to remediate the cause of the complaint; and proposed actions to be taken to prevent reoccurrence in the future.
  - (b) Notifying the Ministry's Spills Action Centre at 1-800-268-6060 of the receipt of the complaint.

## 6.1 Communication Methods

Throughout all site-related phases (construction, operation and decommissioning) of the REGF, signage with instructions and contact information for emergencies and non-emergencies will be posted for the public and any stakeholder.

### 6.1.1 Emergencies

1. Immediately dial **911** for all emergencies.
2. Then call REGF proponent's representative: **1-610-668-0300**.

### 6.1.2 Non-Emergencies

1. Contact the REGF proponent's representative via phone, fax or post. (see 6.2.2 for details)

## 6.2 Contact Details

### 6.2.1 Emergencies

1. Phone: **911**
2. Owner's representative: **1-610-668-0300** (Penn Energy Renewables)



### 6.2.2 Non-Emergencies

1. Owner's representative: Penn Energy Renewables
  - a. **1-610-668-0300** phone
  - b. **1-610-668-0365** fax
  - c. **620 Righters Ferry Road, Bala Cynwyd, PA 19004 USA**

## 6.3 Response Procedures

### 6.3.1 Emergencies

1. Owner's representative will follow-up with local authorities and remain in contact as appropriate until the emergency is resolved.

### 6.3.2 Non-Emergencies

1. All inquiries from the public or any stakeholder will be directed to an appropriate team member for a verbal or written response.
2. All written correspondence will be saved in digital format and will include:
  - a. name, address and telephone number of inquirer;
  - b. time and date of initial contact; and
  - c. if appropriate, action(s) proposed to resolve any issues and prevent reoccurrence.
3. Proponent may share inquiry and response with appropriate stakeholder (e.g. local jurisdiction, provincial ministry, etc.).
4. In the event of a qualifying spill, proponent will notify the Ministry's Spills Action Centre at 1-800-268-6060 following receipt of the complaint.

## 7.0 CONSIDERATION OF OTHER LAND USE PLANNING LAWS

### 7.1 Niagara Escarpment **(not applicable)**

The proposed REGF is not located within the Niagara Escarpment Plan Area.

### 7.2 Lake Simcoe Watershed **(not applicable)**

The proposed REGF is not located within the Lake Simcoe Watershed.

### 7.3 Oak Ridges Moraine **(not applicable)**

The proposed REGF is not located on land subject to the Oak Ridges Moraine Conservation Plan.

### 7.4 Greenbelt **(not applicable)**

The proposed REGF is not located within the Protected Countryside of the Greenbelt.





## 8.0 ADDITIONAL REPORTS

### 8.1 Effluent Management Plan Report (not applicable)

The proposed REGF is not an anaerobic digestion or thermal treatment facility.

### 8.2 Emission Summary & Dispersion Monitoring Report (not applicable)

The proposed REGF is not an anaerobic digestion, thermal treatment or bio-fuel facility.

### 8.3 Environmental Impact Study Reports

None required.

### 8.4 Hydro-geological Assessment Report (not applicable)

The proposed REGF is not an anaerobic digestion or thermal treatment facility.

### 8.5 Odour Study Report (not applicable)

The proposed REGF is not an anaerobic digestion or bio-fuel facility.

### 8.6 Noise Study Report

Please refer to the Acoustic Assessment Report (under separate cover) by HGC Engineering.

### 8.7 Property Line Setback Assessment Report (not applicable)

The proposed REGF is not a wind energy project.

### 8.8 Surface Water Assessment Report (not applicable)

The proposed REGF is not an anaerobic digestion or thermal treatment facility.

### 8.9 Water Bodies Assessment Report

As documented in the *Water Assessment* by Savanta, Inc. (under separate cover), the results of the records review and site investigations identified no lake trout lakes in or within 300m of the REGF Project Location, nor any features that meet the O.Reg. 359/09 definition of “water bodies” in or within 120m of the REGF Project Location; therefore, a Water Bodies Report is unnecessary.





## APPENDICES

- A. Site Plans
- B. Solar Photovoltaic (PV) Modules
- C. Array Racking
- D. Array Foundations
- E. Collection Houses and Low-Voltage (DC) Accessories
- F. Inverters
- G. Secondary Transformers (at collection houses)



## APPENDIX 'A'

### Site Plans





28°

9.40m

3.599m

5.801m

3.599m

4.076m

±3.0m

±1.0m

28°

4.076m

±3.0m

±1.0m

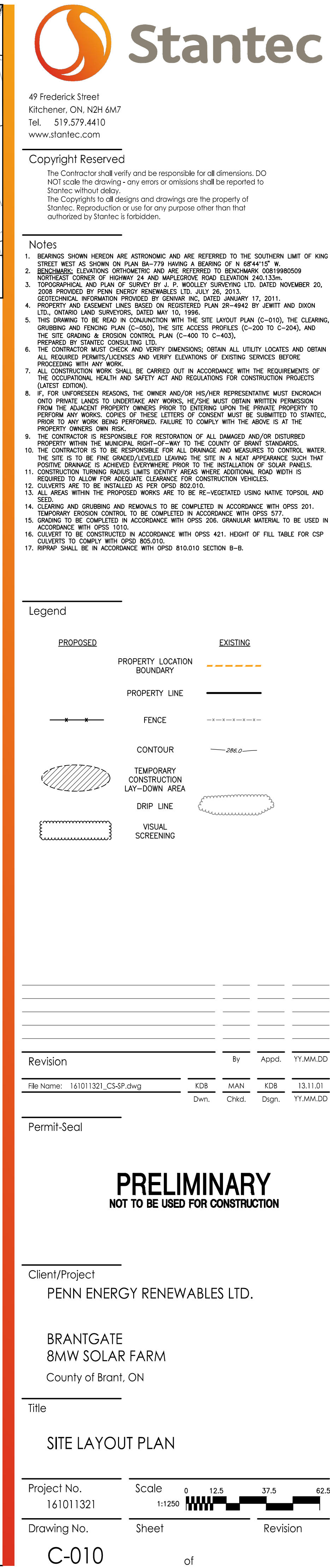
NOTE:

1. TABLE LENGTH = 18.00m

2. 0.3m PROVIDED BETWEEN TABLES (AT 0% GRADE)

**TYPICAL TOE-TO-TOE INSTALLATION**

NTS





## **APPENDIX 'B'**

### Solar Photovoltaic (PV) Modules



# MaxPower CS6X

**280/285/290/295M**



## Key Features

- Industry largest silicon solar module, generating more Watt per panel and reducing BOS cost
- 6 years product warranty (materials and workmanship); 25 years module power output warranty
- Industry leading plus only power tolerance: +5W (+1.7%)
- Strong framed module, passing mechanical load test of 5400Pa to withstand heavier snow load
- The 1st manufacturer in the PV industry certified for ISO:TS16949 (The automotive quality management system) in module production since 2003
- ISO17025 qualified manufacturer owned testing lab, fully complying to IEC, TUV, UL testing standards

## All-purpose Module

MaxPower CS6X is a robust solar module with 72 solar cells. These modules can be used for on-grid solar applications. Our meticulous design and production techniques ensure a high-yield, long-term performance for every module produced. Our rigorous quality control and in-house testing facilities guarantee Canadian Solar's modules meet the highest quality standards possible.

## Applications

- Utility
- Commercial/industrial roof-tops
- Rural area applications
- Other on-grid and off-grid applications

## Quality Certificates

- IEC 61215 / IEC 61730, UL 1703, CEC Listed, CE, MCS
- ISO9001: 2008: Standards for quality management systems
- ISO/TS16949:2009: The automotive quality management system

## Environment Certificates

- ISO14001:2004: Standards for Environmental management systems
- QC080000 HSPM: The Certification for Hazardous Substances Regulations



# CS6X-280/285/290/295M

## MaxPower

### Electrical Data

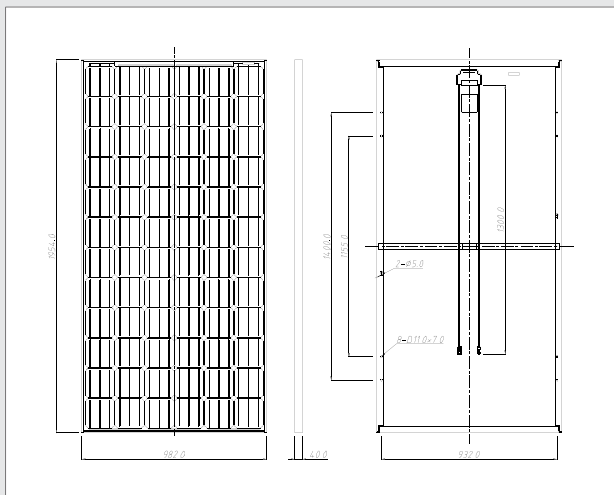
	CS6X-280M	CS6X-285M	CS6X-290M	CS6X-295M
Nominal Maximum Power at STC (Pmax)	280W	285W	290W	295W
Optimum Operating Voltage (Vmp)	36.0V	36.1V	36.3V	36.4V
Optimum Operating Current (Imp)	7.78A	7.89A	8.00A	8.11A
Open Circuit Voltage (Voc)	44.6V	44.7V	44.7V	44.9V
Short Circuit Current (Isc)	8.30A	8.40A	8.51A	8.63A
Operating Temperature	-40°C~+85°C			
Maximum System Voltage	1000V (IEC) /600V (UL)			
Maximum Series Fuse Rating	15A			
Power Tolerance	+5W			
Temperature Coefficient	Pmax	-0.45%/°C		
	Voc	-0.35 %/°C		
	Isc	0.06 %/°C		
	NOCT	45°C		

Under Standard Test Conditions (STC) of irradiance of 1000W/m<sup>2</sup>, spectrum AM 1.5 and cell temperature of 25°C

### Mechanical Data

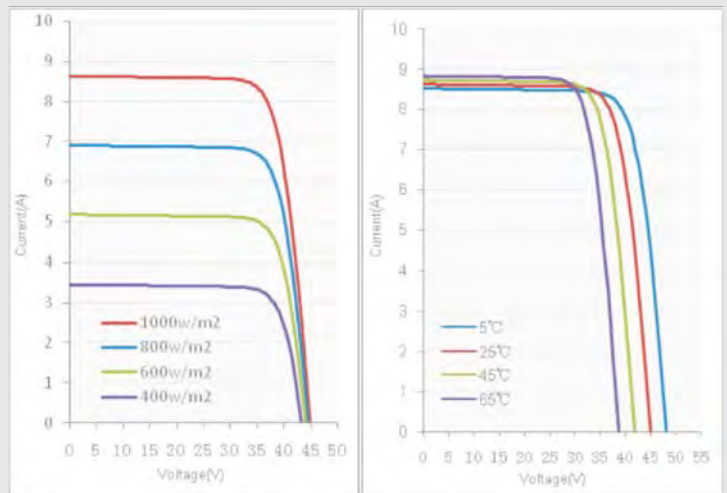
Cell Type	Mono-crystalline
Cell Arrangement	72 (6 x 12)
Dimensions	1954 x 982 x 40mm (76.93 x 38.7 x 1.57in)
Weight	27kg (59.52 lbs)
Front Cover	Tempered glass
Frame Material	Anodized aluminium alloy
Standard Packaging (Modules per Pallet)	20pcs

### Engineering Drawings



\*Specifications included in this datasheet are subject to change without prior notice.

### I-V Curves (CS6X-295M)



### About Canadian Solar

Canadian Solar Inc. is one of the world's largest solar companies. As a leading vertically-integrated manufacturer of ingots, wafers, cells, solar modules and solar systems. Canadian Solar delivers solar power products of uncompromising quality to worldwide customers. Canadian Solar's world class team of professionals works closely with our customers to provide them with solutions for all their solar needs.

Canadian Solar was founded in Canada in 2001 and was successfully listed on NASDAQ Exchange (symbol: CSIQ) in November 2006. Canadian Solar has expanded its cell capacity to 800MW and module capacity to 1.3GW in 2010.

Headquarters | 650 Riverbend Drive, Suite B  
Kitchener, Ontario | Canada N2K 3S2  
Tel: +1-519-954-2057  
Fax: +1-519-578-2097  
inquire.ca@canadiansolar.com  
www.canadiansolar.com

## MaxPower CS6X

265/270/275/280/285P



### Key Features

- Industry largest silicon solar module, generating more Watt per panel and reducing BOS cost
- 6 years product warranty (materials and workmanship); 25 years module power output warranty
- Industry leading plus only power tolerance: +5W (+1.8%)
- Strong framed module, passing mechanical load test of 5400Pa to withstand heavier snow load
- The 1st manufacturer in the PV industry certified for ISO:TS16949 (The automotive quality management system) in module production since 2003
- ISO17025 qualified manufacturer owned testing lab, fully complying to IEC, TUV, UL testing standards

### All-purpose Module

MaxPower CS6X is a robust solar module with 72 solar cells. These modules can be used for on-grid solar applications. Our meticulous design and production techniques ensure a high-yield, long-term performance for every module produced. Our rigorous quality control and in-house testing facilities guarantee Canadian Solar's modules meet the highest quality standards possible.

### Applications

- Utility
- Commercial/industrial roof-tops
- Rural area applications
- Other on-grid and off-grid applications

### Quality Certificates

- IEC 61215 / IEC 61730, UL 1703, CEC Listed, CE, MCS
- ISO9001: 2008: Standards for quality management systems
- ISO/TS16949:2009: The automotive quality management system

### Environment Certificates

- ISO14001:2004: Standards for Environmental management systems
- QC080000 HSPM: The Certification for Hazardous Substances Regulations



# CS6X-265/270/275/280/285P

## MaxPower

### Electrical Data

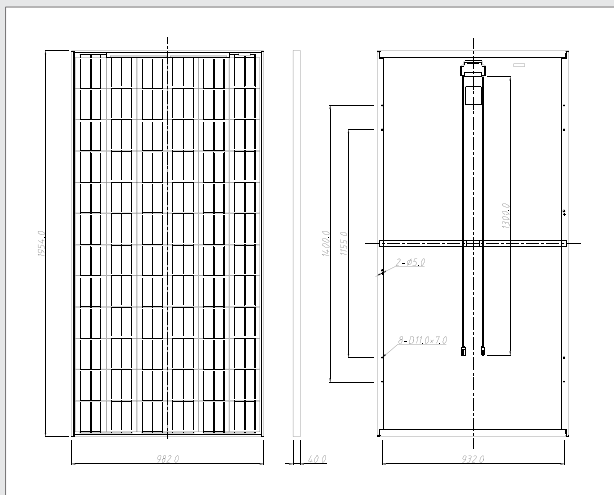
	CS6X-265P	CS6X-270P	CS6X-275P	CS6X-280P	CS6X-285P
Nominal Maximum Power at STC (Pmax)	265W	270W	275W	280W	285W
Optimum Operating Voltage (Vmp)	35.1V	35.3V	35.5V	35.6V	35.8V
Optimum Operating Current (Imp)	7.55A	7.65A	7.76A	7.86A	7.96A
Open Circuit Voltage (Voc)	43.9V	44.1V	44.1V	44.2V	44.3V
Short Circuit Current (Isc)	8.10A	8.19A	8.31A	8.42A	8.53A
Operating Temperature	-40°C~+85°C				
Maximum System Voltage	1000V (IEC) /600V (UL)				
Maximum Series Fuse Rating	15A				
Power Tolerance	+5W				
Temperature Coefficient	Pmax	-0.43%/°C			
	Voc	-0.34 %/°C			
	Isc	0.065 %/°C			
	NOCT	45°C			

Under Standard Test Conditions (STC) of irradiance of 1000W/m<sup>2</sup>, spectrum AM 1.5 and cell temperature of 25°C

### Mechanical Data

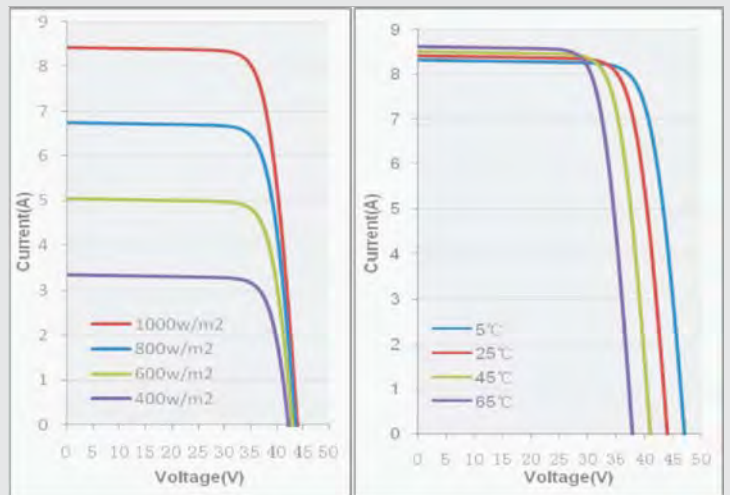
Cell Type	Poly-crystalline
Cell Arrangement	72 (6 x 12)
Dimensions	1954 x 982 x 40mm (76.93 x 38.7 x 1.57in)
Weight	27kg (59.52 lbs)
Front Cover	Tempered glass
Frame Material	Anodized aluminium alloy
Standard Packaging (Modules per Pallet)	20pcs

### Engineering Drawings



\*Specifications included in this datasheet are subject to change without prior notice.

### I-V Curves (CS6X-280P)



### About Canadian Solar

Canadian Solar Inc. is one of the world's largest solar companies. As a leading vertically-integrated manufacturer of ingots, wafers, cells, solar modules and solar systems. Canadian Solar delivers solar power products of uncompromising quality to worldwide customers. Canadian Solar's world class team of professionals works closely with our customers to provide them with solutions for all their solar needs.

Canadian Solar was founded in Canada in 2001 and was successfully listed on NASDAQ Exchange (symbol: CSIQ) in November 2006. Canadian Solar has expanded its cell capacity to 800MW and module capacity to 1.3GW in 2010.

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Fax: +1-519-578-2097  
inquire.ca@canadiansolar.com  
www.canadiansolar.com



## APPENDIX 'C'

### Array Racking



# GROUND-MOUNT for FRAMED Solar Panels



Use ordinary mounting hardware, and a single array of solar panels can take almost 45 minutes to assemble and install in the field. Use the Solar FlexRack, and your array can be set up and ready for sliding in of framed panels in under THREE minutes! And the flow of installation continues uninterrupted: as workers are finishing bolting down one Solar FlexRack, the next one is already being positioned in place.

**Over \$500,000  
in Labor Cost Savings per  
10MW Project**

Do the math: during a full workday, a crew that installs 10 sets of ordinary mounting hardware should be able to install as many as ONE HUNDRED FIFTY Solar FlexRacks! What will that do for your project's cost per watt?

#### Key features:

- pre-assembled for easy installation
- lightweight for easy handling
- passes both snow and wind load criteria
- adapts to a variety of ground posts
- multiple configurations available:  
2 x 4, 2 x 6, 2 x 10, 2 x 12
- custom configurations upon request
- ships economically on a flatbed truck
- corrosion-resistant

*"...the pre-assembly of these units has greatly increased our installation rates. We think the product is great..."*

**Tom Hughes –  
M. Sullivan & Sons Ltd**



U.S. and International: 1-888-380-8138 | Canada: 1-613-366-2008  
www.SolarFlexRack.com

**THE FUTURE IS UNFOLDING...QUICKLY**

**SOLAR  
FLEXRACK**  
THE FUTURE IS UNFOLDING...QUICKLY



# GROUND-MOUNT for FRAMED Solar Panels



The Solar FlexRack can accommodate solar modules in both portrait and landscape orientation. Installation is fast and easy, and the Solar Flex Rack's unique power-grab clip facilitates the installation of heavy modules. When you combine this with the installation speed of the Solar FlexRack itself, you can greatly reduce your balance of system cost by using the Solar FlexRack.

**Over \$500,000**  
*in Labor Cost Savings per*  
**10MW Project**

#### **Solar FlexRack features:**

- pre-assembled at the factory
- unfolds at the site for easy installation
- lightweight for easy handling
- PE-certified for wind and snow loads
- adapts to a variety of ground posts
- complete wire management via innovative cable tray design

*"...proven to be an exceptional product"*

Matthew Leslie – *enXco*

*"...a revolutionary cost saver"*

David Weinberg – *Apogee Solar*

*FIT compliant*

U.S. and International: 1-888-380-8138 | Canada: 1-613-366-2008  
[www.SolarFlexRack.com](http://www.SolarFlexRack.com)

**THE FUTURE IS UNFOLDING...QUICKLY**

**SOLAR FLEXRACK**  
THE FUTURE IS UNFOLDING...QUICKLY



# ISYS GROUND MOUNT

Imagine BIG Possibilities

## Subassembly

ISYS' unique, smart design allows for pre-fabrication of subassemblies prior to delivery to project sites.

**Specifications:** 50 ksi A653-G50 Carbon Steel  
G90 Hot Dipped Galvanized Coating

## Warranty

ISYS is covered by a 20-year limited product warranty. For complete warranties, visit our website at [www.unirac.com](http://www.unirac.com).

## Foundation

Engineered to accommodate every foundation option (driven pile, pre-cast concrete ballast, screw type earth auger, traditional excavation and concrete pier), ISYS adapts to the project site and enables customers to select the most cost-effective foundation system for their project site.

## Hardware

Mounting hardware is galvanized, which is also less expensive than stainless steel.

## I-beams

The I-beam components are manufactured by cold rolling, one of the most efficient manufacturing processes, which is significantly more affordable than aluminum ground mount systems.

**Specifications:** 50 ksi A653-G50 Carbon Steel  
G90 Hot Dipped Galvanized Coating

# KEY BENEFITS

## of ISYS Ground Mount

### Bigger and Better

- Extreme strength-to-weight ratio provides longer spans with minimized foundation points
- Bigger components means fewer connections and alignment issues

### Superior Value

- Lowest total installed cost in solar
- Installs at a rate of 10 modules per man hour
- Designed to work specifically with your module
- Adapts to any site conditions = cost-effective foundation systems
- Economical steel components and galvanized hardware

### Assemble, don't Build

- No fabrication required
- Repeatable installations
- No field drilling or welding

### Complete technical support

- Array design, engineering and installation support
- All structural materials from one source



# And Cost Effective To Boot.



(javascript:void(0))

## Key Benefits

Packed with innovative features, the ISYS Ground Mount is fastest, strongest, most revolutionary PV ground mount solution ever! Optimized for commercial and utility projects ranging from 500 kilowatts to gigawatts and custom designed for each customer's module and site conditions.



pre-assembly saves you money

## Pre-Assemble & Save.

The ISYS Ground Mount allows the pre-assembly of your module columns prior or in parallel to the installation of foundations and racking. Additionally, contractors can build the subassembly or grade land while assembling all modules to our rails in a controlled environment. Both options offer a shorter project turn-around time and reduce field-labor, saving you money.

## Adapts to Any Site

Engineered to accommodate virtually every foundation option, the ISYS Ground Mount easily adapts to any project site by allowing customers to select the most cost-effective foundation system for their specific project site.

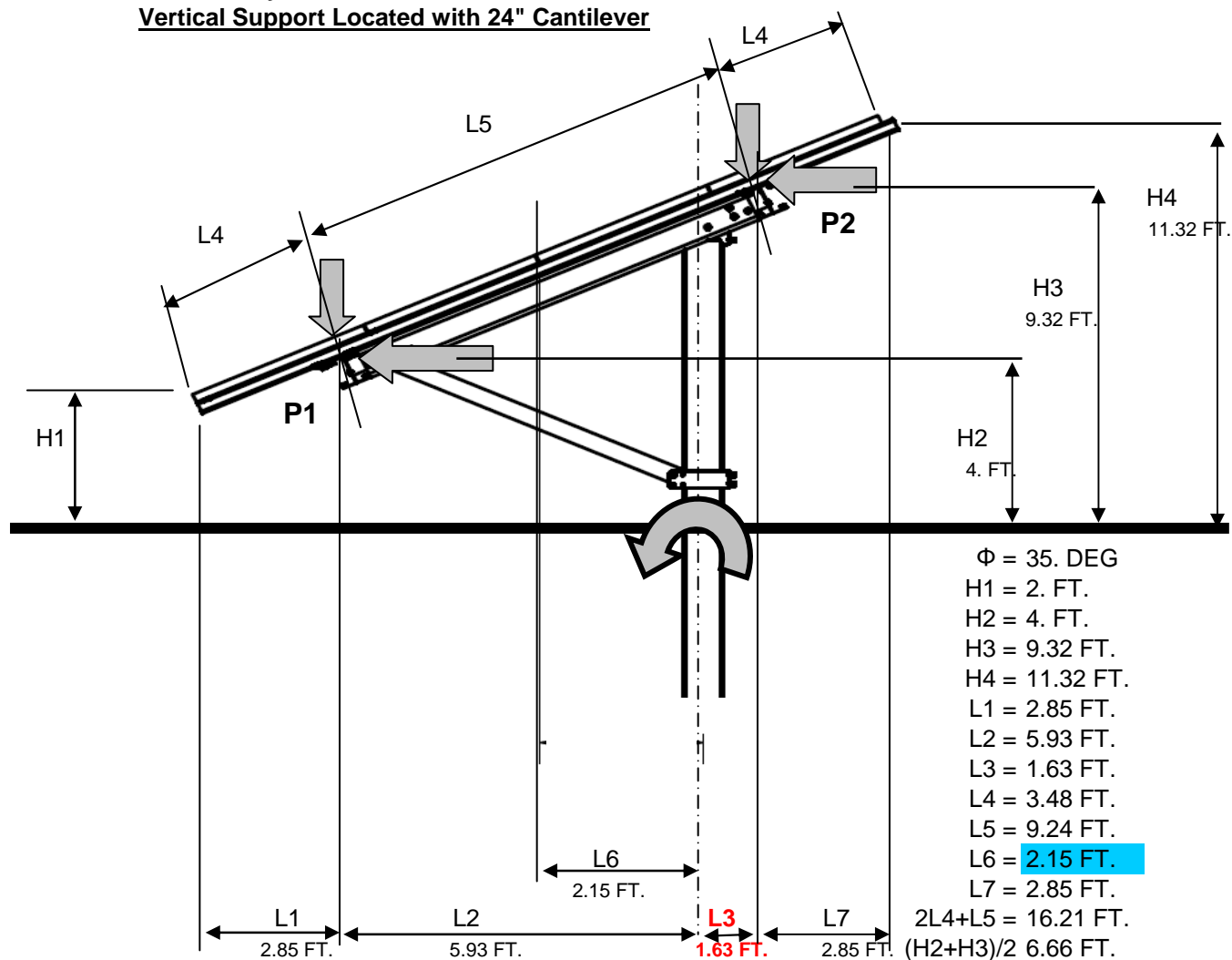


highly adaptable to all foundations

DATE: 10-Nov-10  
 SUBJECT: Fdn Reactions  
 BY: VAM



**5r x 7c array**  
**Vertical Support Located with 24" Cantilever**



AREA OF ARRAY:

611.86

AREA TO ONE COL:

305.93

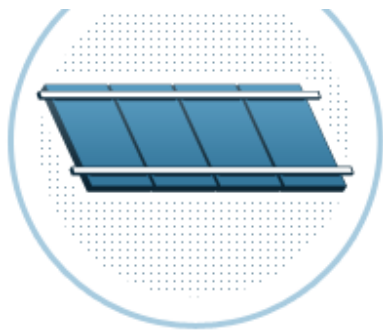
	DEAD	SNOW	WIND <sub>VERT</sub>	WIND <sub>HORZ</sub>	MAXIMUM REACTIONS		
	kips	kips	kips	kips	MOMENT	AXIAL	SHEAR
	1.25	4.69	2.10	1.47			
1.4 D	1.75				3.77	1.75	
1.25D+1.5S+0.4W	1.57	7.03	0.84	0.59	24.20	9.44	0.59
1.25D+0.5S+1.4W	1.57	2.34	2.94	2.06	28.41	6.85	2.06
0.9D+1.4W*	1.13		-2.94	-2.06	-17.58	-1.81	-2.06

Note: W is for downforce, W\* is for uplift



### Assemble, Don't Build

With no absolutely fabrication, field drilling or on-site welding required, scalable & repeatable installations are a snap.



### Subassembly Options

A unique, smart design allows for pre-fabrication of subassemblies prior to delivery to project sites with specific challenges, with the ability to



### Superior Value

With the lowest total installed cost in solar, the ISYS Ground Mount installs at a rate of 10 modules per hour.



### Full Technical Support

Our experienced application engineers will help you optimize your design for maximum power density and return on investment.

## Adaptable & Cost Effective Components

Large, galvanized components make for the most versatile, adaptive and cost effective ground mount system available.



(/sites/default/files  
/igm\_s3\_lrg\_comp4.jpg)

### I-beams

The I-beam components are manufactured by cold rolling, one of the most efficient manufacturing processes, which is significantly more affordable than aluminum ground mount systems.



(/sites/default/files  
/igm\_s3\_lrg\_comp1.jpg)

### Slide Clip



(/sites/default/files  
/igm\_s3\_lrg\_comp2.jpg)

### Diagonal Brace

All mounting hardware, such as slide clips, diagonal braces, and U-clamps, is galvanized. This is less expensive than competitive stainless steel products.



(/sites/default/files  
/igm\_s3\_lrg\_comp3.jpg)

### U-Clamp

## A Total Commitment To Quality

Single sourced materials, quality craftsmanship and truly innovative design, couple



project, and topped with a limited 20 year warranty. Put any concerns to rest, we have you covered with the best warranty in the industry.



Tested, Then Tested Again

Each and every ISYS Ground Mount system we sell has been through a rigorous quality control process, ensuring your system work from day 1.



A 20 Year Warranty, Though Chances Are You'll Never Need It

It is unlikely you will ever need it, but rest easy knowing we have you covered with an industry best, limited part 20-year warranty.



A Large Team of Multi-Disciplinary Engineers & Dedicated Project Managers At Your Service

Our large team of multi-disciplinary engineers and Project Managers bring both expertise and rigor to each and every project, identifying all the steps necessary to optimize product and project performance, out of the gate and over time.

Functional and Beautiful.



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# ISYS™ GROUND MOUNT

## Imagine Big Possibilities



Ground Mount  
Solution

### Introducing the fastest, strongest, most revolutionary PV ground mount solution ever!

Designed to deliver the most cost effective systems with the most responsive and scalable supply chain, ISYS is optimized for commercial and utility projects ranging from 500 kilowatts to gigawatts and custom designed for each customer's module and site conditions.

The extreme strength to weight ratio of components make ISYS the clear choice for large scale PV projects.

ISYS is assembled in the field, not built. The components require zero fabrication – no field welding, drilling, or cutting. Through smart design and pre-fabricated sub-assemblies, ISYS is one of the fastest systems to install with the least amount of labor.



Visit us online at [www.unirac.com](http://www.unirac.com)

# Bright Thinking in Solar



**Our experienced application engineers will help you optimize your design for maximum power density and return on investment.**

Assisted and supported by a dedicated Project Manager from our Utilities and Commercial Systems Group, a team devoted to supplying a complete suite of services, Unirac provides structural design services, on-site installer training, delivery logistics and field support to ensure accurate installation.

All structural materials for the array come from a single source, specifically packed and designed to work with each customer's module and site conditions.



Visit us online at [www.unirac.com](http://www.unirac.com)

## APPENDIX 'D'

### Array Foundations







## Innovative Solar Foundations and Racking







## About us

**TerraFix Solarpark provides comprehensive photovoltaic and solar thermal ground mount solutions for commercial and utility-scale projects.**

Our expertise is in fixed mounting systems and tracking towers. Our patented concrete-free earth screw foundations uniquely position us to create solutions for the most challenging projects. We are able to install over 40 different earth screw models for use in all geologies, from bedrock to marshy soil. TerraFix Solarpark racking is robust and fully customizable to all topographies.

Our technologies are well tested, as we have successfully deployed over 280 MW of installed capacity throughout Europe and North America.

### Our services include:

Engineering • Array Planning & Layout • Designing • Developing • Implementing



## Advantages

### Earth Screws – Concrete-free Foundations

- No grading required, we avoid the need for concrete foundations and earth moving.
- Minimal Ecological Impact.
- Quick installation up to 100 screws per day – per machine and immediately ready for racking in all weather conditions.
- Easy to remove and reuse.
- Recyclable.
- Foundation solutions for slopes up to 38 degrees.
- Galvanized or stainless steel, composed of single, pressed steel pipe, stronger and more corrosion resistant than welded earth screws.
- Sustains wind loads up to 110 mph and snow loads of 50 psf.
- Earth screws can be loaded immediately (no hardening times, such as for concrete).
- Fast project implementation with any racking system.
- Earth screws do not affect the groundwater.



over  
**280 MW**  
installed







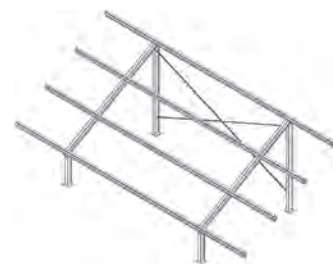
## Racking Systems

**Our racking solutions are robust and can be quickly adapted to suit various wind speeds and terrains.**

We provide project specific designs to match string layouts and the local wind and snow conditions. Our racking can be installed rapidly with most panel types. We use height adjustable racks to accommodate varying terrain.

- A typical racking configuration in portrait orientation is 2 panels high and 7 to 8 panels long.
- In landscape orientation, a typical configuration is 4 panels high and 5 long.

The support frames and fasteners are hot dipped galvanized. Base plates of the frames are bolted to earth screw foundations. Support rails are made of aluminum and span up to 24 ft.



## Advantages

### Racking Systems

- 10 year guarantee: remarkably durable and corrosion resistant with high quality materials. All parts are hot dipped galvanized, stainless steel and aluminum.
- Maximum resistance to high wind speeds (110+ mph) and snow loads (up to 50 psf).
- No grading required: Our racking system is able to follow the contour of any terrain.
- Our continuous racking system uses fewer components, thus maximizing capacity, minimizing cost and lowering maintenance.
- Individual planning, designing and engineering for each project.
- Portrait and Landscape orientation options available.
- We install in the optimal angle for best performance.
- Our system is ideal for thin film, PV and solar thermal.
- Complete systems include earth screws, racking, panel clamps and grounding.

Adjustable  
racking enables  
contouring





# Earth Screw Types



# Compression, Tensile, Lateral Load Testing



# Installation Process



- We have over 40 different anchor models for uses across all geologies spanning from hard bedrock to loose marshy soils.



## ■ Geotechnical capacity table for Terrafox earth screws Type TR1.5-SP3, TR1.5-SP3F

Length: 5', pipe Diameter: 3", Spindle width: 0.6", wing diameter: 5.5"  
Based on on-site tests with maximal deformation in vertical direction of < 1 mm  
Based on on-site tests with maximal deformation in horizontal direction of < 20 mm

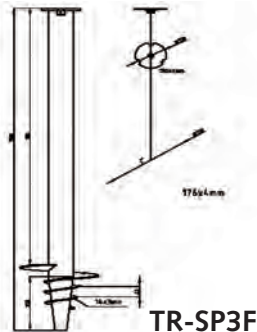
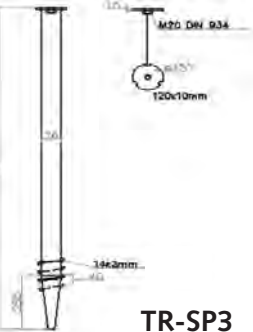
Soil Type	Screw Type	Load Type	Geotechnical Capacity Range			
			lower lbs	upper lbs	lower kN	upper kN
Rock	TR1.5-SP3 - Spindle only	Tension Load	6000	8000	26,7	35,6
		Compression load	8000	10000	35,6	44,4
		Lateral load	2000	3000	8,9	13,3
A Clays, Silty clay, Sandy clays, Clay loam	TR1.5-SP3 - Spindle only	Tension Load	3000	6000	13,3	26,7
		Compression load	4000	7000	17,8	31,1
		Lateral load	1000	2000	4,4	8,9
	TR1.5-SP3F - Spindle and Wing	Tension Load	4000	7000	17,8	31,1
		Compression load	5000	8000	22,2	35,6
		Lateral load	1500	2500	6,7	11,1
B Silt, Silt loam, Sandy Loam	TR1.5-SP3F - Spindle and Wing	Tension Load	1500	2000	6,7	8,9
		Compression load	2000	3000	8,9	13,3
		Lateral load	700	1300	3,1	5,8
C Gravel, Sand Loamy Sand	TR1.5-F - Wing only	Tension Load	1000	1500	4,4	6,7
		Compression load	1500	2000	6,7	8,9
		Lateral load	500	1000	2,2	4,4

1. Evaluate terrain, ground type and required loads to determine applicable anchor.
2. Land survey to determine earth screw locations.
3. Drill pilot hole (if required): rock drill, chisel breaker
4. Install earth screw



- For optimized earth screw installation, we modify excavators: Our hydraulic attachments are customized for controlled torque.

# Earth Screw Specifications





Environmental protection begins with a solid,  
environmentally friendly foundation





Krinner Ground Screws  
provide a solution for  
almost every  
foundation job

**KRINNER**  
Ground Screws







## *Environment*

- *No compression of large areas*
- *Terrain remains undamaged*
- *No interference to spoil surrounding area*
- *Long service life*
- *Cheap and easily removable*
- *Reusable*

## *Costs And Technology*

- *Foundation provided in minutes*
- *No installation waiting time*
- *Can be subjected to loads immediately*
- *Maintenance free*
- *Installation under all weather conditions*
- *Minimum personnel requirements*
- *Cheaper than common foundations*
- *No digging – No concrete*
- *Precise positioning*



## The KRINNER installation equipment



Skid Steer mounted  
on tracks to protect  
the ground surface  
on the building site

One man  
operation possible  
for high cost  
efficiency



A man in blue overalls stands next to a red KRINNER Ground Screw installation machine in a grassy field. In the background, rows of solar panels are visible under a cloudy sky.

*KRINNER is the leading manufacturer of Screw In Foundations for solar fields in Europe. The unique, environmentally friendly, time and cost saving foundation system is used for installations of solar fields and tracker systems in Germany, Spain, France, Italy, Greece and the USA. Where common concrete foundations usually consume a tremendous amount of installation time and money, the KRINNER Ground Screws can be installed in a quarter of the time and are less expensive. The special installation equipment contributes to an almost invisible impact on the building site. And last but not least, the Ground Screws are easy to remove and re-usable.*

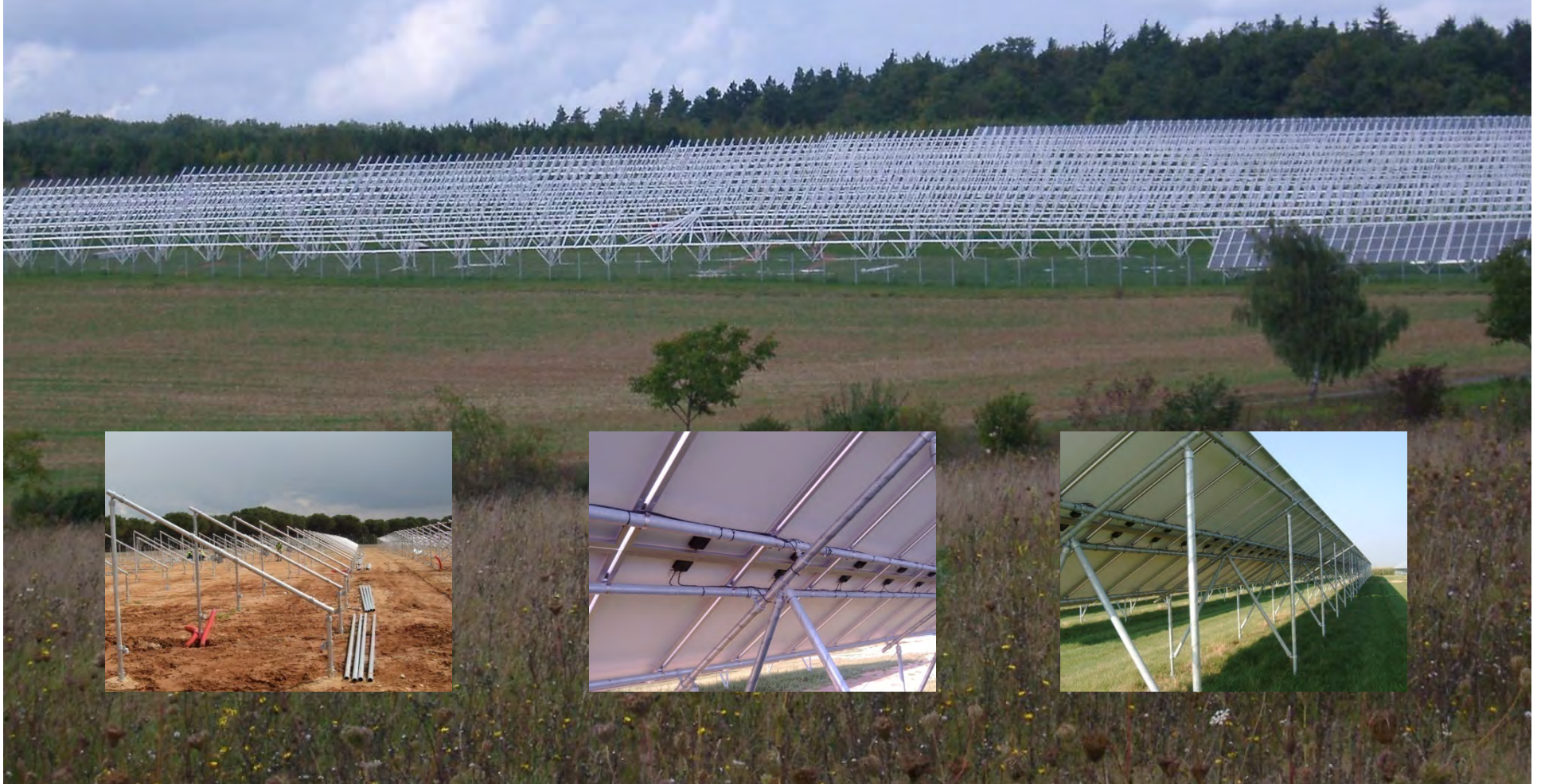


The KRINNER foundation and  
assembly system





KRINNER Ground Screws also provides  
a KRINNER created, easy to install  
rack system for solar panels





Bobcat mounted installation  
mast  
movie



# **KRINNER**

Screw-in Support Systems







Represented in  
Canada and USA

by  
InnoTec Trading Ltd.

Call 1-888-395-7776

Sales Representative

Doug Steven  
Phone: 1-250-791-6547  
[dougsteven@innotectrading.com](mailto:dougsteven@innotectrading.com)  
[www.innotectrading.com](http://www.innotectrading.com)

## APPENDIX 'E'

### Collection Houses and Low-Voltage (DC) Accessories



# MV POWER PLATFORM 1.0 / 1.25 / 1.44 / 1.5 / 1.6 MW with SUNNY CENTRAL CP-US



## Economical

- Outdoor equipment doesn't require HVAC additions, even in desert environments
- Reduced balance of system costs with 1000 VDC, UL 1741 listed inverters

## Efficient

- Highest efficiency in its class
- Full nominal power at ambient temperatures up to 50 °C
- 10% additional power for continuous operation at ambient temperatures up to 25 °C

## Flexible

- Available as open, shaded or enclosed structure
- Options including DC disconnects, transformer fluid containment, and -40 °C low temperature deployment

## Reliable

- Powerful grid management functions, including LVRT and Frequency Ride Through
- Rigorous environmental testing

## MV POWER PLATFORM 1.0 / 1.25 / 1.44 / 1.5 / 1.6 MW with SUNNY CENTRAL CP-US

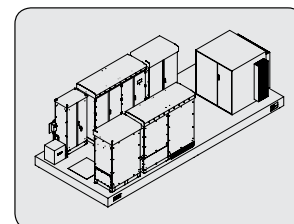
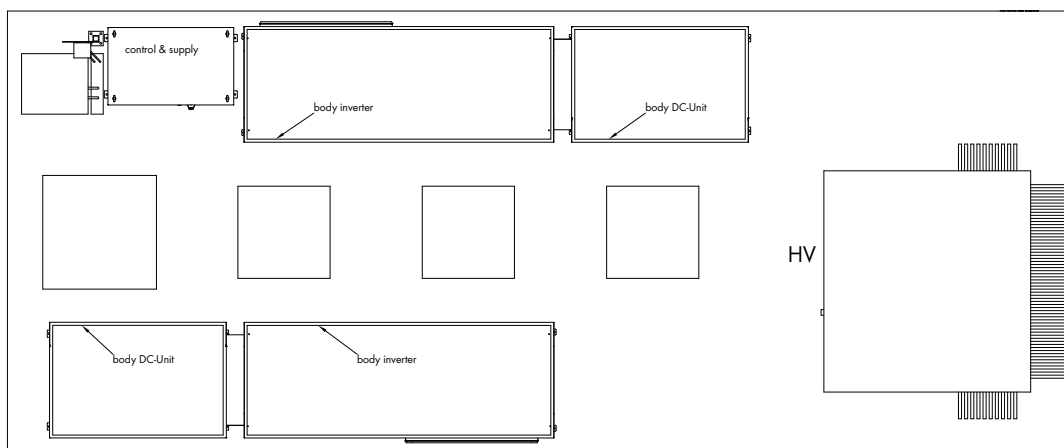
Modular utility-scale power platform

Ensure your project's success and increase your return on investment with SMA's Medium-Voltage Power Platform featuring 1,000 VDC, UL listed Sunny Central inverters. These turnkey 1.0 to 1.6 megawatt solutions include two Sunny Central inverters, a harmonized medium-voltage step-up transformer, optional DC disconnects, integrated AC disconnects, and low voltage auxiliary services for local loads. SMA's MV Power Platform minimizes project risks through convenient plug-and-play installation, a Seismic Zone D compliant design, best in class efficiency, and more than 30 years experience in the world's largest PV plants.



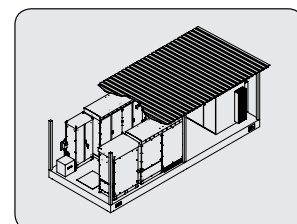
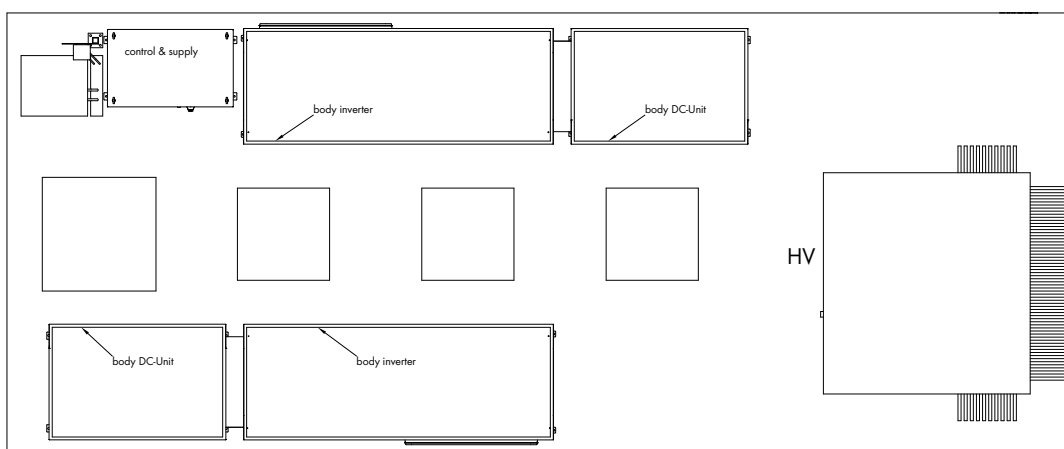
Technical data	SAMPLE CONFIGURATIONS		
	MVPP 1.0 MW	MVPP 1.5 MW	MVPP 1.6 MW
	1000 V DC	1000 V DC	1000 V DC
<b>Input (DC)</b>			
Max. DC power	1120 kW	1706 kW	1796 kW
MPP voltage range (@ 77 °F/122 °F at 60Hz)	430 V ... 820 V / 430 V ... 820 V <sup>a)</sup>	545 V ... 820 V / 545 V ... 820 V <sup>a)</sup>	570 V ... 820 V / 570 V ... 820 V <sup>a)</sup>
Rated input voltage	480 V	595 V	620 V
Max. DC voltage	1000V	1000V	1000V
Max. DC input current	2500 A	3200 A	3200 A
Number of independent MPP inputs	2	2	2
Number of fused DC inputs	18 / 64 (Optiprotect)	18 / 64 (Optiprotect)	18 / 64 (Optiprotect)
<b>Output (AC)</b>			
Nominal AC power	1000 kVA @122 °F	1500 kVA @122 °F	1600 kVA @122 °F
Maximum AC power	1100 kVA @77 °F	1650 kVA @77 °F	1760 kVA @77 °F
Nominal AC voltage options	12.47 kV; 13.8 kV; 20.6 kV; 24.9 kV; 27.6 kV; 34.5 kV	12.47 kV; 13.8 kV; 20.6 kV; 24.9 kV; 27.6 kV; 34.5 kV	12.47 kV; 13.8 kV; 20.6 kV; 24.9 kV; 27.6 kV; 34.5 kV
Total harmonic distortion of grid current	< 3 % @ nominal power	< 3 % @ nominal power	< 3 % @ nominal power
Grid frequency	50 Hz / 60 Hz	50 Hz / 60 Hz	50 Hz / 60 Hz
Power factor (adjustable)	0.80 <sub>lead</sub> - 0.80 <sub>lag</sub>	0.80 <sub>lead</sub> - 0.80 <sub>lag</sub>	0.80 <sub>lead</sub> - 0.80 <sub>lag</sub>
Transformer vector group	Dy1y1	Dy1y1	Dy1y1
Transformer no load taps	±2.5 % & ±5.0 %	-5.0 %; -2.5 %; +2.5 %; +5.0 %; +7.5 %; +10.0 %	-5.0 %; -2.5 %; +2.5 %; +5.0 %; +7.5 %; +10.0 %
Transformer cooling type	KNAN	KNAN	KNAN
<b>Power consumption</b>			
Internal consumption in operation (inverter + MV-transformer) <sup>c)</sup>	< 3400 VA + < 10.1 kVA	< 3400 VA + < 14.6 kVA	< 3400 VA + < 15.7 kVA
Standby consumption (inverter + MV-transformer)	< 200 VA + < 1100VA	< 200 VA + < 1600 VA	< 200 VA + < 1700 VA
Supply via	● / ○	● / ○	● / ○
integrated control power supply /external power supply			
External auxiliary supply voltage	208 V; 480 V; 600 V	208 V; 480 V; 600 V	208 V; 480 V; 600 V
<b>Efficiency</b>			
Inverter max. efficiency / European efficiency / CEC efficiency	98.50% / 98.30% / 98.00%	98.60% / 98.40% / 98.00%	98.70% / 98.40% / 98.50%
MVPP system efficiency	> 97.5%	> 97.5%	> 97.5%

## OPEN CONFIGURATION



	SAMPLE CONFIGURATIONS		
Technical data	MVPP 1.0 MW	MVPP 1.5 MW	MVPP 1.6 MW
	1000 V DC	1000 V DC	1000 V DC
Protection rating and ambient conditions			
Protection rating	NEMA 3R	NEMA 3R	NEMA 3R
Operation temperature range @ nominal power	-4°F ... +122°F	-4°F ... +122°F	-4°F ... +122°F
Storage temperature standard / low temperature option	-4°F ... +140°F / -40°F ... +140°F	-4°F ... +140°F / -40°F ... +140°F	-4°F ... +140°F / -40°F ... +140°F
Relative humidity	15 % ... 95 %	15 % ... 95 %	15 % ... 95 %
Snow load (psf)	>40	>40	>40
Wind load (mph)	>110	>110	>110
Fresh air consumption (CFM)	3531.6	3531.6	3531.6
Max. altitude above sea level (m)	2000	2000	2000
Design lifetime (years)	>20	>20	>20
Compliance and certificates			
Seismic rating according UBC sec. 1632 and IBC sec. 1613 <sup>d)</sup>	Site class D, S <sub>s</sub> =2.0g, S1=1.0g	Site class D, S <sub>s</sub> =2.0g, S1=1.0g	Site class D, S <sub>s</sub> =2.0g, S1=1.0g
NEC 2011 / OSHA 1910	● / ●	● / ●	● / ●
PE certificate on mechanical, electrical, seismic for California / other state	● / ○	● / ○	● / ○
Inverter certificates and approvals	EMC conformity according to FCC, Part 15, Class A, UL 1741, UL 1998, IEEE 1547		
Features			
Disconnect Unit	○	○	○
AC circuit breakers integrated in inverters	●	●	●
Project specific power supply for tracker motors etc.	○	○	○
Auxiliary power fusible disconnect switch / overvoltage protection	● / ○	● / ○	● / ○
Customer SCADA system compartment <sup>a)</sup>	34" x 30" x 12", Supply: 120V/60Hz/max 250W	34" x 30" x 12", Supply: 120V/60Hz/max 250W	34" x 30" x 12", Supply: 120V/60Hz/max 250W
Auxiliary service power	2x 120V/ max. 250W each	2x 120V/ max. 250W each	2x 120V/ max. 250W ea
Transformer alarm contacts: Thermo / Pressure / Fluid level	● / ○ / ○	● / ○ / ○	● / ○ / ○
Transformer oil containment	○	○	○
Delivery Ex-Works / on site	● / ○	● / ○	● / ○

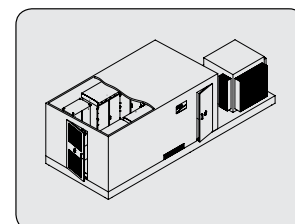
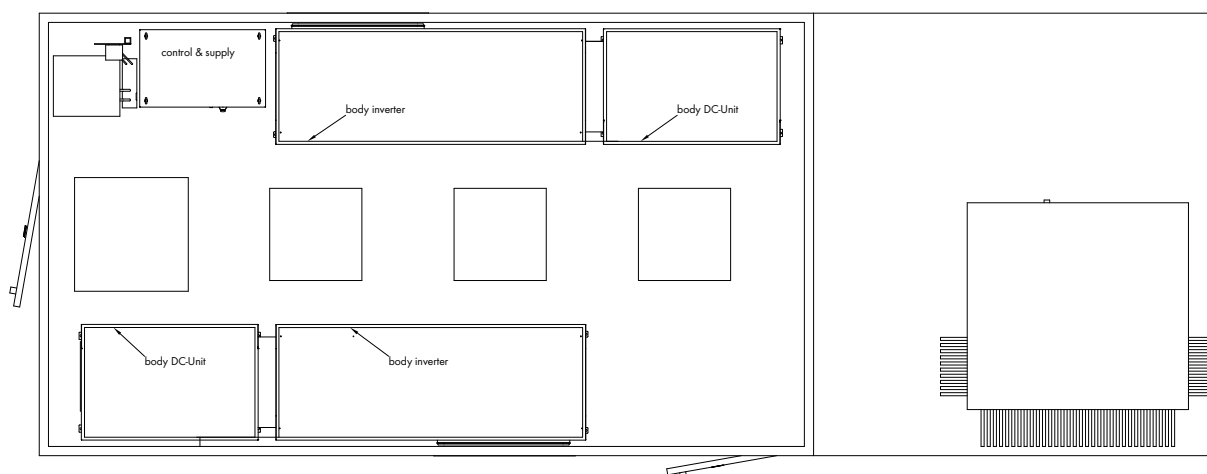
## CANOPY CONFIGURATION



Technical data	SAMPLE CONFIGURATIONS		
	MVPP 1.0 MW	MVPP 1.5 MW	MVPP 1.6 MW
	1000 V DC	1000 V DC	1000 V DC
<b>Platform design</b>			
Open including Disconnect Units			
Width / Height / Depth	29' / 8'9" / 12'	29' / 8'9" / 12'	29' / 8'9" / 12'
Weight (lb)	<39,000	<39,000	<39,000
Open excluding Disconnect Units			
Width / Height / Depth	24' / 8'9" / 12'	24' / 8'9" / 12'	24' / 8'9" / 12'
Weight (lb)	<34,000	<34,000	<34,000
Canopy including Disconnect Units			
Width / Height / Depth (roof)	31' / 10'6" / 14'	31' / 10'6" / 14'	31' / 10'6" / 14'
Weight (lb)	<42,000	<42,000	<42,000
Canopy excluding Disconnect Units			
Width / Height / Depth (roof)	26' / 10'6" / 14'	26' / 10'6" / 14'	26' / 10'6" / 14'
Weight (lb)	<37,000	<37,000	<37,000
Enclosure including Disconnect Units			
Width / Height / Depth	32' / 10'6" / 12'	32' / 10'6" / 12'	32' / 10'6" / 12'
Weight (lb)	<48,000	<48,000	<48,000
Enclosure excluding Disconnect Units			
Width / Height / Depth	27' / 10'6" / 12'	27' / 10'6" / 12'	27' / 10'6" / 12'
Weight (lb)	<43,000	<43,000	<43,000
● Standard features   ○ Optional features   – Not available			
Type designation	MV-1000CP-US	MV-1500CP-US	MV-1600CP-US

- a) @ 1.00  $U_{AC,com}$  and  $\cos \varphi = 1$   
b) Standard: 1000 V DC, optional 1100 V DC with a start-up < 1000 V DC  
c) Not including platform auxiliary service loads  
d) Pier height 3 ft max.  
e) Suitable to -13 °F ... +140 °F, has to include buffer module

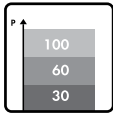
## ENCLOSED CONFIGURATION





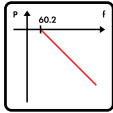
# SMART GRID MANAGEMENT INCLUDED

SMA inverters in the MV Power Platform can fulfill the following grid management specifications with:



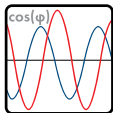
## Power limitation peak shaving / grid safety management

In order to avoid short-term grid overload, the grid operator presets a nominal active power value which the inverter will implement within 60 seconds. The nominal value is transmitted to the inverters via a ripple control receiver in combination with the SMA Power Reducer Box. Typical limit values are 100, 60, 30, or 0 percent of the nominal power.



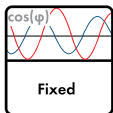
## Frequency-dependent control of active power

Starting at a defined grid frequency, the inverter will automatically reduce the fed-in active power along a preset characteristic curve, which stabilizes grid frequency.



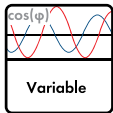
## Grid support through reactive power

In order to keep the grid voltage constant, SMA inverters supply leading or lagging reactive power to the grid. For this, there are three options:



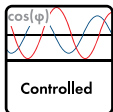
### a) Fixed presetting of the reactive power by the grid operator

The grid operator presets a fixed reactive power value or a fixed phase shift between  $\cos(\varphi)$  leading = 0.9 and  $\cos(\varphi)$  lagging = 0.9.



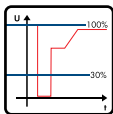
### b) Dynamic presetting of the reactive power by the grid operator

The grid operator presets a dynamic phase shift - any value between  $\cos(\varphi)$  leading = 0.9 and  $\cos(\varphi)$  lagging = 0.9. It is transmitted either through a communication unit or via a standardized current signal ( $I=4\ldots20$  mA) in accordance with IEC.



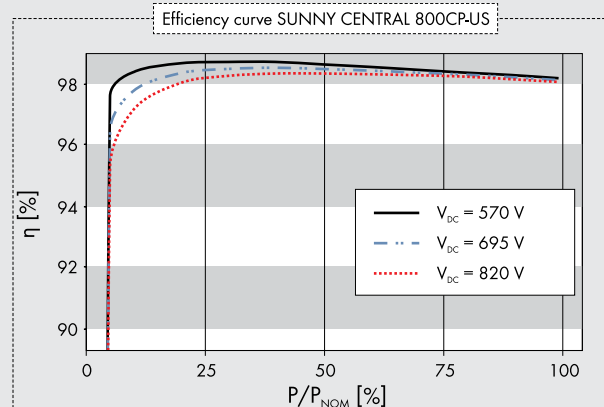
### c) Control of the reactive power through a characteristic curve

Either the reactive power or the phase shift is controlled by a pre-defined characteristic curve - depending on the fed-in active power or grid voltage.



## LVRT (Low Voltage Ride-Through)

Until now, PV systems have had to disconnect from the grid immediately even during short grid voltage losses. Using the monitored dynamic grid support, SMA inverters can feed in immediately after short-term voltage losses—as long as the nominal voltage exceeds fixed values.



# SERVICE FOR POWER PLANT SOLUTIONS

With a PV plant's expected service life exceeding 20 years, careful consideration must be given to not just the technologies used but also the reliability and durability of a system's components. Likewise, a comprehensive plan must be in place for the maintenance and operation of the plant. SMA Service for PV power plants addresses these needs and ensures optimum inverter availability – providing integrators, investors and utilities with the greatest security possible.

SMA also understands that every PV power plant is different and requirements vary. That's why we developed a modular service approach specifically designed for large power plants. This allows our customers to define individual service packages that best meet their needs. Approaching 100 service locations worldwide, SMA Service guarantees outstanding local customer support through a variety of customizable packages.



## **Maintenance**

To optimize system performance, SMA performs controls, cleaning and parts replacement at regular intervals. This preventative maintenance is important for long term operation.



## **Spare parts warranty**

Whether electronic or mechanical, we guarantee the availability of all components over the duration of the complete system life cycle. Our customers can be confident that even as technologies evolve, SMA's support will be constant. This guarantee also provides additional cost security for the operational life of the inverter solution.



## **Diagnostics and repair**

Beginning with remote service, which often eliminates on-site assistance, to First Level, (diagnostics and small repairs), or Second Level Support, (comprehensive repairs), SMA offers the proper service plan for our customers' needs. Customers can optionally administer First Level Support themselves. With local staff to assist, SMA Service quickly provides the appropriate response to any situation.



## **Inverter availability**

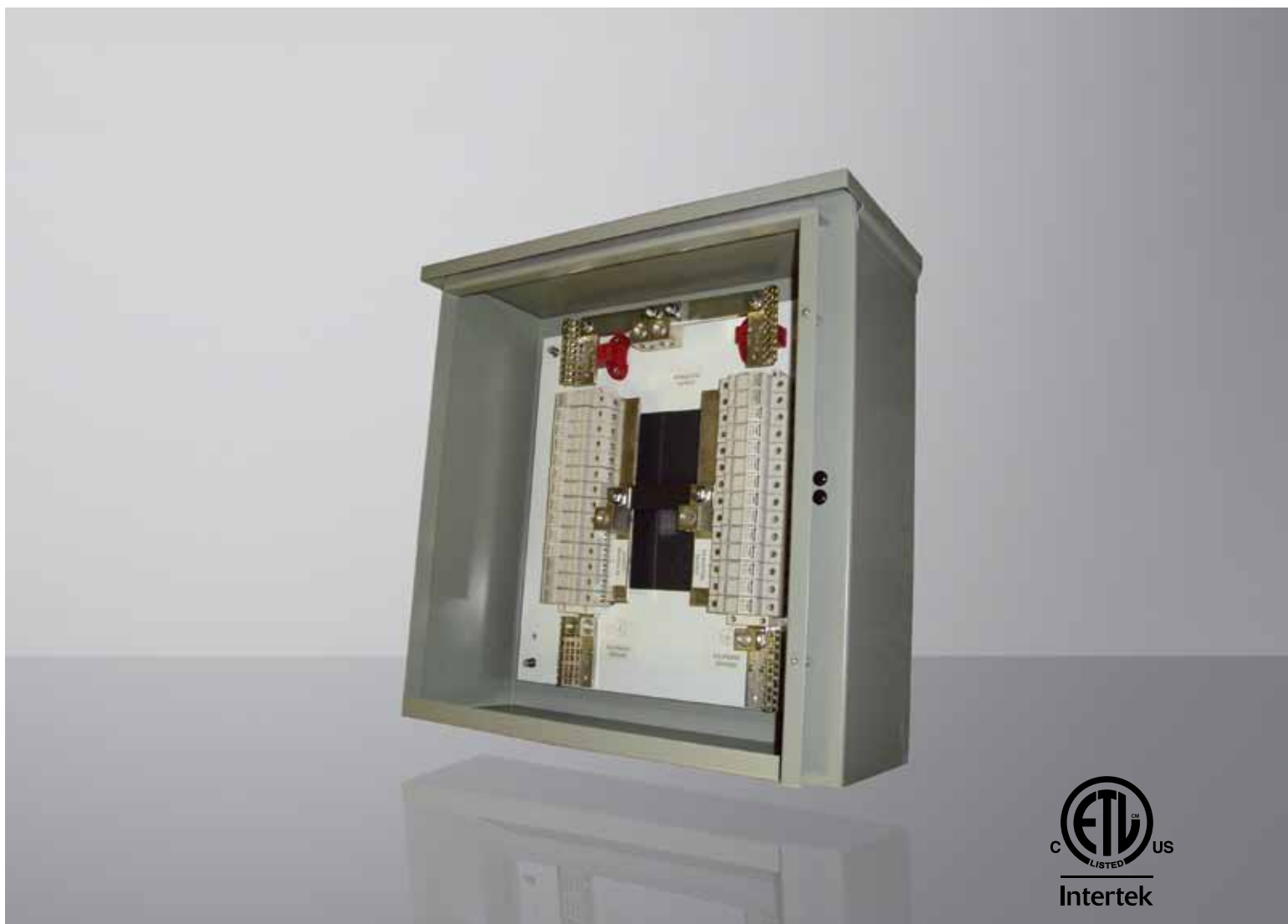
SMA inverters lead the industry. Our customers know our world-class manufacturing and high-quality components result in a superior solution. To fully protect investment security, SMA offers two inverter uptime guarantees: 98 or 99 percent. With these guarantees, we will reimburse the customer for the difference between the actual and agreed-upon inverter uptime. With warranty periods up to 25 years in length, SMA can also guarantee our solution's performance for the life of the PV plant.

## **Need more information?**

Call SMA Power Plant Solutions at +1 888 476 2872 to hear more.



## SUNNY BOY/SUNNY CENTRAL COMBINER BOXES



### Certified

- ETL Listed to UL 1741 for countries that require certification

### Convenient

- Greatly simplifies input and output wiring
- Available in 6 to 52 circuit configurations

### Reliable

- Reliable bus-work for efficient high current conductor combining
- Compact, rugged NEMA 3R/4 wall mount steel enclosure

### Safe

- PV positive wires all land directly on Touch Safe™ fuse holders

## SUNNY BOY/SUNNY CENTRAL COMBINER BOXES

Simplify wiring for added convenience and safety

SMA's Sunny Boy/Sunny Central Combiner Boxes are ETL Listed to UL 1741 for countries requiring certification. Available in sizes ranging from six to 52 PV inputs, they provide greater flexibility and expandability in system design. Oversized bus-work adds high efficiency and dependability where it's needed most. The large NEMA 3R/4 enclosure provides ample room for conductors, which reduces installation time. Designed with installers in mind, the Sunny Boy/Sunny Central Combiner Boxes save valuable time and resources while improving system design and reliability.





# DISCONNECT UNIT



## Compliant

- Full compliance to safety standards of NEC 2011

## Flexible

- Adaptable to all US inverters
- Extendable up to six switch-disconnectors
- Available with or without AC switch

## Compact

- All load break switches in one enclosure
- Available as integrated part of a complete MV block

## Safe

- Easy access and fast handling
- Reliable separation even under full load

## DISCONNECT UNIT

Full NEC conformity in a single enclosure

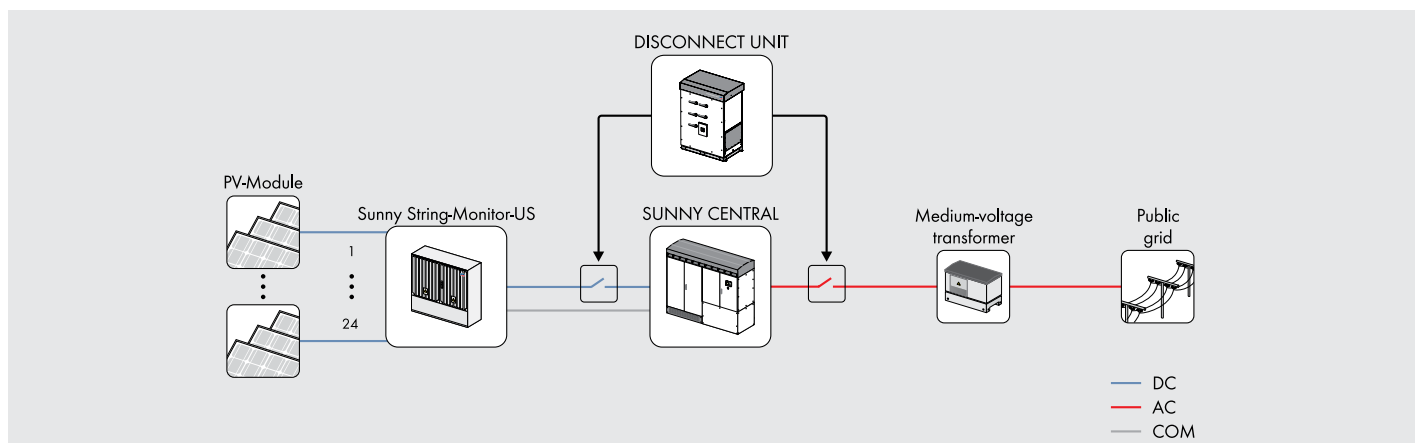
The new Disconnect Unit combines all safety measures into a single, compact enclosure. It is suited perfectly for North American Sunny Central inverters in 600 V to 1000 V systems. All load break switches are located on a single switchboard, working under full load conditions and ampacity reserves required by the NEC 2011. The switching handles are installed directly on the front to identify the switching status easily. This guarantees a secure and fast separation of all energy from the inverter in case of emergency or maintenance.

Technical data	Disconnect Unit 600V	Disconnect Unit 1000V
<b>Input (DC)</b>		
DC voltage range	0 V – 600 V	0 V – 1000 V
Max. nominal DC current	1600 A	1600 A
Number of DC inputs	4 ... 10	6 – 10
Max. current / input (without reduction factors)	450 A	450 A
<b>Data (DC switch)</b>		
Switch type	Switch-disconnector	Switch-disconnector
Max. short-circuit current	20 kA RMS	20 kA RMS
Number of DC switching handles	2 – 5	3 – 5
<b>Data (AC switch)</b>		
Switch type	SC250-US: switch-disconnector, SC500HE-US/CA: switch-disconnector, SC500-US: switch-disconnector	Circuit breaker
AC voltage range	128 V – 528 V	128 V – 528 V
AC switch current / max. short-circuit current	400 A / 200 kA, 800 A / 100 kA, 1600 A / 42, 65, 85 kA	1600 A / 42, 65, 85 kA
Number of AC switching handles	1	1
<b>General data</b>		
Dimensions (W / H / D)	2078 <sup>1</sup> / 1500 / 970 mm (80 / 59 / 39 inch)	2278 / 1500 / 970 mm (80 / 59 / 39 inch)
Weight	522 kg <sup>2</sup> / 1151 lb	664 kg / 1464 lb
Operating temperature range	-25 °C ... +50 °C -13 °F ... +122 °F	-25 °C ... +50 °C -13 °F ... +122 °F
Storage temperature range	-40 °C ... +60 °C -40 °F ... +140 °F	-40 °C ... +60 °C -40 °F ... +140 °F
Degree of protection	NEMA 3R	NEMA 3R
Cooling system	Passive	Passive
Max. permissible value for relative humidity (non-condensing)	15 % ... 95 %	15 % ... 95 %
Max. operating altitude above MSL	4000 m (13000 ft) derating above 2000 m (6500 ft)	4000 m (13000 ft) derating above 2000 m (6500 ft)
<b>Features</b>		
Chemical aggressive environment	●	●
Wire input side / bottom	● / ●	● / ●
Switching handles on front	●	●
Connection via terminal lug / screw terminal	○ / ○	○ / ○
Certificates and approvals (more available on request)	UL 1741	UL 1741 <sup>3</sup>
Compliance with	NEC 2011	NEC 2011
● Standard feature   ○ Optional feature   – Not available		
Type designation	Disconnect Unit 600V	Disconnect Unit 1000 V

<sup>1</sup> 2278 mm / 90 inch for SC500HE-US, SC500HE-CA

<sup>2</sup> 664 kg for SC500HE-US, SC500HE-CA

<sup>3</sup> Listed accessories for the Sunny Central CP-US inverter





## APPENDIX 'F'

### Inverters



# SUNNY CENTRAL 500CP-US / 630CP-US / 720CP-US / 750CP-US / 800CP-US / 850CP-US / 900CP-US



SC 500CP-US-10 / SC 630CP-US-10 / SC 720CP-US-10 / SC 750CP-US-10  
/ SC 800CP-US-10 / SC 850CP-US-10 / SC 900CP-US-10



## Economical

- Savings in balance of system costs due to 1,000 V operating voltage
- Outdoor enclosure allows for direct field deployment
- Small footprint and light weight for easy shipping and installation

## Efficient

- Highest efficiency in its power class
- Full nominal power at ambient temperatures up to 50 °C
- 10% additional power for continuous operation at ambient temperatures up to 25 °C

## Flexible

- Configurable DC voltage range
- Integrated AC disconnect for NEC 2011 compliance
- Optional DC disconnects

## Reliable

- Easy and safe installation and with large, separate connection area
- Powerful grid management functions (incl. Low Voltage Ride Through)
- Full UL1741 and IEEE 1547 compliance

## SUNNY CENTRAL 500CP-US / 630CP-US / 720CP-US / 750CP-US / 800CP-US / 850CP-US / 900CP-US

UL listed for commercial and utility-scale projects

The Sunny Central CP-US series delivers outstanding performance. In combination with an external transformer, the Sunny Central CP-US can be connected to any utility grid or three-phase commercial service while directly providing grid management functions. The CP-US family is UL listed at 1,000 V DC and features an integrated AC disconnect in accordance with NEC 2011 requirements. Both the outdoor enclosure with the OptiCool™ cooling concept and the separate connection area ensures simple installation while maximizing returns. With a peak efficiency of 98.7 percent, it outperforms all other inverters in its class. The Sunny Central CP-US can also be integrated with the Power Plant Controller as well as the Medium-voltage Power Platform for utility-scale applications.

Technical data	Sunny Central 500CP-US	Sunny Central 630CP-US	Sunny Central 720CP-US
<b>Input (DC)</b>			
Max. DC power (@ cos φ = 1)	560 kW	713 kW	808 kW
Max. input voltage <sup>(1)</sup>	1000 V	1000 V	1000 V
MPP voltage range (@ 25 °C / @ 50 °C at 60 Hz)	430 V - 820 V / 430 V - 820 V <sup>(1) (2)</sup>	500 V - 820 V / 500 V - 820 V <sup>(1) (2)</sup>	525 V - 820 V / 525 V - 820 V <sup>(1) (2)</sup>
Rated input voltage	480 V	550 V	565 V
Max. input current	1250 A	1350 A	1600 A
Min. input voltage / V <sub>MPP_min</sub> at I <sub>MPP</sub> < I <sub>DCmax</sub>	429 V	498 V	515 V
Number of independent MPP inputs	1	1	1
Number of DC inputs: busbar / fuses	Busbar / 6 - 9	Busbar / 6 - 9	Busbar / 6 - 9
<b>Output (AC)</b>			
Rated power (@ 25 °C) / nominal AC power (@ 50 °C)	550 kVA / 500 kVA	700 kVA / 630 kVA	792 kVA / 720 kVA
Rated grid voltage / nominal AC voltage range	270 V / 243 V - 297 V	315 V / 284 V - 347 V	324 V / 292 V - 356 V
AC power frequency / range	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz
Rated power frequency / rated grid voltage	50 Hz, 60 Hz / 270 V	50 Hz, 60 Hz / 315 V	50 Hz, 60 Hz / 324 V
Max. output current	1176 A	1283 A	1411 A
Max. total harmonic factor	< 3 %	< 3 %	< 3 %
Power factor at rated power / displacement power factor adjustable	1 / 0.8 leading ... 0.8 lagging		
Feed-in phases / connection phases	3 / 3	3 / 3	3 / 3
<b>Efficiency <sup>(3)</sup></b>			
Max. efficiency / European weighted efficiency / CEC efficiency	98.5 % / 98.3 % / 98.0 %	98.5 % / 98.3 % / 98.0 %	98.6 % / 98.4 % / 98.0 %
<b>Protective devices</b>			
DC disconnect device	DC contactor		
AC disconnect device	AC circuit breaker		
DC overvoltage protection	Surge Arrester Type II		
Grid monitoring	●	●	●
Ground-fault monitoring	○	○	○
Ungrounded PV array <sup>(4)</sup>	○	○	○
Lightning protection	Lightning protection level III	Lightning protection level III	Lightning protection level III
Insulation monitoring	○	○	○
Surge arresters for auxiliary power supply	●	●	●
Protection class / overvoltage category	I / IV	I / IV	I / IV
<b>General data</b>			
Dimensions (W / H / D)	2562 / 2272 / 956 mm (101 / 90 / 38 inches)		
Weight	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)
Operating temperature range	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F
Noise emission <sup>(5)</sup>	60 db(A)	60 db(A)	60 db(A)
Max. self-consumption (in operation) <sup>(7)</sup> / self-consumption (at night) <sup>(6)</sup>	< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W
Auxiliary power supply via external 208 V / external 400 V / external 480 V / integrated green power	○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○
Cooling concept	OptiCool	OptiCool	OptiCool
Degree of protection: electronics / connection area	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R
Degree of protection	4C2, 4S2	4C2, 4S2	4C2, 4S2
Application	In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments
Max. permissible value for relative humidity (non-condensing)	15 % ... 95 %	15 % ... 95 %	15 % ... 95 %
Max. operating altitude above mean sea level	2000 m	2000 m	2000 m
Fresh-air consumption (inverter)	3000 m³/h	3000 m³/h	3000 m³/h
<b>Features</b>			
DC connection	Ring terminal lug	Ring terminal lug	Ring terminal lug
AC connection	Ring terminal lug	Ring terminal lug	Ring terminal lug
HMI touchscreen	●	●	●
Communication / protocols	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus
Communication with Sunny String-Monitor	RS485	RS485	RS485
SC-COM	●	●	●
Color of enclosure, door, base, roof	RAL 9016 / 9016 / 7004 / 7004		
Warranty: 5 / 10 / 15 / 20 / 25 years	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
Certificates and approvals (more available on request)	EMC conformity according to FCC, Part 15, Class A, UL 1741, UL 1998, IEEE 1547		
● Standard equipment   ○ Optional features   – Not available			
*Preliminary information, last updated June 2013			
Type designation	SC 500CP-US-10	SC 630CP-US-10	SC 720CP-US-10



Sunny Central 750CP-US	Sunny Central 800CP-US	Sunny Central 850CP-US*	Sunny Central 900CP-US*
853 kW	898 kW	954 kW	1010 kW
1000 V	1000 V	1000 V	1000 V
545 V - 820 V / 545 V - 820 V <sup>(1) (2)</sup>	570 V - 820 V / 570 V - 820 V <sup>(1) (2)</sup>	620 V - 820 V / 620 V - 820 V <sup>(1) (2)</sup>	655 V - 820 V / 655 V - 820 V <sup>(1) (2)</sup>
595 V	620 V	620 V	620 V
1600 A	1600 A	1600 A	1600 A
545 V	568 V	568 V	568 V
1	1	1	1
Busbar / 6 - 9	Busbar / 6 - 9	Busbar / 6 - 9	Busbar / 6 - 9
825 kVA / 750 kVA	880 kVA / 800 kVA	850 kVA / 935 kVA	900 kVA / 990 kVA
342 V / 308 V - 376 V	360 V / 324 V - 396 V	386 V / 347 V - 425 V	405 V / 364 V - 446 V
50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz
50 Hz, 60 Hz / 342 V	50 Hz, 60 Hz / 360 V	50 Hz, 60 Hz / 360 V	50 Hz, 60 Hz / 360 V
1411 A	1411 A	1411 A	1411 A
< 3 %	< 3 %	< 3 %	< 3 %
1 / 0.8 leading ... 0.8 lagging			
3 / 3	3 / 3	3 / 3	3 / 3
98.6 % / 98.4 % / 98.0 %	98.7 % / 98.4 % / 98.5 %	98.7 % / 98.4 % / 98.5 %	98.7 % / 98.4 % / 98.5 %
DC contactor			
AC circuit breaker			
Surge Arrester Type II			
●	●	●	●
○	○	○	○
○	○	○	○
Lightning protection level III	Lightning protection level III	Lightning protection level III	Lightning protection level III
○	○	○	○
●	●	●	●
I / IV	I / IV	I / IV	I / IV
2562 / 2272 / 956 mm (101 / 90 / 38 inches)			
< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)
-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F
60 db(A)	63 db(A)	63 db(A)	63 db(A)
< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W
○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○
OptiCool	OptiCool	OptiCool	OptiCool
NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R
4C2, 4S2	4C2, 4S2	4C2, 4S2	4C2, 4S2
In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments
15 % ... 95 %	15 % ... 95 %	15 % ... 95 %	15 % ... 95 %
2000 m	2000 m	2000 m	2000 m
3000 m³/h	3000 m³/h	3000 m³/h	3000 m³/h
Ring terminal lug	Ring terminal lug	Ring terminal lug	Ring terminal lug
Ring terminal lug	Ring terminal lug	Ring terminal lug	Ring terminal lug
●	●	●	●
Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus
RS485	RS485	RS485	RS485
●	●	●	●
RAL 9016 / 9016 / 7004 / 7004			
● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
EMC conformity according to FCC, Part 15, Class A, UL 1741, UL 1998, IEEE 1547			
SC 750CP-US-10	SC 800CP-US-10	SC 850CP-US-10	SC 900CP-US-10

<sup>(1)</sup> At 1.00 U<sub>AC,nom</sub> and cos φ = 1

<sup>(2)</sup> The inverter will track MPP to 850V before self-protecting

<sup>(3)</sup> Measured efficiency includes all auxiliary power

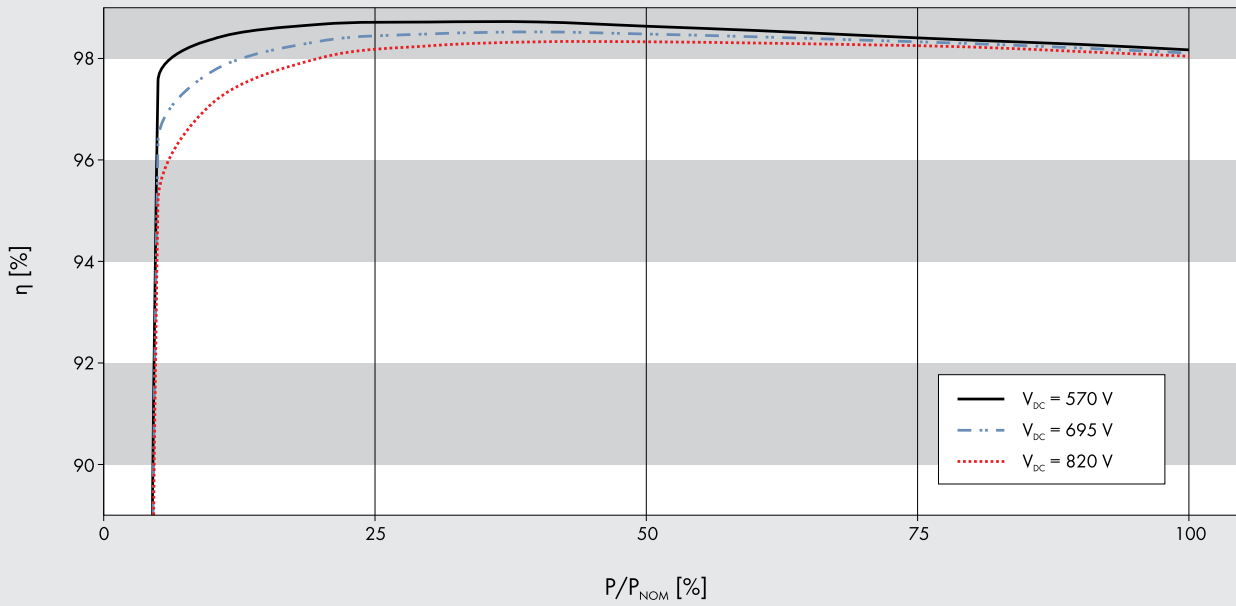
<sup>(4)</sup> Included in the inverter's UL listing

<sup>(5)</sup> Sound pressure level at a distance of 10 m

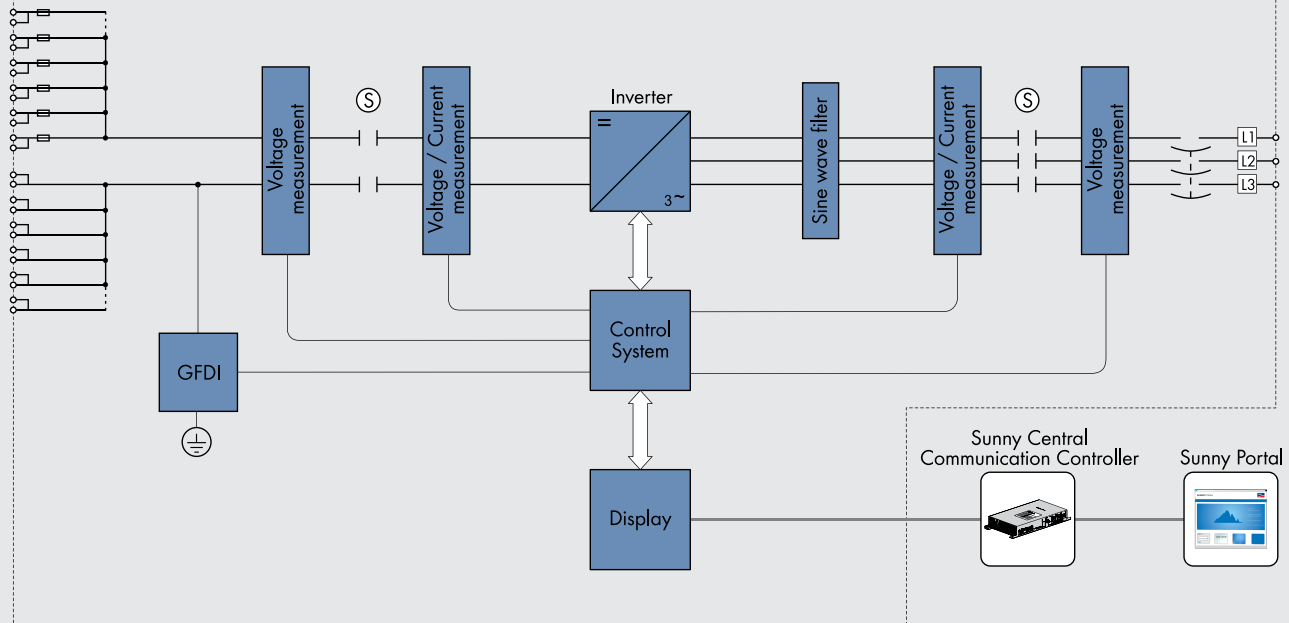
<sup>(6)</sup> Self-consumption at rated operation

<sup>(7)</sup> By external 400 V auxiliary power supply

Efficiency curve SUNNY CENTRAL 800CP-US



SUNNY CENTRAL 500CP-US / 630CP-US / 720CP-US / 750CP-US / 750CP-US / 800CP-US / 850CP-US / 900CP-US



## **APPENDIX 'G'**

### **Interface Transformers (at collection houses)**





## Pad-Mounted, Small Power Transformers

**75–20,000 kVA, 2.5–46 kV Primary Voltage, 120 V–25 kV Secondary Voltage  
Class 7230**

Retain for future use.

### Introduction

Three-phase, pad-mounted transformers, for use on underground power distribution systems, are best suited for commercial applications in public access areas and where underground service is required. These transformers meet modern design requirements for flexibility and provide a visually pleasing installation. Construction allows installation in locations accessible to the general public without the need for protective fencing or vaults. These units are ideally suited for apartment buildings, schools, hospitals, shopping centers, commercial buildings, or industrial sites. Standard, liquid-filled sizes range from 75–20,000 kVA, with primary ratings from 2.5–46 kV.



### Environmental Information

- Sealed tank construction
- Special waste disposal considerations

### Ratings

- 75–20,000 kVA
- Primary voltage: 2.5–46 kV
- Secondary voltage: 120 V–25 kV
- Insulation temperature limit: 120 °C
- Temperature rise: 65 °C (standard); 55 °C or 55/65 °C (optional)

### Certifications

- ISO 9001 registered
- Optional UL and cUL certification
- Optional Factory Mutual listing
- DOE 2010 Energy Efficient (75–2500 kVA)

## Special Design Options

- Special sound requirements
- Special altitude requirements
- Retrofit designs
- Higher efficiency requirements
- Special ambient conditions

## Applicable Standards

- IEEE C57.12.00—Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- IEEE C57.12.34—Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 2,500 kVA and Smaller: High Voltage, 34,500 GrdY/ 19,920 V and Below; Low Voltage, 480 V and Below
- IEEE C57.12.28—Standard for Pad-Mounted Equipment—Enclosure Integrity
- IEEE C57.12.70—Standard for Terminal Markings and Connections for Distribution and Power Transformers
- IEEE C57.12.80—Standard Terminology for Power and Distribution Transformers
- IEEE C57.12.90—Standard Test Code for Liquid-Immersed Distribution, Short-Circuit Testing of Distribution and Power Transformers
- IEEE C57.13—Requirements for Instrument Transformers
- ANSI/IEEE 386—Separable Insulated Connector Systems for Power Distribution Systems Above 600 V
- ASTM D877—Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- NEMA AB1—Molded Case Circuit Breakers
- NEMA TR1—Transformers, Regulators, and Reactors

## Specifications

- A. The transformer(s) shall be compartment type, self-cooled, for mounting on a pad and shall comply with the latest applicable standards.
- B. The average temperature rise of the windings, measured by the resistance method, shall be [55] [65] [55/65] °C when the transformer is operated at the rated kVA output in a 40 °C ambient. The transformer shall be capable of being operated at the rated load in a 30 °C average, 40 °C maximum ambient, as defined by IEEE C57.12.00, without loss of service life expectancy.
- C. Content and insulating fluid shall be [inhibited mineral oil] [less flammable hydrocarbon fluid] [less flammable seed oil-based fluid].
- D. The high and low voltage compartments shall be located side by side, separated by a steel barrier. When facing the transformer, the low voltage compartments shall be on the right. Terminal compartments shall be full height, air-filled, with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened.
- E. The following accessories shall be provided as standard on all transformers:
  - 1. Nameplate in low voltage compartment.
  - 2. One-inch upper filter press and filling plug [one-inch drain plug] [one-inch drain valve with sampling device].
  - 3. Drain plug provided on 75–500 kVA. Drain valve provided on units rated above 500 kVA.
  - 4. [Lightning arrester mounting provisions in live front units only.]
  - 5. Tap changer, for de-energized operation only, which is externally operable and padlockable.
  - 6. The front of both compartments shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs.
  - 7. ANSI tank grounding provisions shall be furnished in both compartments.
- F. The transformer(s) shall be rated [ \_\_\_\_\_ ] kVA, self-cooled (ONAN). Primary voltage \_\_\_\_\_ [delta] [ wye]. Secondary voltage \_\_\_\_\_ [delta] [wye], [3-wire] [4-wire], 60 Hz with two 2½% full capacity above normal taps and two 2½% below normal taps. Impedance shall be [ \_\_\_\_\_ %] [manufacturer's standard impedance], ±7½%. Basic impulse level of the primary winding shall be [ \_\_\_\_\_ kV] [as specified in IEEE C57.12.00 for comparable kV class].
- G. The transformer shall be of sealed-tank construction or sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the fastenings tamper-resistant. The transformer shall remain effectively sealed for a top oil temperature of -5 °C to 105 °C. When required, cooling panels will be provided on the back and sides of the tank. Lifting eyes and packing pads will be provided.
- H. Coils shall be wound with [copper] [aluminum] conductors.
- I. Core and coil assembly shall be three- or five-legged, using high grade, grain-oriented silicon steel laminations. Magnetic flux is to be kept well below the saturation point.
- J. Transformers connected wye-wye shall be built with four- or five-legged core-type design to avoid the tank heating problems sometimes associated with wye-wye connections.
- K. The high voltage terminations and equipment shall be [live front] [dead front].



- L. Live front bushings shall be porcelain with [clamp-type connector] [blade terminals incorporating a two-hole drilling pattern]. Bushings shall be externally clamped and front removable.
- M. Dead front bushings shall be 200 A, either universal wells or one-piece integrated for use with separable connectors. Bushings shall be externally clamped and front removable.
- N. Dead front bushings shall be 600 A, one-piece integrated, with removable stud, for use with separable connectors. Bushings shall be externally clamped and front removable.
- O. The low voltage bushings shall be molded epoxy, and provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing, grounded to the tank by a removable ground strap.
- P. Wye-wye transformers shall have the high and low voltage neutrals internally tied with a removable strap.
- Q. A load break, gang-operated, liquid-immersed switch shall be provided that is externally operable from the high voltage compartment through the use of a distribution hot stick.
- R. Switch to be [two-position "OFF/ON" type for use on a radial feed system] [three-position type for use on an alternate feed system with feed-from-the-left, feed-from-the-right, or OFF] [four-position "sectionalizing" type for use on an extended radial or loop-feed system with feed-from-the-left, feed-from-the-right, isolated-from-either-side, or through-feed-to-both-sides] [two-position switches to be used as "sectionalizing" switches on extended radial or loop-feed systems with feed-from-the-left, feed-from-the-right, isolated-from-either-side, or through-feed-to-both-sides].
- S. Liquid-immersed switch to be rated at [200] [300] [600] A.
- T. Select one of the following options for fusible protection:
  - 1. Internal, liquid-immersed, cartridge fuses sized at \_\_\_\_\_ A [approximately three times the full-load primary current]
  - 2. Bay-O-Net™ liquid-immersed fuses that are externally replaceable with a hot stick without opening the transformer tank
  - 3. Bay-O-Net liquid-immersed fuses in series with oil-immersed, current-limiting fuses. Bay-O-Net fuses are to be externally replaceable with a hot stick without opening the transformer tank
  - 4. Bay-O-Net liquid-immersed, current-limiting fuses that are externally replaceable with a hot stick without opening the transformer tank.
  - 5. Dry-well, canister-mounted, current-limiting fuses that are externally replaceable with a distribution hot stick without opening the transformer tank
  - 6. McGraw-Edison NX Arc-Strangler® fuses or switchblades in series with NX fuses mounted for cold-sequence connection of incoming radial feed line
- U. Provide three \_\_\_\_\_ kV distribution class lightning arresters for surge protection. Arresters are to be mounted in the high voltage compartment.

V. Accessories

1. One-inch drain valve with sampling device, 75–500 kVA only; standard on units above 500 kVA
  2. Dial-type thermometer
  3. Magnetic liquid-level gauge
  4. Pressure vacuum gauge
  5. Pressure relief valve
  6. Automatic pressure relief device (self-resealing with indicator)
  7. Mounting provisions for low voltage current transformers and potential transformers
  8. Busway opening into the low voltage compartment to accommodate Square D® brand I-Line® busway
  9. Molded case circuit breaker in the low voltage compartment rated \_\_\_\_\_ A, with a 2000 A maximum rating
  10. Sudden pressure relay
  11. Key interlock to high voltage door
  12. kWh meter socket with meter, provided with a hinged, padlockable cover externally mounted on the side of the low voltage compartment
- W. Tests shall be conducted in accordance with IEEE C57.12.90, and shall include, as a minimum, the following tests:
1. Ratio
  2. Polarity
  3. Phase rotation
  4. No-load loss
  5. Excitation current
  6. Impedance voltage
  7. Load loss
  8. Applied potential
  9. Induced potential
  10. Quality control impulse

## Technical Data

**Table 1: Standard Transformer Ratings, Primary Voltage Class  
2.5–46 kV, 65 °C Rise, 30 °C Ambient**

kVA Self-Cooled	Secondary Voltage			
	208Y/120 V	240 V Delta	480Y/277 V 480 V Delta 600 V Delta	4160Y/2400 V 4160 V Delta 2400 V Delta
75	X	X	X	
112.5	X	X	X	
150	X	X	X	
225	X	X	X	X
300	X	X	X	X
500	X	X	X	X
750	X	X	X	X
1000	X	X	X	X
1500	X	X	X	X
2000		X	X	X
2500		X	X	X
3000			X	X
3750			X	X
5000			X	X

The above combinations are based on standard designs. Voltages above 35 kV and KVA ratings above 5,000, or other than standard designs may place further restrictions on the availability of voltage and kVA combinations. Consult the factory for final determination.

**Table 2: Audible Sound Levels**

kVA Rating	Decibels (dB)	kVA Rating	Decibels (dB)
75	51	1000	58
112.5	55	1500	60
150	55	2000	61
225	55	2500	62
300	55	3000	63
500	56	3750	64
750	58	5000	66

**Table 3: System Voltages and Transformer BIL Ratings**

Nominal System Voltage (kV)	Standard and Optional Transformer BIL Ratings									
	30	45	60	75	95	110	125	150	200	250
1.2	S	1								
2.5		S	1							
5.0			S	1						
8.7				S	1					
15.0					S	1				
25.0							S	1		
34.5							2	S	1	
46.0									2	S

S = Standard value.

1 = Optional higher levels where exposure to overvoltage occurs and improved protective margins are required.

2 = Lower levels where protective characteristics of applied surge arresters have been evaluated and found to provide appropriate surge protection.



Table 4: Performance Data

Typical Performance Data					Regulation			
kVA	%IZ	%IR	%IX	X/R	1.0 PF	0.9 PF	0.8 PF	0.7 PF
75	3.50	1.63	3.10	1.91	1.67	2.84	3.17	3.36
112.5	3.50	1.22	3.28	2.69	1.27	2.56	2.96	3.21
150	3.75	1.19	3.56	2.98	1.26	2.66	3.11	3.39
225	4.00	1.13	3.84	3.40	1.20	2.73	3.23	3.55
300	4.00	0.99	3.87	3.90	1.07	2.63	3.15	3.48
500	4.50	1.14	4.35	3.82	1.23	2.98	3.56	3.93
750	5.75	1.00	5.66	5.66	1.16	3.48	4.28	4.80
1000	5.75	0.86	5.68	6.59	1.02	3.37	4.18	4.72
1500	5.75	0.77	5.70	7.38	0.93	3.29	4.12	4.67
2000	5.75	0.84	5.69	6.78	1.00	3.35	4.17	4.71
2500	5.75	0.66	5.71	8.62	0.83	3.20	4.04	4.60
3000	5.75	0.95	5.37	5.98	1.11	3.44	4.24	4.77
3750	5.75	0.93	5.68	6.11	1.09	3.42	4.23	4.76
5000	5.50	0.66	5.71	8.05	0.82	3.20	4.04	4.60

Table 5: Standard % Impedance

kVA	IEEE Standard (Nominal)	Square D (Nominal)	Optional Range
75	1.10–5.75	3.50	2.00–5.00
112.5	1.40–5.75	3.50	2.00–5.00
150	1.40–5.75	3.75	2.00–5.00
225	1.40–5.75	4.00	3.00–5.50
300	1.40–5.75	4.00	3.00–5.50
500	1.70–5.75	4.50	3.50–5.50
750–5000	5.75	5.75	5.00–8.00

Table 6: Typical Performance Data: High Voltage—15 kV Class; Low Voltage—600 V Class

kVA	No Load Losses (Watts)	Full Load Losses <sup>1</sup> (Watts)	Total Losses (Watts)	Efficiency <sup>1</sup>				
				112%	100%	75%	50% <sup>1</sup>	25%
75	140	1220	1360	98.05	98.22	98.55	98.91	98.86
112.5	250	1370	1620	98.46	98.58	98.80	99.01	98.82
150	290	1790	2080	98.51	98.63	98.86	99.08	98.94
225	370	2540	2910	98.61	98.72	98.95	99.17	99.07
300	490	2980	3470	98.76	98.86	99.05	99.23	99.11
500	610	5700	6310	98.63	98.75	98.99	99.25	99.23
750	880	7530	8510	98.79	98.89	99.10	99.32	99.28
1000	1290	8630	9920	98.93	99.02	99.19	99.36	99.27
1500	1810	11580	13290	99.04	99.12	99.27	99.42	99.33
2000	1670	16790	18460	99.00	99.09	99.23	99.46	99.46
2500	2700	16560	19260	99.17	99.24	99.36	99.49	99.41
3000	5385	28450	33835	98.79	98.88	99.06	99.17	99.05
3750	7700	34850	42550	98.79	98.88	99.04	99.13	98.96
5000	8240	33020	41250	99.12	99.18	99.29	99.34	99.18

<sup>1</sup> Full load losses and efficiencies are at a reference temperature of 85 °C in accordance with IEEE Standard C57.12.91. The efficiencies of transformers with a 75–2,500 kVA rating at 50% load are at a reference temperature of 55 °C in accordance with DOE Test Procedure 10 CFR, Part 431, Subpart K, Appendix A.

Table 7: Primary Phase-to-Phase Voltage—Delta

kVA	2400	4160	4800	7200	8320	12000	12470	13200	13800	14400	20780	22960	24940	26400	34500
75	A,B,C, F,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,I	A,I	A	A	A
112	A,B,C, G,I,S	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,I	A,I	A	A	A
150	A,B,C,G, I,K,R,S	A,B,C, F,G,I	A,B,C,F, G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,I	A,I	A	A	A
225	A,B,C,H, I,K,R,S	A,B,C, F,G,I,K	A,B,C, F,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,I	A,I	A	A	A
300	A,B,C,H, I,R,S	A,B,C, F,G,I, K,R,S	A,B,C, F,G,I, K,R,S	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,B,C, E,G,I	A,I	A,I	A	A	A
500	A,K,R,S	A,B,C,H, I,K,R,S	A,B,C,H, K,R,S	A,B,C, F,G,I, K,R,S	A,B,C, F,G,I, K,R,S	A,B,C, F,G,I	A,B,C, F,G,I	A,B,C, F,G,I	A,B,C, F,G,I	A,B,C, F,G,I	A,I	A,I	A	A	A
750	—	A,K,H, R,S	A,C,K, H,R,S	A,B,C, F,G,K, R,S	A,B,C, F,G,K, R,S	A,B,C, F,G,I, K,R,S	A,B,C, F,G,I, K,R,S	A,B,C, F,G,I,K	A,B,C, F,G,I,K	A,B,C, F,G,I,K	A,I	A,I	A	A	A
1000	—	A,K	A,K,R,S	A,B,C,H, R,S	A,B,C,H, K,R,S	A,B,C,H, K,R,S	A,B,C,F, H,K,R,S	A,B,C,F, G,K,R,S	A,B,C,F, G,K,R,S	A,B,C,F, G,K,R,S	A,I,K	A,I,K	A	A	A
1500	—	—	A	A,S	A,R,S	A,C,H, K,R,S	A,C,H, K,R,S	A,C,H, K,R,S	A,C,H, K,R,S	A,C,H, K,R,S	A,K	A,K	A	A	A
2000	—	A	A	A	A	A,R,S	A,R,S	A,C,H, R,S	A,C,H, R,S	A,C,H, R,S	A,K	A,K	A	A	A
2500	—	—	—	A	A	A,R,S	A,R,S	A,R,S	A,R,S	A,R,S	A	A	A	A	A
3000	—	—	—	A	A	A	A	A	A	A	A	A	A	A	A
3750	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Legend

A	Weak Link Expulsion Fuse	H	Bay-0-Net Current Sensing Fuse in Series with Parallel Current Limiting Fuse
B	Bay-0-Net Dual Sensing Fuse	I	Drywell Canisters with Current Limiting Fuses
C	Bay-0-Net Current Sensing Fuse	K	Drywell Canisters with Current Limiting Fuses (Parallel)
E	Bay-0-Net Dual Sensing Fuse in Series with Current Limiting Fuse	R	Bay-0-Net High Ampere Overload Sensing Fuse
F	Bay-0-Net Dual Sensing Fuse in Series with Parallel Current Limiting Fuse	S	Bay-0-Net High Ampere Overload with Parallel Current Limiting Fuse
G	Bay-0-Net Current Sensing Fuse in Series with Current Limiting Fuse		

**Table 8: Primary Phase-to-Phase Voltage—Wye**

kVA	4160Y/ 2400	7200Y/ 4160	8320Y/ 4800	12470Y/ 7200	13200Y/ 7620	13800Y/ 7970	20780Y/ 12000	22960Y/ 13200	24940Y/ 14400	34500Y/ 19920
75	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
112	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
150	A,B,C,F,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
225	A,B,C,F,G,I,K	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
300	A,B,C,F, G,I,K,R,S	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A,B,C,E,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
500	A,B,C,H, I,K,R,S	A,B,C,F, G,I,K,R,S	A,B,C,F, G,I,K,R,S	A,B,C,F,G,I	A,B,C,F,G,I	A,B,C,F,G,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
750	A,K,H,R,S	A,B,C,F,G,K, R,S	A,B,C,F, G,K,R,S	A,B,C,F, G,I,K,R,S	A,B,C,F,G,I,K	A,B,C,F,G,I,K	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , F <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , F <sup>2</sup> ,G <sup>2</sup> ,I	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , F <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
1000	A,K	A,B,C,H,R,S	A,B,C,H, K,R,S	A,B,C,F, H,K,R,S	A,B,C,F, G,K,R,S	A,B,C,F, G,K,R,S	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , F <sup>2</sup> ,G <sup>2</sup> ,I,K	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> , F <sup>2</sup> ,G <sup>2</sup> ,I,K	A <sup>1</sup> ,B <sup>1</sup> ,C <sup>1</sup> ,F <sup>2</sup> , G <sup>2</sup> ,I <sup>2</sup> ,K <sup>2</sup>	A <sup>1</sup> ,E <sup>2</sup> ,G <sup>2</sup> ,I <sup>2</sup>
1500	A	A,S	A,R,S	A,C,H,K,R,S	A,C,H,K,R,S	A,C,H,K,R,S	A <sup>1</sup> ,C <sup>1</sup> ,F <sup>2</sup> ,H <sup>2</sup> , K,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,C <sup>1</sup> ,F <sup>2</sup> ,G <sup>2</sup> , K,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,C <sup>1</sup> ,F <sup>2</sup> ,G <sup>2</sup> , K <sup>2</sup> ,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,F <sup>2</sup> ,G <sup>2</sup> , I <sup>2</sup> ,K <sup>2</sup>
2000	A	A	A	A,R,S	A,C,H,R,S	A,C,H,R,S	A <sup>1</sup> ,C <sup>1</sup> ,H <sup>2</sup> , K,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,C <sup>1</sup> ,H <sup>2</sup> , K,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,C <sup>1</sup> ,F <sup>2</sup> ,H <sup>2</sup> , K <sup>2</sup> ,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,F <sup>2</sup> ,H <sup>2</sup> ,K <sup>2</sup>
2500	—	A	A	A,R,S	A,R,S	A,R,S	A <sup>1</sup> ,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,R <sup>2</sup> ,S <sup>2</sup>	A <sup>1</sup> ,K <sup>2</sup>
3000	—	A	A	A	A	A	A <sup>1</sup>	A <sup>1</sup>	A <sup>1</sup>	A <sup>1</sup> ,K <sup>2</sup>
3750	—	—	—	—	—	—	—	—	—	—
5000	—	—	—	—	—	—	—	—	—	—

<sup>1</sup> Recommended fuse is limited to GNDY/GNDY transformers with no more than 25% Delta connected secondary load and with neutral internally grounded.

<sup>2</sup> Recommended fuse is limited to GNDY/GNDY transformers with no more than 50% Delta connected secondary load and with neutral internally grounded.

**Legend**

A	Weak Link Expulsion Fuse	H	Bay-0-Net Current Sensing Fuse in Series with Parallel Current Limiting Fuse
B	Bay-0-Net Dual Sensing Fuse	I	Drywell Canisters with Current Limiting Fuses
C	Bay-0-Net Current Sensing Fuse	K	Drywell Canisters with Current Limiting Fuses (Parallel)
E	Bay-0-Net Dual Sensing Fuse in Series with Current Limiting Fuse	R	Bay-0-Net High Ampere Overload Sensing Fuse
F	Bay-0-Net Dual Sensing Fuse in Series with Parallel Current Limiting Fuse	S	Bay-0-Net High Ampere Overload with Parallel Current Limiting Fuse
G	Bay-0-Net Current Sensing Fuse in Series with Current Limiting Fuse		



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