Exhibit R

Impact Study Report

Westfarms Associates Systems A1, B, & C 2630.7 kW PV Interconnection Distribution System Impact Study

Prepared for

Eversource Energy

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Results you can rely on

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Abstract
This system impact study is to examine three (3) separate PV installations for a total of 2630.7 kW of PV generation at the Westfarms Mall located in Farmington, CT. There is also another proposed PV system at Westfarms Mall that is 199.8 kW, but that system will connect to the 4A9 circuit, so it is not included in this study. A full circuit impact study is needed for this installation due to it failing the fast track screen. This will be a roof and ground mounted installation that will also be participating in net metering. The studied impacts are voltage, equipment ratings, and protection concerns.

This study found that there were no voltage issues during maximum or minimum loading and full PV production. All voltages fell within the acceptable voltage ranges as required by PURA when a unity power factor was used. It was determined that the power factor of the feeder during minimum loading and full PV production would be below regulations, so a solution to fix this major power factor drop needed to be established. It was discovered that the best way to resolve this power factor issue is to change the control method on the 1800 kVAR capacitor from being voltage controlled to VAR controlled. This prevents both capacitors from turning on during minimum load, which was causing this low power factor to occur. Flicker of the system was found to be within the acceptable ranges. The study determined that the large amount of generation within the automatic recloser zones violates the minimum loading criteria, but passes the non-certified inverter screening. The customer will be responsible to provide effective grounding at the installation that includes systems A1 and C, along with providing settings in line with the suggested ones by Eversource. To prevent the operation of the three (3) systems on the alternate feeder, Eversource will provide the customers status of connectivity to the alternate 4A10 supply in the form of a dry contact. Modifications may also have to be made to the circuit's switchgear, if it is set to automatically transfer to the alternate feeder. However, further review determined that islanding is not a concern on the primary circuit and no transfer trip will be required.

Introduction

The purpose of this study is to determine the electrical system impacts of a 2630.7 kW inverter based PV generator, being proposed on the 1C03 circuit. The electrical system impacts considered in this study are voltage, equipment rating, and protection concerns. Recommendations will be based on assurance that all of the customers on the circuit are within the established ratings for voltage, equipment loading, limiting equipment operation, and fault protection is sufficient.

Project Location

Westfarms Associates is proposing the installation of three (3) separate roof or ground mounted PV systems, for a total of 2630.7 kW, at their facility in Farmington. This project is located on the Farmington 1C 23 kV circuit. The system is located approximately 4.0 miles from the substation. A picture illustrating the 1C03 circuit route from the Westfarms Mall to Farmington substation is found in Appendix A. The proposed system layout of PV panels / solar modules is found below in figure 1.

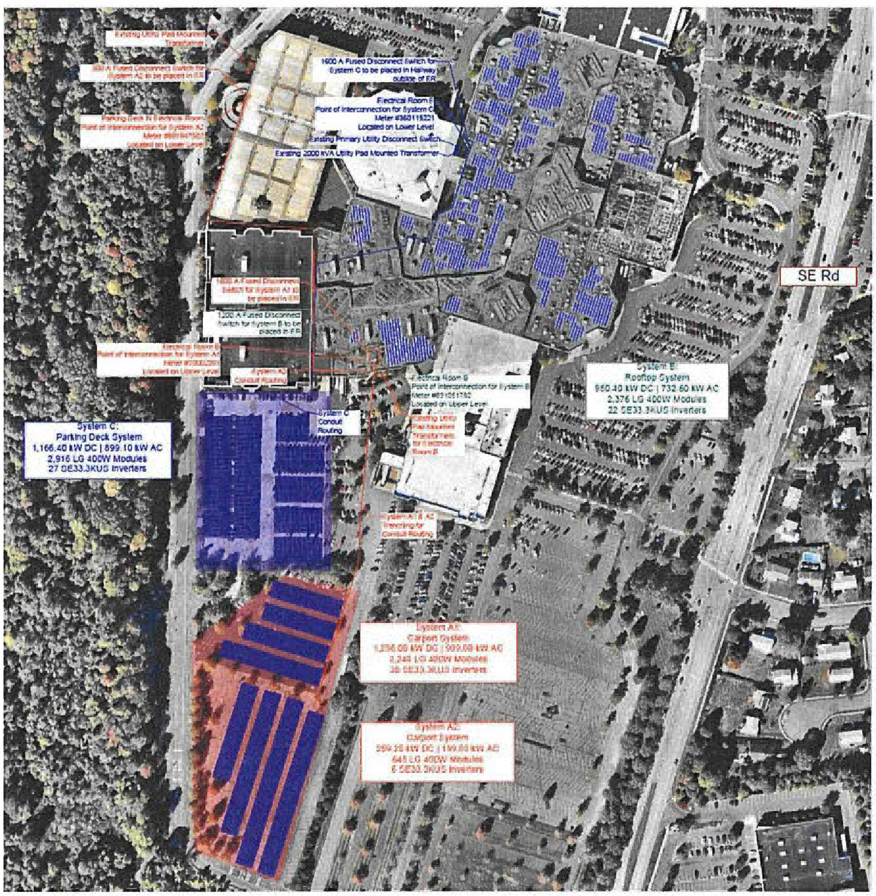


Figure 1: Bird's-Eye View

System Configuration

The primary distribution voltage of the customer is 23 kV and comes from the Farmington 1C substation. The Westfarms Mall is fed by both the 1C03 and 4A9 circuits, but only the 1C03 circuit will be reviewed in this impact study. The customer will be net metering, so the generator will not fully export onto the Eversource system. The mall also has another 724.2 kW of existing and proposed generation that is connected to the 4A9 circuit. There is 931 kW of photovoltaic generation existing on the 1C03 circuit; none of the existing generation is within the same zone of the proposed PV installation. The system was modeled using Synergi™ Electric, with a 99.8% power factor during max peak load for the 1C03 circuit. The proposed system was modeled with a unity power factor for all 3 projects. It was determined that the power factor at the substation and wouldn't stay within regulations, so this issue was resolved by changing the control mode on one of the capacitors. It was decided to change the control mode of the 1800 kVAR capacitor to VAR controlled to eliminate possible operations caused by the proposed PV system. Simulations during minimum and maximum loading periods were studied, with the proposed and existing generation on and off. During those simulations, voltage, power factor, and protection equipment were verified to ensure the circuit still meets regulatory standards after the proposed system is interconnected.

Feeder Power Factor

The below table illustrates the circuit power factor with the current circuit configuration, and if the proposed changes to the 1800 kVAR capacitors operation mode were made.

Current Circuit Configuration												
Max Load							Min Load					
Generation Off			Generation 100% - Steady State				Generation Off			Generation 100% - Steady State		
99.3	99.3	99.3	99.1	99.1	99		-94.1	-94.1	-93.3	-69.2	-70.7	-66.8

Proposed Changes - 1800 kVAR cap VAR controlled												
Max Load							Min Load					
Generation Off			Generation 100% - Steady State				Generation Off			Generation 100% - Steady State		
99.3	99.3	99.3	99.1	99.1	99.1		99.9	99.9	99.9	99.6	99.6	99.6

System Loading

The system loading at the 1C03 circuit breaker was measured to be a max of 11.3 MW in August 2017. The minimum was measured to be 4.5 MW in April 2017.

System Stability

A stiffness calculation was done to determine the stability of the interconnection:

$$\frac{3LG\ Fault\ Current\ (A)}{Amps\ High\ Side\ Eversource\ Xfmr\ (A)} = \text{Stiffness Factor}$$

$$\frac{4666\ A}{47.65\ A} = 97.92$$

As an indicator for Stiffness Factors ranging 50-100, this DG source falls in the minor concern range. Any DG source connecting with a stiffness factor in this range is of moderate concern for fluctuating sources such as wind and PV. The need to assess rates of fluctuations and start/stop cycles still exists, but will most likely not be an issue in most cases.

Generation Characteristics

The proposed PV design uses SolarEdge 33.3 kW inverters along with LG400N2W solar modules. Below illustrates a brief overview of the inverter specifications. For more information on the two inverters, see Appendix D.

Inverter Specifications	
Inverter Manufacturer:	SolarEdge
Inverter Model:	SE33.3KUS
Phase:	Three Phase
Max PV input voltage:	980 Vdc
Nominal input voltage:	840 Vdc
Max AC output apparent power:	33300 VA
Nominal AC output voltage:	277 / 480 Vac
Max continuous output current:	40 Amps
Power Factor:	0.8 lagging to 0.8 leading
CEC Weighted Efficiency:	98.5%
Transformer-less, Ungrounded:	Yes
UL1741 Certified:	Yes

A SEL-351 relay will be used for the redundant protection method. For more information, see the data sheet in Appendix D.

Voltage Impact

CT regulatory requirement require adherence to voltages at -5% to +3% PU. The modeling software uses a nominal voltage of 120 as the output, so the voltages from the model will need to stay between 114 and 123.6. This portion of the study determines if the interconnection can maintain these requirements at peak and minimum loading conditions. The study looks at both peak and minimum loading during time in which the generator is in parallel with the Eversource system.

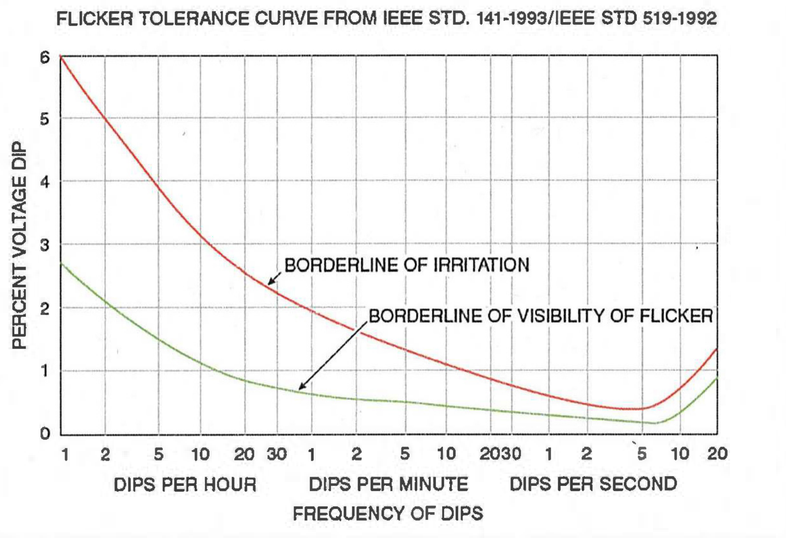


Figure 2: Flicker Tolerance Curve

Peak Loading

At peak loading steady state conditions, with generation at a unity power factor and the customer generation connected, the system is able to sustain voltage within PURA limitations.

Max Load					
Gen Off			Gen On		
120.1	120.8	120.9	121.1	121.5	121.6

Flicker: The average flicker is at worst case of 0.75%. This meets standards defined by the IEEE STD 141-1993 Flicker tolerance curve. Standards indicate the flicker can't be greater than 2%.

Minimum Loading

At minimum loading steady state conditions, with generation at a unity power factor and the customer generation connected, the system is able to sustain voltage within PURA limitations. The system doesn't cause high voltage at the PCC, but the feeder power factor goes below regulations. This is resolved by changing the control mode of the 1800 kVAR capacitor bank; see more information in section below.

Min Load					
Gen Off			Gen On		
121.9	122.2	122.2	122.8	122.9	122.9

Flicker: The average flicker is at worst case of 0.66%. This meets standards defined by the IEEE STD 141-1993 Flicker tolerance curve. Standards indicate the flicker can't be greater than 2%.

Contingencies

This installation will not be able to operate on the contingent feed. Eversource will provide the customer status of connectivity to the alternate 4A10 supply in the form of a dry contact, which they can use to prevent operation while supplied by the alternate feeder. Since this circuit is connected to switchgear, modifications to the switchgear's operation may have to be made, in order to prevent the generation from operating on the alternate feeder.

Regulators and Capacitors

The 1C03 circuit contains no voltage regulators, one (1) 1200 kVAR switched capacitor and one (1) 1800 kVAR switched capacitor. The 1800 kVAR cap is located between the 1C03-73S and the 1C03-74S. The 1200 kVAR cap is located between the 1C03-80M and the 1C19-90T. Neither capacitor is located within the same zone as the proposed PV system. The 1C03 circuit didn't stay within regulations with the current capacitor arrangement, after the proposed generation was added to the circuit. It was determined that the 1800 kVAR cap needs to be changed from voltage controlled to VAR controlled to keep the feeder's power factor within regulations. Changing the control mode from voltage to VAR controlled, eliminates the capacitors operation during minimum load and full PV production, which is when the low power factor was occurring.

Operational Restrictions and Anti-Islanding Protection

Using the "Eversource DER Briefing Sheet – Risk of Islanding Evaluations", the system was checked to determine if a risk of islanding (ROI) condition exists. The screening first looks at if generation is greater than 33% of the minimum load, in the line section of the proposed installation. If the generation to load ratio is greater than 33%, the system must continue through the screening process, where the UL certification of all inverters on the circuit are checked. If the amount of non-certified generation is greater than 10% of the total DG, the circuit must be studied using the Sandia screening process. Lastly, if any of the Sandia screens fail, transfer trip will be necessary.

Risk of Islanding (ROI) Screening

The breaker and 1C03-73S recloser are the protective devices for the customer's zone. In that zone the generation is 2630.7 kW, including the proposed installation, and the minimum load is approximately 1.22 MW. This gives a generation to minimum load of 215.6%. With a ratio more than the allowed 33%, further screening is required.

Since the systems are using UL 1741 certified inverters, it can continue through the screening process. The line section aggregate non-certified generators are less than or equal to 10% of the aggregate distributed generation, and the proposed systems are less than 2 MW each; so a Sandia screening is not necessary. No additional requirements, such as transfer trip, are necessary to protect the circuit from islanding.

System Upgrades and Service

The customer has existing service equipment, but since systems A1 and C are being proposed on the same 1000 kVA transformer, the transformer will need to be replaced with one that exceeds the aggregate of the two PV systems. They also will have to install a grounding bank on the transformer that contains systems A1 and C. Transfer trip equipment is not necessary, but provisions will need to be made to prevent operation on the alternate feeder (4A10). A dry contact will be provided to the customer from the utility switchgear that will give indication that they are being supplied from the alternate feeder. It will be the customer's responsibility to install and design any equipment required to use this contact's status to stop the PV from generating onto Eversource's system while supplied by the alternate feeder. It is required that the systems A1, B, and C each be isolated by an electronically controlled breaker having trip/close capability. These breakers will be the point of isolation for the customer's primary anti-islanding protection not the individual inverters. The customer will provide Eversource with the open/closed status of each breaker in the form of a dry contact. The customer will need to install an outdoor electrical junction box containing a terminal block next to the utility switchgear for Eversource to wire its dry contact to. The customer will also wire the three dry breaker status contacts previously mentioned to this same terminal block. To minimize any voltage drop, the customer will use #12 Copper conductor or larger when wiring to this terminal block. Any customer wiring to this terminal block shall be electrically isolated from any customer owned electronic equipment using an opto-isolator, fiber optic connection, or other equivalent form of isolation. If the 1800 kVAR switched capacitor is set to operate in a voltage control mode, it will need to be changed to VAR controlled to keep the power factor within regulations.

Protection Study

There were no significant concerns found when this project was screened by protection and control engineering. When the project goes to construction a coordination study will be conducted. The customer is expected to follow the Eversource inverter and relay settings. The typical settings are shown below in figure 3.

One major aspect related to protecting the proposed system and electric grid, is whether the system is effectively grounded. Below describes the four (4) main criteria looked at to ensure the system is effectively grounded. All four (4) criteria must pass in order to be deemed effectively grounded.

1. Is the DG less than one (1) megawatt (MW)? *NO
2. Does the proposed system pass the anti-islanding concern or in other words, does it pass the generation to load ratio requirement? *YES

3. Does the fault current at the point of common coupling (PCC) stay below a value that's greater than 10% of the existing value? *YES
4. Is the proposed area unknown to excessive fault currents? *YES

Since this system failed one (1) of the four (4) effective grounding conditions, the customer will be responsible to provide effective grounding on the transformer that will contain systems A1 and C. The customer can accomplish this by installing a low or high voltage grounding bank (depending on the transformer winding configuration), which also needs to be approved by Eversource P&C to make sure it is sized properly. The customer will also need to include equipment that if the grounding bank is out of service the DG cannot operate. The transformer that contains system B is already considered to be effectively grounded, so a grounding bank is not required.

27-1	UNDER VOLTAGE - FAST	(%) = 50
	Line to Line Voltage 480	(27-1) Volts = 240
	Line to Ground Voltage 277	(27-1) Volts = 139
	UV TIMER	(27-1) Seconds = 0.16
	UV TIMER	(27-1) Cycles = 10
27-2	UNDER VOLTAGE - SLOW	(%) = 88
	Line to Line Voltage 480	(27-2) Volts = 423
	Line to Ground Voltage 277	(27-2) Volts = 244
	UV TIMER	(27-2) Seconds = 2.0
	UV TIMER	(27-2) Cycles = 120
59-1	OVER VOLTAGE -FAST	(%) = 120
	Line to Line Voltage 480	(59-1) Volts = 576
	Line to Ground Voltage 277	(59-1) Volts = 333
	OV TIMER	(59-1) Seconds = 0.16
	OV TIMER	(59-1) Cycles = 10
59-2	OVER VOLTAGE - SLOW	(%) = 110
	Line to Line Voltage 480	(59-2) Volts = 528
	Line to Ground Voltage 277	(59-2) Volts = 305
	OV TIMER	(59-2) Seconds = 1.0
	OV TIMER	(59-2) Cycles = 60
81U - 1	UNDER FREQUENCY	(Hz) = 57
	UF TIMER	(81U-1) Seconds = 0.16
	UF TIMER	(81U-1) Cycles = 10
81O	OVER FREQUENCY	(Hz) = 60.5
	OF TIMER	(81O) Seconds = 0.16
	OF TIMER	(81O) Cycles = 10

Figure 3: Inverter and Relay Settings

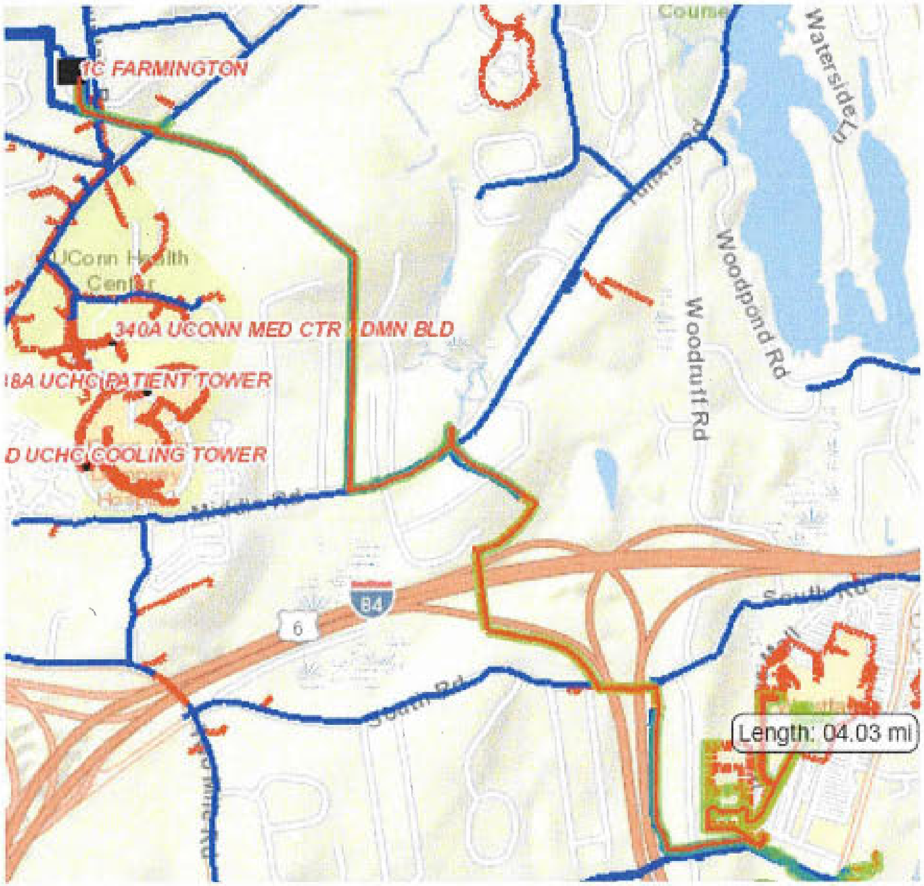
Conclusion

Westfarms Associates have requested to connect three (3) ground or roof mounted PV generators to the 23 kV 1C03 feeder, which comes out of the Farmington 1C substation. System A1 is 999 kW, system B is 732.6 kW, and system C is 899.1 kW, for an aggregate of 2630.7 kW. The three (3) systems will be located at 500 Westfarms Mall, Farmington, CT which is approximately 4 miles from the substation.

Voltage stayed within the -5/+3% regulations during minimum and maximum loading periods, when a unity power factor for the proposed system was studied on the current circuit configuration. Analysis showed changing the existing 1800 kVAR capacitor to a VAR controlled mode, instead of a voltage controlled mode, removed the circuits poor power factor issue. Flicker of the system was also determined to be within the acceptable ranges, the worst case average flicker was 0.75%, which is under the required 2%. Since the system passed the risk of islanding screening, direct transfer trip is not needed, but the system will not be able to operate when the circuit is being supplied by the backup feeder (4A10). Eversource will provide the customer status of connectivity to the alternate 4A10 supply in the form of a dry contact, which they can use to prevent operation while supplied by the alternate feeder. Modifications may also have to be made to the circuit's switchgear, if it is set to automatically transfer to the alternate feeder. It was also determined systems A1 and C failed one (1) of the four (4) effective grounding requirements, so a low or high voltage grounding bank will be necessary on the arrangement that contains those two systems. The customer will be responsible to provide effective grounding, along with all necessary circuit modifications.

Appendices

Appendix A: Distance from Substation



Appendix B: P&C Effective Grounding Screen

Effective Grounding Further Review

Customer: Westfarms Associates Systems A1 and C
Address: 500 Westfarms Mall, Farmington, CT

Circuit:	1C03	Total KW's of this application:	1898.1
Circuit KV:	23	Generator Type:	Solar

A. Effective grounding shall be required for all DG interconnections where any of the following is True:

1. The fault current at the point of common coupling (PCC) is caused to increase to a value 10 percent of the existing value.-->	False
2. Areas where fault current may already be deemed excessive. -->	False
3. DG interconnections larger than 1MW. -->	True
4. Anywhere there may exist a potential Islanding concern in regard to generation to load ratio. -->	False

B. Other Concern Review (Service Transformer High Side Delta Connection)

Is it Service Transformer High Side is Delta Connected -->	No

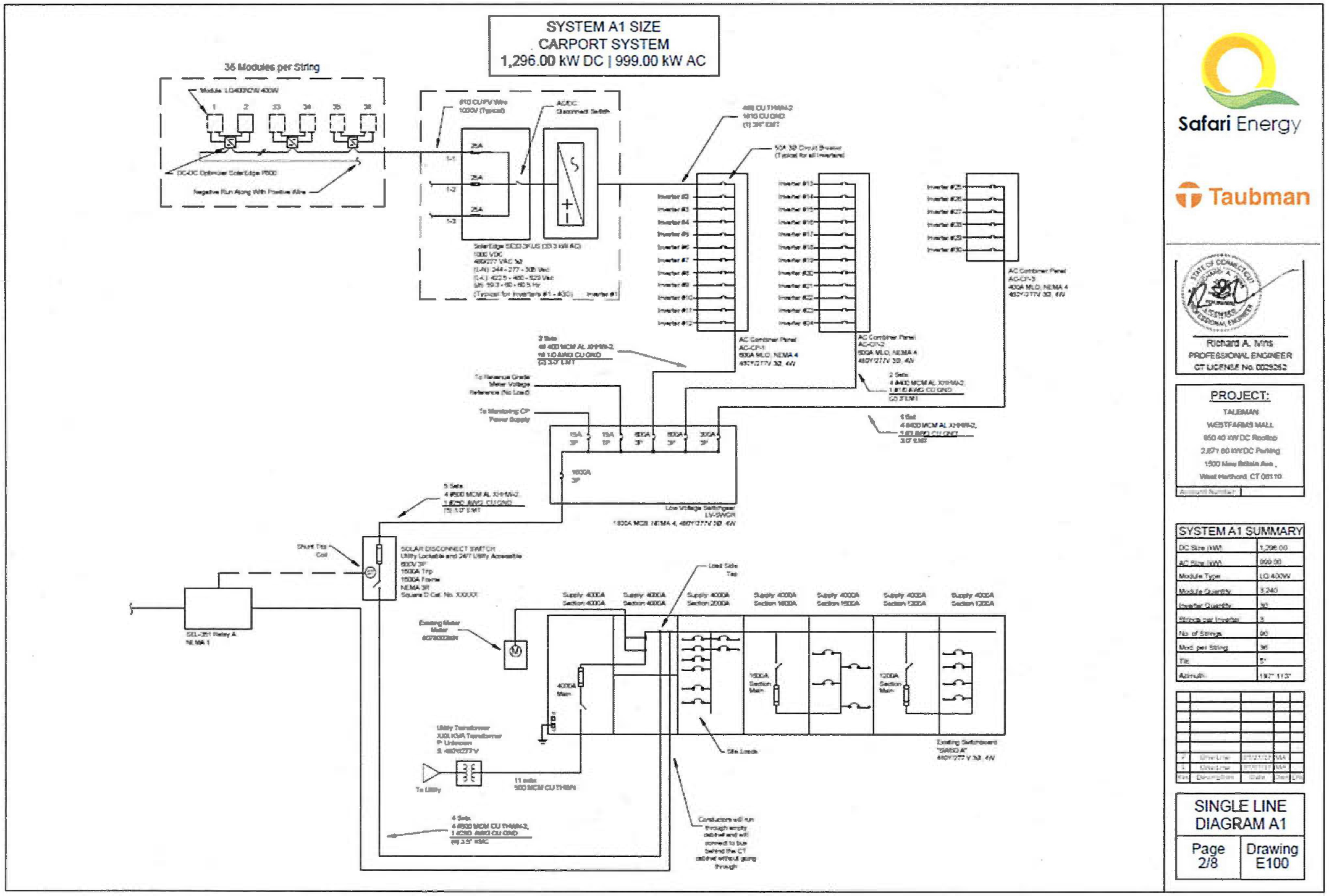
High Side Delta Connection Calculation Required:- **No**

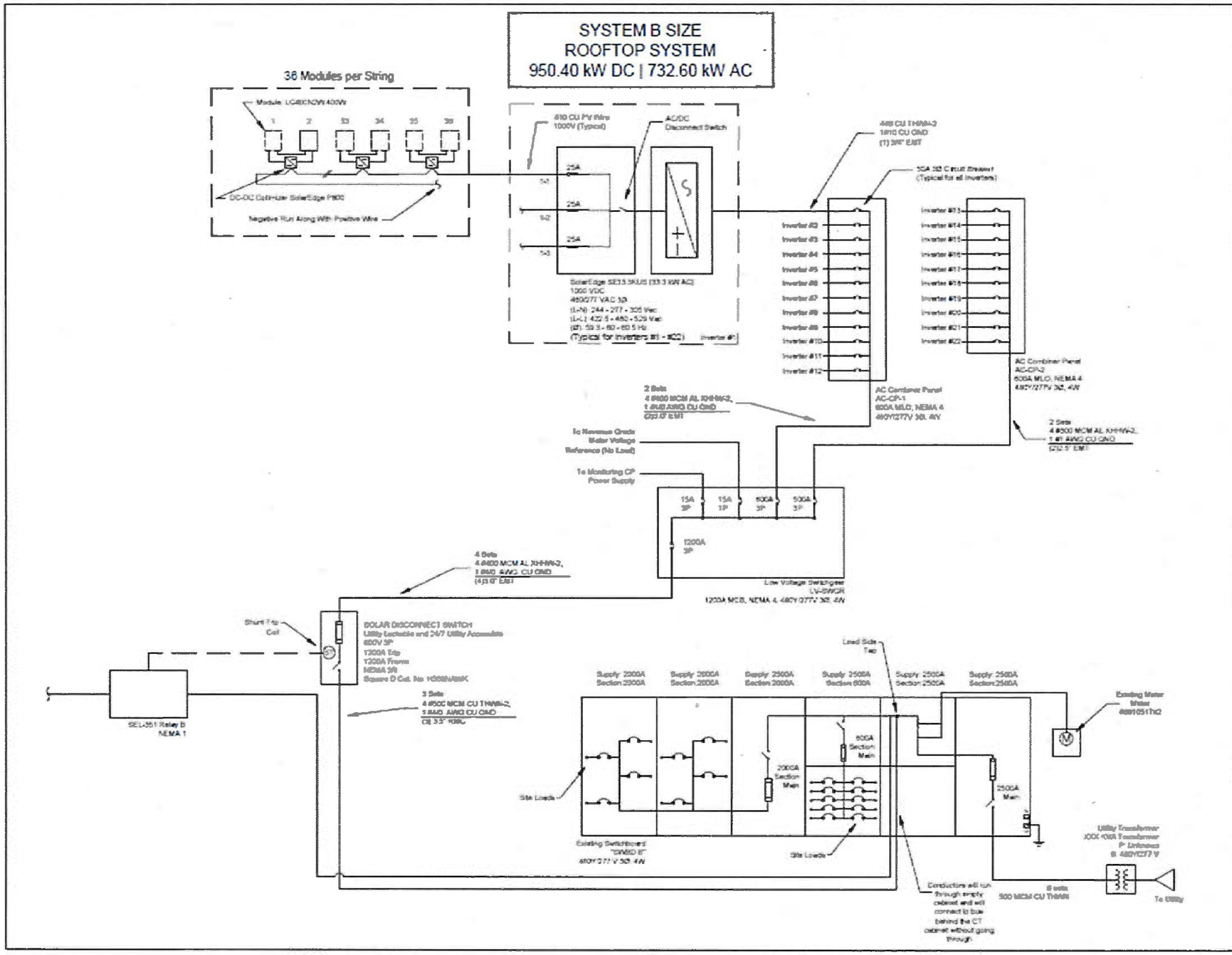
Maximum Load in kW, in the Zone	N/A	KW
Minimum Load kW - 30% of the Maximum kW.	N/A	KW
30% of the Maximum Load in kW, in the Zone x 10% --(Minimum KW)	N/A	KW
Aggregate of all DG generation in the Zone	N/A	KW
Is the Aggregate of all DG generation in the Zone Less than 10% Minimum kW	N/A	

Result:- Needs an Effective Grounding (See Red Flags)

Name:	Ashley Centrella	Date:	04/18/2018

Appendix C: Project One-Lines





Safari Energy

Taubman

Richard A. Mins
PROFESSIONAL ENGINEER
CT LICENSE No. 0029062

PROJECT:

TAUBMAN
WESTFARMS MALL
950.40 kW DC Rooftop
2,671.80 kW DC Parking
1500 New Britain Ave.,
West Hartford, CT 06110

Account Number:

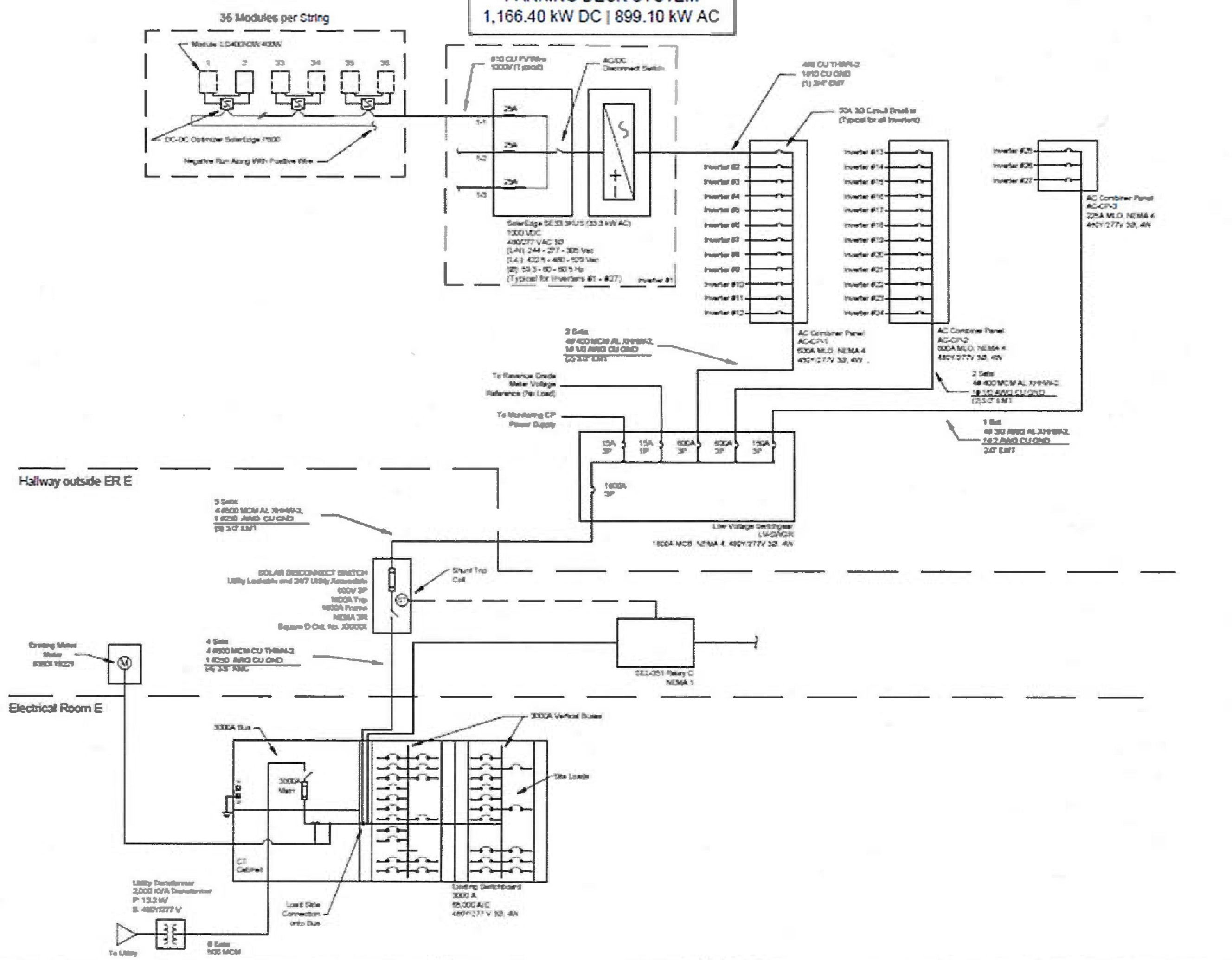
SYSTEM B SUMMARY	
DC Size (kW)	950.40
AC Size (kW)	732.60
Module Type	LG-400W
Module Quantity	2,376
Inverter Quantity	22
Strings per Inverter	3
No. of Strings	66
Mod. per String	36
Tilt	5°
Azimuth	180°, 173°

Rev	Description	Date	Chk'd	Ltr
2	Single Line	[illegible]	MA	
1	Single Line	[illegible]	MA	

SINGLE LINE DIAGRAM B

Page 4/8 | Drawing E120

SYSTEM C SIZE
PARKING DECK SYSTEM
1,166.40 kW DC | 899.10 kW AC



Safari Energy

Taubman

Richard A. Mns
PROFESSIONAL ENGINEER
CT LICENSE No. 0029262

PROJECT:

TAUBMAN
WESTFARMS MALL
950.40 kW DC Rooftop
2,071.60 kW DC Parking
1500 New Britain Ave.,
West Hartford, CT 06110

SYSTEM C SUMMARY	
DC Size (kW)	1,166.40
AC Size (kW)	899.10
Module Type	LG 400W
Module Quantity	2,916
Inverter Quantity	27
Strings per Inverter	3
No. of Strings	81
Mod per String	36
Tilt	5°
Azimuth	[illegible]

Rev	Description	Date	Dwn	Chk
3	One-Line	[illegible]	MA	
2	[illegible]	[illegible]	MA	
1	One-Line	[illegible]	MA	

SINGLE LINE DIAGRAM C

Page	Drawing
5/8	E130

Appendix D: Data Sheets

SEL-351-5, -6, -7 Protection System

Optimize Protection, Automation, and Breaker Control

SEL-351 Protection System shown with front-panel USB port and SafeLock® trip/close pushbuttons with high-visibility breaker status LEDs.

Major Features and Benefits

The SEL-351 Protection System provides an exceptional package of protection, monitoring, control, and fault locating features.

Protection Functions

- Second-harmonic blocking secures relay during transformer energization.
- High-speed breaker failure element and native breaker failure logic enhance breaker failure detection.
- Phase, negative-sequence, residual-ground, and neutral-ground overcurrent elements with directional control optimize radial and looped network protection for lines and equipment. Load-encroachment logic provides additional security to distinguish between heavy load and three-phase faults.
- Under- and overfrequency and under- and overvoltage elements and powerful SELogic® control equations help implement load shedding and other control schemes.
- Built-in communications-assisted trip scheme logic permits fast trip times, reducing fault duration that adversely impacts system loads and power system equipment.
- SELogic control equations permit custom programming for traditional and unique protection and control functions.
- Directional power elements on SEL-351-7.
- Four levels of rate-of-change-of-frequency elements help detect rapid frequency changes to initiate load shedding or network decoupling.

Automatic Reclosing and Synchronism Check

- Program as many as four shots of automatic reclosing with two selectable reclose formats.
- Control reclosing schemes for trip saving or fuse saving, and inhibit reclosing for hot-line maintenance.
- Supervise manual or automatic reclosing with synchronism check and voltage condition logic.

Synchrophasors

- Improve operator awareness of system conditions with standard IEEE C37.118-2005 Level 1 synchrophasors at as many as 60 messages per second.
- Synchronize 128 sample-per-cycle oscillography and event reports to the microsecond to reconstruct complex disturbances. Synchronize meter reports to verify proper phasing.
- Use the "MRI of the power system" to replace state estimation with state measurement.

Metering and Monitoring

- Eliminate expensive, separately mounted metering devices with built-in, high-accuracy metering and harmonic metering functions. Load Profile recording on SEL-351-6 and SEL-351-7.
- Improve maintenance scheduling using circuit breaker contact wear monitor and substation battery voltage monitors. Record relay and external trips and total interrupted current for each pole.
- Use alarm elements to inhibit reclosing and provide local and remote alarm indication.
- Analyze oscillographic and Sequential Events Recorder (SER) reports for rapid commissioning, testing, and post-fault diagnostics.
- Use unsolicited SER protocol to allow station-wide collection of binary SER messages with original time stamp for easy chronological analysis.
- Synchronize all reports with IRIG-B on the standard rear-panel BNC or on serial Port 2, from Simple Network Time Protocol (SNTP) on the standard or optional Ethernet connections, or via DNP serial or Ethernet protocols. Connect all possible time sources and the relay automatically selects the best.
- Use Voltage Sag, Swell, and Interrupt (VSSI) for power quality monitoring on SEL-351-7.

Fault Locator

- Reduce fault location and repair time with built-in impedance-based fault locator and faulted phase indication.
- Efficiently dispatch line crews to quickly isolate line problems and restore service faster.

Operator Interface and Controls

- Standard target LEDs annunciate trip and status indication and fault type.
- Two-line, large font rotating LCD display provides added operator information with programmable display points.
- Optional SafeLock® trip/close pushbuttons with high-visibility breaker status LEDs eliminate expensive panel-mounted breaker control switches and position indicating lights. The breaker status LED clusters are bright and easy to see from all viewing angles.

Communications Protocols

- Optional IEC 61850 MMS and GOOSE. As many as 6 MMS sessions, guaranteed GOOSE performance with 24 subscriptions and 8 publications.
- Standard Modbus® with label-based map settings (serial and Ethernet—as many as three sessions).
- Standard DNP3 Level 2 with label-based map settings (serial and Ethernet—as many as six sessions).
- IEEE C37.118-2005 synchrophasor protocol (serial and Ethernet).

- ASCII, SEL Fast Meter, SEL Fast Message, SEL Unsolicited SER, SEL Fast Operate, and SEL Distributed Port Switch (LMD) serial protocols are all standard.
- Standard Telnet and integrated web server on Ethernet.
- Dual-channel MIRRORED BITS® communications on SEL-351-6 and SEL-351-7.
- Parallel redundancy protocol (when supported by hardware).

Communications Hardware

Two 10/100BASE-T Ethernet ports with RJ45 connector included.

- One or two 10/100BASE-FX Ethernet ports with LC multimode fiber-optic connectors optional.
- One 10/100BASE-T Ethernet port and one 10/100BASE-FX Ethernet port with LC multimode fiber-optic connectors optional.
- Front-panel high-speed USB Type-B port included.
- Front-panel EIA-232 DB-9 serial port included.
- Two rear-panel EIA-232 DB-9 ports included.
- One optional rear-panel EIA-485 port with five-position compression terminal block.
- One optional SEL-2812-compatible fiber-optic serial port.

Single-Phase or Three-Phase Wye- or Delta-Connected Voltage Inputs

- Settings allow either single-phase or three-phase wye or three-phase delta voltage inputs.
- Single-phase voltage input permits phantom phase voltage for balanced three-phase metering and other limited voltage-dependent functions.
- The VS voltage input can be used for either synchronism-check or broken-delta (zero-sequence) voltage connection to the relay.

Other Features and Options

Table 1 SEL-351 Protection System Model Options

Model	Complete Protection and Control Functions With ACSELERATOR QuickSet Support	Load Profile and MIRRORED BITS Communications	Voltage Sag, Swell, Interruption Reports	Power Elements
SEL-351-5	x			
SEL-351-6	x	x		
SEL-351-7	x	x	x	x

- Available 750 KB of on-board storage space for ACSELERATOR QuickSet® SEL-5030 Software settings file, ACSELERATOR QuickSet design template, or anything else you choose.
- Expanded I/O is available. Order any one of the following I/O options:
  - Option X: No extra I/O board
  - Option 2: Additional 8 Inputs and 12 Standard Outputs
  - Option 4: Additional 16 Inputs and 4 Standard Outputs
  - Option 6: Additional 8 Inputs and 12 High Interrupting Current Outputs
- Nominal 5 A or 1 A current inputs: 5 A phase, 5 A neutral; 5 A phase, 1 A neutral; 1 A phase, 1 A neutral; 0.05 A neutral for nondirectional sensitive earth fault (SEF) protection; or 0.2 A neutral for directional ground protection on low-impedance grounded, ungrounded, high-impedance grounded, and Petersen Coil grounded systems.

Note: The 0.2 A nominal channel can also provide nondirectional SEF protection. The 0.05 A nominal neutral channel IN option is a legacy nondirectional SEF option.

solaredge

INVERTERS

SolarEdge Three Phase Inverters for the 277/480V Grid for North America

SE10KUS / SE20KUS / SE30KUS / SE33.3KUS

The best choice for SolarEdge enabled systems

- Specifically designed to work with power optimizers
- Superior efficiency (98.5%)
- Integrated arc fault protection and rapid shutdown for NEC 2014 and 2017, per article 690.11 and 690.12
- UL1741 SA certified, for CPUC Rule 21 grid compliance
- Built-in module-level monitoring
- Internet connection through Ethernet or Wireless
- Small, lightweight, and easy to install outdoors or indoors on provided bracket
- Fixed voltage inverter for longer strings
- Integrated Safety Switch
- Supplied with RS485 Surge Protection Device, to better withstand lightning events

solaredge

Three Phase Inverters for the 277/480V Grid[1] for North America

SE10KUS / SE20KUS / SE30KUS / SE33.3KUS

	SE10KUS	SE20KUS	SE30KUS	SE33.3KUS	
OUTPUT					
Rated AC Power Output	10000	20000	30000	33300	VA
Maximum AC Power Output	10000	20000	30000	33300	VA
AC Output Line Connections	4-wire WYE (L1-L2-L3-N) plus PE				
AC Output Voltage Minimum-Nominal-Maximum[2] (L-N)	244-277-305				Vac
AC Output Voltage Minimum-Nominal-Maximum[2] (L-L)	422.5-480-529				Vac
AC Frequency Min-Nom-Max[2]	59.3 - 60 - 60.5				Hz
Max. Continuous Output Current (per Phase)	12	24	36.5	40	A
GFDI Threshold	1				A
Utility Monitoring, Islanding Protection, Country Configurable Set Points	Yes				
INPUT					
Maximum DC Power (Module STC)	13500	27000	40500	45000	W
Transformer-less, Ungrounded	Yes				
Maximum Input Voltage DC to Gnd	490				Vdc
Maximum Input Voltage DC+ to DC-	980				Vdc
Nominal Input Voltage DC to Gnd	420				Vdc
Nominal Input Voltage DC+ to DC-	840				Vdc
Maximum Input Current	13.5	26.5	39	40	Adc
Maximum Input Short Circuit Current	45				Adc
Reverse-Polarity Protection	Yes				
Ground-Fault Isolation Detection	1MΩ Sensitivity		350kΩ Sensitivity[3]		
CEC Weighted Efficiency	98		98.5		%
Night-time Power Consumption	< 3		< 4		W
ADDITIONAL FEATURES					
Supported Communication Interfaces	RS485, Ethernet, ZigBee (optional)				
Rapid Shutdown – NEC 2014 and 2017 690.12	Automatic Rapid Shutdown upon AC Grid Disconnect[4]				
RS485 Surge Protection	Supplied with the inverter				
STANDARD COMPLIANCE					
Safety	UL1741, UL1741 SA, UL1699B, CSA C22.2, Canadian AFCI according to T.I.L. M-07				
Grid Connection Standards	IEEE1547, Rule 21, Rule 14 (HI)				
Emissions	FCC part15 class B				
INSTALLATION SPECIFICATIONS					
AC output conduit size / AWG range	3/4" minimum / 12-6 AWG		3/4" minimum / 8-4 AWG		
DC input conduit size / AWG range	3/4" minimum / 12-6 AWG				
Number of DC inputs	2 pairs		3 pairs[5]		
Dimensions (H x W x D)	21 x 12.5 x 10.5 / 540 x 315 x 260				in / mm
Dimensions with Safety Switch (H x W x D)	30.5 x 12.5 x 10.5 / 775 x 315 x 260				in / mm
Weight	73.2 / 33.2		99.5 / 45		lb / kg
Weight with Safety Switch	79.7 / 36.2		106 / 48		lb / kg
Cooling	Fans (user replaceable)				
Noise	< 50		< 55		dBA
Operating Temperature Range	-40 to +140 / -40 to +60[6]				˚F / ˚C
Protection Rating	NEMA 3R				

[1] For 208V inverters refer to: http://www.solaredge.com/files/pdfs/products/inverters/se-three-phase-us-inverter-208V-datasheet.pdf
[2] For other regional settings please contact SolarEdge support
[3] Where permitted by local regulations
[4] P/Ns SE10K/SE20K-USOxxxxx have Manual Rapid Shutdown for NEC 2014 compliance (NEC 2017 compliance with outdoor installation)
[5] Field replacement kit for 1 pair of inputs P/N: DCD-3PH-1TBK; Field replacement kit for 3 pairs of fuses and holders P/N: DCD-3PH-6FHK-S1
[6] For power de-rating information refer to: https://www.solaredge.com/sites/default/files/se-temperature-derating-note-na.pdf

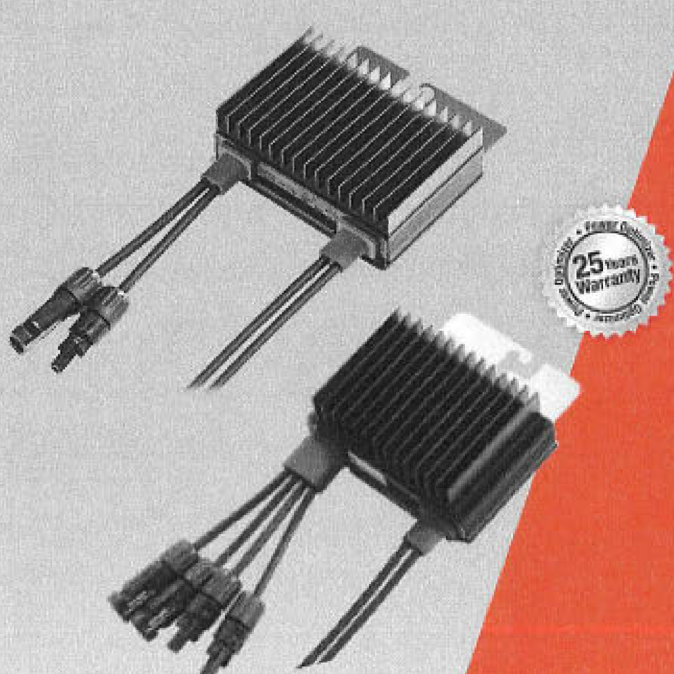
RoHS

SolarEdge Power Optimizer

Module Add-On for Commercial Installations

P600 / P700 / P800p / P800s

POWER OPTIMIZER



PV power optimization at the module-level
The most cost effective solution for commercial and large field installations

- Specifically designed to work with SolarEdge inverters
- Up to 25% more energy
- Superior efficiency (99.5%)
- Balance of System cost reduction; 50% less cables, fuses and combiner boxes, over 2x longer string lengths possible
- Fast installation with a single bolt
- Advanced maintenance with module-level monitoring
- Module-level voltage shutdown for installer and firefighter safety
- Use with two PV modules connected in series or in parallel

SolarEdge Power Optimizer Module Add-On For Commercial Installations P600 / P700 / P800p / P800s

Optimizer model (typical module compatibility)	P600 (for 2 x 60-cell PV modules)	P700 (for 2 x 72-cell PV modules)	P800p (for parallel connection of 2x 96-cell 5" PV modules)	P800s (for series connection of 2x high power or bi-facial modules)	
INPUT					
Rated Input DC Power[1]	600	730	800		W
Absolute Maximum Input Voltage (Voc at lowest temperature)	96	125	83	120	Vdc
MPPT Operating Range	12.5 - 80	12.5 - 105	12.5 - 83	12.5 - 105	Vdc
Maximum Short Circuit Current (Isc)	10.25		14	12.5	Adc
Maximum Efficiency	99.5				%
Weighted Efficiency	98.6				%
Overvoltage Category	II				
OUTPUT DURING OPERATION (POWER OPTIMIZER CONNECTED TO OPERATING SOLAREDGE INVERTER)					
Maximum Output Current	15		18		Adc
Maximum Output Voltage	85				Vdc
OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM SOLAREDGE INVERTER OR SOLAREDGE INVERTER OFF)					
Safety Output Voltage per Power Optimizer	1 ± 0.1				Vdc
STANDARD COMPLIANCE					
EMC	FCC Part15 Class B, IEC61000-6-2, IEC61000-6-3				
Safety	IEC62109-1 (class II safety)				
RoHS	Yes				
Fire Safety	VDE-AR-E 2100-712:2013-05				
INSTALLATION SPECIFICATIONS					
Compatible SolarEdge Inverters	Three phase inverters SE15K & larger	Three phase inverters SE16K & larger			
Maximum Allowed System Voltage	1000				Vdc
Dimensions (W x L x H)	128 x 152 x 43 / 5 x 5.97 x 1.69	128 x 152 x 50 / 5 x 5.97 x 1.93	128 x 158 x 59 / 5 x 6.22 x 2.32	128 x 152 x 59 / 5 x 5.97 x 2.32	mm / in
Weight (including cables)	834 / 1.8	933 / 2.1	1019 / 2.2	1064/2.3	gr / lb
Input Connector[2]	MC4		MC4 Dual Input[4]	MC4	
Output Connector	MC4				
Output Wire Length	1.2 / 3.9 (portrait orientation) or 1.8 / 5.9 (landscape orientation)	1.2 / 3.9 (portrait orientation) or 2.1 / 6.9 (landscape orientation)	1.2 / 3.9 (portrait orientation) or 1.8 / 5.9 (landscape orientation)	1.2 / 3.9 (portrait orientation) or 2.1 / 6.9 (landscape orientation)	m / ft
Operating Temperature Range[3]	-40 - +85 / -40 - +185				˚C / ˚F
Protection Rating	IP68 / NEMA6P				
Relative Humidity	0 - 100				%

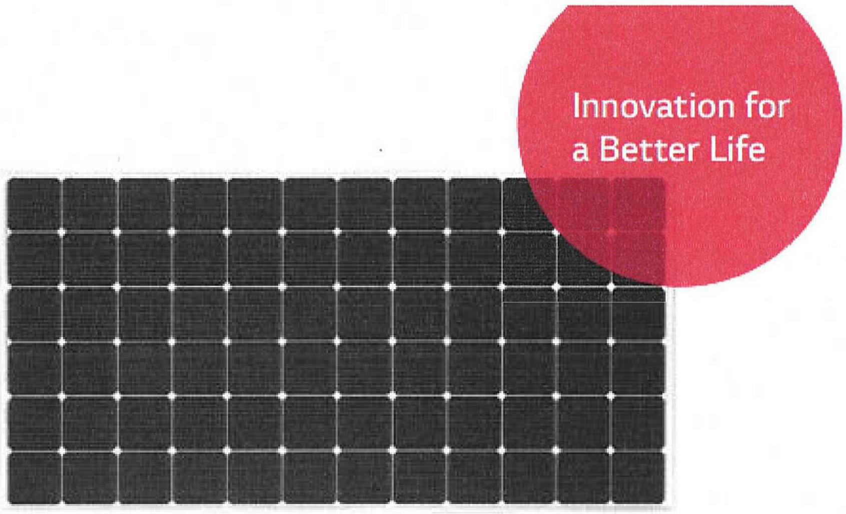
[1] Rated STC power of the module. Module of up to +5% power tolerance allowed.
[2] For other connector types please contact SolarEdge.
[3] For ambient temperature above +70˚C / +158˚F power de-rating is applied. Refer to Power Optimizers Temperature De-Rating Application Note for more details.

PV SYSTEM DESIGN USING A SOLAREDGE INVERTER[5][6]		THREE PHASE SE15K AND LARGER	THREE PHASE SE16K AND LARGER		THREE PHASE FOR MV GRID		
Compatible Power Optimizers		P600	P600, P700	P800	P600, P700	P800	
Minimum String Length	Power Optimizers	13		12	13		
	PV Modules	26		24	26		
Maximum String Length	Power Optimizers	30					
	PV Modules	60					
Maximum Power per String		11250[7]		13500	12750[8]	15300	W
Parallel Strings of Different Lengths or Orientations		Yes					

[5] P600 and P700 can be mixed in one string. It is not allowed to mix P600/P700/P800 with P300/P370/P500/P404/P405/P505 in one string.
[6] In a case of odd number of PV modules in one string it is allowed to install one P600/P700/P800 power optimizer connected to one PV module. When connecting a single module to the P800p seal the unused input connectors with the supplied pair of seals.
[7] For SE27.6K, SE50K, SE55K, SE82.8K: It is allowed to install up to 13,500W per string when 3 strings are connected to the inverter and when the maximum power difference between the strings is up to 2,000W; inverter max DC power: 37,250W.
[8] For inverters for MV grid: It is allowed to install up to 15,000W per string when 3 strings are connected to the inverter and when the maximum power difference between the strings is up to 2,000W; inverter max DC power: 45,000W.

CE

LG
Life's Good



LG NeON® 2 72cell

LG400N2W-A5

72 cell

LG's NeON® 2 module adopts Cello Technology™. Cello Technology™ replaces 3 busbars with 12 thin wires to enhance power output and reliability. The NeON® 2 72cell demonstrates LG's efforts to increase customer value through efficiency, enhanced warranties, durability and performance.

DVE · Intertek · CE

Enhanced Performance Warranty

LG NeON® 2 has an enhanced performance warranty. The annual degradation has fallen from -0.6%/yr to -0.5%/yr. Even after 25 years, the cell guarantees 2.4% more output than the previous LG NeON® 2 modules.

Roof Aesthetics

LG NeON® 2 has been designed with aesthetics in mind, using thinner wires that appear all black at a distance.

Improved Performance on Sunny Days

LG NeON® 2 now performs better on sunny days, thanks to its improved temperature coefficient.

High Power Output

Compared with previous models, the LG NeON® 2 has been designed to significantly enhance its output efficiency, thereby making it efficient even in limited space.

Outstanding Durability

With its newly reinforced frame design, LG has extended the warranty of the LG NeON® 2 for an additional 3 years. Additionally, LG NeON® 2 can endure a front load up to 5400 Pa, and a rear load up to 4300 Pa.

Double-Sided Cell Structure

The rear of the cell used in the LG NeON® 2 contributes to generation, just like the front; the light beam reflected from the rear of the module is reabsorbed to generate additional power.

About LG Electronics

LG Electronics is a global player who has been committed to expanding its operations with the solar market. The company first embarked on a solar energy source research program in 1985, supported by LG Group's vast experience in the semi-conductor, LCD, chemistry, and materials industries. In 2010, LG Solar successfully released its first Mono X® series to the market, which is now available in 32 countries. The LG NeON® (previously known as Mono X® NeON) and the LG NeON® 2 won the "Intersolar Award" in 2013 and 2015, which demonstrates LG Solar's lead, innovation and commitment to the industry.

LG NeON 2 72cell LG400N2W-A5

Mechanical Properties

Cells	6 x 12
Cell Vendor	LG
Cell Type	Monocrystalline / N-type
Cell Dimensions	161.7 x 161.7 mm / 6 inches
# of Busbar	12 (Multi Wire Busbar)
Dimensions (L x W x H)	2024 x 1024 x 40 mm 79.69 x 40.31 x 1.57 inch
Front Load	5400Pa
Rear Load	4300Pa
Weight	21.7kg
Connector Type	MC4
Junction Box	IP68 with 3 Bypass Diodes
Cables	1200mm x 2 ea
Glass	Tempered Glass with AR Coating
Frame	Anodized Aluminium

Certifications and Warranty

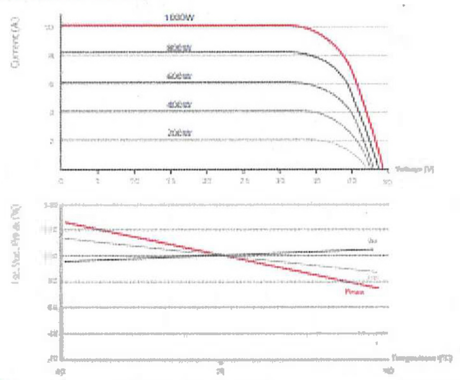
Certifications	IEC 61215, IEC 61730-1/-2
	UL 1703
	IEC 61701 (Salt mist corrosion test)
	IEC 62716 (Ammonia corrosion test)
	ISO 9001
Module Fire Performance (USA)	Type 1
Fire Rating (CANADA)	Class C (ULC / ORD C1703)
Product Warranty	15 years
Output Warranty of Pmax	Linear warranty**

** 1) 1st year : 98%, 2) After 1st year : 0.5% annual degradation, 3) 25 years : 86%

Temperature Characteristics

NOCT	45 ± 3 ℃
Pmpp	-0.36%/℃
Voc	-0.26%/℃
Isc	0.02%/℃

Characteristic Curves



Electrical Properties (STC *)

Module	400W
Maximum Power (Pmax)	400
MPP Voltage (Vmpp)	40.6
MPP Current (Impp)	9.86
Open Circuit Voltage (Voc)	49.3
Short Circuit Current (Isc)	10.47
Module Efficiency	19.3
Operating Temperature	-40 ~ +90
Maximum System Voltage	1500 (UL)
Maximum Series Fuse Rating	20
Power Tolerance (%)	0 ~ +3

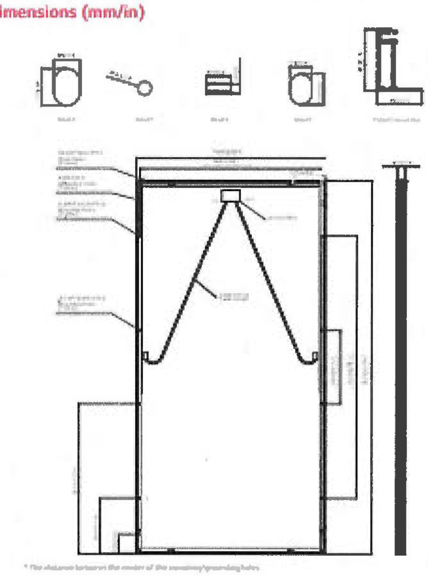
* STC (Standard Test Condition): Irradiance 1,000 W/m², Cell Temperature 25 °C, AM 1.5
* The nameplate power output is measured and determined by LG Electronics at its sole and absolute discretion.
* The Typical change in module efficiency at 200W/m² in relation to 1000W/m² is -2.0%.

Electrical Properties (NOCT*)

Module	400W
Maximum Power (Pmax)	296
MPP Voltage (Vmpp)	37.6
MPP Current (Impp)	7.86
Open Circuit Voltage (Voc)	46.1
Short Circuit Current (Isc)	8.41

* NOCT (Nominal Operating Cell Temperature): Irradiance 800W/m², ambient temperature 20 °C, wind speed 1m/s

Dimensions (mm/in)



* The distance between the center of the mounting/grounding holes.

LG Life's Good

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Contact: lg.solar@lge.com
www.lgsolarusa.com

Product specifications are subject to change without notice.

01/01/2017

Innovation for a Better Life