
Design Considerations for Domestic Content Inverters with Power Optimizers

Technical App Note



solaredge

Introduction: Designs with More Than Two Strings When Using SolarEdge C&I Domestic Content Inverters

This document explains the design considerations when using Power Optimizers that have different output currents with C&I Domestic Content inverters (USE-SIN, SE-DBL and SE-TRI). In certain scenarios, more than two strings per 40kW inverter may be needed. The Domestic Content inverters (USE-SIN, SE-DBL and SE-TRI) **do not include DC fuses**. This guide provides a quick reference on the design considerations for using fuse-less Synergy Managers with current and legacy DC Power Optimizers.

Output Current	Applicable Optimizer Models
15A	S440, S500, S500B, S650B, U650, U650B P605, P650, P701, P730, P801
18A	P850, P860, P950, P960, P1100, P1101, S1200, S1201
24A	C651U

Fusing and Cable Sizing – Based on 2023 NEC section 690

690.8 Circuit Sizing, Current and Conductor Ampacity

Calculating Max Circuit Current — 690.8 (A)(1)(b):

C651U Power Optimizers are a DC-DC converter with maximum current of **24A**. There is one parallel circuit as Power Optimizers are connected in series.

S1201 Power Optimizers are a DC-DC converter with maximum current of **18A**. There is one parallel circuit as Power Optimizers are connected in series.

Calculating Conductor Ampacity

Conductor ampacity to be larger of 690.8 (B)(1) and 690.8 (B)(2)

/ 690.8 (B)(1): $24 \times 1.25 = 30A$

/ 690.8 (B)(2):

/ $24A \div 0.91 (40^{\circ}C \text{ max}) \div 0.8 (4-6 \text{ conductors}) = \mathbf{32.97A}$

/ $24A \div 0.91 \div 0.7 (7-9 \text{ conductors}) = \mathbf{37.68A}$

Calculating Conductor Ampacity

Conductor ampacity to be larger of 690.8 (B)(1) and 690.8 (B)(2)

/ 690.8 (B)(1): $18 \times 1.25 = 22.5A$

/ 690.8 (B)(2):

/ $18A \div 0.91 (40^{\circ}C \text{ max}) \div 0.8 (4-6 \text{ conductors}) = \mathbf{24.73A}$

/ $18A \div 0.91 \div 0.7 (7-9 \text{ conductors}) = \mathbf{28.26A}$

Per NEC table 310.16 for copper wire rated 90°C at ambient temperatures of 40°C or less:

Power Optimizer Output Current	Conductors per Conduit	#10 PV Wire (40A)	#8 PV Wire (55A)
24A	4-6 (up to 3 strings)	✓	✓
18A	7-9 (up to 4 strings)	✓	✓
15A	7-9 (up to 4 strings)	✓	✓

690.9 Overcurrent Protection

690.9(A)(2): Electronic power converter outputs that are current-limited can be exempted from the overcurrent protection requirement.

SolarEdge Power Optimizers inherently limit output current to the listed maximum output (i.e. 24A for C651U), preventing sustained overcurrent conditions. Homerun conductor (minimum #10 PV wire) ampacity is sufficient even in the hottest U.S. locations.

SolarEdge has validated the no-fuse approach, as witnessed by **Brooks Engineering**. Testing has confirmed:

- / Up to five parallel strings can be safely installed without fusing.
- / Fault current stops within 11 milliseconds, preventing conductor overload.

All NEC versions (2020, 2023, 2026) support exceptions to overcurrent protection when:

1. Conductors are sized for maximum circuit current.
2. All source currents do not exceed the maximum overcurrent protective device rating for the optimizer.

SolarEdge inverters cannot back feed current into the array, supporting fuse-less design for two or more circuits. As such, SolarEdge DC-to-DC converter arrays are **fully code-compliant for up to five strings in parallel without fuses**, provided the system design meets SolarEdge's array size and string-length criteria. Eliminating fuses also removes a potential failure point, so it is best to remove them where possible.

More information on the justification and relevant testing can be found in the support letter from Brooks Engineering. See appended at the end of this document.

RMA Use Cases

Newer SolarEdge Domestic Content Inverters without fuses are now being used for RMA of legacy inverters with integrated DC fuses. The above explanation of a SolarEdge system to be compliant with the NEC without fuses should be used to justify the replacement of legacy inverters with the Domestic Content part numbers.



19 December 2025

RE: Protection of SolarEdge Power Optimizer Circuits—No Fuse Evaluation

To Whom It May Concern:

This letter provides an explanation of the National Electrical Code (NEC) compliance of the protection of SolarEdge power optimizer circuits. What SolarEdge terms a power optimizer is referred to in the NEC as a dc-to-dc converter. The circuits connected to these power optimizers are termed dc-to-dc converter source circuits in the 2020 NEC and dc-to-dc converter circuits in the 2023 NEC. This letter discusses NEC compliance related to the protection of these circuits from overcurrents due to fault conditions. The NEC only requires overcurrent protective devices to be installed on dc-to-dc converter circuits in a PV array when there is sufficient current to create an overcurrent situation.

The SolarEdge power optimizers have output conductors which have an ampacity of greater than 50 amps even in the hottest locations in the United States. The limiting factor for these circuits is not dc conductors between the optimizers, but it is the homerun conductors that are used to go from the array to the inverter. A minimum of 10 AWG PV Wire is required as it has an ampacity of 28 amps with six current carrying conductors in a raceway in the hottest U.S. location. Each dc-to-dc converter source circuit is current limited to no more than 24 amps.

Previously, Brooks Engineering has provided technical guidance that showed examples that allowed up to three source circuits to be combined at the inverter input terminals without fusing the individual dc-to-dc converter source circuits. This guidance was based on an oversized homerun conductor of 8 AWG PV Wire to accommodate fault scenarios that necessitated larger conductors during fault conditions. The letter dated November 11, 2020 stated that SolarEdge was planning on doing the required evaluation to prove that fusing is not necessary for three or more strings in parallel. That evaluation is complete, and the findings have confirmed that fusing of SolarEdge dc-to-dc converter circuits is unnecessary.

The SolarEdge testing, witnessed by Brooks Engineering, showed that up to five strings can be safely placed in parallel without string-level fusing. Since no fault current is sustained past 11 msec in a fault, the conductors are never exposed to overload conditions so there is no need to oversize conductors or install fusing. This means that 10 AWG PV Wire copper conductors are sufficient for the new 24-amp dc optimizer circuits with six current carrying conductors in the same raceway.

The three primary versions of the NEC currently being enforced throughout the United States include the 2026, 2023, and the 2020 editions. All three of these versions are identical in how they state the exception to the requirement for overcurrent protection on circuits and equipment in NEC 690.9(A).

690.9(A)(1) Circuits Where Overcurrent Protection Not Required.

Overcurrent protective devices shall not be required where both of the following conditions are met:

- (1) The conductors have sufficient ampacity for the maximum circuit current.*
- (2) The currents from all sources do not exceed the maximum overcurrent protective device rating specified for the PV module or electronic power converter.*



Brooks Engineering
3949 Joslin Lane
Vacaville, CA 95688
(Voice) 707-332-0761
(Fax) 707-451-1765
(email) bill@brooksolar.com

The NEC in section 690.9(A) addresses overcurrent protection for all types of circuits in PV systems. While this section initially did not specifically address dc-to-dc converter source and output circuits, there are strong similarities between PV source and output circuits and dc-to-dc converter source and output circuits. The strongest similarities are related to the current-limited nature of these circuits which is the relevant concern with the exception in 690.9(A).

To increase clarity further on this subject, the 2020 NEC divided 690.9(A) into three sections. The first of these sections is shown above and states the same information in positive language rather than as exception. The new term electronic power converter is added in the 2020 NEC which includes dc-to-dc converters in the definition.

Electronic Power Converter.

A device that uses power electronics to convert one form of electrical power into another form of electrical power.

Informational Note: Examples of electronic power converters include, but are not limited to, inverters, dc-to-dc converters, and electronic charge controllers. These devices have limited current capabilities based on the device ratings at continuous rated power.

2-Circuits Without Fusing:

It is well understood in the PV industry, by contractors and enforcement alike, that two PV source circuits can be connected to a PV inverter input circuit without fusing—provided that the inverter is not capable of backfeeding current into the PV array. In the same way, two dc-to-dc converter circuits can be connected to the inverter input circuit without fusing on these circuits—provided that the inverters, such as the SolarEdge inverters, is not capable of backfeeding current into the dc-to-dc converter array.

3 or more Circuits Without Fusing:

Dc-to-dc converter circuits are unique because they can shutdown current flow from the source (PV modules) in the event of a fault. Previously, this was theoretically understood to be true, but until now that hypothesis had not been tested. We now know conclusively that it is not possible to create an overcurrent condition in multiple parallel circuits in the event of a ground fault. Because of the control capabilities in the SolarEdge optimizers and inverter, SolarEdge has demonstrated that their products are capable of paralleling up to five strings in parallel without fuses. The limiting factor is the maximum array size for the inverter. As long as maximum array size criteria is met as specified in the manufacturer's instructions, and the string lengths match limitations provided by SolarEdge, it is not possible to damage conductors in the array with or without string fusing. Since fuses are now understood to be superfluous, it is best to remove them from the system to prevent the fuses from becoming a failure point in the system.

Summary:

SolarEdge power optimizer arrays are now code compliant with up to five parallel source circuits without overcurrent protection on these circuits.

Sincerely,

Bill Brooks, PE
Principal, Brooks Engineering



Engineering Consulting for the Solar Industry