



PCS Certificate of Compliance

May 30, 2024

Project #X1100-1
Report #LIT30241100

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Subject: UL3141/UL1741 CRD Busbar Overload Control (BBoC) Protection with PV & Battery

Dear Mr. Baligar

This test report represents the results of our evaluation/testing of the PV + Battery Energy storage system to the requirements contained in following standards:

- UL3141 Issue 1 Outline of Investigation for Power Control Systems (PCS), Dated January 11, 2024**
- UL1741 3rd Ed CRD for Power Control Systems (PCS), Dated April 8, 2023**
- UL1741 2nd Ed CRD for Power Control Systems (PCS), Dated March 8, 2019**

Compliance includes management, control, and limitation of power export between Energy Storage Systems and PV with a Point of Connection (PoC), which is typically the point of back feed on a Main (or) Sub-panel to keep the busbar in the panel under safe limits.

The PCS evaluation was conducted on a representative Enphase Energy System and the certification applies to the following configurations which were part of the tested system in the PCS modes defined below.

PCS Modes ¹	PV Model ²	ESS Model ²	Max PV Ratings	Max ESS Ratings	Max PV+ESS Rating	Additional Devices needed for PCS functionality	Optional Devices	Range of PCS controlled export current	Measured Average/Maximum OLRT (s)
BBoC with PV, Battery Power Limiting	IQ8	IQ Battery 5P	64A/ 15.36kVA	128A / 30.72kVA	192A / 46.08kVA	IQ Gateway/ CT's	IQ System Controller ²	128A to 4A	3.3 / 14.4
		IQ Battery 3T/10T		64A / 15.36kVA	128A / 30.72kVA				
BBoC with only Battery Power Limiting	Any Line-to-Line UL Listed PV inverter	IQ Battery 5P	64A/ 15.36kVA	128A / 30.72kVA	192A / 46.08kVA	IQ Gateway/ CT's	IQ System Controller ²	128A to 4A ³	2.2 / 11.5
		IQ Battery 3T/10T		64A / 15.36kVA	128A / 30.72kVA				
BBoC with only PV Power Limiting	IQ8	N/A	64A/ 15.36kVA	N/A	N/A	IQ Gateway/ CT's	IQ System Controller ²	64A to 4A	1.25 / 4.6

¹All modes tested with PCS eSW 1.3.0

²Please see System configuration table further for exact variations of SKU model numbers.

³In Battery Power limiting, the lower limit of the current is limited based on the nameplate of the PV e.g., if the nameplate of the PV inverter is 16A, then the current limit set can be no lower than 16A.

Busbar Overload Control (BBoC) Protection with PV & Battery Power Limiting:

This is a PCS mode where the system was evaluated for its ability to control per-phase currents from the PV, ESS by monitoring the sum of PV, ESS, and Grid Import Currents to keep the busbar within safe limits.

The testing verified that when PV power or system load levels were subjected to step changes the total current of the PV and Battery did not exceed the limit set beyond the response time mentioned in the table.

Additionally, the system was tested for cases where the system loads exceeded the busbar limit set. In this case, the PV and Battery power were observed to be curtailed down to zero, so the original upstream protection mechanism (typically a service breaker) can protect the busbar.



Busbar Overload Control (BBoC) Protection with Only Battery Power Limiting:

This is a PCS mode where the system was evaluated for its ability to control per-phase currents from the ESS by monitoring the sum of PV, ESS, and Grid Import Currents to keep the busbar within safe limits.

The testing verified that when PV power or system load levels were subjected to step changes the total current of the PV and Battery did not exceed the limit set beyond the response time mentioned in the table.

Additionally, the system was tested for cases where the system loads exceeded the busbar limit set. In this case, the Battery power was observed to be curtailed down to zero, so the original upstream protection mechanism (typically a service breaker) can protect the busbar.

In this mode, the PV Nameplate cannot exceed the calculated Busbar limits allowed under jurisdiction rules such as NEC 2020 705.12 (B) (3) which cover Load-Side Source Connections.

Busbar Overload Control (BBoC) Protection with Only PV Power Limiting:

This is a PCS mode where the system was evaluated for its ability to control per-phase currents from the PV by monitoring the sum of PV and Grid Import Currents to keep the busbar within safe limits.

The testing verified that when PV power or system load levels were subjected to step changes the total current of the PV did not exceed the limit set beyond the response time mentioned in the table.

Additionally, the system was tested for cases where the system loads exceeded the busbar limit set. In this case, the PV power was observed to be curtailed down to zero, so the original upstream protection mechanism (typically a service breaker) can protect the busbar.

The table below describes the System configuration and SKUs associated with tested PCS mode(s)

System Component	Product SKUs	Equipment required in PCS mode?		
		BBoC with PV & Battery	BBoC with Only Battery	BBoC with Only PV
Enphase IQ8 PV	IQ8H-240-72-2-US, IQ8-60-2-US, IQ8PLUS-72-2-US, IQ8M-72-2-US, IQ8A-72-2-US, IQ8-60-M-US, IQ8PLUS-72-M-US, IQ8M-72-M-US, IQ8A-72-M-US, IQ8H-240-72-M-US, IQ8MC-72-M-US, IQ8AC-72-MUS, IQ8HC-72-M-US, IQ8X-80-M-US	Required	Any UL-Listed Line-to-Line PV inverter	Required
Enphase Battery	Enphase IQ Battery 5P (Encharge battery 3rd generation): IQBATTERY-5P-1P-NA, B05-T02- US00-1-3-RMA consisting of UL (Listed) IQ8D-BAT/IQ8D-BAT-240 Inverter(s) rated 120/240Vac, intended to be connected to a battery and will charge and discharge the battery. Enphase IQ Battery 3T/10T (Encharge battery 2nd generation): ENCHARGE-3T-1P-NA, ENCHARGE-10T-1P-NA. consisting of UL (Listed) IQ8X-BAT-US/IQ8X-BAT-US-NB Inverter(s) rated 120/240Vac, intended to be connected to a battery and will charge and discharge the battery.	Required	Required	N/A
Enphase IQ Gateway	X-IQ-AM1-240-5, X-IQ-AM1-240-5C, ENV-IQ-AM1-240, ENV2-IQ-AM1- 240, ENV-S-AM1-120, X-IQ-AM1-240-3, X-IQ-AM1-240-3C, X-IQ-AM1-240-3-ES, X-IQ-AM1-240-3C-ES, X-IQ-AM1-240-4, X-IQ-AM1-240-4C, X2-IQ-AM1-240-4, X2-IQ-AM1-240-4C	Required	Required	Required
CTs	For solar production monitoring: At least 1 unit CT-200-SOLID For consumption monitoring: At least 2 units of CT-200-SPLIT or CT-200-CLAMP For battery monitoring: At least 1 unit of CT-200-SPLIT or CT-200-CLAMP	Required	Required	Required
Enphase IQ System Controller	IQ System Controller 3/3G: SC200D111C240US01, SC200G111C240US01 IQ System Controller 2: EP200G101-M240US01	Optional	Optional	Optional

This PCS supports:

- Up to 2 ESS inputs, each with up to 64A of Power of IQ Battery 5P units (or)
- Up to One ESS with upto 64A of IQ Battery 3T units.

Each ESS circuit's charge/discharge current with IQ Battery 5P may also be limited from 64 Amps to 8 Amps continuous.

1. Battery inverter breakers on the combiner box or system controller must be properly sized.
 - a. The maximum breaker size for a single IQ Battery 5P-based branch in a combiner box is 20A.



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- b. The maximum breaker size for the batteries in the system controller input is 80A per circuit.
2. The back feed breaker in the Main Panel must be sized properly based on the main panel busbar and grid breaker, maximum breaker size of 160A is tested with the test setup.
3. Please refer to the equipment installation instructions for system configuration details.

If there are any questions regarding the results contained in this report, please contact me or any Bureau Veritas CPS customer service representative.

Sincerely,

Dishant Patel

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Principal Engineer
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Reviewed by,

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