ENPHASE.

TECHNICAL BRIEF

PCS integration in 4th-generation Enphase Energy Systems

Applicable regions: North America

Contents

1. Introduction to Enphase Power Control

Power Control Systems (PCS), as defined in NFPA 70, National Electrical Code 2020 Edition, control the output of one or more power production sources, energy storage systems (ESS), and other equipment. Power Control Systems can be used in a variety of use cases, for example, to limit current and loading on the busbars and conductors supplied by the power production sources and/or energy storage systems. Enphase Power Control implements power control that complies with the UL 1741 Certification Requirement Decision (CRD) and UL 3141 Outline of Investigation for Power Control Systems.

The 4th-generation Enphase Energy System (EES) has interconnected electric power production sources, such as microinverters and/or IQ Batteries. The amount of power production sources connected to a system is generally governed by various sections of the NEC.

Power Control System integration allows flexible installation of Enphase systems with minimal additional homeowner costs (for example, install more PV or batteries) or comply with special requirements in certain jurisdictions. This technical brief describes the benefits and implementation details of Power Control System integration for real-time current monitoring and export limits.

Distributed energy resources (DER), mentioned in this document, refer to smaller generation units located on the consumer's side of the meter, such as rooftop photovoltaic (PV) units, battery storage units, third-party generators, and other units.

2. Supported configurations for Enphase Power Control

2.1 Overview of the Enphase Energy System

An Enphase Energy System can be classified into two configurations:

- Grid-tied or non-backup systems: In a grid-tied system, Enphase microinverters and (optional) IQ Batteries will need the grid to be available to keep producing power or discharging to the loads.
- Grid-forming or backup systems: Microinverters and IQ Batteries in a grid-forming system do not depend on the grid to keep producing power or to discharge the loads. An additional Microgrid Interconnect Device (MID) is required for these types of systems, for example, IQ Meter Collar.

Both configurations support the Enphase Power Control features. The features supported in each configuration are discussed in the following sections.

2.2 Enphase Power Control in a grid-tied Enphase Energy System

An Enphase Energy System in a grid-tied configuration has the following components:

- IQ8/IQ9 Series Microinverters
- (Optional) IQ Battery
- IQ Combiner 6C

The following figure provides a bird's-eye view of the point of current being measured and limited using Enphase Power Control for each feature.

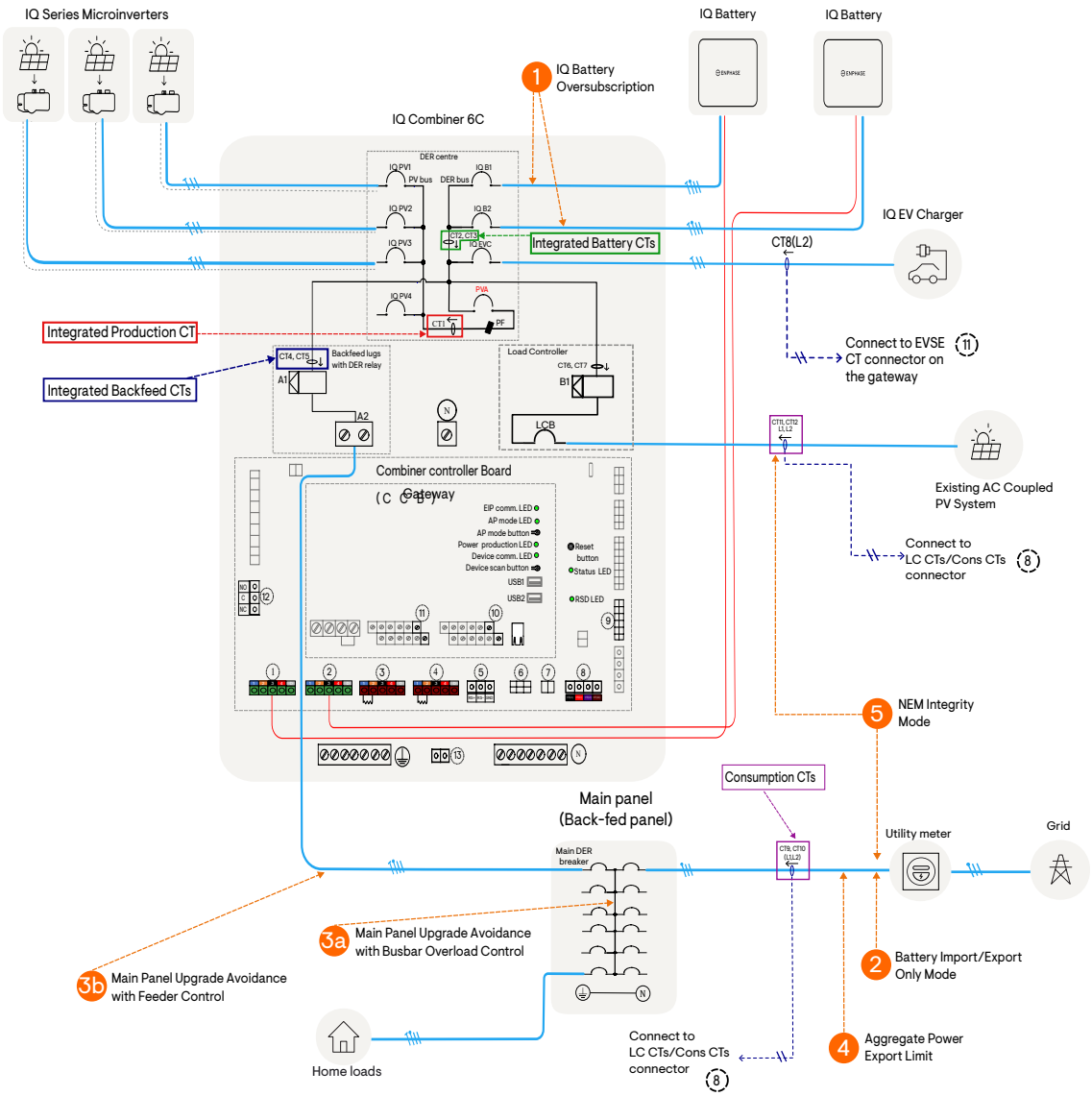


Figure 1: Example of an Enphase Energy System in grid-tied configuration

Enphase Power Control enables five features with Enphase Energy System in grid-tied configuration:

- IQ Battery Over-Subscription Mode (**1**): This feature limits the charge/discharge current and enables more battery capacity to be installed in grid-tied systems. The feature ensures that the total continuous output current from the batteries does not exceed 80% of the battery breaker rating.
- Battery Import/Export Only Mode (**2**):
  - The import-only mode (also called non-exporting) ensures the IQ Battery never exports any power to the grid.
  - The export-only mode (also called charge from PV-only) ensures that the IQ Battery never imports any power from the grid, but can export to the grid. IQ Battery can operate either in battery import-only mode or battery export-only mode.
- Main Panel Upgrade Avoidance (MPUA) mode with:
  - Busbar Overload Control (**3a**): This feature reduces the system payback period by allowing maximum renewable energy generation and helps avoid the cost of panel upgrades for large PV and battery systems.

    - Feeder Control (**3b**): This feature enables avoiding the cost of panel upgrades for large PV and battery systems.
- Aggregate Power Export Limit Mode (**4**): This feature ensures that the aggregate power exported to the grid is limited to the Aggregate Power Export Limit (PEL) defined by the installer.
- NEM Integrity Mode (**5**): This feature ensures that the total system exports no more power than the existing PV system, dynamically maintaining NEM integrity in jurisdictions like California, particularly for homeowners applying under the NEM Multi-Tariff (NEM-MT).

2.3 Enphase Power Control in a grid-forming Enphase Energy System

A typical Enphase Energy System (EES) in a grid-forming configuration has the following components:

- IQ8/IQ9 Series Microinverters
- IQ Battery
- IQ Combiner 6C
- IQ Meter Collar

Enphase Power Control enables four features for grid-forming EESs with IQ Battery 10C, as shown in the following figure. This figure provides a bird's-eye view of the point of current being measured/ monitored and limited using Enphase Power Control for each feature.

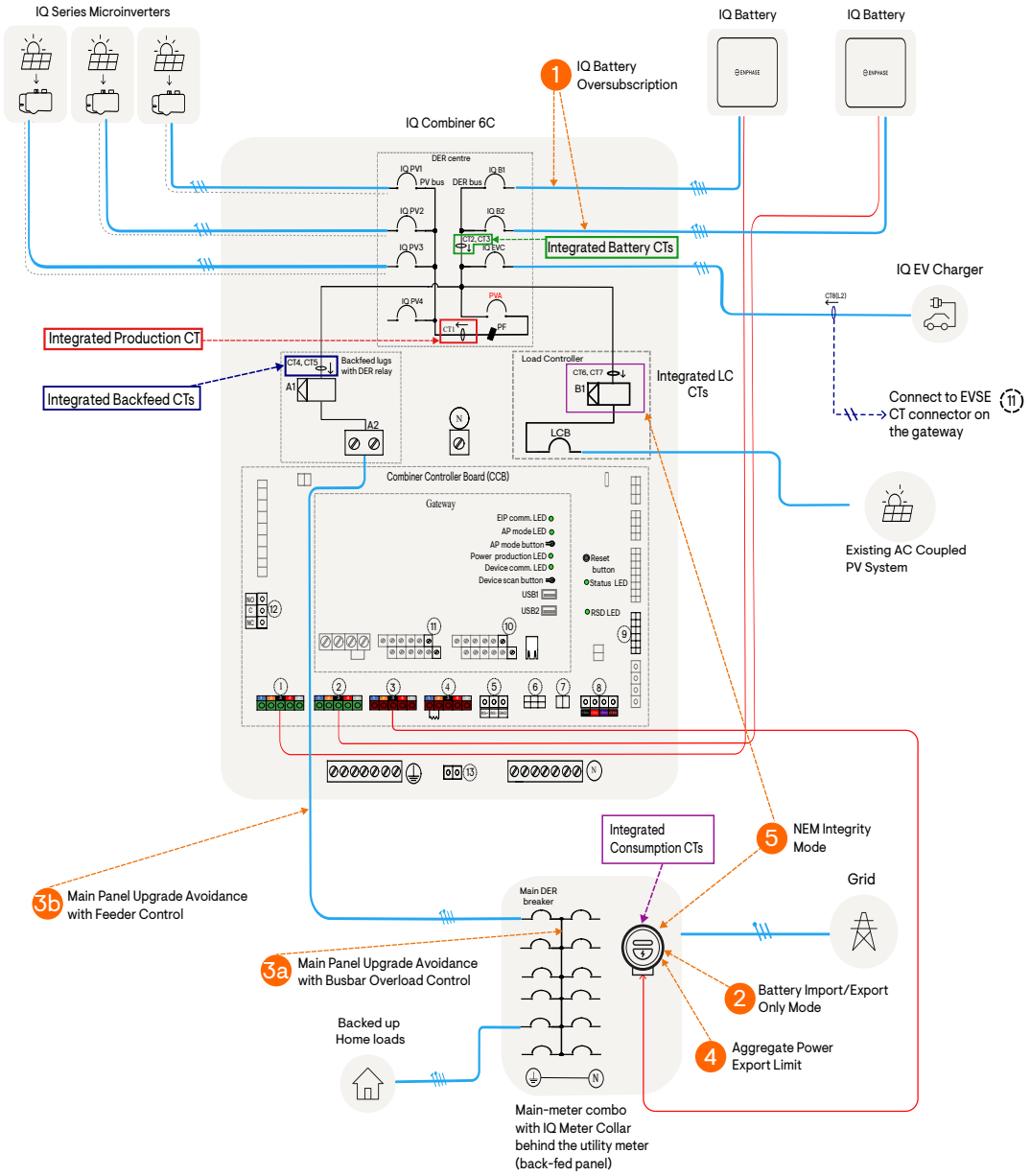


Figure 2: Example of an Enphase Energy System in grid-forming configuration with IQ Meter Collar installed in a main meter combo

- IQ Battery Over-Subscription Mode (**1**): This feature limits the charge/discharge current and allows for more battery capacity to be installed on Storage breaker slot 1 and Storage breaker slot 2 in grid-forming systems than allowed based on the installed breaker rating. The feature ensures that the total continuous output current from the batteries does not exceed 80% of the battery breaker rating.
- Battery Import/Export Only Mode (**2**): The battery import-only feature ensures the IQ Battery never exports any power to the grid. The battery export-only feature ensures that the IQ Battery never imports any power from the grid, but can export to the grid. IQ Battery can operate either in the battery import-only mode or the battery export-only mode.
- MPU avoidance mode with:

  - Busbar Overload Control (**3a**): This feature reduces the system payback period by allowing maximum renewable energy generation and helps avoid the cost of panel upgrades for large PV and battery systems.
  - Feeder Control (**3b**): This feature enables avoiding the cost of panel upgrades for large PV and battery systems.
- Aggregate Power Export Limit Mode (**4**): This feature ensures that the aggregate power exported as measured at the IQ Meter Collar is limited to the power export limit (PEL) value set by the installer.

  NOTE: Enphase PV production and battery discharge ensure that the aggregate export power adheres to the limit regardless of whether the battery is in export-only or import-only mode.
- NEM Integrity Mode (**5**): This feature ensures that the total system exports no more power than the existing PV system, dynamically maintaining NEM integrity in jurisdictions like California, particularly for homeowners applying under the NEM Multi-Tariff (NEM-MT).

3. Benefits of Enphase Power Control

3.1 Avoid costly interconnection equipment upgrades or installations

In the absence of the Enphase Power Control feature (battery import only mode), utilities in California, such as Pacific Gas & Electric (PG&E), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE) may require the installation of an additional net generation output meter (NGOM). This increases the cost of installation of the system for the homeowner. To avoid this additional cost, the homeowner may have to limit their battery to under 10 kW, which may not be sufficient for backing up their home loads. With the Enphase Power Control feature —battery import-only mode, no such trade-off is required when installing an Enphase Energy System.

Utilities such as PG&E require energy storage systems to comply with the import-only mode with an open loop response time (OLRT) of less than two seconds. If the energy storage system complies with this requirement, the utility considers it non-exporting and may not require a feeder transformer upgrade in cases where the addition of an energy storage nameplate exceeds the thermal rating of the feeder transformer.

3.2 Benefit from a smaller payback period

The Enphase Power Control feature, battery export-only mode, allows homeowners in the jurisdiction with NEM 3.0 to charge their IQ Battery from the PV and discharge to their home loads and to the grid. Homeowners can benefit from a lower payback period by storing excess PV power during off-peak hours and discharging the stored energy to the grid during the time when it is most beneficial to the homeowner based on the import and export tariff rates.

The Enphase Power Control feature, MPU avoidance with Busbar Overload Control, allows maximum utilization of available renewable energy while avoiding the cost of main panel upgrades and reducing the payback period for the homeowner.

3.3 Avoid expensive main panel upgrades

The size of the PV and energy storage breakers permitted to be installed at a house may be limited by the NEC based on the size of the main panel and utility service rating. Installers may not be aware of such limits until late into the project. As a result, the system size sold to the homeowner may need an unplanned main panel upgrade, which adds significant labor and hardware costs to the project. The PCS-certified Enphase Power Control features, MPU avoidance with Busbar Overload Control and with Feeder Control, enable large PV and battery systems to be installed while complying with NEC code (NEC 2020 705.13 and NEC 2020 705.12, respectively).

This enables installers to avoid the cost and time due to an unplanned main panel upgrade. Enphase Power Control uses real-time current sensing to monitor and limit the current back-fed into the main panel.

3.4 Benefit from longer backup time with high-power batteries

The Enphase Power Control feature, IQ Battery over-subscription mode, enables up to twice as many batteries per site compared to systems without the Power Control System enabled. The total number of batteries supported by IQ Combiner 6C, with and without the IQ Battery over-subscription feature, is listed in the following table.

Table 1: Maximum continuous current, aggregate power, and aggregate energy comparison with and without the IQ Battery over-subscription

	Without IQ Battery over-subscription				With IQ Battery over-subscription			
IQ Combiner	**Max. allowed IQ Battery 10C units**	**Max. continuous output current per battery (A)**	**Aggregate power from batteries (kW)**	**Aggregate energy storage capacity of batteries (kWh)**	**Max. allowed IQ Battery 10C units**	**Max. continuous output current per battery (A)**	**Aggregate power from the batteries (kW)**	**Aggregate energy storage capacity of batteries (kWh)**
IQ Combiner 6C (X-IQ-	4	29.5	28.32	40	8	16	30.72	80

	Without IQ Battery over-subscription				With IQ Battery over-subscription			
IQ Combiner	Max. allowed IQ Battery 10C units	Max. continuous output current per battery (A)	Aggregate power from batteries (kW)	Aggregate energy storage capacity of batteries (kWh)	Max. allowed IQ Battery 10C units	Max. continuous output current per battery (A)	Aggregate power from the batteries (kW)	Aggregate energy storage capacity of batteries (kWh)
AM1-240-6C)	(2 on storage breaker slot 1 + 2 on storage breaker slot 2)				(4 on storage breaker slot 1 + 4 on storage breaker slot 2)			

3.5 Limit PV and battery power exported to the grid based on regional compliance

Utilities in certain geographies require that the power exported back to the grid is restricted to a prescribed power limit. The aggregate power export limit feature measures the aggregate power across all the phases being exported and limits the PV production and battery power (if present), to ensure that the power export at the location of the IQ Meter Collar with integrated consumption metering or the installed Consumption Current Transformers (point of current measurement) does not exceed the limit specified by the installer in the Enphase Installer App.

3.6 Expand systems in California with NEM multi-tariff

In California, expanding a PV system by more than 10% of the existing nameplate capacity or 1 kW (whichever is smaller) requires a new interconnection application and a transition from the existing NEM 1 or NEM 2 tariffs to NEM 3—also known as the Net Billing Tariff (NBT).

NEM multi-tariff is an interconnection option offered by all three major California utilities (PG&E, SDG&E, and SCE). By using the certified NEM Integrity Mode feature under UL 3741 v2, homeowners can expand existing systems without losing their current tariff structure. More details are available at https://enphase.com/installers/expansion.

4. Power Control System integration in the Enphase Energy System

Enphase Power Control is a supplementary Power Control System. Supplementary Power Control Systems are systems or devices for use in circuits with an overcurrent device suitable for service, feeder, or branch circuit protection.

4.1 Components of Enphase Power Control

- Current transformers (CTs): An Enphase Power Control-enabled site would require
  - A Production CT (integrated with the IQ Combiner 6C: X-IQ-AM1-240-6C). The Production CT provides revenue-grade metering of the power generated by the PV.
  - IQ Meter Collar with integrated Consumption CTs: MC-200-011-V01 or a set of two Consumption CTs: CT-200-CLAMP to be purchased separately.
    IQ Meter Collar (MC-200-011-V01) has integrated consumption metering and can be installed inside the main meter combo or can be installed in a Form 2S socket for measuring the current being exported to the grid or to the backup panel in real-time. Alternatively, in some configurations, Consumption CTs are installed inside the main panel to monitor the current being exported to the grid in real time.
  - A Battery CT (integrated with the IQ Combiner 6C: X-IQ-AM1-240-6C).
- Power control system controller (IQ Gateway): An Enphase Power Control-enabled site incorporates the IQ Gateway to support IQ Microinverter and IQ Battery Systems. The IQ Gateway monitors the currents as reported by the CTs/IQ Meter Collar and uses this information to limit PV and ESS power production as required.
- IQ Battery: Enphase Power Control ensures that the IQ Battery does not export any power to the grid when the battery import-only mode is enabled and that the IQ Battery does not import any power from the grid to charge when the battery export-only mode is enabled.
- Other balance of system components:
  - IQ Combiner: Aggregates PV branches and energy storage. Enphase Power Control can limit the backfeed into the main panel from the IQ Combiner, per NEC requirements in grid-tied and grid-forming systems.

    NOTE: The IQ Combiner includes an integrated IQ Gateway, and the Power Control System controller. IQ Gateway need not be repurchased if an IQ Combiner is already present at a site.
  - IQ Meter Collar: Integrates a microgrid interconnect device (MID) and consumption metering in grid-forming systems.
  - IQ EV Charger: Charges the electric vehicle (EV). It enables the Enphase Power Control feature, IQ EVSE MBTA, to control the EV charge current such that the total import current from the grid for supplying the home loads and for charging the electric vehicle together does not exceed the limit enforced by the main service breaker rating.

4.2 Supported SKUs for the Enphase Power Control

In this document, IQ PV is a family name and generically refers to any of the following model numbers and SKUs.

Enphase Product or Product family	Model/SKU numbers
IQ8 PV	IQ8H-240-72-2-US, IQ8-60-2-US, IQ8PLUS-72-2-US, IQ8M72-2-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, IQ8MC72-M-US, IQ8AC-72-M-US, IQ8HC-72-M-US, IQ8X-80-M-US , IQ8HC-72-M-DOM-US, IQ8X-80-M-DOM-US
IQ9 PV	IQ9N-A-US, IQ9N-A-DOM-US, IQ9N-A-DOM-US-CPA, IQ9N-A-DOM-US-CPB, IQ9N-A-DOM-US-HPA, IQ9N-A-DOM-US-HPB

Please note that additional SKUs may have been added. Refer to the latest certificate for complete information. For the latest PCS-supported SKUs and certification, refer to the Availability of features by System type.

4.3 Setting up Enphase Power Control

4.3.1 Installation of IQ Combiner 6C and IQ Meter Collar in grid-forming configuration for Enphase Power Control

In the grid-forming configuration, the IQ Combiner 6C must be paired with the IQ Meter Collar. For detailed instructions on installing the IQ Meter Collar in a grid-forming configuration, refer to the *IQ Combiner 6C quick install guide (QIG)*.

The QIG contains detailed information required for installers to install the IQ Meter Collar in the main meter combo or in a discrete Form 2S meter pan, and to enable Enphase Power Control, and provides information on the labels required to be added to the Power Control System-enabling devices by the installer. These labels are shipped inside the literature kit as a part of the IQ Combiner 6C.

The high-level diagram of IQ Combiner 6C and IQ Meter Collar installation in a main meter combo in a grid-forming whole home backup configuration is shown in Enphase Power Control in a grid-forming Enphase Energy System on page 6.

The high-level diagram of IQ Combiner 6C and IQ Meter Collar installation in a discrete Form 2S socket in a grid-forming whole home backup configuration is shown in the following figure.

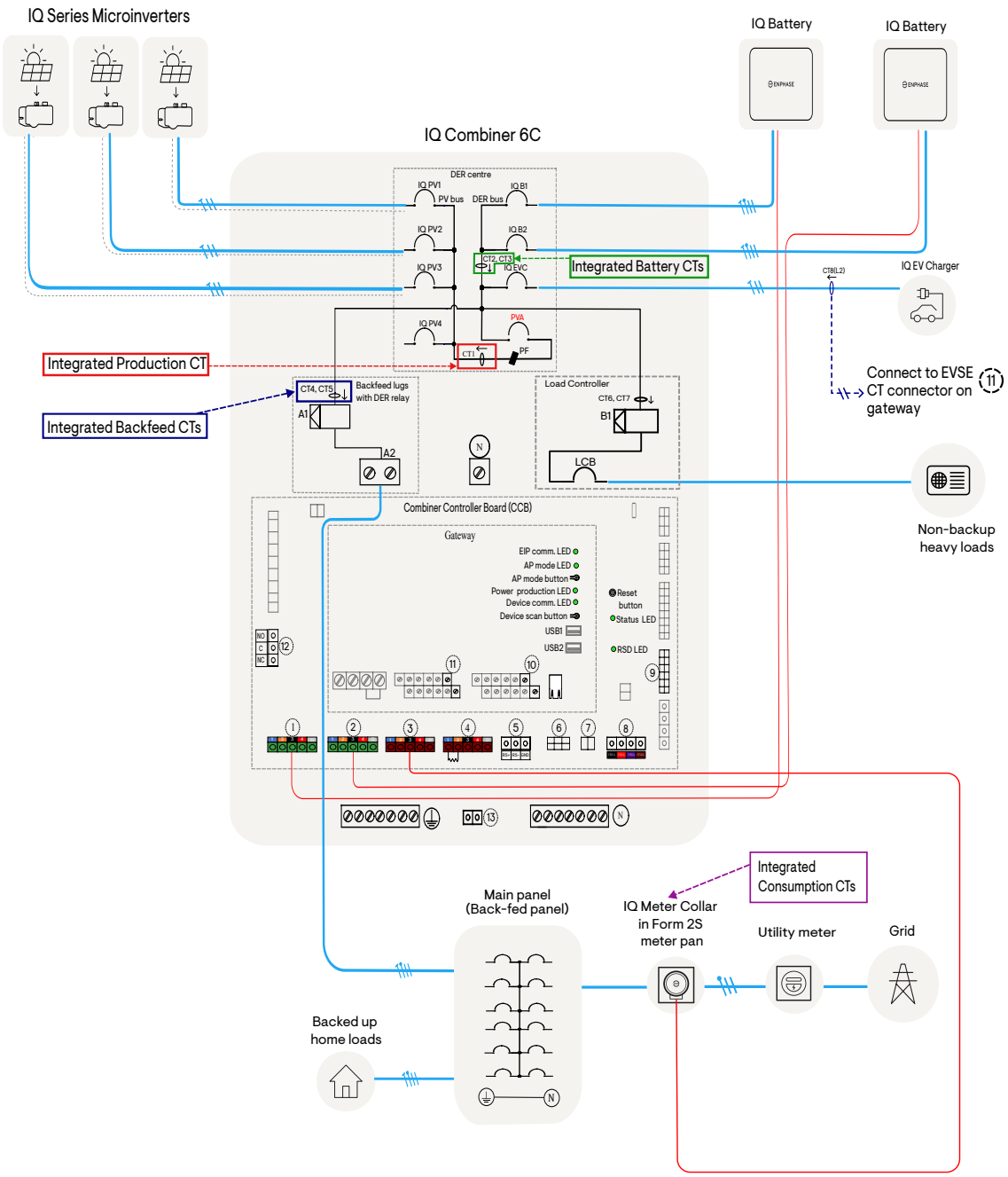


Figure 3: Bird's-eye view of IQ Combiner 6C in grid-forming whole home backup configuration with the IQ Meter Collar installed in a discrete Form 2S socket

4.3.2 Installation of the IQ Combiner 6C and Consumption Current Transformers in grid-tied configuration

Refer to the *IQ Combiner 6C quick install guide (QIG)* for detailed instructions on how to set up an Enphase Power Control-enabled system in a grid-tied configuration.

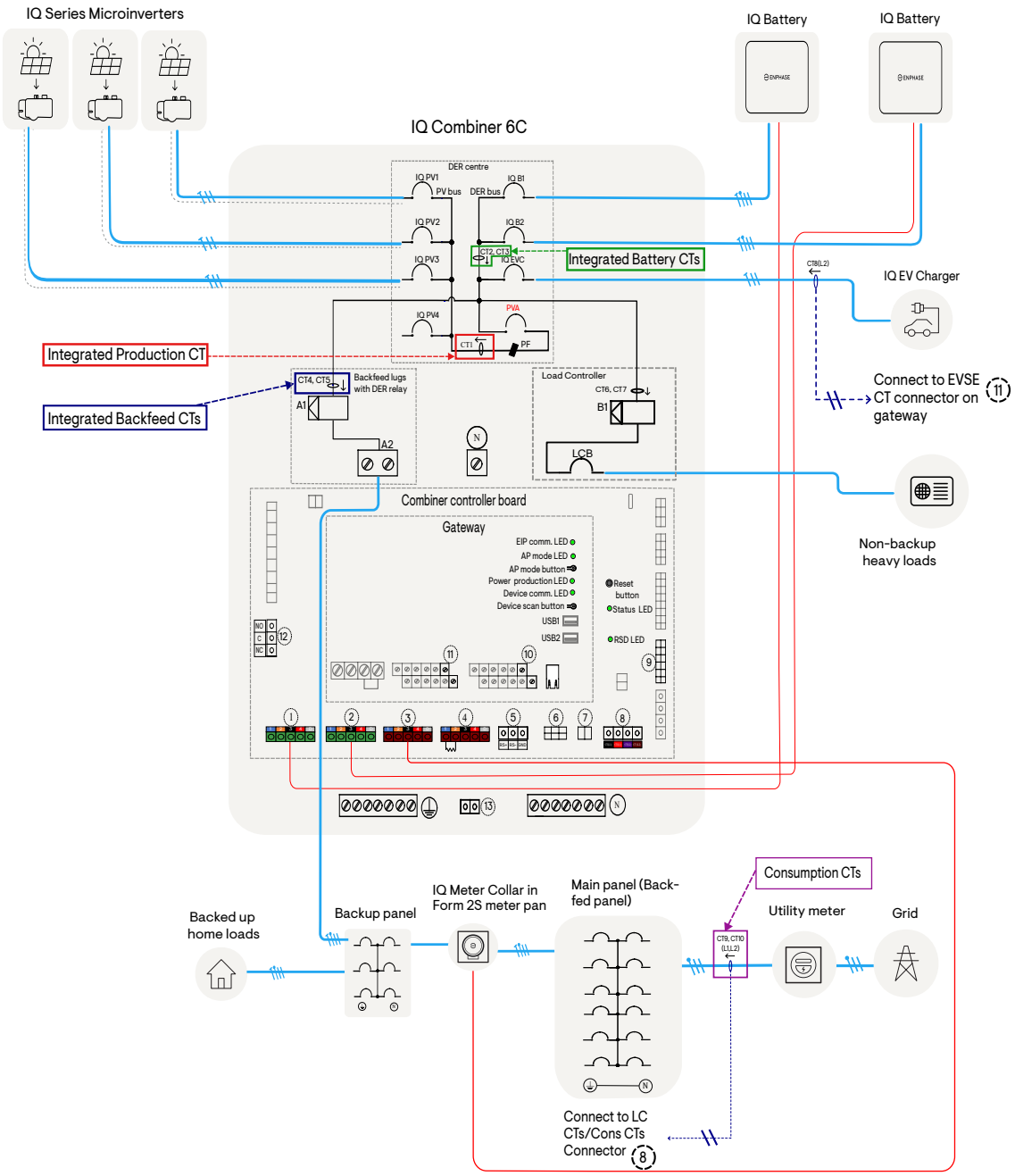


Figure 4: Bird's-eye view of IQ Combiner 6C in grid-tied configuration with the Consumption CTs installed between the main panel and utility meter

NOTE: The IQ Combiner 6C unit includes an integrated load controller that utilizes the load controller CT connector. In this configuration to add consumption CTs, remove the connection to Load Control CT from the connector 8. For more details, refer to the *IQ Combiner 6C quick install guide* .

4.3.3 Current transformer placement for Enphase Power Control features

The current transformer (CT) placement for each of the features is shown in the following table.

Table 2: CT placement for Enphase Power Control features

	Grid-forming configuration		Grid-tied configuration	
Enphase Power Control feature	**CT(s) utilized**	**CT placement**	**CT(s) utilized**	**CT placement**
IQ Battery over-subscription	Integrated battery CT[1]	Integrated battery CT is already present in IQ Combiner 6C. [1]	Integrated Battery CT [1]	Integrated battery CT is already present in IQ Combiner 6C. [1]
Battery import-only	Integrated Production CT, battery CTs, and integrated consumption metering in IQ Meter Collar	Integrated Production CT is already present in IQ Combiner 6C. Integrated battery CT is already present in IQ Combiner 6C. In the whole home backup, IQ Meter Collar for consumption monitoring can be installed in the main meter combo or a discrete Form 2S socket.	Integrated Production C T, integrated battery CT, and Consumption CTs	Integrated Production CT is already present in IQ Combiner 6C. Integrated battery CT is already present in IQ Combiner 6C. Consumption CTs are placed between the main panel and the utility meter.
Battery export-only	Integrated Production CT, integrated Battery CT, and integrated consumption metering in IQ Meter Collar	Integrated Production CT is already present in IQ Combiner 6C. Integrated battery CT is already present in IQ Combiner 6C. In the whole home backup, the IQ Meter Collar for consumption monitoring can be installed in the main meter combo or a discrete Form 2S socket.	Integrated Production C T, integrated battery CT, and Consumption CTs	Integrated Production CT is already present in IQ Combiner 6C. Integrated battery CT is already present in IQ Combiner 6C. Consumption CTs are placed between the main panel and the utility meter.
Main panel upgrade avoidance with busbar overload control (BBoC)	Integrated backfeed CT and integrated consumption metering in IQ Meter Collar	Integrated backfeed CT is already present in IQ Combiner 6C. In the whole home backup, the IQ Meter Collar for consumption monitoring can be installed in the main meter combo or a discrete Form 2S socket.	Integrated backfeed CT and Consumption CTs	Integrated backfeed CT is already present in IQ Combiner 6C. Consumption CTs are placed between the main panel and the utility meter.

[1] Battery CT is not utilized for IQ Battery over-subscription, but it is required for other functionality of IQ Battery 10C.

	Grid-forming configuration		Grid-tied configuration	
Enphase Power Control feature	**CT(s) utilized**	**CT placement**	**CT(s) utilized**	**CT placement**
NEM Integrity Mode	Integrated load control CTs and consumption metering in IQ Meter Collar	The integrated load controller CT is already present in the IQ Combiner 6C. For whole home backup, the IQ Meter Collar for consumption monitoring can be installed in either the main meter combo or a separate Form 2S socket.	Consumption CTs and an additional pair of Consumption CTs	Consumption CTs are installed between the main panel and the utility meter, with the arrows pointing toward the main panel. An additional pair of paralleled Consumption CTs must be installed at the point where the existing PV production lines (L1, L2) connect, with the arrows pointing toward the IQ Combiner 6C.
Main panel upgrade avoidance with NEC 120% rule	Integrated backfeed CT	Integrated backfeed CT is already present in IQ Combiner 6C.	Integrated backfeed CT	Integrated backfeed CT is already present in IQ Combiner 6C.
Aggregate power export limit	Integrated consumption metering in IQ Meter Collar	In the whole home backup, the IQ Meter Collar for consumption monitoring can be installed in the main meter combo or a discrete Form 2S socket.	Consumption CTs	Consumption CTs are placed between the main panel and the utility meter.

NOTE: The installer can configure MPU avoidance, IQ Battery over-subscription, battery import/export-only, and aggregate power export limit Power Control System features using the Enphase Installer App or Enphase Installer Portal.

4.3.4 Application of the label for Enphase Power Control

The installer must apply relevant labels when enabling Enphase Power Control features to comply with regulations. The instructions to apply these labels are provided in the following documents:

- For grid-forming configuration: *IQ Combiner 6C quick install guide* and *IQ Meter Collar quick install guide*
- For grid-tied configuration: *IQ Combiner 6C quick install guide*

5. Enphase Power Control features

5.1 IQ Battery over-subscription

5.1.1 IQ Battery over-subscription in grid-tied or grid-forming configuration

IQ Battery over-subscription allows homeowners to add more IQ Battery 10C(s) to their grid-tied systems, enabling more capacity for self-consumption or economic savings.

In grid-forming configurations, this feature allows homeowners to meet their higher energy storage requirements by adding more batteries to their Enphase Energy System, enabling them to have up to twice as much backup time as the previous generation.

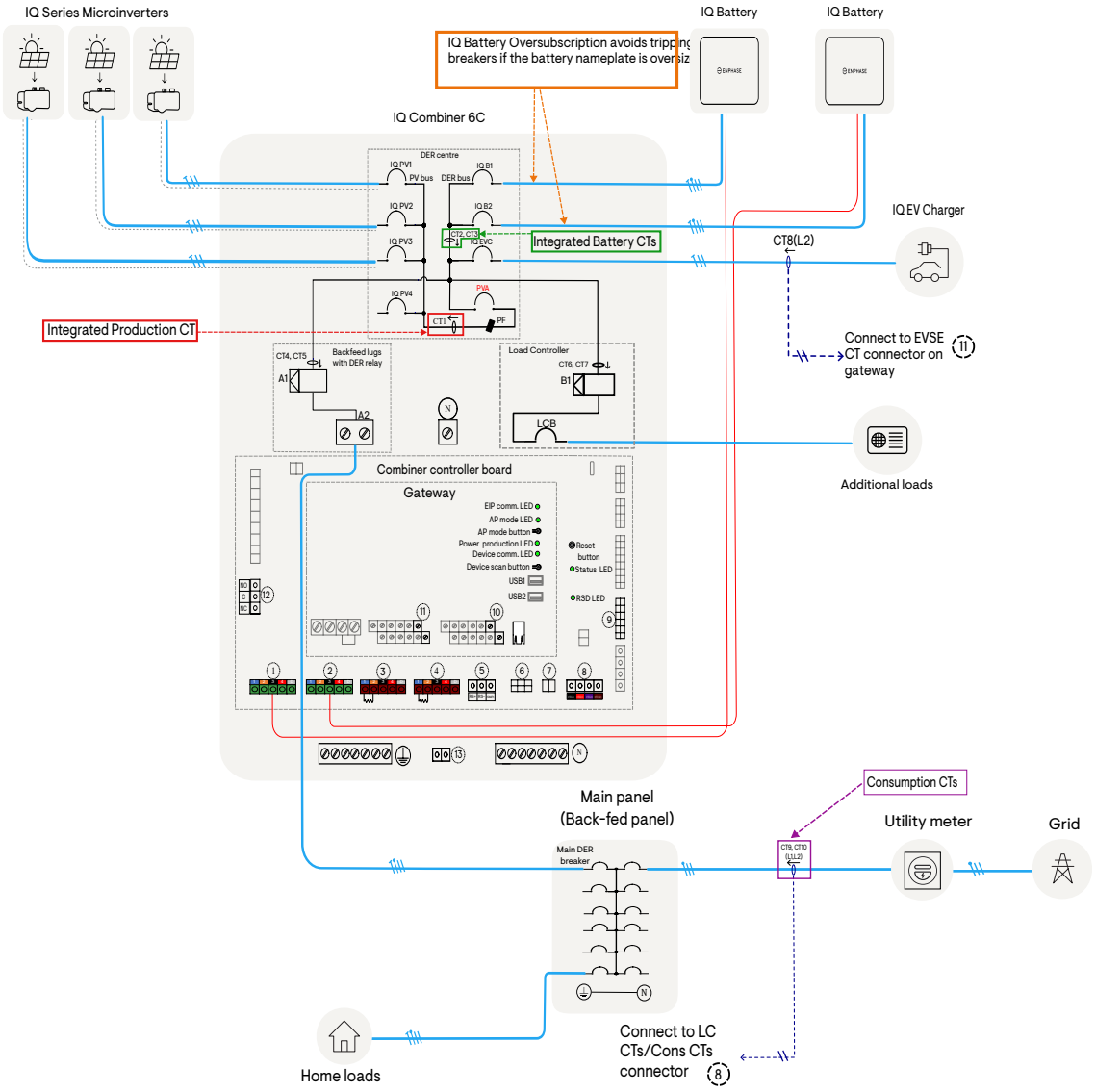


Figure 5: Example of IQ Battery over-subscription in a grid-tied system with IQ Combiner 6C

In a grid-tied or grid-forming configuration, IQ Battery 10C(s) can be connected to the IQ Combiner 6 on one of the two breaker slots. The installer can input the breaker size of storage breaker 1 or

breaker 2 through the Enphase Installer App or Enphase Installer Portal during commissioning. Enphase Power Control ensures that currents on the conductors landing on the IQ Combiner breaker slot are limited to the breaker size. The maximum breaker rating for the single battery breaker slot is 80 A.

5.1.1.1 System design and sizing: IQ Battery over-subscription with IQ Combiner 6

As shown in Benefit from longer backup time with high-power batteries on page 9, IQ Battery over-subscription is supported with IQ Combiner 6C. The IQ Combiner 6C supports up to 2 × 80 A IQ Battery branch circuits.

The IQ Combiner 6C has two storage breakers, so IQ Battery 10C(s) can be connected to a storage port and/or additional DER 3 port. The placement of the IQ Batteries on each port determines the maximum aggregate continuous power available from the battery system. The ideal placement of the IQ Batteries maximizes the aggregate continuous power (kW) and aggregate overload current available from the chosen battery system with the given aggregate storage energy (kWh).

The optimal placement of IQ Battery 10C(s) is shown in the following table, assuming that the breaker rating on each port is adequately sized up to 80 A.

Table 3: Optimal placement of the IQ Battery 10C(s) on two breakers of IQ Combiner 6C

Ideal battery placement			**At Storage Breaker 1**			**At Storage Breaker 2**			**Aggregate**		
Total no. of batteries	**No. of batteries on storage breaker-1**	**No. of batteries on storage breaker-2**	**IQ Battery over-subscription**	**Maximum continuous current from port (A)**	**Maximum overload current from port (A)**	**IQ Battery over-subscription**	**Maximum continuous current from port (A)**	**Maximum overload current from port (A)**	**Maximum continuous current of the system (A)**	**Maximum overload current of the system (A)**	**Maximum energy of the system (kWH)**
$N = N_1 + N_2$	**N_1**	**N_2**	**Enabled if ($N_1 > 2$ batteries)**	**I_1**	**$I_{overload1}$**	**Enabled if ($N_2 > 2$ batteries)**	**I_2**	**$I_{overload2}$**	**$I_1 + I_2$**	**$I_{Overload1} + I_{Overload2}$**	**$(N_1+N_2) * EBattery$**
1	1	0	Disabled	29.5	56	Disabled	0	0	29.5	56	10.0

Ideal battery placement			At Storage Breaker 1			At Storage Breaker 2			Aggregate		
Total no. of batteries	No. of batteries on storage breaker-1	No. of batteries on storage breaker-2	IQ Battery over-subscription	Maximum continuous current from port (A)	Maximum overload current from port (A)	IQ Battery over-subscription	Maximum continuous current from port (A)	Maximum overload current from port (A)	Maximum continuous current of the system (A)	Maximum overload current of the system (A)	Maximum energy of the system (kWH)
$N = N_1 + N_2$	N_1	N_2	Enabled if ($N_1 > 2$ batteries)	I_1	$I_{overload1}$	Enabled if ($N_2 > 2$ batteries)	I_2	$I_{overload2}$	$I_1 + I_2$	$I_{overload1} + I_{overload2}$	$(N_1+N_2) * EBattery$
2	2	0	Disabled	59	112	Disabled	0	0	59	112	20.0
3	2	1	Disabled	59	112	Disabled	29.5	56	88.5	168	30.0
4	2	2	Disabled	59	112	Disabled	59	112	118	224	40.0
5	3	2	Enabled	64	128	Disabled	59	112	123	240	50.0
6	3	3	Enabled	64	128	Enabled	64	128	128	256	60.0
7	4	3	Enabled	64	128	Enabled	64	128	128	256	70.0
8	4	4	Enabled	64	128	Enabled	64	128	128	256	80.0

The optimal placement shown in the preceding table ensures maximum continuous current and maximum overload current at a site. The installer can opt for configurations other than the preceding configurations, but these configurations may result in sub-optimal maximum continuous current and maximum overload current.

5.1.2 Compliance with regulations

Per NFPA and NEC 2020 706.31 (B), the overprotection device rating shall not be less than 125% of the maximum average continuous current in the circuit connected to the energy storage system.

By ensuring that the aggregate output current from all the IQ Batteries connected to the storage DER port or slot (or additional DER port) does not exceed 125% of the corresponding storage DER

breaker rating electronically, the IQ Battery over-subscription feature allows more IQ Batteries to be connected to the Enphase system while being compliant with NEC 2020 706.31 (B).

5.1.3 Open loop response time

Refer to the latest PCS certification on the Enphase webpage to find the response time of this mode.

5.1.4 Failure modes and resolution

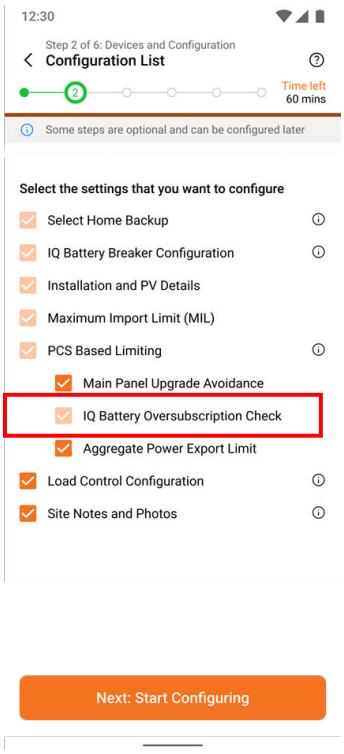
The following table describes failure modes and corresponding resolutions.

Table 4: Failure modes and resolutions

Failure mode	Resolution mechanism
IQ Battery communication failure with IQ Gateway	If the IQ Gateway loses communication with the IQ Battery for more than 20 seconds, • When on-grid, IQ Battery 10C automatically falls into idle mode. That is, there is no charge or discharge. • When off-grid, IQ Battery 10C discharges up to the allowed safe limit current.

5.1.5 Configuration of IQ Battery over-subscription through the Enphase Installer App

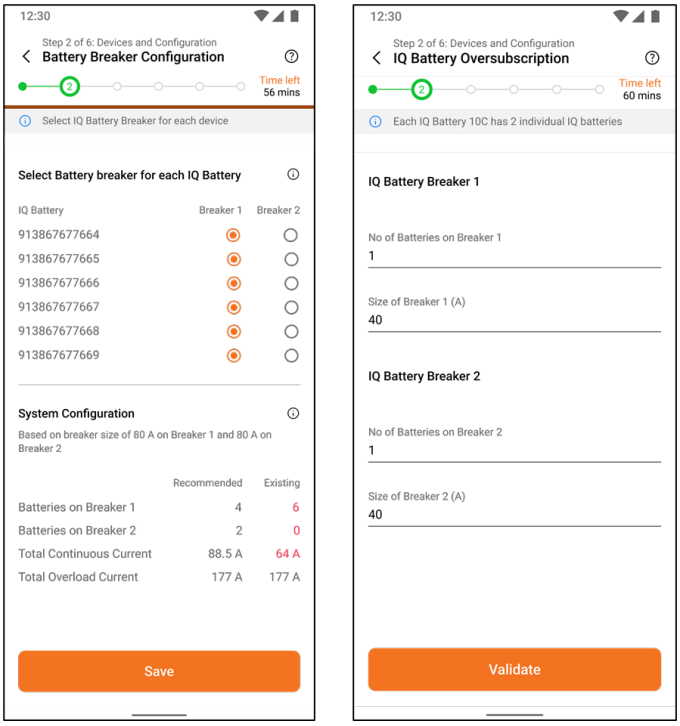
Under **System Details**, go to **Site Configuration** > **PCS Based Limiting** > **IQ Battery Oversubscription Check**.



When configuring the IQ Battery 10C over-subscription, as shown in the following figure, the installer must input the number of IQ Battery 10C(s) and breaker sizes on the port. The Enphase Installer App determines if the IQ Battery over-subscription needs to be enabled if the aggregate current from IQ Battery 10C(s) on a breaker exceeds the breaker rating.

The Enphase Installer App shows the recommended number of IQ Batteries on each port to maximize the continuous and overload currents in the system.

In an IQ Combiner 6C, the Enphase Installer App ensures that the maximum breaker rating for the two battery breaker slots of 80 A each.

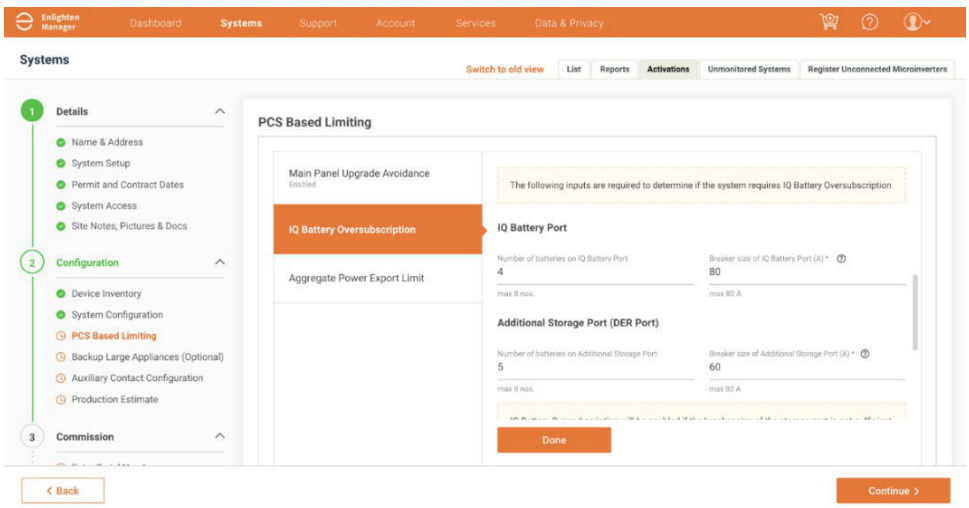


NOTE: Each IQ Battery 10C unit is considered as two separate units in the Enphase Installer App. In the preceding figure, four batteries on Breaker 1 are equivalent to two IQ Battery 10C units, and two batteries on Breaker 2 are equivalent to one IQ Battery 10C unit.

5.1.6 Configuration of IQ Battery over-subscription through the Enphase Installer Portal

Go to **Systems** > **Activations** > **Configuration** > **PCS Based Limiting** > **IQ Battery over-subscription**.

When configuring IQ Battery over-subscription in the Enphase Installer Portal for grid-forming configuration, as shown in the following figure, the installer must input the number of IQ Battery 10C(s) and breaker sizes on each port. If the breaker sizes are insufficient to support the batteries, the Enphase Installer App prompts the installer to enable the IQ Battery Oversubscription feature.



5.2 Battery import/export-only mode for Enphase Energy System

Enphase IQ Batteries can operate either in the battery import-only mode or in the battery export-only mode.

NOTE: Battery modes are selectable only if the battery installation is in California.

5.2.1 Battery import-only mode

The import-only mode feature for IQ Battery 10C ensures that the battery never exports power to the grid. The feature is certified for any systems that have a UL Listed PV inverter.

5.2.1.1 System sizing for battery import-only mode with IQ Battery 10C

Enphase Power Control with battery import-only mode ensures no IQ Battery current is exported to the main panel. This is accomplished by measuring and controlling all production current and power. Enphase Power Control ensures that the current at the Consumption CTs never exceeds the PV production current, thus never exporting battery current past the Consumption CTs.

In the battery import-only mode, the Enphase Energy System does not export battery current past the Consumption CTs. Therefore, the current from IQ Batteries need not be accounted for when calculating the current exported to the grid by the system. As a result, installers only need to account for the size of the PV system while calculating export, and need not account for the size of the IQ Battery system installed. This saves labor and upgrade costs for installers and system owners.

NOTE: Power Control System is covered in Article 705.13 of the NEC 2020 edition. Authorities Having Jurisdiction (AHJs) may not recognize the Power Control System feature until the 2020 NEC is adopted in their region.

5.2.1.2 Open loop response time

The maximum open loop response time (OLRT) with battery import-only mode in the Enphase Energy System is less than two seconds.

5.2.2 Battery export-only mode

Battery export is the only mode for IQ Battery 10C that allows the IQ Battery to export to the grid. This feature is certified with any UL Listed PV inverters.

Homeowners can leverage this feature to lower their payback period on their solar plus battery systems, as Enphase ensures that the IQ Battery stores the excess PV production and exports to the grid when it is most beneficial to the homeowner based on the import and export tariff rates.

5.2.2.1 System sizing for battery export-only mode with IQ Battery 10C

Enphase Power Control with Battery export-only mode ensures that the IQ Battery never imports from the grid. It is performed by ensuring that the battery charge current measured at the Battery CT is always less than the PV production current measured at the Production CT. Battery discharge is only ensured to obey other Power Control System features.

In Battery export-only mode, as Enphase Energy System exports battery current to the grid, the current from IQ Batteries must be accounted for when calculating the current exported to the grid by the system. However, the Battery export-only mode can be paired with other Enphase Power Control features that allow for the installation of large Enphase solar plus battery systems without the need for main panel upgradation costs or additional labor costs if the Enphase system has IQ8/IQ9 Series Microinverters.

5.2.2.2 Open loop response time

The maximum open loop response time (OLRT) with battery export mode in the Enphase Energy System is less than two seconds.

5.2.3 Operation of battery import/export-only mode with other Enphase Power Control features

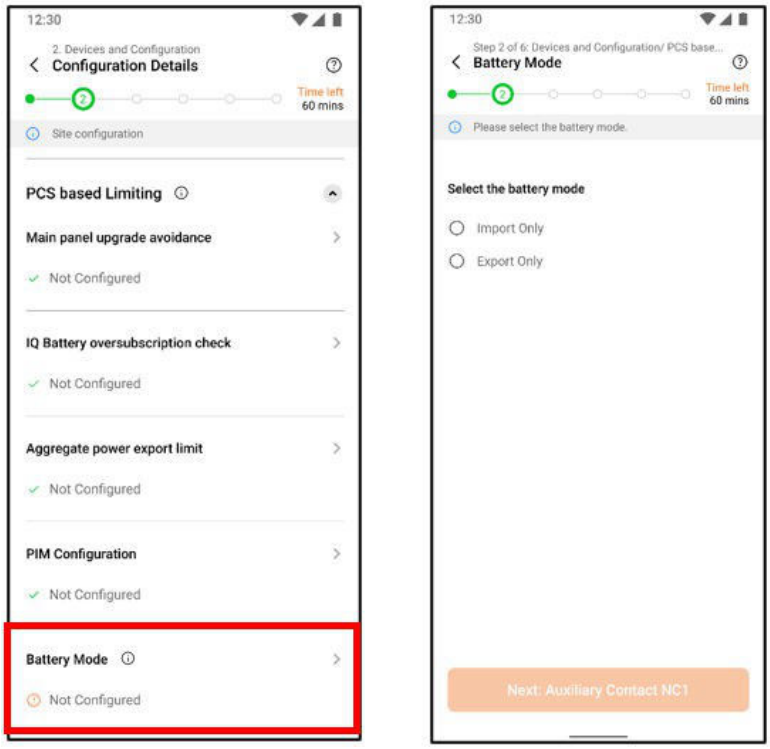
Battery import/export-only mode works in conjunction with other Enphase Power Control features— IQ Battery over-subscription, MPU avoidance, and Aggregate Power Export Limit. Enphase Energy System ensures that the power control limits set with respect to the other features are adhered to when the battery export or import-only modes are enabled.

5.2.4 Configuring battery import/export-only mode via the Enphase Installer App

Under **System Details**, go to **PCS based Limiting** > **Battery Mode**. Then, select **Import Only** or **Export Only**. The battery mode selection expires in seven days, starting from the selection of the tariff structure.

The selection of mode is not possible in the Enphase Installer App if seven days have elapsed after the selection of the tariff structure.

NOTE: Battery export-only mode is currently only available in jurisdictions with Net Energy Metering 3.0 (NEM 3.0). In jurisdictions other than NEM 3.0, the battery mode is set to battery import-only mode by default.



NOTE: If the battery mode needs to be changed after the selection has expired in the Enphase Installer App, contact Enphase Support. The Battery mode can only be changed based on the validity of the claim.

5.3 MPU avoidance

MPU avoidance with Busbar Overload Control allows maximum renewable energy generation and helps avoid the cost of panel upgrades for large PV and battery systems under the National Electric Code (NEC) 2020 705.13, reducing the system payback period.

MPU avoidance with Feeder Control enables avoiding the cost of panel upgrades for large PV and battery systems by controlling the backfeed current into the main panel according to the National Electric Code (NEC) 2020 705.12.

The feature ensures that the backfeed current allowed into the main panel is limited according to the configuration provided by the installer for both grid-tied and grid-forming configurations.

The MPU avoidance feature can be configured using the following three options:

- Using Busbar Overload Control
- With Feeder Control (using the NEC 120% rule)
- With Feeder Control (using the Current Limit Directly Entered)

5.3.1 Compliance with regulations

Compliance of MPU avoidance Busbar Overload Control with NEC 2020 705.13

According to the National Electric Code (NEC) 2020 705.13 (A) through (E), the Enphase Power Control feature, MPU avoidance with Busbar Overload Control, controls the backfeed from the

Enphase PV and IQ Battery 10C such that the sum of the backfeed current from the DERs and the current being drawn from the grid is equal to or less than the rating or the ampacity of the busbar.

Compliance of MPU avoidance with Feeder Control using the NEC 120% rule or the current limit directly entered with NEC 2020 705.12

The National Electric Code (NEC) 2020 705.12 allows backfeed of current from solar or storage into the main panel, subject to the following limit:

Backfeed or continuous current from DERs allowed ≤((120% of busbar rating) – ampacity of the overcurrent protection device protecting the busbar)/125%.

NOTE: The NEC 2020 705.12 section also contains other articles (such as the sum of breakers) that may be used to determine the backfeed limit. However, using the above calculation is the most common. Later in this document, this rule may be referred to as the NEC 120% rule.

5.3.2 MPU avoidance using Busbar Overload Control

When the option to use MPU avoidance using Busbar Overload Control is selected, the feature continuously monitors the backfeed current ($I_{backfeed}$) using the integrated Backfeed CTs, and current entering the main panel from the grid Consumption CTs ($I_{consumption}$), respectively.

It then limits the current from the battery ($I_{battery}$) and PV ($I_{production}$) in real time such that the total current entering the busbar does not exceed the busbar ampacity.

The diagram for MPU avoidance with Busbar Overload Control in the grid-tied configuration is shown in the following figure.

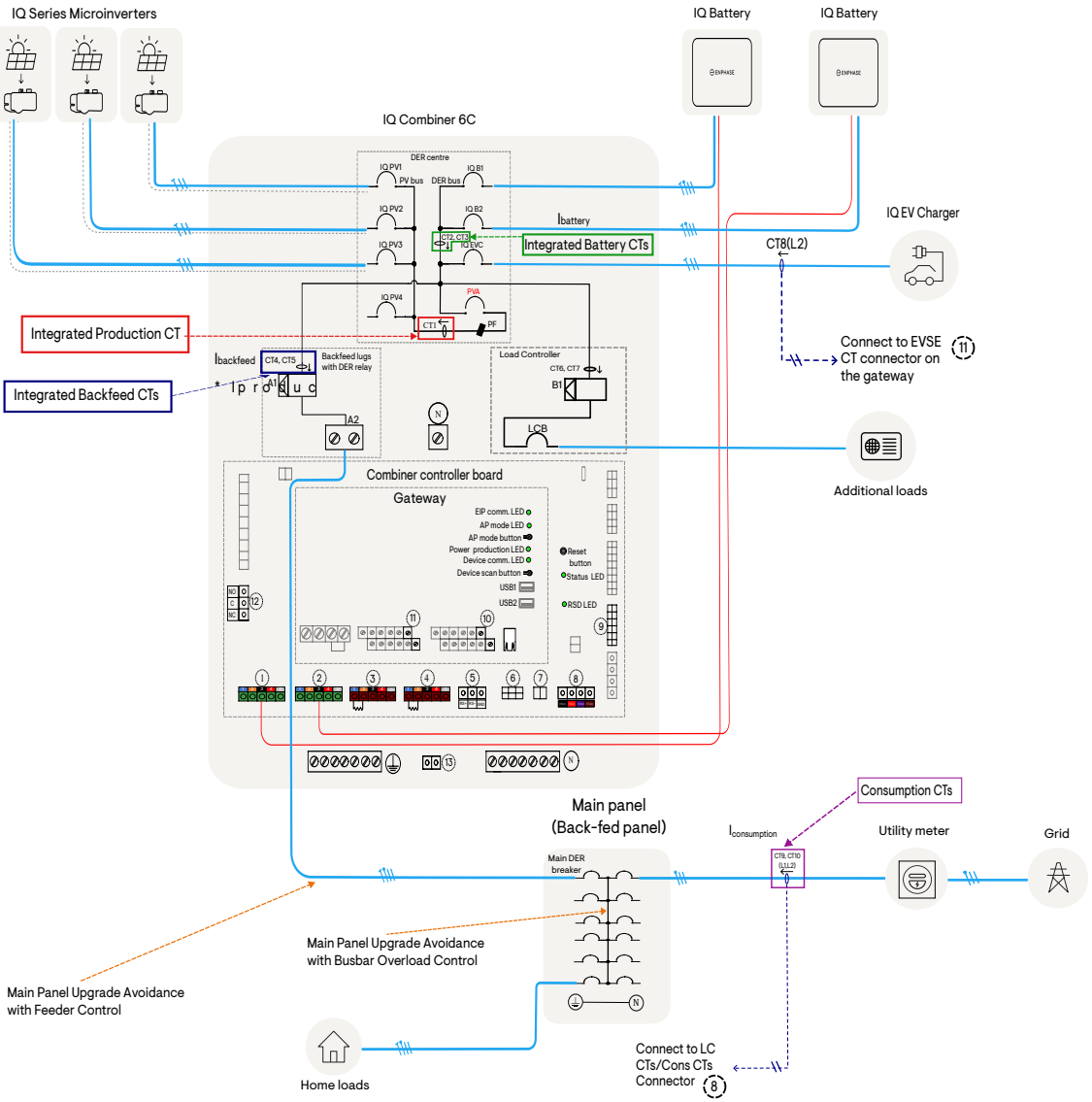


Figure 6: MPU avoidance using Busbar Overload Control in grid-tied configuration

NOTE: Enphase Systems can use Feeder Control on the Main DER breaker along with Busbar Overload Control. This is set automatically if the Main DER breaker is undersized compared to the nameplate, as described in further sections.

The following figure shows the diagram for MPU avoidance with Busbar Overload Control in the grid-forming configuration.

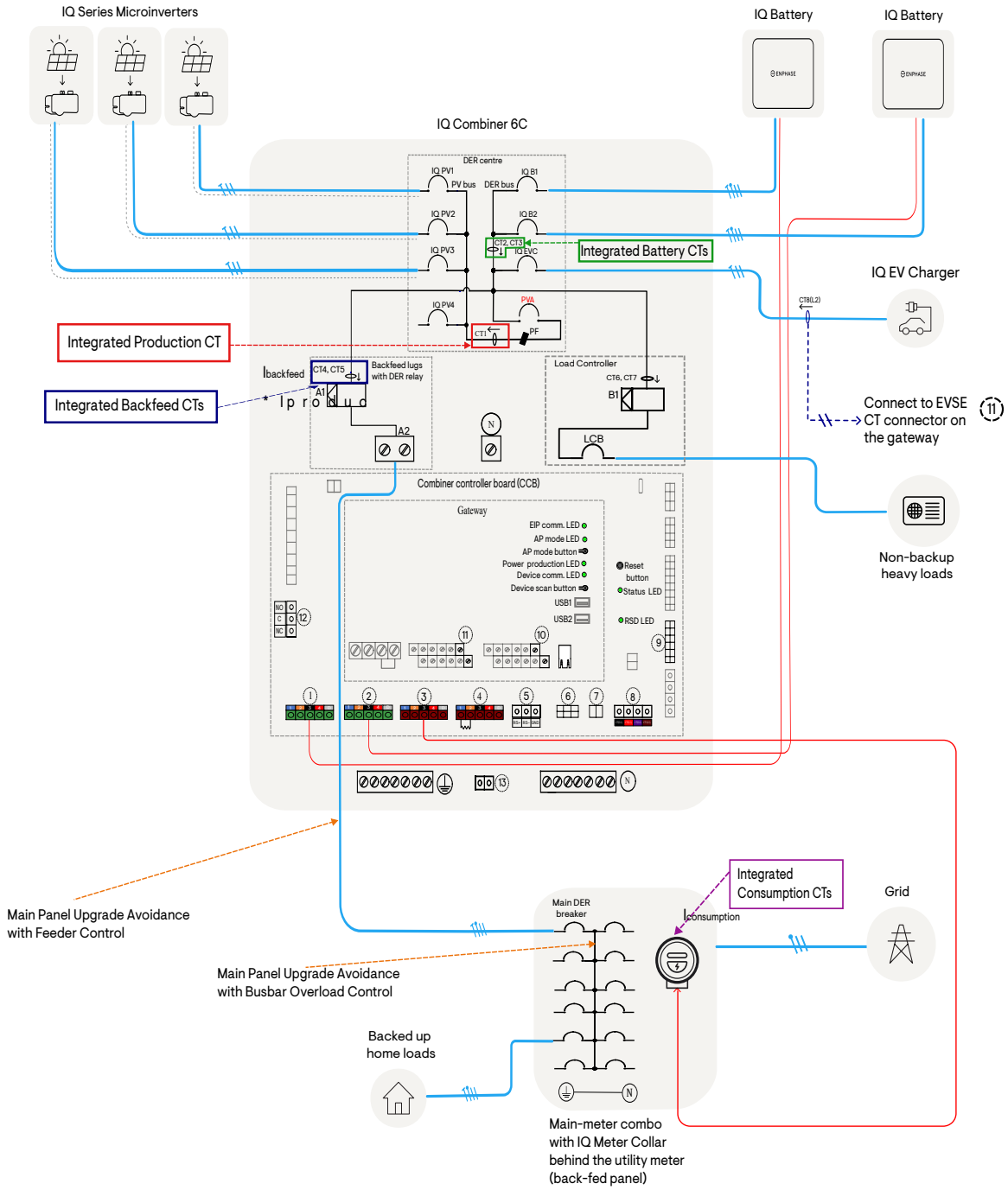


Figure 7: MPU avoidance using Busbar Overload Control in grid-forming configuration

NOTE: For MPU avoidance with Busbar Overload Control in either grid-tied or grid-forming configuration, if Consumption CTs and IQ Meter Collar on a pan are used, they must be placed between the main panel and the grid so current from the grid is accurately measured.

5.3.2.1 System sizing for MPU avoidance with Busbar Overload Control

With the MPU avoidance option, Busbar Overload Control, the maximum allowed main DER breaker size (backfeed breaker size) is given by the lower rating of (main service breaker in Amperes, 80% of main panel busbar rating in Amperes, 125 A).

NOTE: For MPU avoidance with Busbar Overload Control and IQ Combiner 6C, the maximum main DER breaker size (backfeed breaker size) is limited to 125 A.

For example, as seen in the preceding figures, if the main load panel busbar size is 100 A and the grid-side main service breaker size is also 100 A, the maximum continuous current backfeed allowable from the IQ Combiner to the main panel is limited to 80 A (the minimum of three values: 100 A, 80% of 100 A, or 125 A).

Therefore, in this scenario, the main DER breaker can be sized up to 80 A. The system ensures that the production and battery current is limited such that the current in the busbar never exceeds 100 A by monitoring the Production CT, Battery CT, and Consumption CTs.

5.3.3 MPU Avoidance with Feeder control (using NEC 120% or current limit directly entered)

5.3.3.1 In grid-tied configuration

When selecting the option to use MPU avoidance using the NEC 120% rule or current limit directly entered in grid-tied configuration, the feature continuously monitors the current being produced cumulatively by the installed PV array and the IQ Battery using integrated backfeed CTs. It then limits the produced power in real time based on the current limit imposed by the NEC 120% rule. The following figure shows this grid-tied configuration feature.

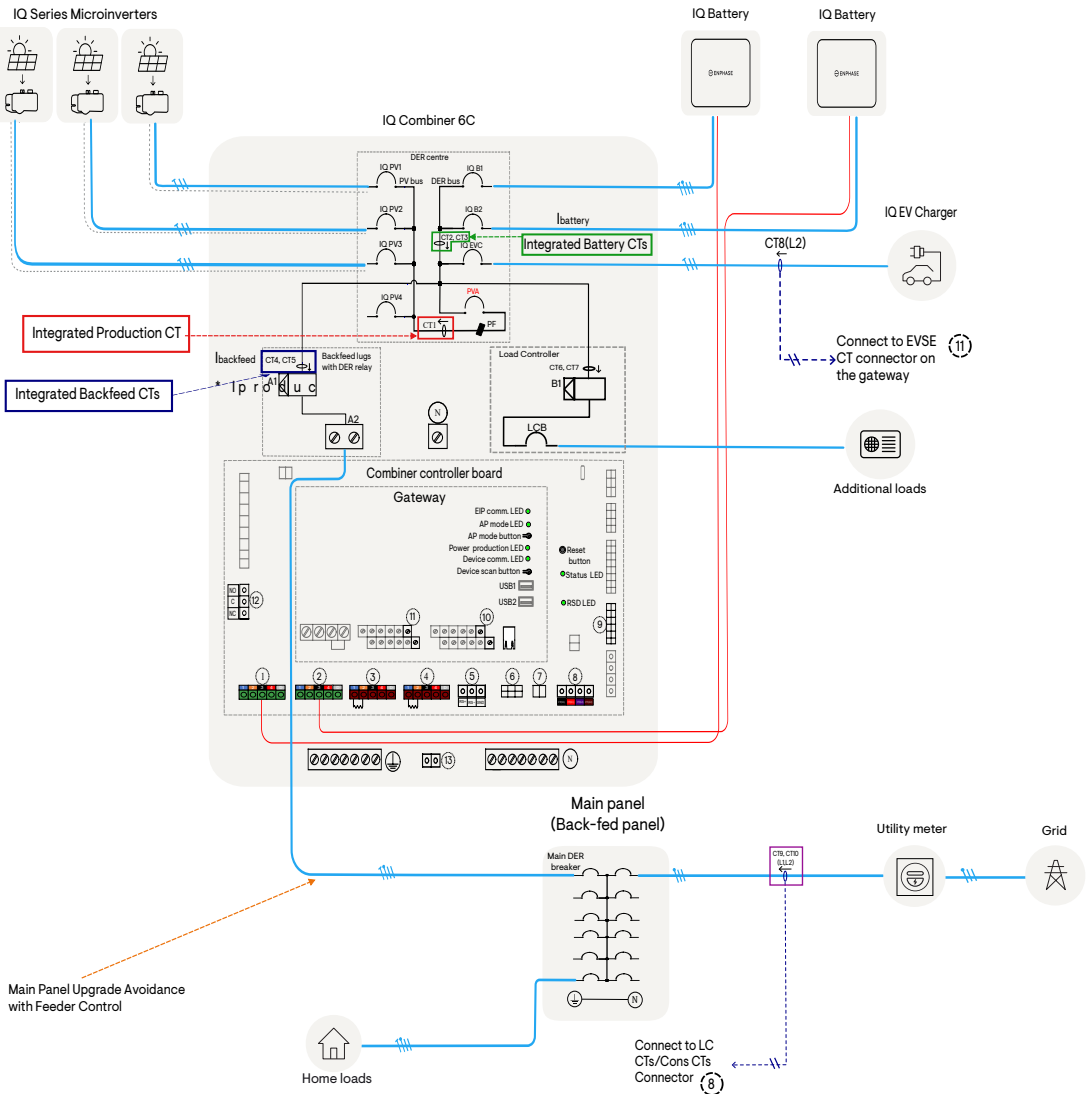


Figure 8: MPU avoidance with Feeder Control in grid-tied configuration

The battery discharge is controlled first, followed by the PV production current to limit $I_{backfeed}$ entering the main DER breaker in the main panel. The main DER breaker must be sized to the PCS limit as per NEC 2020 705.13 (C).

5.3.3.2 System sizing for MPU avoidance with the NEC 120% rule and the current limit directly entered in a grid-tied system

For example, as seen in the preceding figure, if the main load panel busbar size is 200 A and the grid-side main service breaker size is also 200 A, the maximum continuous current backfeed allowable from the IQ Combiner to the main panel, $I_{backfeed}$, is limited to: ((120% * busbar rating) – main service breaker size)/125% = total DER current ((120% × 200)–200)/125% = 32 A.

In this scenario, the system ensures that no more than 32 A of continuous current is exported back to the main panel. The integrated backfeed CTs inside the IQ Combiner 6C will monitor the current being back-fed into the main panel in real time and feed this information to the IQ Gateway. If the

current being back-fed to the main panel increases beyond 32 A, the IQ Gateway sends a signal to PV microinverters and the battery to limit their production and discharge, respectively.

NOTE: The PV branch breakers in the IQ Combiner cannot be oversubscribed and must be sized to the nameplate of the PV on the respective branches.

MPU avoidance in grid-tied configuration supports a maximum PV nameplate rated output of 80 A and a maximum battery nameplate output (to limit per-phase backfeed levels to the main panel) of 118 A.

In systems with IQ Battery 10C, MPU avoidance in grid-tied configuration works in conjunction with IQ Battery over-subscription.

5.3.3.3 Operation with IQ Battery over-subscription

For example, in the preceding figure, the $I_{backfeed}$ allowed is 32 A. If $I_{production}$ is 0 A, the maximum allowed $I_{battery}$ is 32 A. However, consider a scenario where IQ Battery over-subscription is enabled with the Battery breaker on IQ Combiner as 20 A. $I_{backfeed}$ allowed remains 32 A, but if $I_{production}$ is 0 A, the maximum allowed $I_{battery}$ is 16 A.

5.3.3.4 In grid-forming configuration

MPU avoidance in grid-forming configuration, when the option for NEC 120% rule or the current limit directly entered is selected, the feature continuously monitors the current being produced cumulatively by the installed PV array and the IQ Battery using integrated backfeed CTs. It then limits the produced power in real time based on the current limit imposed by the NEC 120% rule.

The following figure shows this grid-forming configuration feature.

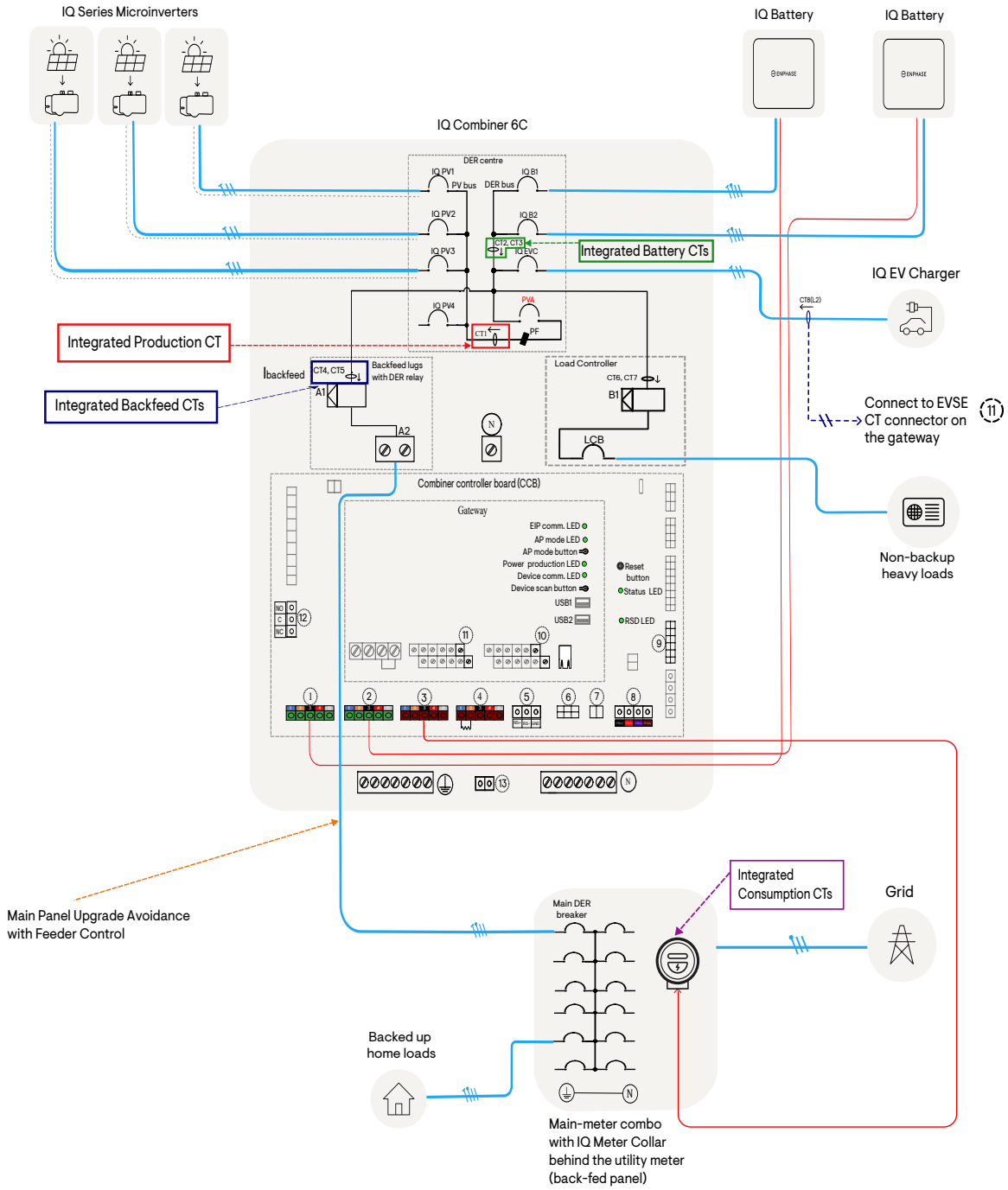


Figure 9: MPU avoidance with Feeder Control in grid-forming configuration

5.3.3.5 System sizing with MPU avoidance using the NEC 120% rule or the current limit directly entered in a grid-forming system

For example, as seen in the preceding figure, if the main load panel busbar is 200 A and the grid size breaker is also 200 A, the maximum continuous current backfeed allowable from the IQ Combiner 6C to the main panel is limited to ((120% × busbar rating) – main breaker size)/125% = total DER current ((120% × 200) – 200)/125% = 32 A.

Therefore, in this scenario, the system ensures that no more than 32 A of continuous current is back-fed to the main panel.

NOTE: The PV breakers in the IQ Combiner 6C cannot be oversized and must be sized to the PV nameplate rating.

NOTE: For this MPU avoidance use case to be accepted by an AHJ, the AHJ must recognize PCS. PCS is part of the 2020 edition of the NEC. The edition of NEC in effect in various states can be found on the NFPA website.

5.3.4 Failure mode and resolution for MPU avoidance

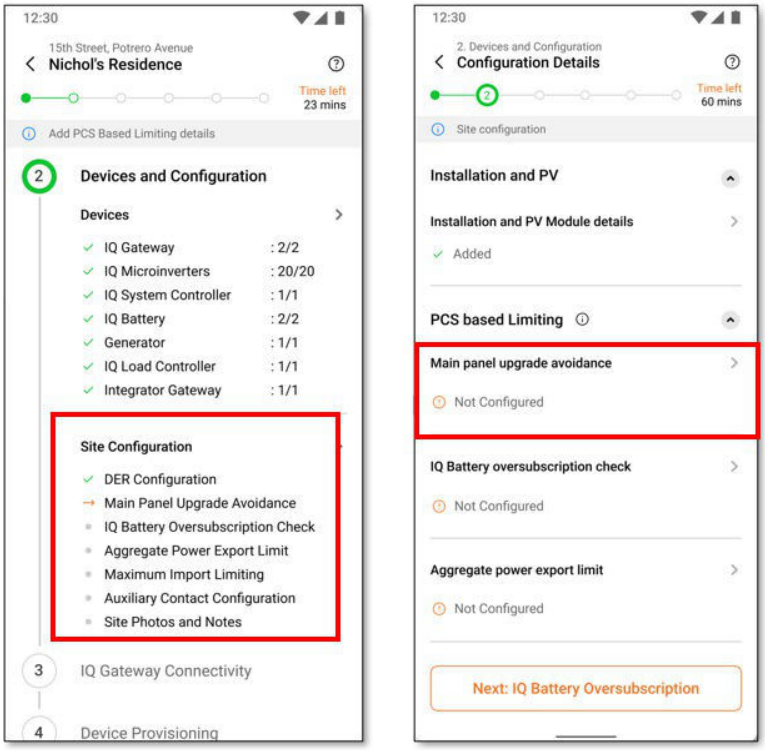
Enphase Power Control is designed for robustness. The system ensures adherence to the NEC guidelines of current back-fed even when one or more devices have stopped communicating with the IQ Gateway.

Table 5: Failure mode and solution mechanism

Failure mode	Resolution mechanism
Production, Battery, Backfeed, or Consumption CTs not reporting the correct value or missing	PV production current and IQ Battery current will be curtailed to a safe limit.
IQ Battery communication failure	If the IQ Gateway loses communication with the IQ Battery for more than 20 seconds, the IQ Battery discharge is completely curtailed.
Microinverter communication failure	If IQ Gateway loses communication with the microinverter for more than 10 seconds, PV production will be curtailed to the safe limit.
PCS controller or IQ Gateway failure	If the IQ Gateway loses communication with the microinverters for more than 10 seconds and with the IQ Battery for more than 20 seconds, all PV and IQ Battery discharges are curtailed to a safe limit.

5.3.5 Configuring MPU avoidance through the Enphase Installer App

Under **System Details**, go to **Site Configuration** > **PCS Based Limiting** > **Main panel upgrade avoidance**, as shown in the following figure.

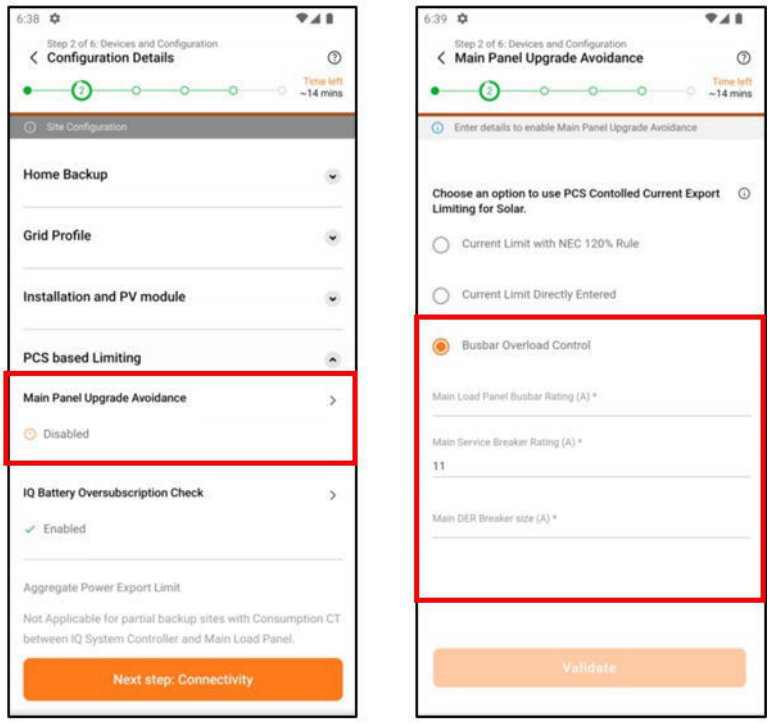


NOTE: For MPU avoidance with Busbar Overload Control, Consumption CTs or IQ Meter Collar must be placed between the main panel and the utility meter.

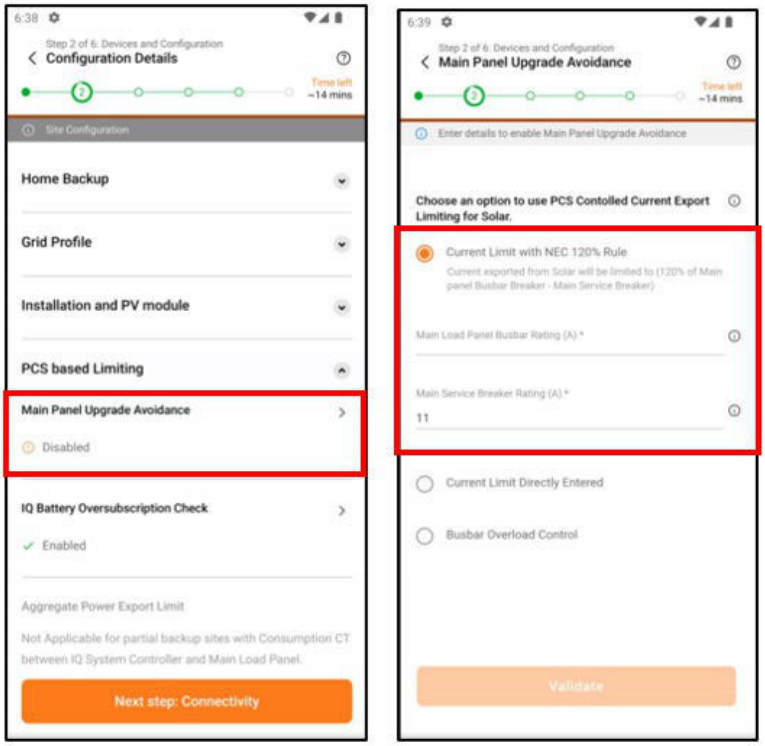
In the **PCS Export Limiting** > **Main panel upgrade avoidance** section, the installer has three ways of setting up the feature:

- **Busbar Overload Control**: In this option, the installer adds information on the rating of the main load panel, the main service breaker, and the main DER breaker. The system utilizes these inputs to configure the Busbar Overload Current feature, compliant with 2020 NEC 705.13 (A) through (E).
- **Current Limit with NEC 120% rule**: In this option, the installer adds information on the rating of the main load panel busbar and the main service breaker rating. The system then auto-calculates the export current limit based on the 2020 NEC 705.12 (B) (2) or (4) rule.
- **Current Limit Directly Entered**: There may be situations where a homeowner may have an additional DER system connected to the main panel that is not monitored by the Enphase Power Control feature. This could be a DER from another manufacturer or Enphase's legacy microinverters. In either case, the installer needs to account for the current being back-fed from such a system and ensure they limit the maximum current export value of the Enphase Energy System so that the total current exported back to the grid remains compliant with the NEC guidelines.

The following figure shows the MPU avoidance configuration with Busbar Overload Control.



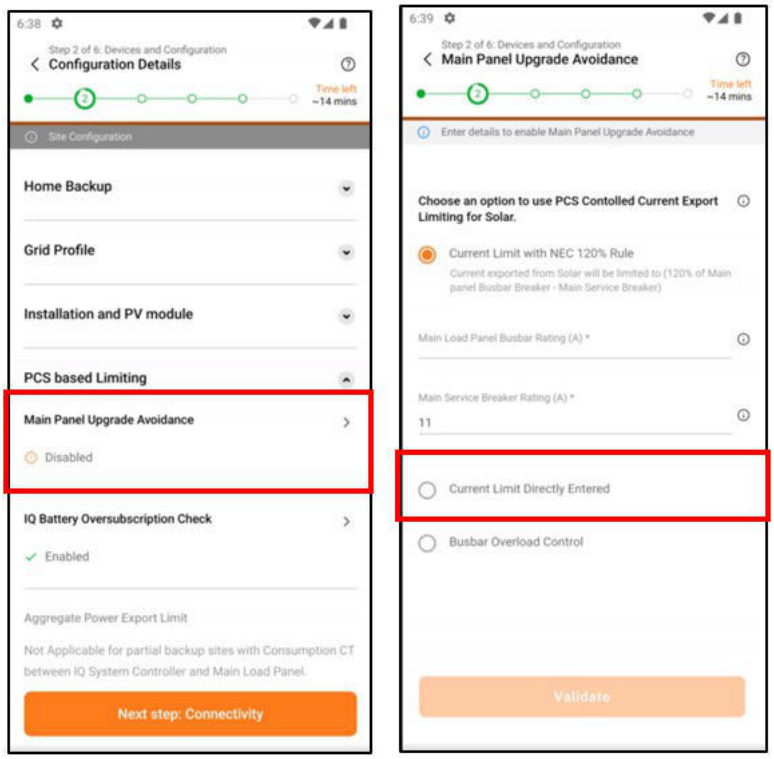
The following figure shows the MPU avoidance configuration with the NEC 120% rule.



There may also be situations where the site complies with a subsection of the 2020 NEC 705.12 rule other than 705.12(B)(2) or 705.12(B)(4), which Enphase Power Control uses to auto-calculate the maximum allowable backfeed current.

To account for such situations, the Enphase Installer App provides installers with the ability to define the maximum allowable backfeed current by setting the Current Limit Directly Entered parameter in the Enphase Installer App. If the Current Limit Directly Entered parameter is set, the system uses this value and does not auto-calculate backfeed current limits based on the NEC 120% rule. As shown in the following figure, the installer can directly set the PCS export current limit based on their discretion with this option.

The following figure shows the MPU avoidance configuration using direct current limit input.



NOTE: For safety, the Current Limit Directly Entered parameter must still comply with the NEC 705.12 rules to keep the main panel within safe limits. See Busbar Overload Control if you need to increase the backfeed current limit.

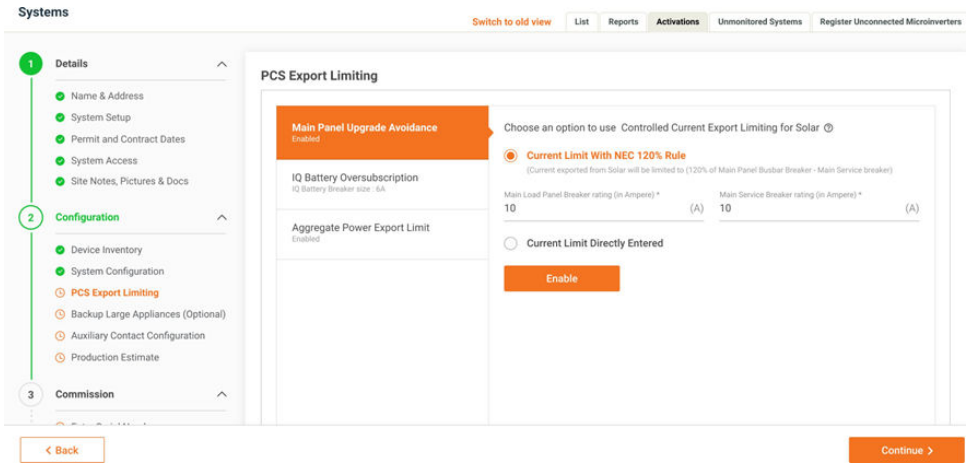
For example, if a site has an Enphase Energy System and a third-party PV system connected to a main panel, the main service breaker rating is 200 A, and the main panel busbar rating is 200 A. The maximum allowed continuous current from both the PV systems is 32 A. If the third-party PV system supplies a maximum continuous current of 16 A, then the installer can manually set the maximum continuous current for the Enphase Energy System to 16 A, that is, 32 A–16 A, using the Current Limit Directly Entered parameter in Enphase Installer App.

The Enphase Power Control feature does not start functioning until the meters are enabled and the site is commissioned in the Enphase Installer App. If the main DER breaker has the risk of tripping before the commissioning has finished, turn off the breakers on 1 or 2 PV branches while enabling the main panel upgrade avoidance feature and turning the PV breakers back on after successful commissioning.

5.3.6 Configuring MPU avoidance through the Enphase Installer Portal

Go to **Systems** > **Activations** > **Configuration** > **PCS Export Limiting** > **Main Panel Upgrade Avoidance**.

The following figure shows the configuration screen of the Enphase Power Control feature.



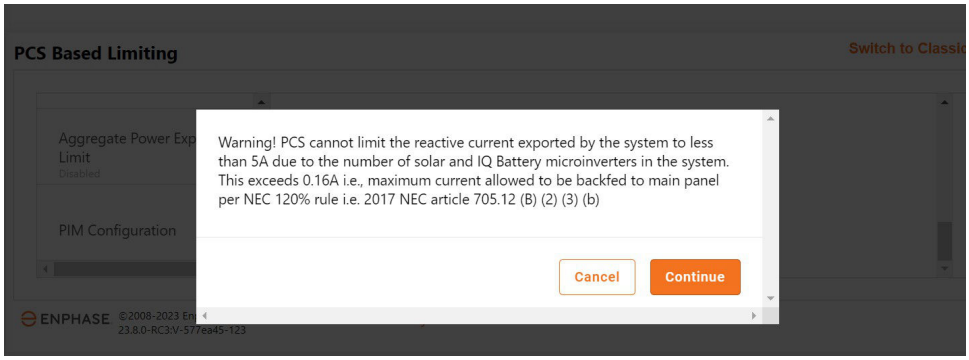
5.3.7 Accounting for currents due to reactive power in the system

There is always a certain amount of reactive power generated in the system due to the presence of capacitors inside the PV microinverters. Due to the presence of this reactive power in the system, the current from the system can never be completely curtailed to 0.

This does not impact our functionality of limiting export to the grid in any way because reactive power is not accounted for by utilities when measuring the export from DER to the utility grid. Utilities calculate exports based on the active power component. However, this current due to reactive power must be considered when using Enphase Power Control to control the export current from the DER to the main panel to avoid a main panel upgrade.

Handling reactive power when the current limit is derived based on the NEC 120% rule

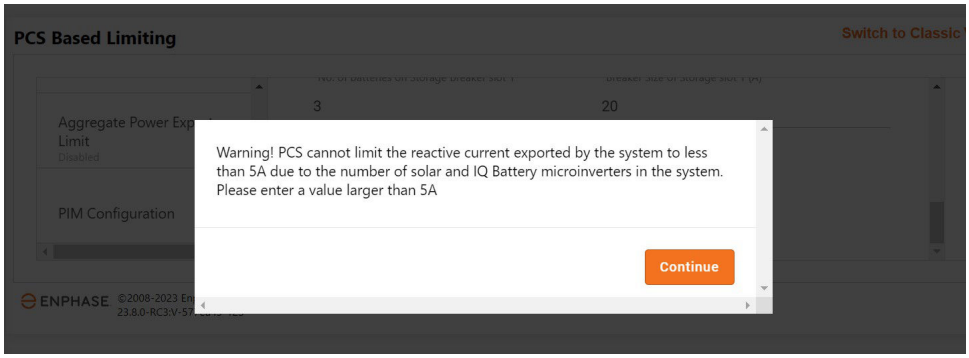
If the installer enters a system configuration such that the total current in the system due to reactive power will exceed the limit to which the export current needs to be curtailed based on the NEC 120% rule, the installer will see a pop-up such as the one mentioned in the following figure.



The installer will have the option to click CANCEL and re-enter the system configuration if required or click CONTINUE and proceed. If the installer chooses to proceed, then the system limits the export current to the current generated due to the reactive power generated in the system, and cannot limit it to any value below that. Therefore, there is a possibility of the system not being compliant with the NEC 120% rule.

Handling reactive power when the current limit is directly entered by the installer

We must account for the presence of currents due to reactive power in the system. If the installer enters a value that is lower than the total current generated by reactive power in the system, the pop-up is displayed as shown, asking the installer to re-enter an appropriate value.



5.4 Aggregate power export limit

The aggregate power export limit feature ensures that the power exported by the Enphase Energy System across all phases, that is, aggregate power, to the grid does not exceed the power export limit set in the Enphase Installer App by the installer.

The Enphase Energy System continuously monitors the aggregate exported power at the point of measurement, that is, at the Consumption CTs or IQ Meter Collar, and controls the power produced from the PV and battery system to keep the exported power below the limit set by the installer.

Aggregate power export limit can be supported in both configurations: grid-tied configuration (Solar + Battery or Solar only) and grid-forming configuration (Solar + Battery). For all supported SKUs with aggregate power export limit, see Enphase Power Control in a grid-tied Enphase Energy System on page 4.

5.4.1 Aggregate power export limit in the grid-tied configuration

In this configuration, the aggregate export power (W_{export}) to the utility grid is monitored through the Consumption CTs placed on the utility/grid side of the main panel. The power produced by the PV and/or battery system is controlled appropriately to keep the W_{export} less than or equal to the set limit.

The following figure shows the aggregate power export limit in grid-tied and grid-forming configurations, respectively.

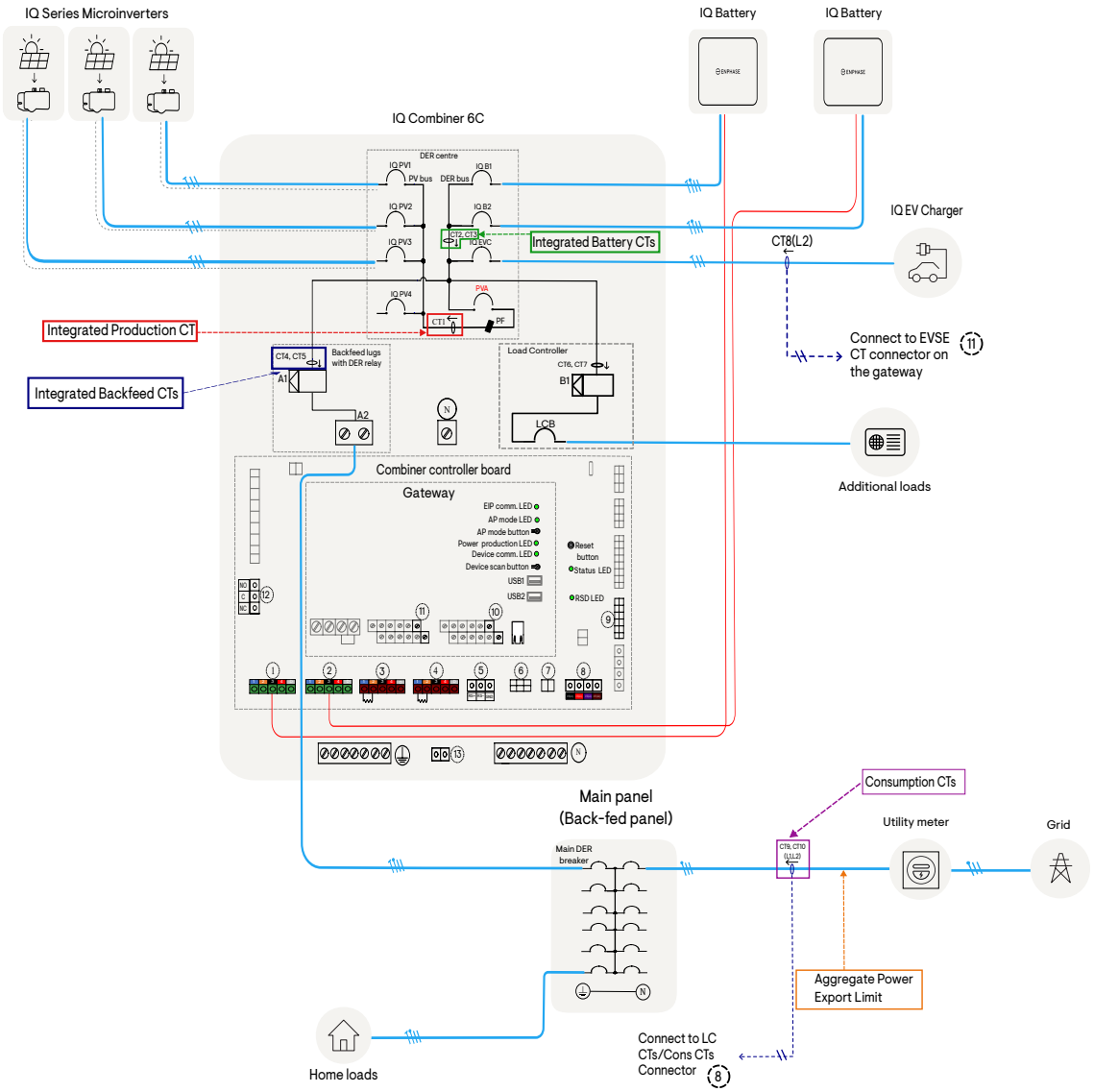


Figure 10: Aggregate power export limit in the grid-tied configuration

5.4.2 Aggregate power export limit in the grid-forming configuration

In this configuration, the aggregate export power (W_{export}) to the utility grid is monitored by the Consumption CTs placed between the main panel and the utility meter. The power produced by the PV and/or battery system is controlled appropriately to keep W_{export} less than or equal to the set limit.

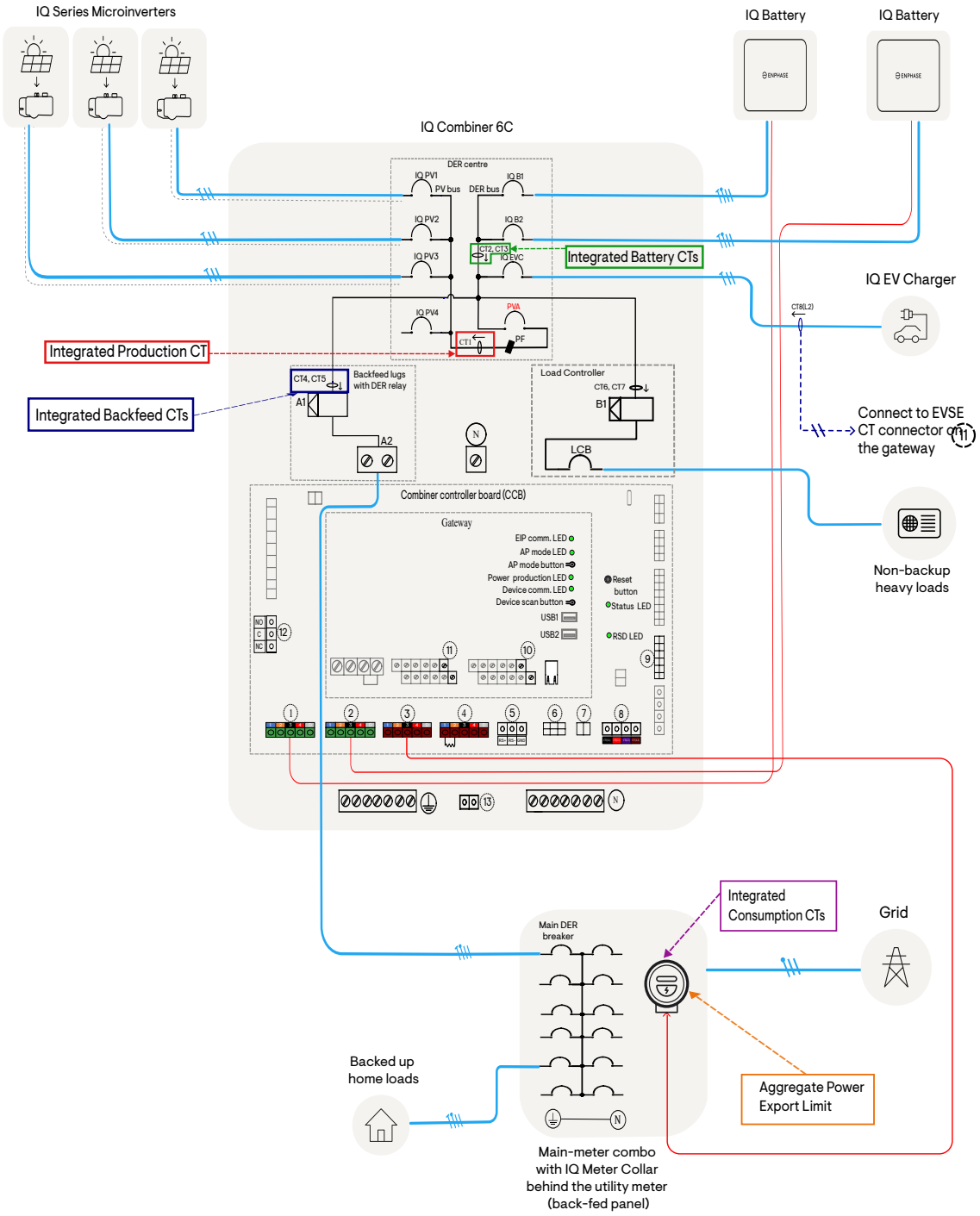


Figure 11: Aggregate power export limit in grid-forming configuration, Consumption CTs placed between the main service breaker and the meter

5.4.3 Compliance with regulations

Utilities in certain geographies require solar energy systems to limit their aggregate export power sent back to the utility grid. In such regions, the Enphase installers can configure the aggregate export power limit equal to or below the level required by the utility using the Enphase Installer App or Enphase Installer Portal. The Enphase Energy System automatically curtails PV production to ensure compliance with the local jurisdiction by adhering to the set aggregate power export limit.

The aggregate power export limit feature set by the installer during commissioning overrides the power export limit set in the specific Enphase grid profile; that is, when an aggregate power export limit is entered by the installer in the Enphase Installer App, the power export limit present in the grid profile is not utilized.

NOTE: Power export limiting works on an aggregate basis for all phases by default.

5.4.4 Failure modes and resolution

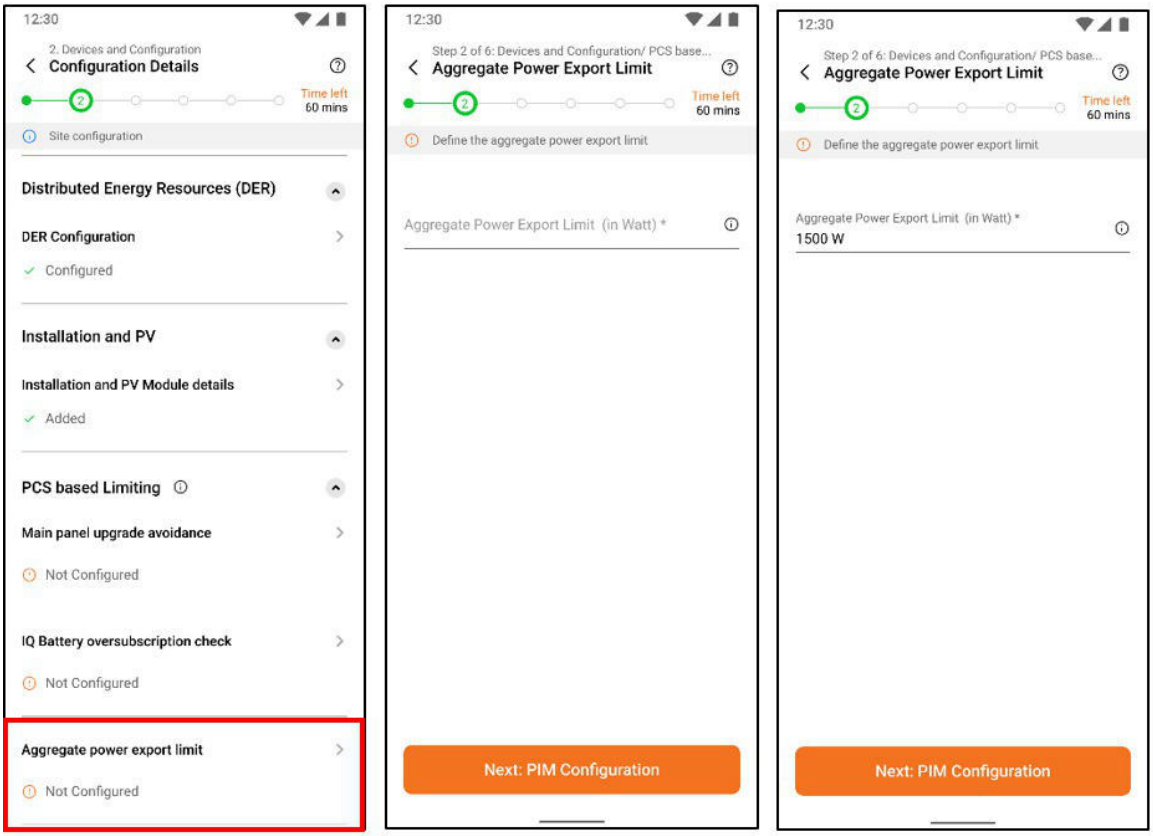
Table 6: Failure modes and resolution

Failure mode	Resolution mechanism
One or more microinverters failed or stopped communicating with the IQ Gateway	If the IQ Gateway loses communication with the PV microinverter for more than 10 seconds, the PV microinverter automatically curtails its output current to the static safe limit (0 Watts).
Consumption CTs or IQ Meter Collar not reporting the correct value or missing Consumption CTs/IQ Meter Collar	The PV production from each of the microinverters automatically defaults to the safe limit (0 Watts). IQ Batteries move to an idle state (neither charge nor discharge).
PCS controller or IQ Gateway failure	If the PCS controller or IQ Gateway fails, the PV production curtails its output current to the static safe limit (0 Watts) within 30 seconds of losing communication. IQ Batteries move to Idle state (neither charge nor discharge).

5.4.5 Configuring aggregate power export limit feature through the Enphase Installer App

Under **System Details**, go to **Site Configuration** > **PCS Export Limiting** > **Aggregate Power Export Limit**.

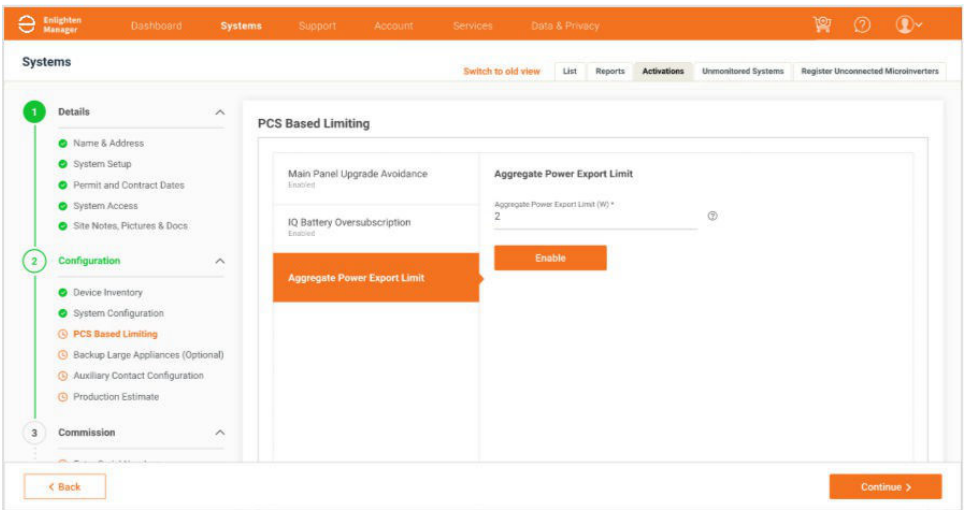
On the **Configuration Details** screen, input the Aggregate Power Export Limit (W) and tap **Next: PIM Configuration** to enable the feature, as shown in the following figure.



5.4.6 Configuring aggregate PEL feature through the Enphase Installer Portal

Go to **Systems** > **Activations** > **Configuration** > **PCS Based Limiting** > **Aggregate Power Export Limit** > **Enable**.

The following figure shows the configuration screen of the Enphase Power Control feature.



On the Configuration screen, input the Aggregate Power Export Limit (in W) and tap **Enable** to enable the Enphase Power Control feature.

5.5 NEM Integrity Mode

NEM Integrity Mode ensures that the power exported by the Enphase Energy System across all phases —i.e., the aggregate power—to the grid does not exceed the power being produced by the existing PV system.

The Enphase Energy System continuously monitors the aggregate exported power at the point of measurement—either the Consumption CTs or the IQ Meter Collar—and controls the power produced by the PV and Battery system to keep the exported power below the limit set by the installer.

NOTE: When NEM Integrity Mode is enabled, the ESS mode *must not* be set to *Export-only*, as the system will not export beyond the point of common coupling (PCC), i.e., the grid.

NEM Integrity Mode is supported in both grid-tied configurations (Solar + Battery or Solar-only) and grid-forming configurations (Solar + Battery).

For all supported SKUs with aggregate power export limits, see Enphase Power Control in a grid-tied Enphase Energy System on page 4.

5.5.1 NEM Integrity Mode in grid-tied configuration

In this configuration, the aggregate export power (W_{export}) to the utility grid is monitored through the Consumption CTs placed on the utility/grid side of the main panel. The power produced by the PV and/or Battery system is controlled accordingly to ensure that W_{export} is less than or equal to the power measured by the paralleled Consumption CTs on the existing PV system.

The following figure illustrates the aggregate power export limit in grid-tied configurations.

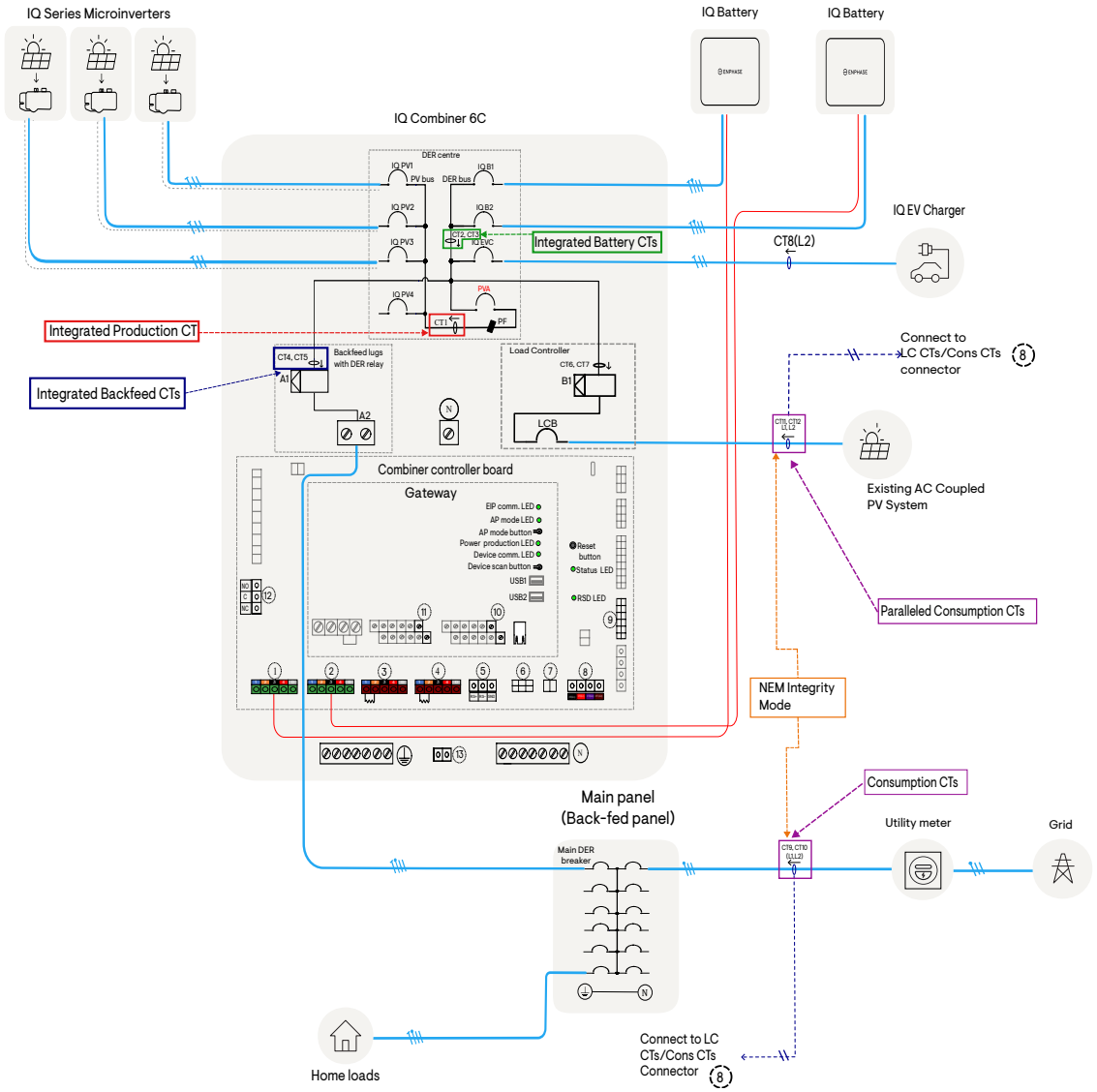


Figure 12: NEM Integrity Mode in grid-tied configuration

5.5.2 NEM Integrity Mode in grid-forming configuration

In this configuration, the aggregate export power (W_{export}) to the utility grid is monitored by the IQ Meter Collar, which is installed between the main panel and the utility meter. The power produced by the PV and/or battery system is regulated to ensure that W_{export} remains less than the power generated by the existing PV system, as measured by the integrated load control CTs in the IQ Combiner 6C.

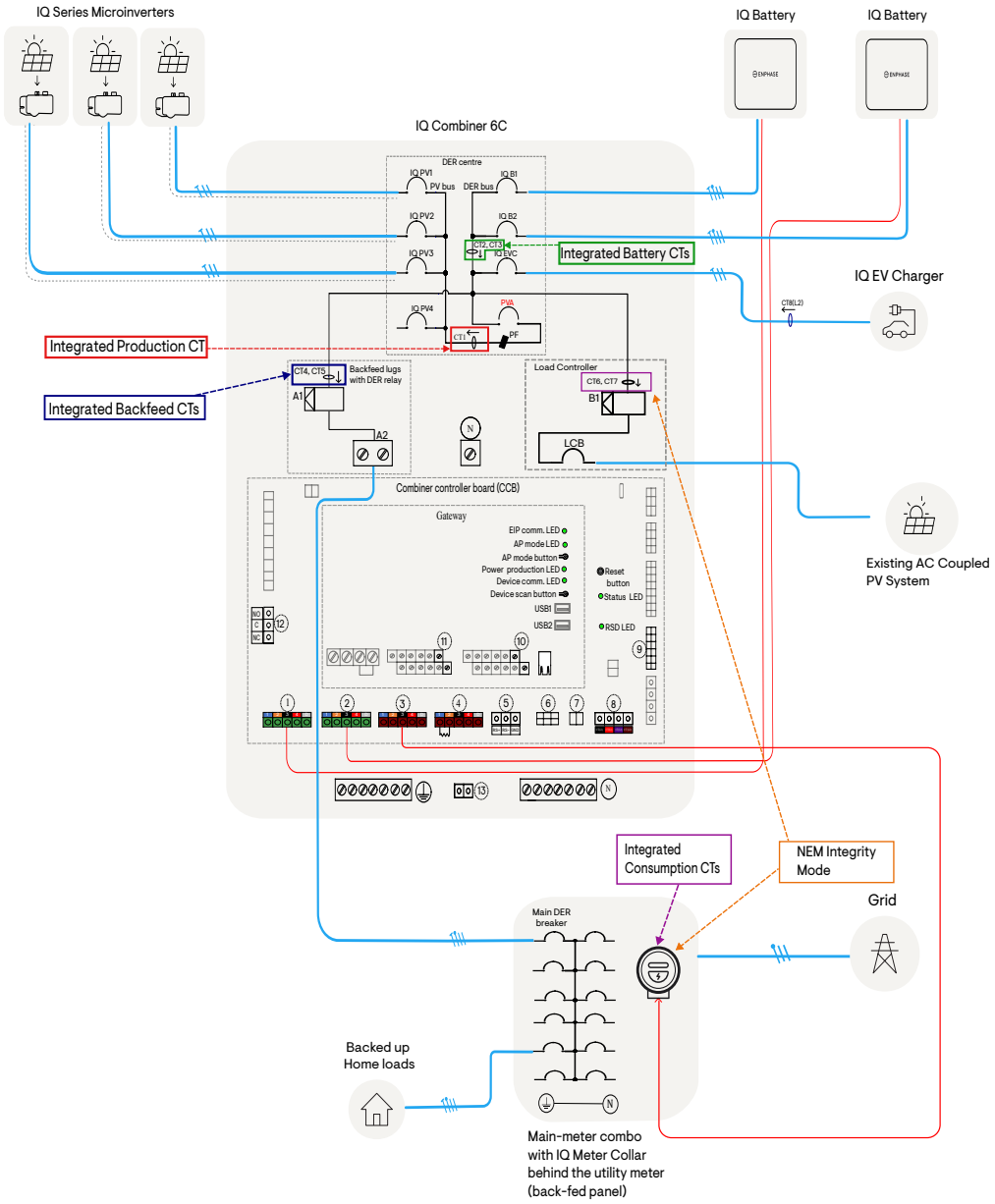


Figure 13: NEM Integrity Mode in grid-forming configuration – IQ Meter Collar placed between the main service breaker and the meter

5.5.3 Compliance with regulations

In California, Enphase installers can configure the NEM Integrity Mode required by the utility using the Enphase Installer App or the Enphase Installer Portal. The Enphase Energy System automatically curtails PV and battery production to ensure compliance with local jurisdictional requirements.

NEM Integrity Mode is certified under UL 3141 v2 and meets the performance requirements of <2-second response time and <10-second settling time (i.e., time to reach steady state), making it compliant with Rule 21 for Non-Export systems.

NOTE: NEM Integrity Mode operates on an aggregate basis across all phases.

5.5.4 Failure modes and resolution

Table 7: Failure modes and resolution mechanisms

Failure mode	Resolution mechanism
One or more microinverters failed or stopped communicating with the IQ Gateway	If the IQ Gateway loses communication with a PV microinverter for more than 30 seconds, the microinverter automatically curtails its output current to the static safe limit (0 watts).
Consumption CTs or IQ Meter Collar not reporting correct values, or missing Consumption CTs/IQ Meter Collar	PV production from each microinverter automatically defaults to the safe limit (0 watts). IQ Batteries transition to an idle state (neither charging nor discharging).
PCS controller or IQ Gateway failure	If the PCS controller or IQ Gateway fails, PV production curtails to the static safe limit (0 watts) within 30 seconds of losing communication. IQ Batteries move to an idle state (neither charging nor discharging).

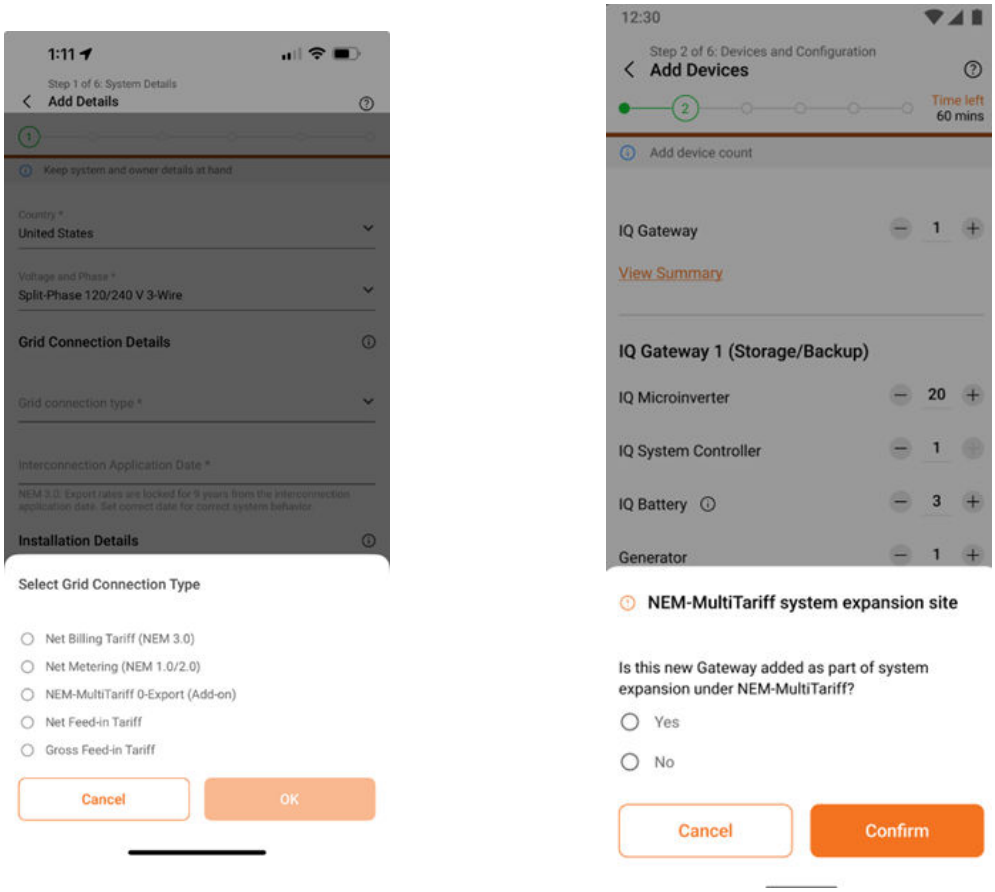
5.5.5 Configuring NEM Integrity Mode through the Enphase Installer App

NEM Integrity Mode is automatically configured through the Enphase Installer App in the following cases:

- For a non-Enphase existing system: During initial site setup, select **NEM-Multitariff 0-Export (Add-on)** under **Grid Connection Type**.
- For an existing Enphase PV system: When adding an additional IQ Gateway or IQ Combiner 6 under **Devices**, an option to select **NEM-MT** is shown.

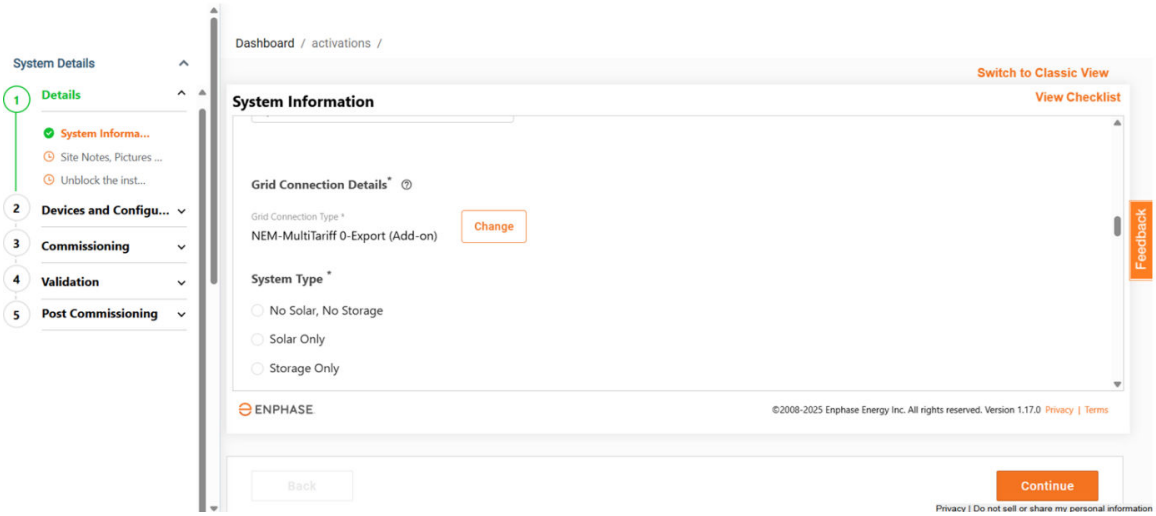
In either case, NEM Integrity Mode is automatically enabled by setting a zero-export limit for the new system, ensuring that the overall system never exports more power than the existing PV system produces.

The following figure shows the configuration screen where NEM Integrity Mode is set using either method.



5.5.6 Configuring NEM Integrity Mode through the Enphase Installer Portal

Go to **Systems** > **Activations** > **Details** > **System Information** > **Grid Connection Details**. The following figure shows the configuration screen for this feature.



6. Revision history

Revision	Date	Description
TEB-00269-3.0	February 2026	Added the section "Supported SKUs for the Enphase Power Control".
TEB-00269-2.0	August 2025	Added information on NEM Integrity Mode.
TEB-00269-1.0	June 2025	Initial release.