

Guidelines for current transformer (CT) installation

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Guidelines for current transformer (CT) installation

This technical brief is intended for solar energy professionals who will install current transformers with the IQ Gateway or the IQ Combiner.

How CTs work

The IQ Gateway/IQ Combiner uses current transformer (CT) readings to report energy production and consumption measurement data. When CTs are wrapped around a live wire, the current going through the wire induces a current on the CT's secondary winding. The current on the secondary winding is proportional to the current on the original circuit and is used for calculating measurements.

Types of CTs supported by Enphase

Current transformers are required for the following use cases:

- **Production metering:** IQ Gateway/IQ Combiner supports solid-core current transformers for revenue-grade PV production metering.
- **Consumption metering:** IQ Gateway/IQ Combiner supports split-core or clamp-style current transformers for consumption metering.
- **IQ Battery metering:** For sites with IQ Battery, the IQ Gateway/IQ Combiner supports metering of the device with split-core or clamp-style current transformers to measure real-time charging and discharging. This is only supported with the IQ Battery 5P.

Use cases for CT installation

The CT measurements provide valuable system information to the installers and homeowners about PV production, home consumption, and IQ Battery charging/discharging. This information is also crucial for remote maintenance and management of the Enphase system. The CT information also enables a site to support the following applications:

1. **Main panel upgrade (MPU) avoidance:** The MPU avoidance feature of PCS uses production and Consumption CTs installed on-site to limit the total current backfed to the main panel to meet the NEC requirements to avoid having to upgrade the main panel.
2. **Aggregate power export limiting (PEL):** The aggregate PEL feature of PCS uses the Consumption CTs installed on a site to limit the total power exported to the grid to the limit defined by the user to meet local code requirements on export power limiting.
3. **Generator metering:** On grid-forming sites with a generator installed, a pair of CT-200-CLAMP CTs (same as the Consumption CTs) can be used for metering the generator power.



NOTE: There may be other local jurisdiction requirements that may mandate energy measurement. Hence, Enphase recommends the installation of current transformers on all sites.

Recommended installation location for current transformers

The following section provides the recommended installation location for current transformers based on the type of system installed at a site.

Current transformer installation for PV-only sites

Based on the site requirement, consumption meters can be installed for load-with-solar or load-only metering.

Load-with-solar configuration

In this configuration, the Consumption CT is installed between the main load center and the utility meter. All Consumption CTs supported by Enphase are service entrance rated and hence can be installed in this configuration.

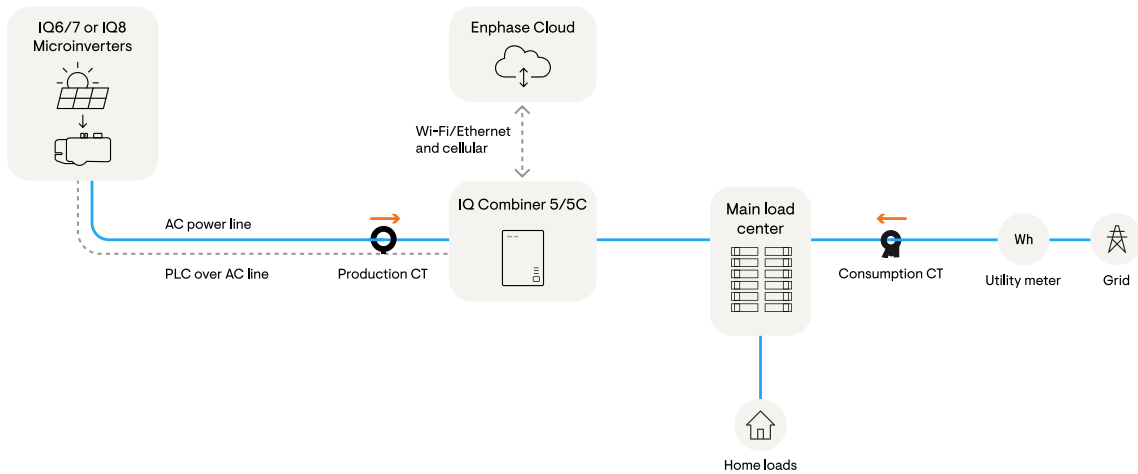


Figure 1: Consumption meters used for net grid metering



NOTE: For sites with IQ Gateway installed instead of IQ Combiner, the Production CT should be placed in the subpanel used for landing the PV branches onto the PV breakers.

Load-only configuration

In this configuration, the Consumption CTs are installed between the main load center and the home loads.

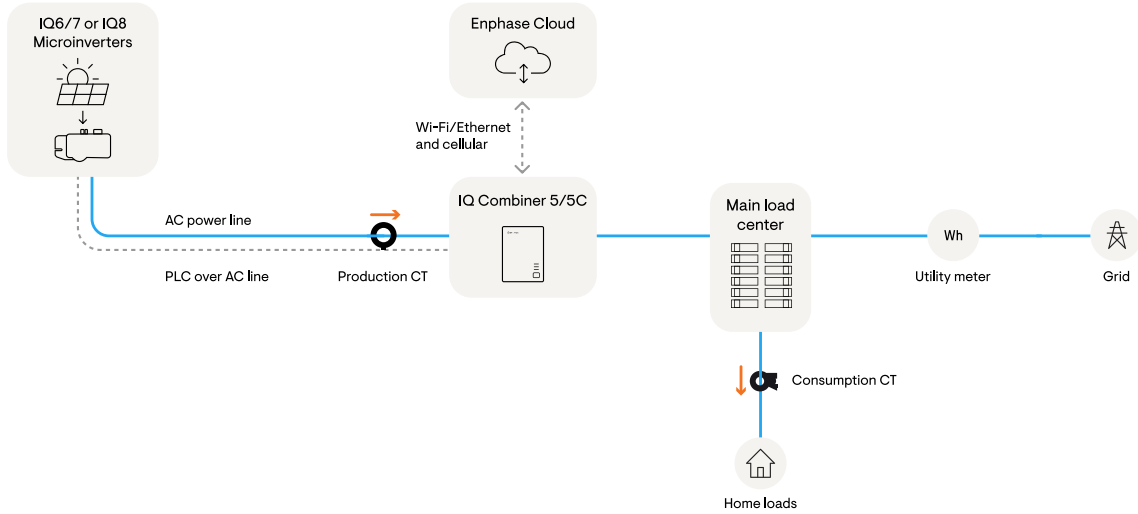


Figure 2: Consumption meters used for home consumption metering

Current transformer installation for grid-tied PV+IQ Battery sites

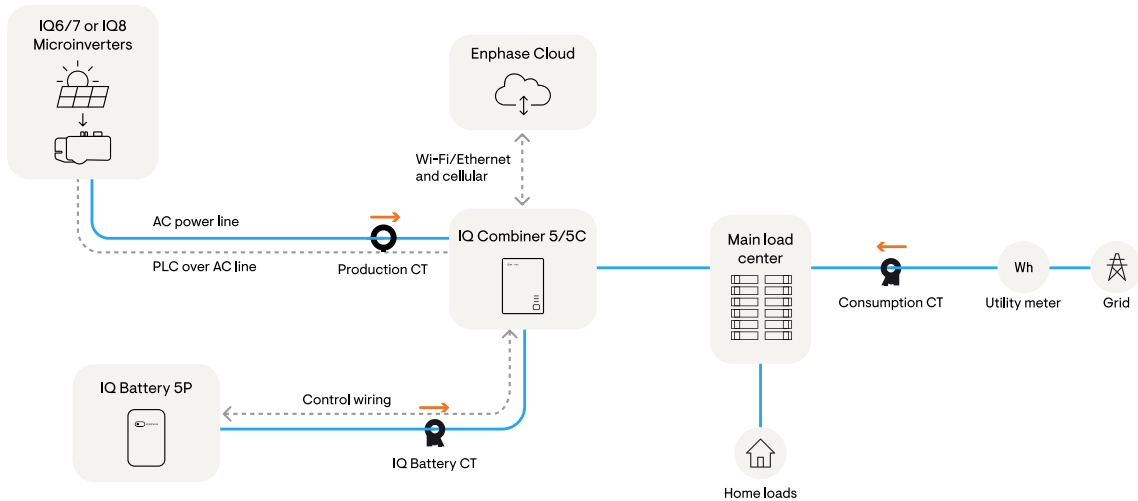


Figure 3: Current transformer installation for grid-tied PV+IQ Battery sites



NOTE: For sites with IQ Gateway installed instead of IQ Combiner, the Production CT and IQ Battery CT should be placed in the subpanel used for landing the PV branches onto the PV breakers and the IQ Battery on the IQ Battery breaker.

Current transformer installation for Enphase Energy Storage system sites

Partial home backup (without MPU avoidance)

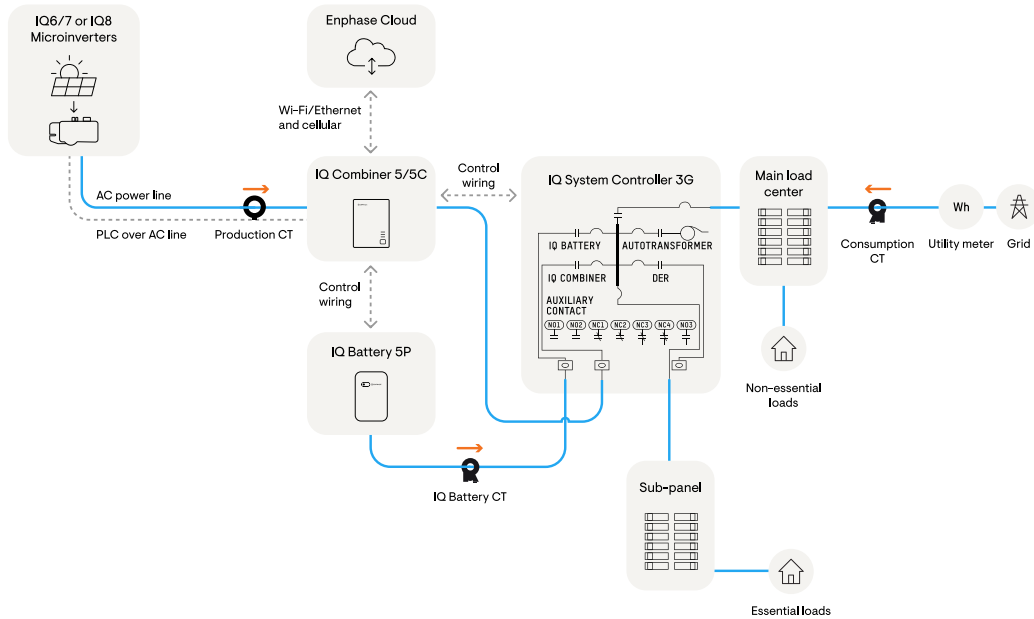


Figure 4: Current transformer installation for Enphase Energy Storage system sites. Partial Home Backup (No MPU Avoidance)

Partial home backup (with MPU avoidance)

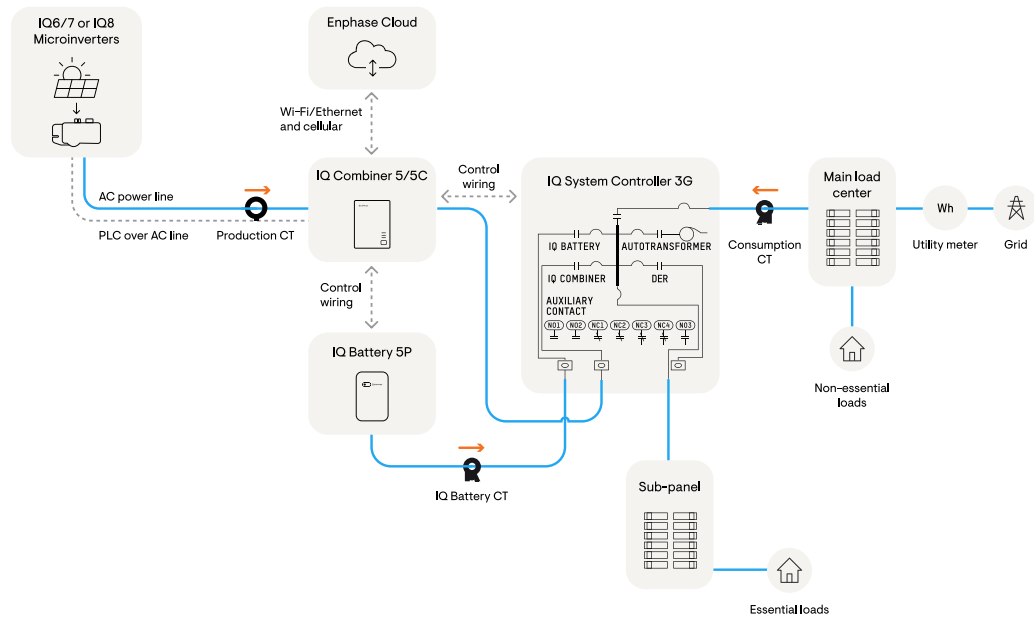


Figure 5: Current transformer installation for Enphase Energy Storage system sites. Partial Home Backup (With MPU Avoidance)

Guidelines on CT wiring

The IQ Combiner 5/5C ships with new color-coded CT wires for ease of installation. The following section provides guidance on CT wiring based on the model of IQ Combiner or IQ Gateway installed on-site.

For IQ Gateway and IQ Combiner 3/3-ES/4

Follow the steps to connect CTs to an IQ Gateway or IQ Combiner 3/3-ES/4:

1. Make sure that the main load center wires are de-energized until you have secured the CT wires in the terminal blocks.
2. The IQ Combiner ships with the Production CT pre-wired. If a site has an IQ Gateway in place of the IQ Combiner, then connect the white and blue wires to the white and blue "P1" terminals on the IQ Gateway.
3. Before running the CT wires through the conduit, use colored tape to mark one of the CTs and the free end of its wires. This ensures the CT is wired to the correct terminal at the IQ Gateway.
4. For the marked CT wires, connect the white and blue wires to the white and blue "C1" terminals (as shown in the following figures).
5. For the unmarked CT wires, connect the white and blue wires to the white and blue "C2" terminals (as shown in the following figures).
6. Tighten all connections to 5 in-lbs.
7. Clamp the marked CT on the load center feed wire Line 1 (matching the phase on IQ Gateway's "L1" voltage terminal) with the CT arrow pointing towards the load (away from the grid).
8. Clamp the unmarked CT on the load center feed wire Line 2 (matching the phase on IQ Gateway's "L2" voltage terminal) with the CT arrow pointing towards the load (away from the grid).



NOTE: For the IQ Combiner, the IQ Gateway board is placed such that the terminals are rotated at 90°.

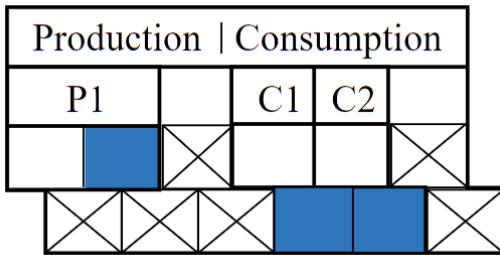


Figure 7: Terminal block in IQ Gateway

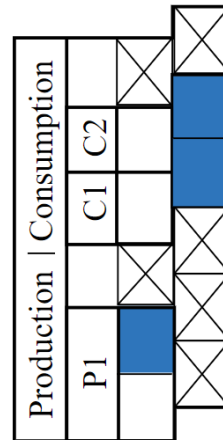


Figure 8: Terminal blocks in IQ Combiners (3,3-ES,4)

For IQ Combiner 5/5C

Follow the steps to connect CTs to an IQ Combiner 5/5C:

1. Make sure that the main load center wires are de-energized until the CT wires are secured in the terminal blocks.
2. Connect the CT red and black wires to the red and black “C1” terminals.
3. Connect the CT purple and brown wires to the purple and brown “C2” terminals.
4. Tighten all connections to 5 in-lbs.
5. Clamp the C1 CT on the load center feed wire Line 1 (matching the phase on IQ Gateway’s “L1” voltage terminal) with the CT arrow pointing towards the load (away from the grid).
6. Clamp the purple and brown C2 CT on the load center feed wire Line 2 (matching the phase on IQ Gateway’s “L2” voltage terminal) with the CT arrow pointing towards the load (away from the grid).

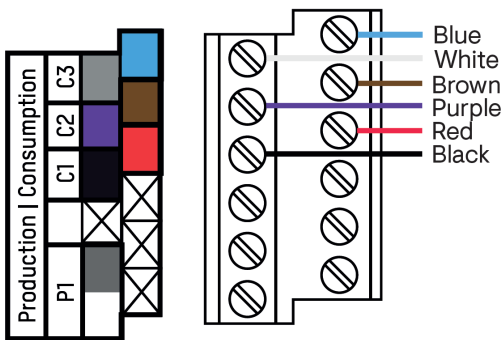


Figure 9: IQ Combiner CT Terminals

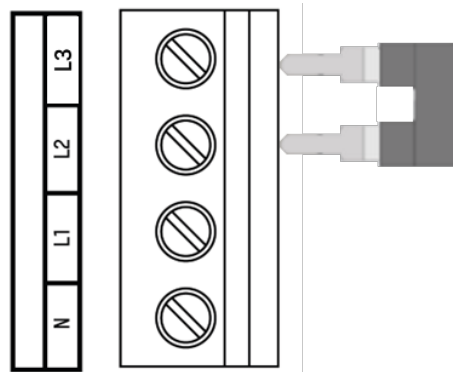


Figure 10: IQ Combiner CT Terminals

IQ Battery metering

Follow the steps to connect an IQ Battery CT (if IQ Battery 5P is installed on-site) to any IQ Gateway or IQ Combiner:

1. If an IQ Battery 5P is present, clamp the blue and white IQ Battery clamp CT on the Line 2 power wire for all branches of the IQ Battery 5P (matching the phase on IQ Gateway’s “L2” voltage terminal) with the CT arrow pointing towards the load (away from the battery).
2. Connect the CT lead wires to the C3 section on the IQ Gateway/IQ Combiner 5’s metering port.



NOTE: The IQ Combiner 5 includes a pre-installed power jumper between the L2 and L3 power terminals of the IQ Gateway, as shown in Figure 10. For a site with a standalone IQ Gateway, a power jumper is provided with COMMS-KIT-02 for shorting the two terminals. It is mandatory to do this to ensure correct readings on the battery CT.

Using the Enphase Installer App to complete the meter configuration

Follow the meter configuration wizard in the Enphase Installer App during system commissioning to validate that the current transformers have been correctly installed.

Setting up the production meter

The steps to configure the production meter are as follows:

1. Navigate to **Meter Configuration**.
2. Tap **Production Meter** to set up the production meter in the system.
3. The **Production Meter** with the phases is displayed.
4. Select the required phase and tap **YES**.
5. The **Enable Production Meter** is displayed with the production phase details.
6. Tap **ENABLE PRODUCTION METER** or **NOT NOW** to cancel the setup.
7. The production meter is enabled in the system.



NOTE: As the IQ Gateway is connected to the device, make sure not to move away.

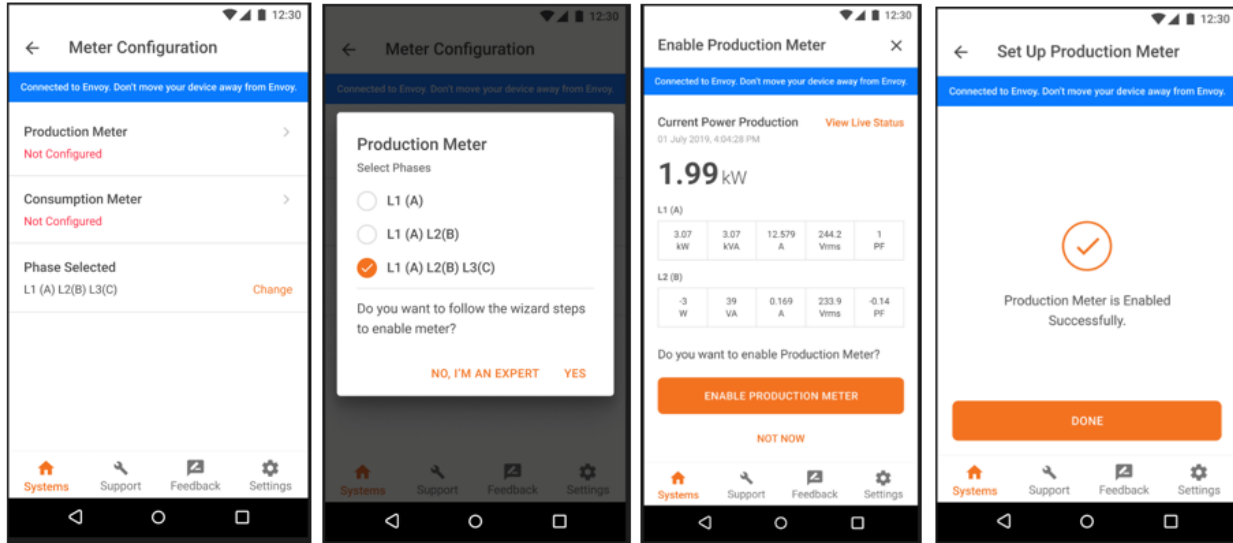


Figure 11: Production meter setup

If the Production CTs are incorrectly installed, the Enphase Installer App highlights the power reading in red and suggests solutions to fix it. Implement the fixes suggested to ensure site metering is set up correctly.

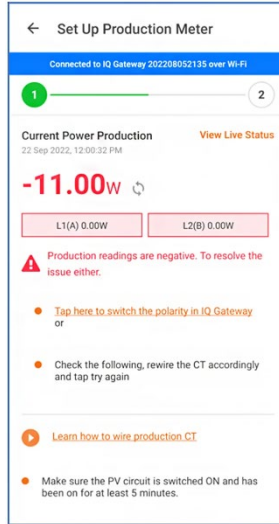


Figure 12: Incorrect installation highlights

Setting up the consumption meter

The steps to configure the consumption meter are as follows:

1. The production meter details are displayed once it is enabled.
2. Similarly, to set up a consumption meter, tap **Consumption Meter**.
3. The **Consumption Meter** with the phases is displayed.
4. Select the required phase option and tap **YES**, as shown.
5. The **Set Up Consumption Meter** is displayed with the consumption phase details.
6. Tap **ENABLE CONSUMPTION METER** to enable the consumption meter in the system.
7. Tap **DONE** to complete the setup.

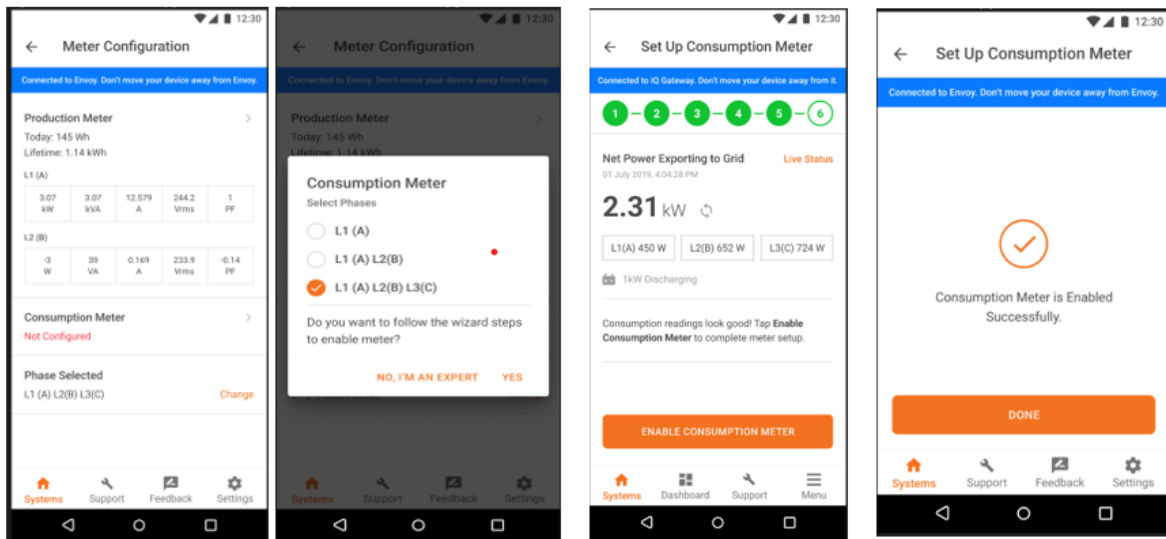


Figure 13: Consumption meter setup

Setting up the storage meter (for systems with IQ Battery 5P)

The steps to configure the storage meter are as follows:

1. To set up the storage meter, tap **Storage Meter**.
2. Tap **ENABLE STORAGE METER** to enable the storage meter in the system.
3. Tap **DONE** to complete the setup.

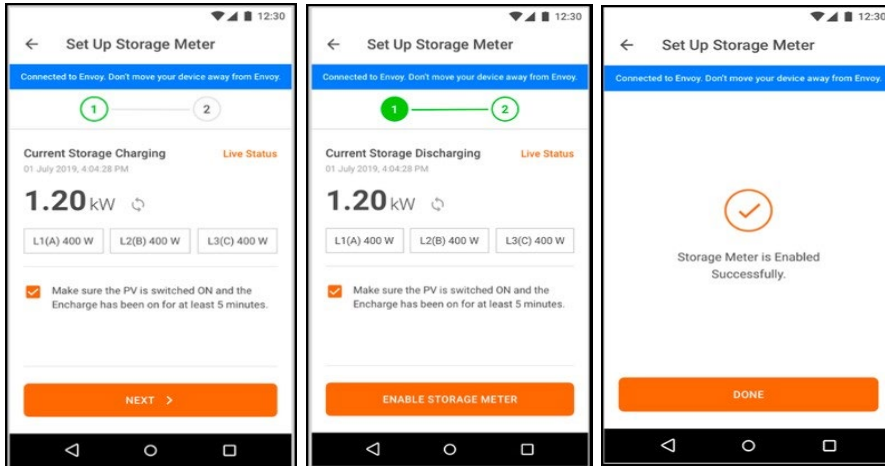


Figure 14: Storage meter setup

Extending the CT lead wires

All current transformers include lead wires for wiring the CT directly into the IQ Gateway terminals.

Production CT lead wires must not be extended if revenue-grade production metering is required. These CTs are certified for revenue-grade production metering. Extending lead wires voids the certification.

Consumption meter lead wires can be extended to be installed in panels away from where the IQ Gateway is located. These wires may be extended to a maximum of 1.5 Ohms per wire and 3 Ohms for both wires end to end. Appropriately rated, 0.75 mm² to 1.5 mm², twisted-pair wire cable is recommended. Install in accordance with all applicable electrical codes and standards.

Table 1: Cable manufacturer and description

Manufacturer	Cable description	Recommended length extension
Elcon Cables	Elcon/LAPP instrumentation cable 1.5 mm ² (1 or 3 core)	100 m (328 ft)
Clipsal CBus	Cat. 5e rated 4 pair unshielded twisted pair (UTP) cable	50 m (164 ft)
Belden	Belden 8471NH unshielded twisted pair cable (1.33 mm ²)	75 m (246 ft)

Enphase SKUs for current transformers

The following table provides a list of recommended SKUs supported:

Table 2: SKU for CT

Product family	SKU	Production metering	Consumption metering	IQ Battery 5P metering
IQ Gateway	<ul style="list-style-type: none"> ENV-IQ-AM1-240 ENV2-IQ-AM1-240 ENV-S-AM1-120 ENV-IQ-AM3-3P 	CT-200-SOLID (Included with IQ Gateway, to be installed in the field)	CT-200-SPLIT (To be purchased separately)	CT-200-SPLIT or CT-200-CLAMP* (To be purchased separately)
IQ Combiner 3/3C, IQ Combiner 3-ES/3C-ES, IQ Combiner 4/4C	<ul style="list-style-type: none"> 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 	CT-200-SOLID (Pre-installed in IQ Combiner)	CT-200-SPLIT (Included with IQ Combiner 3-ES and next generations, to be installed in the field. To be purchased separately for IQ Combiner 3/3C)	CT-200-CLAMP* (To be purchased separately)
IQ Combiner 5/5C	<ul style="list-style-type: none"> X-IQ-AM1-240-5 X-IQ-AM1-240-5C 	CT-200-SOLID (Pre-installed in IQ Combiner)	CT-200-CLAMP (Included with IQ Combiner, to be installed in the field)	CT-200-CLAMP (Included with IQ Combiner, to be installed in the field)

*Ships with the COMMS-KIT-02, which also includes the power jumper that must be installed between the L2 and L3 power terminals of the IQ Gateway.



NOTE: All the current transformers listed above are rated for use up to 200 A. For sites requiring larger current measurements, Enphase recommends installing up to two sets of CTs in parallel. This can be done by installing two Consumption CTs on each line conductor and then parallel connecting the output conductors at the IQ Gateway CT wiring terminals or in a wire connector before landing in the IQ Gateway terminals. Enphase currently does not support using any third-party CT for measuring larger loads.

Appendix A

PV systems with IQ6/IQ7/IQ8 or M Series Microinverters may need to be “split” into grid-forming and grid-tied systems or multiple grid-tied systems. When using such split systems, depending on the configuration, an additional pair of Consumption CTs may need to be added. Refer to Appendix C of the [System planning guide](#) for more information.



NOTE: A maximum of two CTs can be connected in parallel for both production and consumption. If Production CTs are paralleled, then metering will not be revenue-grade anymore.



NOTE: When using the Self-consumption or Savings battery profile in the scenarios illustrated here, the battery is prioritized to discharge to serve loads on the main panel.



NOTE: All Consumption CT wiring must be done for both Line 1 and Line 2.

A few common split system (NEM plus non-export) scenarios commonly found on sites in Hawaii have been explained as follows:

Scenario 1

A system split into one IQ8 grid-forming PV + IQ Battery system and one IQ8 or IQ6/IQ7 grid-tied PV + IQ Battery system with additional loads or subpanels connected to the main panel.

CT Installation:

a. Grid-forming PV + IQ Battery system

CT label	CT placement
a1	Production CT on the PV branch to the IQ Combiner.
a2	Consumption CTs between the main panel and microgrid system paralleled with CT labeled a3 in Figure 15 .
a3	Consumption CTs between the main panel and non-essential loads paralleled with CT labeled a2 in Figure 15 .
a4	Battery CT on the battery L2 branch to the IQ System Controller.

b. Grid-tied PV + IQ Battery system

CT label	CT placement
b1	Production CT on the PV branch to the IQ Combiner.

CT label	CT placement
b2	Consumption CT between the main panel and subpanel with non-essential loads.
b3	Battery CT on the battery L2 branch to the IQ Combiner.

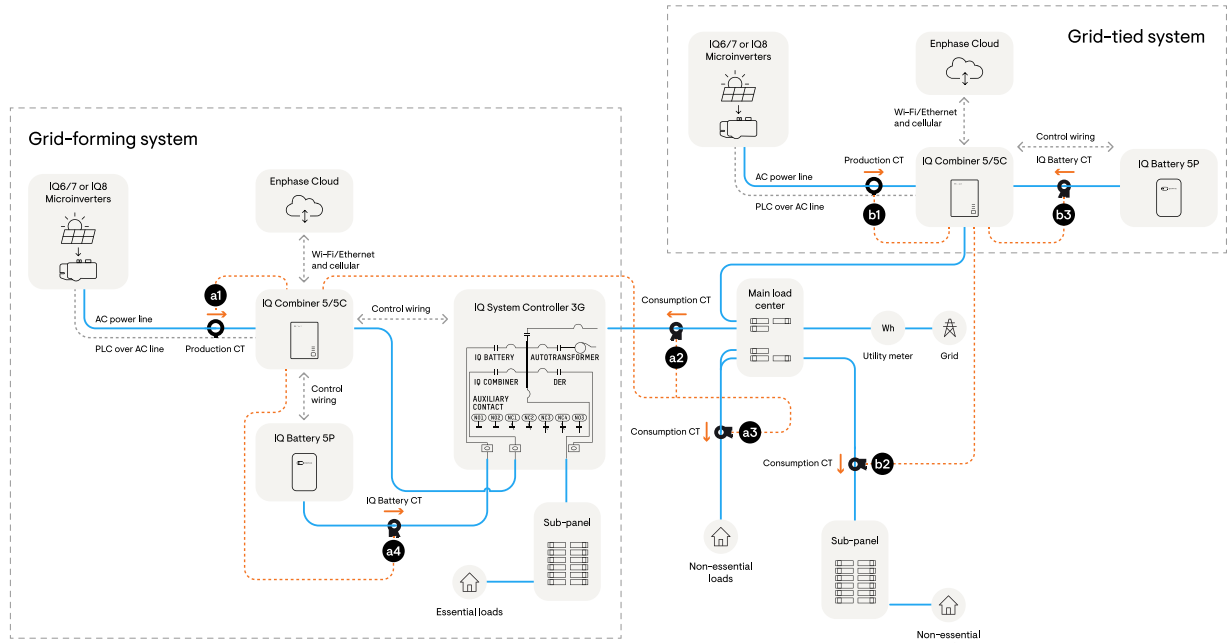


Figure 15: Scenario 1

Scenario 2

A system split into one IQ6/IQ7 or IQ8 grid-tied PV + IQ Battery system and one M Series grid-tied PV system.

CT Installation:

- A. If access to the utility line is available, then
 - a. IQ6/IQ7 or IQ8 grid-tied PV + IQ Battery system:

CT label	CT placement
a1	Production CT on PV branch to IQ Combiner.
a2	Consumption CT between the utility and main panel paralleled with CT labeled a3 in Figure 16
a3	Consumption CT between the subpanel in the grid-tied system with M Series microinverters and the main panel paralleled with CT labeled a2 in Figure 16

CT label	CT placement
a4	Battery CT on battery L2 branch to IQ Combiner.

b. M Series grid-tied PV system:

CT label	CT placement
b1	Production CT on PV branch to IQ Gateway in an off-the-shelf box.

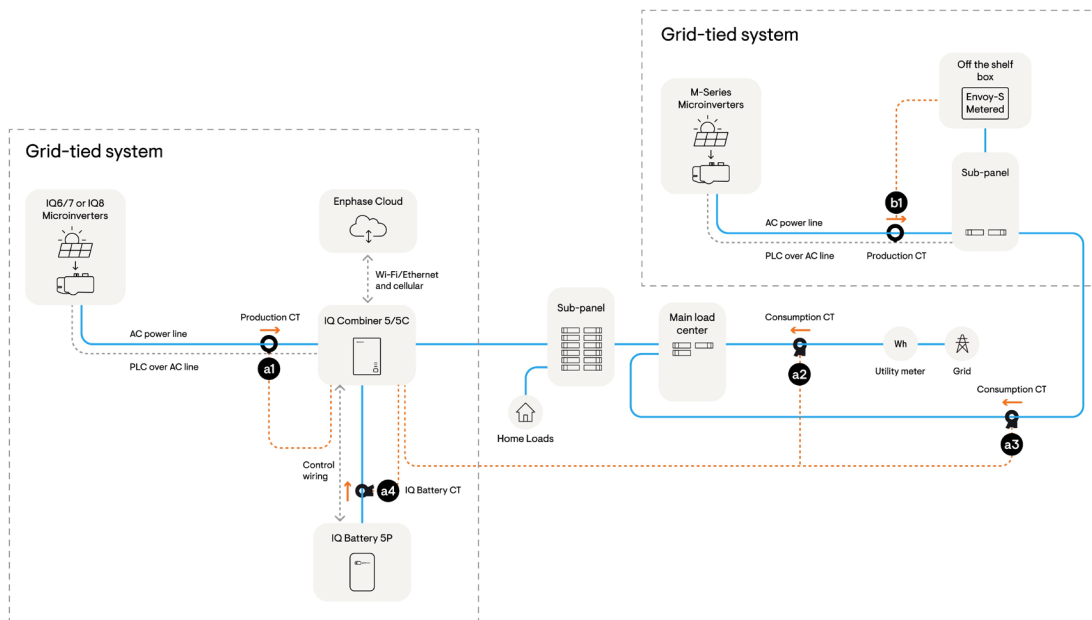


Figure 16: Scenario 2A

B. If there is no access to utility lines, AND if it is possible to rewire the existing PV system (where the power lines from the subpanel in the existing PV system (with M Series microinverters) is terminated on the subpanel with home loads as shown in [Figure 17](#)), then

a. IQ6/IQ7 or IQ8 grid-tied PV + IQ Battery system:

CT label	CT placement
a1	The PV branch to the IQ Combiner AND the power lines that originate from the subpanel in the grid-tied system (with M Series microinverters) and terminate on the subpanel with home loads, both running through the Production CT (a1) it as shown in Figure 17 .
a2	Consumption CT between subpanel with non-essential loads and main panel.

CT label	CT placement
a3	Battery CT on the battery L2 branch to The IQ Combiner.

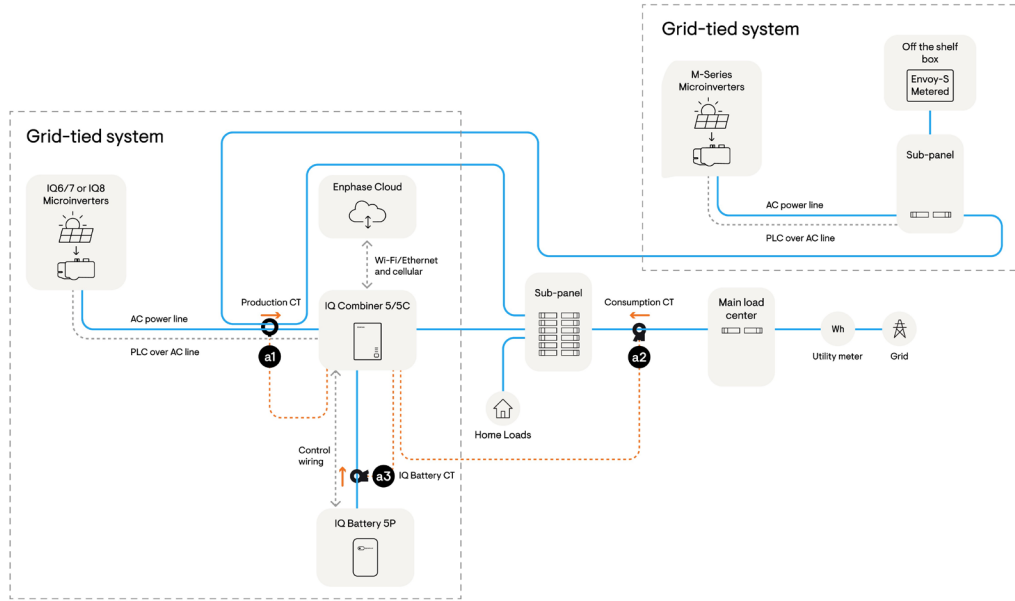


Figure 17: Scenario 2B

- C. If there is no access to utility lines AND if you are unable or unwilling to rewire the existing (grid-tied system with M Series microinverters) system, then
 - a. IQ6/IQ7 or IQ8 grid-tied PV + IQ Battery system:

CT label	CT placement
a1	Production CT on the PV branch to the IQ Combiner is paralleled with Production CT labeled a2 in Figure 18 .
a2	Production CT between subpanel in a grid-tied system with M Series Microinverters and the main panel; paralleled with the Production CT labeled a1 in Figure 18 .
a3	Consumption CT between subpanel with non-essential loads and main panel; paralleled with Consumption CT labeled a4 in Figure 18 .
a4	Consumption CT between subpanels in a grid-tied system with M Series Microinverters and the main panel; paralleled with Consumption CT labelled a3 in Figure 18 .
a5	Battery CT on the battery L2 branch to the IQ Combiner.

b. M Series grid-tied PV system:

CT label	CT placement
b1*	Production CT on PV branch to the IQ Gateway in an off-the-shelf box.

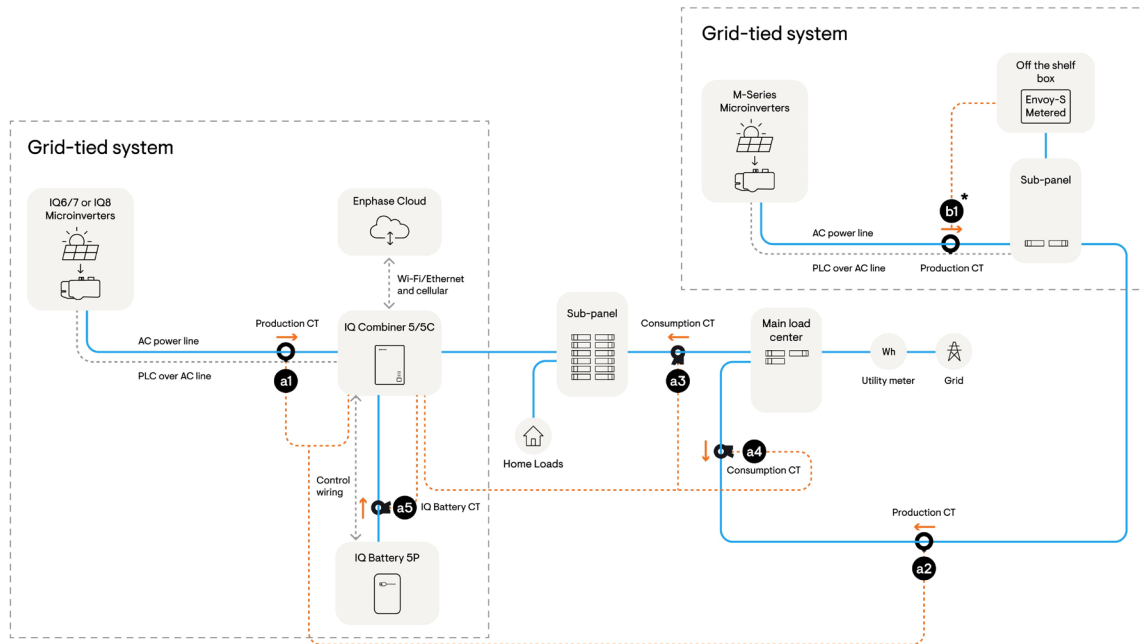


Figure 18: Scenario 2C

* Should ideally be removed; subject to details mentioned in NOTE below



NOTE: Ideally in a system as indicated in scenario 2C, Production CT (b1) must be removed to avoid double counting production since the Enphase App aggregates data from both IQ Gateways. However, if the existing system is TPO (Third party owned), it may not be possible to remove the Production CT (b1). Hence, in such a situation, both systems should be commissioned as separate sites by the installer. The homeowner must be informed that system reports are whole home consumption (in the new site) and total production from the M Series system (in the existing site).

Scenario 3

A system split into one IQ6/IQ7 or IQ8 grid-forming PV + IQ Battery system and one third-party grid-tied PV system.



NOTE: Savings mode behaves as usual, with battery charging at base tariff and battery serving loads while PV exports at peak tariff. The battery does not account for third-party PV during charging; only PV in the IQ system is considered for charging. Self-consumption mode will result in the battery serving load while third-party PV exports to the grid. Acceptable for NEM 2.0 tariff in California. ToU tariff is currently not applicable in Hawaii.

CT Installation:

- A. If access to the utility line is available, then
 - a. IQ6/IQ7 or IQ8 grid-forming PV + IQ Battery system:

CT label	CT placement
a1	Production CT on the PV branch to the IQ Combiner.
a2	Consumption CT between utility and the main panel; paralleled with Consumption CT labeled a3 in Figure 19 .
a3	Consumption CT on third-party PV branch to subpanel with non-essential loads in the grid-tied system; paralleled with Consumption CT labeled a2 in Figure 19 .
a4	Battery CT on the battery L2 branch to the IQ System Controller.

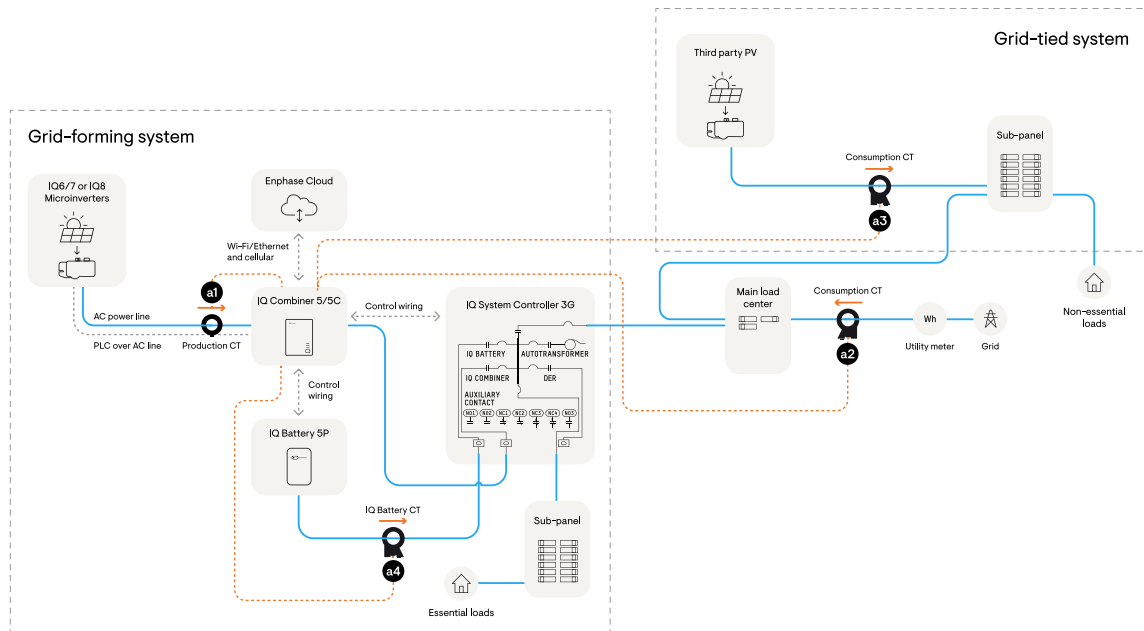


Figure 19: Scenario 3A

- B. If there is no access to utility lines, then
 - a. IQ6/IQ7 or IQ8 grid-forming PV + IQ Battery system:

CT label	CT placement
a1	Production CT on PV branch to the IQ Combiner.
a2	Consumption CT clamped around both wires, i.e., wire from the main panel to the system controller in the grid-forming system and wire from the main panel to the subpanel in the grid-tied system; paralleled with Consumption CT labeled a3 in Figure 20 .
a3	Consumption CT on third-party PV branch to subpanel with non-essential loads in the grid-tied system; paralleled with Consumption CT labeled a2 in Figure 20 .
a4	Battery CT on battery L2 branch to the IQ System Controller.

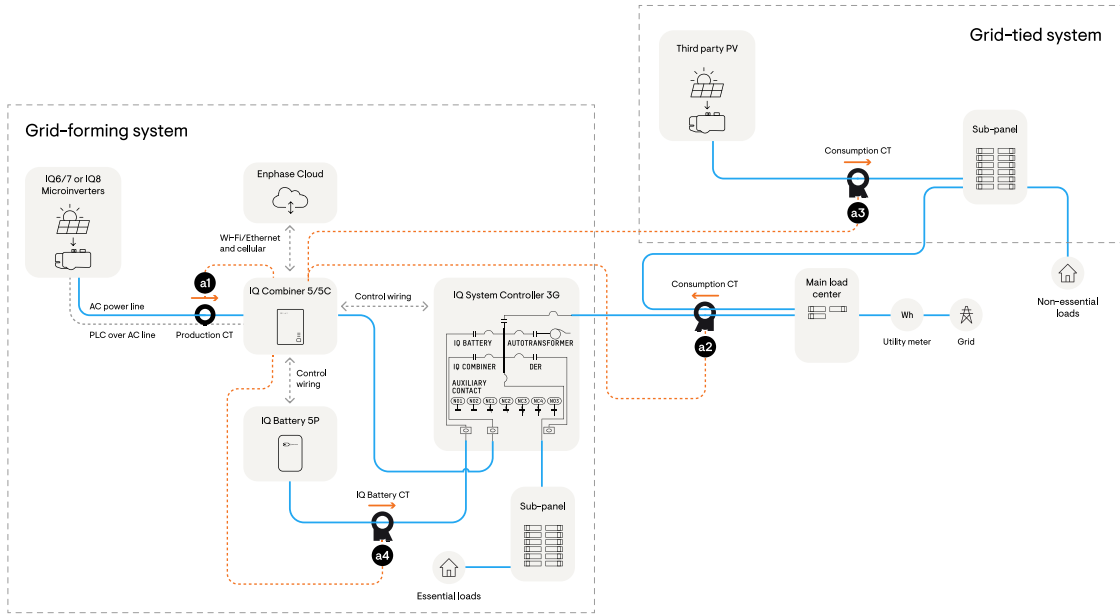


Figure 20: Scenario 3B

Revision history

Revision	Date	Description
TEB-00021-2.0	September 2023	<ul style="list-style-type: none"> • Updated the IQ Combiner CT images in the section “For IQ Combiner 5/5C” under “Guidelines on CT wiring”. • Updated all the images to reflect Clamp CT. • Added a new section, "Appendix A", to include CT installation for split system scenarios.
TEB-00021-1.0	June 2023	Initial release

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