FOX ESS Power Control System
Technical Brief

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Catalog

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1. Overview

Power Control Systems (PCS), as defined in NFPA 70, National Electrical Code (NEC) 2020 Edition, Section 705.13, control the output of one or more power production sources, energy storage systems (ESS), and other equipment. PCS systems limit current and loading on the busbars and conductors supplied by the power production sources and/or energy storage systems.

This technical brief describes the PCS-related functionality of the Fox ESS PowerQ energy storage system, and where applicable the FOX Hub G2, for the purpose of AHJ review and permit documentation. Users can monitor and operate the system remotely through Fox Cloud 2.0 via smartphone app or web portal.

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2. Components of PCS

The FOX ESS PCS architecture includes the following components:

- **FOX Hub G2 —** The system's 1st priority power controller, which interconnects smart load, inverter input, solar inverter, grid, generator, and battery energy to support home loads. (Accessories)
- **Fox ESS PowerQ —** The system's 2nd priority power controller, which interconnects battery input, DC solar input, grid, and battery energy to support home loads. (Battery & Inverter Integrated AIO System)
- **CTs —** The PV production CTs and grid CTs must be installed in accordance with the Quick Installation Guide, applicable to both FOX Hub G2 and standalone Fox ESS PowerQ / US Series installations. The PV production CTs monitor the power generated by the solar inverter. The grid CTs monitor the back-feed current from the FOX Hub G2 to the grid / main panel in real time.
- **Energy Management System (EMS) —** Integrated in the FOX Hub G2 (1st priority) and Fox ESS PowerQ (2nd priority), the EMS receives the current reported by the CTs and limits the Fox ESS PowerQ / US Series output as required to comply with the system grid connection and service entrance limits.
- **FOX ESS App 2.0 —** Authorized personnel only are able to change PCS settings through the smartphone app.

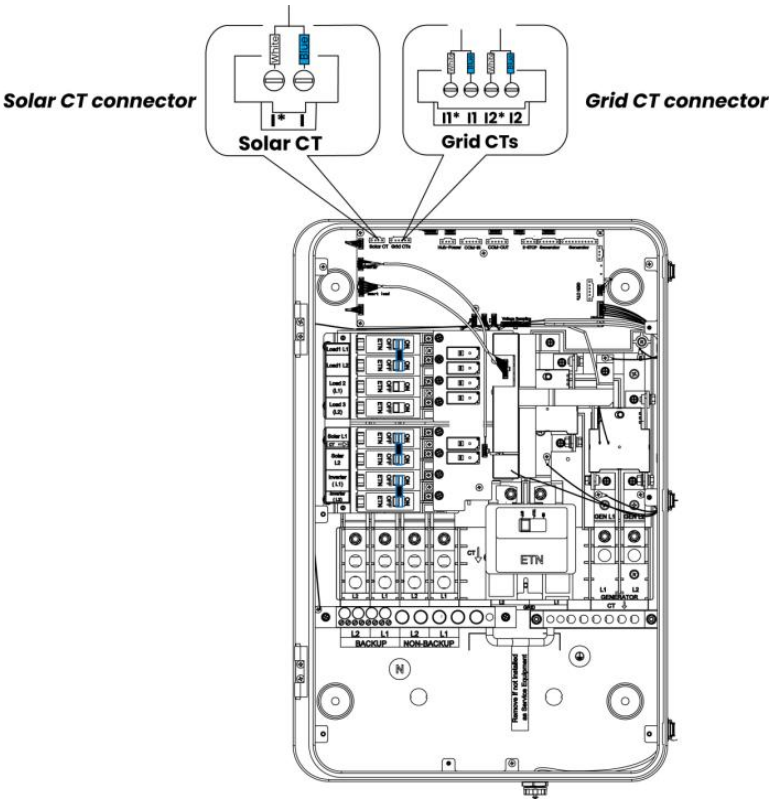

Figure 1 CT connectors in the Fox Hub G2

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3. Supported PCS Functions in the FOX ESS Energy Storage System

The US series and AIO US series Fox ESS PowerQ products have been evaluated with ESS operating modes of Unrestricted Mode and Import Only Mode according to UL 1741 CRD — Power Control Systems (dated March 08, 2019). The evaluated system configurations and response time parameters are detailed in the subsections below.

3.1 ESS Unrestricted Mode

ESS Unrestricted Mode is used to control the power delivered from the grid to the ESS, or from the ESS to the grid within the evaluated system configuration.This export unrestricted mode is factory preset in the software.

Parameter	Value
Applicable Models	H1-3.8-US, H1-5.7-US, H1-7.6-US, H1-9.6-US, H1-11.4-US, AIO-H1-3.8-US, AIO-H1-5.7-US, AIO-H1-7.6-US, AIO-H1-9.6-US, AIO-H1-11.4-US
Grid CT Location	The grid CT is located at the main grid bus, and it must include the output of the FOX ESS equipment and the whole home load.
Maximum Controlled Current	47.5 A (single PowerQ or US Series Inverter)
Maximum Controlled Power	11.4 kW (single PowerQ or US Series Inverter)
Longest Open-loop Response Time	0.051 s
Longest Steady-state Time	9.125 s

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3.2 ESS Import Only Mode

ESS Import Only Mode is used to control the power delivered from the grid to the ESS only. In this mode, the ESS never exports power to the grid, and the battery is permitted to discharge only to serve on-site household loads. Fox ESS PCS supports this import-only control function and as a UL1741 PCS certified solution, limits battery discharge so that output does not exceed the home load demand. This functional needs to be manually set after Installation.

Parameter	Value
Applicable Models	H1-3.8-US, H1-5.7-US, H1-7.6-US, H1-9.6-US, H1-11.4-US, AIO-H1-3.8-US, AIO-H1-5.7-US, AIO-H1-7.6-US, AIO-H1-9.6-US, AIO-H1-11.4-US
CT Location	The grid CT is located at the main grid bus, and it must include the output of the FOX ESS equipment and the whole home load.
Maximum Controlled Current	47.5 A (single PowerQ or US Series Inverter)
Maximum Controlled Power	11.4 kW (single PowerQ or US Series Inverter)
Longest Open-loop Response Time	1.96 s
Longest Steady-state Time	4.8 s

In FOX ESS field applications, this control function is implemented through the ExportLimit setting in Fox Cloud 2.0 / the device commissioning menu. As shown in Figure 2, when PowerLimitPercentOfFeedInGrid is set to 0.0, the permitted feed-in power is limited to 0% of inverter rated output power, which corresponds to Zero Export operation and is used to implement ESS Import Only Mode for projects requiring no export to the grid.

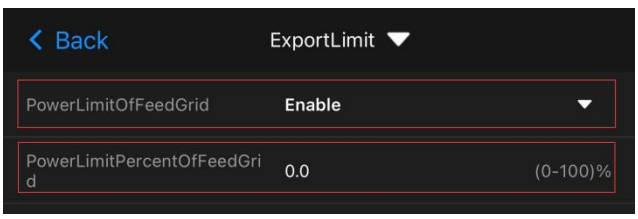

Figure 2 Zero Export setting

The same setting may also be configured to a non-zero percentage when limited export is permitted by the project or utility interconnection requirements. In that case, the maximum allowable export power is equal to the inverter rated output power multiplied by the configured percentage.

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3.3 Charge from Grid Limitation

In certain jurisdictions, the utility limits or prohibits the charging of the ESS from the grid. The FOX ESS system supports this requirement through the EMS commissioning parameters ChargeByGridEnable and ChargeByGridValue under the DER Info2 / EMS settings.

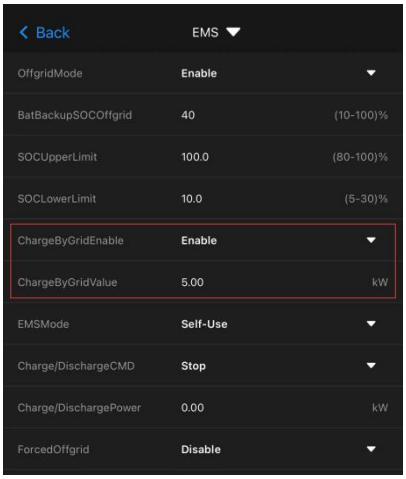

Figure 3 Charge from grid limitation setting

This setting is only required when the main breaker cannot support inverter output during full load, or when utility interconnection agreements restrict grid charging. When grid charging is disabled, the battery can only be charged from solar generation.

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3.4 Main Panel Upgrade (MPU) Avoidance

The FOX ESS system complies with NEC 2023 Article 705.13 in all supported installation topologies. Regardless of whether the FOX Hub G2 is configured as the service panel, the Grid CTs are always installed on the utility service entrance conductors (grid main service line) — either inside the FOX Hub G2 or at the main panel — and remain clamped at that point at all times.

The EMS continuously receives current measurements from the Grid CTs and actively regulates the Fox ESS PowerQ charge/discharge power in real time to ensure the total current at the service entrance never exceeds the capacity of the service conductors. The control logic enforced by the EMS is:

Fox ESS PowerQ output + Grid input + Solar input ≤ Service entrance conductor rating (discharging)

Grid input + Solar input ≤ Service entrance conductor rating (charging)

When the existing solar inverter is not connected to the FOX Hub G2 and is instead connected directly to the service panel, the solar inverter installation shall comply with NEC 2020 Article 705.12(B)(2)(3). In that topology, the FOX ESS PCS continues to operate under NEC 2023 Article 705.13 to regulate the service entrance current and protect the service panel busbar.

2020 NEC 705.12 B(3)(2) mandates export from PV to the main panel as follows:

125% (AC Solar Input) backfeed + Main Breaker Size ≤ (Busbar Rating x 1.2)

This active PCS control eliminates the need for a main panel upgrade (MPU), because the EMS reduces Fox ESS PowerQ / US Series output before any overcurrent condition can occur at the service equipment.

To apply this current-limiting function correctly, the installer must configure the Service Panel Parameter in FOX ESS App 2.0 during commissioning. By setting HubAsServicePanel and MainPanelCapacity to match the actual site configuration, the EMS can enforce the proper service entrance current limit and thereby avoid the need for a service panel upgrade in the application described above.

Where an existing solar inverter remains connected directly to the service panel / main panel busbar rather than to the FOX Hub G2, the protection provided by the FOX ESS PCS under 2023 NEC 705.13 does not by itself verify compliance of the service panel busbar with 2020 NEC 705.12(B). In that topology, the existing solar inverter connection must independently comply with NEC 2020 Article 705.12(B)(3)(2) so that the service panel busbar remains protected.

Under 2020 NEC 705.12(B)(3)(2), the busbar loading condition shall satisfy:

Accordingly, where the existing solar inverter is connected to the main panel, its output circuit breaker and continuous output current shall be selected so that the

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service panel busbar calculation remains compliant with NEC 705.12(B)(3)(2). For the application described in this document, and using a 200 A service panel as the reference example, the existing solar inverter connected to the main panel shall be limited to a maximum continuous output current of 32 A and shall be connected through a 40 A back-fed breaker.

((Busbar Rating x 1.2) – Main Breaker size)/125%= DER current
((200*1.2)-200)/125% = 32A

The back-fed breaker for the existing solar inverter shall be permanently marked: "POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE."

In this topology, HubAsServicePanel shall be set to No, and MainPanelCapacity shall be set to match the actual site main panel ampacity used for the 2020 NEC 705.12(B)(3)(2) verification and 2023 NEC 705.13 EMS current-limiting function.

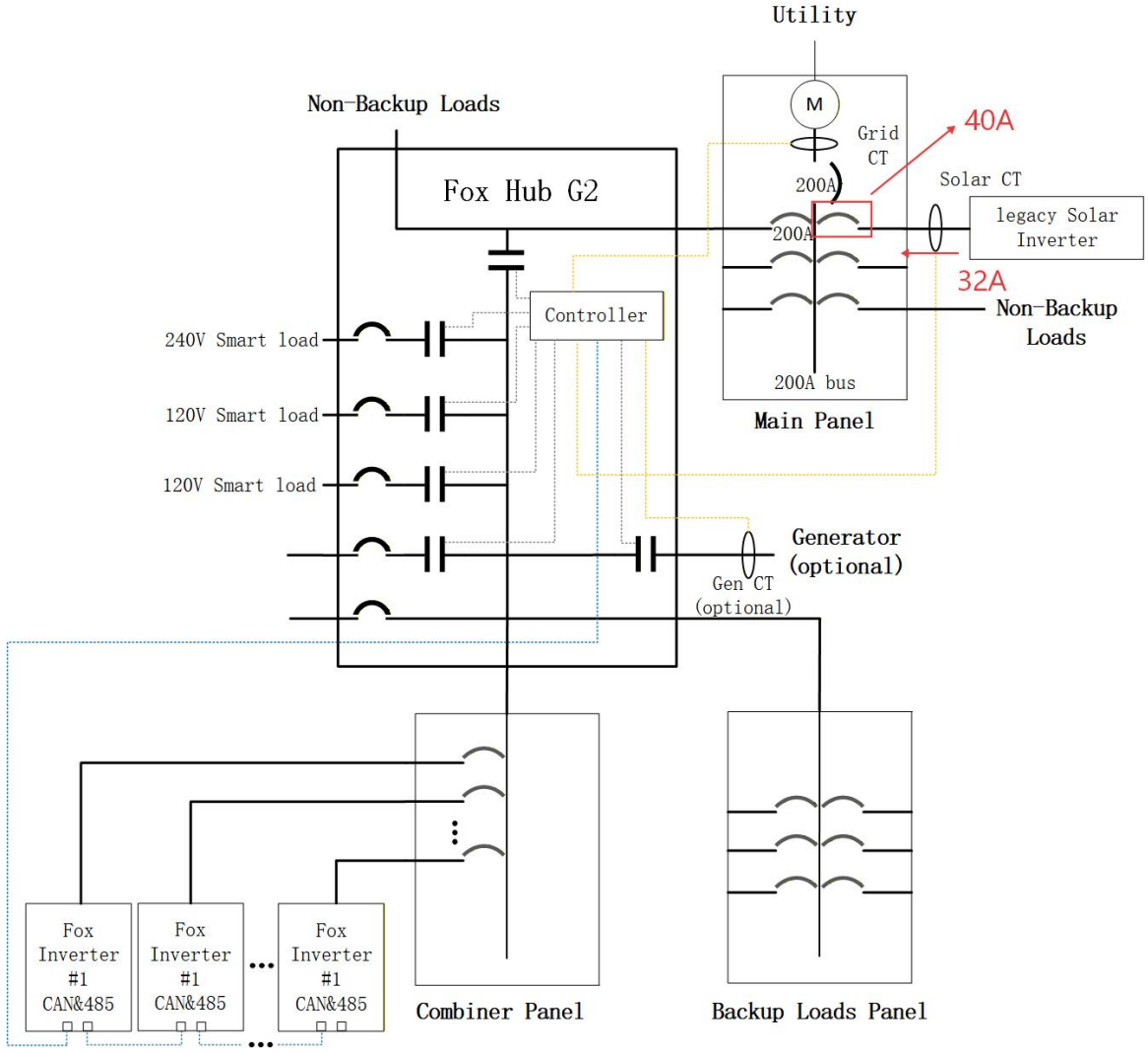

Figure 4 — HUB G2 not as service panel, 200A service panel current monitored in real time

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3.5 Service Panel Configuration

The Service Panel Parameter described in this section is the commissioning setting used to implement the 2023 NEC 705.13 current-limiting function described in Section 3.4. By defining whether the FOX Hub G2 is used as the service panel and by entering the applicable panel ampacity, the EMS can regulate system output in accordance with the actual service entrance capacity.

When the FOX Hub G2 is used as the service panel, a main breaker and line-side barriers (Eaton TICSR300C) must be installed, and the following labels must be applied to the black protection cover:

- SERVICE DISCONNECT
- SUITABLE FOR USE AS SERVICE EQUIPMENT ONLY IN USA WHEN EQUIPPED WITH MAIN BREAKER

When the FOX Hub G2 is not used as the service panel, the bonding jumper must be removed, and the Service Panel Parameter must be configured in the app: HubAsServicePanel = No, and MainPanelCapacity set to match the site main panel ampacity, eg. Existing Service Panel Capacity: 200Amp.

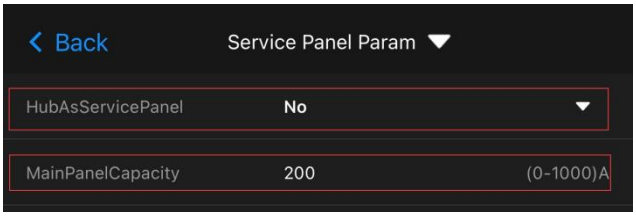

Figure 5 Service Panel Parameter Protecting setting

For Fox ESS PowerQ installations without FOX Hub G2 or FOX HUB G2 as a service panel Installed, the Service Panel Parameter is a not required commissioning item.

4. Application Scenarios

The following scenarios describe how the FOX ESS PCS-related architecture is applied in field installations. These items are presented as commissioning-configured application settings and installation topologies, and should be read in conjunction with the evaluated PCS functions described in Section 3.

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4.1 Existing Solar Inverter Application

For sites with an existing solar inverter (AC-coupled topology), the Solar CT must be installed on the conductors between the existing solar inverter and the panel where it is connected. The Solar CT monitors the existing PV output current in real time, allowing the EMS to account for legacy PV generation when calculating export limits.

The existing solar inverter may be connected to the FOX Hub G2 directly, subject to the following conditions: the system has only one Fox ESS PowerQ, no generator, and the power rating of the existing solar inverter is below the Fox ESS PowerQ's power rating. Otherwise, connection to the main panel applies.

The commissioning item OtherGenerationSystemPow must be set to reflect the rated power of the existing solar inverter.

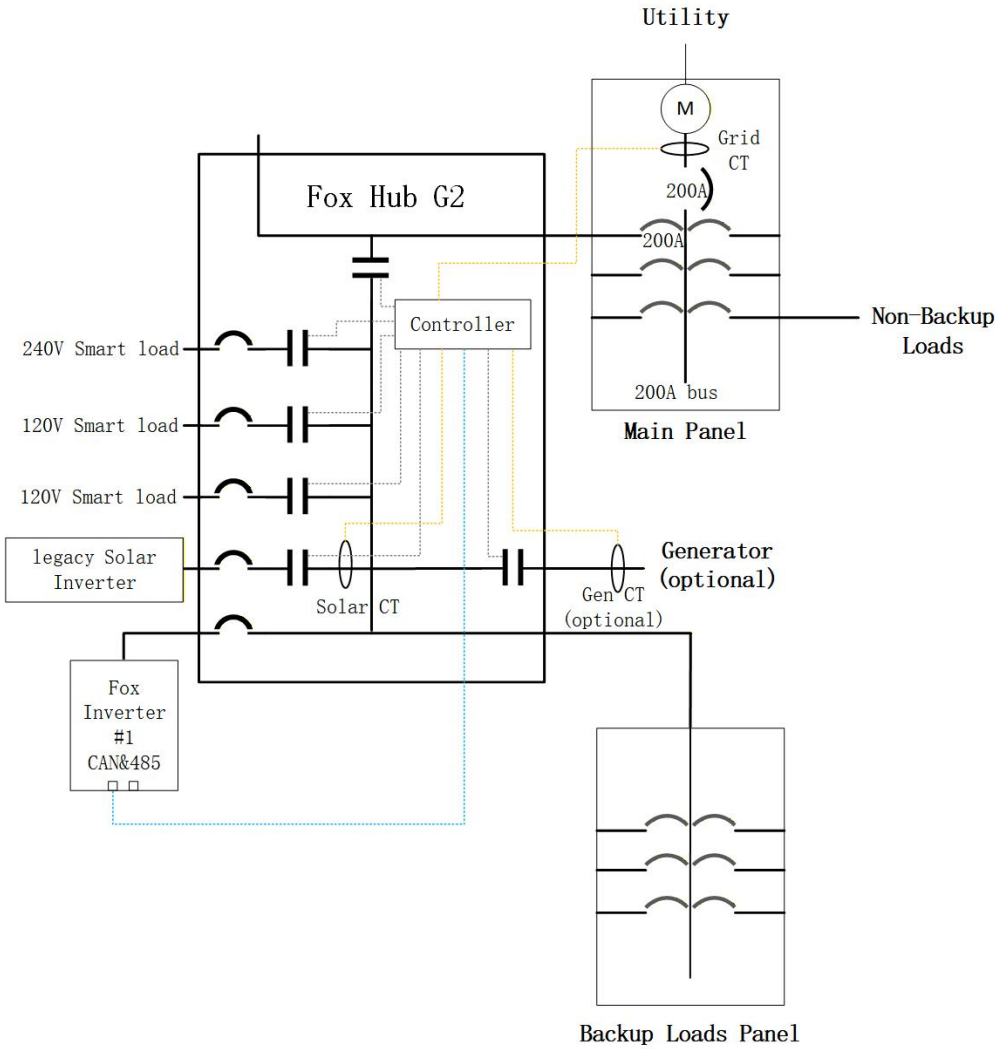

Figure 6 — AC-coupled Topology with Existing Solar Inverter

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4.2 Whole-home Backup

In the whole-home backup configuration, all loads in the home are connected through the FOX Hub G2 or the Fox ESS PowerQ backup port. The system supports both DC-coupled (new PV connected directly to Fox ESS PowerQ) and AC-coupled (existing solar inverter connected to the FOX HUB G2 with Solar CT) topologies.

Grid CT placement varies depending on the installation topology:

With FOX Hub G2: Grid CTs are installed inside the FOX Hub G2 to monitor the grid connection point in real time.

Without FOX Hub G2: Grid CTs are installed at the utility connection or main panel, wired to the Fox ESS PowerQ / US Series P4 terminal.
In Canada, the FOX Hub G2 cannot function as a service panel; a main panel must be added as the service panel between the FOX Hub G2 and the utility meter.

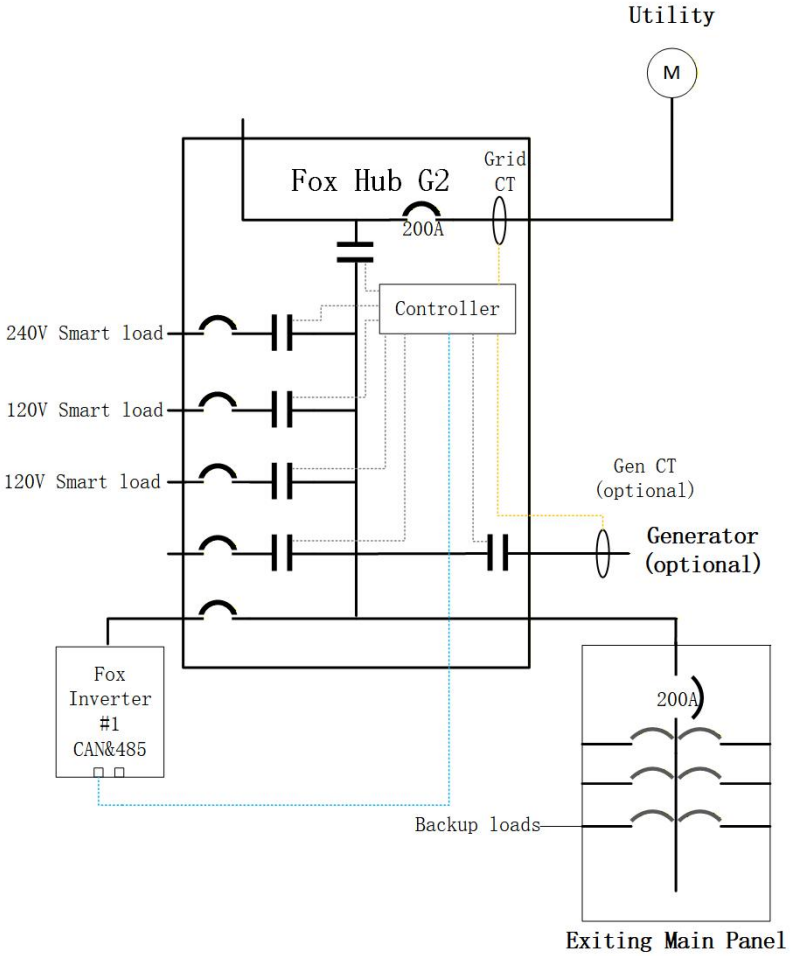

Figure 7 — Whole-home Backup Topology(with Fox Hub G2 Installed)

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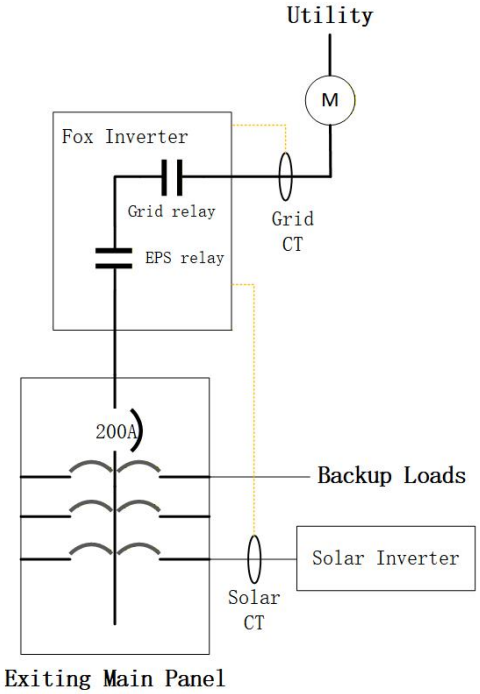

Figure 8 — Whole-home Backup Topology(without Fox Hub G2 Installed)

4.3 Partial-home Backup

In the partial-home backup configuration, backup loads are connected to the backup sub-panel (via FOX Hub G2 backup port or Fox ESS PowerQ backup port), while non-backup loads remain on the main panel.

The Grid CT placement varies depending on whether the FOX Hub G2 is used as the service panel:

- FOX Hub G2 as service panel: Grid CTs are installed inside the FOX Hub G2.
- FOX Hub G2 not as service panel: Grid CTs are installed in the main panel's main busbar.
- Without FOX Hub G2: Grid CTs are installed at the utility connection or main panel, wired to the Fox ESS PowerQ P4 terminal.

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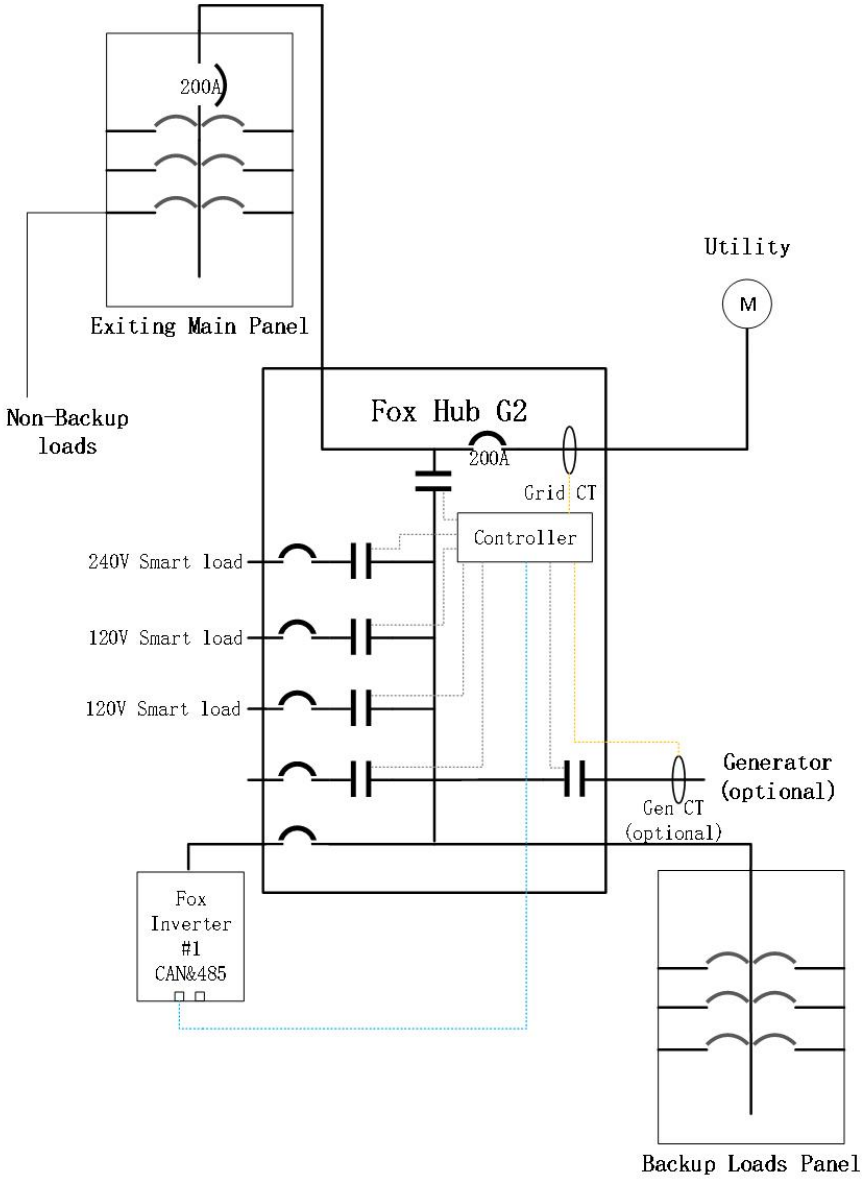

Figure 9 — Partial-home Backup Topology(with Fox Hub G2 Installed)

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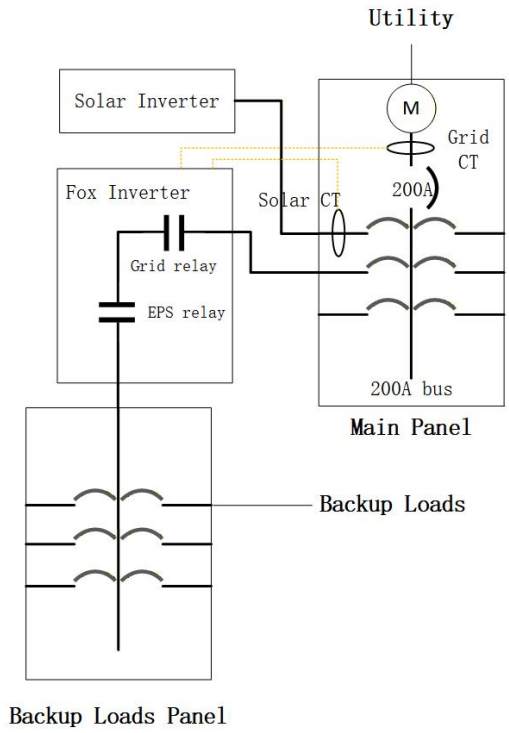

Figure 10 — Partial-home Backup Topology(without Fox Hub G2 Installed)

5. Supplement to PCS

5.1 CT Placement and Measurement Points

The evaluated PCS functions specify that CTs are located at the output of the inverter or between the grid and the local load. In actual field installations, the physical CT placement varies by topology as summarized below:

Topology	CT Type	CT Location
With FOX Hub G2 (any topology)	Grid CT	Inside FOX Hub G2(whole home backup) or grid main service busbar (partial home backup)
Without FOX Hub G2	Grid CT	Utility / main panel, wired to Fox ESS PowerQ / US Series P4
AC-coupled, with FOX Hub G2*(Figure 4 &6)* or without FOX Hub G2*(Figure 10)*	Solar CT	Between existing solar inverter and panel
Generator-integrated	GEN CT	Between standby generator and FOX Hub G2

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5.2 Labels and Field Verification

The following labels are required and must be verified in the field prior to commissioning sign-off:

- WARNING — THIS SENSOR IS PART OF A POWER CONTROL SYSTEM. DO NOT REMOVE. (Applied to Grid CTs)
- SUITABLE FOR USE AS SERVICE EQUIPMENT ONLY IN USA WHEN EQUIPPED WITH MAIN BREAKER (Applied to FOX Hub G2 black protection cover when used as service panel)
- SERVICE DISCONNECT (Applied to FOX Hub G2 when used as service panel)
- POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. (Applied to the existing solar inverter back-fed breaker when the existing solar inverter is connected to the main panel)
- System nameplate must be completed by the installer to indicate installed system power rating and energy capacity.

Final field verification should confirm:

1. CT placement matches the approved topology.
2. Service panel configuration (HubAsServicePanel, MainPanelCapacity) matches site conditions.
3. Zero Back-feed, Existing Solar Inverter Power, and Charge from Grid settings are configured per project requirements.
4. All applicable NEC 705.13 busbar labeling is in place if MPU avoidance is applied.
5. Where the existing solar inverter is connected to the main panel, the solar inverter output is limited to 32 A maximum continuous current, the back-fed breaker is 40 A, and the service panel busbar calculation complies with 2020 NEC 705.12(B)(3)(2).

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5.3 Reference Documents

Document	Purpose
Fox ESS PowerQ Energy Storage System User Manual	Evaluated PCS functions, product specifications, system overview
Fox ESS PowerQ Quick Installation Guide (v1.1c, 2025-10)	Wiring diagrams, CT wiring, commissioning checklist
Project-specific one-line / three-line drawing	Actual installed topology, CT locations, panel configuration
NFPA 70 (NEC) 2023, Article 705.13	Active PCS current control at service entrance; basis for CT-based EMS regulation and MPU avoidance
NFPA 70 (NEC) 2020, Article 705.12(B)(3)(2)	Busbar loading limitation for service panels with multiple power sources; applicable when existing solar inverter is connected to the main panel busbar
UL 1741 CRD — Power Control Systems (March 08, 2019)	PCS evaluation standard
NEC 2020 Edition, Article 705.13	PCS definition; requirement to limit current and loading on busbars and conductors supplied by power production sources and ESS

Note: This document is prepared for AHJ / permit review purposes. All PCS function claims are based on the Fox ESS PowerQ / US Series User Manual and Quick Installation Guide. Application scenarios represent commissioning-configured settings and installation topologies, not additional independently evaluated PCS certifications.

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