

National Electrical Code compliance - Enphase microinverter system

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Overview

This technical brief discusses NFPA, National Electrical Code (NEC) requirements that apply to Enphase microinverter systems. This document is useful for installers, electricians, electrical inspectors, or authorities having jurisdiction (AHJs) in understanding how code-compliance is handled where NEC is adopted.

The following code editions are considered:

- NFPA 70: National Electrical Code (NEC) 2017 [NEC 2017 Codes and Standards](#)
- NFPA 70: National Electrical Code (NEC) 2020 [NEC 2020 Codes and Standards](#)
- NFPA 70: National Electrical Code (NEC) 2023 [NEC 2023 Codes and Standards](#)

The Enphase IQ system includes:

- **IQ Microinverters:** The smart grid-ready IQ Series Microinverters convert the DC output of the PV module into grid-compliant AC power.
- **IQ Gateway:** The Enphase IQ Gateway is a communication device that provides network access to the PV array. The IQ Gateway collects production and performance data from the Enphase IQ Microinverters over on-site AC power lines and transmits the data to Enphase through an internet or cellular modem connection.
- **Enphase Installer Platform:** It is web-based monitoring and management software.
- **Enphase Installer App:** It allows installers to configure the system.
- **IQ Battery:** All-in-one AC coupled storage system that includes embedded, grid-forming multimode microinverters.

The following images show a typical Enphase microinverter system where the microinverter connects to the PV module mounting rails and where the PV module is mounted over the microinverter.



Figure 1: Enphase microinverter system

DC Arc-Fault circuit protection (NEC section 690.11)

As per NEC section 690.11, this requirement is for direct current (DC) Arc-Fault circuit protection that only applies to systems with DC voltages above 80 VDC. This requirement is not applicable to Enphase microinverter systems with one microinverter per panel as they always operate below 80 VDC, and no additional electrical equipment is required.

Rapid shutdown of PV systems on buildings (NEC section 690.12)

There should be rapid shutdown requirements for PV systems on buildings. Enphase microinverter systems fully meets the rapid shutdown requirement without the need to install additional electrical

equipment. As per NEC section 690.56(C), proper labeling of the PV system power source is needed and also rapid shutdown ability is required.

Solar electric PV systems with Enphase microinverters have one utility-interactive inverter directly underneath each solar module, converting low-voltage DC to utility grid-compliant AC. When the utility grid is available and the sun is shining, each microinverter verifies whether the utility grid is operating within the IEEE 1547 requirements. If it does, then it exports AC power into the electric service for use by loads on-site or export power to the utility grid for others to use. When the utility grid has a failure, or the PV system AC circuits are disconnected from the utility service via an AC breaker, AC disconnect, or removal of the solar or main utility service meter; the microinverters stop producing AC power within the requirements of 690.12.

The following figure shows the IQ Series Microinverters system configuration with a rapid shutdown solution.

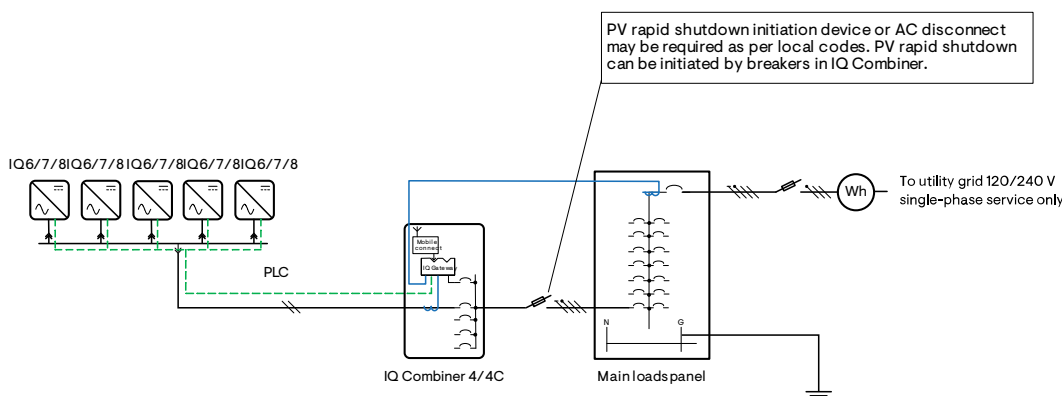


Figure 2: IQ Series Microinverters system configuration with rapid shutdown solution.

AC disconnecting means (NEC section 690.13 or 690.15)

Enphase microinverter systems do not require the installation of any additional rooftop AC disconnect hardware. The microinverter and cable connectors, as part of the product listing, meet the requirements of the NEC.

Section 690.15 requires that inverters (including microinverters) include disconnects from all sources of power and that the disconnecting means are grouped at or within sight of the inverter. Though Enphase microinverters are mounted within the PV array, the connectors have been evaluated, as part of the product listing, to meet the requirements of 690.33 and serve as an isolating device:

- NEC 2017, section 690.15(C)
- NEC 2020, section 690.15(C)
- NEC 2023, section 690.12(D)

The AC circuit breaker in the main panelboard serves as an additional AC disconnecting means per:

- NEC 2017, section 690.15(D)(1)
- NEC 2020, section 690.15(C)

When this panelboard is located near ground level, the installation meets the requirements:

- NEC 2017, section 690.13(A)
- NEC 2020, section 690.13(A)
- NEC 2023, section 690.13(A)(1)

An additional disconnect is unnecessary as the Enphase microinverter system meets the code as described in the single-line diagram.

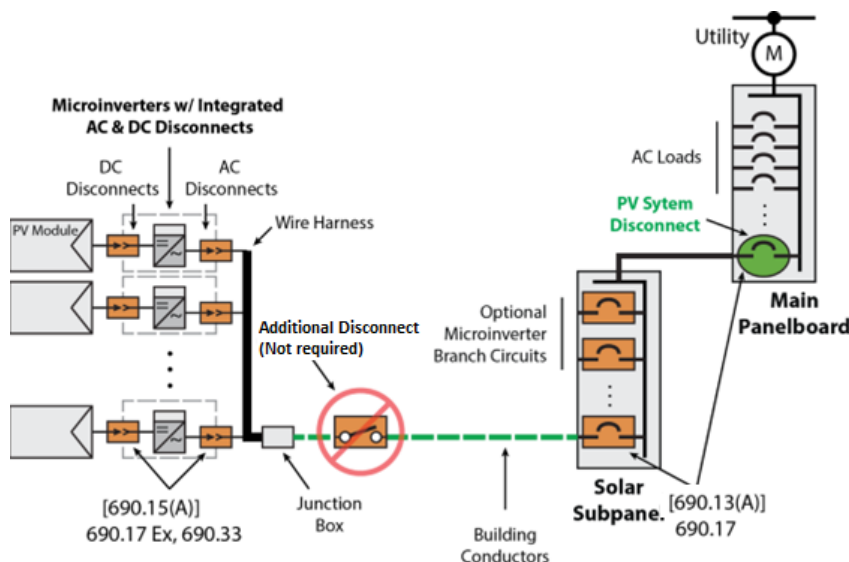


Figure 3: Enphase system - No additional AC disconnect requirement

Point of connection (NEC section 705)

In this section, we explain the grid-connection options for installing an Enphase Energy PV system, and guidelines to comply with NEC section 705, including references made in NEC 2014 to AC AFCI circuit breakers.

Electric power production sources are permitted to be connected on the supply side of the service disconnection means, or they can be connected to the load side.

An AFCI is not required with either connection option. The AFCI requirement added to the 2014 Code was removed in the 2017 Code as no products are available to meet this requirement. Further discussion follows in this section below.

Supply-side connection

Section 705.12A of NEC 2017 states:

705.12(A) Supply-side. An electric power production source shall be permitted to be connected to the supply side of the service disconnecting means as permitted in 230.82(6). The sum of the ratings of all overcurrent devices connected to power production sources shall not exceed the rating of the service.

Solution:

Supply-side connection is permitted and requirements are covered in the:

- NEC 2017, section 705.12(B)
- NEC 2020, section 705.12
- NEC 2023, section 705.12

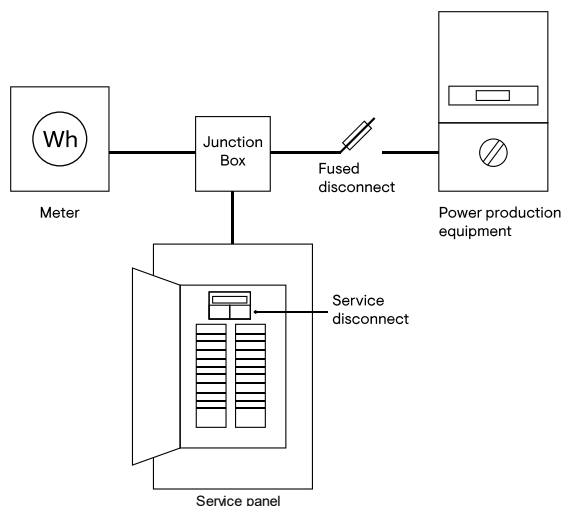


Figure 4: Supply-side connection

Load-side connection to single-phase (120/240 V services)

230.82(6) lists solar photovoltaic systems as eligible for equipment permitted to be connected to the supply side of the service disconnecting means. Since Enphase Energy Systems are solar photovoltaic systems, a supply-side connection of an Enphase System may be accepted by AHJs to fully meet code section 705.12.

Solution:

As 705.12(A) requirements are met, it seems logical that the 705.12(D) requirements for connections to the load-side of the service disconnect means are not applicable.

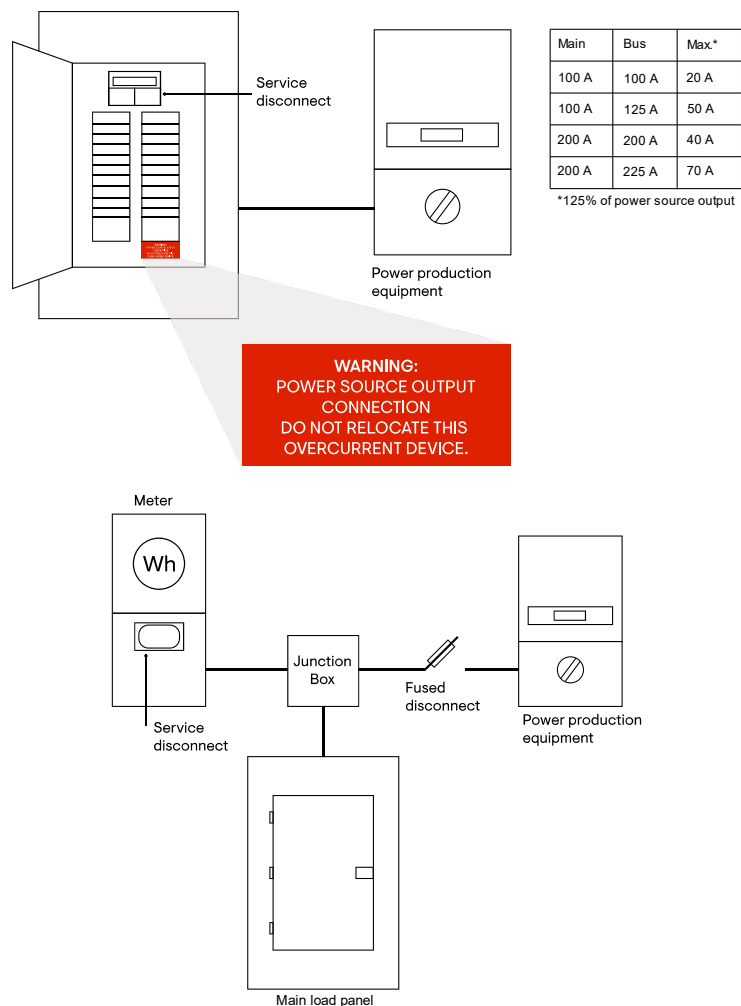


Figure 5: Load-side connection

Section 705.11(A) of NEC 2020 elaborates on the requirement for ratings of all overcurrent devices connected to power production sources to not exceed the rating of the service, and 705.11 (B to E) adds requirements for conductors, overcurrent protection, connections, and ground-fault protection.

Arc-Fault Circuit Interrupter (AFCI)

Scenarios:

NFPA 70: National Electric Code (NEC) 2014 introduced the requirement for AFCI for some connection scenarios. However, no listed devices were available at the time and the requirement was subsequently removed by Tentative Interim Amendments (TIAs).

Solution:

No AFCI devices are required in the installation of Enphase microinverter systems.

Revision history

Revision	Date	Description
TEB-00008-1.0	May 2023	Updated the document with the latest NEC codes: NEC 2017, 2020, and 2023.
Previous releases		