

## Equipment Grounding in an Enphase System

### Overview

An Enphase Energy Microinverter System is the safest photovoltaic system available. The Enphase Microinverter System is safer for service personnel, safer for fire fighter personnel, and less prone to the fire hazards that come with higher voltage DC string systems. Many of these safety advantages are widely known:

- DC voltages are maintained at low, safe levels
- Conduits and conductors are de-energized when the main breaker is shut-off
- Enphase Microinverter Systems are free of DC arc-fault hazards and arc-fault requirements

However, one advantage that is rarely discussed is the high level of ground bonding that exists in an Enphase Microinverter System.

Each microinverter in an Enphase system is bonded to ground through the Enphase Engage cabling system. The Engage Cable provides a robust grounding path to each microinverter, and when properly bonded to racking and to module frames, provides for robust equipment grounding to this equipment, also. When the microinverters, racking, and modules are properly bonded together with listed and approved grounding hardware, the equipment grounding is provided through the microinverter cabling system. This provides a significant cost savings to the labor and balance of system costs.

## Enphase Grounding and the 2011 National Electrical Code

### Equipment Grounding and System Grounding Requirements

The Enphase M250, M215 (M215-60-2LL-Sxx-IG), and C250 fourth generation microinverters meet the requirements of the National Electrical Code Article 690.35 for Ungrounded Photovoltaic Power Systems. NEC 690.35 allows for photovoltaic power systems to be installed with ungrounded photovoltaic source and output circuits. Systems that meet the requirements of NEC 690.35 are exempt from the system grounding requirements of NEC 690.41 System Grounding.

The NEC calls out two distinct types of grounding — equipment grounding and system grounding. Equipment grounding provides for the grounding of metal equipment and enclosures and is generally provided for with equipment grounding conductors (EGCs). System grounding provides the primary grounding path between a grounding electrode (i.e., ground rod or ufer) and a grounded system. System grounding requires the installation of a grounding electrode conductor (GEC). In an Enphase system, the DC conductors are not bonded to ground and the microinverters do not require a GEC, but do require an EGC for equipment grounding.

The term ungrounded is somewhat misleading because ungrounded photovoltaic systems are still required to have equipment grounding provided to the metal frames, equipment, and enclosures in the system, but they are not required to meet the requirements for system grounding. Because of their unique construction, Enphase Microinverters do not require installation of a GEC to the microinverter enclosure.

Other photovoltaic systems that do bond the DC conductors of the photovoltaic source and output circuits to ground must meet the installation requirements for the GECs as called out in NEC 250.64, which requires that the GEC be continuous and protected against damage. The GEC must also be a minimum #8CU conductor, as required by NEC 250.166 for those systems.

## Equipment Grounding Requirements for an Enphase System

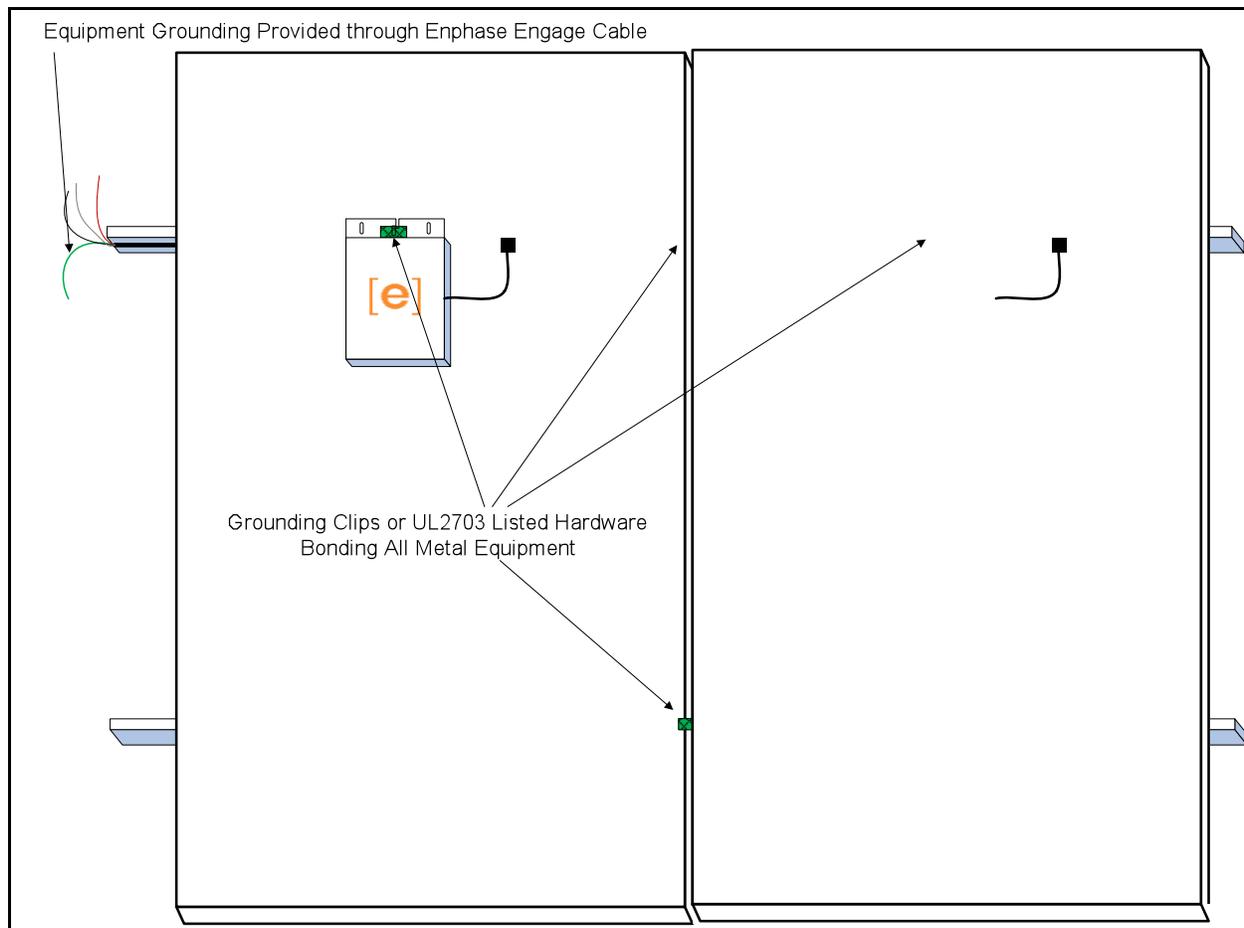
In a system with fourth generation Enphase Microinverters, the requirements for providing a GEC to the microinverters is removed, and only equipment grounding is required. In these systems, it is reasonable and safe to provide the equipment grounding to other photovoltaic system components through the Enphase Engage cabling.

**NEC Article 690.43 Equipment Grounding** specifies that all exposed non-current-carrying metal parts of PV module frames, electrical equipment, and conductor enclosures shall be provided with equipment grounding.

**690.43(C) Structure as Equipment Grounding Conductor** allows for equipment to be used as the equipment grounding conductor in a photovoltaic system. Specifically, *“Devices listed and identified for grounding the metallic frames of PV modules or other equipment shall be permitted to bond the exposed metal surfaces or other equipment to mounting surfaces.”*

The devices listed and identified for grounding the equipment may be stand-alone grounding components or UL-2703 listed mounting hardware.

In an Enphase Microinverter System, if the microinverters and modules are bonded to the racking assemblies with the use of listed and approved grounding clips or grounding components, the equipment grounding conductor provided to the microinverters through the Enphase Engage Cable may also be used to ground the other photovoltaic system components.



**\*\*Always check with your Authority Having Jurisdiction about your proposed grounding methodology prior to installing the system.**

## Meeting the Requirements of NEC 690.35 Ungrounded Photovoltaic Power Systems

Enphase Microinverters meet the requirements of NEC Article 690.35 for Ungrounded Photovoltaic Power systems. The article states:

**690.35 Ungrounded Photovoltaic Power Systems.** Photovoltaic Power Systems shall be permitted to operate with ungrounded photovoltaic source and output circuits where the system complies with 690.35(A) through (G).

- (A) **Disconnects.** In an Enphase system the AC and DC connectors are the disconnecting means.
- (B) **Overcurrent Protection.** In an Enphase system, the AC circuit breaker or fused disconnecting feeding the branch circuit provides overcurrent protection for the inverter output circuit. As per 690.9(A) Exception (b), overcurrent protection is not required on the DC conductors.
- (C) **Ground Fault Protection.** In an Enphase system, ground fault protection is provided in the microinverter. In the Enphase Microinverters with integrated grounding, the ground fault protection is provided by a ground fault sensing circuit.
- (D) **The DC conductors must be PV Wire.** The DC conductors in an Enphase Microinverter are PV Wire.
- (E) Allowed for use in ungrounded battery systems
- (F) **Labelling.** The Enphase Microinverters are labeled as specified.
- (G) **Listing.** The Enphase Microinverters are listed for use in an ungrounded photovoltaic system.