Technical Brief

Dropped Phase Hardware Solution

Overview

When designing commercial PV systems for interconnection to a three-phase service using Enphase M215 Microinverters, some important considerations regarding phase imbalance must be taken to ensure project success. This document details the process of designing such systems in a manner compatible with utility phase imbalance guidelines. Additionally, this document will recommend some best practices.

Glossary

Enphase M215 Microinverter: The M215 Microinverter is 96% efficient and has been designed to work with 60-cell modules up to 260 watts STC. The M215 is rated at 215 watts and can reach outputs as high as 225 watts. The M215 automatically detects the utility voltage and will export power to either 208 Vac or 240 Vac utility services. Each branch circuit of M215s feeds a 20A circuit breaker. The maximum number of M215s on a fully populated branch circuit is 17 at 240 Vac or 25 at 208 Vac, three-phase.

Enphase Engage Cable: The Engage Cable is manufactured with a connector for each microinverter. It contains #12 THWN-2 conductors and is rated to feed a 20 circuit breaker. The cabling is available for single-phase or three-phase applications and must be ordered for the appropriate voltage application. Additionally, the cable comes with its connectors spaced every 1.025 meters for portrait applications or 1.7 meters for landscape applications.

Enphase Envoy Communications Gateway: An Envoy allows module level monitoring for up to 210 Enphase Microinverters. The Envoy uses the power line to communicate with each of its microinverters. Also, the Envoy can be connected to the Internet via a network router. Enphase provides an Ethernet Bridge with each Envoy, which allows for the option of using power line communications between the Envoy and the router.

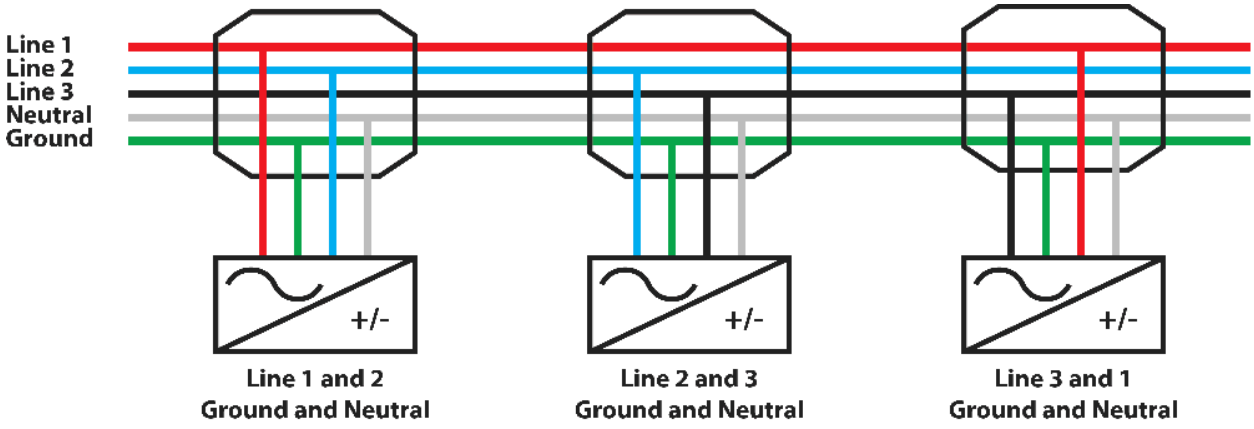
Enphase 100A Line Communications Filter (LCF): When a project requires more than one Envoy, one LCF is required to be installed on every communication domain. An LCF provides noise filtration for each communication domain, which helps to prevent cross-talk between multiple communication domains and filters electrical noise from the site loads. Each LCF includes an Envoy inside it and must be located near the communication domain it serves. Installation of an LCF limits the number of microinverters that can be installed in a communication domain.

Microinverter Subpanel: A microinverter subpanel is an electrical load center that is dedicated to a single communication domain. The microinverter subpanel will feed multiple 20A inverter output branch circuits.

Main Photovoltaic Load Center: An electrical load center that feeds multiple microinverter subpanels.

Dropped Phase Scenario

The Enphase M215 Microinverter connects to two of the three available phases of a three-phase 208V WYE service. Three-phase 208VAC Engage Cable includes five conductors and is used for most commercial installations. Because Enphase Microinverters output onto two phases, three-phase cabling balances the phases by rotating conductor use from one microinverter to the next by alternating between phases (within the cabling) between each microinverter. For example, if the first microinverter (connector A) is connected to phases 1 and 2, then the second will be connected to 2 and 3, the third to 3 and 1, and the fourth to 1 and 2 once again. The pattern continues to repeat itself, modulo three, as shown in the following diagram.



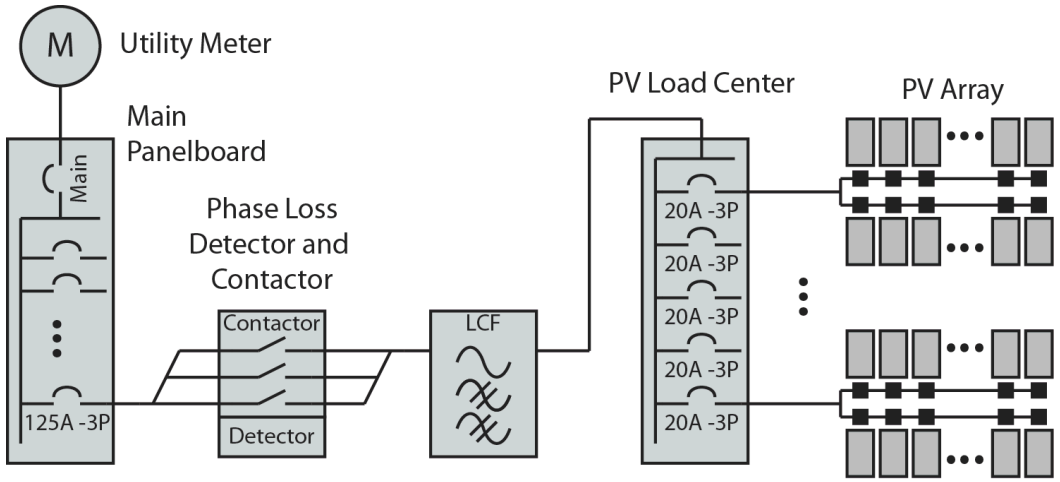
In the event that a grid failure occurs on phase A, and only on phase A, one third of the microinverters (those connected exclusively to phases B and C) will be unable to detect the failure. These microinverters may continue to export power on those phases, contributing to the phase imbalance present on the local grid node.

Dropped Phase Hardware Solution

Enphase recommends the use of an overload relay for loss of phase applications. There are two components to the system. These include the:

- Overload relay that monitors the three line voltages and detects loss of phase
- Contactor that opens all three lines of the circuit to disrupt the power flow

Ideally, the overload relay is mounted directly onto the contactor. If it is not possible to procure a combined unit, the contactor must be hardwired to the overload relay, and the overload relay must be powered by a dedicated breaker connected to grid power on the grid side of the dedicated PV portion of the system. The combined relay-contactor system must be installed on the PV system side of the PCC and on the grid side of the LCF. Or, for systems with no LCF, it should be installed on the grid side of the main PV load center, as shown in the following diagram.



For example, in a 10kW installation, we recommend a 40-50A, general use, IEC rated, 120V coil contactor, available from Allen-Bradley or equivalent. The overload relay part number is in the group 193-xxxx. The contactor part number, also from Allen-Bradley (Rockwell Automation), is in the group 100-xxx.

Siemens, ABB and Square D are all examples of reputable manufacturers of overload relays and contactors.

Conclusion

By following the guidelines in this document, the commercial Enphase installer can ensure that any issues regarding loss of phase incidents are minimized.

Additional Support Documents

The following documents can be found at http://enphase.com/support/downloads.

- Enphase Application Note - M215 Installation
- Enphase Application Note - Voltage Drop Calculations

Enphase Energy provides free design review and design support for commercial systems. Contact your sales representative or send an email to commercial@enphaseenergy.com.