

## AC Coupling of Enphase Microinverters to Battery Based Systems

AC Coupling allows use of Enphase Microinverters with off-grid and battery-based photovoltaic systems. These applications require a battery-based inverter to create a “micro grid” that the microinverters can then be connected to. This is generally referred to as AC coupling because the Enphase Microinverters and the battery-based inverters are “coupled” on their AC outputs.

While these systems are more complicated than traditional grid interconnected systems, they can provide power during power outages, in emergency situations, and to remote locations. Enphase Microinverters, when AC coupled to a battery-based inverter system, offer advantages over other inverter technologies. This is because a microinverter system is divided into branch circuits to provide a tapered charge to the batteries. Offering more flexibility than string inverters, Enphase Microinverter systems can be AC coupled to a battery-based inverter system after installation, and the production capacity and critical loads can be increased or reconfigured to fit storage needs. Enphase Microinverters also offer the design flexibility, increased safety, and increased performance that come with module level maximum power point tracking and monitoring.

At the time of publication of this Technical Brief, the Enphase AC Battery or Enphase IQ Battery are not grid-forming, AC coupling of these storage solutions is not covered in this document.

A battery-based application is generally much more complicated than a utility-interactive system and requires special knowledge to be implemented successfully. Installers and designers must be qualified experts before working with battery-based systems and AC coupled systems. This document does not list all of the requirements and qualifications required, but it does provide guidelines for designing AC-coupled systems with Enphase Microinverters.

For an in-depth discussion of the considerations for such a system, see [Design Considerations when AC Coupling Micros to Battery](#).

In all battery-based systems, there are requirements for safe and reliable operation. Additional safeguards when AC coupling Enphase Microinverter systems include:

- Do not allow the batteries to overcharge. Overcharging batteries can damage the batteries and can potentially cause fires and catastrophic meltdowns. It is smart to provide redundant methods to regulate the charge to the battery.
- Do not connect the Enphase Microinverters to the output of an engine generator. This can cause damage to the microinverters and the generator.
- Design the Enphase Microinverter system so that it does not exceed the pass-through capabilities of the battery-based inverter’s charging system.

Whenever working with batteries, take precautions to ensure safety. This is particularly true for AC coupled systems because traditional inverter chargers and charge controllers are not designed to regulate the charge from an AC coupled system. Therefore, take precautions to ensure that the batteries are not overcharged. The best practice is to shut off the microinverter system when the batteries are charged. To accomplish this, you can use a voltage-controlled relay to shut off the Enphase Microinverter system when the battery reaches a voltage within the manufacturer’s limit. For more complicated systems, use a series of relays to taper the charge to the batteries.

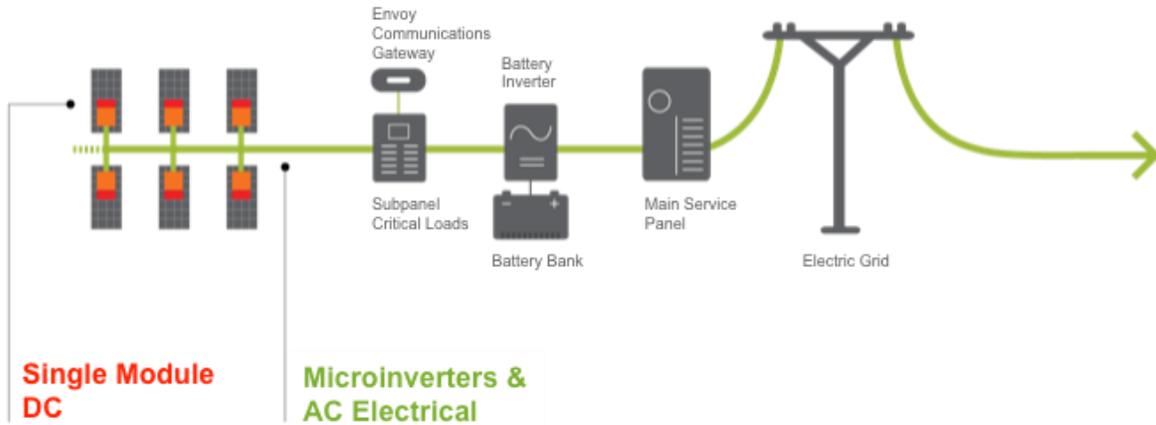
For additional battery protection, use a dump load to drain excess power out of the batteries in the case of overcharging. Do this by using some of the stored power to heat water or air with a listed and approved heating element.

Some battery-based inverters use “frequency shifting” to regulate the charge on batteries. These inverters shift the frequency to a range outside of the utility-interactive inverters’ UL1741 frequency settings. Do not rely on this method of charge regulation alone! An Enphase Microinverter system’s grid parameter settings

can be adjusted remotely, and they may be set outside of the window being used by the battery-based inverter. For this reason, use an additional voltage-controlled relay.

If an engine generator is present, do not connect the Enphase Microinverters to the same load panel as the generator. When using a generator to charge batteries in a battery-based inverter system, the battery-based inverter also internally bypasses the generator's output to the back-up / emergency load panel that the Enphase microinverters are feeding. Allowing this connection can damage the generator and microinverters. Therefore, if using a generator to charge batteries, ensure that the Enphase Microinverters are shut-off when the generator is running. The best method is to use a voltage-controlled relay that is activated by the generator panel. Use a transfer switch to ensure that the generator is always isolated from the Enphase Microinverters.

**Diagram 1: Grid-Tied AC Coupled System**



**Diagram 2: Off-Grid AC Coupled System**

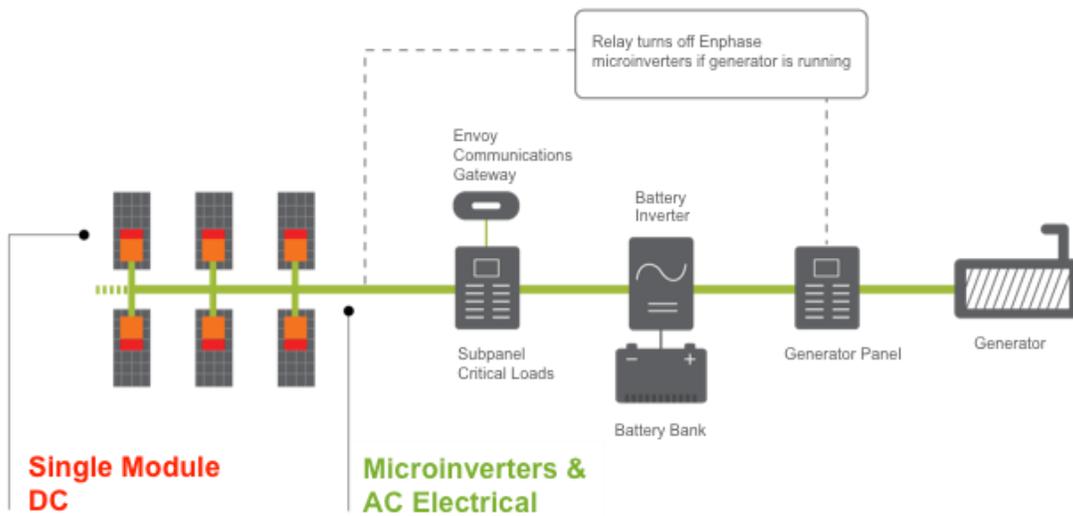
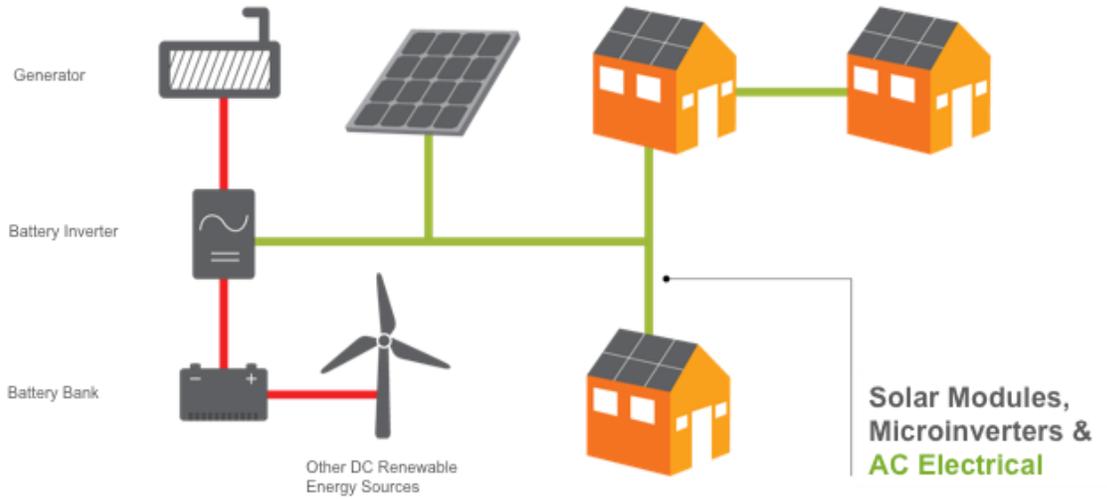


Diagram 3: Microgrid



The Power Room of an AC Coupled System with Enphase Microinverters, Courtesy of Magnum Energy



For additional resources on installing AC-Coupled systems, refer to the battery manufacturer's and battery-based inverter manufacturer's documentation. Enphase Microinverters work with a number of battery-based inverter manufacturers and component manufacturers, including Magnum Energy, Outback Power Systems, MidNite Solar, SMA, and Schneider Electric. You can find many other documents, application notes, and schematics on AC Coupling at the following websites.

Magnum Energy <http://www.magnumenergy.com/Documents/DocsFront.htm>

Outback Power Systems <http://www.outbackpower.com/index.php/applications/ac-coupling>

MidNite Solar <http://www.midnitesolar.com/index.php>

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