SolarEdge Three-Phase Backup System Power Design Guidelines - Application Note

Revision History

Version 1.0, July 2024: Initial Version

Contents

Overview

SolarEdge's three-phase backup system provides reliable power when the utility grid is down. The amount of power and duration of time the backup system provides power depends on various factors set during the design and installation of the system.
This Application Note examines the following factors and offers design guidelines to ensure the dependable operation of inverters for homeowners during a backup event, reliant on the configuration of the installed system. For example:

- Full house Backup (FHB)
- Partial house Backup (PHB)

Factors:

- The inverter's maximum power during backup
- The number of batteries connected to the inverter
- The number of connected inverters
- The number of appliances operating during backup
- The distribution of appliances over the three phases
- The type of load
- The time of the backup event; day or night
- The value of the "Backup Reserved" parameter

The following outlines the key points addressed in this Application Note:

- **SolarEdge Three Phase Hub Inverter Backup Inverter:** An inverter with PN SExxK-XXB48Bxxxx" supports power production when the grid is down if a Backup Interface (BUI) is installed. You need a single BUI on site, even if multiple backup inverters are installed.

NOTE

Only a three-phase hub inverter can be connected to a three-phase BUI. The Backup system must be connected to a three-phase grid for installation and ongoing operation and maintenance.

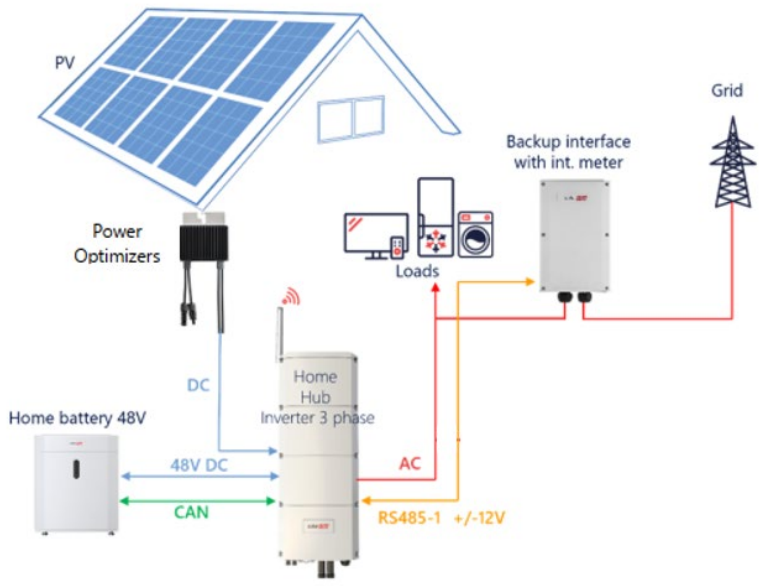
- **Ongrid**: The inverter produces power in parallel with the utility grid. The utility grid provides excess power from the appliances up to the relevant circuit breaker rating which protects the appliances.
- **Backup mode:** The inverter provides power when the utility grid is down. Appliances can consume the inverter's maximum power production per phase during backup. Connecting more appliances to a specific phase during backup, causes the inverter to trip all three phases.

The installed configuration

SolarEdge supports two possible configurations of backup operation:

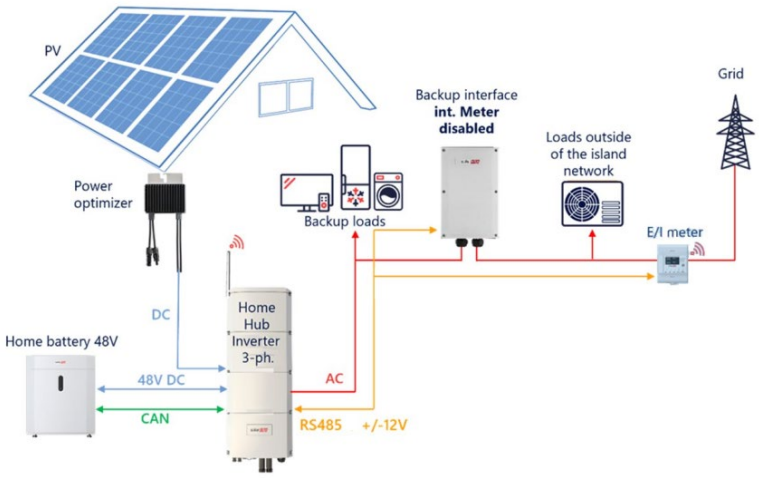
- Full house Backup (FHB)
- Partial House Backup (PHB)

In an FHB configuration, all home appliances are connected to the appliances side of the BUI. The following diagram displays an FHB configuration:



In a PHB configuration, some home appliances are connected on the load side of the BUI. These appliances operate during backup if the load's power consumption meets the design guidelines.

The appliances connected on the BUI's Grid side do not operate during backup. The following diagram displays a PHB configuration:



An inverter's maximum power production during backup

The inverter's maximum power production per phase during backup is described as follows:

- An inverter with a nameplate of 10kW provides a maximum of 10/3kw (3.33kW) in each of its phases.
- An inverter with a nameplate of 8kW provides up to a maximum of 8/3kw (2.67kW) in each phase.

If appliances are connected on the same phase while the inverter is in backup mode, this may result in the power consumption of the appliances exceeding the Inverter's maximum power production per phase during backup. This causes overconsumption, defined below, which causes the inverter to trip.

- **Overconsumption**: Appliances connected to one or multiple phases exceed the maximum power allowed per phase during backup.

Design guidelines

Calculate the allowed maximum power production per phase whilst the inverter is operating in backup mode. Make sure one of the following guidelines is met:

- The maximum allowed power of all devices connected to that specific phase does not exceed the maximum power production per phase during backup.
- Make sure that the homeowner is aware of the limitations of each phase and understands how to recover the inverter if the inverter trips:
    - Which appliances must be disconnected to allow the inverter to work in backup mode.

- SolarEdge's appliance controllers, if available in your region, are configured to prevent the total power per phase from exceeding the maximum power production per phase during backup.

Number of appliances operating during backup

The number of appliances operating during backup mode is taken from the sum of the total power consumption. For some appliances, especially motor-based appliances like air conditioners, heat pumps, compressors, and similar appliances, the following types of parameters should be considered:

- **Steady-state power consumption**: The power consumption of the appliance during normal operation.
- **Ignition power consumption**: The power required to start the motor-based appliance. This can be five to six times higher than steady-state power consumption. The relevant duration of this peak power consumption is provided on the device's datasheet, which is supplied with the purchase of the appliance. You must check the data to make sure the system's design can accommodate the steady-state and ignition power consumption.

The inverter provides up to 20% more than its maximum power production per phase during backup for 120ms.
For example, an inverter with a nameplate of 10kW can supply up to 3.33kW per phase during a steady-state operation. The inverter does not trip if the power consumption of the device exceeds 4kW (current of 19.2A), for a maximum of 120ms.
An inverter with a nameplate of 8kW can supply up to 2.67kW per phase during a steady-state operation. The inverter does not trip if the power consumption of a device exceeds 3.21kW (current of 15.4A), for a maximum of 120ms.
If a load connects during backup and starts to operate, it is important to check its steady state and ignition power. More recent motor-based appliances utilize inverter technologies that shape peak power during ignition. Check the appliance's datasheet for the steady-state and ignition (peak) power consumption.

Examples of typical appliances and the power they consume are displayed in the table below.

NOTE

You must check each appliance's datasheet for accurate power calculations and their system's design.

appliance	watts	appliance	watts	appliance	watts
Coffee Pot	200	Garage door opener	350	Compact fluorescent	
Coffee Maker	800	Ceiling fan	10-50	Incandescent equivalents	
Toaster	800-1500	Table fan	10-25	40 watt equivalent	11
Popcorn Popper	250	Electric blanket	200	60 watt equivalent	16
Blender	300	Blow dryer	1000	75 watt equivalent	20
Microwave	600-1500	Shaver	15	100 watt equivalent	30
Waffle Iron	1200	Waterpik	100		
Hot Plate	1200	Well Pump (1/3-1 HP)	480-1200	Electric mower	1500
Frying Pan	1200			Hedge trimmer	450
		Computer		Weed eater	500
Dishwasher	1200-1500	Laptop	20-50	1/4" drill	250
Sink waste disposal	450	PC	80-150	1/2" drill	750
		Printer	100	1" drill	1000
Washing machine		Typewriter	80-200	9" disc sander	1200
Automatic	500	Television		3" belt sander	1000
Manual	300	25" color	150	12" chain saw	1100
Vacuum cleaner		19" color	70	14" band saw	1100
Upright	200-700	12" black and white	20	7-1/4" circular saw	900
Hand	100	VCR	40	8-1/4" circular saw	1400
Sewing machine	100	CD player	35		
Iron	1000	Stereo	10-30	Refrigerator/Freezer	
		Clock radio	1	20 cu. ft. (AC)	1411 watt-hours/day*
Clothes dryer		AM/FM auto cassette player	8	16 cu. ft. (AC)	1200 watt-hours/day*
Electric NA	4000	Satellite dish	30		
Gas heated	300-400	CB radio	5	Freezer	
		Electric clock	3	15 cu. ft. (Upright)	1240 watt-hours/day*
Heater				15 cu. ft. (Chest)	1080 watt-hours/day*
Engine block NA	150-1000	Radiotelephone			
Portable NA	1500	Receive	5		
Waterbed NA	400	Transmit	40-150		
Stock tank NA	100				
Furnace blower	300-1000	Lights:		Note: TV's, VCR's and other devices left	
Air conditioner NA		100 watt incandescent	100	plugged in, but not turned on, still	
Room	1000	25 watt compact fluor.	28	draw power.	
Central	2000-5000	50 watt DC incandescent	50		
		40 watt DC halogen	40		
		20 watt DC compact fluor.	22		

Number of batteries connected to the inverter

SolarEdge three-phase inverters have two operational modes of maximum backup power:

- When only battery power is available, for example at night or on a cloudy day
- During sunny days when PV and battery power are available

The inverter must have a single battery module connected to provide backup power and the battery must be above the minimum charged state. SolarEdge suggests the battery is charged 30-50% to provide power during night mode operation, and that you specify how much backup reserve is necessary in the event of extreme weather conditions, which may cause grid outages. You can do this using the mySolarEdge app.

Night mode operation

NOTE

Night mode refers to periods when no PV is available, these periods may also refer to winter days.

When a single battery module is connected to the inverter, the maximum power the inverter supplies is 4kW, or 1.33kW per phase. When there are 2-5 battery modules connected to the inverter, the maximum power the inverter supplies is 5kW, or 1.66kW per phase.
SolarEdge inverters provide imbalanced power production up to the maximum power production per phase, as described in the following:

- An inverter with a nameplate of 10kW, which has a maximum power of 3.33kW per phase, operates in backup mode, and is connected to a single battery, can supply a maximum of 4kW in total.
- An inverter with a nameplate of 8kW, which has a maximum power of 2.66kW per phase, operates in backup mode, and is connected to three battery modules can supply a maximum of 5kW in total.

The following phase distributions are possible:

NOTE
The figures provided in the tables are the total power of all phases.

NOTE
L refers to the line or phase.

10kW Nameplate

Scenario	L1 power(kW)	L2 power(kW)	L3 power(kW)	Total Power (kW)
1	2	1	1	4
2	3.33	0.3	0.36	4
3	3.33	0.67	0	4
4	0	3.33	0	4

8 kW Nameplate

Scenario	L1 power(kW)	L2 power(kW)	L3 power(kW)	Total Power (kW)
1	2.66	1	1.33	5
2	2	1	2	5
3	2.66	0	2.33	5
4	0	2.66	2.33	5

Day mode operation

If the inverter is operating during the day, the total power production the inverter provides during backup mode operations is the sum of the power provided by the battery, plus available PV power at a specific moment in time, refer to Night mode operation for more information. Since PV power is not 100% predictable, is dependent on weather conditions, and may be affected by the shadow of a single cloud, it is recommended you set the available power in the mySolarEdge App during day mode with margins. Failing to do so may cause the inverter to trip unexpectedly.

In day mode operation, if excess PV is available, the inverter provides backup power up to its nameplate. For example, an inverter of 10kW supplies the following backup power during the day:

Scenario	L1 power(kW)	L2 power(kW)	L3 power(kW)
1	3.33	3.33	3.33
2	3.33	0	3.33
3	3.33	0	0
4	2	3.33	2

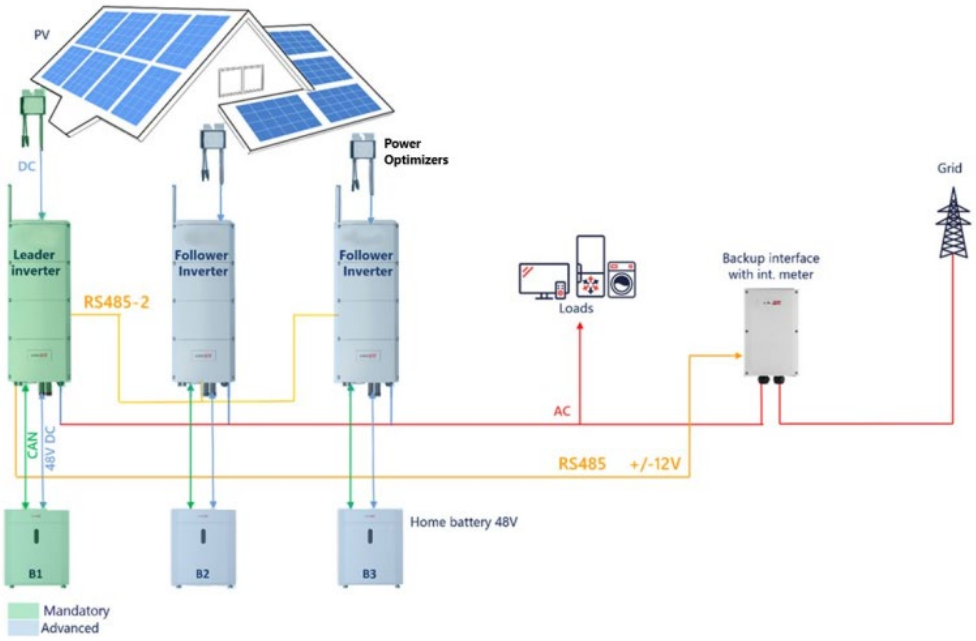
Number of connected backup inverters

NOTE

The following capabilities and configurations are supported on FW version 4.21.xx and above.

- Every connected backup inverter can be firmware upgraded to support the operation of a Multiple Inverter Backup (MIB).
- In an MIB configuration, all backup inverters, if they are connected in a leader-follower configuration, can produce during backup. Up to three backup inverters can be connected in an MIB configuration.
- The overall power production of an MIB configuration is the sum of the available power production of each inverter.
  For example, a site with 2 backup inverters provides a total of 9kW of backup power at night time, and a total of 15kW of maximum backup power, depending on available PV production, in the day time. The following are examples of the total production of each nameplate:
  - A nameplate of 7kW, where the inverter is connected to a single battery, provides a maximum of 4kW.
  - A nameplate of 8kW, where the inverter is connected to multiple batteries, provides a maximum of 5kW.

The following diagram displays an MIB configuration:



If two backup inverters are connected at the same site, one with a nameplate of 7kW and the other with a nameplate of 8kW, where there is 2.66kW for the 8kW inverter and 2.33kW for the 7kW inverter, this equals a total of 5kW.
The following scenarios are available during night mode.

Scenario	L1 power(kW)	L2 power(kW)	L3 power(kW)
1	5 (2.66/2.33)*	3(1.33/1.66)	2(1/1)
2	5	0	5
3	0	5	2
4	0	0	5

* the total power on this phase is 5kW; 2.66kW from the 8kW inverter and 2.33kW from the 7 kW inverter.

The following scenarios are available during day mode, assuming excess PV is available.

Scenario	L1 power(kW)	L2 power(kW)	L3 power(kW)
1	5	5	5
2	5	0	5
3	0	0	5
4	3	3	3