Power. On Your Terms.

SimpliPhi Power PHI Battery

INTEGRATION GUIDE: OUTBACK POWER

Optimized Energy Storage & Management for Residential & Commercial Applications Utilizing Efficient, Safe, Non-Toxic, Energy Dense Lithium Ferrous Phosphate (LFP) Chemistry

SimpliPhi Your Energy Security and Independence

and gain control of your own power.

SimpliPhi helps you manage your power as a personal resource. Anytime. Anywhere. SimpliPhi energy storage optimizes integration of any power generation source – solar, wind, generator – on or off grid and protects your home and mission-critical business functions from power outages and intermittency. SimpliPhi storage technology eliminates operating temperature constraints, toxic coolants and the risk of thermal runaway. Safe lithium ferrous phosphate. No cobalt. No hazards.

SimpliPhi's battery technology utilizes the industry's most environmentally benign chemistry combined with proprietary architecture and power electronics (BMS) that eliminate the need for cooling or ventilation to create products that provide energy security and resiliency – all with a 98% efficiency rate.

SimpliPhi Power offers proprietary, commercially available energy storage and management systems that are safe, non-toxic, reliable, durable, efficient, highly scalable, and economical over the lifetime of the PHI Battery.

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1.0 – Introduction

This integration guide covers the recommended set up and configuration of Outback Power equipment for optimizing performance with SimpliPhi PHI 3.8 kWh batteries. More information on SimpliPhi products can be found on our website: https://simpliphipower.com/.

Outback Power offers many products which are too numerous to be covered here. The specific Outback Power products covered in this guide include, but are not limited to:

- Radian Series Inverters/Chargers
- FLEXmax Series Charge Controllers
- FXR/VFXR Series Inverters/Chargers
- MATE Series System Display & Communications
- OPTICS RE System Monitoring & Control
- FLEXnet DC

2.0 – Charge Controller and Inverter Settings

Outback Power has performed qualification testing of the PHI 3.8 kWh battery with their equipment. Per their testing and recommendations, the following parameters (refer to table below) have been validated. More information on Outback products can be found on their website: http://outbackpower.com/.

3.0 – Battery Bank Sizing

A properly sized PHI battery bank should be at least double (2x) the kW rating of the inverter(s) and have a C/2 rating greater than the maximum charge controller rating. Depending on the specifications of the equipment used in the system, sizing the PHI battery bank based on these two criteria may yield different results. Therefore, the best practice is to calculate the PHI battery bank based on both criteria and use the greater of the two results as the minimum quantity. We can compare these two calculation methods assuming the nomenclature below:

- Battery rated power = Bat_{kWh} (typically @ C/2)
- Inverter power full load = Inv_{kW}
- Maximum battery charge current = $I_{BatChrgMax}$
- PV charge controller maximum = $I_{PVChrgMax}$
- Recommended minimum number of batteries = $B_{\#}$

Discharge equation: $B_{\#Inv} \geq Inv_{kW} / Bat_{kWh}$
Charge equation: $B_{\#PV} \geq I_{PVChrgMax} / I_{BatChrgMax}$

3.1 – Discharge Calculation: Inverter Power Bank Sizing

To optimize the PHI battery bank and protect against over-discharge (voiding the battery Warranty), the PHI battery bank should be sized at least double (2x) the kW rating of the inverter.

Discharge Example: $B_{\#Inv} \geq Inv_{kW} / Bat_{kWh}$

- Inverter is rated at 8 kW
- Battery is rated at 3.8 kWh, therefore the C/2 load rating is 1.9 kW

$B_{\#Inv} \geq$ 8 kW / 1.9 kW = 4.21

A properly sized PHI battery bank based on maximum discharge would have a minimum of 5 batteries. This ensures no greater than C/2 battery load. If the PHI battery bank has fewer batteries than calculated, special care must be taken with the inverter settings to limit the load below the specified rating of the PHI battery. These settings are described in the following sections of this Integration Guide.

3.2 – Charge Calculation: Charge Controller Power Bank Sizing

To optimize solar harvesting, a properly sized PHI battery bank should be able to accept the maximum PV charge current. To determine the minimum number of batteries required to optimize PV, divide the output of the charge controller(s) by the “max continuous charge current” per PHI Battery. Be sure to verify the “max continuous charge current” for the PHI battery model that you’re using, because it may differ from C/2 depending on the model.

Charge Example: $B_{\#PV} \geq I_{PVChrgMax} / I_{BatChrgMax}$

- Max. continuous charge current for PHI 3.8 kWh 48V = 37.5A
- PV charge controller max = 80A

$B_{\#PV} \geq$ 80A / 37.5A = 2.13

A properly sized PHI battery bank based on available PV charge would have a minimum of 3 batteries. This maximizes the use of available PV while ensuring the batteries are never stressed by overcharging. If the PHI battery bank has fewer batteries than calculated, special care must be taken with the inverter settings to limit the charge rate below the specified rating of the PHI battery. These settings are described in the following sections of this Integration Guide.

In summary: When comparing the same system using these two calculations for sizing the PHI battery bank, the minimum number of batteries should be the greater of the two results (Discharge Calculation & Charge Calculation). In this example, this translates into 5 PHI batteries in the system.

4.0 – Program Settings for PHI Batteries

In order to maintain the Warranty, it is critical to ensure that the appropriate settings for the desired Warranty are programmed in all of the system components. This section will cover the basic concepts and settings for Outback Power equipment.

4.1 – Depth of Discharge

In order to optimize performance and the life of your system and PHI batteries, SimpliPhi Power recommends programming the equipment settings for 80% Depth of Discharge (DoD). This qualifies for the SimpliPhi 10-year / 10,000 cycle Warranty on the batteries. Greater DoD is possible but will result in reduced cycle life. Refer to the PHI 3.8 kWh Battery Warranty to compare DoD settings and the associated Warranty.

4.2 – Inverter Settings

Table 1.0 - Settings for SimpliPhi PHI 3.8 kWh 48V Battery w/Outback Inverters

Inverter Settings	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
Absorb Voltage (V), Time	27.2 / 54.4, 1 hour	27.2 / 54.4, 1 hour	28 / 56, 1 hour
Float Voltage and Time	N/A (disable float by setting Float Time to 0)		
Refloat Voltage	N/A (disable float)		
Re-Bulk Voltage	25.6 / 51.2		
AC Input Mode	Grid Tied (default, adjust as needed)		
SellRE (Offset) Voltage (V)	27 / 54 (default)		
AC Charger Limit in AC Amps[1,2]	24V = 5A (240V), 10A (120V)		
	48V = 8A (240V), 17A (120V)		
Low Battery Cut-Out Voltage (V)	25 / 50	24.8 / 49.6	24 / 48
Low Battery Cut-Out Delay[3]	130 seconds		
Low Battery Cut-In Voltage (V)	26 / 52	26 / 52	26 / 52

Notes:

- 1. Per PHI 3.8 kWh battery – Refer to the "AC Input Charger Limit" section for conversion method of DC to AC limits.
- 2. Per PHI 3.8 kWh battery – These settings are calculated by multiplying the nominal per battery value times the # of batteries. Refer to Charge Controller Bank Sizing under the "Battery Bank Sizing" section.
- Levels are typical @ 25C and may need adjusting at temperature extremes.
- When performing rapid deep charge/discharge cycles the battery should be allowed to "rest" 15 minutes in between.

CAUTION: When PHI battery quantities change, the capacity & charge/discharge current settings must be reassessed. Failure to do so will void the Warranty.

4.3 – Charge Controller Settings

Table 2.0 - Settings for SimpliPhi PHI 3.8 kWh 48V Battery w/Outback Charge Controllers

Charge Controller Settings	10k Cycles (80% DoD)	5k Cycles (90% DoD)	3.5k Cycles (100% DoD)
Absorb Voltage (V), Time	27.4 / 54.8, 2 hours	27.4 / 54.8, 2 hours	28.2 / 56.4, 1 hour
Float Voltage	27 / 54 (default)		
Rebulk Voltage (V)	25.6 / 51.2		
DC Current Limit[1]	45A / 37.5A		
Absorb End Amps	0 (default)		

Notes:

- 1. Per PHI 3.8 kWh battery – These settings are calculated by multiplying the nominal per battery value times the # of batteries. Refer to Charge Controller Bank Sizing under the "Battery Bank Sizing" section.
- Levels are typical @ 25C and may need adjusting at temperature extremes.
- When performing rapid deep charge/discharge cycles the battery should be allowed to "rest" 15 minutes in between.

CAUTION: When PHI battery quantities change, the capacity & charge/discharge current settings must be reassessed. Failure to do so will void the Warranty.

4.4 – FLEXnet DC Settings

Table 3.0 - Settings for SimpliPhi PHI 3.8 kWh 48V Battery w/Outback FLEXnet DC

FLEXnet DC Settings	10k Cycles (80% DoD)	5k Cycles (90% DoD)	3.5k Cycles (100% DoD)
FNDC Battery Ah[1]	151Ah / 75Ah		
FNDC Charged Voltage (V)	27.0 / 54.0	27.0 / 54.0	27.8 / 55.6
FNDC Charged Return Amps[1]	8A / 4A		
FNDC Battery Charge Factor	98%		
FNDC Relay Invert Logic	No		
FNDC Relay Voltage High/Low	High = 26.5 / 53, Low = 24.8 / 49.6		
FNDC Relay SOC High/Low	SOC High = 0%, SOC Low = 0%		
FNDC Relay Delay	High = 1, Low = 0		

Notes:

- 1. Per PHI 3.8 kWh battery – These settings are calculated by multiplying the nominal per battery value times the # of batteries. Refer to Charge Controller Bank Sizing under the “Battery Bank Sizing” section.
- Levels are typical @ 25C and may need adjusting at temperature extremes.
- When performing rapid deep charge/discharge cycles the battery should be allowed to "rest" 15 minutes in between.

CAUTION: When PHI battery quantities change, the capacity & charge/discharge current settings must be reassessed. Failure to do so will void the Warranty.

While the FLEXnet DC Battery Monitor provides State of Charge (SoC) readings, the PHI batteries’ most accurate SoC gauge is according to Voltage:

Table 4.0 - SimpliPhi PHI Battery SoC vs. Voltage

SOC	24V	48V
100%	> 26.25 VDC	> 52.5 VDC
95%	25.9 VDC	51.7 VDC
90%	25.8 VDC	51.65 VDC
75%	25.7 VDC	51.4 VDC
50%	25.5 VDC	51.0 VDC
20%	25.1 VDC	50.2 VDC
10%	24.8 VDC	49.5 VDC
0%	24.0 VDC	48.0 VDC

4.5 – MATE3/MATE3s Settings

Table 5.0 - Program Settings for SimpliPhi PHI 3.8 kWh 48V Battery w/Outback MATE3/MATE3s

MATE3 / MATE3s Settings	10k Cycles (80% DoD)	5k Cycles (90% DoD)	3.5k Cycles (100% DoD)
FLEXnet DC Advanced Control	Low SOC Warning = 20%		
FLEXnet DC Advanced Control	Critical SOC Warning = 10%		

5.0 – AC Input Charger Limit

The Outback inverter charger current limit setting is made from the AC input side of the charger (not the DC side of the charger) so the AC charging current must be calculated then entered as the charger limit setting. Per Outback recommendations:

1. First convert DC charge current to DC watts. (AC and DC watts are the same)
2. Then apply the charger efficiency.
3. Then convert AC watts to AC current.

Table 6.0 – Conversion from DC to AC Limit for 1 to 5 PHI 3.8 kWh 24V Batteries (45A DC limit per PHI battery)

A	B	C	D	E	F
# of Parallel Batteries	DC Current Limit	ADC x VDC (24)	WDC ÷ Charger Efficiency (85% = .85)	Column D ÷ Inverter Voltage (120 or 240 VAC, dep. on inverter; 240 VAC used below)	Round down (only whole #s can be used as input)
1	45A	1,080 WDC	1,270.59 WAC	5.29 AAC	**5 AAC**
2	90A	2,160 WDC	2,541.18 WAC	10.59 AAC	**10 AAC**
3	135A	3,240 WDC	3,811.76 WAC	15.88 AAC	**15 AAC**
4	180A	4,320 WDC	5,082.35 WAC	21.18 AAC	**21 AAC**
5	225A	5,400 WDC	6,352.94 WAC	26.47 AAC	**26 AAC**

Table 7.0 – Conversion from DC to AC Limit for 1 to 5 PHI 3.8 kWh 48V Batteries (34A DC limit per PHI battery)

A	B	C	D	E	F
# of Parallel Batteries	DC Current Limit	ADC x VDC (48)	WDC ÷ Charger Efficiency (85% = .85)	Column D ÷ Inverter Voltage (120 or 240 VAC, dep. on inverter; 240 VAC used below)	Round down (only whole #s can be used as input)
1	37.5A	1,800 WDC	2,118 WAC	8.82 AAC	**8 AAC**
2	75A	3,600 WDC	4,235 WAC	17.65 AAC	**17 AAC**
3	112.5A	5,400 WDC	6,353 WAC	26.47 AAC	**26 AAC**
4	150A	7,200 WDC	8,471 WAC	35.29 AAC	**35 AAC**
5	187.5A	9,000 WDC	10,588 WAC	44.12 AAC	**44 AAC**

Example - Using the max DC charge current of 45 amps in a 24V system:

1. Multiply the charge current by the voltage:
   45 Adc x 24 Vdc = 1,080 Wdc
2. Divide this by the charger efficiency (85% = 0.85):
   1,080 Wdc ÷ 0.85 = 1,270 Wac
3. Divide this by the inverter voltage (120 or 240 Vac depending on inverter):
   1,270 Wac ÷ 240Vac = 5.29 Aac
4. Round down because only whole numbers can be used as input, and the lower figure ensures protection against over-charging the battery: 5 Aac

CAUTION: This calculation is for a single PHI battery, and can be increased proportionately with the total number of batteries in parallel. i.e. Setting for Aac using three 24V batteries is (5.29 x $N_{BATTERIES}$ = 15.88 Aac; round up to 16 Aac).

6.0 – Specifications & Warranty

For your reference:

- See PHI 3.8 kWh Specifications sheet.
- See PHI 3.8 kWh 10-Year Warranty; Failure to adhere to installation protocol will void Warranty.

7.0 – SimpliPhi Technical Support

For technical support related to your PHI 3.8 kWh 48V Battery (or other SimpliPhi Power products), please contact us directly at:

805.640.6700
techsupport@simpliphipower.com