Power. On Your Terms.

SimpliPhi Power PHI Battery

INTEGRATION GUIDE: MAGNUM ENERGY

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 and fire. 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 Magnum Energy 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/.

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

- MS 4024 PAE inverter/charger
- MS 4448 PAE inverter/charger
- PT-100 charge controller
- ME-ARC Remote Control
- ME-RTR Remote Control
- ME-RC Remote Control (basic unit with no support for configuring the PT-100 charge controller)

For additional information about the Magnum Energy products covered in this guide, refer to the following documentation:

- Magnum Dimensions PT-100 MPPT Charge Controller
- Magnum Energy ME-RTR Router Control Owner's Manual
- Magnum Energy ME-ARC Advanced Remote Control Owner's Manual

2.0 – Charge Controller and Inverter Settings

Magnum Energy has performed qualification testing of the PHI 3.8 kWh battery with their equipment. Per their testing and recommendations, the following parameters (refer to Section 4.0) have been validated. Magnum Equipment must be programmed using a Magnum Remote Control, preferably the ME-ARC, ME-RTR, or ME-ARTR model.
Note that the ME-RC model remote does not allow for any monitoring or adjustments to Magnum's charge controller (the PT-100).

See Remote Compatibility info from pg. 42 of the PT-100 manual:

Table 4.0 – Remote Compatibility Version

Remote Models	Version with PT Menus	Version Required for Stacking PTs
ME-ARC	≥ Version 4.0	≥ Version 2.0
ME-ARTR	≥ Version 4.0	≥ Version 4.0
ME-RC	NA	≥ Version 2.6
ME-RTR	NA	≥ Version 2.0

More information on Magnum Energy products can be found on their website: http://www.magnum-dimensions.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 and voiding the battery Warranty, the PHI battery bank should be sized at least double (2x) the kW rating of the inverter.

Discharge Example A

This example uses the following calculation:

$$B_{\#Inv} \geq Inv_{kW} / Bat_{kW}$$

This example assumes the following:

- Inverter is rated at 4.4 kW
- PHI 3.8 48V battery has a load rating of 1.92 kW (37.5 Amps DC x 51.2 Volts nominal)

The calculation and assumptions correspond to:

$$B_{\#Inv} \geq 4.4\ kW / 1.92\ kW = 2.29$$

So, a properly sized PHI battery bank based on maximum discharge of the inverter would have a minimum of 3 batteries.

Discharge Example B

This example uses the following calculation:

$$B_{\#Inv} \geq Inv_{kW} / Bat_{kW}$$

This example assumes the following:

- Inverter is rated at 4 kW
- PHI 3.8 24V battery has a load rating of 1.15 kW (45 Amps DC x 25.6 Volts nominal)

$B_{\#Inv} \geq 4\ kW / 1.15\ kW = 3.48$

In this example, a properly sized PHI battery bank based on maximum discharge of the inverter has a minimum of 4 batteries. This ensures no greater than C/2 battery load.

If the PHI battery bank includes fewer batteries than calculated, either:

A) Install additional over-current protection between the battery bank and the inverter to prevent the batteries' over-discharge.
B) Configure the inverter's Auto Generator Start device settings for the generator to power the loads when loads' draw exceeds the PHI battery bank's maximum continuous discharge rating. These settings are described in more detail 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 PHI 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 A

This example uses the following calculation:

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

This example assumes the following:

- Max. continuous charge current for PHI 3.8 48V = 37.5A
- PV charge controller max = 100A

The calculation and assumptions correspond to:

$$B_{\#PV} \geq 100A/37.5A = 2.67$$

In this example, a properly sized PHI battery bank based on the available PV charge has 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 includes fewer batteries than calculated, configure the charge controller settings to limit the controller’s current output. These settings are described in more detail in the following sections of this Integration Guide.

Charge Example B

This example uses the following calculation:

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

This example assumes the following:

- Max. continuous charge current for PHI 3.8 24V = 45A
- PV charge controller max = 100A

The calculation and assumptions correspond to:

$$B_{\#PV} \geq 100A/45A = 2.22$$

In this example, a properly sized PHI battery bank based on the available PV charge also has a minimum of 3 batteries.

In summary: When designing a system using the Discharge Calculation and the Charge Calculation, the minimum number of batteries should be the greater of the two sizing calculation results.

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 Magnum Energy equipment.

4.1 – Depth of Discharge

In order to optimize your system's and your PHI batteries' performance and life, SimpliPhi Power recommends programming the equipment settings to maintain the batteries at a maximum 80% Depth of Discharge (DOD). This qualifies the batteries for the SimpliPhi 10-year / 10,000 cycle Warranty.

Greater DOD is possible but will result in reduced cycle life. To maintain a maximum 80% DOD using Magnum equipment, a backup grid connection or standby generator (with Magnum Auto Generator Start device) is **required**. Refer to the PHI 3.8 kWh Battery Warranty to compare DOD settings and the associated Warranty.

CAUTION: If a firmware update is executed on Magnum Energy equipment, ALL the settings must be re-verified. The programmed settings shown in the following tables must be applied based on desired Warranty/cycle life. 80% Depth of Discharge is recommended.

4.2 – Inverter Settings

General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
MS4024 / MS4448 Inverter			
ME-ARC & ME-RTR	Remote Control		
CTRL			
01 AC In Control			
AC In Control Auto Connect	Auto Connect if AC power source is a generator VDC Connect if AC power source is the grid		
02 CHG Control	Multi-Stage		
03 Gen Control	AGS is required for this setting		
04 PT Control	PT-100 charge controller is required for this setting		
SETUP			
01 System Setup			
01D Max Charge Amps	CC/CV Controlled Displayed once "CC/CV" is selected in 03C Battery Type menu		
01E Link PT CHG Settings	NO		
02 Inverter Setup			
	25.1V / 50.2V for 80% DOD	24.8V / 49.5V for 90% DOD	100% DOD
02B Low Batt CutOut[2] - LBCO (VDC)	24.4V / 48.8V	24.4V / 48.8V	24V / 48V
02C AC In - Time	**IF** you want to connect to grid power at a pre-determined time of day		
Connect Time	The time each day that the incoming AC source connects and powers the loads		
Disconnect Time	The time that the AC source disconnects and no longer powers the loads		
02D AC In - VDC	Grid power connection is required for this setting		
Connect Volts	25.1V / 50.2V for 80% DOD	24.8V / 49.5V for 90% DOD	

General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
Disconnect Volts[4]	27.2V / 54.4V		
02E AC In – SOC	ME-BMK is required for this setting The **02D AC In – VDC** setting is preferred over **02E AC In - SOC**		
Connect SOC	20%		
Disconnect SOC	100%		
02F Power Up Always	OFF		
03 Charger Setup			
03C Battery Type	CC/CV		
Max Charge Amps[1] (ADC)	**45A** per PHI3.8 24V		
	37.5A per PHI3.8 48V		
CV Charge Volts (VDC)	27.2V / 54.4V		
CV Chg Done Time	1 Hr (set to "Hold CV Chg VDC" when generator charging)		
CV Chg Done Amps (ADC)	4A / 2A		
Max CC/CV Time (Hrs)	12 Hrs		
Recharge Volts (VDC)	25.3V / 50.6V		
03D Absorb Done Time	CC/CV Controlled		
03E Max Charge Rate[3] (%)	**45A** per PHI3.8 24V (see footnote 3 for % calculation)		
	37.5A per PHI3.8 48V (see footnote 3 for % calculation)		
03F Max Charge Time	CC/CV Controlled		
03G Final Charge Stage	CC/CV Controlled		
Rebulk Volts (VDC)	25.3V / 50.6V		
03H EQ Reminder Days	OFF		

Notes:

1. Per PHI 3.8 kWh battery – These setting are calculated by multiplying the nominal per-battery value times the number of batteries.
2. The maximum programmable setting of 48.8V is below the recommended LBCO setting. To maintain the batteries at a maximum 80% or 90% DOD, utilize the **02D AC In – VDC** setting for grid backup.
3. Per PHI 3.8 kWh battery and as a percentage of the inverter's or charge controller's maximum charge rating – These settings are calculated by multiplying the nominal per-battery value times the number of batteries, then divide by the equipment's maximum charging current.

Battery Quantity	PHI 3.8 / 24V (45ADC)	1 x MS4024PAE charge rate (105ADC charger)	1 x PT-100 charge rate (100ADC)	PHI 3.8 / 48V (37.5ADC)	1 x MS4448PAE charge rate (60ADC charger)	1 x PT-100 charge rate (100ADC)
2	90A	85%	90%	75A	100%	75%
3	135A	100%	100%	112.5A	100%	100%
4	180A	100%	100%	150A	100%	100%

- 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 and charge/discharge current settings must be reassessed. Failure to do so will void the Warranty.

4.3 – MPPT Charge Controller Settings

Solar charge controllers must be used in DC coupled systems to regulate the power produced by the PV array that is delivered to the batteries. Magnum Energy offers one MPPT charge controller, the PT-100, which is compatible with PHI batteries:

SETUP	
06 PT Setup	
06A Battery Type	Custom
Absorb Volts	27.2V / 54.4V
Float Volts	27V / 54V
EQ Volts	Set to the same value as Absorb Volts to prevent Equalization
EQ Done Time	N/A
06B Absorb Done Time	1 Hr
Absorb Done Amps	4A / 2A
06C Max Charge Rate[3] (%)	**45A** per PHI3.8 24V (see footnote 3 for % calculation)
	37.5A per PHI3.8 48V (see footnote 3 for % calculation)
06D Max Charge Time	12 Hrs
06E Bulk Start	
Daily/SunUp	YES, to set the PT-100 to start a Bulk charge cycle each new day at sun-up
Bulk Start Volts	25.5V / 51V
Bulk Start SOC	50% ME-BMK is required for this setting
06G PT Alarm	PT controller can be programmed fo a low battery voltage alarm

Notes:

1. Per PHI 3.8 kWh battery – These setting are calculated by multiplying the nominal per-battery value times the number of batteries.
2. The maximum programmable setting of 48.8V is below the recommended LBCO setting. To maintain the batteries at a maximum 80% or 90% DOD, utilize the **02D AC In – VDC** setting for grid backup.
3. Per PHI 3.8 kWh battery and as a percentage of the inverter's or charge controller's maximum charge rating – These settings are calculated by multiplying the nominal per-battery value times the number of batteries, then divide by the equipment's maximum charging current.

Battery Quantity	PHI 3.8 / 24V (45ADC)	1 x MS4024PAE charge rate (105ADC charger)	1 x PT-100 charge rate (100ADC)	PHI 3.8 / 48V (37.5ADC)	1 x MS4448PAE charge rate (60ADC charger)	1 x PT-100 charge rate (100ADC)
2	90A	85%	90%	75A	100%	75%
3	135A	100%	100%	112.5A	100%	100%
4	180A	100%	100%	150A	100%	100%

- 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 and charge/discharge current settings must be reassessed. Failure to do so will void the Warranty.

4.4 – Auto Generator Start (AGS) Settings

Verify with Magnum Energy and your generator manufacturer regarding your generator's compatibility with Magnum's AGS device.

SETUP	
04 AGS Setup	AGS is required for this setting Verify AGS-generator compatibility with Magnum / Sensata
04A Gen Run VDC	
Start Gen Volts	25.2V / 50.4V
Start Volts Delay	1 min
Stop Gen Volts[4]	27.2V / 54.4V
Stop Volts Delay	60 min
04C Gen Run Amps	Prevents batteries from over-discharge (amps) by monitoring the battery current used to power the inverter loads
Start Gen AC Amps	Refer to Table 2.0.
Start Amps Delay	10 sec
Stop Gen AC Amps	[Start Amps Delay Value] – 1A
Stop Amps Delay	120 sec

4.5 – Battery Monitoring Kit (BMK) Settings

A Battery Monitoring Kit (BMK) is **not** required for system operation.

SETUP	
05 BMK Setup	
05A Charge Eff	Auto
05B AmpHour Size[1] [200 - 2500 AH]	**151Ah** per PHI 3.8 24V (minimum 2 batteries)
	75Ah per PHI 3.8 48V (minimum 3 batteries)

Table 2.0 – 04C Gen Run Amps

04C Gen Run Amps autostarts the generator based on the amount of AC amps needed to handle the load the inverter is running.

A battery bank with a maximum continuous discharge rate greater than the inverter's load rate does not need to utilize the **04C Gen Run Amps** setting.

For example, 4 x PHI 3.8 48V batteries paired with 1 x Magnum MS 4448 PAE run no risk of over-discharging to power the **instantaneous** load:

- Max. continuous discharge current for 4 x PHI 3.8 48V = 4 x 37.5A = 150ADC
  - 150A x 48V = 7,200 WDC
- Assuming inverter efficiency is 94%*, WattsAC = WDC ÷ 0.94
  - 7,200 WDC ÷ 0.94 = 7,660 WAC
- 1 x Magnum 4448 PAE inverter has a continuous power rating of 4,000 WAC, and a 5 second surge power rating of 5,800 WAC
  - 7,660 W > 5,800 W
  - The 4 batteries have a higher instananteous power rating than the inverter

Conversion from DC to AC Gen Run Amps for 1 to 5 PHI 3.8 kWh 24V Batteries

A	B	C	D	E	F
# of Parallel Batteries	DC Current Limit	ADC x VDC (24)	VDC ÷ Inverter Efficiency (93% = .93)	Column D ÷ Inverter oltage (120 or 240 VAC, dep. on inverter; 240 VAC used below)	Round down rogrammable range = 5 - 60A)
1	45A	1,080 WDC	1,161 WAC	4.8 AAC	
2	90A	2,160 WDC	2,323 WAC	9.7 AAC	**9 AAC**
3	135A	3,240 WDC	3,484 WAC	14.5 AAC	**14 AAC**
4	180A	4,320 WDC	4,645 WAC	19.4 AAC	**19 AAC**
5	225A	5,400 WDC	5,806 WAC	24.2 AAC	**24 AAC**

*The Magnum MS4024PAE has a peak inverter efficiency of 93%.

Conversion from DC to AC Gen Run Amps for 1 to 5 PHI 3.8 kWh 48V Batteries

A	B	C	D	E	F
# of Parallel Batteries	DC Current Limit	ADC x VDC (48)	VDC ÷ Invert Efficiency (94% = 0.94)	Column D ÷ Inverter oltage (120 or 240 VAC, p. on inverter; 240 VAC used below)	Round down (only hole #s can be used as input)
1	37.5A	1,800 WDC	1,915 WAC	8 AAC	**8 AAC**
2	75A	3,600 WDC	3,830 WAC	16 AAC	**16 AAC**
3	112.5A	5,400 WDC	5,745 WAC	23.9 AAC	**23 AAC**
4	150A	7,200 WDC	7,660 WAC	31.9 AAC	**31 AAC**
5	187.5A	9,000 WDC	9,574 WAC	39.9 AAC	**39 AAC**

*The Magnum MS4448PAE has a peak inverter efficiency of 94%.

4.6 – Recharge Voltage Adjustment

The Recharge setting often acts as the trigger in which a new charge cycle will start. The standard voltage set point is 50.5V, as per the manual; however, you can adjust this setting to fit the application in which the battery is being used. The following table shows battery voltage correlated with State of Charge (SOC).

Table 7.0 – Correlating Battery Voltage to State of Charge

SOC	Voltage 48V	Voltage 24V
100%	>52.5	>26.2
95%	51.7	25.9
90%	51.6	25.8
75%	51.4	25.7
50%	51.0	25.5
20%	50.2	25.1
10%	49.5	24.8
0%	48.0	24.0

The following Recharge values are suggested settings for these specific applications:

- **Back-Up battery:** 51.7/26.2
- **Off-Grid:** 51.4/25.8

5.0 – 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.

6.0 – 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