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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 3.5 kWh batteries. More information on SimpliPhi products can be found on our website: http://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 PT100 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 3.5 kWh battery with their equipment. Per their testing and recommendations, the following parameters (refer to table below) have been validated. 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 = $B_{\#PV} \geq I_{PVChrgMax} / I_{BatChrgMax}$

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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

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 3.5 48V battery has a load rating of 1.74 kW (34 Amps DC x 51.2 Volts nominal)

The calculation and assumptions correspond to:

$$B_{\#Inv} \geq 4.4 \text{ kW} / 1.74 \text{ kW} = 2.53$$

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

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

- Inverter is rated at 4 kW
- PHI 3.5 24V battery has a load rating of 1.15 kW (45 Amps DC x 25.6 Volts nominal)
-

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

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 has fewer batteries than calculated, configure 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.

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3.2 – Charge Calculation: Charge Controller Power 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

This example uses the following calculation:

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

This example assumes the following:
- Max. continuous charge current for PHI 3.5 48V = 34A
- PV charge controller max = 100A

The calculation and assumptions correspond to:

$$B_{\#PV} \geq 100A/34A = 2.94$$

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 has fewer batteries than calculated, configure 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 to size the PHI battery bank, the minimum number of batteries should be the greater of the Discharge Calculation & Charge Calculation results.

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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 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. In real-world installation, best practices recommend you use a standby generator or a grid connection to maintain 80% DoD. Refer to the PHI 3.5 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 reverified. The programmed settings shown in the following tables must be applied based on desired Warranty/cycle life. The recommended is 80% depth of discharge.

4.2 – Inverter Settings

Table 1.0 – Program Settings for SimpliPhi PHI 3.5 – 24V/48V Battery w/ Magnum General Settings

General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
MS4024 / MS4448 4kW Inverter			
ME-ARC	Remote Control		
SHORE			
Shore Max (A)	5 - 60		
AGS (if used)			
01 AGS Control - AGS	OFF, Enable Test, Enable w/QT		
05 Start Volts (V) - Start VDC (V)	25.3 / 50.6		
METER			
05 BM: Setup - BM Charge Eff	Auto		
BM Amp Hours[1] (Ah) [200-2500]	**138Ah** per PHI3.5 24V (3 minimum = 414Ah)		
	69Ah per PHI3.5 48V (3 minimum = 207Ah)		
SETUP			
02 Low Batt CutOut[2] - LBCO (V)	25.1 / 50.2	24.8 / 49.6	24 / 48
03 Absorb Time - Absorb Hrs (Hrs)	0.1		
04 Battery Type - BatType	CC/CV		
Max Amps[1] (A)	**45A** per PHI3.5 24V		
	34A per PHI3.5 48V		
Chg Volts (V)	28 / 56	28 / 56	28 / 56
EndChg	DC Amps		
DoneAmps (A)	4 / 2		
MaxTime (Hrs)	OFF		
Recharge (V)	25.3 / 50.6		
05 Charge Rate - Max Charge[3] (%)	50		

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General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
09 Final Charge - Final	Multi		
Rebulk (v)	25.3 / 50.6		
10 Pwr Up Always - Pwr Up	NO		

Notes:

- 1. Per PHI 3.5 kWh battery – These setting are calculated by multiplying the nominal per-battery value times the number of batteries.
- 2. The maximum value of the low battery cut out (LBCO) is 24.4/48.8 V.
- 3. Calculate this value as a percentage of the inverter/charger's maximum charging current.
- 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.**

Table 2.0 – Program Settings for SimpliPhi PHI 3.5 – 24V/48V Battery w/Magnum General Settings

General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
MS4024 / MS4448 Inverter			
ME-ARC	Remote Control		
CTRL			
01 ACIn Control	Auto-Connect		
02 CHG Control	Multi-Stage		
03 Gen Control	OFF (refer to manual if optional ME-AGS-N used)		
04 PT Control			
04A PT CHG Ctrl	Multi-Stage		
04B PT Aux Relay Ctrl	DISENGAGE (can be used if desired)		
04C PT Alarm Control	OFF, Enable Test, Enable w/QT		
04D PT MPPT Sweep	15 Min Sweep		
METER			
01 System Setup			
01D Max Charge Amps[1] (A)	"CC/CV Controlled" will be displayed on this menu's screen once "CC/CV" is selected as the battery type from the 03C Battery Type menu.		
01E Link PT CHG Settings	**YES** if using a PT-100, **NO** if not using a PT-100		
02 Invert Setup			
02A Search Watts	OFF		
02B LBCO Setting[2] (V)	25.1 / 50.2	24.8 / 49.6	24 / 48
02D AC In - VDC Connect Volts (V)	25.3 / 50.6		
02D AC In - VDC Disconnect Volts (V)	28 / 56		
02E AC In - SOC Connect SOC[3] (%)	80		

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General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
02E AC In - SOC Disconnect SOC (%)	100		
02F Power Up Always	OFF		
03 Charger Setup			
03A AC Input[1] (A)	**45A** per PHI3.5 24V		
	34A per PHI3.5 48V		
03B VAC Dropout	*Set as applicable*		
03C Battery Type	CC/CV		
Max Charge[1] (A)	**45A** per PHI3.5 24V		
	34A per PHI3.5 48V		
CV Charge (V)	28 / 56		
CV Charge Done	Amps		
DoneAmps (A)	4 / 2		
MaxTime (Hrs)	12		
Recharge (V)	25.3 / 50.6		
03D Absorb Done	If "CC/CV" has been selected as battery type, "CC/CV Controlled" is displayed		
Time (Hrs)	0.1		
Amps (A)	4 / 2		
SOC[4] (%)	100		
03E Max Charge Rate[5] (%)	45A per PHI 3.5 24V (as a percentage) 34A per PHI 3.5 48V (as a percentage)		
03F Max Charge Time (Hrs)	12 If "CC/CV" has been selected as battery type, "CC/CV Controlled" is displayed		
03G Final Charge Stage	Multi, Rebulk 25.3 / 50.6 If "CC/CV" has been selected as battery type, "CC/CV Controlled" is displayed		
03H EQ Reminder Days	OFF If "CC/CV" has been selected as battery type, "CC/CV Controlled" is displayed		
04 AGS Setup	OFF (if used set as follows)		
04A Gen Run VDC	Start Gen Volts = 25.2 / 50.4 Start Volts Delay = 15 min. Stop Gen Volts = Float for full battery charge or set to specific voltage for partial battery charge Stop Volts Delay = 0 sec (if Stop Gen Volts = Float)		
04C Gen Run Amps1[5] (A)	Refer to Table 6.0		
04F Max Gen Run Time	12 Hrs		
05 BMK Setup			
05A Charge Eff (%)	99		
05B AmpHour Size	**138Ah** per PHI3.5 24V (3 minimum = 414Ah) **69Ah** per PHI3.5 48V (3 minimum = 207Ah)		

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General	10k Cycles (80% DOD)	5k Cycles (90% DOD)	3.5k Cycles (100% DOD)
06 PT Setup			
06A Battery Type	CC/CV		
Max Charge[1] (A)	**45A** per PHI3.5 24V		
	34A per PHI3.5 48V		
CV Charge (V)	28 / 56		
CV Charge Done	Amps		
DoneAmps (A)	4 / 2		
MaxTime (Hrs)	12		
Recharge[7] (V)	25.4 / 50.8		
06B Absorb Done	If "CC/CV" has been selected as battery type, "CC/CV Controlled" is displayed		
Time (Hrs)	0.1		
Amps (A)	4 / 2		
SOC (%)	100		
06C Max Charge Rate (%)	50		
06D Max Charge Time (Hrs)	12		
06E Bulk Start	25.4 / 50.8		

Notes:

- 1. Per PHI 3.5 kWh battery – These setting are calculated by multiplying the nominal per-battery value times the number of batteries.
- 2. LBCO cannot be programmed above 24.4 VDC / 48.8 VDC. Rely on 02D AC In - VDC and/or 04A Gen Ren VDC to protect the battery from discharging below 25.1 / 50.2 or 24.8 / 49.6.
- 3. This setting requires the optional ME-BMK to be installed. Instead of setting this parameter, it is more accurate to use a voltage-related parameter instead (02D).
- 4. A ME-BMK is required to use the Absorb Done SOC setting.
- 5. 03E Max Charge Rate is calculated as a percentage of the inverter/charger's maximum charging capability.
- 6. This menu starts the generator automatically based on the load's AC amps.
- 7. The PT-100 re-initiates bulk charging if the batteries' voltage falls below the Recharge Volts setting, or if the battery voltage falls below ≤12.2 VDC/≤24.4 VDC/≤48.8 VDC. The PT-100 does not re-initiate a bulk charge daily; to program more frequent controller charging, un-"link" the PT-100 charge controller and the inverter (01E Link PT CHG Setting), and then increase the ReCharge Volts setting in the charge controller.
- 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.**

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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:

The PT-100 model is somewhat unique in that allows for slightly larger strings of PV modules to be easily installed and connected to the PHI battery bank.

See PV Input Voltages from pg. 17 of the PT-100 manual:

Table 3.0 – PV Input Voltage Parameters

Nominal Battery Voltage	Operating Range (V_{OC})	MPPT Range (V_{MP})	High (V_{OC} Range (PT Shuts Down*)	Max PV Input Voltage Level (Damage Can Occur)
12V	24V to 187V	60V to 187V	188V* to 210V	211V or higher
24V	40V to 187V	50V to 187V	188V* to 220V	221V or higher
48V	72V to 187V	77V to 187V	188V* to 240V	241V or higher

Although the ME-RC does not allow for any monitoring or adjustments to the PT charge controller??.

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-RC1	NA	≥ Version 2.6
ME-RTR	NA	≥ Version 2.0

SimpliPhi Power recommends the 80% DoD settings in Table 5.0 below in order to maximize the Warranty. Additional settings are outlined based on Warranty and desired cycle life.

Table 5.0 – Magnum RTR

Parameters	Setting
Setup	
02 Inverter Setup	
02A Search Watts	OFF
02B Low Battery Cut Out	24.4 / 48.8
02C AC In - Time	Charges batteries during certain times (e.g., when utility power is inexpensive). Also, enable **Time Connect** in CTRL -> 01 AC In Control.
02D AC In VDC	Maintains an 80% DoD max using Grid as Backup. Also, enable **VDC Connect** in CTRL -> 01 AC In Control.
Set Connect Volts	25.1 / 50.2
Set Disconnect Volts	25.5 / 51
02E AC In - SOC	Do not use; **02D** setting is more accurate.
02F Inverter Always Powered -Up	No

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Parameters	Setting
when DC is Connected	
02G Inverter Threshold to Start Parallel	60% (default)
03 Charger Setup	
03A AC Input Amps	Set to match the current rating of the utility power or the generator's circuit breaker.
03B Low VAC Dropout	AC1 = 80, AC2 = 70 (*default*)
03C Battery Type	
CC/CV	2-stage charging cycle
Max Chg Amps	45 / 34 per battery
CV Chg Volts	27.7 / 55.4
CV Charge Done Time	0.1 hrs: • Max Time = 1 hr • DC Volts to Recharge = 25.3 / 50.6
CV Charge Done Amps	Do not use; see "Info" on page 34 of the Magnum RTR manual.
Hold CV Chg Volts	Never hold CV chg volts for LFP batteries.
03D Absorb Done	CC/CV controlled
03E Max Charge	CC/CV controlled
03F Final Charge Stage	CC/CV controlled
03G Days to remind when to EQ	CC/CV controlled
04 AGS Setup	
04A Gen Run DC Volts	
Start Volts	25.2 / 50.4
Stop Volts	25.7 / 51.4. Or to allow the battery bank to go through a full bulk and absorption charge, set to **Float (Silent)**.
Start Delay	10 s. Increase if generator is nuisance starting.
Stop Delay	5 min.
04B Gen Run Time	Runs generator at a set time each day (e.g., while at work each day to have charged batteries when you get home without having to hear it run).
04C Gen Run AC Amps	
Start AC Amps	Ensures that batteries do not over-discharge. Set "Gen Run AC Amps" according to Table 6.0.
Start Delay	0 sec.
Stop AC Amps	Set to 1A less than the "Start AC Amps" value.
Stop Delay	Depends on loads: • Increase delay time if loads greater than Start AC Amps value come on and off frequently. • Otherwise, use the default setting.
04D Gen Run SOC	Do not use; **04A** setting is more accurate.
04E Gen Run Temp	Runs the generator when temperature increases.
04F Max Gen Run Time	Sets the maximum time the generator will run if autostarted.
04G Gen Quiet Time	Sets the period of time each day in which the generator is not allowed to run automatically.
04H Gen Exercise	Exercises the generator if it has not been operated for a period of time.

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Parameters	Setting
04I Gen No-Load Time	Consult your generator manufacturer for generator's **Warm Up** and **Cooldown** time.
04J Gen 100% SOC	Not needed for LFP batteries.
05 BMK Setup	
05A Charge Efficiency	
05B Battery Amp Hrs Size	138 / 69 per battery
07 PT Setup	
07A Battery Type	
CC/CV	Two-stage charging cycle
Max Chg Rate	45 / 34 per battery. Calculated as a percentage of the inverter's Max Charger Output.
CV Chg Volts	27.7 / 55.4
CV Charge Done Time	0.1 Hrs: • Max Time = 1 hr • DC Volts to Recharge = 25.3 / 50.6
CV Charge Done Amps	Do not use; see "Info" on pg. 34 of the Magnum RTR manual.
Hold CV Chg Volts	Never hold "CV Chg Volts" for LFP batteries.
07B Absorb Done	CC/CV controlled
07C Max Charge	CC/CV controlled
07D Bulk Start	
Daily/SunUp	YES or NO, depending on whether you want the PT-100 to charge the batteries daily.
Low VDC	25.5 / 51
SOC	OFF

Table 6.0 – Gen Run Amps

Number of Parallel Batteries	Amps at 240 VAC	Amps at 120 VAC
PHI 3.5/24V Batteries		
1	5	10
2	10	20
3	15	30
4	20	40
5	25	50
6	30	60
PHI 3.5/48V Batteries		
1	7	15
2	15	30
3	22	45
4	30	60
5	37	75
6	45	90

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4.4 – Recharge or Rebulk Voltage Adjustment

The recharge or rebulk 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 how battery voltage correlates to the state of charge.

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 values are suggested set points for specific operations:

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

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5.0 – Specifications & Warranty

For your reference:

- See PHI 3.5 kWh Specifications sheet.
- See PHI 3.5 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 3.5 kWh 48V Battery (or other SimpliPhi Power products), please contact us directly at:

805.640.1874
techsupport@simpliphipower.com

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