KiloVault® - HLX Series
Lithium Iron Phosphate (LiFePO4)
Deep Cycle Solar Batteries

Installation and Users Manual

Rev. 20181203

The KiloVault™ HLX series of solar lithium batteries were specifically designed and tested for the beating that serious hybrid and off-grid inverters and solar charge controllers can throw at them. Compared to traditional deep cycle batteries, the HLX Series' lithium battery technology more efficiently stores and delivers the renewable energy that you have generated, with no maintenance on your part.

FEATURES:

- Flexible - Works in 12, 24 or 48V configurations
- Gives You More- You can use the full battery's capacity, discharging it 100%
- Long-life- Even after discharging it completely 2000 times, 80% of the capacity remains.
- Maintenance Free - No watering required, or cleaning of hazardous chemicals
- High Efficiency - Giving you up to 12% more use-able stored energy
- Smart Investment - Lower cost per watt-hour/cycle and longer lifespan than lead batteries
- Safer - No thermal run-away issues as with other lithium technologies
- Heavy Duty -Takes up to 150A of continuous charging/discharging current, meeting the tough demands of serious inverters and chargers
- 3 Year Warranty

****WARNING High Voltage Risk of Personal Injury or Death****

- As is the case with all batteries the risk of shock is present. When handling batteries use protective measures.

  When working with or installing batteries use electrically insulated gloves and tools. Remove personal metal items such as watches, rings, bracelets, etc.

TABLE OF CONTENTS

1.0 – Important Safety Information

- Before using the KiloVault Batteries, read all instructions.
- Do not attempt to use any battery that appears damaged during shipment or otherwise.
- Do not submerge the batteries. This could cause personal injury and will void your warranty.
- Do not attempt to disassemble the batteries. This could cause personal injury and will void your warranty
- To avoid risk of shock or fire, ensure all wire is properly sized and in good condition.
- Verify that all equipment that is going to be connected to the batteries is turned off before making any connections.
- A small risk of spark does exist while making connections. Ensure that the area is free of explosive gasses and liquids and is not installed in a confined areas that contains explosive substances. This includes flammable fuel powered machinery, holding tanks, pipe fittings and connectors.
- Respiratory irritation may be caused if the battery is punctured or cracked but it is not expected to cause exposure if remains sealed.
- Skin contact with a punctured or otherwise open battery can cause irritation but not when it is sealed.
- High voltage connections of batteries (configurations of greater than 36V DC nominal) can be dangerous in any DC system. DC voltages over 52V can stop the human adult heart. Note that a 48V nominal system fully charged is over this voltage level. Please be careful and also wear insulated gloves.
- In the unlikely event of a fire, if possible, first shut off the source of the electricity. We recommend having a fire extinguisher in close proximity of your power generating equipment. Class ABC extinguishers are easily obtainable and are best suited for multipurpose fire types such as wood, flammable liquids and electrical appliances.

2.0 – Product Technology Overview

- 12 Volt Lithium Iron Phosphate (LiFeP04) with Bluetooth
- Model Types: KLV1800HLX (150Ah/1800Wh) / KLV3800HLX (300Ah/3600Wh)
- LiFeP04 chemistry prevents thermal runaway as opposed to other lithium technologies.

- IP55 Rated
- KiloVault batteries can be used in RV applications for electrical appliances ONLY. They can NOT be used to crank over motors in such vehicles.
- Every KiloVault battery contains a BMS (Battery Monitoring System) that protects them from over charging/discharging, over current charge/discharging and extreme low and high temperatures while charging and discharging. Nonetheless, they must be installed using the appropriate inverter charge controller settings and devices to protect them from open PV (photovoltaic/solar panel) voltage as well as other high voltage charging sources. Failure to adhere to proper installation requirements will void the warranty.

3.0 - Bluetooth Monitoring App

DISCLAIMER: The KiloVault App is unsupported and is solely intended to get general information. It is not intended to replace a volt meter, nor guaranteed to work with every Android or iPhone.

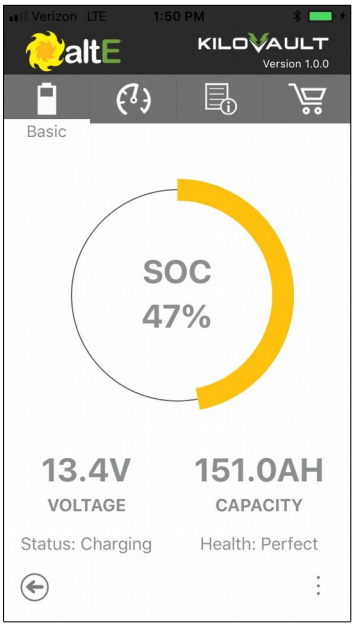
NOTE: Your Android/iPhone must support BLE (Bluetooth Low Energy). Additionally for the Android app to work you must permit access to Location as well as Local Storage.

- The KiloVault smartphone Bluetooth app enables you to view basic information about the selected individual battery. The app is available for free download for both Android and iPhone phones. Each battery is identified by a unique serial number located on a label on the battery.

The information displayed includes:

Screen 1

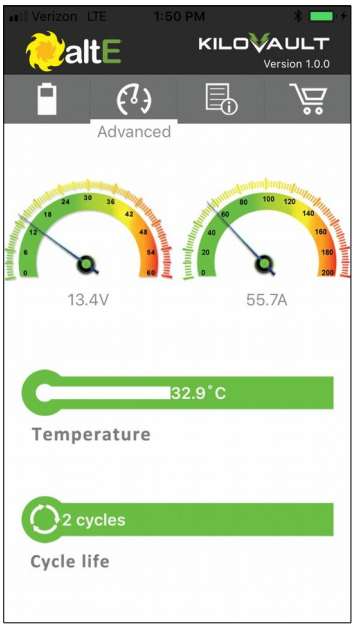
State of Charge (SOC)
Voltage
Capacity
Status (Charging/Discharging/Standby)
Health



Screen 2 (swipe right)

Voltage
Amps (Charging or Discharging)
Temperature (Internal Battery Temperature)

Cycles (Number of times the battery has been cycled over it's lifetime)



- The Bluetooth can help trouble shoot any problems when trying to detect the cause of the battery bank going off-line when there isn't an obvious problem.

3.0 – Pre-Installation Requirements

- NOTE: Due to transportation regulations, LiFePO4 batteries cannot be shipped fully charged. As a result, if you have purchased more than one battery for your system all of them must be charged up fully to *exactly* the same voltage before using. *Please follow the instructions below carefully*.

- <u>Batteries Must Be Fully Charged to Same Voltage Before Use</u>
  It is very important that each battery be individually charged to exactly the same voltage initially and no less than 14.1 volts before putting the batteries into operation (not applicable if you are just using one battery). Selecting a voltage at 14.1 to 14.2V is recommended but alternatively a precisely selected low voltage will work, such as one between 11.5-12.5V.

  Do not charge the batteries initially to just 13.0 - 13.9 volts. There is a very gradual charge voltage versus capacity curve when charging, especially between 13.6 to 13.9V. Charging them to a value in this range (unlike lead acid batteries) can result in a very broad difference in the actual state of charge versus any other battery in your bank. As a result, any one battery in your bank will prematurely shut down during charging or discharging. See the charging graph below to understand the characteristics of the LiFePO4 charging curves.

  Many automotive type battery chargers will not reach 14.1v. Please check charger specifications when selecting your charger or you can contact altE for a recommendation.

- <u>Using a DC Charger Rated for Up to 150A is OK</u>
  Although a nominal charge rate of 100A is recommended on an on-going basis, you can use whatever is available as long as it does not exceed 150A. After the charger is removed for the initial pre-installation charge, allow them to rest for a minimum of two hours.

  Then, using a DC Voltage meter, check to ensure that the voltage difference between any of the batteries is not more than 0.2 volts. Failure to take these preliminary charging steps will result in reduced capacity, make the batteries prematurely shutdown during charging or discharging and could void your warranty.

If the batteries are not charged to exactly the same voltage (preferably above 14.0V) then they are not truly all at the same state-of-charge. As a result, one or more batteries in a bank will have its BMS protectively shutdown the battery (making it an open circuit) because it has either reached its high voltage maximum ahead of the other batteries or prematurely reached its completely discharged voltage (also forcing it offline and making an open circuit).

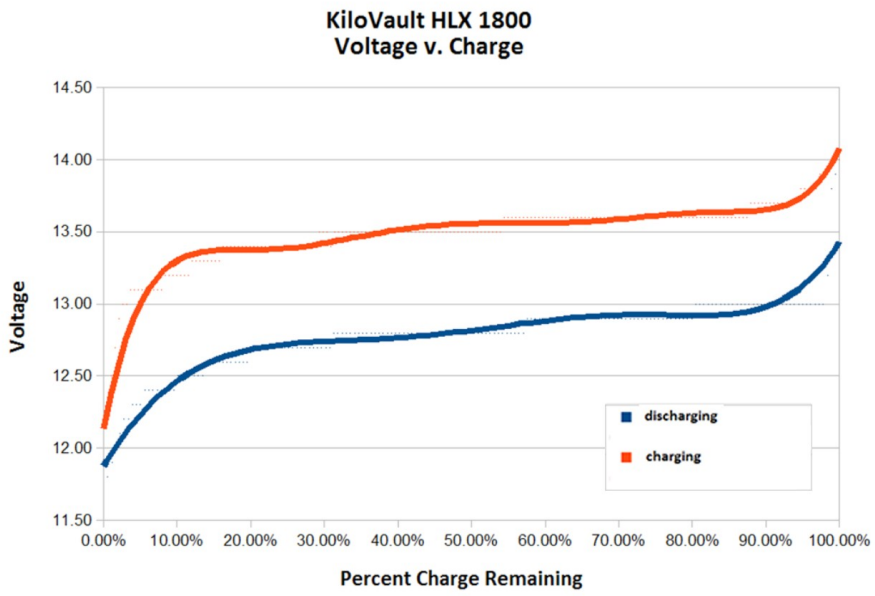


Illustration 1: There is very little voltage difference between 10% and 95% full in LiFePO4 batteries. To ensure batteries are at the same charge level they all must be initially charged to the same voltage at the tail upper end.

- <u>Add Batteries of Exact Same Model Together</u>
  When expanding your battery bank only combine the same model batteries together. Do not mix and match with different models or brands. Doing so will result in the batteries unexpectedly shutting down and possibly cause damage.

- <u>Disable Your Chargers Equalizing Cycle</u>
  If equipped, charge equalizing must be disabled in your charge controller(s), including the one in your inverter, if it has one.

- <u>Do Not Use a Battery Temperature Sensor (BTS)</u>
  Battery temperature sensors (BTS) are used by battery chargers for lead acid batteries because the “full” voltage changes with temperature. This technology is not compatible with lithium batteries and must not be used. Using a BTS is likely to cause the charge controller to over charge the KiloVault battery and damage it.

- Temperature and Battery Physical Spacing
  Because the batteries warm up while in use, you will want to consider your local average and seasonal temperature when positioning your battery bank. If they will be in a warmer environment you may want to leave a minimum of one inch between each of the batteries. If they will possibly be subject to cold temperatures you may want to place them as closely as possible to each other. Please note that the batteries can discharge several degrees below freezing but they will not charge.

- Insulating Battery Enclosure in Cold Temperatures
  Insulation around the batteries should also be considered for winter-time if the batteries will be exposed to temperatures that approach 32°F (0°C). Below freezing the BMS will not allow charging to prevent damage to the cells. (Note that the battery capacity remains essentially unaffected between room temperature and just above freezing.)

  Using an insulated enclosure during these cold period will maintain more of the heat generated during normal charging and reduce the chances of the BMS shutting down the batteries in cold temperatures. However, please make sure to remove the insulation in the hot months, as overheating the batteries will shorten their life and the BMS will also shutdown the battery in temperatures above 149°F (65°C).

- Battery Interconnect Cabling
  Refer to published electrical wiring specifications and ratings for all interconnecting cables. All wire must be the appropriate gauge and construction to handle the loads that will be placed upon it. Heavy gauge, fine stranded copper wire is the industry standard. A minimum of 2/0 or 4/0 AWG copper cable is recommended for battery interconnect cables.

  Cables connecting parallel rows of batteries together must be the same length. Cables of differing lengths will cause voltage differences between the rows. Recall that the parallel rows must be kept within 0.2V of each other to ensure they work correctly and large currents do not occur between rows.

  If your battery bank suddenly shuts down as one or more rows approach fully charged or fully discharged then it's likely that either the batteries are not all at the same state of charge or, if they are measured to be all the same, the voltage drop across the cables connecting the rows is not equal.

- An Inexpensive Digital Voltmeter Works Fine
  Use a standard digital volt meter to verify battery polarity before making any connections.

  Also use the voltmeter to measure the voltages of the batteries after the initial charge to ensure they are all within 0.2V (or less) of each other. The voltmeter needs to be able to read to 0.1V accuracy.

- <u>Environmental Conditions for Batteries</u>
  Ensure the location of the battery bank is dry and as well protected from extreme temperatures as possible. No ventilation is required as these do not off-gas like lead-acid batteries do.

- <u>Maximum of 16 Batteries in a Bank</u>
  The maximum batteries in a bank is limited to sixteen, 4 in parallel and 4 in series for the KiloVault HLX series. Each row of batteries must be kept within 0.2V of each other or battery bank may prematurely shutdown during charging and discharging.

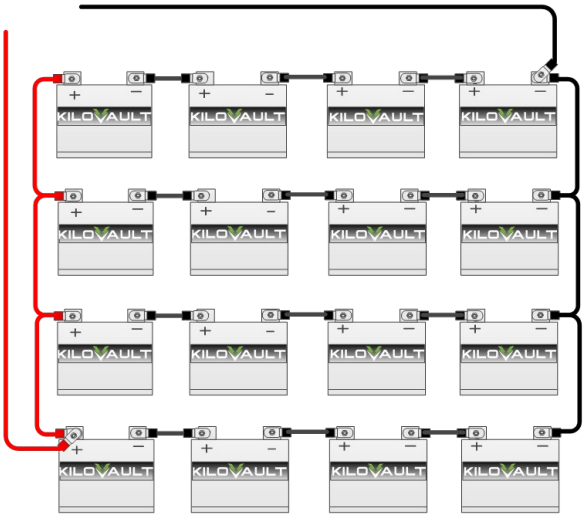


Illustration 2: Maximum configuration for KiloVault HLX series is 16 batteries, 4x4.

4.0 - Specifications

HLX Series	1800 HLX	3600 HLX
Rated Capacity	**1800Wh**	**3600Wh**
Rated Voltage	**12.8V DC**	
Nominal Amp-Hour Capacity	**150Ah**	**300Ah**
Optimal Charger/Inverter Settings		
Bulk/Absorption Voltage	**14.0V recommended***	
	(13.8 - 14.2V acceptable depending on charger)	
Float Voltage	**13.8V recommended (13.4 - 14.0V acceptable)**	
Low Voltage Inverter Cut-Off	**12.0V**	
Equalization	***Disable*. Do not use. Battery will shut down into protection mode.**	
Maximum Cut-Off Voltage	**14.6 ±0.2V**	
Minimum Cut-Off Voltage	**11.5V**	

Continuous Discharge Current	**150A**	
Maximum Discharge Current	**150A (continuous)**	**200A for 30 mins, 150A (continuous)**
Peak Discharge Current (<3 secs)	**500A**	
Standard Charge Current	**100A**	
Maximum Charge Current	**150A**	
Standby Mode Activated	**Current Draw from Load < 0.25A (250mA)**	
Dimensions	**19.1in x 6.7in x 9.4in (485mm x 170mm x 240mm)**	**20.5in x 10.6in x 8.7in (520mm x 269mm x 220mm)**
Battery Weight	**41.7 lbs (18.9kg)**	**84.4 lbs (38.3 kg)**
Shipping Weight	**45.2 lbs (20.5kg)**	**103.4 lbs (46.9 kg)**
Terminals	**Stainless Steel M8-1.25 x 12 mm Bolts**	
Operating Temperature Range	**Charging: 32 - 113°F (0 - 45°C)** **Discharging: -4 - 140°F (-20 – 60°C)**	
Optimal Temperature Range	**59 – 95°F (15 – 35°C)**	
Temperature Protection		
Low Temp. Charge Protection	**32°F (0°C) with protection release at 39°F (4°C)**	
Low Temp. Discharge Protection	**-4°F (-20°C) with protection release at 14°F (4°C)**	
High Temp. Charge Protection	**149°F (65°C) with protection release at 122°F (50°C)**	
High Temp. Discharge Protection	**149°F (65°C) with protection release at 122°F (50°C)**	
Over Current Protection		
Delay until cutoff @255A	**4-6 minutes**	
Delay until cutoff @400A	**5-6 seconds**	
Time until protection is released	**8 seconds after load is disconnected**	
Self-Discharge Rate	**≤2% per month**	
Normal Self-Discharge Current	**≤20mA**	
Estimated # of Cycles Until 80% of Rated Watt-Hour Capacity Remains	**2000 cycles @ 100% Depth of Discharge** **5000 cycles @ 80% Depth of Discharge**	
Voltage Configurations	**12, 24, 36 or 48V**	
Maximum Configuration	**Up to 4 parallel strings of 4 series batteries (16)**	
Battery Management System	**Monitors and optimizes charge & discharge for each cell, provides overcharge, over discharge, temperature and short circuit protection**	
Maximum Time Between Charges	**6 months**	
Warranty	**3 Year Manufacturer Defect Free**	
Monitoring	**Wireless on-site battery status monitoring (optional)**	

** Note: Bulk/Absorption voltage settings is dependent upon the charge rate of the AC or solar charger. For chargers less than 40A, 14.1V is acceptable, for 40-60A chargers, 14.0V is acceptable, and for chargers >60A use 13.8V.*

5.0 – Installation

Configurations

The KiloVault HLX series of batteries can be used 12V, 24V, 36V and 48V configurations where one, two, three and four batteries, respectively, are connected in a row (plus to minus). The batteries can also be used in up to 4 parallel rows.

Bolt Tightening

Note: Torque bolts to 110 In-lb +\- 10%

6.0 – Operation

- Configuring Charge Controller & Inverter Voltage Set-points is Very Important
  Your battery charger (solar, inverter or AC), should be set to stop charging at a maximum voltage and your inverter should be set to shut down at a certain voltage. See the table below:

  Inverter and Charge Controller Set Points

	12V System	*24V System*	*48V System*
Inverter			
Low Voltage Disconnect	12.0V	24.0V	48.0V
Charge Controller			
Bulk/Absorption Voltage			
<40A Chargers	14.1V	28.2V	56.4V
40-60A Chargers	14.0V	28.0V	56.0V
60-150A Chargers	13.8V	27.6V	55.2V
Charge Controller			
Float Voltage*	13.8V	27.6V	55.2V

  * At full charge rate of 150A we recommend allowing the Absorb charge only last 2 minutes to avoid overcharging the batteries. For 40-60A chargers allow the bulk/absorption charge to last only 4 minutes. And for chargers 40-60A use 6-8 minutes. When the batteries are being overcharged the BMS will turn the battery off, making the battery effectively an open circuit in your battery bank.

- Turn **Off** Equalization
  Equalization mode in your charge controller absolutely must be turned off/disabled or the batteries will be permanently damaged. Equalization charge mode is applicable to flooded lead acid batteries. An indication that equalization was left on is that the battery will show a high voltage (HV) event in the Bluetooth App.

- Use 'AGM / Sealed Battery' Settings if Precise Configuration is not Possible
  If your charger has only limited options for charge settings and Lithium is not an option, select

battery type "AGM" or "Sealed Battery". These settings will not be optimal but will work in most cases.

- Energize Your Inverter First and then Other Loads One at Time, Waiting 60s Between
  Due to the special pre-charging function in the BMS it is necessary to *first connect and energize the equipment that draws the largest capacitive load, such as your inverter*. If a smaller device is powered up first the pre-charge loop in the BMS will be lost and unable to handle the greater in-rush from the larger device.

  Power up other devices connected to your battery, like solar charge controllers, battery monitors, etc. one at a time after the inverter, waiting 60 seconds before powering them up.

  Alternatively, in most cases, if everything is powered up all at the same time (or less than 60 seconds of each other) the surge protection circuitry will kick in, shut down the batteries but in less than 1 minute the batteries will restart. If the batteries continue to shutdown repeatedly, then the devices should be started only one at a time, waiting 60 seconds between each one.

- Self-Protecton Mode by the BMS
  In the event that one of the batteries reaches an extreme condition the internal BMS will put the battery into protection mode. When this occurs the batteries will go off-line until they recover back into operational range. Most often this can take any where from just a couple of minutes up to several hours depending on the fault condition. If an 'Under Voltage Protection' event caused the shut down, it will sometimes recover on it's own or, if the battery has been completely depleted it may need to be re-charged at least a few amp-hours for it to recover.

- Charge Rate of 100A Preferred, 150A is OK
  Charging rates below the battery's maximum capacity will extend battery life. A charge rate of 100A is recommended, though up to 150A is allowed. After 3000 cycles at 100% depth-of-discharge the battery's capacity will be approximately 75% of when it was new. When charging above 60A make sure the bulk/absorption voltage is set to no higher than 13.8V.

- Temperature & BMS Self-Protection
  altE strongly recommends staying within a temperature range 32-113°F (0-45°C) for both charging and discharging to prevent damage, extend battery life and ensure expected performance.

  The battery will protect itself and not allow charging below 32°F (0°C). However, it will continue to discharge down to -4°F (-20°C). As a result, it is possible to completely discharge the batteries in cold conditions and not be able to charge them until they are placed into warmer conditions.

- Temperature & Effects on Battery Capacity
  Although extreme low temperatures will not reduce the batteries capacity, their current output will be reduced. At 14°F (-10°C) the available current is reduced by 10 to 20% and decreases further to 60% as it approaches the Low Temperature protection value of -4°F (-20°C).

- Charge More Slowly at First in Very Cold Conditions
  If ambient temperature is below 39°F (4°C), reducing the initial charge current to no greater than 60A until the batteries have had a chance to warm up is recommended before introducing the nominal charge rate of 100A.

- Ensure Batteries are within 11.5V – 14.4V Before Putting into Operation
  When putting the batteries back into operation, be sure that the batteries are within operational range prior to initiating charging. They must be all the exact same voltage. See the Pre-Installation instructions above.

- Ensure All Batteries are within 0.2V of Each Other
  Verify the voltage of each individual battery to ensure they are still all within no more than 0.2V of each other. If not, you will need to re-perform the charging step found in the Pre-Installation section of this manual above.

7.0 – Storage and Re-Commissioning

- Disconnect Batteries for Long Term Storage
  For long term storage simply disconnect all sources of charge and discharging from the battery bank.

- Self-Discharge & Maximum Period Between Charging
  Although the batteries have a very low self discharge rate (≤2%/month, ≤12%/year) they should be charged a minimum of every six months.

- Temperature & Humidity
  Recommended: 15°C to 35°C, 45% to 75％Relative Humidity
  Less than 1 month: -4°F to 113°F (-20°C to 45°C), 45% to 75％Relative Humidity
  Less than 3 months: 14°F to 95°F (-10°C to 35°C), 45% to 75％Relative Humidity

- Avoid Using Trickle Chargers
  Connecting a trickle charger is not recommended, unless the charger is sophisticated enough to know to shutdown at 14.2V or below. Over-charging the battery triggers the over-charge protection which shuts the battery down until the voltage goes down enough by itself. Once

that happens the trickle charger would quickly raise the voltage up too high once again. As a result, the constant cycling of this circuitry will shorten the life of the entire battery.

- Before Re-Commissioning the following steps should be taken:

1. **Ensure Batteries are at 11.5-12.5V or 14.0 – 14.2V Before Putting into Operation**
   When putting the batteries back into operation, be sure that the batteries are within operational range prior to initiating charging and all exactly the same voltage. The exact same voltage must be chosen between 11.5-12.5V or 14.0-14.2V (but not in the 12.6-13.9V range because the levels of actual state of charge can vary with minute voltage differences). See the Pre-Installation instructions above.

2. **Ensure All Batteries are no More than 0.2V from Each Other**
   Verify the voltage of each individual battery to ensure they are still all within 0.2V of each other (or less). If not, you will need to re-perform the charging step found in the Pre-Installation section of this manual above.

   Because of the nature of the voltage versus state of charge curve of the Lithium battery, the voltage differences will be most pronounced with any of the batteries is nearly full or nearly discharged (i.e. 14.0-14.3V or 11.5-12.5V). It is recommended to check that all voltages are within 0.2V of each other at these nearly full or discharged levels.

   Checking voltage differences in the 12.6-13.9V region is not useful to ensuring all of the batteries are really at the same state of charge (see the illustration below to better understand the voltage to state of charge curve better).

3. **Charge More Slowly at First in Very Cold Conditions**
   If ambient temperature is below 39°F (4°C), reducing the initial charge current to no greater than 60A until the batteries have had a chance to warm up is recommended before introducing the nominal charge rate of 100A.

8.0 – Certifications

- UN DOT
- IP55 Rated

9.0 – Disposal

- Do Not Incinerate
- Recycle in accordance with local laws and services

10.0 – Troubleshooting and Q&A

1. *Why is the battery bank is suddenly shutting off?*

   Possible Cause 1:
   It is likely that one or more of your batteries are not truly at the same state of charge as the others. Those batteries are hitting the upper or lower voltage limits ahead of the others and the BMS is shutting them down.

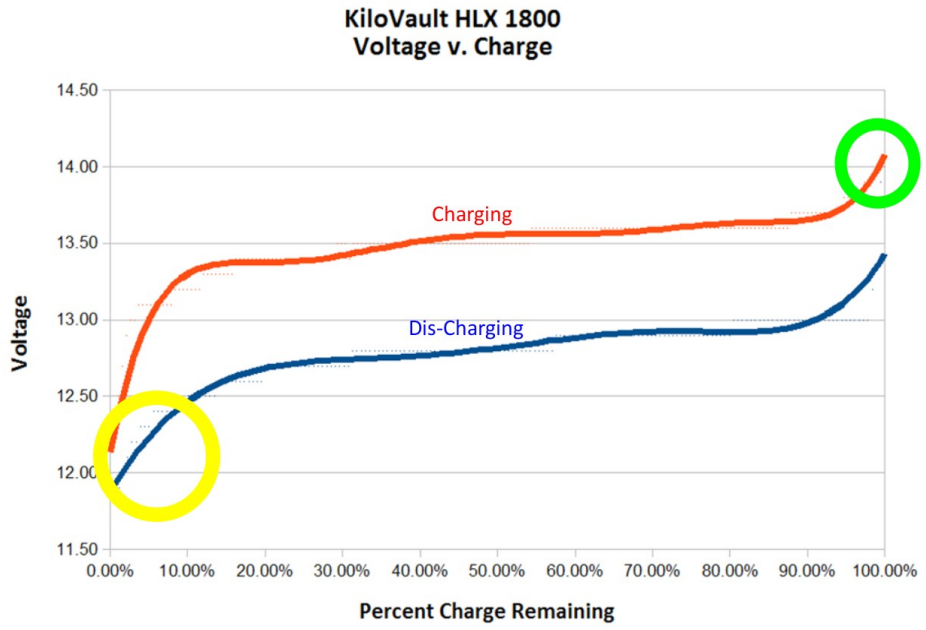


Illustration 3: To ensure that the batteries don't unexpectedly shutdown they all must be charged to (or discharged to) the exact same voltage. That voltage must lie either on the upper end of the charge curve where it flares up (green circle) or the lower end (yellow circle).

Solution:
The batteries must be individually charged to the same voltage at the part of the LiFePO4 charging curve where either the voltage quickly swings up (between 13.8V-14.4V, circled in green in the graph below) or, less preferably, discharged to where the voltage quickly drops off (between 11.5-12.5V circled in yellow below). Consider using a simple 12V AC charger but it must be able to achieve 14.0-14.4V. Use a multimeter or voltmeter to ensure that once the batteries are fully charged they are all at the same voltage.

Possible Cause 2:
Your load (i.e. inverter or DC load) has exceeded the current capabilities of the batteries. The KiloVault batteries are capable of handling 150A continuous, and for a very brief moment handle up to 500A for a surge load. If your load is known to be close to 150A continuous or has a couple of very high surge loads (e.g. pumps, AC/HVAC systems, etc.) it is possible that the load is simply too high for the bank.

Solution:
Adding an additional parallel row of KiloVault batteries will increase the current capacity of the bank. Note that in the case that one battery shuts down or if the bank is not voltage balanced it is possible that despite having multiple parallel rows a row shutdowns down and the current capacity is reduced to that of the remaining rows. This example is another good reason to make sure your batteries and the rows are all at exactly the same voltage.

2. *The battery Voltages do not remain equal over time. What's going on?*

Possible Cause 1
Battery cables are not of equal length or damaged.

Possible Cause 2
Cable terminal hardware not tightened properly.

Solutions:
Ensure all interconnects are of equal length, gauge and are in good condition.

Ensure all terminal hardware is properly tightened.

Using the Ohms setting on a standard voltmeter measure and record the resistance between the cable lugs on each of your battery cables to ensure proper contact between the wires and the terminal lugs.

3. *The battery has reversed polarity – what is happening?*

Possible Cause 1
Battery voltage dropped below operating range and BMS protection has initiated

Solutions
Verify voltmeter probe orientation.

Wait for battery to reset itself or introduce a charge to manually reset.

Possible Cause 2
Faulty BMS

Solution
Contact kilovault.support@altestore.com

4. *I have a small DC device/inverter connected to battery and it seems the battery is turning off and on. Is something wrong?*

   Possible Cause 1:
   The KiloVault batteries have an automatic standby mode where they will shut themselves down if they do not see a load of more than 200-250mA. That is about 3 Watts per series battery (i.e. 3 watts for a single 12V battery, 6 watts for 24V series, 12 watts for 48V). In the standby mode the battery turns back on about every 15-20 seconds to search and see if there is load connected to it. If you're load is not larger than this minimum current then the battery will not stay on.

   Solution:
   Consider connecting an additional small DC load to the batteries to increase the current draw to over 250mA. If you are using an inverter, it is possible that it is going into its own standby mode and it is consuming less than the minimum current required to keep the batteries on. Also for this case of the inverter, consider adding another small additional DC load to increase the current draw to over 250mA.

5. *Can you Charge your batteries with your RV Alternator?*
   As long as the alternator provides less than 150A of charging current and does not exceed 14.0V it can be used.

6. *What size is the terminal mounting hardware?*
   M8 x 1.25 x 16mm (Models shipped before 10/31/2018 will be M8 x 1.25 x 12mm)

7. *What voltage settings do you recommend for a generator?*
   We recommend a low-voltage start of 12.3V and a cut-off voltage of 13.9V (multiply those numbers by 2 for 24V and 4 for 48V systems).

8. *What voltage settings do you recommend for 80% depth-of-discharge?*
   We recommend an absorption voltage of 13.8V, float voltage of 13.7 and low voltage disconnect (for the inverter or DC load) of 12.2V. Multiply those values by 2 for a 24V system and 4 for a 48V system.

9. *Do I need a special 'app' to connect via Bluetooth to the batteries?*
   Yes. Currently there are apps only available for Android and iPhone and can be found on their

respective stores by searching for 'KiloVault'. Your smartphone's Bluetooth must be turned on for the app to find the batteries. Android requires location services to be turned on for the app to work. The app has been found to not work on some models of Android phones. Please note that the app is not officially supported but provided as a free troubleshooting tool.

10. *I understand that the batteries have to be **all** charged up to the same voltage of a recommended 14.1V DC but my inverter does not have an AC charger. What can I do?*

    There are a couple of options for you:

    a) Use a 12V AC charger (capable of charging up to 14.1V) connected to a generator or the utility company's power to charge each battery. We recommend the Iota Engineering DLS series of 12V AC Chargers that are capable of being configured for this slightly higher voltage.
    b) Use a 12V solar charge controller (set to 14.1V or 'sealed battery' charging, as long as it gets to 14.1V) with a solar panel to charge up the batteries individually. This method will take longer than an AC charger unless you are using a high amperage charge controller will sufficient solar panels.
    c) (least recommended option) Carefully discharge the batteries all to a precise voltage (down to 1/10th of a volt) between 11.9 to 12.3V (e.g. select a voltage of 12.2V DC). You will need to carefully monitor the voltage with a voltmeter or multimeter to make sure you remove the load discharging the battery right when it hits that precise voltage. We recommend using a discharging load of no more than 50A (i.e. maximum of 600W) so they don't discharge so fast you miss the exact point when they hit the targeted low voltage.

    Note that in all of the cases above (whether your are charging or discharging) the voltage will either 'relax' back down a few tenths of a volt when you remove the charger or go back up when you remove the DC load on the battery. Don't panic. That's ok. The important part is you stop the dis/charging at the same point in time when it reaches those target voltages.

11. *I have a simple battery monitor or a low power device connected to the battery and it seems the battery is cycling, turning off and on. What's going on?*

    The KiloVault batteries need a minimum of 250mA to be drawn or they will go into their power saving, standby mode. The simplest solution is to connect additional loads to reach at least 250mA (3 Watts).

12. *The voltage on the battery momentarily drops when a load is initially connected – what's going on?*

    This is normal result of the battery switch from it's pre-charge function to provide enough

current when connected to devices that have input capacitors and, in turn, high current surges in an extremely short period of time. The battery will resume its normal voltage and function mode within a few short seconds afterwards.

13. *The battery is not working when it is connected to the inverter.*

    Some inverters have higher input capacitors whose current draw overcomes that of the pre-charge function of the battery. To minimize the initial discharge when the batteries are initially connected to the inverter, make sure that the inverter is off while connecting. Then wait 45 seconds before powering up the inverter.

14. *The Bluetooth app is show a short circuit event in the log. What's happening?*

    When the battery is connected to a DC load or a charging load the pre-charging function of the battery is disabled. That pre-charging function is used to compensate for the surge capacitors on the input side of inverters and other devices. This order of connecting devices may trigger the short circuit protection in the BMS once the high inrush device (usually an inverter) is connected. The solution here is to disconnect all devices from the battery (even battery monitors), first connect the inverter, wait 45 seconds and then connect the remaining devices.

    Warning: Repeated triggering of the short circuit protection may damage the BMS circuitry.

IMPORTANT – PLEASE READ!

1) Each battery must be individually charged to exactly a voltage between 14.1V and 14.2V (choose one and use it for all batteries) before placing it into operation with other batteries. Otherwise, the batteries will independently hit 'full' or 'empty' and shut off before others in the same battery bank.

2) Equalization charge <u>must be turned off</u> in your solar charge controller or AC charger. If left on, the equalization charge will raise the voltage too high and damage the batteries.

3) Bulk/Absorption charge voltage should be set to no higher than 14.1V for a 12V system (of 60A charging current or less), 28.2V for 24V system, and 56.4V for a 48V system. Going any higher risks one or more batteries automatically shutting off in a high voltage protection mode.

4) Similarly, the 'Low Voltage Cut-Off' on the inverter should be set for no lower than 12.0V, 24.0V and 48.0V for a 12V, 24V and 48V system, respectively. Going any lower risks one or more batteries automatically shutting off in a low voltage protection mode.

5) When turning on or flipping on breakers to inverters, charge controllers, battery monitors, etc. connected to the batteries wait 45-60 seconds between powering up each device. The KiloVault's battery management system has special circuitry to detect short circuits and protect itself. Many brands of inverters, charge controllers and battery monitors will present a very high but very brief surge that can be interpreted as a short. The KiloVault can handle one of these 'shorts' every 45-60 seconds.

Alternatively, in most circumstances all devices can be powered up at once but the batteries will go into auto-protect mode and turn off for 30-60 seconds but then restart normally.