

Kendrick Lithium Iron Phosphate (LiefPo4) 50 Amp Hour Battery Packs

User Guide



Model Versions: SKU: 2084 (Base Model) and SKU: 2084-XX which has a built-in “DC Power Supply (inverter) to boost voltage to either 15V / 18V / 24V / 48V”.

Congratulations on your purchase of a Kendrick Lithium Iron Phosphate Power Pack. With proper care, this portable power pack will last decades. It is designed to deliver sustained 12V power over long periods of time. Most astronomers will draw less than 10 amps and for many, this power pack can power your astronomy gear for several nights before needing recharge.

Another advantage of LifePo4 batteries is rapid charging. Unlike a lead-acid battery that can take hours to charge the last 20%, a LifePo4 battery charges at full speed right up to the last 5% (float). With the right equipment, it is also ideally suited for Solar Charging. Portable solar panels and a MPPT Charge Controller can connect to the Anderson Power Pole ports on the Power Pack and rapidly recharge during daylight. Easy!

Lithium Iron Phosphate is just 1 of several “lithium chemistries” but it is consider the “safe” version because it does not experience “thermal runaway” like lithium Ion or other lithium variants that include cobalt, nickel, manganese, aluminum. Lithium Iron Phosphate has slightly less “energy density” than other chemistries but has the advantage of safety and exceptional lifespan.

This power pack differs from most general consumer brands in that it is purpose designed to deliver true native (NOT simulated) 12V power. Almost all astronomy equipment was designed to be run using a 12V car battery, so it is ideal for reliable power in the field.

Compared to some of the consumer brands (and even some astronomy brands), you will notice that there are no AC outlets or gadgets like reading lights, radio, and other components. Our design choice was to keep the physical size small and fill the space with battery capacity rather than bulky and unnecessary gadgets. Quite often, the consumer brands give you a “simulated” 12V power port, but the battery itself is NOT 12V and the component that boosts voltage to 12V is unable to deliver the amount of current (amps) that a typical astronomy rig requires.

Do you need AC Power? This Power Pack is well suited to connecting a small AC Inverter to one of the 12V power ports. A typical portable astrophotography setup would have mostly 12V equipment, but if your laptop computer power supply needs 120VAC, an AC Inverter is ideal and they are an easy find everywhere. For example, a 300W Pure Sinewave† model is approx. \$50.00.



† We strongly recommend you only consider “Pure Sinewave” models.

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All Models Feature:

- A rugged steel enclosure
- Padded carry bag
- 50 Amp-Hour capacity – Useable Capacity†: 100%
- Ultra “flat” voltage curve where voltage tends to be constant until the last few % of remaining capacity.
- 2 cigarette lighter sockets†.
 - †Optional “inverter” models (voltage step-up to 15V/18V/24V/48V) exchange 1 of the cigarette lighter sockets for a 3-pin “XLR” connector and ON/OFF switch.
- 2-banks of dual Anderson Connectors (total of 4 power port positions).
- Resettable Circuit Breakers
- USB Charge Ports
- A battery 10 Amp LifePo4 Battery Charger connects to any of the Anderson Power Pole ports for recharging
- On-Board Battery Monitor with LCD Display. This is a high-end “shunt” based monitor that continuously meters incoming & outgoing current (amps), Voltage, and calculates an accurate State of Charge.
- Bluetooth Smartphone Battery Monitor App.
- On-board Battery Management System (BMS) which continuously monitors the health of the battery pack to protect against:
 - Over discharge current (amps)
 - Temperature extremes
 - Internal cell balancing

† Temperature, state-of-charge, voltage will influence actual useable capacity.

Terms Used:

- **SOC** = State of Charge
- **BMS** = Battery Management System

Anderson Power Pole Connector Polarity

Anderson connectors are arranged in a “bank” of 2 circuits sharing a common Circuit Breaker. It means you can connect 1 or 2 devices here. Anderson Connectors are always 12V output.

Red = +POS / BLACK = -NEG

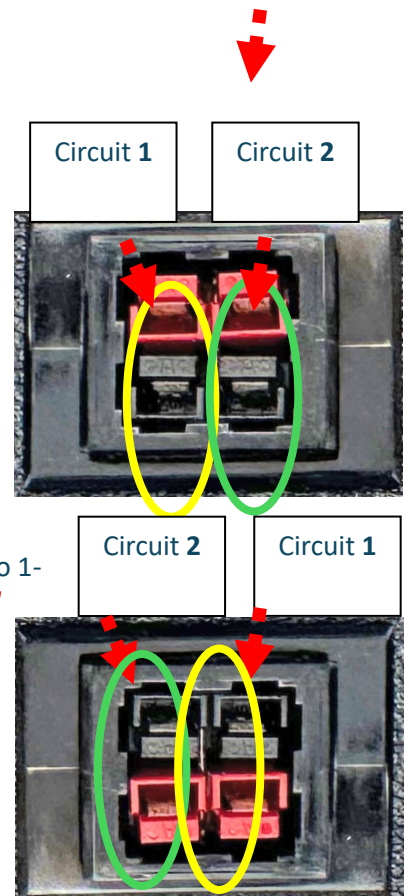
Mating circuits are “stacked VERTICAL”.

Beware that there is no “universal” plug orientation for Anderson Connectors. Unlike a “circular connector” where center is almost always +POS, Anderson connectors can be arranged in many ways and no 1-way is either correct or incorrect. Kendrick uses “VERTICAL” stacking for OUTPUT power, but for some of our other products, INPUT power is “stacked horizontal” to prevent accidentally plugging things into the wrong place.

Beware: There is no “universal standard” for orientation of connectors, other than RED = +POS and BLACK = -NEG. Kendrick uses a “vertical stack” for OUTPUT power ports and “horizontal stack” for INPUT power. If you have Anderson power cords made by others, you may need to re-orient the connectors to mate with the Kendrick Power Pack.

Perspective

BOTH of these views here are identical. The only difference is which way the view is rotated.



Battery Specifications

Battery Type (Chemical Composition): LiFePO₄ (Lithium Iron Phosphate)

Nominal Capacity: 50Amp-Hour

Nominal Voltage: 12.8V – The internal “BMS” has high and low voltage protection that permits voltage range 14.6V – 10.5V

***Cycle Life:** 3500 times (charge/discharge).

*Useable capacity diminishes with time and can be improved by limiting depth of discharge to 20% SOC. With reasonable care, most owners can expect the usable capacity to be 80% even after 3,500 cycles.

Standard charge and discharge Charge/Discharge Current: 0.5C/0.5C (25 Amp)

Standard charge and discharge Charge/Discharge Cut-off Voltage: 14.6V/10.0V

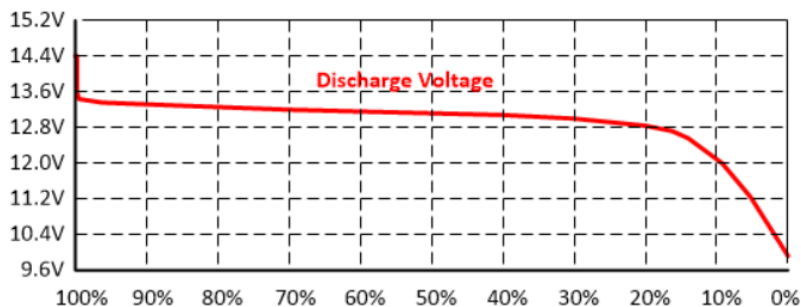
Recommended State of Charge Range : 10% ~ 90%

†Charging Working Temperature: 0°C ~ 55°C (32°F ~ 131°F)

Discharging Working Temperature: -20°C ~ 55°C (-4°F ~ 131°F)

†Beware that the onboard BMS will disconnect incoming charge current when the internal temperature is 0C (32F) or below, or over 55C (131F). Charging will automatically resume when the internal temperature returns to an acceptable temperature. The battery CAN provide outgoing power when internal temperature is within -20C (-4F) to 55C (131F). In cold temperatures, cold-soaked surfaces become a “heat-sink” and we recommend that you avoid placing the battery pack on a cold surface and consider placing insulating foam board under the battery pack.

Discharge Characteristics



A major advantage of Lithium Iron Phosphate is relatively “flat” voltage curve. Beware that excessively large loads will cause voltage to drop below the normal voltage curve.

Self-Discharge (idle):

The onboard electronics (BMS, LCD Monitor, and Bluetooth) require approx.. 0.03A and will deplete a fully charged battery in approx.. 60 days. The USB Charge ports and optional step-up voltage inverter will also add to the idle drain if left ON. The onboard BMS protects against over discharge and will shunt-down the battery once voltage reaches the minimum level. To revive, simply charge the battery. Discharging the battery to the point of shut-off does NOT damage the battery.

Best practices:

- 1) To achieve full capacity in the field is to place the Power Pack on-charge prior to usage.
- 2) Turn OFF USB Charge Ports and optional step-up voltage inverter when not in use.

Useable Capacity

The official technical specifications for the battery cells are that a new healthy battery can deliver 100% of its rated capacity, however there are some variables that could reduce the total available capacity.

- **Actual State of Charge.** Allow extra charge time so the charger completes the “float charge” cycle which is typically, the last 5%. That last 5% can take about 1 hour to top-off the battery to 100%. During the charge cycle, the internal “BMS” is also actively equalizing individual cell voltage.
- **Temperature.** All batteries, of any chemistry, don’t perform as well when internal temperature is extreme (low or high).
- **Age.** Official cycle life is 3,500 charge/discharge cycles. A LifePo4 battery that is handled with reasonable care should still deliver approx.. 80% of its rated capacity even after thousands of cycles.
- **Voltage.** When the battery is approaching empty, voltage will drop as low as 10.5V before the “BMS” disconnects power. But you may have some other equipment that has a low-voltage cut-off protection feature that shuts-down below 12.0V.

Long Term Storage Recommendation: For infrequent use, the lifespan of the battery pack can be protected by storing the battery at a 60-80% state of charge. If you think you won’t be using the Power Pack for 3-months or more, at the end of a session, look at the SOC and if remaining capacity is within 60-80%, consider delaying the recharge until you are ready to use the battery pack again.

BMS – Battery Management System Onboard

You can’t see it, but there is a BMS component built into the battery pack, and it monitors the battery and takes action to protect the battery from harm.:

- **Over voltage, over current** (amps)
- **Low voltage disconnect:** At 10V, the battery will disconnect. To revive, connect the charger.
- **Temperature**⚠️: When the battery temperature is outside the min/max range, the battery will disconnect.
- **Low Temperature Charging:** The one thing you can’t do with a LifePo4 battery is charge it when it’s frozen. Discharge down to -20C/-4F is OK, but the battery will need to warm-up before it will allow incoming charge current.

⚠️2 temperature sensors are located inside the battery enclosure. Beware that the internal temperature will differ from outside ambient air temperature.

Optional Step-Up DC-DC Power Supply (inverter) Models: 15V / 18V / 24V / 48V

2084-XX models have an on-board Step-Up power Supply that boost 12V battery voltage to a higher voltage (15V / 18V / 24V / 48V). It is intended to be used for telescope mounts that prefer voltage higher than 12V. The boosted voltage output is a 3-prong “XLR” connector and Kendrick manufactures custom power cords for popular telescope mounts:

<https://www.kendrickastro.com/telescope-power-cables.html>

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A toggle-switch turns ON output power. Turn OFF when not needed as it will deplete your battery if left ON

WARNING: Turn Inverter OFF before storing!

Even if nothing is connected to the inverter port, the inverter will drain the battery if left ON during long term storage. The nature of the low current draw is such that the BMS doesn't get triggered to shut-down, and the battery can drain all the way to zero, given enough time. Best practice advice... connect the charger. It will keep the battery topped off.



USB Charge Ports (2)

Dual charge ports support up to 36W/3A (combined) power demand. Use the power switch to turn unit ON/OFF. Leave OFF when not needed to prevent the battery from draining.

WARNING: Turn Charging Port OFF before storing!

Even if nothing is connected to the charging ports, there is a step-down power supply inside that will drain the battery if left ON during long term storage. The nature of the low current draw is such that the BMS doesn't get triggered to shut-down, and the battery can drain all the way to zero, given enough time. Best practice advice... connect the charger. It will keep the battery topped off.

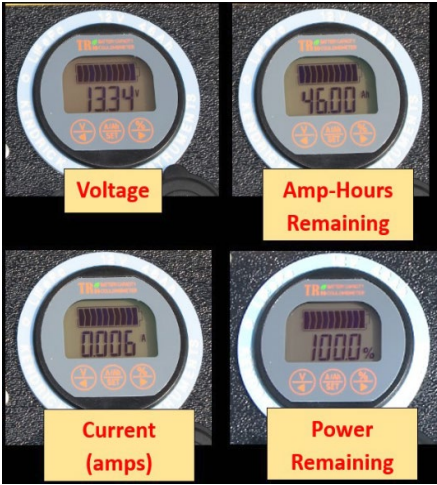
Circuit Breakers

Resettable circuit breakers protect against over-current (amps). If current is greater than the circuit breaker amp rating, the power will be disconnected by the circuit breaker. Depending on the type of power port, circuit breakers are:

- Cigarette sockets: 5A or 10A
- Inverter: 5A
- Anderson Dual “Bank” : 25A shared by 2 outputs



To reset the breaker: Unplug the equipment from the power port. The press down on the center of the breaker (they pop-up when tripped). You may need to wait until the breaker cools down as they are “heat” sensitive. You should also investigate why the equipment was drawing excess current, which could be that your equipment requires more current (amps) that the power port can support, OR there is a short circuit which often happens when we trip on unsecured power cords in the dark. Likely the most common....your mount snagged a wire and pulled it to the breaking point.



Battery Monitor LCD Display:

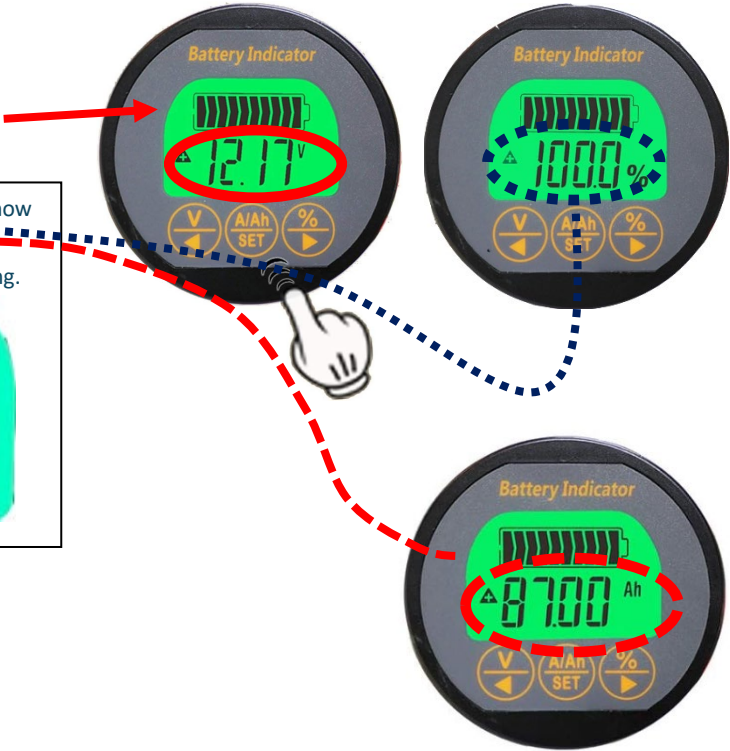
Because a LifePo4 battery has such a “flat” voltage curve, we can’t use voltage as an indicator of remaining available power. The Battery Monitor uses a “shunt” and continuously meters incoming and outgoing power.

The display allows you to see 4 data points that include:

- “Gas Gauge” shows power remaining as a graphic
- Voltage
- % percentage available
- Amp-Hours Remaining
- Rate of Discharge.

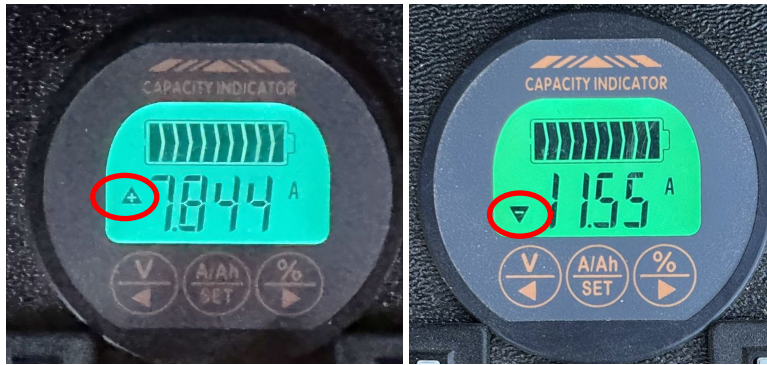
Note: During active charge/discharge, the display becomes illuminated. It is NOT possible to turn the light off, but the battery pack has a flap on the carry bag that will do a nice job of covering the light.



This setting will show how “fast” the battery is charging or discharging.



Understanding Charging vs. Discharging

When in “Current (amps) Meter Mode” (middle button)



 = Incoming Charge Current  = Discharging

To switch between data-points, press the applicable button (V, A/Ah, %)

Note: During active charge/discharge, the display becomes illuminated. It is NOT possible to turn the light off, but the battery pack has a flap on the carry bag that will do a nice job of covering the light.

Recalibrate the Battery Monitor:

State of Charge (% remaining) and Amp-Hour Capacity are values that can be recalibrated. We do this for you at the factory, but if you find that the display is not accurate, it can be easily recalibrated. The most likely reason you might need to do this is:

- 1) You accidentally pushed and held the button (which puts it into calibration mode)
- 2) The BMS disconnected the battery (protection mode), which also takes the monitor offline and programming is lost.

To reset the calibration, push the button to display the “mode” (AH or %SOC) then press AND HOLD the appropriate, then use the direction arrow buttons to increase/decrease the value.

Reset the battery capacity:

- Press the “A/Ah” button, then press and HOLD that button for 3 seconds.
- Use the arrow buttons (left arrow decreases, right arrow increases) to increase/decrease the value that represents the battery pack capacity. Use “50” as the amp-hour capacity
- Then press the A/Ah button to set the new value.

Reset The % Remaining:

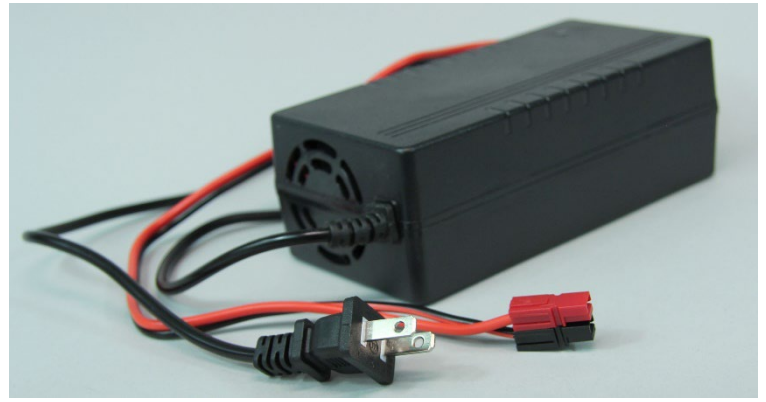
In most cases, the calibration for this is automatically “recalibrated” when you leave the battery on charge over a long period of time. If this value needs to be recalibrated, you first need to know what the current state of charge really is. The easy way to do that is to first charge the battery until you are certain it is full. But sometimes you’re not sure if the battery is finished charging yet. To be sure you are at 100%, use the monitor and switch to the “A/Ah” mode and look at the “rate” of current (amps) coming IN. When the battery is under charge, you will see that 9.5A-10A, is incoming, but when fully charged, you will only see a “trickle” (like 0.01A). Then you know you are at 100% and can now recalibrate. To do that:

- Choose the “%” mode, then press and hold that button until the display shows 100%

Charging the Power Pack

A 10 Amp Lithium Iron Phosphate Battery Charger is included with the purchase of your Power Pack. Simply plug the charger into 120VAC and connect to any of the Power Pack Anderson Power Pole ports.

This is a “Smart Charger” which means it knows when the battery is full and will automatically revert to “trickle charge” mode to keep the battery fully charged. You can safely keep the charger connected during storage.



NOTES:

- 1) This charger is specifically designed to charge 12V Lithium Iron Phosphate batteries. ***Do NOT use this charger for lead-acid batteries.***
- 2) If the Power Pack was used in extreme temperature (hot or cold), allow the temperature to normalize before attempting to recharge. The internal “BMS” will only allow incoming charge current to pass when the battery internal temperature is within charging temperature range of 0°C ~55°C (32°F ~131°F)

Lights

Yes, there are lights.

- Battery Monitor will illuminate when power flows (either during discharge or incoming charging)
- The USB Charge Port is illuminated when powered ON
- The power switch for the optional step-up voltage inverter is illuminated when switched ON

To shield light output, close the flap on the padded carry bag.

Bluetooth Battery Monitor

The on-board BMS system also provides a Bluetooth connection that you can use to monitor battery status using iOS and Android devices such as a Smartphone or Tablet.

The intended purpose is strictly for monitoring of voltage, current draw (amps), and State of Charge. Beware that this app also gives you the ability to alter battery settings but PLEASE DO NOT DO THAT!!!! **Settings preset by Kendrick should never be altered and doing so risks damage to the product.**

Step-by-Step Bluetooth Instructions:

1. To use the Bluetooth feature, DOWNLOAD and Install the “Smart BMS” on Apple Store or Google Play Store.
2. Look for the Product Label on the side of the Power Pack and take note of:



50Ah Lithium Iron Phosphate (LiefPo4)
Battery Pack with Bluetooth and Step-Up Inverter

Model SKU: 2084-XX

XLR Voltage Preset: 15V

Manufacture Date: September 20xx

Serial#/Bluetooth Device ID: KENDRICK 04E6

Bluetooth Password: 123456

- Bluetooth Device ID
- Password

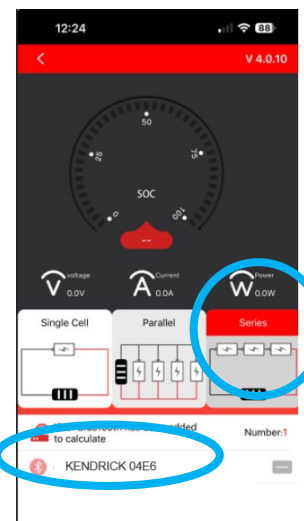
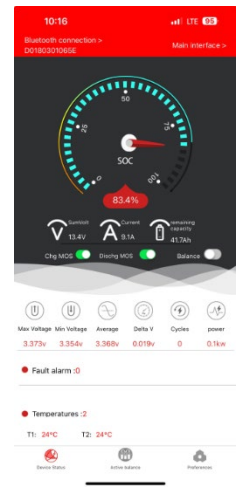
The app will ask for this information when you connect to the Power Pack the 1st time.

3. Now launch the app, THEN:

- Select “SERIES”
- it will show you devices nearby, then select the Device ID that matches the product label.
- The app will now display Battery Status

TIPS:

- 1) If the Device ID is not displayed, the battery pack might be in “Sleep Mode”. When idle, the BMS System will turn OFF Bluetooth. To awaken, discharge or charge the battery pack.
- 2) Technical Support for this app is NOT available from Kendrick. Contact the app developer (Daly) if you have any questions. We don’t want you to tamper with settings, so we will NOT answer questions about how settings are configured. The preset settings are exactly what they need to be for the type and capacity of the battery technology installed.



3rd-Party AC Inverter Options

Some owners will want to purchase an AC Inverter to power small devices that need 120V AC power. A laptop power supply is a good example. BEWARE that there are limits to how much power the Power Pack can supply. The output port you connect to will determine what the max limit is.

Understanding Power Draw: $\text{watts} \div \text{volts} = \text{Amps}$ **OR** $\text{Amps} \times \text{Volts} = \text{Watts}$. The “volts” refers to the 12V power pack.
le: you CANNOT power a 1200-watt hair dryer!!!!!!

Each output port has a circuit breaker that is either 5A/10A/25A. That will govern how many “WATTS” it will support.

- 5A @ 12V = 60 watts
- 10A @ 12V = 100 watts – *this is the maximum wattage available when your AC Inverter has a cigarette lighter plug power cord*
- 25A† @ 12V = 300 watts

† Remember that the Anderson outputs have 2-ports “per bank of 2” that share a 25A Circuit Breaker. So, if you have 2 things plugged into the same bank, your combined Amperage must be less than 25A.

TIP: You can use an AC-Inverter that is more that 300 watts capacity, BUT the power draw still cannot exceed 300 watts. The Inverter itself only draws a few watts when idle, but the device being power by the inverter is what will draw the bulk of the power.

Extreme Temperature Operation Tips

Lithium Iron Phosphate batteries are superior to conventional lead-acid batteries in harsh temperature, however, no battery, of any chemistry, performs well in extreme temperatures. These are a few basic tips that will help protect the power pack from experiencing extreme internal temperature.

- **When operating in extreme cold:**
Place the Power Pack on foam. Frozen ground is an efficient “heat sink” and foam will help reduce the rate that the power pack cools-down. Also shield from wind.
- **When operating in high heat:**
Shield the power pack from direct sunlight and ensure that there is plenty of ventilation. Rapid discharge can also generate internal heat. Remove the battery pack from the padded carry bag if you have a large load to power.