Experimental Power Packs for KX3 Radio

Along with the general Lithium-Ion safety guidelines detailed later in this document, here are more specific instructions regarding this DIY sample hardware applications project:

- All battery cells used in these devices must be charged to full capacity prior to each use in a specific charger designed for the voltage and chemistry, and immediately following each use. Any battery showing indications of improper charging, damage, heat, gas emissions or physical distress must be discarded following recommended procedures.
- Care must be taken when dislodging and inserting batteries into their holders. Do not use metallic implements to pry them up. Use wooden or plastic (e.g. a “popsicle stick”, toothpick or plastic guitar pick) to gently lift them up at the positive or button end.
- Care should be taken to exactly match the indicated polarity of the inserted batteries, per the molded outline picture in the case. Any deviation from this will be explicitly marked on the power pack case, and the original markings clearly removed, or rendered otherwise unreadable or covered, to avoid confusion.
- Batteries in a given power pack must be matched in terms of chemistry, voltage, manufacturer, age in service and state of charge. If necessary, measure the voltage of each cell, and ensure that they are within 0.03 volt of one another for parallel connections, and within 0.1 volt for serial, especially immediately after full charging.

Experimental power pack specifications:

You must not assume that the battery holder case reflects anything about the internal wiring. This experimental DIY project has rewired the holders to accommodate a particular electrical result, given the battery chemistry and voltage for which it was designed. Please follow carefully the “+” and “-“ symbols marked on the case, or affixed label.

Model : 4S1P32LFPO: 4 x 3.2V Li-Fe-PO4 14500 "AA" cells ONLY. EST WH 7.7

No other chemistry, battery voltage or size is supported. Maximum continuous power dissipation allowed is 12W at 1.2A, or up to 24W at 2A intermittently at 50% duty cycle. Power pack has no BMS, hence the battery level indicator must be checked periodically, and power pack use discontinued immediately upon reaching the lowest level, whereupon the batteries removed and recharged after a few minutes of rest. Any signs of overdue heating or other stress should be grounds for retiring the batteries and / or the power pack itself. Estimated KX3 run time at full power = 15 min, with 600 mah batteries.

Model : 4S2P32LFPO: 8 x 3.2V Li-Fe-PO4 14500 "AA" cells ONLY. EST WH 15.4

No other chemistry, battery voltage or size is supported. This power pack is wired for parallel current sourcing of two (2) independent 4 battery sub-packs, using a simple proprietary circuit. Maximum continuous power dissipation allowed is 30W at 2.4A, or higher if less than 100% duty cycle at no more than 2.4A average current. Power pack has no BMS, hence the battery level indicator must be checked periodically, and power pack use discontinued immediately upon reaching the lowest level, whereupon the batteries removed and recharged after a few minutes of rest. Any signs of overdue heating or other stress should be grounds for retiring the batteries and / or the power pack itself. Estimated KX3 run time at full power = 30 min, with 600 mah batteries.

Model: 4S3P32LFPO: 12 x 3.2V Li-Fe-PO4 14500 "AA" cells ONLY. EST WH 23

No other chemistry, battery voltage or size is supported. This power pack is wired for parallel current sourcing of three (3) independent 4 battery sub-packs, using a simple proprietary circuit. Maximum continuous power dissipation is not specified, except that average current dissipation must remain below 3.6A, regardless of duty cycle. Power pack has no BMS, hence the battery level indicator must be checked periodically, and power pack use discontinued immediately upon reaching the lowest level, whereupon the batteries removed and recharged after a few minutes of rest. Any signs of overdue heating or other stress should be grounds for retiring the batteries and / or the power pack itself. Estimated KX3 run time at full power = 40 min, with 600 mah batteries.

Model: 12S1P12NMIH <u>12 x 1.2V NMiH "AA" cells ONLY</u>. EST WH 29

No other chemistry, battery voltage or size is supported. This power pack is wired for series connection of all 12 batteries, yielding a nominal 12 – 16V voltage range. Maximum continuous power dissipation is about 16 watts, where the voltage will have dropped to about 10V. Power pack has no BMS, hence the battery level indicator must be checked periodically, and power pack use discontinued immediately upon reaching the lowest level, whereupon the batteries removed and recharged after a few minutes of rest. Any signs of overdue heating or other stress should be grounds for retiring the batteries and / or the power pack itself. Estimated KX3 run time at fill power = 60 min(*), with 2000 mah batteries.

(*) Note that while the NMiH pack, based on the math has higher capacity, it will not deliver its energy at a voltage high enough run the KX3 at maximum power. And its power delivery curve is not as flat as lithium. Thus the NMiH pack will last "longer," but at perhaps an unsatisfactory performance level in this application. The lithium battery packs may not last as long – clock time, but will allow the KX3 to run at maximum power output for nearly that full time.

Model : 5S1PLIPO "Ninja" KX3 Power Pack <u>5 x 3.7V Li-ion "18350" PROTECTED</u> . EST WH 22 - 26

No other chemistry, battery voltage or size is supported. This power pack is wired for series connection of all 5 batteries, yielding between 15V (safely discharged) and 21V (fully charged). This output voltage is supplied to a fully shielded buck converter, set for 14.2 – 14.6V output. An internal BMS is provided for additional protection over the individually protected cells. DIY Build to order is available here.

18350 (1200 – 1400mah) (PROTECTED): This combination allows this very small footprint to deliver over 40 watts of DC at 14+ volts, for up to 15 minutes continuous, or for up to 45min at 50% transmit duty cycle. With "Power ninja" you can boost your KX3 to full 15W transmission at the flick of a switch, from a compact "grab and go" format. In the pictures shown, the batteries are 18mm diameter x 38mm long, requiring specially adapted battery holders to accommodate the longer profile.

Mandatory Safety Precautions:

- DO NOT use the KX3 Power ninja, for continuous transmissions of data or audio for more than 15 minutes at a time. The batteries are likely to get warm, but they should not be too hot to touch.
- DO NOT, under any circumstances use unprotected batteries. They will work, but it is not safe.
- Check the maximum discharge rating of the batteries you select. Typical consumer grade cells at the time of this writing can be safely discharged at up to 3A, and down to 3V under load. The KX3 Power ninja has been designed to respect these limits, but the higher the discharge rating of your batteries, the less stress you will subject them to, and they will run cooler to the touch.
- Do not use this pack, if output voltage meter shows greater than 15V with fresh fully charged batteries
- Do not use this pack, if output voltage meter shows less than 14V with fresh fully charged batteries

- Discontinue use immediately if the voltage output drops below 14V. This indicates that the internal BMS might have failed.

Li-Fe-PO4 Reference Information

In general, the safest **charge rate** for Li-Fe-Po batteries is **1C**. The **1C charge rate** for a battery with 600mAh is 600mA. Discharge rates are allowed above that, but not generally above 2C, in order to maximize battery lifespan. A discharge rate of 2C for a 600mah battery is thus 1.2A. At full charge, 4 x 3.2V Li-Fe-PO4 can read up to 14.8V, quickly dropping to the nominal 12.8V or less during use. A voltage of 2.0V per cell (8V for 4 cells in series) is the absolute lowest voltage that a 3.2V cell can be discharged to. The slim power meter strips used in these power packs indicate depletion at about 10V, giving a good margin to allow for periodic manual observation.

Powerstream LiFePO4 web Page: Some easy to read information.

Li-ion Battery Safety (Credit: Orbitronic.com)

WARNING + Li-ion BATTERY SAFETY INSTRUCTIONS:

IMPORTANT BATTERY SAFETY INSTRUCTIONS AND WARNINGS | ALL LI-ION BATTERY USERS MUST READ BEFORE USING LITHIUM-ION BATTERIES.

Failure to read, and follow Li-ion safety instructions, and warnings may result in fire, personal injury, and property damages if the battery is charged and/or used improperly.

- **DO NOT SHORT CIRCUIT. Short circuits may cause a fire and injury!**
- Charge battery fully to 4.2V before first use.
- Use high-quality charger specifically designed to charge Li-ion batteries.
- Do not charge unattended.
- Always keep your battery that is not in use inside the plastic battery holder(container).
- Do not keep a bare battery in your pocket, purse, or anywhere together with other metal (conductive) objects.
- Never attach any metal moving part |magnet| to the top positive or the bottom negative battery contact.
- DO NOT USE WITH E-CIGARETTE, VAPORIZER, (E-cig, vape, mod) OR SIMILAR DEVICE
- Stop using the battery with damaged PVC tube (wrap) or terminal insulator immediately.
- If the battery is damaged in any way stop using it immediately.
- Never discharge a Li-ion battery at a rate exceeding the maximum discharge current specified for that battery.
- Never use force to install (insert) Li-ion battery.
- Do not use old, and new batteries together.
- Do not solder directly onto the battery.
- Do not immerse in any liquid.
- Do not drop the battery. Always keep it in a plastic protective holder.
- Do not place the battery in high-pressure containers, microwave ovens, or on induction cookware.
- Immediately discontinue use of the battery if, while using, charging or storing the battery, the battery emits an unusual smell, feels hot, changes color or shape, or appears abnormal in any other way.
- Do not carry, or store the batteries together with hairpins, necklaces, or other conductive metal objects.
- Use only high-quality battery Li-ion charger (CC/CV 4.2V max).
- Do not expose to heat.
- Do not disassemble, or modify the battery.
- Keep the battery away from children, and pets.
- Never charge, or store the batteries inside your car in extreme temperature. Extreme temperatures (low or high) might ignite the battery, and cause a fire.
- Do not short (connect) positive, and negative battery terminals (contacts) intentionally, or unintentionally.
- Never charge the battery over 4.25V (properly charged li-ion battery is 4.2 Volts / full charge).
- Do not reverse the positive (+) and negative (-) terminals when charging, or using the battery.
- Never charge the battery at a current exceeding manufacturer-specified charging current.
- Do not expose the battery to water or salt water, or allow the battery to get wet.
- You must verify polarity before connecting the battery to the host device (or charger).

- Never completely discharge the Li-ion battery (below 2.5V under load).
- After the battery is discharged-don't leave it discharged-charge battery as soon as possible (10 min. rest time).
- It is your responsibility to determine that your charger and host device works properly.
- On (battery electrolytes) exposure to skin, flush with water immediately.
- If eye exposure occurs, flush with water for 15 minutes, and seek emergency care immediately.
- Always keep metal objects or other materials that can short circuit battery terminals away from the batteries

What is short circuit?

The situation when battery positive (+) and negative (-) connect. The current will become extremely high because there is no resistance in the path to limit current flow. This Short circuit will result in dangerously high temperature which may cause a fire.

Warning:

The use of any unprotected li-ion cylindrical battery as a stand-alone device, including with e-cigarettes, vaporizer mods or other products, constitutes a DANGEROUS misuse of the battery cells that poses a SERIOUS RISK of personal injury or property damage. These cells are only for prototyping with proper electronic protection circuits, and not for stand-alone use.

Warning:

These are high discharge current & high capacity Li-ion batteries. If mishandled or mistreated, these batteries can cause you SERIOUS INJURY. USE AT YOUR OWN RISK.