

Batteries for the Elecraft KX3 and Other Low-Power Radios

How to choose batteries for portable operation.



Eliot Mayer, W1MJ

I assembled an Elecraft KX3 low-power (QRP) transceiver from the no-solder kit, and have enjoyed operating portable with it, from ARRL Field Day on a mountaintop in New Hampshire to the shores of Easter Island as CEØY/W1MJ (see the sidebar, “Must-Haves for Portable Operation,” for some tips). Choosing a battery for these field operations with the KX3 was not obvious. Choices for other QRP radios are similar, but there are differences too.

Battery Types Considered

The KX3 has an internal battery case for eight AA cells, but I did not find this a very useful feature. I was also concerned about having this case pressing directly against the delicate surface-mount components in the radio. Elecraft said that there were no reported reliability issues caused by this arrangement. Even so, I removed the holder and turned it into a spare external battery pack that holds non-rechargeable, long shelf life lithium cells. It serves as a backup to my rechargeable batteries.

The selection of rechargeable batteries for a QRP radio depends mainly on weight and budget considerations. The radio specifications and intended usage also factor in. I carried the radio up the 4,000-foot Galehead Mountain in New Hampshire at age 60, so weight was a big factor for me. Also, because I transmit only with the traditional QRP upper limit of 5 W, I can use lower voltages than the KX3 requires for operation at 10 – 15 W. Check the manual about power supply requirements for other radios.

Table 1 summarizes the most common rechargeable battery options. Lithium-ion batteries are very lightweight, but they are available only in multiples of the 3.7 V cell voltage. An 11.1 V battery works well for a KX3 at 5 W operation.

Must-Haves for Portable Operation

For battery-powered portable operations, be sure to bring spare batteries, even if they don't match the capacity of your primary source. You may just need enough energy to finish a contact and end your session.

Many hams log contacts using computers, but bringing along laptops, smartphones, or GPS devices means more battery consumption. To keep things simple, always take along a compass and map for navigating, and use a pen and paper for logging contacts.

Weatherproof carrying cases for equipment can help protect expensive gear. To protect yourself, bring bug spray, sunscreen, a first aid kit, and water on every portable excursion.

Table 1
Summary of Rechargeable Battery Types

Battery Type	Cost	Weight	Comment
14.8 V lithium ion	High	Lowest	Requires voltage reducing circuit
11.1 V lithium ion	High	Lowest	Limits KX3 to 5 W output
12.8 V lithium iron phosphate (LiFePO ₄)	High	Low	Good overall choice; author's favorite
12 V sealed lead acid	Low	High	Best choice on a budget

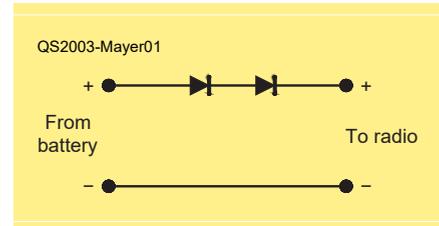


Figure 1 — A simple battery voltage reducer.

A 14.8 V lithium-ion battery can run the KX3 at its full 15 W output. However, its voltage when fully charged exceeds the KX3 15 V power supply limit, so a voltage reducer or regulator is needed. Two series diodes (see Figure 1) rated at least 2 A and 25 V in the power cables should suffice. 1N5402 diodes (Digi-Key 1N5402RLGOSCT-ND) are appropriate for this task.

Phil Salas, AD5X, developed a circuit with two such diodes and a relay that bypasses the diodes when the battery voltage is below 15 V (see his article in the April 2015 issue of *QST* for more information). I also found a solution using an efficient switching regulator in KR7W's SOTA Adventure Blog (www.kr7w-sota.blogspot.com/2013/01/qrp-ops-battery-power-fyi.html). However, looking at the flat spot from 13 V to 15 V in Figure 2, it appears that the AD5X and KR7W circuits might not extend KX3 operating time per charge beyond that of the simple two-diode approach. More KX3 power consumption data is available on the www.arrl.org/qst-in-depth web page.

Supply Current vs. Supply Voltage

Battery capacity is measured in ampere-hours (Ah). A 5 Ah battery should nominally deliver 1 A for 5 hours. For more on battery capacity, see Rick Palm's, K1CE, "Public Service" column in the March 2015 issue of *QST*. When selecting a battery for your radio, consider that its power supply current may vary with battery voltage.

The current-voltage relationship goes in opposite directions on different QRP radios. According to measurements by Clinton Turner, KA7OEI, the Yaesu FT-817 draws more current as the power supply voltage increases (www.ka7oei.com/ft817_pwr.html). My own measurements show that the KX3 current



decreases as the voltage increases. For 5 W operation, the KX3 supply voltage can range from 9 to 15 V dc, and power supply current is significantly lower at 15 V than at 9 V. This is probably because efficient switching voltage regulators are used for some of the radio circuitry. Switchers draw approximately the same power independent of the input voltage, so current goes down as voltage goes up.

Figure 2 shows my KX3 measurements with the radio set for 5 W transmit power on 14.060 MHz. The backlight, preamp, and receiver isolation amp (RX ISO) were all turned off — they would consume an additional 53 mA when on. I calculated the average power at 25% transmit duty cycle; this duty cycle is based on active Field Day CW operation using full-break-in keying, where the radio switches to receive mode between every dit and dah. In the semi-break-in mode, the radio uses more than double the power between dits and dahs than it uses during receive.

Battery and Charger Suppliers

I strongly recommend buying battery packs that include protection against over-charging, over-discharging, and over-current. One example is the LiFePO₄ 18650 battery, rated at 12.8 V and 4,500 mAh, available from www.batteryspace.com

UN38.3 Battery Certification

Occasionally, you'll read stories about lithium batteries in laptop computers, cell phones, and other devices suddenly overheating and bursting into flames. These incidents are rare, but they are destructive and even potentially life threatening when they occur.

A number of years ago, the United Nations established strict standards concerning transportation safety when it comes to lithium metal and lithium ion cells and batteries. These standards have been adopted by most nations.

For a battery design to receive a UN38.3 certification, it must pass a series of rigorous tests that subject the battery to:

- Low air pressures
- Extremes of heat and cold
- Powerful vibrations
- Severe impacts
- External short circuits
- Crushing
- Overcharges
- Forced discharges

Failure to pass any of these tests means that a battery cannot be shipped by air, rail, boat, or vehicle, or be used to power a device that might be transported in this fashion.

and other battery and battery accessory suppliers, like Bioenno Power (www.bioennopower.com) and Powerwerx (powerwerx.com/batteries-chargers).

The battery is UN38.3 certified, which means that the battery is safe to transport (see the sidebar, "UN38.3 Battery Certification"). It is wise to purchase batteries with this designation. It is also a good idea to purchase a matching charger, as recommended by the seller. Clicking "Related Products" on the Battery Space web page for the 12.8 V battery shows such a charger. Other chargers, such as solar chargers, are also okay as long as you follow the charging specifications for the battery.

Not surprisingly, it is easier to find batteries online these days than in physical stores. An online search will show many more suppliers than the few I have mentioned, but physical battery stores do still exist. For example, check the store locator for Batteries + Bulbs to see if one is in your area (www.batteriesplus.com).

It is also possible to assemble your own battery pack from components, just like my friend Jacques Patry,

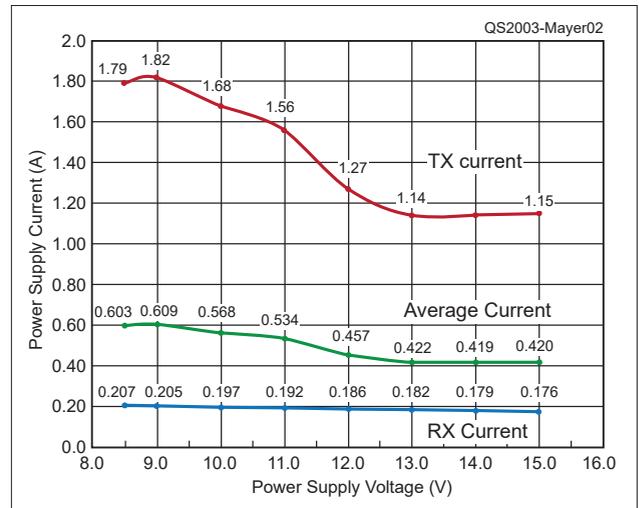


Figure 2 — Power supply current versus voltage for the KX3. Other QRP radios have very different current versus voltage behavior.

WD11, does. He shops on sites like www.aliexpress.com and www.banggood.com. Jacques mentions that you should be sure to include a battery maintenance system (BMS) board. It prevents over-charge and over-discharge. It also equalizes the charge on each cell and maintains equilibrium.

Summary

Battery selection for your QRP radio depends primarily upon your budget, and on the importance of weight for your planned usage. Sealed lead-acid batteries are the best choice for hams on a budget. Lithium iron phosphate (LiFePO₄) batteries are much lighter, but are more expensive. Lithium-ion batteries are priced similar to lithium iron phosphate batteries, and are even lighter, but the available voltages are not always a good match for the radio. I hope this helps you select a battery for your QRP radio.

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