Application Note: Using the K1 with a 9.6-volt Battery Pack

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If you take your K1 hiking or camping, chances are you'll want a small battery pack. The rig works great running from a 12-V battery, putting out typically 5 watts on all available bands.

The 9.6-Volt Option

Another excellent choice, especially for backpacking, is to use 8 AA-size NiMH cells. These batteries have a nearly flat discharge curve, so 8 cells will stay near 9.6 volts until they're almost discharged. The K1 will remain perfectly stable on transmit and receive down to 8.0 volts, squeezing a lot of extra life out of the pack (test results given below confirm this).

NiMH cells typically have a 1500 mA-h rating, which might translate to over 10 hours of normal operation, based on a current drain of 150 mA averaged over transmit and receive periods. For receive-only use, I'd expect over 24 hours of continuous operation, assuming an average RX current drain of 60 mA. Your mileage may vary, of course.

What Power Output Should I Use?

For a given supply voltage, the transmitter's power amp will be most efficient at a specific power output level. You can calculate the approximate level from the formula:

Po = V^2/(2*Z)

where Z is the PA impedance. In the case of the K1, Z is 12.5 ohms, because of the 1:4 step-up transformer at the output.

Plugging in the numbers, the most efficient power level at 13.5 V is about 7 watts; at 12 V, about 5.5 watts, and at 9.6 V, about 3.5 watts. In practice, the DC voltage at the PA collector will be somewhat lower on key-down. For a 9.6-V NiCd or NiMH battery pack, the collector voltage might average 9 V or so, which puts the most efficient power output level at about 3 watts. The lowest battery voltage you'd want to transmit at is about 8 volts on key-down, at which the optimal level is closer to 2 watts.

This "optimal" power level is a good thing to keep in mind while operating portable. Operation above this level will result in much worse PA efficiency, quickly draining your batteries. The difference between 3 W and 5 W is only about 2 dB, so if your goal is to maximize operating time, it's a good compromise.

You'll want to get into the habit of checking your battery voltage once every hour or two using the K1's BAT display mode, adjusting power if necessary to preserve battery life. If you go into TUNE mode or hold down a manual key while in BAT display mode, you'll see exactly how far your battery voltage drops on key-down. This is the level on which you should base your power output selection.

Transmit Tests at Low Voltages

In the lab, I tested the K1 at voltages between 8 and 10 volts to simulate the use of an 8-cell NiMH battery pack over its full voltage range. The results were encouraging.

The most important thing to note is that virtually no clicks or VFO frequency shift could be detected on transmit, regardless of power level selected, as long as the supply voltage remained above 8 volts. (I dropped it to 7.8 volts at one point--still no shift.) This is a result of the use of two voltage regulators in series in the K1. The first regulator is a low-dropout 8-volt unit; the second is a high-accuracy 6-volt unit (2.5%). The VFO, receiver, and all low-level transmit stages run from this 6-volt supply.

At a measured PA collector voltage of 9.6 VDC (key-down), the K1 had no trouble putting out over 5 watts on 40 meters. However, the goal was to simulate real-world voltage drops with an 8-cell pack.

At 9.0 volts, 3 watts could be easily achieved on both 40 and 20 meters. PA efficiency was calculated at around 65-70%, and the TX keying waveform looked very clean.

These tests pointed out one "gotcha" that people often take for granted: for a given power output, the transmit current drain will go UP as the battery voltage goes down. For example, at 3 watts on 40 meters running from 9 volts, the current is around 650 mA. But this is to be expected. Subtracting out the non-PA current (about 150 mA, est.) leaves 500 mA, and at 9 volts, that's a DC collector input power of 4.5 watts, or a PA efficiency of 3/4.5 = 67%.

From this figure (650 mA), I estimated average current drain based on typical operating style. Suppose you transmit 30% of the time (probably on the high side), and assume that the duty cycle of CW is 50%. If the other 70% of the time is spent receiving using headphones (usually < 60 mA), you arrive at a average long-term current drain of (.65A * .50 * .30) + (.06A * .70) = 150 mA. This figure was used above in estimating the life of a 1500 mA NiMH battery pack (10 hours).

Summary

Low-voltage operation is stable, efficient, and practical on the K1. However, it's a good idea to check your supply voltage, and keep the power set at an appropriate level.