# BatMon

Here's a fun little project that was originally developed for as an accessory for radio controlled model airplane transmitters.

## Background

Last Fall, some local RC modelers were converting their transmitters from NiMH to LiPO battery packs because they provide much longer time between charges. LiPO batteries can be damaged if discharged too deeply, and I was asked to create a low voltage indicator to monitor the LiPO packs.

Coincidentally I had just smoked the finals in my KD1JV ATS3 due to antenna matching with a fully charged Sealed Lead Acid. Steve cautions about applying more than 12 volts to the rig. So I decided to use a buck/boost regulator set for 12 volts. That worked very well for the rig, but could cause battery life issues.

As the battery discharges, the rig still sees the 12 volts, but without monitoring or alarms, the battery can be inadvertently discharged too deeply and seriously shorten its useful life. A charge level indicator was needed, preferably an audible one that didn't require visual monitoring. This project does the job. It's simple, inexpensive, and easy to build - all good QRP attributes.

## Circuit description (see schematic below)

Controlling the circuit is a 741 op amp functioning as a non-inverting comparator. As the battery discharges, it will reach a level where the voltage at pin 2 is drops below the reference voltage at pin 3. At that point the output at pin 6 goes high, enabling the 555 timer. According to my voltmeter, switching occurs in this circuit when the voltage difference is only .01 volt - close enough for my needs. The reference voltage at pin 3 is set by the 5 volt regulator, and the trip point at pin 2 is set by the 10k pot.

The LM555 timer is configured as an astable oscillator with a period of about .1 second on and 2 seconds off. The piezo buzzer attached to the output at pin 3 beeps every 2 seconds. It is activated when the reset pin (pin 4) goes high as the op amp switches. The interval between beeps can be changed by changing the value of capacitor C1, or the resistors R1 and R2. Experiment and have fun. [5]

## The Trip Point (Table 1 below)

Set the trip point by attaching BATMON to a variable power supply and set the voltage at the desired level, see Table 1. Then adjust the 10k pot until the piezo just begins to beep. Run the power supply voltage up and down a few times until you're satisfied that the set point is where you want it.

At what voltage should it be set? It depends on the type of battery in use.

### Sealed Lead Acid

Probably the most common battery for portable ops is the 12 volt SLA. There are many opinions as to the maximum discharge to allow before charging, and one can spend hours researching it, and it's far beyond the scope of this short article, even if I knew what the research was saying. The bottom line seems to be that an unloaded voltage of 12 volts at 77 degrees indicates a 50 % discharge and should be recharged. [1] If the unloaded voltage drops to 11.5 volts an SLA may not recover. [1]

### Lithium

Rising rapidly in popularity is the rechargeable Lithium family of batteries. These include the LiPOs, Lions, and the LiFePO4 technologies. The LiPOs are undoubtedly the most popular due to widespread use in model aviation. There is no ambiguity here, if a LiPO cell falls below 3 volts, consider it toast.[2] For a 3 cell LIPO pack set the trip point at 10V, and set a 4 cell pack at 13V for safety.

LiFePO4 batteries, also referred to as A123, perform well for portable ops and have a voltage range of 2-3.8V/cell.[4] Don't allow them to go below 2V/cell or they will be damaged. These are great battery packs for portable ops, and I don't allow my 6 cell pack to fall below 12.6 volts.

### Nickel Metal Hydride

While falling out of favor due to the onset of the Lithium technologies, NiMH batteries still offer good value. Fully charged, each cell is about 1.4V, and is over discharged if the charge level falls below .9v. Discharging below .9 volts per cell can permanently damage the battery.[3] RC'ers recharge a 4 cell pack when it reaches 4.8-5V. I suggest that 1.1V/cell, when in a pack, should be the lower limit for portable ops.

## Conclusion

So there you have it, a low parts count, easy to build, audible, and accurate battery monitor that can extend the life of your expensive battery packs. Give it a try and let me know how it performs for you. You can reach me at wa0itp@wa0itp.com

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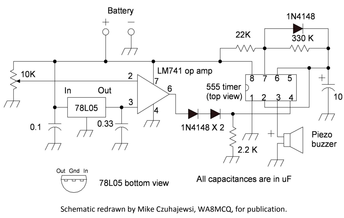


Schematic redrawn by Mike Czuhajewsj, WA8MCQ, for publication.

Table 1

**BatMon**

**Suggested Minimum Voltages**

| Type | Min/Cell | Typical Battery Pack * |
|---|---|---|
| Sealed Lead Acid | 2 | 12 volts (50% discharge) |
| LiPO | 3 | 10 volts for 3 cell pack |
| LiFePO4 | 2 | 12.6 volts for 6 cell pack |
| NiMH | 0.9 | 9 volts for 8 cell pack |

*These voltages reflect higher than minimum voltages for a safety buffer.


References:

1. http://www.yuasabatteries.com/pdfs/TechManual_2009.pdf

2. http://batteryuniversity.com/learn/article/charging_lithium_ion_batteries

3. http://www.rechargebatteryguide.com/batteries/rechargable-battery-care-and-tips also http://www.rcgroups.com/forums/showthread.php?t=111188

4. http://www.batteryspace.com/pcb-for-8-cells-25.6v-lifepo4-battery-pack-at-16a-limit.aspx (for info only usual disclaimers apply)

5. http://home.cogeco.ca/~rpaisley4/LM555.html An excellent 555 page.