

# Anatomy of a Li-Ion Battery Pack

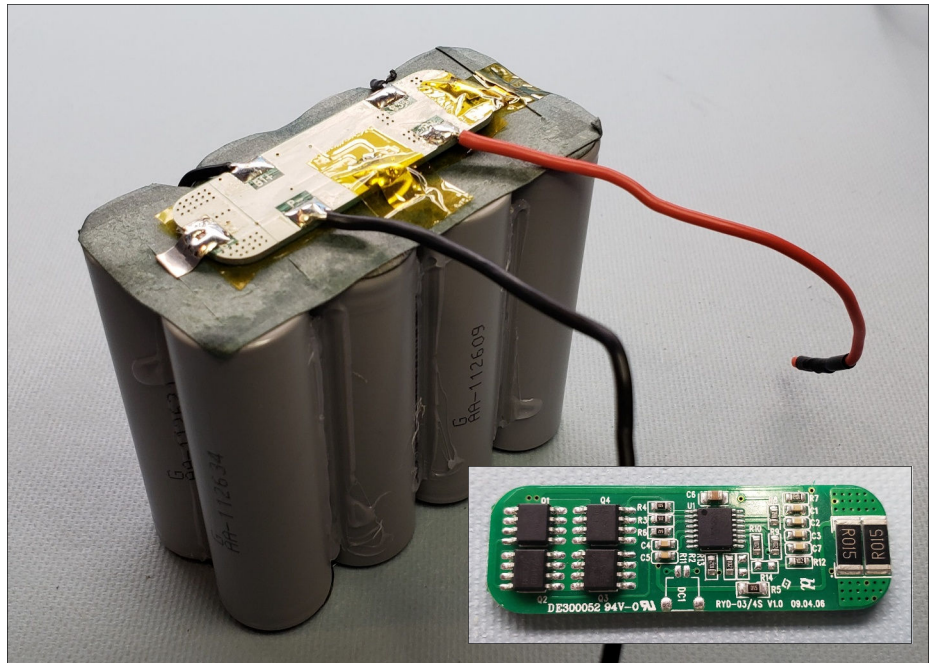
by Del Tapparo

What's inside your Lithium-Ion battery pack? This is a look inside a Tenenergy 14.8V, 4400mah Li-Ion battery pack.

Battery voltage determines the speed of our locos. Battery capacity, measured in mah (milli-amp hours), determines the run time.

Li-Ion batteries have a nominal voltage of 3.7 volts. Each cell has a nominal current capacity of about 2200mah. In order to get the voltage up to 14.8V, 4 cells are connected in series. We now have a 14.8V, 2200mah battery pack. To boost the current capacity, we take two of the 4 cell packs and connect them in parallel. Now we have a 14.8V, 4400mah battery pack. This is referred to as a 4S,2P battery pack (4 series, 2 parallel).

But we aren't finished yet. You may have heard Li-Ion batteries can catch on fire! Yes, they can! So each battery pack is fitted with electronics for safety. The battery pack is monitored for over charging (>4.3V per cell), over



A 14.8V, 4400mah Li-Ion Battery Pack with outer shrink wrap removed. Individual cells are welded together with straps. The protection circuit board (inset photo) is mounted on top of the pack.

discharging (<2.0V per cell), and over temperature (>90 deg C).

When running our trains on Ni-Cad/ Ni-Mh battery packs, we get some warning as to low batteries. The train just keeps slowing down. But with Li-Ion battery packs, they just abruptly shut down when the protection board detects a low voltage. And of course, due to Murphy's Law, it will stop in the tunnel or in some other inaccessible

location. That is why we off a Low Voltage Warning System in our RailBoss 4 Plus controls. Prior to the protection board kicking in, the RailBoss will cut the throttle in half and start flashing the loco lights. Once aware of the problem, you can stop the loco, which makes full throttle available again, and you can drive the loco home for re-charging.



Looking at the straps on the bottom (left photo) is a bit of a puzzle at first, but is indeed 4 in series, and two sets of four in parallel. Straps on the other end (right photo) connect these two groups together in series, and connections at each end for positive and negative wires out.

