



## Is My Lithium Ion Battery Dead?

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Occasionally, clients come to us asking us to diagnose their lithium ion battery packs that show no voltage. More often than not, the battery is not dead -- the battery is simply over discharged and the protection circuitry has opened the MOSFETs (the switches that allow the pack to be charge and discharge), kicking it into a low power mode. This article attempts to describe how you can conduct your own self-assessment to determine whether or not your battery pack is faulty.

### Background

The external protection circuit is designed to do one thing – protect the battery. It is not supposed to be the end of discharge stop mechanism; it is not supposed to be the charge voltage stop mechanism. Its sole purpose is to protect the battery in case something goes wrong outside the battery. As a side note, if something were to fail internally to the protection circuitry, most cells have built in safety mechanisms that will activate and protect the pack, although they will usually render the battery unusable.

The failure mechanisms that the external protection circuit protects against are: Over Charge, Over Discharge and Short Circuit.

### Over Charge

A lithium ion battery should be charged to a maximum of 4.2V per cell. The protection circuitry protects against charge voltage going over that limit. Typically it is designed to cut off at 4.3V per any given cell. Once it detects an over voltage condition, it opens the charge FET and keeps it open until the voltage source is removed and the cell voltage has dropped below a minimum value (usually 4.0V). Note, this is not the mechanism to stop the battery from charging, but rather it is built in protection for the cells. If this occurs there is most likely something wrong, presumably with the charger, and the situation should be investigated. You should still be able to read the pack voltage and you should be able to discharge the pack. The over voltage condition is usually reset once the over voltage condition is removed or once the voltage of each cell has dropped below a threshold maximum.

### Over Discharge

The end of discharge for a lithium ion battery is usually between 2.5 - 3V per cell. The protection circuitry is designed to protect against an over discharge condition, so usually it will open the discharge FET around 2.0 - 2.3V per any given cell. When this happens it will put itself into a very low power/sleep mode to absolutely minimize load on the battery. The battery will recover once the voltage per cell rises above the minimum value – usually 3V. When the battery is in this low power/sleep mode, you will not be able to read the battery voltage at that point and the pack will appear dead – voltage will be approximately 0V. All it takes for the battery to wake up is to start charging it. So if you have a battery that appears to be dead and you can't measure its voltage, if you think it might be discharged, the first thing to do is to charge it. If it won't take a charge, then the issue might be more severe and the pack should be diagnosed.

### **Short Circuit**

The third mode the protection circuitry protects a battery from is a short circuit. As soon as a short is detected, the battery immediately opens the FETs. Once the short condition is removed, depending on the protection circuitry, it either closes the FETs and the battery recovers, or it keeps the FETs open. If the board is of the type that keeps the FETs open after the short condition is removed, then when you attempt to read the voltage, it will be ~0V. All that is needed to revive the pack is to charge it briefly. As stated earlier, though, if charging doesn't wake it back up, then the issue might be more severe and the pack should be looked at further.

### **In Conclusion**

If you are unfamiliar with the workings of the safety circuit on the battery and its function, it is easy to assume that the battery is dead or faulty if it shows no voltage. Because of the nature of lithium ion batteries and their need for a protection circuit, behavior under certain conditions is different from other rechargeable battery chemistries. Usually, the best thing to do if your battery seems dead is simply to try charging the battery briefly.

Hopefully this has helped clear some of the confusion around your lithium ion battery pack and its behavior. For further information please contact Rose Electronics: [sales@rose-elec.com](mailto:sales@rose-elec.com)