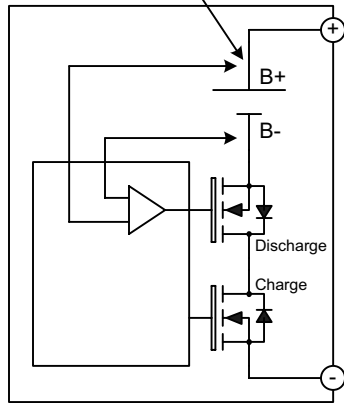


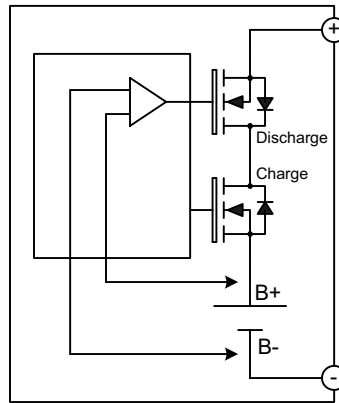
# Li-Ion protection circuit primer

Note that "PACK" is the assembled battery, protection circuit and control FETs where "CELL" refers only to the actual Li-Ion device.



Actual configuration of a typical protection circuit showing over discharge comparator.

Note that B- is the switched node, as this allows the use of cheaper N-Channel FETs

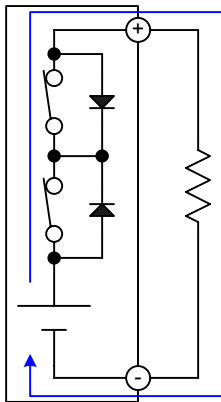


Equivalent circuit.

While low side switching is used in actual packs, I'll show high side switching for reader comfort! It works the same both ways.

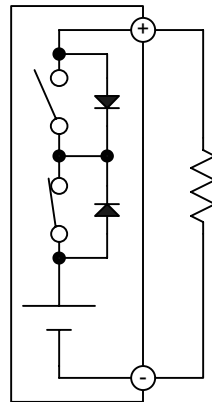
## Over-Discharge protection trip and recovery sequence of events.

(Over charge protection works the same but by controlling the Charge FET)



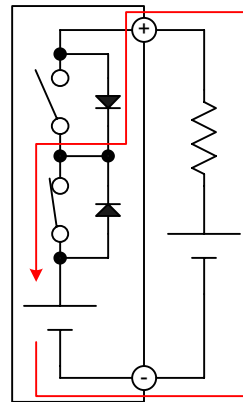
0

The battery discharges into a load, battery voltage drops over time. With both FETs closed, the pack voltage tracks the cell voltage closely.



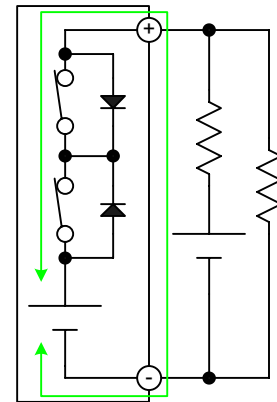
0 >> 1

The over discharge threshold is reached and the discharge FET is opened by the protection circuit. The voltage at the pack terminals drops to zero, even though the cell voltage is not zero.



1 >> 2

A charging voltage is applied to the pack and is clamped to a level one diode drop above the cell voltage. The cell voltage rises over time, always a diode drop below the pack terminals.



3 >> 4

Once the cell has charged up to the over discharge release threshold, the protection circuit closes the discharge FET and the battery now charges and discharges normally.

