
Lithium Battery Management Systems

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BMS Purpose

- Protection
 - Protect cells from damaging conditions
 - Prolong cell life
 - Monitoring
 - Fuel gauge (State Of Charge - SOC)
 - Weak cells (Internal resistance)
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Protection

- Overcharging and undercharging decrease battery life

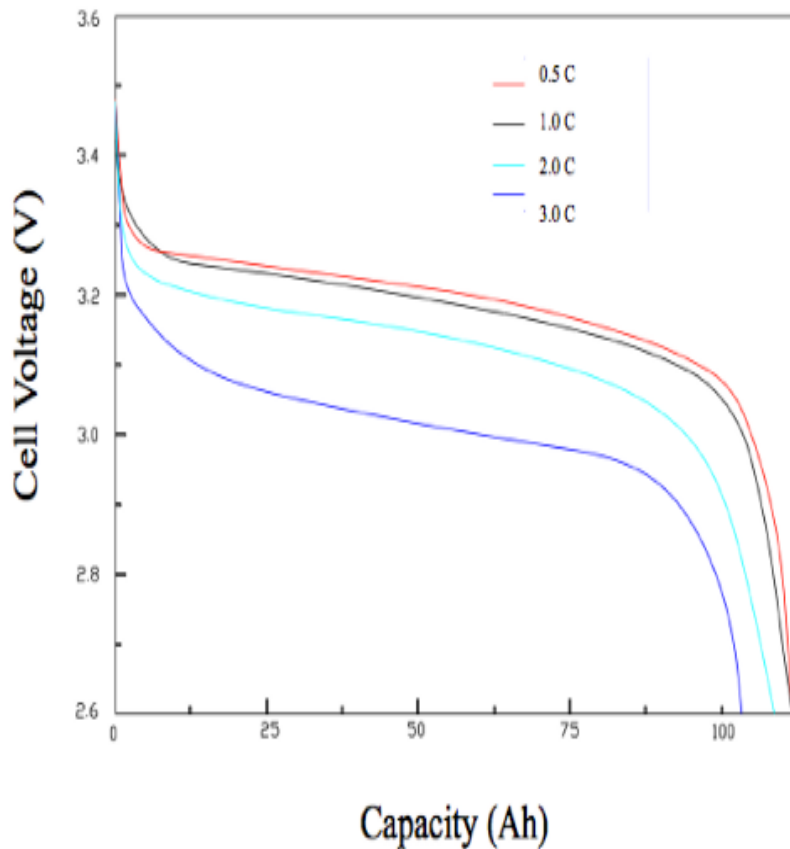
Lithium Based Cells

- Sealed container
 - Overvoltage can lead to separator breakdown causing **rapid discharge**
 - Overcharge can cause increased heat, leading to separator breakdown or **thermal runaway** in some chemistries
 - Under voltage can lead to lithium plating and a loss of electrical characteristics
 - Cell life related to operating conditions of cells
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Battery characteristics

Representative example

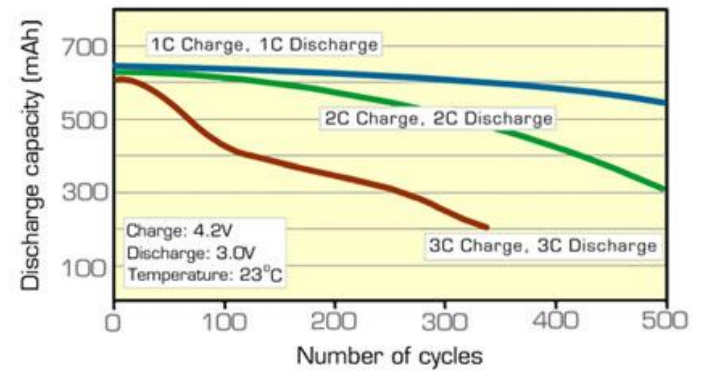
Image 1



Representative example

Image 2

Cycle performance at various charge/discharge rates



C-rate: "...the rate at which a cell can be charged or discharged..." - Build Your Own Electric Vehicle

Monitoring

- Fuel gauge or SOC
 - How much energy is left in pack?
 - Cell voltage is not accurate

- Cell health
 - Internal resistance



- Detect issues before they become problems

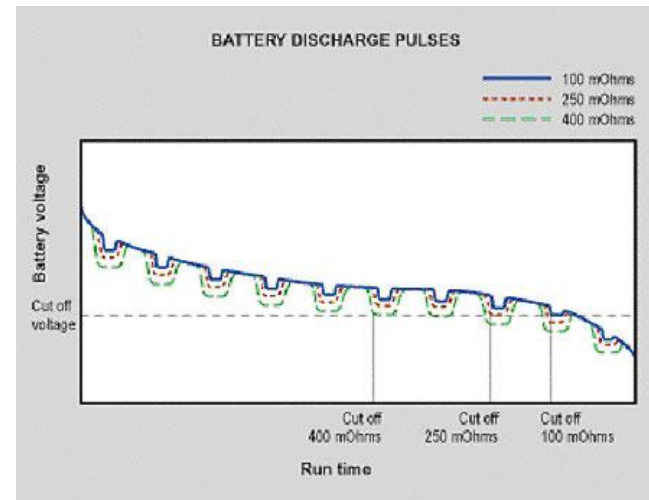


Image 3

Types of BMS systems

- Protection circuits
 - Designed to indicate an over/under voltage condition
 - Simple
 - Cheap
 - Chemistry specific
 - May not be designed for high power systems
 - “Full featured” BMS
 - Many are controlled by microprocessor
 - Software allows for more complex calculations
 - Can communicate with current sensor to do current integration
“Coulomb counting”
 - Cell balancing
 - More expensive
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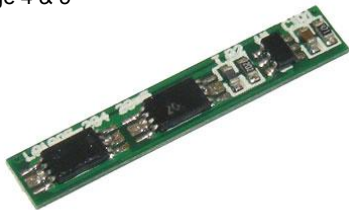
Example protection circuits



7.4v 7A Lithium protection circuit - <http://www.all-battery.com>

2-cell	\$4.32 each	4.0v - 2.4v / cell	Breaks current	9-13A overcurrent	No Balancing
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Image 4 & 5



3.2v 4A Lithium protection circuit - <http://www.all-battery.com>

1-cell	\$1.74 each	3.9v - 2.0v / cell	Breaks current	4A maximum	No Balancing
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Image 6



Black Sheep - TS-LFP60AHA - <http://bsio.us>

1-cell	~\$30	3.2v / cell	Indication signal	Unknown current	Top Balancing
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“Full Featured” BMS

- Provide complete monitoring for vehicle
 - Monitor pack as well as manage pack
 - Cell level monitoring
 - Multi-point temperature monitoring
 - Integrated current sensor (SOC)
 - Estimate state-of-health
 - Cell level balancing
 - Charge control
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Centralized BMS

- Voltage taps run to individual cells with a main processing board

Orion BMS

Ewert Systems
<http://orionbms.com>

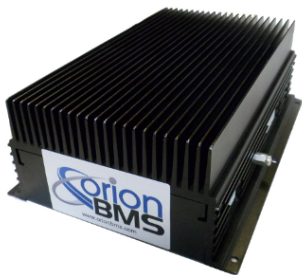


Image 7

CleanPower MiniBMS

Clean Power Auto
<http://cleanpowerauto.com>



Image 8

DIY BMS systems

- <http://www.evdl.org/docs/twbattmon.pdf>
- Gordon Stallings - <http://genki.home.ionet.net/BattMon/BattMonArticle.html>
- Lee Hart - <http://www3.telus.net/nook/balancerland/balancer/index.htm>
- OpenBMS - LTC based board, schematic & BOM <https://github.com/rickygu/openBMS>

Distributed BMS

- Voltage monitoring is spread across multiple units
- Can have central processing board

Elithion

Lithiumate Pro

<http://elithion.com>

Cell units & Master unit

EV Power BMS

EV Power

<http://www.ev-power.com.au>

Cell units & Master unit

Manzanita Micro

MK3x12LD

<http://manzanitamicro.com>

Distributed units



Image 9

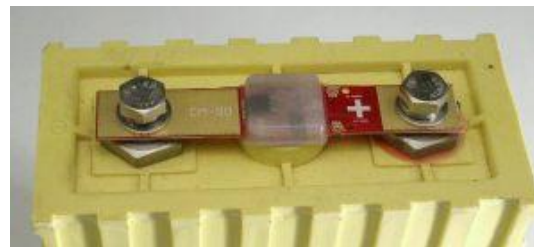


Image 10



Image 11

Links and Resources

Resources:

<http://batteryuniversity.com/>

<http://diyelectriccar.com>

Protection Circuits:

Protection circuits - <http://www.batteryspace.com/pcmforlifepo4packs.aspx>

Protection Circuit Components:

PCM with BOM and parts - <http://www.all-battery.com/pcbfor72vli-poandli-ion186501850072vbatterypacks7alimit-pcb72v11a-32005.aspx>

Ricoh R5460x Cell protector IC - www.ricoh.com/LSI/product_power/bmu/r5460/r5460-e.pdf

Ricoh Cell protector series - http://www.ricoh.com/LSI/product_power/bmu/

IR MOSFET for protection - <http://datasheetz.com/data/Discrete%20Semiconductor%20Products/MOSFETs%20-%20Single/IRF7832-datasheetz.html>

Links and Resources

BMS Resources:

<http://liionbms.com/> - BMS selector, large collection of BMS systems

BMS Links:

Black Sheep - Thundersky BMS - http://www.bsio.us/?slug=product_info.php&products_id=165

Clean Power - Small, Centralized, Florida based - <http://www.cleanpowerauto.com/MiniBMS.html>

Elithion - Distributed BMS - <http://elithion.com/>

Evaira - http://www.evaira.com/index1.html#/product_overview/products/evaira_ems

Chris Ewert Orion BMS - Illinois - <http://www.orionbms.com/>

Flux Power - Escondido, CA - <http://fluxpwr.com/products/bmsm/>

Genasun - Massachusetts - <http://genasun.com/all-products/genasun-lithium-battery-systems/gli-cp-1/>

Manzanita - Washington - <http://www.manzanitamicro.com>

Zanthic - Canada - <http://www.zanthic.com/project31.htm>

Sources

Image 1 - <http://www.technomadia.com/2011/10/lithium-update-2-the-promise-of-lithium-rv-batteries/>

Image 2 - http://batteryuniversity.com/learn/article/the_high_power_lithium_ion

Image 3 - http://batteryuniversity.com/learn/article/how_does_internal_resistance_affect_performance

Image 4 & 5 - <http://www.batteryspace.com/pcmforlifepo4packs.aspx>

Image 6 - <http://www.bsio.us/>

Image 7 - <http://www.orionbms.com>

Image 8 - <http://minibms.mybigcommerce.com/products/HousePower-BMS.html>

Image 9 - <http://elithion.com>

Image 10 - <http://www.ev-power.com.au/-Thundersky-Battery-Balancing-System-.html>

Image 11 - <http://manzanitamicro.com>
