BMS Functions , Types & Features

This is a beginner's summary of the common functions, types and features of BMSs. The descriptions do not attempt to list all information of all BMSs, but it is intended to give you a base understanding of BMSs

The document is in 4 sections:

1. Types of BMSs
2. Typical BMS functions
3. Common BMS Features.
4. Communicating between devices (advanced)
5. Voltage settings for BMS, Chargers and Loads.

Note: The descriptions of the BMS types are independent of the cell configurations/voltages. The examples shown in the following pages use a 1P8S, 24V cell configuration, but any other cell configuration would work for the example.

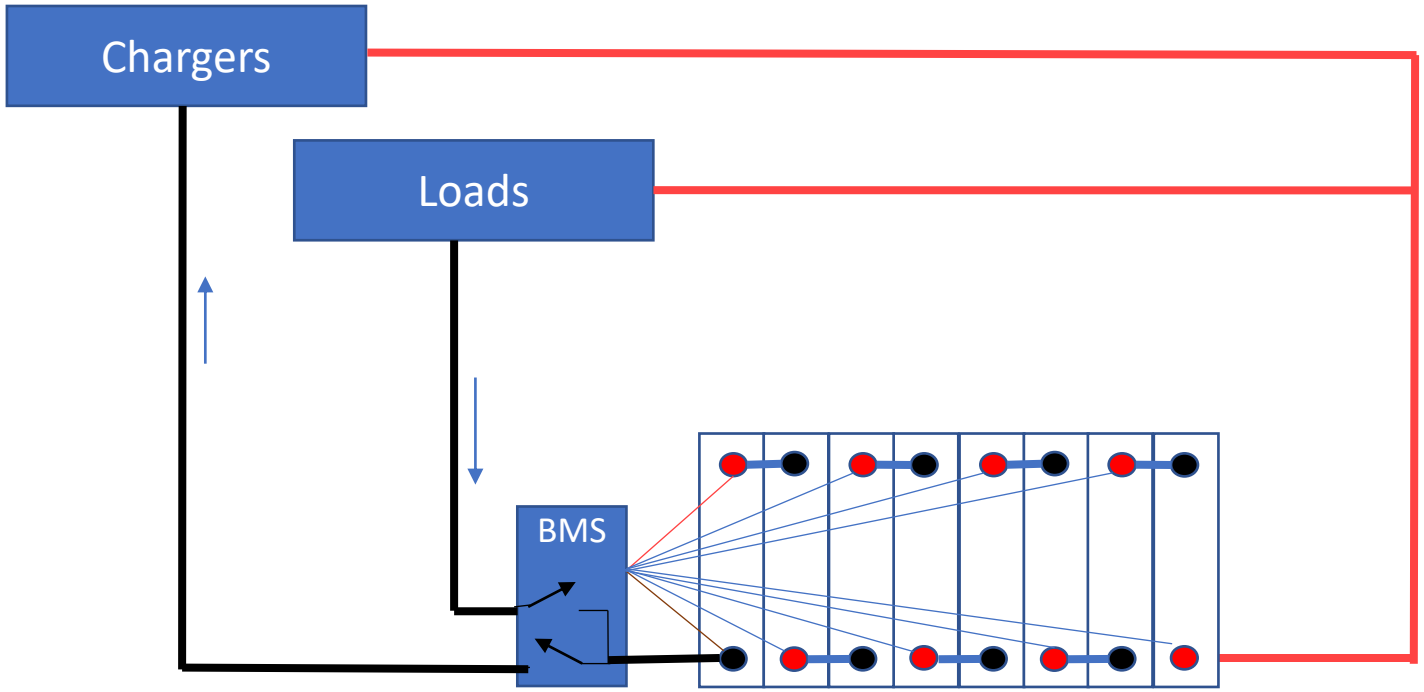
See Also: (@ https://diysolarforum.com/resources/)

Beginners explanation of Top and Bottom balancing

1P and 2P cell configurations for 12V, 24V & 48V LiFePO4 batteries:

1. Types of BMSs

Separate Port

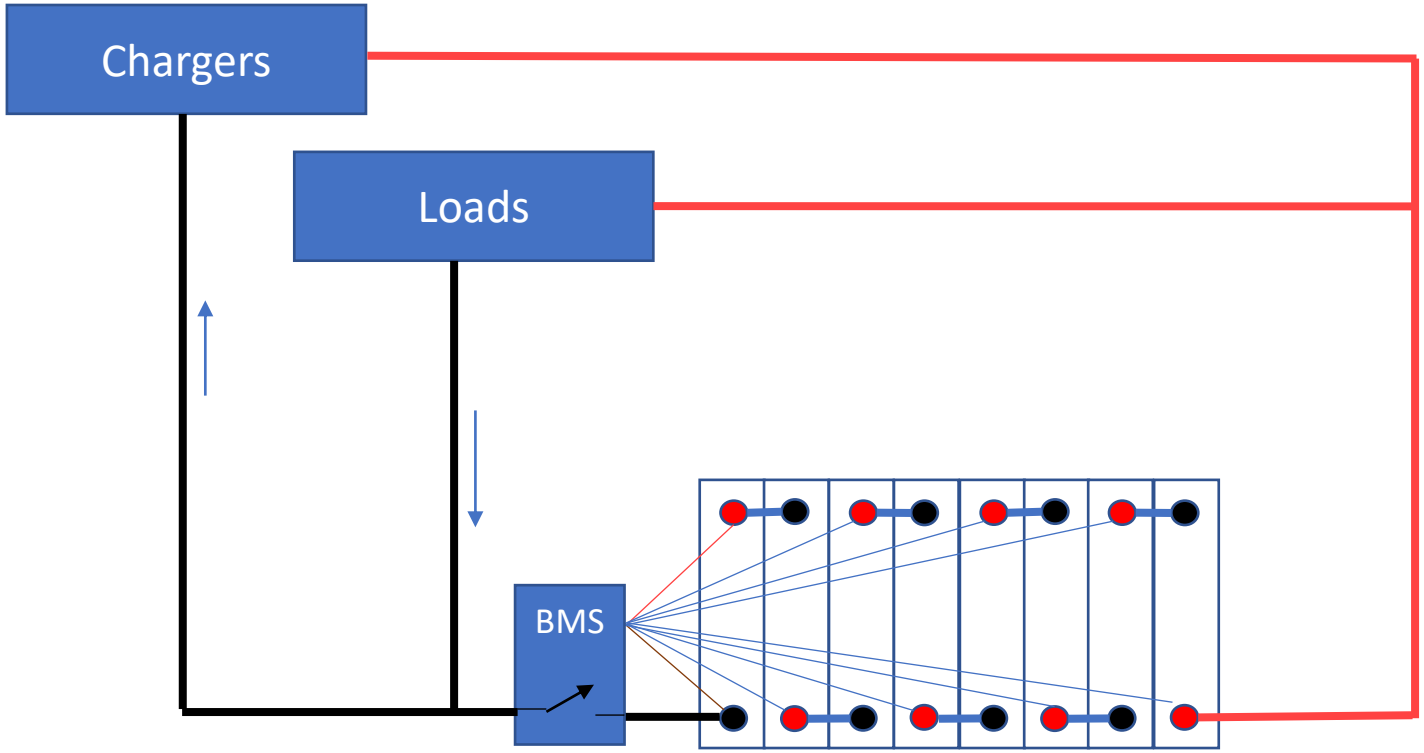


Charge Current can be controlled separate from the load current.

- FET based (Internal FETs will turn the current on and off.) It is best if your continuous current is only 50% to 60% of the BMS continuous current rating.
- Be careful, these are sometimes rated at the surge current, not the continuous current
- Typically the charge current is very low on these type BMS.
- These don’t work well if you have an inverter/charger
- This type of BMS will have internal shunt(s) for measuring the Load and Charge currents.
- Daly has some of this type of BMS

1. Types of BMSs

Common Port



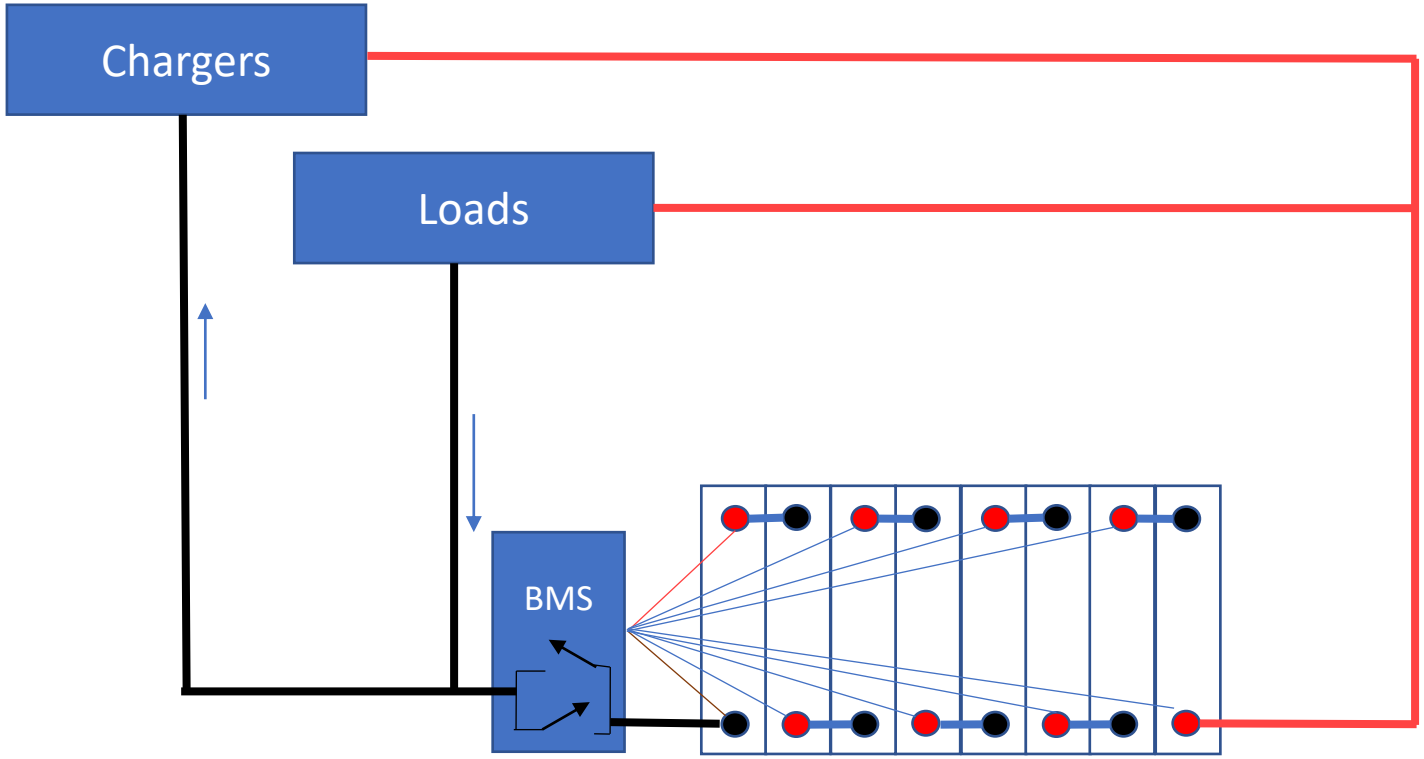
Charge Current can NOT be controlled separate from the load current.

- FET based (Internal FETs will turn the current on and off.) It is best if your continuous current is only 50% to 60% of the BMS continuous current rating.
- Be careful, these are sometimes rated at the surge current, not the continuous current
- An undervoltage or overvoltage event typically requires manual intervention to correct
- This type of BMS will have internal shunt(s) for measuring the Load and Charge currents.
- Daly sells BMSs like this.

1. Types of BMSs

Hybrid Port

Note: 'Hybrid' is my name for these. If there is a better 'industry accepted' name, please let me know

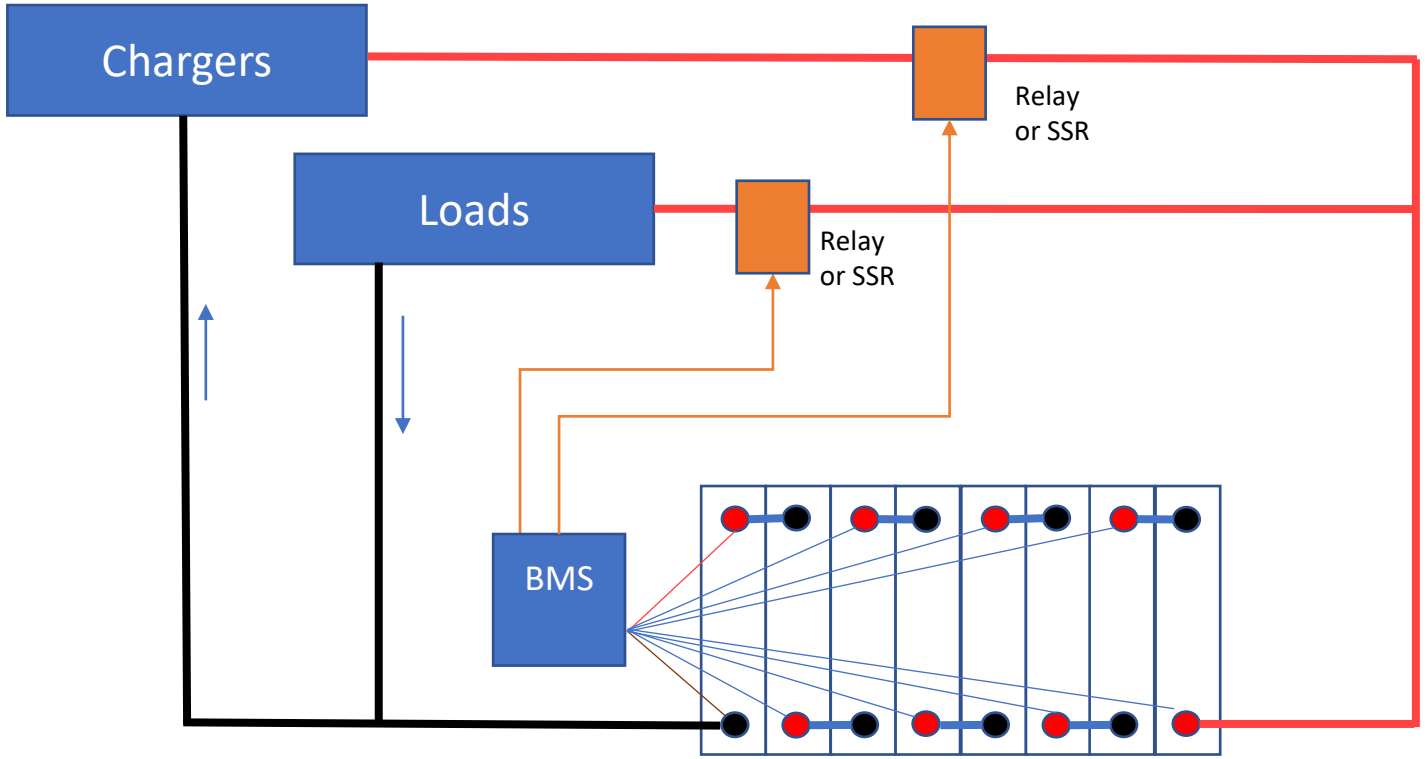


One port but Charge Current can be controlled separate from the Load Current.

- FET based (Internal FETs will turn the current on and off.) It is best if your continuous current is only 50% to 60% of the BMS continuous current rating.
- Be careful, these are sometimes rated at the surge current, not the continuous current
- Charge current rating is typically 50% or less of the load current rating.
- This type of BMS will have internal shunt(s) for measuring the Load and Charge currents.
- Overkill and Ant are examples of this type of BMS

1. Types of BMSs

External control w/ relays or SSR

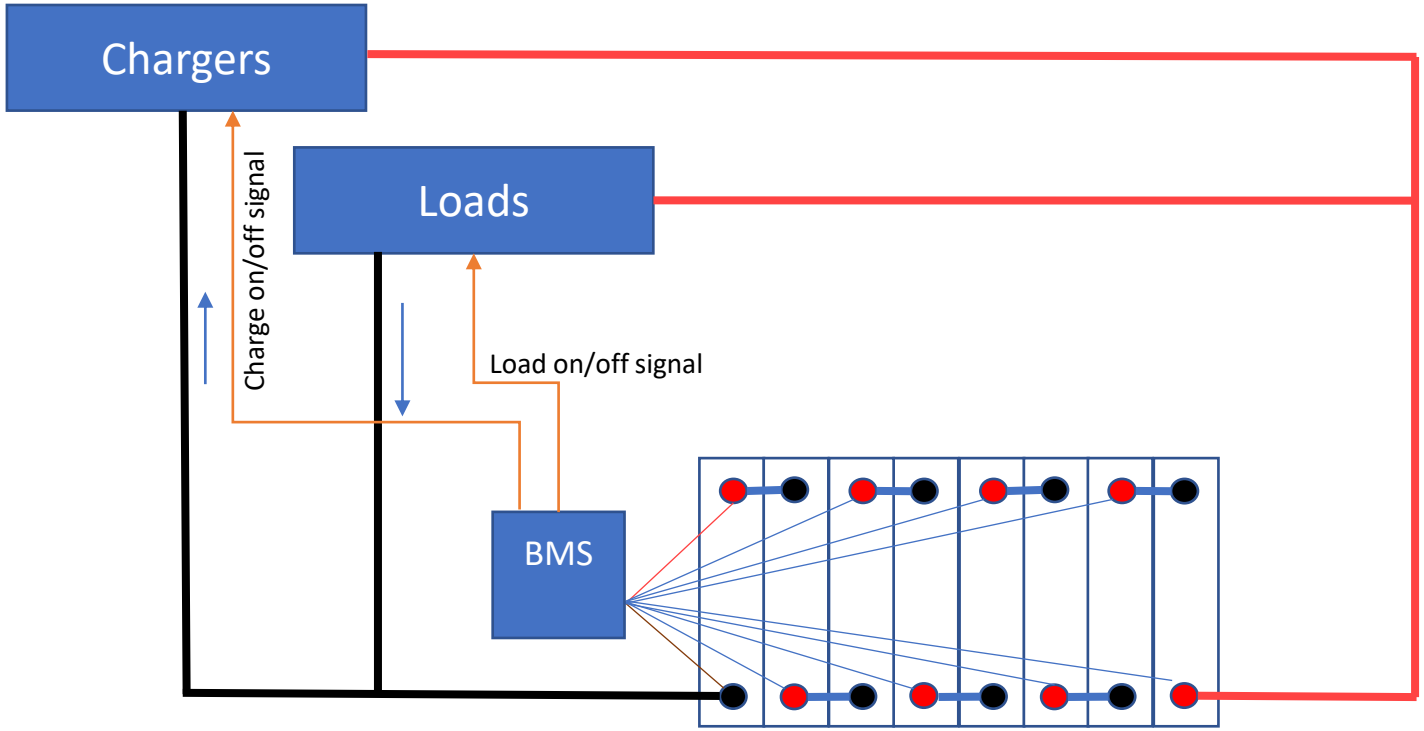


Charge Current and Load Current are controlled with External Relays or SSRs

- Adequate SSRs or Relays can be expensive.
- The relays or SSRs can create a significant power loss for the system. (Some are much better than others)
- With an Inverter/Charger, any error will switch off both Charge and Load currents.
- This type of BMS will usually have external shunt(s) for measuring the Load and Charge currents.
- Chargery and Electrodacus are good examples of this type of BMS

1. Types of BMSs

External control w/ direct control of loads and chargers through signals.

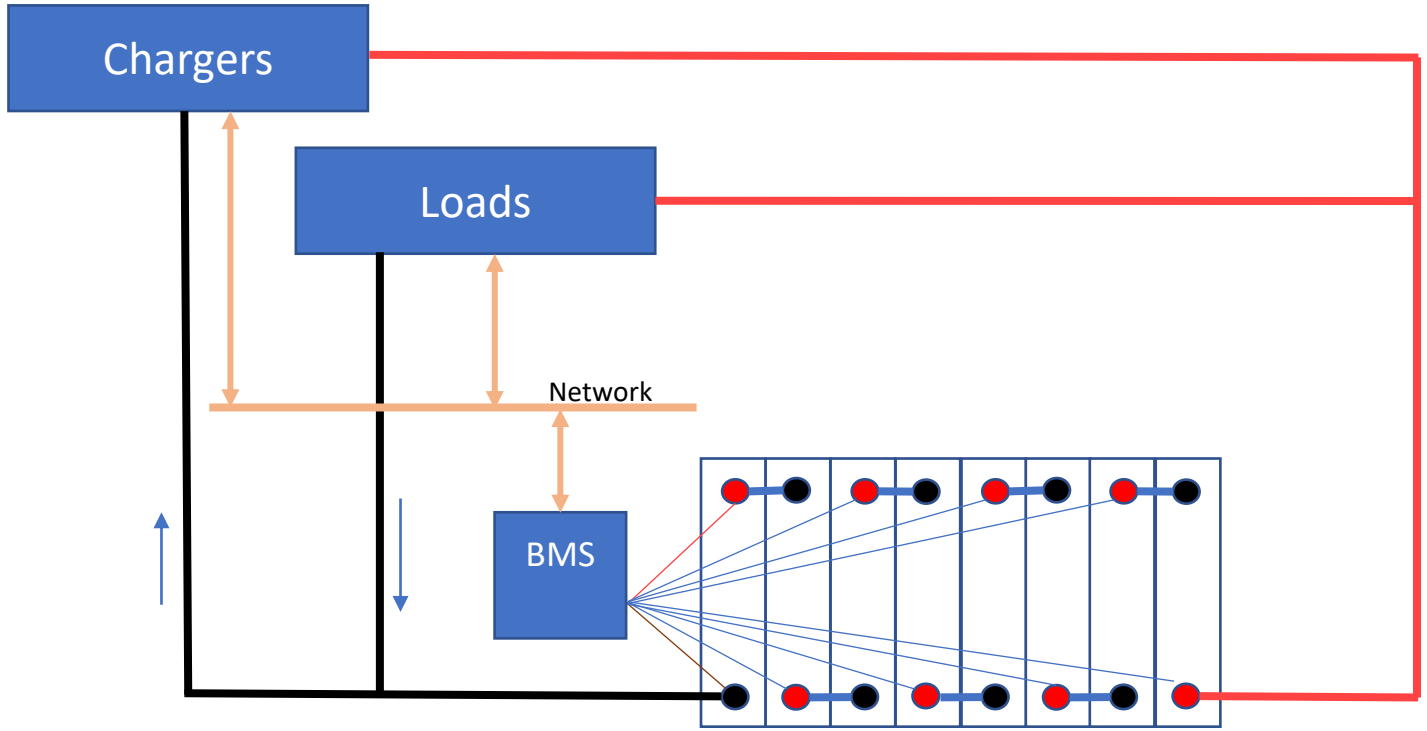


The BMS is used to directly turn the Loads and Chargers On or off

- Depending on the devices, there can still be a small load on the batteries even after the device is turned off.
- Requires loads and chargers that can be controlled externally. (It is possible to do a combination of Direct control for some devices and Relays/SSRs for other devices)
- Chargery and Electrodacus are good examples of this type of BMS

1. Types of BMSs

External control w/ direct control of loads and chargers through a network



The BMS is used to directly turn the Loads and Chargers On or off through commands over a network.

- Depending on the devices, there can still be a small load on the batteries even after the device is turned off.
- Requires loads and chargers that can be controlled over the network.
- The BMS and the networked devices must be designed to work together over the network. (This limits the combinations of BMS and specific brands of equipment available.
- CanBus seems to be the most common network used for this, but there are other networks used.
- Batrium and Rec BMSs are examples of this. Victron seems to be the most common equipment brand that works with BMSs over a network.
- With the networked system, the BMS can often signal chargers to reduce or increase charge (not just on/off)
- The BMSs commonly used in this way tend to be very expensive

2. Typical BMS Functions

Not all BMSs have the same functions, but the following pages is a list of some key BMS functions you will see in a BMS. This is not intended as an exhaustive list of possible functions, but if you have a general understanding of these functions, it will serve as a good foundation for understanding BMSs in general and make it easier to learn the specifics of a particular BMS

- **Cell voltage monitoring.**
  This is one of the more important functions of a BMS. The BMS will watch the voltage of each cell or bank of paralleled cells and if one of the cells or BPC gets too high or too low it will cut off charge or discharge current to the pack. This keeps the cells from getting damaged. The BMS monitors a Cells voltage by way of a single wire to the positive post of the Cell, ie. 1p. This single wire is used for monitoring the voltage of a Cell, as well as allowing charging, discharging and balancing of the Cell or BPC.

  Note: In some battery configurations, multiple cells are wired in parallel and then these groups of cells are wired in series to create a high current battery. In this case, the BMS treats the parallel group of cells as a single bigger cell.

  The BMS will also watch for the overall battery voltage getting too high or too low and shut off charge or discharge accordingly. However, I view this as secondary to the cell voltage monitoring.

- **Cell Temperature Monitoring.**
  LiFePO4 can be damaged by charging or discharging at higher temps and can be damaged by charging below 0C. Many BMSs have temp probes that can be put on/near the cells to watch for problems. (A good BMS will be able to watch for high and low temps but a lot of BMSs, particularly older ones, do not watch for low temp issues.) If the BMS detects an overt-temp condition it will shut off both Charge and discharge current. If the BMS detects a low temp condition it will shut off charge current but may allow discharge current to a lower temp.

2. Typical BMS Functions

- **Cell Balancing.**
  Typically the BMS will try to Top Balance the cells so you get the most possible out of the pack.

  Passive Balancing.
  This simple balancing method just drains a little energy from the higher voltage cells and waists the energy as heat

  Active Balancing.
  This more advanced balancing involves moving energy from the top charged cell to the lower charged cell.
  Note: There is some debate about the value of active balance. (None of the BMSs I work with does active balance.)

- **Discharge Rate Monitoring.**
  A LiFePO4 cell typically has an upper current limit for discharging without damage. Most BMSs are able to watch the discharge load and shut off discharge if it gets too high. Some BMSs have one setting that will allow a short period of surge current and a second, higher setting that will shut off immediately if there is a short.

- **Charge rate Monitoring**
  A LiFePO4 cell typically has an upper limit for charging without damage. A BMS will often be able to watch the charge rate and shut down charge if it gets too high.

3. Common BMS Features

Beyond the functions of a BMS there are various features that can make the device easier to incorporate into a particular build and easier to use. While many BMS share similar features, the implementation of the feature might be significantly different between one BMS and another.

The following describes the some of the common features I look for in a BMS

- **Programmable settings.**
  Some BMSs come preset at the factory and the user is unable to adjust any of the settings. The better BMSs typically have a way to adjust the settings for all of the functions above. This is typically done either through a built-in display or a Bluetooth app on a phone.

- **Multiple battery chemistries.**
  This resource is focused primarily on LiFePO4 systems, but it is important to note that the features and functions listed here are equally applicable to other Lithium Battery chemistries. Many (most?) programable BMSs are designed with parameter ranges that allow for several different battery chemistries. (Be sure you purchase a BMS that can handle your needs). Many of the programable BMSs even have an ability to select defaults for a particular chemistry with one click.

3. Common BMS Features

- **Real time Display**

  The programable BMSs almost always have a way of real-time monitoring critical parameters such as cell voltages, current, State-of-charge and temperature. This is typically done either through a built-in display or a Bluetooth app on a phone.

- **Multiple Cell Counts**

  Many BMSs are able to be used on a range of cell counts. As an example, the Electrodacus SBMS0 can be used with anything from 3 to 8 cells. Be sure the BMS you select can handle the cell count you need.

  Note: When multiple cells are wired in parallel, the BMS treats them as a single cell.

- **Current Capability**

  The BMS must be able to handle a continuous current at least as large as your system will ever demand.

  FET Based BMS (Common port, Separate Port and Hybrid Port)

  These BMSs have built in FETs that will turn the current on and off and therefor have a limit to the current that the BMS can handle. Furthermore, in order to ensure reliability, you should not run a FET based BMS at it's full rating. The general rule of thumb is that the BMS should be rated for 2x the max continuous current of your system.

  External Control BMS (e.g. Chargery and Electrodacus SBMS0)

  These BMSs do not internally control the current. Instead the current is controlled externally by relays, SSRs or direct control of devices. Since the BMS is not directly switching the current, they can typically handle quite high currents. However, if relays or SSRs are used to switch the current, be sure to get quality units that can handle the high current.

3. Common BMS Features

- **Series Batteries**
  There are some instances where it is desirable to build multiple batteries, each with it's own BMS, and then string the batteries in series. This is somewhat unusual but If you need to do this, make sure the BMS you choose is capable of switching the full voltage of all of the batteries in series. (If one of the BMS's turns off, the voltage of the whole string of batteries will be across it's FETs.

- **Packaging and mounting**
  The physical presentation of BMSs varies wildly from just a PC board to fully packaged in aluminum cases. One of the things to consider when designing a system is how the BMS will be physically mounted and what protection needs to be around it.

4. Communicating between devices.

For the BMSs typically discussed on the forum, there is very little communication with other devices in the system. The only indication a device has that the BMS has done something is that the access to the battery has been disabled or enabled.

The exception to this is when we use a signal from the BMS to turn a device on or off. This can be done with most BMSs with some tricky wiring but the cleanest way to do it is to use a BMS that is designed with external signals to turn current on and off. The Chargery BMS was designed with signals to turn Relays or SSRs on or off, but those same signals can be used to turn devices on or off. The Electrodacus was designed specifically for turning devices on or off.
Note the following page has a design example of external control of devices using signals.

More advanced systems have networking interfaces with the ability to tell devices to turn on/off over the network.

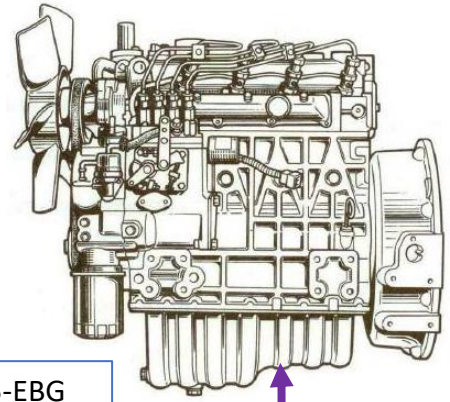
One of the challenges to using signals or a network to control devices is that the device has to have a way of accepting the signal or networking interface & protocol. Some manufacturers (like Victron) provide functionality to accept signals/and or network commands, many others don't. (Note that for a networked interface, the BMS and device(s) must not only use the same physical network, but also the same network protocol and commands.) If a device has a rocker switch for on/off, you can typically replace it with a SSR that is controlled by the BMS. If the device has a push-button on/off switch, it can be difficult to control remotely.

Many of the BMSs have communications ports that can talk to a computer and some folks have discussed writing programs to do systemwide control from a computer….. I do not know how successful these efforts have been.

Example Design using External Device Control

400W 400W 400W
400W 400W 400W
QCELL-400-72DUO Panels

Victron Smartsolar 250/100



Newage Stamford Generator
BC I164D1L 12KVA

Kubata d905-EBG

Charge enable/disable signal

Generator Start

PV Shunt

Bus Bar

Fuses

2-PVp

1-PVn

7 – EXTIO6-

8 – EXTIO6+

14 - EXTIO4+

13 - EXTIO4-

Charge enable/disable signal

11 – EXTIO3+

12 – EXTIO3-

Load enable/disable signal

Aux 1 +

Aux 1 -

Aux 2 +

Aux 2 -

Electrodacus SBMS0

3-ADC1P

3-ADC1n

Bat Shunt

Fuse

10,11,12

9

8

7

6

5

4

3

1,2

Victron MultiPlus 5000 24-120

To AC panel

5P8S Cells

Control

Balance Harness

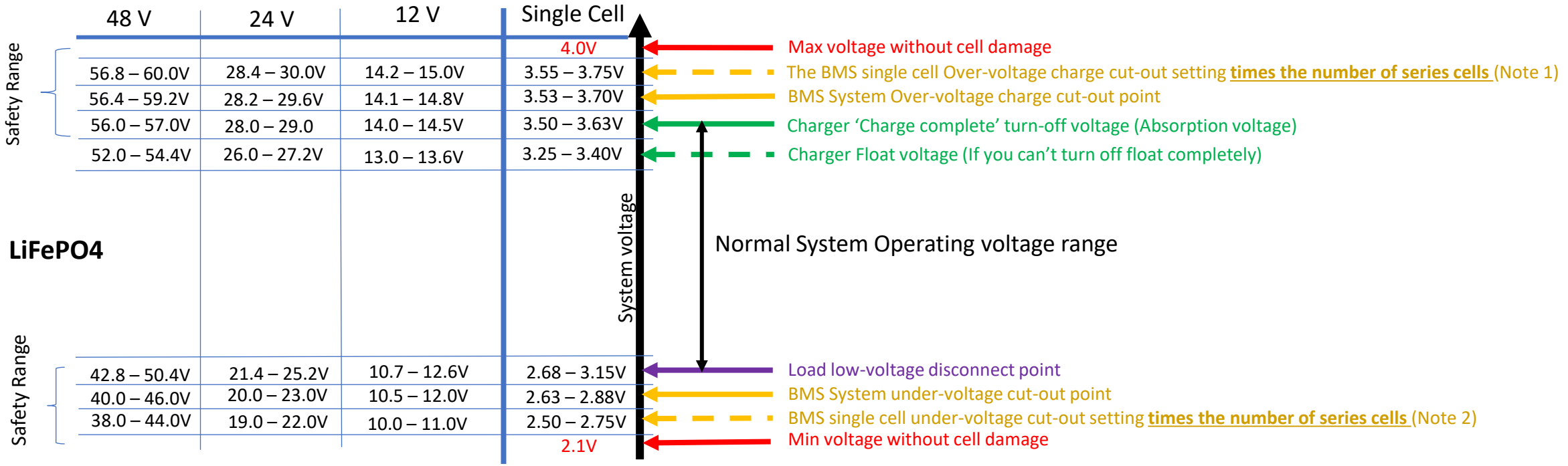
24 Volt System

BMS, Load and Charger voltage settings.

When setting up your system, the various voltage settings on the BMS, Loads and Chargers are critical for a hassle free but safe system operation. The decision on each setting is driven by several, sometimes conflicting factors.

- Protect the cells from under-voltage or over-voltage conditions.
- Maximizing the available storage
- Being gentle on the cells to prolong their life
- Ensuring the Loads or Chargers turn on/off before the BMS does.
- Ensuring there is a sufficient gap between the various setting to ensure there are no unintended 'nuisance' triggers of the BMS. (*Note:* Having well matched and balanced cells allows for narrower gaps between the various settings)
- Available settings ranges on the system devices
- Manufactures specs on the cells.

The diagram below shows typical ranges and relative relationships for the various Battery, BMS, Chargers and Loads settings.



Note 1: The BMS cell Over-voltage setting is typically the same or slightly less than the voltage used for top balancing the cells
Note 2: The BMS cell Under-voltage setting is typically the same or slightly more than the voltage used for bottom balancing the cells
More on voltage settings for the system can be found at: https://diysolarforum.com/resources/lifepo4-voltage-settings-guide-for-bms-chargers-and-loads.121/