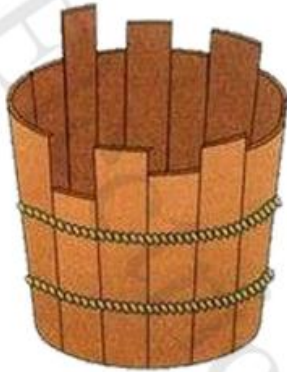


BMS FUNDIMENTALS



The old saying that “A chain is only as strong as its weakest link” is somewhat applicable to a uncontrolled series string of lithium batteries. Only with a string of lithium batteries this analogy is really much more complicated. A Lithium cell is much more sensitive to mistreatment than a comparable lead acid battery.

CHARGING: If lithium cells are overcharged, it will shorten their lifespan or perhaps permanently damage them. So with a LiFePO₄ (Lithium Iron Phosphate) battery whose nominal voltage is 3.2 volts you should never charge them above 4.0 volts and it is best to have something in the system that will shut the charger off when they reach a maximum charge voltage of 3.85 volts.

DISCHARGING: Conversely, a LiFePO₄ lithium battery cannot be discharged below 2.0 volts without damage to the cells. So there must be some mechanism in the system which will automatically throttle back and eventually shut the battery pack down in the event of a discharge condition that goes below 2.2 volts. If that mechanism isn't in place you risk damaging some of the batteries in your pack. This system is commonly referred to as a Battery Management System or BMS or in the case of some smaller battery packs, like in a bicycle, a PCM.

BALANCING: Having a number of batteries all connected up together storing electric energy is somewhat like having a barrel that is made from wooden staves which are of varying length that is storing water. Some batteries will accept a charge better than other batteries in the string. When they reach a predetermined voltage like 3.85 for LiFePO₄ batteries then there has to be a way to shunt current from that highest charged battery and prevent it from becoming overcharged while their weaker batteries in the same string catch up. To simplify that I have used the storing water in a wooden barrel analogy and show the longer staves as the good batteries while the shorter staves represent the weaker batteries. This is the third function of a BMS. A good BMS will balance all the batteries so that they reach full charge in about the same time. This might be shown as a barrel that has all of the staves at the same length. Cheap BMS systems do not do this they merely turn the charger off when the first battery nears 3.85 volts. With those systems the battery pack could still be charged with a greater amount of power but there isn't any way these cheap systems will allow that to happen. Thus you may lose as much as 20% of the battery packs full potential capacity for the sake of a few dollars saving when purchasing the BMS system. In motor vehicles that can amount to a big loss of range.

The fourth BMS function concerns protecting and balancing the batteries from over discharging. If the batteries are somehow not balanced so that all of the staves are equal, which a properly engineered BMS system will do, than as the battery is discharged the weakest battery, represented in my illustration by the shortest stave in the barrel, will reach its full discharge shutoff point ahead of the rest of the pack. A good BMS system will keep all the cells balanced so that the weakest cell voltage will not go below 2.2 volts while the other batteries are allowed to drain their energy. A well designed BMS will assure that all of the batteries are close to equal in storing and discharging their energy uniformly.

The last function of a good BMS system is monitoring and controlling the temperatures within the cells or the total pack. Many lithium chemistries like Lithium Cobalt can spontaneously burst into flames if they are over charged or discharged. Metal fires are extremely hot and water or even fire fighting foams alone will not extinguish the flames. Of all the lithium chemistries Lithium Iron Phosphate (LiFePO₄) is the least volatile and theoretically will not combust. However, extreme heat can damage and shorten the life in all lithium cells. A good BMS system will monitor the temperatures within a pack and either shut the pack down or throttle back the discharge or charging current so that the cells never reach a point of overheating.

There are people who claim that you don't need a BMS system! And, in fact they are right. You only need one if you are concerned about the most available power from the pack along with the health and longevity of the lithium cells that you paid a lot of money for. You will add years to your pack life if you use a good, well designed, BMS system. My personal preference is the Ligoo system. It is engineered right and relatively easy to install. To top it off; It has features that are equal or better than the more expensive systems.

In summation there is another saying that applies. “You get what you pay for!” Lithium batteries are expensive and you deserve to get a long battery storage life from every dollar that you spend on both the batteries and the BMS system. A good BMS system will pay for itself several times over the lifetime of your battery pack!