INDY POWER SYSTEMS

BCMOS™

battery cell management

Manage any combination of power sources, in any ratio, and in any direction:

- Equalizes cell voltages
- Equalize cell State of Charge (SOC)
- Move energy from cell with high SOC to cell with low SOC
- Maintain constant current
- Passively monitor cell SOC, energizing only as required

BCMOS™ Battery Cell Management Technology

The two largest market constraints for Lithium-ion (Li-ion) batteries are cost and safety. Indy Power Systems' Battery Cell Management and Optimization System (BCMOS) can reduce the cost of Li-ion batteries and improve safety.

By more closely managing cell State of Charge (SOC), batteries can be operated throughout a wider range of SOC. For example, it is reported that a well-known plug-in hybrid vehicle will be using a Li-ion battery pack that will be restricted to a SOC range of from 30% to 80%. With the BCMOS, it may be possible to expand that range 10% to 20%, effectively extending the capability of the existing pack 10% to 20%. Of course, this would also allow a reduction in the size of the existing battery pack to manage the original duty cycle. The BCMOS can also improve safety by keeping the cells within a tighter range of SOC and thus keeping temperatures lower.

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Battery Cell Management

The Battery Cell Management and Optimization System (BCMOS™) will save energy, make battery packs safer, speed charging, and extend battery life. The BCMOS will manage energy among battery cells, moving energy among cells to maintain a targeted range of State of Charge (SOC). This is materially different from existing state-of-the-art which periodically stops charging and burns off energy from cells with the highest SOC(s). The BCMOS also passively monitors cells to conserve energy until a cell is "latched on" for specific action. In addition, it will compensate for under-performing cells and allow hot-swapping of cells while maintaining target energy flow. The BCMOS will revolutionize battery pack safety and efficiency, greatly reducing the chance of thermal runaway while saving energy during charging and operation.

There is a growing need for advanced battery cell balancing because there are inconsistencies in the construction and materials of every cell that while small, can have a material impact on the cell's charge and discharge characteristics. This non-uniformity tends to magnify differences in cells over time when compared to other cells similarly charged and discharged. While balancing cell SOC in a battery can extend the life of the battery, it can also reduce the chance that a cell may experience a thermal event that can range from gassing to combustion.

Life and performance of cells can be enhanced by maintaining tighter range of cell SOC. While most battery cells (and hence the battery) display some sort of degradation in performance if over- or under-charged, the Lithium-ion (Li-ion) battery has a history of gassing or catching fire if overcharged and cells can be irreparably damaged if allowed to drop below a minimum SOC threshold. And the closer a cell comes to its limits, the faster it degrades.

For years there have been efforts to redistribute energy between battery cells during the charge cycle, and some have also attempted to redistribute energy during the discharge cycle. Existing battery cell management system designs to move energy between cells require material amounts of energy to "latch on" to cells to monitor their SOC. Latching on to a cell is defined as the energizing of a circuit to isolate a cell and read information. Constantly energizing the system to latch on to each cell for measurement wastes energy. As such, until the BCMOS, there has been no commercially successful battery cell management system that manages energy between individual battery cells. The Indy Power Systems design for the BCMOS passively monitors cells and has the ability to latch on to a cell or module only when energy movement is required. Because of this the BCMOS is much more energy efficient.

By implementing the BCMOS, the battery can be operated throughout a wider range of SOC because the BCMOS can keep cells in a tighter range of SOC. The Cell Quality Distribution chart above illustrates the potential impact of increasing the usable range of a battery pack approximately 20%. By doing so for a Hybrid or Battery Electric Vehicle battery pack, the battery powered range of the vehicle could be increased 20% without adding batteries. Similarly, the amount of batteries could be decreased approximately 20% with no material degradation in distance or performance. So, either the range could be maintained with fewer batteries, saving 20% on the cost of batteries, or the range could be increased 20% using the same battery pack. Battery cost and performance improvements would apply to other markets as well.