Ruggedized and Reliable Connector Solutions for Automotive Battery Management and Power Electronics Applications

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Automotive battery management systems (BMS) continue to progress in complexity and storage capacity, challenged by architecture and interconnectivity solutions that require ruggedization and reliability criteria over the life of the vehicle. Power train components, including inverters/amplifiers, are also placing peripheral demands on energy consumption throughout the hybrid (HEV/PHEV) and electrical vehicle (FEV) drive systems. Stringent electro-mechanical requirements and diverse architectures can be met with new connectivity offerings designed with rugged interfaces that are ideal for automotive related applications.

BMS & CMC Systems

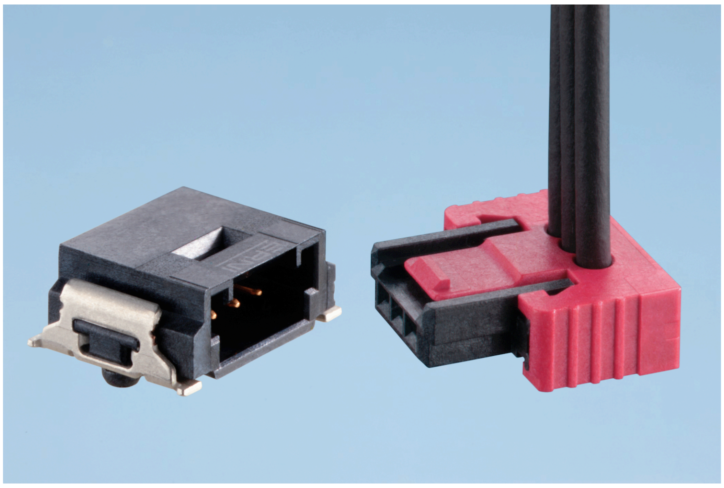
Energy availability and functional reliability of the battery storage systems are the responsibility of the BMS, via two primary sub-systems. The battery management controller (BMC) is the central unit with interface to the vehicle. The BMC is charged with communicating to various other systems within the vehicle that will demand energy, as well as monitor the health of the batteries. The BMC relies on connectivity to ensure the role of governing, maintaining and communicating if variables exceed their respective margins. Like the BMC, the cell management controller (CMC) is focused on reliability and monitoring within the individual battery packs. The CMC communicates variables to/from the BMC for analysis on a broader scale and encompassing other sub-systems that require the energy throughout the operation of the vehicle. Efficient monitoring of key operational parameters, such as charging/discharging, voltage levels, individual cell performance and protection if faults are detected, is dependent on reliable interfaces both within the system (battery cells) and external to other dependent components. Prolonging battery life is a primary function of the BMC and CMC, which means protecting it from damage due to variable swings harmful to cells or the overall system. Preventative maintenance is vital to optimize battery cell performance.

Importance of Interconnectivity

The electro-mechanical nature of the power delivery system within a HEV or FEV has requirements that are important to an optimal and operational monitoring system. Requirements such as accuracy, reliability, power carrying capacity, high temperature requirement, shock/vibration resistance and reduced size/weight are central to future BMS designs. Certainly these attributes are not unique only to a battery controller, but many are primarily electro-mechanical. Connections between batteries in parallel provide required current capacity, while series connections enable voltage range(s) for the various operations throughout the vehicle system.

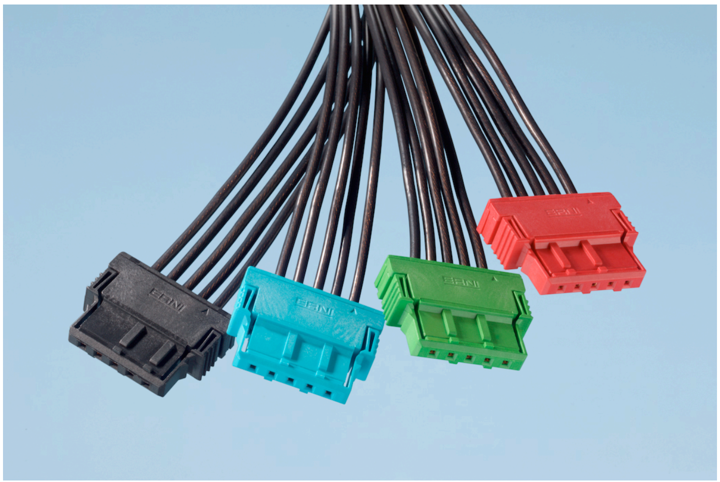
These connections are often a wire-to-board solution or perhaps a buss-bar offering depending on the architecture, or both. Connectors with less bulk resistance mean less heat when operating near their respective current capacity limits; improving efficiency/accuracy in overall energy management. Likewise, a well designed connector interface will mitigate the connection resistance over time and through prolonged environmental exposure and temperature swings, improving upon reliability and dependability of the connector chosen. Thermal monitoring throughout the battery/pack is often achieved via a wire to board solution that is both dense (small pin-to-pin pitch) and reliable. The monitoring of cells or hot spots within a battery pack is often accomplished with a cable solution and thermistor terminated on one end. But the connection and mating interface to a board mount header is critical in order for the sensing circuits to function reliably and throughout the life of the battery. Look for active latching features and strain relief mechanisms that ensure that stresses and high vibrations are placed on the connector as a whole and not solely on the signal/power conductors themselves.

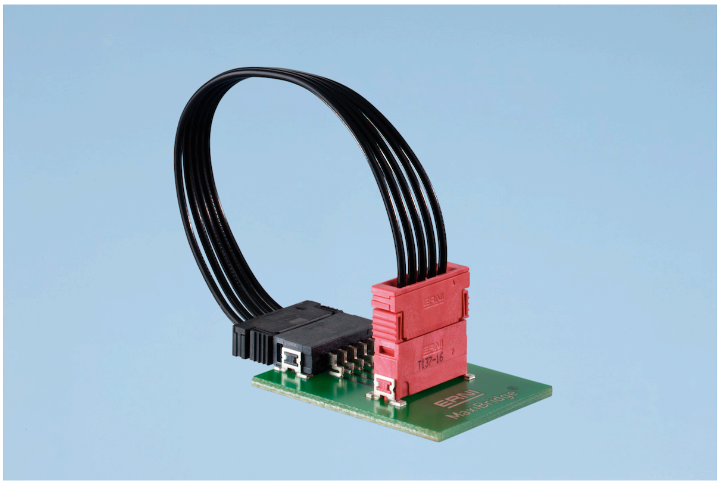
Power Delivery Systems
Inverters/amplifiers of the power electronics systems have similar interconnect challenges, but signal density versus power isolation and current derating means often diverse pitch and electromechanical requirements. Energy (flow) management and power delivery are two primary functions of the inverter sub-system; managing various requirements and demands during operation, idle, startup, charging, etc. of the vehicle. Functionally and reliably converting this energy to more mechanical outputs relies on robust and well designed interconnectivity solutions similar to those discussed in the BMS environment. Of course, there are high voltage and more standardized interfaces coupled to the inverter input/output connections, but within the enclosure are electronics and some mid-high current requirements that demand maximum reliability in minimum space.



Connectors that achieve 4A per pin in a 1.27mm pitch interconnect family, like ERNI's MiniBridge Koshiri connector, are available for such applications.

More demanding requirements can be supported in 2.54mm single and dual row offerings extending to 12A per conductor as found in the MaxiBridge product family. The various color options and physical keying features (each color offering unique coding/keying features mechanically) means improved cable and sub-system integration during manufacturing. Higher current applications that buss-bars are often delegated to resolve can be further supported and enhanced via power element conductors meeting upwards of 300A per element. These single conductor solutions are ideal for terminating a buss-bar to the host board or sub-system or managing a bulk wire application and terminating it reliably to the PCBA, via press-fit or new SMT options. All automotive BMS connectors should offer a wide operating temperature range of -50 degree C to 125 degree C.





These high-performance connectors must also provide design flexibility and meet any evolving automotive BMS application requirements – particularly miniaturization and weight restrictions. The SMC for example, is offered in a number of different pin counts, heights and configurations in a 1.27mm grid. Offering secure data transmission rates up to 3Gbps and current carrying capacity of 1.7A per contact, the connector is ideal for applications with limited space. Combining a ‘permanent’ latching mechanism with a dual-beam mating interface and long contact wipe length, the connector is rugged and proven in automotive/inverter applications.

Conclusion
Wire-to-board interconnects are becoming an optimal solution for BMS and inverter applications. Important too are innovative design features such as color and mechanical keying that allow improved processing and integration of assemblies within a complex BMS or inverter system. Look for these type of feature sets to improve your overall interconnect design while meeting your expected reliability requirements over the life of your battery or inverter application.