

CONNECTIVITY SOLUTIONS FOR BATTERY MANAGEMENT



In the same way that the internal combustion engine (ICE) was considered the heart of the traditional motor vehicle, the battery is considered the heart of electric vehicles (EVs), with battery technology at the forefront of innovation.

The key driver of battery technology development is range. However, at the same time engineers at OEMs and battery manufacturers need to offer designs that optimize power-to-weight/size performance while also maintaining the highest levels of safety.

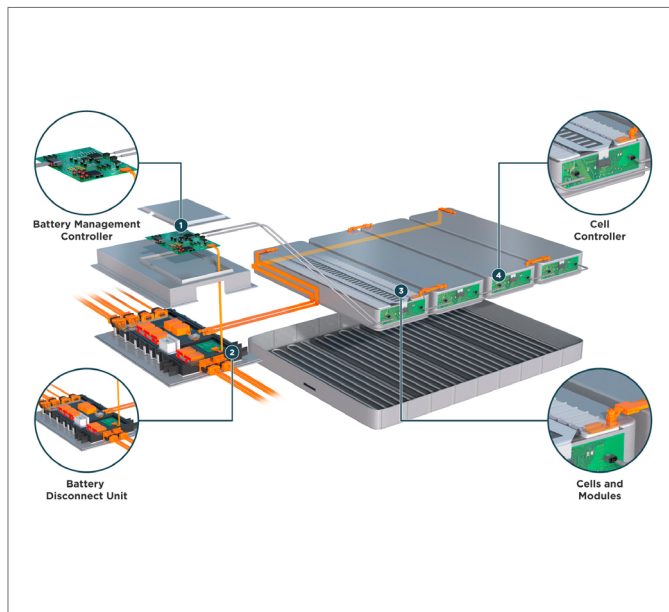


Figure 1: Battery Pack

BATTERY MANAGEMENT SYSTEM

Low voltage solutions are essential in meeting the requirements of modern and EV batteries. These batteries typically operate at lower voltages compared to high-voltage systems used in other parts of the vehicle, such as the powertrain.

As the demand for low voltage connections in EV batteries increases, there is a need for long-lasting, flexible, and miniaturized signal connections. These connections play a crucial role in transmitting signals and data within the battery system, including communication between the battery cells, the battery management system (BMS), and other vehicle components.

A BMS is the electronic system that manages the battery pack and the cells within and is critical for optimum battery performance and safety which means it must operate with a high degree of accuracy and reliability and must be of highly robust construction. However, it must also be compact and lightweight, adding the least possible bulk to the overall battery pack geometry.

Its purpose is to protect the battery from operating outside its safe limits by monitoring its state, including voltage, temperature, state-of-charge and current and coolant flow. It processes collected data, transmitting them to the elements that balance or control the module environment.

THE ROLE OF CONNECTIVITY

Electronics connectivity technology is a key enabler of the battery management system. Its role is to transfer analog and digital signals from monitoring technology. Analog cell sensing signals, such as low voltage and temperature, are usually processed into digital signals by a Cell Management Controller (CMC) and shared to a master Battery Management System (BMS). The BMS and CMC work in tandem to safely balance cell voltages and enable controlled flow of power, for example, during charging.

CONNECTIVITY REQUIREMENTS

BMS electronics require highly compact, yet flexible connector systems because of the vertical and horizontal space limitations of a battery pack. Given that the ratio between battery cells and CMC's vary according to the vehicles energy and capacity requirements, connector systems must also have the power to accommodate multiple connector configurations and support different types of cables, including flat flexible (FFC) and flexible printed (FPC) cables allowing for easier installation, routing, and connection of components in tight spaces. They provide versatility and can be bent or folded to be routed around compact and complex battery geometries while maintaining reliable signal transmission.

In addition, the connector system requires a safe creepage and clearance distance between the pins, so that there's no risk of failure from short circuits caused by pollution, such as dust or condensation, or arcing. As battery modules and battery management systems are integrated in a sealed pack enclosure, OEMs and battery pack manufacturers must ensure the critical BMS connections meet the strict specification (i.e. LV214) for automotive-grade robustness and reliability.

CONNECTIVITY SOLUTIONS FOR BATTERY MANAGEMENT SYSTEMS

TE Connectivity (TE) offers a variety of miniature automotive-grade connectors and terminals for electric vehicle battery management systems. TE's [PicoMQS](#) and [NanoMQS](#) miniaturized interconnection systems are designed for 0.5 x 0.4mm tabs, support [FFC/FPC cables](#), and round wires (0.13mm² to 0.35mm²) with multiple pin count and pitch variations without sacrificing vibration stability and can facilitate FFC/FPC-to-board, FFC/FPC-to-wire, and wire-to-board connections.

Connectivity Solutions for Battery Management

Additionally, with the increased prevalence of automated manufacturing from the harness maker to the OEM, TE's NanoMQS and PicoMQS interconnection systems are ready for completed, automated assembly.

LV214 and USCAR compliant, the PicoMQS and NanoMQS interconnection systems are vibration resistant up to SG4 and operates in temperatures up to 170° C. Their range of housings include a variant with click-audible connector position assurance to provide secure mating. The header system is highly compact but at the same time, supports a pitch between 1.27mm (30% reduction) to 1.8 mm providing necessary creepage distance between pins.

The [ERNI MicroBridge](#) connector product family fulfills the high demands of the automotive industry for mating reliability and ruggedness. It is not only the high temperature that stands out on the MicroBridge connector but also the VO UL94 Flammability rating. With a pitch of 1.27 millimeters, the connectors have a compact design while also being robust.

They can be used in small areas and are temperature-resistant up to 150 °C. They support more secure connections even in high-heat areas.

The connectors easily handle the vibrations that occur in the vehicle, thanks to the locking mechanisms on both sides.

In addition, other pin pitch variations can be made available according to specific battery design requirements

BATTERY DISCONNECT UNIT

The battery disconnect unit (BDU) in an electric vehicle essentially acts as an on/off switch to the battery for different EV operating modes, employed to monitor the voltage levels within the car continuously. If the voltage exceeds a certain threshold, the battery is required to deactivate, enabling safety. TE's [MQS high voltage sensing detection header](#) plays an important role in this process as it is used as a high voltage detection triggered by low voltage measurements. It monitors the voltage across the cells in the battery pack. If not done properly, cell degradation and accelerated aging can occur.

CONTACT TE FOR MORE INFORMATION ▶

ROLE OF BATTERY MANAGEMENT SYSTEM (BMS)



Figure 2: What a battery management system monitors

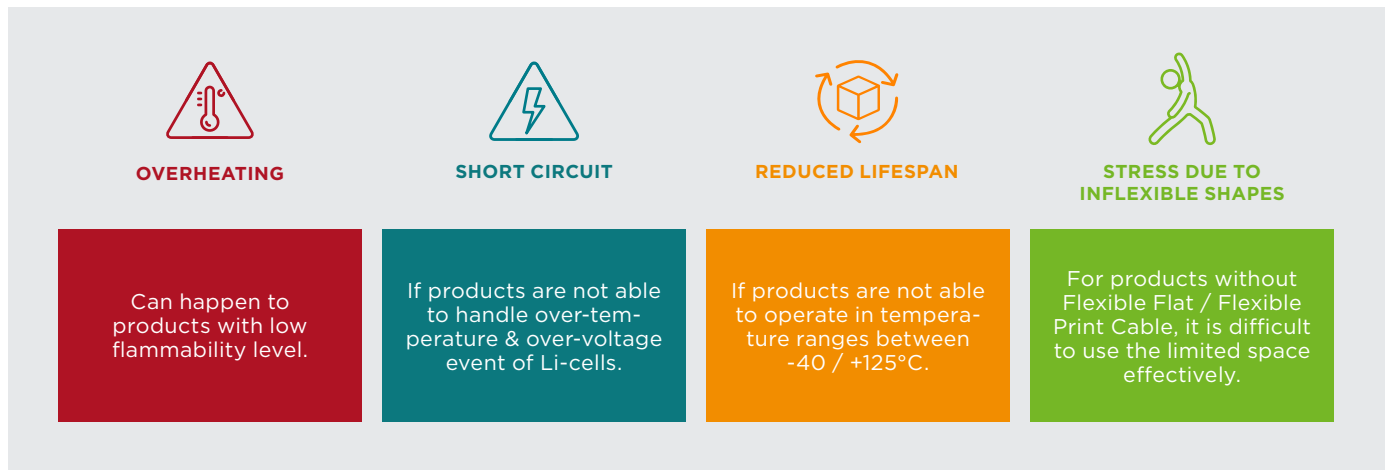


Figure 3: Why are solutions specialized for battery important?

PicoMQS Miniaturized Automotive Interconnection System

Dimensions

- 1.27mm pin-to-pin pitch with 55% reduction in crimp length
- 0.13 FLR mm² FLR
- 0.22 mm² FLU & FLR wire range
- 0.014- 0.042 mm² foil cross section
- Mating for 0.5 x 0.4 blade size

Performance

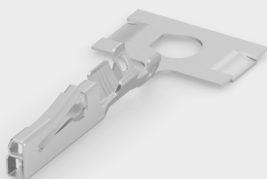
- Current capacity: 4A (90°C) / 1A FFC
- Max. Temperature 130°C (Sn) / 105°C FFC
- SG2 vibration grade, unsealed (Sn)
- LV214 European automotive standard compliant
- Present in various European OEMs

Mating Security

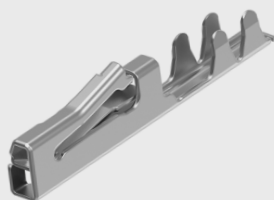
- Locking Lance design
- Primary and secondary contact locking
- Click-audible connector position assurance (CPA) possible

Board Mounting

- SMD / Through-hole mounting
- 1-row (2-10 positions) and 2-row (12, 18 and 22 positions)
- 90° / 180° pin orientation



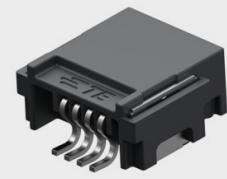
PicoMQS Round Wire Terminal



PicoMQS FFC/FPC Terminal



PicoMQS 4 position connector

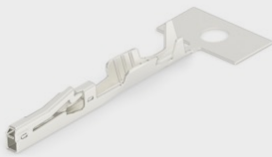


PicoMQS 4 position header

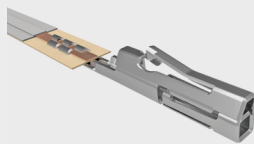
NanoMQS Miniaturized Automotive Interconnection System

Dimensions

- 1.8 mm pin-to-pin pitch (other variants available on request)
- 0.13 mm² to 0.35 mm² wire range
- Mating for 0.5 mm x 0.4 mm blade size
- Available for flat flexible / printed cables (FFC/FPC)



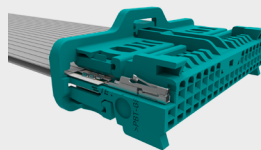
NanoMQS Round Wire Terminal



NanoMQS FFC/FP Wire Terminal

Performance

- Current capacity: 6A (90° C)
- Max. temperature 170° C (Ag)
- SG4 vibration Grade (Ag)
- LV214 compliant / USCAR validation in process
- Flame resistant UL 94 V0



NanoMQS 32 position FFC Connector



NanoMQS Header

Mating Security

- Locking Lance design
- Primary and secondary contact locking
- Click-audible connector position assurance (CPA) option
- Click-audible mating
- 4 codings with different colors

Board Mounting

- SMD / Through-hole mounting
- 1 or 2 rows, 6 to 40 positions (CPA option up to 28 positions)
- FFC crimped 8, 20, 32 and 40 positions
- 90° / 180° pin orientation
- Low profile headers (height <10mm)
- Side and top latch (plugs)

MQS High Voltage Sensing Detector

Dimensions

- Tab size 0.63mm
- 0.13 mm² to 0.75 mm² wire range



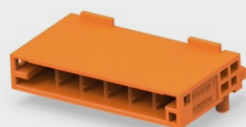
MQS Terminal



MQS High Voltage Sensing 6 position connector

Performance

- High-voltage, low-current connector
- 800-to-1000-volt readiness
- Flame resistance UL 94 V0
- Auto-grade LV214 and USCAR qualified
- -40°C up to 150°C temperature range
- Vibration Class: SG3
- Pollution degree 2 compliant



MQS High Voltage Sensing 6 position header

Mating Security

- 2 codings with different colors
- Inline applications with clip function
- Locking mechanism with and without a CPA

Board Mounting

- 2, 6, and 10 position and 90° or 180° pin orientation
- SMD / Through-Hole mounting

ERNI MicroBridge Connectivity Solutions

Dimensions

- 1.27mm pin pitch IDC



Performance

- Auto-grade LV214 compliant
- Pollution degree 2 compliant
- Up to 6A, 150°C operating temperature
- Flame resistant UL 94 V0

Mating Security

- Dual IDC termination with integrated strain relief
- Side Latching to minimize component profile
- Electrical CPA (eCPA) option

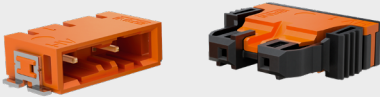
Board Mounting

- 1-row, 2 to 20 positions with 90° or 180° pin orientation
- 3.5mm PCB height and 9mm depth
- Board-to-board, wire-to-board, foil-to-board

ERNI Voltron High Voltage Sensing

Dimensions

- 6.2mm pitch
- SMT and crimp termination



Performance

- 1000V DC
- Flame resistant UL 94 V0
- Auto-grade LV214 and USCAR compliant
- Pollution degree 2 compliant
- > 5.0mm creepage distance
- Up to 150°C operating temperature

Mating Security

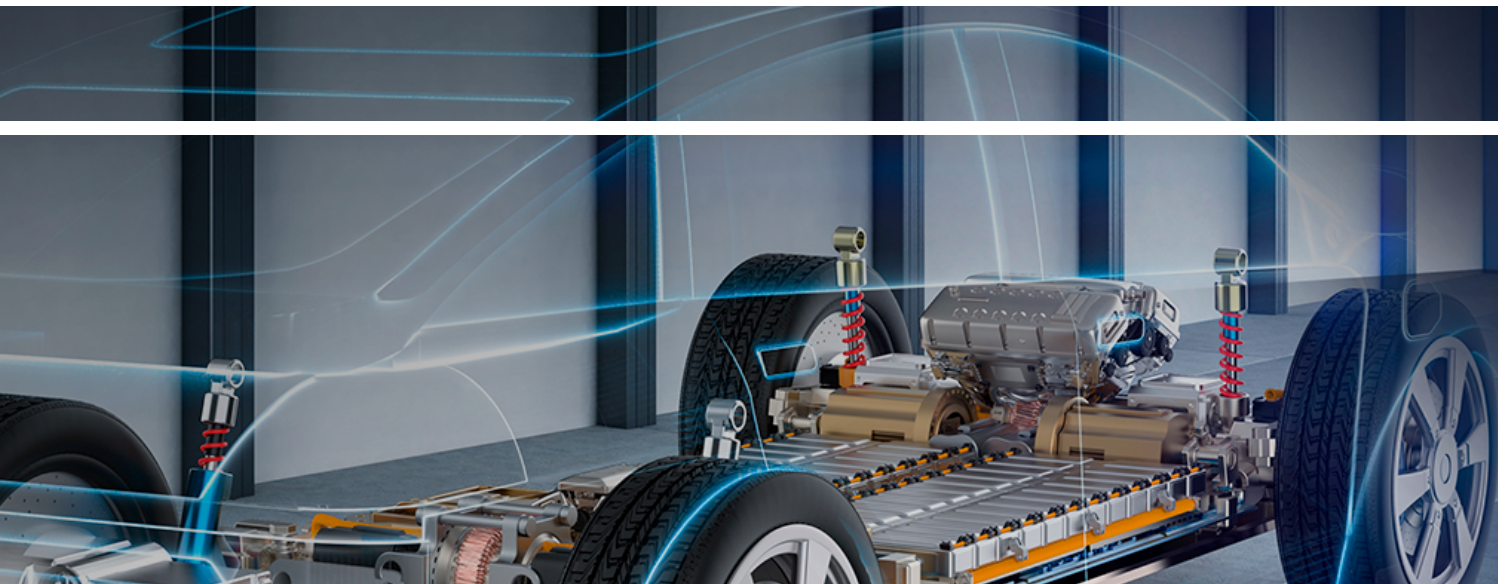
- Primary and secondary locking
- CPA potential

Board Mounting

- 1-row, 2, 5, and 6 position

NOTES

A grid of 20 columns and 27 rows of small dots. The dots are arranged in a regular pattern. In the 6th column, the 3rd dot from the top is orange. In the 14th column, the 21st dot from the top is orange. In the 18th column, the 24th dot from the top is orange. In the 19th column, the 27th dot from the top is orange. All other dots are light gray.



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