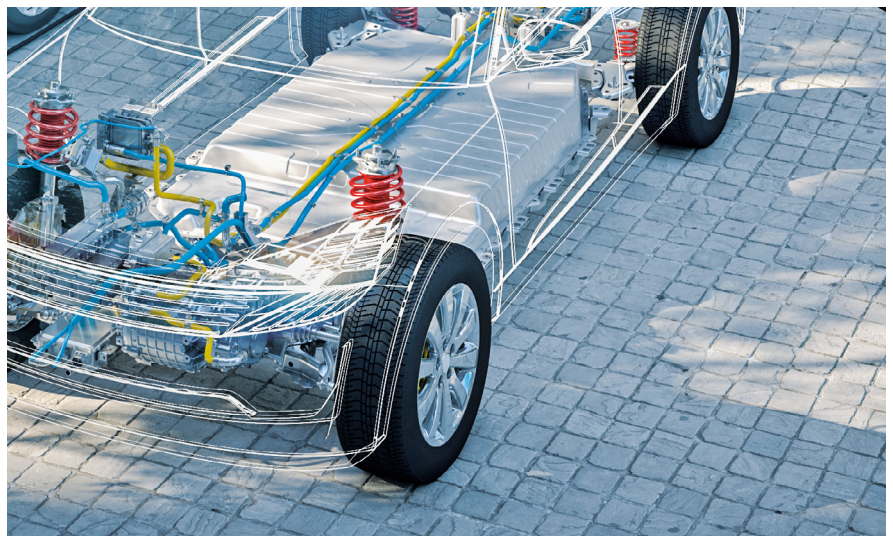
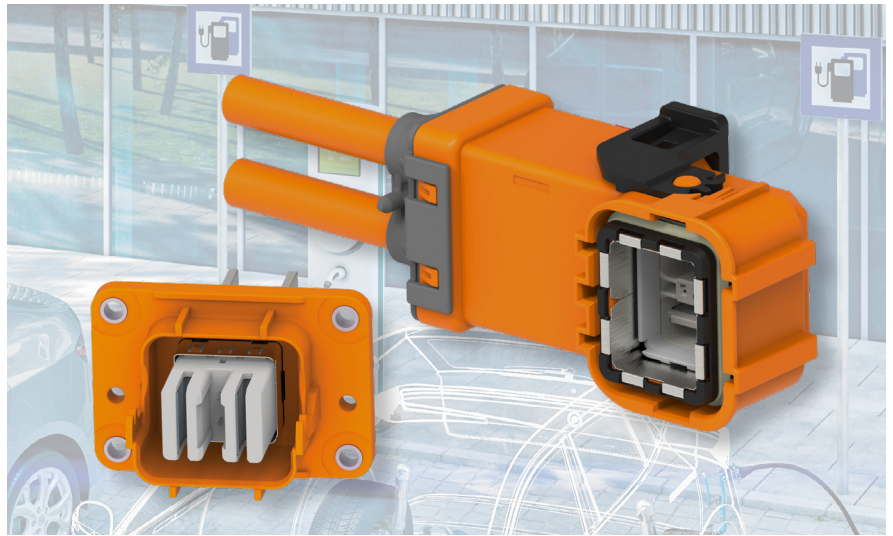


HC-STAK HIGH-VOLTAGE INTERCONNECTION SYSTEM

Technical Solution Paper



EXECUTIVE SUMMARY

TE Connectivity's most recent high-voltage (HV) terminal and connector system the HC-STAK interconnection system is specifically designed to provide a safe and reliable connection between the HV battery and inverter or the power distribution and e-motor (figure 1).

With a voltage rating of up to 1,000 VDC and a current carrying capability of up to 257 A at 85°C with 50 mm² wire the HC-STAK 25 interconnection system, featured here, represents a high-performance connection system that is both scalable and capable of reliable high-power distribution to each aggregate.

An innovative double-ended fork terminal system provides a low contact resistance arrangement while meeting sealing, shielding, and touch-safe requirements in a compact package designed for electric vehicle (EV) applications. It has the flexibility to interconnect with a wide range of conductor cross-sections, geometry, and materials.

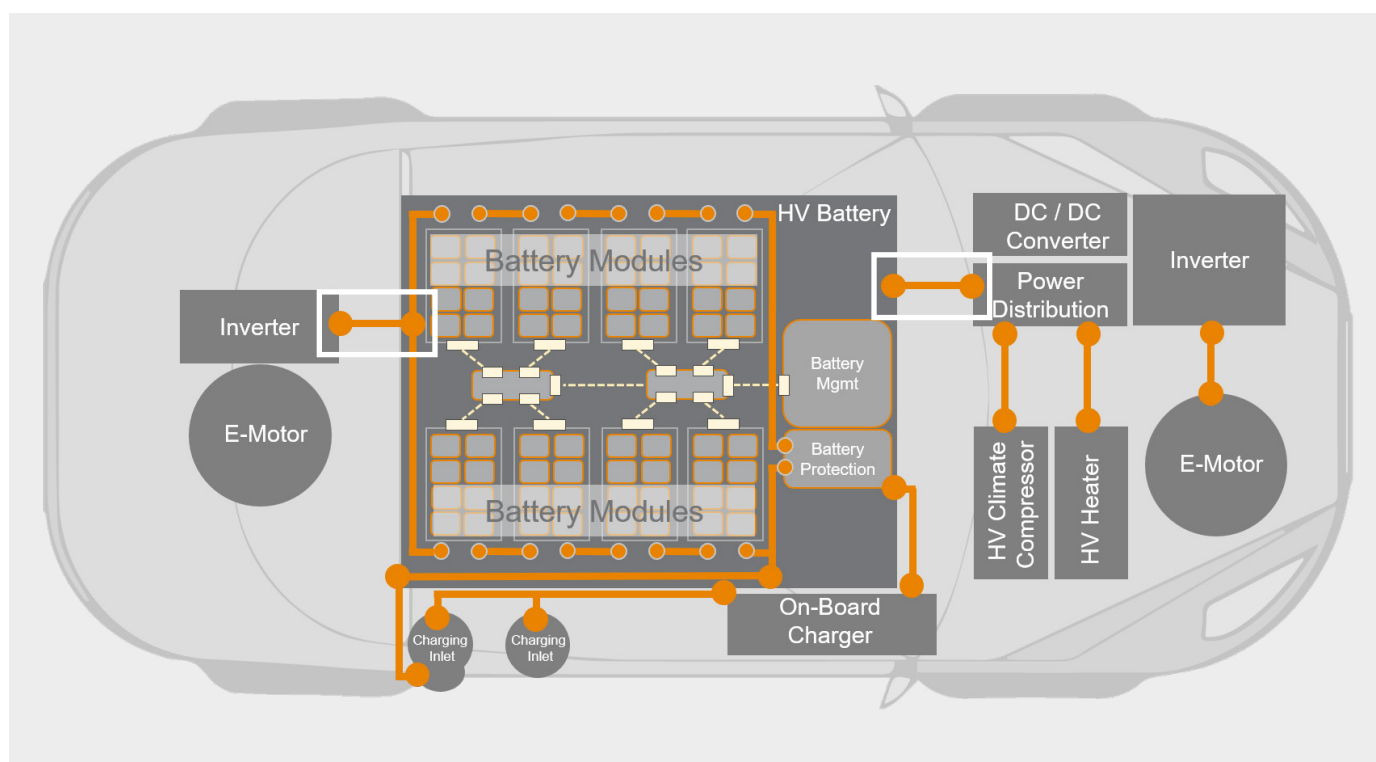


Fig. 1: Illustration of HC-STAK 25 connector system connections in an electrified vehicle architecture.

THE ELECTRIFICATION CHALLENGE

Since the advent of electric mobility, there has been a need for compact, robust, and reliable high-performance connection interfaces to transfer power in the most efficient manner from the charger through the battery pack to the inverter and drive motors. However, the transmission of this critical power presents a unique set of challenges.

For example, the ability to reliably handle high power surges during swift acceleration throughout the lifetime of the vehicle, while ensuring an optimum component design in terms of compact and flexible packaging geometry, weight and cost. With the HC-STAK 25 interconnection system, TE Connectivity has developed a new terminal and connector system that is both scalable and capable of reliable high-power distribution to each aggregate throughout the lifetime of the vehicle.

DEVELOPMENT OBJECTIVES FOR HC-STAK CONNECTION SYSTEM

Electrified vehicle connection systems must have the ability to carry high current in a compact package. Additionally, as electrical current levels continue to increase there is an urge for adapting to those needs which can be accomplished with a scalable contact system. Therefore, TE Connectivity's objective was to design a scalable contact system that could interface with a wide range of conductor sizes from 25 mm² to 95 mm² and beyond.

This is what gave rise to the development of two new interconnection systems: the HC-STAK 25 interconnection system, arranged with 40 contact points per circuit, achieving 257 A continuous current with a 50 mm² Cu conductor and its larger counterpart, the HC-STAK 35 interconnection system with 64 contact points that can achieve 407 A continuous current with a 95 mm² Cu conductor.

Further development requirements:

- A contact system able to terminate both aluminum and copper conductor cables while permitting both a 90° and a 180° cable exit
- A connection system that meets IP2XB and IP67 touch-proof requirements
- Creepage and clearance conditions to meet or exceed requirements for 1,000 VDC pollution degree 2 per IEC 60664-1
- A shielded system with contact interfaces being silver plated to permit improved vibration and temperature performance
- Connector materials must meet V0 requirements where in contact with the HV circuits

HC-STAK CONTACT SYSTEM

At the core of the HC-STAK high-voltage interconnection system is the HC-STAK double-ended fork contact (figure 2). A profile cut contact allows for a tighter gap tolerance that can be repeatably produced and easily inspected as opposed to a formed contact spring.

This contact system is a layering of identical, double-ended fork contacts that are able to act independently. The fork layer's independent movement maintains contact with negligible impact on the contact performance despite the tab's terminal offset, twist, and angularity.

Finally, the HC-STAK contact system is easily tailored to match the application current carrying requirements by simply adding or subtracting fork layers.

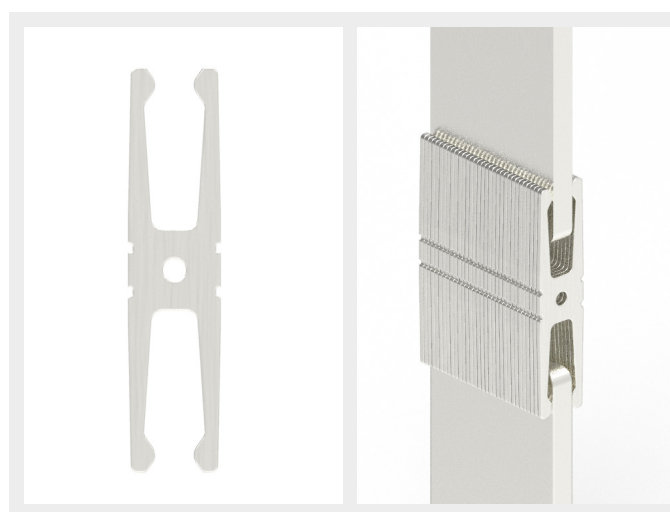


Fig. 2: Using layers of identical fork contacts on the HC-STAK interconnection system lets designers scale the contact system to meet current carrying requirements.

HC-STAK PLUG HARNESS

The plug harness system (figure 3) of the HC-STAK interconnection system consists of silver-plated tabs that can be ultrasonically welded to either aluminum or copper conductors. After being crimped to the shielded cable the inner and outer ferrule system provides a connection between the cable shielding and the connection system shielding.

The cable to plug housing interface is sealed by an overmolded cable seal. A collet/retainer system provides strain-relief to further protect the welded joint.

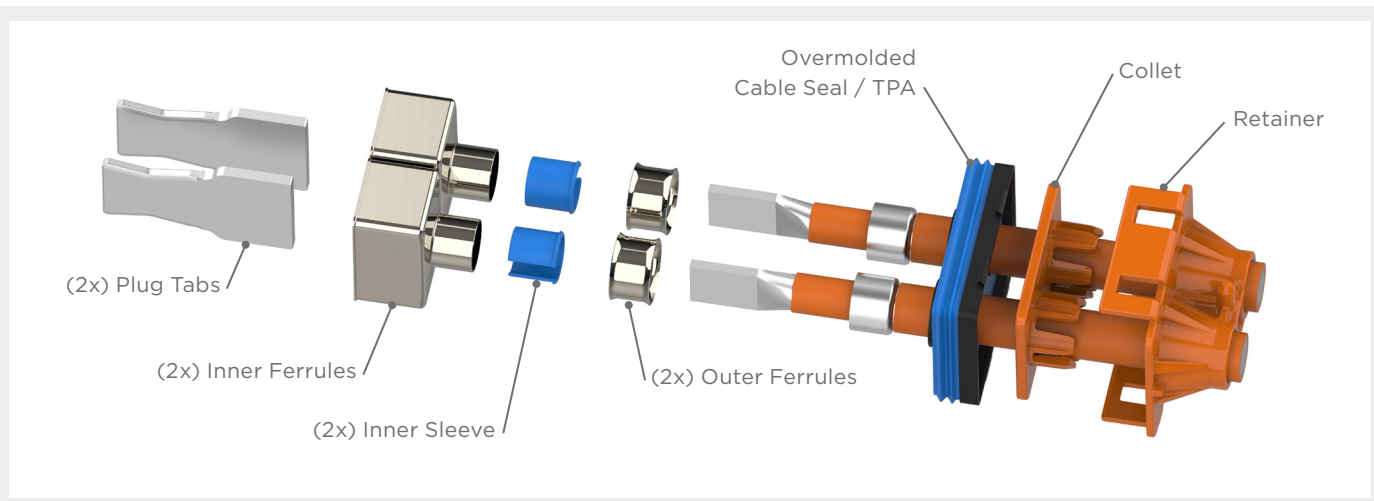


Fig. 3: The HC-STAK 25 plug harness is adaptable to multiple cable sizes and conductor materials.

HC-STAK PLUG CABLE ASSEMBLY

The plug harness is retained in the HC-STAK plug assembly (figure 4) with high strength stainless steel springs. The harness incorporates a mechanical assist lever reducing mating force of a connection system with multiple contact points. Closing the connector position assurance (CPA) after the lever action is complete provides additional retention of the lever in the closed position.

A peripheral seal protects the header interface, while the system is shielded by a copper alloy with silver plated interfaces.

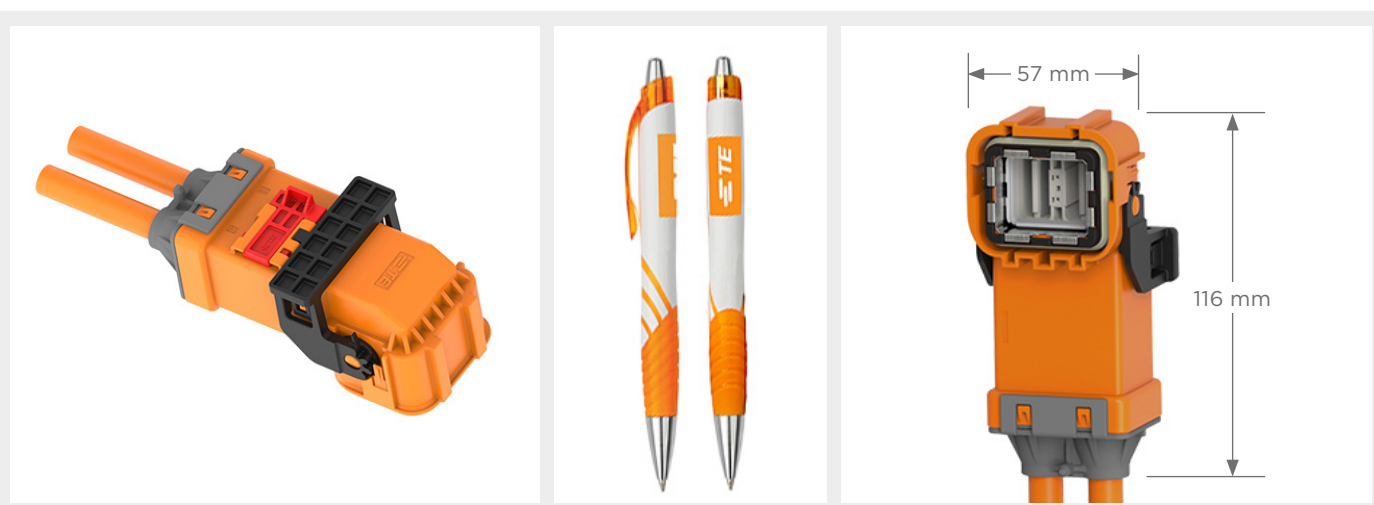


Fig. 4: The HC-STAK 25 plug assembly incorporates shielding, sealing, and mechanical assist elements in a compact package.

HC-STAK HEADER ASSEMBLY

The HC-STAK header assembly (figure 5) accommodates installation of a wide variety of header blade configurations including:

- Formed busbars
- Tabs with welded conductors
- Tabs attachable to terminal eyelet systems

The HC-STAK contacts are contained within the touchproof, V0 rated inner housing. The header provides features for keying to the device in addition to the mating plug. It is sealed to the device via a face seal, and the connector shielding system interacts with the device with contact points on all four sides. Solid aluminum compression limiters are within the outer housing for the bolted mount to device.

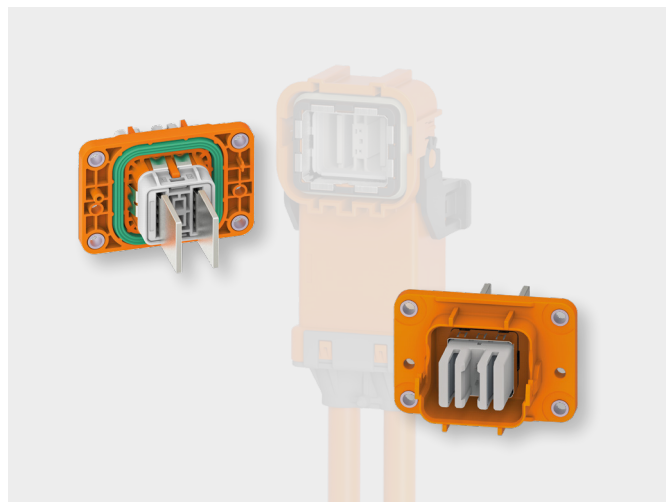


Fig 5: The header assembly contains the HC-STAK contact system which is shielded and sealed to the device.

HC-STAK MATED ASSEMBLY

The HC-STAK mated connector assembly is a compact connection system capable of carrying high current.

The HC-STAK 25 high-voltage interconnection system (figure 6) is available for general sales and features a current carrying capability of up to 257 A at 85°C with 50 mm² Cu conductor.

Its larger counterpart HC-STAK 35 interconnection system, due to be ready later in 2021, reaches a current carrying capability of up to 407 A at 85°C with 95 mm² Cu conductor.

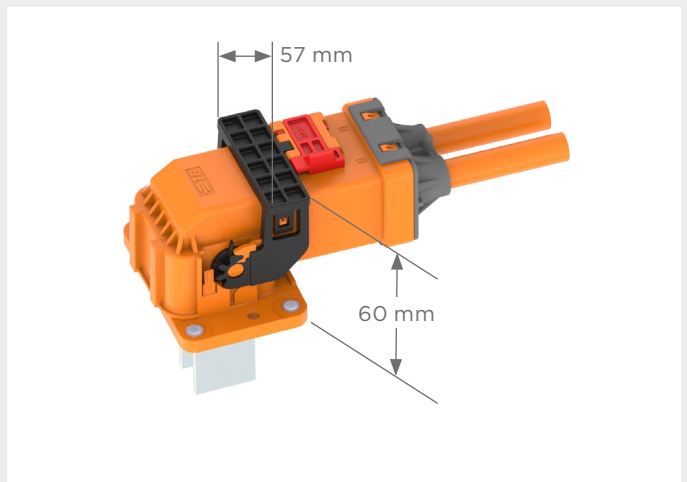
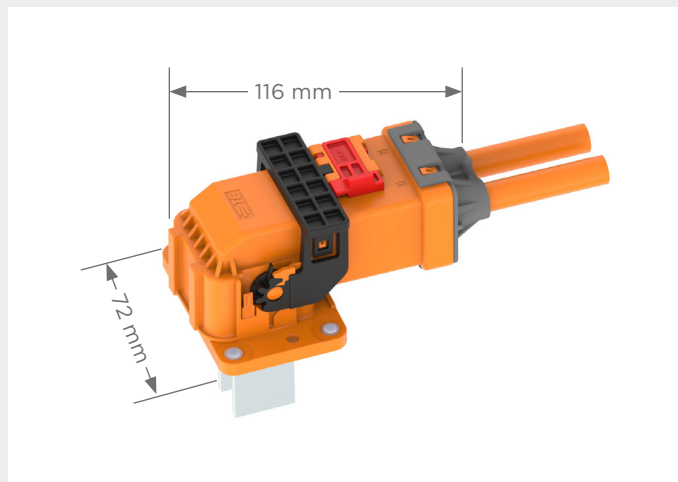


Fig. 6: HC-STAK 25 mated high-voltage interconnection system

SUMMARY

The HC-STAK interconnection system offers EV OEMs a consistent platform solution that provides multiple design advantages. These range from the geometric flexibility and scalability of its double-ended fork contacts to the ability to handle both copper and aluminum wires or pre-assembled plugs.

Its inherent versatility delivers a high level of manufacturability. At the same time, the HC-STAK 25 interconnection system achieves the development requirements for safety – meeting the IP2XB, IP67 as well as the V0 flammability standards.

TECHNICAL DATA AT A GLANCE

Suitable for connector voltage levels up to 1,000 VDC

- Very compact dimensions 50 x 57 x 116 mm
- Wire range from 25 mm² to 50 mm²
- Current capability 257 A at 85°C (50 mm²)
- Connector options 90° plug and 180° header
- Multiple contact points up to 40 per circuit
- Double-ended fork contact
- Vibration level USCAR V1

TYPICAL APPLICATIONS

Hybrid and electric vehicle powertrains:

- HV battery and inverter
- Power distribution / e-motor.

About TE Connectivity

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