

Electronics and Semiconductors

Q&A: Advantages of different vehicle connector types; with Ralph Semmeling



A variety of connectors are used for different motors and electronics inside vehicles. Determining which works with each part of the cars is a bit more of a challenge.

Both low and high-voltage connectors are used across the automotive spectrum for different needs.

But where one signal connector would work well with advanced driver assistance systems (ADAS) or for infotainment, the same connector won't work with sectors of the vehicle like the powertrain.



Ralph Semmeling is the product portfolio direct for signal interconnects at Ennovi.

Ralph Semmeling, product portfolio director for signal interconnects at ENNOVI, sat down to chat with GlobalSpec to discuss the trends happening in the connector space for automotive electronics and how ENNOVI fits into the mix. As well as benefits of certain connectors to certain parts of vehicles and why some have more benefits than others.

GlobalSpec: *How do you distinguish between a low-voltage and high-voltage connector, and how are they typically used within a vehicle?*

Ralph Semmeling: Every signal connector, even a high data speed connector like an Ethernet connector, is in principle a low-voltage connector, as it operates at less than 50 V. Signals are used in many applications within the vehicle, including ADAS. In the powertrain, however, you see high-voltage connectors operating from 800 V up to 1,600 V.

By GlobalSpec: *Can you explain the difference between solder-based connectors and press-fit connectors and why there is a trend toward the latter?*

Semmeling: Solder-based connectors require a soldering process to attach to a board, providing a permanent, rigid connection. Press-fit connectors mechanically fit into the board without the additional heating process required for soldering, creating a more reliable electrical connection to the board. With access to press-fit interconnects, automotive Tier 1 suppliers are presented with a far simpler and faster assembly process, with a much lower risk of errors. Also, from an environmental perspective, there are good reasons to move to press fit.

GlobalSpec: *How does ENNOVI differentiate itself in the market of connector manufacturers, particularly regarding press-fit technology?*

Semmeling: Many connector manufacturers offer solder-based pins, but only a few can design and manufacture press-fit. We offer low and high-voltage connectors that are predominantly press-fit, and also solder-based depending on the customer's needs. If you compare ENNOVI with other global connector manufacturers, they develop connector designs for a broad market. We focus on the automotive space, where generally an off-the-shelf product doesn't fit. Take, for example, the ENNOVI-Net Ethernet connector; it is a completely customizable press-fit based design.

GlobalSpec: *In what ways does ENNOVI provide customized solutions, and how does this approach benefit Tier 1 suppliers, especially in terms of manufacturing and design flexibility?*

Semmeling: The car OEM decides which mating interface the cable harness will use — for example, the connection from the powertrain to its electronic control unit (ECU). Then, the mating interface header must be captured in its housing and attached to the board, which could be oriented vertically or at a right angle relative to the board. So, the Tier 1 supplier develops and manufactures the system solution and that's where our customizable build-for-manufacture capabilities come into play. We can optimize that design into an approved manufacturable part.

GlobalSpec: *How do the application and performance requirements influence the choice between solder-based and press-fit connectors?*

Semmeling: The choice between solder-based and press-fit connectors depends on application-specific requirements. For high-speed data lines, like Automotive Ethernet, press-fit might be preferred for its performance advantages. However, the decision could be a little clearer for low-speed, high-voltage applications and depend on factors like the system board design and manufacturing capabilities of our customers.

GlobalSpec: *How would high-speed data lines benefit from using a press-fit connector?*

Semmeling: With high-speed data transmission, precision becomes increasingly important — even minor deviations in shape can affect their electrical performance. Press-fit connectors are designed with precision, featuring pins of exact shape and length that adhere to strict manufacturing tolerances, ensuring minimal variability. When these pins are matched with a PCB of the corresponding hole size, the result is a highly consistent and reliable connection with little room for error. In contrast, solder-based connections can introduce variability in the amount of solder used, potentially compromising the connection's integrity and performance.

GlobalSpec: *What are the benefits of having a press-fit, multi-row, board-to-board connector?*

Semmeling: If you apply forces to a solder-based interface, over time, the rigid link can crack and loosen from the pad — the press-fit pin has some ability to move slightly and to set before cold weld connections are established and as such minimizing internal stresses. Conforming with automotive performance requirements, these press-fit board-to-board (BTB) connectors can withstand mechanical shock and vibration over the lifetime of the vehicle.

GlobalSpec: *Is the ENNOVI-MB2B stackable multi-row board-to-board connector platform also customizable?*

Semmeling: Although we offer these board-to-board (BTB) connectors as off-the-shelf parts, they are also customizable. The platform covers board stacking heights from 7 to 30 mm, with between one and six rows, and up to 30 contact terminals per row. Pending specific customer requirements and business cases, new configurations will become tooled and offered as a catalogue solution to the market.

GlobalSpec: *On the high-voltage side, do you offer a press-fit power busbar connector design?*

Semmeling: Yes, we offer both press-fit and surface-mount versions. As power densities increase, assembly designs for power steering systems, traction drives, power conversion, inversion and distribution systems become more complex. Our ENNOVI BusMate Power busbar connectors combine a small footprint with a large ampacity-to-size ratio. Our proprietary floating contact technology ensures a low and stable contact resistance while allowing for wide positional tolerance ± 0.8 mm blade offset and $\neq 16^\circ$ of twist of the mating blade. The power busbar couplers of our press-fit version can support 40 to 60 A interfaces.

GlobalSpec: *What are the main challenges manufacturers face when considering switching from solder-based to press-fit connectors in their production lines?*

Semmeling: We still see many solder-based connectors, but we are beginning to recognize a trend from solder to press-fit due to enhanced reliability requirements. If you look at how the Tier 1 suppliers process their board, even if there could be an advantage that one connector is press-fit, if the rest are solder-based, the chances of changing to press-fit are relatively small due to change over cost for their assembly line. However, the decision is much easier if the line is equipped with press-fit connectors. Also, for low-voltage, high-speed connectors, where there are real performance advantages to moving to press-fit, the decision to move the other connectors to press-fit is easy. And, if it is a standalone board, putting a press-fit connector there is a simple decision. The debate over whether soldering or press-fit is the superior method for interconnects remains open, yet press-fit takes the lead from environmental, reliability and precision standpoints.