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Advancing Automotive Electronics by Thinking Inside the Box

A look at connector solutions that help engineers meet growing in-vehicle demands.

This article is sponsored by TTI Inc.



(Image: TTI Inc.)

As modern vehicles grow more sophisticated, automakers are integrating an increasing number of electronic features inside the cabin. Infotainment systems, steering wheel controls, LED lighting arrays, heads-up displays, smart mirrors, and power-operated windows and seats all rely on compact, high-performance electronics embedded throughout the vehicle interior.

Unlike “outside-the-box” connectors—those used in safety-critical environments and governed by standards such as USCAR — “inside-the-box” connectors are installed within sealed electronic modules. These internal modules don’t face the same thermal extremes but must still operate under conditions of shock and vibration within a limited space.

To address these constraints, [Molex](https://www.molex.com) offers a range of miniaturized connectors engineered specifically for use within automotive electronic modules. These products support flexible configurations and incorporate features that help guard against common points of failure—offering practical solutions for a wide variety of in-cabin systems.

“Although automotive standards like USCAR and LV214 aren’t required, we still design our products and test them to many of these standards just as an added layer of assurance to de-risk the

connectors in these applications,” says Nathan Piette, Group Product Manager for the Power and Signal business unit at Molex.



(Image: TTI Inc.)

Key Molex “Inside the Box” Products

The [Micro-Fit 3.0 connector system](#) is a longstanding option in Molex’s compact connector lineup. With a 3.0 mm pitch and current ratings up to 10.5 A per pin, it comes in a wide range of configurations, including wire-to-wire, wire-to-board, and board-to-board. Designers can choose from termination styles such as through-hole, surface-mount, and compliant pin. Most versions are rated to 105°C, with some extending to 125°C. The system supports both V-0 and V-2 resin types and offers either tin or gold terminal plating. While tin is the standard choice for cost reasons, gold offers a corrosion-resistant alternative for harsher environments.

For additional retention strength, an optional terminal position assurance (TPA) feature helps ensure terminals are fully seated during assembly, reducing the risk of intermittent connections caused by incomplete insertion. TPAs also prevent terminals from backing out if cables are tugged or bent after installation.

Micro-Fit+ builds on this platform with improved current handling—up to 13 A per pin, with a 14-gauge option in development that will raise it to 15 A. It also reduces mating force by around 40% compared to standard Micro-Fit and other comparable solutions. Added features include a connector position assurance (CPA) mechanism to reduce the risk of unmating by providing a secondary locking feature, as well as TPA for terminal retention. The entire system is rated to 125°C.

“That’s a T3 level in USCAR automotive parlance,” says Piette. “A lot of inside-the-box applications only require 85°C or 105°C temperature rating. This is a super robust system that far exceeds the performance requirements of the typical use case.”

“It’s a premium product,” adds John Crimmins, Worldwide Account Manager at Molex. “It’s foolproof. You can’t mismatch it. It’s the highest power in the industry for something that small.”

Where space constraints are more pressing, the [Micro-Lock Plus series](#) offers pitches as small as 1.25 mm and 2 mm, with 1.5 mm on the way. The mated retention force — the force required to pull the

connectors apart once they're engaged — is 49 N, which is unusually high for this class of interconnects.

“When you think of small connector systems, you might think they're flimsy or maybe delicate,” says Piette. “This is a reliable, robust micro-miniature wire-to-board system.”

The product family also supports potting, so it's well-suited for customers who use epoxy, conformal coating, or other techniques to seal their boards against environmental ingress. The 1.25 mm version supports up to 3.6 amps per pin; the 2 mm version supports up to 4.7 amps. The series also includes TPA features.

“Molex has the broadest portfolio of micro-miniature wire-to-wire and wire-to-board products from 2 mm pitch and below on the market,” says Piette.

The Pico-Clasp family is Molex's flagship signal connector in the micro-miniature wire-to-board category. With a 1 mm pitch, it offers one of the most compact footprints in the portfolio. The series includes a wide range of layout and termination styles, including vertical and right-angle orientations, single- and dual-row formats, and surface-mount versions. A variety of locking features are also available, including friction locks for basic retention, and both outer and inner positive locks that provide audible feedback during mating.

“Our over-80-year history of connector design and manufacturing know-how really sets us apart — especially in the power and signal space,” says Piette. “These products are core to our product portfolios overall, and so widely used and applied in the market. We have had a lot of experience and feedback in developing and optimizing these. Micro-Fit has been out for decades. The rest of the world has since copied and pasted that design because of its industry-leading quality and capabilities.”

“While some competitors have a lot of these attributes, rarely any of them have all,” adds Crimmins. “We have the most options, and they're readily available through TTI with no lead time.”

To learn more, visit [Molex at TTI](#).