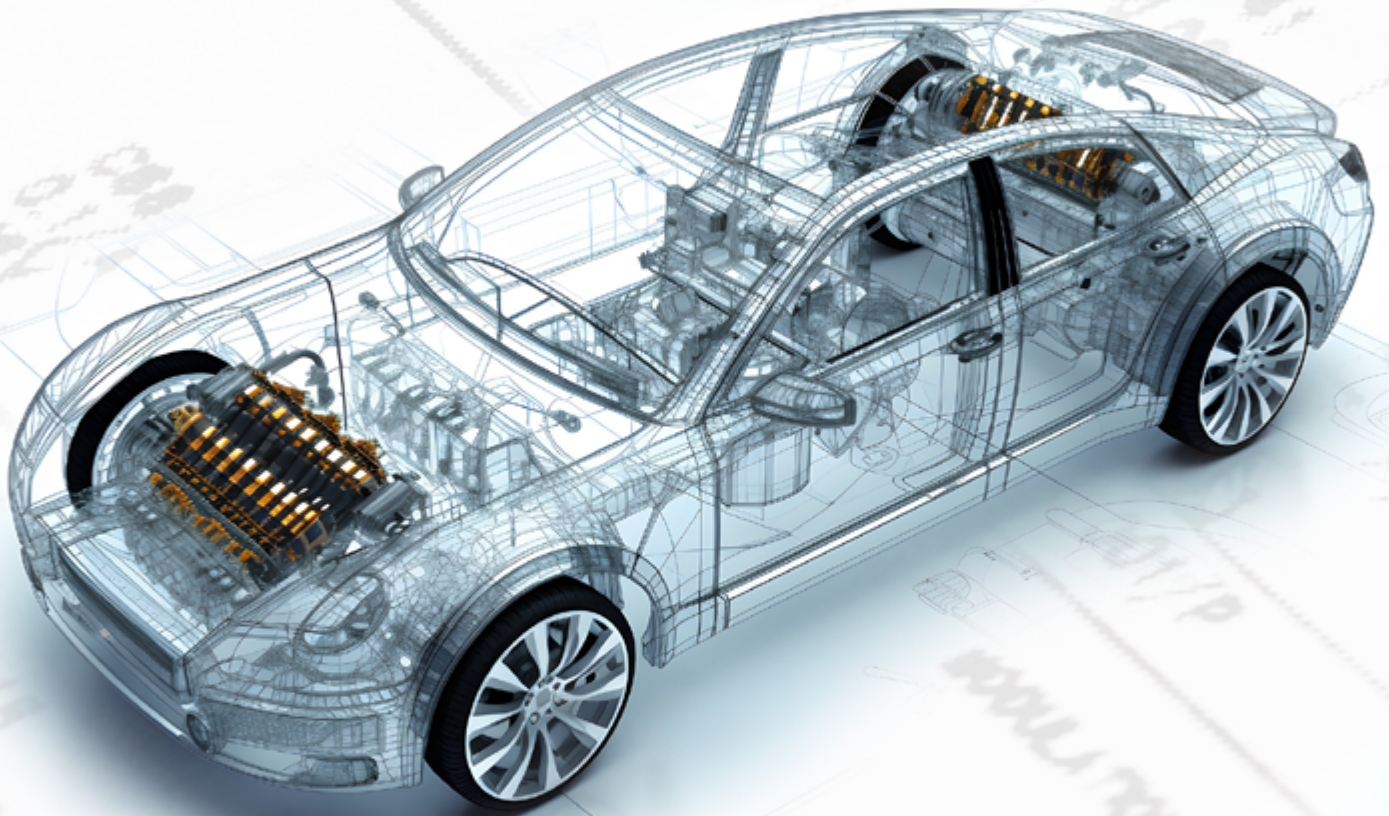


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AVNET®



/ LEADING THE FUTURE: NAVIGATING THE
TRENDS IN EMERGING VEHICLES

INTRODUCTION

As we stand on the cusp of a transformative era in transportation, the automotive industry is undergoing a seismic shift propelled by technological innovation and evolving consumer demands. At the heart of this evolution lies the transition towards electric and autonomous vehicles, heralding a new era of mobility characterized by efficiency, connectivity, and safety.

Avnet is proud to play a pivotal role in shaping this future landscape, enabling cutting-edge solutions that power and connect the vehicles of tomorrow. In this ebook, we delve into the intricacies of several different subsystems of emerging vehicle trends and the indispensable role that Molex connectors play in driving this evolution forward.

TRENDS IN EMERGING VEHICLES

From the electrification of passenger vehicles to the integration of advanced driver assistance systems and connectivity solutions, the automotive industry is undergoing a paradigm shift that necessitates robust and reliable interconnect solutions. This shift spans from standard ICE (Internal Combustion Engines) where start/stop systems are being implemented at an increasing rate to reduce emissions to the growth of HEV (Hybrid Electric Vehicle) and BEV (Battery Electric Vehicle) which are becoming more common.

Vision systems and cameras are more important to vehicle designs than ever before. In a shift toward autonomous driving, cameras play a critical role in providing crucial data for navigation, obstacle detection, lane departure, driver monitoring and decision-making. Beyond these applications, cameras are also being implemented in some very interesting spaces such as a “baby cam”. This is a camera that allows the driver to easily monitor a small child in the back seat via the in-dash display. There are vehicles on the road today with over a dozen cameras. Keeping all of that data flowing quickly and accurately requires high-quality interconnect solutions to reliably transmit the volume of high-speed video data.

Video isn't the only source of data in emerging vehicles. Wireless communications based on 5G are quickly becoming commonplace in systems like:

- In-car hot spots and infotainment
- Maintenance monitoring
- Vehicle to Vehicle communication
- Vehicle to Everything communication

These systems provide large amounts of data that make drivers and passengers more comfortable, safer and more informed about the status of their vehicle. In a commercial setting, owners can use 5G to track assets, ensure safe driving habits and keep deliveries on the most efficient route. When combined with the plethora of sensors, the state of the vehicle can be monitored to address potential issues before they occur. This keeps everyone safe and also saves money by fixing issues before they become catastrophic.

POWER MATTERS

All of these advancements require vast amounts of data that needs to be communicated quickly both within the vehicle, and to the cloud as well. But power is also a factor that needs to be considered. These systems require stable power sources and ICE vehicles traditionally relied on a 12V battery to keep everything going. But with the introduction of HEVs and BEVs, engineers are also designing much higher voltage systems as battery packs with voltages ranging from 48 to 800 volts typically. Now engineers are finding ways to convert and deliver this voltage to the drive motors and other systems within the vehicle.

ARE YOU IN THE ZONE?

There's been a lot of discussion about Zonal Architecture in emerging vehicle design, but what does it mean and why should you consider it?

Historically, vehicles were designed with a Domain Architecture. This approach is constructed by function to provide control for the entire vehicle with a central processing unit. Each functional element features its own domain controller. This type of architecture creates a complex web of vehicle-spanning domains which require an incredible amount of cabling which adds weight and decreases efficiency.

Vehicles with traditional domain architectures can have between 100 and 150 electronic control units (ECUs). Each of these needs its own wiring making for an even more complex harness system.

Zonal Architecture is a decentralized system that consists of electric controllers to several modular zones or hardware gateways which are located at key points throughout the vehicle. This architecture assigns a group of electrical features to a dedicated zonal controller. Engineers can reduce overall harness weight by up to 50% by switching to a zonal architecture by structuring devices and computer controls into isolated hubs. This also provides the scalability needed to accommodate high-speed data required for emerging vehicles as well as efficiency, safety and production advantages to automakers.

THE MOLEX ADVANTAGE

Molex connectors, renowned for their durability, performance, and innovation, stand as the cornerstone of this technological revolution, enabling seamless power and data distribution in the vehicles of today and tomorrow. These interconnect solutions bring innovations in connectivity, autonomous driving, in-vehicle experience and electrification. Automotive manufacturers have a lot on their minds as they're developing new vehicles. Some of the key concerns are size and weight constraints, cost, reliability and of course speed and power handling capabilities.

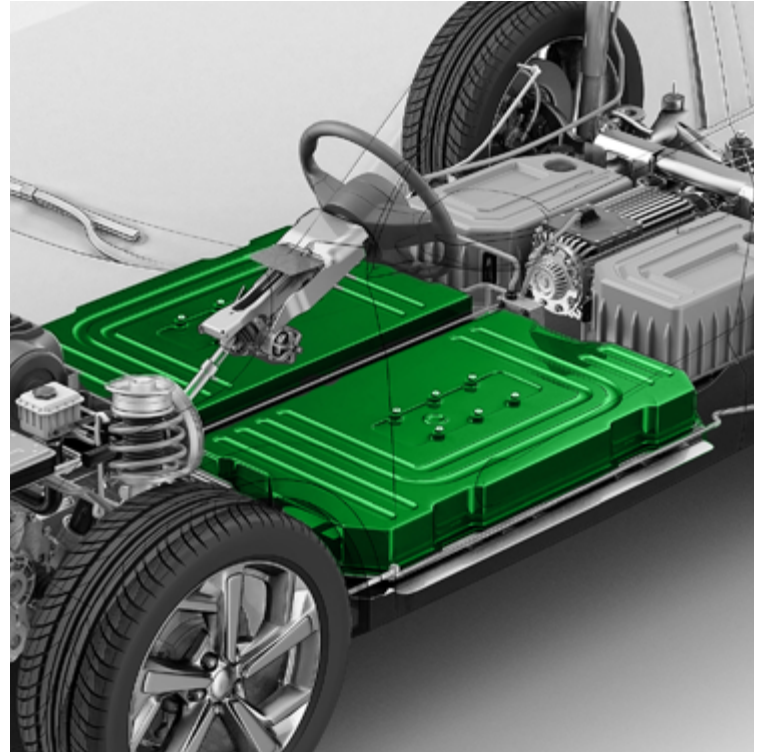
The Molex products shine in each of these areas by leveraging their 80+ years of engineering expertise and innovations that bring the interconnect solutions for your specific application.

In this ebook, we delve into the intricacies of several different subsystems of emerging vehicle trends and the indispensable role that Molex connectors play in driving this evolution forward.

BATTERY MANAGEMENT SYSTEM (BMS)

The BMS is the silent guardian behind the seamless operation of EVs, ensuring efficient power delivery and prolonged battery life. As electrification surges in emerging vehicle designs, the BMS becomes a critical component and designers face a myriad of challenges from managing thermal runaway risks to optimizing energy efficiency and ensuring reliable communication which demands innovative solutions.

Within batteries, voltages and capacities are increasing to keep up with demand and increase range. The BMS system monitors and regulates the charging and discharge of batteries with connectors like the sealed MX123 family for high-vibration under-the-hood applications that facilitate efficient communication within the BMS. The BMS also monitors battery type, voltage, temperature, capacity, state of charge, power consumption, remaining operating time and charging cycles.

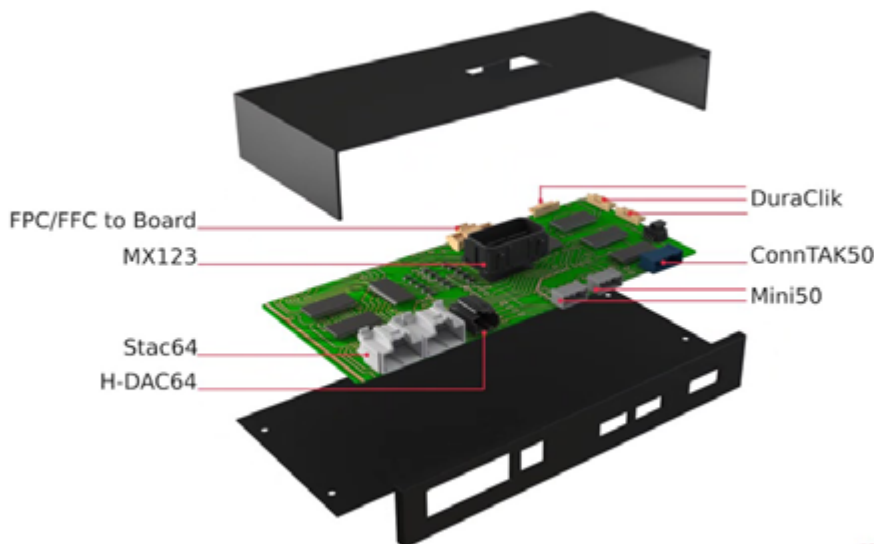


Keeping all of these crucial signals and power levels moving quickly and securely requires many rugged and reliable interconnect products such as the Flat Printed Circuit (FPC) and Flat Flex Circuit (FFC) to Board that not only save space with pitches as small as 0.20mm and up to 96 circuits, but can withstand up to +150°C and 125V.

Saving space and integrating as many signals into a single connection saves cost also by reducing the overall number of connectors required. This is where the Stac64 and H-DAC shine. These stackable connectors provide single or multi-pocket solutions and can be stacked together like building blocks essentially making custom headers. The Mini50 and ConnTAK50 are designed to save 50% more space over traditional USCAR 0.64mm connectors with both sealed and unsealed options available. The difference between the two is the Mini50 is US-based and has the latch on the top,

whereas the ConnTAK50 is based on the European Arbeitskreis interface and features side latches.

In any vehicle application, there are temperature swings and vibrations. For these environments, one of the best wire to board solutions is the DuraClik which is designed for temperatures up to 125 C and features an integrated secondary locking system for the terminals.



BODY CONTROL MODULE (BCM)

BCMs are responsible for managing various electrical functions in emerging vehicles, such as interior and exterior lighting, power windows, door locks, climate control and more. And with more and more functions becoming automatic and electrified, automakers are implementing even more BCMs to manage everything.

With these systems being spread throughout the car, the connections that bring all of these signals and power supplies are just as important as the module that manages them. Molex brings the technology you need to make the connections that matter.

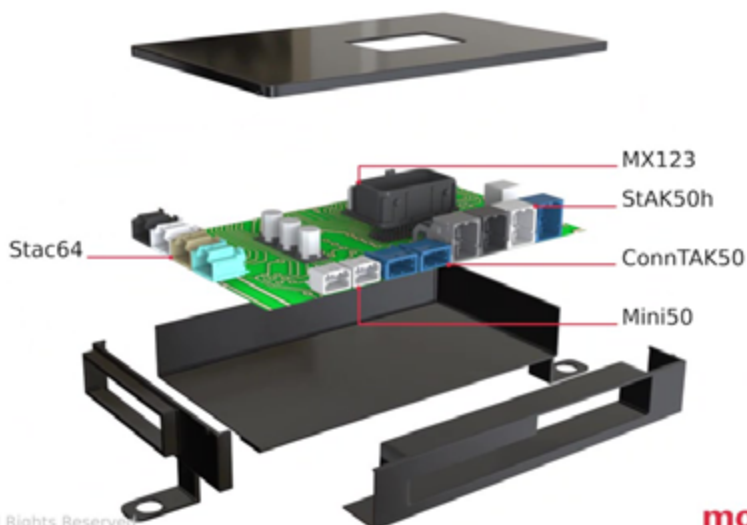
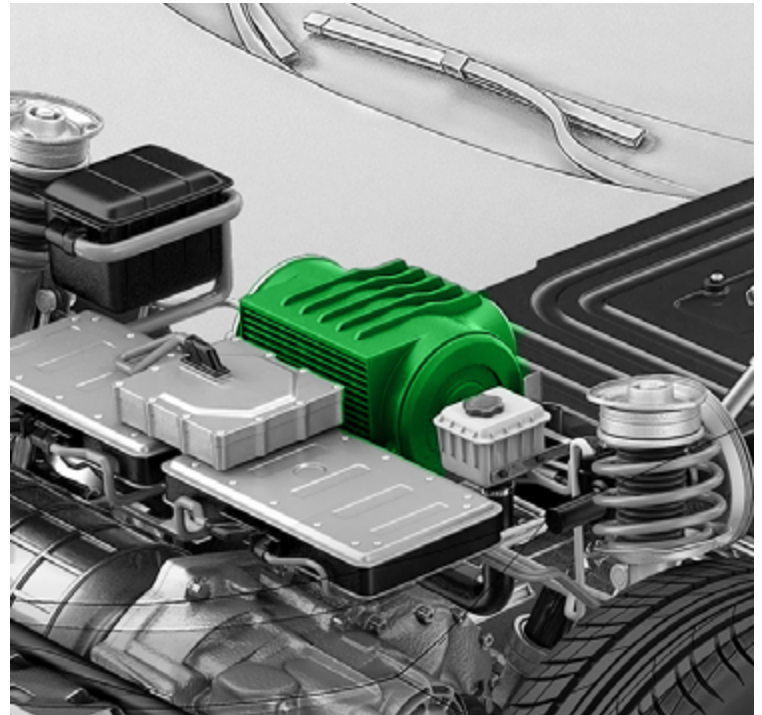
The Molex Solution

For under-the-hood applications where IP67, IP68 and IP69K specs, Temp Class III operating temperature and Vibration Class I specifications are required, the MX123 sealed connector system is available with 49 to 80 circuits and 25.0A and offers a rugged interface.

MX123 connectors have been used for over 20 years in automotive control modules that can be mounted on the engine or transmission case.

Where a custom header and both signal and Ethernet connectivity are necessary, the Stac64 and StAK50h stackable connector systems bring a small footprint. Each connector can be used in applications from low-current signals (5.0A) to high-power (30.0A) and up to 80 circuits.

In applications where a smaller footprint is needed for low-current circuits in interior environments, the Mini50 family comes in both sealed and unsealed options from 4-38 circuits with the industry's only USCAR 050 approved interface.



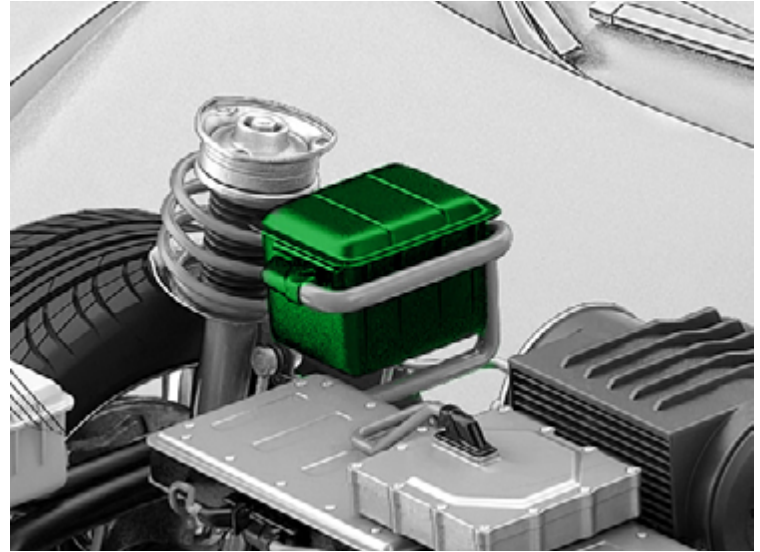
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DCU+ZCU (DOMAIN CONTROL UNIT/ZONAL CONTROL UNIT)

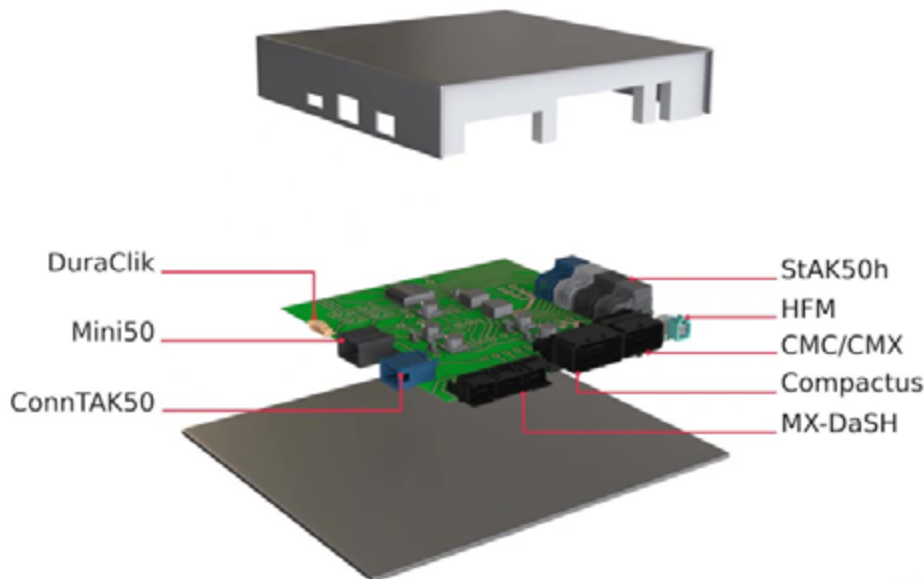
The various comfort, convenience and lighting systems are controlled by zone and domain controllers to create an enjoyable driving experience. However, vehicle designs are evolving to a zone-based control that incorporates localized power distribution and in-vehicle network communications with higher bandwidth to keep up with demands.

Designers are choosing a more zonal approach to simplify cabling which then allows for increases in data and power capabilities to keep up with consumer demands. This then provides for greater efficiencies in cost, weight and assembly for the manufacturer creating a win-win scenario for everyone.



As with just about any automotive design, space is a consideration. This is where the interconnect solutions from Molex make all the difference. The High-Speed FAKRA Mini (HFM) Coaxial Cable solutions provide an 80% reduction in size over standard FAKRA while delivering 20 GHz signal speed capability to support modern LiDAR, camera and radar applications in emerging vehicles.

When you need to save space while combining high-speed data, signals and power into a single connector, designers can select from 0.50 mm to 4.80 mm terminal sizes with up to 22 circuits for harsh conditions inside or outside the cabin. The MX-DaSH (Molex Data-Signal Hybrid) family is set to replace multiple traditional connectors while reducing size, weight and cost in your automotive application. These products are ideal for camera systems, autonomous driving modules, gateway/switch modules and LiDAR devices.



Combining high-speed data, signals and power is key for emerging vehicles. The Compactus family adds rugged reliability and design flexibility for harsh environments where IP69K-rated connections with latching connections are needed. Three terminal sizes including 0.50, 1.00 and 2.80mm can be combined into a single housing. Designers can simplify the wire harness, and reduce cost, size and weight in a common connector.

In domain and zone controller designs, there are instances where high-density connections are necessary to bring a host of signals including the multitude of sensors and various mid-power lines together in a sealed housing with latching capabilities for field-proven robustness. This is where the CMC/CMX line provides connections from 22 to 154 circuits with wire sections from 0.35 to 5.00mm².

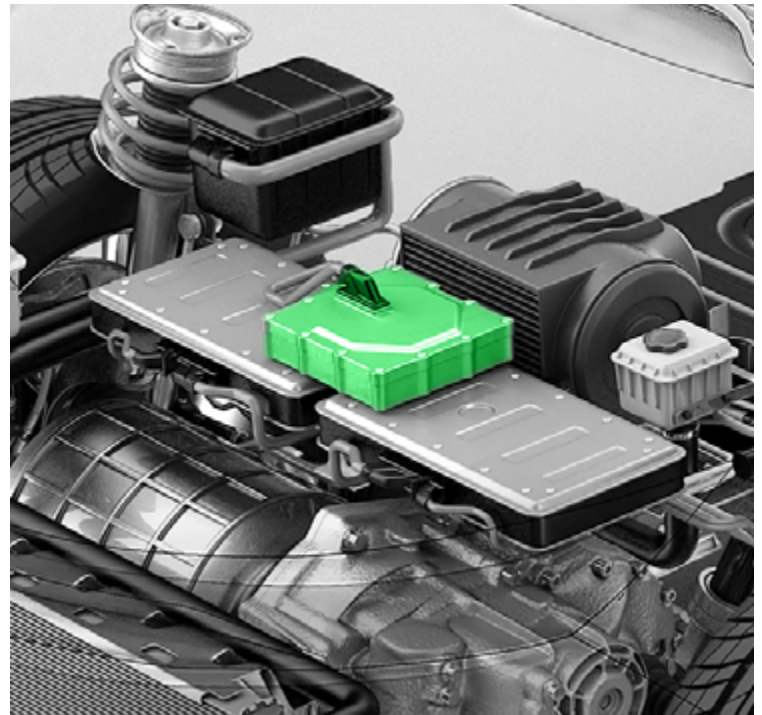
No matter which type of controller architecture you choose for your design, there are common considerations such as vibration and wide temperature swings. The DuraClik family brings the retention options for stable mating with 3.0A in 3-15 circuits. As well as the Mini50 and ConnTAK50 lines which also bring independent secondary locking terminal retention that's molded into the housing for secure connections.

The stAK50 family brings an industry-approved terminal design that's sure to make your next design come together quickly and smoothly. Engineers can leverage USCAR color-coding and PCB-alignment posts to ensure quick and secure mating in any application.

DC/DC, PDU, MCU, OBC (4 IN 1)

Our final example is actually a combination of 4 different automotive subsystems. These include the DC/DC converters, Power Distribution Units (PDU), Motor Control Unit (MCU) and the Onboard Charger (OBC). Whether you're designing for a full electric vehicle, a hybrid or a standard internal combustion vehicle, power conversion is key. Many automotive applications rely on 12VDC, but as more convenience and features are incorporated into modern designs, the power requirements are changing to keep up. This means higher voltages such as the 48-volt systems that are entering the marketplace. These systems allow automakers to deliver higher power without sacrificing weight and size constraints.

Since these applications focus mainly on power, it stands to reason that Molex families such as the Busbar products come in rigid, flexible and laminated options to deliver crucial power in any environment while also dissipating heat and conserving space and handling 30 to over 200A current ratings.



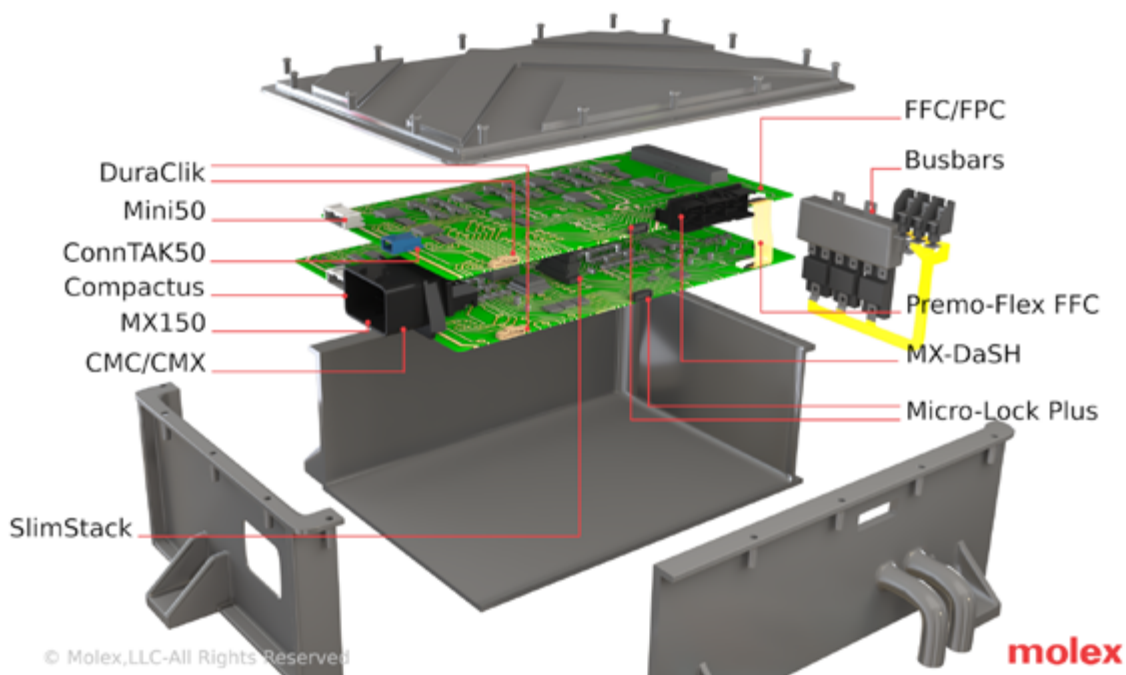
Space is limited in any design, but especially in automotive applications where more features are being designed in while driving towards higher efficiencies. Products like the Easy-On FFC/FPC and the Micro-Lock Plus come into play. These

connectors keep space in mind without sacrificing performance. The Easy-On devices cover pitches from 0.20mm to 2.00mm and circuits from 2 to 120 while withstanding up to 150°C and 4.7A. And let's not forget the SlimStack Floating Board-to-Board system. These devices feature an impressive 0.60mm minimum mating height that not only saves space but will simplify the assembly process.

These rugged environments are ideal for the Mini50 sealed connectors and ConnTAK50 products because they are designed to function at a maximum temperature of +125°C in a space-conscious format. We can't discuss a rugged environment without bringing in sealed interconnect systems such as the MX150. This family delivers reliable operations with the available T2/V1/S3-rated sealing and the mat seal. This eliminates the need for individual cable seals which reduces cost and assembly time. The CMC/CMX family of products features high-density, sealed solutions for up to 21.0A of power while meeting the strictest requirements.

Beyond sealing, retention is also a key point of concern in automotive designs. This is where the DuraClik connectors deliver high PCB retention due to their inner positive locking that prevents latch breakage from wire tangling.

The final family in this section is the Compactus. While this is a sealed hybrid connector, it's also robust and dependable. These feature IP69K-rated sealed connections with headers available up to 186 circuits in a compact 0.50mm terminal system which reduces the interface area by 20% compared to the standard 0.64mm products.



CONCLUSION

The Molex Difference

As you can see, Molex has a very broad portfolio of industry-leading interconnect options to fit virtually any need. Each of these products has been meticulously designed with materials, features and qualifications to meet the stringent requirements of the automobile industry.

We've also highlighted several products that aren't designed solely for vehicles, many products are built for non-transportation products but are suitable for in-vehicle designs due to the high level of quality that is always maintained at Molex.

But in the case that your design requires a very specific cable, check out the custom cable maker section for a solution that meets your exact needs.

The Avnet Difference

From idea to EOL, Avnet is here to support you. This includes engineers who can walk you through any challenges you might run into and block diagrams to get you started on your own to quoting tools and robust supply chain solutions. We've been meeting the needs of customers for over 100 years.

Learn more at [avnet.com/transportation](https://www.avnet.com/transportation)

