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# Solution Guide to Rugged, Miniaturized Connectors



## SOLUTION GUIDE TO RUGGED, MINIATURIZED CONNECTORS

Evolving consumer demands and commercial expectations are driving the need for smaller and more capable devices and systems. A surge in sensor density to support Internet of Things (IoT) functionality and other emerging features is challenging today's engineers to design for size without sacrificing performance. At the same time, as complex electronic systems grow more prevalent, electronic components are frequently exposed to harsh environmental conditions, such as vibration, extreme temperature, water and dust. For many applications, rugged reliability is no longer optional; it is a requirement.

Engineers are now finding new uses for field-tested connectors from automotive and transportation applications, where rugged miniaturization has been critical for the development of more feature-packed cars and electric vehicles. These design techniques are being applied in almost every industry, such as agricultural equipment, industrial robotics and outdoor lighting and displays.



## WHAT'S DRIVING MINIATURIZATION?

The demand for smaller, lighter and more compact connectors is influenced by factors including:



Sensor proliferation



Feature density



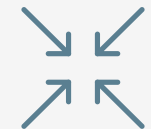
Modularity



High speed



Portability



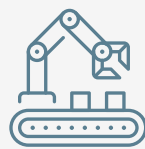
Space constraints



Weight reduction



IoT functionality



Advanced manufacturing techniques



Cost optimization



Competitive positioning

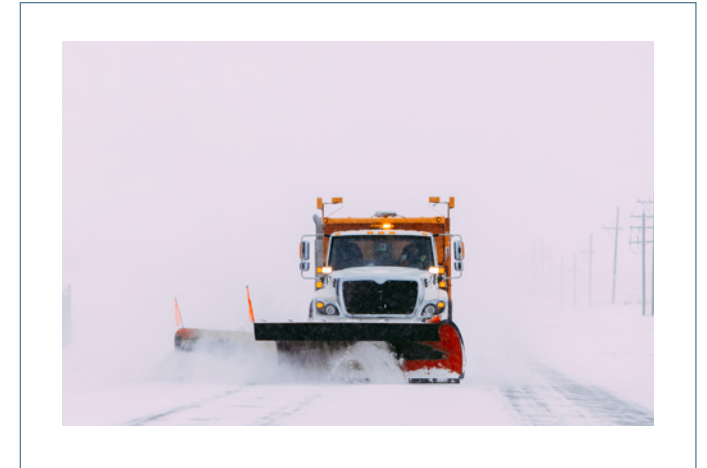
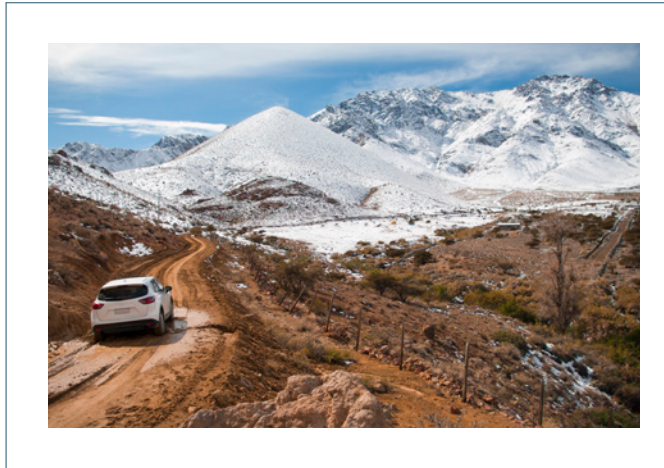
## APPLICATION SPOTLIGHT

### SETTING THE TREND FOR RUGGED MINIATURIZATION

Life on the road for a vehicle isn't easy, and few applications expose electronic systems and their components to a wider range of environmental considerations than transportation. From internal engine vibrations and battery heat to extreme factors like mountain ice, desert sand and rain, transportation applications are the ultimate test of connector reliability. But as the industry increasingly demands more feature-heavy and more efficient vehicles, trucks, bikes and other means of transport, design engineers must also simultaneously design for higher electronic densities, smaller space considerations and reduced weights.

Molex offers a wide range of rugged, miniaturized solutions that have been proven on and off the road. These connectors feature:

- Superior vibration resistance
- Innovative locking and latching mechanisms
- Extended operating temperature ranges
- IP67, IP68 and IP69k ratings
- Reduced pitches
- Compact packaging sizes



## SENSING A TREND

One major trend propelling innovation in miniaturization is sensor technology. From IoT integration to advanced vehicle safety features, sophisticated microsensors are quickly emerging in devices across industries, all of which are dependent on connectivity.

# VIBRATION

## ESTABLISHING A SECURE CONNECTOR

Plenty of devices encounter high vibrations, resulting in signal loss and operational failure in their connectors. Whether it's in a boat or a gaming device, connectors that were improperly mated during assembly or not designed with the environment in mind risk not only losing electrical connection but introducing unnecessary safety risks such as short circuits and electric shocks.

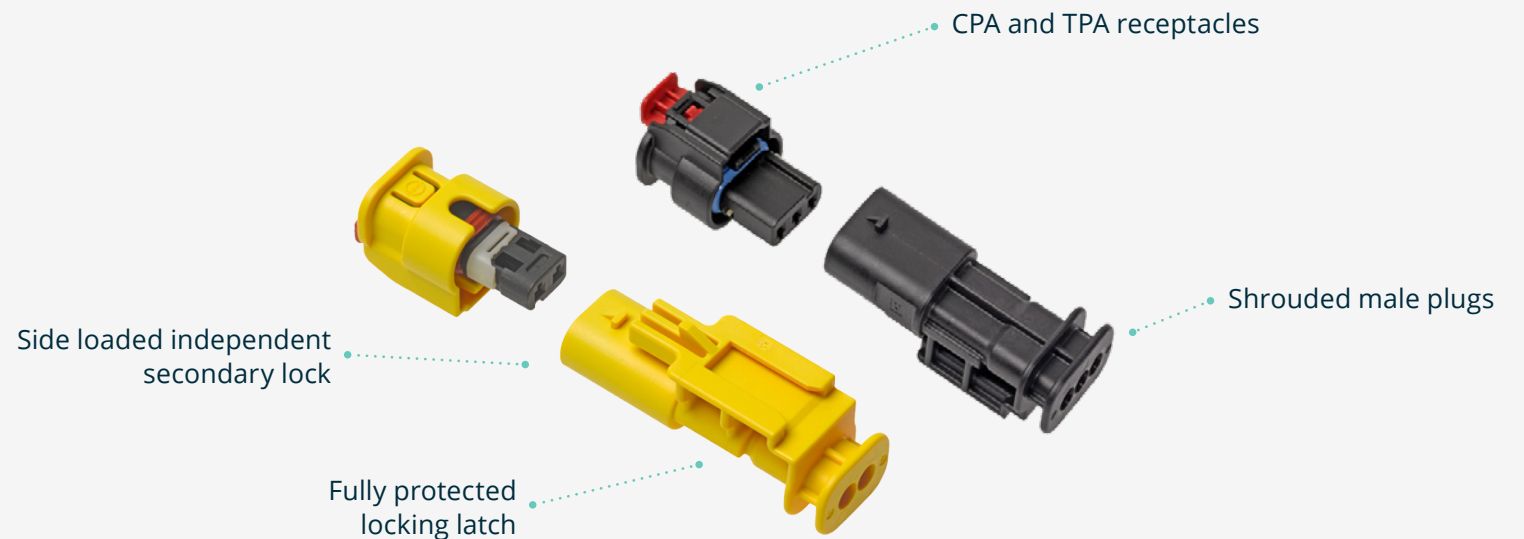
Molex offers a range of miniaturized connectivity solutions designed for high vibration applications. A variety of innovative mechanisms, such as connector position assurance (CPA), terminal position assurance (TPA), primary lock reinforcement (PLR), inertia lock and independent secondary lock (ISL) minimize the risk of assembly error and unintentional disconnect. Improved connector performance is further supported by additional design choices, such as rugged housings, audible latching interfaces and board alignment features.



## FEATURED PRODUCT

### MXP120

The compact, wire-to-wire 1.20mm terminal MXP120 connectors deliver a 4.00mm-pitch, single-row system with sealed crimp technology that protects the connection in even the harshest environments. To avoid unintentional disconnect due to vibration, male blade connectors feature PLR while female receptacles provide ISL, ensuring efficient terminal positioning and minimizing the risk of partial installation of terminals.



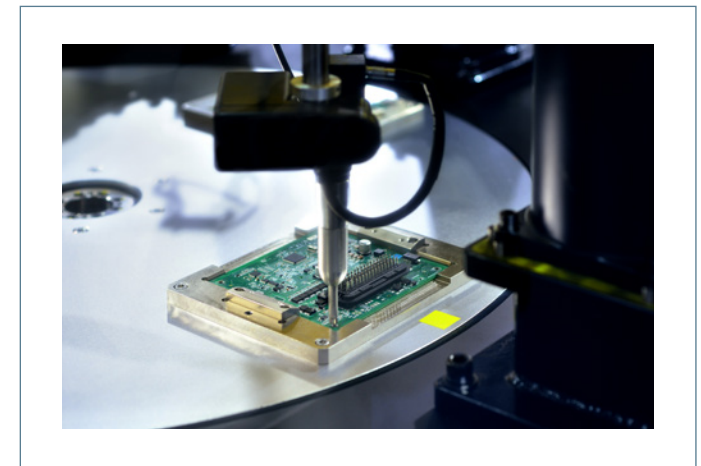
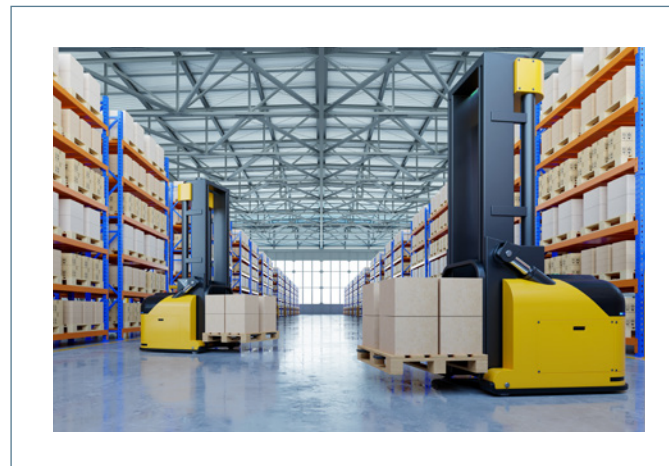
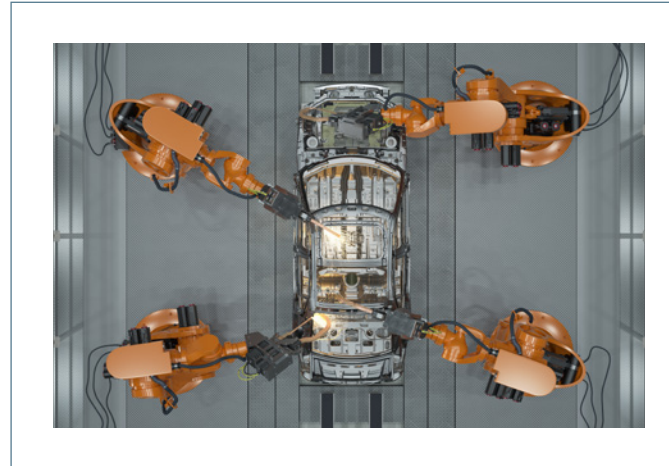
# VIBRATION

## APPLICATION SPOTLIGHT

### DESIGNING ROBOTS FOR HIGH VIBRATION ACTIVITIES

Rugged connectors are key to supporting the reliability and longevity of robotic systems prone to high vibrations, such as those caused by movement and terrain. Molex's rugged, miniature connectors are well suited for robots that are consistently exposed to vibration, such as:

- Automated guided vehicles (AGVs)
- Automotive manufacturing robots
- Autonomous mobile robots (AMRs)
- Automated soldering systems and arc welders
- Collaborative robots (cobots)
- Foundry and die casting robots
- Semiconductor manufacturing robots
- Thermal spray robots



## ENGINEERING SOLUTIONS FOR CHALLENGING ENVIRONMENTS

Molex has designed its industry-leading miniaturized connectors to handle the toughest conditions. Our rugged products have been extensively tested to ensure they will perform in the most demanding situations.

# TEMPERATURE

## WITHSTANDING EXTREME TEMPERATURES

Continued growth of IoT is increasingly causing sensitive sensors and supporting electronic systems to be placed in extreme temperature environments. From remotely controlling an HVAC system to monitoring robotic systems on a factory floor or tracking a fleet of trucks, thermal resistance to extreme heat and cold can protect from loss of electrical function, electrical arcing, fire or other system failure.

Molex designs its miniaturized connectors with extreme operating temperatures in mind, and support operating temperature ratings of -40 to +125°C. DuraClik and Mini50 connectors also feature high-temperature thermoplastic housings to withstand infrared (IR) lead-free solder processing at a maximum temperature of +255°C, simplifying the manufacturing and assembly process and avoiding the unnecessary costs associated with wave soldering.



## FEATURED PRODUCT

### DURACLIK

DuraClik connectors are one of the industry's smallest solutions for harsh, extreme temperature environments. These 2.00mm pitch wire-to-board solutions provide superior electrical contact reliability, space savings and high PCB retention force capability. The wide operating temperature range enables DuraClik connectors to maintain performance in high-heat applications.



## TEMPERATURE RANGE

- Operating temperature: -40 to +125°C
- Solder processing: Max temperature +255°C

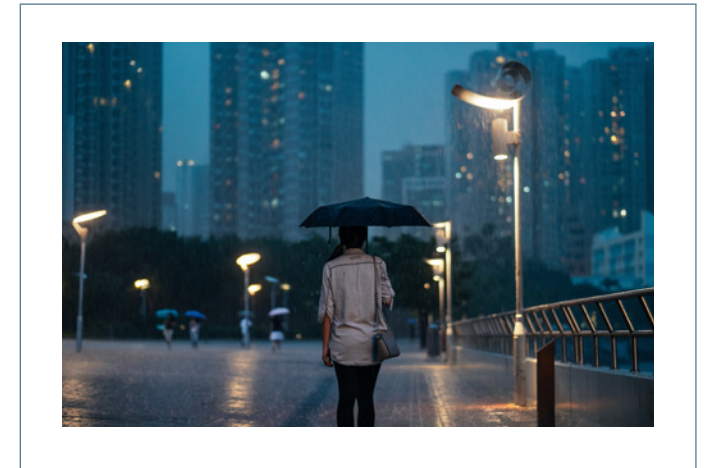
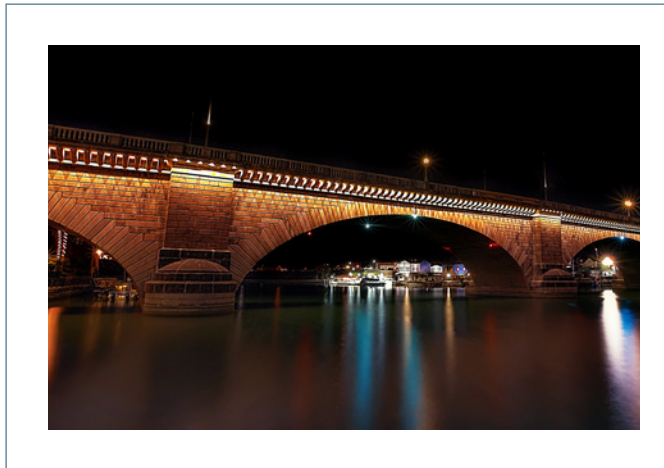
# TEMPERATURE

## APPLICATION SPOTLIGHT

### HOLDING THE HEAT AT BAY

Whether for a large display, emergency vehicle lighting, signage or a network of streetlights, outdoor lighting installations often generate and are exposed to extreme temperatures, many accompanied by weather-related effects such as ice. A failed connection means lights out and can introduce unnecessary risks of lost IoT functionality, complete failure and even fire. Connectors with wide operating temperature ranges ensure reliability through continued exposure to internally and externally generated heat and freezing conditions. This is accomplished through:

- High-quality material selection
- Robust enclosure design
- Sealing for tight barriers
- Secure connector mating
- Waterproof coatings to enhance resistance
- Protective caps as an extra layer



# INGRESS PROTECTION

## KEEPING THE ELEMENTS OUT

In industries and applications where protection against liquid and debris is essential, electrical connectors with appropriate Ingress Protection (IP) ratings play a crucial role. Applications like outdoor displays, watercraft and rugged outdoor equipment are dependent on connectors that provide a reliable seal against the elements to ensure uninterrupted functionality and durability in challenging environmental conditions.

Depending on the demands of the application, Molex's miniaturized connectors are available with IP67, IP68/IPX8 and IP69k rating to protect against dust and/or submersion. IP69k rated products are noted for their resistance to high water pressure and high heat applications, such as an offroad vehicle being sprayed down with a pressure washer or a device undergoing a sterilization process.



## FEATURED PRODUCT

### MINI50

Achieve 50% space savings over traditional 0.64mm connectors with sealed or unsealed Mini50 single- and dual-row receptacles. These connectors are available with high-performing sealed receptacles using matte-seal designs and offer up to IP69k rating to withstand the harshest conditions.

IP68 and IP69k options



• Matte seal for wires

• Ring seal for mated interface

• Rated for 30 minutes of submersion

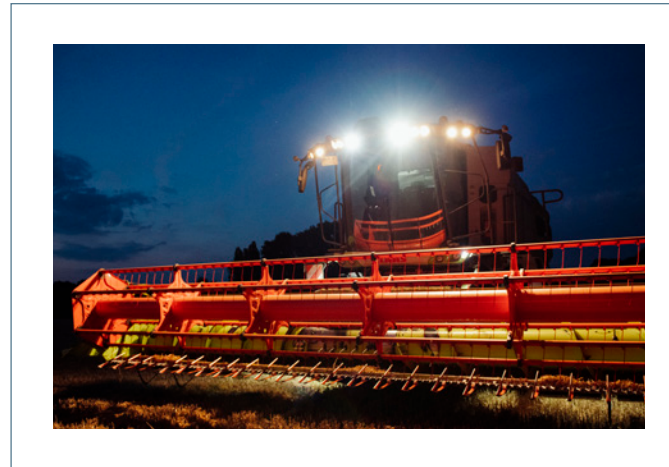
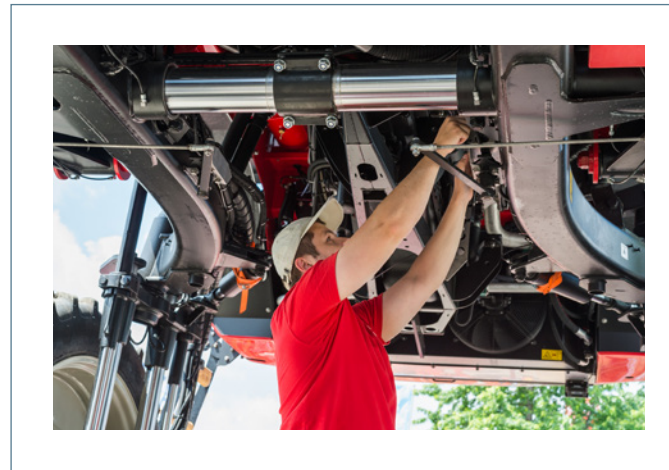
# INGRESS PROTECTION

## APPLICATION SPOTLIGHT

### BRINGING IN THE HARVEST WITHOUT INTERRUPTIONS

Agricultural applications are rugged in nature, often exposing systems to outdoor elements such as water, dust, other debris and extreme temperature fluctuations. But few are at greater risk of ingress than combine harvesters, which in addition to having to maneuver over dusty, muddy terrain, must rely on networks of large rotating wheels, drums and belts to cut, process and transfer crops: each producing large amounts of debris. These massive machines rely heavily on environmentally sealed connectors throughout their:

- Engine controls
- Harvesting heads
- Control panels and displays
- Hydraulic systems
- Lighting systems
- Data collection sensors



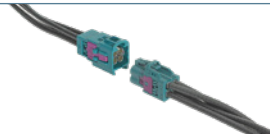








## SPECIFYING RUGGED, MINIATURIZED CONNECTORS

Molex is at the forefront of ruggedized miniaturization technology, with a complete suite of off-the-shelf interconnect solutions and custom capabilities. With features like vibration resistance, protection from fluid and particulate and the ability to withstand extreme temperatures, Molex connectors deliver best-in-class performance in the most challenging environments – from the factory floor to the operating room and beyond. Here’s how to select the right connector for your application.

### WHY MOLEX?

- 80+ years of experience delivering the highest quality connectivity solutions at scale
- Active involvement in the organizations and standards committees driving miniaturization trends
- Extensive global footprint with local engineering, manufacturing and supply chain resources
- Cross-disciplinary engineering experience backed by innovations like predictive engineering
- Industry-leading portfolio of standard products for power and signal connectivity
- Customer collaboration at the forefront of every solution, no matter how custom

	Connector	Configuration	Row	Orientation	Operating Temp	Sealed	Circuit Count	Pitch	Max Current	Vibration Resistance
	DuraClik	Wire-to-board	Single, right angle, vertical	Right angle, vertical	-40 to +125°C	No	2 to 15	2.00mm	Up to 3.0A	High
	Mizu	Wire-to-wire	Single	n/a	-40 to +155°C	IP67, IP69k	2 to 6	2.50 to 5.00mm	Up to 7.0A	High
	HFM	Wire-to-board, Wire-to-wire	Single, dual, quad	Right angle, vertical	-40 to +105°C	IP68	Up to 4	4.00mm	1.5A	High
<b>0.50mm Terminals</b>										
	Mini50	Wire-to-board, Wire-to-wire	Single, dual	Right angle, vertical	-40 to +125°C	IP68, IP69k (with backshell)	2 to 114	2.00mm	Up to 4.0A	High
	stAK50h	Wire-to-board	Multiple	Right angle, vertical	-40 to +105°C	No	Up to 56	2.00 to 5.20mm	Up to 30.0A	High
	ConnTAK50	Wire-to-board	Single, dual	Right angle, vertical	-40 to +105°C	No	2 to 22	1.80mm	Up to 4.0A	High
<b>0.64mm Terminals</b>										
	Stac64	Wire-to-board	Dual	Right angle, vertical	-40 to +105°C	No	8 to 80	2.54 to 5.25mm	Up to 36.0A	High
	MX64	Wire-to-board	Single	Vertical	-40 to +125°C	IP67	Up to 8	2.54mm	Up to 10.0A	High
<b>1.20mm Terminals</b>										
	MXP120	Wire-to-device	Single	Straight	-40 to +125°C	IP69k	Up to 6	4.00mm	Up to 13.0A	Extreme



To learn more about Molex's capabilities and to see our complete product offering of rugged, reliable and miniaturized connectors, visit us at: [molex.com/auto-miniaturization](https://molex.com/auto-miniaturization)