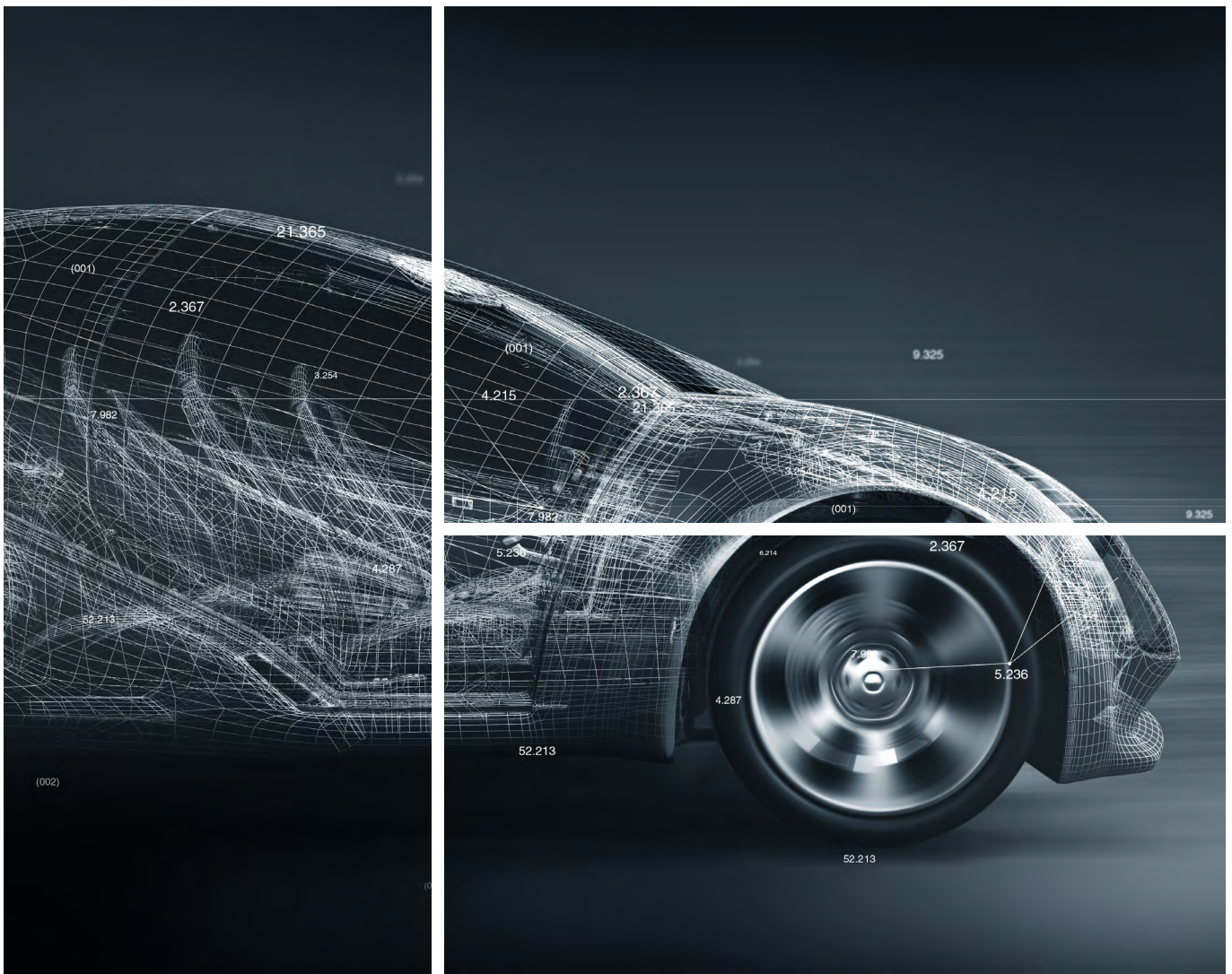


AUTOMOTIVE CONNECTOR STRATEGIES AND SOLUTIONS FOR SPACE REDUCTION



New car buyers will be familiar with the process of selecting all the features, functionality and add-ons for their new vehicle. At a basic level, this could be selecting the paint color or upholstery material but increasingly it includes choosing from a vast array of electronic safety, convenience, entertainment and communications options.

The new generation of automotive consumers increasingly expect a fully customizable driving or passenger experience. The automotive industry has responded by adding more and more new features and functions - with an ever-increasing number of sensors, actuators and electronic control units (ECUs) - with millions of lines of software code. Indeed, modern cars can contain over 150 ECUs and 5km of wiring - with the wire harness, at up to 80 kilograms, often being the third heaviest component in the vehicle.

Each area of innovation is driving an increasing number of electronic components within the vehicle. However, the size of cars is not increasing, and, at the same time, automotive manufacturers are under pressure to reduce weight and CO₂ emissions. Component miniaturization is therefore a key enabler of automotive innovation, particularly in relation to connector technology that transports electrical power, signaling and data within the harnesses to these new electronic components themselves. The challenge, facing automotive manufacturers, is not just about the reduction of component footprint and packaging space it is also about achieving the necessary robustness and reliability when deployed in harsh high-vibration, high-temperature automo-

tive environments. Automotive engineers also need connector component suppliers to offer extensive portfolios that address the geometric and robustness challenges as well as the varying levels of complexity presented by applications around the vehicle.

In this paper, we examine how manufacturers can achieve strategic space saving goals by using miniaturized connectors that provide true automotive-grade robustness. Specifically, we examine five of TE Connectivity’s (TE) miniaturized interconnection platforms for automotive applications; NanoMQS, MCON 0.50, Generation 50, 0.50 Series and the new PicoMQS interconnection systems – examining how they meet industry specifications, provide key technical advantages, and enable space saving of up to 78 percent (when compared to MQS).

We also consider other factors contributing to the robustness of miniaturized components, such as small-wire crimp quality, and discuss how to address the increased risk of metallic whisker growth on high-density PCB pin connections..

Content

Meeting Increasing Automotive Requirements	3	PicoMQS Header Options and Advantages	6
An Overview Of NanoMQS Terminals and Connectors: Design And Technical Specifications	3	How PicoMQS Follows Industry Standards	7
Automotive-Grade Miniaturized Terminals Provide Reliable Ongoing Performance	3	MCON 0.50 Interconnection System For Extremely Harsh Automotive Environments	8
NanoMQS Polarized Locking Mechanism Prevents Incorrect Insertion	4	Generation 50	8
Two Options For High-Grade Thermoplastic Connector Housings And Headers	4	0.50 Series	9
NanoMQS Housing – Top Latch (TL) Version	4	Dimensions And Performance	9
NanoMQS Housing – Side Latch (SL) Version	5	The Role Of Tooling In Automatic Handling	10
How NanoMQS Terminals Deliver Up To 50% Space Reduction	5	Why Are Smaller Wires Harder To Crimp?	10
How The NanoMQS Platform Supports Up To Level Four High Vibration Resistance	5	Application Tooling For Small Wires And Miniaturized Terminals	10
PicoMQS Miniaturized Interconnection System	6	How OCEAN Applicator 2.0 Improves Small-Wire Crimping	10
PicoMQS Characteristics	6	Anti-Whisker Press-Fit Pin Plating	11
PicoMQS Terminal Design	6	Introducing LITESURF Plating – An Environmentally Friendly Anti-Whisker Plating For Press-Fit	11
PicoMQS Side Latch Version	6	Why Partner With TE?	12
PCB Header S-Bend Design	6	Optimizing A Global End-to-End Value Chain	12

Meeting Increasing Automotive Requirements

A modern passenger car can contain up to 150 ECUs, each with increasing levels of complexity. Each ECU contains at least one printed circuit board (PCB) and a single header mounted on a PCB. An ECU can accommodate up to several hundred wire connections which in turn are contained within complex wire harness systems.

In addition, existing applications are becoming more complex, with the introduction of more functions within the vehicle. As an example, LED headlamp units can contain up to 60 circuits, 15 connectors, and 120 terminals. With the increased safety levels of many of these new functions, automotive manufacturers are challenged to ensure all these ECU and modules are reliably connected to the vehicle wiring system. They must ensure that they stay connected and functional, withstanding adverse conditions such as vibrations, fluid ingress, and extreme temperatures in the vehicle that could interrupt safe continuous operation. Specifically, they need to meet OEM specifications such as LV214, in Europe and USCAR2, in North America.

TE Connectivity Solutions for Miniaturized Automotive Connectivity

NanoMQS Miniaturized Interconnection System

Based on the MQS terminals design, the NanoMQS interconnection system was launched to address manufacturers' need to miniaturize electronic components. The NanoMQS interconnection system incorporates miniaturized terminals (contacts), connectors, and headers to address dense vehicle electronics.

This design reduces the PCB footprint by approximately 50 percent while offering up to six amps of nominal current capacity. In addition, the NanoMQS interconnection system can accommodate wire-cross sections as small as 0.13 mm²,

allowing manufacturers to reduce wire harness weight if needed. The sealed version of NanoMQS system also offers an exceptional level of vibration resistance of up to 400g sinus.

Automotive-Grade Miniaturized Terminals Provide Reliable Ongoing Performance

At the core of the NanoMQS interconnection platform is a single-piece crimp terminal (Figure 2). The standard version of the receptacle contact is made from tin-plated copper. It is available in wire-cross sections of 0.13 mm² to 0.17 mm² and 0.22 mm² to 0.35 mm². The receptacle contacts are designed for contact blades measuring 0.5 by 0.4 millimeters.

**Up to 78%
reduced
PCB footprint**

- The version with tin-plated terminals is approved for ambient temperatures between -40°C and up to +130°C.
- A version with silver-plated terminals can be used in conditions of up to 170°C and is therefore suitable for applications within the engine bay area.
- A version with gold-plated terminals increases the number of mating cycles up to 100 times. It also significantly reduces chances of metal corrosion, increasing contact lifespan and usability for safety applications such as airbag systems.

NanoMQS terminals and connectors have a nominal current carrying capacity of up to six amps. However, it can also support short peaks of up to five times the nominal limit. When mated, the receptacle contact establishes two electrical points of contact to the corresponding blade via a robust L-shaped spring that exerts a high normal force.

The NanoMQS receptacle contacts feature a closed-box design contact chamber which works with comparatively large lead-in chamfers on the housing to ensure a smooth guided insertion. This prevents the blade colliding with the receptacle contact during mating ("stubbing"), which could deform and damage the contact lance due to incorrect insertion.

On top of the terminal is a locking lance, which audibly and tangibly latches onto the plastic housing once the terminal is fully inserted. The locking lance provides the primary locking mechanism for the two-level contact retention system. The locking hole is visible via a cutout, enabling manufacturers to confirm that lances are correctly inserted (Figure 2).

The maximum insertion force for the primary locking device is 5 N, enabling a minimum retention force of 25 N. The

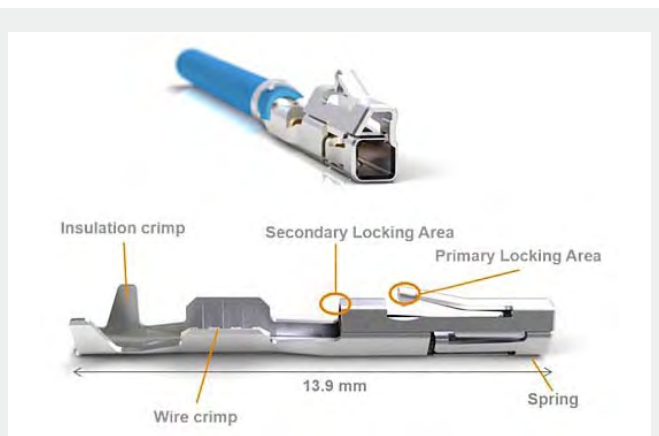


Figure 1: NanoMQS terminal

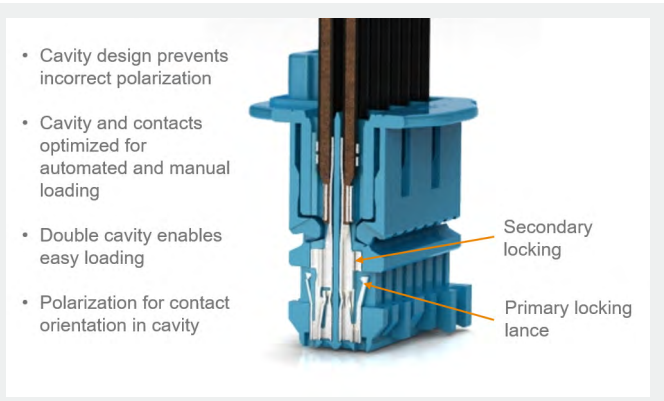


Figure 2: NanoMQS locking mechanism

second independent secondary locking device, which latches onto an undercut on the housing, enables a retention force greater than 50 N.

NanoMQS Polarized Locking Mechanism Prevents Incorrect Insertion

Despite its small dimensions, the terminal features contact cavities that provide a polarized cross-section. This design means that the risk of incorrect inserting is effectively eliminated, and the NanoMQS system can be safely and conveniently handled. Like the MQS platform, the NanoMQS platform is designed for 20 mating cycles. Customers can select whether terminals are placed into plastic connector housings via manual assembly or fully automated insertion.

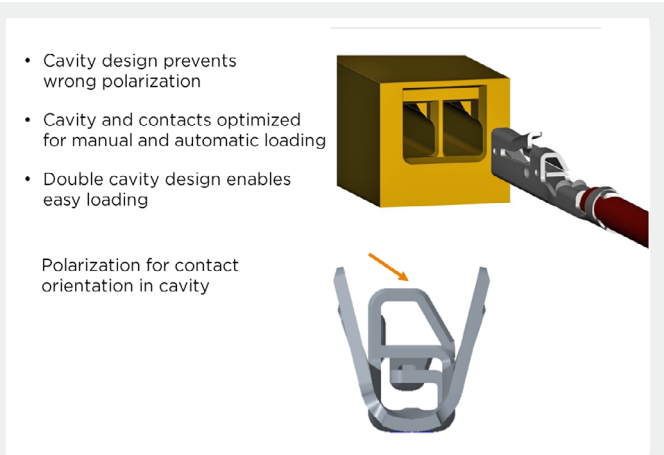


Figure 3: Polarization of NanoMQS contact

Two Options For High-Grade Thermoplastic Connector Housings And Headers

NanoMQS housing components (headers and connectors) are made from high-grade thermoplastic. There are two versions, Top Latch (TL) and Side Latch (SL), both of which are available in a perpendicular or parallel orientation to the PCB. A notable difference between the two versions is the position of the locking device of TL version, which is located centrally on top of the housing (Figure 4).

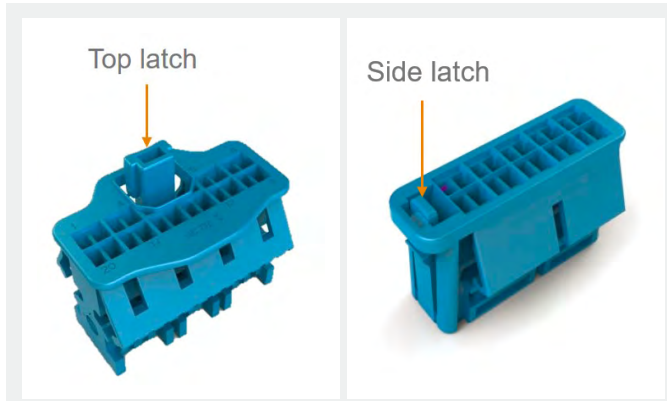


Figure 4: NanoMQS housings - top latch and side latch version

NanoMQS Housing - Top Latch (TL) Version

The TL version’s central locking device position makes it easier to mount connectors side-by-side, which increases packaging flexibility. For example, during the development of a new model, three generic connectors can be mounted side-by-side initially to establish a high-position interconnection of up to 96 pins. Manufacturers can then switch to a single customer-specific part without changing technology. On the TL version, housing rigidity is reinforced by ribs for two to 32 positions. The primary role of the ribs is to increase locking options in versions with 20 positions and more.

NanoMQS Housing - Side Latch (SL) Version

On the slightly more compact SL version, the locking device is located at the side of the housing (Figure 4). With the SL version, the device can be locked at up to 20 positions without the need for reinforcement ribs. In addition, the plastic locking and latching profiles have compact geometries. For example, the overlap between the connector and header fronts has a wedge shape that ensure a smooth guiding-in of the two halves during connector mating. When fully mated, the overlap results in a strong, positive connection formed by two wedge shapes securing each other.

How NanoMQS Terminals Deliver Up To 50% Space Reduction

NanoMQS series terminals are designed for a nominal pitch, corresponding to the distance between the pins connecting with the PCB of 1.8 millimeters. Therefore, the same number of positions on a NanoMQS header requires only approximately half the space on a PCB compared to an MQS header needs (Figure 5).

As depicted in the figure, the header footprint of the MQS platform is reduced from 840 mm² to 411 mm² with NanoMQS system. Clearly, high-position interconnections will be much in demand with next-generation car architectures with significant packaging density. In an engine ECU NanoMQS terminals could save 60 percent of the ECU’s spatial footprint.

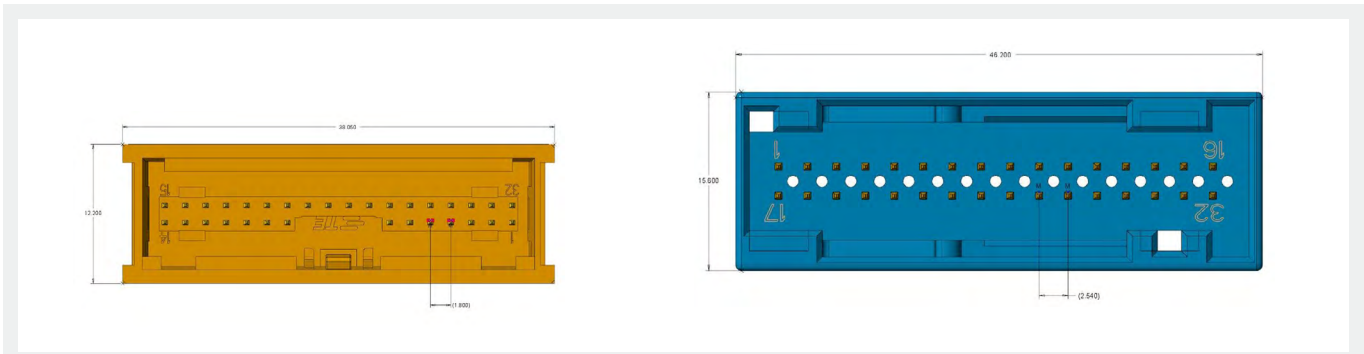


Figure 5: NanoMQS header (left) compared to a MGS header.

Current NanoMQS terminal versions can accommodate up to 320 positions. This makes the NanoMQS platform ideally suited for hybrid connectors, as every contact of the MGS family can be integrated into a grid as a multiple of the next size up (Figure 6). This capability is enabled by the fact that the secondary locking device is on the same level on all housings.

How The NanoMQS Platform Supports Up To Level Four High Vibration Resistance

Electric connections within vehicles must sustain vibration and shock resistance. Miniaturized components such as the NanoMQS interconnection system are often deployed in sub-system modules, known as “black boxes,” in severely space-constrained spaces that are hard to access.

In Europe, major German vehicle manufacturers define vibration test levels in specifications such as LV 214. The standard unsealed versions of the NanoMQS series meet the LV214 level 4 (Ag-plated contacts) at around 181 m/s² effective acceleration.

This is notable because the NanoMQS system meets the requirement for a sealed connector. With the high-contact normal force of the NanoMQS system, connectors incorporating an additional seal can achieve level three vibration for close-proximity installation and level four vibration in the case of direct engine mounting (Figure 7).

Robust by design, NanoMQS terminals and connectors can also meet very high 400 g sinus vibration resistance requirements, as stipulated for injection valves or other direct engine mounted applications.

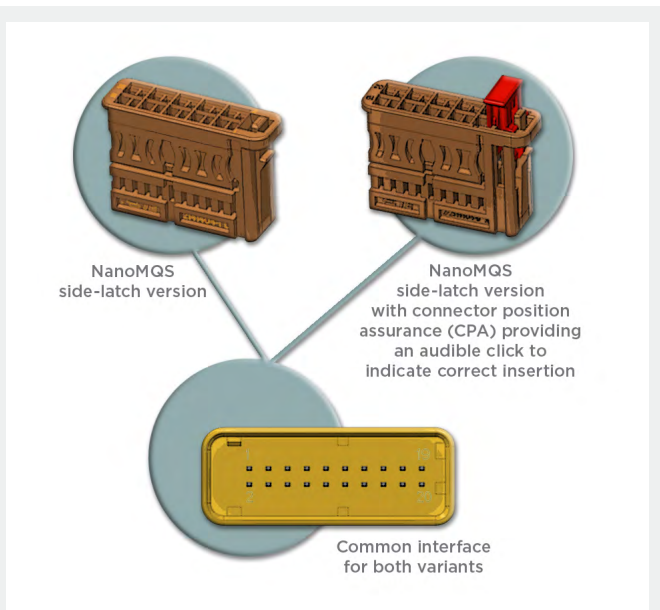


Figure 6: NanoMQS connector variants with a common interface



Figure 7: NanoMQS system, sealed version housing

PicoMQS Miniaturized Interconnection System

PicoMQS is a smaller version of NanoMQS interconnection systems which are designed for modules that have tight packaging requirements. The PicoMQS connector system has a reduced overall length than NanoMQS and includes a set of terminals, female housings and PCB headers as part of its initial portfolio.



Figure 8: PicoMQS Miniaturized Connector System is used within vehicle sub-systems or modules, known as 'blackboxes', including headlamp and steering wheel units, as well as EV battery management systems.

PicoMQS Characteristics

Its overall design is 55% shorter than the NanoMQS system when mated. It achieves this whilst incorporating the same locking lance design for primary and secondary contacts. PicoMQS has a significant weight reduction appeal for manufacturers who incorporate it for low current applications, along with the advantage of Vibration Level 2 (LV214) conformance. Meeting the automotive requirements of an ultra small connector, the PicoMQS system has built-in polarization, which eliminates the possibility of incorrect insertion direction into the connector cavity.

PicoMQS Terminal Design

PicoMQS terminals are a single-piece construction, using copper as the base material and coming in tin or silver (concept phase) plating. Compatible with 0.13, 0.17 and 0.22 mm cross-section wire, the PicoMQS system mates to a blade of 0.5 x 0.4 mm. With rating up to four amps nominal current when using 0.22 mm² FLU wire.

- Tin plated terminals are compliant with ambient temperatures of -40°C to +130°C.
- A version with silver-plated terminals can be used in conditions of up to +170°C, this is currently in the concept phase and will be released in due course.

The maximum insertion force for the primary locking device is under 2N, enabling a minimum retention force of at least 15N. The secondary locking device, which latches onto an undercut on the housing, enables a retention force greater than 25N.

The plating on each contact surface is also designed for up to ten mating cycles, making it suitable for inside blackboxes, connection between PCBs, or outside modules within link harnesses. Due to the size of PicoMQS terminals, TE recommends automated processes for assembling the connector, including terminal insertion. Using the latest block loading technology found at harness maker suppliers during final assembly.

PicoMQS Side Latch Version

With a side latch design, female housings are inserted at a right angle into the PCB headers. This design allows reduction of the overall height of the module being designed and meets tight packaging requirements for applications such as headlamps, steering and battery modules.

PCB Header S-Bend Design

The S-bend design on PicoMQS headers reduces packaging space on circuit boards by up to 30 percent over more traditional Z and J type headers. Reducing the size of the overall PCB allows for a smaller casing that surrounds it, saving weight and material for the module supplier and automotive manufacturer.

PicoMQS Header Options and Advantages

Each PCB header and connector are available in 2-10 positions in a single row configuration. With a nominal 1.27 mm pitch spacing, this is one of the smallest in the industry, reducing the overall volume by 78% over an equivalent MQS connector. With a 0.46 mm creepage and clearance distance, it will conform to the arcing requirements within the specified range of voltage and current.



Figure 9: Optimizing PCB space - 78% space reduction (when compared to MQS)

As shown in the comparison, (Figure 9), the PicoMQS footprint is just 1.4 cm³, a significant reduction over the MQS and NanoMQS equivalents which take up 6.3 cm³ and 3.7 cm³ respectively.

All of these aspects aid in reducing the carbon footprint of a vehicle. Less weight means a less powerful motor is required to move the vehicle, resulting in less power consumption and smaller battery size needed for EVs.

How PicoMQS Follows Industry Standards

Within the PicoMQS housing construction, a portion of glass fiber is used alongside its thermoplastic base material. This allows for greater robustness and durability within the connector housing without compromising on weight or size.

As a result, the strict automotive standards are met for PicoMQS in terms of LV214 (or the neutral equivalent TE209-XXX Spec). This includes heat ageing, thermal shock, insertion and removal forces and temperature rise and derating tests.

Consumer electronic connectors are often used within blackboxes and over time their reliability is reduced. PicoMQS has been fully validated to Vibration class 2 within LV214 classification. Resulting in the smallest automotive qualified crimped terminal, connector, and header system currently on the market.

MCON 0.50 Interconnection System for Extremely Harsh Automotive Environments

The miniaturized MCON 0.50 interconnection system is part of TE’s MCON interconnection product family, which has been designed for deployment in very harsh automotive environments. It is a sealed system that features specially engineered silicone seals. These seals prevent fluid and moisture ingress into areas of electrical contact, which

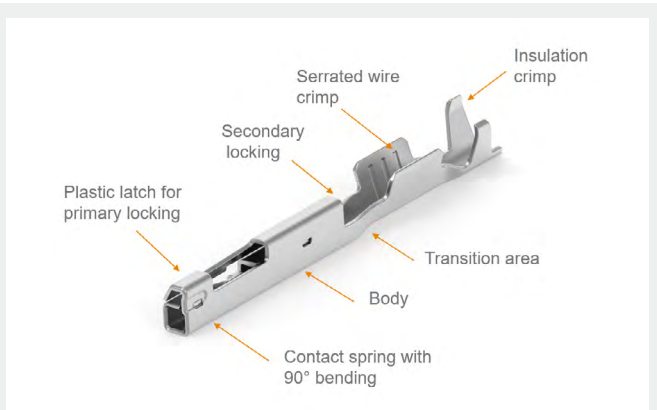


Figure 10: MCON 0.50 system “clean-body design”

is required for applications found in the engine bay area. MCON 0.50 terminals and connectors meet LV214 level 3 requirements for close-proximity installations and level 4 requirements for direct engine mounting. It also achieves an IP9 level of water protection.

Unlike NanoMQS interconnection system and the rest of the MCON family, the MCON 0.50 terminal by design has no primary locking lance, offering what is known as a “clean-body approach” (Figure 10).

This means that there are no flanges that extend out from the connector to lock it into place inside the housing, creating a cleaner body profile. This design is intended to minimize any wear and tear on the interior of the connector housing, which might compromise the moisture seal.

The sealed version provides the highest level of water and moisture resistance. MCON 0.50 systems can be submerged in several meters of water and take 80 bars of force from an IPX steam jet.

Generation 50

TE Connectivity’s Generation 50 miniaturized interconnection system offers clean body and locking lance terminal designs to support automotive-robust miniaturized connectivity, also supporting wire sizes from 0.13 mm² to 0.35 mm². The Generation 50 interconnection system can support PCB retention of up to 80N and meets USCAR ergonomic requirements.

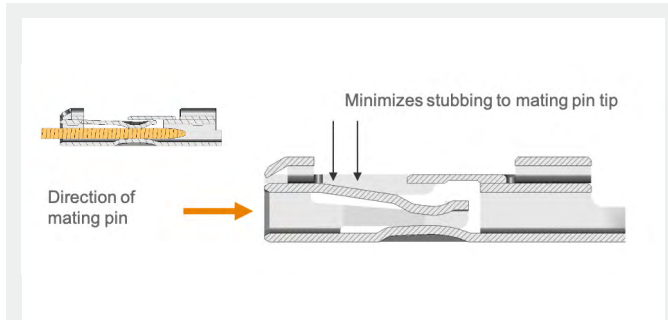


Figure 11: Generation 50 terminal

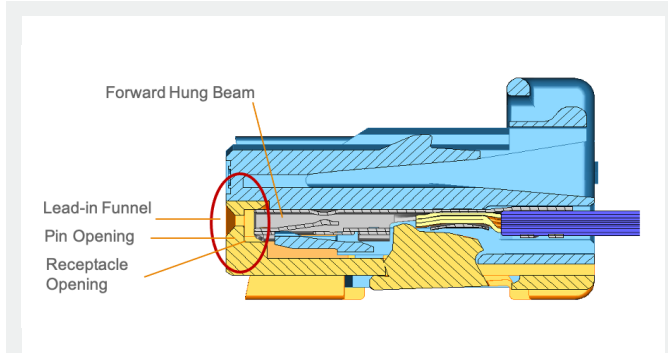


Figure 12: Generation 50 housing

The terminal design incorporates a beam spring geometry whereby the beam tip points towards the rear of the terminal, congruent with the mating direction, which eliminates the risk of stubbing that can lead to terminal push out.

The Generation 50 connector housings are also designed to eliminate stubbing through positive terminal location. This is achieved by accommodating the pin opening, receptacle opening and lead-in funnel within the same plastic.

Generation 50 headers are also designed to minimize connector assembly tolerances and variations from the product’s overall coplanarity. This is achieved by the use of an alignment rib on the header housing to set the coplanarity of all SMT surfaces, such as leads and retention plates.



Figure 13: 0.50 series terminal

0.50 Series

Supporting a wire size range of 0.13 mm² - 0.5 mm² and providing a pin pitch of 1.5 mm, TE Connectivity's 0.50 Series connector system is also specifically designed to support high component density as well as automotive grade robustness.

The portfolio of headers include surface mounting as well as a through hole mounting variant, while the 0.50 Series connectors have a low center of gravity specifically designed for stable surface mounting. In addition, the connectors feature a highly ergonomic design, meaning they are compact but easy to mate and require a mating force of under 55 N for the 40 position size.

Dimensions and Performance

Product	PicoMQS	NanoMQS	MCON 0.50	Generation 50	0.50 Series
Dimensions					
Pin-to-pin Pitch	1.27 mm	1.8 mm	1.8 mm	1.8 mm	1.5 mm (SMT)
Wire Size	0.13 mm ² - 0.22 mm ²	0.13 mm ² - 0.35 mm ²	0.13 mm ² - 0.35 mm ²	0.13 mm ² - 0.35 mm ²	1.6 mm (DIP)
Tab Size	0.5 x 0.4 mm	0.5 x 0.4 mm	0.5 x 0.4 mm	0.5 x 0.4 mm	0.13 mm ² - 0.5 mm ² 0.5 x 0.4 mm
Performance					
Current Capacity	4A (90°C)	6A (90°C)	3A (90°C)	4A (90°C)	5A
Max. Temperature	130°C (Sn) / 150°C (Ag)	170°C (Ag)	170°C (Ag)	105°C	85°C
Vibration Resistance	SG2	SG4 (Ag)	SG4 (Ag)	V1	V1
Position Assurance	Primary and secondary locking	Primary and secondary locking	Primary and secondary locking	Primary and secondary locking	Primary and secondary locking
OEM Specification	LV214	LV214*	LV214, VW75174	USCAR/GMW3191	Release by Japanese OEMs, USCAR

* USCAR validation in progress

The Role of Tooling in Automatic Handling

The challenge of miniaturizing automotive-grade components extends to the wire termination and crimping process. Application tooling plays a vital role in ensuring high-performance connectivity and true automotive vibration resistance with the termination of smaller wires.

Why Are Smaller Wires Harder To Crimp?

Intrinsically, miniaturized terminals are constructed from thinner material, which means that they are easier to deform or mangle during the crimping process. It also means that the presence of flash, or crimp deformation in the form of protrusions, becomes more significant as it can form a larger percentage of the overall terminal profile. This is problematic because flash can hinder insertion into, or damage to, a connector housing, particularly its sealing components.



Figure 14: TE's OCEAN 2.0 Applicator

Small-wire applications typically require smaller tooling gaps to avoid producing significant flash. Tooling gap refers to the flash escapement space between a crimper and anvil when the two are at crimp height. For reference, a tooling gap as small as 0.05 mm can produce significant flash for a terminal with a crimp width of 1.00 mm.

The smaller size also makes it much more challenging to accurately position the wire within the terminal during the crimping process. Small-gauge wires are less rigid which makes them susceptible to drooping or bending, hindering insertion into the terminal. Similarly, it is more difficult to align the terminal to the anvil within the crimp applicator tool.

Crimp asymmetry is another characteristic of lower-quality crimping that can cause reduced electrical and mechanical performance. Inaccurate placement of terminals over the anvil is a leading cause of asymmetry and flash. This

inaccuracy can be caused by improper setup or by a substandard terminal feed mechanism. Typically, high-quality pneumatic feed applicators produce more accurate results than mechanical or lower-quality pneumatic feed applicators.

Application Tooling For Small Wires and Miniaturized Terminals

TE applicators for small-wire crimping use highly accurate pneumatic or servo feed mechanisms. These mechanisms enable users to set the initial terminal alignment easily and maintain consistent alignment while the applicator is in use.

TE collaborates with partners early in the development stage to develop complete component and tooling solutions that meet unique application needs. TE pre-tests these component and tooling solutions against automotive standards so that end-users obtain a holistic and certified solution they can completely rely on.

How OCEAN Applicator 2.0 improves Small-Wire Crimping

The OCEAN Applicator 2.0 is the latest in TE's series of applicators, featuring several upgrades designed to improve small-wire crimping (smaller than 0.35 mm²). General design advantages include an optimized anvil geometry, a pinned-base plate to prevent anvil misalignment, and a new black nitriding finish for significantly improved resistance to wear and tear (Figure 14).

TE has developed features to aid small-wire crimping, which include easier feed adjustments and strip guide lock improvements. In addition to the new optimized anvil geometry, the OCEAN Applicator 2.0 features a new System 3 terminal hold-down mechanism to ensure accurate and stable terminal positioning.

It also provides a robust crimp height adjustment feature, as well as a locking mechanism. Manufacturers can perform quality control and verification of the automated crimping process via standard crimp monitoring systems, which are also suitable for fine wires. In addition, the TE CrimpData App enables partners to conduct efficient wireless monitoring of the automated crimp processes, including monitoring of cycle numbers setting alarms to conduct maintenance and replace spare parts.

TE's manual crimp tools deliver exactly the same crimp connection quality as automated wire termination. In addition, the manual tool's good ergonomics enable it to be used within confined spaces.

Anti-Whisker Press-Fit Plating

The trend towards miniaturization also increases the industry’s need for solutions that prevent metallic whisker formation. The increasing amount of electronics in vehicles has led component manufacturers to use press-fit technology for printed circuit board (PCB) connectivity as a reliable alternative to solder-based solutions. Plating is applied to press-fit pins to facilitate lubrication and protect against surface damage due to oxidization and other causes. Today, these plating solutions are comprised primarily of tin (Sn).

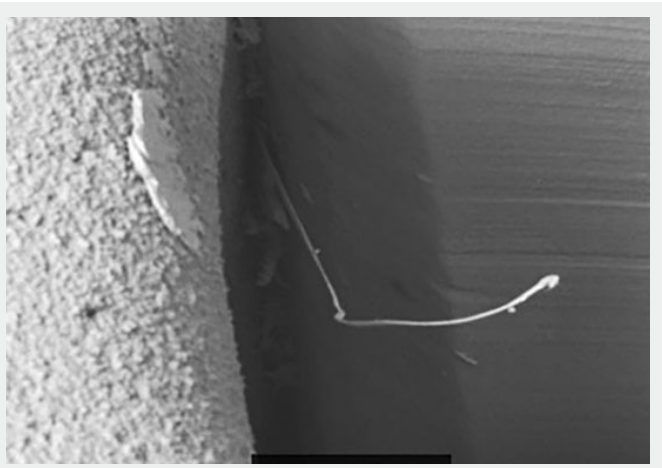


Figure 15: Tin whisker growing from a Press-Fit pin

However, tin has a high susceptibility to whisker growth. Tin whiskers can grow spontaneously from their root in hair-like formations when the tin film is stressed, such as when it is inserted into a PCB. Since tin whiskers are metal, they are electrically conductive and can grow long enough to bridge to other metal components. In extreme cases, they can short-circuit electronic operations. In the past, this problem was addressed by the inclusion of lead within plating.

Lead has been phased out of manufacturing processes because it harms the environment. Since vehicle manufacturers are reducing pin-pitch distances and adopting pin-plating solutions that primarily consist of tin, they are seeking new alternatives to reduce the risk of tin whisker formation.

Introducing LITESURF Plating - An Environmentally Friendly Anti-Whisker Plating For Press-Fit

TE’s LITESURF plating technology is an anti-whisker plating for press-fit applications. It provides automotive electronics manufacturers with an alternative to tin that has virtually no risk of whisker growth. Based on bismuth (Bi), it is environmentally sustainable and totally harmless.

LITESURF plating technology is the result of more than five years of research and development to investigate a tin-free plating that relieves the risk of whisker-induced failures and is suited to the high-stress conditions of press-fit pin connections. LITESURF plating was developed to meet manufacturers’ needs for progressive miniaturization, reduced pin pitch, and a smaller connector footprint on PCBs.

As TE developed the LITESURF plating technology, more than 12 different deposit compositions were researched, investigating whisker formation as well as other behavioral characteristics impacting production processes such as melting temperatures.

TE experts created a detailed matrix of all options. The TE study concluded that the optimal deposit for plating was an electroplated Bismuth-based coating. Using Bismuth has additional benefits, allowing manufacturers to use an application process that follows the typical galvanic plating line procedure that is comparable to a standard tin bath.

Bismuth-based LITESURF plating can be implemented within existing plating lines without any additional process changes. Extensive LITESURF plating tests were performed on more than 5,600 multi-spring and action pins and on three different types of PCB technologies.

Tests demonstrated that LITESURF plating can reduce the risk of whisker incidence by a factor of over 1,600, based on the number and size of particles detected combined with Bismuth’s lower conductivity, which is 90 percent lower than tin’s conductivity.



Figure 16: Tin whisker growing from a Press-Fit pin

Why Partner with TE?

Ever since the crimp was invented, TE has been partnering with automotive manufacturers to co-create leading connectivity solutions that set industry standards for innovation and performance. Today, the rapid increase of electronic content in cars and the need for miniaturized technologies are presenting new challenges that require more technologically sophisticated solutions with true automotive-grade robustness. TE continues to engage with customers early in the development process and serve as true partners in co-creating solutions that enable vehicles to be smarter and safer.

Taking a strategic approach to designing automotive space savings solutions requires a holistic approach. TE is able to offer connectivity solutions for terminals, connectors, headers, and press-fit technology as well as co-developed application tooling. Together, these solutions can reduce components' PCB footprint by as much as 50 percent, while interoperating seamlessly as part of a system with pre-verified interfaces. In addition, TE's miniaturized interconnection systems are designed for harsh environment applications meeting LV214 and USCAR requirements for vibration and IP9 levels for water resistance.

Optimizing A Global End-to-End Value Chain

TE is able to support all aspects of product development in-house. TE is in full control of all stages of manufacturing from product design and validation; to development, including stamping, molding, plating, and assembly; and testing, quality assurance, application and customer support. This means we can offer greater flexibility with manufacturing volumes, provide high quality assurance at each stage of key processes, and provide faster and controlled delivery times.

Get automotive-grade, miniaturized solutions for your automotive application. [Contact TE today.](#)

About TE Connectivity

TE Connectivity is a global industrial technology leader creating a safer, sustainable, productive, and connected future. Our broad range of connectivity and sensor solutions, proven in the harshest environments, enable advancements in transportation, industrial applications, medical technology, energy, data communications, and the home. With more than 85,000 employees, including over 8,000 engineers, working alongside customers in approximately 140 countries, TE ensures that EVERY CONNECTION COUNTS. Learn more at www.te.com and on [LinkedIn](#), [Facebook](#), [WeChat](#) and [Twitter](#).

Connect with us

We make it easy to connect with our experts and are ready to provide all the support you need.

Visit www.te.com/support to chat with a Product Information Specialist.

LITESURF, NanoMQS, MCON, MQS, OCEAN, TE Connectivity, TE, TE connectivity (logo) and EVERY CONNECTION COUNTS are trademarks owned or licensed by the TE Connectivity Ltd. family of companies.

USCAR is a trademark.

All other logos, products and/or company names referred to herein might be trademarks of their respective owners.

The information given herein, including drawings, illustrations and schematics which are intended for illustration purposes only, is believed to be reliable. However, TE Connectivity makes no warranties as to its accuracy or completeness and disclaims any liability in connection with its use. TE Connectivity's obligations shall only be as set forth in TE Connectivity's Standard Terms and Conditions of Sale for this product and in no case will TE Connectivity be liable for any incidental, indirect or consequential damages arising out of the sale, resale, use or misuse of the product. Users of TE Connectivity products should make their own evaluation to determine the suitability of each such product for the specific application.

© 2022 TE Connectivity Corporation. All Rights Reserved.

Revision 09-2022