NanoMQS
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Author:
Julius Maier
Rolf Jetter
Michael Spielvogel

Tyco Electronics
AMP GmbH

a TE Connectivity Ltd.
company

Ampèrestraße 12-14
D-64625 Bensheim
www.te.com

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NanoMQS – The new miniaturized automotive interconnection system

A TE Connectivity whitepaper

W H I T E P A P E R

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Small spatial requirements – low weight – high vibration resistance

Based on the MQS product group's connectors, which are being used by more or less all European vehicle manufacturers plus others worldwide, TE Connectivity has expanded its range by a miniaturized version. The NanoMQS system's capability for small wire cross sections down to 0.13 mm² paves the way for harness weight saving measures. At the same time NanoMQS is also an interconnection system offering an exceptional level of vibration resistance (for instance up to 400 g sinus for the sealed version). The robust miniaturized terminals (contacts), connectors and headers address the increasing density of electronics in the vehicle. They reduce the footprint on the printed circuit board (PCB) by roughly 50 %, and still offer up to 3 amps of nominal current carrying capacity. The first generic connectors offer up to 32 contact positions in the TL version, the even more compact SL version has up to 20 positions.

Introduction

The original MQS interconnection system was designed in the mid 90ies as an automotive termination solution with high packing density, robust design, two locking levels, and compact dimensions. This MQS system for wire-to-wire and wire-to-board contacting with its 2.54 millimeter pitch proved very successful: In 2011 alone TE Connectivity manufactured 11 billion MQS terminals. Over the years the original MQS series has been expanded by the Micro-Power Quadlok (MPC), and the Power Quadlok (PQ) series among others to carry higher currents (Fig. 1).

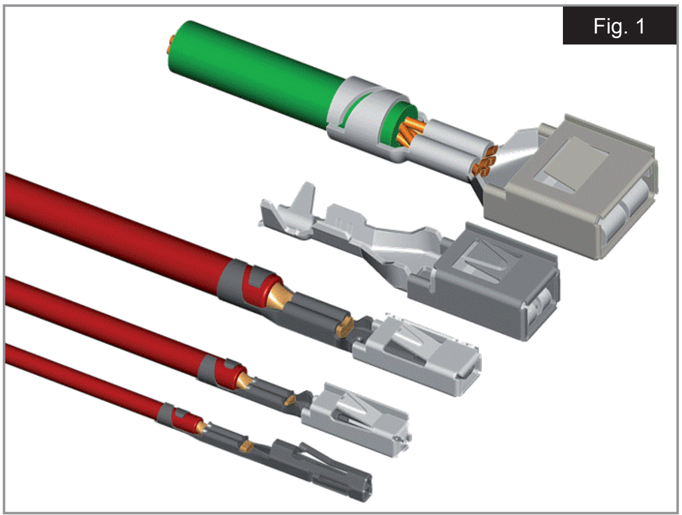
Fig. 1

Driven by the continuously rising share of electronics in the car there is a need for miniaturizing components. As the scope of functions grows, the PCB in electronic control units (ECUs), for instance, has to be as compact as possible. This trend is also valid for the interconnection technology. In some cases – sensors in the engine bay provide an example – the connector has meanwhile become the limiting factor for miniaturization. Therefore TE Connectivity has expanded the MQS product family again by developing the miniaturized NanoMQS interconnection system. The terminals along with the first generic headers and connector housings are meanwhile available in production numbers and are being used in vehicles.

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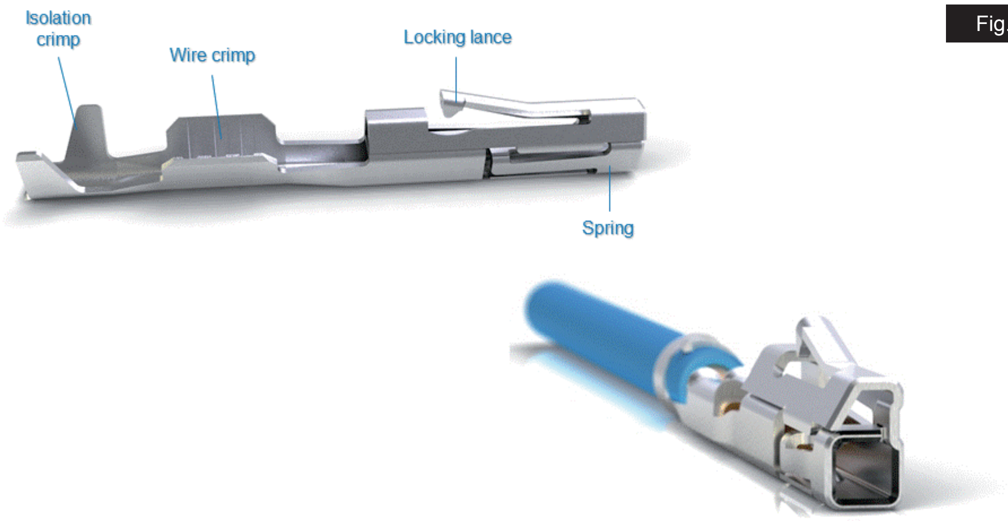
Components of the NanoMQS interconnection system

A – Terminals for small installation spaces and demanding vibration profiles

The single-piece crimp terminal (contact) forms the very core of the NanoMQS family (Fig. 2).

Fig. 2



In the standard version the receptacle contact is made from tin plated copper. It is available in two sizes for wire cross sections of 0.13 mm² to 0.22 mm², and for wires measuring up to 0.35 mm². The receptacle contacts are designed for rectangular contact blades measuring 0.5 by 0.4 millimeters.

The connectors with tin plated terminals are approved for ambient temperatures between -40 °C and up to 105 °C. A silver plated version permits usage at up to 170 °C – conditions which can be found in the engine bay, for instance. The nominal current carrying capacity is up to 3 amps, however, short peaks of up to five times the nominal limit are possible. When mated, the receptacle contact establishes two electrical points of contact to the blade via a robust L-shaped spring that exerts a high normal force.

Among the quality features of the NanoMQS receptacle contacts is the closed box design of the contact chamber. Combined with comparatively large lead-in chamfers on the housing, which ensure a smooth guiding-in, this design prevents the blade from colliding with the receptacle contact during mating (no “stubbing”) which could otherwise deform and damage the contacting lance. An incorrect insertion is prevented by the design.

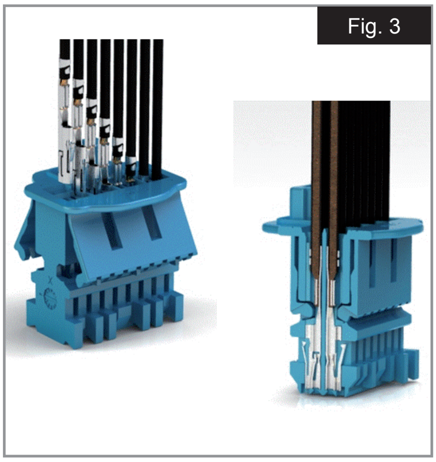


Fig. 3

A locking lance on top of the contact, which audibly and tangibly latches into the plastic housing when the terminal is fully inserted, provides the primary locking mechanism within the two-level contact retention (Fig.3).

A cut-out provides visual access to the locking hole and thus permits visual confirmation of the correct insertion. At a maximum insertion force of 5 N this primary locking device already gives a minimum retention force of 30 N. The independent secondary locking device, which latches into an undercut on the housing, provides a retention force greater than 50 N.

Polarization prevents incorrect insertion

To ensure an excellent level of safe and convenient handling despite the terminal's small dimensions, its cross section is polarized – same as the contact cavities in the housings. Incorrect insertion is thus effectively ruled out. Just like the MQS series, the NanoMQS series is designed for 20 mating cycles. Customers can freely choose their preferred way of loading the terminals into the plastic connector housings: Options include manual assembly just as well as a fully automated populating of the receptacle contacts.

Spatial envelope nearly halved

The NanoMQS series terminals are designed for a nominal pitch of 1.8 millimeters. Therefore the same number of positions on a NanoMQS header requires only roughly half the board space which a MQS header needs (Fig. 4).

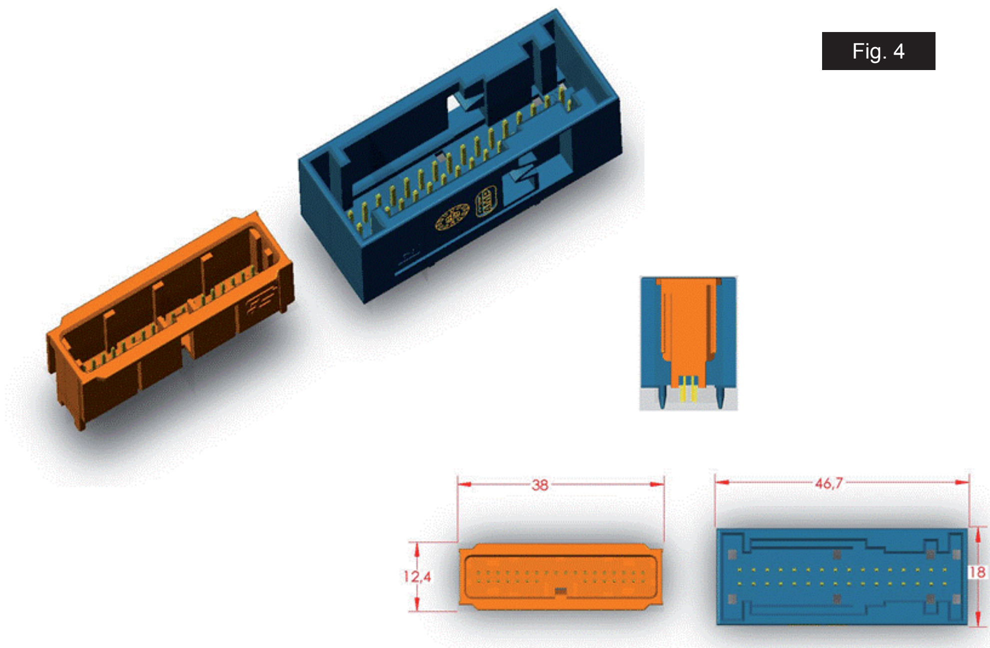


Fig. 4

Such a dense nominal pitch requires thin-walled housings, which in turn can only be manufactured in production numbers with a wealth of injection molding know-how. TE Connectivity has this comprehensive expertise: All the main production processes, including injection molding, are united under one roof here.

Obviously high-position interconnections will benefit most from the NanoMQS interconnection system's great packing density: In the example depicted in Fig.4, the header footprint drops from 840 mm^2 with MQS to a mere 411 mm^2 with NanoMQS. Fig. 5 shows an engine ECU header study. In this application NanoMQS could save 60 % of the ECU's spatial envelope. Comparable projects for 254 and 284 position engine ECUs are currently being developed.

Fig. 5

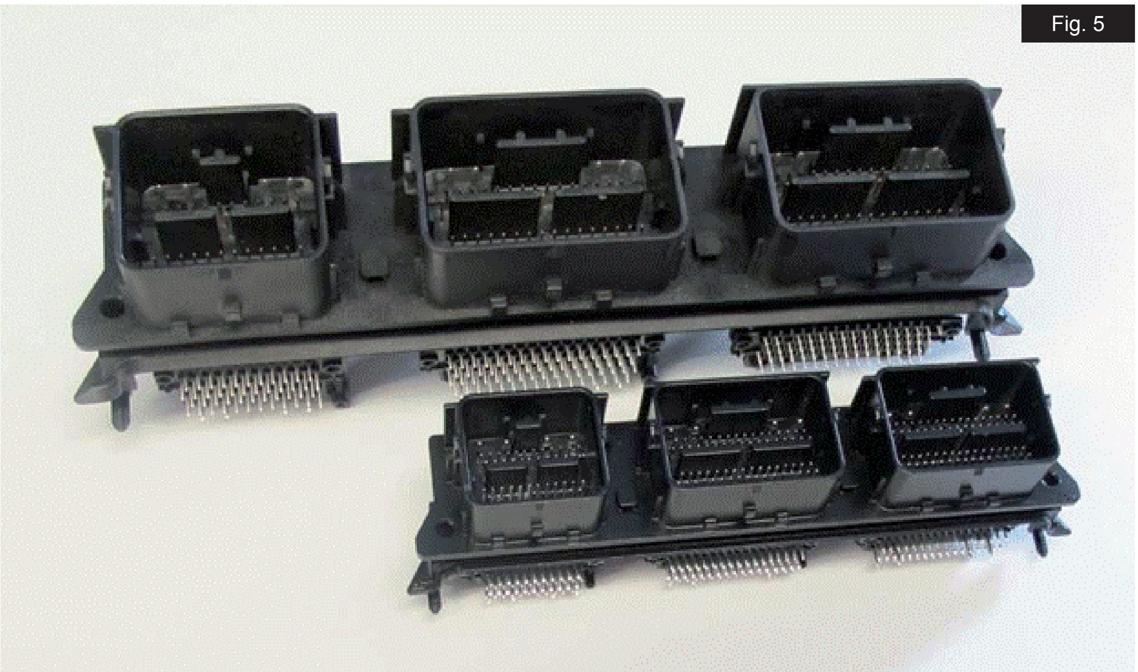
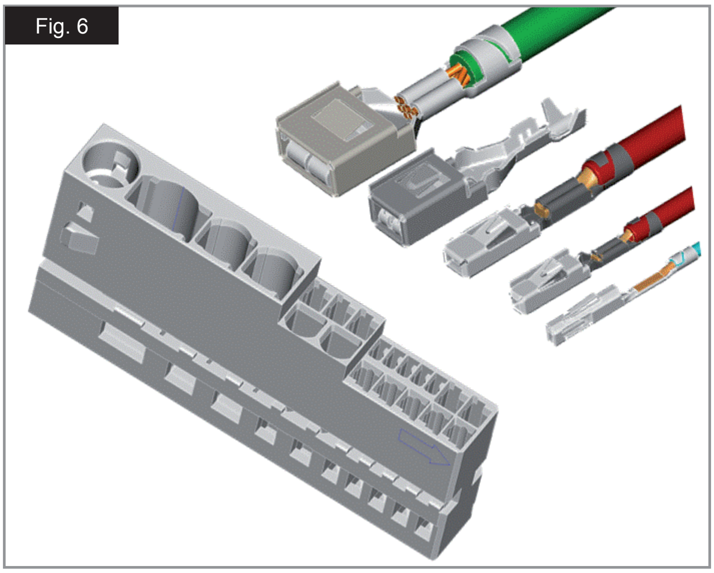


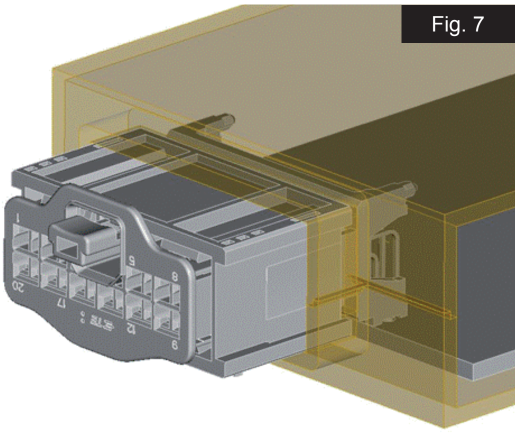
Fig. 6



Its 1.8 millimeter nominal pitch makes NanoMQS a perfect option for hybrid connectors as every contact of the MQS family can be integrated in a grid as an integer multiple of the next size up (Fig. 6). To make this possible, the secondary locking device is on the same level on all housings.

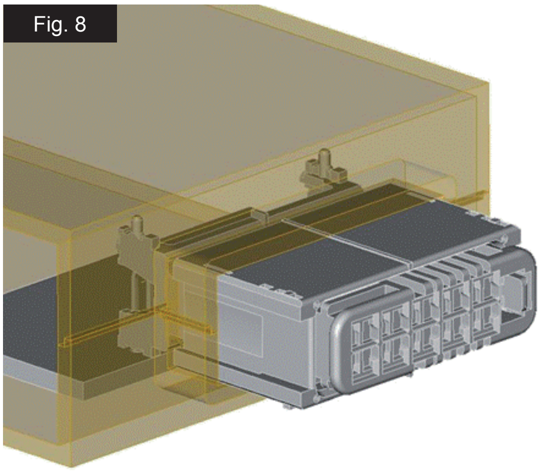
B – Connector housings and headers made from high-grade thermoplastic

Fig. 7



NanoMQS housings (headers and connectors), made from a high-grade thermoplastic, are available in two versions, called Top Latch (TL) and Side Latch (SL), both of which are available with a perpendicular or parallel orientation to the PCB. Both versions differ in some respects. The most striking difference is the position of the locking device, which is located centrally on top of the housing (Fig. 7) of the TL versions (Fig. 7). With the locking device positioned in the middle it is easier to mount connectors side by side. This increases flexibility: For instance, if three generic connectors are initially mounted side by side to establish a high-position interconnection with up to 96 pins during the ramp-up of a new model, the switch to a single customer specific part can be made any time later without change of technology.

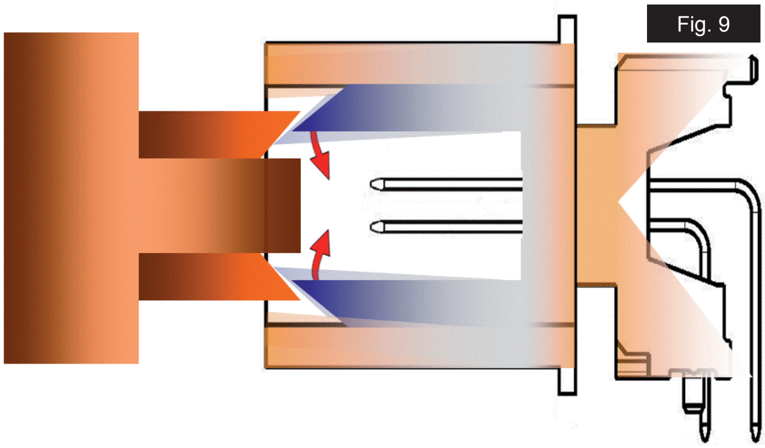
Fig. 8



In contrast, the locking device is located at the side of the slightly more compact SL version housings (Fig. 8.). In the case of the TL versions with 2 to 32 positions, the housing stiffness is further increased by reinforcing ribs, which primarily serve to raise the stiffness level of the versions with 20 positions and more. The SL versions do not require stiffening ribs as the locking is ensured without ribs at up to 20 positions.

As the plastic locking and latching profiles have compact geometries, the overlap between the connector and header fronts, for instance, was given in a new wedge shape. During connector mating this provides a smooth guiding-in of the two halves. When fully mated, the overlap results in a strong, positive connection formed by two wedge shapes securing each other (Fig 9.).

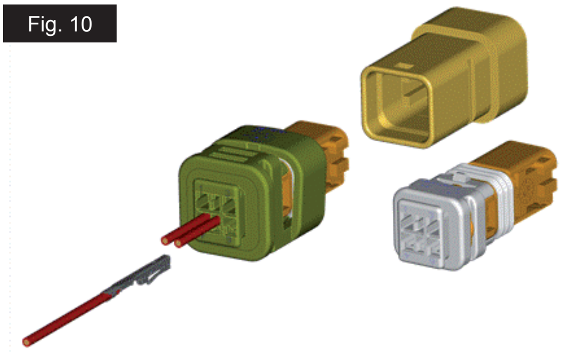
Fig. 9



High vibration resistance up to level 4

Vibration and shock resistance are core requirements which electric connections in the vehicle have to meet. Corresponding test levels are defined in the standard LV 214 for the EMEA region. According to this standard the regular versions of the NanoMQS series meet level 2 without any further measures (level 2: around 3 g effective random and 30 g shock). This is quite remarkable in so far as this level is already met by an unsealed NanoMQS system although level 2 was specified for sealed systems.

Fig. 10



If an additional seal is included in the connector, the high contact normal force of NanoMQS will make it possible to achieve level 3 for an installation close to components as well as level 4 for direct engine mounting (Fig. 10). NanoMQS systems can even achieve the extremely harsh 400 g sinus requirement which was identified as a trait of injection valves.

Fully designed for automatic handling

From day one NanoMQS has been designed for the production number and quality requirements of the automotive industry. To terminate wires with cross sections between 0.13 and 0.35 mm^2 the options include manual crimp tools and automated applicators, which can have a pneumatic or servo-driven crimp terminal feed. The quality control and verification of the automated crimping process can be done via standard crimp monitoring systems which are suitable for fine wires. Using the manual crimp tool delivers exactly the same crimp connection quality which results from automated wire termination. In addition the manual tool's good ergonomics permit its use within confined spaces.

Headers have all the features necessary for automated handling: Grippers can grab the offset surfaces while suction caps can use the middle section of the surfaces. On the PCB side, where the most flexibility is needed, it is always the same main element which is used for contacting the PCB. Currently the pins are designed either for thru hole, wave soldering, or the pin-and-paste process (reflow soldering). A press-fit version is currently under development. The version for surface mounting (SMD) also ensures level alignment with the PCB. To facilitate a test procedure before soldering, a sheet metal bracket for a board lock is also available. A strain relief can be integrated either via grooves in the housing or via the collar on the rear of the header.

Guide posts provide a minimum positioning aid for placing the header on the PCB. The posts ensure that the gripper can place the header force-free, and that the header stays in the correct position on the PCB.

Summary

The NanoMQS series provides a new miniaturized solution to terminate signal circuit wires in the vehicle. Depending on the application, the compact system with its 1.8 millimeter nominal pitch can reduce the PCB footprint or the spatial envelope of the connector by up to 50 %. Add to this the mass reduction of the connector, and the wire size which can be reduced down to 0.13 mm^2 with NanoMQS. On top of that NanoMQS supports the design of high-position hybrid connectors for power and signal as NanoMQS terminals can be seamlessly integrated at half the grid measure of the larger MQS terminals. As far as mating cycles, ambient temperatures, extraction forces, and vibration resistance are concerned, the NanoMQS interconnection system does not only offer the strengths of the MQS versions, which have proven themselves billions of times, but even goes beyond them in some respects. First NanoMQS applications can be found in the vehicle interior (roof module) and as sealed systems.