

EXPAND YOUR IMAGINATION WITH THE SURPRISING VERSATILITY OF MIL-DTL-38999 CIRCULAR CONNECTORS

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Introduced in the 1970s and still widely used today, MIL-DTL-38999 circular crimp connectors are sometimes taken for granted. Their long history and general popularity make it easy to overlook the ability of the broad 38999-connector family to help engineers solve contemporary size, weight, and power (SWaP) challenges. In fact, the 38999-connector family continues to adapt new composite materials and form factors to meet demanding weight and size requirements, while design derivatives have evolved to support higher speeds and higher frequencies in this surprisingly versatile I/O connector family.

Versatility is bred into the DNA of 38999 connectors

The MIL-DTL-38999 standard (originally MIL-C-38999) was born in the 1970s to define a robust, practically foolproof I/O circular crimp connector that would support the use of more signal and less power. At that time, size 22 contacts were specified to enable higher speed data transmission through smaller gauge wire.

To handle higher vibration of planes flying faster and higher, robust coupling mechanisms were implemented. The 38999 standard defines bayonet, threaded or breach coupling mechanisms in four series:

- **Series I:** A quick-disconnect bayonet coupling system for blind mating. It withstands high-vibration, severe wind and moisture problems (SWAMP) through the use of appropriate accessories. A "scoop-proof" design uses a long receptacle shell that makes it nearly impossible to

damage exposed contact pins when the mating plug is cocked during hasty or careless connection. Operating temperatures for all four Series range from -65 to +200°C.

- **Series II:** A lighter-weight, lower-profile, bayonet-coupled version for use where high vibration and SWAMP are not issues. Not a scoop-proof design.
- **Series III:** A threaded version for normal mating with vibration-resistance. Features SWAMP and scoop-proof advantages.
- **Series IV:** A breach lock version for blind mating requiring only 90 degrees of rotation to engage or disengage. Also features very robust vibration-resistance as well as SWAMP and scoop-proof advantages.

Initial 38999 design developments were focused on meeting higher vibration requirements, improving EMI shielding, and increasing durability in fluid resistance and environmental sealing. The next evolutionary jump occurred in the 1980s and 1990s when higher fuel efficiency, longer flight times, and heavier payloads were the focus.

During this period, advances in materials science made it possible to offer a lighter-weight alternative to stainless steel and aluminum shells. The solution was a composite shell, which was adopted by the now well-known DEUTSCH brand of 38999 Series III-style connectors that employ military-qualified, rugged thermoplastic housing material. These composite shells are up to 40% lighter

than aluminum with four times greater corrosion resistance and with durability that extends to 1,500 mating cycles.



Figure 1: Example of 38999 Series III-style acme threaded connectors that support 10 Gb/s Ethernet and higher. (CeeLok FAS-X connectors provided by TE Connectivity.)

Relevant here is TE's DEUTSCH ACT MIL-DTL-38999 Series III composite connector, which is one of the most widely used mil-spec circular connectors in the industry. The versatility of ACT 38999 series connector configurations now extends to: 3 shell styles, 6 shell clockings, 2 platings, over 50 different insert arrangements supporting size 22, 20, 16, and 12 contacts for power and signal systems, as well as coax and twinax contacts.

Evolving a host of 38999 derivatives

Today's challenging avionics systems, aircraft data networks, military communications, in-flight entertainment, and aerospace applications demand higher data speeds at higher frequencies. These requirements continue to drive the evolution of several MIL-DTL-38999 derivatives to meet these challenges:

To improve electrical performance in more intelligent systems: Two connecting points have been removed in 38999 connectors that use PC tail contacts instead of crimp contacts. This feature enables direct connection to the PC board rather than to a wire then another connector on the PC board. The result is a higher density connection with fewer wires, which helps designers build higher speed systems with a smaller size.

To support higher contact density for Gigabit Ethernet: Providing nearly double the contact density of standard mil-spec high-density inserts to support Gigabit Ethernet speeds, 38999 Series III type connectors are available using 24 and 26 awg wire sizes. These threaded connector designs feature anti-vibration coupling and scoop-proof interfaces.

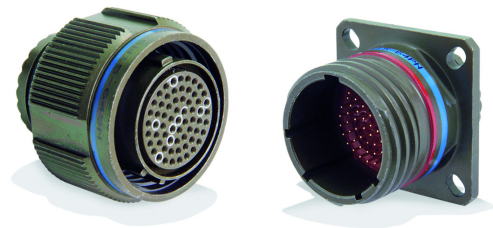
To support up to 3 GHz frequencies and up to 2 Gb/s speeds:

A custom 38999-style Series III connector style is used in the highly versatile Quadrax multi-signal contact system consisting of two differential pairs (matched impedance) for quadaxial Ethernet and Fiber Channel cables.

To support 10 Gb/s and higher for 10G Ethernet, IEEE 1394,

USB 2.0: A 38999-style Series III connector was developed by TE Connectivity with a size 11 shell to support a 10 Gb/s Ethernet channel and size 25 shells to support four Gb/s Ethernet channels. These connectors use an acme threaded coupling mechanism.

As the 38999-connector family has evolved, its versatility is meeting challenges beyond defense and aerospace applications. 38999 connectors are used in Formula 1 racing cars where track conditions produce severe vibration in the chassis and in wiring harnesses. It's also being used aboard America's Cup sailing yachts for sophisticated navigational computing where 38999



connectors provide a weather-tight coupling against moisture and salt spray.

Figure 2: Example of 38999 Series III-style threaded connectors enabling higher contact density than mil-spec high-density inserts. Available with PC tail contacts, which are not visible (DEUTSCH Wildcat 38999-Style connectors provided by TE Connectivity).

Originally designed as a simple solution to meet the challenges of battlefield and aerospace environments, 38999 connectors have evolved to meet increasingly diverse challenges. As the world moves to intelligent sensors, streaming video, and complex robotic motion control, 38999 connectors are evolving to meet higher data loads in a robust, compact form factor. Thanks to the amazing versatility of the 38999 family, its ability to meet today's and tomorrow's challenges is only limited by the designer's imagination.



ABOUT THE AUTHOR

Scott Miller is currently the MIL-DTL-38999 Global Product Manager for the Aerospace, Defense & Marine business unit of TE Connectivity (TE). With nearly 20 years of experience supporting various military circular harsh environment connector product families, he has a copious amount of knowledge in both industry and products.

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