Going Faster with Circular Connectors

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Few interconnect systems have received the broad acceptance that the MIL-DTL-38999 (formerly MIL-C-38999) connector series has enjoyed over the many years since its inception. Developed for severe wind and moisture problem (SWAMP) conditions in the 1930s, the 38999 connectors served the Army and Navy well until the 1940's when the Air Force introduced requirements for reduced weight. Space programs in the 70s reinforced the weight restrictions along with additional environmental requirements. Needless to say, the 38999-interconnect system continued to evolve to meet environmental requirements for the first 70 years of its existence. That said, little had been done prior to this past decade, with regards to the pin and socket contact interface to prepare it for the advent of high band width electronics. Increased bandwidth requirements proved the ever-popular pin and socket contacts to be inadequate for the performance needed: Requirements driven by Ethernet, DisplayPort, USB, SATA, InfiniBand®, etc. have forced innovation in contact designs and contact arrangements.

A Quadrax configuration is an early example of attempts to increased bandwidth by rearranging the signal and ground contacts within a 38999 insert to isolate the signals from one another for improved crosstalk characteristics. While increasing the bandwidth capability to 2.5Gb/s, the Quadrax pin and socket design incorporated little innovation in contact design to accommodate the ever-increasing need for higher bandwidths. The design resulted in a very large tradeoff between pin count/pin density and overall performance. It was time for the old pin and socket contacts to move aside.

Defense prime contractors and integrators were clamoring for high-speed interconnect systems for SWAMP conditions. The widespread use of high-speed switched serial fabric backplanes in the rugged embedded computer market created a need for a connector system capable of supporting serial I/O at full bandwidth between platforms. New backplane architectures were supporting link speeds in excess of 10 Gbaud. The desire of system designers to implement these speeds and to operate independent boxes or platforms at full system bandwidth required a new generation of high bandwidth (10 Gbaud) ruggedized I/O connectors. These connectors must also be able to withstand the basic tests for shock and vibration that VPX and Mil-C-38999M, series lll connectors were subjected to. Unfortunately, little work was being done on standards for such an interconnect system.

Meritec had become involved with VITA and its standards as a result of the Meritec VPX+ connector/cable products developed in support of VPX. Meritec brought the issue of a lack of suitable high-speed 38999 solutions to the attention of the VITA Standards Organization (VSO) members which led to the launch of the VITA 76 working group. The working group established the goal to develop a standard that addressed a new connector interface. The standard would support bandwidth greater than 10 Gbaud with both copper cabling and fiber optic cabling. Meritec turned full attention toward solving the problem. A leading contact interface to consider was Meritec's time proven HERMI contact, a hermaphroditic contact that Meritec had utilized in many previous connectors.

The HERMI contact design was not new as it had been used in various Meritec connectors for over 30 years. It differed from the traditional pin and socket design in that it was a flat hermaphroditic contact. The contact interface is identical in both the cable plug and the receptacle. When mated, the flat mating surfaces provide two points of contact and, when combined with welded wire termination techniques, it provides a virtually transparent signal impedance path. There are no electrical stubs like those typically found in pin and socket contact designs and no inductivity resulting from the added mass of the socket as well as the added mass of solder cups or crimp features. And while many attempts have been made to embed commercial connectors such as Ethernet and USB within 38999 shells to make them stand up to rugged military environments, the new hermaphroditic contact design became the obvious solution for a smaller, lighter solution with tremendous bandwidth capability for accommodating the various protocols.

Working Group Objectives

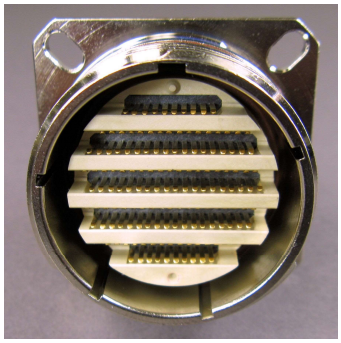
When the VITA 76 working group was formed, they established the following objectives for the standard:

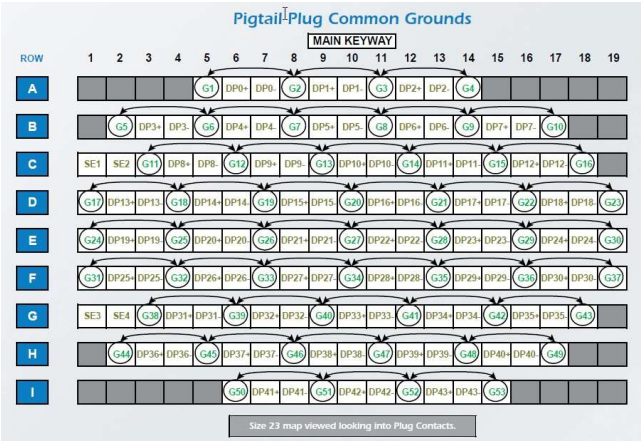
- It must be high pin count.
- It must be rugged, able to meet SWAMP conditions.
- The interconnect system must be capable of 10 Gbaud per differential pair.
- Describe the copper interface for a new generation of ruggedized circular connectors housed within a MIL-DTL-38999M, Series III circular shell.
- The connectors must be able to withstand the basic tests that VPX was subjected to for shock and vibration and Mil-C-38999M, series lll for the shell work.
- The copper contact interface of the bulkhead receptacle must be mateable with both the plug on the copper cabling as well as the plug on the active optic cabling allowing for interoperability between copper cables and active optic cables (AOC).

Overview

VITA 76 utilizes QPL MIL-DTL-38999 series III Standard circular shells. Designed for blind mating, high-vibration, and elevated temperatures, they are also suitable for "severe wind and moisture problem" (SWAMP). The VITA 76 contact interface has been through similar testing to assure it's up to the task.

The interconnect system defined in the VITA 76 standard ranges in size from the #9 shell size MIL-D-38999M, Series III to the #23 shell size. Both smaller and larger shell sizes may be added as the need arises. The #9 shell contains a total of 8 contacts or 2 differential pairs and is suitable for USB 2.0 for example. The #23 shell contains a total 145 contacts or 44 differential pairs and 4 non-differential contacts (spares) suitable for PCIe-X16 or 12X InfiniBand. The 44 differential pairs configured in 22 bi-directional data lanes at 10 GB/s per lane delivers an aggregate of 220 GB/s bandwidth per connector. The capabilities of the in-between shell sizes of 11, 13, 15, 17, are scaled accordingly.





Size 23 Shell with 44 Differential Data Pairs (22 Lanes)

The use of standard shells allows for the use of most standard back shell hardware for straight or angled egress of cable and wire, strain reliefs, etc.

The copper interface of the bulkhead connector is common to both copper cabling solutions and active optic cabling solutions allowing for interoperability between copper cable and active optic cables (AOC) utilizing a single copper contact interface in the panel mount receptacle while also meeting the necessary signal density emerging in the ruggedized embedded ecosystem.

The ANSI/VITA 76.0-2016, High Performance Cable Standard with Meritec's Hercules connector was approved by VITA and ANSI in 2016 and re-affirmed in 2021. More recently, the Sensor Open Systems Architecture (SOSA) consortium adopted the standard as part of the high speed, high density, multiple protocol interconnect designating the shell size 17 in the SOSA J-7 connector in the first release of the SOSA Technical Standard.

Conclusion

Technology incorporated in high performance critical embedded computing systems encompasses many components. High performance cabling is an integral part of the system. The VITA 76 standard provides a solution for the key connector and cabling component. Other work has been inspired by the VITA 76 working group. VITA has at least two other working groups using MIL-DTL-38999 as the foundation connector strategy for MT optical connections.

The VITA 87 MT Circular Connectors – Type 1 standard defines MT options for 12 or 24 fibers per MT and for physical contact or lensed MT.

The VITA 89 MT Circular Connectors – Type 2 standard defines MT options for 48 fibers per MT and for physical contact or lensed MT. The working groups are reviewing draft documents in both cases.

About Meritec – A Qnnect Company known as The Xtreme High-Speed Xperts, signal integrity leader and global ISO 9001 supplier of cost-effective solutions specializing in ruggedized, space-grade Mil/Aero, Defense, Marine interconnects that exceed high-density performance parameters. At AUSA, Meritec recently exhibited its ruggedized, space-grade high-speed Hercules® interconnect System, which is reaffirmed (as of October 2021) ANSI/VITA standard v76.0 and has been selected by SOSA for use as the J7 High-speed copper connector. Other offerings include Hercules harness and connectors with integration versatility including NEW HS-D – high-speed D-Sub for applications not previously accommodated by Industry Standard Connectors, and VPX3: Meritec's latest generation of cabling solutions for Open VPX with data speeds up to 25GBPs capable of carrying PCI Gen 4 and 100GBase-KR4 Ethernet, in addition to Meritec's proven line of supporting interconnect products. NAICS 334417 – 334418 – 334419 – 335999 - 335929 / CAGE 0RAG4. MERITEC.com / 888-MERITEC 637-4832 or 440.354.2100 /info@meritec.com