Rugged embedded systems for avionics applications get smaller

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This article describes the latest developments and requirements for ruggedized small form factor boards and systems especially for avionics applications.

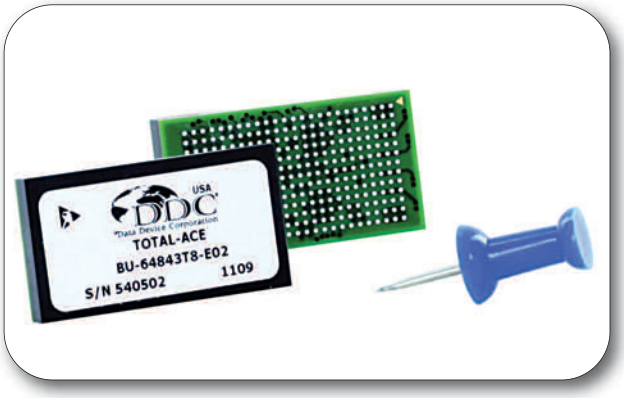

Figure 1. Total-ACE fully integrated MIL-STD-1553 terminal

As technology progresses the need for higher performance computational systems, combining multiple functions in a smaller footprint, becomes a need rather than a desire. As time goes on there are new capabilities introduced that could save time and increase efficiency onboard many aircraft if effectively added. New capabilities are constantly being added to platforms with the intent of decreasing the time it takes to perform a function, or increasing the functionality and capability of an aircraft. Yet when new systems are proposed there is always a tradeoff between the added weight of the system and a potential drop in carrying weight. The two parameters that are constantly focused on is aircraft survivability versus combat mission effectiveness. In many cases going to smaller and lighter electronics can increase the survivability and intelligence of a platform without any decrease in combat mission effectiveness. More than ever before this increases the need for even smaller systems onboard, or combining many functions in a smaller box.

Integrated electronic components and small form factors are all new ways to decrease the footprint of electronics such that the overall systems become smaller. MIL-STD-1553 design includes protocol, memory management, transceivers, and transformers in addition to software drivers and software development kits. For designers looking to develop a small form factor 1553 card, Data Device Corporation (DDC) has created the Total-ACE to simplify development efforts and save critical board space. The Total-ACE is the first fully integrated 1553 terminal consolidating all the necessary MIL-STD-1553 components within a single, small, cost-effective plastic BGA package. With one single plastic BGA package that is only 15mm x 27mm you can now create a complete interface to a dual redundant MIL-STD-1553 bus. The small size saves valuable space on the small form factor board and the single package allows for an easier layout. The Total-ACE is powered entirely by +3.3V to minimize board space even further by eliminating the need for having multiple voltage regulators. Having just one part for a complete MIL-STD-1553 interface also increases overall reliability of the small form factor board.

MIL-STD-1553 has also defined an RT validation test plan to ensure that the bus is electrically safe and reliable, and that all parameters are within specifications and no external noise or dynamic offset exists on the line. All DDC MIL-STD-1553 products have successfully undergone full RT validation. In addition to this, with the Total-ACE you can achieve DO-254 qualification on the end system if required. DO-254 is an FAA standard that provides guidelines for design assurance of complex airborne electronic hardware and calls out objectives that must be met by avionics equipment manufacturers to ensure continued airworthiness, safety, and reliability. DO-254 certification is required for all civil airborne electronic hardware, and military contractors are finding DO-254 increasingly important for military aircraft that must fly through civil airspace.

The PC/104-Plus and PCI-104 form factors are very popular small form factors that have allowed embedded and laboratory system designers to keep development costs low through the use of commercial off-the-shelf (COTS) products. These form factors are small and compact designs that are well suited for small embedded applications and rapid prototyping in the lab. The cards are only 90mm x 96mm and use a stacking concept where one card sits on top of the other, which allows to build a tower of cards. The pins from one card insert into the card below it to provide the bus interface. The stacking concept allows system designers to eliminate backplanes that consist of large metal card cages making the overall format smaller in size and lower in cost. The I/O from each board is cabled out to rugged circular military style connectors that are on the side of the rugged enclosure.

Data Device Corporation provides cards for MIL-STD-1553/1760, Enhanced Bit Rate 1553, ARINC-429, and Synchro/Resolver with many cards combining multiple types of I/O on one board to save even more power, space, weight, and cost. Additionally, AceXtreme 1553 PC/104-

Plus or PCI-104 cards provide Multi-RT support with concurrent bus monitor, or bus controller with concurrent bus monitor per 1553 channel, allowing legacy LRUs and systems that responded to only one RT address to be consolidated into one small form factor. Furthermore, newest DDC PC/104-Plus and PCI-104 cards that contain ARINC-429, MIL-STD-1553 and Multi-I/O 1553/429 on one board can be powered off only +5V.

More recent industry activity has pushed for even smaller footprint cards compared to PC/104-Plus type systems. VITA is an incorporated, non-profit organization of vendors and users having a common market interest in real-time, rugged embedded computing systems. VITA members have worked together to define and develop key computer bus, board, and system specifications such as VME, PCI mezzanine card (PMC), VPX, XMC and others. The community has realized that there is a driving need for electronic systems to get smaller and lighter. This resulted in three new competing standards VITA-73, VITA-74, and VITA-75. VITA-73 is based on the VPX (VITA 46/48) electrical standards in a much smaller footprint. This specification is about the same size as PC/104-Plus cards without all the individual interconnects required to get the I/O out of the box since it is a slot based design with a small chassis. VITA-74 based boards are also very small size, a bit smaller than PC/104-Plus based and use a high speed PCIe back end interface. They are specifically engineered for harsh, rugged conduction-cooled environments. All three specifications provide a standard mechanical format for standardization of switched serial interconnects for small form-factor applications, with specific concern taken to allow deployment in ruggedized environments. One example of these smaller systems comes from Themis which earlier this year announced their Nano ATR VITA-74 compliant system that provides a very small footprint, rugged computing system. The Small Form Factor Special Interest Group (SFF-SIG) is another independent group that develops, promotes, and supports small form factor circuit board, I/O, and storage specifications. The group embraces the latest technologies, but also has a philosophy of maintaining legacy compatibility and enabling smooth transitions to next-generation interfaces. SFF-SIG is focused on trying a variety of different approaches to suit the miniaturization of board-level electronics. The Stackable USB camp, for its part, is focused on using USB to replace ISA, PCI, or PCIe as the board-to-board interconnects in rugged stacked systems. A new group has also formed around a new specification called FeaturePak, to address small modules.

DDC has recently introduced a series of small form factor boards that are ideal for many applications requiring something smaller and lighter. DDC BU-67114H is a standard full-size (F2) PCI Express mini card supporting one or two dual redundant MIL-STD-1553/1760 channels. This form factor is designed for use in rugged/embedded systems or laptops that provide a standard full-size PCI Express mini slot. At a small size of just 30mm x 50.95mm, this tiny card incorporates 2 dual redundant channels of 1553 protocol, memory, transceivers, and transformers on a small board such that the system designer can easily add 1553 to any system with a standard slot. Additionally, BU-67113U is a small form factor board that connects to any host computer with a USB port via a standard USB 2.0 cable. This allows the board to be mounted anywhere inside a system with no need to modify the base or host board to provide a slot or socket assembly as long as a USB port is available. The small board from DDC is only 50mm x 63mm and provides up to two dual redundant 1553 channels. ■

Figure 2. DDC MIL-STD-1553 small form factor card