Rugged modules and boards for MIL-STD-1553 and ARINC 429 standards

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This article describes the MIL-STD-1553 and ARINC 429 standards and their differences in detail, and introduces a wide range of components, test boards, rugged embedded boards, rugged small form factor boards and software corresponding to these standards.

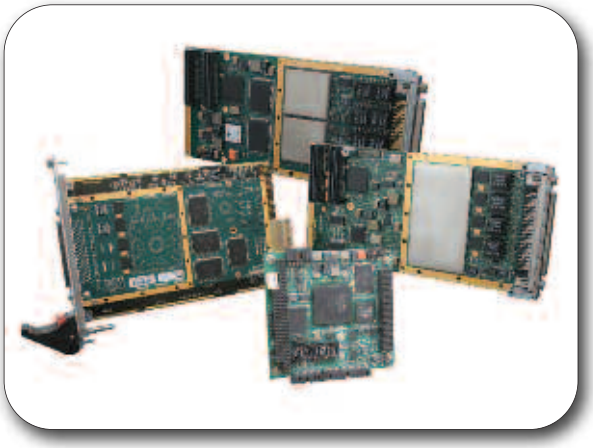

Figure 1. Various DDC MIL-STD-1553 and ARINC 429 boards

MIL-STD-1553 is a protocol standard that defines the electrical and functional characteristics of a serial data bus that has been mainly used in military aircraft. The bus architecture of MIL-STD-1553 allows for reduced size and weight of systems and the wiring that interconnects them, is inherently reliable, and incorporates redundancies that make it a safe data bus solution. Since 1978 it has served as the primary command and control interconnect in military aircraft. Its performance, reliability and safety made MIL-STD-1553 the standard for military aircraft for more than three decades, and it is now being designed-in as the standard for next-generation commercial aircraft.

ARINC 429 is a data bus that has separate transmit and receive ports, and has been widely used on many commercial aircraft since its introduction in the late 1970s. This standard defines the air transport industry bus for the transfer of digital data between avionics systems on commercial aircraft. The physical connection wires are twisted pairs carrying balanced differential signaling. This bus architecture offers a point-to-point connection for a receiver and transmitter. The standard does allow up to 20 receivers to be hooked up to one transmitter. The transmitter identifies the equipment and message type via an 8-bit label that is part of the standard 32-bit message.

ARINC 429 has been thought to be the lower-cost, lower-reliability alternative for 1553 for commercial aircraft. However the lower speed, lack of redundancy, and inferior lightning protection in the bus adds cost to system architects who must find ways to meet high-level safety-critical standards. Conversely, 1553 inherent reliability, robustness, maturity, and superior EMI performance, combined with recent competitive prices, has allowed 1553 to be used on commercial aircraft. Most recently Airbus has selected Data Device Corporation MIL-STD-1553 components for use in critical primary flight control systems on the A350 XWB. ARINC 429 is still, and will continue to be, widely used in many commercial aircraft electronic communication systems, yet 1553 promises distinct advantages in critical applications and will continue to expand in use.

MIL-STD-1553 has a large installed base in a wide variety of ground vehicles, ships, helicopters, fighter aircraft, missiles, satellites and more recently commercial aircraft. Since more systems are meant to be used in many different applications on multiple platforms, having a plug-in hardware option for 1553 or 429 allows the system designer to design a hardware core system that can be used in many different types of platforms while adding the I/O required via plug-in cards. A system-level solution that can be used for many different applications and can add MIL-STD-1553 or ARINC 429 for those applications requiring it is becoming very popular. This is a common approach with standard PMC or PC/104-Plus type form factor boards. The PC/104-Plus form factor is a small and compact design that is well suited for small embedded applications and rapid prototyping in the lab. The card is only 3.575 inches x 3.775 inches (90mm x 96mm) and uses a stacking concept where one card sits on top of the other, allowing designers to build a tower of cards. PMC boards can go onto VME, VPX, cPCI/PXI, or PCI chassis systems with large metal card cages. A standard-size PMC board is 5.87 inches x 2.91 inches (149 mm x 74 mm) and plugs onto a baseboard such that the two boards are parallel to each other. DDC also offers a complete line of PMC, PCI, cPCI, PC/104-Plus and PCI-104 cards (figure 1) that offer a mix of MIL-STD-1553 only, ARINC 429 only, or a combination of 1553/429 on one card. Mixing MIL-STD-1553 and ARINC 429 on one board allows for overall savings in power, weight, space, and cost, for platforms such as helicopters, cargo aircraft and commercial aircraft that use both MIL-STD-1553 and ARINC 429.

Other common interfaces include, but are not limited to, digital and avionics (+35V) level discrete I/O, IRIG-B input/output, and RS-232/422/485 serial I/O channels. Each card

Figure 2. Total-ACE integrates MIL-STD-1553 components within a single, small, cost-effective plastic BGA package.

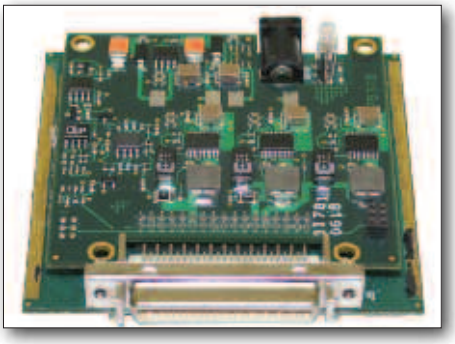

Figure 3 MIL-STD-1553/ARINC 429 USB small form factor board

has the ability to inhibit the transmitters for monitoring-only applications, or disable the bus controller for RT-only applications on a channel-by-channel basis. This is done via a customer configuration utility that is run once on the card. Once each 1553 channel on the card is configured in the desired manner, host software cannot change this configuration. If the software commands the card to transmit data as a bus controller on channel one, the hardware will not do so if the defined channel is inhibited or BC-disabled. DDC offers this capability as a standard feature with each of the AceXtreme PMC, PCI, cPCI, PC/104-Plus and PCI-104 cards. These features are usually requirements for customers who deal with flight safety critical applications to satisfy very strict security requirements. Some safety-critical applications require the monitoring of a classified data bus while communicating as a remote terminal on another bus. Each card includes the MIL-STD-1553 AceXtreme and Multi-I/O ARINC 429 ANSI C software development kits (SDKs) and drivers to support all modes of operation for 32-bit and 64-bit versions of Linux, VxWorks, Windows 2000/XP, and 32-bit and 64-bit versions of Windows Vista and Windows 7, including source code samples and detailed documentation. PMC and PC/104-Plus form factors however can at times be too large and heavy for some applications. Demand for lightweight, low-power, rugged, reliable bus interfaces for smaller platforms such as UAVs has increased the demand for small components or small form factor rugged boards. DDC offers a complete line of MIL-STD-1553 components and rugged small form factor boards for applications that are very size- and weight-limited. Traditional applications incorporate DDC MIL-STD-1553 and ARINC 429 components on a base board or small module that plugs into a complete system that is customized and designed by the system manufacturer with DDC component level solutions. The company offers a wide range of ceramic and plastic BGA components for these types of applications including the recent introduction of the Total-ACE. The MIL-STD-1553 Total-ACE design includes protocol, memory management, transceivers, and transformers in addition to software drivers and software development kits. For designers looking to add 1553 to boards, the Total-ACE was created to make development easy.

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 as small as 0.6 inch by 1.1 inch (15.24mm x 27.94mm), a complete interface can now be created to a dual-redundant MIL-STD-1553 bus, with transformers included inside the small package. The small size saves valuable space and the single package allows for an easier layout. The Total-ACE is powered entirely at +3.3V to minimize board space even further by eliminating the need for multiple voltage regulators. Having just one part for a complete MIL-STD-1553 interface also increases overall reliability.

There are a number of small form factor standards that are available today and more are emerging with the objective of saving space, power, and weight in overall system development. As more and more unmanned systems become smaller, and the need to save weight in aircraft systems increases, and as system architects try to create more common box architectures, these types of small rugged modules allow a system designer to add I/O to fit in an

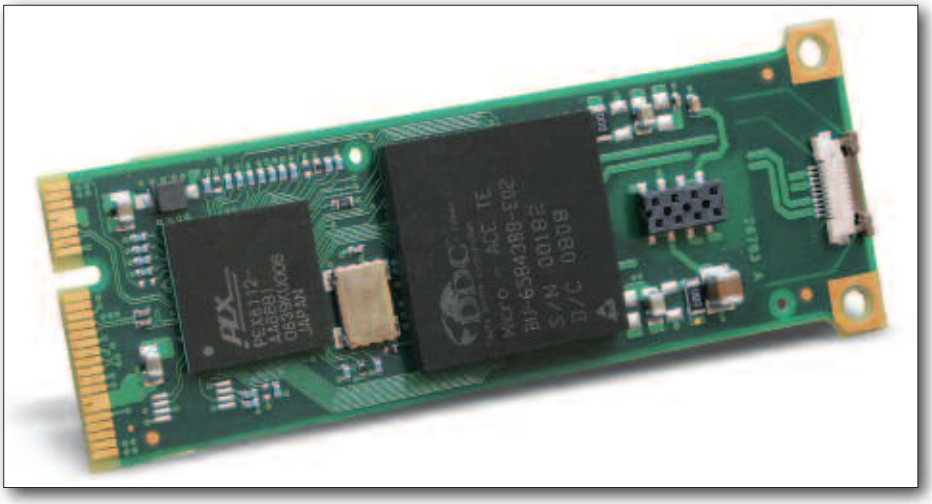

Figure 4. MIL-STD-1553 Mini-PCI-e small form factor board

application or platform that would not have previously been possible without a redesign of the box to add critical I/O capability. The small form factor special interest group (SFF-SIG) is an 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.

DDC has a USB small form factor board that contains up to 2 dual-redundant MIL-STD-1553 channels, 4 ARINC 429 receivers, 2 ARINC 429 transmitters, 8 user-programmable digital discrete I/Os, IRIG-B time code input, and a 1 pulse-per-second (PPS) output. The USB board is approximately 3 inches x 2.6 inches (76.2mm x 66mm) and can meet rugged levels of shock and vibration along with a temperature range of -40°C to +85°C.

The rugged USB board solution is available as 1553 only, 429 only or fully populated with 1553/429 Multi-I/O. The USB board can be powered directly from the USB interface eliminating the need for multiple power supplies to provide mixed voltages to the board. Its small size, light weight, and durable construction make the USB 1553/429 board an ideal solution for use in-flight instrumentation applications, small displays, situational awareness systems, portable rugged laptop type applications, or other small systems that do not have a standard form factor. DDC has also created a small Mini-PCI-e-like form factor that has one dual-redundant 1553 channel that is approximately 3 inches x 1 inch. It connects 1553 to a PCI-e x1 lane bus via an edge connector just like the standard mini-PCI-e small form factor, and is ideal for laptop systems with mini-PCI-e that can fit this size 1553 solution. ■

Product News

Curtiss-Wright: VPX single-slot physical layer switch

Curtiss-Wright has announced the availability of its new VPX2500. This VPX-based managed, non-blocking, multi-protocol Layer 1 PLS is packaged in a 6U VPX form factor. The VPX2500 is able to connect any serial digital signal input to any single output at speeds up to 2.5Gbps. Its flexible, expandable crossbar switch performance enables users to control their network configurations while reducing set-up time, limiting network errors, and cutting costs. Designed for defense and aerospace applications, it speeds and eases the integration of high performance switching.

News ID 14525

PCI-Systems: open VPX 3U conduction cooled 6 slot instrumentation chassis

PCI-Systems announces an OpenVPX conduction cooled rugged armoured portable 6 slot chassis with many integrated functions, enabling accelerated development of rugged conduction cooled embedded systems. The chassis is a OpenVPX COTS product for 3U VPX instrumentation and can be used for multiple applications by changing the switch mezzanine to customer needs. PCIe Gen 2 „noStub" routing is used throughout the system to maximize data throughput. Also it is possible to use a Gb Ethernet switch and a serial Rapid I/O switch on this mezzanine, if needed.

News ID 13342

DDC: commercial avionics software support for new ARINC 429 cards

Data Device Corporation announces extended Commercial Avionics Utilities Data Bus Analyzer and ARINC 615 Data Loader software support for its line of ARINC 429 PMC, PCI, cPCI/PXI, and USB data bus cards. DDC's BU-671 Series ARINC 429 lineup includes multi-I/O combo cards (ARINC 429 and MIL-STD-1553), ideal for dual protocol applications, and ARINC 429 only cards optimized for single protocol use.

News ID 17136

Steatite: MIL-STD-810F certified embedded system for in-vehicle connectivity

Steatite Embedded has launched the new ICP-PES2041M, an extremely rugged, fanless embedded system. The ICP-PES2041M is designed for use in vehicle-based computing applications, including CCTV, ANPR, navigation and communications. This embedded system's features include GPS, 3.5G mobile wireless, 4x serial ports, isolated digital I/O and PCI expansion. The cable-free design results in an embedded system that is highly tolerant to external shock/vibration and is certified to MIL-STD-810F, making it ideal for use in commercial applications such as in waste trucks or emergency vehicles.

News ID 14533

GE: 6U OpenVPX starter kit supports multiple fabric topologies

GE Intelligent Platforms announces the 6U OpenVPX CUDA Starter Kit. Allowing systems developers to easily and cost-effectively acquire a complete, integrated, pre-tested hardware and software development environment, it is designed as a response to the rapidly growing interest in using GPGPU – general purpose computing on a graphics processing unit – technology for rugged, size/weight-constrained, deployed mission computing applications such as radar, sonar, image processing, signals intelligence and ISR.

News ID 17186