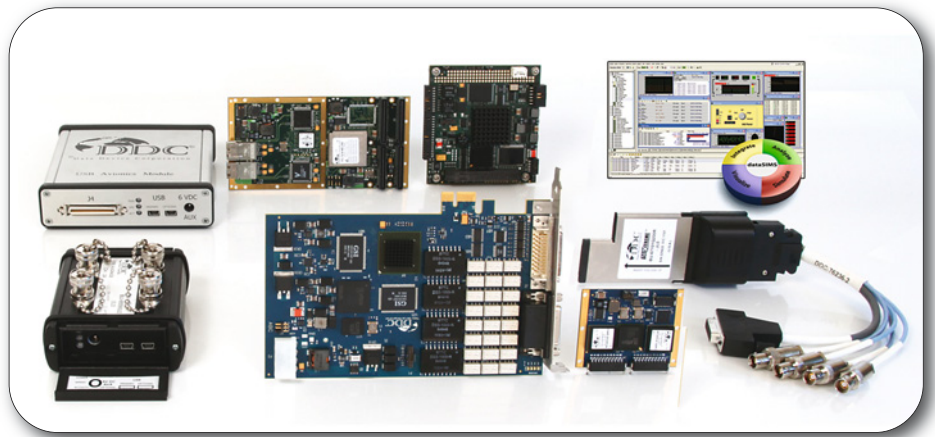# Safety in civil airplanes via DO-254 certifiable MIL-STD-1553 interfaces

By George Los, Data Device Corporation

This article introduces a wide range of MIL-STD-1553 components, test cards, rugged embedded cards, and software from a single company. Originally intended for military requirements, the standard is increasingly considered for use in civil aircraft.

■ MIL-STD-1553 is a protocol standard that defines the electrical and functional characteristics of a data bus used in military aircraft. The standard describes the method of communication, the data bus requirements, and the electrical interface requirements for the data bus. The 1553 data bus is dual-redundant and bidirectional, and features encoding and high bit error reliability. The bus architecture of MIL-STD-1553 allows for a reduction in the size and weight of systems and the wiring that interconnects them, is inherently reliable, and incorporates redundancies and electrical characteristics that make it a very safe data bus solution.

Data Device Corporation (DDC) designs and manufactures a wide range of MIL-STD-1553 components, test cards, rugged embedded cards, and software. DDC also produces a line of ARINC-429, AFDX, Ethernet, ARINC-407 (Synchro), Fibre Channel, and solid state power controller products. The products of the company meet military requirements such as high reliability, safety, low CPU utilization, real-time performance, and ruggedness for harsh environments. The products also cover a flexible range of performance and cost requirements. DDC MIL-STD-1553 solutions have been designed into such projects as the F-16 Falcon, the B-1 Bomber, the F-35 (JSF), the AH-64 Apache attack helicopter, the M1A2 tank, the

Space Shuttle, the Eurofighter, the International Space Station, and the New Horizons spacecraft. In addition to military applications, the MIL-STD-1553 components have also been designed into flight control applications on the Airbus A350. These components have more than 200 million hours of flight history, which proves their reliability and performance. DDC MIL-STD-1553 components also have unique attributes to further ensure the flight safety of a MIL-STD-1553 data bus.

MIL-STD-1553 runs at a data rate of 1MHz and is connected to a bus architecture with 70 ohm impedance wire. Electrically this is a bi-phase signal where transmitters and receivers are coupled to the bus by isolation transformers and stub connectors, in conjunction with isolation resistors and coupling transformers within the transformer coupled case. MIL-STD-1553 defines two different connection methods to the data bus. Connections can be made in either long stub (transformer coupled) or short stub (direct coupled) configuration methods. Direct coupling connections are wired directly to the bus cabling, and allow a wire length of up to 12 inches. The isolation resistors and transformer are internal to the terminal device, so no additional coupling hardware is required. In comparison, transformer coupling utilizes a second transformer located external to the terminal device with the isolation resis-

tors, and a wire length of up to 20 feet is allowed. Transformer coupling provides electrical isolation, better impedance matching, and higher noise rejection characteristics than direct coupling. The electrical isolation prevents a terminal fault or stub impedance mismatch from affecting bus performance. The MIL-STD-1553 electrical bus characteristics include voltage output of 18V to 27V peak to peak. The unique bus configuration, 1553 isolation transformers, transformer coupling modes, and voltage range make MIL-STD-1553 a very safe data bus providing high voltage lightning protection without the need to design very complex external circuitry.

MIL-STD-1553 has 3 operating modes defined as Bus Controller (BC), Remote Terminal (RT) and Monitor (MT). The bus is a flight critical reliable bus by design, offering redundancy and reliability, along with resistance to EMI. Bus redundancy is built into the MIL-STD-1553 specification, and the specification is intended to support system design. Each channel has A and B buses which are completely independent. If a failure occurs on bus A and no response is received by the Bus Controller then the system can automatically switch over to the other bus. The Bus Controller commands the bus and can command an RT to receive data, send data to the BC, or send data to another RT. The main function of the Bus Con-
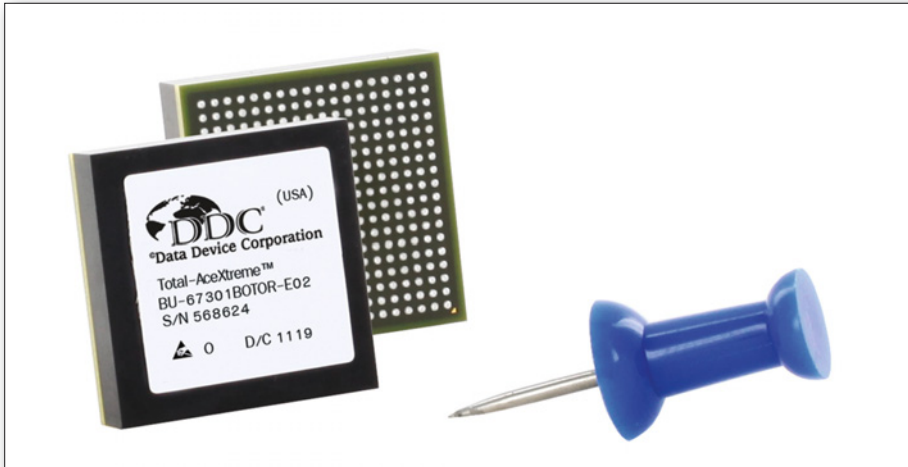
Figure 1. The Total-ACE and Total-AceXtreme series are BGA packages that include protocol, memory, transceivers and transformers inside one package.

troller (BC) is to provide data flow control for all transmissions on the bus. All information is communicated in a command and response format. The BC sends a command to the RTs that then reply with a response. The RT never sends data on the bus unless it is commanded to do so by the BC.

A Monitor is defined as a 1553 interface that records all the traffic on the bus but can never transmit any data onto the bus. Some applications need to record classified data as a monitor and ensure that a software glitch on the host computer does not inadvertently transmit this data over an unclassified bus. DDC Tx Inhibit feature on components allows end users to easily accomplish this task. By setting one of the input pins of the device to the correct logic level, the device is inhibited from ever transmitting on the bus even if it is commanded to do so by the host computer. DDC has gone one step further and brought out the internal data connection between the 1553 protocol logic

and the 1553 transceivers to external ball connection sets on the plastic BGA packages. The sets must be connected in order for the device to function as a fully programmable BC/RT/MT. If the desired application is only monitoring data from a classified bus and must never transmit on the bus, then these external connections are simply left unconnected on the layout. This is a very common concern among avionics systems that need to capture data but must never re-transmit this data onto the bus. Safety concerns must ensure that even if a software glitch or software error occurs the device never transmits, and DDC Total-ACE and Micro-ACE series ensures this high level of safety.

Another critical requirement that often comes up on systems acting as just a remote terminal is to ensure that the component can never take control of the bus and act as a bus controller. Since the part is configurable as BC, RT, MT via host software there needs to be a method to disable the BC logic. DDC offers parts that

can be ordered as RT only to ensure that this safety-critical requirement is met. The Total-ACE and Total-AceXtreme series are BGA packages that include protocol, memory, transceivers and transformers inside one package that brings out a signal which can be used to disable the device from acting as a Bus Controller. MIL-STD-1553 also has defined an RT validation test plan to ensure that the bus is electrically safe and reliable, and that all parameters are within specifications and that no external noise or dynamic offset exists on the line. All of DDC MIL-STD-1553 products have successfully undergone full RT Validation.

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. There are five levels of compliance, A-E, which depend on the effect a failure will have on the operation of the aircraft. Level A is the most stringent, and defines a failure as catastrophic, while a failure of Level E hardware will not affect the safety of the aircraft. DO-254 certification is required for all civil airborne electronic hardware, and military contractors are also finding DO-254 increasingly important for military aircraft that must fly through civil airspace.

Although MIL-STD-1553 was originally designed for use with military avionics, due to its robustness and safety it has recently become increasingly considered for use in commercial aircraft. MIL-STD-1553 has caught the attention of commercial aircraft manufacturers, such as Airbus, who seek to capitalize upon 1553 inherent reliability, robustness, maturity, and superior EMI performance. Airbus has selected MIL-STD-1553 components from Data

Device Corporation for use in critical primary flight control systems on the A350 XWB. Another important consideration influencing Airbus choice was that DDC products facilitate achieving RTCA/DO-254 Level A certification, a significant factor in the avionics industry. DDC offers DO-254 certifiable MIL-STD-1553 interfaces, such as the Enhanced Mini-ACE, Mini-ACE Mark 3, Micro-ACE and Total-ACE family of products which have extensive in-service history, and are supported by detailed documentation packages, as well as proven performance, experience, safety and reliability. For MIL-STD-1553 components, DDC can supply a documentation package that provides data specific to the aspects of certification in accordance with RTCA/DO-254 Level A. The 1553 family of products of the company has achieved over 200 million hours of in-flight operation within over 1000 unique designs, and is an example of the qualification data provided.

The company also offers a complete line of boards and box level assemblies that offer a mix of MIL-STD-1553 only, ARINC-429 only, or a combination of MIL-STD-1553/ARINC-429 on one board or box. Other common interfaces include, but are not limited to, digital and avionics (+35V) level discrete I/O, IRIG-B input/output, RS-232/422/485 serial I/O channels, CANBus, ARINC-717 and AFDX. The cards, just like the components, are designed to meet strict safety and reliability concerns of the military avionics community. With this in mind DDC has implemented a way to enable end users to configure the card to meet these safety concerns. In addition to full BC validation and RT validation, each card is a fully functional device that has the capability to operate as a bus controller or multi-remote terminal, each optionally running a concurrent bus monitor.

Each card 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 then host software cannot change this configuration. If the software commands the card to transmit data as a bus controller on channel 1, the hardware will not do so if the defined channel is inhibited or BC disabled. Pre-defined versions can also be ordered if the end user does not want to configure each card. This ensures the safety and reliability of the systems that include these cards. Each of the cards and boxes that DDC sells go through CE certification. This ensures that the products comply with the Low Voltage Directive and EMC Directive to be sold as electronic products in Europe to address user safety concerns. ■

Product News

■ GE: rugged 6U OpenVPX GPGPU multiprocessor

GE Intelligent Platforms announced the rugged IPN251 6U OpenVPX GPGPU Multiprocessor. A successor to the IPN250, the IPN251 combines the latest 384-core NVIDIA Kepler GPGPU technology with a third generation Intel Core i7 quad core processor to deliver outstanding computing performance in a wide range of demanding data-intensive applications, particularly ISR (intelligence, surveillance, reconnaissance).

News ID 17035

■ Kontron: 3U VPX graphics board provides desktop-class AMD graphics in rugged form factor

Kontron has launched the Kontron 3U VPX graphics board VX3324 in an embedded form factor targeting military and aerospace applications. It has been designed for long lifecycle applications and is equipped with the AMD Radeon E6460 graphics processing unit. The new VPX graphics board has been optimized for size, weight, power and cooling constrained applications and supports the latest high-end graphics performance features such as DirectX 11 OpenGL 4.0 and Shader model 5.0, providing an immersive 3D user experience.

News ID 17117

■ Emerson: VPX system chassis simplifies development, testing and deployment

Emerson Network Power announces its latest VPX system chassis: the KR8-VPX-3-6-1. Designed primarily for development, testing and lab duties, the KR8-VPX-3-6-1 can also be deployed in ground benign installations as it meets Emerson's standard safety, electromagnetic compatibility and environmental requirements.

News ID 17174

■ Artila: ARM9 Linux computer with 8-port isolated RS-485

Artila Electronics releases Matrix-516, the new generation of its ARM-based box computer. Artila's Matrix-516 industrial box computer is a small form-factor, low power consumption, and Linux-ready computing platform. With a 400MHz Atmel AT91SAM9G20 CPU, 64MB SDRAM and 128MB NAND Flash inside, Matrix-516 ensures system high performance. Matrix-516 is equipped with multiple I/O interfaces, including 2 LANs, 8 x isolated RS-485 serial ports, 2 x USB hosts, 1x micro-SD and 21 x GPIOs. It is easy to develop pure C/C++programs or Web-based applications such as SQLite+ and PHP to run on top of the Matrix-516.

News ID 17146

■ SECO: energy-efficient CUDA ARM development kit

SECO unveiled its latest energy-efficient DevKit – powered by the NVIDIA Tegra 3-based Qseven module on a Mini ITX form factor carrier board – the SECO mITX GPU DevKit. The SECO mITX GPU DevKit is a GPU computing development kit designed to support the growing worldwide demand for power-efficient ARM/ and ARM+GPU HPC and server solutions. Integrating a PCI Express x4 interface on PCI-e x16, the SECO mITX GPU DevKit allows the use of a range of NVIDIA GPUs, including those based on the NVIDIA Kepler compute architecture.

News ID 17058

■ MSC: Qseven starter kit with AMD Embedded G-Series APU

MSC is announcing the availability of a new Qseven Starter Kit based on MSC's Qseven modules featuring the AMD Embedded G-Series APU. The MSC Q7-SK-A50M-EP4 Starter Kit consists of MSC's 3.5" Qseven baseboard Q7-MB-EP4 with suitable heatspreader and heatsink and an integrated power supply with cable kit. The kit comes with a ready-to-run Linux installation in Flash Disk to enable an out-of-the-box functional experience.

News ID 17086

■ Trenz: compatible all-programmable SoMs feature Artix, Kintex, and Zynq

Trenz Electronic presents its new series of FPGA and SoC modules. They are based on the latest Xilinx all-programmable devices (Artix, Kintex, and Zynq-7000) and are available in a uniform 4×5 cm form factor. Trenz Electronic's new product series is comprised of FPGA and SoC industrial modules, which can also be deployed in harsh environments, such as those occurring in the industry and aeronautics.

News ID 17088

■ DFI: complete line of Computer-On-Module products

Due to the increasing demand of Computer-On-Module products, aside from Type 2, DFI completed its COM Express product line by adding Type 6, Type 10, and Mini form factor. In addition, we added several COM Express products that use BGA-package processor to satisfy vertical markets that require product stability. DFI now offers Type 2, Type 6, and Type 10 in Mini, Compact and Basic form factors. At present, DFI has 19 Computer-On-Module products that are readily available for shipment and 14 more modules that will be released throughout the year.

News ID 17121