boards & solutions

the european embedded computing magazine

kontron

Cover Story
Kontron Global Software Design Center

Special Features
- Safety & Security
- Industrial Computing
- Networking

Boosting Customer Development Performance

Application Ready Platforms

Verification and Validation Services, Software Design

Middleware Services

OS and Virtualization Services

Firmware Services

Hardware Services, COTS, modified, Custom and ODM

Meeting safety-critical requirements with MIL-STD-1553

By George Los, Data Device Corporation

MIL-STD-1553, which has served as the primary command and control interconnect in military aircraft for more than 3 decades, is now being designed-in as the standard for next-generation commercial aircraft, thanks to its performance, reliability and safety.
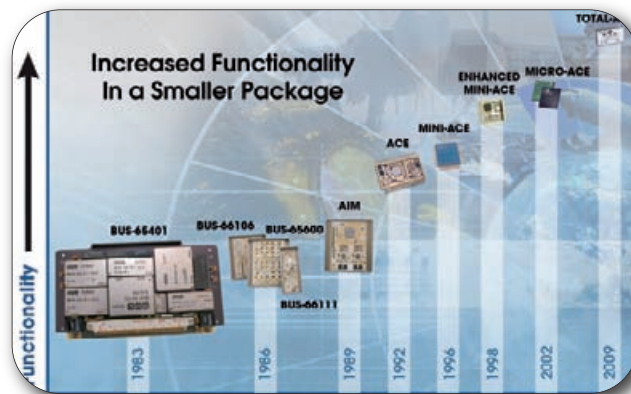

Figure 1. MIL-STD-1553 component evolution

■ 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 1553 standard describes the method of communication, the data bus requirements, and the electrical interface requirements for the data bus. 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. MIL-STD-1553A was published in 1975 and later revised in 1978 to MIL-STD-1553B, and has since served as the primary command and control interconnect in military aircraft. The performance, reliability and safety that made MIL-STD-1553 the standard for military aircraft for more than 3 decades is now being designed-in as the standard for next-generation commercial aircraft.

Data Device Corporation (DDC) designs and manufactures a wide range of MIL-STD-1553 components, test cards, rugged embedded cards, and software. The company also produces a complete line of ARINC-429, ARINC-407 (Synchro), fibre channel, and remote power controller products. DDC products 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 per-

formance and cost requirements. The 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.

DDC MIL-STD-1553 components have been designed in numerous military aircraft models and recently have been designed in multiple Airbus A350 flight control applications. These devices have more than 60 million hours of flight history that proves their reliability and performance. The MIL-STD-1553 components of the company have unique attributes that ensure the flight safety and security of a 1553 data bus. 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. It offers redundancy and reliability and is resistant to EMI. 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. A bus controller commands the bus and can command an RT to receive data, send data, or send data to another RT. The RT never sends data on the bus unless it is commanded to do so from the BC. 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 that exists internal to the device as a connection to the packaged component. The connection is routed to external ball connections 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 simply leave these external connections unconnected on your layout with Total ACE or Micro ACE series from DDC and safety is ensured. 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. 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,
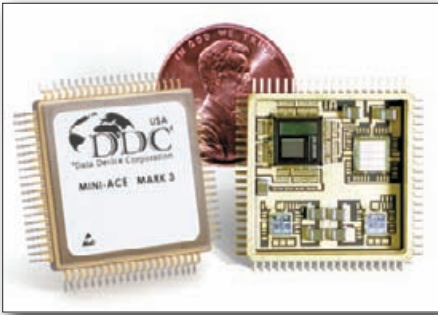
Figure 2. Mini-ACE Mark3 3.3V MIL-STD-1553 Terminal

Figure 3. Total-ACE fully integrated MIL-STD-1553 solution with transceivers and transformers inside

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 series is a BGA package that brings out a signal that can disable the device from acting as a bus controller. Total-ACE includes 1553 protocol, memory, 2 transceivers and 2 transformers all in one compact .6" x 1.1" plastic BGA package. All the DDC MIL-STD-1553 components are based on a core that has been proven reliable and safe with more than 62 million hours of in-flight operation. 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 no external noise exists or dynamic offset on the line. All the 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 to E, which depend on the effect a failure will have on the operation of the aircraft. Level A is the most stringent, defined 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 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 interesting for use in commercial aircraft. Considered a standard, MIL-STD-1553 has caught the attention of commercial aircraft manufacturers based upon its inherent reliability, robustness, maturity, and superior EMI performance. Airbus selected Data Device Corporation MIL-STD-1553 components for use in critical primary flight control systems on the A350 XWB. Another important consideration was that these 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, the company can supply a documentation package that pro-
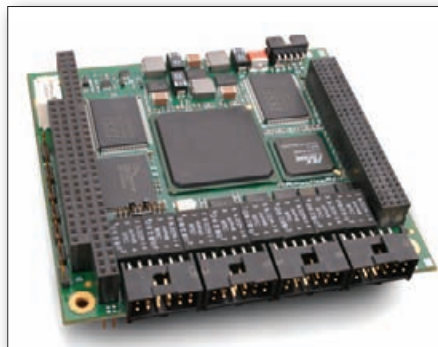

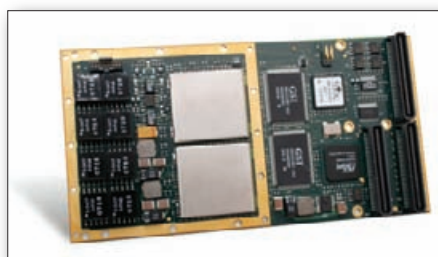*Figure 4. BU-67105C 4-channel MIL-STD-1553 PC/104 Plus card*

Figure 5. BU-67110M 8-channel MIL-STD-1553 PMC card

vides data specific to the aspects of certification in accordance with RTCA/DO-254 Level A. The 1553 family of products has in-flight operation of over 62 million hours with over 1000 unique designs, and is an example of the qualification data provided. DDC also offers a complete line of PMC, PCI, cPCI, PC/104 Plus and PCI-104 cards that offer a mix of MIL-STD-1553 only, ARINC-429 only or combination 1553/429 on one card. 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. 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. This capability is offered as a standard feature with each of the AceXtreme PMC, PCI, cPCI, PC/104 Plus and PCI-104 cards. 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, which are based on the same 1553 core that has over 62 million hours of in-service history.

Each card includes the MIL-STD-1553 AceXtreme ANSI C Software Development Kit (SDK) and drivers to support all modes of operation for Linux, VxWorks, and Windows 2000/XP/Vista/7, including source code samples and detailed documentation. The SDK allows users to develop source code to simulate, monitor, or troubleshoot 1553 data buses with support for the latest versions of operating systems. This SDK allows you to quickly integrate DDC 1553 cards into your ANSI C source code applications. A common SDK exists across all operating systems allowing the programmer portability across different platforms. The easy-to-use high-level functions abstract all low-level hardware accesses and memory allocation, such that specific hardware knowledge is not required. Cards that contain ARINC-429 also include the ARINC-429 Multi-IO C SDK and drivers to support all modes of operation. ◼

Product News

■ **DDC: MIL-STD-1553 components choosen by Airbus**

Data Device Corporation has been selected by Airbus to supply MIL-STD-1553 components for its A350 XWB aircraft. Considered a standard, MIL-STD-1553 has caught the attention of commercial aircraft manufacturers, such as Airbus, who seek to capitalize upon 1553's inherent reliability, robustness, maturity, and superior EMI performance.

■ DDC: 2 channel MIL-STD-1553 ExpressCard for portable applications

Data Device Corporation introduces its MIL-STD-1553 BU-67101Q AceXtreme ExpressCard designed around DDC's AceXtreme 1553 Core, featuring advanced 1553 functionality. The BU-67101Q ExpressCard offers up to two dual redundant MIL-STD-1553 channels, two user-programmable digital discrete I/O, and two user-programmable Avionics Discrete I/O.