Next-generation commercial aviation data bus interfaces

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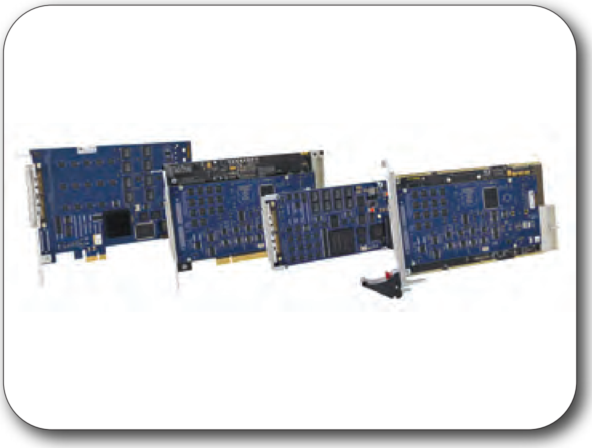
Commercial aircraft generally have multiple interfaces onboard such as ARINC-429, MIL-STD-1553, synchro/resolvers, discrete signals, AFDX, and other data busses, yet ARINC-429 often serves as the main command and control bus. This article reviews these various standards and their use in combination, including the sharing of data from one bus over to another.



■ 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 bus of the air transport industry for the transfer of digital data between avionics systems on commercial aircraft. The physical connection wires are twisted pairs carrying balanced differential signals. 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 used in all commercial aircraft and has traditionally been the lower cost commercial alternative for MIL-STD-1553. There are a variety of suppliers for ARINC-429 boards and components and it is still, and will continue to be, widely used in many commercial aircraft electronic communication systems.

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. 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. 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. The inherent reliability, robustness, maturity, and superior EMI performance of MIL-STD-1553, combined with recent competitive price reductions, has allowed it to be used on commercial aircraft. As an example, recently Airbus selected Data Device Corporation MIL-STD-1553 components for use in critical primary flight control systems on the A350 XWB commercial aircraft. Data Device Corporation (DDC), designs and manufactures a wide range of MIL-STD-1553 and ARINC-429 components, test boards, rugged embedded boards, rugged small form factor boards, and software.

ARINC-717 is another bus standard and it is used for all commercial aircraft and helicopter flight data recorders, quick access recorders, and black boxes. Commercial aircraft generally utilize multiple interfaces, such as synchro/resolvers, discrete signals, ARINC-429, MIL-STD-1553, AFDX, and other data busses. A main computer, called the DFDAU (digital flight data acquisition unit), sits in the front of the aircraft and collects all the various I/O inputs and outputs via one ARINC-717data bus that interfaces to the back of the aircraft. This saves the weight of having to bring multiple interfaces to the recorders and also lowers the recorder size and weight. In addition, all commercial aircraft can now understand recordings acquired on other platforms. For example, Boeing aircraft can understand Airbus recordings. There are a few different types of data recorders used depending upon application and data requirements. A QAR (quick access recorder) is used by lab technicians to download flight data and simulate it in the lab, while the FDR (flight data recorder) is only accessed in catastrophic failures. There are times when flight entertainment systems need to access some data on the avionics bus, and need to either input ARINC-717, if located near the recorders, or ARINC-429, if in the front of the aircraft.

As technology progresses, the need for higher computational systems and higher speeds have become necessary for some of the critical airborne systems. Also as time goes on, new capabilities are introduced that could save time and increase efficiency onboard many aircraft if these capabilities were effectively added. Additionally, new capabilities are constantly being added to platforms with the intent of decreasing the time it takes to perform a function, or increasing functionality and capability of an aircraft while at the same time decreasing the weight of the electronics onboard the aircraft. Yet when new systems are proposed there is always a tradeoff between the added weight of the system and a potential drop in weight-carrying capability. New flight entertainment systems are a great example of added capability onboard many commercial airliners. In many cases new busses like AFDX or Gigabit Ethernet have been added to commercial systems but ARINC-429 still is used for command and control in applications where lower bandwidth is acceptable.

As more upgrades occur the number of ARINC-429 channels may actually increase and different busses may be added to the aircraft. This creates a need for higher channel count ARINC-429 cards for use in systems integration labs and simulators. Many systems integration labs and simulation systems deal with hundreds of ARINC-429 channels at a time within a system and they also deal with many real-time challenges. Onboard the aircraft there are typically 4 or 5 receivers connected to each transmitter, so to drive communications in a simulator you need the inverse setup. DDC recently introduced a complete series of ARINC-429 cards that offer up to 36 channels of ARINC-429, 2 channels of ARINC-717, and 16 avionics level discrete I/O. Each ARINC channel can be programmed to either be a receiver or a transmitter, to offer ultimate flexibility in simulators and systems integration labs where the channel mix can vary between transmitters and receivers.

Systems integration labs also commonly add real avionics units in the loop at various points of integration and might simulate the box at other points. With the DDC card you can keep your existing cabling and change a transmitter to a receiver or vice versa when using real hardware, or simulating the hardware with the card. The boards also meet the stringent real-time demands of simulation systems by utilizing onboard hardware scheduling and a DMA offload engine to ensure real-time performance and data sample consistency. The DMA engine allows for burst data transfers between the card and the host computer to reduce processor utilization on the host computer. The series is available in PCI, cPCI/PXI, PMC, and PCIe form factors for compatibility in all types of systems. The PCIe card is an x1 lane PCIe interface such that it can plug into all PCIe slot types from x1 lane to x16 lane interfaces. The cards offer the most advanced test features with parametric test functionality/error injection, variable output voltage, and onboard voltage monitoring. Now there is no longer a need to carry a heavy oscilloscope to your lab if you are debugging an ARINC-429 bus issue. As different busses are added to airborne platforms, an increasing demand has surfaced to share data from one bus over to another bus interface. For example, Ethernet sensors might need to share data with a mission computer that only has ARINC-429 interfaces on it. Instead of upgrading mission computers, a network bridge device can be used to port Ethernet to ARINC-429 or vice versa. DDC is presently in the process of introducing the AceXtreme bridge device (ABD) that contains 6 programmable Tx/Rx ARINC-429 Channels, 2 Gigabit Ethernet Channels, and 2 MIL-STD-1553 channels. The device can be configured to port any protocol to any other supported protocol so that the device will automatically run when powered up. This will allow platform upgrades that add new capabilities to take place while leaving existing command and control avionics networks intact without requiring any changes. With this modular approach aircraft data can be shared with any system onboard.

While ARINC-429 remains an option as a data bus for critical applications in commercial avionics, designers can now take advantage of performance, safety advantages, and lower weight offered by supplementary data buses, such as MIL-STD-1553. Data Device Corporation remains committed to providing total support for all commercial and military data bus applications and requirements, now and in the future. ■