MIL-STD-1553

AIRCRAFT INTERNAL TIME DIVISION COMMAND / RESPONSE MULTIPLEX DATA BUS

OVERVIEW

by

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What is MIL-STD-1553?

MIL-STD-1553 is a military standard that specifies the requirements for a digital command/response time division multiplex data bus for integration of aircraft subsystems. Simply stated, digital command / response time division multiplexing is the transmission of information between subsystems over a pair of wires with different subsystems transmitting at different points in time in response to commands.

The 1553 Standard contains several sections and describes the method of communication, the data bus requirements and the electrical interface requirements for subsystems connected to the data bus. Although there are some very specific requirements, there are also many vague requirements and many options to give the designers flexibility in their applications. MIL-STD-1553 IS A STANDARD, NOT A SPECIFICATION. Invoking MIL-STD-1553 by a simple reference is not sufficient or adequate. There needs to be a multiplex system specification written around MIL-STD-1553 and the specific system requirements.

Historical Development of MIL-STD-1553

After the end of World War II, it was clear that future aircraft would be carrying too many subsystems to individually wire one subsystem to another. It was necessary to reduce the size and weight of the subsystems and the wiring that connected them, to eliminate duplication of subsystems, to increase system performance and reliability and to reduce costs. A common data bus that all the subsystems could be connected to was needed to solve these problems. In 1968, the Society of Automotive Engineers (SAE) formed a sub-committee of government and industry personnel to develop a digital time division multiplex data bus. After five years, in 1973, MIL-STD-1553 was published as an Air Force standard. The Standard was revised twice; MIL-STD-1553A was published in 1975 as a tri-service standard and MIL-STD-1553B was released in 1978 as a tri-service/NATO standard. Since then, two notices incorporating further changes and clarifications were issued: Notice 1 in 1980 and

Notice 2 in 1986. Also in 1986, the RT Validation Test Plan was published to provide a standard set of tests for remote terminals.

1553 Applications

The 1553 data bus is the most commonly used military data bus today. It is used in systems where data integrity and system reliability are critical. It is heavily used in aircraft avionics and stores and in ships, submarines and ground vehicles such as tanks. The data bus is also being used in space in numerous satellites and the Space Station and in some commercial applications such as reactors, subway cars and oil drilling.

Functional Elements of 1553

The functional elements of 1553 consist of the data bus and terminals. The Standard defines the data bus to be a single path between the bus controller and all remote terminals. This includes the twisted, shielded pair cable, terminators and couplers. Most systems today use two buses operating standby redundant bus, meaning that one bus operates as the data path and the other serves as the back-up.

There are three types of terminals in 1553: the bus controller, remote terminal and bus monitor. The bus controller is the master device and there is only one terminal operating as bus controller at any one point in time. The bus controller initiates all information transfers on the data bus. The standard requires information transfers between terminals to follow a command/response format. The bus controller sends commands to the remote terminals to tell them what to do. The bus controller can be a separate subsystem or just a portion of a subsystem.

The remote terminal is the device that connects the data bus to the sub-system and transfers data in and out of the subsystem in response to the bus controller. The remote terminal can be a separate subsystem or just a portion of the subsystem. The Standard allows for up to 31 remote terminals in the system.

The bus monitor is optional and is a passive device that examines all data that is on the bus. It can record all data or selected data for off-line applications such as flight-test recording, maintenance or mission analysis. The data could also be used as an information source for a back-up bus controller.

1553 Communication

1553 communication uses three word types: command, status and data. All words are 20 bits long. Three bits are used for the word sync, 16 bits are used for information and 1 bit for parity. The word sync differentiates data words from command and status words. Command words are only transmitted by the bus controller. They direct a remote terminal to transmit data, receive data or perform a specified operation. The status word is only transmitted by a remote terminal and provides general information on the state of the remote terminal. Data words may be transmitted by either the bus controller or remote terminals.

Information is transferred in packets or messages with a maximum of 32 data words per message. Messages are defined for bus controller to remote terminal transfers, remote terminal to bus controller transfers, and remote terminal to remote terminal transfers. In addition, mode messages are defined for managing the bus system and error recovery.

Data Integrity and System Reliability

MIL-STD-1553 provides a high degree of data integrity by specifying word and message validation requirements. These include checks for parity, proper Manchester encoding, bit count, word count and proper timing. The Standard also specifies a tolerance to input signal zero crossings, requirements for noise rejection and wide margins between the transmitted signal and the received signal.

To improve system reliability, most systems today use two buses operating standby redundant (dual standby redundant).

Testing 1553

When working with MIL-STD-1553 there are a number of phases of testing that should be considered: development testing, validation testing, system integration/simulation. Once the system has been deployed, periodic maintenance is required to spot check performance and test for operational failures or battle damage. Since the Standard emphases word and message validation it is necessary to test with injected errors in all phases of testing to verify the operation of the validation and error detection circuits. The use of special test equipment designed for 1553 testing should provide this capability and save time and money.

Help is Available

TEST SYSTEMS, Inc., has been supporting MIL-STD-1553 since 1979 by providing test equipment, training and validation testing service. The 1553 BUS TESTER series has full error injection/detection capability for all phases of testing. The 1553 NOISE GENERATOR provides band-limited, additive white Gaussian noise for noise rejection testing of terminals designed to MIL-STD-1553. The 1553 PC based cards for PCI, ISA, PC104 and PCMCIA, provide a 1553 interface to PC compatible computers that can be operated as a Bus Controller, Remote Terminal or Bus Monitor.

TEST SYSTEMS provides extensive training in 1553 through a comprehensive seminar. This seminar provides a thorough discussion of MIL-STD-1553 theory, application and testing. Lab sessions are combined with lecture to enhance the learning and provide a better understanding of the material presented. This seminar is offered twice a year in Phoenix and is available to be taught at a customers facility.

Our independent validation testing service provides remote terminal testing to the RT Validation Test Plan. A comprehensive test report documents the test results. Assistance in analyzing and solving problems is provided if there are failures. Testing is available in Phoenix or at a customers facility.