This paper introduces the MIL-STD-1553 bus, focusing on its physical layer, as well as word definitions and message types.

The following topics are discussed:

3.1 Overview

Introduced in the mid 1970s, MIL-STD-1553 Aircraft Internal Time Division Command/Response Multiplex Data Bus is a military standard (currently in revision B) that became one of the key components used today for the integration of avionics systems.

The following figure illustrates the key elements of MIL-STD-1553. The bus consists of a Bus Controller (BC), which commands up to 31 Remote Terminals (RT address 0 to 30) to transmit or receive. Data transfer is via a 1 Mbps, transformer coupled, command response bus. The bus is dual redundant in the sense that only one bus is used at a time. The other bus is used if a remote terminal fails to respond.
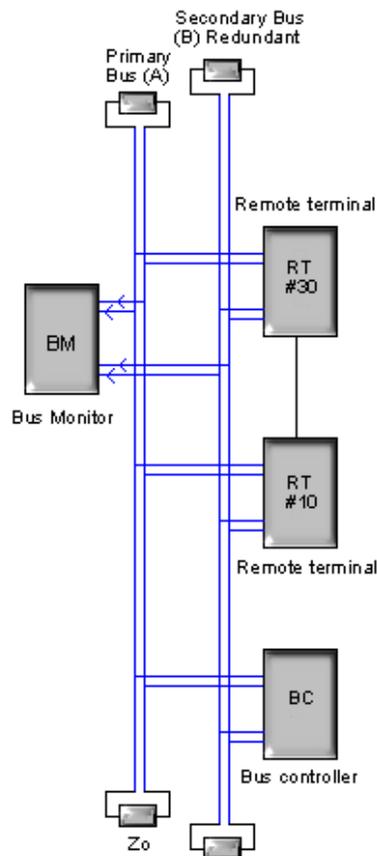

Figure 3-1: Overview of MIL-STD-1553 bus

Any number of bus monitors (BMs) such as the KAD/MSB/001 can be connected to the bus. BMs cannot transmit on the bus. Data is sent in 20-bit words organized into various types of messages as discussed in "3.2 The physical layer" on page 2.

3.2 The physical layer

The MIL-STD-1553 bus is twisted shielded pair, transformer coupled (see the following figure) for one half of the dual redundant busses.
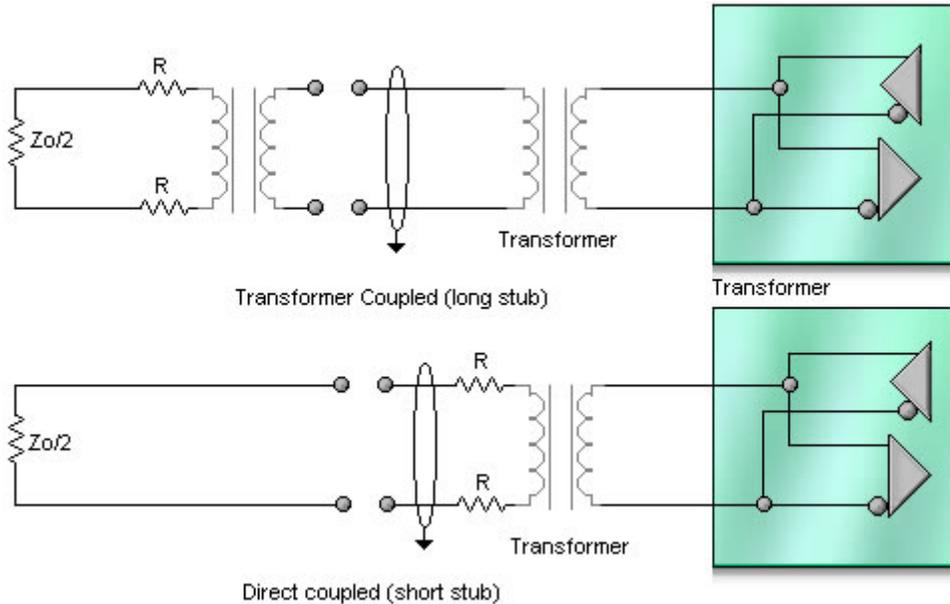

Figure 3-2: Transformer Coupled and Direct Coupled stubs

The high/low voltage levels are typically greater than ±10V line-to-line on the bus. Data is transferred at 1 Mbps in 20-bit words; the code used is BI∅L (with illegal synchronization bits as described in "3.3 Word definition" on page 2).

3.3 Word definition

There are three types of word available on a MIL-STD-1553 (see the following figure).
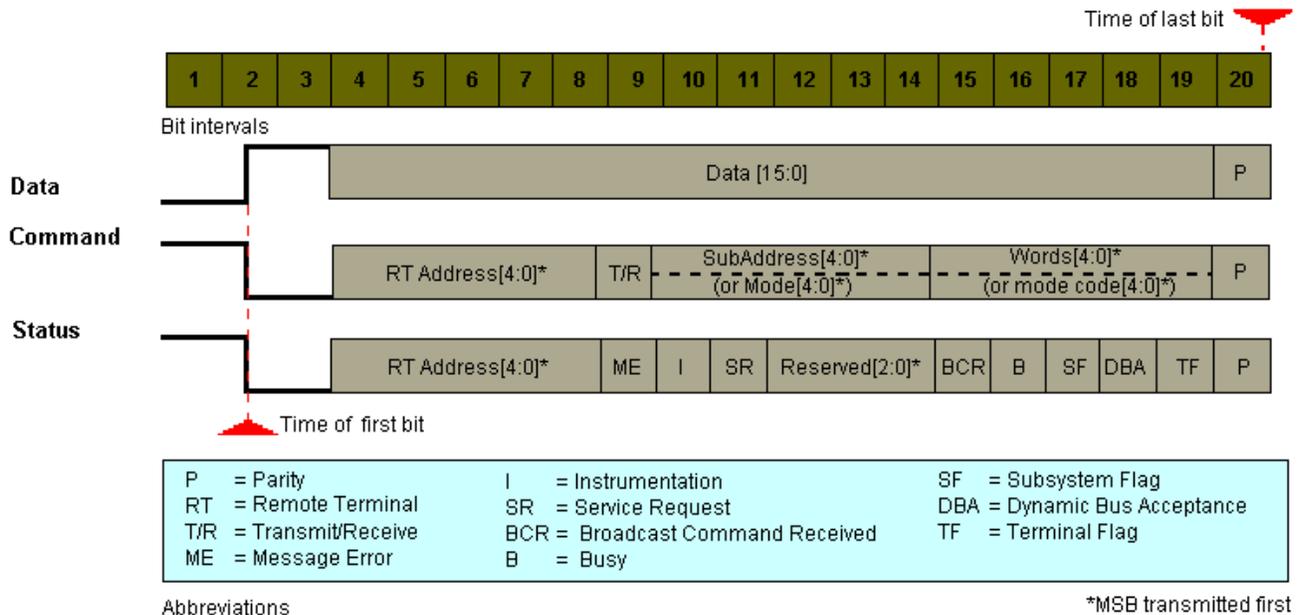

Figure 3-3: Word definitions of MIL-STD-1553

A word is always 20 µs long. The last bit transmitted is a parity bit (odd). The first bit transmitted is a synchronization bit that is illegal (in the sense that the bit interval is 3 µs as opposed to 1 µs for other bits).

The synchronization bit differentiates a data word from a non-data word (command or status). Occasionally (but not always), the instrumentation bit in the status word is used to differentiate a status word (I = 0) from a command word (I = 1). However, this reduces the number of available RT addresses by 50%. While command/status words are usually determined from the context in which they are received, some other rules that can be used are:

- Two consecutive non-data words must be commands (see RT-to-RT(s) in Figure 3-4 on page 4).
- If the reserved bits are zero (often the case), any set to 1 indicates a command word.
- An RT address of 31 decimal (1F hex, 11111 binary) always indicates a broadcast command.
- The first non-data word after the predefined time-out period can be assumed to be a command.

The time at which a word appears is determined by the mid-point of the sync-bit. The response time of a remote terminal is the time from the midpoint of the last bit of the last word received to the midpoint of the synchronization bit of the status word. Physically, this cannot be less than 2 µs and is usually specified as between a minimum and a maximum response time.

Words[4:0] represents the number of data words (for non-mode commands), 1 to 31 decimal with 0 meaning 32 decimal.
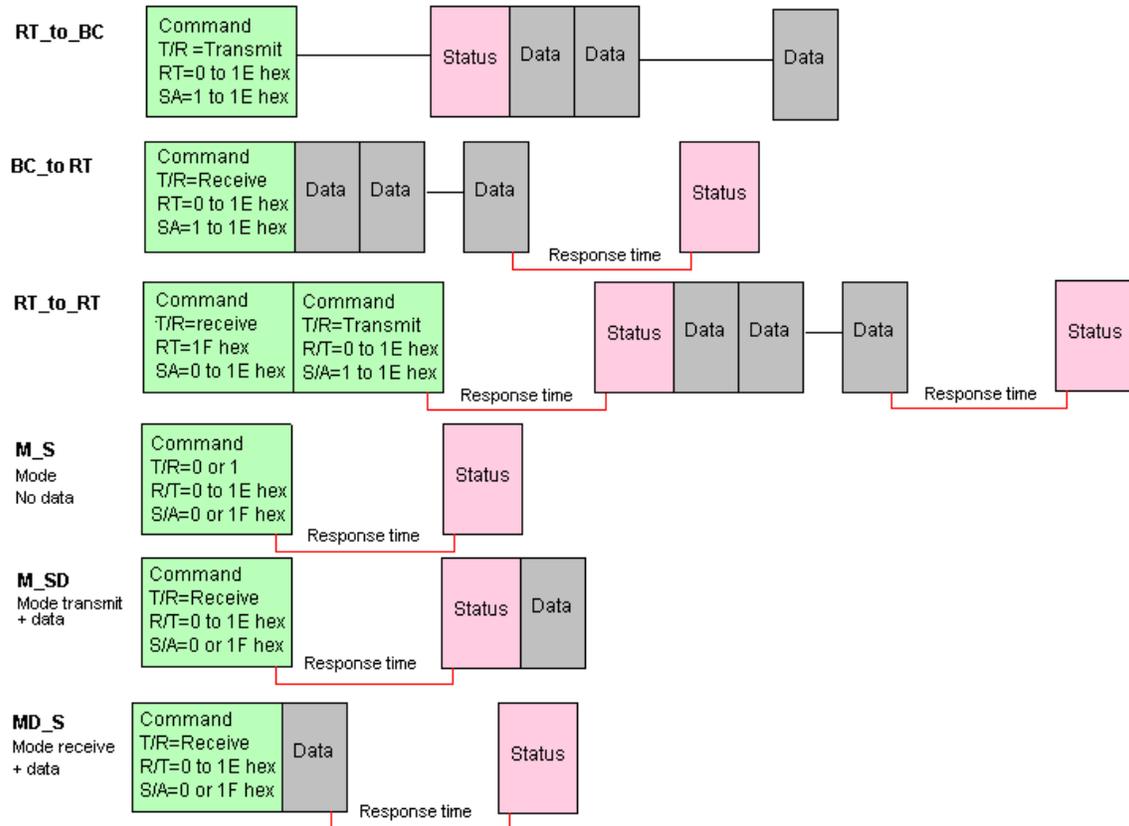
3.4 Message types

All data transfer is in messages that are always initiated by a command from the bus controller (BC). See the following figure.

When commanding a particular remote terminal (RT) to transmit or receive, the RT[4:0] bits of the command words are used to identify the RT in question. When broadcasting, the BC can command all busses to receive by setting the RT address to 31 decimal (1F hex, 11111 binary).

Only one device can transmit at a time. When a remote terminal transmits, the data is always preceded by a status word. If only one RT receives data (the data is not broadcast), the RT sends a single status word to acknowledge the transfer.

The SubAddress[4:0] specified in a command identifies what to transmit or receive.

Mode commands are short messages with either no data or just one data word. A mode command is identified by a SubAddress[4:0] = 00000 bin or 11111 bin. Many mode codes are defined as part of the standard being used (A or B) and others can be defined for a particular application. All RTs must accept all the mode codes defined for a particular application.

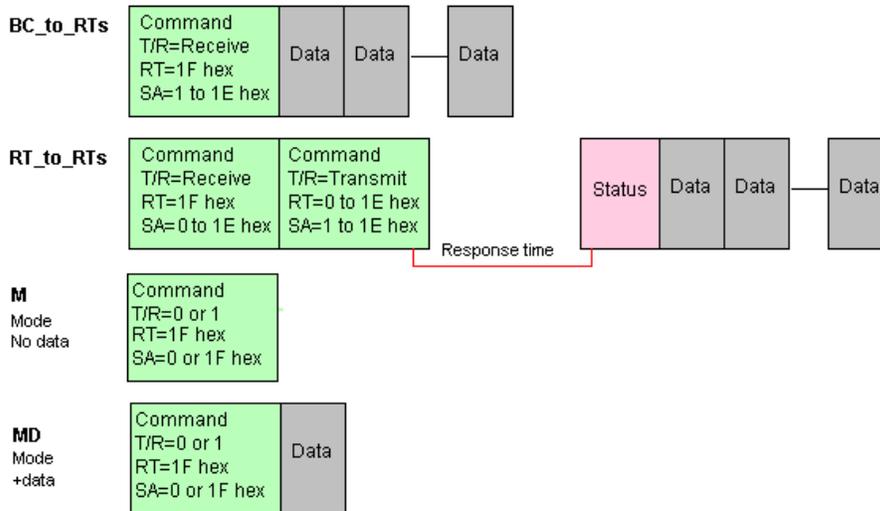*Figure 3-4: The 10 MIL-STD-1553 message types*

RT_to_BC	Remote terminal to bus controller
BC_to_RT(s)	Bus controller to remote terminal(s)
RT_to_RT(s)	Remote terminal to remote terminal(s)
M_S	Mode command to remote terminal
M_SD	Mode command (transmit) to remote terminal with single data word

MD_S	Mode command (transmit) to remote terminal with single data word
M	Broadcast mode without data word
MD	Broadcast mode with data word

3.5   Dynamic change of bus control

There can be only one BC at a time. However the BC may relinquish control to a capable RT, which then becomes the new BC, hence the Dynamic Bus Acceptance (DBA) bit in the status word.

This has implications for bus monitoring. Messages must be defined not only by the receiving RT but also by the transmitting RT in case either becomes BC.

3.6   Conclusion

In this paper, some of the nomenclature associated with MIL-STD-1553 was introduced. The different types of words and messages were also illustrated.

3.7   References

MIL-STD-1553 Designer's Guide

ILC Data Device Corporation®

105 Wilbur Place

Bohemia

New York 11715-2482

Military standards:

MIL-STD-1553 A

MIL-STD-1553 B

MIL-STD-1553 Multiplex Applications Handbook

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