An Overview Of

MIL-STD-1553

OVERVIEW

History and Background

During the mid-1960's, there was a growing complexity in integrated avionics systems. This additional complexity usually resulted in a growing number of discrete interconnects between various components on an aircraft, providing both additional size and weight. To deal with this increasing complexity, in 1968 the Aerospace Branch of the Society of Automotive Engineers (SAE) developed the first draft of a multiplexed data bus standard. The U.S. Department of Defense adopted the draft as MIL-STD-1553, to be used and applied by the military services and their contractors. The military standard established engineering and technical requirements for processes, procedures, practices and methods that have been adopted as standard. It was amended in 1978 to MIL-STD-1553B. This document will address MIL-STD-1553B.

MIL-STD-1553B sets the guidelines for time-division multiplexing. This is the transmission of data between several avionics units over a "single twisted shielded pair" cable. Communications between different units can take place at different moments in time, and all communications between units share the same bus. The standard is now used on new military airplane and helicopter systems, space systems, and even land-based vehicles.

There are two major advantages in standardizing a digital time-division multiplex data bus:

- Significant savings in size and weight of avionics units and the interconnecting wiring between them
- Cost savings, since a unit can be used on different aircraft with little or no modification

Structure

MIL-STD-1553 defines three types of terminals (see Figure 1):

- Bus Controller (BC)
- Remote Terminal (RT)
- Bus Monitor (BM)

The Bus Controller transmits and receives data, as well as coordinating the flow of information on the data bus. All information is communicated in command/response mode, and states that the "sole control of information transmission on the bus shall reside with the bus controller, which shall initiate all transmission."

The Remote Terminal gathers information, for example, from aircraft sensors. It formats this data for transfer on the data bus. The Remote Terminal can also receive information from the data bus, and convert this data to a format suitable for use by the aircraft. The Remote Terminal may contain little or no intelligence, such as a simple interface unit, or may be a full avionics computer. The standard allows for up to 32 remote terminals to be connected to the data bus.

The Bus Monitor listens to the information flowing on the bus and records all or selected pieces of data. The Bus Monitor may record data for later analysis, as in a flight test program. It is strictly passive and is used only as a test device.

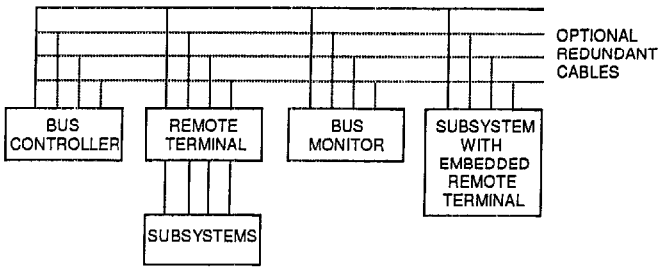

Figure 1 – Sample Bus Architecture

A review of the major aspects of MIL-STD-1553:

- Up to 32 Remote Terminals can be connected to the data bus
- Information must be transferred in a command/response mode
- No Remote Terminal shall speak unless spoken to first by the Bus Controller and specifically commanded to transmit

Data To Be Transferred

MIL-STD-1553 also defines the information that will flow on the data bus. This information can consist of the following three words:

- Command word
- Status word
- Data word

The command word is transmitted only by the Bus Controller. This word directs a Remote Terminal to either transmit or receive information across the data bus.

The status word is transmitted only by a Remote Terminal. This word indicates the general status of the Remote Terminal. It indicates whether any error conditions were detected in the information received by the Remote Terminal or other general RT status conditions.

The data word is transmitted by the Bus Controller or a Remote Terminal. This word contains the actual information that will be transferred from one avionics unit to another, across the bus.

Bus Controller

The Bus Controller is an avionics computer that controls the flow of information on the data bus. It does so by transmitting commands to Remote Terminals at predetermined points in time. The command may be followed by data words, or it may request data from a Remote Terminal.

The BC must be able to respond to changes in the aircraft environment. These changes may be the result of deliberate action on the part of the pilot crew, such as changing the aircraft mode from air-to-ground attack mode to air-to-air combat mode. Changes in the aircraft may also be the result of some unexpected event such as an avionics unit failing, or battle damage. Regardless of the cause, the BC must be able to respond to the change.

In the case of some unplanned event, such as a Remote Terminal failure, the BC has the capability of detecting the occurrence of an error on the data bus. The Bus Controller will then take action to recover from the error condition.

For a planned change, such as a mode change in the aircraft, a BC will typically modify the flow of information on the bus in a predetermined way. The Bus Controller changes the sequence and frequency of messages between RTs.

During error detection, the Bus Controller will typically retransmit a command to the suspected Remote Terminal. If multiple attempts of transmitting to a Remote Terminal result in errors, the Bus Controller will try to establish communications with the failing RT on the redundant, backup data bus.

Remote Terminal

A Remote Terminal is an avionics unit designed to transfer data between an aircraft subsystem and the MIL-STD-1553 data bus. It may be embedded within the subsystem it is interfacing, or it may stand alone, external to the interfaced subsystem.

A MIL-STD-1553 Remote Terminal does more than simply reformat and transfer data between the aircraft subsystem and data bus. It receives and decodes commands from the Bus Controller, following the prescribed protocol of MIL-STD-1553. A Remote Terminal detects errors in transmissions from the Bus Controller and responds to these errors according to the specification. The RT must be able to properly handle both protocol and electrical errors.

A protocol error is an error where the incoming command word and data words are electrically correct, but the message deviates from the protocol established by MIL-STD-1553. For example, a protocol error occurs when commands are followed by an incorrect number of data words. An electrical error is where the command and/or data words received from the BC contain some sort of waveform error, such as rise or fall time violations or excessive ringing.

Bus Monitor

A Bus Monitor is a unit used for data bus testing. It can be attached to an aircraft's data bus during flight-testing. In this manner, it is used to examine, in real time, the flow of information on the data bus. The Bus Monitor can also store all or select messages for later post capture analysis.

As a laboratory bus tester, the Bus Monitor examines all the traffic flowing on a MIL-STD-1553 bus. It detects and tabulates electrical and protocol errors. The Bus Monitor can generally be used to display snap-shots of bus traffic.

Data Bus

The fourth integral part of MIL-STD-1553 is the data bus. The technical definition of a data bus is "a twisted shielded pair transmission line made up of a main bus and a number of attached stubs." In short, a data bus is a cable whose electrical characteristics are defined by MIL-STD-1553.

There are two different ways of connecting a terminal to the data bus:

- Direct coupled
- Transformer coupled

Pictorial representations of these bus topologies are shown in Figures 2A and 2B.

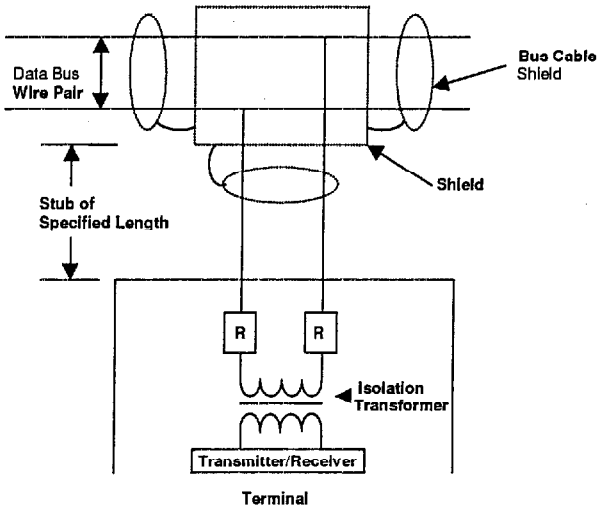

Figure 2A – Direct Coupled Bus

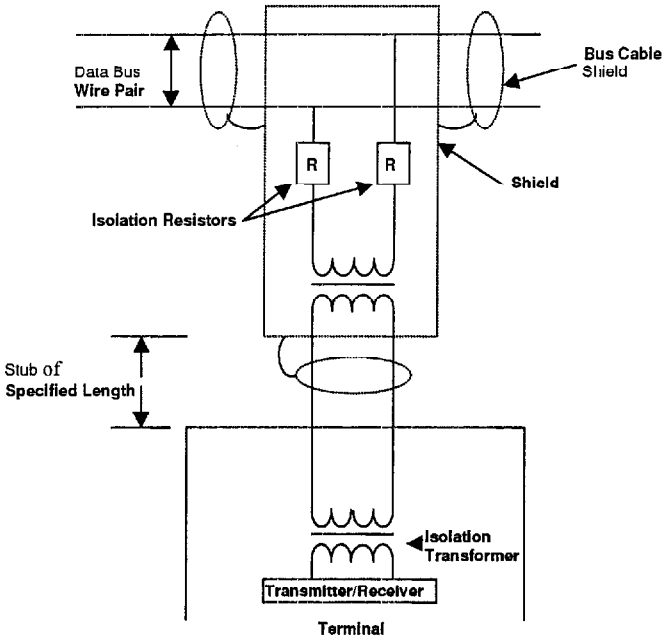

Figure 2B – Transformer Coupled Bus

These connections are referred to as stubs. Two differences separate the types of coupling. Direct coupling can only be used with stubs less than one foot long. With direct coupling, the transformer and isolation resistors are internal. Transformer coupling is used with stub lengths less than 20 feet. A second transformer is added in transformer coupling, and the transformers and isolation resistors are external to the Remote Terminal, in their own box.

Word Types

Three distinct types of words are defined by MIL-STD-1553:

- Command words
- Status words
- Data words

Bits are encoded in each of the words using Manchester II bi-phase encoding. In a Manchester format, bit values of one are positive for a ½-bit period, followed by a negative level for a ½-bit period. Zero values are the opposite – a negative level is followed by a positive one. The Sync pattern is a unique invalid Manchester encoding that signals the start of each word. A command sync is positive level for 1 ½-bit periods followed by a negative level for 1 ½-bit periods. A data sync is reversed. A status sync is identical to a command sync. Command and status words are differentiated by both word content and temporal context, i.e., the occurrence of such a sync in the timing of a message. Figure 3 shows the various Manchester II encoded patterns. Note that the 1553 bus is a differential bus. The waveform shows are for the positive leg of the bus. Of course, the negative leg is exactly the opposite.

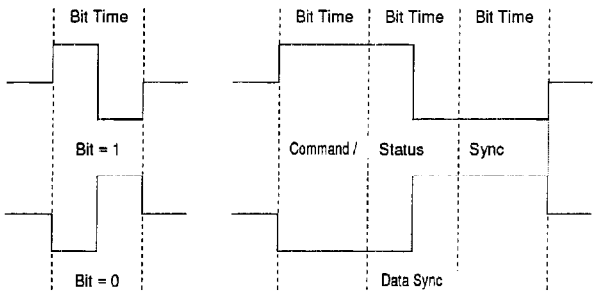

Figure 3 – Manchester Bit and Sync Encodings

Each of the three word types has a unique format. All three share a common structure. They contain a command sync or a data sync. The sync character is always transmitted first. Sixteen information bits follow. The parity bit is always transmitted last. This extra bit ensures that if a hardware failure occurs and a bit is lost in transmission, its loss can be detected. All words transmitted on a MIL-STD-1553 bus must have odd parity.

Command Word

Figure 4 shows a 1553 command word.

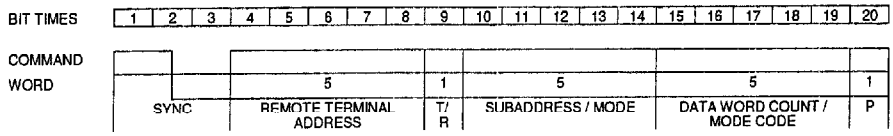

Figure 4 – 1553 Command Word

The command word consists of 16 bits divided into four distinct fields. The command word always begins with a command sync character. A five-bit Remote Terminal address field always follows the sync character. The purpose of the address field is to identify to which Remote Terminal a command is being transmitted. Each Remote Terminal in a system is assigned a unique address. The Remote Terminal examines the address field of all incoming commands. If the address field matches the address of the Remote Terminal, the RT will act on the remainder of the command. If the address field of the command does not match the address of the RT, the command is ignored. The limitation of a maximum of 32 terminals on a 1553 data bus comes from this five-bit address field. The RT address range is 0 to 31.

MIL-STD-1553B extended the RT address protocol definition to include broadcast messages; that is, commands from the BC to all RTs simultaneously. RT address 31 was defined as the broadcast RT. Individual RTs could enable or disable the processing of broadcast messages, but no RT could respond as a singular RT to the broadcast address. This limits the number of RTs in a 1553B bus system to 31, plus the broadcast address.

The next field is only one bit in length. The transmit/receive, or T/R Bit, indicates the action required of the Remote Terminal. The point of view for this bit is from the RT, that is, if the BC commands the RT to transmit data (data flow from RT to BC, T/R bit is 1) or receive data (data flow from BC to RT, T/R bits is 0).

1 = RT transmit data in response to the command

0 = RT receive data along with the command

The sub-address/mode field follows the T/R bit. A sub-address is a function or an area within the RT to which the command is being directed. The sub-address directs the RT to a specific grouping of data to be transmitted onto the bus, or it tells the RT what to do with the data it is about to receive.

MIL-STD-1553A defined one special sub-address, sub-address 0, as the mode code sub-address. MIL-STD-1553B extended this definition to also include sub-address 31. All other values of this field indicate a Remote Terminal sub-address to which the command is being directed.

MIL-STD-1553 defines a series of commands to aid in the management of the data bus and the electrical control of the RTs as opposed to typical data transfer commands. These commands are called mode control, mode code, or mode commands. Some examples of mode codes are:

- Reset RT
- Initiate self-test
- Transmit last command

NOTE: MODE COMMANDS EXCHANGE AT MOST ONE DATA WORD, AND MAY INVOLVE NO DATA WORDS AT ALL.

Almost every aircraft specification requires at least a basic subset of the mode commands to be implemented.

The final field in a command is the word count/mode code field. This five-bit field either specifies the mode code or the number of words which are to be exchanged with the Bus Controller. When the previous field, the sub-address mode field, is all zeros or all ones, the word count/mode code field uniquely identifies which mode command is being transmitted. In this way, up to 32 different mode commands can be specified. When the command is not a mode command, the word count/mode code field identifies the number of data words that are to be exchanged along with this command.

The following table summarizes the mode codes defined by MIL-STD-1553B:

T/R Bit	Mode Code	Function	Associated Data Word	Broadcast Command Allowed
1	00000	Dynamic Bus Control	No	No
1	00001	Synchronize	No	Yes
1	00010	Transmit Status	No	No
1	00011	Initiate Self Test	No	Yes
1	00100	Transmitter Shutdown	No	Yes
1	00101	Override Transmitter Shutdown	No	Yes
1	00110	Inhibit Terminal Flag Bit	No	Yes
1	00111	Override Inhibit Terminal Flag Bit	No	Yes
1	01000	Reset Remote Terminal	No	Yes
1	01001	RESERVED	No	TBD
1	to			
1	01111	RESERVED	No	TBD
1	10000	Transmit Vector Word	Yes	No
0	10001	Synchronize	Yes	Yes
1	10010	Transmit Last Command	Yes	No
1	10011	Transmit Built-In Test Word	Yes	No
0	10100	Selected Transmitter Shutdown	Yes	Yes
0	10101	Override Selected Transmitter Shutdown	Yes	Yes
1 or 0	10110	RESERVED	Yes	TBD
	to			
1 or 0	11111	RESERVED	Yes	TBD

Data words are always associated with a data transfer command to or from a sub-address.

EXAMPLE: Data Transfer Commands
00001 = one data word is to be exchanged
11111 = 31 data words
00000 = 32 words are to be exchanged

NOTE: THERE IS NO WAY TO SPECIFY ZERO DATA WORDS

SAMPLE COMMANDS

Example One

BC transmits 10110 1 00101 01001

Address field = 10110	(RT with the address 22)
T/R bit = 1	(transmit)
Sub-address/mode = 00101	(sub-address five)
Word count/mode code = 01001	(nine words)

Example Two

BC transmits 01010 1 00000 00011

Address field = 01010	(RT with the address 10)
T/R bit = 1	(transmit)
Sub-address/mode = 00000	(mode code command)
Word count/mode code = 00011	(initiate self-test – no data word associated with command)

Status Word

The status word relays state information from the RT to the BC. This information can describe the condition of the RT, whether the RT detected any errors in the command or data words it just received, etc. See Figure 5. A status word is only transmitted by a RT in response to a command from the BC. Like the command word, it always begins with a command sync and remote terminal address. The purpose of transmitting the RT address in a status response is twofold. First, it allows the BC to verify that the status response is from the correct RT and that the last command was not misinterpreted. Second, it prevents any other RT from mistaking the status response as a command, since the sync pattern for both is the same. If an RT mistakenly decodes another RTs status response as a command, it will find that the address does not match its own, and ignore the command.

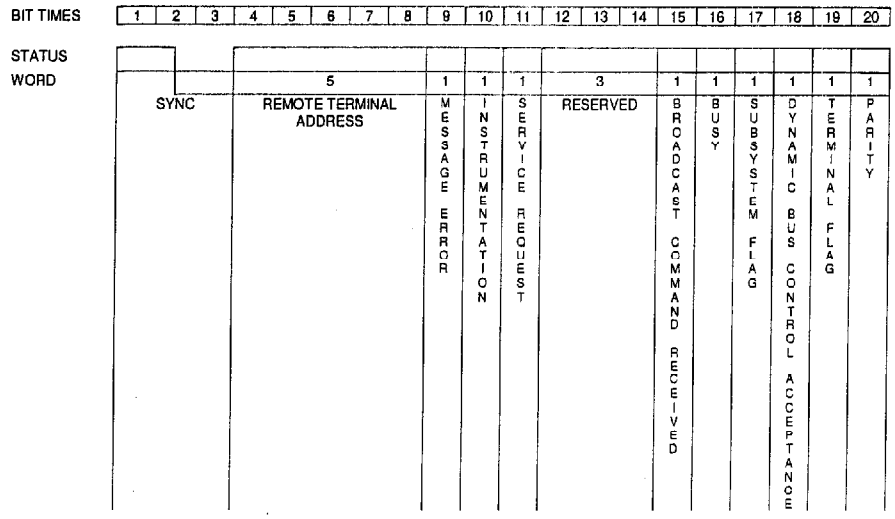

Figure 5 – RT Status Word

Following the address field are eleven bits, eight of which are defined by MIL-STD-1553B with the remaining three bits undefined but reserved for future use.

The bit immediately following the remote terminal address field is the Message Error Bit. This bit, when set to a logic one, is used by the RT to indicate that something was wrong with the command or data words it just received from the BC.

The Message Error Bit is set when any of the following conditions occur:

- A data word received from the Bus Controller contains an error
- A gap is detected between data words
- A received command is not implemented by the RT
- The wrong number of data words is received by the RT

If an error occurs in a message, the sending of the status word is suppressed. The BC must use the "transmit last status" mode command to attempt to determine the reason for no response.

The message error bit is set until it is transmitted in a status or until a new valid command other than a "transmit last status" mode command is received by this RT.

The Instrumentation Bit follows the Message Error Bit. It is an optional bit used to help differentiate command and status words. This bit should always be zero.

The Service Request Bit indicates that the RT requires service. Setting this bit can direct the BC to undertake a predefined data transfer or mode command. This bit is also optional. If it is not implemented, it must always be a logic zero. If used, this bit is reset following transmission.

The next three bits are reserved and must always be a logic zero.

The Broadcast Command Received Bit is used by a RT to indicate that it received a valid broadcast command. When a broadcast command is received, the bit is set to a logic one and remains set until it is either transmitted or until a valid non-broadcast command is received by this RT. If not implemented, it is cleared to the zero state.

The Busy Bit is an optional bit, which indicates that the RT is unable to move data to or from the subsystem in response to a command. Once set, it remains a logic one as long as the busy condition exists. If this bit is not used, it must be set to logic zero.

The Subsystem Flag Bit is an optional bit used by a RT to alert the BC that a fault exists in the subsystem and the data being transmitted may be invalid. A logic one indicates the presence of a fault condition, and a logic zeros its absence. Once set, it will remain active until the subsystem fault is resolved. If the subsystem flag bit is not used, it must be set to a logic zero.

The Dynamic Bus Control Acceptance Bit is an optional bit. If not used, it should be set to a logic zero. When set to one, indicates to the BC that the RT has accepted the dynamic bus control mode command, and will immediately take over the task of bus control as the backup Bus Controller. The bit is cleared upon transmission. If the RT rejects dynamic bus control, it sets this bit to a logic zero.

The Terminal Flag Bit is also optional, and like the others if not used, it must be set to a logic zero. When set to a logic one, the Terminal Flag Bit indicates the existence of a fault in the RT itself. It will remain set until the condition causing the fault is resolved.

Data Word

Data words contain the actual information that is to be transferred between RTs and the BC, or between two RTs. They may be transmitted by either the BC or an RT. Data words contain the most information, yet they are the least structured types of word in MIL-STD-1553. Data word format is shown in Figure 6.

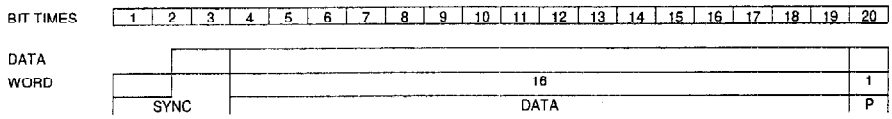

Figure 6 – Data Word

Data word requirements:

- Begin with a data sync
- Have 16 information bits
- End with a parity bit
- Be transmitted most significant bit first

No standard exists which describes the contents of a data word. The contents and format of a data word vary from unit to unit and aircraft to aircraft.

Basic Bus Protocol

Protocol is the relationship of how the three types of MIL-STD-1553 words are used to transfer data between terminals. MIL-STD-1553 protocol dictates ten different types of messages with the following stipulations:

- All messages begin with a command from the BC
- There must be a minimum gap between messages
- If an RT is to respond to a command, that response must begin with a status word
- There can be no gaps between data words

There are two types of microsecond intervals in bus protocol, the RT response time and inter-message gap time. The RT response time is the specific time window during which the remote terminal must respond. It is required to be within the range of 4-12 microseconds. The inter-message gap is always a minimum time period of four microseconds between messages. Both of these times (RT response and inter-message gap) are measured between the zero crossing of the parity bit and the zero crossing of the sync bit.

The RT will only respond with a status word if there are no errors in a message.

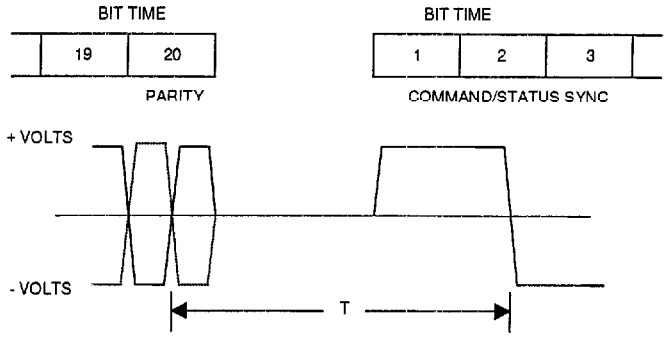

Figure 7 – Inter-message Gap and Response Time

Transfers

BC-to-RT

This is the simplest type of transfer to visualize. The BC sends data to a RT. The T/R Bit in the command is set to zero, indicating that the RT is to receive data. The receiving RT validates the incoming command and data words. If the message meets all the validity requirements outlined in MIL-STD-1553B, the RT responds with a status word, acknowledging the reception of the command and data.

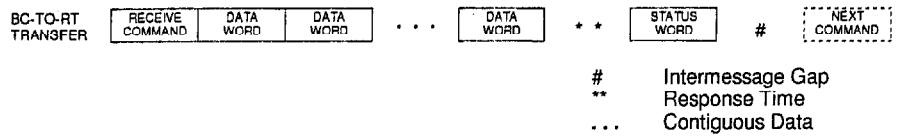

Figure 8 – BC to RT Transfer

RT-to-BC

The BC sends a command onto the data bus. In this command, the address field is set to equal the address of the RT from which the BC wishes to elicit data. The T/R Bit is set to one indicating the RT is to transmit data. The word count field indicates the number of data words that are to be transferred. After validating the command, the RT responds with its status word and the appropriate number of data words.

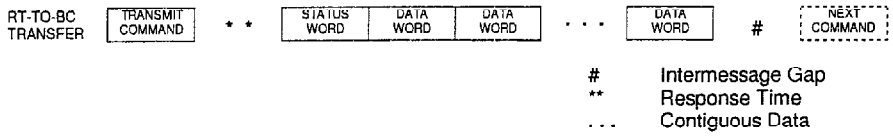

Figure 9 – RT to BC Transfer

RT-to-RT

The BC directs this transfer. It transmits two back-to-back commands; the first for the RT which is to receive the data and the second for the RT which is to transmit the data.

In the first command, the receive command, the address field contains the address of the receiving Remote Terminal, and the T/R Bit is set to a logic zero indicating that the RT is to receive data words. The word count field indicates the number of data words the RT should expect to receive.

In the second command, the transmit command, the address of the Remote Terminal which is to transmit the data words. The T/R Bit is set to one. Finally, the word count field indicates the number of data words the RT should transmit.

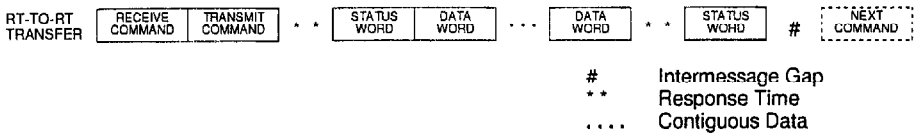

Figure 10 – RT to RT Transfer

NOTES: THE ADDRESS IN THE RECEIVE COMMAND SHOULD ALWAYS BE DIFFERENT FROM THE ADDRESS IN THE TRANSMIT COMMAND.

IN ORDER TO MAKE AN RT-TO-RT TRANSFER WORK, IT IS NECESSARY THAT THE WORD COUNT FIELDS IN BOTH THE TRANSMIT COMMAND AND THE RECEIVE COMMAND MATCH.

THE FIRST STATUS WORD IS THAT OF THE TRANSMIT RT. THE SECOND STATUS WORD IS THAT OF THE RECEIVE RT.

Commands

Mode Command without a Data Word

The BC issues a command to an RT with the T/R Bit equal to one, and the sub-address mode field equal to all zeros or all ones. The word count field now contains the mode code for the command to be implemented. Examples of mode command that do not require data would include reset and self-test commands. The Remote Terminal, after validating the command, responds with its status word.

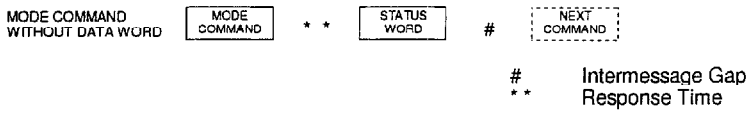

Figure 11 – Mode Command without Data Word

Mode Command With a Data Word (Transmit)

Certain types of mode commands require the RT to send back a single data word along with the status response, for example, to report a Built-in Test (BIT) word, or transmit the last received command.

For this type of command, the T/R Bit is set to a one, indicating the RT is to transmit data. The sub-address/ mode field is set to all zeros or all ones, indicating a mode command. The word count field identifies the particular command being implemented.

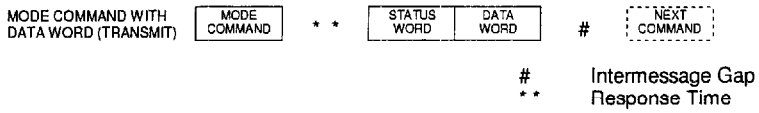

Figure 12 – Transmit Mode Command with Data Word

After receiving and validating the command, the RT responds with its status word and a single data word. The content of the word count field in a particular command determines if a mode command has an associated data word.

Mode Command With a Data Word (Receive)

For this type of command, the T/R Bit is set to a zero, indicating the RT is to receive data. Examples of this type of command would be a selected transmitter shutdown, where a data word might contain encoded information concerning which transmitter. After receiving and validating the command, the RT responds with its status word. The content of the word count field in a particular command determines if a mode command has an associated data word. Figure 13 shows a receive mode command with a data word.

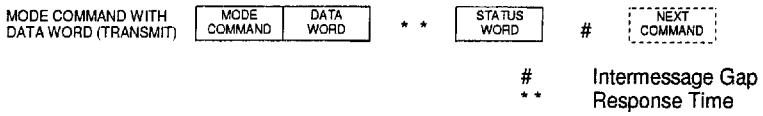

Figure 13 – Receive Mode Command with Data Word

Broadcast

As part of MIL-STD-1553, the BC can disseminate information to all RTs at the same time. The four types of broadcast command correspond with some of the transfers and mode commands previously mentioned:

- BC-to-RT transfer
- RT-to-RT transfer
- Mode Command with Data Word (Receive)
- Mode Command without Data Word

Figure 14 shows broadcast message transfer formats.

The BC always transmits broadcast commands to RT address 31 (11111). The receive RTs do not respond with status words to broadcast commands. Upon seeing a command with this address, all Remote Terminals with the broadcast option accept the command and data, if any, as if the command had been directed at them. Note that with the exception of the transmit command portion of the RT to RT transfer, where one RT is selected to broadcast data to all other RTs, a broadcast command cannot be a transmit command. Multiple RTs responding to a transmit command by sending data onto a single bus would provide corrupt data. Likewise, RTs cannot respond with a status due to this bus collision problem.

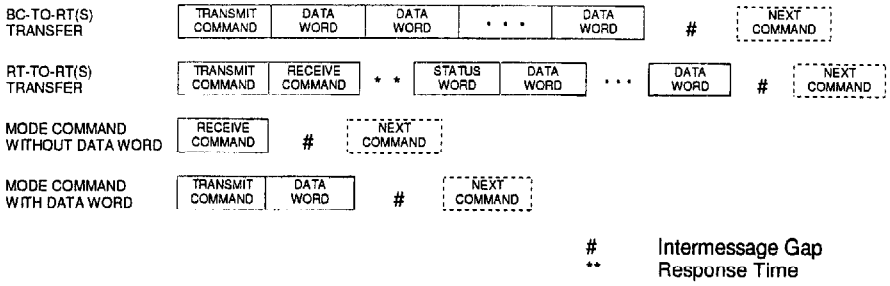

Figure 14 – Broadcast Message Transfer Formats

NOTE: FOR AN RT-TO-RT BROADCAST TRANSFER, THE RECEIVE COMMAND IS THE BROADCAST COMMAND, AND THE TRANSMIT COMMAND IS TO THE RT WHICH IS TO PROVIDE THE BROADCAST DATA. LIKEWISE, THE STATUS RESPONSE IS THAT OF THE TRANSMIT RT.

The RT sets the Broadcast Command Received Bit in the RT's Status Word. The Bus Controller determines whether a broadcast command was property received by polling each Remote Terminal, requesting its status word through a Transmit Last Status mode code command, and checking if the Broadcast Command Received Bit is set.

Message Validation

Message validation depends upon the RT to detect electrical and protocol errors in a message and to validate the command and data words received from the BC.

There are two classes of words and message with errors:

- Invalid
- Illegal

Invalid

An invalid word is a command or data word that contains any or all of the following conditions:

- An improper sync character
- A bit with an invalid Manchester II code
- The wrong parity (sixteen bits plus parity)

An invalid message is a message that is defined by one or more of the following conditions:

- An invalid word
- Discontinuous data (a condition where a gap exists between any two data words, between the command word and data words, or between the transmit status and data words)
- A word count error (a condition where the RT did not receive the proper number of data words based on the T/R bit, sub-address/mode field, and word count/mode code field)

Illegal

An illegal command is simply a command that a Remote Terminal was not designed to accept. A command to an unimplemented sub-address/mode code warrants an illegal command.

If an RT detects a command word with a validity error (bad sync, Manchester error, the wrong number of bits, etc.), protocol demands that it will ignore the whole message. In other words, no error flags are set. The RT disregards the entire message. It should not respond to a message containing this class or error. Because the error was in the command word, there is no assurance that the command was for this RT in the first place.

When an RT detects validity errors in the data portion of a message, it should set the Message Error Bit in the status word. The sending of the status word is still repressed. This Message

Error Bit could be retrieved by the BC following a no-response timeout by using the Transmit Status Word Mode Command.

The BC must validate status words and data words from an RT. If the BC detects errors, it must also disregard the information received.

Electrical Characteristics

MIL-STD-1553 defines the waveform output of a terminal and the input with which a terminal is required to work. The full realm of MIL-STD-1553 electrical verification is beyond the scope of this introductory document.

A Glossary of MIL-STD-1553 Terms

Broadcast Command Receive Bit: This bit is used by a Remote Terminal to indicate that it received a valid broadcast command.

Bus Controller: A device that coordinates the flow of information on the data bus.

Bus Monitor: A passive unit used for data bus testing. It listens to all information flowing on the bus and records all or selected pieces of data.

Busy Bit: This bit indicates that the Remote Terminal is unable to move data to or from the subsystem in response to a command.

Command Sync: A structure common to MIL-STD-1553 words, it consists of a positive level for 1 ½-bit periods followed by a negative level for 1 ½-bit periods.

Data Bus: A cable for transferring data and electrical signals between the central processing unit, storage, and all the input/output devices of a computer system.

Data Sync: A structure common to MIL-STD-1553 words, it consists of a negative level for 1 ½-bit periods followed by a positive level for 1 ½-bit periods.

Data Word: A word transmitted by the Bus Controller or Remote Terminal(s). This word contains information to be transferred from the Bus Controller to the Remote Terminals and Information to be transferred between Remote Terminal(s) and the Bus Controller, or between two Remote Terminals.

Dynamic Bus Control Acceptance Bit: An optional status word bit. If it is set to one, this bit indicates to the Bus Controller that the Remote Terminal has accepted the dynamic bus control mode command. The Remote Terminal will immediately begin bus control as the backup Bus Controller.

Electric Error: An error where the command and/or data words received from the Bus Controller contain some sort of waveform error.

Illegal Command: A command a Remote Terminal was not designed to accept.

Instrumentation Bit: An optional status word bit, always set to zero.

Inter-message Gap: A minimum four-microsecond gap that must always exist between messages.

Invalid Command: A word which does not begin with a valid sync field, an Invalid Manchester II code, or an even parity.

Message Error Bit: A bit in the status word, used by the Remote Terminal to indicate that something was wrong with the message it just received from the Bus Controller.

Mode Control Commands (Mode Code Commands or Mode Commands): A series of commands defined by MIL-STD-1553 to aid in the management of the data bus and the electrical control of the RTs.

Odd Parity: The sum of the preceding 16 bits plus the Parity Bit must be odd.

Parity Bit: An extra bit that is always odd, according to the logic of the system.

Polling: A communications control method whereby a computer asks many devices whether they have information to send.

Protocol: The relationship of how the three types of MIL-STD-1553 words are used to transfer data between terminals.

Protocol Error: An error where the incoming command and data are electrically correct but the message is illegal by the protocol established with MIL-STD-1553.

Remote Terminal: An avionics unit designed to transfer data between an aircraft subsystem and the MIL-STD-1553 data bus.

Remote Terminal Response Time: The 4 to 12 microseconds during which the Remote Terminal must respond.

Service Request Bit: A bit provided to indicate to the active Bus Controller that the Remote Terminal is requesting service.

Standard Interface: A unit developed for one aircraft, which can be used on another aircraft with little or no modification.

Status Word: A word transmitted only by a Remote Terminal to the Bus Controller. This word gives information as to the general status of the Remote Terminal itself. The status word indicates whether any error conditions were detected in the command or data words just received by the Remote Terminal.

Sub-address: A function or an area within the RT to which a command is being directed.

Subsystem Flag Bit: An optional status word bit used by an Remote Terminal to alert the Bus Controller that a fault is in the subsystem. It also tells the Bus Controller that the data being transmitted may be invalid.

Sync Character: Part of the MIL-STD-1553 word structure. This command or data character is always transmitted first.

Terminal Flag Bit: A bit which indicates the existence of a fault in the Remote Terminal.

Time-Division Multiplexing: The transmission of information between several avionics units on an aircraft over a single cable, with communications between different units taking place at different moments in time.

Transmit/Receive (T/R) Bit: A bit which indicates if the RT is to transmit or receive data.

Word Count/Mode Code Field: A field in the command word that either specifies the mode code or the number of words, which are to be exchanged with the Bus Controller.