SAE Aerospace
An SAE International Group

AEROSPACE INFORMATION REPORT

AIR4295

Issued 1992-10
Reaffirmed 2011-11

Handbook for the Digital Time Division Command/Response Multiplex Data Bus Test Plans

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

Table of Contents

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APPENDIX

List of Figures

Figure

1. SCOPE:

This document contains guidance for using SAE publications, AS4112 through AS4117 (MIL-STD-1553 related Test Plans). Included herein are the referenced test plan paragraphs numbers and titles, the purpose of the test, the associated MIL-STD-1553 paragraph, commentary concerning test methods and rationale, and instrumentation requirements.

CHAPTER 1

INTRODUCTION:

The primary purpose of the MIL-STD-1553 Test Plans Handbook is to provide users of the following Society of Automotive Engineers (SAE) documents rationale for tests and procedures defined therein:

Chapter 2 - AS4112 - Production Test Plan For the Aircraft Time Division Command/Response Multiplex Data Bus Remote Terminals,

Chapter 3 - AS4113 - Validation Test Plan For The Aircraft Internal Time Division Command/Response Multiplex Data Bus Bus Controllers,

AS4114 - Production Test Plan For The Aircraft Internal Time Division Command/Response Multiplex Data Bus Bus Controllers,

Chapter 4 - AS4115 - Test Plan For The Digital Internal Time Division Command/Response Multiplex Data Bus System,

Chapter 5 - AS4116 - Test Plan For The Digital Time Division Command/Response Multiplex Data Bus Monitors, and

Chapter 6 - AS4117 - Test Plan For The Time Division Response Multiplex Data Bus Couplers.

The rationale appears in Chapters 2-6. Also contained in these chapters are, where appropriate, suggested implementation schemes. This is provided in an effort to standardize testing of MIL-STD-1553 devices.

The documents listed above were developed by the SAE AS-1A Test Plans Task Group (TPTG). The TPTG was formed in 1982 and was chartered to developed and publish test plans for MIL-STD-1553 equipment and systems. The Task Group membership was a diverse representation from the 1553 community, including members from industry and the military, both foreign and domestic. All areas of 1553 hardware development and manufacture were represented along with the system integrators. This assured that a wide diversity of viewpoints were considered, resulting in the accepted test plans. This handbook is a reference document that provides the rationale for the tests and supports the application of MIL-STD-1553 and the Test Plans.

The goals of the TPTG were realized with the publication of the six Test Plan documents. Those documents, and this document, are published by the SAE and are available from the SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

Rationale for the test paragraphs is listed and referenced to the applicable test documents in Chapters 2-6. These chapters are organized such that the **TEST PLAN PARAGRAPH** number is indicated first. Below this line is **PURPOSE**, which provides the general intent of the test and, in some cases is a reiteration of the purpose stated in the test plan. Following this is the **1553** paragraph which references the standard paragraph being tested and, when required, is **COMMENTARY** pertaining to the test plan paragraph. Appearing last is instrumentation, included to discuss the **INSTRUMENTATION** requirements for a given test.

CHAPTER 2

AS4112 PRODUCTION TEST PLAN FOR THE AIRCRAFT INTERNAL TIME DIVISION COMMAND/ RESPONSE MULTIPLEX DATA BUS REMOTE TERMINAL.

INTRODUCTION:

Production testing of Remote Terminals (RTs) differs from validation testing in many ways. For this reason, certain consideration must be given toward designing production specific test stands or fixtures. Speed, confidence, accuracy and ease of automation were the main goals established prior to the writing of AS4112. The exhaustive characterization of validation testing is not required in production. The emphasis is on testing the RT as inexpensively and as fast as possible without compromising the verification of performance.

GENERAL INSTRUMENTATION NEEDS:

Most of the tests written in this Test Plan require that a valid command be sent to the RT under test. This requires the use of a programmable MIL-STD-1553 waveform generator that provides the following:

1. Generates valid MIL-STD-1553 waveforms and invalid waveforms with injected errors.

2. Provides amplitude levels of 0.20, 0.86, and 6.0 V_{pp} for transformer-coupled stubs and 0.28, 1.2, and 9.6 V_{pp} for direct-coupled stubs.

3. Provides rise and fall times of a trapezoidal waveform of less than or equal to 100ns.

Note that the intent of this handbook is to provide minimum test hardware requirements and not to discuss all of the various implementations available.

TEST PLAN PARAGRAPH: 4.1 GENERAL MONITORING REQUIREMENTS.

PURPOSE: This paragraph is added to establish monitoring criteria.

1553 PARAGRAPH: See Below.

COMMENTARY: It is intended that the parameters listed be monitored constantly during testing. This implies that a bus monitor function is required and must be capable of verifying certain timing events, word formats, and protocol responses. Generally, the test device monitoring the MIL-STD-1553 bus is also the Bus Controller (BC) and RT (for tests requiring additional RT responses). This reduces the hardware required in the set up. This device must be capable of interpreting MIL-STD-1553 activity and detecting when a device under test operates outside the boundaries defined for the parameters listed.

INSTRUMENTATION: The general monitoring requirements listed in paragraph 4.1 of the test plan are basic requirements of 1553. The instrument must be capable of capturing the 1553 messages and verifying timing events, protocol errors, and word formats specified in MIL-STD-1553. The required monitoring requirements and the MIL-STD-1553 paragraphs are listed below.

1) response time - 1553 para. 4.3.3.8 - "RESPONSE TIME"

The monitor used in the production environment must be able to detect and decode UUT responses which fall not only within the 4 - 12μs required in MIL-STD-1553, but also responses which occur in less than 4 and greater than 12μs. This is important for distinguishing a "no response" from a late or early response. Since no tolerance is provided in MIL-STD-1553, a safe method for ensuring that UUTs meet the response time criteria is to impose slightly tighter response time requirements in the monitor.

2) contiguous data - 1553 para. 4.4.1.2 - "TRANSMISSION CONTINUITY"

1553 states that all data shall be contiguous, but does not set an actual limit. The monitor used for production testing should be able to detect discontinuities of 2.5μs. Monitoring the UUT for no discontiguity is ideal; however, it is felt that the 2.5μs figure (or limit) imposed is reasonable (2.5μs as measured in Figure 1 at the end of this document).

3) proper Manchester encoding - 1553 para. 4.3.3 - "TRANSMISSION METHOD"

The monitor used in this function must be able to detect and flag 1553 words with missing transitions. This applies for any edge in any word on the 1553 bus.

4) proper bit count - 1553 para. 4.3.3.4 - "WORD SIZE"

The monitor should flag any 1553 words which contain the wrong number of bits. Most available decoders can detect missing bits anywhere in a 1553 message. Also, most decoders can detect extra bits anywhere in the message except the last word of a transmission (last data word of a receive message or a transmit command word). It is generally considered that RTs cannot pass noise (1553 paragraph 4.5.2.1.4) and detect extra bits at the end of a transmission. The monitor used in production testing need not pass the rigors of 1553 noise rejection. This means that the optimum monitor for the production environment would be one which can detect and flag extra bits in a 1553 word no matter where they occur in the message.

5) odd parity - 1553 para. 4.3.3.5.1.6 - "PARITY"

The bus monitor function in the production test environment must be able to detect and flag 1553 words on the data bus whose bit time 20, parity bit, is not the proper phase to indicate odd parity.

6) proper word count - 1553 para. 4.3.3.5.1.5 - "DATA WORD COUNT/MODE FIELD"

The monitor needs to be cognizant of the word count in the commands and verify proper UUT operation.

7) proper terminal address in status - 1553 para. 4.3.3.5.3.2 - "RT ADDRESS" (STATUS)

It is the responsibility of the bus monitor function to ensure that the RT address field of the UUT status words is always equal to the RT address of the associated command word. Generally, this simple task is managed in the software of an automated set up.

8) reserved status and instrumentation bits are set to zero - 1553 para. 4.3.3.5.3.6 - "RESERVED STATUS BITS", - 1553 para. 4.3.3.5.3.4 - "INSTRUMENTATION BIT"

The monitor must detect and flag any UUT status response where the reserved and/or instrumentation bits are not logical zero.

9) proper sync - 1553 para. 4.3.3.5.1.1 - "SYNC" command words - 1553 para. 4.3.3.5.2.1 - "SYNC" data words

All sync fields of all words transmitted by the UUT must be examined for the proper sync waveform.

TEST PLAN PARAGRAPH: 5.1.1.1 AMPLITUDE

PURPOSE: To ensure proper output amplitude (6 - $9V_{pp}$) for direct, and (18 - $27V_{pp}$) for transformer-coupled stub connections.

1553 PARAGRAPH: 4.5.2.1.1.1

INSTRUMENTATION: A 50MHz (minimum) bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: 5.1.1.2 RISE AND FALL TIME

PURPOSE: To test for rise and fall times of 100 to 300ns.

1553 PARAGRAPH: 4.5.2.2.1.2

INSTRUMENTATION: A 100MHz bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: 5.1.1.3 ZERO CROSSING STABILITY

PURPOSE: To ensure that output zero crossing stability is within ± 25ns for zero crossings of 500, 1,000, 1,500, and 2,000ns.

1553 PARAGRAPH: 4.5.2.1.1.2

INSTRUMENTATION: To handle the ± 25ns accuracy measurement, a 100MHz bandwidth scope with a 5ns accuracy is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: 5.1.1.4 DISTORTION, OVERSHOOT, AND RINGING

PURPOSE: To verify that output waveform distortion, overshoot, and ringing does not exceed ± 900mV for transformer-coupled stubs and ± 300mV for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.1.1.2

INSTRUMENTATION: A 100MHz bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: 5.1.1.5 OUTPUT SYMMETRY

PURPOSE: To verify that the output residual voltage is less than 250mV peak for transformer-coupled stubs and less than 90mV peak for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.2.1.4

COMMENTARY: The six data word patterns used in this test are:

8000 (HEX), 7FFF (HEX), 0000 (HEX)
FFFF (HEX), 5555 (HEX), AAAA (HEX)

These data word patterns are obtained from 1553 paragraph 4.5.2.2.1.4. These patterns are used because they represent the basic switching frequencies that the transmitter circuitry must be able to support. For instance, the patterns of all zeros (0000) and all Fs (FFFF) are 1MHz patterns. The 1MHz patterns are the highest frequency achievable on the 1553 bus. Patterns of all 5's (5555) and all A's (AAAA) are equal to 500kHz. The patterns 7FFF and 8000 contain composites of the lowest and highest switching frequencies possible on the 1553 bus. 7FFF, when used with a status word, causes a 2.0μs sustained low output occurring when bit time 4, a zero in this case, follows a status sync field. This low is then followed by the 1MHz switching. The longest sustained high output occurs when the 8000 pattern is used with a data sync. In this case, bit time 4 is a logical one. This, with the second half of a data sync, causes a 2.0μs sustained high pulse. Again this is followed by the 1MHz switching pattern. These patterns do, in fact, provide a practical means to demonstrate a transmitter's capabilities. The use of alternating patterns such as AAAA and 5555, or FFFF and 0000, ensures that both halves of the transmitter output stages are operational and balanced (biased) properly. In other words, that the positive and negative energy is equal and that a charge is not acquired in the transmission line during transmission.

The use of the different switching frequencies also provides an adequate means of testing the basic frequency response characteristics of the transformer associated with that output.

It is also important to consider that there are UUTs which cannot support the data patterns called for in this test. If a UUT cannot generate the data patterns specified, the use of the test "Wrap Subaddress" may be required. If this is also not available, the test engineer must try to use the data patterns available which, as closely as possible, resemble the switching patterns specified. For example, if the eight Most Significant Bits (MSBs) of the data words are always "FF", but the eight Least Significant Bit (LSBs) are selectable, then the patterns used in test may resemble:

FF80(HEX), FF7F(HEX), FF00(HEX)
FFFF(HEX), FF55(HEX), FFAA(HEX)

If the UUT can only transmit a fixed set of data, then the fixed data shall be used. Or, if the UUT only transmits status words, then the status word should be manipulated, if possible, to contain the specified patterns.

In any case, a maximum effort should be made to exercise the UUT transmitter circuitry with the listed patterns.

INSTRUMENTATION: A 50MHz (minimum) bandwidth scope is recommended so the 1553 waveform may be viewed and the measurement taken.

TEST PLAN PARAGRAPH: 5.1.1.6 OUTPUT NOISE

PURPOSE: To verify that quiescent rms noise is less than 14mV rms for transformer-coupled stubs and less than 5mV rms for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.2.1.3

INSTRUMENTATION: A true rms voltmeter is required for this test. The equipment must have a (DC) to 10MHz minimum frequency bandwidth with 1MΩ input impedance.

TEST PLAN PARAGRAPH: 5.1.1.7 POWER ON/OFF NOISE

PURPOSE: To ensure that spurious noise output by the UUT during power up and down is less than 250mV peak for transformer-coupled stubs and 90mV peak for direct-coupled stubs.

1553 PARAGRAPH: 30.10.6 (NOTICE 2)

COMMENTARY: This is a requirement of Notice 2 to MIL-STD-1553B. The TPTG felt this test was important enough to add to the Production Test Plan. Successful completion of Power On/Off Noise tests during validation testing does not imply that all UUTs, in a production environment, will comply. The pass/fail limits are as specified in Notice 2 to 1553B.

In addition to transient noise spikes, it is important that the UUT be tested to verify that the UUT does not emit any 1553 words during normal power sequencing. For example, UUTs that can be also configured as BCs are more likely to have this type of problem. This is also true for UUTs utilizing on-board RAM. If the UUT RAM is not controlled during power up, the RAM may assume data patterns configuring the UUT as a BC issuing commands. This is extremely dangerous and it is intended that the Power On/Off test flags this type of action as an error.

It should be noted that noise induced by the test hardware must be minimized so that test results are not significantly effected. Proper power-up procedure should also be observed.

INSTRUMENTATION: A 50MHz storage scope is recommended so that any spurious differential output may be captured during the power up or power down sequences. A storage scope is necessary since you must be able to capture a single event. A 1553 monitor should also be on the bus to monitor any possible 1553 spurious messages.

TEST PLAN PARAGRAPH: 5.1.2.1.1 AMPLITUDE VARIATIONS

PURPOSE: To verify that UUT thresholds are within the transformer- and direct-coupled stub windows of 0.2 to $0.86V_{pp}$ and 0.28 to $1.2V_{pp}$, respectively, and that the UUT can respond properly to signal inputs throughout the allowable range of 0.86 to $6.0V_{pp}$ and 1.2 to $9.0V_{pp}$, respectively.

1553 PARAGRAPH: 4.5.2.1.2.1

COMMENTARY: It is only required that three input voltage levels, per stub, be used in this test. The levels are the extremes: required rejection level, and minimum and maximum bus level. The three voltages represent the minimum requirements of 1553. This is set up this way to minimize test time.

Since there is no zero crossing distortion or noise rejection testing in the Production Test Plan, one may wish to establish periodic characterization of 1553 receivers to ensure proper performance during production. This is important because a verified receiver design, one which passes validation testing, is not necessarily demonstrative of production units. This is due to the analog nature of the receiver in general and, in particular, the filtering circuitry. The amplitude variations test is a means of testing the basic capabilities of the receiver circuitry. Where large numbers of UUTs are concerned, periodic characterization enables the test facility to observe trends in circuitry and component performance. Facilities should maintain and analyze test data to ensure that component tolerances designed in are adequate.

Automated test stands can determine, to within $50mV_{pp}$, thresholds of a UUT in less than 5 seconds. This is accomplished by successive approximation of test input levels centered and beginning + or - $200mV_{pp}$ above or below the typical threshold of production units.

INSTRUMENTATION: The waveform generator must provide variable voltage outputs in response to the UUT as specified by the Test Plan. A monitor is also needed to verify the response of the UUT for each message sent.

TEST PLAN PARAGRAPH: 5.1.2.1.2 INPUT IMPEDANCE

PURPOSE: To ensure that UUT impedance is greater than 1KΩ for transformer-coupled stubs and greater than 2KΩ for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.1.2.3

COMMENTARY: This test, as well as the Amplitude Variations test, provides a means for the test facility to verify receiver construction and operation. The wiring to the UUT, transformer and transmitter contributions to the input impedance are also verified during this test. If possible, it is desirable to determine the phase angle of the impedance. Imposing in-house phase angle requirements will ensure that the UUTs are able to maintain similar input impedance characteristics during RT production.

Note that the UUT should be tested off-line per test plan using minimum length calibrated cables.

INSTRUMENTATION: An impedance analyzer is recommended for this test. It should be capable of measurements at 1MHz. It should be able to measure complex impedance and generate a sine wave at 1 to 2V rms at 1MHz.

TEST PLAN PARAGRAPH: 5.2 PROTOCOL TESTS

PURPOSE: This major paragraph contains tests on the protocol requirements of MIL-STD-1553.

1553 PARAGRAPH: 4.4.1.3

COMMENTARY: This section permits relief from testing on both stub types (per bus). This is because the stub connections and transformer turns ratios were tested as part of the Electrical Tests. Once it has been established that the connections to both stubs are intact, it is not necessary to test the protocol requirements on both stubs.

INSTRUMENTATION: There are many pieces of test equipment available that provide the necessary components for the protocol portion of this Test Plan. The equipment must be capable of simulating the BC functions, such as RT-to-RT transfers, mode codes, general receive and transmit commands, and broadcast commands to the UUT. The equipment must also be capable of simulating at least one RT. The test signal amplitude should be $3.0V_{pp}$ for direct-coupled stubs and $2.1V_{pp}$ for transformer-coupled stubs measured at point A of Figure 1 in the Test Plan. Any other specific simulation or error injection functions will be discussed in the individual tests below. The test equipment used should also be able to perform all of the monitoring requirements outlined in 4.1 GENERAL MONITORING REQUIREMENTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.1.1.1 VALID RT ADDRESS

PURPOSE: To ensure that the UUT responds to 1553 commands which contain, in the RT address field, the address which the UUT is assigned.

1553 PARAGRAPH: 4.3.3.5.1.2, 4.3.3.6, 4.4.3

COMMENTARY: This section ensures that the UUT address recognition circuitry is operational. A walking logical one is walked through the RT address field to ensure that all bits can be programmed as either a logical zero or one.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.1.1.2 INVALID RT ADDRESS

PURPOSE: To ensure that the UUT does not respond to commands which do not contain, in the RT address field, the address which the UUT is assigned.

1553 PARAGRAPH: 4.3.3.5.1.2, 4.3.3.6,4.4.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.1.2 WORD COUNT

PURPOSE: To ensure that the UUT responds properly to all implemented word counts.

1553 PARAGRAPH: 4.3.3.5.1.5, 4, 4.3.3.6, 4.4.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.1.3 SUBADDRESS

PURPOSE: To ensure that the UUT responds properly to all implemented sub-addresses.

1553 PARAGRAPH: 4.3.3.5.1.4, 4.3.3.6, 4.4.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.1.4 ERROR INJECTION

PURPOSE: This series of tests verify proper UUT action when errors are present in the message stream.

1553 PARAGRAPH: 4.4.1.1, 4.4.3.1

COMMENTARY: The Error Injection test is written to exercise the minimum response requirements of MIL-STD-1553. Table 1 of the test plan, Error Formats, contains fewer scenarios than the exhaustive tests of characterization testing. The production method requires far less time and offers confidence in proper receiver/decoder operation. It is recommended that if the UUT implements the Transmit Status Word mode command, it be used in Step 3 of the test plan. This addition further tests the UUT functionality. The proper responses for using the Transmit Status Word mode command in Step 3 of 5.2.1.4 are as follows: CS for error conditions within command words; ME for error conditions within data words.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the equipment used to simulate the BC function must be able to inject the following errors:

1. Parity Errors.

2. Bit Count: -1 and +2 bits.

3. Bi-phase Encoding, both high and low. The capability to specify the bit of the bi-phase error is also necessary.

4. Sync errors:
   Command words: 111100, 110000, 111001, 011000, 000111
   Data words: 000011, 001111, 000110, 100111, 111000.

5. Contiguous data error between command and data words and between two data words of 4.0μS.

6. Word count: Receive message: +1 data word; Transmit message: ± 1 data word.

TEST PLAN PARAGRAPH: 5.2.2.1 DUAL REDUNDANT OPERATION

PURPOSE: This test ensures proper UUT operation when used in a dual standby redundant configuration.

1553 PARAGRAPH: 4.6.3, 4.6.3.1, 4.6.3.2

COMMENTARY: The Dual Redundant Operation test is included in the Production Test Plan to verify that the UUT responds properly when configured with dual standby redundant buses. Specifically, the UUT can properly process overlapping commands. The test is performed with a fixed delay time between the original command and the interrupting command. This was written this way to minimize test time.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.2 MODE COMMANDS

PURPOSE: This section ensures that the UUT responds to mode commands as defined by MIL-STD-1553. Note that the information content of the data word associated with some mode commands and the action taken by the UUT in response is application dependent, and is therefore not checked by these tests.

1553 PARAGRAPH: 4.3.3.5.1.7

COMMENTARY: The mission aspects (data word specific implementation) of the mode commands are not included as part of these tests. The reason this was excluded is because it is not reasonable to expect that the test plan can predict, beyond that which is defined in MIL-STD-1553, the exact mission specific action taken by the UUT after receipt of a mode command. For example, the data word transmitted as a result of a Transmit Vector Word mode command may be different for different RTs. Also, the reaction to a Reset Remote Terminal or Initiate Self-Test mode command will probably be different for different RTs. However, it is expected that the test facility perform tests pertaining to the mission aspects of mode commands to ensure that the UUT meets the requirements of the equipment specification. It is recommended that, if the UUT utilizes timers or clock periods to accomplish the functional aspects of the mode command, these periods be tested to designed limits.

The following is a cross reference of MIL-STD-1553 mode commands to the appropriate test paragraphs.

TEST PLAN PARAGRAPH	TITLE	MIL-STD-1553 PARAGRAPH
5.2.2.2.1	DYNAMIC BUS CONTROL	4.3.3.5.1.7.1
5.2.2.2.2.1	SYNCHRONIZE (WITHOUT DATA WORD)	4.3.3.5.1.7.2
5.2.2.2.2.2	SYNCHRONIZE (WITH DATA WORD)	4.3.3.5.1.7.1.2
* 5.2.2.2.3	TRANSMIT STATUS WORD	4.3.3.5.1.7.3
,*** 5.2.2.2.4	INITIATE SELF TEST	4.3.3.5.1.7.4
5.2.2.2.5	TRANSMIT BIT WORD	4.3.3.5.1.7.14
5.2.2.2.6.1	DUAL REDUNDANT SHUTDOWNS AND OVERRIDES	4.3.3.5.1.7.5 4.3.3.5.1.7.6
*** 5.2.2.2.6.2	SELECTIVE TRANSMITTER SHUTDOWNS AND OVERRIDE	4.3.3.5.1.7.15 4.3.3.5.1.7.16
**** 5.2.2.2.7	TERMINAL FLAG BIT INHIBIT AND OVERRIDE	4.3.3.5.1.7.7 4.3.3.5.1.7.8
***** 5.2.2.2.8	RESET REMOTE TERMINAL	4.3.3.5.1.7.9
5.2.2.2.9	TRANSMIT VECTOR WORD	4.3.3.5.1.7.11
5.2.2.2.10	TRANSMIT LAST COMMAND	4.3.3.5.1.7.13

* Step 3 of this test verifies that the UUT has recognized the associated command word to be valid and the data word is not valid. This is implied in the proper response to Step 3. Step 4 is a repeat of Step 3 to ensure that the contents of the status register were not altered. Step 5 ensures that the status register is reset upon the receipt of the valid legal command.

** For ease of testing and reduction of test time, this test can be combined with the next test, Transmit BIT Word. Generally, the Initiate Self-Test mode command will cause the UUT to perform a predefined self-test. The results of this test are then stored in a register or RAM. This information may be transmitted to the BC as the data word of a Transmit BIT Word mode command in some designs.

*** Bit times 9 and 15 - 19 = 0 10100. Selected Transmitter Shutdown is used in Step 3 of the test sequence. Bit times 9 and 15 - 19 = 0 10101, Override Selected Transmitter Shutdown is used in Steps 6 and 8. These commands require that the associated data words contain the data pattern which cause the predefined alternate bus transmitters to either be shut down or have that shutdown be overridden. Transmitters on other buses not defined in the associated data word shall not be effected.

**** Step 2 of this test uses the phrase "Introduce a condition which will set the Terminal Flag." It is written this way to allow for the differences in designs for the setting and resetting of the Terminal Flag (TF) bit. For example, some UUTs may require a forced Built-in-Test failure during a status transmission for the setting of the TF bit in subsequent commands. If this is the case, then Step 2 of the test sequence will contain two commands: the first to begin the short loop failures and the second to report the short loop failures by setting the TF bit. The same philosophy is indicated in Step 7; only this case is associated with resetting the TF bit.

***** These commands may cause the UUT to be off-line for an extended period of time. One should consider these commands and generate test code such that the effects of receiving these commands are predictable.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.3 STATUS WORD

To verify that implemented status bits are properly set and cleared.

1553 PARAGRAPH: 4.3.3.5.3

COMMENTARY: This section is designed to exercise the status word bits of the UUT. In most cases, the expression "perform procedures which cause the status word bit under test to be set" is used to allow for the different methods of setting bits for different RTs. In other words, it is permissible to utilize additional commands to condition the UUT to set and reset status bits. For example, the testing of the Terminal Flag bit may require commands be sent to the UUT to control simulated short loop failures which set and reset the Terminal Flag bit.

The following is a cross reference of MIL-STD-1553 status bits to the appropriate test plan paragraph.

TEST PLAN PARAGRAPH	TITLE	MIL-STD-1553 PARAGRAPH
5.2.2.3.1	SERVICE REQUEST	4.3.3.5.3.5
5.2.2.3.2	BROADCAST COMMAND RECEIVED	4.3.3.5.3.7
5.2.2.3.3	BUSY	4.3.3.5.3.8
5.2.2.3.4	SUBSYSTEM FLAG	4.3.3.5.3.9
5.2.2.3.5	TERMINAL FLAG	4.3.3.4.3.11

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.4 BROADCAST MESSAGES

PURPOSE: This major paragraph introduces the broadcast messages section.

1553 PARAGRAPH: 4.3.3.6.7, 4.3.3.6.7.1, 4.3.3.6.7.2, 4.3.3.6.7.3, 4.3.3.6.7.4

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.4.1 RESPONSE TO BROADCAST COMMANDS

PURPOSE: This paragraph discusses the three categories of broadcast commands to be used in the subsequent test paragraphs. Also found in this paragraph is the test sequence.

1553 PARAGRAPH: 4.3.3.6.7, 4.3.3.6.7.1, 4.3.3.6.7.2, 4.3.3.6.7.3, 4.3.3.6.7.4

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.4.1.1 BC-to-RT BROADCAST COMMANDS

PURPOSE: To verify proper UUT responses to all non-mode, BC-to-RT Broadcast commands.

1553 PARAGRAPH: 4.3.3.6.7.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.4.1.2 BROADCAST MODE COMMANDS

PURPOSE: This paragraph introduces the subparagraphs for Broadcast Mode Commands.

1553 PARAGRAPH: 4.3.3.6.7.3, 4.3.3.6.7.4

COMMENTARY: The mission aspects of the Broadcast Mode Commands are not included as part of these tests. The reason this was excluded is because it is not reasonable to expect that the test plan can predict, beyond that which is defined in MIL-STD-1553, the exact mission specific action taken by the UUT after receipt of a broadcast mode command. For example, the reaction to a Broadcast Reset Remote Terminal or Broadcast Initiate Self-Test mode command will probably be different for different RTs. However, it is expected that the test facility perform tests pertaining to the mission aspects of mode commands to ensure that the UUT meets the requirements of the equipment specification. It is recommended that if the UUT utilizes timers or clock periods to accomplish the functional aspects of the mode command, these periods be tested to designed limits.

The following is a cross reference of MIL-STD-1553 Broadcast Mode Commands and the corresponding test plan paragraphs.

TEST PLAN PARAGRAPH	TITLE	MIL-STD-1553 PARAGRAPH
5.2.2.4.1.2.1	BROADCAST SYNCHRONIZE (WITHOUT DATA WORD)	4.3.3.6.7.3 4.3.3.5.1.7.2
5.2.2.4.1.2.2	BROADCAST SYNCHRONIZE (WITH DATA WORD)	4.3.3.6.7.4 4.3.3.5.1.7.12
* 5.2.2.4.1.2.3	BROADCAST INITIATE SELF TEST	4.3.3.6.7.3 4.3.3.5.1.7.4
5.2.2.4.1.2.4.1	BROADCAST DUAL REDUNDANT SHUTDOWN AND OVERRIDES	4.3.3.6.7.3 4.3.3.5.1.7.5 4.3.3.5.1.7.6
5.2.2.4.1.2.4.2	BROADCAST SELECTIVE BUS SHUTDOWN AND OVERRIDES	4.3.3.6.7.4 4.3.3.5.1.7.15 4.3.3.5.1.7.16
**5.2.2.4.1.2.5	BROADCAST TERMINAL FLAG BIT INHIBIT AND OVERRIDE	4.3.3.6.7.3 4.3.3.5.1.7.7 4.3.3.5.1.7.8
* 5.2.2.4.1.2.6	BROADCAST RESET REMOTE TERMINAL	4.3.3.6.7.3 4.3.3.5.1.7.9

* These commands may cause the UUT to be off-line for an extended period of time. One should consider these commands and generate test code such that the effects of receiving these commands are predictable.

** Bit times 4 - 9 and 15 - 19 = 11111 1 00110 for Step 3. Bit times 4 - 9 and 15 - 19 = 11111 1 00111 for Step 6. A clarification of the wording in the last sentence of Step 4 is required. It should read a response followed by a data word containing the last command (command word from Step 3) shall be verified.

INSTRUCTION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.4.1.3 RT-to-RT BROADCAST COMMANDS

PURPOSE: This test ensures that the UUT can properly participate in an RT-to-RT Broadcast command.

1553 PARAGRAPH: 4.3.3.6.7.2

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.5.1 RT-to-RT TRANSMIT

PURPOSE: This test verifies that the UUT can properly participate as the transmitting RT in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.6.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.5.2 RT-to-RT RECEIVE

PURPOSE: To verify proper UUT operation while being the receiving RT in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.6.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.5.3 RT-to-RT TIMEOUT

PURPOSE: To ensure that the UUT Receiver/Decoder "times out" during RT-to-RT transfers where the transmitting RT's response is delayed.

1553 PARAGRAPH: 4.3.3.6.3, 30.9

COMMENTARY: The TPTG decided that the RT-to-RT Timeout requirement is implied in MIL-STD-1553B and, therefore it is included in the Production Test Plan. Notice 2 to MIL-STD-1553B made this requirement explicit. This is the only test performed to ensure that an RT times out within the period specified. The timeout discussed here is not the Terminal Fail-Safe Timer, required in 1553, paragraph 4.4.1.3. This is a timer function required, similar to a "no response timer", to disable the RT decoding circuitry in the event of a delayed response by the transmitting RT in an RT-to-RT transfer. RT's which do not operate within these guidelines compromise reliable system performance.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: 5.2.2.6 ILLEGAL COMMANDS

PURPOSE: To verify proper UUT responses to illegal commands

1553 PARAGRAPH: 4.4.3.4

COMMENTARY: Steps 1 thru 4 test every combination of subaddress, receive-transmit, and word count fields, ensuring a complete test of all legal and illegal commands. Interspersed between each command is a known valid command to ensure that the Message Error (ME) bit in the status word is reset. Step 5 tests that the UUT checks validity first, not illegality of a command. Step 6 ensures that the invalid data word was in fact detected and reported. Steps 8 and 9 repeat the process for an invalid command, with the UUT ensuring that the invalid word was in fact detected, and in the status word of Step 9, there should be no ME indication. Finally, Steps 11 and 12 check all mode code combinations.

With the testing of all combinations of subaddress and mode command codes, the word count (5.2.1.2) and subaddress (5.2.1.3) tests are done as part of this test and, therefore, are not required to be run separately when this test is implemented.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A1 UNIQUE ADDRESS

PURPOSE: To verify that the UUT can assign a unique address, and that the UUT does not respond to commands when a single point failure is introduced into the RT address assignment mechanism.

1553 PARAGRAPH: 30.3

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A2 MODE CODES

PURPOSE: This paragraph requires the testing of the listed paragraphs, 5.2.2.2.3 Transmit Status, 5.2.2.2.6 Transmitter Shutdown and Override, and 5.2.2.2.8 Reset Remote Terminal.

1553 PARAGRAPH: 30.4.2.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A3 RESET REMOTE TERMINAL

PURPOSE: To verify that the UUT recognizes the Reset Remote Terminal mode command and resets itself within its designed limits.

1553 PARAGRAPH: 30.4.3

COMMENTARY: The TPTG felt that testing the UUT to the designed reset time (T_{dr}) was important. MIL-STD-1553B, Notice 2, paragraph 30.4.3 specifies that the UUT must reset in < 5ms. The last sentence of the introduction paragraph of the test plan ensures that this is accomplished . However, testing at 5ms only is not sufficient for UUTs with a T_{dr} of (for example) 100μsec. The UUT must be tested to within its designed limits to ensure proper operation.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A4 INITIATE SELF TEST

PURPOSE: To ensure that the UUT, upon command, initiates its self-test function within its designed time limits.

1553 PARAGRAPH: 30.4.3

COMMENTARY: The same philosophy stated for Reset Remote Terminal applies to this paragraph. Even though the standard allows for up to 100ms for self-test, the UUT must be tested to its designed limits (T_{dr}) to ensure proper operation.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A5 POWER ON RESPONSE

PURPOSE: This test verifies that the UUT transmits valid responses throughout its power-up cycle.

1553 PARAGRAPH: 30.5.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A6 DATA WRAPAROUND

PURPOSE: This test verifies that the UUT properly implements the data wrap-around capability.

1553 PARAGRAPH: 30.7

COMMENTARY: The pass criteria for Step 2 includes CS. CS, defined in paragraph 3.1.3 of the test plan, allows the busy bit to be set. Thus, per MIL-STD-1553, paragraph 4.3.3.5.3.8, there would be no ensuing data words. This, seemingly, defeats the purpose of the test. However, for the purpose of this test, the busy bit must be reset. It is recommended that the busy condition be inhibited or defeated, if possible. If not, the test equipment may "retry" until the busy condition relents.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A7 RT to RT VALIDATION

PURPOSE: This paragraph causes the Transmit Status Word mode command, a requirement of Notice 2, to be included in the RT-to-RT Test, 5.2.2.5.3.

1553 PARAGRAPH: 30.9

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: A8 CONNECTOR POLARITY

PURPOSE: To ensure that the connector wiring has been implemented correctly: center pin for (Positive) Manchester signal; the inner ring for low (Negative) Manchester signal.

1553 PARAGRAPH: 30.10.3

COMMENTARY: Ensure that the correct polarity has been implemented for the connector wiring.

CHAPTER 3

AS4113 VALIDATION TEST PLAN FOR THE AIRCRAFT TIME DIVISION COMMAND/RESPONSE MULTIPLEX DATA BUS BUS CONTROLLERS.

AS4114 PRODUCTION TEST PLAN FOR THE AIRCRAFT TIME DIVISION COMMAND/RESPONSE MULTIPLEX DATA BUS BUS CONTROLLERS.

INTRODUCTION:

The methods for testing BCs are different from RT testing. With RTs, conformance to the requirements of MIL-STD-1553 is evaluated only by examining the responses seen on the data bus. To evaluate the performance of a BC, however, it is necessary to determine the internal response of the BC to conditions on the data bus. This may require access to the subsystem interface and intrusion into the BC box if no special test connectors are provided. In addition, existing BC system software may be incompatible with this Test Plan and test-specific software may be required. If the BC is a programmable terminal that can be configured as a BC or an RT, one may choose to test the UUT as an RT for Electrical and Noise Rejection requirements.

This chapter pertains to both BC test plans, validation and production. The paragraphs are listed for BC VAL, for AS4113; and BC PRO, for AS4114.

GENERAL INSTRUMENTATION NEEDS:

Most of the tests written in these two Test Plans require a valid RT response be sent to the UUT. This requirement imposes the use of a controllable MIL-STD-1553 waveform generator. This device must perform the following tasks:

1. Capable of generating valid MIL-STD-1553 waveforms and respond as an RT to valid 1553 commands, as required, as well as invalid waveforms with injected errors.

2. Provide amplitude variations from $0.1V_{pp}$ to $6.0V_{pp}$ into 70Ω, and $0.2V_{pp}$ to $9.0V_{pp}$ into 35Ω.

3. Programmable for zero crossing distortion to $\pm$ 200ns on any edge specified with 3ns resolution or better.

4. Provides rise and fall times of a trapezoidal waveform of less than or equal to 100ns.

Note that the intent of this handbook is to provide minimum test hardware requirements and not to discuss all of the various implementations available.

TEST PLAN PARAGRAPH: 4.1 GENERAL MONITORING REQUIREMENTS

PURPOSE: This paragraph is added to establish monitoring criteria.

1553 PARAGRAPH: See Below.

COMMENTARY: It is intended that the parameters listed be monitored constantly during testing. This implies that a bus monitor function is required and must be capable of verifying certain timing events, word formats, and protocol responses. The test device monitoring the 1553 bus may also be used for tests requiring RT responses. This reduces the hardware required in the set up. This device must be capable of interpreting MIL-STD-1553 activity and detecting when a device under test operates outside the boundaries defined for the parameters listed.

INSTRUMENTATION: The instrumentation selected must be capable of monitoring MIL-STD-1553 signals. It should be capable of verifying timing events, protocol errors, and word formats specified in MIL-STD-1553. The required monitoring requirements and the 1553 paragraphs are listed below.

1) contiguous data - 1553 para. 4.4.1.2 - "DATA CONTINUITY"

1553 states that all data shall be contiguous, but does not set an actual limit. The monitor used for validation testing should be able to detect discontinuities of 2.5μsec. Monitoring the UUT for no discontiguity is ideal; however, it is felt that the 2.5μs figure (or limit) imposed is reasonable (2.5μs as measured in Figure 1 at the end of this document).

2) proper Manchester encoding - 1553 para. 4.3.3 - "TRANSMISSION METHOD"

The monitor used in this function must be able to detect and flag 1553 words with missing transitions. This applies for any edge in any word on the 1553 bus.

3) proper bit count - 1553 para. 4.3.3.4 - "WORD SIZE"

The monitor should flag any 1553 words which contain the wrong number of bits. Most available decoders can detect missing bits anywhere in a 1553 message. Also, most decoders can detect extra bits anywhere in the message except the last word. It is generally considered that terminals cannot pass noise (1553 para. 4.5.2.1.4) and detect extra bits at the end of a transmission. The monitor used in validation testing need not pass the rigors of 1553 noise rejection. This means that the optimum monitor would be one which can detect and flag extra bits in a 1553 word, no matter where they occur in the message.

4) odd parity - 1553 para. 4.3.3.5.1.6 - "PARITY"

The bus monitor function in the test environment must be able to detect and flag 1553 words on the data bus whose bit time 20, parity bit, is not the proper phase to indicate odd parity.

5) proper word count - 1553 para. 4.3.3.5.1.5 - "DATA WORD COUNT/MODE FIELD"

The monitor needs to be cognizant of the word count in the commands and verify proper UUT operation.

6) proper intermessage gap times - 1553 para. 4.3.3.7 - "INTERMESSAGE GAP"

The monitor must be capable of detecting the time between the BC's initiation of a new message and the end of the preceding message, and flagging gap times of less than 4.0μs.

7) proper sync. - 1553 para. 4.3.3.5.1.1 - "SYNC" command words - 1553 para. 4.3.3.5.2.1 - "SYNC" data words

All sync fields of all words transmitted by the UUT must be examined for the proper sync waveform.

8) proper CMS transmission - 1553 para. 4.3.3.5.1 - "COMMAND WORD" -1553 para. 4.3.3.6 - "MESSAGE FORMATS"

The monitor must be able to decode the command word (or words) and determine that the CMS is appropriate to the specific command word.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.1 AMPLITUDE

PURPOSE: To ensure proper output amplitude (6 - 9V_{pp}) for direct- and (18 - 27V_{pp}) for transformer-coupled stub connections.

1553 PARAGRAPH: 4.5.2.1.1.1

INSTRUMENTATION: A 50MHz (minimum) bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.2 RISE AND FALL TIME

PURPOSE: To test for rise and fall times of 100 to 300ns.

1553 PARAGRAPH: 4.5.2.2.1.2

INSTRUMENTATION: A 100MHz bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.3 ZERO CROSSING STABILITY

PURPOSE: To ensure that output zero crossing stability is within ±25ns for zero crossings of 500, 1,000, 1,500, and 2,000ns.

1553 PARAGRAPH: 4.5.2.1.1.2

INSTRUMENTATION: To handle the ± 25ns accuracy measurement, a 100MHz bandwidth scope with a 5ns accuracy is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.4 DISTORTION, OVERSHOOT, AND RINGING

PURPOSE: To verify that output waveform distortion, overshoot, and ringing does not exceed ±900mV for transformer-coupled stubs and ±300mV for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.1.1.2

INSTRUMENTATION: A 100MHz bandwidth scope is recommended so that the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.5 OUTPUT SYMMETRY

PURPOSE: To verify that the output residual voltage is less than 250mV peak for transformer-coupled stubs and less than 90mV peak for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.2.1.4

COMMENTARY: The six data word patterns used in this test are:

8000 (HEX), 7FFF (HEX), 0000 (HEX)
FFFF (hex), 5555 (hex), AAAA (HEX)

These data word patterns are obtained from 1553 paragraph 4.5.2.2.1.4. These patterns are used because they represent the basic switching frequencies that the transmitter circuitry must be able to support. For instance, the patterns of all zeros (0000) and all Fs (FFFF) are 1MHz patterns. The 1MHz patterns are the highest frequency achievable on the 1553 bus. Patterns of all 5s (5555) and all As (AAAA) are equal to 500kHz. The patterns 7FFF and 8000 contain composites of the lowest and highest switching frequencies possible on the 1553 bus. The longest sustained high output occurs when the 8000 pattern is used with a data sync. In this case, bit time 4 is a logical one. This, with the second half of a data sync, causes a 2.0μs sustained high pulse. Again this is followed by the 1MHz switching pattern. These patterns do, in fact, provide a practical means to demonstrate a transmitter's capabilities. The use of alternating patterns such as AAAA and 5555, or FFFF and 0000, ensures that both halves of the transmitter output stages are operational and balanced (biased) properly. In other words, that the positive and negative energy is equal and that an offset has not built up during transmission.

The use of the different switching frequencies also provides an adequate means of testing the basic frequency response characteristics of the transformer associated with that output.

It is also important to consider that there are UUTs which cannot support the data patterns called for in this test. If a UUT cannot generate the data patterns specified, the test engineer must try to use the data patterns available which, as closely as possible, resemble the switching patterns specified. For example, if the eight MSBs of the data words are always "FF", but the eight LSBs are selectable, then the patterns used in test may resemble:

FF00 (HEX), FFFF (HEX), FFAA (HEX)
FF55 (HEX), FF7F (HEX), FF80 (HEX)

If the UUT can only transmit a fixed set of data, then the fixed data shall be used.

In any case, a maximum effort should be made to exercise the UUT transmitter circuitry with the listed patterns.

INSTRUMENTATION: A 50MHz (minimum) bandwidth scope is recommended so the 1553 waveform may be viewed and measured.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.1.1.6 OUTPUT NOISE

PURPOSE: To verify that quiescent rms noise is less than 14mV rms for transformer-coupled stubs and less than 5mV rms for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.2.1.3

INSTRUMENTATION: A true rms voltmeter is required for this test. The equipment must have a DC to 10MHz minimum frequency bandwidth with 1MΩ input impedance.

TEST PLAN PARAGRAPH: BC VAL. 5.1.1.7 OUTPUT ISOLATION

PURPOSE: To verify that the isolation between the active bus and all inactive buses exceeds 45db.

1553 PARAGRAPH: 4.6.1

COMMENTARY: This test is run by measuring the output amplitude on the active bus and the voltage on the inactive bus during the transmission. The isolation is expressed as 20 $\log_{10}$ (active bus amplitude/inactive bus amplitude).

INSTRUMENTATION: A 50MHz (or better) bandwidth scope is recommended so the 1553 waveform may be viewed and the amplitude measured on the active bus and the voltage simultaneously measured for the inactive bus.

TEST PLAN PARAGRAPH: BC VAL. 5.1.1.8, BC PRO. 5.1.1.7 POWER ON/OFF NOISE

PURPOSE: To ensure that the output spurious noise during power up and down is less than 250mV peak for transformer-coupled stubs and 90mV for direct-coupled stubs.

1553 PARAGRAPH: 30.10.6 (NOTICE 2)

COMMENTARY: This is a requirement of Notice 2 to MIL-STD-1553B. The TPTG felt this test was important enough to add to the Test Plan. The pass/fail limits are as specified in Notice 2 to 1553B.

In addition to transient noise spikes, it is important that the UUT be tested to verify that the UUT does not emit any 1553 words during normal power sequencing.

It should be noted that noise induced by the test hardware must be minimized so that test results are not significantly effected. Proper power-up procedures should be observed.

INSTRUMENTATION: A 50MHz storage scope is recommended so that any spurious differential output may be captured during the power up or power down sequences. A storage scope is necessary since you must be able to capture a single event. A monitor should also be on-line to monitor any possible spurious 1553 messages.

TEST PLAN PARAGRAPH: BC. VAL., & BC PRO. 5.1.2.1.1 ZERO CROSSING DISTORTION

PURPOSE: To ensure that the receiver/decoder in the UUT is capable of accepting 1553 messages with zero crossings displaced from the ideal by at least 150ns.

1553 PARAGRAPH: 4.5.2.1.2.1, 4.5.2.2.2.1

COMMENTARY: MIL-STD-1553B does not specify the amplitude of the input waveform for this requirement. The values used in the Test Plan are the same as in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the same as the amplitudes specified for the noise rejection test in MIL-STD-1553B. This was thought to be a good compromise between required response and nominal bus amplitudes.

INSTRUMENTATION: A controllable waveform generator must be able to induce positive and negative zero crossing distortions of 150ns minimum from the ideal with respect to the previous zero crossing. The amplitude of the transmitted signal to the UUT must be $2.1V_{pp}$ for transformer-coupled stubs and $3.0V_{pp}$ for direct-coupled stubs. A monitor is also needed to determine when the UUT detects the zero crossing distortions.

TEST PLAN PARAGRAPH: BC. VAL., & BC PRO. 5.1.2.1.2 AMPLITUDE VARIATIONS

PURPOSE: To verify that UUT thresholds are within the transformer- and direct-coupled stub windows of 0.2 to 0.86 V_{pp} or 0.28 to 1.2V_{pp}, respectively, and that the UUT can respond properly to signal inputs throughout the allowable range of 0.86 to 6.0V_{pp} and 1.2 to 9V_{pp}, respectively, and characterize the UUT threshold values.

1553 PARAGRAPH: 4.5.2.1.2.1, 4.5.2.2.2.1

FOR PRODUCTION TESTING:

COMMENTARY: It is only required that three input voltage levels, per stub, be used in this test. The levels are the extremes: required rejection level and minimum and maximum bus level. The three voltages represent the minimum requirements of 1553. This is set up this way to minimize test time.

Since there is no noise rejection testing in the Production Test Plan, one may wish to establish periodic characterization of 1553 receivers to ensure proper performance during production. This is important because a verified receiver design, one which passes validation testing, is not necessarily demonstrative of production unit. This is due to the analog nature of the receiver in general and, in particular, the filtering circuitry. The amplitude variations test is a means of testing the basic capabilities of the receiver circuitry. Where large numbers of UUTs are concerned, periodic characterization enables the test facility to observe trends in circuitry and component performance. Facilities should maintain and analyze test data to ensure that component tolerances designed in are adequate.

Automated test stands can determine, to within 50mV_{pp}, thresholds of a UUT in less than 5 seconds. This is accomplished by successive approximation of test input levels centered and beginning + or - 200mV_{pp} above or below the typical threshold of production units.

INSTRUMENTATION: The waveform generator must provide variable voltage outputs in response to the UUT, as specified by the Test Plan. The operator must determine a way to probe the UUT for VSMS and NR in order to determine the pass/fail status of the UUT.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO.
5.1.2.1.3 RISE AND FALL TIME
5.1.2.1.3.1 TRAPEZOIDAL
5.1.2.1.3.2 SINUSOIDAL

PURPOSE: To test the ability of the UUT to recognize and decode 1553 messages with the fastest specified (100ns trapezoid) and slowest specified ("approximating a 1MHz sinusoid") rise and fall times.

1553 PARAGRAPH: 4.5.2.1.2.1, 4.5.2.2.2.1

COMMENTARY: MIL-STD-1553B does not specify the amplitude of the input waveform for this requirement. The values used in the Test Plan are the same as in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the same as the amplitudes specified for the noise rejection test in MIL-STD-1553B. This was thought to be a good compromise between required response and nominal bus amplitudes.

INSTRUMENTATION: The controllable waveform generator must respond with 1553 messages that have a signal amplitude of $2.1V_{pp}$ for transformer-coupled stubs and $3.0V_{pp}$ for direct-coupled stubs. The rise and fall times should be less than or equal to 100ns for trapezoidal waveforms (5.1.2.1.3.1) and approximate a 1MHz sine wave for the sinusoidal waveforms (5.1.2.1.3.2). The operator must determine a way to probe the UUT for VSMS and NR in order to determine the pass/fail status of the UUT.

TEST PLAN PARAGRAPH: BC VAL. 5.1.2.2 COMMON MODE REJECTION

PURPOSE: To verify that the UUT operates properly in the presence of common mode voltage levels of + and - 10 volts peak, line to ground for DC and 1Hz to 2MHz.

1553 PARAGRAPH: 4.5.2.1.2.2, 4.5.2.2.2.2

COMMENTARY: MIL-STD-1553B does not specify the amplitude of the input waveform for this requirement. The values used in the Test Plan are the same as in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the minimum amplitudes at which terminals must recognize messages.

INSTRUMENTATION: A function generator is recommended to provide common mode voltage levels of: $\pm$ 10VDC to ground and a $\pm$ $10V_p$ line to ground sinusoidal signal that is swept from a range of 1Hz to 2MHz. The operator must determine a way to probe the UUT for VSMS and NR in order to determine the pass/fail status of the UUT.

TEST PLAN PARAGRAPH: BC VAL. 5.1.2.3, BC PRO. 5.1.2.2 INPUT IMPEDANCE

PURPOSE: To ensure that UUT impedance is greater than 1KΩ for transformer-coupled stubs and greater than 2KΩ for direct-coupled stubs.

1553 PARAGRAPH: 4.5.2.1.2.3

COMMENTARY: This test, as well as the Amplitude Variations test, provides a means for the test facility to verify receiver construction and operation. The wiring to the UUT, transformer, and transmitter contributions to the input impedance are also verified during this test. If possible, it is desirable to determine the phase angle of the impedance. Imposing in-house phase angle requirements will ensure that the UUTs are able to maintain similar input impedance characteristics during production.

Note that the UUT should be tested off-line per test plan using minimum length calibrated cables.

INSTRUMENTATION: An impedance analyzer is recommended for this test. It should be capable of measurements at: 75kHz, 100kHz, 250kHz, 500kHz, and 1MHz. It should be able to measure complex impedance and generate a sine wave at 1 to 2V rms at the above frequencies.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2 PROTOCOL TESTS

PURPOSE: This major paragraph contains tests on the protocol requirements of MIL-STD-1553.

1553 PARAGRAPH: 4.3, 4.4

COMMENTARY: These tests are performed with the same input waveform amplitude specified in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the same as the amplitude specified for the noise rejection test in MIL-STD-1553B. The tests are performed on only one stub type (direct- or transformer-coupled) per bus since both stub types were tested as part of the electrical tests.

INSTRUMENTATION: There are many pieces of test equipment available that provide the necessary components for the protocol portion of these two Test Plans. The equipment must be capable of simulating the RT responses to the UUT. The test signal amplitude should be $3.0V_{pp} \pm 0.1V_{pp}$ for direct-coupled stubs and $2.1V_{pp} \pm 0.1V_{pp}$ for transformer-coupled stubs (measured at Figure 1 for BC Val, Figures 1A or B for BC Pro, point A of the Test Plan). The test equipment should be able to perform all of the monitoring requirements outlined in 4.1 GENERAL MONITORING REQUIREMENTS of the Test Plan. The operator must determine a way to probe the UUT for VSMS, ISMS, NR and CS in order to determine the pass/fail status of the UUT. Any other specific simulation or error injection functions will be discussed in the individual tests below.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.1 COMMAND VOCABULARY VERIFICATION

PURPOSE: To verify the UUT's ability to send every command word required by its design.

1553 PARAGRAPH: 4.3, 4.4

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.2.1 CORRECT ADDRESS FIELD WITH BC-to-RT MESSAGE TRANSFERS

PURPOSE: To verify that the UUT rejects responses with incorrect address fields for BC-to-RT transfers and RT-to-BC transfers.

1553 PARAGRAPH: 4.3.3.5.1.2, 4.3.3.6.1, 4.3.3.6.2, 4.4.2

COMMENTARY: Address "31" (11111) is omitted from this test because it is the Broadcast address and will not be transmitted by RTs. This test verifies that the UUT's address recognition circuitry is operational.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.2.2 CORRECT ADDRESS FIELD WITH RT-to-RT MESSAGE TRANSFERS

PURPOSE: To verify that the UUT rejects responses with incorrect address fields in RT-to-RT transfers.

1553 PARAGRAPH: 4.3.3.5.1.2, 4.3.3.6.3, 4.4.2

COMMENTARY: This test verifies the ability of the UUT to recognize both the transmitting and receiving RT's address in an RT-to-RT transfer.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.3.1 MINIMUM RESPONSE TIME: BC-to-RT TRANSFERS

PURPOSE: To ensure that the UUT recognizes a response returned in the minimum allowable response time of 4.0μs.

1553 PARAGRAPH: 4.3.3.8

COMMENTARY: Each test is repeated a minimum of 1000 times for validation testing and 100 times for production testing. Repetition is necessary in an asynchronous system to ensure that the UUT will pass the test for any phase difference between its clock and the test equipment (or RT) clock.

Note that although MIL-STD-1553B restricts the minimum RT response time to 4.0μs, there is no restriction on the acceptance limit of the BC, i.e., the BC may accept response times less than 4.0μs.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. The maximum response time required for the test equipment is 4.0μs.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.3.2 MINIMUM RESPONSE TIME: RT-to-RT TRANSFERS

PURPOSE: To ensure that the UUT recognizes RT-to-RT responses returned in the minimum allowable response time of 4.0μs.

1553 PARAGRAPH: 4.3.3.8

COMMENTARY: Each test is repeated a minimum of 1000 times for validation testing and 100 times for production testing. Repetition is necessary in an asynchronous system to ensure that the UUT will pass the test for any phase difference between its clock and the test equipment (or RT) clock.

Note that although MIL-STD-1553B restricts the minimum RT response time to 4.0μs, there is no restriction on the acceptance limit of the BC, i.e., the BC may accept response times less than 4.0μs.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. The maximum response time required for the test equipment is 4.0μs.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.4.1 MINIMUM NO-RESPONSE BC-to-RT TRANSFER

PURPOSE: To verify that the UUT does not indicate a no-response before the minimum no-response time in a BC-to-RT transfer.

1553 PARAGRAPH: 4.3.3.9

COMMENTARY: Each test is repeated a minimum of 1000 times for validation testing and 100 times for production testing. Repetition is necessary in an asynchronous system to ensure that the UUT will pass the test for any phase difference between its clock and the test equipment (or RT) clock.

Note that although MIL-STD-1553B requires a minimum no-response timeout of 14.0μs, there is no restriction on the acceptance limit of the BC, i.e., the BC may accept response times greater than 14.0μs.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. The response time required for the test equipment is 14.0μs.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.4.2 MINIMUM NO-RESPONSE TIMEOUT: RT-to-RT TRANSFERS

PURPOSE: To verify that the UUT does not indicate a no-response before the minimum no-response time in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.9

COMMENTARY: Each test is repeated a minimum of 1000 times for validation testing, and 100 times for production testing. Repetition is necessary in an asynchronous system to ensure that the UUT will pass the test for phase differences between its clock and the test equipment (or RT) clock.

Note that although MIL-STD-1553B requires a minimum no-response timeout 14.0μs, there is no restriction on the acceptance limit of the BC, i.e., the BC may accept response times greater than 14.0μs.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. The response time required for the test equipment is 14.0μs.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.5.1 NO RESPONSE TIME-OUT: BC-to-RT TRANSFERS

PURPOSE: To verify that the UUT detects a non-response when an RT does not respond and, for validation, to characterize the UUT's acceptance limit.

1553 PARAGRAPH: 4.3.3.9

COMMENTARY: MIL-STD-1553B requires that BCs allow a minimum of 14.0μs for RT responses, but does not specify a maximum. These tests characterize the actual response time allowed by the UUT.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.5.2 NO-RESPONSE TIME-OUT: RT-to-RT TRANSFERS

PURPOSE: To verify that the UUT detects a no-response when an RT does not respond to an RT-to-RT transfer, and for validation, to characterize the UUT's acceptance limit.

1553 PARAGRAPH: 4.3.3.9

COMMENTARY: MIL-STD-1553B requires that BCs allow a minimum of 14.0μs for RT responses, but does not specify a maximum. In the Validation Test Plan, these tests characterize the actual response time allowed by the UUT.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6 ERROR INJECTION BC-to-RT TRANSFERS

PURPOSE: To introduce the error injection portion of the test plan and to provide the general test sequence to be used during the tests in paragraphs 5.2.1.6 to 5.2.1.6.6.

1553 PARAGRAPH: See subparagraph references

INSTRUMENTATION: See specific tests below.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.1 PARITY
5.2.1.6.1.1 STATUS WORD VALIDATION FOR TRANSMIT COMMANDS
5.2.1.6.1.2 STATUS WORD VALIDATION FOR RECEIVE COMMANDS
5.2.1.6.1.3 DATA WORD VALIDATION

PURPOSE: To test UUT responses with parity errors injected in the message stream.

1553 PARAGRAPH: 4.4.1.1

COMMENTARY: Parity errors are injected in various places in the message stream, as indicated by the test paragraph titles.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject a parity error into the status and data words.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.2 WORD LENGTH
5.2.1.6.2.1 STATUS WORD VALIDATION FOR TRANSMIT COMMANDS
5.2.1.6.2.2 STATUS WORD VALIDATION FOR RECEIVE COMMANDS
5.2.1.6.2.3 DATA WORD VALIDATION

PURPOSE: To ensure proper UUT operation when word length errors are injected in a message stream.

1553 PARAGRAPH: 4.3.3.4, 4.4.1.1

COMMENTARY: Word length errors are injected in various places in the message stream, as indicated by the test paragraph titles. The test plans specifically exclude testing of high bit count errors at the very end of any message segment. This policy was established in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. Noise on the bus occurring during a message may be masked by the bus signal. Noise on the bus during quiet times may exceed receiver thresholds but would only effect terminals if the noise looked like the start of a valid 1553 message, an unlikely occurrence. The noise on the bus that is coincident with the end of a message could easily look like an extra bit. If a terminal were required to recognize high bit counts at the end of a message, it would likely reject good messages in the presence of noise at the end of the message.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to shorten the status and data words by both one and two bits, and lengthen the status and data words by both two and three bits.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.3 BI-PHASE ENCODING
5.2.1.6.3.1 STATUS WORD VALIDATION FOR TRANSMIT COMMANDS
5.2.1.6.3.2 STATUS WORD VALIDATION FOR RECEIVE COMMANDS
5.2.1.6.3.3 DATA WORD VALIDATION

PURPOSE: These tests verify the ability of the UUT to detect an invalid Manchester II code.

1553 PARAGRAPH: 4.3.3.2, 4.4.1.1

COMMENTARY: Bi-phase encoding errors are placed in various places in the message stream. These are indicated by the test paragraph titles. These tests require that the injection of a bi-phase error not cause a parity error. This means that the bit containing the error (i.e., a missing mid-bit zero crossing) shall be considered a logic one if it is high throughout the bit time or a logic zero if it is low throughout the bit time and the polarity of the parity bit shall be determined by this definition.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject a bi-phase encoding error into the status word and each data word requested by the UUT. Only one bi-phase error may be injected per message.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.4 SYNC ENCODING
5.2.1.6.4.1 STATUS WORD SYNC VALIDATION
5.2.1.6.4.2 DATA WORD SYNC VALIDATION

PURPOSE: To verify the UUT's ability to detect and reject status and data words with invalid sync waveforms.

1553 PARAGRAPH: 4.3.3.5.3.1, 4.3.3.5.2.1, .4.1.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject the following sync patterns into the status word: 111100, 110000, 111001, 011000, 000111. The following sync patterns must be able to be injected into the data words: 000011, 001111, 000110, 100111, 111000.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.5 RESPONSE MESSAGE LENGTH
5.2.1.6.5.1 RESPONSE TO RECEIVE COMMANDS
5.2.1.6.5.2 RESPONSE TO TRANSMIT COMMANDS

PURPOSE: To verify proper UUT operation when message length errors are injected in the message stream.

1553 PARAGRAPH: 4.3.3.5.1.5, 4.3.3.6.2

COMMENTARY: For receive commands, the UUT must be able to reject a response to a receive command that contains a contiguous data word. For transmit commands, both high and low word counts are tested. For high word count, only one additional data word is added. For low word count, every possibility including zero is tested.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject both high and low word count errors and simulate contiguous data (data word contiguously following a status word and data word contiguously following a data word).

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.6.6 DISCONTIGUOUS DATA

PURPOSE: To verify the UUT's ability to detect a gap within a message.

1553 PARAGRAPH: 4.4.1.2

COMMENTARY: MIL-STD-1553B does not define a time for a discontiguous gap in a message. The value used in the test plan is 4.0μs (mid-parity to mid-sync). This value is carried forward from the RT Validation Test Plan, MIL-HDBK-1553A, Section 100.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject discontiguous data errors. The error must be between the status word and first data word and a data word pair. The gap between words should be 4.0μs (mid-parity to mid-sync). Only one error may be injected per message.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7 ERROR INJECTION: RT-to-RT TRANSFERS

PURPOSE: To verify the UUT's ability to detect errors in RT-to-RT message streams.

1553 PARAGRAPH: 4.3.3.6.3, 4.4.2 (See subsequent paragraphs below for specific errors.)

COMMENTARY: For those RT-to-RT error injection tests that have the error in the transmitting RT's message, each test sequence is run twice, once with a response from the receiving RT and once without. Normally, an error in the transmitting RT's message would cause the receiving RT to suppress its status response. It is possible, however, that an error may be caused by noise on the bus or a transient disturbance in the UUT's operation, and that a receiving RT would not detect an error reported by the BC. Therefore, the behavior of the UUT must be tested for both cases.

INSTRUMENTATION: See the specific tests below.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7.1 PARITY
5.2.1.7.1.1
STATUS WORD VALIDATION FOR RESPONSES TO RT- to-RT TRANSMIT COMMANDS
5.2.1.7.1.2
STATUS WORD VALIDATION FOR RESPONSES TO RT- to-RT RECEIVE COMMANDS
5.2.1.7.1.3
RT-to-RT DATA WORD VALIDATION

PURPOSE: To verify the UUT's ability to detect parity errors during RT-to-RT transfers.

1553 PARAGRAPH: 4.4.1.1

INSTRUMENTATION: See information in 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject the following: a parity error in the status word for the transmit command in an RT-to-RT command pair, a parity error in the status word for the receive command in the RT-to-RT command pair, and a parity error in a data word in the RT-to-RT command.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7.2 WORD LENGTH
5.2.1.7.2.1
STATUS WORD VALIDATION FOR RESPONSES TO RT- to-RT TRANSMIT COMMANDS
5.2.1.7.2.2
STATUS WORD VALIDATION FOR RESPONSES TO RT- to-RT RECEIVE COMMANDS
5.2.1.7.2.3
DATA WORD VALIDATION

PURPOSE: To verify the UUT's ability to detect word length errors in RT-to-RT responses.

1553 PARAGRAPH: 4.3.3.4, 4.4.1.1

COMMENTARY: The test plan specifically excludes testing of high bit count errors at the very end of any message segment. This policy was established in the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. Noise on the bus occurring during a message is masked by the bus signal. Noise on the bus during quiet times may exceed receiver thresholds but would only effect terminals if it looked like the start of a valid 1553 message, an unlikely occurrence. Noise on the bus that is coincident with the end of a message could easily look like an extra bit. If a terminal were required to recognize high bit counts at the end of a message, it would likely reject good messages in the presence of noise at the end of the message.

INSTRUMENTATION: See information in 5.2 PROTOCOL TESTS. In addition, the test equipment must be able to inject the word length errors:

1. Shorten the status word of the transmit response by both one and two bits, and lengthen the status word by both two and three bits.

2. Shorten the status word of the receive response by both one and two bits.

3. Shorten the data word by both one and two bits, and lengthen the data word by both two and three bits.

Only one error may be injected within a message.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7.3 BI-PHASE ENCODING
5.2.1.7.3.1
STATUS WORD VALIDATION FOR RESPONSES TO RT-to-RT TRANSMIT COMMANDS
5.2.1.7.3.2
STATUS WORD VALIDATION FOR RESPONSES TO RT-to-RT RECEIVE COMMANDS
5.2.1.7.3.3
DATA WORD VALIDATION

PURPOSE: To verify the ability of the UUT to detect an invalid Manchester II code in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.2, 4.4.1.1

COMMENTARY: The injection of a bi-phase error should not cause a parity error. This means that the bit containing the error (i.e., a missing mid-bit zero crossing) should be considered a logic one if it is high throughout the bit time, or a logic zero if it is low throughout the bit time, and the parity bit should be determined by this definition.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject a bi-phase encoding error in the status word of the transmit and receive responses and inject a bi-phase encoding error in the data words of the RT-to-RT response.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7.4 SYNC ENCODING
5.2.1.7.4.1
STATUS WORD SYNC VALIDATION FOR RESPONSE TO RT-to-RT TRANSMIT COMMANDS
5.2.1.7.4.2
STATUS WORDS SYNC VALIDATION FOR RESPONSE TO RT-to-RT RECEIVE COMMANDS
5.2.1.7.4.3
DATA WORD SYNC VALIDATION

PURPOSE: To verify the ability of the UUT to detect sync errors in status and data words in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.5.3.1, 4.3.3.5.2.1, 4.4.1.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject the following sync patterns into the status word of both the transmit and receive responses: 111100, 110000, 111001, 011000, 000111. It must also be able to inject the following sync patterns into each data word: 000011, 001111, 000110, 100111, 111000.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.1.7.5 RESPONSE MESSAGE LENGTH
5.2.1.7.5.1
MESSAGE LENGTH VALIDATION FOR RT-to-RT TRANSMIT COMMANDS
5.2.1.7.5.2
MESSAGE LENGTH VALIDATION RT-to-RT RECEIVE COMMANDS

PURPOSE: To verify the UUT's ability to reject a response containing an incorrect number of data words in an RT-to-RT transfer.

1553 PARAGRAPH: 4.3.3.5.1.5, 4.3.3.6.2

COMMENTARY: Both high and low word counts are tested. For high word count, only one additional data word is added. For low word count, every possibility including zero is tested. Also refer to 5.2.1.7 above.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to increase the requested data word count by one and reduce the requested data word count to zero, in increments of one. It must also be able to simulate contiguous data (data word contiguously following a status word) in response to the RT-to-RT receive command.

TEST PLAN PARAGRAPH: 5.2.1.7.6 DISCONTIGUOUS DATA

PURPOSE: To verify the UUT's ability to detect a gap within the transmit segment of an RT-to-RT transfer.

1553 PARAGRAPH: 4.4.1.2

COMMENTARY: MIL-STD-1553B does not define a time for a discontiguous gap in a message. The value used in the Test Plan is 4.0μs (mid-parity to mid-sync). This value is carried forward from the RT Validation Test Plan, MIL-HDBK-1553A, Section 100.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to inject discontiguous data errors. The error must be between the status word and first data word and a data word pair. The amount of gap to be injected is 4.0μs (mid-parity to mid-sync). Only one error may be injected per message.

TEST PLAN PARAGRAPH: BC VAL., BC PRO. 5.2.2.1 MODE COMMANDS
5.2.2.1.1 DYNAMIC BUS CONTROL
5.2.2.1.2 MODE COMMANDS WITHOUT DATA WORDS
5.2.2.1.3 TRANSMIT MODE COMMANDS WITH DATA WORDS
5.2.2.1.4 RECEIVE MODE COMMANDS WITH DATA WORDS

PURPOSE: This section verifies the UUT's ability to issue mode commands and process responses to mode commands.

1553 PARAGRAPH: 4.3.3.5.1.7

MC#	FUNCTION	PARAGRAPH
MC0	DYNAMIC BUS CONTROL	4.3.3.5.1.7.1
MC1	SYNCHRONIZE	4.3.3.5.1.7.2
MC2	TRANSMIT STATUS WORD	4.3.3.5.1.7.3
MC3	INITIATE SELF-TEST	4.3.3.5.1.7.4
MC4	TRANSMITTER SHUTDOWN	4.3.3.5.1.7.5
MC5	OVERRIDE TRANSMITTER SHUTDOWN	4.3.3.5.1.7.6
MC6	INHIBIT TERMINAL FLAG BIT	4.3.3.5.1.7.7
MC7	OVERRIDE INHIBIT TERMINAL FLAG BIT	4.3.3.5.1.7.8
MC8	RESET REMOTE TERMINAL	4.3.3.5.1.7.9
MC16	TRANSMIT VECTOR WORD	4.3.3.5.1.7.11
MC17	SYNCHRONIZE (WITH DATA WORD)	4.3.3.5.1.7.12

The term "MC n" was used in these tests for ease of reading.

MC#	FUNCTION	PARAGRAPH
MC18	TRANSMIT LAST COMMAND	4.3.3.5.1.7.13
MC19	TRANSMIT BIT WORD	4.3.3.5.1.7.14
MC20	SELECTED TRANSMITTER SHUTDOWN	4.3.3.5.1.7.15
MC21	OVERRIDE SELECTED TRANSMITTER SHUTDOWN	4.3.3.5.1.7.16

The term "MC n" was used in these tests for ease of reading.

Erroneous responses are used in the test sequences to ensure the UUT's ability to accept only valid responses.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to set the status response as shown for each test below (asterisk denotes instrumentation requirements for BC Validation only).

5.2.2.1.1 DYNAMIC BUS CONTROL

1. Set the Dynamic Bus Control Bit.

2.* Inject a parity error with the Dynamic Bus Control bit set.

3.* A valid status word with an invalid RT address.

4.* A valid status word with the Dynamic Bus Control bit set and a contiguous valid data word.

5.* Legal status word with the Dynamic Bus Control bit set on an alternate bus.

5.2.2.1.2 MODE COMMANDS WITHOUT DATA WORDS

1. Valid, legal status word.

2.* No response.

3.* A legal status word with invalid parity.

4.* A valid status word with an invalid RT address.

5.* A valid status word with an contiguous valid data word.

6.* Valid status word on an alternate bus.

5.2.2.1.3 TRANSMIT MODE COMMANDS WITH DATA WORDS

1. Valid status word and one contiguous data word

2.* No response

3.* Status word with valid parity and a valid data word

4.* A valid status word with an invalid RT address and a valid data word.

5.* A valid status word without a data word.

6.* A valid status word with two contiguous, valid data words.

7.* A valid status word and a legal data word with a parity error.

8.* Status word and one contiguous valid data word on an alternate bus.

5.2.2.1.4 RECEIVE MODE COMMANDS WITH DATA WORDS

1. Valid status word and one contiguous data word.

2.* No response.

3.* A legal status word with invalid parity.

4.* A valid status word with an invalid RT address.

5.* A valid status word with a contiguous valid data word.

6.* Status word on an alternate bus.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.2.2 STATUS WORD
5.2.2.2.1
STATUS BITS, RECEIVE COMMANDS
5.2.2.2.2
STATUS BITS, TRANSMIT COMMANDS
5.2.2.2.3
STATUS BITS, RT-to-RT COMMANDS, TRANSMITTER STATUS
5.2.2.2.4
STATUS BITS, RT-to-RT COMMANDS, RECEIVE STATUS
5.2.2.2.5
STATUS BITS, MODE COMMANDS

PURPOSE: To verify the UUT's ability to recognize each of the eleven status code bits in a returned status word.

1553 PARAGRAPH: 4.3.3.5.3

COMMENTARY: During these tests, status bits are tested for each message transfer type. The types are indicated by the test paragraph name. Below is a list of the eleven status bits and their related MIL-STD-1553 paragraph.

1553 BIT TIME	MIL-STD-1553 NAME	PARAGRAPH
09	MESSAGE ERROR	4.3.3.5.3.3
10	INSTRUMENTATION	4.3.3.5.3.4
11	SERVICE REQUEST	4.3.3.5.3.5
12 - 14	RESERVED	4.3.3.5.3.6
15	BROADCAST COMMAND RECEIVED BIT	4.3.3.5.3.7
16	BUSY BIT	4.3.3.5.3.8
17	SUBSYSTEM FLAG BIT	4.3.3.5.3.9
18	DYNAMIC BUS CONTROL ACCEPTANCE BIT	4.3.3.5.3.10
19	TERMINAL FLAG BIT	4.3.3.5.3.11

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to set each of the eleven remaining bits in the status word. It must also respond with the appropriate number of data words, excluding the "Busy" bit state.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.2.3 BROADCAST COMMAND
5.2.2.3.1 BROADCAST RECEIVE COMMANDS
5.2.2.3.2 BROADCAST RECEIVE COMMANDS WITH RESPONSES
5.2.2.3.3 BROADCAST RT-to-RT COMMANDS
5.2.2.3.3.1 BROADCAST RT-to-RT COMMAND WITH NO RESPONSE
5.2.2.3.3.2 BROADCAST RT-to-RT COMMAND WITH RESPONSES
5.2.2.3.3.3 NORMAL BROADCAST RT-to-RT COMMAND
5.2.2.3.4 BROADCAST MODE COMMANDS
5.2.2.3.5 BROADCAST MODE COMMANDS WITH RESPONSE

PURPOSE: To test UUT behavior in the broadcast mode of operation.

1553 PARAGRAPH: 4.3.3.6.7, 4.3.3.6.7.1, 4.3.3.6.7.2, 4.3.3.6.7.3, 4.3.3.6.7.4

COMMENTARY: All broadcast message transfers are tested during these tests. The transfer type is indicated by the test paragraph title.

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. In addition, the test equipment must be able to respond to a receive broadcast command with a valid status word. It must be able to respond to both the transmit and receive portions of the RT-to-RT broadcast command with status words and appropriate number of data words. Finally, it must respond with a valid status word in conjunction with the appropriate broadcast mode commands.

TEST PLAN PARAGRAPH: BC VAL., & BC PRO. 5.2.2.4 RESPONSE ON ALTERNATE BUS

PURPOSE: To verify that the UUT does not accept a response on the alternate bus.

1553 PARAGRAPH: 4.6.3.1

INSTRUMENTATION: See information under 5.2 PROTOCOL TESTS of the Test Plan. The test equipment must respond to every command received from the UUT on the opposite bus.

TEST PLAN PARAGRAPH: BC VAL. 5.3 NOISE REJECTION

PURPOSE: To verify the UUT's ability to operate in the presence of noise.

1553 PARAGRAPH: 4.5.2.2.2.4

COMMENTARY: MIL-STD-1553B defines a noise rejection test appropriate to RTs but not to BCs. Where an error for an RT is defined as a No-Response or the setting of the message error bit, the Test Plan defines an error for a BC as any condition resulting in an invalid word detection (and therefore an invalid message segment). The pass/fail criteria are the same as defined in MIL-STD-1553B for RTs.

INSTRUMENTATION: A white Gaussian noise generator is necessary for this test. The noise must have a bandwidth from 1.0kHz to 4.0 MHz with an rms amplitude of 140mV for transformer-coupling and 200mV for direct-coupling. The noise generator load is 70Ω for transformer coupling and 35Ωs for direct-coupling. Refer to Figure 8 of the Test Plan for the hardware configuration. Table 2 in the Test Plan gives the pass/fail criteria for this test.

CHAPTER 4

AS4115 TEST PLAN FOR THE AIRCRAFT TIME DIVISION COMMAND/RESPONSE DATA BUS SYSTEM.

INTRODUCTION:

The purpose of the system test plan is to provide a guide for system integration testing. It is intended that the individual components which comprise the system have been verified using the appropriate test plan for that equipment level. This is the first test plan where a piece of equipment may be removed from the laboratory environment and connected in the actual system configuration. It is of particular importance to verify that, in this configuration, the equipment still meets the requirements of MIL-STD-1553. Successful completion of the test plan for that equipment indicates that the system, as configured, is compliant. If the system is reconfigured at any time after verification, it is expected that the appropriate tests be performed to re-verify performance.

GENERAL INSTRUMENTATION NEEDS:

A waveform generator that is capable of simulating valid MIL-STD-1553 signals is needed in some of the tests in this Test Plan. This device should have the following minimum characteristics:

1. Capable of generating valid MIL-STD-1553 waveforms, as both the BC and RT.

2. Provide a minimum amplitude of $9.0V_{pp}$ for direct-coupled stubs and $27.0V_{pp}$ for transformer-coupled stubs.

Note that the intent of this handbook is to provide minimum test hardware requirements and not to discuss all of the various implementations available.

TEST PLAN PARAGRAPH: 4.1 GENERAL MONITORING REQUIREMENTS

PURPOSE: To establish test equipment monitoring criteria.

1553 PARAGRAPH: See Below.

COMMENTARY: It is intended that the parameters listed be monitored constantly during testing. The Test Plan paragraph implies that a bus monitor function is required and must be capable of verifying certain timing events, word formats and protocol responses. The general monitoring requirements listed in paragraph 4.1 of the test plan are basic requirements of 1553. The monitoring requirements and the 1553 paragraphs are listed below in the instrumentation section.

INSTRUMENTATION: The instrumentation selected must be able to monitor MIL-STD-1553 signals. It must be capable of capturing the 1553 messages that are sent over the 1553 bus. The monitor should be capable of verifying timing events, protocol errors, and word formats specified in MIL-STD-1553. Minimum monitoring requirements are listed below:

1) response time - 1553, para. 4.3.3.8 - "RESPONSE TIME"

The monitor used in this environment must be able to detect and decode UUT responses which fall not only within the 4 - 12μs required in MIL-STD-1553, but also responses which occur in less than 4 and greater than 12μsec. This is important for distinguishing a "no response" from a late or early response. Since no tolerance is provided in MIL-STD-1553, a safe method for ensuring that UUTs meet the response time criteria is to impose slightly tighter response time requirements in the monitor.

2) contiguous data - 1553 para. 4.4.1.2 - "DATA CONTINUITY"

1553 states that all data shall be contiguous, but does not set an actual limit. The monitor used for system testing should be able to detect discontiguities of 2.5μsec. Monitoring the UUT for no discontiguity is ideal; however, it is felt that the 2.5μs imposed is reasonable (2.5μs as measured in Figure 1 at the end of this document).

3) proper manchester encoding - 1553 para. 4.3.3 - "TRANSMISSION METHOD"

The monitor used in this function must be able to detect and flag 1553 words with missing transitions. This applies for any edge in any word on the 1553 bus.

4) proper bit count - 1553 para. 4.3.3.4 - "WORD SIZE"

The monitor should flag any 1553 words which contain the wrong number of bits. Most available decoders can detect missing bits anywhere in a 1553 message. Also, most decoders can detect extra bits anywhere in the message except the last word of a receive message. It is generally considered that RTs cannot pass noise (1553 paragraph 4.5.2.1.4) and detect extra bits at the end of a transmission. The monitor used in production testing need not pass the rigors of 1553 noise rejection. This means that the optimum monitor for the production environment would be one which can detect and flag extra bits in a 1553 word, no matter where they occur in the message.

5) odd parity - 1553 para. 4.3.3.5.1.6 - "PARITY"

The bus monitor function in the production test environment must be able to detect and flag 1553 words on the data bus whose bit time 20, parity bit, is not the proper phase to indicate odd parity.

6) proper terminal address in status - 1553 para. 4.3.3.5.3.2 - "RT ADDRESS" (STATUS)

7) proper word count - 1553 para. 4.3.3.5.1.5 - "DATA WORD COUNT/MODE FIELD"

The monitor needs to be cognizant of the word count in the commands and verify proper UUT operation.

It is the responsibility of the bus monitor function, BC, or both, to ensure that the RT address field of the UUT status word is always equal to the RT address of the associated command word. Generally, this simple task is managed in the software of an automated set up.

8) reserved status and instrumentation bits are set to zero - 1553 para. 4.3.3.5.3.6 - "RESERVED STATUS BITS", - 1553 para. 4.3.3.5.3.4 - "INSTRUMENTATION BIT"

The monitor must detect and flag any UUT status response where the reserved and/or instrumentation bits are not logical zero.

9) proper sync - 1553 para. 4.3.3.5.1.1 - "SYNC" command words
1553 para. 4.3.3.5.2.1 - "SYNC" data words

All sync fields of all words transmitted by the UUT must be examined for the proper sync waveform.

10) That the specified command sequences and timing are tested and verified.

11) Illegal bus traffic.

The system commands and/or responses that are not implemented should be detected as errors and commands that are implemented be executed in proper sequence.

TEST PLAN PARAGRAPH: 4.2 TIME DOMAIN REFLECTOMETRY (TDR) CONSIDERATIONS

PURPOSE: This paragraph is a suggestion for qualitative evaluation of the physical bus network.

1553 PARAGRAPH: 4.5.1

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.1 BUS NETWORK TESTS

PURPOSE: To verify the bus network as a separate physical entity prior to BC and RT integration.

1553 PARAGRAPH: 4.5

COMMENTARY: 1KΩ and 2KΩ values were selected because these values represent the minimum values in 1553 for minimum impedance. If the terminal is not present, the worst case values are used.

Pertaining to the "shorting stub" (Test Plan requirements a and b), 0Ω is selected for transformer connections because a zero ohm short may exist. The 110Ω simulates a failure on the terminal side of the fault isolation resistors.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.1.1.1 SHIELD CONTINUITY

PURPOSE: To ensure continuity of the bus cable shield throughout the bus network.

1553 PARAGRAPH: N/A

COMMENTARY: .012Ω/ft is used in this paragraph because this is what a typical shield should measure. This is accomplished section by section-to-avoid confusion where couplers are connected to frame ground.

INSTRUMENTATION: An ohmmeter is needed to measure the continuity for the shield.

TEST PLAN PARAGRAPH: 5.1.1.2 BUS CONTINUITY

PURPOSE: To verify continuity of the data bus physical transmission medium.

1553 PARAGRAPH: N/A

INSTRUMENTATION: An ohmmeter is needed to measure the continuity for the bus.

TEST PLAN PARAGRAPH: 5.1.1.3 BUS ISOLATION

PURPOSE: To establish a reasonable criteria for DC resistance between the connectors and shields of the actual cable used in a 1553 system.

1553 PARAGRAPH: N/A

COMMENTARY: This test is included to ensure a minimum, reasonable DC isolation resistance of the bus cable prior to installation of the bus couplers and other components.

INSTRUMENTATION: A megohmmeter is needed to measure the bus isolation.

TEST PLAN PARAGRAPH: 5.1.1.4 TRANSFORMER-COUPLED STUBS

PURPOSE: To verify reasonable DCR of the transformers in parallel.

1553 PARAGRAPH: N/A

INSTRUMENTATION: An ohmmeter is needed to take this measurement.

TEST PLAN PARAGRAPH: 5.1.1.5 TRANSFORMER-COUPLED FAULT ISOLATION RESISTANCE

PURPOSE: To determine that the bus isolation resistors are intact.

1553 PARAGRAPH: 4.5.1.5.1.2

COMMENTARY: $R_t = R_{ISO1} + R_{ISO2} + R_{tdcr}$. This includes the allowable Z_o variation as specified in 1553 plus the dR of winding plus 2% tolerance of isolation resistors.

INSTRUMENTATION: An ohmmeter is needed to take this measurement.

TEST PLAN PARAGRAPH: 5.1.1.6 TRANSFORMER-COUPLED ISOLATION

PURPOSE: To establish a minimum isolation of the coupling transformer.

1553 PARAGRAPH: N/A

INSTRUMENTATION: A megohmmeter is needed to take this measurement.

TEST PLAN PARAGRAPH: 5.1.2 IMPEDANCE

PURPOSE: To set up sequence for the following impedances.

1553 PARAGRAPH: 4.5.1

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.1.2.1 BUS IMPEDANCE

PURPOSE: To characterize, for reference, the bus impedance.

1553 PARAGRAPH: 4.5.1

INSTRUMENTATION: An impedance analyzer is recommended for this test. It should be capable of measurements at 1MHz. It should also be able to measure complex impedance and generate a sine wave of 1 to 2V rms at 75kHz and 1.0MHz.

TEST PLAN PARAGRAPH: 5.1.2.2 STUB IMPEDANCE FOR TRANSFORMER-COUPLED STUBS

PURPOSE: To characterize stub impedances.

1553 PARAGRAPH: 4.5.1

COMMENTARY: Performance of this test will yield data important to the characterization of the bus network, especially to determine if there are any adverse effects to performance when stubs are shorted. This test also provides reference data which can be used for comparison during system production testing. Comparing the reference data to production data demonstrates consistency of the components which compromise the bus network.

INSTRUMENTATION: An impedance analyzer is recommended for this test. It should be capable of measurements at 1MHz. It should also be able to measure complex impedance and generate a sine wave of 1 to 2V rms at 75kHz and 1.0MHz.

TEST PLAN PARAGRAPH: 5.1.3 DYNAMIC FAULT EFFECTS

PURPOSE: This test was developed to simulate possible intermittent shorts caused by shorted components.

1553 PARAGRAPH: 4.5.1.5.1, 4.5.1.5.2, 4.5.1.5.1.2, 4.5.1.5.1.4, 4.5.1.5.2.1, 4.5.1.5.2.3

INSTRUMENTATION: A BC and RT are necessary for this test as well as a high speed electronic switch. The operating requirements for the switch are:

1. An "on" resistance of less than 5Ω.

2. A switching speed of less than 1μs.

3. Be able to operate at a frequency of 30kHz ± 3kHz.

TEST PLAN PARAGRAPH: 5.1.4.1 BUS ATTENUATION

PURPOSE: This test is performed for characterization purposes.

1553 PARAGRAPH: N/A

COMMENTARY: The test frequencies, 250kHz and 1.0MHz, represent the lowest and highest switching frequencies utilized in 1553 bus traffic.

INSTRUMENTATION: A function generator that is capable of $6.0V_{pp}$ into 35Ω at 250kHz and 1MHz is required to inject a sinusoidal frequency onto the bus. A 50MHz bandwidth oscilloscope is necessary to measure the value of V_b for both frequencies.

TEST PLAN PARAGRAPH: 5.1.4.2 BUS/COUPLER ATTENUATION

PURPOSE: To verify proper levels are maintained throughout the bus network.

1553 PARAGRAPH: N/A

COMMENTARY: Minimum output amplitudes from a terminal are used to verify minimum receiver input amplitudes at every other terminal position; for example 6.0V_{pp} from any direct terminal position must produce a minimum of 1.2V_{pp} at any other terminal position.

INSTRUMENTATION: A function generator that is capable of 6.0V_{pp} into 140Ω and 18.0V_{pp} into 70Ω at 1MHz is required to inject a sinusoidal frequency onto the the bus. A 50MHz bandwidth oscilloscope is necessary to measure the value of V_s.

TEST PLAN PARAGRAPH: 5.1.5.1 REDUNDANT BUS ISOLATION

PURPOSE: To verify that the bus network isolation is 65dB minimum.

1553 PARAGRAPH: 4.6.1

COMMENTARY: 65dB between buses was chosen to exceed required isolation within any terminal so that bus network does not contribute to coupling between buses.

INSTRUMENTATION: A function generator that is capable of 9.0V_{pp}, 35Ω at 1MHz is required to inject a sinusoidal frequency onto the bus. A 50MHz bandwidth oscilloscope is necessary to measure the value of V_b.

TEST PLAN PARAGRAPH: 5.1.5.2 MULTIPLE BUS ISOLATION

PURPOSE: To verify 65dB minimum isolation between any two buses in a multiple bus configuration.

1553 PARAGRAPH: 4.6.1

COMMENTARY:????

INSTRUMENTATION: A function generator that is capable of 9.0V_{pp}, 35Ω at 1MHz is required to inject a sinusoidal frequency onto the bus. A 50MHz bandwidth oscilloscope is necessary to measure the value of V_b.

TEST PLAN PARAGRAPH: 5.1.6 COMMON MODE REJECTION

PURPOSE: To verify proper bus network operation in the presence of large common mode signals.

1553 PARAGRAPH: 4.5.2.1.2.2

COMMENTARY: The repetition rate (50%) and test duration (90 sec) are specified in this test to ensure a reasonable sampling of each sweep frequency.

INSTRUMENTATION: A BC and RT are needed for this test. A function generator is also needed to provide a common mode voltage levels of ± 10.0VDC line-to-ground and a ± 10.0V_p line-to-ground sinusoidal signal swept from 1.0Hz to 2.0MHz.

TEST PLAN PARAGRAPH: 5.1.7.1 ZERO CROSSING DISTORTION

PURPOSE: To characterize zero crossing distortions contributed by the bus network.

1553 PARAGRAPH: 4.5.2.1.1.2, 4.5.2.2.1.1.2, 4.5.2.1.2.1, 4.5.2.2.2.1

COMMENTARY: The worst case distortions can probably be observed using different combinations of high/low and longest/shortest pulse durations. These patterns are obtained using the following sync/data fields:

1) Command sync followed by logical zero for bit time 4.

2) Data sync followed by logical one for bit time 4.

3) Parity bit of logical one followed by data sync.

4) Parity bit of logical zero followed by command sync.
(**NOTE:** THIS PATTERN CAN BE OBTAINED IN RT-to-RT TRANSFERS)

INSTRUMENTATION: See GENERAL INSTRUMENTATION NEEDS above. In addition, the test equipment must be capable of providing a zero crossing deviation of ± 10ns from the ideal. The amplitude must be 9.0V_{pp} for direct-coupled stubs and 27.0V_{pp} for transformer-coupled stubs. The rise/fall times must be 300ns ± 30ns. A 100MHz bandwidth scope is recommended so the 1553 waveform may be viewed and the measurement taken.

TEST PLAN PARAGRAPH: 5.1.8 DATA PATH INTEGRITY

PURPOSE: To verify the integrity of every data path of the network using actual BC and RTs and messages at each stub.

1553 PARAGRAPH: 4.2, 4.3.3.7, 4.3.3.8, 4.4.3.5, 4.4.3.6

COMMENTARY: The test is an operating test where messages are sent on the bus network, proper responses checked, and data content checked.

INSTRUMENTATION: A BC and RT are needed for this test. The transmitted waveforms must have an amplitude of 6.0V_{pp} for direct-coupled stubs and 18.0V_{pp} for transformer-coupled stubs.

TEST PLAN PARAGRAPH: 5.2.1 INTRODUCTION

PURPOSE: Lead in to system tests
1553 PARAGRAPH: N/A

COMMENTARY: This paragraph explains the purpose and methodology of the ensuing test paragraphs, namely that they are guideline requirements since bus systems can vary so drastically depending on function.

INSTRUMENTATION: An active BC, RT(s), a Bus Monitor(s), and the actual bus network(s) are advised for the System Integration Tests.

TEST PLAN PARAGRAPH: 5.2.2 ASSUMPTIONS

PURPOSE: Statement of preliminary requirements

1553 PARAGRAPH: N/A

COMMENTARY: The individual components of the bus system must have been checked for proper operation prior to integration. System integration tests will then determine whether the system meets its requirements when all components are operating together.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.3 POWER UP SEQUENCE

PURPOSE: Verify proper system power up sequence. Also, verify that during power sequencing, no 1553 words are improperly emitted from the terminals and that spurious noise is within specified limits.

1553 PARAGRAPH: 4.5.2.1.1.3, 4.5.2.2.1.3, 30.10.6

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.3.1 RT POWER-UP

PURPOSE: Verify proper RT power-up sequence, that during power sequencing, no 1553 words are improperly emitted from terminals, and that the spurious noise is within specified limits.

1553 PARAGRAPH: 4.5.2.1.1.3, 4.5.2.2.1.3, 30.10.6

COMMENTARY: In these tests, the BC(s) is (are) simulated by test equipment. The system defined power-up sequence is checked, as well as the power off/on noise and bus traffic. The simulated BC(s) then transmit the system initialization, test, etc., commands as defined by the system specification and the responses are checked for conformity to required responses. BIT capabilities are also tested in these tests. The software in the simulated BC(s) is test software, written specifically for these tests, borrowing some of the OFP Input/Output (I/O) software, where applicable.

INSTRUMENTATION: A bus tester is needed to provide the BC and Bus Monitor functions. See 4.1 of the Test Plan for Monitoring Requirements for the Bus Monitor. The BC functions in this test are limited to sending messages to the RTs on the bus. A 50MHz bandwidth oscilloscope is recommended to perform the necessary measurements.

TEST PLAN PARAGRAPH: 5.2.3.2 BC POWER-UP

PURPOSE: These tests verify normal system power-up, particularly checking the initial messages on the bus, and proper BC operation. Noise is also checked.

1553 PARAGRAPH: 4.5.2.1.1.3, 4.5.2.2.1.3, 30.10.6

COMMENTARY: These tests are run with the system in its operational configuration and with test equipment attached for monitoring purposes only. The power-up bus traffic is monitored and checked for compliance with that specified for the power-up sequence. Results of BIT procedures are also checked for compliance. Finally, at the end of these tests, start of normal operation is verified.

INSTRUMENTATION: A Bus Monitor is needed for this test. See 4.1 of the Test Plan for specific requirements. A 50MHz bandwidth oscilloscope is recommended to perform the necessary measurements.

TEST PLAN PARAGRAPH: 5.2.4 NORMAL OPERATION

PURPOSE: Check subparagraph tests for normal system operation.

1553 PARAGRAPH: N/A

COMMENTARY: This is a title lead in to subparagraphs only.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.4.1 DEFINITION

PURPOSE: To define normal operational bus traffic.

1553 PARAGRAPH: N/A

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.4.2 MONITOR FOR PROPER SEQUENCING

PURPOSE: To check that the bus traffic is in the proper sequence as designed for I/O routines. Time limits are also monitored.

1553 PARAGRAPH: N/A

COMMENTARY: These tests check that all message formats, message location within minor or sub-frames, and frame positioning are per defined I/O sequencing. In addition, response and intermessage gap times are also checked for conformance with system requirements.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific requirements.

TEST PLAN PARAGRAPH: 5.2.4.3 OPERATIONAL MODES

PURPOSE: To test the system under the various modes of operation.

1553 PARAGRAPH: N/A

COMMENTARY: Operational modes of a system produce different message traffic patterns, in some cases effecting signal characteristics. Any required simulation may not change the bus traffic for a mode of operation.

INSTRUMENTATION: A 100MHz oscilloscope is recommended to monitor the electrical characteristics of the bus (i.e. ringing, wave shape, common mode voltage etc.) during the changing modes.

TEST PLAN PARAGRAPH: 5.2.4.4 EXERCISE OF OPTIONS

PURPOSE: To test the optional 1553 requirements implemented for the bus system.

1553 PARAGRAPH: VARIOUS

COMMENTARY: This is a lead in paragraph to those which follow.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.4.4.1 DYNAMIC BUS CONTROL

PURPOSE: To test the dynamic bus control operation, where implemented in a bus system.

1553 PARAGRAPH: 4.3.3.5.1.7.1, 4.3.3.5.3.10

COMMENTARY: This is a lead in paragraph to those following. The tests will probably require some test software or the setting of an external condition to cause the terminal to accept or reject bus control. It should be noted that these tests were not performed in the BC Validation or Production Test Plans since they are considered system functions.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor function. See 4.1 of the Test Plan for specific requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.1.1 ACCEPTANCE

PURPOSE: To test that a terminal successfully accepts, and the former BC relinquishes the BC function.

1553 PARAGRAPH: 4.3.3.5.1.7.1, 4.3.3.5.3.10

COMMENTARY: The Dynamic Bus Control Acceptance bit in the RT status word is monitored for indication of acceptance by the terminal. Also, cessation of issuance of commands by the former BC is monitored, following detection of the setting of the Bus Control Acceptance bit.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the addressed RT takes over the BC functions and the BC stops performing controller functions. See 4.1 of the Test Plan for specific monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.1.2 REJECTION

PURPOSE: To monitor that if a terminal rejects bus control, the present BC will continue in that function.

1553 PARAGRAPH: 4.3.3.5.1.7.1, 4.3.3.5.3.10

COMMENTARY: The Dynamic Bus Control Acceptance bit in the status word of the RT is monitored for a logic zero (non-acceptance) with the RT offered bus control forced not to accept bus control. Some external means or test software must be used to force the RT offered control to reject same or to be placed in a mode where it would normally reject control.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the RT addressed does not take over the BC functions. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.2 BACKUP BC

PURPOSE: To test the capability of backup BC(s) to take control of a bus and shutdown the primary BC.

1553 PARAGRAPH: N/A

COMMENTARY: These tests are only for terminals where BC switchover function is controlled by discrete(s). The switchover can easily be forced by externally controlling the input discrete(s) which control(s) the switchover. Bus traffic is monitored to verify that the backup BC has taken control and that the primary BC has relinquished control. These tests are most important in United States Air Force (USAF) applications where Dynamic Bus Control is not allowed to be implemented.

Backup BCs which assume control only under error conditions or those which also have such capability in addition to normal discrete direction, have their functions tested in 5.2.6.4.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the backup BC takes over the bus control functions and the primary BC no longer controls the bus. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.3 SERVICE REQUEST

PURPOSE: Verify that the BC follows the system defined required response when an RT sets the Service Request bit in the RT status word.

1553 PARAGRAPH: 4.3.3.5.3.5

COMMENTARY: The Service Request bit can be artificially set or monitored for normal operational setting. The BC action is monitored for proper response such as a vector word command transmitted, direct subaddress command for data, or no action if the Service Request bit is set improperly, as defined by the system specification or Multiplex Interface Control Documents (MICDs).

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the BC reacts in accordance with the system specification when the service request bit is set in an RT's status word. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.4 BUSY

PURPOSE: Verify that the BC follows the system defined required response when an RT sets the busy bit in its status word response.

1553 PARAGRAPH: 4.3.3.5.3.8

COMMENTARY: The Busy bit can be artificially set or monitored for normal operational setting. The BC operation is monitored for retry, following a prescribed delay, polling until busy is reset, or no action, as defined by the system specification or MICD.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the BC reacts to system specification when the Busy bit is set in a RT's status word. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.5 MODE COMMANDS

PURPOSE: To ensure proper system implementation of mode commands.

1553 PARAGRAPH: 4.3.3.5.1.7

COMMENTARY: It is expected that during this test, the mission aspects of the terminals be tested. The performance criteria shall be as specified in the system specification or MICD.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions, specifically that the mode codes sent are handled properly. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.4.4.6 EMERGENCY POWER OPERATION

PURPOSE: To ensure that the system operates properly during emergency power modes.

1553 PARAGRAPH: N/A

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitor requirements.

TEST PLAN PARAGRAPH: 5.2.5 ERROR MONITORING

PURPOSE: This test characterizes errors which may occur during normal system operation.

1553 PARAGRAPH: N/A

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. All errors that occur during the four hour test must be recorded. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.6 ERROR HANDLING PROCEDURES
5.2.6.1 RT-to-RT TRANSFERS
5.2.6.2 SUPPRESSED RESPONSE
5.2.6.3 POWER CYCLE TEST
5.2.6.4 BACKUP BUS CONTROLLER OPERATIONS
5.2.6.5 BUS RETRIES
5.2.6.6 SYSTEM RESET
5.2.6.7 BUS SWITCHING
5.2.6.8 ILLEGAL COMMANDS

PURPOSE: To verify proper error response of the system.

1553 PARAGRAPH: N/A

COMMENTARY: During these series of tests, the UUT is subjected to abnormal (erroneous) situations and the responses are characterized. The ability to properly handle an erroneous sequence is built into the individual terminals. These system level tests examine the system response and interactions among terminals.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements. In addition, the tester may be used for the RTs to inject a parity or encoding error into the data word. The tester must also be able to monitor both buses (primary and secondary) simultaneously.

TEST PLAN PARAGRAPH: 5.2.7 MULTIPLE BUS ARCHITECTURE
5.2.7.1 INTRODUCTION

PURPOSE: To the interrelationship between channels in a multiple bus architecture.

1553 PARAGRAPH: N/A

COMMENTARY: The tests in the succeeding three sections determine the authenticity of data (validity and latency) that is transferred between channels (where a channel is a MIL-STD-1553 bus, see Figure 4) via a subsystem's terminal interchange. In addition, one channel should not experience difficulty (e.g., stop transferring data) because it is awaiting data from another channel. This should also be checked.

INSTRUMENTATION: See tests 5.2.7.2 - 5.2.7.4.

TEST PLAN PARAGRAPH: 5.2.7.2 DATA VALIDITY

PURPOSE: To check that valid data is correctly transferred from one bus to another and that invalid data is not.

1553 PARAGRAPH: 1553A: 4.2.5.4.4
1553(USAF): 4.2.5.5
1553B: 4.4.1.1, 4.4.3.5, 4.4.3.6

COMMENTARY: Messages, or subsets of messages, on one channel of a bus system may be transferred to another channel. This is usually done via equipment with terminals on multiple channels, such as a control computer. Checks should be made to ensure that messages or data words match. Validity errors introduced in messages or data words on one channel shall cause rejection of such messages or data, and those messages or data must therefore not be transferred to another channel.

INSTRUMENTATION: A bus tester for each channel is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements. In addition, the tester must be able to monitor both buses (primary and secondary) simultaneously.

TEST PLAN PARAGRAPH: 5.2.7.3 LATENCY

PURPOSE: To check that the data is passed between channels within the time constraints specified by the system specification.

1553 PARAGRAPH: N/A

COMMENTARY: Messages on one channels of a bus system may be transferred to another channel. The timing of this transfer may be dependent on frame rates, I/O channel interrupts and associated processing time, or error processing time. Checks shall be made to ensure that the data arrives at the sink terminal(s) within the time constraints specified by the system specification or MICD.

INSTRUMENTATION: A bus tester for each channel is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements. In addition, the tester must be able to monitor both buses (primary and secondary) simultaneously.

TEST PLAN PARAGRAPH: 5.2.7.4 DEADLOCK

PURPOSE: To ensure that a bus system is designed to prevent a dead-lock in data transfer on one channel because of unavailability of data from another channel.

1553 PARAGRAPH: N/A

INSTRUMENTATION: A bus tester for each channel is needed to provide the Bus Monitor functions. See 4.1 for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.8 MIXING 1553 (USAF) 1553A AND 1553B TERMINALS

PURPOSE: The succeeding paragraphs detail the system design problems which must be resolved and checked where 1553 (USAF), 1553A, and 1553B terminals are mixed on the same bus.

1553 PARAGRAPH: N/A

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.8.1 STATUS WORD BITS

PURPOSE: To check that the status words from 1553 (USAF), 1553A, and 1553B terminals are processed properly by the BC.

1553 PARAGRAPH:

1553A	4.2.3.5.3
1553B	4.3.3.5.3
1553(USAF)	4.2.3.5.3

COMMENTARY: With the differences in makeup of the status words among the three standards, it must be verified that the BC properly interprets the bits. This becomes a test of the software I/O routines where, depending on terminal specification requirements, the status word contents may differ.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH:

5.2.8.2 MODE COMMANDS
5.2.8.2.1 DEFINED MODE COMMANDS
5.2.8.2.2 SUBADDRESS/MODE FIELD

PURPOSE: To check that mode commands to 1553(USAF) , 1553A, and 1553B terminals are properly implemented and that a proper terminal response is received.

1553 PARAGRAPH:

1553A	4.2.3.5.1.7
1553B	4.3.3.5.1.7
1553(USAF)	4.2.3.5.1.4

COMMENTARY: The differences in definition of mode codes for the 1553 (USAF), 1553A, and 1553B require that special care be taken as to the mode codes issued to those terminals. In addition, the subaddress/mode values 00000 and 11111 can be interpreted differently for 1553 (USAF), 1553A, and 1553B terminals. The software I/O routines must be checked carefully to ensure that the proper protocol for that type terminal is observed. In addition, effect on broadcast of the various protocols must also be checked.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.8.3 RESPONSE TIME

PURPOSE: To check that the response times of the 1553 (USAF), 1553A, and 1553B terminals are handled properly.

1553 PARAGRAPH: 1553 4.3.1
1553B 4.3.3.8
1553(USAF) 4.3.1

COMMENTARY: Proper time out of 1553A and 1553B BCs must be checked for compatibility with the 1553A and 1553B RTs.

INSTRUMENTATION: A bus tester is needed to provide the Bus Monitor functions. See 4.1 of the Test Plan for specific Monitoring requirements.

TEST PLAN PARAGRAPH: 5.2.8.4 COUPLER VARIATIONS

PURPOSE: To verify use of the proper bus couplers in a mixed terminal configuration.

1553 PARAGRAPH: 1553A 4.2.4.6
1553B 4.5.1.5.1; Notice 2:30.10.5
1553(USAF) 4.2.5.1, 4.2.5.2

COMMENTARY: Care must be taken to match the bus coupler to the terminal in a mixed terminal configuration to ensure that the proper min-max voltages appear at a terminal receiver. In addition, the loading on the terminal driver is effected by the coupler used. Driver reliability should not be compromised by excess loading caused by an improper coupler transformer ratio.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.8.2 VOLTAGE LEVELS
5.2.8.5.1 OUTPUT VOLTAGE
5.2.8.5.2 INPUT VOLTAGE

PURPOSE: To ensure that the proper terminal input and output voltages are maintained where different terminals are on a bus.

1553 PARAGRAPH: 1553A 4.2.5.3.1, 4.2.5.3.3, 4.2.5.4.1, 4.3.3
1553B 4.5.2.1.1.1, 4.5.1.5.1.4, 4.5.1.5.2.3, 4.5.2.1.2.1, 4.5.2.2.1.1, 4.5.2.2.2.1, 4.5.2.1.1.3, 4.5.2.1.2.4, 4.5.2.2.1.4, 4.5.2.2.2.4
Notice 2:30.10.6
1553(USAF) 4.2.5.3.2, 4.2.5.3.4, 4.2.5.4.1, 4.2.5.4.2

COMMENTARY: These paragraphs and the preceding (couplers) paragraphs go together in that the solution of coupler determines these voltage levels. Another area which should be addressed herein is the noise level requirements for each type terminal. Original requirements were not as stringent so that effect of noise outputs from the various terminal types on the bus system must be measured and assessed.

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 5.2.8.6 TERMINAL ADDRESS

PURPOSE: To ensure compatibility of 1553 USAF and 1553A RT address assignments with system protocol (use of broadcast for 1553B RTs).

1553 PARAGRAPH:	1553A	4.2.3.5.1.2
	1553B	4.3.3.5.1.2
	1553(USAF)	4.2.3.5.1.2

COMMENTARY: The major concern is that address 11111 (Broadcast in 1553B) not be assigned to any type terminal. To verify this, reaction of each RT to the issuance of a Broadcast Command is checked to verify that address 31_{10} was not assigned.

INSTRUMENTATION: N/A

CHAPTER 5

AS4116 TEST PLAN FOR THE DIGITAL TIME DIVISION COMMAND/RESPONSE MULTIPLEX DATA BUS BUS MONITORS.

INTRODUCTION:

The purpose of this Test Plan is to provide a standard for testing bus monitor functions as specified in MIL-STD-1553, either as bus monitors "only" or those functions in terminals which also operate as RTs and/or BCs.

Since a bus monitor can be a very general or a special terminal with the "monitor" functions not specifically described in MIL-STD-1553, that protocol must be defined in an equipment specification. The specific tests, therefore, must be detailed in a test procedure using the guidelines specified in the Test Plan.

Since in some cases a bus monitor can operate as a responding RT, the electrical characteristics tests are those run for an RT and the appropriate test plans are referred to. Similarly, the protocol tests for responding RTs are specified by referring to the appropriate test plans. Much of the methodology of the protocol tests is taken from the BC Test Plans since, much like the BC, the bus monitor terminal must validate, check, and pass the message or components thereof through to the monitor subsystem. This, therefore, as with the BC, assumes that sufficient interface test points or output indicators exist to make these determinations. For military hardware particularly, maintainability fault isolation requirements usually dictate the designing in of these test points or other indicators. The following sections detail the rationale for each of the tests.

The section numbers following are those of the Test Plan. Only those bearing directly on tests are included.

GENERAL INSTRUMENTATION NEEDS:

Many of the tests written in this Test Plan require valid MIL-STD-1553 messages be sent to the UUT. This requires the use of a controllable MIL-STD-1553 waveform generator. This device can be anything that performs the following tasks:

1. Capable of generating valid MIL-STD-1553 waveforms for both the BC and RT functions.

2. Provide amplitude variations from $0.1V_{pp}$ to $9.0V_{pp}$ into 70Ω, and $0.2V_{pp}$ to $18.0V_{pp}$ into 35Ω.

3. Programmable for zero crossing distortion to $\pm$ 200ns on any edge specified with 3ns resolution or better.

4. Provide rise and fall times of a trapezoidal waveform of less than or equal to 100ns.

Note that the intent of this test plan is to provide minimum test hardware requirements and not to discuss all of the various implementations available.

TEST PLAN PARAGRAPH: 1.2 APPLICATION

PURPOSE: The purpose of this section is to specify the application of the Test Plan. It shall be noted that some test software may be required, where applicable.

1553 PARAGRAPH: N/A

INSTRUMENTATION: N/A

TEST PLAN PARAGRAPH: 4.1 GENERAL MONITORING REQUIREMENTS

PURPOSE: This continuous test assures that the bus monitor does not respond when operating as an RT. The normal RT monitoring requirements specified in the RT test plan apply.

1553 PARAGRAPH: 4.4.4

INSTRUMENTATION: The general monitoring requirements listed in paragraph 4.1 of the Test Plan are basic requirements of 1553. The test instrument must be capable of capturing the 1553 messages and verifying timing events and protocol errors specified in MIL-STD-1553. Specifically, the bus monitor that is being tested must be continuously monitored throughout all tests for no response. If the bus monitor responds to a unique address, the general monitoring requirements of Paragraph 4.3 of the RT Validation Test Plan (Section 100 of MIL-HDBK-1553A) will apply; for production testing the requirements of paragraph 4.1 of SAE AS4112 will apply.

NOTE: The user must find a way to probe the bus monitor under test for the AMS and UMS signals. These are used throughout the Test Plan to determine the pass/fail status of the bus monitor.

TEST PLAN PARAGRAPH: 5.1.1.1 OUTPUT NOISE

PURPOSE: The test measures the output noise of the terminal when operating as a bus monitor (receiving or power off mode).

1553 PARAGRAPH: 4.5.2.1.1.3, 4.5.2.2.1.3

INSTRUMENTATION: A true rms voltmeter is required for this test. The equipment must have a DC to 10MHz minimum frequency bandwidth with 1MΩ input impedance.

TEST PLAN PARAGRAPH: 5.1.1.2 POWER ON/OFF NOISE

PURPOSE: The test measures the output noise of the UUT when power is turned on or off.

1553 PARAGRAPH: 30.10.6 in Notice 2

COMMENTARY: For 1553B and Notice 1 terminals, this test is not required, but should be performed.

INSTRUMENTATION: A 50MHz storage scope is recommended so that any spurious differential output may be captured during the power up or power down sequences. A storage scope should be used since it is necessary to capture a single event. A monitor should also be on-line to monitor any possible spurious 1553 messages.

TEST PLAN PARAGRAPH: 5.1.2.1 INPUT WAVEFORM COMPATIBILITY

PURPOSE: These tests are run to ensure that the UUT accepts, as valid, message segments with waveforms which are within the specified limits.

1553 PARAGRAPH: 4.5.2.1.2.1, 4.5.2.2.2.1

INSTRUMENTATION: See tests 5.1.2.1.1 - 5.1.2.1.3 below.

TEST PLAN PARAGRAPH: 5.1.2.1.1 ZERO CROSSING DISTORTION

PURPOSE: To ensure that the UUT accepts messages with zero crossing distortions of 150ns.

1553 PARAGRAPH: N/A

INSTRUMENTATION: See NOTE under 4.1 of the Test Plan. In addition, a controllable waveform generator (see 4.0 of the Test Plan) must be able to induce positive and negative zero crossing distortions of 150ns minimum from the ideal, with respect to the previous zero crossing. The amplitude of the transmitted signal to the UUT must be $2.1V_{pp}$ for transformer-coupled stubs and $3.0V_{pp}$ for direct-coupled stubs.

TEST PLAN PARAGRAPH: 5.1.2.1.2 AMPLITUDE VARIATIONS

PURPOSE: To ensure that the UUT accepts messages from .86 to $6.0V_{pp}$ for transformer-coupled stubs, 1.2 to $9.0V_{pp}$ for direct-coupled stubs, and rejects messages at $\leq 0.28V_{pp}$ for direct-coupled stubs.

1553 PARAGRAPH: N/A

COMMENTARY: The performance of the UUT is characterized for validation testing. In production testing, just the voltage extremes for threshold and rejection are used. This was written this way to minimize test time.

TEST PLAN PARAGRAPH: 5.1.2.1.3 RISE AND FALL TIME
5.1.2.1.3.1 TRAPEZOIDAL
5.1.2.1.3.1 SINUSOIDAL

PURPOSE: To test the ability of the UUT to recognize and decode 1553 messages with the fastest specified (100ns trapezoid) and slowest specified ("approximating a 1MHz sinusoid") rise and fall times.

1553 PARAGRAPH: 4.5.2.1.2.1, 4.5.2.2.2.1

COMMENTARY: MIL-STD-1553B does not specify the amplitude of the input waveform for this requirement. The values used in the Test Plan are the same as for the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the same as the amplitudes specified for the noise rejection test in MIL-STD-1553B. This was thought to be a good compromise between required response and nominal bus amplitudes.

TEST PLAN PARAGRAPH: 5.1.2.2 INPUT IMPEDANCE

PURPOSE: These tests are run to ensure that the terminal input impedance is within the specified limits.

COMMENTARY: Note that the UUT should be tested off-line using minimum length calibrated cables.

1553 PARAGRAPH: 4.5.2.1.2.3, 4.5.2.2.2.3

INSTRUMENTATION: An impedance analyzer is recommended for this test. It should be capable of measurements at: 75.0kHz, 100.0kHz, 250.0kHz, 500.0kHz, and 1.0MHz. It should be able to measure complex impedance and generate a sine wave at 1 to 2V rms at the above frequencies.

TEST PLAN PARAGRAPH: 5.1.2.3 COMMON MODE REJECTION

PURPOSE: These tests are the same as those for RT and BC function terminals. They are run to ensure that the bus monitor receiver performance is not degraded by line to ground signals of less than the MIL-STD-1553B specified levels.

1553 PARAGRAPH: 4.5.1.2.2, 4.5.2.2.2.2

COMMENTARY: MIL-STD-1553B does not specify the amplitude of the input waveform for this requirement. The values used in the Test Plan are the same as for the RT Validation Test Plan, MIL-HDBK-1553A, Section 100. They are the minimum amplitudes at which terminals must recognize messages.

INSTRUMENTATION: See NOTE in 4.1 of the Test Plan above. In addition, a function generator is recommended to provide common mode voltage levels of: ± 10VDC to ground and a ± 10Vp line to ground sinusoidal signal that is swept from 1Hz to 2MHz.
