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Test Plan for the Digital Time Division Command/Response Multiplex Data Bus Bus Monitors

RATIONALE

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

FOREWORD

This document contains two major sections for the testing of bus monitors: electrical tests and protocol tests.

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1. SCOPE:

1.1 General:

This Aerospace Standard (AS) defines the test requirements for determining that bus monitors meet the requirements of MIL-STD-1553B, Digital Time Division Command/Response Multiplex Data Bus.

1.2 Application:

This standard is a general test plan for validation or production test of any bus monitor designed to meet the requirements of MIL-STD-1553B. These requirements shall apply to the bus monitor under test, when invoked in a specification or statement of work.

The primary intent of this test plan is to test those requirements of MIL-STD-1553 for Bus Monitors that have been implemented in hardware, software, or firmware. However, it is recognized that some additional software may be required to meet this intent and that this software may be the operational software (or some portion thereof), special test software, or some combination of these.

Tests specified herein may be performed in any order, combined with one another, or combined with other tests of the subsystem in which the bus monitor may be embedded.

This document deals only with bus monitor functions that are explicitly described in MIL-STD-1553. This document does not specify tests that check the integrity of the data from the subsystem to the bus, nor does it attempt to address the system test requirements.

For tests specified to be used in production test of a bus monitor chip, module, or function within an equipment, it is intended that all stimuli and measurements be made via external connections and/or test points. No required access to any other points is intended.

2. APPLICABLE DOCUMENTS:

2.1 Standards, Military:

MIL-STD-1553B, 21 Sep 1978 Aircraft Internal Time Division Command/Response Multiplex Data Bus, with Notice 2, 8 September 1986.

MIL-HDBK-1553A, 1 November, 1988 Multiplex Applications Handbook

2.2 Other Documents:

SAE AS4112 Production Test Plan for the Digital Time Division Command/ Response Multiplex Data Bus Remote Terminal

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3. DEFINITIONS:

3.1 MESSAGE: A single message is the transmission of a command word, status, and data words if they are specified. For the case of a remote terminal to remote terminal (RT to RT) transmission, the message shall include the two command words, one or two status words, and data words.

3.2 MESSAGE SEGMENT: A message segment is any word or contigous part of a message up to and including the entire message.

3.3 BUS CONDITIONS: The following are definitions of bus conditions that bus monitors may be required to detect. A description of the actual signal, state, or action taken within the bus monitor that is used during test procedures to indicate the detection of each of the following bus conditions shall be attached to the test results.

3.3.1 AMS - ACCEPTABLE MESSAGE SEGMENT: An AMS condition occurs within a bus monitor when it determines that a message segment contains only valid word(s), and valid data words, and that the words are contiguous where required and that the bus monitor is programmed to accept such a valid message segment.

3.3.2 UMS - UNACCEPTABLE MESSAGE SEGMENT: A UMS condition occurs when a bus monitor determines that a message segment is not an AMS.

3.4 Other Definitions:

3.4.1 VW - VALID WORD: A word that conforms to the following minimum criteria:

a. The word begins with a valid sync field
b. The bits are in a valid Manchester II code
c. The information field has 16-bits plus parity
d. The word parity is odd

3.4.2 UUT - UNIT UNDER TEST: For the purposes of this test plan, UUT refers to the bus monitor under test.

3.4.3 BC - BUS CONTROLLER: As defined in the paragraph titled "Bus Controller" of MIL-STD-1553.

3.4.4 RT - REMOTE TERMINAL: As defined in the paragraph titled "Remote Terminal" of MIL-STD-1553.

3.4.5 BM - BUS MONITOR: As defined in the paragraph titled "Bus Monitor" of MIL-STD-1553.

4. GENERAL TEST REQUIREMENTS:

The following paragraphs define the configurations, pass/fail criteria, and general procedures for testing bus monitors. Specifically, this document contains the test configurations and procedures for the Electrical Tests (5.1), the Protocol Tests (5.2), and Noise Rejection Tests (5.3) for MIL-STD-1553 bus monitors. The bus monitor under test is referred to as the unit under test (UUT). Proper terminal responses are defined in each paragraph.

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4.1 General Monitoring Requirements:

In addition to the specific tests that follow, bus monitors must be continuously monitored throughout all tests for no response. For bus monitors that respond to a unique address, the general monitoring requirements of 4.3 of the RT Validation Test Plan contained in Section 100 of MIL-HDBK-1553 shall also apply; for production testing, the requirements of 4.1 of SAE AS4112 shall also apply. The UUT shall have failed the test if at any time during the test it fails to meet the conditions of the general monitoring requirements.

5. DETAILED REQUIREMENTS:

5.1 Electrical Tests:

Each test paragraph contains the requirements for both transformer and direct coupled stubs. A UUT that provides both transformer and direct coupled stubs must be tested on both stubs. Electrical tests shall be performed on all buses for UUTs with redundant bus configurations.

5.1.1 Output Characteristics: The following tests are designed to verify that all UUT output characteristics comply with MIL-STD-1553. All output characteristic tests shall use Figure 1A, with all measurements taken at point "A", unless otherwise noted.

5.1.1.1 Output Noise: The test configuration shown in Figure 2 shall be used to test the UUT bus output noise levels. The test shall be conducted while the UUT is in the power-on state and the power-off state. The output noise (Vrms) shall be measured at point "A" as shown in Figure 2 for both states. Measurements shall be made with an instrument that has a minimum frequency bandwidth of from DC to 10 MHz.

The pass criteria are Vrms </= 14.0 mV for transformer coupled stubs and Vrms </= 5.0 mV for direct coupled stubs.

5.1.1.2 Power On/Off Noise: A UUT shall limit any spurious differential output during a power-up or power-down sequence. Power shall be applied to the UUT and any outputs from the UUT onto the bus shall be measured. Power shall be removed from the UUT and any output onto the bus from the UUT shall be measured. Repeat the test ten times.

The pass criteria are:

a. For transformer coupled stubs, any spurious noise pulses produced shall be less than ±250 mV peak.
b. For direct coupled stubs, any spurious noise pulses produced shall be less than ±90 mV peak.

NOTE: This test shall be performed using the normal on/off power sequency to the UUT.

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5.1.2 Input Characteristics: The input tests are designed to verify that multiplex devices can properly decode bi-phase data. All input characteristic electrical tests shall use Figure 1A or 1B, with all measurements taken at point "A" unless otherwise noted.

5.1.2.1 Input Waveform Compatibility:

5.1.2.1.1 Zero Crossing Distortion: A message with a message segment acceptable to the UUT shall be transmitted to the UUT by the test equipment. Positive and negative zero crossing distortions equal to 150 ns minimum, with respect to the previous zero crossing shall then be introduced individually to each zero crossing of each word transmitted to the UUT. The transmitted signal amplitude at point "A", Figure 1A or 1B, shall be 2.1 Vpp for transformer coupled stubs and 3.0 Vpp for direct coupled stubs. Each zero crossing distortion shall be transmitted to the UUT a minimum of 1000 times. There shall be only one zero crossing deviation per message. This test is only required for validation testing.

The pass criterion is the detection of an AMS by the UUT for each message with a zero crossing distortion.

5.1.2.1.2 Amplitude Variations: A message with a message segment acceptable to the UUT shall be transmitted to the UUT by the test equipment. The voltage of the test equipment's transmission shall be decremented from 6.0 Vpp to 0.1 Vpp for transformer coupled stubs and from 9.0 Vpp to 0.1 Vpp for direct coupled stubs in steps no greater than 0.1 Vpp for validation testing. For production testing it shall be set to 0.20 Vpp, 0.86 Vpp, and 6.0 Vpp for transformer coupled stubs; and to 0.28 Vpp, 1.2 Vpp, and 9.0 Vpp for direct coupled stubs. A minimum of 1000 messages shall be transmitted for each setting.

The pass criteria are:

a. An AMS for each message with 0.86 </= Vpp </= 6.0 for transformer coupled stubs and 1.2 </= Vpp </= 9.0 for direct coupled stubs for validation testing. For production testing an AMS for each message at 0.86 Vpp and 6.0 Vpp for transformer coupled stubs and at 1.2 Vpp and 9.0 Vpp for direct coupled stubs.
b. A UMS for each message with Vpp </= 0.20 for transformer coupled stubs and Vpp </= 0.28 for direct coupled stubs for validation testing. For production testing a UMS for each message at 0.20 Vpp for transformer coupled stubs and Vpp at 0.28 Vpp for direct coupled stubs.

For validation testing the measured parameter, Vpp, at which the UMS first occurs shall be recorded.

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5.1.2.1.3 Rise and Fall Time:

5.1.2.1.3.1 Trapezoidal: A message with a message segment acceptable to the UUT involving one or more data words shall be sent to the UUT. The test equipment shall be set to a signal amplitude of 2.1 Vpp for the transformer coupled stub and 3.0 Vpp for the direct coupled stub. The rise and fall times shall be less than or equal to 100 ns, as shown in Figure 3.

The pass criterion is an AMS by the UUT for each message transmitted.

5.1.2.1.3.2 Sinusoidal: A message with a message segment acceptable to the UUT involving one or more data words shall be sent to the UUT. The test equipment shall be set to a signal amplitude of 2.1 Vpp for the transformer coupled stub and 3.0 Vpp for the direct coupled stub. The rise and fall times of the signal shall approximate that of a 1 MHz sinusoidal signal.

The pass criterion is an AMS by the UUT for each message transmitted.

5.1.2.2 Input Impedance: The input impedance of the UUT shall be measured with the UUT power on and with the UUT power off. The input impedance, Zin, shall be measured with a sinusoidal waveform having an amplitude 1.0 to 2.0 Vrms, at the following frequencies: 75.0 kHz, 100.0 kHz, 250.0 kHz, 500.0 kHz, and 1.0 MHz.

The pass criteria are Zin >/= 1000 Ω for transformer coupled stubs and Zin >/= 2000 Ω for direct coupled stubs.

NOTE: Do not use Figure 1A or 1B for this test; remove all loads from UUT.

5.1.2.3 Common Mode Rejection: The Common Mode Test Configuration, Figure 4A and Figure 4B, shall be used for this test. Messages with message segments acceptable to the UUT with the UUT's maximum word count, shall be transmitted at the maximum rate consistent with the minimum intermessage gap defined in 4.3.3.7 of MIL-STD-1553 by the test equipment with a common mode voltage injected at point "C". The voltage of the transmitted message measured at point "A" shall be 0.86 Vpp for transformer coupled stubs and 1.2 Vpp for direct coupled stubs. The following common mode voltage levels shall be applied in turn; +10.0 VDC to ground, -10.0 VDC to ground, and a ±10 Vp line to ground sinusoidal signal that is swept through the range of 1 Hz to 2 MHz. Each test condition shall be present for a minimum time period of 90 s.

The pass criterion is an AMS by the UUT for each message transmitted at each setting.

If a failure occurs, the frequency of the common mode signal injected shall be recorded.

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5.1.3 Output Characteristics for Bus Monitors With an Assigned Unique Address: For UUTs that are designed to respond to a unique address, the tests for RTs (except those already tested in 5.1.1) shall be performed per the RT Validation Test Plan for validation tests and the RT Production Test Plan for production tests.

5.2 Protocol Tests:

All tests in this section shall use the test configuration shown in Figure 1A or 1B. The test signal amplitude shall be 3.0 Vpp ± 0.1 Vpp for direct coupled stubs and 2.1 Vpp ± 0.1 Vpp for transformer coupled stubs measured at point A. For UUTs having both direct and transformer coupled stubs the protocol tests need only be performed on one stub type per bus. Any condition that causes the UUT to behave other than as called out in MIL-STD-1553, to lock up, or require a power cycle in order to recover from a failure shall automatically cause that UUT to fail the test. The protocol test shall be performed on all buses for UUTs with redundant bus configurations.

5.2.1 Required Nonresponding Bus Monitor Operation: The following tests verify all required nonresponding operations of a UUT as a BM.

5.2.1.1 BM Message Acceptance: The purpose of these tests is to determine whether the UUT accepts valid messages with message segments that it is designed to accept and rejects all others. If a UUT is designed to respond to a specific address assigned, commands with such addresses shall not be sent in this test.

The test equipment shall transmit all combinations of messages to the UUT with the status word response(s) bits set as appropriate for the message transmitted. For each message transmitted the pass criteria shall be an AMS for all messages with message segments that are by design accepted by the BM and UMS for all messages not accepted. The tests shall be repeated with no status word response(s) in the message. The pass criteria shall be a UMS for all messages if the UUT is designed to reject such messages and the same pass criteria as for messages with response(s) if not designed to reject such messages.

5.2.1.2 Error Injection (RT-BC, BC-RT Transfers): The purpose of these tests is to determine whether the UUT will reject messages that it is designed to accept if they fail the validity criteria. Unless otherwise noted, the test sequence described below shall be used for all error injection tests. The error to be encoded in Step 2 for a given message is also specified in each test paragraph. Where applicable, the appropriate status word response/nonresponse or ME bit set shall be observed.

Test Sequence:

Step 1. A valid BC-RT or RT-BC message with a message segment that is acceptable to the UUT shall be transmitted.
Step 2. The message as in Step 1 containing the specified error shall be transmitted to the UUT.

The pass criteria shall be an AMS for Step 1 and a UMS for Step 2.

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5.2.1.2.1 Parity: The purpose of these tests is to verify the UUTs capability of detecting parity errors embedded in different words within a message.

5.2.1.2.1.1 Status Word Validation for Transmit Commands: This test verifies the ability of the UUT to detect a parity error occurring in a status response to a transmit command word. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command and a parity error encoded into the status word for Step 2.

5.2.1.2.1.2 Status Word Validation for Receive Commands: This test verifies the ability of the UUT to recognize a parity error occurring in a status response to a receive command word. The test sequence as defined in 5.2.1.2 shall be performed with a receive command and a parity error encoded in the status word for Step 2.

5.2.1.2.1.3 Data Word Validation: This test verifies the ability of the UUT to recognize a parity error occurring in a data word. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command and a parity error encoded in a data word for Step 2. The message shall have the maximum number of data words that the UUT is designed to handle. The test sequence must be sent N times, where N equals the number of data words sent. Each data word must have the parity bit inverted in turn, but only one parity error is allowed per message.

Repeat for a receive command.

5.2.1.2.1.4 Command Word Validation: This test verifies the ability of the UUT to detect a parity error occurring in a command word. The test sequence as defined in 5.2.1.2 shall be performed with a parity error encoded in transmit command word for Step 2.

Repeat for a receive command.

5.2.1.2.2 Word Length: These tests verify the ability of the UUT to recognize an error in word length occurring within a message. The test plan excludes testing of high bit count errors at the end of any message.

5.2.1.2.2.1 Status Word Validation for Transmit Commands: This test verifies the ability of the UUT to recognize word length errors in a status response to transmit commands. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command and with the status word response defined below for Step 2. Repeat this test with each of the status words defined below:

a. Shorten the status word by one bit
b. Shorten the status word by two bits
c. Lengthen the status word by two bits
d. Lengthen the status word by three bits

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5.2.1.2.2.2 Status Word Validation for Receive Commands: This test verifies the ability of the UUT to recognize word length errors occurring in a status response to receive commands. The test sequence as defined in 5.2.1.2 shall be performed with a receive command and with the status word response as defined below for Step 2. Repeat this test with each of the status words defined below:

a. Shorten the status word by one bit
b. Shorten the status word by two bits

5.2.1.2.2.3 Data Word Validation: This test verifies the ability of the UUT to recognize data word length errors. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command as defined below for Step 2. The message shall include a status word with the maximum number of data words that the UUT is designed to handle. Repeat this test with each of the data words defined below:

a. Shorten the data word by one bit
b. Shorten the data word by two bits
c. Lengthen the data word by two bits
d. Lengthen the data word by three bits

The test sequence of 5.2.1.2 shall be performed N times for A and B, and N-1 times for C and D, where N equals the number of data words sent. High bit count errors shall not be tested in the last data word of the response. Only one data word shall be altered at a time in a given message; steps A and B shall be performed in turn for each data word in the message. Steps C and D shall be performed in turn for each data word except the last.

Repeat for receive command.

5.2.1.2.2.4 Command Word Validation: This test verifies the ability of the UUT to recognize word length errors in a command word. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command as defined below for Step 2:

a. Shorten the command word by one bit
b. Shorten the command word by two bits

Repeat for a receive command as defined below for test Step 2:

a. Shorten the command word by one bit
b. Shorten the command word by two bits
c. Lengthen the command word by two bits
d. Lengthen the command word by three bits

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5.2.1.2.3 Bi-phase Encoding: This test verifies the ability of the UUT to recognize bi-phase errors. A bi-phase encoding error is defined to be the lack of a zero crossing in the center of a bit time. A bi-phase error occurs as either a logic high or low for the duration of a bit time. Each bit location, except the sync period, of each word shall have a single bi-phase error encoded into it in turn. Only a single bi-phase error shall be injected for each message. (Note: Bi-phase errors shall be injected in such a way as not to cause a parity error.)

5.2.1.2.3.1 Status Word Validation for Transmit Commands: This test verifies the ability of the UUT to recognize bi-phase encoding errors in the status word response to transmit commands. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command and a bi-phase encoding error encoded into the status word for test Step 2. Only one bi-phase error is allowed per status word. A test set involves performing the test sequence 17 times, once for each bit location. A complete test requires two test sets to be performed, once for high bi-phase errors and once for low bi-phase errors.

5.2.1.2.3.2 Status Word Validation for Receive Commands: This test verifies the ability of the UUT to recognize bi-phase encoding errors in response to receive commands. The test sequence as defined in 5.2.1.2 shall be performed with a receive command and a bi-phase error encoded into a status word for Step 2. Only one bi-phase error is allowed per command word. A test set involves performing the test sequence 17 times, once for each bit location. A complete test requires two test sets to be performed, once for high bi-phase errors and once for low bi-phase errors.

5.2.1.2.3.3 Data Word Validation: This test verifies the ability of the UUT to recognize bi-phase encoding errors in data words. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command requesting the maximum number of data words that the UUT is designed to receive and a bi-phase error encoded into each data word in the response for Step 2. Individually, each bit location of each data word shall have a bi-phase error encoded into it in turn; only one bi-phase error is allowed for each message. A test set involves performing the sequence 17 times, once for each location. The test set shall be repeated N times, where N equals the number of data words sent. A complete test requires 2 N test sets to be performed, once for high bi-phase errors and once for low bi-phase errors.

Repeat for a receive command.

5.2.1.2.3.4 Command Word Validation: This test verifies the ability of the UUT to recognize bi-phase encoding errors in a command word. The test sequence as defined in 5.2.1.2 shall be performed with a bi-phase error encoded into a transmit command word for Step 2. Only one bi-phase error is allowed per command word. A test set involves performing the test sequence 17 times, once for each bit location. A complete test requires two test sets to be performed, once for high bi-phase errors and once for low bi-phase errors.

Repeat for the receive command.

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5.2.1.2.4 Sync Encoding: This test verifies the ability of the UUT to recognize sync errors. The sync pattern, as defined for this test, is a waveform with six 0.5 µs divisions. The divisions are represented as a 1 or 0 to indicate the polarity of the division on the data bus. A proper status sync is represented as 111000, and a proper data sync is represented as 000111.

5.2.1.2.4.1 Status Word Validation: This test verifies that the UUT rejects status words with invalid sync waveforms. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command with the maximum number of data words the UUT is designed to handle and a sync error encoded in a status word for Step 2. The following invalid sync patterns shall be used:

a. 111100
b. 110000
c. 111001
d. 011000
e. 000111

The test sequence shall be performed for each of these invalid sync patterns.

5.2.1.2.4.2 Data Word Validation: This test verifies that the UUT rejects invalid data sync waveforms. Perform the test sequence as defined in 5.2.1.2 with a transmit command with the maximum number of data words that the UUT is designed to handle and with a sync error encoded into each data word for Step 2. Only one data word per message shall have an invalid sync encoded into it. The following invalid sync patterns shall be used:

a. 000011
b. 001111
c. 000110
d. 100111
e. 111000

The test sequence shall be performed N times for each of these invalid sync patterns, where N equals the maximum number of data words in the message. The test shall be performed so that each sync error shall occur with each data word.

5.2.1.2.4.3 Command Word Validation: This test verifies that the UUT rejects command words with invalid sync waveforms. The test sequence as defined in 5.2.1.2 shall be performed with a transmit command with the maximum number of data words the UUT is designed to accept and a sync error encoded in the command word for Step 2. The following invalid sync patterns shall be used:

a. 111100
b. 110000
c. 111001
d. 011000
e. 000111

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5.2.1.2.5 Discontiguous Data: This test verifies that the UUT recognizes discontiguous data in a message. Perform the test sequence as defined in 5.2.1.2 with a transmit command with a 4.0 µs data word gap error in a status response to a transmit command for Step 2. The gap is measured as in Figure 5. This response shall be a status word with the maximum number of data words that the UUT is designed to receive with a gap between the status word and the first data word or between a data word pair. The test sequence shall be performed N times, where N equals the maximum number of data words. Each test sequence shall be performed with the gap appearing before a different data word. Only one gap time insertion is allowed per message.

5.2.1.3 Error Injection (RT to RT Transfers): The purpose of these tests is to determine whether the UUT will reject RT-RT messages that it is deigned to accept if they fail the validity criteria. Unless otherwise noted, the test sequence described shall be used for all error injection tests. The error to be encoded in Step 2 for a given message is also specified in each test paragraph.

Test Sequence:

Step 1. A valid RT to RT message which is acceptable to the UUT shall be transmitted as specified in each paragraph.
Step 2. The same message as in Step 1 shall contain the specified error (if any) and shall be sent to the UUT by the test equipment.

The pass criteria shall be an AMS for Step 1 and a UMS for Step 2.

5.2.1.3.1 Parity: These tests verify the ability of the UUT to detect parity errors embedded in different words within an RT to RT message.

5.2.1.3.1.1 Status Word Validation for Responses to RT to RT Transmit Commands: This test verifies the ability of the UUT to detect a parity error occurring in the status response to the transmit command in an RT to RT command. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with a parity error encoded in status word response to the transmit command and a CS for the receive command status word response in Step 2.

The test sequence shall be performed the second time with a parity error encoded in the status word response to the transmit command and no response for the receive command response in Step 2.

5.2.1.3.1.2 Status Word Validation for Responses to RT to RT Receive Commands: This test verifies the ability of the UUT to recognize a parity error occurring in the status response to a receive command in an RT to RT command. The test sequence as defined in 5.2.1.3 shall be performed with no errors in the transmit command response Step 2, and a parity error in the status word response to the receive command for Step 2.

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5.2.1.3.1.3 RT to RT Data Word Validation: This test verifies the ability of the UUT to recognize a parity error occurring in a data word in an RT to RT message. The test sequence as defined in 5.2.1.3 shall be performed twice. The first sequence shall be performed with the RT to RT command pair requesting the maximum number of data words allowable by the UUTs design, a parity error encoded in a data word, and a CS in the receive command status word response for Step 2.

The test sequence shall be performed the second time with a parity error in a data word and no response to the receive command for Step 2.

Each test sequence of 5.2.1.3 must be sent N times, where N equals the number of data words sent. Only one data word shall have the parity bit inverted for each message sent, with a different data word being altered for each execution of the test sequence.

5.2.1.3.1.4 Command Word Validation: This test verifies the ability of the UUT to detect a parity error in a command word in an RT-RT message. The test sequence as defined in 5.2.1.3 shall be performed with a parity error encoded in the transmit command in Step 2.

Repeat for the receive command.

5.2.1.3.2 Word Length: These tests verify the ability of the UUT to recognize word length errors within any word in an RT to RT message. The test plan excludes testing of high bit count errors at the end of any word sequence.

5.2.1.3.2.1 Status Word Validation for Responses to RT to RT Transmit Commands: This test verifies the ability of the UUT to recognize word length errors occurring in the status response to an RT to RT transmit command. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with the transmit command status response word defined below and a status appropriate to the message for the receive command response in Step 2. The test sequence shall be performed a second time with no response to the receive command. Repeat those sequences with each of the status words defined below:

a. Shorten status word by one bit
b. Shorten status word by two bits
c. Lengthen status word by two bits
d. Lengthen status word by three bits

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5.2.1.3.2.2 Status Word Validation for Responses to RT to RT Receive Commands: This test verifies the ability of the UUT to recognize word length errors occurring in the status response to an RT to RT receive command. The test sequence as defined in 5.2.1.3 shall be performed with no errors in the transmit command response in Step 2, and with the status word defined below used for the receive command response. Repeat this test with each of the status words defined below:

a. Shorten status word by one bit
b. Shorten status word by two bits

5.2.1.3.2.3 Data Word Validation: This test verifies the ability of the UUT to recognize data word length errors. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with the RT to RT command pair requesting the maximum number of data words allowable by the UUTs design a data word from the list below, and a status appropriate to the message in the receive command status word response.

The test sequence shall be performed a second time with no response. Repeat these sequences using each data word shown below:

a. Shorten data word by one bit
b. Shorten data word by two bits
c. Lengthen data word by two bits
d. Lengthen data word by three bits

Each test sequence of 5.2.1.3 shall be performed N times for A and B and N-1 times for C and D, where N equals the number of data words sent. High bit count errors shall not be tested in the last data word of the response. Only one data word shall be altered at a time in a given message. Steps A and B shall be performed for each data word in the message. Steps C and D shall be performed for each data word except the last.

5.2.1.3.2.4 Command Word Validation: This test verifies the abilitity of the UUT to recognize word length errors in a command word. The test sequence as defined in 5.2.1.3 shall be performed with the transmit command defined below for Step 2:

a. Shorten receive command word by one bit
b. Shorten receive command word by two bits
c. Lengthen receive command word by two bits
d. Lengthen receive command word by three bits

Repeat for the transmit command as defined below for Step 2:

a. Shorten the transmit command word by one bit
b. Shorten the transmit command word by two bits

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5.2.1.3.3 Bi-phase Encoding: These tests verify the ability of the UUT to recognize bi-phase errors within any word in an RT to RT message. A bi-phase error is defined to be the lack of a zero crossing in the center of a bit time. A bi-phase error occurs as either a logic high or low for the duration of a bit time. Each bit location, except the sync period, of each word shall have a single bi-phase error encoded into it. Only a single bi-phase error shall be injected for each message. (Note: Bi-phase errors shall be injected in such a way as to not cause a parity error.)

5.2.1.3.3.1 Status Word Validation for Responses to RT to RT Transmit Command: This test verifies the ability of the UUT to detect bi-phase encoding errors occurring in the status response to an RT to RT transmit command. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with a bi-phase error encoded in the transmit command status word and a CS in the receive command status word response.

The test sequence shall be performed the second time with a no response to the receive command. Only one bi-phase error is allowed per status word. A test set involves performing each test sequence 17 times, once for each bit location. A complete test requires two test sets to be performed, once for high bi-phase errors, once for low bi-phase errors.

5.2.1.3.3.2 Status Word Validation for Responses to RT to RT Receive Commands: This test verifies the ability of the UUT to recognize bi-phase encoding errors occurring in the status response to an RT to RT receive command. The test sequence as defined in 5.2.1.3 shall be performed with no errors in the transmit command status word response and a bi-phase error in the status word response to the receive command for Step 2. Only one bi-phase error is allowed per status word. A test set involves performing the test sequence 17 times, once for each bit location. A complete test requires two test sets, once for high bi-phase errors and once for low bi-phase errors.

5.2.1.3.3.3 Data Word Validation: This test verifies the ability of the UUT to recognize bi-phase encoding errors occurring in a data word in an RT to RT message. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with the RT to RT command pair requesting the maximum number of data words allowable by the UUTs design, a bi-phase error encoded in a data word and a CS in the receive command status word response.

The test sequence shall be performed the second time with no status word response to the receive command.

A test set involves performing each sequence of 5.2.1.3 N times, where N equals the number of data words sent. Only one data word shall have a bi-phase encoding error for each message sent, with a different data word being altered for each execution of the test sequence.

A complete test requires 2 x N test sets to be performed, once for high bi-phase errors and once for low bi-phase errors.

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5.2.1.3.3.4 Command Word Validation: This test verifies the ability of the UUT to recognize bi-phase encoding errors occurring in a command word. The test sequence as defined in 5.2.1.3 shall be performed with a bi-phase error in the RT-RT receive command for Step 2. Only one bi-phase error is allowed. The test set involves performing the test sequence 17 times, once for each bit location. A complete test requires two test sets, once for high bi-phase errors and once for low bi-phase errors.

Repeat for the transmit command.

5.2.1.3.4 Sync Encoding: This test verifies the ability of the UUT to recognize sync errors in the command, status, and data word syncs in an RT to RT message. The sync pattern, as defined for this test, is a waveform with six 0.5 µs divisions. Each division is represented as a 1 or 0 to indicate the polarity of the divisions on the data bus. A proper command or status sync is represented as 111000 and a proper data sync is represented as 000111.

5.2.1.3.4.1 Status Word Validation for Response to RT to RT Transmit Commands: This test verifies the ability of the UUT to recognize invalid sync waveforms in the status response to an RT to RT transmit command. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with a sync error (as shown below) encoded in the status word response to the transmit command and a CS in the receive command status word response. The second test sequence shall be performed with no response to the receive command. The following invalid sync patterns shall be used:

a. 111100
b. 110000
c. 111001
d. 011000
e. 000111

Each test sequence shall be performed for each of the above invalid sync patterns.

5.2.1.3.4.2 Status Word Validation for Response to RT to RT Receive Commands: This test verifies the ability of the UUT to recognize invalid sync wave forms in the status response to an RT to RT receive command. The test sequence as defined in 5.2.1.3 shall be performed with no errors in the transmit command status word response, and a sync error (as shown below) encoded in the status word response to the receive command. The following invalid sync patterns shall be used:

a. 111100
b. 110000
c. 111001
d. 011000
e. 000111

The test sequence shall be performed for each of the above invalid sync patterns.

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5.2.1.3.4.3 Data Word Validation: This test verifies the ability of the UUT to recognize invalid data sync waveforms inan RT to RT message. The test sequence as defined in 5.2.1.3 shall be performed twice. The first test sequence shall be performed with the RT to RT command pair requesting the maximum number of data words allowable by the UUTs design. A sync error shall be encoded into each data word and a CS in the transmit command status word response. The test sequence shall be performed the second time with no response to the receive command. Only one data word per message shall have an invalid sync encoded into it. The following invalid sync patterns shall be used:

a. 000011
b. 001111
c. 000110
d. 100111
e. 111000

Each test sequence shall be performed N times for each of the above invalid sync patterns, where N equals the maximum number of data words in the message. The test shall be performed so that each sync error shall occur with each data word.

5.2.1.3.4.4 Command Word Validation: This test verifies the ability of the UUT to recognize invalid sync waveforms in an RT-RT command word. The test sequence as defined in 5.2.1.3 shall be performed with a sync error encoded in the transmit command. The test sequence shall be performed for each of the following sync patterns:

a. 111100
b. 110000
c. 111001
d. 011000
e. 000111

Repeat with the sync errors encoded in the receive command.

5.2.1.3.5 Discontiguous Data: This test verifies that the UUT recognizes discontiguous data in an RT to RT message. The test sequence as defined in 5.2.1.3 shall be performed with the transmit command in the RT to RT command pair requesting the maximum number of data words allowable by the UUTs design. A 4.0 µs gap shall be injected either between the status word and the first data word or between a data word pair with no errors in the receive command status word response. The gap is measured as in Figure 5.

The test sequence shall be performed N times, where N equals the maximum number of data words. Each test sequence shall be performed with the gap appearing before a different data word. Only one gap time insertion is allowed per message. The test sequence shall be performed the second time with a no response to the receive command.

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5.2.2 Optional Dual Redundant Operation: This test shall be performed only if the UUT is configured with dual redundant buses designed to receive superseding messages. The requirements are as follows:

1. The UUT is required to accept a valid message received on the alternate bus while operating on a message or part thereof received on the original bus.
2. The UUT is required to accept the valid messages occurring later in time when overlapping valid messages are received on both buses.
3. When Step 1 or 2 occurs, the UUT shall reset and operate on the new message on the alternate bus.

Only messages acceptable to the UUT shall be used in this test. The following test sequence shall be performed twice for each interrupting message, once for each redundant bus:

Step 1. Send a valid message to the UUT having the maximum number of data words that the UUT is designed to accept.
Step 2. Send the interrupting command on the alternate bus beginning no sooner than 4.0 µs after the beginning of the command of the first valid message.

The pass criteria shall be a AMS or UMS for Step 1 (depending on the equipment specification requirements) and an AMS for Step 2.

5.2.3 Bus Monitor Optional Responding Operation: For BMs that are designed to respond to a unique address, the protocol tests designed to verify that the UUT meets the required operations of a responding BM are the same as those specified for an RT in 5.2 of SAE AS4112 for production test and 5.2 of the RT Validation Test Plan contained in Section 100 of MIL-HDBK-1553 for validation tests. Since the BM can be a specialized RT when responding, the required tests are only those which are needed to ensure that the UUT meets those requirements specified in the equipment specification.

5.3 Noise Rejection:

This test to be performed for validation testing only verifies the UUTs ability to operate in the presence of noise. Figure 6 depicts a typical configuration for conducting the noise rejection test. The maximum word error rate for a BM is one part in 10E7. While performing this test, all words received by the UUT shall be in the presence of an additive white Gaussian noise distributed over a bandwidth of 1.0 KHz to 4.0 MHz with an rms amplitude of 140 mV for transformer coupled stubs or 200 mV for direct coupled stubs measured at point A of Figure 6. This test shall be conducted with a signal level of 2.1 V peak-to-peak, line-to-line for transformer coupled or 3.0 V peak-to-peak, line-to-line for direct coupled stubs measured at point A of Figure 6. For the purposes of this test, an error shall include any fault that causes the UUT to detect an invalid word. The noise test shall run continuously until the total number of all words received by the UUT exceeds the required number for acceptance by the UUT, or is less than the required number for the rejection by the UUT, as specified in Table 1. All data words used in the tests shall contain random

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