1090-WP-16-04
10 December 2002

RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #16

Proposed Revisions to Section 2.3 of DO-260A

Presented by: Bob Saffell

SUMMARY
This Working Paper shows those changes necessary to change or add to the test procedures for Environmental Conditions to conform to the changes already made in Section 2.4 of DO-260A. All proposed changes that have been made to this section that are different from those in Draft-6 of DO-260A are shown in BLUE, so as to be easily identifiable.

This page intentionally left blank.

2.3 Equipment Performance - Environmental Conditions

The environmental tests and performance requirements described in this subsection provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those that may be encountered in actual aeronautical operations.

Some of the environmental tests contained in this subsection need not be performed unless the manufacturer wishes to qualify the equipment for that particular environmental condition. These tests are identified by the phrase "When Required." If the manufacturer wishes to qualify the equipment to these additional environmental conditions, then these "when required" tests **shall** be performed.

The test procedures applicable to a determination of equipment performance under environmental test conditions are contained in RTCA DO-160D (EUROCAE ED-14D), Environmental Conditions and Test Procedures for Airborne Equipment, July 1997.

Some of the performance requirements in Subsections 2.1 and 2.2 are not tested by test procedures herein. Moreover, not all tests are required to be done at each of the environmental conditions in RTCA DO-160D (EUROCAE ED-14D). Judgment and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in Subsections 2.1 and 2.2 will not be measurably degraded by exposure to these environmental conditions.

The specified performance tests cover all classes of ADS-B Transmitting and Receiving Subsystems. Only those tests that are applicable to the class of equipment being qualified need be performed. Additional tests may have to be performed in order to determine performance of particular design requirements that are not specified in this document. It is the responsibility of the manufacturer to determine appropriate tests for these functions.

Specific ADS-B Transmitting and Receiving Subsystem performance tests have been included in this section for use in conjunction with the environmental procedures of DO-160D (EUROCAE ED-14D). These tests have been chosen as a subset of the ADS-B Transmitting and Receiving Subsystem performance tests provided in subsection 2.4. Normally, a MOPS document does not provide specific equipment performance tests to be used in conjunction with the environmental procedures of RTCA DO-160D (EUROCAE ED-14D). However, there is a sufficiently large number of ADS-B Transmitting and Receiving Subsystem performance tests in subsection 2.4 that it would be impractical to repeat all of those tests in conjunction with all of the appropriate environmental procedures.

2.3.1 Environmental Test Conditions

Table 2.3.1a lists all of the environmental conditions and test procedures (hereafter referred to as environmental procedures) that are documented in RTCA DO-160D (EUROCAE ED-14D). Table 2.3.1b lists the sets of ADS-B Transmitting and Receiving Subsystem performance tests that are specified in detail in this section and which are intended to be run subject to the various environmental procedures of RTCA DO-160D (EUROCAE ED-14D). In order to simplify the process of relating the environmental procedures to the ADS-B equipment performance tests, Table 2.3.1a divides the environmental procedures into groups. All of the procedures in a given group are carried out in conjunction with the same set of ADS-B Transmitting and Receiving Subsystem performance tests. Using this approach, the environmental procedures fall into five groups. The environmental procedures that apply to all of the sets of ADS-B Transmitting and Receiving Subsystem tests fall into group 1. Group 2 procedures apply to 9 of the sets of ADS-B Transmitting and Receiving Subsystem performance tests. Group 3 procedures apply to 6 of the sets of ADS-B Transmitting and Receiving Subsystem performance tests. Group 4 procedures apply to one set of the performance tests. Group 5, which applies to none of the ADS-B Transmitting and Receiving Subsystem performance tests, includes only environmental procedures that are intended to determine the effect of the ADS-B Transmitting and/or Receiving Subsystem on rack mounting hardware, compass needles, explosive gases, and other RF hardware.

Table 2.3.1b indicates which of the groups of environmental procedures is related to each set of ADS-B Transmitting and/or Receiving Subsystem performance tests. Each ADS-B Transmitting and/or Receiving Subsystem performance test **shall** be validated under all of the environmental procedures in the groups required for that test as indicated in Table 2.3.1b.

Table 2.3.1a: Environmental Test Groups

TEST #	ENVIRONMENTAL CONDITION	RTCA DO-160D Paragraph	EUROCAE ED-14D Paragraph	GROUPS	REMARKS
4a	Temperature	4.5	4.4 – 4.5	1	
4b	Altitude	4.6.1	4.6.1	3	
4c	Decompression & Overpressure	4.6.2 - 4.6.3	4.6.2 - 4.6.3	3	
5	Temperature Variation	5.0	5.0	3	
6	Humidity	6.0	6.0	2	
7a	Operational Shock	7.2	7.1	2	
7b	Crash Safety	7.3	7.2	5	NO TESTS
8	Vibration	8.0	8.0	3 & 1	3 during: 1 after
9	Explosion	9.0	9.0	5	NO TESTS
10	Waterproofness	10.0	10.0	2	
11	Fluids Susceptibility	11.0	11.0	2	
12	Sand and Dust	12.0	12.0	2	
13	Fungus Resistance	13.0	13.0	2	
14	Salt Spray	14.0	14.0	2	
15	Magnetic Effect	15.0	15.0	5	NO TESTS
16	Power Input Momentary Interruptions All Others	16.0	16.0	4 3 & 2	3 during: 2 after
17	Voltage Spike	17.0	17.0	2	
18	Audio Frequency Conducted Susceptibility	18.0	18.0	1	
19	Induced Signal Susceptibility	19.0	19.0	1	
20	RF Susceptibility	20.0	20.0	1	
21	Emission of RF Energy	21.1	21.1	5	NO TESTS
22	Lightning Induced Transient Susceptibility	22.0	22.0	3	
23	Lightning Direct Effects	23.0	23.0	3	
24	Icing	24.0	24.0	2	
25	Electrostatic Discharge	25.0	25.0		NO TESTS

Note: *Tests in Group 5 determine the effects of the ADS-B equipment on other equipment (mounts, compass needles, explosive gases, and other RF equipment) and therefore do not involve the ADS-B equipment performance requirements of this document.*

Table 2.3.1b: Performance Test Requirements During Environmental Tests

Test Procedure Paragraph	DESCRIPTION	Required Environmental Test Groups (See Table 2-77)				
		1	2	3	4	5
§2.3.2.1	Transponder Based Transmitters	X	X	X		
§2.3.2.2	Stand Alone (non-Transponder)based Transmitters	NT	NT	NT	NT	NT
§2.3.2.2.1	Frequency	X	X	X		
§2.3.2.2.2	Pulse Shapes	X				
§2.3.2.2.3	Pulse Interval	X				
§2.3.2.2.4	Preamble	X				
§2.3.2.2.5	Data Pulses	X		X		
§2.3.2.2.6	RF Peak Output Power	NT	NT	NT	NT	NT
§2.3.2.2.6.1	Class A0 Equipment RF Peak Output Power	X	X			
§2.3.2.2.6.2	Class B Equipment RF Peak Output Power	X	X			
§2.3.2.2.7	Transmission Rates for Transponder - Based Transmitters	NT	NT	NT	NT	NT
§2.3.2.2.7.1	Transmission Rates Compliant with RTCA DO-181C	X	X			
§2.3.2.2.7.2	Transmission Rates not specified in RTCA DO-181C	X	X			
§2.3.2.2.7.3	Maximum Transmission Rates for Transponder - Based Transmitters	X	X			
§2.3.2.2.8	Transmission Rates for Stand-Alone Transmitters	X	X			
§2.3.2.2.8.1	Power-On Initialization	X	X			
§2.3.2.2.8.2	ADS-B Airborne Position Message Broadcast Rate	X				
§2.3.2.2.8.3	ADS-B Surface Position Message Broadcast Rate	X				
§2.3.2.2.8.4	ADS-B Aircraft Identification and Type Message Broadcast Rate	X				
§2.3.2.2.8.5	ADS-B Velocity Information Message Broadcast Rate	X				
§2.3.2.2.8.6	ADS-B Aircraft Target State and AStatus Message Broadcast Rates	X				
§2.3.2.2.8.7	ADS-B Aircraft Operational Status Message Broadcast Rates	X				
§2.3.2.2.8.8	"Extended Squitter Aircraft Status" ADS-B Message Broadcast Rate	X				
§2.3.2.2.8.9	"TYPE 23 (TEST)" ADS-B Message Broadcast Rate	X				
§2.3.2.2.8.10	Maximum ADS-B Message Transmission Rates	X				
§2.3.2.3	Receivers Shared with a TCAS Unit	X	X	X		
§2.3.2.3.1	TCAS Compatibility	X				
§2.3.2.3.2	Re-Triggerable Reply Processor	X	X			
2.3.2.3.3	Verification of Enhanced Squitter Reception Techniques	NT	NT	NT	NT	NT
2.3.2.3.3.1	Combined Preamble and Data Block Tests with A/C Fruit	X				
2.3.2.3.3.2	Data Block Tests with Mode S Fruit	X				
2.3.2.3.3.3	Re-Triggering Performance	X				
§2.3.2.4	Receivers Not Shared with TCAS (2.2.4.3)	NT	NT	NT	NT	NT
§2.3.2.4.1	In-Band Acceptance	X	X	X		
§2.3.2.4.2	Dynamic Range	X	X	X		
§2.3.2.4.3	Re-Triggerable Capability	X	X			
§2.3.2.4.4	Out-of-Band Rejection	X	X			
§2.3.2.4.5	Dynamic Minimum Trigger Level	X	X			
§2.3.2.4.6	Criteria for ADS-B Message Transmission Pulse Detection	X				
§2.3.2.4.7	Criteria for Data Block Acceptance in ADS-B Message Signals	X				
2.3.2.4.8	Verification of Enhanced Squitter Reception Techniques (2.2.4.4)	NT	NT	NT	NT	NT
2.3.2.4.8.1	Combined Preamble and Data Block Tests with A/C Fruit	X				
2.3.2.4.8.2	Data Block Tests with Mode S Fruit	X				
2.3.2.4.8.3	Re-Triggering Performance	X				
2.3.2.4.9	Track File Maintenance	X	X	X		

Table 2-78: Performance Test Requirements During Environmental Tests (Continued)

Test Procedure Paragraph	DESCRIPTION	Required Environmental Test Groups (See Table 2-77)				
		1	2	3	4	5
§2.3.2.5	Self Test and Monitors	NT	NT	NT	NT	NT
§2.3.2.5.1	Transponder Based Equipment Address	X	X	X	X	
§2.3.2.5.2	Non-Transponder Based Equipment	X	X	X	X	
§2.3.2.6	Response to Mutual Suppression	NT	NT	NT	NT	NT
§2.3.2.6.1	Transmitting Device Response to Mutual Suppression Pulses	X				
§2.3.2.6.2	Receiving Device Response to Mutual Suppression Pulses	X				
§2.3.2.7.1	Transmitting Diversity	TBD	TBD	TBD	TBD	TBD
§2.3.2.7.2	Receiving Diversity	NT	NT	NT	NT	NT
§2.3.2.7.2.1	Full Receiver and Message Processing or Receiver Switching Front-End Diversity	X	X			
§2.3.2.7.2.2	Receiving Antenna Switching Diversity	X	X			
§2.3.2.8	Power Interruption	NT	NT	NT	NT	NT
§2.3.2.8.1	Power Interruption to ADS-B Transmitting Subsystems	X			X	
§2.3.2.8.2	Power Interruption to ADS-B Receiving Subsystems	X			X	
2.3.2.9	Verification of Traffic Information Services-Broadcast (TIS-B)	NT	NT	NT	NT	NT
2.3.2.9.1						

Note: *"NT" in the above table means "NO TEST."*

2.3.2 Detailed Environmental Test Procedures

The test procedures set forth below are considered satisfactory for use in determining equipment performance under environmental conditions. Although specific test procedures are cited, it is recognized that other methods may be preferred. These alternative procedures may be used if the manufacturer can show that they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternative procedures. The ADS-B Transmitting and Receiving Subsystem performance tests do not include specific pass/fail criteria. It is intended that those criteria be obtained from the ADS-B Transmitting and Receiving performance requirements provided in subsection 2.2.

2.3.2.1 Transponder Based Transmitters (§2.2.2.1)

Transponder Based transmitters **shall** be tested to comply with the requirements of RTCA DO-181C, §2.3.2.2 inclusive (EUROCAE ED-73B, chapter 4).

2.3.2.2 Stand Alone (non-Transponder) based Transmitters (§2.2.2.2)

No specific test procedure is required to validate §2.2.2.2.

2.3.2.2.1 Frequency (§2.2.2.2.1)

Equipment Required:

Provide equipment capable of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test through the operational interface.

Stub Tuner (Microlab/FXR Sl-05N, or equivalent).

Variable Air Line (Line Stretcher) (Microlab/FKR SR-05N, or equivalent).

Slotted Line (HP 805C, or equivalent).

Measurement Procedure:

Determine the transmission frequency

Load valid data into the ADS-B Airborne Position format and ensure that the expected ADS-B transmissions occur. Adjust the stub to establish a l.5:l VSWR at the antenna end of the coax line specified by the manufacturer. If the ADS-B transmitter requires a minimum length of a specified cable type, an attenuator equal to the loss of the minimum amount of cable may be placed between the 1.5:1 VSWR point and the equipment antenna jack. Alternately, a length of cable equal to the specified minimum length and cable type may be used in lieu of the attenuator. Adjust the line stretcher for maximum transmitter frequency shift above and below 1090 MHz. Determine that the frequency shift does not exceed the requirements of §2.2.2.2.1.

2.3.2.2.2 Pulse Shapes (§2.2.2.2.4)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B broadcast message for display on an oscilloscope.

Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Measurement Procedure:

Step 1: ADS-B Message Pulse Amplitude Variation (§2.2.3.1.3.a)

Load valid data into the ADS-B Airborne Position Message and verify that the messages are being transmitted by the equipment under test. Measure the maximum power differential between pulses in ADS-B broadcast messages. Verify that it is within the tolerance specified in §2.2.3.1.3.a.

Step 2: ADS-B Message Pulse Shape (§2.2.3.1.3.b and c)

Load valid data into the ADS-B Airborne Position Message and verify that the messages are being transmitted by the equipment under test. Measure the rise and decay time of the ADS-B broadcast message pulses. Verify that they are within the tolerances specified in §2.2.3.1.3.b and c.

Note: *Pulse Rise Time is measured as the time interval between 10 percent and 90 percent of peak amplitude on the leading edge of the pulse. Pulse Decay Time is measured as the time interval between 90 percent and 10 percent of peak amplitude on the tailing edge of the pulse. See "Caution" statement below.*

***CAUTION**:* *If the detector is not known to be linear, checks should be made to determine what amplitude points on the detected pulse correspond to the*

10 percent and 90 percent amplitude points of the RF pulses. In addition, checks should be made to determine the rise and decay time of the detector.

2.3.2.2.3 Pulse Interval (§2.2.2.2.6)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope. Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Measurement Procedure:

ADS-B Message Pulse Spacing Tolerance (§2.2.3.1.4)

Load valid data into the ADS-B Airborne Position Message and verify that the messages are being output. Determine that the leading edge of any reply pulse is within 50 nanoseconds of its assigned position.

Note: *Interval measurements are measured between half voltage points of the respective pulses as detected by a linear detector. If the detector is not known to be linear, a check should be made to determine the half voltage points.*

2.3.2.2.4 Preamble (§2.2.2.2.7)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Measurement Procedure:

Determine Preamble Pulse Spacing

Load valid data into the ADS-B Airborne Position Message and verify that the messages are being transmitted by the equipment under test. Display the ADS-B Messages on the oscilloscope. Measure the pulse duration of the first four message pulses. Measure the pulse spacing between the leading edge of the first and each of the second, third, and fourth pulses. Determine that the spacing of the pulses is within the tolerances specified in §2.2.3.1.1.

Note: *Interval measurements are measured between half voltage points of the respective pulses as detected by a linear detector. If the detector is not known to be linear, a check should be made to determine the half voltage points.*

2.3.2.2.5 Data Pulses (§2.2.2.2.8)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Measurement Procedure:

Determine Message Data Pulse Width and Duration

Note 1: *For tests in this section, unless otherwise specified, examine pulses at the beginning, middle and end of the ADS-B broadcast messages.*

Load valid data into the ADS-B Airborne Position Message and verify that the messages are being transmitted by the equipment under test. Measure the pulse duration of the pulses transmitted in the ADS-B Message throughout the message transmission. Determine that the duration of the pulses is within the tolerance specified in §2.2.3.1.2.

Measure the pulse spacing of the fifth reply pulse with reference to the first reply pulse. Determine that the pulse spacing is within the tolerance specified in §2.2.3.1.2.

Note 2: *Interval measurements are measured between half voltage points of the respective pulses as detected by a linear detector. If the detector is not known to be linear, a check should be made to determine the half voltage points.*

2.3.2.2.6 RF Peak Output Power (§2.2.2.2.10)

No specific test procedure is required to validate §2.2.2.2.10.

2.3.2.2.6.1 Class A0 Equipment RF Peak Output Power (§2.2.2.2.10.1)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test.

Wide Band Dual Channel Oscilloscope (HP l7l0B, or equivalent).

Measurement Procedure:

Load valid data into the ADS-B Airborne Position format and ensure that the expected ADS-B transmissions occur. Measure the single pulse having the maximum RF power output. Determine that the maximum power output meets the requirements of §2.2.2.2.10.1.

2.3.2.2.6.2 Class B Equipment RF Peak Output Power (§2.2.2.2.10.2)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test.

Wide Band Dual Channel Oscilloscope (HP l7l0B, or equivalent).

Measurement Procedure:

Load valid data into the ADS-B Airborne Position format and ensure that the expected ADS-B transmissions occur. Measure the single pulse having the maximum RF power output. Determine that the maximum power output meets the requirements of §2.2.2.2.10.2.

2.3.2.2.7 Transmission Rates for Transponder - Based Transmitters (§2.2.3.3.1)

No specific test procedure is required to validate §2.2.3.3.1.

2.3.2.2.7.1 Transmission Rates Compliant with RTCA DO-181C (§2.2.3.3.1.1)

Performance of ADS-B transmitters based on Mode S transponders **shall** validate Message Update Rates in accordance with RTCA DO-181C §2.5.4.6.2, for each class of transponder defined in FAA TSO-C112.

2.3.2.2.7.2 Transmission Rates that are not specified in RTCA DO-181C (§2.2.3.3.1.2) (EUROCAE ED-73B, §3.21.2.6.3)

When the transmission rate of a particular message type is not specified or is not tested in RTCA DO-181C (EUROCAE ED-73B), then the Mode S transponder based ADS-B transmitters **shall** verify the message delivery performance for those messages in accordance with §2.3.2.2.8 through §2.3.2.2.8.10 of this document for Stand - Alone Transmitters. If there is conflict between the requirements of RTCA DO-181C and this document, then the requirements of RTCA DO-181C (EUROCAE ED-73B) **shall** be adhered to.

2.3.2.2.7.3 Maximum Transmission Rates for Transponder - Based Transmitters (§2.2.3.3.1.3)

Performance of ADS-B transmitters based on Mode S transponders **shall** validate maximum transmission rates in accordance with RTCA DO-181C (EUROCAE ED-73B), for each class of transponder defined in FAA TSO-C112.

When the maximum transmission rate of a particular message type is not specified or is not tested in RTCA DO-181C (EUROCAE ED-73B), then the Mode S transponder based ADS-B transmitters **shall** verify the maximum message delivery rate in accordance with §2.3.2.2.8.10 of this document for Stand-Alone transmitters. If there is conflict between the requirements of RTCA DO-181C (EUROCAE ED-73B) and this document, then the requirements of RTCA DO-181C (EUROCAE ED-73B) **shall** be adhered to.

2.3.2.2.8 Transmission Rates for Stand - Alone Transmitters (§2.2.3.3.1.4)

Purpose/Introduction:

a. Stand-Alone Transmitters for Class A0 and Class B equipment are implemented independent of a Mode S transponder. Such transmitters **shall** meet the transmission rate requirements of §2.2.3.3.1.3 and the message update rate requirements specified in the following subparagraphs.

b. Add a quantization interval for the transmitted message jitter of 15 milliseconds or less.

Equipment Required:

Provide a method of loading valid data for the generation of ADS-B Airborne Position, Surface Position, Aircraft Identification and Type, Airborne Velocity, Target State and Status, and Operational Status broadcast messages into the ADS-B Transmitting Subsystem under test.

Provide a method of recording and time stamping all ADS-B Broadcast messages transmitted by the ADS-B Transmitting Subsystem under test with the time stamping quantization being 15 milliseconds or less.

Measurement Procedure:

Step 1: ADS-B Message Broadcast Setup

Provide the ADS-B Transmitting Subsystem under test with all valid necessary data for the generation of ADS-B Airborne Position, Aircraft Identification and Type, Airborne Velocity, Target State and Status, and Operational Status broadcast messages.

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Messages.

Step 2: ADS-B Message Recording and Time Stamping

Record and time stamp all ADS-B Messages that are broadcast by the ADS-B Transmitting Subsystem for a period of not less than 5 minutes.

Step 3: Distribution Checks

For each of the ADS-B Airborne Position, Aircraft Identification and Type, Airborne Velocity, Target State and Status, and Operational Status Message types transmitted, verify that the messages are distributed over the specified range of transmission intervals for each particular message type.

Step 4: Interval Quantization Checks

For each of the ADS-B Airborne Position, Aircraft Identification and Type, Airborne Velocity, Target State and Status, and Operational Status Message types transmitted, verify that the messages were distributed with the jitter spacing being 15 milliseconds or less between messages of equivalent type.

2.3.2.2.8.1 Power-On Initialization (§2.2.3.3.2.1.1)

Equipment Required

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope. Provide a Wide Band Dual Channel Oscilloscope (HP 1710B, or equivalent).

Measurement Procedure

Step 1: No Data Available (§2.2.3.3.2.1.1.a)

Ensure that no appropriate valid message data are available for any of the possible ADS-B broadcast messages. Power up the equipment. Verify that no transmissions occur.

Step 2: Valid Data available (§2.2.3.3.2.1.1.b)

For each ADS-B Position and Velocity message type in turn, ensure that appropriate valid ADS-B Message data are available for that message type only. Power up the equipment. Verify that the correct ADS-B broadcast message is transmitted starting no later than 2.0 seconds after Power-On.

2.3.2.2.8.2 ADS-B Airborne Position Message Broadcast Rate (§2.2.3.3.2.2)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope, or equivalent method of observing the message content.

Measurement Procedure:

Ensure that the equipment is set to the "Airborne" condition and that the appropriate valid ADS-B Airborne Position data is available. Verify that the ADS-B Airborne Position Message is broadcast at intervals that are distributed over the range of 0.4 to 0.6 seconds as specified in §2.2.3.3.2.2.

2.3.2.2.8.3 ADS-B Surface Position Message Broadcast Rate (§2.2.3.3.2.3)

Equipment Required:

Provide a method of loading valid data for broadcasting ADS-B Messages into the ADS-B equipment under test. Provide a method of monitoring the transmitted ADS-B Messages and measuring the rate at which they are output.

Measurement Procedure:

Step 1: Switching from High Rate to Low Rate (§2.2.3.3.2.3.a(1) and c)

Ensure that the equipment is set to the "On the Ground" condition and that the appropriate valid ADS-B Surface Position data is provided such that the position is changing at a rate of 10.1 meters in a 30 second sampling interval. At least 61 seconds after the start of the data input, verify that the ADS-B Surface Position Message is broadcast at intervals that are distributed over the range of 0.4 to 0.6 seconds as specified in §2.2.3.3.2.3.b.

Input new ADS-B Surface Position data with the position data changing at a rate of 9.9 meters in a 30 second sampling interval. At least 61 seconds after the inputting of the new data, verify that the ADS-B Surface Position Message is broadcast at intervals that are distributed over the range of 4.8 to 5.2 seconds as specified in §2.2.3.3.2.3.c.

Step 2: Switching from Low Rate to High Rate (§2.2.3.3.2.3.a(2) and c)

Ensure that the equipment is set to the "On the Ground" condition and that the appropriate valid ADS-B Surface Position data is provided such that the position is stationary. At least 61 seconds after establishing the data, verify that the ADS-B Surface Position Messages are broadcast at intervals that are distributed over the range of 4.8 to 5.2 seconds as specified in 2.2.3.3.2.3.c.

Input new ADS-B Surface Position data such that the position is stationary and 10.1 meters away from the position above. One (1) second after inputting the new data, verify that the ADS-B Surface Position Messages are broadcast at intervals that are distributed over the range of 0.4 to 0.6 seconds as specified in §2.2.3.3.2.3.b. Also verify that at least 61 seconds after establishing the new data that the ADS-B Surface Position Message is broadcast at intervals that are distributed over the range 4.8 to 5.2 seconds as specified in §2.2.3.3.2.3.c.

2.3.2.2.8.4 ADS-B Aircraft Identification and Type Message Broadcast Rate (§2.2.3.3.2.4)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Step 1: Airborne (§2.2.3.3.2.4.a)

Ensure that the equipment is set to the "Airborne" condition and that the appropriate valid ADS-B Aircraft Identification and Type data is available. Verify that the ADS-B Aircraft Identification and Type message is broadcast at intervals that are distributed over the range of 4.8 to 5.2 seconds as specified in §2.2.3.3.2.4.a.

Step 2: On the Ground (§2.2.3.3.2.4.b)

Ensure that the equipment is set to the "On the Ground" condition and that the appropriate valid ADS-B Aircraft Identification and Type data is available. Verify that the ADS-B Aircraft Identification and Type message is broadcast at intervals that are distributed over the range of 9.8 to 10.2 seconds as specified in §2.2.3.3.2.4.b.

2.3.2.2.8.5 ADS-B Velocity Information Message Broadcast Rate (§2.2.3.3.2.5)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Ensure that the appropriate valid ADS-B Velocity Information data is available. Verify that the ADS-B Velocity Information message is broadcast at intervals that are distributed over the range of 0.4 to 0.6 seconds as specified in §2.2.3.3.2.5.a.

2.3.2.2.8.6 Target State and Status Message Broadcast Rates (§2.2.3.3.2.6.1)

Equipment Required:

Provide a Method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Ensure that no Target State data is available. Verify that no Target State and Status Message is output for a period of 20 seconds. Inject the appropriate valid ADS-B Target State data and verify that the ADS-B Target State and Status Message is broadcast at intervals that are distributed over the range of 1.2 to 1.3 seconds as specified in §2.2.3.3.2.6.1.b for as long and data is available.

Repeat the procedure for each Target State and Status Message independently as necessary.

2.3.2.2.8.7 ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.2.6.2)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Ensure that no Aircraft Operational Status data is available. Verify that no Aircraft Operational Status Message is output for a period of 20 seconds. Inject the appropriate valid ADS-B Aircraft Operational Status data. Verify that the ADS-B Aircraft Operational Status Message is broadcast at intervals that are distributed over the range of 2.4 to 2.6 seconds as specified in §2.2.3.3.2.6.2.b for a period of 24 +/- 1 seconds if Target State and Status Messages are being broadcast. Verify that the ADS-B Aircraft Operational Status Message is broadcast at intervals that are distributed over the range of 0.7 to 0.8 seconds as specified in §2.2.3.3.2.6.2.b for a period of 24 +/- 1 seconds if Target State and Status Messages are not being broadcast.

2.3.2.2.8.8 "Extended Squitter Aircraft Status" ADS-B Message Broadcast Rate (§2.2.3.3.2.6.3)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Establish the emergency condition in accordance with Appendix A., Figure A.8-9, Note 2. Verify that the Emergency/Status Message (TYPE-28, Subtype=1) is broadcast at intervals that are distributed over the range of 0.7 to 0.8 seconds if the Target State and Status Message is not being broadcast. Verify that the Emergency/Status Message (TYPE-28, Subtype=1) is broadcast at intervals that are distributed over the range of 2.4 to 2.6 seconds if the Target State and Status Message is being broadcast. Clear the established emergency condition and verify that NO Emergency/Status Messages are broadcast.

2.3.2.2.8.9 "TYPE 23 (TEST)" ADS-B Message Broadcast Rate (§2.2.3.3.2.7)

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting the RF pulses of the ADS-B Broadcast Message for display on an oscilloscope.

Measurement Procedure:

Update the TEST ADS-B Message and verify that it is broadcast only once. Repeat 10 times.

2.3.2.2.8.10 Maximum ADS-B Message Transmission Rates (§2.2.3.3.2.10)

Equipment Required:

Provide equipment capable of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test through the operational interface. Provide a method of monitoring ADS-B broadcast messages output by the equipment under test. Provide a Wide Band Dual Channel Oscilloscope (HP l7l0B, or equivalent).

Measurement Procedure:

Step 1: Maximum Combined ADS-B Message Output rate (§2.2.3.3.2.10--Airborne

Set the Airborne condition and load valid data into all the ADS-B Broadcast messages that can be supported by the equipment under test at a rate ensuring maximum transmission rate. Also ensure that the data for all event driven messages changes at a rate requiring more than the permitted maximum output rate of two messages per second. Verify that each of the ADS-B Broadcast messages types are output at rates within the specified tolerance, that the Airborne Position Messages are being transmitted, and that only two event driven messages per second are transmitted. Also verify that the total combined rate is less than or equal to 6.2 messages per second.

During this test, also verify that the transmitted output power remains within the specified limits.

2.3.2.3 Receivers Shared with a TCAS Unit (§2.2.4.2)

ADS-B receivers implemented as part of a TCAS unit **shall** demonstrate compliance with Test Procedures specified in RTCA DO-185A, TCAS MOPS, §2.4.2.1.2.

In addition to tests specified in RTCA DO-185A, TCAS MOPS, §2.4.2.1.2, TCAS units operating with receivers that are more sensitive than the MTL requirements specified in RTCA DO-185A, TCAS MOPS **shall** be submitted to the following test procedures provided through §2.3.2.4.7.

2.3.2.3.1 TCAS Compatibility (§2.2.4.2.1.1)

Purpose/Introduction:

This test verifies that no more than 10% of ADS-B Messages received at a level of −78 dBm or below **shall** be passed to the TCAS surveillance function.

Input:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

“DF”	=	17
“CA”	=	0
“AA”	=	Any discrete address
Message Rate	=	50 Hz
Frequency	=	1090 MHz
Power	=	-78 dBm

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Apply ADS-B **Input** Message

Apply **Input** at the receiver input port.

Step 2: Verify ADS-B **Input** Message Reception

Verify that no more than 10% of all ADS-B Messages are passed on to the TCAS surveillance function.

Step 3: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 and 2 on all other applicable receiver RF input ports of the UUT.

2.3.2.3.2 Re-Triggerable Reply Processor (§2.2.4.2.2)

Purpose/Introduction:

The following procedures verify the capability of the TCAS shared ADS-B receiver to detect overlapping Mode-S replies or ADS-B Messages in the TCAS level range.

Inputs:

All Intruder Aircraft:

Frequency = 1090 MHz.
Altitude Rate = 0 FPM

Intruder Aircraft 1:

Equipage	=	Mode-S ADS-B
Squitter Power	=	-50 dBm
Altitude	=	8000 ft.
Range	=	2 NM at T=0 sec.

Intruder Aircraft 2:

Equipage	=	Mode-S ADS-B
Squitter Power	=	-44 dBm
Altitude	=	8000 ft.
Range	=	Maintained such that the leading edge of the first preamble pulse from Intruder 2 occurs 12 +/- 1.0 µs later than the leading edge of the first preamble pulse from Intruder 1 throughout the scenario.

TCAS Aircraft:

Altitude	=	8000 ft.
Altitude Rate	=	0 FPM
Range	=	0 NM
Sensitivity Level Selection	=	Automatic

ADS-B Message Format (Intruder 1):

All ADS-B Message transmissions **shall** have the following standard data field values:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address

Mode-S Squitter Format (Intruder 2):

All Mode-S squitter transmissions **shall** have the following standard data field values:

"DF"	=	11
"CA"	=	0
"AA"	=	Any discrete address

Conditions:

TCAS initialized and operating at T = 0 seconds. Intruders 1 and 2 **shall** each transmit squitters during the squitter listening period following each whisper-shout sequence and **shall** reply with a short special surveillance format (DF = 0) to each TCAS discrete interrogation.

Scenario Description:

Both Intruders are co-altitude with TCAS and each transmits squitters when TCAS is in squitter listening mode and replies to discrete interrogations from TCAS. Intruder 2 is overlapping the Intruder 1 reply window.

Measurement Procedure:

The receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Apply ADS-B and Mode-S Input Messages

Apply the message inputs specified above to the receiver input port.

Verify that the TCAS receiver detects intruder #2.

Step 2: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 on all other applicable receiver RF input ports of the UUT.

Step 3: Vary Signal Power Levels

Repeat Steps 1 and 2 with the following additional squitter power levels:

a. Intruder Aircraft 1 – Squitter Power = -30 dBm

Intruder Aircraft 2 – Squitter Power = -24 dBm

b. Intruder Aircraft 1 – Squitter Power = MTL + 3 dB

Intruder Aircraft 2 – Squitter Power = MTL + 9 dB

Verify that the TCAS receiver detects Intruder Aircraft #2 for each case.

2.3.2.3.3 Verification of Enhanced Squitter Reception Techniques (§2.2.4.4)

No specific test procedures are required to validate §2.3.2.3.3.

The following procedures apply to Class A1, A2, and A3 receivers that implement Enhanced Squitter Reception Techniques and are part of the TCAS Receiver.

2.3.2.3.3.1 Combined Preamble and Data Block Tests with A/C Fruit

Perform the procedures provided in section 2.3.2.4.8.1.

2.3.2.3.3.2 Data Block Tests with Mode S Fruit

Perform the procedures provided in section 2.3.2.4.8.2.

2.3.2.3.3.3 Re-Triggering Performance

Perform the procedures provided in section 2.3.2.4.8.3.

2.3.2.4 Receivers Not Shared With TCAS (§2.2.4.3)

No specific test procedure is required to validate §2.2.4.3.

2.3.2.4.1 In-Band Acceptance (§2.2.4.3.1.1.a)

Purpose/Introduction:

This test verifies the compliance of the ADS-B receiver with the sensitivity requirements specified for the particular ADS-B equipage class.

Input:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-68 dBm

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Apply ADS-B Input Messages

Apply **Input** at the receiver input port.

Step 2: Establish UUT Receiver MTL

Decrease the input power level and determine the minimum RF signal level required to produce a 90 percent ADS-B Message reception rate by the UUT receiver.

This value plus the loss line value represents the measured MTL of the UUT ADS-B receiver.

Verify that the measured MTL is in compliance with the limits specified in §2.2.4.3.1.1.a for the UUT equipment class.

Step 3: Verify UUT Receiver MTL over the Operational Frequency Range

Vary the RF signal frequency over the range of 1089 to 1091 MHz and determine the variation in RF signal level required to produce 90 percent ADS-B Message reception rate by the UUT receiver.

Verify that the measured MTL continues to comply with the limits specified in §2.2.4.3.1.1.a for the UUT equipment class.

Step 4: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 through 3 on all other applicable receiver RF input ports of the UUT.

2.3.2.4.2 Dynamic Range (§2.2.4.3.1.1.b)

Purpose/Introduction:

This test verifies that the ADS-B receiver can detect and decode valid ADS-B Messages over the equipment's specified dynamic range.

Input:

Equipment:

Provide a method of providing the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-68 dBm

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Apply ADS-B Input Messages

Apply **Input** at the receiver input port.

Step 2: Establish UUT Receiver MTL

Decrease the input power level and determine the minimum RF signal level required to produce 90 percent ADS-B Message reception rate by the UUT receiver.

This value plus the loss line value represents the measured MTL of the UUT ADS-B receiver.

Step 3: Verify UUT Receiver Dynamic Range

Increase the input signal power level to MTL + 3 dB.

Verify that the receiver properly detects and decodes at least 99% of all ADS-B Messages received.

Increase the input signal power level in 10 dB steps up to a signal level of -21 dBm.

At each step, verify that the receiver properly detects and decodes at least 99% of all ADS-B Messages received.

Step 4: Verify Class A3 UUT Receiver Performance

Decrease the input signal power level to -87 dBm. Verify that the receiver properly detects and decodes at least 15% of all ADS-B Messages input.

Step 5: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 through 3 on all other applicable receiver RF input ports of the UUT.

2.3.2.4.3 Re-Triggerable Capability (§2.2.4.3.1.2)

Purpose/Introduction:

The following procedures verify the capability of the Stand alone ADS-B receiver to detect overlapping ADS-B broadcast messages.

Input:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-50 dBm

Followed by a second Valid Mode S Extended Squitter:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address different from the first one
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-44 dBm

Starting 12.0 +/- 1.0 μsec later than the leading edge of the first ADS-B Message.

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Re-Trigger Capability - Part 1

Apply **Input** at the receiver input and verify that at least 90 percent of the second valid ADS-B Messages are correctly decoded.

Step 2: Re-Trigger Capability - Part 2

Repeat Step 1 with the **Input** signal power level at MTL + 6 dB for the first ADS-B Message and MTL + 12 dB for the second ADS-B Message.

Step 3: Re-Trigger Capability - Part 3

Repeat Step 1 with **Input** level at -30 dBm for the first ADS-B Message and

-24 dBm for the second ADS-B Message.

Step 4: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 through 3 on all other applicable receiver RF input ports of the UUT.

2.3.2.4.4 Out-of-Band Rejection (§2.2.4.3.2)

Purpose/Introduction:

This test verifies that the ADS-B out-of-band rejection is in accordance with the specified values.

Input A:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	MTL + 3 dB Where MTL is the measured value of MTL made at 1090 MHz.

Input B:

Same as Input A with:

Frequency	=	1084.5 MHz
Power	=	MTL + 6 dB

Input C:

Same as Input A with:

Frequency	=	1080.0 MHz
Power	=	MTL + 23 dB

Input D:

Same as Input A with:

Frequency	=	1075.0 MHz
Power	=	MTL + 43 dB

Input E:

Same as Input A with:

Frequency	=	1065.0 MHz
Power	=	MTL + 63 dB

Input F:

Same as Input A with:

Frequency	=	1095.5 MHz
Power	=	MTL + 6 dB

Input G:

Same as Input A with:

Frequency	=	1100.0 MHz
Power	=	MTL + 23 dB

Input H:

Same as Input A with:

Frequency	=	1105.0 MHz
Power	=	MTL + 43 dB

Input I:

Same as Input A with:

Frequency	=	1115.0 MHz
Power	=	MTL + 63 dB

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Apply Initial ADS-B Input Messages

Apply Input B at the receiver input port and decrease the power level until the percentage of decoded ADS-B Messages is less than or equal to 90 percent.

Verify that the measured signal power level required to produce a message decoding percentage of greater than or equal to 90 percent is greater than the limit specified in Table 2-63 in §2.2.4.3.2.

Step 2: Vary the Input Signal Power and Frequency

Repeat Step 1 using inputs C, D, E, F, G, H, and I.

Step 3: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 and 2 on all other applicable receiver RF input ports of the UUT.

2.3.2.4.5 Dynamic Minimum Trigger Level (DMTL) (§2.2.4.3.3)

Purpose/Introduction:

This test verifies that, when DMTL control is implemented (see §2.2.4.3.3), then the ADS-B receiver DMTL is capable of rejecting low level signals during a valid squitter reception and that DMTL is capable of recovering in not more than 128 microseconds after the leading edge of the first preamble pulse of a valid ADS-B Message.

Note: *This test procedure is only applicable to equipment that do not use the enhanced reception techniques. That is, it is not applicable to equipage classes A1, A2 and A3.*

Input A:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-61 dBm

Overlapped by a pulse having the following characteristics:

Pulse Width	=	120 +/- 1 μsec
Pulse Rise Time	=	0.05 to 0.1 μsec
Pulse Fall Time	=	0.05 to 0.2 μsec
Frequency	=	1090 MHz
Power	=	-69 dBm

Starting 0.7 +/- 0.2 μsec after the leading edge of the first preamble pulse of the ADS-B Message.

Input B:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-40 dBm

Overlapped by a pulse having the following characteristics:

Pulse Width	=	120 +/- 1 µsec
Pulse Rise Time	=	0.05 to 0.1 µsec
Pulse Fall Time	=	0.05 to 0.2 µsec
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-49 dBm

Starting 0.7 +/- 0.2 µsec after the leading edge of the first preamble pulse of the ADS-B Message.

Input C:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-21 dBm

Overlapped by a pulse having the following characteristics:

Pulse Width	=	120 +/- 1 µsec
Pulse Rise Time	=	0.05 to 0.1 µsec
Pulse Fall Time	=	0.05 to 0.2 µsec
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-30 dBm

Starting 0.7 +/- 0.2 µsec after the leading edge of the first preamble pulse of the ADS-B Message.

Input D:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-21 dBm

Followed by a second Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-60 dBm

Starting 129 +/- 1 µsec after the leading edge of the first preamble pulse of the first ADS-B Message.

Input E:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-70 dBm

Preceded by a pulse having the following characteristics:

Pulse Width	=	0.50 μsec
Pulse Rise Time	=	0.05 to 0.1 μsec
Pulse Fall Time	=	0.05 to 0.2 μsec
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-60 dBm

Starting 4.0 μsec before the leading edge of the first preamble pulse of the ADS-B Message.

Input F:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-70 dBm

Preceded by a pulse having the following characteristics:

Pulse Width	=	0.50 μsec
Pulse Rise Time	=	0.05 to 0.1 μsec
Pulse Fall Time	=	0.05 to 0.2 μsec
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-60 dBm

Starting 9.0 μsec before the leading edge of the first preamble pulse of the ADS-B Message.

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: DMTL Desensitization - Part 1

Apply **Input A** at the receiver input and verify that at least 90 percent of the valid ADS-B Messages are correctly decoded.

Step 2: DMTL Desensitization - Part 2

Repeat Step 1 using **Input B**.

Step 3: DMTL Desensitization - Part 3

Repeat Step 1 using **Input C**.

Step 4: DMTL Recovery - Part 4

Apply **Input D** at the receiver input and verify that at least 90 percent of the second valid ADS-B Messages are correctly decoded.

Step 5: DMTL Desensitization after a Single Pulse

Apply **Input E** at the receiver input and verify that no more than 10 percent of the valid ADS-B Messages are correctly decoded.

Step 6: DMTL Recovery after a Single Pulse

Apply **Input F** at the receiver input and verify that at least 90 percent of the valid ADS-B Messages are correctly decoded.

2.3.2.4.6 Criteria for ADS-B Message Transmission Pulse Detection (§2.2.4.3.4.7.1and §2.2.4.3.4.7.2)

Purpose/Introduction:

These tests verify that the ADS-B reply processor correctly detects the presence of a valid ADS-B preamble whose pulse characteristics are within the allowable limits and rejects preambles having pulse spacing and position characteristics that are outside the allowable limits.

Reference Input:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

“DF”	=	17
“CA”	=	0
“AA”	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-23 dBm (for the first preamble pulse level

Input A:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-79: Input A: Preamble Pulse Characteristics

Pulse	Rise time (μsec)	Fall time (μsec)	Δ Width (μsec)	Δ Position (μsec)	Δ Amplitude (dB)
1	0.05 - 0.1	0.05 - 0.2	+0.05	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.05	-0.125	+2
3	0.05 - 0.1	0.05 - 0.2	+0.05	+0.125	+2
4	0.05 - 0.1	0.05 - 0.2	-0.05	-0.125	0

Input B:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-80: Input B: Preamble Pulse Characteristics

Pulse	Rise time (μsec)	Fall time (μsec)	Δ Width (μsec)	Δ Position (μsec)	Δ Amplitude (dB)
1	0.05 - 0.1	0.05 - 0.2	-0.3	—	—
2	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
3	0.05 - 0.1	0.05 - 0.2	-0.3	0	0
4	0.05 - 0.1	0.05 - 0.2	-0.3	0	0

Input C:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-81: Input C: Preamble Pulse Characteristics

Pulse	Rise time (μsec)	Fall time (μsec)	Δ Width (μsec)	Δ Position (μsec)	Δ Amplitude (dB)
1	0.05 - 0.1	0.05 - 0.2	0	—	—
2	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
3	0.05 - 0.1	0.05 - 0.2	0	+0.2	0
4	0.05 - 0.1	0.05 - 0.2	0	+0.2	0

Input D:

Same as the **Reference Input**, but having the following preamble pulse characteristics:

Table 2-82: Input D: Preamble Pulse Characteristics

Pulse	Rise time (μsec)	Fall time (μsec)	Δ Width (μsec)	Δ Position (μsec)	Δ Amplitude (dB)
1	0.05 - 0.1	0.05 - 0.2	+4.5	—	—
2	Pulse Not Present				
3					
4					

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 1

Apply **Input A** at the receiver input and verify that at least 90 percent of the ADS-B messages are correctly decoded.

Step 2: Preamble Pulse Characteristics set to the Extreme Limits of their Tolerance Range - Part 2

Repeat Step 1 with the signal power level at -65 dBm.

Step 3: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 1

Apply **Input B** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 4: Preamble Pulse Widths set to Out-of-Tolerance Values - Part 2

Repeat Step 3 with the signal power level at -65 dBm.

Step 5: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 1

Apply **Input C** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 6: Preamble Pulse Positions set to Out-of-Tolerance Values - Part 2

Repeat Step 5 with the signal power level at -65 dBm.

Step 7: Preamble Single Pulse - Part 1

Apply **Input D** at the receiver input and verify that no more than 10 percent of the ADS-B Messages are correctly decoded.

Step 8: Preamble Single Pulse - Part 2

Repeat Step 7 with the signal power level at -65 dBm.

2.3.2.4.7 Criteria for Data Block Acceptance in ADS-B Message Signals (§2.2.4.3.4.7.3)

Purpose/Introduction:

This test verifies that ADS-B Messages are accepted when DF field is 17 or 18 and when no more than seven consecutive bits fail the confidence test, as specified by §2.2.4.3.4.7.3.

Input A:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-50 dBm

The normal data block content **shall** be modified to contain energy throughout both halves (i.e., chips) of bit positions 33 to 39. The amplitude of the pulse in the half that would ordinarily contain no energy **shall** be 3 dB below the amplitude of the normal pulse in the other half of the bit position.

Input B:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	18
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-50 dBm

The normal data block content **shall** be modified to contain energy throughout both halves (i.e., chips) of bit positions 33 to 39. The amplitude of the pulse in the half that would ordinarily contain no energy **shall** be 3 dB below the amplitude of the normal pulse in the other half of the bit position.

Input C:

Equipment:

Provide a method of supplying the UUT with:

Any Valid ADS-B Message having:

"DF"	=	17
"CA"	=	0
"AA"	=	Any discrete address
Message Rate	=	50 Hz.
Frequency	=	1090 MHz
Power	=	-50 dBm

The normal data block content **shall** be modified to contain energy throughout both halves (i.e., chips) of bit positions 33 to 40. The amplitude of the pulse in the half that would ordinarily contain no energy **shall** be 3 dB below the amplitude of the normal pulse in the other half of the bit position.

Measurement Procedure:

The ADS-B receiver power levels specified in this procedure are relative to the loss at the RF message source end of the transmission line used to interface the RF message source to the UUT receiver input port. For each ADS-B equipage class, the specified power level **shall** be adjusted to compensate for the maximum line loss for which the UUT receiver has been designed. For example, if the line loss is 3 dB, then each of the RF message power levels specified in the test procedures **shall** be lowered by 3 dB.

Step 1: Valid DF=17 ADS-B Message

Apply **Input A** at the receiver input and verify that all ADS-B Messages are correctly decoded.

Step 2: Valid DF=18 ADS-B Message

Apply **Input B** at the receiver input and verify that all ADS-B Messages are correctly decoded.

Step 3: Corrupted DF=17 ADS-B Messages - Part 1

Apply **Input C** at the receiver input and verify that ADS-B Messages are not decoded.

Step 4: Repeat on all Applicable Receiver Input Ports

Repeat Steps 1 through 3 on all other applicable receiver RF input ports of the UUT.

2.3.2.4.8 Verification of Enhanced Squitter Reception Techniques (§2.2.4.4)

No specific test procedures are required to validate §2.2.4.4.

2.3.2.4.8.1 Combined Preamble and Data Block Tests with A/C Fruit (§2.2.4.4.2)

Purpose/Introduction:

The following tests verify the performance of the equipment under test in decoding the Extended Squitter preamble and data block overlapped with Mode A/C fruit while being subjected to environmental conditions.

Equipment:

Refer to section 2.4.4.4.2.1.1 for Mode A/C Fruit Signal Source requirements.

Refer to section 2.4.4.4.2.1.3 for Extended Squitter Signal Source requirements.

Measurement Procedure:

Step 1: Verification of Operation of Equipment Under Test

Connect the Extended Squitter signal source and set the power level at the receiver input equal to the MTL limit required for the UUT equipment class:

–79 dBm for A1 equipment class or,

–79 dBm for A2 equipment class or,

–84 dBm for A3 equipment class.

Inject the Extended Squitter signal **100** times and record the Extended Squitters that are declared to be output as error free. Compare the decoded content of each Extended Squitter with the known content of the injected Extended Squitter. Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 90% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Test with Three Mode A/C Fruit Overlaps

Set the Extended Squitter signal source as specified in Step 1.

Set the power level of three Mode A/C fruit sources at the receiver input to the value corresponding to the UUT equipment class:

-71, -67 and –63 dBm for A1 or A2 equipment class or,

-76, -72 and –68 dBm for A3 equipment class.

Activate the Mode A/C fruit source so that the fruit is pseudo randomly distributed across the Extended Squitter preamble and data block as specified in 2.4.4.4.2.1.

Inject the Extended Squitter waveform **100** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Step 3: Determination of Success or Failure

Compare the results recorded above with the appropriate requirements in Table 2.3.2.4.8.1a, Table 2.3.2.4.8.1b or Table 2.3.2.4.8.1c.

Table 2.3.2.4.8.1a: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A1 Equipment

Number of Fruit	**3**
	.55
Minimum Probability	TBD
Max Undetected Errors	1

Table 2.3.2.4.8.1b: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A2 Equipment

Number of Fruit	**3**
	.91
Minimum Probability	.93
Max Undetected Errors	1

Table 2.3.2.4.8.1c: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A3 Equipment

Number of Fruit	**3**
	.95
Minimum Probability	*TBD*
Max Undetected Errors	1

2.3.2.4.8.2 Data Block Tests with Mode S Fruit (§2.2.4.4.2)

Purpose/Introduction:

The following tests verify the performance of the equipment under test in decoding the Extended Squitter data content overlapped with Mode S fruit while being subjected to environmental conditions.

Equipment:

Refer to section 2.4.4.4.2.1.2 for Mode S Fruit Signal Source requirements.

Refer to section 2.4.4.4.2.1.3 for Extended Squitter Signal Source requirements.

Measurement Procedure:

Step 1: Verification of Operation of Equipment Under Test

Connect the Extended Squitter signal source. Set and verify that the power level at the receiver input is equal to the MTL limit required for the UUT equipment class plus 12 dB:

–67 dBm for A1 or A2 equipment class or,

–72 dBm for A3 equipment class.

Inject the signal **100** times and record the Extended Squitters that are declared to be output as error free. Compare the decoded content of each Extended Squitter with the known content of the injected Extended Squitter.

Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 95% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Test with One Mode S Fruit Overlap

Set the Extended Squitter signal source as specified in Step 1.

Activate the Mode S fruit source so that the Mode S fruit is pseudo randomly distributed across the data Extended Squitter data block as specified in §2.4.4.4.2.1.2.

Set the Extended Squitter power to 0 dB relative to the Mode S fruit signal level.

Inject the Extended Squitter waveform **100** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Repeat the above step for relative powers of signal to interference (S/I) of +8 dB.

Calculate the probability of correct reception and the number of undetected errors for each of the four power levels.

Step 3: Determination of Success or Failure

Compare the results recorded above with the appropriate requirements in Table 2.3.2.4.8.2a, Table 2.3.2.4.8.2b or Table 2.3.2.4.8.2c.

Table 2.3.2.4.8.2a: Success Criteria for Data Block Tests with Mode S Fruit – Class A1 Equipment

Relative Power (S/I) dB	**0**	**+8**
	.01	.99
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

Table 2.3.2.4.8.2b: Success Criteria for Data Block Tests with Mode S Fruit – Class A2 Equipment

Relative Power (S/I) dB	**0**	**+8**
	.05	1.00
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

Table 2.3.2.4.8.2c: Success Criteria for Data Block Tests with Mode S Fruit – Class A3 Equipment

Relative Power (S/I) dB	**0**	**+8**
	0	1.00
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

2.3.2.4.8.3 Re-Triggering Performance (§2.2.4.4.2)

Purpose/Introduction:

The following tests verify the performance of the equipment under test to detect Extended Squitters that are preceded by lower level Mode S fruit while being subjected to environmental conditions.

Equipment:

Refer to section 2.4.4.4.2.1.2 for Mode S Fruit Signal Source requirements.

Refer to section 2.4.4.4.2.1.3 for Extended Squitter Signal Source requirements.

Measurement Procedure:

Step 1: Verification of Operation of Equipment Under Test

Connect the Extended Squitter signal source. Set and verify that the power level at the receiver input is equal to the MTL limit required for the UUT equipment class plus 12 dB:

–67 dBm for A1 or A2 equipment class or,

–72 dBm for A3 equipment class.

Inject the signal **100** times and record the Extended Squitters that are declared to be output as error free. Compare the decoded content of each Extended Squitter with the known content of the injected Extended Squitter. Any differences that are detected are recorded as an undetected error and that squitter reception is deleted from the count of error free receptions.

Calculate the measured probability of correct receptions and the number of undetected errors. The test is passed if the probability of correct receptions is at least 95% and there is no more than one undetected error event.

If this test is successful, proceed to Step 2. Otherwise, the test setup and equipment under test should be checked and Step 1 is repeated.

Step 2: Re-triggering Test with Varying Position Mode S Fruit

Connect the Mode S Fruit signal source. Set and verify that the power level at the receiver input is equal to the MTL limit required for the UUT equipment class plus 12 dB:

–67 dBm for A1 or A2 equipment class or,

–72 dBm for A3 equipment class.

Set the Extended Squitter power to +4 dB relative to the Mode S fruit signal level.

Activate the Mode S fruit source so that the 112-bit Mode S fruit signal is uniformly randomly distributed across the time interval beginning at –112 microseconds and ending at –6 microseconds relative to the signal. The time indicated is the spacing between the P1 pulse of the signal and the P1 pulse of the fruit, where negative values indicate that the fruit is received earlier.

Inject the Extended Squitter waveform **T** times and record the receptions that are declared to be error free. Check for undetected errors and adjust as necessary the number of correctly received replies as specified in Step 1. Calculate the measured probability of correct reception and the number of undetected errors.

Repeat the above step for relative powers of Signal to Interference (S/I) of + 12 dB.

Calculate the probability of correct reception and the number of undetected errors for each of the three power levels.

Compare the results recorded above with the appropriate requirements in Table 2.3.2.4.8.3a, Table 2.3.2.4.8.3b or Table 2.3.2.4.8.3c.

Table 2.3.2.4.8.3a: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A1 Equipment

Relative Power, (S/I) dB	**+4**	**+12**
	.13	.96
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

Table 2.3.2.4.8.3b: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A2 Equipment

Relative Power, (S/I) dB	**+4**	**+12**
	.76	.99
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

Table 2.3.2.4.8.3c: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A3 Equipment

Relative Power, (S/I) dB	**+4**	**+12**
	.13	.99
Minimum Probability	*TBD*	*TBD*
Max Undetected Errors	1	1

2.3.2.4.9 Track File Maintenance (§2.2.8 through §2.2.10)

Purpose/Introduction:

This procedure is used to verify the general performance characteristics of the ADS-B Receiving Subsystem under environmental conditions. The scenarios described herein should be repeated as needed to test the various aspects of the environmental requirements of the ADS-B Receiving Subsystem.

Equipment:

Provide a method of loading valid ADS-B Broadcast messages of all types into the ADS-B Receiving Subsystem under test.

Provide a method of loading valid position information into the ADS-B Receiving Subsystem under test.

Measurement Procedure:

Step 1: Establish ADS-B Receiving Subsystem Position

Provide the ADS-B Receiving Subsystem with valid position data as listed in Table 2-83.

Step 2: Surface Participant Stimulus and Track File Maintenance

At a reference time of time zero, begin generation of a series of “even” and “odd” Surface Position from Participants 1 through 4 shown in Table 2-83. Each Message should be structured using subfield data shown in Table 2-83. Each message should be provided at the appropriate rate in accordance with §2.2.3.3.2.2.

a. For Receiving Functions that provide only Output Messages in accordance with §2.2.6, verify that the Receiving function delivers appropriate Output Messages to the user interface or to the Report Assembly function for all Surface Participants.

b. For Receiving Functions that provide a Report Assembly function, verify that the Receiving function delivers appropriate State Vector Reports for all Surface Participants in accordance with §2.2.8.1.

Step 3: Airborne Participant Stimulus and Track File Maintenance

While continuing to transmit the Surface Position Messages described in Step 1, begin generation of a series of “even” and “odd” Airborne Position Messages from Participants 5 through 28 shown in Table 2-83. Each message should be structured using subfield data shown in Table 2-83. Each message should be provided at the appropriate rate in accordance with §2.2.3.3.2.2.

While continuing to transmit the messages required by Step 1 and the previous paragraph, begin generation of Airborne Velocity Messages for participants 5 through 28. Each message should be structured using subfield data shown in Table 2-83. Each message should be provided at the appropriate rate in accordance with §2.2.3.3.2.5.

a. For Receiving Functions that provide only Output Messages in accordance with §2.2.6, verify that the Receiving function delivers appropriate Output Messages to the user interface or to the Report Assembly function for all Airborne Participants.

b. For Receiving Functions that provide a Report Assembly function, verify that the Receiving function delivers appropriate State Vector Reports for all Airborne Participants in accordance with §2.2.8.1.

Step 4: Broadcast Message Termination

Terminate the delivery of broadcast messages for all participants. Wait for at least 200 seconds.

a. For Receiving Functions that provide only Output Messages in accordance with §2.2.6, verify that the Receiving function ceases to deliver Output Messages to the user interface or to the Report Assembly function for All Participants.

b. For Receiving Functions that provide a Report Assembly function, verify that the Receiving function ceases to deliver State Vector Reports for all Airborne Participants.

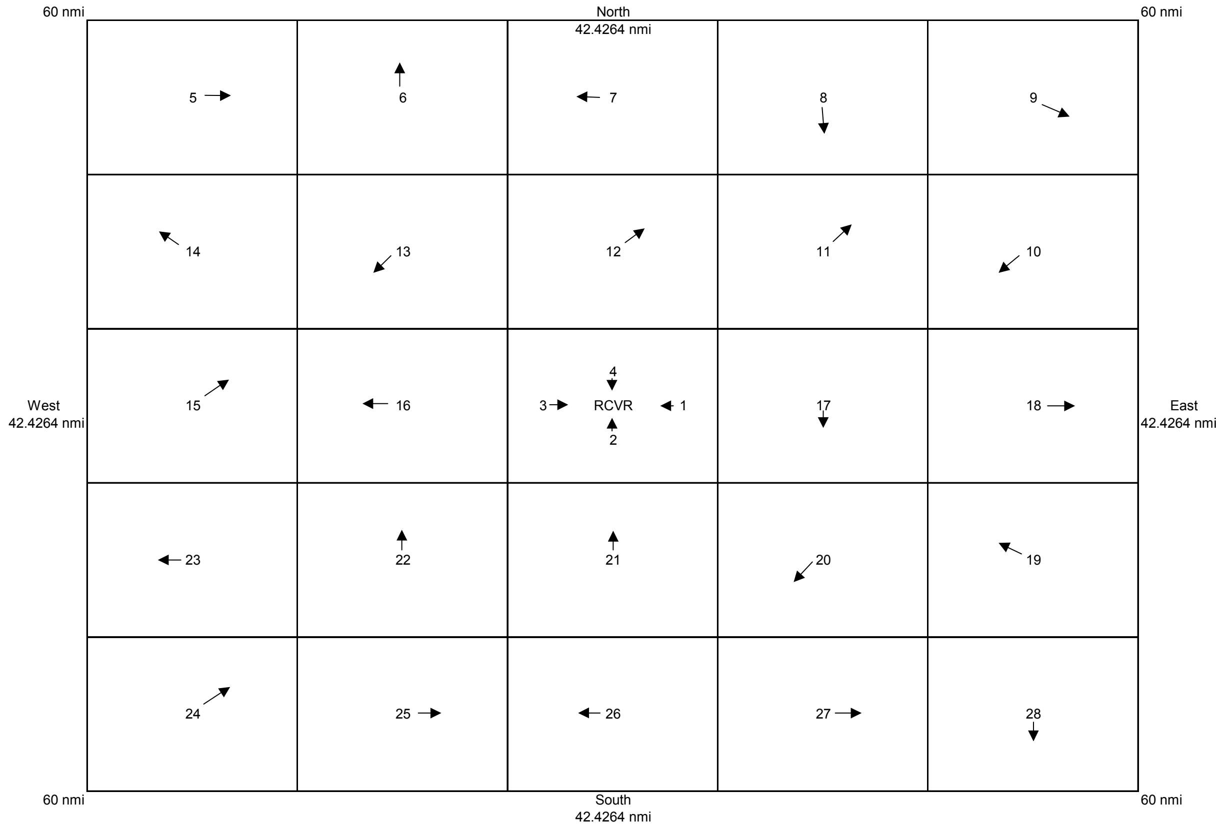

Figure 2-18: ADS-B Receiving Subsystem Environmental Test Scenario Pattern

Note: *Figure 2-18 provides a visual indication of the placement of the participants listed in Table 2-83*

Table 2-83: ADS-B Receiving Subsystem Environmental Test Scenario

Target Number	DF (Binary)	CA (Binary)	AA (HEX)	Latitude	Longitude	Altitude (feet)	E/W Direction Bit (Binary)	E/W Velocity (knots)	N/S Direction Bit (Binary)	N/S Velocity (knots)	Ground Speed (knots)	Ground Track (degrees)
UUT Receiver Location				33.9425361	-118.4080744	126						
1	1 0001	100	AA AA AA	33.9425361	-118.3833333	126					10	270
2	1 0001	100	AA BB BB	33.9166666	-118.4080744	126					25	357
3	1 0001	100	AA CC CC	33.9425361	-118.4250000	126					35	90
4	1 0001	100	AA DD DD	33.9583333	-118.4080744	126					60	180
5	1 0001	101	BB AA AA	34.6496427	-119.1151811	35000	0	600	0	0		
6	1 0001	101	BB BB BB	34.6496427	-118.7616277	20000	0	0	0	700		
7	1 0001	101	BB CC CC	34.6496427	-118.4080744	10000	1	500	0	0		
8	1 0001	101	BB DD DD	34.6496427	-118.0545211	15000	0	0	1	550		
9	1 0001	101	BB EE EE	34.6496427	-117.7009677	9000	0	500	1	500		
10	1 0001	101	CC AA AA	34.2960894	-117.7009667	25000	1	400	1	400		
11	1 0001	101	CC BB BB	34.2960894	-118.0545211	15000	0	300	0	300		
12	1 0001	101	CC CC CC	34.2960894	-118.4080744	12000	0	250	0	250		
13	1 0001	101	CC DD DD	34.2960894	-118.7616277	30000	1	400	1	400		
14	1 0001	101	CC EE EE	34.2960894	-119.1151811	37000	1	600	0	600		
15	1 0001	101	DD AA AA	33.9425361	-119.1151811	8000	0	300	0	300		
16	1 0001	101	DD BB BB	33.9425361	-118.7616277	29000	1	600	0	0		
17	1 0001	101	DD CC CC	33.9425361	-118.0545211	26000	0	0	1	650		
18	1 0001	101	DD DD DD	33.9425361	-117.7009667	28000	0	600	0	0		
19	1 0001	101	DD EE EE	33.5889827	-117.7009667	31000	1	600	0	600		
20	1 0001	101	EE AA AA	33.5889827	-118.0545211	25000	1	400	1	400		
21	1 0001	101	EE BB BB	33.5889827	-118.4080744	14000	0	0	0	300		
22	1 0001	101	EE CC CC	33.5889827	-118.7616277	15000	0	0	0	300		
23	1 0001	101	EE DD DD	33.5889827	-119.1151811	16000	1	900	0	0		
24	1 0001	101	EE EE EE	33.2354294	-119.1151811	15000	0	400	0	500		
25	1 0001	101	FF AA AA	33.2354294	-118.7616277	36000	0	700	0	0		
26	1 0001	101	FF BB BB	33.2354294	-118.4080744	19000	1	600	0	0		
27	1 0001	101	FF CC CC	33.2354294	-118.0545211	25000	0	955	0	0		
28	1 0001	101	FF DD DD	33.2354294	-117.7009667	35000	0	0	1	850		

2.3.2.5 Self Test and Monitors (§2.2.11)

No specific test procedure is required to validate §2.2.11.

2.3.2.5.1 Transponder Based Equipment Address (§2.2.11.3.1)

Transponder Based Equipment **shall** be tested in accordance with the procedures provided in §2.3.2.5.2.

Note: *The requirement to test transponder based equipment is provided herein due to the fact that the test requirements provided in RTCA DO-181C do not test the function adequately.*

2.3.2.5.2 Non-Transponder Based Equipment (§2.2.11.3.2)

Purpose/Introduction:

The following Test Procedures **shall** be used to verify that the ADS-B Transmitting monitor function properly enunciates the "Fail Warn" condition in the event that the ICAO 24-Bit Address (§2.2.5.1.1) provided to the ADS-B Transmitting Subsystem is set to ALL ZEROs or ALL ONEs.

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test. Provide a method of detecting and monitoring ADS-B broadcast messages. Provide a method of modifying the ICAO 24-Bit Address provided to the Unit Under Test.

Measurement Procedure:

Step 1: Initial Conditions

Establish any state where the ADS-B Transmission Function is operational and indicating no Fail Warn conditions.

Step 2: Address set to ALL ZEROs

Remove power from the Unit Under Test (UUT)

Set the ICAO 24-Bit Address provided to the UUT to ALL ZEROs.

Apply power to the UUT.

Verify that the ADS-B transmission function properly enunciates the "Fail Warn" state within no more than 2.0 seconds.

Step 3: New Initial Conditions

Repeat Step 1.

Step 4: Address set to ALL ONEs

Remove power from the Unit Under Test (UUT)

Set the ICAO 24-Bit Address provided to the UUT to ALL ONEs.

Apply power to the UUT.

Verify that the ADS-B transmission function properly enunciates the "Fail Warn" state within no more than 2.0 seconds.

Step 5: Restore Normal Operations

Establish any state where the ADS-B Transmission Function is operational and indicating no Fail Warn conditions prior to continuing with further testing.

2.3.2.6 Response to Mutual Suppression Pulses (§2.2.12)

No specific test procedure is required to validate §2.2.12.

2.3.2.6.1 Transmitting Device Response to Mutual Suppression Pulses (§2.2.12.1)

Purpose/Introduction:

The following Test Procedures **shall** be used to verify that the ADS-B Transmitting Subsystem functions properly in the Mutual Suppression environment.

Equipment Required:

Provide a method of loading valid data for ADS-B broadcast messages into the ADS-B equipment under test.

Provide a method of supplying the ADS-B Transmitting Subsystem with Mutual Suppression Pulses.

Provide a method of monitoring and recording ADS-B transmissions and the time at which such transmissions are generated with respect to the end of a mutual suppression pulse.

Measurement Procedure:

Step 1: Initialize ADS-B Airborne Participant Transmissions

Provide the ADS-B Transmitting Subsystem with all necessary information to enable the transmitting function to generate the following DF=17 transmitted messages:

(1). Airborne Position Messages (§2.2.3.2.3),

(2). Aircraft Identification and Type Messages (§2.2.3.2.5), and

(3). Airborne Velocity Messages (§2.2.3.2.6)

Verify that the ADS-B Transmitting Subsystem properly transmits Airborne Position, Aircraft Identification and Type, and Airborne Velocity Messages at the rates required in §2.2.3.3.2.2, §2.2.3.3.2.4 and §2.2.3.3.2.5.

Step 2: Apply Mutual Suppression

Apply Mutual Suppression pulses of the maximum length that the suppression interface is designed to accept.

Verify that no ADS-B transmissions occur during the suppression period.

Record the transmissions that are generated and verify that transmissions can be output no later than 15 microseconds after the end of the mutual suppression pulse.

2.3.2.6.2 Receiving Device Response to Mutual Suppression Pulses (§2.2.12.2)

Purpose/Introduction:

The following Test Procedures **shall** be used to verify that the ADS-B Receiving device functions properly in the Mutual Suppression environment.

Equipment Required:

Provide a method of supplying ADS-B Transmitted messages to the ADS-B Receiving Subsystem.

Provide a method of supplying the ADS-B Receiving Subsystem with Mutual Suppression Pulses that can be synchronized to the ADS-B Transmitted messages provided to the ADS-B Receiving Subsystem.

Provide a method of monitoring and recording the Receiving function decoded ADS-B Messages or structured ADS-B Reports.

Measurement Procedure:

Step 1: Initialize ADS-B Message Reception

Provide the ADS-B Receiving Subsystem with appropriate ADS-B Messages at a minimum rate of two per second and having a signal level of the Receiver MTL + 3 dB.

Verify that the Receiving function decodes at least 99 % of the messages provided to the receiver.

Step 2: Apply Mutual Suppression

a. Apply Mutual Suppression pulses synchronized to start before each ADS-B Message provided to the Receiving function.

   Ensure that the duration of each Mutual Suppression pulse exceeds that of the ADS-B Messages being provided to the Receiving function.

Verify that no ADS-B Messages are successfully decoded by the Receiving function.

b. Apply Mutual Suppression pulses that do not over lap any of the ADS-B Messages provided to the Receiving function and are synchronized to finish 15 microseconds prior to the start of each ADS-B Message provided to the Receiving function.

   Verify that at least 90 percent of the ADS-B Messages provided to the Receiving function are properly decoded by the Receiving function.

2.3.2.7 Diversity Operation (§2.2.13.6)

No specific test procedure is required to validate §2.2.13.6.

2.3.2.7.1 Transmitting Diversity (§2.2.13.6.1)

Purpose/Introduction:

This test procedure verifies that an ADS-B Transmitting Subsystem implements transmitting diversity properly by transmitting each required type of ADS-B Message alternately from the top and bottom antennas.

Equipment Required:

Provide a method of supplying the ADS-B Transmitting Subsystem with all data necessary to structure ADS-B Airborne Position, Airborne Velocity, and Aircraft Identification and Type messages. All data **shall** be provided via the operational interfaces.

Provide a method of monitoring the ADS-B Broadcast Messages transmitted by the ADS-B Transmitting Subsystem.

Measurement Procedure:

Step 1: Broadcast Message Initialization

Provide the ADS-B Transmitting Subsystem with all data necessary to structure Airborne Position, Airborne Velocity, and Aircraft Identification and Type ADS-B Broadcast Messages.

Step 2: Broadcast Message Verification

Verify that the ADS-B Transmitting Subsystem properly transmits the appropriate Airborne Position Messages alternately on the Top and Bottom RF ports.

Verify that the ADS-B Transmitting Subsystem properly transmits the appropriate Airborne Velocity Messages alternately on the Top and Bottom RF ports.

Verify that the ADS-B Transmitting Subsystem properly transmits the appropriate Aircraft Identification and Type Messages alternately on the Top and Bottom RF ports.

2.3.2.7.2 Receiving Diversity (§2.2.13.6.2)

Appropriate test procedures to required to verify the performance of §2.2.13.6.2 are provided in §2.3.2.7.2.1 through §2.3.2.7.2.2.

2.3.2.7.2.1 Full Receiver and Message Processing or Receiver Switching Front-End Diversity (§2.2.13.6.2)

Purpose/Introduction:

This procedure verifies that the ADS-B Receiving Subsystem properly implements diversity by demonstrating proper reception of ADS-B Broadcast Messages from either the top antenna, or the bottom antenna, or both antennas. This procedure applies to those configurations that implement Full receiver and message processing function diversity as discussed in §2.2.13.6.2.a. This procedure also apples to those configurations that implement Receiver Switching Front-End diversity as discussed in §2.2.13.6.2.b.

Equipment Required:

Provide a method of supplying the equipment under test with appropriate Airborne Position ADS-B Broadcast Messages.

Provide a method of monitoring the Output Messages and/or ADS-B Reports generated by the ADS-B Receiving Subsystem.

RF Splitter/Combiner (2 port, or 3 dB type)

RF Attenuators (Fixed, various attenuation values, as needed)

Measurement Procedure:

Step 1: Test Equipment Configuration

Connect the ADS-B Broadcast Message generator to the RF Splitter input. Connect each output from the RF Splitter to the input of an RF Attenuator. Connect the output of one RF Attenuator to the Top Channel RF input port of the equipment under test. Connect the output of the other RF Attenuator to the Bottom Channel RF input port of the equipment under test.

Step 2: Top Channel is Primary Receiver

Adjust the Top Channel attenuator such that the signal level provided to the Top Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Adjust the Bottom Channel attenuator such that the signal level provided to the Bottom Channel RF input port is 20 dB less than the MTL of the equipment under test.

Configure the ADS-B Broadcast Message generator to provide only Airborne Position Messages for a single participant with the position continuously changing in the message.

Verify that the ADS-B Receiving Subsystem generates appropriate Output Messages or State Vector Reports for at least 90% of the Airborne Position Messages provided to the Top Channel RF input port.

Step 3: Bottom Channel is Primary Receiver

Adjust the Bottom Channel attenuator such that the signal level provided to the Bottom Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Adjust the Top Channel attenuator such that the signal level provided to the Top Channel RF input port is 20 dB less than the MTL of the equipment under test.

Configure the ADS-B Broadcast Message generator to provide only Airborne Position Messages for a single participant with the position continuously changing in the message.

Verify that the ADS-B Receiving Subsystem generates appropriate Output Messages or State Vector Reports for at least 90% of the Airborne Position Messages provided to the Bottom Channel RF input port.

Step 4: Top / Bottom Channel Equivalent

Adjust the Bottom Channel attenuator such that the signal level provided to the Bottom Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Adjust the Top Channel attenuator such that the signal level provided to the Top Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Configure the ADS-B Broadcast Message generator to provide only Airborne Position Messages for a single participant with the position continuously changing in the message.

Verify that the ADS-B Receiving Subsystem generates appropriate Output Messages or State Vector Reports for between 90% and 100% of the Airborne Position Messages provided to the Bottom Channel RF input port.

2.3.2.7.2.2 Receiving Antenna Switching Diversity (§2.2.13.6.2)

Purpose/Introduction:

This procedure verifies that the ADS-B Receiving Subsystem properly implements diversity by demonstrating proper reception of ADS-B Broadcast Messages from either the top antenna or the bottom antenna. This procedure applies to those configurations that implement Receiving Antenna switching as discussed in §2.2.13.6.2.c.

Equipment Required:

Provide a method of supplying the equipment under test with appropriate Airborne Position ADS-B Broadcast Messages.

Provide a method of monitoring the Output Messages and/or ADS-B Reports generated by the ADS-B Receiving Subsystem.

RF Attenuators (Fixed, various attenuation values, as needed).

Measurement Procedure:

Step 1: Top Channel is Primary Receiver

Connect the ADS-B Broadcast Message generator to the RF Attenuator input. Connect the output of the RF Attenuator to the Top Channel RF input port of the equipment under test.

Adjust the attenuator such that the signal level provided to the Top Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Configure the ADS-B Broadcast Message generator to provide only Airborne Position Messages for a single participant with the position continuously changing in the message.

Verify that the ADS-B Receiving Subsystem generates appropriate Output Messages or State Vector Reports for at least 45% of the Airborne Position Messages provided to the Top Channel RF input port.

Step 2: Bottom Channel is Primary Receiver

Connect the ADS-B Broadcast Message generator to the RF Attenuator input. Connect the output of the RF Attenuator to the Bottom Channel RF input port of the equipment under test.

Adjust the attenuator such that the signal level provided to the Bottom Channel RF input port is at least 3 dB above the MTL of the equipment under test.

Configure the ADS-B Broadcast Message generator to provide only Airborne Position Messages for a single participant with the position continuously changing in the message.

Verify that the ADS-B Receiving Subsystem generates appropriate Output Messages or State Vector Reports for at least 45% of the Airborne Position Messages provided to the Bottom Channel RF input port.

2.3.2.8 Power Interruption (§2.2.15)

Appropriate test procedures are found in 2.3.2.8.1 and 2.3.2.8.2.

2.3.2.8.1 Power Interruption to ADS-B Transmitting Subsystems (§2.2.15)

Purpose/Introduction:

The purpose of this procedure is to verify that the ADS-B Transmitting Subsystem regains operational capability to within its operational limits within two seconds after the restoration of power following a momentary power interruption.

Equipment Required:

Provide equipment capable of loading valid data for ADS-B broadcast messages into the ADS-B Transmitting Subsystem under test through the operational interface.

Measurement Procedure:

Step 1: Enable Transmission of Airborne Position Messages

Supply the ADS-B Transmitting Subsystem with the appropriate data necessary to establish Airborne Position Messages.

Verify that the ADS-B Transmitting Subsystem generates appropriate Airborne Position Messages at the rate specified in §2.2.3.3.1.1 or §2.2.3.3.2.2.

Note: *If the Transmission function uses diversity and the test is being performed on one RF output interface at a time, then the specified rate necessary to satisfy this test is half of that given in §2.2.3.3.1.1 or §2.2.3.3.2.2.*

Step 2: Apply momentary power interrupts

Apply momentary power interrupts to the ADS-B Transmitting Subsystem under test in accordance with RTCA DO-160D section 16 and (EUROCAE ED-14D, section 16). Then restore the power to normal operating conditions.

Verify that the ADS-B Transmitting Subsystem resumes generation of appropriate Airborne Position Messages no later than 2.0 seconds after the restoration of normal power.

Step 3: Repeat for additional RF Output Interfaces

If the ADS-B Transmitting Subsystem implements diversity, then repeat steps 1 and 2 on the additional RF Output Interface.

2.3.2.8.2 Power Interruption to ADS-B Receiving Subsystems (§2.2.15)

Purpose/Introduction:

The purpose of this procedure is to verify that the ADS-B Receiving Subsystem regains operational capability to within its operational limits within two seconds after the restoration of power following a momentary power interruption.

Equipment Required:

Provide equipment capable of supplying valid ADS-B broadcast messages to the ADS-B Receiving Subsystem under test via the appropriate RF interface.

Measurement Procedure:

Step 1: Enable Reception of Airborne Position Messages

Via the receiver RF interface and in the absence of interference, apply valid 1090 MHz. Airborne Position Messages at a uniform rate of 2 per second and at a signal level that is at least 15 dB above the MTL of the ADS-B Receiving Subsystem.

Verify that the ADS-B Receiving Subsystem delivers appropriate Output Messages to the user interface or to the Report Assembly function for all messages received and that the Output Message formats are consistent with the requirements of §2.2.6.1.1.

Step 2: Apply momentary power interrupts

Apply momentary power interrupts to the ADS-B Receiving Subsystem under test in accordance with RTCA DO-160D section 16 (EUROCAE ED-14D, section 16). Then restore the power to normal operating conditions.

Verify that the ADS-B Receiving Subsystem resumes generation of appropriate Output Messages to the user interface or to the Report Assembly function no later than 2.0 seconds after the restoration of power.

Then verify that the ADS-B Receiving Subsystem continues to deliver appropriate Output Messages to the user interface or to the Report Assembly function for all messages received and that the Output Message formats are consistent with the requirements of §2.2.6.1.1.

Step 3: Repeat for additional RF Output Interfaces

If the ADS-B Receiving Subsystem implements diversity, then repeat steps 1 and 2 on the additional RF Input Interface.

2.3.2.9 Verification of Traffic Information Services – Broadcast (TIS-B) (§2.2.17)

No specific test procedure is required to validate the requirements of §2.2.17.

2.3.2.9.1 Verification of TIS-B Report Generation (§2.2.17.4.6)

Purpose/Introduction:

As TIS-B Messages are received, the information is reported to applications. All received information elements, other than position, **shall** be reported directly. The reporting format is not specified in detail, except that the information content reported **shall** be the same as the information content received. The report **shall** be issued within 0.5 seconds of the message reception.

When a TIS-B position message is received, it is compared with tracks to determine whether it can be decoded into target position, as specified in §2.2.17.4.2. If the message is decoded into target position, a state vector report **shall** be generated, within 0.5 seconds of the message reception. The report **shall** contain the received position information with its time of applicability, the most recently received velocity measurement with its time of applicability, estimated position and velocity, applicable to a common time of applicability, address, and all other information in the received message. The estimated values **shall** be based on the received position information and the track history of this target.

When a TIS-B Velocity Message is received, if it is correlated to a complete track, then a state vector report **shall** be generated, within 0.5 seconds of the message reception. The report **shall** contain the received velocity information with its time of applicability, the most recently received position measurement with its time of applicability, estimated position and velocity, applicable to a common time of applicability, address, and all other information in the received message. The estimated values **shall** be based on the received velocity information and the track history of this target.

Note: *In the absence of TIS-B Message receptions, it is possible for reports to be generated, but this is not required. Such additional reports might be useful as a means of counteracting possible flaws in an on-board data bus between ADS-B and an application.*

Measurement Procedure:

Step 1: Verification of Non-Position Report Elements and Timing

Set up to simulate TIS-B Transmitted Messages by inputting TIS-B Message information directly to the Receiving Subsystem. Input a simulated TIS-B message.

Verify that within 0.5 seconds of the receipt of this message that all of the non-position elements are reported directly as received. Repeat this step for each of the TIS-B message types.

Step 2: Verification of Position Report Elements and Timing

Set up to simulate TIS-B Transmitted Messages by inputting TIS-B Message information directly to the Receiving Subsystem. Input a simulated TIS-B message.

Verify that within 0.5 seconds of the receipt of this message that all of the position elements (latitude, longitude, altitude, address and TOA) are reported directly as well as all of the other information received. Repeat this step for each of the TIS-B message types.