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ADS-B UAT MOPS

Meeting #12

Draft #4 of Section 2.4 for Review in Washington

Presented by The Test Procedure Team

SUMMARY
This Draft #4 of Section 2.4 of the UAT MOPS for review in Washington DC.

TABLE OF FIGURES

TABLE OF TABLES

1.0 Purpose And Scope

2.0 Equipment Performance Requirements and Test Procedures

2.1 General Requirements

2.2 Equipment Performance – Standard Conditions

2.3 Equipment Performance – Environmental Conditions

2.4 Equipment Test Procedures

The test procedures set forth in the following subparagraphs are considered satisfactory for use in determining required performance under standard and stressed conditions. Although specific test procedures are cited, it is recognized that other methods may be preferred by the testing facility. These alternate procedures may be used if the equipment 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 alternate procedures.

2.4.1 Definition of Standard Conditions of Test

The following definitions of terms and conditions of tests are applicable to the equipment tests specified herein commencing at subparagraph 2.4.2:

a. <u>Power Input Voltage</u> – Unless otherwise specified, all tests shall be conducted with the power input voltage adjusted to design voltage +/- 2 percent. The input voltage shall be measured at the input terminals of the equipment under test.

b. <u>Power Input Frequency</u>

   (1). In the case of equipment designed for operation from an AC source of essentially constant frequency (e.g., 400 Hz), the input frequency shall be adjusted to design frequency +/- 2 percent.

   (2). If the equipment is designed for operation from an AC source of variable frequency (e.g., 300 to 1000 Hz), tests shall be conducted with the input frequency adjusted to within five percent of a selected frequency and, unless otherwise specified, within the range for which the equipment is designed.

c. <u>Accuracy of Test Equipment</u> – Throughout this section, the accuracy of the test equipment is not addressed in detail, but rather is left to the calibration process prescribed by the agency that certifies the testing facility.

d. <u>Adjustment of Equipment</u> – The circuits of the equipment under test shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to application of the specified tests. Unless otherwise specified, adjustments may not be made once the test procedures have started.

e. Test Instrument Precautions – During the tests, precautions shall be taken to prevent the introduction of errors resulting from the connection of voltmeters, oscilloscopes and other test instruments, across the input and output terminals of the equipment under test.

f. Ambient Conditions – Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure and humidity. However, the room temperature shall not be lower than 10 degrees C.

g. Connected Loads – Unless otherwise specified, all tests shall be performed with the equipment connected to loads having the impedance values for which it is designed.

h. Standard ADS-B Broadcast Message Test Signals

The ADS-B Broadcast Message general signal conventions shall be as specified in subparagraphs 2.2.1 and 2.2.2.

General Characteristics

(a). Radio Frequency: The carrier frequency of the signal generator for ADS-B Broadcast Messages shall be 978 +/- 19.56 kHz.

(b). CW Output: The CW output between transmissions shall be a maximum level of –98 dBm.

(c). Amplitude Variation: The instantaneous amplitude during a message shall not fall more than 1 dB below the maximum value.

(d). Signal Level: Unless otherwise noted in the measurement procedure, the signal level shall be -60 +/- 3 dBm.

(e). ICAO 24-Bit Discrete Address: Unless otherwise noted in the measurement procedure, the ADS-B Transmitting System address used for all broadcast messages shall be: Hexadecimal – AA AAAA, (i.e., binary – 1010 1010 1010 1010 1010 1010).

2.4.1.1 Verification of Signal Levels (subparagraph 2.2.1.1)

No specific test procedure is required to validate subparagraph 2.2.1.1.

2.4.1.2 Verification of Desired Signals (subparagraph 2.2.1.2)

No specific test procedure is required to validate subparagraph 2.2.1.2.

2.4.2 Verification of ADS-B Transmitter Characteristics (subparagraph 2.2.2)

No specific test procedure is required to validate subparagraph 2.2.2.

2.4.2.1 Verification of Transmission Frequency (subparagraph 2.2.2.1)

Purpose/Introduction:

The transmission frequency f_0 **shall** be 978 MHz, +/- 20 PPM.

Note: *All transmissions from ground stations will operate at the same transmission frequency and frequency tolerance.*

Equipment Required:

The tests performed in this subparagraph require a Vector Signal Analyzer (VSA), or an equivalent Signal Analyzer, with the following characteristics:

A minimum capability of displaying a standard "Eye Diagram" as described in Appendix A, as well as providing a computed measurements summary which includes a computed Center Frequency, or Carrier Offset from Center Frequency, and a Modulation Frequency Deviation. Examples: HP89441A, or the HP89600 series.

For subparagraphs 2.4.2.1 through 2.4.2.4, configure the Vector Signal Analyzer equipment for Digital Demodulation Mode according to Table 2.4.2.1.

Notes:

1. *Equipment parameter labels, menus, setup options, and units may vary from one manufacturer to another, and parameter labels are usually abbreviated. In Table 2.4.2.1, text enclosed in brackets is not displayed on the HP89441A display. The bracketed text is added to clarify the functional terms and setting values for those not using the HP89441A.*

2. *The use of the word "symbol," when directly associated with the HP89441A, means a single data bit, instead of an 8-bit byte.*

<u>Table 2.4.2.1:</u> Digital Demodulation Mode Configuration

VECTOR SIGNAL ANALYZER PARAMETER SETTINGS	
Parameter Item/Function	**Parameter Setting Value**
Preset	(press to Preset Equipment)
Instrument Mode	Digital Demodulation
Instrument Mode / demodulation setup / demod[ulation] format	[2 FSK]
Instrument Mode / demodulation setup / symbol rate	1.014667 MHz
Instrument Mode / demodulation setup / result [message] length	420 sym[bols]
Instrument Mode / demodulation setup / meas[urement] filter	root raised cosine
Instrument Mode / demodulation setup / ref[erence] filter	raised cosine
Instrument Mode / demodulation setup / [filter] alpha	0.5
Instrument Mode / demodulation setup / normalize	off
Frequency / center frequency	978 MHz
Frequency / frequency span	[preferably] 5 MHz
Range / ch[annel] 1 [signal] range	–50 dBm
Time / result [message] length	420 sym[bols]
Time / sync search	on
Time / sync pattern	"EACDDA4E2" Hexidecimal (per subparagraph 2.2.3.1.1)
Time / points/symbol	4
Average / average	on
Average / num[ber of] averages	10
Average / average type	rms expo[nential]
Trigger / trigger type	IF ch[annel]1
Trigger / IF level	0.0001 V[olts]
Trace A – Measurement Data	FSK measured time
Trace A – Data Format	part real (I)
Trace A – RefLvl/Scale / Y per div[ision]	78.125 kHz
Trace C – Measurement Data	FSK measured time
Trace C – Data Format	eye diagram I
Trace C – Data Format / more format setup / eye length	1
Trace C – RefLvl/Scale / Y per div[ision]	70 kHz
Trace D – Measurement Data	symbol table/error summary

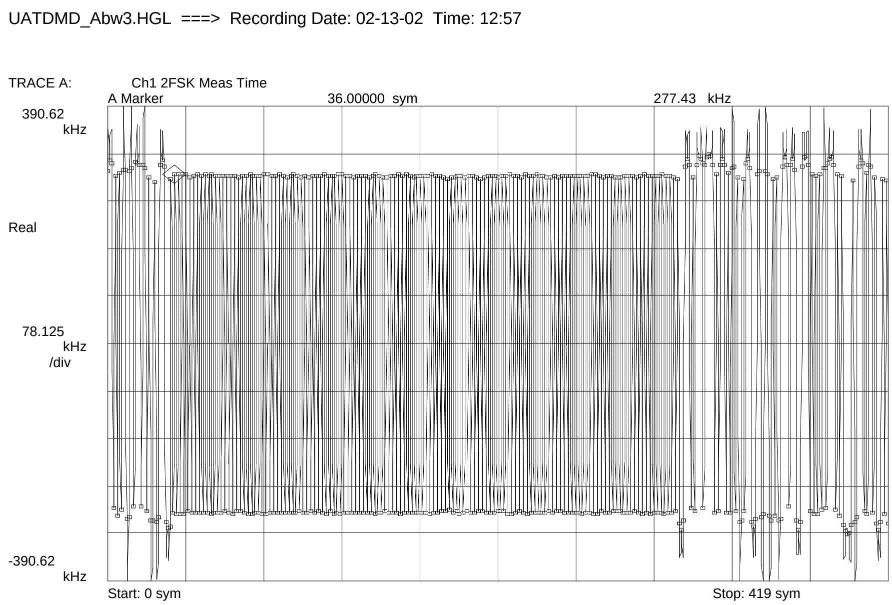
<u>Measurement Procedures:</u>

<u>Step 1:</u> <u>Equipment Setup (subparagraph 2.2.2.1)</u>

For the tests in this subparagraph, configure the Vector Signal Analyzer according to the Digital Demodulation Mode setup listed in Table 2.4.2.1. See Appendix N for the state file "UAT-DMD.STA" to automatically setup the HP89441A Vector Signal Analyzer. If the Trace A – RefLvl/Scale / Y per div[ision] setting does not equal 78.125 kHz, manually enter the value.

<u>Step 2:</u> <u>Transmission Frequency Pre-Test Setup (subparagraph 2.2.2.1)</u>

Connect the ADS-B Transmitting Equipment to the Vector Signal Analyzer through enough attenuation to present a signal at the Vector Signal Analyzer input of –60 ± 5 dBm, and initiate a series of Long ADS-B fixed pattern test messages each having the following message elements: the 36 bit SYNCH, followed by a 272 bit Payload having a repeating bit pattern of alternating ONEs and ZEROs, and a 112 bit FEC as generated by the Reed-Solomon algorithm. Trace A Ch1 2FSK Meas Time should show a somewhat noisy SYNCH element (34.56 microseconds), followed by a less noisy Payload element (261.12 microseconds), and finishing with a somewhat noisy FEC element (107.52 microseconds), similar to Figure 2.4.2.1.



<u>Figure 2.4.2.1:</u> Digital Demodulation Mode – Trace A: Ch1 2FSK Meas Time

<u>Step 3:</u> <u>Transmission Frequency Test (subparagraph 2.2.2.1)</u>

The maximum carrier frequency offset is:

$$f_{off} = \pm 20 * f_0 \text{ (in MHz)} = \pm 19560 \text{ Hz}$$

Verify that the Carrier Offset f_{off}, as shown in the Trace D Error Summary from the Vector Signal Analyzer display, is in the following range:

$$-19560 \text{ Hz} \;<=\; f_{off} \;<=\; +19560 \text{ Hz}$$

2.4.2.2 Verification of Modulation Rate (subparagraph 2.2.2.2)

<u>Purpose/Introduction:</u>

The nominal modulation rate is 1.041667 megabits per second.

<u>Measurement Procedure:</u>

The test in subparagraph 2.4.2.4 includes the verification of Modulation Rate.

2.4.2.3 Verification of Modulation Type (subparagraph 2.2.2.3)

<u>Purpose/Introduction:</u>

These test procedures will verify that data **shall** be modulated onto the carrier using binary Continuous Phase Frequency Shift Keying. The modulation index, *h*, **shall** be 0.6; this implies that if the data rate is R_b, then the nominal frequency separation between "mark" (binary 1) and "space" (binary 0) is $\Delta f = h \bullet R_{b.}$ A binary 1 **shall** be indicated by a shift up in frequency from the nominal carrier frequency of $\Delta f/2$ (+312.5 kHz) and a binary 0 by a shift of -Δf/2 (-312.5 kHz). These frequency deviations apply at the optimum sampling points for the bit interval.

Equipment Required:

The test performed in this subparagraph requires equipment described in subparagraph 2.4.2.1.

Measurement Procedures:

Step 1: Equipment Setup (subparagraph 2.2.2.3)

For the test in this subparagraph, configure the Vector Signal Analyzer according to the Digital Demodulation Mode setup listed in Table 2.4.2.1. See Appendix N for the state file "UAT-DMD.STA" to automatically setup the HP89441A Vector Signal Analyzer. If the Trace A – RefLvl/Scale / Y per div[ision] setting does not equal 70 kHz, manually enter the value. On a display of 10 vertical divisions, deviations of ±280 kHz will occur at ±4 vertical divisions, respectively, from the display center.

Step 2: Transmission Frequency Modulation CPFSK, Index, and Shift Test (subparagraph 2.2.2.3)

Connect the ADS-B Transmitting Equipment to the Vector Signal Analyzer through enough attenuation to present a signal at the Vector Signal Analyzer input of –60 ± 5 dBm, and initiate a series of Long ADS-B fixed pattern test messages each having the following message elements: the 36 bit SYNCH, followed by a 272 bit Payload having a repeating bit pattern of alternating ONEs and ZEROs, and a 112 bit FEC as generated by the Reed-Solomon algorithm. In Trace A Ch1 2FSK Meas Time, verify that the FSK modulation measured by the display marker, positioned at each of the whole numbered bits, is greater than +280 kHz for evenly numbered bits, and less than –280 kHz for oddly numbered bits. In the Trace D Error Summary, verify that the Deviation is a minimum of 280 kHz (rms).

2.4.2.4 Verification of Modulation Distortion (subparagraph 2.2.2.4)

Purpose/Introduction:

These test procedures verify that the minimum opening of the eye diagram of the transmitted signal (measured at the optimum sampling points) **shall** be no less than 560 kHz when measured over an entire Long ADS-B message containing pseudorandom payload data.

This test procedure also verifies the Modulation Rate specified in subparagraph 2.2.2.2, by measurement of the Eye Diagram.

Equipment Required:

The test performed in this subparagraph requires equipment described in subparagraph 2.4.2.1.

Measurement Procedures:

Step 1: Equipment Setup (subparagraph 2.2.2.4)

For the test in this subparagraph, configure the Vector Signal Analyzer according to the Digital Demodulation Mode setup listed in Table 2.4.2.1. See Appendix N for the state file "UAT-DMD.STA" to automatically setup the HP89441A Vector Signal Analyzer. If the Trace C – RefLvl/Scale / Y per div[ision] setting does not equal 70 kHz, manually enter the value. On a display of 10 vertical divisions, deviations of ±280 kHz will occur at ±4 vertical divisions, respectively, from the display center.

Step 2: Modulation Distortion (subparagraphs 2.2.2.2 and 2.2.2.4)

Connect the ADS-B Transmitting Equipment to the Vector Signal Analyzer through enough attenuation to present a signal at the Vector Signal Analyzer input of –60 ± 5 dBm, and initiate a series of Long ADS-B test messages each having the following message elements: the 36 bit SYNCH, followed by a 272 bit Payload having a pseudo-random series of bits which changes for each successive payload, and a 112 bit FEC as generated by the Reed-Solomon algorithm. On the Trace C "Eye Diagram," find the minimum upper crossing, and the maximum lower crossing, at the horizontal center of the display, and verify that the upper crossing minus the lower crossing is no less than 560 kHz (8 vertical divisions). Trace C should resemble Figure 2.4.2.4.

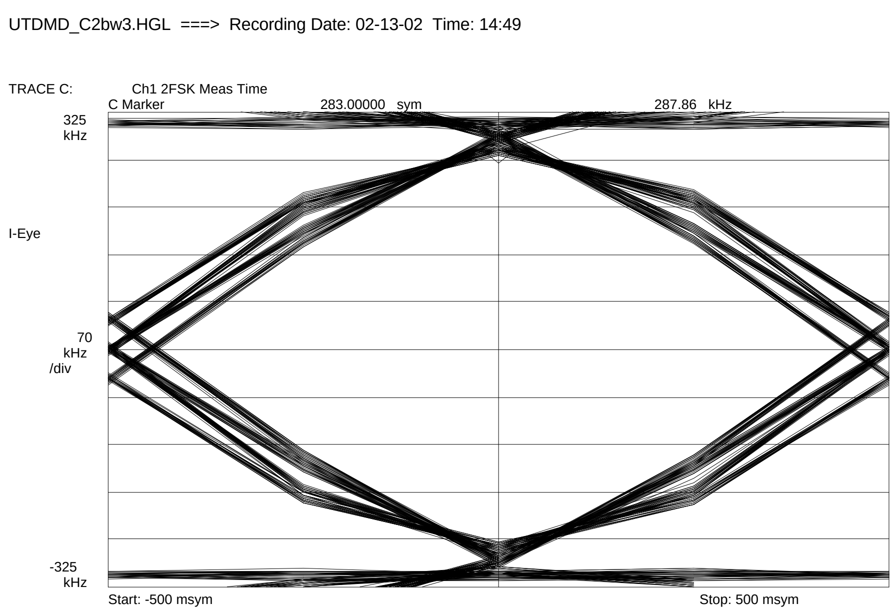


Figure 2.4.2.4: Digital Demodulation Mode – Trace C: "Eye Diagram"

2.4.2.5 Verification of Transmitter Power Output (subparagraph 2.2.2.5)

Purpose/Introduction:

The Time/Amplitude profile of an ADS-B Message Transmission **shall** fall within the following limits relative to a *reference time* defined as 0.48 microseconds prior to the center of the first bit of the synchronization sequence (subparagraph 2.2.3.1.1) appearing at the output port of the equipment.

All power measurements for subparagraphs **a** and **f** assumes a 300 kHz bandwidth. All power measurements for subparagraphs **b**, **c**, **d** and **e** assumes a 2 MHz bandwidth.

a. Prior to 8 bit periods before the reference time, the average RF output power **shall** not exceed –80 dBm.

Note: *This unwanted power requirement is necessary to ensure that the ADS-B transmitter does not prevent closely located UAT receiving equipment from meeting its requirements. It assumes that the isolation between transmitter and receiver equipment exceeds 20 dB.*

b. Between 8 and 4 bit periods prior to the reference time, the RF output power **shall** remain at least 20 dB below the minimum power requirement for the appropriate equipment class per Table 2.1.11.

c. During the Active state, defined as beginning at the reference time and continuing for the duration of the message (276 bit periods for the Basic Message and 420 bit periods for the Long Message), the RF output power **shall** comply with Table 2.1.12.

d. The RF output power **shall** not exceed the maximum limits of Table 2.1.12 at any time during the ADS-B Message Transmission.

e. Within 4 bit periods after the end of the Active state, the RF output power **shall** be at a level at least 20 dB below the minimum power requirement for the appropriate equipment class per Table 2.1.11.

f. Within 8 bit periods after the end of the Active state, the average RF output power **shall** fall to a level not to exceed –80 dBm.

Note: *This unwanted power requirement is necessary to ensure that the ADS-B transmitter does not prevent closely located UAT receiving equipment from meeting its requirements. It assumes that the isolation between transmitter and receiver equipment exceeds 20 dB.*

This test procedure verifies that the UAT Transmitter outputs the required power for the appropriate equipment class as stipulated in subparagraph 2.2.2.5. The transmitter power requirements are verified for the Active state, the Inactive state and the defined intervals prior to and subsequent to the transmitted message.

Equipment Required:

The test configuration requires that data sources be provided to the appropriate UAT Transmitter interfaces to enable generation of Long ADS-B Messages. This could also be accomplished by the use of an internally generated Long ADS-B test message with randomly generated data content. Measure the power at the RF antenna port, or with appropriate attenuation for the RF power measuring equipment, and account for the loss.

The RF power measurement system must be capable of measuring average RF power of the modulated signal sampled over a defined interval indicated for each of the measurements below.

Measurement Procedures:

In all of the power measurements below, the power output measurement must be adjusted to take into account the loss allocated for cabling to the antenna of the aircraft. In the case of diversity transmitters, both top and bottom channel measurements must be performed. Unless specified otherwise, for the following power measurements, use a 2 MHz bandwidth filter setting.

Step 1: Measure Active State RF Power Output

Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the average RF power over 1 microsecond intervals of the transmitted signal during the message transmission interval, i.e., first bit of the synchronization pattern to the last bit of the message. Verify that the output power is at least the corresponding value in Table 2.1.12 for the equipment class under test. Verify that the power measurement does not exceed the maximum allowable and does not fall below the minimum allowable power level for the equipment class. Verify that the minimum and maximum power values specified in Table 2.1.12 for the equipment class are satisfied over the entire message by measuring the power at the 1 microsecond interval yielding the maximum power measurement and the interval yielding the minimum power.

Step 2: Verify RF Transmitter Power Prior to the Active State

a) Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the average RF power of the transmitted signal using 1 microsecond intervals over the interval which commences 8 bit periods (7.679997542 microseconds) prior to the active state, i.e., the start of the first bit of the synchronization pattern and ends 4 bits (3.839998771 microseconds) prior to the active state. The measured power level must be a minimum 20 dB below the corresponding minimum power value in Table 2.1.12 for the equipment class under test. The maximum allowed power values are: Low Power = 18.5 dBm, Medium Power = 22.0 dBm, High Power = 28.0 dBm. Verify that the power measurement does not exceed the corresponding allowable power level for the equipment class.

b) Measure the average RF power of the transmitted signal using 1 microsecond intervals over the interval which commences 4 bit periods prior to the active state. The measured power level must be at or below the corresponding maximum power value in Table 2.1.12 for the equipment class under test. The maximum allowed power values are: Low Power = 42.5 dBm, Medium Power = 46.0 dBm, High Power = 52.0 dBm. Verify that the power measurement does not exceed the corresponding allowable power level for the equipment class.

Step 3: Verify RF Transmitter Power Post Active State

a) Measure the average RF power of the transmitted signal using 1 microsecond intervals over the time interval which begins at the end of the Active state and ends 4 bit periods later. The measured power level must be at or below the corresponding maximum power value in Table 2.1.12 for the equipment class under test. The maximum allowed power values are: Low Power = 42.5 dBm, Medium Power = 46.0 dBm, High Power = 52.0 dBm. Verify that the power measurement does not exceed the corresponding allowable power level for the equipment class.

b) Measure the average RF power of the transmitted signal using 1 microsecond intervals over the interval which commences 4 bit periods from the end of the message Active state and ends 4 bit periods later. The measured power level must be a minimum 20 dB below the corresponding minimum power value in Table 2.1.12 for the equipment class under test. The maximum allowed power values are: Low Power = 18.5 dBm, Medium Power = 22.0 dBm, High Power = 28.0 dBm. Verify that the power measurement does not exceed the corresponding allowable power level for the equipment class.

Step 4: Measure Inactive State RF Power Output

Set up the UAT Transceiver to transmit a Long ADS-B Message. For the following power measurement, use a 300 kHz bandwidth filter setting. Measure the average RF power over a 1 microsecond interval ending 8 bit periods prior to the start of the active state. Verify that the output power is –80 dBm or lower. Measure the peak RF power 8 bit periods after the end of the last transmitted message bit. Verify that the output power is –80 dBm or lower. Verify that the output power remains under –80 dBm for the 100 microsecond interval following the last transmitted bit. Repeat power measurement with no message transmission and verify that the output power when measured with a 300 kHz bandwidth is –80 dBm or lower.

2.4.2.6 Verification of In Band Transmission Spectrum (subparagraph 2.2.2.6)

Purpose/Introduction:

The average spectrum of a UAT message transmission modulated with pseudo-random payload data **shall** fall within the limits specified in Table 2.2.2.6 and Figure 2.2.2.6 when measured in a 100 kHz bandwidth.

This test procedure verifies that the UAT Transmitter output conforms to the required transmission spectrum as stipulated in subparagraph 2.2.2.6. The transmitter in band spectrum is specified for 250% of the occupied bandwidth or 3.25 MHz.

Equipment Required:

The test configuration requires data sources be provided to the appropriate UAT Transmitter interfaces to enable generation of Long ADS-B Messages. This could also be accomplished by the use of an internally generated Long ADS-B test message with randomly generated data content. Measure the power at the RF antenna port or with appropriate attenuation for the RF power measuring equipment and account for the loss. The RF power measurement system must be capable of measuring average RF power of the modulated signal sampled over a defined interval indicated for each of the measurements below. In all of the power measurements below, the power output measurement must be adjusted to take into account the loss allocated for cabling to the antenna of the aircraft.

Measurement Procedures:

In the case of diversity transmitters, perform all measurements for both top and bottom channels.

Step 1: Measure RF Power Output At Center Frequency

Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the peak RF power of the transmitted signal during the message transmission interval with a 100 kHz bandwidth at 978 MHz frequency. Repeat the measurement over the range from 977.5 MHz to 978.5 MHz to determine the maximum power.

Step 2: Measure RF Power Output Over Frequency Spectrum

Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the peak RF power of the transmitted signal with a 100 kHz bandwidth at the following frequencies and verify that the levels are at or below the corresponding values relative to the power level recorded in Step 1 above:

Table 2.4.2.6: Maximum Allowable Power versus Frequency

Frequency Offset (MHz)	Relative Maximum Power (dB)
±1.0	-18
±1.5	-34
±2.0	-50
±2.5	-54
±3.0	-58
±3.25	-60

2.4.2.7 Verification of Out-of-Band Emissions (subparagraph 2.2.2.7)

Purpose/Introduction:

Out-of-Band emissions **shall** comply with applicable FCC regulations beyond 250% of the authorized bandwidth, that is, 3.25 MHz from the center frequency. Reference 47 CFR, Part 87.139.

This test procedure verifies that the UAT Transmitter output conforms to the required out-of-band transmission emissions as stipulated in subparagraph 2.2.2.7. The transmitter out-of-band spectrum is specified for frequencies beyond the 250% occupied bandwidth frequency points centered around 978 MHz. The frequencies of interest based on the occupied bandwidth of 3.25 MHz are below 974.75 MHz and above 981.25 MHz. The requirements for out-of-band emissions are based on FCC requirements published in Title 47 of the Code Of Federal Regulations, Part 87, paragraph 139: Emission Limitation. The limitation allowed is determined and measured according to the FCC guidelines.

Equipment Required:

The test configuration requires data sources be provided to the appropriate UAT Transmitter interfaces to enable generation of Long ADS-B Messages. This could also be accomplished by the use of an internally generated Long ADS-B test message with randomly generated data content. Measure the power at the RF antenna port with RF power measurement equipment capable of measuring peak RF power of the modulated signal. In the case of diversity transmitters, perform the measurements on both top and bottom antenna ports.

Measurement Procedures:

Step 1: Measure RF Power Output At Center Frequency – Set up

Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the peak RF power of the transmitted signal during the message transmission interval with a 100 kHz bandwidth at 978 MHz. Repeat the measurement over the range from 977.5 MHz to 978.5 MHz to determine the maximum power.

Step 2: Measure RF Power Output Over Frequency Spectrum

Set up the UAT Transceiver to transmit a Long ADS-B Message. Measure the peak RF power of the transmitted signal with a 100 kHz bandwidth at the following frequencies and verify that the levels are at or below –40 dB relative to the power level recorded in Step 1 above: 973 MHz, 974.75 MHz, 981.25 MHz and 982 MHz. Repeat at the following frequencies: 1.956 GHz, 2.934 GHz and 3.912 GHz.

2.4.3 Verification of Broadcast Message Characteristics (subparagraph 2.2.3)

No specific test procedure is required to validate subparagraph 2.2.3.

2.4.3.1 Verification of ADS-B Message Format (subparagraph 2.2.3.1)

No specific test procedure is required to validate subparagraph 2.2.3.1.

2.4.3.1.1 Verification of Synchronization (subparagraph 2.2.3.1.1)

Purpose/Introduction:

Following ramp up, the message **shall** include a 36-bit synchronization sequence. For the ADS-B messages the sequence **shall** be:

111010101100110111011010010011100010

with the left-most bit transmitted first.

This test procedure verifies that the UAT Transmitter equipment correctly outputs the 36-bit synchronization sequence that is transmitted with each UAT Message.

Equipment Required:

The test configuration requires data sources be provided to the appropriate UAT Transmitter interfaces to enable generation of ADS-B Messages. Connect the RF antenna port through appropriate attenuation so that the output message can be received by measurement equipment that can detect and decode the modulated bit pattern to verify the 36 bits of the synchronization sequence.

Measurement Procedures:

Step 1: Verify Synchronization Sequence

Set up the UAT Transceiver to transmit a Long ADS-B Message. Verify that the first 36 bits transmitted contains the sequence:

111010101100110111011010010011100010.

2.4.3.1.2 Verification of Payload (subparagraph 2.2.3.1.2)

No specific test procedure is required to validate subparagraph 2.2.3.1.2.

2.4.3.1.3 Verification of FEC Parity (subparagraph 2.2.3.1.3)

Appropriate test procedures required to validate the requirements of subparagraph 2.4.3.1.3 are included in subparagraph 2.4.3.1.3.1.

2.4.3.1.3.1 Verification of Code Type (subparagraph 2.2.3.1.3.1)

Purpose/Introduction:

The FEC Parity generation **shall** be based on a systematic Reed-Solomon (RS) 256-ary code with 8 bit code word symbols. FEC Parity generation **shall** be per the following code:

a. Basic ADS-B message: Parity **shall** be per a RS (30, 18) code

Note: *This results in 12 bytes (code symbols) of parity capable of correcting up to 6 symbol errors per block.*

b. Long ADS-B message: This **shall** be per a RS (48, 34) code

Note: *This results in 14 bytes (code symbols) of parity capable of correcting up to 7 symbol errors per block.*

For either message length the primitive polynomial of the code **shall** be as follows:

$$p(x) = x^8 + x^7 + x^2 + x + 1.$$

The generator polynomial **shall** be as follows:

$$\prod_{i=120}^{P} (x - a^i).$$

P = 131 for RS (30,18) code and P = 133 for RS (48,34) code

a is a primitive element of a Galois field of size 256 (i.e., GF(256)).

Note: *See Appendix C for more information on the implementation of the Reed Solomon code.*

The “FEC Parity” field is a 96-bit field (bit 1 of byte 19 through bit 8 of byte 30) for Basic ADS-B messages, and a 112-bit field (bit 1 of byte 35, through bit 8 of byte 48) for Long ADS-B messages. The “FEC Parity” symbols sequence is generated based on systematic encoding of Reed-Solomon (RS) 256-ary code with 8-bit code word symbols.

The following test procedure verifies that an ADS-B Transmitting System correctly generates the proper FEC for both Basic and Long ADS-B messages.

This test procedure also verifies that an ADS-B Transmitting System correctly outputs the properly generated FEC in the transmitted Basic and Long ADS-B messages.

<u>Equipment Required:</u>

a. Provide a method to supply controlled ADS-B Messages containing the payloads stipulated in the following tests. The message contents are input prior to the RS Encoding to verify proper RS parity encoding.

b. Provide a method to monitor the transmitted ADS-B Message sequences and associated FEC Parity resulting from the RS Encoding.

<u>Measurement Procedures:</u>

<u>Step 1:</u> <u>Establish the Initial Conditions</u>

Configure the ADS-B UAT Transmitting system to transmit Basic and Long ADS-B messages and verify that the equipment under test is transmitting both messages.

<u>Step 2:</u> <u>Verify FEC Parity for Basic Message (subparagraph 2.2.3.1.3.1)</u>

Load the set of Basic test messages given in Table 2.4.3.1.3.1A into the equipment under test. For each case of provided stimulus given in Table 2.4.3.1.3.1A, verify that the ADS-B UAT Transmitting System properly generates the associated FEC Parity sequence as given in column 3 of Table 2.4.3.1.3.1A.

Verify that all the FEC symbols sequences generated in column 3 of Table 2.4.3.1.3.1A follow the trailing end of the associated transmitted messages in left to right order as given in the following example message:

<u>ADS-B Basic Message Payload (input to the RS encoder)</u>

`913D23BB0C59DFACFCD7209492DFEEEDF381`

<u>Transmitted ADS-B Basic Massage (output from the RS encoder)</u>

`913D23BB0C59DFACFCD7209492DFEEEDF381`<u>**`E00B381341E499399E8B62BF`**</u>

Note: *Underlined data in the above transmitted ADS-B Basic Message is the FEC Parity sequence of that Basic ADS-B Message Payload.*

<u>Step 3:</u> <u>Verify FEC Parity for Long Message (subparagraph 2.2.3.1.3.1)</u>

Load the set of Long test messages given in Table 2.43.1.3.1B into the equipment under test. For each case of provided stimulus given in Table 2.4.3.1.3.1B, verify that the ADS-B UAT Transmitting System properly generates the associated FEC Parity sequence as given in column 3 of Table 2.4.3.1.3.1B.

Verify that all of the FEC symbol sequences generated in column 3 of Table 2.4.3.1.3.1B follow the trailing end of the associated transmitted messages in left to right order as shown in the following example message:

<u>ADS-B Long Message Payload (input to RS encoder)</u>

```
88C14FE677A75B489603580CAA606FD81EE91B64CBABA0563FC0C
E1C2DA3016B2BA3
```

<u>Transmitted ADS-B Long Message (output from the RS encoder)</u>

88C14FE677A75B489603580CAA606FD81EE91B64CBABA0563FC0C
E1C2DA3016B2BA3**<u>A078D3F21607140B4B6CB3E6EE2C</u>**

<u>Note</u>*:* *Underlined data in the above transmitted Long ADS-B Message is the FEC Parity sequence of that Long ADS-B Message Payload.*

Table 2.4.3.1.3.1A: FEC Parity Encoding for Basic ADS-B Message

No.	Basic Message	FEC Parity
1	913D23BB0C59DFACFCD7209492DFEEEDF381	E00B381341E499399E8B62BF
2	CDB4DB1F9A0CCDEA489D8E6633517082B58C	A1B8F183C8E609566F658B4A
3	17E2DCA2CCD5CBB109093A79330A9FFCDE97	CF7B4C67EEB1ADA4A75C757C
4	E5F871DECAF67B1EBD90BCC6E12883A283A9	26856284FF1846544E806833
5	F88BB215044741EB4503DB45EB0E088F5954	238909EF489ECCFA9C517103
6	2DDED1237D3CB84FDFD08DB934FA2F509288	B7E88C2AAC53B4FA680BDD63
7	1BFC58B922B425BF58082B5B2F6557D186FA	F53ACB6EB8CC7F09630B6D7C
8	CDD81CE4BAAB269060F3157CFCBA9ED06777	F389A23D7325C965A417DB8D
9	3DE973832F4D0B8A11AC04B0C06E228E0F56	42F4FE5F593C439ACD2E59B4
10	D5BF734F90953E6FD73D0EAEE96079F20F8C	0B7E1F709281212459963B78
11	B06978700FCCC13DDB8A7F2A32F3E2FB4DE4	D8B0D03BB104BD8092E4FF9A
12	5D06390EDA86A0C5F0532EA31837CDADD985	E12FD9632FB81081BA93453F
13	AE6A7620E7A0801B1594EBAF3F04770F043B	970F50A979D8312E1644C627
14	94EEBF889F502A52FF492DADA564682CD6E4	4168AF9AC449F62A2E32C22E
15	A84753F740104D900BA1A19B12E468B4092F	32A5FF94A0D4082083E22F55
16	2E802B5B8EE72A40EB4C2B3F707D1654B876	5EDC4A263D142BCEBAB36405
17	AC46B6B6A5F833BEC977877BCC33682DE61E	19D387B6C981C1E0198D0E98
18	DC1DD3024B21D65522BA5CE608744997AC20	B2DC6A2236A84CF530B3E273
19	B78696AE86E5FE4613D4AD4404FE595A6C54	B7C9E95FA0D7D7CA6AD7F3AA
20	F969C1A21E56D8602AF07769092D9D0E4AC2	33F36D4A513F133C8CB0850E
21	19A7AB011597F35820E3C770EB5A4051B3DE	662C2B69418B4927F2DDF7A4
22	6EEBA1E49C120EA576226715E2F9C2373D79	E6671F503C6AD08457F6B933
23	BE41419F4C3A3D96F97C7BA7EA486CF97E5E	719637E7650F9348F0355659
24	739E56B97628DA6585F33B123B5FB3DD3274	F29E2577F1C3A580AC28792B
25	897124E7F8661C5F979EC7E6E8F9D3041097	AE6352F2F849AA7C7BEE6FC1
26	DD4C708CEDF7ADBAFD4BC9BBF6D6D27B3CE2	F462D294648FAF59BBDA9F6A
27	F808A811E0A5057892A7F552EB3453FED45D	AAE09B6BF747200DDEACAC1F
28	6B6EBA3A33B5886E536693D118EAC116B7F6	CF23176AAD1781DCA56995F3
29	5E267BDADF9CA9BD120A559568EEDFE4F418	2120E3658F1F4CC802F7C486
30	DC7CAFCC1F6A2C6E1C464E09F7711DEDD49E	5EBFA9BFD7EB0D675A3A944B

Table 2.4.3.1.3.1B: FEC Parity Encoding for Long ADS-B Message

No.	Long Message	FEC Parity
1	88C14FE677A75B489603580CAA606FD81EE91B64CBABA0563FC0CE1C2DA3016B2BA3	A078D3F21607140B4B6CB3E6EE2C
2	739F75B1744FE00C87AA9F7EF0878830D23419434CEEC8B8391CEC5D1614C3381BAE	7AB075D35A6813030823D0B86148
3	F7B2895F117D54FB38EB0995CEB8B876A1FE2B1F4ADF316A8A01D924A9795A3F2450	71446A127F22DC38CCF6AA942818
4	7BF8B323408D048D38D81BF61F7DBC5F407063B8BBFF098CAC3BD5D6C64E84E56C30	7C4D68B1A532B310E1F4C0AAC2AC
5	FCB5D44275F7C1B8B55460F026954F7F593AE4A8CCB0360CE5B37BAD077FC22D4167	BE8964B29C12D09551ED3294F9E1
6	1C4FE476AD33112F584C7D8B61FF934D37069DD15FDD19E797027DE02CAAFC5B2741	E04F254E947E2C1C277C764ABEF3
7	8B8848D93ED768DF48DBC3B7A050478B2A88578A563E3CC41D7D94FA4D2A09F409DF	FF6029E7BFDF3E2D8DC1E2A25D33
8	22D0F51374CDEB578780AD17A70201A28F8127F591C3FF7FB17FF3E0589D5F630ED1	60748ED1FF0578140C3D9C91823B
9	939B650F35FF024810E5F486999F3E46B741C022A445F7B159FE32C1F6ADA528959C	22B6F9BB18DAAC43F24A0690D630
10	A6EDD48FCC8F42F74B094AB3DD6FDBC8F851EBE0251D06F8B4BA1A8EC4361FB92B89	D76929F61929FF6A963971FDBBDD
11	5DEFC36EDD7A4BCCD1C8AB288528ED9E9C96376129B5843976878A707806E4D64842	8B353AB2A7E79DDD650BECA9A646
12	090E24911DEB507BAAAE516C54265F62EFB39493C83D20D05B608C8BCE1CEED9802C	47431D8E69AFA71CC5F5C67AD845
13	7AD1E6D34A9CA0D7799A675843EE58DA3FE12D9E8C53E023EAC764F5143D549B6846	BB47BB5EAE83C13D3D8228CE9C48
14	D84229B09708E1A966FBB9A03B33C263E187182E0469462C2552D92A71C019ECA4CC	233FCB722101B928780F6847C43D
15	B9EE5CBB0F8393AA978C27ACDED299F501B478F6769C97F5488E8896DEB7FEDC2CC6	B98EC747D02F064510C784CD4094
16	03812A8935D098FA6F4B735A8C3E6B6DAFA57773C2F64A0F8FACAD8CA12D95D761FC	C0C28F63377126FB49EC9AF92ACF
17	7F0D163159EAAAA6091C75845B1362E2677EB5C23104BE221DC6C8CF6F7690E38256	B03A848FBD41F3028294787502C8
18	85DF5C0EB4EBC9AA1444BD938DAF897C7D17B077932D693438A9962B6F8347A054C6	F7A24606BA6C64E6D59E44AAABB2
19	86CAAC59028EAD4C6093F09F47253108602ACE1AF3163570CAB29F38071ADAA32239	F4C149C242B2EC2222192A020FA3
20	F444274488BEF7E710DD29A1E87DBB0FF5C4BF248833317D87F420E6F2085DA73413	9162AAEED525C53F29EC69D105AB
21	4C3C6F11981C3325E00DC1B2244F519FF587FF51D3325143921E7BD9CA98D644AEDA	C29E4A0F06E1F9EBF26F7CAF4517
22	3310BEEE66C7C07AD937DAC5EEB1E25EECFF1EA8EABB85CA56D0DDBF0CE42BF7A758	ED2B84F52713986644AB601BCAA3
23	C9D17AAA3F6FD86D09821F14F63CA5C6E16B868F40EC6BFCF10AC51CC3DE23DCFB6E	AE480E7E9C7B642C90E504E172ED
24	82C67962E58DBBC8787447250382D23E99FEB0F5A3BDC592BB1F9F510264FA1C5728	5A01A378DD239B679973E95B0E3B
25	ADC32EA3DF10D1150A16E2638B935EE2E9CEEEC8F8AB693A0983A30853EB1570BFF2	2DBB1FE1563CB0F472688639441F
26	610FCC04C9CB9C7AA7EE871654259E52BEA714DB0C4F6E9B6CB8731F1BD4B646B382	4FFCF3041CD1819FC386DCF7BEE0
27	3706C10380B636FB28A13CC52ACE0B39FD5B2950613842B6AD2E8D1E3D0560853DA7	A9319228174413D125E1F867FBBE
28	5DB8599FF7B8B1C51CD608884E2D0799864719699299394 1D529246FA1735CB1077E	F338358C9E2266FFB5C01EF1492B
29	6E015A24CD483EFFDB378589DE3730CDEEB04C4B303A1EE75D3438FC7BA0EBF92D16	5235F0CC8F97FA043B1E96AD3A5E
30	4F1488A232FBE98335A89D8973156389620B9229D8DC027969A460A2FBE626144C30	5D6647DEF9E73CBFAE6D605A1707
31	D280C7991A8F6237BB1CE460955F4CE9C2D5B7234B58FD42B79BEB900CA04B740242	AF644F247F765B9A5A823F28A985
32	95BBFB6C98B6972B5B89CD9008CF073BB36719DDC18090A4B6DA39544932CEFD775A	721B2D4CC23D7EBEA0F2783C4301
33	4023E5FB7228717AF6F291770B86896A708B0560DE08983A293F488D557B097EBB2E	FC3C3E45783264E555B46718F5C3
34	5DB1F23A86B39DCEEFEDDC1D39FF76D61EB37B4692BAFB63CE7F9837AEC8E7FB16D4	0163745136488B0A9C031CA751BB
35	22B83EC97660281571930693782863 23A0126978763564D37AE20DEB62EF29B6EDB4	48EC70F7392515B4BE76663A7721

36	7FE4D4D5C6261CB4789FE3DD34A96FD4A6268021982B45620EADEB62357DA8EC7440	A31F0994ECDB931F3F008AE6DF10
37	B556DB291BFF5CB64D48EE956BA8970AA705FA7AA6CEE06BEA1E5E2188D80D2B36F8	F5968F9911568FC113113468CB66
38	7A7D8A28C27D6C2CF70C7DDE4DFD9AB02389ADF477916861CAF02621FB8A18C93AD5	B623395367CF47B8754206001FE1
39	6F94FDAC9AC43905EEF91CEF2E6D2AF35154072411E0250DFFA439D643C8B5B8AEDD	E52D541A8095AF2AA5E4395C2490
40	2890593C9F4A71B19C61DBF3ACACE8240BBA36C21A6B7873FD1B41E98FFF94549C8B	A45AFF6327F998395AEF39F8A9DD
41	4B371AFA1971AEE8BDF24CF6314A3F7F4E235FD454D44BF7C096685ACF7AFA9137C7	D9D838E28B4E13754B8693F133B5
42	9E0DDBDA7030968CAF6ACA652831718F29E7BE4264A0132A68C9F287272C09F9A4C6	0A40F4600B88244B68F8745D0AB6
43	183F49F3C85680F33CC58B24DD0DB29544684E5DAFF43C2674E3CA7850C8A9420CA7	A7C75E04043159891F506EB40CC1
44	5F885E5AEAD4EC6FF1BDF491BB23D62AD40AB0BB1219AFB0CF26C0272DEF5C5023D2	A3A7B3455C440B5175616B22745F
45	819822A12A1C2A79BA0A84AA4D1D8997D4B59F2163C068FBAFF7B5140FA7C34C0502	72BC9F3E5E3698B9D7BA8CCADA60
46	D9C0A438C6E5D9D35619E0893B89FC8F1A10321987D19996CAC412D136835C7DCD71	89CDB99711192AE95ED9A77108EF
47	71E41EA79FC27830AFEE057730E8BD0EA27664941E50F7EEB427341A9F633B420AF4	FB93C7DBF32B423DB4E9A6DC6C94
48	C8F3FC9E3D843BFE408C1AD7CB93A045FCC58164CED02A323BC68A04E19849F2A696	C9F02B36C8171AF59AE4087BC7B3
49	07A1F480699D0B0A86E285EFFAA811792989657E0BB38B527E21882C711CD86E77FB	A26A29143A37629BFEC8681DCF2D
50	76618366C9C36A873446E2F823D9A1E9D05FD21F2B1CFEEFF98AA75EC56EAB4F9C39	A07DE4E95FCD470D812220635C19
51	B826A3215AB4238BEFC0FC239A20B1AE611B6194351C8192F361979DA435C6EC995F	781CE9C5A6DA28D43305EEFF82E2
52	031E91CEA08B9EBCA9A6653FA57C7B063DC26C42F2F9C3FBBB160837D5B49DC617CB	812C8A0200CF06D5508C21A43E0D
53	6E2E81654BE17AC87BCBD12BC66C103F16F621C8E63C64091FD432A09C4654CCF120	2CF9A1B6141D59DBDB1D7891B2A0
54	9D89BAD4818277405FF2D094EC3AC63EE8DB936289B65802C410557BEFD944634FBE	3BCA615E5E9855DFE5C2484EC6B6
55	13F2986219087B5F89742EF33592A5636162E1F64225FCB96A3965BEAEACF7215E48	C80533045488FABF82B63A156461
56	5C07C205555043387044BFE339644E656FB5951A4D25DF04745A2025789D8C98AA27	B1C57A12030650463F913ACCFD5E
57	7B0DA278B7C0941364918A36BAC8F0F1A8AE2DB2A1169F232AE7BBF770DA280BF0E7	6B6B181A0477B99072291D08BA26
58	1BDE012041DEC9F401856B1D6D3DFAA79691FB5DAE1F8384AAC540B93F1070D4FB5F	C9DDAE407B765F6EC354B11F5F44
59	211F5E3936550C5389A6303F2CBB074821FAAC6A0781B57197931926ED03852AF939	8E2780D213F6C92CBD998270E451
60	18C918731D74215EC6338316033027C4E7B53355D0B8F3FB28D380997C42541E61C8	777E1834F68AE8C02902AA0C4E55

2.4.3.1.3.2 Verification of Generation and Transmission Order of FEC Parity (subparagraph 2.2.3.1.3.2)

Appropriate test procedures required to validate the generation and transmission order of FEC Parity are included in subparagraph 2.4.3.1.3.1.

2.4.3.2 Verification of Ground Uplink Message Format (subparagraph 2.2.3.2)

No specific test procedure is required to validate subparagraph 2.2.3.2.

2.4.3.2.1 Verification of Synchronization (subparagraph 2.2.3.2.1)

No specific test procedure is required to validate subparagraph 2.2.3.2.1.

2.4.3.2.2 Verification of Payload (Before Interleaving and After De-interleaving) (subparagraph 2.2.3.2.2)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.

2.4.3.2.2.1 Verification of UAT-Specific Header (subparagraph 2.2.3.2.2.1)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.

2.4.3.2.2.1.1 Verification of "GROUND STATION LATITUDE" Field Encoding (subparagraph 2.2.3.2.2.1.1)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.1.

2.4.3.2.2.1.2 Verification of "GROUND STATION LONGITUDE" Field Encoding (subparagraph 2.2.3.2.2.1.2)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.2.

2.4.3.2.2.1.3 Verification of "POSITION VALID" Field Encoding (subparagraph 2.2.3.2.2.1.3)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.3.

2.4.3.2.2.1.4 Verification of "UTC" Field Encoding (subparagraph 2.2.3.2.2.1.4)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.4.

2.4.3.2.2.1.5 Verification of Reserved Bits (subparagraph 2.2.3.2.2.1.5)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.5.

2.4.3.2.2.1.6 Verification of "APPLICATION DATA VALID" Field Encoding (subparagraph 2.2.3.2.2.1.6)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.6.

2.4.3.2.2.1.7 Verification of “SLOT ID” Field Encoding (subparagraph 2.2.3.2.2.1.7)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.7.

2.4.3.2.2.1.8 Verification of “TIS-B SITE ID” Field Encoding (subparagraph 2.2.3.2.2.1.8)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.8.

2.4.3.2.2.1.9 Verification of Reserved Bits (subparagraph 2.2.3.2.2.1.9)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.1.9.

2.4.3.2.2.2 Verification of Ground Uplink Application Data (subparagraph 2.2.3.2.2.2)

No specific test procedure is required to validate subparagraph 2.2.3.2.2.2.

2.4.3.2.3 Verification of FEC Parity (Before Interleaving and After De-interleaving) (subparagraph 2.2.3.2.3)

No specific test procedure is required to validate subparagraph 2.2.3.2.3.

2.4.3.2.3.1 Verification of Code Type (subparagraph 2.2.3.2.3.1)

No specific test procedure is required to validate subparagraph 2.2.3.2.3.1.

2.4.3.2.3.2 Verification of Generation and Transmission Order of FEC Parity (subparagraph 2.2.3.2.3.2)

No specific test procedure is required to validate subparagraph 2.2.3.2.3.2.

2.4.3.2.4 Verification of Interleaved Payload and FEC Parity (subparagraph 2.2.3.2.4)

No specific test procedure is required to validate subparagraph 2.2.3.2.4.

2.4.4 Verification of The ADS-B Message Payload (subparagraph 2.2.4)

No specific test procedure is required to validate subparagraph 2.2.4.

2.4.4.1 Verification of Payload Type (subparagraph 2.2.4.1)

No specific test procedure is required to validate subparagraph 2.2.4.1.

2.4.4.2 Verification of Payload Elements (subparagraph 2.2.4.2)

No specific test procedure is required to validate subparagraph 2.2.4.2.

2.4.4.3 Verification of ADS-B Payload Composition by Payload Type Code (subparagraph 2.2.4.3)

No specific test procedure is required to validate subparagraph 2.2.4.3.

2.4.4.4 Verification of Payload Transmission Order (subparagraph 2.2.4.4)

Appropriate test procedures are provided in subparagraphs 2.4.4.5 through 2.4.4.5.8.

2.4.4.5 Verification of Payload Contents (subparagraph 2.2.4.5)

No specific test procedure is required to validate subparagraph 2.2.4.5.

2.4.4.5.1 Verification of HEADER Element (subparagraph 2.2.4.5.1)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.1 are included in subparagraphs 2.4.4.5.1.1 through 2.4.4.5.1.3.6.

2.4.4.5.1.1 Verification of "PAYLOAD TYPE CODE" Field Encoding (subparagraph 2.2.4.5.1.1)

Purpose/Introduction:

The "PAYLOAD TYPE CODE" field is a 5-bit (bit 1 of byte 1 through bit 5 of byte 1) field used to identify the payload for decoding by the receiver. Definition of the "PAYLOAD TYPE CODE" field encoding that **shall** be used for all ADS-B messages is provided in Table 2.2.4.3.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing Payload Type Code information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Verify the following test procedures for each Message Type according to the capability of the UAT equipage classes.

Step 2: Verify Payload Type Code Encoding for UAT Messages

Set the ADS-B Transmitting system to transmit ADS-B Messages according to the capability of UAT equipage classes.

Verify that for each of the UAT equipage classes, transmitted ADS-B Message Type is encoded according to Table 2.2.4.3.

2.4.4.5.1.2 Verification of "ADDRESS QUALIFIER" Field Encoding (subparagraph 2.2.4.5.1.2)

Purpose/Introduction:

The "ADDRESS QUALIFIER" field is a 3-bit (bit 6 of byte 1 through bit 8 of byte 1) field used to indicate what the 24-bit "ADDRESS" field represents. Definition of the "ADDRESS QUALIFIER" field encoding that **shall** be used for all ADS-B messages is provided in Table 2.2.4.5.1.2.

Measurement Procedure:

Step 1: Verification of Ownship ICAO 24-bit Aircraft Address

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Address Selection (ICAO vs. Temporary) input (see Table 2.4.7.1) to ICAO.

Verify that the “ADDRESS QUALIFIER” field is set to ZERO (binary 000). If this information is not available, verify that the “ADDRESS QUALIFIER” field is set to ZERO (binary 000).

Step 2: Verification of Ownship Self-Assigned Temporary Address

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Address Selection (ICAO vs. Temporary) input (see Table 2.4.7.1) to Temporary.

Verify that the “ADDRESS QUALIFIER” field is set to ONE (binary 001). If this information is not available, verify that the “ADDRESS QUALIFIER” field is set to ZERO (binary 000).

Step 3: Verification of Data Lifetime (subparagraph 2.2.7.1)

Disconnect the Address Selection input and verify that, after 60 seconds, the “ADDRESS QUALIFIER” field in the next transmitted message is set to ZERO (binary 000).

2.4.4.5.1.3 Verification of “ADDRESS” Field Encoding (subparagraph 2.2.4.5.1.3)

No specific test procedure is required to validate subparagraph 2.2.4.5.1.3.

2.4.4.5.1.3.1 Verification of ICAO 24-bit Aircraft Address of Transmitting Aircraft (subparagraph 2.2.4.5.1.3.1)

Purpose/Introduction:

An “ADDRESS QUALIFIER” value of ZERO (binary 000) **shall** indicate that message is an ADS-B message from an aircraft, and that the “ADDRESS” field holds the ICAO 24-bit address that has been assigned to that particular aircraft. The ICAO Aircraft Address **shall** be stored (or “latched”) in the UAT Transmitting System upon Power Up.

If the Address Selection Input becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, the “ADDRESS QUALIFIER” **shall** default to a value of ALL ZEROs.

Note: *The world-wide method for allocating and assigning the 24-bit ICAO aircraft addresses is described in Annex 10 to the Convention on International Civil Aviation, Volume III, Chapter 9. [ICAO Annex 10, Vol. III, Ch. 9].*

Measurement Procedure:

Step 1: Verification of ICAO 24-bit Aircraft Address of Transmitting Aircraft

Set up the ADS-B Transmitting System to transmit UAT messages. Set the Address Selection input to ICAO. Input each address in Table 2.4.4.5.1.3.1.

Verify that the “ADDRESS” field holds the input value of the input address and that the “ADDRESS QUALIFIER” field has a value of ZERO (binary 000).

Table 2.4.4.5.1.3.1: ICAO 24-bit Aircraft Address Encoding

“AA” [HEX]
AA AA AA
55 55 55
77 77 77
BB BB BB
DD DD DD
EE EE EE
FE DC BA
AB CD EF

2.4.4.5.1.3.2 Verification of Self-Assigned Temporary Address of Transmitting Aircraft (subparagraph 2.2.4.5.1.3.2)

Purpose/Introduction:

An “ADDRESS QUALIFIER” value of ONE (binary 001) **shall** indicate that the message is an ADS-B message from an aircraft, and that the “ADDRESS” field holds the transmitting aircraft’s self-assigned own-ship temporary address.

If the Address Selection Input becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, the “ADDRESS QUALIFIER” **shall** default to a value of ALL ZEROs.

The self-assigned temporary address **shall** be generated as follows:

Let: $ADDR_P$ = the ICAO 24-bit address that has been assigned to the aircraft;

$ADDR_T$ = the temporary address that is to be generated;

M(1) = the 12 least significant bits (LSBs) of the own-ship “LATITUDE” field (per subparagraph 2.2.4.5.2.1) at the time the temporary address option is selected;

M(2) = the 12 least significant bits (LSBs) of the own-ship “LONGITUDE” field (per subparagraph 2.2.4.5.2.1) at the time the temporary address option is selected;

M(3) = $4096 \times M(1) + M(2)$; and

TIME = the number of seconds that have elapsed since UTC midnight at the time the temporary address option is selected, represented as a 24-bit number.

Also, let "⊕" denote the modulo 2 bit-by-bit addition (or "exclusive OR") operation.

a. If the transmitting aircraft's ICAO 24-bit address $ADDR_P$ is available, then the temporary address $ADDR_T$ **shall** be the modulo 2, bit-by-bit summation of the permanent address and M(3), that is:

$$ADDR_T = ADDR_P \oplus M(3).$$

b. If the aircraft's 24-bit ICAO address $ADDR_P$ is not available, then time of day **shall** be used as an additional randomizer. In that case, the temporary address $ADDR_T$ **shall** be the modulo 2, bit-by-bit summation of TIME and M(3), that is,

$$ADDR_T = TIME \oplus M(3).$$

Measurement Procedure:

Step 1: Establish Initial Conditions

Set up the ADS-B Transmitting System to transmit UAT messages.

Step 2: Verify the Encoded Data when the ICAO 24-bit Address is Available

Via the appropriate interface, provide the UUT with the exact Latitude, Longitude and $ADDR_P$ data provided in Table 2.4.4.5.1.3.2A and set the Address Selection (ICAO vs Temporary) to Temporary.

For each input Latitude and Longitude, verify the output "ADDRESS" field holds the exact 24-bit value in the $ADDR_T$ column in Table 2.4.4.5.1.3.2A.

Table 2.4.4.5.1.3.2A: Temporary Addresses with ICAO 24-bit Address

Latitude	Longitude	M(1)	M(2)	M(3)	$ADDR_P$	$ADDR_T$
234567	155555	567	555	567555	123456	444103
0AF3C4	097DB0	3C4	DB0	3C4DB0	030562	3F48D2
378536	214C37	536	C37	536C37	155555	463962
14C208	1553CA	208	3CA	2083CA	391122	1992E8
295AF6	047D5B	AF6	D5B	AF6D5B	E1E1E1	4E8CBA
0C3B98	22C97A	B98	97A	B9897A	FAA123	432859
123099	304532	099	532	099532	2E6A53	27FF61
3FFFFF	000001	FFF	001	FFF001	9F2BA6	60DBA7
044C64	211853	C64	853	C64853	B2C5A0	748DF3
1379A4	23F786	9A4	786	9A4786	D3C975	498EF3
11AE25	079F6C	E25	F6C	E25F6C	C47A3C	262550
247F01	395888	F01	888	F01888	A77130	5769B8
33A042	2FC9FB	042	9FB	0429FB	6431A6	60185D
006FAB	123543	FAB	543	FAB543	40AE48	BA1B0B
197605	0FF41F	605	41F	60541F	59562E	390231

Step3: Verify the Encoded Data when the ICAO 24-bit Address is **not** Available

Via the appropriate interface, provide the UUT with the exact Latitude and Longitude data provided in Table 2.4.4.5.1.3.2B and set the Address Selection (ICAO vs Temporary) to Temporary.

For each input Latitude and Longitude, verify the output "ADDRESS" field holds the exact 24-bit value in the $ADDR_T$ column in Table 2.4.4.5.1.3.2B.

Table2.4.4.5.1.3.2B: Temporary Addresses without ICAO 24-bit Address

Latitude	Longitude	M(1)	M(2)	M(3)	Time	$ADDR_T$
234567	155555	567	555	567555	007E90	560BC5
0AF3C4	097DB0	3C4	DB0	3C4DB0	00E880	3CA530
378536	214C37	536	C37	536C37	014370	522F47
14C208	1553CA	208	3CA	2083CA	010A47	21898D
295AF6	047D5B	AF6	D5B	AF6D5B	00A1ED	AFCCB6
0C3B98	22C97A	B98	97A	B9897A	00301F	B9B965
123099	304532	099	532	099532	002D5A	09B868
3FFFFF	000001	FFF	001	FFF001	012A65	FEDA64
044C64	211853	C64	853	C64853	010101	C74952
1379A4	23F786	9A4	786	9A4786	0015E6	9A5260
11AE25	079F6C	E25	F6C	E25F6C	0109EA	E35686
247F01	395888	F01	888	F01888	00FACE	F0E246
33A042	2FC9FB	042	9FB	0429FB	000158	0428A3
006FAB	123543	FAB	543	FAB543	0019E6	FAACA5
197605	0FF41F	605	41F	60541F	00E430	60B02F

Step 4: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "ADDRESS" field. Disconnect the "ADDRESS" input and verify that, after 60 seconds, the "ADDRESS" field in the next transmitted message is set to ALL ZEROs.

Resume "Vertical Data Available" input with a value of hex "AA AA AA" and verify that this value is reflected in the next transmitted message.

2.4.4.5.1.3.3 Verification of ICAO 24-bit Aircraft Address of TIS-B Target Aircraft (subparagraph 2.2.4.5.1.3.3)

No specific test procedure is required to validate subparagraph 2.2.4.5.1.3.3.

2.4.4.5.1.3.4 Verification of TIS-B Track File Identifier (subparagraph 2.2.4.5.1.3.4)

No specific test procedure is required to validate subparagraph 2.2.4.5.1.3.4.

2.4.4.5.1.3.5 Verification of Surface Vehicle Address (subparagraph 2.2.4.5.1.3.5)

No specific test procedure is required to validate subparagraph 2.2.4.5.1.3.5.

2.4.4.5.1.3.6 Verification of Fixed ADS-B Beacon Address (subparagraph 2.2.4.5.1.3.6)

No specific test procedure is required to validate subparagraph 2.2.3.5.1.3.6.

2.4.4.5.2 Verification of STATE VECTOR Element (subparagraph 2.2.4.5.2)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.2 are included in subparagraphs 2.4.4.5.2.1 through 2.4.4.5.2.10.

2.4.4.5.2.1 Verification of "LATITUDE" and "LONGITUDE" Field Encoding (subparagraph 2.2.4.5.2.1)

a. The "LATITUDE" field is a 23-bit (bit 1 of byte 5 through bit 7 of byte 7) field used to encode the latitude of the ADS-B transmitter in WGS-84. The encoding of this field **shall** be as indicated in Table 2.2.4.5.2.1. Also see Figure 2.2.4.5.2.1.

b. The "LONGITUDE" field is a 24-bit (bit 8 of byte 7 through bit 7 of byte 10) field used to encode the latitude of the ADS-B transmitter in WGS-84. The encoding of this field **shall** be as indicated in Table 2.2.4.5.2.1. Also see Figure 2.2.4.5.2.1.

c. The encoding of ALL ZEROs in the "LATITUDE" and "LONGITUDE" and "NIC" (subparagraph 2.2.4.5.2.4) fields **shall** indicate that Latitude/Longitude information is "unavailable."

Note*: Since the encoding of ALL ZEROs is a valid location on the earth, ADS-B receiving systems will interpret this as Latitude/Longitude information "unavailable" only if the NIC field is also set to ZERO.*

2.4.4.5.2.1.1 Verification of Latitude and Longitude for $NAC_P < 9$ (subparagraphs 2.2.4.5.2.1 and 2.2.7.2.1)

Purpose/Introduction:

The following test procedure verifies the UAT Transmitting equipment meets the latitude and longitude encoding requirements of subparagraph 2.2.4.5.2.1 for NAC_P values less than NINE (9).

The following test procedures verify that ADS-B Transmitting systems correctly receive Latitude and Longitude position data from the Navigation source and output encoded Latitude and Longitude data in the Basic ADS-B Message. Latitude and Longitude data are encoded according to Angular Weighted Binary Encoding Method with a resolution of 2^{-24} circles. This test is required for all equipment.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B Transmitting system to transmitADS-B Messages and verify that the equipment under test is transmitting the messages.

Step 2: Verify the Encoded Latitude and Longitude – Data UNAVAILABLE

Set up the ADS-B Transmitting System as above and provide the valid non-zero Latitude and Longitude values in degrees at the nominal rate of the navigation data source.

Discontinue providing Latitude and/or Longitude data to the ADS-B transmission device. After 2 seconds, verify that for each UNAVAILABLE Longitude and/or Longitude input entry in columns 2 and 3 of Table 2.4.4.5.2.1.1C, that the resultant "LATITUDE," "LONGITUDE" and "NIC" fields yield binary coding values of ALL ZEROs as described in Table 2.4.4.5.2.1.1C.

The test shall be considered to have failed if the “LATITUDE” or “LONGITUDE” or “NIC” field is NOT encoded as ALL ZEROs. Otherwise, the test shall be considered to have passed.

Step 3: Verify the Encoded Latitude and Longitude – Data Equal ZERO

Set up the ADS-B Transmitting System as above and provide ZERO DEGREE Latitude and/or Longitude values at the nominal rate of the navigation data source.

Verify that each ZERO DEGREE Longitude and/or Longitude input value in degrees in Table 2.4.4.5.2.1.1C (Cases 6 through 8) matches the corresponding binary coding value in the “LATITUDE” and “LONGITUDE” fields, and the binary coding values of NOT ALL ZEROs in the “NIC” field, as described in Table 2.4.4.5.2.1.1C.

The test shall be considered to have failed if the “NIC” field is encoded as ALL ZEROs. Otherwise, the test shall be considered to have passed.

Step 4: Verify the Encoded Latitude and Longitude Data - Discrete Values

Via the appropriate Navigation Data Source interface, provide the ADS-B Transmitting system with the exact Latitude and Longitude data provided in the Latitude and Longitude values columns for each line item given in Table 2.4.4.5.2.1.1A, Table 2.4.4.5.2.1.1B and Table 2.4.4.5.2.1.1C respectively.

Provide the Latitude and Longitude data via the interface at the nominal rate of the navigation data source.

Allow the system to stabilize after applying the data prior to continuing with following steps.

For each Basic ADS-B message that is broadcast by the ADS-B Transmitting System:

1. Verify that each Latitude input value in degrees in Table 2.4.4.5.2.1.1A correctly matches the corresponding binary coding value in Table 2.4.4.5.2.1.1A.

   If the encoded value differs from the binary value in Table 2.4.4.5.2.1.1A, then the test shall be considered to have failed. Otherwise, the test is considered to have passed.

2. Verify that for each Longitude input value in degrees in Table 2.4.4.5.2.1.1B correctly matches the corresponding binary coding value in Table 2.4.4.5.2.1.1B.

   If the encoded value differs from the binary value in Table 2.4.4.5.2.1.1B, then the test shall be considered to have failed. Otherwise, the test is considered to have passed.

Step 5: Verify Latitude and Longitude Data Encoding – Input Resolution (Part 1)

If the input data used to establish the LATITUDE and LONGITUDE subfields have more resolution than that required by the LATITUDE and LONGITUDE subfields (i.e., more than 24 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the LATITUDE and LONGITUDE subfield.

If the input data fields that are used to determine the output value of the LATITUDE and LONGITUDE subfields do not have finer resolution than that required by the LATITUDE and LONGITUDE subfields, skip Step 5 and stop.

Enter an input value corresponding to Latitude of 45.0000107288360595703125 degrees North.

Verify that the value of the Latitude subfield in the output message is either “2097152”(binary 0010 0000 0000 0000 0000 0000, representing 45 degrees) or “2097153”(binary 0010 0000 0000 0000 0000 0001, representing 45.0000214576721191 40625 degrees).

If the input field used to establish the Latitude subfield does not have resolution finer than 0.0000107288360595703125 degree, skip the rest of Step 5 and stop. Otherwise (Latitude input resolution is finer than 0.0000107288360595703125 degree), let **Z** be equal to the smallest possible value that can be represented by the number of bits in the input field (i.e., **Z** is the value of the least significant bit of the input field). Set the value of the input field to correspond to Latitude of (45.0000107288360595703125 – **Z**).

Verify that the value of Latitude subfield in the output UAT message is “2097152” (binary 0010 0000 0000 0000 0000 0000, representing 45 degrees). Set the value of input field to correspond to Latitude of (45.0000107288360595703125 + **Z**).

Verify that the value of secondary Latitude subfield in the output UAT message is “2097153” (binary 0010 0000 0000 0000 0000 0001, representing 45.000021457672119140625 degrees).

Note: *If the resolution of the Latitude/Longitude input is such that a Latitude of 45.0000107288360595703125 degrees can be represented (but still finer than 0.0000107288360595703125 degrees, e.g., a resolution of 0.00001 degree increments), then values corresponding to Latitude/Longitude must be tested, and the output examined for each value to confirm that output is within +/- 0.0000107288360595703125 degrees (inclusive) of the input value.*

Step 6: Verify Latitude and Longitude Data Encoding – Input Resolution (Part 2)

Repeat step 4 with an input value corresponding to Longitude of 45.0000107288360595703125 degrees East.

<u>Table 2.4.4.5.2.1.1A:</u> Latitude Encoding Values

Latitude (degrees)	**Latitude Coding (binary)**
0.000000000	000 0000 0000 0000 0000 0000
0.000026822	000 0000 0000 0000 0000 0001
0.000048280	000 0000 0000 0000 0000 0010
0.000112653	000 0000 0000 0000 0000 0101
0.000219941	000 0000 0000 0000 0000 1010
0.000434518	000 0000 0000 0000 0001 0100
0.000885129	000 0000 0000 0000 0010 1001
0.001764894	000 0000 0000 0000 0101 0010
0.003545880	000 0000 0000 0000 1010 0101
0.007086396	000 0000 0000 0001 0100 1010
0.014167428	000 0000 0000 0010 1001 0100
0.028329492	000 0000 0000 0101 0010 1000
0.056653619	000 0000 0000 1010 0101 0000
0.113301873	000 0000 0001 0100 1010 0000
0.226598382	000 0000 0010 1001 0100 0000
0.453191400	000 0000 0101 0010 1000 0000
0.906377435	000 0000 1010 0101 0000 0000
1.812749505	000 0001 0100 1010 0000 0000
3.625493646	000 0010 1001 0100 0000 0000
7.250981927	000 0101 0010 1000 0000 0000
14.501958489	000 1010 0101 0000 0000 0000
29.003911614	001 0100 1010 0000 0000 0000
58.007817864	010 1001 0100 0000 0000 0000
90.000000	100 0000 0000 0000 0000 0000
-66.093739	101 0001 0000 0000 0000 0000
-60.468739	101 0101 0000 0000 0000 0000
-90.000000	100 0000 0000 0000 0000 0000

Table 2.4.4.5.2.1.1B: Longitude Encoding Values

Longitude (degrees)	**Longitude Coding (binary)**
0.000018	0000 0000 0000 0000 0000 0000
0.000037	0000 0000 0000 0000 0000 0001
0.000073	0000 0000 0000 0000 0000 0011
0.000147	0000 0000 0000 0000 0000 0110
0.000294	0000 0000 0000 0000 0000 1101
0.000587	0000 0000 0000 0000 0001 1011
0.001175	0000 0000 0000 0000 0011 0110
0.002350	0000 0000 0000 0000 0110 1101
0.004699	0000 0000 0000 0000 1101 1011
0.009398	0000 0000 0000 0001 1011 0110
0.018797	0000 0000 0000 0011 0110 1100
0.037594	0000 0000 0000 0110 1101 1000
0.075188	0000 0000 0000 1101 1011 0000
0.150375	0000 0000 0001 1011 0110 0000
0.300751	0000 0000 0011 0110 1100 0000
0.601501	0000 0000 0110 1101 1000 0000
1.203003	0000 0000 1101 1011 0000 0000
2.406006	0000 0001 1011 0110 0000 0000
4.812012	0000 0011 0110 1100 0000 0000
9.624023	0000 0110 1101 1000 0000 0000
19.248047	0000 1101 1011 0000 0000 0000
38.496094	0001 1011 0110 0000 0000 0000
76.992188	0011 0110 1100 0000 0000 0000
153.984375	0110 1101 1000 0000 0000 0000
-52.031250	1101 1011 0000 0000 0000 0000
-104.062500	1011 0110 0000 0000 0000 0000
151.875000	0110 1100 0000 0000 0000 0000
-56.250000	1101 1000 0000 0000 0000 0000
-112.500000	1011 0000 0000 0000 0000 0000
135.000000	0110 0000 0000 0000 0000 0000
-90.000000	1100 0000 0000 0000 0000 0000
180.000000	1000 0000 0000 0000 0000 0000

Table 2.4.4.5.2.1.1C: Latitude and Longitude Encoding Values for Data Unavailable and Data Equal ZERO Cases

Case	Input Latitude (degree)	Input Longitude (degree)	Latitude Coding (binary)	Longitude Coding (binary)	NIC Coding (binary)
1	Unavailable	0.000018	ALL ZEROs	ALL ZEROs	ALL ZEROs
2	0.000055	Unavailable	ALL ZEROs	ALL ZEROs	ALL ZEROs
3	Unavailable	0.000000	ALL ZEROs	ALL ZEROs	ALL ZEROs
4	0.000000	Unavailable	ALL ZEROs	ALL ZEROs	ALL ZEROs
5	Unavailable	Unavailable	ALL ZEROs	ALL ZEROs	ALL ZEROs
6	0.000000	0.000000	ALL ZEROs	ALL ZEROs	*NOT ALL ZEROs*
7	14.501958489	0.000000	0x0A5000	ALL ZEROs	*NOT ALL ZEROs*
8	0.000000	-56.250000	ALL ZEROs	0xD80000	*NOT ALL ZEROs*

2.4.4.5.2.1.2 Verification of Latitude and Longitude for NAC_P >= 9 (subparagraphs 2.2.4.5.2.1 and 2.2.7.2.2)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.2.1.2 are included in subparagraphs 2.4.7.2.2.1 and 2.4.7.2.2.2.

2.4.4.5.2.2 Verification of "ALTITUDE TYPE" Field Encoding (subparagraph 2.2.4.5.2.2)

Purpose/Introduction:

The "ALTITUDE TYPE" field is a 1-bit (bit 8 of byte 10) field used to identify the source of information in the "ALTITUDE" field. The encoding of this field is reflected in Table 2.2.4.5.2.2.

If the Altitude Type Selection Input becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, the "ALTITUDE TYPE" **shall** default to a value of ZERO.

A means **shall** be provided to operationally select the ALTITUDE TYPE that is reported.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing valid non-zero altitude information. Verify the following test procedures for the Messages Types according to the capability of the UAT equipage classes.

Step 2: Verify Altitude Type Encoding

Set the ADS-B Transmitting System to transmit ADS-B Messages.

Operationally select Barometric Pressure Altitude as the Primary Altitude information. Verify that the "ALTITUDE TYPE" field in SV (bit 8 of byte 10) is set to ZERO.

Operationally select Geometric Pressure Altitude as the Primary Altitude information. Verify that the "ALTITUDE TYPE" field in SV (bit 8 of byte 10) is set to ONE.

Step 3: Verify "Altitude Type" Encoding - Data Lifetime

Operationally select Geometric Pressure Altitude as the Primary Altitude information. Discontinue the input of Altitude Type data to the ADS-B system. Verify that, after 2 seconds, the "ALTITUDE TYPE" field is set to ZERO (0).

Resume Altitude Type data input and verify that the ADS-B message contains "ALTITUDE TYPE" field that is set to ONE (1).

2.4.4.5.2.3 Verification of "ALTITUDE" Field Encoding (subparagraph 2.2.4.5.2.3)

Purpose/Introduction:

The "ALTITUDE" field is a 12-bit (bit 1 of byte 11 through bit 4 of byte 12) field used to encode the altitude of the ADS-B transmitter. The encoding of this field **shall** be as indicated in Table 2.2.4.5.2.3.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing Altitude information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: Selection of Primary Altitude Information

Operationally select Barometric Pressure Altitude as the Primary Altitude information for the following steps (step 3 through step 7) and verify that the "ALTITUDE TYPE" field in (bit 8 of byte 10) is set to ZERO.

Step 3: Verify Altitude Field Encoding – Altitude Data Lifetime

Set up the system to enable broadcast of UAT Messages. Provide valid non-zero Altitude data and valid non-zero velocity data to the ADS-B system.

Discontinue the input of Altitude data to the ADS-B system. Verify that after the Altitude data has not been provided to the ADS-B transmitting device for 2 seconds, that the "ALTITUDE" field is set to a value of "0"(binary 0000 0000 0000).

Resume Altitude data input with a value of –775 feet and verify that the ADS-B message contains an "ALTITUDE" field that is set to a value of "10" (binary 0000 0000 1010).

Step 4: Verify Altitude Field Encoding – Altitude Equal ZERO

Set the Altitude input data to represent an altitude of ZERO feet. Verify that the "ALTITUDE" field is set to a value of "41"(binary 0000 0010 1001).

Step 5: Verify Altitude Field Encoding – Discrete Values

Verify that for each integer Altitude input values in feet in Table 2.4.4.5.2.3 that the system generates UAT Messages that Altitude subfield in each such message is set to the corresponding binary coding value in Table 2.4.4.5.2.3.

Verify that the Altitude subfield in the transmitted message is not incremented until the input value reaches a number corresponding to a multiple of 25 feet.

Table 2.4.4.5.2.3: Altitude Field Encoding

ALTITUDE DATA		
MEANING (ALTITUDE IN FEET)	CODING (DECIMAL)	CODING (BINARY)
-1000	1	0000 0000 0001
-900	5	0000 0000 0101
-775	10	0000 0000 1010
-500	21	0000 0001 0101
25	42	0000 0010 1010
1100	85	0000 0101 0101
3225	170	0000 1010 1010
7500	341	0001 0101 0101
16025	682	0010 1010 1010
33100	1365	0101 0101 0101
67225	2730	1010 1010 1010
86425	3498	1101 1010 1010
92825	3754	1110 1010 1010
99225	4010	1111 1010 1010
100425	4058	1111 1101 1010
100825	4074	1111 1110 1010
101225	4090	1111 1111 1010
101300	4093	1111 1111 1101
101325	4094	1111 1111 1110

Step 6: Verify Altitude Field Encoding – Maximum Values

Continue to increase the Altitude value.

Verify that if the resolution of the input value is the same as the output resolution (i.e, 25 feet), verify that for an input corresponding to an altitude of 101,350 feet, the altitude field is set to “4095”(binary 1111 1111 1111).

If the resolution of input value is greater than output resolution, verify that for an input corresponding to an altitude of greater than 101,325 feet but less than or equal to 101,337.5 feet, the altitude field continue to be set to “4094”(binary 1111 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 101,337.5 feet, then this value shall be input and it shall verify that the Altitude subfield for all such messages is set to either

"4094"(binary 1111 1111 1110, representing 101,325 feet) or "4095"(binary 1111 1111 1111, representing 101,337.5 feet).

Step 7: Verify Altitude Field Encoding – Input Resolution

If the input data used to establish the ALTITUDE subfield has more resolution than that required by the ALTITUDE subfield (i.e., more than 12 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the ALTITUDE subfield.

If the input data field that is used to determine the output value of the ALTITUDE subfield does not have finer resolution that required by the ALTITUDE subfield, then skip Step 7 and stop.

Enter an input value corresponding to an altitude of 37.5 feet.

Verify that the value of the ALTITUDE subfield in the output message is either "42"(binary 0000 0010 1010, representing 25 feet) or "43"(binary 0000 0010 1011, representing 50 feet).

If the input field used to establish the Altitude subfield does not have resolution finer than 12.5 feet, skip the rest of Step 7 and stop. Otherwise (Altitude input resolution is finer than 12.5 feet), let **Z** be equal to the smallest possible value that can be represented by the number of bits in the input field (i.e., **Z** is the value of the least significant bit of the input field). Set the value of the input field to correspond to altitude of (37.5 –**Z**).

Verify that the value of the altitude subfield in the output UAT message is "42"(binary 0000 0010 1010, representing 25 feet). Set the value of input field to correspond to an altitude of (37.5+**Z**).

Verify that the value of altitude subfield in the output UAT message is "43"(binary 0000 0010 1011, representing 50 feet).

Note: *If the resolution of the Altitude input is such that an altitude of 37.5 feet can be represented (but still finer than 12.5 feet, e.g., a resolution of 10 feet increments), then values corresponding to altitude must be tested, and the output examined for each value to confirm that output is within +/- 12.5 feet (inclusive) of the input value.*

Step 9: Reselection of Primary Altitude Information

Operationally select Geometric Pressure Altitude as the Primary Altitude information for Steps 3 through 7 and verify that the "ALTITUDE TYPE" field in bit 8 of byte 10 is set to ONE.

Repeat Steps 3 through 7 with Geometric Pressure Altitude as the Primary Altitude data and verify the encoding.

2.4.4.5.2.4 Verification of "NIC" Field Encoding (subparagraph 2.2.4.5.2.4)

Purpose/Introduction:

The Navigation Integrity Categories ("NIC") field is a 4-bit (bits 5, through 8, of byte 12) field used to allow surveillance applications to determine whether the reported position has an acceptable level of integrity for the intended use. The value of the NIC parameter specifies an integrity containment radius, R_C. The encoding of this field **shall** be as indicated in Table 2.2.4.5.2.4.

If the NIC Input becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, the "NIC" **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages. Provide NIC data at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: Verify "NIC" Field Encoding for UAT Messages

Set the ADS-B Transmitting system to transmit ADS-B Messages.

Verify that with each of the NIC parameter input values that specifies an integrity containment radius, R_C in Table 2.2.4.5.2.4, the system generates UAT Messages such that "NIC" subfield in each such message set to the corresponding binary coding value in Table 2.2.4.5.2.4.

Step 3: "NIC" Field Encoding – Data Lifetime

Discontinue providing update of NIC data. After 2 seconds, verify that the "NIC" subfield in the ADS-B Message is set to ZERO (binary 0000).

Resume providing NIC data and verify that the ADS-B message contains a "NIC" subfield set equal to the corresponding binary coding value shown in the Table 2.2.4.5.2.4.

2.4.4.5.2.5 Verification of "A/G STATE" Field Encoding (subparagraph 2.2.4.5.2.5)

Purpose/Introduction:

The Air/Ground State ("A/G STATE") field is a 3-bit (bits 1 through 3 of byte 13) field that indicates the format used for representing horizontal velocity. The value of this field determines the encoding of the "HORIZONTAL VELOCITY" field. The "A/G STATE" field is composed of three (3) 1-bit fields used as follows:

1. The Vertical Status bit (bit 1 of byte 13) is used to reflect the AIRBORNE or ON-GROUND condition as determined in subparagraph 2.2.4.5.2.5.1.

2. The Subsonic/Supersonic bit (bit 2 of byte 13) is used to indicate the scale factor for the velocity information. The Subsonic/Supersonic bit (bit 2 of byte 13) **shall** be set

to ONE (1) if either the East – West Velocity OR the North – South Velocity, OR the Airspeed exceeds 1022 knots. The Subsonic/Supersonic bit (bit 2 of byte 13) **shall** be reset to ZERO (0) if the East - West and the North - South Velocities, OR the Airspeed drop below 1000 knots.

3. The Geometric Reference/Air Reference bit (bit 3 of byte 13) is used to indicate whether the velocity information is based on geometric reference sensors (navigation systems), or, if geometric-based velocity is not available, then, on air reference sensors (Heading and Airspeed).

If this indication is present in the UAT Transmitting System, and if the AIRBORNE/ON-GROUND Indication input becomes “unavailable” after the “Data Lifetime” timeout listed for this input in Table 2.4.7.1, then the “A/G STATE” field **shall** default to a value of ALL ZEROs.

The encoding of “A/G STATE” field **shall** be as indicated in Table 2.2.4.5.2.5.

Measurement Procedure:

Step 1: Verification of the “Subsonic/Supersonic” bit for Subsonic Velocities

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Ensure the ADS-B Transmitting System has any inputs necessary to establish the AIRBRONE condition. Provide velocity information in the form of Velocity Over Ground (i.e., Ground Speed) with a valid value that is greater than zero but non-supersonic (i.e., both North/South AND East/West velocity inputs are less than 1000 knots).

Verify that ADS-B Messages are generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0), indicating the “Subsonic” setting.

Raise the East/West Velocity input to a value of 1021 knots, and verify that ADS-B Messages are continuing to be generated with the ”Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0). Lower the East/West Velocity input to a value below 1000 knots, and raise the North/South Velocity input to a value of 1021 knots.

Verify that ADS-B Messages are continuing to be generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0).

Lower the North/South Velocity input to a value below 1000 knots, then raise both the East/West and North/South Velocity inputs to values of 1021 knots.

Verify that ADS-B Messages are continuing to be generated with the Subsonic/Supersonic bit (bit 2 of byte 13) set to ZERO (0).

Note: *During the execution of the previous step, care must be taken to ensure that neither the East/West nor the North/South Velocity inputs are raised to a value greater than 1021 knots.*

Step 2: Verification of the “Subsonic/Supersonic” Bit Transition

This step verifies that the ADS-B Transmitting System correctly transitions between the Subsonic and Supersonic scale.

Set up the system to enable broadcast of UAT Messages as indicated in Step 1. Provide velocity information in the form of Velocity Over Ground (i.e., Ground Speed). Initially, both the East/West Velocity input and the North/South velocity input shall be greater than 0 knots but less than 1000 knots, as in Step 1. Raise the East/West velocity to a value of 1023 knots.

Verify that ADS-B Messages are generated with A/G STATE Velocity Flag (bit 2 of byte 13) set to ONE (1), indicating the “Supersonic” scale.

Decrease the East/West velocity input to a value of 999 knots. Verify that ADS-B Messages are generated with “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0). Raise the North/South velocity to a value of 1023 knots.

Verify that ADS-B Messages are generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ONE (1).

Decrease the North/South velocity input to a value of 999 knots.

Verify that ADS-B Messages are generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0).

Raise both North/South and East/West input values to 1023 knots, and verify that ADS-B Messages are generated with “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ONE (1).

Decrease both North/South and East/West input values to 999 knots, and verify that ADS-B Messages are generated with “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0).

Step 3: Verification of the “Subsonic/Supersonic” bit Setting for Subsonic Airspeed

Provide velocity information in the form of Airspeed and Heading Information with a valid value that is greater than zero but non-supersonic (i.e., the Airspeed input is less than 1000 knots).

Verify that ADS-B UAT Messages are generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0), and the A/G STATE Field set to ONE (binary 001).

Raise the Airspeed input to 1021 knots, without exceeding the value of 1022 knots in the process.

Verify that ADS-B Messages continued to be generated with the “Subsonic/Supersonic” bit (bit 2 of byte 13) set to ZERO (0), and the A/G STATE Field set to ONE (binary 001).

Step 4: Verification of the "Subsonic/Supersonic" bit Setting for Subsonic/Supersonic Transition - Airspeed

This step verifies that the ADS-B Transmitting System correctly transitions between the "Subsonic/Supersonic" bit setting of ZERO (Subsonic) and ONE (Supersonic) in UAT Messages containing Airspeed and Heading Information.

Set up the system to enable broadcast of UAT Messages as indicated in Step 1 but with velocity information provided in the form of Airspeed and Heading Information rather than Velocity Over Ground. Initially, the Airspeed input shall be greater than 0 knots but less than 1000 knots, as in Step 1. Then, raise the input Airspeed to a value of 1023 knots.

Verify that ADS-B UAT Messages are generated with the "Subsonic/Supersonic" bit (bit 2 of byte 13) set to ONE (1), and the A/G STATE Field set to THREE (binary 011).

Decrease the Airspeed input to a value of 999 knots.

Verify that ADS-B Messages are generated with "Subsonic/Supersonic" bit (bit 2 of byte 13) set to ZERO (0), and that all such messages revert to the A/G STATE Field set to ONE (binary 001).

Step 5: Verification Of "Geo Ref/Air Ref" Transition – AIRBORNE Condition

This step verifies that the proper A/G State Field and Horizontal Velocity subfield formats are output as determined velocity data available to the ADS-B Transmitting System when in the AIRBORNE condition. Set up the system to enable broadcast of UAT Messages as indicated in Step 1. Ensure the ADS-B Transmitting System has the inputs necessary to be in the AIRBORNE condition.

Provide both the East/West Velocity and the North/South Velocity inputs. Input an East/West Velocity value of 500 Knots East and a North/South Velocity value of 600 knots North. For installations that require or optionally support Airspeed and Heading input, provide an Airspeed value of 800 knots and Heading value of 90 Degrees at the input. Verify that the A/G State Field is set to ZERO and the Horizontal Velocity subfield of the transmitted ADS-B Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to 600 and bit 7 of byte 14 through bit 1 of byte 16 value equal to 500.

Disconnect both the East/West Velocity and the North/South Velocity inputs to the ADS-B Transmitting System Continue to maintain the Airspeed and Heading data. Two seconds after discontinuing the East/West Velocity and North/South Velocity inputs, verify that the A/G State Field equals ONE. Verify that the ADS-B Transmitted Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to 800 and bit 7 of byte 14 through bit 1 of byte 16 value equal to 90. For those ADS-B Transmitting Systems that do not support Airspeed and Heading input, verify that the A/G State Field equals ZERO and that the ADS-B Transmitted Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to ZERO and bit 7 of byte 14 through bit 1 of byte 16 value equal to ZERO.

Input an East/West Velocity value of 1050 Knots East and a North/South Velocity value of 600 knots North. For installations that require or optionally support Airspeed and Heading input, provide an Airspeed value of 1100 knots and Heading value of 90 Degrees at the input. Verify that the A/G State Field is set to TWO and the Horizontal Velocity subfield of the transmitted ADS-B Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to 600 and bit 7 of byte 14 through bit 1 of byte 16 value equal to 1050.

Disconnect both the East/West Velocity and the North/South Velocity inputs to the ADS-B Transmitting System Continue to maintain the Airspeed and Heading data. Two seconds after discontinuing the East/West Velocity and North/South Velocity inputs, verify that the A/G State Field equals THREE. Verify that the ADS-B Transmitted Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to 1100 and bit 7 of byte 14 through bit 1 of byte 16 value equal to 90. For those ADS-B Transmitting Systems that do not support Airspeed and Heading input, verify that the A/G State Field equals TWO and that the ADS-B Transmitted Message contains bit 4 of byte 13 through bit 6 of byte 16 value equal to ZERO and bit 7 of byte 14 through bit 1 of byte 16 value equal to ZERO.

Step 6: Verification Of “Geo Ref/Air Ref” bit –ON GROUND Condition

This step verifies that the proper A/G State Field and Horizontal Velocity subfield formats are output as determined by the Vertical Status and velocity data available to the ADS-B Transmitting System. Set up the system to enable broadcast of UAT Messages as indicated in Step 1. Ensure that the ADS-B Transmitting System has the inputs necessary to be in the ON-GROUND condition.

Provide navigational data input such that the North velocity component is 16 knots and the East velocity component is 12 knots. Also provide Heading input if the UUT supports this input.

Verify that the “A/G STATE” field is set to FIVE.

Verify that the “Speed” subfield (bit 4 of byte 13 through bit 6 of byte 14) contains the value “20.”

If the UUT supports a Heading input, verify that the “Track Angle/Heading” subfield (bit 7 of byte 14 through bit 1 of byte 16) contains the value of the applied Heading input. When Heading input is removed, verify that this subfield assumes the value “37” (i.e., the resulting Track Angle).

If the UUT does not support a Heading input, verify that the “Track Angle/Heading” subfield contains the value “37.”

2.4.4.5.2.5.1 Verification of Vertical Status (subparagraph 2.2.4.5.2.5.1)

Purpose/Introduction:

The ADS-B Transmitting System **shall** determine its Vertical Status using the procedure below.

a. If there is a means to automatically determine the Vertical Status of the ADS-B emitter target category, then such information **shal**l be used to determine the Vertical Status.

Note: *An "automatic" means of determining vertical status could come from a weight-on-wheels or strut switch, etc. Landing gear deployment is not considered a suitable automatic means.*

b. If there is no means to automatically determine the Vertical Status of the ADS-B transmitter, then the ADS-B transmitter **shall** assume the AIRBORNE condition except under the conditions given for each of the ADS-B Emitter Category types given in Table 2.2.4.5.2.5.1A. If the conditions given in Table 2.2.4.5.2.5.1A are met for the given ADS-B Emitter Category, then the ADS-B transmitter **shall** be in the ON-GROUND condition.

If "Radio Altitude" is present in the UAT Transmitting System, and if "Radio Altitude" becomes "unavailable" after the "Data Lifetime" timeout listed in Table 2.4.7.1 for this indication, then the "A/G STATE" field **shall** change according to the condition in Table 2.2.4.5.2.5.1.

Measurement Procedure:

Step 1 Verify Vertical Status (with automatic means)

Provide input to the UUT to the Automatic AIRBORNE/ON-GROUND Indication data input to indicate ON-GROUND condition. Setup the UUT to broadcast ADS-B messages by providing data from the navigation source. Provide no radio altitude data, or airspeed data to the UUT. Verify that the ADS-B Messages broadcasted properly contain Vertical Status (bit 1 of byte 13) equal to ONE.

Provide input to the UUT to the Automatic AIRBORNE/ON-GROUND Indication data input to indicate AIRBORNE condition. Setup the UUT to broadcast ADS-B messages by providing data from the navigation source. Provide no radio altitude data, or airspeed data to the UUT. Provide both East/West Velocity input and the North/South Velocity input data less than 1000 knots. Verify that the ADS-B Messages broadcasted properly contain Vertical Status (bit 1 of byte 13) equal to ZERO.

Step 2 Verify Vertical Status (without automatic means)

Setup the ADS-B Transmitting System to broadcast messages by providing data from the navigation source. Provide Emitter Category, radio altitude data, ground speed and airspeed data to the UUT according to the values defined in Table 2.4.5.2.5.1 or in the case of no data, do not provide the data as indicated. Ensure that NO input is applied to the Automatic AIRBORNE/ON GROUND indication data input. Verify that the UUT broadcasts ADS-B Messages that contain the proper Vertical Status (bit 1 of byte 13) as indicated for each row of Table 2.4.5.2.5.1.

Table 2.4.5.2.5.1: Vertical Status Determination when no Automatic AIRBORNE/ON GROUND Indication is Available

Vertical Status Determination				
Emitter Category / Coding[1]	**Ground Speed (knots)**	**Airspeed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status Bit Bit 1 of byte 13**
2 – 6, 15	50	100	100	ON-GROUND
2 – 6, 15	100	75	100	ON-GROUND
2 – 6, 15	No Data	75	100	ON-GROUND
2 – 6, 15	No Data	50	No Data	ON-GROUND
2 – 6, 15	100	100	25	ON-GROUND
2 – 6, 15	100	No Data	No Data	AIRBORNE
2 – 6, 15	100	100	100	AIRBORNE
2 – 6, 15	75	No Data	No Data	ON-GROUND
2 – 6, 15	No Data	100	100	ON-GROUND
2 – 6, 15	100	No Data	25	ON-GROUND
2 – 6, 15	No Data	No Data	50	ON-GROUND
2 – 6, 15	100	100	No Data	AIRBORNE
2 – 6, 15	No Data	100	100	AIRBORNE
2 – 6, 15	100	No Data	100	AIRBORNE

Note: *The Air/Ground State bit for other Emitter Categories shall be in accordance with Table 2.2.4.5.2.5.1.*

2.4.4.5.2.5.2 Verification of Validation of Vertical Status (subparagraph 2.2.4.5.2.5.2)

Purpose/Introduction:

When an automatic means of determining Vertical Status indicates ON-GROUND, the AIRBORNE/ON-GROUND state **shall** be changed to AIRBORNE under the conditions listed in Table 2.2.4.5.2.5.2.

If “Radio Altitude” is present in the UAT Transmitting System, and if “Radio Altitude” becomes “unavailable” after the “Data Lifetime” timeout listed in Table 2.4.7.1 for this indication, then the “A/G STATE” field **shall** change according to the condition in Table 2.2.4.5.2.5.1.

Note: *The Vertical Status can be used by ADS-B transmitters to select only the TOP antenna when in the ON-GROUND condition. A false indication of the automatic means could therefore impact signal availability. To minimize this possibility, this validation procedure has been established.*

Measurement Procedure:

Step 1 ON-GROUND Override Verification - input data variation

For ADS-B Transmitting Systems with automatic means of determining on the ground status, provide input external to the UUT to indicate ON-GROUND condition. Setup the UUT to broadcast ADS-B Messages by providing data from the navigation source. Provide Emitter Category, radio altitude data, ground speed and airspeed data to the UUT according to the values defined in Table 2.4.4.5.2.5.2 or in the case of no data, do not provide the data or discontinue providing the data as indicated. Verify that the UUT transmits ADS-B Messages with the Vertical Status bit as indicated in Table 2.4.4.5.2.5.2 for each run.

Table 2.4.4.5.2.5.2: ON-GROUND Override Verification

ON GROUND Override				
Emitter Category / Coding[1]	**Ground Speed (knots)**	**Airspeed (knots)**	**Radio Altitude (feet)**	**Resulting Vertical Status Indication Bit 1 of byte 13**
2 – 6, 15	150	100	50	AIRBORNE
2 – 6, 15	100	100	75	AIRBORNE
2 – 6, 15	100	150	50	AIRBORNE
2 – 6, 15	No Data	150	50	AIRBORNE
2 – 6, 15	No Data	150	No Data	AIRBORNE
2 – 6, 15	100	No Data	51	AIRBORNE
2 – 6, 15	100	No Data	No Data	ON-GROUND
2 – 6, 15	50	75	No Data	ON-GROUND
2 – 6, 15	100	100	50	ON-GROUND
2 – 6, 15	50	No Data	25	ON-GROUND
2 – 6, 15	150	No Data	No Data	AIRBORNE
2 – 6, 15	No Data	No Data	150	AIRBORNE
2 – 6, 15	No Data	50	No Data	ON-GROUND
2 – 6, 15	No Data	No Data	100	ON-GROUND
2 – 6, 15	200	50	No Data	AIRBORNE
2 – 6, 15	No Data	100	50	ON-GROUND

Note: *The Air/Ground State bit for other Emitter Categories shall be in accordance with Table 2.2.4.5.2.5.1.*

Step 2 ON-GROUND Override Verification – Velocity input data variation

For ADS-B Transmitting Systems with automatic means of determining on the ground status, provide input external to the UUT to indicate ON-GROUND condition. Setup the UUT to broadcast ADS-B Messages by providing data from the navigation source. Provide position data and North/South Velocity and East/West Velocity initially to 1000 knots. Provide Heading input value of 45 Degrees. Provide Emitter Category, radio altitude data, ground speed and airspeed data to the UUT according to the values defined in Table 2.4.4.5.2.5.2 or in the case of no data, do not provide the data or discontinue providing the data as indicated. Verify that the UUT transmits ADS-B Messages with the Airborne/On-Ground State bit as indicated in Table 2.4.4.5.2.5.2 for each run. For each run that results in Airborne state, verify that the A/G State Field equals ZERO and the correct Horizontal Velocity subfield value (North/South Velocity and East/West Velocity) is contained in the ADS-B Transmitted Message. For each run that results in ON-GROUND state, verify that the A/G

State Field equals FIVE and the correct Horizontal Velocity subfield value (Ground Speed and Heading) is contained in the ADS-B Transmitted Message.

Repeat above except provide North/South Velocity and East/West Velocity data equal to 1200 knots. For each run that results in Airborne state, verify that the A/G State Field equals TWO.

Repeat except discontinue North/South Velocity and East/West Velocity data input. For each run that results in Airborne state, verify that the A/G State Field equals THREE.

2.4.4.5.2.6 Verification of "HORIZONTAL VELOCITY" Subfields (subparagraph 2.2.4.5.2.6)

No specific test procedure is required to validate subparagraph 2.2.4.5.2.6.

2.4.4.5.2.6.1 Verification of Encoding as "North Velocity" Form (subparagraph 2.2.4.5.2.6.1)

Purpose/Introduction:

When the "A/G STATE" field is set to "0," or "2," the "North Velocity or Airspeed or Ground Speed" component **shall** assume the "North Velocity" format indicated in Table 2.2.4.5.2.6.1.

a. The "N/S Sign" subfield (bit 4 of byte 13) **shall** be used to indicate the direction of the North/South velocity vector as shown in Table 2.2.4.5.2.6.1.a.

b. The "North Velocity Magnitude" subfield (bit 5 of byte 13 through bit 6 of byte 14) **shall** be used to report the magnitude of the North/South velocity of the ADS-B transmitter. The Range, Resolution and No Data encoding of the "North Velocity Magnitude" subfield **shall** be as shown in Table 2.2.4.5.2.6.1.b.

2.4.4.5.2.6.1.1 Verification of the "North/South Velocity" Sign Flag (subparagraph 2.2.4.5.2.6.1.a)

Purpose/Introduction:

The "N/S Sign" subfield (bit 4 of byte 13) **shall** be used to indicate the direction of the North/South velocity vector as shown in Table 2.2.4.5.2.6.1.a.

This test procedure verifies that the "N/S Sign" bit in UAT Messages is correctly set to "0" for travel in a northward direction, and "1" for travel in a southward direction.

These test procedures are intended for use for UAT Messages where the "A/G STATE" field is set to "0" or "2." The values of the input Velocity data should be set so as to ensure that the "A/G STATE" is set to either "0" or "2."

Measurement Procedure:

Step 1: North / South Sign Bit Verification – Velocity Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity data at the nominal update rate. Ensure the ADS-B Transmitting System has the inputs necessary to be in the AIRBORNE condition. Provide valid non-zero barometric pressure altitude data and valid non-zero velocity data to the ADS-B System.

Step 2: North / South Direction Bit Verification – Directional Components

The method for testing this field depends largely upon the nature of the input for North/South Velocity Data.

CASE 1:

If the directional component of the input is a single bit or a "flag" type (i.e. a single discrete value is used to represent "NORTH," and another discrete value is used to represent "SOUTH"), then the procedure for this step shall be as follows:

Set this input to the value that indicates travel in a northward direction, and check that ADS-B UAT Messages are generated with "A/G STATE" set to either "0" or "2," and that all such messages contain a "N/S Sign" bit subfield with a value of "0."

Next, set the input to the value that indicates travel in a southward direction, and verify that ADS-B UAT Messages are generated with "A/G STATE" set to either "0" or "2," and that all such messages contain a "N/S Sign" bit subfield with a value of "1."

CASE 2:

If the directional component of the input is variable (e.g., a heading expressed in degrees or other similar manner, so that the input value must be evaluated by the ADS-B transmission device in order to determine the proper value for the "N/S Sign" bit), then the test procedure shall be as follows.

In this case, the input variable must be made to assume values corresponding to movement in a northward direction, and it must be verified, for each such value, that UAT Messages are generated with "A/G STATE set to either "0" or "2," and that all such messages contain a "N/S Sign" bit subfield with a value of "0."

The input must then be made to assume values corresponding to movement in a southward direction, and it must be verified, for each such value, that the transmitter generates UAT Messages with "A/G STATE set to either "0" or "2," and that all such messages contain a "N/S Sign" bit subfield with a value of "1."

2.4.4.5.2.6.1.2 Verification of the "North Velocity Magnitude" Subfield - Subsonic (subparagraph 2.2.4.5.2.6.1.b)

Purpose/Introduction:

When the "A/G STATE" field is set to "0" or "2," the "North Velocity or Airspeed or Ground Speed" component **shall** assume the "North Velocity" format indicated in Table 2.2.4.5.2.6.1.

The "North Velocity Magnitude" subfield is a 10-bit (bit 5 of byte 13 through bit 6 of byte 14) field that **shall** be used to report the magnitude of the North/South Velocity of the ADS-B transmitter. The Range, Resolution and No Data encoding of the "North Velocity Magnitude" subfield **shall** be as shown in Table 2.2.4.5.2.6.1.b.

This test procedure verifies that the North/South Velocity subfield in UAT Messages is correctly set for the subsonic condition where the "A/G STATE" field is set to ZERO (0).

Measurement Procedure:

Step 1: North / South Velocity Verification – Velocity Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set up the UUT to enable broadcast of UAT Messages such that the "A/G STATE" field is "0." Provide valid non-zero velocity data to the ADS-B System.

Discontinue North/South Velocity data and verify that when North/South Velocity Data is not provided to the ADS-B transmission device, the North/South Velocity subfield is set to ZERO (binary 00 0000 0000).

Step 2: North / South Velocity Verification – Velocity Equal ZERO

Set up the ADS-B Transmitting System as above and set the North/South Velocity input to represent a velocity of ZERO knots.

Verify that the North/South Velocity subfield is set to ONE (binary 00 0000 0001).

Step 3: North / South Velocity Verification – Discrete Values

Verify that for each integer North/South Velocity input value in knots in Table 2.4.4.5.2.6.1.2 that the system generates UAT Messages with the "A/G STATE" set to "0," and that the North/South Velocity subfield in each such message is set equal to the corresponding binary coding value in Table 2.4.4.5.2.6.1.2.

Table 2.4.4.5.2.6.1.2: Discrete Values for North/South Velocity

North/South Velocity (Subsonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (N/S Velocity in knots)
00 0000 0010	2	N/S Velocity = 1 knot
00 0000 0101	5	N/S Velocity = 4 knots
00 0000 1010	10	N/S Velocity = 9 knots
00 0000 1111	15	N/S Velocity = 14 knots
00 0101 0000	80	N/S Velocity = 79 knots
00 0101 1010	90	N/S Velocity = 89 knots
00 1010 0101	165	N/S Velocity = 164 knots
00 1010 1010	170	N/S Velocity = 169 knots
01 0101 0101	341	N/S Velocity = 340 knots
10 0101 0101	597	N/S Velocity = 596 knots
10 1010 1010	682	N/S Velocity = 681 knots
11 0101 0101	853	N/S Velocity = 852 knots
11 1010 1010	938	N/S Velocity = 937 knots
11 1111 1110	1022	N/S Velocity = 1021 knots

Step 4: North / South Velocity Verification – Maximum Values

If the resolution of the input value is the same as the output resolution (i.e., 1 knot), verify that for an input corresponding to a northward velocity of 1022 knots, UAT Messages are generated with “A/G STATE” set to “0,” and all such messages contain a North/South Velocity subfield with a value of 1023 (binary 11 1111 1111).

If the resolution of the input value is greater than the output resolution, verify that for input value corresponding to the largest possible northward velocity that is less than 1021.5 knots, UAT Messages are generated with “A/G STATE” of “0,” and all such messages contain a North/South Velocity subfield with a value of 1022 (binary 11 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 1021.5 knots, then this value shall be input and it shall be verified that the resultant North/South Velocity output field is equal to either 1022 (binary 11 1111 1110, representing 1021 knots) or 1023 (binary 11 1111 1111, representing > 1021.5 knots).

Step 5: North / South Velocity Verification – Data Accuracy

If the input data used to establish the North/South Velocity subfield has more resolution than that required by the North/South Velocity subfield (i.e., more than 10 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the North/South Velocity subfield. If the input data field that is used to determine the output value of the North/South Velocity subfield consists of 10 bits or less, proceed to Step 6.

Enter an input value corresponding to a northward velocity of 1.5 knots.

Verify that the value of the North/South Velocity subfield in the output message is either “2” (binary 00 0000 0010, representing 1 knot) or “3” (binary 00 0000 0011, representing 2 knots).

If the input field used to establish the North/South Velocity subfield has exactly 11 bits, skip to step 6. Otherwise (indicating that more than 11 bits are used to establish North/South Velocity subfield), let ***Z*** be equal to the smallest possible fraction that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to a northward velocity of (1.5 – ***Z***).

Verify that the value of the North/South Velocity subfield in the output UAT Message is “2” (binary 00 0000 0010, representing 1 knot).

Set the value of the input field to correspond to a northward velocity of (1.5 + ***Z***).

Verify that the value of the North/South Velocity subfield in the output UAT Message is “3” (binary 00 0000 0011, representing 2 knots).

Note: *If the resolution of the North/South Velocity input is such that a northward velocity of 1.5 knots cannot be represented (but is still greater than 1 knot, e.g., a resolution of 0.2 knot increments), then values corresponding to northward velocity must be tested, and the output examined for each value to confirm that the output is within +/- 0.5 knots (inclusive) of the input value.*

Step 6: North / South Velocity Verification - Part 6

Note: *If the nature of the inputs is such that a separate bit or “flag” type field is input to the transmitter to indicate “North” or “South,” the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the N/S Sign Bit, the following step must be performed.*

Repeat Steps 3, 4 and 5 so that each step is performed with North/South Velocity input data indicating travel in both NORTH and SOUTH directions, i.e., replace the word “northward” with “southward” in steps 3, 4 and 5.

2.4.4.5.2.6.1.3 Verification of the “North Velocity Magnitude” Subfield - Supersonic (subparagraph 2.2.4.5.2.6.1.b)

Purpose/Introduction:

When the “A/G STATE” field is set to “0” or “2,” the “North Velocity or Airspeed or Ground Speed” component **shall** assume the “North Velocity” format indicated in Table 2.2.4.5.2.6.1.

The “North Velocity Magnitude” subfield is a 10-bit (bit 5 of byte 13 through bit 6 of byte 14) field that **shall** be used to report the magnitude of the North/South Velocity of the ADS-B transmitter. The Range, Resolution and No Data encoding of the “North Velocity Magnitude” subfield **shall** be as shown in Table 2.2.4.5.2.6.1.b.

This test procedure verifies that the North/South Velocity subfield in UAT Messages is correctly set for the supersonic condition where the "A/G STATE" field is set to TWO (2).

Measurement Procedure:

Step 1: North / South Velocity Verification – Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages with A/G State set to "2" by providing North/South Velocity input data with a value greater than 1022 knots.

Set the ADS-B Transmitting System to Airborne status. Discontinue North/South Velocity data and verify that when North/South Velocity Data is not provided to the ADS-B transmission device, the North/South Velocity subfield in output UAT Messages is set to ZERO (binary 00 0000 0000).

Step 2: North / South Velocity Verification – Velocity Equal ZERO

Setup the ADS-B Transmitting System as above and set the North/South Velocity input to represent a velocity of ZERO knots.

Verify that the North/South Velocity subfield in subsequent UAT Messages is set to ONE "1" (binary 00 0000 0001).

Step 3: North / South Velocity Verification – Discrete Values

Verify that for each integer North/South Velocity input value in knots identified in Table 2.4.4.5.2.6.1.3 that the system generates UAT Messages with the North/South Velocity Subfield set equal to the corresponding binary coding value in the table.

Table 2.4.4.5.2.6.1.3: North/South Velocity Discrete Values

North/South Velocity (supersonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (N/S Velocity in knots)
00 0000 0010	2	N/S Velocity = 4 knots
00 0000 0101	5	N/S Velocity = 16 knots
00 0000 1010	10	N/S Velocity = 36 knots
00 0000 1111	15	N/S Velocity = 56 knots
00 0101 0000	80	N/S Velocity = 316 knots
00 0101 1010	90	N/S Velocity = 356 knots
00 1010 0101	165	N/S Velocity = 656 knots
00 1010 1010	170	N/S Velocity = 676 knots
01 0101 0101	341	N/S Velocity = 1,360 knots
10 0101 0101	597	N/S Velocity = 2,384 knots
10 1010 1010	682	N/S Velocity = 2,724 knots
11 0101 0101	853	N/S Velocity = 3,408 knots
11 1010 1010	938	N/S Velocity = 3,748 knots
11 1111 1110	1022	N/S Velocity = 4,084 knots

Verify that for 4 knot increases in the input value, the North/South Velocity subfield in subsequent UAT Messages of A/G STATE equal “2” is incremented by one from the previous value (i.e., that the value of the North/South Velocity subfield corresponds to the values given in the table in the above referenced section).

Verify that the North/South Velocity subfield in the output message is not incremented until the input value reaches a number corresponding to an even multiple of 4 knots.

Step 4: North / South Velocity Verification – Maximum Velocity

Continue to increase the value of the North/South Velocity Data input.

Verify that, for discrete values greater than or equal to 4084 knots but less than or equal to 4086 knots, the North/South Velocity subfield continues to be set to “1022” (binary 11 1111 1110).

Continue to increase the value of the North/South Velocity input.

Verify that for discrete input values representing a North/South Velocity greater than 4086 knots, up to the maximum possible input value, that the transmitter continues to generate UAT Messages with a A/G STATE subfield equal to “2,” and that the North/South Velocity subfield for all such messages is set to “1023” (binary 11 1111 1111).

Step 5: North / South Velocity Verification – Input Resolution

If the input data used to establish the North/South Velocity subfield has finer resolution than that required by the North/South Velocity subfield, then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the North/South Velocity subfield. If the input data field that is used to determine the output value of the North/South Velocity subfield does not have finer resolution than that required by the North/South Velocity subfield, proceed to Step 6.

Enter an input value corresponding to a northward velocity of 6 knots.

Verify that the value of the North/South Velocity subfield in the output message is either “2” (binary 00 0000 0010, representing 4 knots) or “3” (binary 00 0000 0011, representing 8 knots).

If the input field used to establish the North/South Velocity subfield does not have resolution finer than 2 knots, skip to step 6. Otherwise (North/South Velocity input resolution is finer than 2 knots), let ***Z*** be equal to the smallest possible value that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to a northward velocity of (6 – ***Z***).

Verify that the value of the North/South Velocity subfield in the output UAT Message is “2” (binary 00 0000 0010, representing 4 knots). Set the value of the input field to correspond to a northward velocity of (6 + ***Z***).

Verify that the value of the North/South Velocity subfield in the output UAT Message is “3” (binary 00 0000 0011, representing 8 knots).

Note: *If the resolution of the North/South Velocity input is such that a northward velocity of 6 knots cannot be represented (but is still finer than 4 knots, e.g., a resolution of 1.75 knot increments), then values corresponding to northward velocity must be tested, and the output examined for each value to confirm that the output is within +/- 2 knots (inclusive) of the input value.*

Step 6: North / South Velocity Verification - Part 6

Note: *If the nature of the inputs is such that a separate bit or “flag” type field is input to the transmitter to indicate “North” or “South,” the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the N/S Sign bit, the following step must be performed.*

Repeat Steps 3, 4 and 5 so that each step is performed with North/South Velocity input data indicating travel in both NORTH and SOUTH directions, i.e., replace the word “northward” with “southward” in steps 3, 4 and 5.

2.4.4.5.2.6.2 Verification of Encoding as “Airspeed or Ground Speed” Form (subparagraph 2.2.4.5.2.6.2)

Purpose/Introduction:

When the “A/G STATE” field is set to “1,” “3,” or “5” the “North Velocity or Airspeed or Ground Speed” component **shall** assume the “Airspeed or Ground Speed” format indicated in Table 2.2.4.5.2.6.2. An “A/G STATE” of “1” or “3” **shall** cause Airspeed to be encoded, and an “A/G STATE” of “5” **shall** cause Ground Speed to be encoded.

a. The “Format” subfield is a 1-bit (bit 4 of byte 13) field that **shall** be used to indicate the format for Airspeed or Ground Speed information as shown in Table 2.2.4.5.2.6.2.a.

b. The “Speed” subfield is a 10-bit (bit 5 of byte 13 through bit 6 of byte 14) field that **shall** be used to report the Airspeed or Ground Speed of the ADS-B transmitter (in knots). The Range, Resolution and No Data encoding of the “Speed” subfield **shall** be as shown in Table 2.2.4.5.2.6.2.b.

2.4.4.5.2.6.2.1 Verification of the Encoding of the Airspeed Format (IAS or TAS) (subparagraph 2.2.4.5.2.6.2.1.a)

Purpose/Introduction:

This test does not apply to systems that do not support an Airspeed input.

When the “A/G STATE” field is set to “1,” “3,” or “5” the “North Velocity or Airspeed or Ground Speed” component **shall** assume the “Airspeed or Ground Speed” format indicated in Table 2.2.4.5.2.6.2. An “A/G STATE” of “1” or “3” **shall** cause Airspeed to be encoded; and “A/G STATE” of “5” **shall** cause Ground Speed to be encoded.

The “Format” subfield is a 1-bit (bit 4 of byte 13) field that **shall** be used to indicate the format for Airspeed or Ground Speed information as shown in Table 2.2.4.5.2.6.2.a.

This test procedure will verify that the Airspeed Format subfield is correctly set to ZERO (0) to if the Airspeed Format is Indicated Airspeed (IAS), and ONE (1) if the Airspeed Format is True Airspeed (TAS).

These test procedures are intended for use of UAT messages with A/G STATE set to “1” or “3.” The values of the input Velocity data should be set so as to generate UAT messages with the appropriate A/G STATE field.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B Transmitting System such that messages are transmitted with the “A/G STATE” field set to “1”. Specifically, ensure that ground reference velocity is not available, airspeed is available non-zero and less than 1022 knots, heading is available, and the automatic AIRBORNE/ON GROUND indication (if used) is AIRBORNE.

Step 2: Airspeed Format Verification – Indicated Airspeed (IAS)

Provide input airspeed data to the ADS-B Transmitting System in the form of “Indicated Airspeed” (IAS) data. Verify that the output UAT Messages have an Airspeed Format subfield with a value of ZERO (0).

Step 3: Airspeed Format Verification – True Airspeed (TAS)

Discontinue the input of IAS data to the ADS-B Transmitting Device and instead provide input airspeed data in the form of “True Airspeed” (TAS) data.

Verify that subsequent UAT messages have an Airspeed Format subfield with a value of ONE (1).

Step 4: Repeat for Supersonic Airspeed scale

Configure the ADS-B Transmitting System such that messages are transmitted with the "A/G STATE" field set to "3". Specifically, ensure that ground reference velocity is not available, airspeed is available non-zero and greater than 1023 knots, heading is available, and the automatic AIRBORNE/ON GROUND indication (if used) is AIRBORNE. Then repeat steps 2 and 3 above.

2.4.4.5.2.6.2.2 Verification of the Encoding of the Airspeed or Ground Speed Magnitude – Subsonic (subparagraph 2.2.4.5.2.6.2.1.b)

Purpose/Introduction:

When the "A/G STATE" field is set to "1," "3," or "5" the "North Velocity or Airspeed or Ground Speed" component **shall** assume the "Airspeed or Ground Speed" format indicated in Table 2.2.4.5.2.6.2. An "A/G STATE" of "1" or "3" **shall** cause Airspeed to be encoded; and "A/G STATE" of "5" **shall** cause Ground Speed to be encoded.

The "Speed" subfield is a 10-bit (bit 5 of byte 13 through bit 6 of byte 14) field that **shall** be used to report the Airspeed or Ground Speed of the ADS-B transmitter (in knots). The Range, Resolution and No Data encoding of the "Speed" subfield **shall** be as shown in Table 2.2.4.5.2.6.2.b.

This test procedure will verify that the "Speed" subfield in these messages is correctly encoded by the ADS-B Transmitting System.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B Transmitting System such that messages are transmitted with the "A/G STATE" field set to "1." Specifically, ensure that ground reference velocity is not available, airspeed is available, non-zero, and less than 1022 knots, heading is available, and the automatic AIRBORNE/ON GROUND indication (if used) is AIRBORNE.

Step 2: Airspeed/Ground Speed Verification – Data Not Available

Provide valid non-zero, subsonic airspeed and heading data to the ADS-B System.

Discontinue Airspeed data and verify that when Airspeed data is not provided to the ADS-B Transmitting System, the "Speed" subfield in subsequent UAT output messages is set to ZERO (binary 00 0000 0000).

***Note**: It is also acceptable for the system to assume an "A/G STATE" of "0" and indicate ALL ZEROS in the entire "HORIZONTAL VELOCITY" field.*

Step 3: Airspeed/Ground Speed Verification – Data Equal to ZERO

Setup the ADS-B Transmitting System as above and set the Airspeed input to represent a velocity of ZERO knots.

Verify that the "A/G STATE" field is set to "1" and that the "Speed" subfield in subsequent UAT output messages is set to ONE (binary 00 0000 0001).

Step 4: Airspeed/Ground Speed Verification – Discrete Values

Verify for each integer Airspeed/Ground Speed (expressed in knots) in Table 2.4.4.5.2.6.2.3, that the system generates UAT Messages with "A/G STATE" set to "1," and that the Airspeed/Ground Speed subfield coding in each such message is set equal to the corresponding binary coding value in the table.

Table 2.4.4.5.2.6.2.3: Discrete Values for Airspeed/Ground Speed

Airspeed (IAS or TAS) or Ground Speed (subsonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (Speed in knots)
00 0000 0010	2	Speed = 1 knot
00 0000 0101	5	Speed = 4 knots
00 0000 1010	10	Speed = 9 knots
00 0000 1111	15	Speed = 14 knots
00 0101 0000	80	Speed = 79 knots
00 0101 1010	90	Speed = 89 knots
00 1010 0101	165	Speed = 164 knots
00 1010 1010	170	Speed = 169 knots
01 0101 0101	341	Speed = 340 knots
10 0101 0101	597	Speed = 596 knots
10 1010 1010	682	Speed = 681 knots
11 0101 0101	853	Speed = 852 knots
11 1010 1010	938	Speed = 937 knots
11 1111 1110	1022	Speed = 1021 knots

Step 5: Airspeed/Ground Speed Verification – Maximum Values

If the resolution of the input value is the same as the output resolution (i.e., 1 knot), verify that for an input corresponding to an Airspeed/Ground Speed of 1022 knots, UAT Messages are generated with "A/G STATE" set to "1," and all such messages contain a Airspeed/Ground Speed subfield with a value of 1023 (binary 11 1111 1111).

If the resolution of the input value is greater than the output resolution, verify that for input value corresponding to the largest possible Airspeed/Ground Speed that is less than 1021.5 knots, UAT Messages are generated with "A/G STATE" of "1," and all such messages contain a Airspeed/Ground Speed subfield with a value of 1022 (binary 11 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 1021.5 knots, then this value shall be input and it shall be verified that the resultant Airspeed/Ground Speed output field is equal to either 1022 (binary 11 1111 1110, representing 1021 knots) or 1023 (binary 11 1111 1111, representing > 1021.5 knots).

Step 6: Airspeed/Ground Speed Verification – Data Accuracy

If the input data used to establish the Airspeed/Ground Speed subfield has more resolution than that required by the Airspeed/Ground Speed subfield (i.e., more than 10 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the Airspeed/Ground Speed subfield. If the input data field that is used to determine the output value of the Airspeed/Ground Speed subfield consists of 10 bits or less, proceed to Step 6.

Enter an input value corresponding to an Airspeed/Ground Speed of 1.5 knots.

Verify that the value of the Airspeed/Ground Speed subfield in the output message is either "2" (binary 00 0000 0010, representing 1 knot) or "3" (binary 00 0000 0011, representing 2 knots).

If the input field used to establish the Airspeed/Ground Speed subfield has exactly 11 bits, skip to Step 7. Otherwise (indicating that more than 11 bits are used to establish Airspeed/Ground Speed subfield), let ***Z*** be equal to the smallest possible fraction that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to an Airspeed/Ground Speed of (1.5 – ***Z***).

Verify that the value of the Airspeed/Ground Speed subfield in the output UAT Message is "2" (binary 00 0000 0010, representing 1 knot).

Set the value of the input field to correspond to an Airspeed/Ground Speed of (1.5 + ***Z***).

Verify that the value of the Airspeed/Ground Speed subfield in the output UAT Message is "3" (binary 00 0000 0011, representing 2 knots).

Note: *If the resolution of the Airspeed/Ground Speed input is such that an Airspeed/Ground Speed of 1.5 knots cannot be represented (but is still greater than 1 knot, e.g., a resolution of 0.2 knot increments), then values corresponding to Airspeed/Ground Speed must be tested, and the output examined for each value to confirm that the output is within +/- 0.5 knots (inclusive) of the input value.*

Step 7: Airspeed/Ground Speed Verification - Part 7

Note: *If the nature of the inputs is such that a separate bit or "flag" type field is input to the transmitter to indicate "Indicated Airspeed" or "True Airspeed," the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the Airspeed Format, the following step must be performed.*

Repeat Steps 4, 5 and 6 so that each step is performed with Airspeed Format input data indicating both Indicated Airspeed (IAS) and True Airspeed (TAS).

2.4.4.5.2.6.2.3 Verification of the Encoding of the Airspeed or Ground Speed Magnitude – Supersonic (subparagraph 2.2.4.5.2.6.2.1.b)

Purpose/Introduction:

When the “A/G STATE” field is set to “1,” “3,” or “5” the “North Velocity or Airspeed or Ground Speed” component **shall** assume the “Airspeed or Ground Speed” format indicated in Table 2.2.4.5.2.6.2. An “A/G STATE” of “1” or “3” **shall** cause Airspeed to be encoded; and “A/G STATE” of “5” **shall** cause Ground Speed to be encoded.

The “Speed” subfield is a 10-bit (bit 5 of byte 13 through bit 6 of byte 14) field that **shall** be used to report the Airspeed or Ground Speed of the ADS-B transmitter (in knots). The Range, Resolution and No Data encoding of the “Speed” subfield **shall** be as shown in Table 2.2.4.5.2.6.2.b.

This test procedure will verify that the Airspeed/Ground Speed subfield in these messages is correctly encoded by the ADS-B Transmitting System.

Measurement Procedure:

Step 1: Establish initial conditions

Configure the ADS-B Transmitting System such that messages are transmitted with the “A/G STATE” field set to “3.” Specifically, ensure that ground reference velocity is not available, airspeed is available, non-zero, and greater than 1022 knots, heading is available, and the automatic AIRBORNE/ON GROUND indication (if used) is set to AIRBORNE.

Step 2: Airspeed/Ground Speed Verification – Data Not Available

Provide valid non-zero, supersonic airspeed and heading data to the ADS-B System.

Discontinue Airspeed data and verify that when Airspeed data is not provided to the ADS-B Transmitting System, that the “Speed” subfield in subsequent UAT output messages is set to ZERO (binary 00 0000 0000).

***Note**: It is also acceptable for the system to assume an “A/G STATE” of “0” and indicate ALL ZEROS in the entire “HORIZONTAL VELOCITY” field.*

Step 3: Airspeed/Ground Speed Verification – Data Equal to ZERO

Setup the ADS-B Transmitting System as above and set the Airspeed input to represent a velocity of ZERO knots.

Verify that the A/G STATE field is set to “3” and that the “Speed” subfield in subsequent UAT output messages is set to ONE (binary 00 0000 0001).

Step 4: Airspeed/Ground Speed Verification – Discrete Values

Verify for each integer Airspeed/Ground Speed (expressed in knots) in Table 2.4.4.5.2.6.2.4, that the system generates UAT Messages with A/G STATE “3” and that the Airspeed/Ground Speed subfield coding in each such message is set equal to the corresponding binary coding value in the table.

Table 2.4.4.5.2.6.2.4: Discrete Values for Airspeed/Ground Speed

AIRSPEED (IAS or TAS) or Ground Speed (supersonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (Speed in knots)
00 0000 0010	2	Speed = 4 knots
00 0000 0101	5	Speed =16 knots
00 0000 1010	10	Speed = 36 knots
00 0000 1111	15	Speed = 56 knots
00 0101 0000	80	Speed = 316 knots
00 0101 1010	90	Speed = 356 knots
00 1010 0101	165	Speed = 656 knots
00 1010 1010	170	Speed = 676 knots
01 0101 0101	341	Speed = 1,360 knots
10 0101 0101	597	Speed = 2,384 knots
10 1010 1010	682	Speed = 2,724 knots
11 0101 0101	853	Speed = 3,408 knots
11 1010 1010	938	Speed = 3,748 knots
11 1111 1110	1022	Speed = 4,084 knots

Verify that for 4 knot increases in the input value, the Airspeed/Ground Speed subfield in subsequent UAT Messages with the “A/G STATE” set to “3” is incremented by one from the previous value (i.e., that the value of the Airspeed/Ground Speed subfield corresponds to the values given in the table in the above referenced section).

Verify that the Airspeed/Ground Speed subfield in the output message is not incremented until the input value reaches a number corresponding to an even multiple of 4 knots.

Step 5: Airspeed/Ground Speed Verification – Maximum Velocity

Continue to increase the value of the Airspeed/Ground Speed Data input.

Verify that, for discrete values greater than or equal to 4084 knots but less than or equal to 4086 knots, the Airspeed/Ground Speed subfield continues to be set to “1022” (binary 11 1111 1110).

Continue to increase the value of the Airspeed/Ground Speed input.

Verify that for discrete input values representing an Airspeed/Ground Speed greater than 4086 knots, up to the maximum possible input value, that the transmitter continues to generate UAT Messages with a “A/G STATE” subfield equal to “3,” and that the Airspeed/Ground Speed subfield for all such messages is set to “1023” (binary 11 1111 1111).

Step 6: Airspeed/Ground Speed Verification – Input Resolution

If the input data used to establish the Airspeed/Ground Speed subfield has finer resolution than that required by the Airspeed/Ground Speed subfield, then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the Airspeed/Ground Speed subfield. If the input data field that is used to determine the output value of the Airspeed/Ground Speed subfield does not have finer resolution than that required by the Airspeed/Ground Speed subfield, proceed to Step 7.

Enter an input value corresponding to an Airspeed/Ground Speed of 6 knots.

Verify that the value of the Airspeed/Ground Speed subfield in the output message is either "2" (binary 00 0000 0010, representing 4 knots) or "3" (binary 00 0000 0011, representing 8 knots).

If the input field used to establish the Airspeed/Ground Speed subfield does not have resolution finer than 2 knots, skip to Step 7. Otherwise (Airspeed/Ground Speed input resolution is finer than 2 knots), let ***Z*** be equal to the smallest possible value that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to an Airspeed/Ground Speed of (6 – ***Z***).

Verify that the value of the Airspeed/Ground Speed subfield in the output UAT Message is "2" (binary 00 0000 0010, representing 4 knots). Set the value of the input field to correspond to an Airspeed/Ground Speed of (6 + ***Z***).

Verify that the value of the Airspeed/Ground Speed subfield in the output UAT Message is "3" (binary 00 0000 0011, representing 8 knots).

Note: *If the resolution of the Airspeed/Ground Speed input is such that an Airspeed/Ground Speed of 6 knots cannot be represented (but is still finer than 4 knots, e.g., a resolution of 1.75 knot increments), then values corresponding to Airspeed/Ground Speed must be tested, and the output examined for each value to confirm that the output is within +/- 2 knots (inclusive) of the input value.*

Step 7: Airspeed/Ground Speed Verification - Part 7

Note: *If the nature of the inputs is such that a separate bit or "flag" type field is input to the transmitter to indicate "Indicated Airspeed" or "True Airspeed," the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the Airspeed Format, the following step must be performed.*

Repeat Steps 4, 5 and 6 so that each step is performed with Airspeed Format input data indicating both Indicated Airspeed (IAS) and True Airspeed (TAS).

2.4.4.5.2.6.3 Verification of Encoding as "East Velocity" Form (subparagraph 2.2.4.5.2.6.3)

Purpose/Introduction:

When the "A/G STATE" field is set to "0" or "2," the "East Velocity or Track Angle/Heading" component **shall** assume the "East Velocity" format indicated in Table 2.2.4.5.2.6.3.

a. The "E/W Sign" subfield (bit 7 of byte 14) **shall** be used to indicate the direction of the East/West velocity vector as shown in Table 2.2.4.5.2.6.3.a.

b. The “East Velocity Magnitude” subfield (bit 8 of byte 14 through bit 1 of byte 16) **shall** be used to report the East/West velocity of the ADS-B transmitter (in knots). The Range, Resolution and No Data encoding of the “East Velocity Magnitude” subfield **shall** be as shown in Table 2.2.4.5.2.6.3.b.

2.4.4.5.2.6.3.1 Verification of the “East/West Velocity” Sign Flag (subparagraph 2.2.4.5.2.6.3.a)

Purpose/Introduction:

The “E/W Sign” subfield (bit 4 of byte 13) **shall** be used to indicate the direction of the East/West Velocity vector as shown in Table 2.2.4.5.2.6.3.a.

This test procedure verifies that the “E/W Sign” bit in UAT Messages is correctly set to “0” for travel in a eastward direction, and “1” for travel in a westward direction.

These test procedures are intended for use for UAT Messages where the “A/G STATE” field is set to “0” or “2.” The values of the input Velocity data should be set so as to ensure that the “A/G STATE” is set to either “0” or “2.”

Measurement Procedure:

Step 1: East/West Sign Bit Verification – Velocity Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity data at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages. Verify that the ADS-B Transmitting System is set to Airborne status. Provide valid non-zero barometric pressure altitude data and valid non-zero velocity data to the ADS-B System.

Step 2: East/West Direction Bit Verification – Directional Components

The method for testing this field depends largely upon the nature of the input for East/West Velocity Data.

CASE 1:

If the directional component of the input is a single bit or a “flag” type (i.e. a single discrete value is used to represent “EAST,” and another discrete value is used to represent “WEST”), then the procedure for this step shall be as follows:

Set this input to the value that indicates travel in a eastward direction, and check that ADS-B UAT Messages are generated with “A/G STATE” set to either “0” or “2,” and that all such messages contain a “E/W Sign” bit subfield with a value of “0.”

Next, set the input to the value that indicates travel in a westward direction, and verify that ADS-B UAT Messages are generated with “A/G STATE” set to either “0” or “2,” and that all such messages contain a “E/W Sign” bit subfield with a value of “1.”

CASE 2:

If the directional component of the input is variable (e.g., a heading expressed in degrees or other similar manner, so that the input value must be evaluated by the ADS-B transmission device in order to determine the proper value for the "E/W Sign" bit), then the test procedure shall be as follows.

In this case, the input variable must be made to assume values corresponding to movement in a eastward direction, and it must be verified, for each such value, that UAT Messages are generated with "A/G STATE" set to either "0" or "2," and that all such messages contain a "E/W Sign" bit subfield with a value of "0."

The input must then be made to assume values corresponding to movement in a westward direction, and it must be verified, for each such value, that the transmitter generates UAT Messages with "A/G STATE" set to either "0" or "2," and that all such messages contain a "E/W Sign" bit subfield with a value of "1."

2.4.4.5.2.6.3.2 Verification of the "East Velocity Magnitude" Subfield - Subsonic (subparagraph 2.2.4.5.2.6.3.b)

Purpose/Introduction:

When the "A/G STATE" field is set to "0" or "2," the "East Velocity or Track Angle/Heading" component **shall** assume the "East Velocity" format indicated in Table 2.2.4.5.2.6.3.

The "East Velocity Magnitude" subfield is a 10-bit (bit 8 of byte 14 through bit 1 of byte 16) field that **shall** be used to report the magnitude of the East/West Velocity of the ADS-B transmitter. The Range, Resolution and No Data encoding of the "East Velocity Magnitude" subfield **shall** be as shown in Table 2.2.4.5.2.6.3.b.

This test procedure verifies that the East/West Velocity subfield in UAT Messages is correctly set for the subsonic condition where the "A/G STATE" field is set to ZERO (0).

Measurement Procedure:

Step 1: East/West Velocity Verification – Velocity Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set up the system to enable broadcast of UAT Messages with the "A/G STATE" set to "0." Verify that the ADS-B Transmitting System is set to Airborne status. Provide valid non-zero velocity data to the ADS-B System.

Discontinue East/West Velocity data and verify that when East/West Velocity Data is not provided to the ADS-B transmission device, the East/West Velocity subfield is set to ZERO (binary 00 0000 0000).

Step 2: East/West Velocity Verification – Velocity Equal ZERO

Set up the ADS-B Transmitting System as above and set the East/West Velocity input to represent a velocity of ZERO knots. Verify that the East/West Velocity subfield is set to "1."

Step 3: East/West Velocity Verification – Discrete Values

Verify that for each integer East/West Velocity input value in knots in Table 2.4.4.5.2.6.3.2 that the system generates UAT Messages with the "A/G STATE" set to "0," and that the East/West Velocity subfield in each such message is set equal to the corresponding binary coding value in Table 2.4.4.5.2.6.3.2.

Table 2.4.4.5.2.6.3.2: Discrete Values for East/West Velocity

East/West Velocity (subsonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (E/W Velocity in knots)
00 0000 0010	2	E/W Velocity = 1 knot
00 0000 0101	5	E/W Velocity = 4 knots
00 0000 1010	10	E/W Velocity = 9 knots
00 0000 1111	15	E/W Velocity = 14 knots
00 0101 0000	80	E/W Velocity = 79 knots
00 0101 1010	90	E/W Velocity = 89 knots
00 1010 0101	165	E/W Velocity = 164 knots
00 1010 1010	170	E/W Velocity = 169 knots
01 0101 0101	341	E/W Velocity = 340 knots
10 0101 0101	597	E/W Velocity = 596 knots
10 1010 1010	682	E/W Velocity = 681 knots
11 0101 0101	853	E/W Velocity = 852 knots
11 1010 1010	938	E/W Velocity = 937 knots
11 1111 1110	1022	E/W Velocity = 1021 knots

Step 4: East/West Velocity Verification – Maximum Values

If the resolution of the input value is the same as the output resolution (i.e., 1 knot), verify that for an input corresponding to an eastward velocity of 1022 knots, UAT Messages are generated with "A/G STATE" set to "0," and all such messages contain a East/West Velocity subfield with a value of 1023 (binary 11 1111 1111).

If the resolution of the input value is greater than the output resolution, verify that for an input value corresponding to the largest possible eastward velocity that is less than 1021.5 knots, UAT Messages are generated with "A/G STATE" of "0," and all such messages contain a East/West Velocity subfield with a value of 1022 (binary 11 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 1021.5 knots, then this value shall be input and it shall be verified that the resultant East/West Velocity output field is equal to either 1022 (binary 11 1111 1110, representing 1021 knots) or 1023 (binary 11 1111 1111, representing > 1021.5 knots).

Step 5: East/West Velocity Verification – Data Accuracy

If the input data used to establish the East/West Velocity subfield has more resolution than that required by the East/West Velocity subfield (i.e., more than 10 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the East/West Velocity subfield. If the input data field that is used to determine the output value of the East/West Velocity subfield consists of 10 bits or less, proceed to Step 6.

Enter an input value corresponding to a eastward velocity of 1.5 knots.

Verify that the value of the East/West Velocity subfield in the output message is either "2" (binary 00 0000 0010, representing 1 knot) or "3" (binary 00 0000 0011, representing 2 knots).

If the input field used to establish the East/West Velocity subfield has exactly 11 bits, skip to step 6. Otherwise (indicating that more than 11 bits are used to establish East/West Velocity subfield), let ***Z*** be equal to the smallest possible fraction that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to an eastward velocity of (1.5 – ***Z***).

Verify that the value of the East/West Velocity subfield in the output UAT Message is "2" (binary 00 0000 0010, representing 1 knot).

Set the value of the input field to correspond to a eastward velocity of (1.5 + ***Z***).

Verify that the value of the East/West Velocity subfield in the output UAT Message is "3" (binary 00 0000 0011, representing 2 knots).

Note: *If the resolution of the East/West Velocity input is such that a eastward velocity of 1.5 knots cannot be represented (but is still greater than 1 knot, e.g., a resolution of 0.2 knot increments), then values corresponding to eastward velocity must be tested, and the output examined for each value to confirm that the output is within +/- 0.5 knots (inclusive) of the input value.*

Step 6: East/West Velocity Verification - Part 6

Note: *If the nature of the inputs is such that a separate bit or "flag" type field is input to the transmitter to indicate "East" or "West," the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the E/W Sign Bit, the following step must be performed.*

Repeat Steps 3, 4 and 5 so that each step is performed with East/West Velocity input data indicating travel in both EAST and WEST directions, i.e., replace the word "eastward" with "westward" in Steps 3, 4 and 5.

2.4.4.5.2.6.3.3 Verification of the "East Velocity Magnitude" Subfield - Supersonic (subparagraph 2.2.4.5.2.6.3.b)

Purpose/Introduction:

When the "A/G STATE" field is set to "0" or "2," the "East Velocity or Track Angle/Heading" component **shall** assume the "East Velocity" format indicated in Table 2.2.4.5.2.6.3.

The "East Velocity Magnitude" subfield is a 10-bit (bit 8 of byte 14 through bit 1 of byte 16) field that **shall** be used to report the magnitude of the East/West Velocity of the ADS-B transmitter. The Range, Resolution and No Data encoding of the "East Velocity Magnitude" subfield **shall** be as shown in Table 2.2.4.5.2.6.3.b.

This test procedure verifies that the East/West Velocity subfield in UAT Messages is correctly set for the supersonic condition where the "A/G STATE" field is set to TWO (2).

Measurement Procedure:

Step 1: East/West Velocity Verification – Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages with "A/G STATE" set to "2" by providing East/West Velocity input data with a value greater than 1022 knots.

Set the ADS-B Transmitting System to Airborne status. Discontinue East/West Velocity data and verify that when East/West Velocity Data is not provided to the ADS-B transmission device, the East/West Velocity subfield in output UAT Messages is set to ZERO (binary 00 0000 0000).

Step 2: East/West Velocity Verification – Velocity Equal ZERO

Setup the ADS-B Transmitting System as above and set the East/West Velocity input to represent a velocity of ZERO knots.

Verify that the East/West Velocity subfield in subsequent UAT Messages is set to ONE (binary 00 0000 0001).

Step 3: East/West Velocity Verification – Discrete Values

Verify that for each integer East/West Velocity input value in knots identified in Table 2.4.4.5.2.6.3.3 that the system generates UAT Messages with the East/West Velocity Subfield set equal to the corresponding binary coding value in the table.

Table 2.4.4.5.2.6.3.3: East/West Velocity Discrete Values

East/West Velocity (supersonic)		
Coding (binary)	**Coding** (decimal)	**Meaning** (E/W Velocity in knots)
00 0000 0010	2	E/W Velocity = 4 knots
00 0000 0101	5	E/W Velocity = 16 knots
00 0000 1010	10	E/W Velocity = 36 knots
00 0000 1111	15	E/W Velocity = 56 knots
00 0101 0000	80	E/W Velocity = 316 knots
00 0101 1010	90	E/W Velocity = 356 knots
00 1010 0101	165	E/W Velocity = 656 knots
00 1010 1010	170	E/W Velocity = 676 knots
01 0101 0101	341	E/W Velocity = 1,360 knots
10 0101 0101	597	E/W Velocity = 2,384 knots
10 1010 1010	682	E/W Velocity = 2,724 knots
11 0101 0101	853	E/W Velocity = 3,408 knots
11 1010 1010	938	E/W Velocity = 3,748 knots
11 1111 1110	1022	E/W Velocity = 4,084 knots

Verify that for 4 knot increases in the input value, the East/West Velocity subfield in subsequent UAT Messages of "A/G STATE" equal "2" is incremented by one from the previous value (i.e., that the value of the East/West Velocity subfield corresponds to the values given in the table in the above referenced section).

Verify that the East/West Velocity subfield in the output message is not incremented until the input value reaches a number corresponding to an even multiple of 4 knots.

Step 4: East/West Velocity Verification – Maximum Velocity

Continue to increase the value of the East/West Velocity Data input.

Verify that, for discrete values greater than or equal to 4084 knots but less than or equal to 4086 knots, the East/West Velocity subfield continues to be set to "1022" (binary 11 1111 1110).

Continue to increase the value of the East/West Velocity input.

Verify that for discrete input values representing a East/West Velocity greater than 4086 knots, up to the maximum possible input value, that the transmitter continues to generate UAT Messages with a "A/G STATE" subfield equal to "2," and that the East/West Velocity subfield for all such messages is set to "1023" (binary 11 1111 1111).

Step 5: East/West Velocity Verification – Input Resolution

If the input data used to establish the East/West Velocity subfield has finer resolution than that required by the East/West Velocity subfield, then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the East/West Velocity subfield. If the input data field that is used to determine the output value of the East/West Velocity subfield does not have finer resolution than that required by the East/West Velocity subfield, proceed to Step 6.

Enter an input value corresponding to a eastward velocity of 6 knots.

Verify that the value of the East/West Velocity subfield in the output message is either “2” (binary 00 0000 0010, representing 4 knots) or “3” (binary 00 0000 0011, representing 8 knots).

If the input field used to establish the East/West Velocity subfield does not have resolution finer than 2 knots, skip to step 6. Otherwise (East/West Velocity input resolution is finer than 2 knots), let ***Z*** be equal to the smallest possible value that can be represented by the number of bits in the input field (i.e., ***Z*** is the value of the least significant bit of the input field). Set the value of the input field to correspond to a eastward velocity of (6 – ***Z***).

Verify that the value of the East/West Velocity subfield in the output UAT Message is “2” (binary 00 0000 0010, representing 4 knots). Set the value of the input field to correspond to a eastward velocity of (6 + ***Z***).

Verify that the value of the East/West Velocity subfield in the output UAT Message is “3” (binary 00 0000 0011, representing 8 knots).

Note: *If the resolution of the East/West Velocity input is such that a eastward velocity of 6 knots cannot be represented (but is still finer than 4 knots, e.g., a resolution of 1.75 knot increments), then values corresponding to eastward velocity must be tested, and the output examined for each value to confirm that the output is within +/- 2 knots (inclusive) of the input value.*

Step 6: East/West Velocity Verification - Part 6

Note: *If the nature of the inputs is such that a separate bit or “flag” type field is input to the transmitter to indicate “East” or “West,” the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the E/W Sign bit, the following step must be performed.*

Repeat Steps 3, 4 and 5 so that each step is performed with East/West Velocity input data indicating travel in both EAST and WEST directions, i.e., replace the word “eastward” with “westward” in Steps 3, 4 and 5.

2.4.4.5.2.6.4 Verification of Encoding as “Track Angle/Heading” Form (subparagraph 2.2.4.5.2.6.4)

Purpose/Introduction:

When the “A/G STATE” field is set to “1,” “3,” or “5” the “East Velocity or Track Angle/Heading” component **shall** assume the “Track Angle/Heading” format indicated in Table 2.2.4.5.2.6.4. An “A/G STATE” of “1” or “3” **shall** cause Heading to be encoded. An “A/G STATE” of “5” **shall** cause Heading to be encoded if available; if not available Track Angle shall be encoded.

a. The Track Angle/Heading Type (“TA/H Type”) is a 2-bit subfield (bit 7 and 8 of byte 14) that **shall** be used to distinguish Track Angle from Heading as shown in Table 2.2.4.5.2.6.4.a.

b. The “Track Angle/Heading” subfield is a 9-bit (bit 1 of byte 15 through bit 1 of byte 16) that **shall** be used to report the Track Angle or Heading of the ADS-B transmitter as shown in Table 2.2.4.5.2.6.4.b.

2.4.4.5.2.6.4.1 Verification of “Track Angle/Heading Type” Flag Subfield (subparagraph 2.2.4.5.2.6.4.a)

Purpose/Introduction:

The Track Angle/Heading Type (“TA/H Type”) is a 2-bit subfield (bit 7 and 8 of byte 14) that **shall** be used to distinguish Track Angle from Heading as shown in Table 2.2.4.5.2.6.4.a.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing Track Angle/Heading information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: Track Angle/Heading Type Bit Verification – A/G STATE “1” and “3” Data Available

Set the ADS-B Transmitting system to AIRBORNE status. Provide non-zero airspeed and heading data to the ADS-B system. Ensure that geometric reference velocity is not available to the UUT. The airspeed data should indicate subsonic velocity (less than 1022 knots) for testing “A/G STATE” equal to “1” messages, and supersonic (greater than 1022 knots) for testing of messages with the “A/G STATE” set to “3.”

Verify that for an “A/G STATE” subfield set to “1” or “3,” if the Magnetic Heading information is provided, that the “TA/H Type” subfield is set to TWO (binary 10).

Verify that if the True Heading information is provided, that the “TA/H Type” subfield is set to THREE (binary 11).

Step 3: Track Angle/Heading Flag Bit Verification – A/G STATE “1” and “3” Data Lifetime

Discontinue the input of Heading data to the ADS-B system. Verify that, after 2 seconds, the “TA/H Type” subfield is set to ZERO (binary 00).

Resume Heading data input with True Heading information to the ADS-B system and verify that “TA/H Type” field is set to THREE (binary 11).

<u>Step 4:</u> <u>Track Angle/Heading Flag Bit Verification – A/G STATE "5" Data Available</u>

Set the ADS-B Transmitting System to ON GROUND status. Provide non-zero ground speed and Heading/Tracking data to the ADS-B system. This data should indicate ground velocity for testing messages with the "A/G STATE" set to "5."

Verify that for an "A/G STATE" set to "5," if the True Track Angle information is provided, that the "TA/H Type" subfield is set to ONE (binary 01).

Verify that if the True Heading information is provided, that the "TA/H Type" subfield is set to THREE (binary 11).

Verify that if the Magnetic Heading information is provided, that the "TA/H Type" subfield is set to TWO (binary 10).

<u>Step 5:</u> <u>Track Angle/Heading Flag Bit Verification – A/G STATE "5" Data Lifetime</u>

Discontinue the input of the Track Angle/Heading data to the ADS-B system. Verify that, after 2 seconds, the "TA/H Type" subfield is set to ZERO (binary 00).

Resume Heading data input with True Heading information to the ADS-B system and verify that "TA/H Type" field is set to THREE (binary 11).

2.4.4.5.2.6.4.2 Verification of the "Track Angle/Heading" Data Subfield (subparagraph 2.2.4.5.2.6.4.4.b)

<u>Purpose/Introduction:</u>

The "Track Angle/Heading" subfield is a 9-bit (bit 1 of byte 15 through bit 1 of byte 16) that **shall** be used to report the Track Angle or Heading of the ADS-B transmitter as shown in Table 2.2.4.5.2.6.4.b.

This test procedure will verify that the ADS-B Transmitting System correctly outputs UAT Messages with the correct "Track Angle/Heading" subfield data.

<u>Measurement Procedure:</u>

<u>Step 1:</u> <u>"Track Angle/Heading" Verification – Input Validation</u>

Configure the ADS-B Transmitting System to transmit UAT Messages by providing position information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages at the nominal rate. Set the ADS-B Transmitting System to "On-Ground" status. Provide valid, non-zero "Track Angle/Heading" data to the ADS-B System. Verify that the "Track Angle/Heading" subfield is NOT set to ZERO (0). Set the "Track Angle/Heading" input to exactly ZERO degrees and verify that the encoding of the "Track Angle/Heading" subfield is set to ZERO (binary 0 0000 0000).

<u>Step 2:</u> <u>“Track Angle/Heading” Verification – Discrete Values</u>

Raw data used to establish the “Track Angle/Heading” subfield will normally have more resolution (i.e., more bits) than that required by the “Track Angle/Heading” subfield. When converting such data to the “Track Angle/Heading” subfield, the accuracy of the data shall be maintained such that it is not worse than +/- ½ LSB where the LSB is that of the “Track Angle/Heading” subfield.

Set up the ADS-B Transmitting System as above and set the “Track Angle/Heading” data input to 0.703125 degrees. Verify that the “Track Angle/Heading” subfield is set to ONE (binary 0 0000 0001). Continue increasing the “Track Angle/Heading” data input in increments of 0.703125 degrees and verify that for each such increment, the encoding of the “Track Angle/Heading” subfield is set to the corresponding binary code shown in Table 2.2.4.5.2.6.4.b, for all possible encodings.

2.4.4.5.2.7 Verification of “VERTICAL VELOCITY OR A/V SIZE” Field (subparagraph 2.2.4.5.2.7)

No specific test procedure is required to validate subparagraph 2.2.4.5.2.7.

2.4.4.5.2.7.1 Verification of Encoding as “Vertical Velocity” Form (subparagraph 2.2.4.5.2.7.1)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.4.5.2.7.1 are included in subparagraphs 2.4.4.5.2.7.1.1 through 2.4.4.5.2.7.1.3.

2.4.4.5.2.7.1.1 Verification of “VV Src” Subfield Encoding (subparagraph 2.2.4.5.2.7.1.1)

<u>Purpose/Introduction:</u>

The Vertical Velocity Source (“VV Src”) subfield is a 1-bit (bit 2 of byte 16) field that **shall** be used to indicate the source of Vertical Rate information as defined in Table 2.2.4.5.2.7.1.1.

Vertical Rate information **shall** come from a Geometric source when the *Precision* condition is met, specifically when:

a. the “NAC_P” value is “10” or “11”, or, if “NAC_P” is not available, then

b. the “NIC” value is “9”, “10” or “11”

Otherwise, the *Non-Precision* condition is in effect and Vertical Rate information **shall** come from a barometric source.

<u>Measurement Procedure:</u>

<u>Step 1:</u> <u>Verification of Geometric Source – Part 1</u>

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the NAC_P field (bits 1 through 4 of byte 26) to a value of TEN (binary 1010) and verify that bit 2 of byte 16 is ZERO (0) in the next transmitted message.

Repeat this Step for a NAC_P field value of ELEVEN (binary 1011) and again verify that bit 2 of byte 16 is ZERO (0) in the next transmitted message.

Step 2: Verification of Geometric Source – Part 2

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the NAC_P field (bits 1 through 4 of byte 26) to a value of ZERO (binary 0000) to indicate data not available. Set the NIC field (bits 5 through 8 of byte 12) to a value of NINE (binary 1001) and verify that bit 2 of byte 16 is ZERO (0) in the next transmitted message. Repeat this Step for a NIC value of 10 (binary 1010) and again for a NIC value of ELEVEN (binary 1011) and, in each case, verify that bit 2 of byte 16 is ZERO (0) in the next transmitted message.

Step 3: Verification of Barometric Source – Part 1

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the NAC_P field (bits 1 through 4 of byte 26) to a value of ONE (binary 0001) and verify that bit 2 of byte 16 is ONE (1) in the next transmitted message. Repeat this step for NAC_P values of 2 (binary 0010) through NINE (binary 1001) and, in each case, verify that bit 2 of byte 16 is ONE (1) in the next transmitted message.

Step 4: Verification of Barometric Source – Part 2

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the NAC_P field (bits 1 through 4 of byte 26) to a value of ZERO (binary 0000) to indicate data not available. Set the NIC field (bits 5 through 8 of byte 12) to a value of ONE (binary 0001) and verify that bit 2 of byte 16 is ONE (1) in the next transmitted message. Repeat this step for NIC values of 2 (binary 0010) through EIGHT (binary 1000) and, in each case, verify that bit 2 of byte 16 is ONE (1) in the next transmitted message.

2.4.4.5.2.7.1.2 Verification of "VV Sign" Subfield Encoding (subparagraph 2.2.4.5.2.7.1.2)

Purpose/Introduction:

The Sign Bit for Vertical Rate ("VV Sign") subfield is a 1 bit (bit 3 of byte 16) field used to indicate the direction of the "Vertical Rate" subfield. Encoding of this subfield **shall** be as indicated in Table 2.2.4.5.2.7.1.2.

Measurement Procedure:

Step 1: Vertical Rate Sign Bit Verification – Data Not Available

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set the ADS-B Transmitting System to Airborne status. Provide valid non-zero barometric pressure altitude data and valid non-zero velocity data to the ADS-B System.

Verify that when Vertical Rate Data is not provided to the ADS-B transmission device, the Vertical Rate Sign Bit is set to "0," as specified in Table 2.2.4.5.2.7.2.

Step 2: Vertical Rate Sign Bit Directional Component Verification

The method for testing this field depends largely upon the nature of the input for Vertical Rate Data.

CASE 1:

If the directional component of the input is a single bit or a “flag” type (i.e. a single discrete value is used to represent “UP,” and another discrete value is used to represent “DOWN”), then the procedure for this step shall be as follows:

Set this input to the value that indicates an upward direction, and verify that ADS-B UAT Messages are generated with PAYLOAD TYPE, set to a value of ZERO (0), and verify that all such messages contain a Vertical Rate Sign Bit subfield with a value of ZERO (0). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate Sign Bit subfield with a value of ZERO (0).

Next, set the input to the value that indicates a downward direction, and verify that ADS-B UAT Messages are generated, and that all such messages contain a Vertical Rate Sign Bit subfield with a value of ONE (1). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate Sign Bit subfield with a value of ONE (1).

CASE 2:

If the directional component of the input is variable (e.g., a heading expressed in degrees or other similar manner, so that the input value must be evaluated by the ADS-B transmission device in order to determine the proper value for the Vertical Rate Sign Bit), then the test procedure shall be as follows.

In this case, the input variable must be made to assume values corresponding to an upward climb, and it must be verified, for each such value, that UAT Messages are generated with PAYLOAD TYPE set to a value of ZERO (0), and that all such messages contain a Vertical Rate Sign Bit subfield with a value of ZERO (0). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate Sign Bit subfield with a value of ZERO (0).

The input must then be made to assume values corresponding to a descent, and it must be verified, for each such value, that the transmitter generates UAT Messages with PAYLOAD TYPE, set to a value of ZERO (0), and that all such messages contain a Vertical Rate Sign Bit subfield with a value of ONE (1). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate Sign Bit subfield with a value of ONE (1).

2.4.4.5.2.7.1.3 Verification of “Vertical Rate” Subfield Encoding (subparagraph 2.2.4.5.2.7.1.3)

Purpose/Introduction:

The “Vertical Rate” subfield is a 9-bit (bit 4 of byte 16 through bit 4 of byte 17) field is used to report the Vertical Rate (in feet/minute) of the ADS-B transmission device.

Range, Resolution, and No Data encoding of the “Vertical Rate” subfield **shall** be as shown in Table 2.2.4.5.2.7.1.3.

Measurement Procedure:

Step 1: Vertical Rate Not Available Verification

Configure the ADS-B Transmitting System to transmit UAT Messages by providing velocity information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages. Set the ADS-B Transmitting System to Airborne status. Provide valid non-zero barometric pressure altitude data and valid non-zero velocity data to the ADS-B System.

Verify that when Vertical Rate Data is not provided to the ADS-B transmission device, the Vertical Rate subfield in UAT output messages is set to “0” (binary 0 0000 0000).

Step 2: Vertical Rate Equal To ZERO Verification

The input for this field shall initially be set to represent a Vertical Rate of ZERO feet per minute.

Verify that the ADS-B transmission device generates UAT Messages with PAYLOAD TYPE, set to a value of ZERO (0), and that the Vertical Rate subfield in each such message contains the value “1” (binary 0 0000 0001). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate subfield with a value of ONE (binary 0 0000 0001).

Step 3: Vertical Rate Verification – Discrete Values

Increase the value of the Vertical Rate Data input so that it assumes each discrete decimal coding value from Table 2.4.4.5.2.7.1.3.

Verify that for each discrete decimal coding input value, the Vertical Rate subfield in subsequent UAT Messages with PAYLOAD TYPE set to a value of ZERO (0), matches identically to the corresponding Binary Coding value from Table 2.4.4.5.2.7.1.3. Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate subfield that matches identically to the corresponding Binary Coding value from Table 2.4.4.5.2.7.1.3.

Table 2.4.4.5.2.7.1.3: Vertical Rate Discrete Values

VERTICAL RATE		
Coding (binary)	**Coding** (decimal)	**Meaning** (VERTICAL RATE in feet / minute)
0 0000 0101	5	Vertical Rate = 256 feet / minute
0 0000 1010	10	Vertical Rate = 576 feet / minute
0 0000 1111	15	Vertical Rate = 896 feet / minute
0 0101 0000	80	Vertical Rate = 5,056 feet / minute
0 0101 1111	95	Vertical Rate = 6,016 feet / minute
0 1010 0000	160	Vertical Rate = 10,176 feet / minute
0 1010 1111	175	Vertical Rate = 11,136 feet / minute
0 1111 1111	255	Vertical Rate = 16,256 feet / minute
1 0000 0000	256	Vertical Rate = 16,320 feet / minute
1 0101 0101	341	Vertical Rate = 21,760 feet / minute
1 1010 1010	426	Vertical Rate = 27,200 feet / minute
1 1111 1110	510	Vertical Rate = 32,576 feet / minute

Verify that the Vertical Rate subfield in the output message is not incremented until the input value reaches a number corresponding to an even multiple of 64 feet/minute.

Step 4: Vertical Rate Verification – Out of Bounds Test

Continue to increase the value of the Vertical Rate Data input.

Verify that for values greater than 32,576 feet per minute but less than or equal to 32,608 feet per minute, the Vertical Rate subfield continues to be set to "510" (binary 1 1111 1110).

Continue to increase the value of the vertical rate input.

Verify that for values representing a vertical rate greater than 32,608 feet per minute, up to the maximum possible input value, that the transmitter continues to generate UAT Messages with PAYLOAD TYPE set to a value of ZERO (0) with the Vertical Rate subfield for all such messages is set to "511" (binary 1 1111 1111). Repeat this step for ADS-B UAT Messages generated with PAYLOAD TYPE set to values of ONE (1) through TEN (10), and verify that all such messages contain a Vertical Rate subfield that is set to "511" (binary 1 1111 1111).

Step 5: Vertical Rate Verification - Part 5

Note: *If the nature of the inputs is such that a separate bit or "flag" type field is input to the transmitter to indicate "Up" or "Down," the following step is not necessary. However, if the transmitter must perform some interpretation of its inputs in order to determine the correct output value of the Vertical Rate Sign Bit, the following step must be performed.*

Repeat steps 3 through 5, so that each step is performed with Vertical Rate input data indicating directional vectors of both UP (climb) and DOWN (descent) turns.

2.4.4.5.2.7.2 Verification of Encoding as "A/V Length and Width Code" Form (subparagraph 2.2.4.5.2.7.2)

Purpose/Introduction:

When the ADS-B transmitter is in the ON-GROUND condition the "VERTICAL VELOCITY OR A/V SIZE" field **shall** assume the "A/V Length and Width Code" form as shown in Table 2.2.4.5.2.7.2A. The encoding of the "A/V Length and Width Code" **shall** be as shown in Table 2.2.4.5.2.7.2B.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B Transmitting System to transmit UAT Messages by providing aircraft size information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: A/V Length and Width Code Verification- Part 1

Set up the system to enable broadcast of UAT Messages with the A/G State set to "5," according to the conditions defined in the subparagraph 2.2.4.5.2.5.1.

Verify that for each Length and Width value of the Aircraft, in meters, is encoded according to Table 2.2.4.5.2.7.2B in the first 4 bits of the "A/V Length and Width Code" subfield.

Verify that the remaining 7 bits of "A/V Length and Width Code" subfield is set to ALL ZEROs.

Step 3: A/V Length and Width Code Verification-Part 2

Set up the system to enable broadcast of UAT Messages with the A/G State set to "1," AIRBORNE status.

Provide valid Length and Width value of the Aircraft in meters (length 34 m, wingspan 34 m). Verify that the 9 bits (bit 4 of byte 16 through bit 4 of byte 17) which represent the "Vertical Rate" subfield in the AIRBORNE status are encoded ALL ZEROs.

Step 4: A/V Length and Width Code Verification-Data Not Available

TBD

2.4.4.5.2.8 Verification of "UTC" Field Encoding (subparagraph 2.2.4.5.2.8)

Purpose/Introduction:

The "UTC" field is a 1-bit field (byte 17, bit 5) that indicates whether the ADS-B Transmitting System is in the "UTC Coupled" condition or the "Non-UTC Coupled" condition (subparagraph 2.2.5). The encoding of this field **shall** be as indicated in Table 2.2.4.5.2.8.

If the UTC 1-PPS Timing Input becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, then the “UTC” field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B Transmitting System to transmit UAT Messages by providing position, velocity and time (PVT) data via the appropriate Navigation Data Source interface at the nominal update rate.

Step 2: “UTC” Field Encoding Verification - Part 1

If the ADS-B Transmitting System accepts a GNSS TIME MARK, or equivalent input from the navigation data source, verify that the “UTC” subfield is set to ONE (1).

If the ADS-B Transmitting System is not capable of receiving a GNSS Time Mark, or if the input is not available, verify that the “UTC” subfield is set to ZERO (0).

Step 3: “UTC” Field Encoding Verification - Part 2

Disconnect the UTC Time Mark input. Provide a valid non-zero formatted Ground uplink message to the ADS-B Transmitting system.

Verify that while receiving a ground uplink messages the “UTC” subfield is set to ZERO (0).

Step 4: “UTC” Field Encoding – Data Lifetime

Disconnect the UTC Time Mark input. Verify that, after 2 seconds, the “UTC” subfield is set to ZERO (0).

Resume UTC Time Mark input and verify that the ADS-B message contains a “UTC” subfield that is set to ONE (1).

2.4.4.5.2.9 Verification of Reserved Bits (subparagraph 2.2.4.5.2.9)

Purpose/Introduction:

Bits 6 through 8 of byte 17 are reserved for future use and shall be set to ZERO when the “ADDRESS QUALIFIER” field is set to “0,” “1,” “4,” or “5.”

Measurement Procedure:

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages. Set the ADS-B Transmitting system to transmit ADS-B Messages according to the capability of the UAT equipage classes. Verify that bit 6 through bit 8 of byte 17 are set to ALL ZEROs.

2.4.4.5.2.10 Verification of Reserved Byte 18, Payload Type Zero (subparagraph 2.2.4.5.2.10)

Purpose/Introduction:

Byte 18 of the ADS-B Message Payload definition in Table 2.2.4.3 is reserved for future use, and **shall** be set to ALL ZEROs.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing the Payload Type Code and other available information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: Reserved Byte Verification

Set the ADS-B Transmitting system to transmit Type 0 Messages. Verify that the Reserved Byte “18” is set to ZERO.

2.4.4.5.3 Verification of STATE VECTOR Element (For TIS-B) (subparagraph 2.2.4.5.3)

No specific test procedure is required to validate subparagraph 2.2.4.5.3.

2.4.4.5.3.1 Verification of “TIS-B SITE ID” Field Encoding (subparagraph 2.2.4.5.3.1)

No specific test procedure is required to validate subparagraph 2.2.4.5.3.1.

2.4.4.5.3.2 Verification of Encoding for All Other Fields (subparagraph 2.2.4.5.3.2)

No specific test procedure is required to validate subparagraph 2.2.3.4.5.3.2.

2.4.4.5.4 Verification of MODE STATUS Element (subparagraph 2.2.4.5.4)

Appropriate test procedures are provide in subparagraphs 2.4.4.5.4.1 through 2.4.4.5.4.14.

2.4.4.5.4.1 Verification of “EMITTER CATEGORY” Field (subparagraph 2.2.4.5.4.1)

Purpose/Introduction:

The “EMITTER CATEGORY” field is encoded as a radix 40 value in the range of 0-39. The “EMITTER CATEGORY” field **shall** be encoded as shown in Table 2.2.4.5.4.1.

Measurement Procedure:

Step 1: “EMITTER CATEGORY” Field (subparagraph 2.2.4.5.4.1)

Set the first two characters of the “FLIGHT ID” to the ‘0’ character (Base 40 Code value ZERO), and configure the ADS-B Transmitting Equipment to transmit valid ADS-B Long Messages with Payload Type Code 1 (or Type Code 3 for the A1H equipment class). For each case in Table 2.4.4.5.4.1

below, except for the "(Unassigned)," and "(reserved)" cases, select the "EMITTER CATEGORY" listed, and verify that Bytes 18 and 19 of the received ADS-B Long Message match the corresponding Binary Encoding value in the table.

Table 2.4.4.5.4.1: "EMITTER CATEGORY" Encoding Test Data

EMITTER CATEGORY ENCODING					
Base 40 Code	**Emitter Category**	**Binary Encoding Byte 18 Byte 19 MSB LSB**	**Base 40 Code**	**Emitter Category**	**Binary Encoding Byte 18 Byte 19 MSB LSB**
0	No aircraft type information	0000 0000 0000 0000	20	Cluster Obstacle	0111 1101 0000 0000
1	Light (ICAO) < 15 500 lbs	0000 0110 0100 0000	21	Line Obstacle	1000 0011 0100 0000
2	Small - 15 500 to 75 000 lbs	0000 1100 1000 0000	22	(reserved)	1000 1001 1000 0000
3	Large - 75 000 to 300 000 lbs	0001 0010 1100 0000	23	(reserved)	1000 1111 1100 0000
4	High Vortex Large (e.g., B757)	0001 1001 0000 0000	24	(reserved)	1001 0110 0000 0000
5	Heavy (ICAO) - > 300 000 lbs	0001 1111 0100 0000	25	(reserved)	1001 1100 0100 0000
6	Highly Maneuverable > 5G acceleration and high speed	0010 0101 1000 0000	26	(reserved)	1010 0010 1000 0000
7	Rotocraft	0010 1011 1100 0000	27	(reserved)	1010 1000 1100 0000
8	(Unassigned)	0011 0010 0000 0000	28	(reserved)	1010 1111 0000 0000
9	Glider/sailplane	0011 1000 0100 0000	29	(reserved)	1011 0101 0100 0000
10	Lighter than air	0011 1110 1000 0000	30	(reserved)	1011 1011 1000 0000
11	Parachutist/sky diver	0100 0100 1100 0000	31	(reserved)	1100 0001 1100 0000
12	Ultra light/hang glider/paraglider	0100 1011 0000 0000	32	(reserved)	1100 1000 0000 0000
13	(Unassigned)	0101 0001 0100 0000	33	(reserved)	1100 1110 0100 0000
14	Unmanned aerial vehicle	0101 0111 1000 0000	34	(reserved)	1101 0100 1000 0000
15	Space/transatmospheric vehicle	0101 1101 1100 0000	35	(reserved)	1101 1010 1100 0000
16	(Unassigned)	0110 0100 0000 0000	36	(reserved)	1110 0001 0000 0000
17	Surface vehicle - emergency vehicle	0110 1010 0100 0000	37	(reserved)	1110 0111 0100 0000
18	Surface vehicle - service vehicle	0111 0000 1000 0000	38	(reserved)	1110 1101 1000 0000
19	Point Obstacle (includes tethered baloons)	0111 0110 1100 0000	39	(reserved)	1111 0011 1100 0000

Step 2: "EMITTER CATEGORY" Field Not Updated (Table 2.2.7.1, Element # 18)

While the ADS-B Transmitting Equipment continues to transmit valid ADS-B Long Messages as in Step 1, and for all cases validated in Step 1, stop updating the selected "EMITTER CATEGORY" condition, and verify that after 60 seconds, Bytes 18 and 19 of the received ADS-B Long Message indicate the "No aircraft type information" condition with a binary encoding of ALL ZEROs.

Note: *In the event that the "EMITTER CATEGORY" Field is considered to be Fixed Data for the intended application, it is not necessary to perform Step 2.*

2.4.4.5.4.2 Verification of "FLIGHT ID" Field (subparagraph 2.2.4.5.4.2)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.4.5.4.2 are included in subparagraphs 2.4.4.5.4.3.1, 2.4.4.5.4.3.2, 2.4.4.5.4.3.3, and 2.4.4.5.4.3.4.

2.4.4.5.4.3 Verification of Compressed Format Encoding for "EMITTER CATEGORY" and "FLIGHT ID" (subparagraph 2.2.4.5.4.3)

No specific test procedure is required to validate subparagraph 2.2.4.5.4.3.

2.4.4.5.4.3.1 Verification of Bytes #18 and #19 (subparagraph 2.2.4.5.4.3.1)

Purpose/Introduction:

Bytes #18 and #19 **shall** be encoded such that:

B_2 - Represents the "EMITTER CATEGORY" field (subparagraph 2.2.4.5.4.1)

B_1 - Represents Character #1 of the "FLIGHT ID" field (subparagraph 2.2.4.5.4.2)

B_0 - Represents Character #2 of the "FLIGHT ID" field (subparagraph 2.2.4.5.4.2)

Measurement Procedure:

Step 1: Bytes 18 and 19 Field (subparagraph 2.2.4.5.4.3.1)

Configure the ADS-B Transmitting Equipment to transmit valid ADS-B Long Messages with Payload Type Code 1 (or Code 3 for A1H equipment class). For each case in Table 2.4.4.5.4.3.1 below, select the "EMITTER CATEGORY" listed in column 1, select the Flight ID Characters listed in column 2, and verify that Bytes 18 and 19 of the received ADS-B Long Message match the corresponding Binary Encoding value in the table.

Table 2.4.4.5.4.3.1: "EMITTER CATEGORY" And Bytes 18 & 19 Encoding Test Data

"EMITTER CATEGORY" AND BYTES 18 & 19 ENCODING		
Emitter Category	**Flight ID Characters**	**Binary Encoding Byte 18 Byte 19 MSB LSB**
No aircraft type information	00000000	0000 0000 0000 0000
No aircraft type information	01000000	0000 0000 0000 0001
No aircraft type information	02000000	0000 0000 0000 0010
No aircraft type information	04000000	0000 0000 0000 0100
No aircraft type information	08000000	0000 0000 0000 1000
No aircraft type information	0H000000	0000 0000 0001 0001
No aircraft type information	0Y000000	0000 0000 0010 0010
No aircraft type information	1S000000	0000 0000 0100 0100
No aircraft type information	3G000000	0000 0000 1000 1000
No aircraft type information	6W000000	0000 0001 0001 0000
No aircraft type information	DO000000	0000 0010 0010 0000
No aircraft type information	R8000000	0000 0100 0100 0000
Light (ICAO) < 15 500 lbs	EG000000	0000 1000 1000 0000
Small - 15 500 to 75 000 lbs	SW000000	0001 0001 0000 0000
Heavy (ICAO) - > 300 000 lbs	HO000000	0010 0010 0000 0000
Lighter than air	Z8000000	0100 0100 0000 0000
Cluster Obstacle	UG000000	1000 1000 0000 0000
Small - 15 500 to 75 000 lbs	KG000000	0001 0000 0000 0000
Heavy (ICAO) - > 300 000 lbs	4W000000	0010 0000 0000 0000
Lighter than air	9O000000	0100 0000 0000 0000
Cluster Obstacle	J8000000	1000 0000 0000 0000

2.4.4.5.4.3.2 Verification of Bytes #20 and #21 (subparagraph 2.2.4.5.4.3.2)

Purpose/Introduction:

Bytes #20 and #21 **shall** be encoded such that:

B_2 - Represents Character #3 of the “FLIGHT ID” field (subparagraph 2.2.4.5.4.2)

B_1 - Represents Character #4 of the “FLIGHT ID” field (subparagraph 2.2.4.5.4.2)

B_0 - Represents Character #5 of the “FLIGHT ID” field (subparagraph 2.2.4.5.4.2)

Measurement Procedure:

Step 1: Bytes 20 and 21 Field (subparagraph 2.2.4.5.4.3.2)

Configure the ADS-B Transmitting Equipment to transmit valid ADS-B Long Messages with Payload Type Code 1 (or Code 3 for A1H equipment class). For each case in Table 2.4.4.5.4.3.2 below, select the Flight ID Characters listed, and verify that Bytes 20 and 21 of the received ADS-B Long Message match the corresponding Binary Encoding value in the table.

Table 2.4.4.5.4.3.2: Bytes 20 & 21 Encoding Test Data

BYTES 20 & 21 ENCODING			
Flight ID Characters	**Binary Encoding Byte 20 Byte 21 MSB LSB**	**Flight ID Characters**	**Binary Encoding Byte 20 Byte 21 MSB LSB**
00001000	0000 0000 0000 0001	00FJC000	0110 0000 1100 0100
00003000	0000 0000 0000 0011	0042Y000	0001 1001 0111 0010
00007000	0000 0000 0000 0111	00IE5000	0111 0010 1011 0101
0000F000	0000 0000 0000 1111	00SPSB00	1110 0101 0110 1011
0001S000	0000 0000 0001 1111	009JK000	0011 1011 0100 1111
0001Q000	0000 0000 0100 0010	00JCA000	0111 1000 1010 1010
0003P000	0000 0000 1001 0001	002YU000	0001 0001 1110 1110
0007O000	0000 0001 0011 0000	00E5K000	0101 1000 0101 1111
000FK000	0000 0010 0110 1101	00SBK000	1011 0000 1100 1100
000VG000	0000 0100 1110 1000	00JKD000	0111 1010 0110 0101
001Q5000	0000 1010 0101 0101	00CA0000	0100 1100 1001 0000
003PK000	0001 0110 1011 1101	00YUA000	1101 1001 0011 1010
007O6000	0010 1111 1000 0110	005KK000	0010 0010 1110 1100
00FKK000	0110 0001 0001 1110	00BK3000	0100 0111 1110 0011
00VG7000	1100 0100 0100 0111	00KDH000	1001 0001 1101 1001
00Q5P000	1010 0011 0110 0001	00A0Z000	0011 1110 1010 0011
00PKE000	1001 1111 1001 0110	00UA6000	1011 1101 0001 0110
00O61000	1001 0110 1111 0001	00KKC000	1001 0010 1110 1100
00KKD000	1000 0110 1011 1101	00K3O000	0111 1101 1001 0000
00G7R000	0110 0101 0011 0011	00DHB000	0101 0011 1111 0011
005PI000	0010 0011 0011 1010	000ZX000	0000 0101 1001 1001
00KE9000	1000 0101 0111 1001	00A62000	0011 1111 0111 0010
0061T000	0010 0101 1100 0101	00KC4000	0111 1110 1110 0100
00KDK000	1000 1011 1001 1110	003O8000	0001 0110 1000 1000
007RH000	0011 0000 0000 1001	00HBG000	0110 1100 0000 1000
00PI8000	1001 1111 0001 1000	00ZXW000	1110 0000 0000 1000
00E9Q000	0101 1001 0000 0010	00621000	0010 0101 1101 0001
001TF000	0000 1010 1101 0111	00C43000	0100 1011 1010 0011
00DK4000	0101 0100 1011 0100	00O87000	1001 0111 0100 0111
00RHI000	1010 1011 0111 1010	00BGF000	0100 0111 0100 1111
00I8SP000	0111 0001 1110 0100	00XWV00	1101 0011 0101 1111
009Q9000	0011 1100 0101 1001	0021Q000	0000 1100 1100 0010
00TFJ000	1011 0111 1010 1011	0043P000	0001 1001 1001 0001
00K42000	1000 1010 0010 0010	0087O000	0011 0011 0011 0000
00HIE000	0110 1101 0001 1110	00GFK000	0110 0110 0110 1101
008SPS000	0011 0111 1011 1100	00WVG00	1100 1100 1110 1000
00Q9J000	1010 0011 1111 1011	001Q5000	0000 1010 0101 0101

2.4.4.5.4.3.3 Verification of Bytes #22 and 23 (subparagraph 2.2.4.5.4.3.3)

Purpose/Introduction:

Bytes #22 and #23 **shall** be encoded such that:

B_2 - Represents Character #6 of the "FLIGHT ID" field (subparagraph 2.2.4.5.4.2)

B_1 - Represents Character #7 of the "FLIGHT ID" field (subparagraph 2.2.4.5.4.2)

B_0 - Represents Character #8 of the "FLIGHT ID" field (subparagraph 2.2.4.5.4.2)

Measurement Procedure:

Step 1: Bytes 22 and 23 Field (subparagraph 2.2.4.5.4.3.3)

Configure the ADS-B Transmitting Equipment to transmit valid ADS-B Long Messages with Payload Type Code 1 (or Code 3 for A1H equipment class). For each case in Table 2.4.4.5.4.3.3 below, select the Flight ID Characters listed, and verify that Bytes 22 and 23 of the received ADS-B Long Message match the corresponding Binary Encoding value in the table.

Table 2.4.4.5.4.3.3: Bytes 22 & 23 Encoding Test Data

BYTES 22 & 23 ENCODING			
Flight ID Characters	**Binary Encoding Byte 22 Byte 23 MSB LSB**	**Flight ID Characters**	**Binary Encoding Byte 22 Byte 23 MSB LSB**
00000001	0000 0000 0000 0001	00000FJC	0110 0000 1100 0100
00000003	0000 0000 0000 0011	0000042Y	0001 1001 0111 0010
00000007	0000 0000 0000 0111	00000IE5	0111 0010 1011 0101
0000000F	0000 0000 0000 1111	00000SPSB	1110 0101 0110 1011
0000001S	0000 0000 0001 1111	000009JK	0011 1011 0100 1111
0000001Q	0000 0000 0100 0010	00000JCA	0111 1000 1010 1010
0000003P	0000 0000 1001 0001	000002YU	0001 0001 1110 1110
0000007O	0000 0001 0011 0000	00000E5K	0101 1000 0101 1111
000000FK	0000 0010 0110 1101	00000SBK	1011 0000 1100 1100
000000VG	0000 0100 1110 1000	00000JKD	0111 1010 0110 0101
000001Q5	0000 1010 0101 0101	00000CA0	0100 1100 1001 0000
000003PK	0001 0110 1011 1101	00000YUA	1101 1001 0011 1010
000007O6	0010 1111 1000 0110	000005KK	0010 0010 1110 1100
00000FKK	0110 0001 0001 1110	00000BK3	0100 0111 1110 0011
00000VG7	1100 0100 0100 0111	00000KDH	1001 0001 1101 1001
00000Q5P	1010 0011 0110 0001	00000A0Z	0011 1110 1010 0011
00000PKE	1001 1111 1001 0110	00000UA6	1011 1101 0001 0110
00000O61	1001 0110 1111 0001	00000KKC	1001 0010 1110 1100
00000KKD	1000 0110 1011 1101	00000K3O	0111 1101 1001 0000
00000G7R	0110 0101 0011 0011	00000DHB	0101 0011 1111 0011
000005PI	0010 0011 0011 1010	000000ZX	0000 0101 1001 1001
00000KE9	1000 0101 0111 1001	00000A62	0011 1111 0111 0010
0000061T	0010 0101 1100 0101	00000KC4	0111 1110 1110 0100
00000KDK	1000 1011 1001 1110	000003O8	0001 0110 1000 1000
000007RH	0011 0000 0000 1001	00000HBG	0110 1100 0000 1000
00000PI8	1001 1111 0001 1000	00000ZXW	1110 0000 0000 1000
00000E9Q	0101 1001 0000 0010	00000621	0010 0101 1101 0001
000001TF	0000 1010 1101 0111	00000C43	0100 1011 1010 0011
00000DK4	0101 0100 1011 0100	00000O87	1001 0111 0100 0111
00000RHI	1010 1011 0111 1010	00000BGF	0100 0111 0100 1111
00000I8SP	0111 0001 1110 0100	00000XWV	1101 0011 0101 1111
000009Q9	0011 1100 0101 1001	0000021Q	0000 1100 1100 0010
00000TFJ	1011 0111 1010 1011	0000043P	0001 1001 1001 0001
00000K42	1000 1010 0010 0010	0000087O	0011 0011 0011 0000
00000HIE	0110 1101 0001 1110	00000GFK	0110 0110 0110 1101
000008SPS	0011 0111 1011 1100	00000WVG	1100 1100 1110 1000
00000Q9J	1010 0011 1111 1011	000001Q5	0000 1010 0101 0101

2.4.4.5.4.3.4 Verification of Unavailable "FLIGHT ID" Field (subparagraph 2.2.4.5.4.2)

Purpose/Introduction:

If the "FLIGHT ID" field is not available, then all eight characters of the FLIGHT ID field shall be set to the Base-40 Digit code 37 ("Not Available").

Measurement Procedure:

Step 1: Flight ID Not Available

Configure the ADS-B Transmitting Equipment to transmit valid ADS-B Long Messages with Payload Type Code 1 (or Code 3 for A1H equipment class) as in subparagraph 2.4.4.5.4.1. While the ADS-B Transmitting Equipment transmits valid ADS-B Long Messages, stop updating the "FLIGHT ID" field. Set the EMITTER CATEGORY Field to the appropriate value for the intended application, per Table 2.4.4.5.4.1. Verify that after 60 seconds, all eight of the character values associated with Bytes 18 through 23 contain the Base-40 Digit value 37 ("Not Available").

2.4.4.5.4.4 Verification of "EMERGENCY/PRIORITY STATUS" Field Encoding (subparagraph 2.2.4.5.4.4)

Purpose/Introduction:

The "EMERGENCY/PRIORITY STATUS" field is a 3-bit (bits 1 through bit 3 of byte 24) field. The encoding of this field **shall** be as indicated in Table 2.2.4.5.4.4.

If the Emergency/Priority Status Selection Input becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "EMERGENCY/PRIORITY STATUS" field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Emergency/Priority Status Encoding (subparagraph 2.2.4.5.4.4)

Configure the ADS-B Transmitting Equipment to transmit valid Long ADS-B Messages of Payload Type 1 and/or 3 according to the capability of the UAT equipage classes.

For each case in Table 2.2.4.5.4.4, select and/or create the Emergency/Priority Status Conditions listed, and verify that bits 1 through 3 of byte 24 of the transmitted ADS-B Long Message match the corresponding Binary Encoding value in the table.

Step 2: Emergency/Priority Status - Data Not Available (Table 2.2.4.5.4.4)

While the ADS-B Transmitting Equipment continues to transmit valid Long ADS-B Messages, and for any case in Table 2.4.4.5.4.4 above, discontinue providing "EMERGENCY/PRIORITY STATUS" condition, and verify that after 60 seconds bits 1 through 3 of byte 24 of the transmitted Long ADS-B Message are set to ALL ZEROs (binary 000).

2.4.4.5.4.5 Verification of “UAT MOPS VERSION” Field Encoding (subparagraph 2.2.4.5.4.5)

Purpose/Introduction:

The “UAT MOPS VERSION” field is a 3-bit (bits 4 through 6 of byte 24) field. The encoding of this field **shall** be internally hard coded to ONE (binary 001) by all ADS-B Transmitting Systems for equipment complying with this MOPS.

Measurement Procedure:

Step 1: “UAT MOPS VERSION” Encoding (subparagraph 2.2.4.5.4.5)

Configure the ADS-B Transmitting Equipment to transmit valid Long ADS-B Messages of Payload Type 1 and/or 3 according to the capability of the UAT equipage classes.

Verify that bits 4 through 6 of byte 24 of the received Long ADS-B Message are set to ONE (binary 001) signifying conformance with the initial version of this MOPS.

2.4.4.5.4.6 Verification of “SIL” Field Encoding (subparagraph 2.2.4.5.4.6)

Purpose/Introduction:

The Surveillance Integrity Level (“SIL”) field is a 2-bit (bits 7 and 8 of byte 24) field used to define the probability of the integrity containment radius, used in the “NIC” field, being exceeded, without alerting. This includes the effects of airborne equipment condition, which airborne equipment is in use, and which external signals are being used by the navigation source. The encoding of the “SIL” field **shall** be as indicated in Table 2.2.4.5.4.6.

If the “SIL” field becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, then the “SIL” field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast Long ADS-B Messages by providing SIL data at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set the ADS-B Transmitting system to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Step 2: “SIL” Encoding (subparagraph 2.2.4.5.4.6)

Verify that for each “SIL” parameter input condition that is specified by the Probability of Exceeding the R_C Integrity Containment Radius without detection (i.e., the value in Table 2.2.4.5.4.6), that the system generates UAT Messages with the “SIL” subfield set equal to the corresponding binary coding value shown in the Table 2.2.4.5.4.6.

Step 3: "SIL" Encoding – Data Lifetime

Discontinue providing update of SIL data. After 2 seconds, verify that the "SIL" subfield in the ADS-B Message is encoded ZERO (binary 00).

Resume providing SIL data and verify that the ADS-B message contains the "SIL" subfield set equal to the corresponding binary coding value shown in the Table 2.2.4.5.4.6.

2.4.4.5.4.7 Verification of "TRANSMIT MSO" Field Encoding (subparagraph 2.2.4.5.4.7)

Purpose/Introduction:

The "TRANSMIT MSO" field is a 6-bit (bits 1 through 6 of byte 25) field that **shall** be used to encode the 6 LSBs of the Message Start Opportunity (subparagraph 2.2.6.2.1) determined for this message transmission.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast Long ADS-B Messages by providing position information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set the ADS-B Transmitting system to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Step 2: "TRANSMIT MSO" Encoding (subparagraph 2.2.4.5.4.7)

Verify that for each transmission, the "TRANSMIT MSO" is the 6 LSBs of Message Start Opportunity (MSO) assigned for each transmission.

Note: *Test procedure 2.4.6.2 verifies the correct MSO assignment.*

2.4.4.5.4.8 Verification of Reserved Bits Field (subparagraph 2.2.4.5.4.8)

Purpose/Introduction:

Bits 7 and 8 of byte 25 are reserved for future use and **shall** be set to ALL ZEROs for equipment conforming to this MOPS.

Note*:* *This field is reserved for future reporting of Barometric Altitude Quality.*

Measurement Procedure:

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages. Set the ADS-B Transmitting system to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Verify that bits 7 and bit 8 of byte 25 are set to ALL ZEROs, signifying that this field is conformant to the initial version of this MOPS.

2.4.4.5.4.9 Verification of "NAC_P" Field Encoding (subparagraph 2.2.4.5.4.9)

Purpose/Introduction:

The Navigation Accuracy Category for Position ("NAC_P") field is a 4-bit (bits 1 through bit 4 of byte 26) field used for applications to determine if the reported State Vector has sufficient position accuracy for the intended use. The encoding of the "NAC_P" field **shall** be as indicated in Table 2.2.4.5.4.9.

If the "NAC_P" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "NAC_P" field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast Long ADS-B Messages by providing NAC_P data at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set the ADS-B Transmitting System to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Step 2: "NAC_P" Encoding (subparagraph 2.2.4.5.4.9)

Verify that for each "NAC_P" parameter input condition that is specified by the EPU and VEPU value in Table 2.2.4.5.4.9, that the system generates UAT Messages with the "NAC_P" subfield set equal to the corresponding binary coding value shown in Table 2.2.4.5.4.9.

Step 3: "NAC_P" Encoding – Data Lifetime

Discontinue providing update of NAC_P data. After 60 seconds, verify that "NAC_P" subfield in the ADS-B Message is set to ALL ZEROs (binary 0000).

Resume providing the update of NAC_P data and verify that the ADS-B message contains a "NAC_P" subfield set equal to the corresponding binary coding values shown in the Table 2.2.4.5.4.6.

2.4.4.5.4.10 Verification of "NAC_V" Field Encoding (subparagraph 2.2.4.5.4.10)

Purpose/Introduction:

The Navigation Accuracy Category for Velocity ("NAC_V") field is a 3-bit (bits 5 through bit 7 of byte 26) field used for applications to determine if the reported State Vector has sufficient velocity accuracy for the intended use. The "NAC_V" field reflects the least accurate velocity component being transmitted. The "NAC_V" field **shall** be encoded as indicated in Table 2.2.4.5.4.10.

If the "NAC_V" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.2.7.1, then the "NAC_V" field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast Long ADS-B Messages by providing NAC_V data at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Set the ADS-B Transmitting System to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Step 2: "NAC_V" Encoding (subparagraph 2.2.4.5.4.10)

Verify that for each "NAC_V" parameter input condition that is specified by the Horizontal Velocity Error and Vertical Geometric Velocity Error in Table 2.2.4.5.4.10, that the system generates UAT Messages with the "NAC_V" subfield set equal to the corresponding binary coding values shown in the Table 2.2.4.5.4.10.

Step 3: "NAC_V" Encoding – Data Lifetime

Discontinue providing update of NAC_V data. After 60 seconds, verify that the "NAC_V" subfield in the ADS-B Message is set to ALL ZEROs (binary 000).

Resume providing update of NAC_V data and verify that the ADS-B message contains a "NAC_V" subfield set equal to the corresponding binary coding values shown in the Table 2.2.4.5.4.6.

2.4.4.5.4.11 Verification of "NIC_{BARO}" Field Encoding (subparagraph 2.2.4.5.4.11)

Purpose/Introduction:

The Barometric Altitude Integrity Code ("NIC_{BARO}") field is a 1-bit (bit 8 of byte 26) field that indicates whether or not the barometric pressure altitude provided in the State Vector element of the payload has been cross checked against another source of pressure altitude. The "NIC_{BARO}" field **shall** be encoded as indicated in Table 2.2.4.5.4.11.

If the "NIC_{BARO}" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.2.7.1, then the "NIC_{BARO}" field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast Long ADS-B Messages by providing NIC_{BARO} data at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: "NIC_{BARO}" Encoding (subparagraph 2.2.4.5.4.10)

Set the ADS-B Transmitting System to transmit ADS-B Message Payload Type 1 or Type 3 according to the capability of the UAT equipage class.

Operationally select Barometric Pressure Altitude as the Primary Altitude information and verify that the “ALTITUDE TYPE” field in bit 8 of byte 10 is set to ZERO (0).

Input to the ADS-B Transmitting System the condition that signifies that the barometric pressure altitude has been cross checked against another source of pressure altitude. Verify that NIC_{BARO} field is set to ONE (1).

Input to the ADS-B Transmitting System the condition that signifies that the barometric pressure altitude has NOT been cross checked against another source of pressure altitude. Verify that NIC_{BARO} field is set to ZERO (0).

Step 3: “NIC_{BARO}” Encoding – Data Lifetime

Set up the ADS-B Transmitting System to enable the transmission of ADS-B messages that include the contents of the “NIC_{BARO}” field. Discontinue providing update of altitude information including “NIC_{BARO}” data. Verify that, after 60 seconds, the “NIC_{BARO}” subfield in the transmitted ADS-B Message is set to ZERO (0).

Resume transmitting altitude information including “NIC_{BARO}” data input, with a value of “ONE,” and verify that resultant ADS-B message contains a “NIC_{BARO}” field set to ONE (1).

2.4.4.5.4.12 Verification of “CAPABILITY CODES” Field Encoding (subparagraph 2.2.4.5.4.12)

Appropriate test procedures to validate the requirements of subparagraph 2.2.4.5.4.12 are included in subparagraphs 2.4.4.5.4.12.1 and 2.4.4.5.4.12.2.

2.4.4.5.4.12.1 Verification of “CDTI Traffic Display Capability” Subfield (subparagraph 2.2.4.5.4.12.1)

Purpose/Introduction:

The Capability Code for “Cockpit Display of Traffic Information (CDTI) traffic display capability” **shall** be set to ONE if the transmitting aircraft has the capability of displaying nearby traffic on a CDTI. Otherwise, this code **shall** be ZERO.

If the “CDTI Traffic Display Capability” field becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, then the “CDTI Traffic Display Capability” field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of CDTI Traffic Display Capability – Affirmative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the CDTI Traffic Display Capability input to Affirmative. Verify that bit 1 of byte 27 is set to ONE (1).

Step2: Verification of CDTI Traffic Display Capability – Negative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the CDTI Traffic Display Capability input to Negative. Verify that bit 1 of byte 27 is set to ZERO (0).

Step 3: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the CDTI Traffic Display Capability. Disconnect the CDTI Traffic Display Capability input and verify that, after 60 seconds, bit 1 of byte 27 in the next transmitted message is set to ZERO (0).

Resume CDTI Traffic Display Capability input with a value of "1" and verify that this value is reflected in the next transmitted message.

2.4.4.5.4.12.2 Verification of "TCAS/ACAS Installed and Operational" Subfield (subparagraph 2.2.4.5.4.12.2)

Purpose/Introduction:

The Capability Code for "TCAS/ACAS installed and operational" **shall** be set to ONE if the transmitting aircraft is fitted with a TCAS (ACAS) computer and that computer is turned on and operating in a mode that can generate Resolution Advisory (RA) alerts. Otherwise, this Capability Code **shall** be ZERO.

If the "TCAS/ACAS installed and operational" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "TCAS/ACAS installed and operational" field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of TCAS/ACAS installed and operational – Affirmative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the TCAS/ACAS installed and operational input to Affirmative. Verify that bit 2 of byte 27 is set to ONE (1).

Step2: Verification of TCAS/ACAS installed and operational – Negative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the TCAS/ACAS installed and operational input to Negative. Verify that bit 2 of byte 27 is set to ZERO (0).

Step 3: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "TCAS/ACAS installed and operational" subfield. Disconnect "TCAS/ACAS installed and operational" input and verify that, after 60 seconds, bit 2 of byte 27 in the next transmitted message is set to ZERO (0).

Resume "TCAS/ACAS installed and operational" input with a value of "1" and verify that this value is reflected in the next transmitted message.

2.4.4.5.4.13 Verification of "OPERATIONAL MODES" Field Encoding (subparagraph 2.2.4.5.4.13)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.4.5.4.13 are included in subparagraphs 2.4.4.5.4.13.1 and 2.4.4.5.4.13.2.

2.4.4.5.4.13.1 Verification of "TCAS/ACAS Resolution Advisory" Flag (subparagraph 2.2.4.5.4.13.1)

Purpose/Introduction:

A transmitting ADS-B participant **shall** set the TCAS/ACAS Resolution Advisory Active Flag to ONE in the messages that it transmits to support the MS report so long as a TCAS/ACAS resolution advisory is in effect. At all other times, the transmitting ADS-B participant **shall** set the TCAS/ACAS Resolution Advisory Active Flag to ZERO.

If the "TCAS/ACAS Resolution Advisory" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "TCAS/ACAS Resolution Advisory" field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of "TCAS/ACAS Resolution Advisory Flag – Affirmative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the TCAS/ACAS Resolution Advisory Active input to Affirmative. Verify that bit 3 of byte 27 is set to ONE (1).

Step 2: Verification of "TCAS/ACAS Resolution Advisory Flag – Negative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the TCAS/ACAS Resolution Advisory Active input to Negative. Verify that bit 3 of byte 27 is set to ZERO (0).

Step 3: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "TCAS/ACAS Resolution Advisory" flag. Disconnect "TCAS/ACAS Resolution Advisory" input and verify that, after 60 seconds, bit 3 of byte 27 in the next transmitted message is set to ZERO (0).

Resume "TCAS/ACAS Resolution Advisory" input with a value of "1" and verify that this value is reflected in the next transmitted message.

2.4.4.5.4.13.2 Verification of "IDENT Switch Active " Flag (subparagraph 2.2.4.5.4.13.2)

Purpose/Introduction:

The "IDENT Switch Active" Flag is activated by an IDENT switch. Initially, the "IDENT switch active" code is ZERO. Upon activation of the IDENT switch, this flag **shall** be set to ONE in all scheduled ADS-B messages containing the MODE STATUS element for an interval of 20 seconds +/-4 seconds. After the time interval expires, the flag **shall** be set to ZERO.

If the "IDENT Switch Active" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "IDENT Switch Active" field **shall** default to a value of ZERO.

Note: *This allows an ATC ground station 4-5 reception opportunities to receive the IDENT indication.*

Measurement Procedure:

Step 1: Verification of IDENT Switch Active Flag – Affirmative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the IDENT Switch Active input to Affirmative. Verify that bit 4 of byte 27 is set to ONE (1).

Step 2: Verification of IDENT Switch - 20 Second Timeout

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the IDENT Switch Active input to Affirmative and verify that bit 4 of byte 27 is set to ONE (1). Wait 20 seconds +/- 4 seconds. Verify that after the 20 second +/- 4 seconds interval, that bit 4 of byte 27 is set to ZERO (0).

Step 3: Verification of IDENT Switch Active Flag – Negative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the IDENT Switch Active input to Negative. Verify that bit 4 of byte 27 is set to ZERO (0).

Step 4: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "IDENT Switch Active" field. Disconnect the "IDENT Switch Active" input and verify that, after 60 seconds, bit 4 of byte 27 in the next transmitted message is set to ZERO (0).

Resume "IDENT Switch Active" input with a value of "1" and verify that this value is reflected in the next transmitted message.

2.4.4.5.4.13.3 Verification of "Receiving ATC Services" Flag (subparagraph 2.2.4.5.4.13.3)

Purpose/Introduction:

The "Receiving ATC Services" flag is based on a pilot setting. This flag **shall** be set to ONE to indicate that the transmitting ADS-B participant is receiving ATC services; when not receiving ATC services, a transmitting ADS-B participant should set this flag to ZERO.

If the "Receiving ATC Services" field becomes "unavailable" after the "Data Lifetime" value listed for this input in Table 2.4.7.1, then the "Receiving ATC Services" field **shall** default to a value of ZERO.

Note: *This provides for a ground ATC system to identify aircraft that is receiving ATC services, similar to an SSR transponder providing a squawk code of other than "1200."*

Measurement Procedure:

Step 1: Verification of Receiving ATC Services Flag – Affirmative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Receiving ATC Services input to Affirmative. Verify that bit 5 of byte 27 is set to ONE (1).

Step 2: Verification of Receiving ATC Services Flag – Negative

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Receiving ATC Services input to Negative. Verify that bit 5 of byte 27 is set to ZERO (0).

Step 3: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "Receiving ATC Services" flag. Disconnect the "Receiving ATC Services" input and verify that, after 60 seconds, bit 5 of byte 27 in the next transmitted message is set to ZERO (0).

Resume "Receiving ATC Services" input with a value of "1" and verify that this value is reflected in the next transmitted message.

2.4.4.5.4.14 Verification of True/Magnetic Heading Flag (subparagraph 2.2.4.5.4.14)

Purpose/Introduction:

The True/Magnetic Heading Flag in the Mode-Status Element is a one-bit field (bit 6 of byte 27) which **shall** be set to ZERO to indicate that heading is reported referenced to true north, or set to ONE to indicate that heading is reported referenced to magnetic north. This True/Magnetic Heading Flag supports the "Heading/Track Indicator" Flag in the TARGET STATE Element defined in subparagraph 2.2.4.5.6.1.1.

If the “True/Magnetic Heading Flag” field becomes “unavailable” after the “Data Lifetime” value listed for this input in Table 2.4.7.1, then the “True/Magnetic Heading Flag” field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of True North

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the True/Magnetic input to True. Verify that bit 6 of byte 27 is set to ZERO (0).

Step 2: Verification of Magnetic North

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the True/Magnetic input to Magnetic. Verify that bit 6 of byte 27 is set to ONE (1).

Step 3: Verification of True/Magnetic Heading – Data Lifetime

Set up the ADS-B Transmitting System to enable the transmission of ADS-B Messages that include the value of the “True/Magnetic Heading” Flag. Discontinue the “True/Magnetic Heading” input and verify that, after 60 seconds, bits 2 and 3 of byte 30 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.4.15 Verification of Reserved Bits (subparagraph 2.2.4.5.4.15)

Purpose/Introduction:

This Reserved Bits field is an 18-bit (bit 7 of byte 27 through bit 8 of byte 29) field that may be used in the future to indicate the capability of a participant to support engagement in various operations. This Reserved Bits field is reserved for future use and **shall** be set to ALL ZEROs.

Measurement Procedure:

Step1: Verification of Reserved Bits

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message and verify that bit 7 of byte 27 through bit 8 of byte 29 are set to ALL ZEROs.

2.4.4.5.5 Verification of AUXILIARY STATE VECTOR Element (subparagraph 2.2.4.5.5)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.4.5.5 are included in subparagraphs 2.4.4.5.5.1 and 2.4.4.5.5.2.

2.4.4.5.5.1 Verification of "SECONDARY ALTITUDE" Field Encoding (subparagraph 2.2.4.5.5.1)

Purpose/Introduction:

The "SECONDARY ALTITUDE" field is a 12-bit (bit 1 of byte 30 through bit 4 of byte 31) field used to encode either the geometric altitude or barometric pressure altitude depending on the setting of the "ALTITUDE TYPE" field (subparagraph 2.2.4.5.2.2). The altitude encoded in the "SECONDARY ALTITUDE" field is the opposite type to that specified by the "ALTITUDE TYPE field. The encoding **shall** be consistent with that used for "ALTITUDE" described in Table 2.2.4.5.2.3.

Measurement Procedure:

Step 1: Establish Initial Conditions

Configure the ADS-B/UAT Transmitting System to broadcast UAT Messages by providing Altitude information at the nominal update rate. Provide the data externally at the interface to the ADS-B system.

Step 2: Selection of Secondary Altitude Information

Operationally select Geometric Pressure Altitude as the Secondary Altitude information for the following steps (step 3 through step 7) and verify that the "ALTITUDE TYPE" field in (bit 8 of byte 10) is set to ZERO.

Step 3: Verify Secondary Altitude Field Encoding – Altitude Data Lifetime

Set up the ADS-B/UAT Transmitting System to transmit ADS-B Message Payload Types "1" and/or "2" and/or "5" and/or "6" according to the capability of the UAT equipage classes.

Provide valid non-zero Altitude data and valid non-zero velocity data to the ADS-B system.

Discontinue providing the update of Altitude data to the ADS-B system. Verify that after the Altitude data has not been provided to the ADS-B transmitting device for 2 seconds, that the "SECONDARY ALTITUDE" field is set to a value of "0"(binary 0000 0000 0000).

Resume altitude data input with a value of –775 feet and verify that the ADS-B message contain "SECONDARY ALTITUDE" field is set to a value of "10" (binary 0000 0000 1010).

Step 4: Verify Secondary Altitude Field Encoding – Altitude Equal ZERO

Set the Altitude input data to represent an altitude of ZERO feet. Verify that the "SECONDARY ALTITUDE" field is set to a value of "41"(binary 0000 0010 1001).

Step 5: Verify Secondary Altitude Field Encoding – Discrete Values

Verify that for each integer Altitude input value in feet in Table 2.4.4.5.2.3 that the system generates UAT Messages such that the secondary Altitude subfield in each such message is set to the corresponding binary coding value in Table 2.4.4.5.2.3.

Verify that the Secondary Altitude subfield in the transmitted message is not incremented until the input value reaches a number corresponding to a multiple of 25 feet.

Table 2.4.4.5.5.1: Secondary Altitude Field Encoding

Altitude Data		
Meaning (Altitude in feet)	**Coding (decimal)**	**Coding (binary)**
-1000	1	0000 0000 0001
-900	5	0000 0000 0101
-775	10	0000 0000 1010
-500	21	0000 0001 0101
25	42	0000 0010 1010
1100	85	0000 0101 0101
3225	170	0000 1010 1010
7500	341	0001 0101 0101
16025	682	0010 1010 1010
33100	1365	0101 0101 0101
67225	2730	1010 1010 1010
86425	3498	1101 1010 1010
92825	3754	1110 1010 1010
99225	4010	1111 1010 1010
100425	4058	1111 1101 1010
100825	4074	1111 1110 1010
101225	4090	1111 1111 1010
101300	4093	1111 1111 1101
101325	4094	1111 1111 1110

Step 6: Verify Secondary Altitude Field Encoding – Maximum Values

Continue to increase the Altitude value.

If the resolution of the input value is the same as the output resolution (i.e, 25 feet), verify that for an input corresponding to an altitude of 101,350 feet, the secondary altitude field is set to “4095”(binary 1111 1111 1111).

If the resolution of input value is greater than output resolution, verify that for an input corresponding to an altitude of greater than 101,325 feet but less than or equal to 101,337.5 feet, the secondary altitude field continue to be set to “4094”(binary 1111 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 101,337.5 feet, then this value shall be input and it shall verify that the Secondary Altitude subfield for all such messages is set to either “4094”(binary 1111 1111 1110, representing 101,325 feet) or “4095”(binary 1111 1111 1111, representing 101,337.5 feet).

Step 7: Verify Secondary Altitude Field Encoding – Input Resolution

If the input data used to establish the SECONDARY ALTITUDE subfield has more resolution than that required by the SECONDARY ALTITUDE subfield(i.e., more than 12 bits), then this step shall be used to ensure that the accuracy of the data is maintained such that it is not worse than +/- ½ LSB, where the LSB is the least significant bit of the SECONDARY ALTITUDE subfield.

If the input data field that is used to determine the output value of the SECONDARY ALTITUDE subfield does not have finer resolution that required by the SECONDARY ALTITUDE subfield, skip Step 7 and stop.

Enter an input value corresponding to an altitude of 37.5 feet.

Verify that the value of the SECONDARY ALTITUDE subfield in the output message is either "42"(binary 0000 0010 1010, representing 25 feet) or "43"(binary 0000 0010 1011, representing 50 feet).

If the input field used to establish the Secondary Altitude subfield does not have resolution finer than 12.5 feet, skip the rest of Step 7 and stop. Otherwise (Altitude input resolution is finer than 12.5 feet), let **Z** be equal to the smallest possible value that can be represented by the number of bits in the input field(i.e., **Z** is the value of the least significant bit of the input field). Set the value of the input field to correspond to an altitude of (37.5 –**Z**).

Verify that the value of secondary altitude subfield in the output UAT message is "42"(binary 0000 0010 1010, representing 25 feet). Set the value of input field to correspond to an altitude of (37.5+**Z**).

Verify that the value of the secondary altitude subfield in the output UAT message is "43"(binary 0000 0010 1011, representing 50 feet).

Note: *If the resolution of the Altitude input is such that a altitude of 37.5 feet can be represented (but still finer than 12.5 feet, e.g., a resolution of 10 feet increments), then values corresponding to altitude must be tested, and the output examined for each value to confirm that output is within +/- 12.5 feet (inclusive) of the input value.*

Step 8: Reselection of Secondary Altitude Information

Operationally select Barometric Pressure Altitude as the Secondary Altitude information Steps 3 through 7 and verify that the "ALTITUDE TYPE" field in bit 8 of byte 10 is set to ONE.

Repeat Steps 3 through 7 with Barometric Pressure Altitude as the Secondary Altitude data and verify the encoding.

2.4.4.5.5.2 Reserved Bits (subparagraph 2.2.4.5.5.2)

Purpose/Introduction:

Bit 5 of byte 31 through bit 8 of byte 34 are reserved for future use, and **shall** be set to ALL ZEROs.

Note: *This field is reserved for future definition to contain either air-referenced velocity or perhaps wind vector and temperature.*

Measurement Procedure:

Step1: Verification of Reserved Bits

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message and verify that bit 5 of byte 31 through bit 8 of byte 34 are set to ALL ZEROs.

2.4.4.5.6 Verification of TARGET STATE Element (Payload Type Codes “3” and “4”) (subparagraph 2.2.4.5.6)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.6 are included in subparagraphs 2.4.4.5.6.1.1 through 2.4.4.5.6.2.7.

2.4.4.5.6.1 Verification of “TARGET HEADING OR TRACK ANGLE” Field Encoding (subparagraph 2.2.4.5.6.1)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.6 are included in subparagraphs 2.4.4.5.6.1.1 through 2.4.4.5.6.2.7.

2.4.4.5.6.1.1 Verification of “Heading/Track Indicator” Flag Encoding (subparagraph 2.2.4.5.6.1.1)

Purpose/Introduction:

The “Heading/Track Indicator” flag (bit 1 of byte 30) **shall** be set to ZERO to indicate that the “Target Heading or Track Angle” subfield conveys target heading, or ONE to indicate that it conveys target track angle. The reference direction (true north or magnetic north) is conveyed in the “True/Magnetic Heading Flag” of the Mode Status Element referenced in subparagraph 2.2.4.5.4.14.

If this indication is present in the UAT Transmitting System, and if the “Heading/Track Indicator” field becomes “unavailable” after the “Data Lifetime” timeout listed for this field in Table 2.4.7.1, then the “Heading/Track Indicator” field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of Target Heading

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Heading/Track Indicator input to Target Heading. Verify that bit 1 of byte 30 is set to ZERO (0).

Step 2: Verification of Track Angle

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Heading/Track Indicator input to Target Track Angle. Verify that bit 1 of byte 30 is set to ONE (1).

Step 3: Verification of "Heading/Track Indicator" – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the "Heading/Track Indicator" flag. Discontinue the "Heading/Track Indicator" input and verify that, after 60 seconds, bits 2 and 3 of byte 30 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.1.2 Verification of "Target Source Indicator (Horizontal)" Subfield Encoding (subparagraph 2.2.4.5.6.1.2)

Purpose/Introduction:

The "Target Source Indicator (Horizontal)" is a 2-bit (bits 2 and 3 of byte 30) field that indicates the source of Target Heading/Track Angle information. The encoding of this field **shall** be as indicated in Table 2.2.4.5.6.1.2.

Measurement Procedure:

Step 1: Verification of Data Not Available

Set up the ADS-B Transmitting System to transmit ADS-B messages. Discontinue the Target Heading/Track Angle input. Verify that bits 2 and 3 of byte 30 are set to ZERO (binary 00).

Step 2: Verification of Autopilot Control Panel Selected Value

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Target Heading/Track Angle input to Autopilot control panel selected value. Verify that bits 2 and 3 of byte 30 are set to ONE (binary 01).

Step 3: Verification Maintenance of Current Heading or Track Angle

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Target Heading/Track Angle input to maintaining current heading or track angle. Verify that bits 2 and 3 of byte 30 are set to TWO (binary 10).

Step 4: Verification of FMS/RNAV System

Set up the ADS-B Transmitting System to transmit ADS-B messages. Set the Target Heading/Track Angle input to FMS/RNAV system. Verify that bits 2 and 3 of byte 30 are set to THREE (binary 11).

Step 5: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "Target Heading/Track Angle" field. Disconnect the "Target Heading/Track Angle" input and verify that, after 60 seconds, bits 2 and 3 of byte 30 in the next transmitted message are set to ZERO (binary 00).

Resume "Target Heading/Track Angle" input with a value of "01" and verify that this value is reflected in the next transmitted message.

Note: *If there is a data lifetime time-out in any of the fields associated with Target Heading or Track Angle (see Table 2.2.4.5.6.1) or in the True/Magnetic Heading Flag(see subparagraph 2.4.4.5.4.14) then bits 2 and 3 of byte 30 will be set to ALL ZEROs to indicate data not available.*

2.4.4.5.6.1.3 Verification of "Mode Indicator (Horizontal)" Flag Encoding (subparagraph 2.2.4.5.6.1.3)

Purpose/Introduction:

The "Mode Indicator (Horizontal)" is a 1-bit (bit 4 of byte 30) field that reflects the aircraft's state relative to the target heading or track angle. A ZERO **shall** be used to reflect that the target heading or track angle is being *Acquired* and a ONE **shall** be used to indicate that the target heading or track angle is being *Captured or Maintained*.

If this indication is present in the UAT Transmitting System, and if the "Mode Indicator (Horizontal)" field becomes "unavailable" after the "Data Lifetime" timeout listed for this field in Table 2.4.7.1, then the "Mode Indicator (Horizontal)" field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of Target Heading or Track Angle being Acquired

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message that mimes one wherein the target heading or track angle is being Acquired. Verify that the "Mode Indicator (Horizontal)" field is set to ZERO (0).

Step 2: Verification of Target Heading or Track Angle being Captured or Maintained

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message that mimes one wherein the target heading or track angle has been Captured or is being Maintained. Verify that the "Mode Indicator (Horizontal)" field is set to ONE (1).

Step 3: Verification of “Mode Indicator (Horizontal)” Flag – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the “Mode Indicator (Horizontal)” flag. Discontinue the “Mode Indicator (Horizontal)” input and verify that, after 60 seconds, bits 2 and 3 of byte 30 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.1.4 Verification of Reserved Bits (subparagraph 2.2.4.5.6.1.4)

Purpose/Introduction:

Bits 5 and 6 of byte 30 are reserved for future use and **shall** always be set to ZERO.

Measurement Procedure:

Step 1: Verification of Reserved Bit

Set up the ADS-B Transmitting System to transmit UAT messages. Input a message. Verify that bits 5 and 6 of byte 30 are set to ZERO (binary 00).

2.4.4.5.6.1.5 Verification of “Target Heading or Track Angle” Subfield Encoding (subparagraph 2.2.4.5.6.1.5)

Purpose/Introduction:

The “Track Angle/Heading” subfield is a 9-bit (bit 7 of byte 30 through bit 7 of byte 31) subfield that **shall** be used to report the Track Angle or Heading of the ADS-B transmitter as shown in Table 2.2.4.5.6.1.5.

If this indication is present in the UAT Transmitting System, and if the “Track Angle/Heading” field becomes “unavailable” after the “Data Lifetime” timeout listed for this field in Table 2.4.7.1, then the “Track Angle/Heading” field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: “Track Angle/Heading” Verification – Input Validation

Configure the ADS-B Transmitting System to transmit UAT Messages by providing position information at the nominal update rate. Provide the data externally at the interface to the ADS-B system. Set up the system to enable broadcast of UAT Messages at the nominal rate. Set the ADS-B Transmitting System to “On-Ground” status. Provide valid, non-zero “Track Angle/Heading” data to the ADS-B System. Verify that the “Track Angle/Heading” subfield is NOT set to ZERO (0). Set the “Track Angle/Heading” input to exactly ZERO degrees and verify that the encoding of the “Track Angle/Heading” subfield is set to ZERO (binary 0 0000 0000).

Step 2: "Track Angle/Heading" Verification – Discrete Values

Raw data used to establish the "Track Angle/Heading" subfield will normally have more resolution (i.e., more bits) than that required by the "Track Angle/Heading" subfield. When converting such data to the "Track Angle/Heading" subfield, the accuracy of the data shall be maintained such that it is not worse than +/- ½ LSB where the LSB is that of the "Track Angle/Heading" subfield.

Set up the ADS-B Transmitting System as above and set the "Track Angle/Heading" data input to 0.703125 degrees. Verify that the "Track Angle/Heading" subfield is set to ONE (binary 0 0000 0001). Continue increasing the "Track Angle/Heading" data input in increments of 0.703125 degrees and verify that for each such increment, the encoding of the "Track Angle/Heading" subfield is set to the corresponding binary code shown in Table 2.2.4.5.2.6.4.b.

Step 3: Verification of "Target Heading or Track Angle" – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the "Target Heading or Track Angle" field. Discontinue the "Target Heading or Track Angle" input and verify that, after 60 seconds, bits 2 and 3 of byte 30 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.2 Verification of "TARGET ALTITUDE" Field Encoding (subparagraph 2.2.4.5.6.2)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.4.5.6.2 are included in subparagraphs 2.4.4.5.6.2.1 through 2.4.4.5.6.2.6.

2.4.4.5.6.2.1 Verification of "Target Altitude Type" Flag Encoding (subparagraph 2.2.4.5.6.2.1)

Purpose/Introduction:

The "Target Altitude Type" flag is a 1-bit (bit 8 of byte 31) field that indicates whether the target altitude is barometric pressure altitude or flight level (used for target altitudes above the transition level between altitude types), or a locally corrected altitude (used for target altitudes below the transition level). The "Target Altitude Type" **shall** be encoded as indicated in Table 2.2.4.5.6.2.1.

If this indication is present in the UAT Transmitting System, and if the "Target Altitude Type" field becomes "unavailable" after the "Data Lifetime" timeout listed for this field in Table 2.4.7.1, then the "Target Altitude Type" field **shall** default to a value of ZERO.

Note: *This flag is set based on the relationship of the target altitude to the "transition level."*

Measurement Procedure:

Step 1: Verify Barometric Corrected Altitude

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message containing barometric corrected altitude. Verify that the "Target Altitude Type" flag is set to ONE (1).

Step 2: Verify Pressure Altitude

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message containing pressure altitude. Verify that the "Target Altitude Type" flag is set to ZERO (0).

Step 3: Verification of "Target Altitude Type" Flag – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the "Target Altitude Type" flag. Discontinue the "Target Altitude Type" input and verify that, after 60 seconds, bits 1 and 2 of byte 32 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.2.2 Verification of "Target Source Indicator (Vertical)" Subfield Encoding (subparagraph 2.2.4.5.6.2.2)

Purpose/Introduction:

The "Target Source Indicator (Vertical)" is a 2-bit (bits 1 and 2 of byte 32) field that indicates the source of Target Altitude information. The encoding of this field **shall** be as indicated in Table 2.2.4.5.6.2.2.

Measurement Procedure:

Step 1: Verification of the Source of Target Altitude Information Data Not Available

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the "Target Source Indicator (Vertical)" set to data not available. Verify that the "Target Source Indicator (Vertical)" field contains ZERO (binary 00).

Step 2: Verification of Autopilot Control Panel

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the "Target Source Indicator (Vertical)" set to Autopilot Control Panel. Verify that the "Target Source Indicator (Vertical)" field is set to ONE (binary 01).

Step 3: Verification of Holding Altitude

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the "Target Source Indicator (Vertical)" set to Holding Altitude. Verify that the "Target Source Indicator (Vertical)" field is set to TWO (binary 10).

Step 4: Verification of FMS or RNAV system

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the "Target Source Indicator (Vertical)" set to FMS or RNAV system. Verify that the "Target Source Indicator (Vertical)" field is set to THREE (binary 11).

Step 5: Verification of Data Lifetime (subparagraph 2.2.7.1)

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the contents of the "Target Source Indicator (Vertical)" flag. Disconnect the "Target Source Indicator (Vertical)" input and verify that, after 60 seconds, the "Target Source Indicator (Vertical)" flag in the next transmitted message is set to ZERO (binary 00).

Resume "Target Altitude Type" input with a value of "01" and verify that this value is reflected in the next transmitted message.

Note: *If there is a data lifetime time-out in any of the fields associated with Target Altitude (see Table 2.2.4.5.6.2.2) then bits 1 and 2 of byte 32 will be set to ALL ZEROs to indicate data not available.*

2.4.4.5.6.2.3 Verification of "Mode Indicator (Vertical)" Flag Encoding (subparagraph 2.2.4.5.6.2.3)

Purpose/Introduction:

The "Mode Indicator (Vertical)" is a 1-bit (bit 3 of byte 32) field that reflects the aircraft's state relative to the target altitude. A ZERO **shall** be used to reflect that the target altitude is being *Acquired* and a ONE **shall** be used to indicate that the target altitude has been *Captured* or is being *Maintained.*

If this indication is present in the UAT Transmitting System, and if the "Mode Indicator (Vertical)" field becomes "unavailable" after the "Data Lifetime" timeout listed for this field in Table 2.4.7.1, then the "Mode Indicator (Vertical)" field **shall** default to a value of ZERO.

Measurement Procedure:

Step 1: Verification of Target Altitude being Acquired

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message that mimes one wherein the target altitude is being Acquired. Verify that the "Mode Indicator (Vertical)" field is set to ZERO (0).

Step 2: Verification of Target Altitude being Captured or Maintained

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message that mimes one wherein the target altitude has been Captured or is being Maintained. Verify that the "Mode Indicator (Vertical)" field is set to ONE (1).

Step 3: Verification of “Mode Indicator (Vertical)” Flag – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the “Mode Indicator (Vertical)” flag. Discontinue the “Mode Indicator (Vertical)” input and verify that, after 60 seconds, bits 1 and 2 of byte 32 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.2.4 Verification of “Target Altitude Capability” Subfield Encoding (subparagraph 2.2.4.5.6.2.4)

Purpose/Introduction:

The “Target Altitude Capability” is a 2-bit (bit 4 and 5 of byte 32) field that describes the value occupying the “Target Altitude” subfield. The encoding of this field **shall** be as indicated in Table 2.2.4.5.6.2.4.

If this indication is present in the UAT Transmitting System, and if the “Target Altitude Capability” field becomes “unavailable” after the “Data Lifetime” timeout listed for this field in Table 2.4.7.1, then the “Target Altitude Capability” field **shall** default to a value of ALL ZEROs.

Measurement Procedure:

Step 1: Verification of Target Altitude Capability – Data Not Available

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the “Target Altitude Capability” set to data not available. Verify that the “Target Altitude Capability” field is set to ZERO (binary 00).

Step 2: Verification of Target Altitude Capability – Holding Altitude Only

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the “Target Altitude Capability” set to holding altitude only. Verify that the “Target Altitude Capability” field is set to ZERO (binary 00).

Step 3: Verification of Target Altitude Capability – Autopilot Control Panel Selected

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the “Target Altitude Capability” set to holding altitude or autopilot control panel selected altitude. Verify that the “Target Altitude Capability” field is set to ONE (binary 01).

Step 4: Verification of Target Altitude Capability – FMS/RNAV Level-off Altitude

Set up the ADS-B Transmitting System to transmit ADS-B messages. Input a message with the “Target Altitude Capability” set to holding altitude, autopilot control panel selected altitude, or any FMS/RNAV level-off altitude.

Verify that the “Target Altitude Capability” field is set to TWO (binary 10).

Step 5: Verification of "Target Altitude Capability" Subfield – Data Lifetime

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the "Target Altitude Capability" Subfield. Discontinue the "Target Altitude Capability" input and verify that, after 60 seconds, bits 1 and 2 of byte 32 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.6.2.5 Verification of Reserved Bit (subparagraph 2.2.4.5.6.2.5)

Purpose/Introduction:

Bit 6 of Byte 32 is reserved for future use and **shall** always be set to ZERO.

Measurement Procedure:

Step 1: Verification of Reserved Bit

Devise a method of inputting an ADS-B/UAT message to the UUT. Verify that bit 6 of byte 32 is set to ZERO (0).

2.4.4.5.6.2.6 Verification of "Target Altitude" Subfield Encoding (subparagraph 2.2.4.5.6.2.6)

Purpose/Introduction:

"Target Altitude" is a 10-bit (bit 7 of byte 32 through bit 8 of byte 33) field that is the aircraft's next intended level flight attitude if in a climb or descent or its current intended altitude if commanded to hold altitude. The encoding of this field **shall** be as indicated in Table 2.2.4.5.6.2.6.

Measurement Procedure:

Step 1: Verification of Data Not Available

Set up the ADS-B Transmitting System to transmit Airborne Position messages. Remove the input and verify that the binary values are ALL ZEROs in the "Target Altitude" subfield.

Step 2: Verification of Current/Next Intended Target Altitude

For each altitude in Table 2.4.4.5.6.2.6 below, generate valid Airborne Messages with "Type" codes of 0 through 10, and verify that the "Target Altitude" subfield contains the exact binary sequence corresponding to the input altitudes in the table.

Table 2.4.4.5.6.2.6: "Target Altitude" Encoding Values

Coding	Meaning
00 0000 0000	Target Altitude information not available
00 0000 0001	Target Altitude = -1000 feet
00 0000 0010	Target Altitude = -900 feet
00 0000 1000	Target Altitude = -300 feet
00 0000 1010	Target Altitude = -100 feet
00 0000 1011	Target Altitude = ZERO feet
00 0000 1100	Target Altitude = 100 feet
00 0010 0000	Target Altitude = 2100 feet
00 0100 0000	Target Altitude = 5300 feet
00 0110 1111	Target Altitude = 10,000 feet
00 1101 0011	Target Altitude = 20,000 feet
11 1111 0011	Target Altitude = 100,000 feet
11 1111 1110	Target Altitude = 101,100 feet
11 1111 1111	Target Altitude > 101,150 feet

Step 3: Target Altitude Verification – Maximum Values

If the resolution of the input value is the same as the output resolution (i.e., 100 feet,) verify that for an input corresponding to a Target Altitude of 101,200 feet, UAT Messages are generated with a Target Altitude subfield with a value of 1023 (binary 11 1111 1111.)

If the resolution of the input value is greater than the output resolution, verify that for an input value corresponding to the largest possible Target Altitude that is less than 101,150 feet, UAT messages are generated with a Target Altitude subfield with a value of 1022 (binary 11 1111 1110).

If the resolution of the input data makes it possible to enter an input value that corresponds to exactly 101,150 feet, then this value shall be input and it shall be verified that the resultant Target Altitude output field is equal to either 1022 (binary 11 1111 1110, representing 101,100 feet) or 1023 (binary 11 1111 1111, representing > 101,150 feet).

Step 4: Target Altitude Verification – Data Accuracy

If the input data used to establish the Target Altitude subfield has more resolution than that required by the Target Altitude subfield (i.e., more than 10 bits), then this step is used to ensure that the accuracy of the data is maintained such that it is not worse than +/– ½ LSB, where the LSB is the least significant bit of the Target Altitude subfield.

Enter an input value corresponding to a Target Altitude of –950 feet.

Verify that the value of the Target Altitude subfield in the output message is either "1" (binary 00 0000 0001, representing –1000 feet) or "2" (binary 00 0000 0010, representing –900 feet).

If more than 11 bits are used to establish the Target Altitude subfield, let **Z** be equal to the smallest possible fraction that can be represented by the number of bits in the input field (i.e., **Z** is the value of the least significant bit of the input field). Set the value of the input field to correspond to a Target Altitude of (–950–**Z**).

Verify that the value of the Target Altitude subfield in the output UAT message is “1” (binary 00 0000 0001, representing –1000 feet).

Set the value of the input field to correspond to a Target Altitude of (–950+**Z**).

Verify that the value of the Target Altitude subfield in the output UAT message is “2” (binary 00 0000 0010, representing –900 feet).

<u>Note:</u> *If the resolution of the Target Altitude input is such that a Target Altitude of -950 feet cannot be represented (but is still greater than -1000 feet, e.g., a resolution of 25 foot increment,) then values corresponding to Target Altitude must be tested, and the output examined for each value to confirm that the output is within +/- 50 feet (inclusive) of the input value.*

<u>Step 5:</u> <u>Verification of “Target Altitude” Subfield – Data Lifetime</u>

Set up the ADS-B Transmitting System to enable transmission of ADS-B messages that include the value of the “Target Altitude” Subfield. Discontinue the “Target Altitude” input and verify that, after 60 seconds, bits 1 and 2 of byte 32 in the next transmitted message are set to ZERO (binary 00).

2.4.4.5.7 Verification of TARGET STATE Element (Payload Type Code “6”) (subparagraph 2.2.4.5.7)

Appropriate test procedures required to validate the requirement of subparagraph 2.2.4.5.7 are included in subparagraphs 2.4.4.5.6.1.5 through 2.4.4.5.6.2.6.

2.4.4.5.8 Verification of TRAJECTORY CHANGE Element (subparagraph 2.2.4.5.8)

<u>Purpose/Introduction:</u>

This element contains 96 bit that are reserved for future definition. Equipment conforming to this MOPS **shall** insert ALL ZEROs in this element whenever present in a transmitted message. See Appendix L to see how this reserved field could be used to meet the requirements of reporting TCR+0 and TCR+1 in the future.

<u>Measurement Procedure:</u>

<u>Step 1:</u> <u>Verification of Reserved Bits</u>

Set up the ADS-B Transmitting System to transmit UAT messages. Send a message with a Payload Type Code of “4.”

Verify that bytes 18 through 29 are all set to ZERO (0). Repeat this procedure with a message with Payload Type Code of “5,” and again verify that bytes 18 through 29 are all set to ZERO (0).

2.4.5 Verification of Procedures for Processing of Time Data (subparagraph 2.2.5)

Appropriate test procedures required to validate the requirements of subparagraph 2.4.5 are included in subparagraphs 2.4.6.2.1, 2.4.6.2.2, 2.4.7.2.1, 2.4.7.2.2 and 2.4.8.3.5.

2.4.5.1 Verification of UTC Coupled Condition (subparagraph 2.2.5.1)

Purpose/Introduction:

The “UTC Coupled” subfield **shall** be set to ONE, except under the conditions discussed in subparagraph 2.2.5.2.

Note: *Operation of the UAT system in normal mode presumes GNSS, or equivalent, equipage on system participants to, for example, prevent media access conflict with the UAT ground up-link transmissions. Short term GNSS outages are mitigated by UAT ground infrastructure providing timing information and/or the ability to maintain UAT system timing for a minimum of 20 minutes in the absence of GNSS (subparagraph 2.2.5.3[d]). In areas without ground up-link transmissions, there is no media access conflict.*

This test procedure verifies that the UUT meets the requirements for use of an external UTC coupled time source that are contained in subparagraph 2.2.5.1.

Notes:

1. *This test procedure is only necessary if the UUT is intended for use with an external UTC timing source.*

2. *This procedure assumes that the test procedure of subparagraph 2.4.6.3 has been performed, so the own-ship reports can be used to monitor the UUT performance. If this is not the case, a UAT test receiver is required.*

Equipment Required:

External UTC Time Mark source.

Step 1: Verify the processing of the external UAT Time Mark signal.

Provide the UUT with an external Time Mark signal that is marked as invalid. Verify that the “UTC Coupled” subfield in the ADS-B ownship report contains the ZERO value.

Provide the UUT with an external Time Mark signal that is marked as valid. Verify that the “UTC Coupled” subfield in the ADS-B ownship report contains the ONE value.

This verifies the requirements of subparagraphs 2.2.5.1.a and 2.2.5.1.c.

Step 2: Verify the receiver time of applicability reporting.

Provide the UUT with an external Time Mark signal that is marked as valid. Verify that the Time of Applicability field of the own-ship ADS-B report correctly indicates the proper transmission epoch for each UUT ADS-B message transmission.

This verifies the requirement of subparagraph 2.2.5.1.b.

Note: *Step 2 does not validate the processing of an invalid external Time Mark signal.*

2.4.5.2 Verification of Non-UTC Coupled Condition (subparagraph 2.2.5.2

Purpose/Introduction:

a. This condition **shall** be entered when the ADS-B equipment has not been provided a GPS/GNSS, or equivalent, time mark. This is not the normal condition; it is a degraded mode of operation.

b. Within 2 seconds of entering the non-UTC Coupled Condition, the UAT equipment **shall** set the "UTC Coupled" subfield to ZERO in any transmitted messages.

c. While in the non-UTC Coupled Condition, Class A0, A1, A2 and A3 equipment with operational receivers **shall** be capable of aligning to within +/- 6 milliseconds of UTC time based upon successful message reception of any Ground Uplink Message with the "UTC Coupled" bit set.

Note*: This assumes the Ground Uplink message is aligned with UTC time.*

d. While in the non-UTC Coupled Condition when Ground Uplink messages cannot be received, the UAT transmitter **shall** estimate — or "coast" — time through the outage period such that the drift rate of estimated time, relative to actual UTC-coupled time, is no greater than 12 milliseconds in 20 minutes.

e. While in the non-UTC Coupled Condition, ADS-B transmissions **shall** continue.

f. The UAT equipment **shall** change state to the UTC coupled condition within 2 seconds of availability of the UTC coupled source.

Notes:

1. *Item "d" above is consistent with an initial drift rate of 10 PPM in the baud clock over the 12 millisecond air-ground segment guard time. Clock drift can be compensated up to the time coasting begins.*

2. *In the non-UTC Coupled Condition, the estimated 1 second UTC epoch signal does NOT indicate the time of validity of Position, Velocity and Time (PVT) information.*

3. *Any installations of Class A equipment involving separated transmitters and receivers must provide a mechanism to fulfill the requirement stated in subparagraph c) above.*

4. *This reversionary timing exists for the following reasons:(**a**) to support ADS-B message transmission using an alternate source of position and velocity, if available; (**b**) to support ADS-B message transmission in absence of position and velocity data in order that any available fields are conveyed (e.g., barometric altitude) and (**c**) that a signal is provided in the event the ground network can perform an ADS-B-independent localization of the A/V (e.g., multilateration).*

This test verifies that the UUT meets the requirements when the non-UTC coupled condition exists, that are contained in subparagraph 2.2.5.3.

Note: *This procedure assumes that the test procedure of subparagraph 2.4.6.3 has been performed, so the own-ship reports can be used to monitor the UUT performance. If this is not the case, a UAT test receiver is required.*

Equipment Required:

- UAT ground station Uplink generator with the following characteristics:

  Message rate: 1.000 Hz.

  Payload data: Time Slot field must correspond with the time slot of the uplink message. The "UTC Coupled" field of the Uplink message is set to ONE. Other payload fields may contain pseudo-random data.

- UAT test receiver with data logging and UTC 1 second time mark.

- Uplink transmitter with timing referenced to UTC 1 second time mark.

Step 1: Verify the processing of the external UAT Time Mark signal.

The requirements of subparagraph 2.2.5.3.a and 2.2.5.3.b are validated through the test procedure of subparagraph 2.4.5.1, step 1.

Step 2: Verify the time alignment for Class A equipment in the non-UTC case.

Through use of a test mode, force the UUT to transmit using MTO 752. While receiving Uplink messages, and without supplying the UUT with a valid UTC timing reference, observe the Time of Message Receipt value reported by the UAT test receiver. Verify that the Time of Message Receipt values are consistent with the timing accuracy requirement in subparagraph 2.2.5.3.c; i.e. that the timing of the ADS-B own-ship messages does exceed 6 milliseconds from the nominal timing for ADS-B messages sent at MTO 752.

Note: *The purpose of this requirement is to prevent the loss of UTC time reference from causing the UUT equipment to transmit ADS-B messages during the Uplink time segment.*

Step 3: Measure the UUT reference time.

Disable the UAT Uplink generator. Through use of a test mode, force the UUT transmitter to always transmit using Tx MSO 752. Record the current time, and measure the time offset between the UTC 1 second time reference and the Time of Message Reception by the UAT test receiver.

Step 4: Observe continued ADS-B transmissions.

Verify that while in the non-UTC coupled condition, the UUT continues to transmit ADS-B messages. This validates the requirements of subparagraph 2.2.5.3.e.

Step 5: Validate the rate of reference time drift.

Allow the UUT to continue transmitting ADS-B messages. Measure the rate at which the Time of Message Reception reported by the UAT test receiver diverges from the time reference measured in Step 4.

Validate that the rate of message transmission time drift is less than the requirements stated in subparagraph 2.2.5.3.d (i.e. 12 milliseconds in 20 minutes).

Step 6: Measure the response to the application of the UTC timing source.

Record the current time, and provide the UUT a valid UTC timing source, so that the equipment achieves the UTC Coupled condition. Verify that the elapsed time between application of the valid timing source and the reporting of the 'UTC Coupled" condition is not more than 2.0 seconds. This validates the requirements of subparagraph 2.2.5.3.f.

2.4.6 Verification of Procedures for ADS-B Message Transmission (subparagraph 2.2.6)

No specific test procedure is required to validate subparagraph 2.2.6.

2.4.6.1 Verification of Scheduling of ADS-B Message Types (subparagraph 2.2.6.1)

No specific test procedure is required to validate subparagraph 2.2.6.1.

2.4.6.1.1 Verification of Payload Selection Cycle (subparagraph 2.2.6.1.1)

No specific test procedure is required to validate subparagraph 2.2.6.1.1.

2.4.6.1.2 Verification of ADS-B Payload Type Allocation (subparagraph 2.2.6.1.2)

Appropriate test procedures required to validate the requirements in subparagraph 2.2.6.1.2 are included in subparagraph 2.4.6.1.3.

2.4.6.1.3 Verification of Message Transmission Cycle (Transmitter Diversity) (subparagraph 2.2.6.1.3)

Purpose/Introduction:

A message transmission cycle of 16 seconds is defined to ensure a proper mix of message payloads for installations that support ADS-B message transmission from dual (diversity) antennas (see subparagraph 2.1). Transmissions **shall** occur through Top (T) and Bottom (B) antennas each Message Transmission Cycle as shown in Figure 2.2.6.1.3.

This test procedure verifies the compliance of the ADS-B UAT transmitter with the Payload Type allocation and Message Transmission cycle requirements (including transmit antenna selection) of subparagraphs 2.2.6.1.2 and 2.2.6.1.3.

Equipment Required:

Supply the UUT with data interfaces appropriate for the equipment class and intended application. Provide two UAT test receivers that can provide data logging of all received messages are required for this test procedure.

Measurement Procedure:

Step 1: Prepare the transmitting UUT and adjust signal levels.

Connect each UUT antenna port to a UAT test receiver. Use RF attenuators to adjust the signal to each UAT test receiver to 10 dB above the receiver's sensitivity threshold.

Note: *This provides that each receiver will only respond to messages transmitted on the antenna port that it is connected to.*

Step 2: Record the sequence of transmitted messages from the UUT.

Allow the UUT to transmit ADS-B messages for a minimum of two Message Transmission Cycles (32 seconds). The test receivers will record the Payload Types for each received message on its antenna port

Step 3: Analyze the recorded messages.

For each receiver, determine that the proper sequence of Payload Types has been recorded for the appropriate class of equipment, per Table 2.4.6.1.3.

Table 2.4.6.1.3: Payload Type and Tx Antenna Selection vs. Equipment Class

Eqpt Class ->	A0		A1L, A1H, B1		A1H		A2		A3	
Time (sec)	**Bot**	**Top**	**Bot**	**Top**	**Bot**	**Top**	**Bot**	**Top**	**Bot**	**Top**
1		1		1		1		1		1
2		2		2		6		4		4
3	0		0		3		4		4	
4	0		0		0		2		5	
5		0		0		0		2		5
6		1		1		1		1		1
7	2		2		6		4		4	
8	0		0		3		4		4	
9		0		0		3		4		4
10		0		0		0		2		5
11	1		1		1		1		1	
12	2		2		6		4		4	
13		2		2		6		4		4
14		0		0		3		4		4
15	0		0		0		2		5	
16	1		1		1		1		1	

2.4.6.2 Verification of ADS-B Message Transmit Timing (subparagraph 2.2.6.2)

No specific test procedure is required to validate subparagraph 2.2.6.2.

2.4.6.2.1 Verification of The Message Start Opportunity (MSO) (subparagraph 2.2.6.2.1)

Purpose/Introduction:

ADS-B Messages **shall** be transmitted at discrete Message Start Opportunities (MSO) chosen by a pseudo-random process. The specific pseudo-random number (*R*) chosen by an aircraft depends on the aircraft's current position and on the previously chosen random number. Let:

N(0) = 12 L.S.B.'s of the most recent valid "LATITUDE"
N(1) = 12 L.S.B.'s of the most recent valid "LONGITUDE"

where the "LATITUDE" and "LONGITUDE" are as defined in subparagraph 2.2.4.1.2 and 2.2.4.1.3 respectively.

The procedure below **shall** be employed to establish the transmission timing for the current UAT frame *m*.

$$R(m) = \{4001 \cdot R(m-1) + N(m \bmod 2)\} \bmod 3200$$

The MSO **shall** be 752 + R(*m*). The initial R(*0*) **shall** be ZERO.

This test procedure verifies that the UAT Transmitter output transmission timing meets the requirements of subparagraph 2.2.6.2.1. The transmitter is required to output at the discrete MSO determined by a pseudo-random calculation based on the last ownship valid latitude and longitude position. The following procedure verifies that the output occurs at the proper MSO based on the calculation.

Equipment Required:

The test configuration requires data sources be provided to the appropriate UAT Transmitter interfaces to enable transmission of ADS-B Messages. This could also be accomplished by the use of an internally generated ADS-B test message with controllable data content. Determine the elapsed time by an external timing source capable of measuring the time from message transmission relative to the UTC time mark. The interval may vary from the time to the first MSO to the last MSO in the one second epoch.

Measurement Procedures:

Set up the UAT Transmitting equipment as configured in Figure 2.4.6.2.1. The time of transmission is measured relative to the UTC Time Mark or equivalent to the start of the first bit of the synchronization sequence of the transmitted message. The timing measurement is required to provide a minimum of 50 nanosecond timing resolution.

Step 1: Message Start Opportunity Verification

Provide data to the UAT transmitting equipment to output the following fixed latitude and longitude values:

Latitude:	000 1000 1010 1000 0110 1000 (MSB) (LSB)
Longitude:	0000 0101 1010 0010 0011 1010

Maintain this input to the latitude and longitude inputs to enable verification of correct MSO assignment. Power down the transmitter so that the last valid latitude and longitude values stored by the UAT transmitting equipment are as indicated. Power on the UAT Transmitting equipment with the latitude and longitude data input maintained at the fixed values. The sequence of MSOs that are valid assuming an initialization at t = 0 are as indicated in Table 2.4.6.2.1. Due to differences in power up timing and initialization procedures, the transmission sequence may not commence from the very beginning of the table but once aligned with the table, verify the transmission times for a minimum of 10 transmissions. The time interval from the UTC Time Mark to the first bit of the synchronization sequence establishes the MSO number. If the MSO is contained in the output message, it can be used to validate the proper MSO timing.

Table 2.4.6.2.1: MSO Sequence Validation

M	MSO	M	MSO	M	MSO
0	752	10	3162	20	2372
1	1322	11	2132	21	2942
2	1874	12	1084	22	3494
3	844	13	1654	23	2464
4	2996	14	2206	24	1416
5	3566	15	1176	25	1986
6	918	16	3328	26	2538
7	3088	17	3898	27	1508
8	2040	18	1250	28	3660
9	2610	19	3420	29	1030

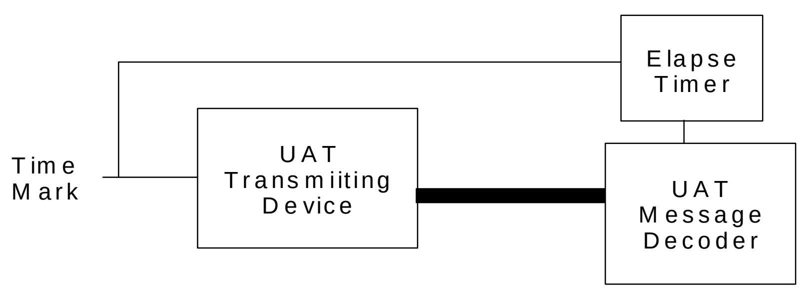


Figure 2.4.6.2.1: MSO Timing Measurement Configuration

2.4.6.2.2 Verification of Relationship of the MSO to the Modulated Data (subparagraph 2.2.6.2.2)

Purpose/Introduction:

The optimum sample point of the first bit of the UAT synchronization sequence at the antenna terminal of the UAT equipment **shall** occur at T_{TX} microseconds after the 1 second UTC epoch according to the following formula:

$$T_{TX} \text{ (microseconds)} = 6000 + (250*\text{MSO})$$

within the following tolerances:

a. +/- 500 nanoseconds for UAT equipment with an internal UTC coupled time source,

b. +/- 500 nanoseconds for UAT equipment with an external UTC coupled time source.

Notes:

1. *This is required to support ADS-B range validation by a receiving application. This requirement sets the ultimate timing accuracy of the transmitted messages under the UTC Coupled condition. See Appendix I for a discussion of UAT Timing Considerations.*

2. *Referencing this measurement to the optimum sampling point is convenient since this is the point in time identified during the synchronization process.*

3. *There is no requirement to demonstrate this relationship when in the non-UTC Coupled condition.*

This test procedure verifies that the timing relationship between the Transmit MSO number and the data modulation complies with the requirements of subparagraph 2.2.6.2.2.

Equipment Required:

Supply the UUT with a pseudorandom stream of payload data.

Provide a UTC 1-second timing reference signal.

Provide a Vector Signal Analyzer (VSA), per subparagraph 2.4.2.1, configured per Table 2.4.2.1 excepting use of external trigger mode.

Provide a trigger timing delay generator connected between the UTC 1 second timing source, and the VSA external trigger input. Timing delay range is from 194.000 milliseconds to 993.750 milliseconds.

Provide access to GPS constellation signals or simulated signal source.

Provide an external GPS receiver if necessary for the intended application.

Measurement Procedure:

Step 1: Configure the UUT transmitter

Configure the UUT in a test mode that causes the Transmitted MSO to be selected in sequence from the following list: MSO = (752, 2352, 3951).

Note: *This sequence causes the UUT transmitter to transmit at the earliest, middle, and latest possible MSOs in the Air segment.*

Step 2: Trigger delay setup.

Set the trigger delay generator so that the 1 PPS timing source is delayed by 194.000 milliseconds for MSO 752, 594.000 milliseconds for MSO 2352, or 993.750 milliseconds for MSO 3951.

Step 3: Measure the Modulated Data Timing

On Trace A on the VSA, find the optimum sample point of the first bit of pseudorandom data that follows the 36-bit synchronization pattern. The time offset between the trigger point and this optimum sample point, minus 34.56 microseconds, should meet the timing requirements of subparagraph 2.2.6.2.2.a.

Note: *The modulation timing is based on measurement to the first bit following the synchronization pattern, because there is no clear eye pattern opening available with the static data of the synchronization pattern.*

Step 4: Repeat test with external GPS receiver

If the equipment is intended for use with an external GPS source, repeat step 3 with the external GPS receiver. The timing requirement of subparagraph 2.2.6.2.2.b should be met.

2.4.6.3 Verification of Report Assembly on Transmission of Ownship ADS-B Message (subparagraph 2.2.6.3)

Purpose/Introduction:

The transmitter **shall** issue a report reflecting each ADS-B message transmission and explicitly identify the report as “own-ship”.

Reports **shall** contain all elements of the transmitted message payload with range and accuracy of each payload field preserved.

Notes:

1. *This is to aid any application process that uses ADS-B message propagation time to perform a validity check of received ADS-B messages by providing a reference point for measured ranges.*

2. *Allows independent monitoring of the transmitted position.*

This test procedure verifies that the UUT transmitter generates an ADS-B report for each of its transmissions in compliance with subparagraphs 2.2.6.3.

Equipment Required:

Supply the UUT with data interfaces appropriate for the equipment class and intended application. Provide one UAT test receiver that provides data logging of all received messages is required for this test procedure.

Step 1: Verifying the own-ship report.

Verify that each UUT ADS-B transmission is accompanied by a message on the UUT report interface, indicating that the report is of the "own-ship" type.

Step 2: Verify the own-ship report contents.

Compare the data received by the UAT test receiver, with the contents of the UUT own-ship reports, and verify that the range and accuracy of each of the report fields is preserved.

2.4.7 Verification of UAT Transmitter Message Data Characteristics (subparagraph 2.2.7)

No specific test procedure is required to validate subparagraph 2.2.7.

2.4.7.1 Verification of UAT Transmitter Input Requirements (subparagraph 2.2.7.1)

Purpose/Introduction:

This subparagraph contains requirements for access to the input elements required to compose the ADS-B messages so their bits can be verified for their mapping into the structure of the transmitted message.

a. The UAT ADS-B transmitting device **shall** accept the input data elements listed in Table 2.2.7.1 via an appropriate data input interface and use such data to establish the corresponding ADS-B message contents.

b. Data elements indicated as "Optional," that have no input interface, **shall** always indicate the "data unavailable" condition.

Table 2.4.7.1: **UAT ADS-B Transmitter Input Requirements**

Element #	Input Data Element	Relevant Paragraph	Data Lifetime (seconds)	Applicable UAT Equipment Class						
				A0, B1	A1L	A1H	A2	A3	B2	B3
1	ICAO 24-bit Address	2.2.4.5.1.3.1	n/a	M	M	M	M	M	M	M
2	Address Selection (ICAO vs Temporary)	2.2.4.5.1.3.1 2.2.4.5.1.3.2	60	Input required only if installation is to have selectable address						
3	Latitude	2.2.4.5.2.1	2	If input not directly accessible, a means to verify encoding must be demonstrated						
4	Longitude	2.2.4.5.2.1	2							
5	Altitude Type Selection (Barometric vs Geometric)	2.2.4.5.2.2	60	O	O	O	O	O	n/a	M
6	Barometric Pressure Altitude	2.2.4.5.2.3	2	M	M	M	M	M	n/a	O
7	Geometric Altitude	2.2.4.5.2.3	2	M	M	M	M	M	n/a	M
8	NIC	2.2.4.5.2.4	2	M	M	M	M	M	M	M
9	Automatic AIRBORNE / ON-GROUND Indication	2.2.4.5.2.5	2	O	O	M	M	M	n/a	n/a
10	North Velocity	2.2.4.5.2.6.1	2	If input not directly accessible, a means to verify encoding must be demonstrated						
11	East Velocity	2.2.4.5.2.6.3	2							
12	Airspeed	2.2.4.5.2.6.2	2	O	O	M	M	M	n/a	n/a
13	Track Angle	2.2.4.5.2.6.4	2	O	M	M	M	M	n/a	n/a
14	Heading	2.2.4.5.2.6.4	2	O	O	M	M	M	n/a	n/a
15	Barometric Vertical Rate	2.2.4.5.2.2 2.2.4.5.2.3 2.2.4.5.2.7.1.3	2	One or the other is Mandatory						
16	Geometric Vertical Rate	2.2.4.5.2.2 2.2.4.5.2.3 2.2.4.5.2.7.1.3	2							
17	UTC 1 PPS Timing	2.2.4.5.2.8	2	If input not directly accessible, a means to verify timing must be demonstrated						
18	Emitter Category	2.2.4.5.4.1	60	M	M	M	M	M	M	M
19	Call Sign / Flight ID	2.2.4.5.4.2	60	M	M	M	M	M	O	O
20	Emergency / Priority Status Selection	2.2.4.5.4.4	60	M	M	M	M	M	O	n/a
21	SIL	2.2.4.5.4.6	60	M	M	M	M	M	M	M
22	NACp	2.2.4.5.4.9	2	M	M	M	M	M	M	M
23	NACv	2.2.4.5.4.10	2	M	M	M	M	M	n/a	n/a
24	NICbaro	2.2.4.5.4.11	60	Can be internally "hard coded"		M	M	M	n/a	n/a
25	CDTI Traffic Display Capability	2.2.4.5.4.12.1	60	M	M	M	M	M	n/a	n/a
26	TCAS Installed and Operational	2.2.4.5.4.12.2	60	M	M	M	M	M	n/a	n/a
27	TCAS/ACAS Resolution Advisory Flag	2.2.4.5.4.13.1	60	Required only if ADS-B transmitter is intended for installation with TCAS/ACAS; otherwise can be "hard coded"						
28	IDENT Selection	2.2.4.5.4.13.2	60	M	M	M	M	M	M	n/a
29	"Receiving ATC Services" Flag	2.2.4.5.4.13.3	60	M	M	M	M	M	M	n/a
30	"True/Magnetic Heading" Flag	2.2.4.5.4.14	60	n/a	n/a	O	M	M	M	n/a
31	Heading / Track Indicator	2.2.4.5.6.1.2	60	n/a	n/a	O	M	M	n/a	n/a
32	Target Source Indicator (Horizontal)	2.2.4.5.6.1.4	60	n/a	n/a	O	M	M	n/a	n/a
33	Horizontal Mode Indicator (Horizontal)	2.2.4.5.6.1.5	60	n/a	n/a	O	M	M	n/a	n/a
34	Target Heading or Track Angle	2.2.4.5.6.1.7	60	n/a	n/a	O	M	M	n/a	n/a
35	Target Altitude Type	2.2.4.5.6.2.2	60	n/a	n/a	O	M	M	n/a	n/a
36	Target Source Indicator (Vertical)	2.2.4.5.6.2.4	60	n/a	n/a	O	M	M	n/a	n/a
37	Mode Indicator (Vertical)	2.2.4.5.6.2.5	60	n/a	n/a	O	M	M	n/a	n/a
38	Target Altitude Capability	2.2.4.5.6.2.6	60	n/a	n/a	O	M	M	n/a	n/a
39	Target Altitude	2.2.4.5.6.2.7	60	n/a	n/a	O	M	M	n/a	n/a
40	Radio Altitude	2.2.4.5.2.5.1	2	O	O	O	O	O	n/a	n/a

O = Optional M = Mandatory

Measurement Procedure:

TBD

2.4.7.2 Verification of Time Registration and Latency (subparagraph 2.2.7.2)

No specific test procedure is required to validate subparagraph 2.2.7.2.

2.4.7.2.1 Verification of Requirements When in Non-Precision Condition and UTC Coupled (subparagraph 2.2.7.2.1)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.7.2.1 are included in subparagraphs 2.4.7.2.1.1 and 2.4.7.2.1.2.

2.4.7.2.1.1 Verification of Requirements When in Non-Precision Condition and UTC Coupled (subparagraph 2.2.7.2.1.a)

Purpose/Introduction:

a. At the time of the ADS-B Message transmission, position information encoded in the "LATITUDE," "LONGITUDE," and "ALTITUDE" fields **shall** be applicable as of the start of the current 1 second UTC Epoch.

b. Any updated ADS-B Message fields, other than "LATITUDE," "LONGITUDE" or "ALTITUDE," that are provided at the ADS-B equipment input interface at least 200 milliseconds prior to the time of a scheduled ADS-B Message transmission that involves those fields, **shall** be reflected in the transmitted message.

Notes:

1. *Specifically, any extrapolation of position performed should be to the start of the 1-second UTC Epoch and not the time of transmission.*

2. *Velocity information cannot be extrapolated and may therefore have additional ADS-B imposed latency.*

The following test procedure verifies the UAT Transmitting equipment meets the time registration and latency requirements of subparagraph 2.2.7.2.1 for NAC_P values greater than or equal to 9. The Latitude, Longitude and Altitude data contained in the transmitted ADS-B message is applicable at the one second UTC Epoch. All other data contained in the transmitted message reflects all values that were updated 200 milliseconds or more prior to the transmission time of the message.

Equipment Required:

The test configuration must include data sources to be provided at the input interfaces of the UAT Transmitting equipment so that the appropriate data is available and loaded into the corresponding fields in the transmitted message. Equipment that serves as a source for the latitude, longitude, altitude and velocity data must be capable of providing position updates synchronized to the UTC Time Mark at a minimum of a 1 second update rate. The position updates must be recomputed each second according to the velocity data required by the test procedure. The position data must be provided to the UAT Transmitting equipment within 200 milliseconds of the UTC Time Mark. The UTC Time Mark or its equivalent will serve as the synchronization for all timing measurements. The transmitted messages from the UAT Transmitting equipment must be received and decoded by appropriate receiving equipment with either the capability of internally tagging time of message receipt within 1 millisecond of the time of message receipt relative to UTC Time Mark, or of providing an external signal representing time of message receipt for external time measurement. External timing relative to the UTC Time Mark is required to measure elapsed time with a resolution of 100 nanoseconds or better.

Measurement Procedure

Step 1: Verify Latitude Data

Set up the UUT to transmit ADS-B messages. Initialize the equipment providing position data to the UUT to the following conditions:

Longitude:	30.0	degrees	WEST
Latitude:	60.0	degrees	NORTH
N/S Velocity:	1,200	knots	SOUTH

Initialize the UUT and after stable, apply the initial position values to the equipment. Provide latitude, longitude and altitude data at the input interface to the UUT. The UTC Time Mark prior to the first position data is the initial data collection point at the output of the UUT. Take 60 consecutive samples and compare the reported latitude in the UAT Transmitted Message to the Computed Latitude derived from the initial conditions. The position will change approximately 617.333 meters each one-second update. Verify that the Latitude data transmitted is within 2.5 meters of the Computed Latitude.

Step 2: Verify Longitude Data

Set up the UUT to transmit ADS-B messages. Initialize the equipment providing position data to the UUT to the following conditions:

Longitude:	30.0	degrees	WEST
Latitude:	60.0	degrees	NORTH
E/W Velocity:	1,200	knots	WEST

Initialize the UUT and after stable, apply the initial position values to the equipment. Provide latitude, longitude and altitude data at the input interface to the UUT. The UTC Time Mark prior to the first position data is the initial data collection point at the output of the UUT. Take 60 consecutive samples and compare the reported Longitude in the UAT Transmitted Message to the Computed Longitude derived from the initial conditions. The position will change approximately 617.333 meters each one-second update. Verify that the Longitude data transmitted is within 1.25 meters of the Computed Longitude.

Step 3: Verify Latitude Data – Crossing the Equator

Repeat the procedure in Step 1 for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	0.0625	degrees	NORTH
N/S Velocity:	1,200	knots	SOUTH

Step 4: Verify Longitude Data – Crossing the Equator

Repeat the procedure in Step 2 for the following data:

Longitude:	30.0	degrees	WEST
Latitude:	60.0	degrees	NORTH
E/W Velocity:	1,200	knots	WEST

Step 5: Verify Latitude Data – Crossing the North Pole

Repeat the procedure in Step 1 for the following data:

Longitude:	45.0	degrees	EAST
Latitude:	89.937	degrees	NORTH
N/S Velocity:	1,200	knots	NORTH

Step 6: Verify Longitude Data – Crossing the North Pole

Repeat the procedure in Step 2 for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	89.937	degrees	NORTH
E/W Velocity:	1,200	knots	WEST

Step 7: Verify Latitude Data – Crossing the South Pole

Repeat the procedure in Step 1 for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	89.937	degrees	SOUTH
N/S Velocity:	1,200	knots	SOUTH

Step 8: Verify Longitude Data – Crossing the South Pole

Repeat the procedure in Step 2 for the following data:

Longitude:	45.0	degrees	EAST
Latitude:	89.937	degrees	SOUTH
E/W Velocity:	1,200	knots	EAST

2.4.7.2.1.2 Verification of Requirements When in Non-Precision Condition and UTC Coupled (subparagraph 2.2.7.2.1.b)

Purpose/Introduction:

a. At the time of the ADS-B Message transmission, position information encoded in the "LATITUDE," "LONGITUDE," and "ALTITUDE" fields **shall** be applicable as of the start of the current 1 second UTC Epoch.

b. Any updated ADS-B Message fields, other than "LATITUDE," "LONGITUDE" or "ALTITUDE," that are provided at the ADS-B equipment input interface at least 200 milliseconds prior to the time of a scheduled ADS-B Message transmission that involves those fields, **shall** be reflected in the transmitted message.

Notes:

1. *Specifically, any extrapolation of position performed should be to the start of the 1-second UTC Epoch and not the time of transmission.*

2. *Velocity information cannot be extrapolated and may therefore have additional ADS-B imposed latency*.

Equipment Required:

The test configuration must include data sources to be provided at the input interfaces of the UAT Transmitting equipment so that the appropriate data is available and loaded into the corresponding fields in the transmitted message. Equipment that serves as a source for the latitude, longitude, altitude and velocity data must be capable of providing position updates synchronized to the UTC Time Mark at a minimum of a one second update rate. The position updates must be recomputed each second according to the velocity data required by the test procedure. The position data must be provided to the UAT Transmitting equipment within 200 milliseconds of the UTC Time Mark. The UTC Time Mark or its equivalent will serve as the synchronization for all of the timing measurements. The transmitted messages from the UAT Transmitting equipment must be received and decoded by the appropriate receiving equipment with either the capability of internally tagging time of message receipt within 1 millisecond of the time of message receipt relative to the UTC Time Mark, or of providing an external signal representing the time of message receipt for an external time measurement. External timing relative to the UTC Time Mark is required to measure the elapsed time with a resolution of 100 nanoseconds or better.

Measurement Procedure:

Step 1: Verify Data Updates Prior to 200 Milliseconds of the UTC Time Mark

Set up the UUT to transmit ADS-B messages. Input an ADS-B message and update the input values each second at least 200 milliseconds prior to the next scheduled message transmission. Verify that each transmitted message reflects the updated values input each second.

Step 2: Verify Data Updates Within 200 Milliseconds of the UTC Time Mark

Set up the UUT to transmit ADS-B messages. Input an ADS-B message and update the input values each second within 200 milliseconds of the next scheduled message transmission.

Verify that the updated values are not reflected in the next transmitted message, but are reflected in the message following that one and likewise for each subsequent input.

2.4.7.2.2 Verification of Requirements When in Precision Condition and UTC Coupled (subparagraph 2.2.7.2.2)

Appropriate test procedures required to validate the requirements of subparagraph 2.2.7.2.2 are included in subparagraphs 2.4.7.2.2.1 and 2.4.7.2.2.2.

2.4.7.2.2.1 Verification of Requirements When in Precision Condition and UTC Coupled (subparagraph 2.2.7.2.2.a)

Purpose/Introduction:

a. At the time of the ADS-B message transmission, the position information encoded in the “LATITUDE,” “LONGITUDE”, and “ALTITUDE” fields shall be applicable as of the start of the current 0.2 second UTC Epoch.

b. Any updated ADS-B Message fields, other than “LATITUDE,” “LONGITUDE” or “ALTITUDE,” that are provided at the ADS-B equipment input interface at least 200 milliseconds prior to the time of a scheduled ADS-B Message transmission that involves those fields, **shall** be reflected in the transmitted message.

Notes:

1. *Specifically, any extrapolation of position performed should be to the start of the 0.2 second UTC Epoch and not the time of transmission.*

2. *Operation in this condition assumes a GPS/GNSS sensor output rate of 5 Hz or greater is available to the ADS-B transmitter.*

The following test procedure verifies that the UAT Transmitting equipment meets the time registration and latency requirements of subparagraph 2.2.7.2.2 for NAC_P values greater than or equal to 9. The latitude, Longitude and Altitude data contained in the transmitted ADS-B message is applicable at the 0.2 second UTC Epoch. All other data contained in the transmitted message reflects all values that were updated 200 milliseconds or more prior to the transmission time of the message.

Equipment Required:

The test configuration must include data sources to be provided at the input interfaces of the UAT Transmitting equipment so that the appropriate data is available and loaded into the corresponding fields in the transmitted message. Equipment that serves as a source for the latitude, longitude, altitude and velocity data must be capable of providing position updates synchronized to the UTC Time Mark at a minimum of a 0.2 second update rate. The position updates must be recomputed each 0.2 second according to the velocity data required by the test procedure. The position data must be provided to the UAT Transmitting equipment within 200 milliseconds of the UTC Time Mark. The UTC Time Mark or equivalent will serve as the synchronization for all timing measurements. The transmitted messages from the UAT Transmitting equipment must be received and decoded by appropriate receiving equipment with either the capability of internally tagging time of message receipt within 1 millisecond of the time of message receipt relative to UTC Time Mark, or of providing an external signal representing time of receipt for external time measurement. External timing relative to the UTC Time Mark is required to measure elapsed time with a resolution of 100 nanoseconds or better.

Measurement Procedure:

Step 1: Verify Latitude Data

Set up the UUT to transmit ADS-B messages. Initialize the equipment providing position data to the UUT to the following conditions:

Longitude:	30.0	degrees	WEST
Latitude:	60.0	degrees	NORTH
N/S Velocity	1,200	knots	SOUTH

Initialize the UUT and, after stable, apply the initial position values to the equipment. Provide latitude, longitude and altitude data at the input interface to the UUT. The 0.2 second UTC Epoch prior to the first position data is the initial data collection point at the output of the UUT. The data should reflect the change over time, in 0.2 second increments, since the UTC time mark. Take 60 consecutive samples and compare the reported latitude in the UAT Transmitted Message to the Computed Latitude derived from the initial conditions. The position will change approximately 617.333 meters for each one second update, and so will change approximately 123.466 meters for each 200 milliseconds. Verify that the Latitude data transmitted reflects the change over time in position of 123.466 meters since the start of the previous 0.2 seconds interval and is within 2.5 meters of the Computed Latitude.

Step 2: Verify Longitude Data

Set up the UUT to transmit ADS-B messages. Initialize the equipment providing position data to the UUT to the following conditions:

Longitude:	30.0	degrees	WEST
Latitude:	60.0	degrees	NORTH
E/W Velocity	1,200	knots	WEST

Initialize the UUT and, after stable, apply the initial position values to the equipment. Provide latitude, longitude and altitude data at the input interface to the UUT. The 0.2 second UTC Epoch prior to the first position data is the initial data collection point at the output of the UUT. The data should reflect the change over time, in 0.2 second increments, since the UTC time mark. Take 60 consecutive samples and compare the reported latitude in the UAT Transmitted Message to the Computed Longitude derived from the initial conditions. The position will change approximately 617.333 meters for each one second update, and so will change approximately 123.466 meters for each 200 milliseconds. Verify that the Longitude data transmitted reflects the change over time in position of 123.466 meters since the start of the previous 0.2 seconds interval and is within 1.25 meters of the Computed Longitude.

Step 3: Verify Latitude Data – Crossing the Equator

Repeat the procedure in step one for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	0.0625	degrees	NORTH
N/S Velocity	1,200	knots	SOUTH

Step 4: Verify Longitude Data – Crossing the Equator

Repeat the procedure in step two for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	0.0625	degrees	NORTH
E/W Velocity	1,200	knots	WEST

Step 5: Verify Latitude Data – Crossing the North Pole

Repeat the procedure in step one for the following data:

Longitude:	45.0	degrees	EAST
Latitude:	89.937	degrees	NORTH
N/S Velocity	1,200	knots	NORTH

Step 6: Verify Longitude Data – Crossing the North Pole

Repeat the procedure in step two for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	89.937	degrees	NORTH
E/W Velocity	1,200	knots	WEST

Step 7: Verify Latitude Data – Crossing the South Pole

Repeat the procedure in step one for the following data:

Longitude:	45.0	degrees	WEST
Latitude:	89.937	degrees	SOUTH
N/S Velocity	1,200	knots	SOUTH

Step 8: Verify Longitude Data – Crossing the South Pole

Repeat the procedure in step two for the following data:

Longitude:	45.0	degrees	EAST
Latitude:	89.937	degrees	SOUTH
E/W Velocity	1,200	knots	EAST

2.4.7.2.2.2 Verification of Requirements When in Precision Condition and UTC Coupled (subparagraph 2.2.7.2.2.b)

Purpose/Introduction:

Any updated ADS-B Message fields, other than “LATTITUDE,” “LONGITUDE,” or “ALTITUDE,” that are provided at the ADS-B equipment input interface at least 200 milliseconds prior to the time of a scheduled ADS-B Message transmission that involves those fields, shall be reflected in the transmitted message.

Equipment Required:

The test configuration must include data sources to be provided at the input interfaces of the UAT Transmitting equipment so that the appropriate data is available and loaded into the corresponding fields in the transmitted message. Equipment that serves as a source for the latitude, longitude, altitude and velocity data must be capable of providing position updates synchronized to the UTC Time Mark at a minimum of a one second update rate. The position updates must be recomputed each second according to the velocity data required by the test procedure. The position data must be provided to the UAT Transmitting equipment within 200 milliseconds of the UTC Time Mark. The UTC Time Mark or its equivalent will serve as the synchronization for all of the timing measurements. The transmitted messages from the UAT Transmitting equipment must be received and decoded by the appropriate receiving equipment with either the capability of internally tagging time of message receipt within 1 millisecond of the time of message receipt relative to the UTC Time Mark or of providing an external signal representing the time of message receipt for an external time measurement. External timing relative to the UTC Time Mark is required to measure the elapsed time with a resolution of 100 nanoseconds or better.

Measurement Procedure:

Step 1: Verify Data Updates Prior to 200 Milliseconds of the UTC Time Mark

Set up the UUT to transmit ADS-B messages. Input an ADS-B message and update the input values each second at least 200 milliseconds prior to the next scheduled message transmission. Verify that each transmitted message reflects the updated values input each second.

Step 2: Verify Data Updates Within 200 Milliseconds of the UTC Time Mark

Set up the UUT to transmit ADS-B messages. Input an ADS-B message and update the input values each second within 200 milliseconds of the next scheduled message transmission.

Verify that the updated values are not reflected in the next transmitted message, but are reflected in the message following that one and likewise for each subsequent input.

2.4.7.2.3 Verification of Requirements when Non-UTC Coupled (subparagraph 2.2.7.2.3)

Purpose/Introduction:

a. At the time of ADS-B message transmission, each most recent ADS-B message field provided to the transmitter within the previous 2.0 seconds **shall** be reflected in the subsequent transmitted message containing that message field.

b. No extrapolation of position **shall** be performed in this condition.

Measurement Procedure:

TBD

2.4.7.2.4 Verification of Data Timeout (subparagraph 2.2.7.2.4)

Purpose/Introduction:

At the Time of Applicability for the ADS-B message transmission, any ADS-B message fields without an update provided to the transmitter within the Data Lifetime parameter (in seconds) of Table 2.2.7.1 **shall** be encoded as “data unavailable” in the subsequent transmitted message containing that message field.

Measurement Procedure:

TBD

2.4.8 Verification of Receiver Characteristics (subparagraph 2.2.8)

No specific test procedure is required to validate subparagraph 2.2.8.

2.4.8.1 Verification of Receiving Diversity (subparagraph 2.2.8.1)

Purpose/Introduction:

"Receiving diversity" refers to an ADS-B receiving subsystem's use of signals received from either the top antenna, or the bottom antenna, or both antennas. For the purpose of these requirements, several alternate ADS-B receiving subsystem architectures that employ receiving antenna "diversity" are illustrated in Figure 2.2.8.1.

a. Full receiver and message processing function diversity:

   (see Figure 2.2.8.1, part a.)

   There are two receiver input channels, each with its own receiver front end, message synchronization, bit demodulation, and FEC decoding. All Successful Message Receptions from both channels **shall** be provided to the Report Assembly function. In the event both channels result in Successful Message Reception of identical messages, a single copy of this message may be provided.

b. Other diversity techniques. Other diversity implementations may be used. Any implementation must demonstrate equivalent or better performance to (a) above.

c. Receiving antenna switching:

   (see Figure 2.2.8.1, part b.)

   A single receiver input channel, consisting of receiver RF front end, message synchronization, bit demodulation and FEC decoding, is internally connected alternately and periodically, on the UTC second, between the top and bottom antennas. If this method is implemented, switching **shall** occur such that:

   1. Bottom and top antennas are alternated each second, AND

   2. No more than a single Long type ADS-B message arriving at the receiver at the beginning of the 1-second UTC Epoch is lost.

      Note: *The purpose of this requirement is to place an upper bound on the time to switch antennas.*

Measurement Procedure:

If receiver diversity is implemented using a switching technique as specified in subparagraph 2.2.8.1.c., the following procedure will verify that the receiver properly alternates between the top and bottom antenna ports within a time interval that results in the loss of no more than one Long ADS-B message.

Step 1: Receiver Switching Verification – Top Antenna Port

Input a valid Long ADS-B message to the Top antenna port of the receiver and terminate the Bottom antenna port. Input the message with timing relative to the UTC second, measured from the start of the first bit of the synchronization pattern, of –750 microseconds to 750 microseconds in 50 microsecond increments. Monitor and record the output of the receiver at each relative time interval to determine if the Long ADS-B message is successfully received.

Verify that the Long ADS-B message is received at all intervals less than or equal to -400 microseconds or greater than or equal to 400 microseconds relative to the UTC second.

Step 2: Receiver Switching Verification – Bottom Antenna Port

Repeat Step 1 except input a valid Long ADS-B message to the Bottom antenna port of the receiver and terminate the Top antenna port.

2.4.8.2 Verification of Receiver Performance (subparagraph 2.2.8.2)

No specific test procedure is required to validate subparagraph 2.2.8.2.

2.4.8.2.1 Verification of Receiver Sensitivity (subparagraph 2.2.8.2.1)

No specific test procedure is required to validate subparagraph 2.2.8.2.1.

2.4.8.2.1.1 Verification of Long ADS-B Message is Desired Signal (subparagraph 2.2.8.2.1.1)

Purpose/Introduction:

A desired signal level of –93 dBm applied at the antenna end of the feedline **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset plus air-to-air Doppler at 1200 knots closure/opening.

b. The desired signal is subject to the maximum modulation distortion allowed in subparagraph 2.2.2.4.

Note: *This also ensures that the Basic ADS-B Message will be received at the same desired signal level.*

This test verifies the compliance of the UAT receiver with the sensitivity requirements when the desired signal is a Long ADS-B message, under conditions of maximum Doppler shift and maximum allowed modulation distortion.

Equipment Required:

Desired Message Signal:

Provide a method of supplying the UUT with ADS-B messages having:

- RF Power Level: -93 dBm
- Center Frequency: 978 MHz +/- 2.0 kHz (see Note below)
- FM Deviation: 560 kHz (measured at the minimum eye pattern opening per subparagraph 2.2.2.4)
- Message Contents: Long ADS-B Message with pseudo-random payload data, and valid FEC Parity field per subparagraph 2.2.3.1.3.
- Message Rate: 100 per second

Note: *Maximum Doppler shift at 1200 knot closing rate is derived as follows: Velocity (m/s) = 1200 NM/hr * 1853 m/NM / 3600 sec/hr = 617 m/sec. Doppler shift = 617 m/sec / 3e+08 m/sec = 2.06 PPM. Frequency deviation due to Doppler shift is 978 MHz * 2.06 PPM = +/- 2.01 kHz.*

Measurement Procedures:

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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 at maximum negative frequency offset

Apply the **Desired Message Signal** with the Center Frequency set to the minimum value (978 MHz – 2.0 kHz) at the UUT receiver port.

Step 2: Measure the UUT receiver sensitivity

Decrease the input power level and determine the minimum RF signal required to produce an average reception rate of 90 percent by the UUT receiver.

Verify that this RF signal level is in compliance with the limits specified in subparagraph 2.2.8.2.1.1.

Step 3: Apply ADS-B Input Messages at maximum positive frequency offset

Apply the **Desired Message Signal** with the Center Frequency set to the minimum value (978 MHz + 2.0 kHz) at the UUT receiver port.

Step 4: Repeat UUT receiver sensitivity measurement

Repeat Step 2 to measure the UUT receiver sensitivity at the maximum positive frequency offset.

Step 5: Repeat for all Applicable Receiver Input Ports

Repeat Steps 1 through 4 for each applicable receiver RF input port of the UUT.

2.4.8.2.1.2 Verification of Ground Uplink Message is Desired Signal (subparagraph 2.2.8.2.1.2)

Purpose/Introduction:

A desired signal level of –91 dBm applied at the antenna end of the feedline **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset plus ground-to-air Doppler at 600 knots closure/opening.

b. The desired signal is subject to the maximum modulation distortion allowed in subparagraph 2.2.2.4.

Note: *This requirement ensures the baud rate accuracy supporting demodulation in the UAT equipment is adequate to properly receive the longer Ground Uplink message (assuming that the baud rate accuracy of the ground transmitter is 2 PPM).*

This test verifies the compliance of the UAT receiver with the sensitivity requirements when the desired signal is a Ground Uplink message, under conditions of maximum Doppler shift and maximum allowed modulation distortion.

Equipment Required:

Desired Message Signal:

Provide a method of supplying the UUT with ADS-B messages having:

- RF Power Level: -91 dBm
- Center Frequency: 978 MHz +/- 1.0 kHz (see Note below)
- FM Deviation: 560 kHz (measured at the minimum eye pattern opening per subparagraph 2.2.2.4)
- Message Contents: Ground Uplink Message with pseudo-random payload data, with valid FEC Parity field and Interleaving per subparagraph 2.2.3.2.
- Message Rate: 10 per second in the Uplink segment only.

Note: *Maximum Doppler shift at 600 knot ground speed is derived as follows: Velocity (m/s) = 600 NM/hr * 1853 m/NM / 3600 sec/hr = 308 m/sec. Doppler shift = 308 m/sec / 3e+08 m/sec = 1.007 PPM. Frequency deviation due to Doppler shift is 978 MHz * 1.03 PPM = +/- 1.0 kHz.*

Measurement Procedures:

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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 Ground Uplink Input Messages at maximum negative frequency offset

Apply the **Desired Message Signal** with the Center Frequency set to the minimum value (978 MHz – 1.0 kHz) at the UUT receiver port.

Step 2: Measure the UUT receiver sensitivity

Decrease the input power level and determine the minimum RF signal required to produce a reception rate of 90 percent by the UUT receiver, averaged over a minimum of 100 received messages.

Verify that this RF signal level is in compliance with the limits specified in subparagraph 2.2.8.2.1.2.

Step 3: Apply Ground Uplink Input Messages at maximum positive frequency offset

Apply the **Desired Message Signal** with the Center Frequency set to the minimum value (978 MHz + 1.0 kHz) at the UUT receiver port.

Step 4: Repeat UUT receiver sensitivity measurement

Repeat Step 2 to measure the UUT receiver sensitivity at the maximum positive frequency offset.

Step 5: Repeat for all Applicable Receiver Input Ports

Repeat Steps 1 through 4 for each applicable receiver RF input port of the UUT.

2.4.8.2.2 Verification of Receiver Desired Signal Dynamic Range (subparagraph 2.2.8.2.2)

Purpose/Introduction:

The receiver **shall** achieve a Successful Message Reception rate of 99% or better when the desired signal level is between –90 dBm and –10 dBm at the antenna in the absence of any interfering signals.

Notes:

1. *The value of –10 dBm represents 120-foot separation from an A3 transmitter at maximum allowed power.*

2. *Certain installations that rely on over-air reception of the own-ship transmission to meet the requirements of subparagraph 2.2.6.3 may need to achieve Successful Message Reception at significantly higher levels than –10 dBm.*

This test verifies the compliance of the UAT receiver with the dynamic range requirements. The desired signal is the Long ADS-B Message.

Equipment Required:

Desired Message Signal:

Provide a method of supplying the UUT with ADS-B messages having:

- RF Power Level: -90 dBm
- Frequency: 978.0 MHz
- FM Deviation: 625 kHz (measured at the minimum eye pattern opening per subparagraph 2.2.2.4)
- Message Contents: Long ADS-B Message with pseudo-random payload data, and valid FEC Parity field per subparagraph 2.2.3.1.3.
- Message Rate: 100 per second (recommended minimum)

Measurement Procedures:

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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 the **Desired Message Signal** at the UUT receiver input port.

Step 2: Measure the UUT receiver sensitivity

Decrease the input power level and determine the minimum RF signal required to produce an average reception rate of 99 percent by the UUT receiver. At least 1000 message receptions should be measured in making this determination.

Verify that this RF signal level is in compliance with the limits specified in subparagraph 2.2.8.2.2.

Step 3: Verify the UUT receiver dynamic range

Starting from the signal level measured in Step 2, increase the input signal by 10 dB steps, up to a level of –10 dBm.

At each step, verify that the receiver properly detects and decodes at least 99% of the Desired Messages received per subparagraph 2.2.8.2.2.

Step 4: Repeat for all Applicable Receiver Input Ports

Repeat Steps 1 through 4 for each applicable receiver RF input port of the UUT.

2.4.8.2.3 Verification of Receiver Selectivity (subparagraph 2.2.8.2.3)

Purpose/Introduction:

These test procedures verify that the receiver **shall** provide the following minimum signal rejection ratios as a function of frequency offset as listed in Table 2.2.8.2.3.

Equipment Required:

The tests performed in this subparagraph require the following equipment:

a. Vector Signal Analyzer (VSA), or an equivalent Signal Analyzer, with minimum capabilities of displaying the envelope of a captured ADS-B Long message, displaying a corresponding spectrum, band power markers, and the corresponding computed band power. Examples: HP89441A, or the HP89600 series.

b. Signal Generator (SG), with minimum capabilities of up to 1 GHz carrier, power levels up to 0 dBm, continuous wave (CW) and digital two-state FSK modulation at a rate greater than 1 megabits/second, selectable root raised cosine and rectangular filtering, internal and external triggering, programmable power levels and bit states. Example: Rohde & Schwarz (Tektronix) SMIQ-02B.

c. Four Terminal Hybrid Junction with a frequency range covering 1 GHz.

For this subparagraph, configure the Vector Signal Analyzer equipment for Vector Mode according to Table 2.4.8.2.3a.

Note: *Equipment parameter labels, menus, setup options, and units may vary from one manufacturer to another, and parameter labels are usually abbreviated. In Tables 2.4.8.2.3a and 2.4.8.2.3b, text enclosed in brackets is not displayed on the HP89441A display. The bracketed text is added to clarify the functional terms and setting values for those using neither the HP89441A, nor the SMIQ-02B.*

Table 2.4.8.2.3a: Vector Mode Configuration

VECTOR SIGNAL ANALYZER PARAMETER SETTINGS	
Parameter Item/Function	**Parameter Setting Value**
Preset	(press to Preset Equipment)
Instrument Mode	Vector
Frequency / center frequency	978 MHz
Frequency / frequency span	preferably 5 MHz
ResBW/Window / main length	450 us
ResBW/Window / main window	Hanning
ResBW/Window / num[ber of] freq[uency] p[oin]ts	3201
Range / ch[annel] 1 [signal] range	–35 dBm
Time / gate	off
Time / gate length	400 us
Time / ch[annel]1 gate d[e]l[a]y	25 us
Average / average	on
Average / num[ber of] averages	50
Average / average type	rms expo[nential]
Trigger / trigger type	IF ch[annel]1
Trigger / ext[ernal] level	0.0005 V[olts]
Trigger / ch1 delay	-17.5 us
Display	2 grids
Trace A – Measurement Data	main time
Trace A – Data Format	magnitude linear
Trace A – RefLvl/Scale / Y ref level	0 uVpk
Trace A – RefLvl/Scale / Y per div[ision]	700 uVpk
Trace A – RefLvl/Scale / ref[erence] position	0 %
Trace B – Measurement Data	spectrum
Trace B – Data Format	magnitude log(dB)
Trace B – RefLvl/Scale / Y ref level	-70 dBm
Trace B – RefLvl/Scale / Y per div[ision]	7.5 dB
Trace B – RefLvl/Scale / ref[erence] position	100 %
Trace B – Marker Function / band power markers / band pwr mkr	on
Trace B – Marker Function / band power markers / band center	978 MHz
Trace B – Marker Function / band power markers / band width	3 MHz
Trace B – Marker Function / band power markers / [computation]	band power

For this subparagraph, configure the Signal Generator equipment according to Table 2.4.8.2.3b.

Table 2.4.8.2.3b: Signal Generator Configuration

SIGNAL GENERATOR PARAMETER SETTINGS	
Parameter Item/Function	**Parameter Setting Value**
Preset	(press to Preset Equipment)
RF ON/OFF	RF OFF
FREQUENCY	979 MHz
LEVEL	-35 dBm
DIGITAL MOD[ULATION] / STATE	OFF

Measurement Procedures:

Step 1: Equipment Setup (subparagraph 2.2.8.2.3)

For the tests in this subparagraph, configure the Vector Signal Analyzer according to the Vector Mode setup listed in Table 2.4.8.2.3a. See Appendix N for the state file “UAT-VECT.STA” to automatically setup the HP89441A Vector Signal Analyzer. As the very last configuration step, set Time / gate to “on.”

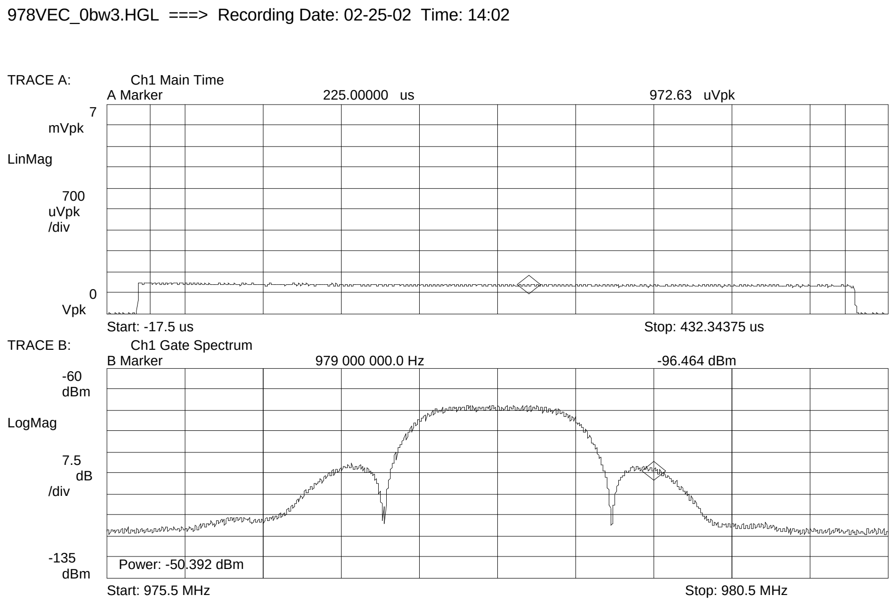
Configure the Signal Generator equipment according to the setup listed in Table 2.4.8.2.3b.

Step 2: Receiver Selectivity Pre-Test Setup (subparagraph 2.2.8.2.3)

Using a Four Terminal Hybrid Junction, connect the Signal Generator, and an attenuated ADS-B Transmitter, to the ADS-B Receiving Equipment, and to the Vector Signal Analyzer. At the output of the ADS-B Transmitter, adjust the attenuation to present a signal of –50 ± 0.5 dBm to the ADS-B Receiving Equipment, and initiate a series of Long ADS-B test messages, each having the following message elements: the 36 bit SYNCH, followed by a 272 bit Payload having a pseudo-random series of bits which changes for each successive message, and a 112 bit FEC as generated by the Reed-Solomon algorithm. Trace A should show: 1) a stable triggered message envelope, 2) that the leftmost vertical gating line occurs just after the rise of the envelope, and 3) that the rightmost gating line occurs just before the fall of the envelope.

Step 3: Receiver Selectivity Pre-Test Setup (subparagraph 2.2.8.2.3)

The Vector Signal Analyzer Trace A display should resemble the upper trace of Figure 2.4.8.2.3a, and the Vector Signal Analyzer Trace B display should resemble the lower trace of Figure 2.4.8.2.3a. Verify that the ADS-B Receiving Equipment is reporting all received test messages.



<u>Figure 2.4.8.2.3a</u>: ADS-B Long Message Envelope & Spectrum – No Interference

<u>Step 4:</u> <u>Receiver Selectivity Pre-Test Setup (subparagraph 2.2.8.2.3)</u>

Ensure that the Signal Generator is programmed for Continuous Wave at a frequency of 979 MHz, and ensure that the Vector Signal Analyzer Range / ch[annel] 1 [signal] range is –35 dBm. Turn the Signal Generator RF ON/OFF to "ON," place the Trace B marker at 979 MHz, temporarily turn the Vector Signal Analyzer Average / average to "off," and adjust the received Signal Generator signal level P_{CW} ("Power" displayed at lower-left of Trace B) to be –35 ± 0.5 dBm. The Vector Signal Analyzer Trace A display should resemble the upper trace of Figure 2.4.8.2.3b, and the Vector Signal Analyzer Trace B display should resemble the lower trace of Figure 2.4.8.2.3b. Verify that the ADS-B Receiving Equipment is reporting all received test messages.

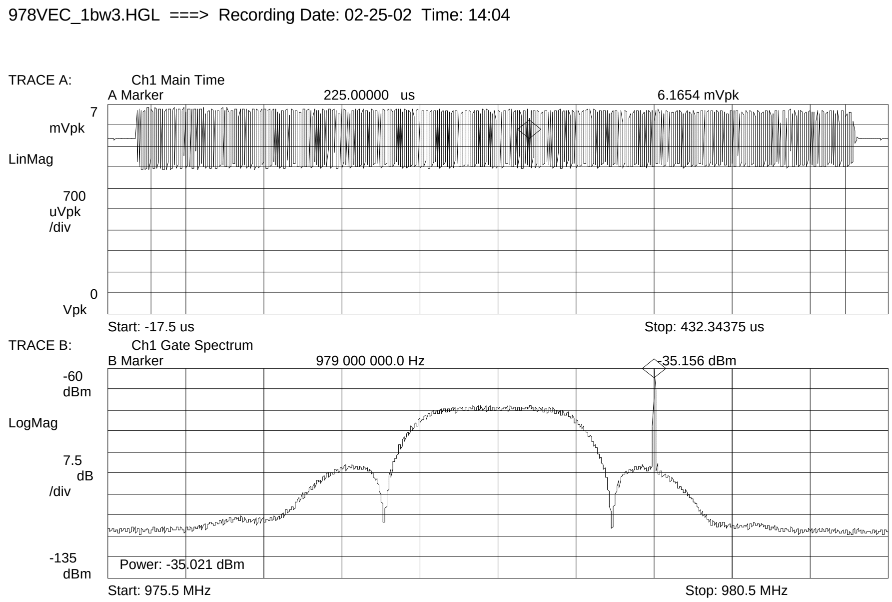


Figure 2.4.8.2.3b: ADS-B Long Message Envelope & Spectrum– With CW

Step 5: Receiver Selectivity Test (subparagraph 2.2.8.2.3)

Reduce the Signal Generator output by 40 dB, and reduce the ADS-B Transmitter output by 40 dB so that the UAT test message power level at the ADS-B Receiver input is P_{RCVR} = –90 ± 0.5 dBm. Using Table 2.4.8.2.3c, for each class of equipment, and for each frequency offset (above and below center frequency), adjust the Signal Generator Continuous Wave level at the ADS-B Receiver input to the level shown (adjusting the Vector Signal Analyzer Trace B - Marker Function / band center frequency as needed), and adjust the Vector Signal Analyzer Range per column 4 of the Table (or as needed to avoid distorted results). In each case, count a total of at least 2500 test messages, count the number of good messages, and verify that the ADS-B Receiver is reporting good received test messages at a 99% Message Success Rate.

Table 2.4.8.2.3c: Selectivity Rejection Ratios

Center Frequency Offset, f_0	**Continuous Wave Interference Level(dB)**		**Vector Signal Analyzer Range**
	Equipment Class A0, A1L, A1H, A2	**Equipment Class A3**	
±1.0 MHz	[-75]	[??]	-50 dBm
±2.0 MHz	[-40]	[??]	-35 dBm
±10.0 MHz	[-30]	[??]	-25 dBm

2.4.8.2.4 Verification of Receiver Tolerance to Pulsed Interference (subparagraph 2.2.8.2.4)

Purpose/Introduction:

The receiver **shall** be capable of receiving messages in the presence of interference from on channel and off channel sources of pulse interference. The receiver **shall** be tolerant to pulse interference from TACAN/DME. The UAT receiver may experience pulsed interference from TACAN/DME channels operating in the 978 MHz to 1215 MHz frequency range. The UAT receiver must also be tolerant of pulsed interference from other L-Band systems operating and located on the aircraft. These may include 1030 MHz ATCRBS/Mode S interrogation signals from on-board TCAS and 1090 MHz ATCRBS/Mode S reply signals from on-board ATCRBS/Mode S Transponders. The receiver **shall** meet the reception probability dictated under the following conditions:

a. For all equipment classes:

   The receiver **shall** be capable of achieving 99% reception probability of ADS-B messages when the desired signal level is between –90 dBm and –10 dBm when subjected to TACAN/DME interference under the following conditions: TACAN/DME pulse pairs at a nominal rate of 3,600 pulse pairs per second at either 12 or 30 microseconds pulse spacing at a level of –30 dBm for any 1 MHz channel frequency between 980 MHz an 1215 MHz inclusive.

b. For the A0, A1L, A1H, and A2 equipment classes:

   The receiver **shall** be capable of achieving 90% reception probability of ADS-B messages when the desired signal level is between –88 dBm and –10 dBm when subjected to TACAN/DME interference under the following conditions: TACAN/DME pulse pairs at a nominal rate of 3,600 pulse pairs per second at a 12 microseconds pulse spacing at a level of –53 dBm and a frequency of 979 MHz.

c. For the A3 equipment class:

   The receiver **shall** be capable of achieving 90% reception probability of ADS-B messages when the desired signal level is between –88 dBm and –10 dBm when subjected to TACAN/DME interference under the following conditions: TACAN/DME pulse pairs at a nominal rate of 3,600 pulse pairs per second at a 12 microseconds pulse spacing at a level of –42 dBm and a frequency of 979 MHz.

d. Following a 21 microsecond pulse at a level of 0 dBm and at a frequency of 1090 MHz, the receiver **shall** return to within 3 dB of normal sensitivity level within 12 microseconds.

Equipment Required:

The tests performed in this subparagraph require Vector Signal Analyzer equipment as described in subparagraph 2.4.8.2.3.

Also required is a TACAN/DME source, which is capable of producing 3600 pulse pairs per second, with pulse pair spacings of 12 and 30 microseconds, and a power level of up to –30 dBm. Example: IFR ATC-1400A Transponder/DME Test Set.

Measurement Procedures:

Step 1: Pulsed Interference Tolerance Pre-Test Setup (subparagraph 2.2.8.2.4)

For the tests in this subparagraph, configure the Vector Signal Analyzer according to the Vector Mode setup listed in Table 2.4.8.2.3. See Appendix N for the state file “UAT-VECT.STA” to automatically setup the HP89441A Vector Signal Analyzer. As the very last configuration step, set Time / gate to “on.”

Configure the TACAN/DME source to output 3600 DME pulse pairs per second, spaced at 12 microseconds apart, at a frequency of 980 MHz, with the output level set to –56 dBm, and with output power initially “OFF.”

Step 2: Pulsed Interference Tolerance Pre-Test Setup (subparagraph 2.2.8.2.4)

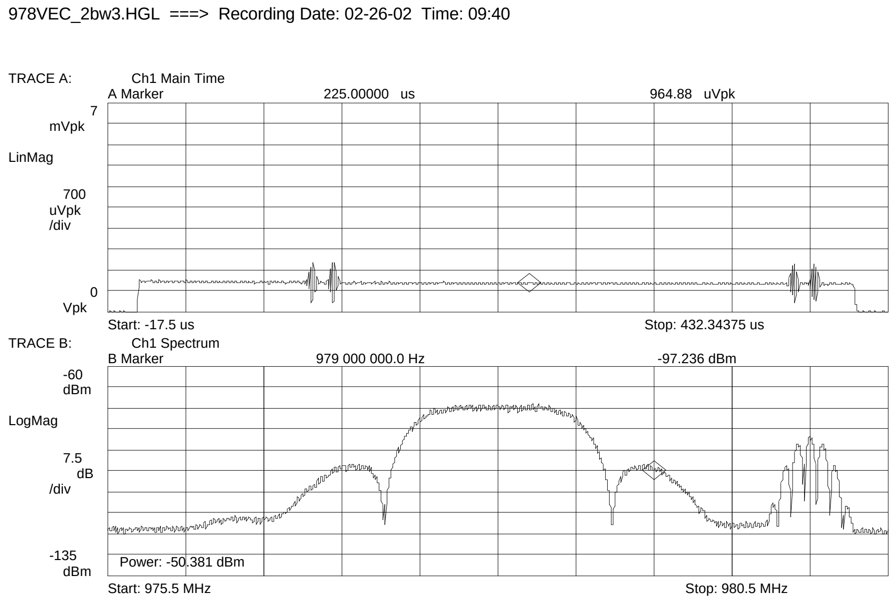
Using a Four Terminal Hybrid Junction, connect an attenuated TACAN/DME, and an attenuated ADS-B Transmitter, to the ADS-B Receiving Equipment, and to the Vector Signal Analyzer. At the output of the ADS-B Transmitter, adjust the attenuation to present a signal of –50 ± 0.5 dBm to the ADS-B Receiver input, and initiate a series of Long ADS-B test messages, each having the following message elements: the 36 bit SYNCH, followed by a 272 bit Payload having a pseudo-random series of bits which changes for each successive message, and a 112 bit FEC as generated by the Reed-Solomon algorithm. Trace A should show: 1) a stable triggered message envelope, 2) that the leftmost vertical gating line occurs just after the rise of the envelope, and 3) that the rightmost gating line occurs just before the fall of the envelope.

Step 3: Pulsed Interference Tolerance Pre-Test Setup (subparagraph 2.2.8.2.4)

The Vector Signal Analyzer Trace A display should resemble the upper trace of Figure 2.4.8.2.3a. The Vector Signal Analyzer Trace B display should resemble the lower trace of Figure 2.4.8.2.3a. Verify that the ADS-B Receiving Equipment is reporting all received test messages.

Step 4: Pulsed Interference Tolerance Pre-Test Setup (subparagraph 2.2.8.2.4)

Turn the TACAN/DME source “ON,” and adjust the Vector Signal Analyzer Time / gate length and Time / ch[annel]1 gate d[e]l[a]y to bracket one of the DME pulses, and adjust the received TACAN/DME source signal level P_{DME} (“Power” displayed at lower-left of Trace B) to be –56 ± 0.5 dBm. Adjust the Vector Signal Analyzer Trigger / IF level to about 900 uV to present a stabile display of the ADS-B test message. The Vector Signal Analyzer Trace A display should resemble the upper trace of Figure 2.4.8.2.4a, and the Vector Signal Analyzer Trace B display should resemble the lower trace of Figure 2.4.8.2.4a. Verify that the ADS-B Receiving Equipment is reporting all received test messages.



<u>Figure 2.4.8.2.4a:</u> ADS-B Long Message Envelope & Spectrum– With TACAN/DME

<u>Step 5:</u> <u>Off Channel Pulsed Interference Tolerance Test – Greater than 1 MHz Offset (subparagraph 2.2.8.2.4)</u>

Increase the Vector Signal Analyzer Range / ch[annel]1 range to –30 dBm, increase the Signal Generator output by 26 dB so that the DME level at the ADS-B Receiver input is P_{RCVR} = –30 ± 0.5 dBm, and reduce the ADS-B Transmitter output by 40 dB so that the level at the ADS-B Receiver input is P_{RCVR} = –90 ± 0.5 dBm. For each equipment class, and for each frequency from 980 MHz to 985 MHz in 1 MHz steps, and from 990 MHz to, and including 1215 MHz in 50 MHz steps, count a total of at least 2500 test messages, count the number of good messages, and verify that the ADS-B Receiver is reporting good received test messages at a 99% Message Success Rate.

<u>Step 6:</u> <u>Off Channel Pulsed Interference Tolerance Test – Greater than 1 MHz Offset (subparagraph 2.2.8.2.4)</u>

Reconfigure the DME source to produce pulse pairs spaced at 30 microseconds apart. For each equipment class, and for each frequency from 980 MHz to 985 MHz in 1 MHz steps, and from 990 MHz to, and including 1215 MHz in 50 MHz steps, count a total of at least 2500 test messages, count the number of good messages, and verify that the ADS-B Receiver is reporting good received test messages at a 99% Message Success Rate.

Execute either step 7a, or step 7b, depending on equipment class.

Step 7a: Off Channel Pulsed Interference Tolerance Test – 1 MHz Offset (subparagraph 2.2.8.2.4)

For A0, A1L, A1H, and A2 equipment classes only:

Decrease the Signal Generator output by 31 dB so that the DME level at the ADS-B Receiver input is P_{RCVR} = –61 ± 0.5 dBm, change the Signal Generator frequency to 979 MHz, decrease the Vector Signal Analyzer Range / ch[annel]1 range to –50 dBm, and increase the ADS-B Transmitter output by 2 dB so that the level at the ADS-B Receiver input is P_{RCVR} = –88 ± 0.5 dBm.

For each of the A0, A1L, A1H, and A2 equipment classes, make adjustments to the ADS-B Transmitter output so that the levels at the ADS-B Receiver input are P_{RCVR} = within ± 0.5 dBm of –88 to -85 in 1 dB steps, and –80 to –10 dBm in 10 dB steps, and in each case, count a total of at least 2500 test messages, count the number of good messages, and verify that the ADS-B Receiver is reporting good received test messages at a 99% Message Success Rate.

Step 7b: Off Channel Pulsed Interference Tolerance Test – 1 MHz Offset (subparagraph 2.2.8.2.4)

For A3 equipment class only:

Decrease the Signal Generator output by 18 dB so that the DME level at the ADS-B Receiver input is P_{RCVR} = –48 ± 0.5 dBm, change the Signal Generator frequency to 979 MHz, decrease the Vector Signal Analyzer Range / ch[annel]1 range to –45 dBm, and increase the ADS-B Transmitter output by 2 dB so that the level at the ADS-B Receiver input is P_{RCVR} = –88 ± 0.5 dBm.

For the A3 equipment class, make adjustments to the ADS-B Transmitter output so that the levels at the ADS-B Receiver input are P_{RCVR} = within ± 0.5 dBm of –88 to -85 in 1 dB steps, and –80 to –10 dBm in 10 dB steps, and in each case, count a total of at least 2500 test messages, count the number of good messages, and verify that the ADS-B Receiver is reporting good received test messages at a 99% Message Success Rate.

2.4.8.2.5 Verification of Receiver Tolerance to Overlapping ADS-B Messages (Self Interference) (subparagraph 2.2.8.2.5)

Purpose/Introduction:

A Successful Message Reception rate of 90% or better, for the stronger of two overlapping desired messages, **shall** result when the level of the stronger message is no weaker than -80 dBm and the stronger message is at least ***X*** dB above the weaker message, when the stronger message and weaker message are aligned in time.

Where the value of ***X*** is:

4 dB for Equipment Classes A0, A1L, A1H, and A2

9 dB for Equipment Class A3

Notes:

1. *The different values across equipment classes reflect the fact that Class A3 receivers will utilize a narrow filter that degrades demodulation performance slightly in order to gain added rejection from adjacent channel DME ground stations.*

2. *Signal values ensure both the desired and undesired signal levels are above the noise floor.*

This test verifies the compliance of the UAT receiver with the requirements for reception of overlapping Long ADS-B messages.

Equipment Required:

Desired Message Signals:

Provide a method of supplying the UUT with two sources of desired Long ADS-B messages that are aligned in time to within 5 microseconds, with the following characteristics:

Message Source 1

- RF Power Level: -80 dBm

Message Contents:
- Payload Type Code = 1
- Address Qualifier = 0
- ICAO address: 0x000001
- Fill remaining payload with pseudo-random payload data, and valid FEC Parity field per subparagraph 2.2.3.1.3.
- Message Rate: 100 per second

Message Source 2

- RF Power Level: -68 dBm

Message Contents:
- Payload Type Code = 1
- Address Qualifier = 0
- ICAO address: 0x000002
- Fill remaining payload with pseudo-random payload data, and valid FEC Parity field per subparagraph 2.2.3.1.3.
- Message Rate: 100 per second

Measurement Procedures:

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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.

<u>Step 1:</u> <u>Apply ADS-B Input Messages</u>

Apply the **Desired Message Signals** at the UUT receiver input port. Observe that the UUT equipment reports reception of messages with ICAO address 0x000002 at the rate specified in subparagraph 2.2.8.2.5.

<u>Step 2:</u> <u>Measure the Receiver Tolerance to Overlapping Messages</u>

Reduce the input signal level for Message Source 2 and determine the minimum level required to produce a 90% message reception rate of messages with ICAO Address 0x000002 by the UUT receiver. Verify that the measured performance is in compliance with the limits specified in subparagraph 2.2.8.2.5 for the appropriate category of receiver equipment.

Set the signal level for Message Source 2 to –80 dBm.

Increase the input signal level for Message Source 1 and determine the minimum level required to produce a 90% message reception rate of messages with ICAO Address 0x000001 by the UUT receiver. Verify that the measured performance is in compliance with the limits specified in subparagraph 2.2.8.2.5 for the appropriate category of receiver equipment.

<u>Notes:</u>

1. *This procedure demonstrates that the UUT can receive messages from both Message Sources, and that the control variable in this procedure is the input signal level.*

2. *Performing this procedure on all applicable receiver ports is not necessary, once the procedure of subparagraph 2.4.8.2.1 (Receiver Sensitivity) has been executed and validated.*

2.4.8.3 Verification of Receiver Message Processing (subparagraph 2.2.8.3)

No specific test procedure is required to validate subparagraph 2.2.8.3.

2.4.8.3.1 Verification of Criteria for Successful Message Reception (subparagraph 2.2.8.3.1)

No specific test procedure is required to validate subparagraph 2.2.8.3.1.

2.4.8.3.1.1 Verification of ADS-B Messages (subparagraph 2.2.8.3.1.1)

<u>Purpose/Introduction:</u>

The receiver **shall** declare Successful Message Receipt for an ADS-B message when there are NO uncorrected errors indicated by the RS decoding process. The decoding process **shall** use hard decision decoding with no erasures allowed.

<u>Notes</u>*:*

1. *Message format (Basic vs Long ADS-B) can be ascertained by attempting to decode both forms of the RS block if necessary.*

2. *Appendix M provides the analytic determination of the Undetected Message Error Rate (UMER) achieved though use of the RS coding. Due to the straightforward*

calculation of the UMER and the fact that the UMER is quite low, no explicit requirement/test is needed for a "False Message Reception Rate."

The following test procedures will verify that the ADS-B UAT receiver system correctly declares the Successful Receipt of ADS-B Messages as defined in subparagraph 2.2.8.3.1.1. The ADS-B UAT receiver system declares the Successful Message Reception when there are NO uncorrected errors indicated by the RS decoding process.

The Corrupted Messages (Erroneous Messages) provided in the Tables are designed as follows:

a. Table 2.4.8.3.1.1A has burst errors of three different sizes (50/42/12 consecutive erroneous bits) that are NOT perfectly lined up with the byte boundary of ADS-B Message symbols.

   The errors in each message are at different BIT POSITIONS and the number of erroneous symbols induced into the ADS-B Messages largely depends on where the error burst resides in the ADS-B Message sequence.

b. Table 2.4.8.3.1.1B has random burst errors that are perfectly lined up with the byte boundary of the ADS-B Message symbols. The errors in each message are at different symbol positions and the number of erroneous symbols induced into the ADS-B Messages can be from 1 to 10 bytes.

<u>Equipment Required:</u>

Provide a method to supply controlled ADS-B Messages to the appropriate ADS-B UAT Receiver input.

<u>Measurement Procedures:</u>

<u>Step 1:</u> <u>Establish the Initial Conditions</u>

Configure the ADS-B UAT Receiver system to receive both Basic and Long ADS-B messages and verify that the interface is providing the test data to the Receiver system.

<u>Step 2:</u> <u>Verify Successful Message Reception of ADS-B Message (subparagraph 2.2.8.3.1.1)</u>

a. Load the set of test messages given in Table 2.4.8.3.1.1A and Table 2.4.8.3.1.1B into the Receiver input.

<u>Notes:</u>

1. *This test procedure is designed based on the assumption that the RS decoder has the ability to sort (with very high probability) which of two possible types was actually sent.*

2. *The size of the provided stimulus given in column 2 of Table 2.4.8.3.1.1A and Table 2.4.8.3.1.1B is the same as the size of the long ADS-B Message. The decoder will first attempt to decode the incoming data sequence as a Long Message and if it fails, it will attempt to decode it as a Short Message.*

b. For each case of provided stimulus given in Table 2.4.8.3.1.1A and Table 2.4.8.3.1.1B, verify that the ADS-B UAT Receiver system properly reports Successful Messages (Corrected Messages when errors induced in the Messages are correctable) and the associated Message Types as described in column numbers 5 and 4 of Table 2.4.8.3.1.1A and Table 2.4.8.3.1.1B.

c. Verify that the Receiver system reports neither Message Type nor Payload Data other than “DATA NOT AVAILABLE (N/A)” in the cases where there are more errors than it is capable of correcting as described in column numbers 5 and 4 of Table 2.4.8.3.1.1A and Table 2.4.8.3.1.1B.

CAUTION: *RS decoder shall use hard decision decoding to meet the proper Message Error Rate requirement.*

Table 2.4.8.3.1.1A: ADS-B Message Reception

No.	Erroneous ADS-B Messages	Status	Type	RS Decoded ADS- B Messages
1	908196782DD44238C1453855F89980C7524FE9DC42D5621A BB990C04D2E2761BBCD9FCC817D82E2D1ACF90CA78DA3C49	[1]Pass$_{b42}$	Basic	6F7E6987D2D74238C1453855F89980C7524F
2	6F7E6987D328BDC73EBA3955F89980C7524FE9DC42D5621A BB990C04D2E2BB7B190B2EA0EACC7237B7B01B036E07EE04	[1]Fail $_{b42}$	N/A	N/A
3	6F7E6987D2D74238C146C7AA07667FC7524FE9DC42D5621A BB990C04D2E2DBE78F0C386EB860D64E9BA9E06B95BEB66A	[1]Pass$_{b42}$	Basic	6F7E6987D2D74238C1453855F89980C7524F
4	6F7E6987D2D74238C1453855F8998738ADB016A342D5621A BB990C04D2E2171F980B40C8B76AC0791254EE04AA73A982	[1]Pass$_{b42}$	Basic	6F7E6987D2D74238C1453855F89980C7524F
5	6F7E6987D2D74238C1453855F89980C7524FE9D3BD2A9DE5 84990C04D2E2B22C710A46621200763F2DF70CBCBFCA1721	[1]Pass$_{b42}$	Basic	6F7E6987D2D74238C1453855F89980C7524F
6	5A8CAA4ABC7AEE2AD0929EB80DA044D556B452A7A73A5716 CD1DB40964F5BA105D9DAAD75342196DEBB63CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
7	A57355B5438412D52F6D61470CA044D556B452A7A73A5716 CD1DB40964F5BA105D9DAAD75342196DEBB63CC972994DEA	[1]Fail $_{b50}$	N/A	N/A
8	A57355B54385ED2AD0929EBBF25FBB2AA94B52A7A73A5716 CD1DB40964F5BA105D9DAAD75342196DEBB63CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
9	A57355B54385ED2AD0929EB80DA044D556B3AD5858C5A869 CD1DB40964F5BA105D9DAAD75342196DEBB63CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
10	A57355B54385ED2AD0929EB80DA044D556B452A7A73A5719 32E24BF69BCABA105D9DAAD75342196DEBB63CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
11	A57355B54385ED2AD0929EB80DA044D556B452A7A73A5716 CD1DB40964EA45EFA26255C85342196DEBB63CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
12	A57355B54385ED2AD0929EB80DA044D556B452A7A73A5716 CD1DB40964F5BA105D9DAAE8ACBDE69214B93CC972994DEA	[1]Pass$_{b50}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
13	51D7E73F83C10D2BF6B961410BEE0C2FD5A4E3764EE8CB3E 336C974D3A9FF64260211F48524C5A5590A16E3EAF4068AB	[1]Pass$_{b42}$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4
14	AE2818C07D3DF2D4094660410BEE0C2FD5A4E3764EE8CB3E 336C974D3A9F6DD7F172B5B56FF8F49067515A8A55D64D5E	[1]Fail $_{b42}$	N/A	N/A
15	AE2818C07CC20D2BF6BA9EBEF411F32FD5A4E3764EE8CB3E 336C974D3A9FC06F20916457C90BC47D261C8DEFE3ED74C5	[1]Pass$_{b42}$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4
16	AE2818C07CC20D2BF6B961410BEE0BD02A5B1C094EE8CB3E 336C974D3A9F33CE68A8ABDCF663EAF24B3B2B1369D92C8D	[1]Pass$_{b42}$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4
17	AE2818C07CC20D2BF6B961410BEE0C2FD5A4E379B11734C1 0C6C974D3A9F15B194556A7E44E71C724666C96E55DEE72E	[1]Pass$_{b42}$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4

18	D6199AB732C4F6BAD854BDD26B14598C515810717B02C9C7 9B79F029CEEE6B4DD1E8F1F77F4CAB43AD74CBB01ECD155C	[1]Fail_{b50}	N/A	N/A
19	D6199AB732C5094527AB422E95EBA673AEA710717B02C9C7 9B79F029CEEE6B4DD1E8F1F77F4CAB43AD74CBB01ECD155C	[1]Pass_{b50}	Long	D6199AB732C5094527AB422D6A14598C515810717B02C9 C79B79F029CEEE6B4DD1E8
20	AC87A823307BB8091FCD45DB71A6613830C7C4D859F34BD3 05CED0F22A0F56B23FE012E38800FEA87CD23E50498A0BE0	[1]Fail_{b42}	N/A	N/A
21	87AAEE174F870829071A6AA2FEE44BBE816ED8C89004918D 683DD22C608523EFAC727A23A788A711FCA51139D874D5C8	[1]Fail_{b50}	N/A	N/A
22	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C890049182 97C22DD39FBA23EFAC727A23A788A711FCA51139D874D5C8	[1]Pass_{b50}	Long	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C8900491 8D683DD22C608523EFAC72
23	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C89004918D 683DD22C609ADC10538D853CA788A711FCA51139D874D5C8	[1]Pass_{b50}	Long	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C8900491 8D683DD22C608523EFAC72
24	46D9B1EE2C1721937FD831A5E99E1D0BB742FF717C21B9BB 21D0B164595D7181B14C131EA2DCCDD5B86D46824464BE9A	[1]Fail_{b50}	N/A	N/A
25	46D9B1EE2C16DE6C8027CE5AE89E1D0BB745008E83DE46C4 21D0B164595D7181B14C131EA2DCCDD5B86D46824464BE9A	[1]Pass_{b50}	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C
26	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9B4 DE2F4E9BA6627181B14C131EA2DCCDD5B86D46824464BE9A	[1]Pass_{b50}	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C
27	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9BB 21D0B16459428E7E4EB3EC01A2DCCDD5B86D46824464BE9A	[1]Pass_{b50}	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C
28	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9BB 21D0B164595D7181B14C13215D23322A476246824464BE9A	[1]Pass_{b50}	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C
29	287F318C2A9FFF7F0784CA4036E252DEB0226A9F9E183CBB 933FA68DBF5E1F018F635195DE87894F16BDA55E42A64137	[1]Pass_{b42}	Basic	D780CE73D59CFF7F0784CA4036E252DEB022
30	D780CE73D4630080F87BCB4036E252DEB0226A9F9E183CBB 933FA68DBF5E161C9333D935A0C83220FC2799D84A139CAB	[1]Fail_{b42}	N/A	N/A
31	157A70631C56E8945CF8C8F7844B66FF4083C2AF2D96F628 422CDA1A522295B85ED8C975F24E9B5B41FBB3A402210E02	[1]Pass_{b50}	Long	157A70631C56E8945CF8C8F7844B66FF4083C2AF2D96F6 28422CDA1A522295B85ED8
32	773448BE613236BD3F0C53F45DCA5CC6F0B2C0A92F6B6DF3 072E0BEFFC8ADAA641EE602AC8B2DDE9A4429FAAB9AFD694	[1]Pass_{b50}	Long	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6D F3072E0BEFFC8ADAA641EE
33	88CBB7419ECCCA42C0F3AC0B5CCA5CC6F0B2C0A92F6B6DF3 072E0BEFFC8ADAA641EE602AC8B2DDE9A4429FAAB9AFD694	[1]Fail_{b50}	N/A	N/A
34	88CBB7419ECD35BD3F0C53F7A235A3390F4DC0A92F6B6DF3 072E0BEFFC8ADAA641EE602AC8B2DDE9A4429FAAB9AFD694	[1]Pass_{b50}	Long	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6D F3072E0BEFFC8ADAA641EE
35	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6DF3 072E0BEFFC8ADAA641EE6015374D22165B4D9FAAB9AFD694	[1]Pass_{b50}	Long	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6D F3072E0BEFFC8ADAA641EE
36	EE62BBECF66420F249ECF8FBC08F8FB3092B6EB4C61D6C26 4DB6F333BEA5570E0407693351FA9161858E6460DE629EFE	[1]Pass_{b50}	Long	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C 264DB6F333BEA5570E0407

37	119D4413099B23F249ECF8FBC08F8FB3092C914B39E29359 4DB6F333BEA5570E0407693351FA9161858E6460DE629EFE	[1]Pass$_{b50}$	Long	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C 264DB6F333BEA5570E0407
38	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C26 4DB6F333BEA5570E0407690CAE056E9E7A816460DE629EFE	[1]Pass$_{b50}$	Long	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C 264DB6F333BEA5570E0407
39	908E6987D2D74238C145C7A5F89980C7524FE9DC42D5621A BB990C04D2E2761BBCD9FCC817D82E2D1ACF90CA78DA3C49	[3]Pass$_{b12}$	Basic	6F7E6987D2D74238C1453855F89980C7524F
40	5A8355B54385ED2AD0929EB80DA044D556B452A758CA5716 CD1DB40964F5BA10A26DAAD75342196DEBB63CC972994DEA	[3]Pass$_{b12}$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
41	AE28E73F7CC20D2BF6B961410BEE0C2FD5A4E3764EE8CB3E 336C974D3A9FBB7B190B2EA0EACC7237B7B01B036E07EE04	[3]Pass$_{b12}$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4
42	70942CA2E9B424A54521DB1F069746BC9938B7C2ADC28840 BD3DE08985F8DBE78F0C386EB860D64E9BA9E06B95BEB66A	[3]Pass$_{b12}$	Basic	70942CA2E9B42B5A4521DB1F069746436938
43	D616654732C5094527AB422D65EBA98C515810717B02C9C7 94860029CEEE6B4DD1E8F1F77F4CAB43AD74CBB01ECD155C	[3]Fail$_{b12}$	N/A	N/A
44	AC8857D3318447091F3244DB71A661C7CFC7C4D859F34BD3 05CED0F22A0FDBE78F0C386EB860D64E9BA9E06B95BEB66A	[3]Fail$_{b12}$	N/A	N/A
45	87AAEE174F86F7D6F81A6A5DFFE44BBE819127C89004918D 683D2DD3608523EFAC727A23A788A711FCA51139D874D5C8	[3]Pass$_{b12}$	Long	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C8900491 8D683DD22C608523EFAC72
46	46D9B1EE2CE9216C8027CE5AE861E20BB742FF717C21B944 DED0B164595D7181B14C131EA2DCCDD5B86D46824464BE9A	[3]Pass$_{b12}$	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C

[1]Pass$_{b50}$ - Long Message corrupted with one 50 consecutive bits burst error is Passed
[3]Pass$_{b12}$ - Message corrupted with three 12 consecutive bits burst error is Passed
[1]Pass$_{b42}$ - Basic Message corrupted with one 42 consecutive bits burst error is Passed
[1]Fail$_{b42}$ - Basic Message corrupted with one 42 consecutive bits burst error is Failed
[1]Fail$_{b50}$ - Long Message corrupted with one 50 consecutive bits burst error is Failed
[3]Fail$_{b12}$ - Message corrupted with three 12 consecutive bits burst error is Failed

Table 2.4.8.3.1.1B: ADS-B Message Reception

Table 2.4.8.3.1.1B: ADS-B Message Reception

No.	Erroneous ADS-B Messages	Status	Type	RS Decoded ADS-B Messages
1	6F7E6987D2D74238C1453855F89980C7524FE9DC42D5621A BB990C04D2E20855093D9A55E5D5638F787E3D39D98B0422	[0]Pass$_R$	Basic	6F7E6987D2D74238C1453855F89980C7524F
2	A57355B54385ED2AD0929EB80DA044D556B452A7A73A5716 CD1DB40964F5BA105D9DAAD7536A196DEBB63CC972994DEA	[1]Pass$_R$	Long	A57355B54385ED2AD0929EB80DA044D556B452A7A73A57 16CD1DB40964F5BA105D9D
3	AE2818C07CC20D03F6B961410BEE0C2FD5A4E3764EE8CB03 336C974D3A9F0855093D9A55E5D5638F787E3D39D98B0422	[2]Pass$_R$	Basic	AE2818C07CC20D2BF6B961410BEE0C2FD5A4
4	70942C2EE9B42B724521DB1F069746436938B7C2ADC2887D BD3DE08985F80855093D9A55E5D5638F787E3D39D98B0422	[3]Pass$_R$	Basic	70942CA2E9B42B5A4521DB1F069746436938
5	D6199AB732F8094527AB422D6A14598C51581D717B02C9C7 9B79F029CEEE6B4DD1E8F1F77F64ABCFAD74CBB01ECD155C	[4]Pass$_R$	Long	D6199AB732C5094527AB422D6A14598C515810717B02C9 C79B79F029CEEE6B4DD1E8
6	AC87A8AF318447DE263244DB71A6613830C7C9D859F34BEE 05CED0F22A0F0855093D9A55E5D5638F787E3D39D98B0422	[5]Pass$_R$	Basic	AC87A823318447F6E03244DB71A6613830C7
7	87AAEE174FBBF7D6F8E5955DFFE44BBE816ED5C87C04918D 683DD22C608523EF6A727A23A7A0A79DFCA51139D874D5C8	[6]Pass$_R$	Long	87AAEE174F86F7D6F8E5955DFFE44BBE816ED8C8900491 8D683DD22C608523EFAC72
8	46D9B1EE2C2BDE6C802BCE5AE89E1D0BB742F2719021B9BB 21D0B164595D7181774C131EA2F4CD59B86D46824464BE9A	[7]Pass$_R$	Long	46D9B1EE2C16DE6C8027CE5AE89E1D0BB742FF717C21B9 BB21D0B164595D7181B14C
9	D780CEFFD59CD857C184CA4036E2BED2B022679F9E183C86 933FA68DBF5E0855093D9A55E5D5638F787E3D39D98B0422	[8]Fail$_R$	N/A	N/A
10	157A704F1C6BE8945CF4C8F7844B66FF4083CFAFC196F628 652CDA1A522295B898D8C94A0D996428BEF4B3A402210E02	[9]Fail$_R$	N/A	N/A
11	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6DF3 072E0BEFFC8ADAA641EE602AC8B2DDE9A4429FAAB9AFD694	[0]Pass$_R$	Long	88CBB7419ECD35BD3F0C53F45DCA5CC6F0B2C0A92F6B6D F3072E0BEFFC8ADAA641EE
12	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C26 4DB6F333BEA5570E0407693351D29161858E6460DE629EFE	[1]Pass$_R$	Long	119D4413099B23F249ECF8FBC08F8FB3092B6EB4C61D6C 264DB6F333BEA5570E0407
13	266497D59D0188BB308D6CE710843C5CEC330522E2CAE1C7 49ED429B4B1E0855093D9A55E5D5638F787E3D39D98B0422	[2]Pass$_R$	Basic	266497D59D018893308D6CE710843C5CEC33
14	27A050A856F68F5F79444D24A7B2CFD3D1B941E0CC7B4C7C 036C12D430B5D6AA219E05A1ABC05A6956321C3803128E7B	[3]Pass$_R$	Long	27A050A856CB8F5F79444D24A7B2CFD3D1B941E0CC7B4C 7C036C12D430B5D6AA219E
15	ED51BF10AFEEEF8C9105338E05E8A5307535BD154731EC25 9F27DB553CEE0855093D9A55E5D5638F787E3D39D98B0422	[4]Pass$_R$	Basic	ED51BF9CAFEEEFA49105338E05E8A5307535
16	60C84B50290143E1998BBBB462F06CE1ABE77B93C3C24655 277112B17B9EC4E7B2EED67F4A7448E247E688B2FFA81FAD	[5]Pass$_R$	Long	60C84B50293C43E1998BBBB462F06CE1ABE77693C3C246 55277112B17B9EC4E774EE
17	B9C70FD6791EE3026E48F20F35C66F702769765D96E4F668 9F5106D592719E485F6C4008A9A6C69B8BB74D5E05380D73	[6]Pass$_R$	Long	B9C70FD67923E3026E48F20F35C66F7027697B5D7AE4F6 689F5106D592719E48996C

18	8E3960151FC88220C073BA416095BBD99E3826E9B369B91A80CA2B86206E0855093D9A55E5D5638F787E3D39D98B0422	$^{7}\text{Fail}_R$	N/A	N/A
19	04A82A652B9BE68A9D89D51E07F01003A662BBC57402099B4B72BD563F46D8CE5B3523EA6A5E6777411F41037C7F49F7	$^{8}\text{Fail}_R$	N/A	N/A
20	6EDE5B413146A1EEA20720A17F9AAE914D624844555F7C0A954DBD0CC10F0855093D9A55E5D5638F787E3D39D98B0422	$^{9}\text{Fail}_R$	N/A	N/A
21	163F93F2F2AD7870D966DA15B7AAC8795F9E03EA3ACAA84E459094D5D855F3C2703E8D92697667BB52258417645DB103	$^{0}\text{Pass}_R$	Long	163F93F2F2AD7870D966DA15B7AAC8795F9E03EA3ACAA84E459094D5D855F3C2703E
22	D27CAF989F6C77C0F3EE5664EC2B4F55F37132DDF33EB9DFF05613FAFFD80855093D9A55E5D5638F787E3D39D98B0422	$^{1}\text{Pass}_R$	Basic	D27CAF989F6C77E8F3EE5664EC2B4F55F371
23	294B0831CCE4B59FB2DB2078C6A796AC873977A0061D2AB8FC057583D30AA1429DFBAC89A4D9A9D94D17D93FB5A982BA	$^{2}\text{Pass}_R$	Long	294B0831CCD9B59FB2DB2078C6A796AC873977A0061D2AB8FC057583D30AA1429DFB
24	A30D2EF671EAA5618EFCAAEEFA838793C5870666163872133E2539F2806D5B1CEC3255DB609286E77CD2E927188DAC0A	$^{3}\text{Pass}_R$	Long	A30D2EF671D7A5618EFCAAEEFA838793C5870666163872133E2539F2806D5B1CEC32
25	D216EDC5265A03B9A9761E388E0E5442143B86CD8F4889B0843954CA88D6AE7E735868556B8CBF613273E2FCFF1604E4	$^{4}\text{Pass}_R$	Long	D216EDC5266703B9A9761E388E0E5442143B8BCD8F4889B0843954CA88D6AE7E7358
26	4392ADDE55E0FDBCDC6A63E90E96784012A920CE42660EDF0BC9EC886E760DC7CB7E9B3FA505176A2E90F4C69EDA07F6	$^{5}\text{Pass}_R$	Long	4392ADDE55DDFDBCDC6A63E90E96784012A92DCE42660EDF0BC9EC886E760DC70D7E
27	AEA3967D976C5D5E10C74721F51CB8BDD9675C60312CB85376A8BF2670880855093D9A55E5D5638F787E3D39D98B0422	$^{6}\text{Pass}_R$	Basic	AEA396F1976C5D76D6C74721F51C54BDD967
28	A3764670806799EE87CB7178FB1EED52BBBDB35054C0F0F10C1FB1350DA63A24644DEA5F5EBD561AC56858C093594BF1	$^{7}\text{Pass}_R$	Long	A3764670805A99EE87C77178FB1EED52BBBDBE50B8C0F0F10C1FB1350DA63A24A24D
29	3FA75112E29C34283F20F1A006431013E1E250AEB99402770F7440F966B77040693B9FD27033689D3F6BCABB38B1AB7C	$^{8}\text{Fail}_R$	N/A	N/A
30	91CBB99048C9BE290B9733440CE28275CD27DA3222B5901E2E261604B37D0855093D9A55E5D5638F787E3D39D98B0422	$^{9}\text{Fail}_R$	N/A	N/A
31	B9783A10478AC59240C1EA57C9741831654EBD42B5ABE1CFE32D599B76BB1005B2A444579E1CB41B68D2CEF6CD02E2B0	$^{0}\text{Pass}_R$	Long	B9783A10478AC59240C1EA57C9741831654EBD42B5ABE1CFE32D599B76BB1005B2A4
32	BEF0F217696E4652DE8CB92BEC089CFA688E91363C4C627EEDC50B2B36B1CD80A407357B966ECF133CDE92807BDE083A	$^{1}\text{Pass}_R$	Long	BEF0F217696E4652DE8CB92BEC089CFA688E91363C4C627EEDC50B2B36B1CD80A407
33	25F2846879C974085AD651F61011A07E55B92EF8412B72F0889CCBABD4ABE51C2CECE97C25264F5FAB16CEDAFA5CE238	$^{2}\text{Pass}_R$	Long	25F2846879F474085AD651F61011A07E55B92EF8412B72F0889CCBABD4ABE51C2CEC
34	A6A70493254DDD4086C2871192F7C78FA1C25E164AACA66C580C7DFD20DD97266759DA130C6CA1912F87498C76CD952A	$^{3}\text{Pass}_R$	Long	A6A704932570DD4086C2871192F7C78FA1C25E164AACA66C580C7DFD20DD97266759
35	0F7FA9F029EA8B5A1B1449E84A73D7D761129D49D1D2398CD4815DB7E471BD8323A6C32A01C84A86E3D1DC457B3B387E	$^{4}\text{Pass}_R$	Long	0F7FA9F029D78B5A1B1449E84A73D7D761129049D1D2398CD4815DB7E471BD8323A6
36	88B6DB9B5A8C6C4F640C688B2A976C217B8DD8C4D460D8E3824571101E380855093D9A55E5D5638F787E3D39D98B0422	$^{5}\text{Pass}_R$	Basic	88B6DB175A8C6C67A20C688B2A976C217B8D

37	A38B84FA46AB7170B71B9BCE491CE2E7C61DC6A88A80545D 1B2D129FBB3808A002F18A2B786FA3D356BFE897BFF31E71	[6]$Pass_R$	Long	A38B84FA46967170B71B9BCE491CE2E7C61DCBA8668054 5D1B2D129FBB3808A0C4F1
38	ED26FEF474DDF6DA4FE2A90134AD7F4C79CC1DFBF9F779BB 96B6FF7966CB7D301C7B0E12E4BF054EEFBF64726AF41A65	[7]$Pass_R$	Long	ED26FEF474E0F6DA4FEEA90134AD7F4C79CC10FB15F779 BB96B6FF7966CB7D30DA7B
39	EFF08254569BB9B3B2D2959C9A3597E429B4CA71F9DDD9D5 56DC9CADC46BBDB671BD2446C0111D28ACB7D62FF4DE4448	[8]$Fail_R$	N/A	N/A
40	369AF300BF4D667CD7D9D4B316DA46E4B53227E1AD51F64C 61DBE856337197681842F879B6C5B7B0308D85D5E6EC2834	[9]$Fail_R$	N/A	N/A
41	BC560931105731F486BCE2B75D2EBA4FFC4F09299671C980 E3F1D485650E0855093D9A55E5D5638F787E3D39D98B0422	[0]$Pass_R$	Basic	BC560931105731F486BCE2B75D2EBA4FFC4F
42	8D264F73C42014181D475A812755061B88B784F2D7E57866 DAF007EA4AD20D7B5829E103C0CBDF069015893738D26FC1	[1]$Pass_R$	Long	8D264F73C42014181D475A812755061B88B784F2D7E578 66DAF007EA4AD20D7B5829
43	1E11EE3AFD53565B9D80545F1D978A8E75E2AD8B5578CFA5 654F896EE5EB0855093D9A55E5D5638F787E3D39D98B0422	[2]$Pass_R$	Basic	1E11EE3AFD5356739D80545F1D978A8E75E2
44	6B5E661BAC91B7DF8FAEF808A77D84078AC30BEDD1143EF7 A7B51CEB362D0855093D9A55E5D5638F787E3D39D98B0422	[3]$Pass_R$	Basic	6B5E6697AC91B7F78FAEF808A77D84078AC3
45	E6BBF0358BF8D4595667A99E6B3C1872795557C066D5A438 7D4F8821001F0855093D9A55E5D5638F787E3D39D98B0422	[4]$Pass_R$	Basic	E6BBF0B98BF8D4715667A99E6B3C18727955
46	5A7B6F9BEF95DA4DFBA0ED6253FA096926C1E6E0899BC390 3A8415367DF4756951DB0F53F56A272D4229F3654F5FB489	[5]$Pass_R$	Long	5A7B6F9BEFA8DA4DFBA0ED6253FA096926C1EBE0899BC3 903A8415367DF4756997DB
47	58A626E0D8766A51A498CAF387403156AFB78E9FC0840FA5 2D6A1C4A9E7B8D3493B967AFA9EDDF7B6713E85867587966	[6]$Pass_R$	Long	49A626C7D8766A51A498CAF387403156AFB78E9FC0840F A52D6A1C4A9E7B8D3493E5
48	D80317A3A32B86C159E2A18859083B9737E724261F477D34 51D333795C275CA801E2FFF271349F7665D60BAD12AF2F10	[7]$Pass_R$	Long	C9031784A32B86C159E2A18859083B9737E7F4261F477D 3451D333795C275CA801BE

[1]$Pass_R$ - Long Message corrupted with one random burst error is Passed
[7]$Fail_R$ - Message corrupted with seven random burst errors is Failed

2.4.8.3.1.2 Verification of Ground Uplink Messages (subparagraph 2.2.8.3.1.2)

Purpose/Introduction:

The receiver **shall** determine Successful Message Receipt for a Ground Uplink message according to the following procedure:

a. Each de-interleaved RS block of the Ground Uplink message **shall** be individually examined for errors. Each RS block **shall** be declared as valid only if it contains NO uncorrected errors after RS decoding. The decoding process **shall** use hard decision decoding with no erasures allowed.

b. Successful Message reception **shall** be declared for a Ground Uplink message when all six constituent RS blocks are declared valid from (a) above.

Note: *Appendix M provides the analytic determination of the Undetected Message Error Rate achieved though use of the RS coding. Due to the straightforward calculation of the UMER and the fact that the UMER is quite low, no explicit requirement/test is needed for a "False Message Reception Rate" test.*

The following test procedure will verify that the UAT receiver system correctly declares the Successful Receipt of Ground Uplink Messages as defined in subparagraph 2.2.8.3.1.2. The receiver system must declare the Successful Message Reception only when there is NO uncorrected error indicated in all six constituent de-interleaved RS blocks after the RS decoding processes.

The Corrupted Messages (Erroneous Messages) provided in the Tables are designed as follows:

a. Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J have random burst errors that are perfectly lined up with the byte boundary of ADS-B Message symbols. The errors in each message are at different symbol positions and the number of erroneous symbols that are induced into the ADS-B Messages can be from 1 to 14 bytes.

Equipment Required:

Provide a method to supply controlled De-Interleaved RS blocks of Ground Uplink Messages to the appropriate ADS-B UAT Receiver interface.

Measurement Procedures:

Step 1: Establish the Initial Conditions

Configure the UAT Receiver system to receive Ground Uplink Messages and verify that the interface is providing the test data to the UUT.

Step 2: Verify Successful Reception of each De-Interleaved RS Blocks

a. Load the set of test messages provided in Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J into the Receiver Interface.

b. For each case of provided stimulus given in Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J, verify that each de-interleaved RS block of Ground Uplink Messages properly reports the Successful RS block (Corrected Messages when errors induced in each RS block are correctable) as described in column 5 of Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J.

c. Verify that each de-interleaved RS block of Ground Uplink Messages report "DATA NOT AVAILABLE (N/A)" if there exist more errors than it can correct as described in column 5 of Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J.

Step 3: Verify Successful Reception of Ground Uplink Messages

a. Verify that the UAT receiver system declares Successful Ground Uplink Messages Reception only when all six constituent RS blocks are declared valid as described in column 6 of Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J.

b. Verify that the UAT receiver system FAILs to report Successful Ground Uplink Messages Reception when one or more failed/invalid RS blocks exists in any of six constituent RS blocks as described in column 6 of Table 2.4.8.3.1.2A through Table 2.4.8.3.1.2J.

CAUTION: *RS decoder shall use hard decision decoding to meet the proper Message Error Rate requirement.*

<u>Table 2.4.8.3.1.2A:</u> De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	FA1F424AD9F4B06814BBC1401975CCBA86A6D96E DAD21985672C1CDB815E69F44231D9A6EA90FC8F 24A059BE3F67419BB140A9F5569924D1D3BDFA54 2090FFDFF19A15CAB23B0CBDC45C27312D923281 BC99E458FB2B4A7E74D2439A	$^{0}\text{Pass}_{R}$	Grd_{1}	FA1F424AD9F4B06814BBC1401975CCBA86A6D96E DAD21985672C1CDB815E69F44231D9A6EA90FC8F 24A059BE3F67419BB140A9F5569924D1D3BDFA54 2090FFDFF19A15CAB23B0CBD	Report successful ground message.
2	3862CAA751ADE24FF1B60B6A910F9AD9779D8257 91DA66C41F31C2F8AFEE4FB1CE14040164EBF659 91B8718820E3704642F884B43E5BA2D143FE76BF 83163FFC4BF9BBE235BBC611DAA44D72EBA30337 4103DE72612A5773565DE276	$^{1}\text{Pass}_{R}$	Grd_{2}	3862CAA751ADE24FF1B60B6A910F9AD9779D8257 91DA66C41F31C267AFEE4FB1CE14040164EBF659 91B8718820E3704642F884B43E5BA2D143FE76BF 83163FFC4BF9BBE235BBC611	
3	3BA98F9BB43FA0920AB017CDB2A540083DC1862E 7613D60774916766A32A9DA17EA2610727B9A890 075A149BA2414DBB4FEA0F9CEFB8960AF4074688 B1B8CC0CCFED20BFF46309641ACFCCBE12ED6388 2C9F28FD348A02708DBA40ED	$^{2}\text{Pass}_{R}$	Grd_{3}	3BA98F9BB43FA0920AB017CDB2A540083DC1862E 7613D607749167F9A32A9DA17EA2610727B9A890 075A149BA2414DBB4FEA0F9CEFB8960AF4074688 B1B8CC0CCFED20BFF4630964	
4	57BD9AA761A7DA179D9FEE0B804F01945C3ED461 07DC28A1868BD04E3D3E4786F9578B11694B8298 B33BC88E5A929E891C4ED97070FE890BDE2FFCD8 453FEEC3D4D80E8B570CDC11CAC31C6016FC08A5 FC5E3E6EFD036FC319D281D3	$^{3}\text{Pass}_{R}$	Grd_{4}	57BD9AA761A7DA179D9FEE0B804F01945C3ED461 07DC28A1868BD0D13D3E4786F9578B11694B8298 B33BC88E5A929E891C4ED97070FE890BDE2F35D8 453FEEC3D4D80E8B570CDC11	
5	FECA03CE5334F99E0D825CAF5C7D4CC2F7C15908 F45E0BBA31268CC3ED430926508E4A87E4D6A3DD 6757A832DCA8521A575D0825D854AFE13A58FA61 10BB29CFDD7E0D872F94AFA686D235AC7B9B408A DC46E613FB6AEC35A427863A	$^{4}\text{Pass}_{R}$	Grd_{5}	FECA03CE5334F99E0D825CAF5C7D4CC2F7C15908 F4510BBA31268C5CED430926508E4A87E4D6A3DD 6757A832DCA8521A575D0825D854AFE13A583361 10BB29CFDD7E0D872F94AFA6	
6	4C81CE1C2B457E33E253D28A2117EF0182FAF486 48BCE45D42C2FD2B7378B42BBCE623A5228DBA86 E6A610A52362E7B47D5189D0446065707B39DC06 18024E7221A23C1E402FF3DD1640FCFCDD5360E0 39814E3D046C198D2ECA6B5E	$^{5}\text{Pass}_{R}$	Grd_{6}	4C81CE1C2B457E33E253D28A2117EF01823BF486 48B3E45D42C2FDB47378B42BBCE623A5228DBA86 E6A610A52362E7B47D5189D0446065707B391506 18024E7221A23C1E402FF3DD	

<u>Table 2.4.8.3.1.2B:</u> De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	150ED7F7556FB36D06CDE756D5E65AFB69B5F687 A7291C564483F87CA9CA9959FDF50798D46D74EF D61BD1C2F06375CCD4B964D9CFCD4284D20BBE6D A574216D9C7E3FB0637DD1D3868E736E3D45F5F1 7E0F47D77062F7016F1B6C07	[6]Pass_R	Grd_1	150ED7F7556FB36D06CDE756D5E65AFB69740D87 A7261C564483F8E3A9CA9959FDF50798D46D74EF D61BD1C2F06375CCD4B964D9CFCD4284D20B776D A574216D9C7E3FB0637DD1D3	Fail to report successful ground message.
2	7154C5D330656E7EE4835EAFE4D3670162316743 1F3802604AFA65E1E2367206BB4A0DDCCF6F7F82 29FC82D1DA89B721E8208F03A58E3A4F49737BD4 5EA106473D81AFC532F8E61E5BC86AA16F2267EC 27579EA5BC03B4AFC8F07C41	[7]Pass_R	Grd_2	1254C5D330656E7EE4835EAFE4D3670162F09C 43 1F3702604AFA657EE2367206BB4A0DDCCF6F7F 82 29FC82D1DA89B721E8208F03A58E3A4F4973A2 D4 5EA106473D81AFC532F8E61E	
3	708A1C1C4DB1E39040373DDB6CEC49A7BB629897 FF313E2CE2347B965CED67EBF741B9FEF9079DCC A8095515CAB734ADA9FA5A43197E509B5E4E5C31 F5AC47D891E9AEFDC3B49D282B069D3D37B579AB C15072CBC4084653B1EE53F4	[8]Pass_R	Grd_3	138A1C1C4DB1E39040373DDB6CEC49A7BBA36397 FF3E3E2CE2347B095CED67EBF741B9FEF9079DCC A8095515CAB734ADA9FA5A43197E509B5E4E85B5 F5AC47D891E9AEFDC3B49D28	
4	A09A4C06BCC684787F9C7B631DC775D443AE64EE 4F87D1267E0391AFB1D81F8D1929591CE16945F4 8BE1FF9BA5756AE58B6EE76A5849D4E8C0BE6747 EB8A612C94A2F9D87B5E086110949546549AA6F7 0485633C289B6E84DEAB6839	[9]Pass_R	Grd_4	C39A4C06BCC684787F9C7B631DC775D4436F9FEE 4F88D1267E039130B1D81F4A1929591CE16945F4 8BE1FF9BA5756AE58B6EE76A5849D4E8C0BEBEC3 EB8A612C94A2F9D87B5E0861	
5	67D4E3A06ED472349352B8742628A30BCA40A876 435FA81D0228ED5073DC609680366B3ED7285378 1DD7B76BF158154A3EE5341DA7A73CBE9612E12F D28DE72C7A789850E5A6D43E825D3F8DFCB41937 2C0F325864E6270AA0354677	[10]Pass_R	Grd_5	04D4E3A06ED472349352B8742628A30B3D815376 4350A81D0228EDCF73DC605180366B3ED7285378 1DD7B76BF158154A3EE5341DA7A73CBE961238AB D28DE72C7A789850E5A6D43E	
6	2871C8C299788238F1398820B1FFE6099E2AD928 4B83BA2ED34535D4C17946A0A78895811E234A3A 6A7EB97A99BCF945F371B696AE6CF9664FF69636 B7BE77A620A20E4126E1D088353A3DD47AD2320C D14E5DE716A19E00D319EB05	[11]Fail_R	Grd_6	N/A	

<u>Table 2.4.8.3.1.2C:</u> De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	7F6878BD4037C893161847DC7332C83762DF4DA0 B605BF0683A04DADF834FBF461AD370C26BB29E2 1185E67137D6D259B2FD814554DFF761097C5213 840EB698790EAC1EF10A787D0A8209FB70A4EE9C DE9C9346F10B7E49AD58E5EB	$^{12}\text{Fail}_R$	Grd_1	N/A	Fail to report successful ground message.
2	6D15EDE4B7C7C058150E09DF483B7D69BF6BBAC7 5B596D701CB7FADFEDD515BB961D79D45965C513 92796949EF0A33A1BD53812EB0E695C20966B4D5 0949E3CC9886E7F7A28516BD4E56E0B3B564E88D CDCB70A112BE57DC15E1AF78	$^{13}\text{Fail}_R$	Grd_2	N/A	
3	83A184694AAFFC644AD48FC86091246E871200C7 D4714B34F0227008BEF1E9999D507EBDFC01455C 333EEF2C651793A30AEEC4A8088637C53D531D0B FDE6FD51C7A7415A5049790B30E9485F3065DE24 92CC42234048632CBF656299	$^{14}\text{Fail}_R$	Grd_3	N/A	
4	A1D5EE7D6330646806D8D3917CE598EC31F647D0 D217134642C97964AE460B44229219F81D871696 F966F932B194606942215562D4266D41572E9894 AAA9EF3025A2C0ECFD3CB15B8DC13ED5D9EFEA63 EB04D816D82E968C3D82469C	$^{0}\text{Pass}_R$	Grd_4	A1D5EE7D6330646806D8D3917CE598EC31F647D0 D217134642C97964AE460B44229219F81D871696 F966F932B194606942215562D4266D41572E9894 AAA9EF3025A2C0ECFD3CB15B	
5	E1A2C74EC8FD084D5417245A40ADD49831B8543A 7799A1CCFF667CA313E1C138994A96BD89038BFD 2F54AA67F2BA1777DF822437EDB11DE8EB72A55F 0D7F5402644F7F6CDC7868B6A1531A95D6B3D813 9A46A602C5C75E7A5F33D2AE	$^{1}\text{Pass}_R$	Grd_5	E1A2C74EC8FD084D5417245A40ADD49831B8543A 7799A1CCFF667C3C13E1C138994A96BD89038BFD 2F54AA67F2BA1777DF822437EDB11DE8EB72A55F 0D7F5402644F7F6CDC7868B6	
6	FA09264A714F855F575546010A7EE4A9840E5B5F C18FFAE2E65862C3D1A5A486481516D6E1DFF221 6FB13B21EB837E084B39FDDBA983CC582B3E629E 1A4846CE09113E7891D5B86677E27B2E4407681D 51D71D68067BD0AAE0E5D9B4	$^{2}\text{Pass}_R$	Grd_6	FA09264A714F855F575546010A7EE4A9840E5B5F C18FFAE2E658625CD1A5A486481516D6E1DFF221 6FB13B21EB837E084B39FDDBA983CC582B3E629E 1A4846CE09113E7891D5B866	

Table 2.4.8.3.1.2D: De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	E34CC8B7D8B6F24FA521B508E2BB65B39F0E675B 0D0FD8C59647A736EC0FB3A9540AF6743881D0A1 DA2D6BAAAE11639A960A1B51A31EEC772837D47C 8ADBC339458A149D96C228F1321F8DBFF8AF80E5 34CBF4D0B9F49D67BE0417D6	[3]Pass_R	Grd_1	E34CC8B7D8B6F24FA521B508E2BB65B39F0E675B 0D0FD8C59647A7A9EC0FB3A9540AF6743881D0A1 DA2D6BAAAE11639A960A1B51A31EEC7728371D7C 8ADBC339458A149D96C228F1	Report successful ground message.
2	1A754D1F72CEE785C329ED4D7E8D9541DF12AF16 9F0D4FBA9E1AAF12A44D8F09F1C4CCD338339AC3 C29391B4DD6B6A55BD3FB22E07B93CA52BBEEB33 37E42184D81EA14CABF225F4ACC68A74DC316130 284DCC4C7D550439F24A7AD1	[4]Pass_R	Grd_2	1A754D1F72CEE785C329ED4D7E8D9541DF12AF16 9F024FBA9E1AAF8DA44D8F09F1C4CCD338339AC3 C29391B4DD6B6A55BD3FB22E07B93CA52BBE2233 37E42184D81EA14CABF225F4	
3	91287EFFA836873BAA5A3F14C2B178431CEEFF8F C4C87953A53545809EB3B78F90F6EDBA69620BCB F0B031A6F38AF4340456A9386B20B93A18F33C76 089103DB87C761054ED89A38CF91726E491B7AB4 8962C1B7C618ACDC8341B083	[5]Pass_R	Grd_3	91287EFFA836873BAA5A3F14C2B178431C2FFF8F C4C77953A535451F9EB3B78F90F6EDBA69620BCB F0B031A6F38AF4340456A9386B20B93A18F3F576 089103DB87C761054ED89A38	
4	3F4528DB62D926ECDBD53FD76B1388534FB54813 FE943FF91E92990EA9F45BFFA7CE883CF9280434 7D8025ACA7351088CF0BC7C6425527586486692A F1877BFA2239F96549F20CA4EDAA8D8DEB37812E F20D84FF4AD6CA34502D0DB1	[6]Pass_R	Grd_4	3F4528DB62D926ECDBD53FD76B1388534F74B313 FE9B3FF91E929991A9F45BFFA7CE883CF9280434 7D8025ACA7351088CF0BC7C6425527586486A02A F1877BFA2239F96549F20CA4	
5	C8DC85072A91FB1C83B83A783335773E4BC5C5A9 415A28D38922699804AABE2E8829CDCE1F25FF21 36B85924D5A77445272103FF561518081CDB5CE7 82369F151BD2ADFCD5E3CF027A883E4D5086AD72 45F0965241DD5ABE5B69C41D	[7]Pass_R	Grd_5	ABDC85072A91FB1C83B83A783335773E4B043EA9 415528D38922690704AABE2E8829CDCE1F25FF21 36B85924D5A77445272103FF561518081CDB85E7 82369F151BD2ADFCD5E3CF02	
6	7AF639D7558AE3D934A8C23113F37FEBFDAF385F 3E62B76FD07E1A0042B3267941932C37FD31903E 0F169356FE129B24B3935BDAD69E14AA790414DD FDEDC099A7E44FF74164C807DFC41D48E1C9CA2F 79C214551BEBA37F22F82C67	[8]Pass_R	Grd_6	19F639D7558AE3D934A8C23113F37FEBFD6EC35F 3E6DB76FD07E1A9F42B3267941932C37FD31903E 0F169356FE129B24B3935BDAD69E14AA7904CD59 FDEDC099A7E44FF74164C807	

Table 2.4.8.3.1.2F: De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	75E817FB19AFF01239C9EB777B965C5488FA2027 22168304BE212B15B6882DFE5FECCD147E1684DC 0779B0DD8F773D385E688B78110551BCA8E5EB77 0F143B8C5967FC02D8A954771886AB2E1BFD9FC5 51CF49244725401FB51499C0	$^{0}\text{Pass}_{R}$	Grd$_1$	75E817FB19AFF01239C9EB777B965C5488FA2027 22168304BE212B15B6882DFE5FECCD147E1684DC 0779B0DD8F773D385E688B78110551BCA8E5EB77 0F143B8C5967FC02D8A95477	Report successful ground message.
2	40C66535F27735F7C1A935499DAA2D0B2037E40E DC0F48D157226123A37AE38581FC2A0AFC9054BD D7657C97D6CE99FEB3F8952F496CA720B01D7B4D FE8A38FF4D18DEF9A5B4B10714899D8A9781DB9C 0A2916295DFCE8D6676D2F60	$^{1}\text{Pass}_{R}$	Grd$_2$	40C66535F27735F7C1A935499DAA2D0B2037E40E DC0F48D1572261BCA37AE38581FC2A0AFC9054BD D7657C97D6CE99FEB3F8952F496CA720B01D7B4D FE8A38FF4D18DEF9A5B4B107	
3	2B7583F8ED2E1F7A5741C0429D16B2A0210D11D0 B04E5A3306C72BA80B446825296631943BF9C935 605A7046CAE9C44E49D8ABFA9FB1583F75F1F88B 6D18973EA3FBB126375528B785C0272EECF34CC7 E15915233E6B06073CFF2189	$^{2}\text{Pass}_{R}$	Grd$_3$	2B7583F8ED2E1F7A5741C0429D16B2A0210D11D0 B04E5A3306C72B370B446825296631943BF9C935 605A7046CAE9C44E49D8ABFA9FB1583F75F1F88B 6D18973EA3FBB126375528B7	
4	8AC36FC963B840772C1C16905893439949AEF5CF 32FA60C9D1A8F36181D84DE173AFCEF11F470942 3326E3EC0C43B10911CB937463AB6A18CB996381 5C8FD1E5200561F9D9CE07A3E167041449DFBC5D F90AB05E34735F4DAE0A70E0	$^{3}\text{Pass}_{R}$	Grd$_4$	8AC36FC963B840772C1C16905893439949AEF5CF 32FA60C9D1A8F3FE81D84DE173AFCEF11F470942 3326E3EC0C43B10911CB937463AB6A18CB99AA81 5C8FD1E5200561F9D9CE07A3	
5	A77C69FB8F0ABB2BC248097A2E5EDFC88F2BCCA6 2D73D1CA74DD40B212FD27683B55BFC1D82080EF 37D9507AE4B96F51FFEE95F9FE906BE9BE0A0E6C EA745B2F029D43D28535219C9CA2F653AACEF83B 89173E3704A0B2F41B9DA2FF	$^{4}\text{Pass}_{R}$	Grd$_5$	A77C69FB8F0ABB2BC248097A2E5EDFC88F2BCCA6 2D7CD1CA74DD402D12FD27683B55BFC1D82080EF 37D9507AE4B96F51FFEE95F9FE906BE9BE0AC76C EA745B2F029D43D28535219C	
6	2AE8271E7AD84C7AE1AA041B8036C3F12B4A172D ACC7156BF1F21546576AC2C83C1310268ACBAB64 60575C3F03C80265CD1A1378C182D066E8AAD594 31568F61F3A7D0E3D094C8FDB309B7CD3720EC1F AB0C2CABFAB29AF8E6C91930	$^{5}\text{Pass}_{R}$	Grd$_6$	2AE8271E7AD84C7AE1AA041B8036C3F12B8B17 2D ACC8156BF1F215D9576AC2C83C1310268ACBAB 64 60575C3F03C80265CD1A1378C182D066E8AA1C 94 31568F61F3A7D0E3D094C8FD	

Table 2.4.8.3.1.2G: De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	8824242DFC18D01C1D9FE2EA3A208739268C0455 9A8D3427B92D7321AFAA620ECAF127418968DFBD F33A7335C8913D544C932D80C16EE3AE595A8C32 ACF9BBAD7F56F36BE673E3CB37B6C81F20DEE364 A7E3673F34FEDBEB6A5E02DD	[6]Pass$_R$	Grd_1	8824242DFC18D01C1D9FE2EA3A208739264DFF55 9A823427B92D73BEAFAA620ECAF127418968DFBD F33A7335C8913D544C932D80C16EE3AE595A4532 ACF9BBAD7F56F36BE673E3CB	Fail to report successful ground message.
2	72BCF39C45BDF37BE4EF5612768BD15F84DC224D 706E9A4A5F1C5EAF76651417972FD9FBABFCB446 5B86EF182BBF3AF5CF1507B147B3C9A508BF2526 C0DBABC58D4B5C3D991D0D1F7AE07E4138AC4674 E188F3280A705200B6721CDA	[7]Pass$_R$	Grd_2	11BCF39C45BDF37BE4EF5612768BD15F841DD94D 70619A4A5F1C5E3076651417972FD9FBABFCB446 5B86EF182BBF3AF5CF1507B147B3C9A508BFFC26 C0DBABC58D4B5C3D991D0D1F	
3	9DABB232FA665883B419661825B817547B33D07A 6D626A53DE7F777E535D8DC5046E9B98214DEF6C 0FAF564A9DAA56C09F9C07EDCCA1938DD9EFB585 C075C9CE818CEC15FDB545690BF93277F7B73333 B82FF7AD4D3DCCAC04C519B9	[8]Pass$_R$	Grd_3	FEABB232FA665883B419661825B817547BF22B7A 6D6D6A53DE7F77E1535D8DC5046E9B98214DEF6C 0FAF564A9DAA56C09F9C07EDCCA1938DD9EF6C01 C075C9CE818CEC15FDB54569	
4	FC16F8A76ABA5E283E5475D2CFF4EE9732304641 EB01DA21747BA99B95D622C18C3EB223E80A889B 056B1D100ED549E6FC90B4E106C25DF73C6144DC 10DA5423DCCAB0431A31348154AE671CA3AB4090 2E67739330E6AABB23276CAE	[9]Pass$_R$	Grd_4	9F16F8A76ABA5E283E5475D2CFF4EE9732F1BD41 EB0EDA21747BA90495D622068C3EB223E80A889B 056B1D100ED549E6FC90B4E106C25DF73C619D58 10DA5423DCCAB0431A313481	
5	65DFE725402C7047370B5CB16126F1E2EA5BAF98 BB502DF47F17DEBB25BA43D53869061FC64C38D5 BD538595F33DBDC4BD361EDD06770384432DA9F7 50A59C5CF2F0E9232305F80631E370B7DF7BA79F 4CE4E66B8CF63DD976C336EC	[10]Pass$_R$	Grd_5	06DFE725402C7047370B5CB16126F1E21D9A5498 BB5F2DF47F17DE2425BA43123869061FC64C38D5 BD538595F33DBDC4BD361EDD06770384432D7073 50A59C5CF2F0E9232305F806	
6	B790C3095B8168D5AA79915784A8AEAEA90EA174 8AEA2B40F515CA777B958ED9A254EF17D5DF1EA1 545A07C4F06D8D23E8F2D7FE66625D73E226FD38 99B1573731082660C6399187FF77DCD2870C4285 9F9FD883BB7585606C7EEC2C	[11]Fail$_R$	Grd_6	N/A	

Grd_{10} – De-Interleaved RS Block number 10 of the Ground Uplink Message

<u>Table 2.4.8.3.1.2H:</u> De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	EE861CFD253381E6603FE57D96F5A57F49EA4F7E EC0C384271146B84B5E2F4FC0F9331ECA2DDEFD0 A591C76EF6F07A4374DDFFA1072418FFB4B8AA0B CD2703C273EDEB8E8E42C30F2CDE8DE7AE2B38FB EC4D2883DF11105E8C1A98BA	^{12}Fail$_R$	Grd$_1$	N/A	Fail to report successful ground message.
2	9FF982E50315D76E51AA4C2F1E26E107C55E6D1A DECE757A24869B6A31ABE8E50FF4E0895D9A3A88 06B425C18D0E07428427DBAD5B6590934C1FE043 7457D1DD69D57115CAACA567DC911BC57BEAC439 1745324DA6079F3128CE4C90	^{13}Fail$_R$	Grd$_2$	N/A	
3	C951DA0A5252F8EF2B62B2CC5CB5160E1C2911BF EBF873E9646EABC9B36A20FBB7407D4B10DFB123 089850139ACC4FC446C7FE2A4AB248459D686BB7 A7E534878B1B675F0D172A41146399C158CCB437 9613571072B9795D6250A8DC	^{14}Fail$_R$	Grd$_3$	N/A	
4	E244AB2AF6378A616AD1EC69E7244EBD8459531F 56A8701D677932AF32CC6485E593025675779563 4ED3F37341580579CE090727952BE7A771C73C3E 1048E17EA06AD26BBB02461EBD517D5A3B0C1439 DAE5BADBFCC0A9782E76E64D	^{0}Pass$_R$	Grd$_4$	E244AB2AF6378A616AD1EC69E7244EBD8459531F 56A8701D677932AF32CC6485E593025675779563 4ED3F37341580579CE090727952BE7A771C73C3E 1048E17EA06AD26BBB02461E	
5	C9CD135376D1F2EF7E73AD6A5E5FB02633E12A1E 56C6AB0E055EE14F963F763A177311A54C08A3ED 764BEE9A4E26E6661B5462F7DD774C6A6A3A3885 F30E8132D5AB759C2B6421945091121BB5EC3B3F 2FBC259FEBA3E128B87D3E6A	^{1}Pass$_R$	Grd$_5$	C9CD135376D1F2EF7E73AD6A5E5FB02633E12A1E 56C6AB0E055EE1D0963F763A177311A54C08A3ED 764BEE9A4E26E6661B5462F7DD774C6A6A3A3885 F30E8132D5AB759C2B642194	
6	80F3B3FF275826117AE18F079E7E54200CFDA099 69BEC6550B920F619EC40157C806AC744DC0131F 87FEA01B3974570B87D92C322C162D489E776D26 D7FBD5FE61CF48E7CB9DD45CC294165AC8BEACEF D98FF05F06C787180D1E736D	^{2}Pass$_R$	Grd$_6$	80F3B3FF275826117AE18F079E7E54200CFDA099 69BEC6550B920FFE9EC40157C806AC744DC0131F 87FEA01B3974570B87D92C322C162D489E776D26 D7FBD5FE61CF48E7CB9DD45C	

Grd$_8$ – De-Interleaved RS Block number 8 of the Ground Uplink Message

Table 2.4.8.3.1.2I: De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	DCD5CA18EEE56CDE61B72E8897CD1C015C5FE680 ABCE39A83DCEBEC3CDA3146B76C381F626D22F22 FF2F3FE8AC93014CF201940F11FACA44B7BBC368 26790142B75B04C3692F3F2EF1D07C4696B9851B AC3EFE9FC1D806672B251CFA	[3]$Pass_R$	Grd_1	DCD5CA18EEE56CDE61B72E8897CD1C015C5FE680 ABCE39A83DCEBE5CCDA3146B76C381F626D22F22 FF2F3FE8AC93014CF201940F11FACA44B7BB0A68 26790142B75B04C3692F3F2E	Report successful ground message.
2	2C913CB58D87CAC8F7C85268A52A2A958BFB6739 C9B64EA965624E8266E3C0B3976044E102C0EE69 61D542B7A702FEB6DAAE5A0C5174313EAA51EDB7 EF4CD93353D23B77F44667F715784CA08EE3C737 488E7EF13CEDBDE07968A8D7	[4]$Pass_R$	Grd_2	2C913CB58D87CAC8F7C85268A52A2A958BFB6739 C9B94EA965624E1D66E3C0B3976044E102C0EE69 61D542B7A702FEB6DAAE5A0C5174313EAA5124B7 EF4CD93353D23B77F44667F7	
3	0D7BC8B77E977092A9A228B3FBAC64F213968D5B 7CB7B78357D1C98C7696AE0D39418FBD2FF42F6A DF5DDA18A9D8A78D935555E3266E0ACF7D7E1266 B9224699896403AE6997E8D296D6F242846C091E 8693A357A535CFE9B6475394	[5]$Pass_R$	Grd_3	0D7BC8B77E977092A9A228B3FBAC64F213578D5B 7CB8B78357D1C9137696AE0D39418FBD2FF42F6A DF5DDA18A9D8A78D935555E3266E0ACF7D7EDB66 B9224699896403AE6997E8D2	
4	CC98BFB3DEE53D26FFE00A422BA4039605EADAB5 1540B26187D3551C7B73D633213F6A9547316B2A 92C4FEF96E075BA8115D8E5A84F57C7B1EB2B2CA D86E304A6FF3B0602E0F7C5CE91FE29DA52575FA 4F46BD46D34033DBBDE2E56D	[6]$Pass_R$	Grd_4	CC98BFB3DEE53D26FFE00A422BA40396052B21B5 154FB26187D355837B73D633213F6A9547316B2A 92C4FEF96E075BA8115D8E5A84F57C7B1EB27BCA D86E304A6FF3B0602E0F7C5C	
5	8B7D4BA276B7CD2EA750DA4127E4B1D21D19D627 1C6E332631092B5486C6C05105BC4AE76C499A22 B4F283EBC1DADF2738D2E8CD019B222C4409E322 64910873CCE91B0A20448451CB78D69583ADC02E 7017F1079F099E13A1EAAF76	[7]$Pass_R$	Grd_5	E87D4BA276B7CD2EA750DA4127E4B1D21DD82D27 1C61332631092BCB86C6C05105BC4AE76C499A22 B4F283EBC1DADF2738D2E8CD019B222C44093A22 64910873CCE91B0A20448451	
6	64E7C86E398F9D8D07E0EE88675E4215E8F006C2 812DAA7E8A9C204202A4545ECF06AD719B2C046B 0674C4B553E1DCEB45EFDD203B980384EAA326CE AADBD4412857FAB2164B2F7BC7A727F865A9CD59 EE2F862A9E3F9E5DD915FA4C	[8]$Pass_R$	Grd_6	07E7C86E398F9D8D07E0EE88675E4215E831FDC2 8122AA7E8A9C20DD02A4545ECF06AD719B2C046B 0674C4B553E1DCEB45EFDD203B980384EAA3FF4A AADBD4412857FAB2164B2F7B	

Grd_6 – De-Interleaved RS Block number 6 of the Ground Uplink Message

Table 2.4.8.3.1.2J: **De- Interleaved six consecutive RS Blocks Values of a Ground Uplink Message**

No.	De-Interleaved six constituent erroneous RS Blocks	Status (RS Blk)	Type	De-Interleaved six constituent RS Decoded Blocks	Status (Grd Msg)
1	763733C8ED4DBF145FEB8341130EEF6C013E5CCA D142D542099A3C9C7C01BE977704C7450442BB3F 277CDC422E8C536EC1E8C571D850AB81D2441843 C65057CA566B534504CF28777453237FB4F0DC73 E0D1675E7A8B759E4A2ADD89	[9]Pass$_R$	Grd$_1$	153733C8ED4DBF145FEB8341130EEF6C01FFA7CA D14DD542099A3C037C01BE507704C7450442BB3F 277CDC422E8C536EC1E8C571D850AB81D244C1C7 C65057CA566B534504CF2877	Fail to report successful ground message.
2	09301CD0D514141888C6CB604033AC71B1396479 10BBA2233B2FEA67037E5C5F6146373078979CCA 1138F2502EB435D70D152E24971A4D6598C8BE1B 3BC73853223368B7A57E5C3CA2233FDD7F14A16E 8D0C15B75A4BB555C76EB524	[10]Pass$_R$	Grd$_2$	6A301CD0D514141888C6CB604033AC7146F89F79 10B4A2233B2FEAF8037E5C986146373078979CCA 1138F2502EB435D70D152E24971A4D6598C8679F 3BC73853223368B7A57E5C3C	
3	9D8EB50DED0A24CF30A60A6BC06186F048A51E92 06151C2B2A21ADCD9423C4325607D1F5ECD8DDC6 9D6F1281925F84786A60C838E5D6ED7A5BEA9079 1C564DD482B24B803E4049FFE5220D7D42F51BC6 31B01B88E250CA9DED03F0AA	[11]Fail$_R$	Grd$_3$	N/A	
4	C9E6E930385F7E8333D03390FDD417EB8E633BCE 3C55F00B5029C72D1850D2D58CF17C54029CB1EE 1B7D8F2C97DD8401AD8D5F6C14E5AC9EF253EEAE 540BE9675EC17260624A5EE813DF26EAA544065C A814364890A9D330D434CD70	[12]Fail$_R$	Grd$_4$	N/A	
5	65628B331E31290D05A3B20FEA2584E709477896 71E5813E071710C8718B4AB3396616DDA28079BA 70900C8829B6FD93EE4D62BB125A9028B17CCDD7 697A3D69E3C6657AD9F1EF04F7247971CE5D6470 D0D1DEB3EEC2B6949CFB8A6D	[13]Fail$_R$	Grd$_5$	N/A	
6	27B5033B5C2EA4A5A0E429707DBB950E2B2F9281 ABAC03F48C42DCF41B9E097C3A60EF9CB51306F0 D43E74A29B618C284C1DFC223989EC14BE6BA222 E296C784ED32F1B80A5E36A18ABC263A6A8461EA A24857393D9A264D45D734CF	[14]Fail$_R$	Grd$_6$	N/A	

Grd$_2$–De-Interleaved RS Block number 2 of the Ground Uplink Message

2.4.8.3.2 Verification of Receiver Discrimination Between ADS-B and Ground Uplink Message Types (subparagraph 2.2.8.3.2)

Purpose/Introduction:

The receiver **shall** determine the message type by means of the correlation between the received bits, and the synchronization sequences given in subparagraphs 2.2.3.1.1 and 2.2.3.2.1.

Note: *Specifically, the receiver should not attempt to distinguish ADS-B messages from Ground Uplink messages by their position in the UAT frame.*

The following test procedure verifies that the UAT receiver system correctly differentiates ADS-B Messages from Ground Uplink Message Types regardless of their position in the UAT frame as defined in subparagraph 2.2.8.3.2.

Equipment Required:

Provide a method such that controlled Ground Uplink Message Data can be supplied to the appropriate ADS-B UAT Receiver at any given time of UAT frame with a resolution of at least 100 nanoseconds.

Measurement Procedures:

a. Apply a valid Ground Uplink Message to the Receiver Interface 250 msec away from the UTC Time mark such that the first bit of the synchronization sequence of the transmitted Ground Uplink Message is 250 msec offset from UTC Time Mark.

b. Verify that the UAT receiver declares the Successful Message Reception of a Ground Uplink Message.

2.4.8.3.3 Verification of Receiver Processing of ADS-B Synchronization "Trigger" (subparagraph 2.2.8.3.3)

Purpose/Introduction:

Receivers **shall** meet the following message processing requirements:

a. When an initial ADS-B trigger occurs (no message decode in progress), the Message Reception process associated with this trigger **shall** be completed regardless of other trigger activity subsequently detected.

b. A second, subsequent ADS-B trigger event that occurs during the Message Reception process of an initial ADS-B trigger event **shall** also be completed regardless of other trigger activity subsequently detected.

c. A third ADS-B trigger event that occurs during the simultaneous decoding of an initial and second ADS-B trigger **shall** also be completed regardless of other trigger activity subsequently detected.

Notes:

1. *Detection of the ADS-B synchronization sequence is referred to as a "trigger."*

2. *These requirements ensure that the receiver "re-trigger" procedure does not abandon the initial trigger when a close match to the sync pattern appears in the payload, and that the transmitter need not preclude the sync pattern from occurring in the payload.*

3. *From simulation, this three-level decoding depth also assures that — in the highest self interference environments — the receiver will be >99.5% efficient in decoding of all ADS-B messages that appear at the receiver with an adequate SIR for Successful Message Reception.*

4. *See Appendix H for one potential method to implement a "re-trigger" capability of the synchronization mechanism, and for a recommended synchronization threshold value for ADS-B.*

5. *During decoding of an ADS-B trigger, it is acceptable for the receiver to be "locked out" to Ground Uplink triggers.*

This test verifies the compliance of the UAT receiver with the requirements for detection and processing of ADS-B Synchronization trigger events.

Equipment Required:

Desired Message Signals:

Provide a method of supplying the UUT with four sources of desired Long ADS-B messages. The center of the first bit of the ADS-B Synchronization pattern of the 1st message source is the timing reference T0. The 2nd, 3rd, and 4th message sources transmit at a fixed offset from the reference time T0. The RF signal level of each message source is set per the specific procedure step. The data contents and timing offsets for the message sources are:

Message Contents for all Message Sources:

- Payload Type Code = 1
- Address Qualifier = 0
- ICAO address: (see below)
- Byte 25 bit 1 through Byte 29 bit 4 (36 bits): Fill these bits with data corresponding to the ADS-B Synchronization Pattern (see subparagraph 2.2.3.1.1). This is referred to as the "embedded sync pattern".
- Fill remaining payload (Byte 5 bit 1 through Byte 24 bit 8, and Byte 29 bit 5 through Byte 32 bit 8) with pseudo-random payload data, and valid FEC Parity field per subparagraph 2.2.3.1.3.
- Message Rate: 100 per second

ICAO Addresses and Fixed Time Offsets:

- Message Source 1: ICAO address 0x000001, Time Offset 0.0 seconds
- Message Source 2: ICAO address 0x000002, Time Offset 150 microseconds
- Message Source 3: ICAO address 0x000003, Time Offset 300 microseconds
- Message Source 4: ICAO address 0x000004, Time Offset 450 microseconds

Note: *This arrangement of timing offsets creates overlap between the messages such that the Synchronization pattern of each subsequent Message Source occurs before the embedded sync pattern of the previous Message Source. This also causes the beginning of Message Source 4 to occur after the end of Message Source 1, so that they do not overlap each other.*

Measurement Procedures:

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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 and test for non-overlapping reception

Apply the **Desired Message Signals** at the UUT receiver input port. Set the RF signal levels so that:

Message Source 1: -50 dBm
Message Source 2: -65 dBm
Message Source 3: -65 dBm
Message Source 4: -50 dBm

Observe that the UUT equipment reports only reception of messages with ICAO address 0x000001 and 0x000004 at a success rate of 90% or greater.

Note: *This procedure verifies the requirements of subparagraph 2.2.8.3.3.a, in that the embedded Synchronization pattern in the Message Source 1 data does not prevent the reception of that message, nor does it prevent the reception of the non-overlapping message supplied by Message Source 2.*

Step 2: Apply ADS-B Input Messages and test for two overlapping receptions

Apply the **Desired Message Signals** at the UUT receiver input port. Set the RF signal levels so that:

Message Source 1: -65 dBm
Message Source 2: -50 dBm
Message Source 3: -65 dBm
Message Source 4: -65 dBm

Observe that the UUT equipment reports reception of only messages with ICAO address 0x000002 at a success rate of 90% or greater.

Note: *This procedure verifies the requirements of subparagraph 2.2.8.3.3.b, in that the louder of two overlapping messages is properly detected and reported.*

Step 3: Apply ADS-B Input Messages and test for three overlapping receptions

Apply the **Desired Message Signals** at the UUT receiver input port. Set the RF signal levels so that:

Message Source 1: -80 dBm
Message Source 2: -65 dBm
Message Source 3: -50 dBm

Message Source 4: -65 dBm

Observe that the UUT equipment reports reception of only messages with ICAO address 0x000003 at a success rate of 90% or greater.

Note: *This procedure verifies the requirements of subparagraph 2.2.8.3.3.c, in that the loudest of three overlapping messages is properly detected and reported.*

2.4.8.3.4 Verification of Receiver Processing of Ground Uplink Synchronization "Trigger" (subparagraph 2.2.8.3.4)

Purpose/Introduction:

Receivers **shall** meet the following message processing requirements:

a. When an initial Ground Uplink trigger occurs (no message decode in progress), the decode process associated with this trigger **shall** be completed regardless of other trigger activity subsequently detected.

b. A second, subsequent Ground Uplink trigger event that occurs during the decode process of an initial Ground Uplink trigger event **shall** also be completed regardless of other trigger activity subsequently detected.

Notes:

1. *This two-level decoding depth assures that a strong Ground Uplink message will be decoded when a distant (>200 NM) station on the preceding time slot triggers the receiver. This minimizes planning constraints when assigning slot resources to ground stations.*

2. *See Appendix H for one potential method to implement a "re-trigger" capability of the synchronization mechanism.*

3. *During reception of a Ground Uplink message, it is acceptable for the receiver to be "locked out" to ADS-B triggers.*

This test procedure verifies the compliance of the UAT receiver with the requirements for detection and processing of Ground Uplink Synchronization trigger events.

Equipment Required:

Desired Message Signals:

Provide a method of supplying the UUT with two sources of desired Ground Uplink messages. The center of the first bit of the Ground Uplink Synchronization pattern of the 1^{st} message source is the timing reference T_0. The 2^{nd} message source transmits at a time offset from the reference time T_0. The RF signal level and time offset of each message source is set per the specific procedure step. The data contents and rates for the message sources are:

Message Contents for all Message Sources:

- TIS-B Site ID (bits 1 through 4 of byte 8): Message Source 1 = 0x1, Message Source 2 = 0x2.

- Bit 1 of byte 25 through bit 4 of byte 29 (36 bits): Fill these bits with data corresponding to the Ground Uplink Synchronization Pattern (see subparagraph 2.2.3.2.1). This is referred to as the “embedded sync pattern”.
- Fill remaining payload (bit 1 of byte 1 through bit 8 of byte 7, bit 5 of byte 8 through bit 8 of byte 24, and bit 5 of byte 29 through bit 8 of byte 432) with pseudo-random payload data, with interleaving and FEC Parity field per subparagraph 2.2.3.2.3.
- Message Rate: 1 per second for each message source.

<u>Measurement Procedure:</u>

The signal power level specified in this procedure is relative to the message source end of the transmission line used to interface the UUT receiver port to the message source. The specified RF power level applied to the UUT shall be compensated 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.

<u>Step 1:</u> <u>Apply Ground Uplink Input Messages and test for non-overlapping reception</u>

Apply the **Desired Message Signals** at the UUT receiver input port. Set the RF signal levels and time offset so that:

Message Source 1: -85 dBm — Time Offset: 0.0 milliseconds.
Message Source 2: -70 dBm — Time Offset: 5.5 milliseconds.

Observe that the UUT equipment reports reception of messages with both TIS-B site IDs 0x1 and 0x2 at a success rate of 99% or greater.

<u>Note:</u> *This procedure verifies the requirements of Section 2.2.8.3.4.a, in that the embedded Synchronization pattern in the Message Source 1 data does not prevent the reception of that message, nor does it prevent the reception of the non-overlapping message supplied by Message Source 2.*

<u>Step 2:</u> <u>Apply ADS-B Input Messages and test for one overlapping reception</u>

Apply the **Desired Message Signals** at the UUT receiver input port. Set the RF signal levels and time offset so that:

Message Source 1: -85 dBm — Time Offset: 0.0 milliseconds.
Message Source 2: -70 dBm — Time Offset: 1.0 milliseconds.

Observe that the UUT equipment reports reception of only messages with TIS-B Site ID = 0x2, at a success rate of 99% or greater.

<u>Note:</u> *This procedure verifies the requirements of Section 2.2.8.3.4.b, in that the louder overlapping message is properly detected and reported.*

2.4.8.3.5 Verification of Receiver Time of Message Receipt (subparagraph 2.2.8.3.5)

Purpose/Introduction:

The receiver **shall** declare a Time of Message Receipt (TOMR) and include this as part of the report issued to the on-board application systems. The TOMR value **shall** be reported to within the parameters listed below:

a. Range of at least 25 seconds expressed as seconds since GPS midnight modulo the range.

b. Resolution of 100 nanoseconds or less.

c. Accuracy of +/- 500 nanoseconds of the actual time of receipt for UAT equipment using either an internal, or external UTC coupled time source.

d. The reported TOMR will be equal to the following quantity: seconds since the previous UTC midnight modulo the specified TOMR range.

Note: *TOMR is required to support ADS-B Time of Applicability range validation by a receiving application. See Appendix I for a discussion of UAT Timing Considerations.*

The purpose of this test procedure is to verify that the Time of Message Receipt (TOMR) is declared by the receiver as a part of the report issued to the on-board application systems according to the parameters outlined in 2.2.8.3.5.

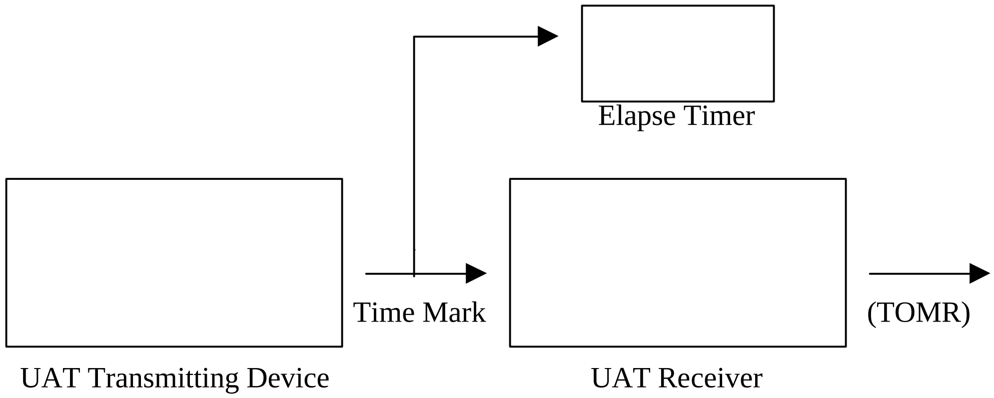
Equipment Required:

Provide equipment capable of supplying valid ADS-B messages to the ADS-B receiver equipment being tested. Provide an Elapse Timer with a resolution of at least 100 nanoseconds.

Measurement Procedure:

Step 1: Apply messages to the receiver and verify the (TOMR) output

Apply valid ADS-B messages to the receiver relative to the UTC time mark such that they are equivalent to the first bit of the synchronization sequence of the transmitted message. Verify that the time measurement has a minimum of 100 nanoseconds timing resolution. Verify that the ADS-B receiving function delivers appropriate output messages in formats that are consistent with the requirements of subparagraph 2.2.8.3.5.



<u>Figure 2.4.8.3.5:</u> Time of Message Receipt

2.4.9 Verification of Report Assembly Requirements (subparagraph 2.2.9)

<u>Purpose/Introduction:</u>

Each Successful Message Reception **shall** result in report assembly.

<u>Note:</u> *Exemplary report formats are presented in Appendix J.*

<u>Measurement Procedure:</u>

<u>TBD</u>

2.4.9.1 Verification of Report Assembly on Receipt of ADS-B Message (subparagraph 2.2.9.1)

<u>Purpose/Introduction:</u>

Reports **shall** contain the following information:

a. All elements of the received message payload applicable to the ADS-B report type with range and accuracy of each payload field preserved.

b. The Time of Message Receipt value measured by the receiver.

<u>Note</u>: *Time of Applicability may be derived by the receiving application from the TOMR.*

<u>Measurement Procedure:</u>

<u>TBD</u>

2.4.9.2 Verification of Report Assembly on Receipt of Ground Uplink Message (subparagraph 2.2.9.2)

<u>Purpose/Introduction:</u>

Reports **shall** contain the following information:

a. The 432 byte received message payload unaltered.

b. The Time of Message Receipt value measured by the receiver.

Note: *Time of Applicability may be derived by the receiving application from the TOMR.*

Measurement Procedure:

TBD

2.4.10 Verification of Receiver Subsystem Capacity and Throughput Requirements (subparagraph 2.2.10)

Purpose/Introduction:

The ADS-B receiving subsystem **shall** process Successful Message Receptions and make them available at the output interface as specified in the subparagraphs below.

Measurement Procedure:

TBD

2.4.10.1 Verification of Fundamental Principals of Report Assembly (subparagraph 2.2.10.1)

No specific test procedure is required to validate subparagraph 2.2.10.1.

2.4.10.2 Verification of Capacity for Successful Message Reception (subparagraph 2.2.10.1)

Purpose/Introduction:

Receiving subsystems shall demonstrate the ability to perform Successful Message Reception at the message input rates specified in Table 2.2.10.2.

Measurement Procedure:

TBD

2.4.10.3 Verification of Applicable Messages (subparagraph 2.2.10.2)

Purpose/Introduction:

Applicable Messages are defined as those requiring Report Assembly. Successful Messages are deemed to be Applicable Messages according to the criteria below:

a. For Successful Message Reception of ADS-B messages one of the following two criteria **shall** apply:

   1. All Successful Message Receptions, OR

   2. As a minimum, only those Successful Message Receptions from targets within the range criteria from Table 2.2.10.3A.

3. Should the number of targets from which a Successful Message is received exceed the values in Table 2.2.10.3A, the ADS-B UAT equipment may discard those messages received from targets at the greatest distance from Ownship. Any discarded reports **shall** be at greater range than those that are reported.

b. For Successful Message Reception of Ground Uplink messages, one of the following two criteria shall apply:

   1. All Successful Message Receptions, OR

   2. Only those Successful Message Receptions from ground stations within the range criteria from Table 2.2.10.3B.

Measurement Procedure:

TBD

2.4.10.4 Verification of Message Reception-to-Report Completion Time (subparagraph 2.2.10.3)

Purpose/Introduction:

All ADS-B Applicable Messages **shall** be output from the Report Assembly Function within 200 milliseconds of message input.

All Ground Uplink Applicable Messages **shall** be output from the Report Assembly Function within 500 milliseconds of message input.

Measurement Procedure:

TBD

2.4.11 Verification of Special Requirements for Transceiver Implementations (subparagraph 2.2.11)

No specific test procedure is required to validate subparagraph 2.2.11.

2.4.11.1 Verification of Transmit-Receive Turnaround Time (subparagraph 2.2.11.1)

Purpose/Introduction:

A transceiver **shall** be capable of switching from transmission to reception within 2 milliseconds.

Note: *Transmit to receive switching time is defined as the time between the optimum sampling point of the last information bit of one transmit message and the optimum sampling point of the first bit of the synchronization sequence of the subsequent receive message.*

Measurement Procedure:

TBD

2.4.11.2 Verification of Receive-Transmit Turnaround Time (subparagraph 2.2.11.2)

Purpose/Introduction:

A transceiver **shall** be capable of switching from reception to transmission within 2 milliseconds.

Note: *Receive to transmit switching time is defined as the time between the optimum sampling point of the last information bit of one receive message and the optimum sampling point of the first bit of the synchronization sequence of the subsequent transmit message.*

Measurement Procedure:

TBD

2.4.12 Verification of Response to Mutual Suppression Pulses (subparagraph 2.2.12)

Purpose/Introduction:

UAT equipment **shall not** provide suppression signals.

Note: *Adequate compatibility to other systems is achieved because of the power levels, frequency separation and duty factor of UAT transmissions without providing suppression signals.*

UAT equipment **shall not** receive suppression signals.

Note: *Adequate compatibility from other on-board systems is provided by the requirement of subparagraph 2.2.8.2.4.*

Measurement Procedure:

TBD

2.4.13 Verification of Self Test and Monitors (subparagraph 2.2.13)

No specific test procedure is required to validate subparagraph 2.2.13.

2.4.13.1 Verification of Self Test (subparagraph 2.2.13.1)

Purpose/Introduction:

If a self-test feature or monitor is provided as part of the equipment:

a. The device which radiates test ADS-B messages or prevents messages from being broadcast during the test period **shall** be limited to no longer than that required to determine the status of the system.

b. The self-test message signal level at the antenna end of the transmission line **shall** not exceed -40 dBm.

c. If provision is made for automatic periodic self-test procedure, such self-testing **shall** not radiate ADS-B messages at an average rate exceeding one broadcast every ten seconds.

Measurement Procedure:

TBD

2.4.13.2 Verification of Broadcast Monitoring (subparagraph 2.2.13.2)

Purpose/Introduction:

A monitor **shall** be provided to verify that ADS-B message transmissions are generated per the schedule defined in subparagraph 2.2.6.1. If any of the ADS-B message types for which the equipment is certified is not transmitted, then the equipment **shall** be considered as failed and the appropriate "Fail/Warn" indicators **shall** be set to the "Fail/Warn" state.

Measurement Procedure:

TBD

2.4.13.3 Verification of Address Verification (subparagraph 2.2.13.3)

Purpose/Introduction:

The ADS-B transmission device **shall** declare a device failure in the event that it's own ICAO 24-bit Address (if required to have a ICAO 24 bit address) is set to all "ZEROs" or all "ONEs."

Measurement Procedure:

TBD

2.4.13.4 Verification of Receiver Self Test Capability (subparagraph 2.2.13.4)

Purpose/Introduction:

ADS-B Receiving Devices **shall** be designed to provide sufficient self-test capability to detect a loss of capability to receive ADS-B messages, structure appropriate ADS-B reports, and make such reports available to the intended user interface. Should the receiving device detect that these basic functions cannot be performed properly, then the receiving device **shall** be considered as failed and the appropriate "Fail/Warn" indicators **shall** be set to the "Fail/Warn" state.

Measurement Procedure:

TBD

2.4.13.5 Verification of Failure Annunciation (subparagraph 2.2.13.5)

No specific test procedure is required to validate subparagraph 2.2.13.5.

2.4.13.5.1 Verification of ADS-B Transmission Device Failure Annunciation (subparagraph 2.2.13.5.1)

Purpose/Introduction:

An output **shall** be provided to indicate the validity/non-validity of the ADS-B transmission device. Failure to generate ADS-B messages at a nominal rate, a failure detected by self-test or the monitoring function, or failure of the address verification **shall** cause the output to assume the invalid state. Momentary power interrupts **shall** not cause the output to assume the invalid state. The status of the ADS-B transmission device **shall** be enunciated to the flight crew where applicable.

Measurement Procedure:

TBD

2.4.13.5.2 Verification of ADS-B Receiving Device Failure Annunciation (subparagraph 2.2.13.5.2)

Purpose/Introduction:

An output **shall** be provided to indicate the validity/non-validity of the ADS-B receiving device. Failure to accept ADS-B messages, structure appropriate ADS-B reports, make such reports available to the intended user interface, or failure detected by self-test or monitoring functions **shall** cause the output to assume the invalid state. Momentary power interrupts **shall** not cause the output to assume the invalid state. The status of the ADS-B receiving device **shall** be enunciated to the flight crew where applicable.

Measurement Procedure:

TBD

2.4.13.5.3 Verification of Co-Located ADS-B Transmission and Receiving Device Failure Annunciation (subparagraph 2.2.13.5.3)

Purpose/Introduction:

In installations where the ADS-B transmission and receiving functions are implemented in a common unit, it **shall** be permissible to use a singe Fail/Warn output that is used in common to satisfy the requirements of subparagraphs X. Otherwise, the Fail/Warn mechanisms for the ADS-B transmission function and the ADS-B receiving function **shall** be independent.

Measurement Procedure:

TBD

2.4.14 Verification of Antenna System (subparagraph 2.2.14)

No specific test procedure is required to validate subparagraph 2.2.14.

2.4.14.1 Verification of Polarization (subparagraph 2.2.14.1)

Purpose/Introduction:

The antenna **shall** be predominantly vertically polarized.

Measurement Procedure:

TBD

2.4.14.2 Verification of Antenna Voltage Standing Wave Ratio (VSWR) (subparagraph 2.2.14.2)

Purpose/Introduction:

The Voltage Standing Wave Ratio (VSWR) produced on the antenna transmission line by the antenna **shall** not exceed 1.7:1 at 978 MHz when the antenna is mounted at the center of a 1.2 meter (4 foot) diameter (or larger) flat circular ground plane. The transmission line impedance **shall** be that as specified by the equipment manufacturer.

Measurement Procedure:

TBD

2.4.15 Verification of Interfaces (subparagraph 2.2.15)

No specific test procedure is required to validate subparagraph 2.2.15.

2.4.15.1 Verification of ADS-B Transmitting Device Interfaces (subparagraph 2.2.15.1)

No specific test procedure is required to validate subparagraph 2.2.15.1.

2.4.15.1.1 Verification of ADS-B Transmitting Device Input Interfaces (subparagraph 2.2.15.1.1)

Purpose/Introduction:

Data delivery mechanisms **shall** ensure that each data parameter is provided to the input function of the ADS-B Transmitting device at sufficient update rates to support the ADS-B Message Update Rates provided in subparagraph 2.2.6.1

Measurement Procedure:

TBD

2.4.15.1.1.1 Verification of Discrete Input Interfaces (subparagraph 2.2.15.1.1.1)

Purpose/Introduction:

Appropriate discrete inputs may be used to provide the ADS-B Transmitting device with configuration and control information. When implemented, all discrete inputs **shall** provide appropriate diode isolation to prevent sneak current paths.

Measurement Procedure:

TBD

2.4.15.1.1.2 Verification of Digital Communication Input Interfaces (subparagraph 2.2.15.1.1.2)

Purpose/Introduction:

Approved Avionics Digital Communication interfaces **shall** be used to provide all digital data parameters (including control information) to the ADS-B Transmitting device. Such input interfaces **shall** implement appropriate error control techniques (i.e., parity as a minimum) to ensure that data is properly delivered to the ADS-B Transmitting device control and message generation functions.

Measurement Procedure:

TBD

2.4.15.1.1.3 Verification of Processing Efficiency (subparagraph 2.2.15.1.1.3)

Purpose/Introduction:

The ADS-B Transmitting Device input processing function **shall** be capable of efficiently processing all data input interfaces in a manner that ensures that the most recent update received for all required data parameters is made available to the message generation function to support the rates identified in subparagraph 2.2.6.1.

Measurement Procedure:

TBD

2.4.15.1.2 Verification of ADS-B Transmitting Device Output Interfaces (subparagraph 2.2.15.1.2)

No specific test procedure is required to validate subparagraph 2.2.15.1.2.

2.4.15.1.2.1 Verification of Discrete Output Interfaces (subparagraph 2.2.15.1.2.1)

Purpose/Introduction:

Appropriate discrete outputs may be used by the ADS-B Transmitting device to provide Mode Status and Failure Monitoring information to other users or monitoring equipment. When implemented, all discrete outputs **shall** provide appropriate diode isolation to prevent sneak current paths.

Measurement Procedure:

TBD

2.4.15.1.2.2 Verification of Digital Communication Output Interfaces (subparagraph 2.2.15.1.2.2)

Purpose/Introduction:

Appropriate Avionics Digital Communication output interfaces **shall** be implemented by the ADS-B Transmitting device to provide status and data communication to other user or monitoring equipment. Such output interfaces **shall** implement appropriate error control techniques (i.e., parity as a minimum) to ensure that data is properly delivered to other user or monitoring equipment.

Measurement Procedure:

TBD

2.4.15.2 Verification of ADS-B Receiving Device Interfaces (subparagraph 2.2.15.2)

No specific test procedure is required to validate subparagraph 2.2.15.2.

2.4.15.2.1 Verification of ADS-B Receiving Device Input Interfaces (subparagraph 2.2.15.2.1)

No specific test procedure is required to validate subparagraph 2.2.15.2.1.

2.4.15.2.1.1 Verification of Discrete Input Interfaces (subparagraph 2.2.15.2.1.1)

Purpose/Introduction:

Appropriate discrete inputs may be used to provide the ADS-B Receiving device with configuration and control information. When implemented, all discrete inputs **shall** provide appropriate diode isolation to prevent sneak current paths.

Measurement Procedure:

TBD

2.4.15.2.1.2 Verification of Digital Communication Input Interfaces (subparagraph 2.2.15.2.1.2)

Purpose/Introduction:

Approved Avionics Digital Communication interfaces **shall** be used to provide all digital data parameters (including control information) to the ADS-B Receiving Device. Such input interfaces **shall** implement appropriate error control techniques (i.e., parity as a minimum) to ensure that data is properly delivered to the ADS-B Receiving device control and Report Assembly functions.

Measurement Procedure:

TBD

2.4.15.2.1.3 Verification of Processing Efficiency (subparagraph 2.2.15.2.1.3)

Purpose/Introduction:

The ADS-B Receiving Device input processing function **shall** be capable of efficiently processing all data input interfaces in a manner that ensures that the most recent update received for all required data parameters is made available to the Report Assembly function.

Measurement Procedure:

TBD

2.4.15.2.2 Verification of ADS-B Receiving Device Output Interfaces (subparagraph 2.2.15.2.2)

No specific test procedure is required to validate subparagraph 2.2.15.2.2.

2.4.15.2.2.1 Verification of Discrete Output Interfaces (subparagraph 2.2.15.2.2.1)

Purpose/Introduction:

Appropriate discrete outputs may be used by the ADS-B Receiving device to provide Mode Status and Failure Monitoring information to other users or monitoring equipment. When implemented, all discrete outputs **shall** provide appropriate diode isolation to prevent sneak current paths.

Measurement Procedure:

TBD

2.4.15.2.2.2 Verification of Digital Communication Output Interfaces (subparagraph 2.2.15.2.2.2)

Purpose/Introduction:

Appropriate Avionics Digital Communication output interfaces **shall** be implemented by the ADS-B Receiving device to provide status and data communication to other user or monitoring equipment. Such output interfaces **shall** implement appropriate error control techniques (i.e., parity as a minimum) to ensure that data is properly delivered to other user or monitoring equipment.

Measurement Procedure:

TBD

2.4.16 Verification of Power Interruption (subparagraph 2.2.16)

Purpose/Introduction:

The ADS-B transmitting and/or receiving equipment **shall** regain operational capability to within its operational limits within two seconds after the restoration of power following a momentary power interruption.

Note: *The ADS-B transmitting and/or receiving equipment is not required to continue operation during momentary power interruptions.*

Measurement Procedure:

TBD

2.4.17 Verification of Compatibility with Other Systems (subparagraph 2.2.17)

No specific test procedure is required to validate subparagraph 2.2.17.

2.4.17.1 Verification of EMI Compatibility (subparagraph 2.2.17.1)

Purpose/Introduction:

The ADS-B transmitting and/or receiving equipment **shall** not compromise the operation of any co-located communication or navigation equipment, or ATCRBS and/or Mode-S transponders. Likewise, the ADS-B antenna **shall** be mounted such that it does not compromise the operation of any other proximate antenna.

Measurement Procedure:

TBD

2.4.17.2 Verification of Compatibility with GPS Receivers (subparagraph 2.2.17.2)

Purpose/Introduction:

The ADS-B transmitting and/or receiving equipment **shall** not compromise the operation of a co-located proximate GPS receiver.

Measurement Procedure:

TBD

2.4.17.3 Verification of Compatibility with Other Navigation Receivers and ATC Transponders (subparagraph 2.2.17.3)

Purpose/Introduction:

The ADS-B transmitting and/or receiving equipment **shall** not compromise the operation of VOR, DME, ADF, LORAN, ATCRBS or Mode-S equipment installed in a proximate location.

In addition, the ADS-B receiver must be fully operational when located in close proximity of an ATCRBS or Mode-S transponder.

Measurement Procedure:

TBD