2.4.8.3.2 Verification of Receiver Discrimination Between ADS-B and Ground Uplink Message Types (§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 §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 §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. Also provide a method such that an ADS-B Message 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 milliseconds away from the UTC Time mark such that the first bit of the synchronization sequence of the transmitted Ground Uplink Message is 250 milliseconds offset from UTC Time Mark.

b. Verify that the UAT receiver declares the Successful Message Reception of a Ground Uplink Message.

c. Apply a valid ADS-B Message to the Receiver Interface 100 milliseconds away from the UTC Time mark such that the first bit of the synchronization sequence of the transmitted ADS-B Message is 100 milliseconds offset from UTC Time Mark.

d. Verify that the UAT receiver declares the Successful Message Reception of an ADS-B Message.

2.4.8.3.3 Verification of Receiver Processing of ADS-B Synchronization "Trigger" (§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 decode process associated with this trigger shall be completed regardless of other trigger activity subsequently detected.

b. The decode process associated with 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. The decode process associated with 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 §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 §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 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 4.*~~

~~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 §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 §2.2.8.3.3.c, in that the loudest of three overlapping messages is properly detected and reported.*~~

Provide a method of supplying the UUT with a single source of desired bit patterns, each of which contains at least one complete valid Long ADS-B message. The content of the messages shall be selected from among the following three Data Sets, as specified in the test procedure Steps. The rate of message generation should be selected to allow for convenient measurement.

These Data Sets define what may be considered the entire time span of up to three overlapping Long ADS-B Messages. Each Data Set begins with the ADS-B Sync pattern (right-justified to 5 bytes as 0x0EACDDA4E2), and ends with a valid FEC encoding parity field that is calculated over only the final 34 payload bytes immediately preceding it. Data Sets 2, 3, 4 and 5 contain at least one additional embedded Sync pattern. Bytes labeled 'PN' may be filled with pseudo-random data as necessary. The Parity bytes are labeled 'P1' through 'P14.'

Data Set 1 consists of a Long ADS-B message whose payload content includes the ADS-B Sync pattern. One such pattern is listed below.

Byte #	**Data**							
1-8	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
9-16	PN	PN	PN	PN	PN	PN	PN	PN
17-24	PN	PN	PN	PN	PN	PN	PN	PN
25-32	PN	PN	PN	PN	PN	PN	PN	PN
33-40	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	P1
41-48	P2	P3	P4	P5	P6	P7	P8	P9
49-53	P10	P11	P12	P13	P14			

Data Set 2 consists of an ADS-B Sync pattern, followed by 11 bytes of PN data, followed by a valid Long ADS-B message. One such pattern is listed below. The Parity field is computed over Bytes 22 through 55.

Byte #	**Data**							
1-8	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
9-16	PN	PN	PN	PN	PN	PN	PN	PN
17-24	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
25-32	PN	PN	PN	PN	PN	PN	PN	PN
33-40	PN	PN	PN	PN	PN	PN	PN	PN
41-48	PN	PN	PN	PN	PN	PN	PN	PN
49-56	PN	PN	PN	PN	PN	PN	PN	P1
57-64	P2	P3	P4	P5	P6	P7	P8	P9
65-69	P10	P11	P12	P13	P14			

Data Set 3 consists of an ADS-B Sync pattern, followed by 11 bytes of data, followed by a second ADS-B Sync pattern, followed by 11 bytes of data, followed by a valid Long ADS-B message. One such pattern is listed below. The Parity field is computed over Bytes 38 through 71.

Byte #	**Data**							
1-8	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
9-16	PN	PN	PN	PN	PN	PN	PN	PN
17-24	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
25-32	PN	PN	PN	PN	PN	PN	PN	PN
33-40	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
41-48	PN	PN	PN	PN	PN	PN	PN	PN
49-56	PN	PN	PN	PN	PN	PN	PN	PN
57-64	PN	PN	PN	PN	PN	PN	PN	PN
65-72	PN	PN	PN	PN	PN	PN	PN	P1
73-80	P2	P3	P4	P5	P6	P7	P8	P9
81-85	P10	P11	P12	P13	P14			

Data Set 4 consists of an ADS-B Sync pattern, followed by 11 bytes of data, followed by a second ADS-B Sync pattern, followed by 11 bytes of data, followed by a third Sync pattern, followed by 19 bytes of data, followed by a fourth Sync pattern and a valid Long ADS-B Message corresponding to the third Sync pattern. One such pattern is listed below. The Parity field is computed over Bytes 38 through 71.

Byte #	**Data**							
1-8	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
9-16	PN	PN	PN	PN	PN	PN	PN	PN
17-24	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
25-32	PN	PN	PN	PN	PN	PN	PN	PN
33-40	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
41-48	PN	PN	PN	PN	PN	PN	PN	PN
49-56	PN	PN	PN	PN	PN	PN	PN	PN
57-64	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
65-72	PN	PN	PN	PN	PN	PN	PN	P1
73-80	P2	P3	P4	P5	P6	P7	P8	P9
81-88	P10	P11	P12	P13	P14	PN	PN	PN

Data Set 5 consists of an ADS-B Sync pattern, followed by 11 bytes of data, followed by a second ADS-B Sync pattern, followed by 11 bytes of data, followed by a third Sync pattern, followed by 19 bytes of data, followed by a fourth Sync pattern, and a valid Long ADS-B Message corresponding to the fourth Sync pattern. One such pattern is listed below. The Parity field is computed over Bytes 62 through 95.

Byte #	**Data**							
1-8	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
9-16	PN	PN	PN	PN	PN	PN	PN	PN
17-24	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
25-32	PN	PN	PN	PN	PN	PN	PN	PN
33-40	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
41-48	PN	PN	PN	PN	PN	PN	PN	PN
49-56	PN	PN	PN	PN	PN	PN	PN	PN
57-64	0x0E	0xAC	0xDD	0xA4	0xE2	PN	PN	PN
65-72	PN	PN	PN	PN	PN	PN	PN	PN
73-80	PN	PN	PN	PN	PN	PN	PN	PN
81-88	PN	PN	PN	PN	PN	PN	PN	PN
89-96	PN	PN	PN	PN	PN	PN	PN	P1
97-104	P2	P3	P4	P5	P6	P7	P8	P9
105-112	P10	P11	P12	P13	P14	PN	PN	PN

Measurement Procedures:

Step 1: Verification of §2.2.8.3.3.a (Initial Trigger Processing Completed)

Configure the message source to generate Data Set 1.

Verify that at least 10 messages from Data Set 1 are successfully received.

Step 2: Verification of §2.2.8.3.3.b (Second Trigger Processing Completed)

Configure the message source to generate Data Set 2.

Verify that at least 10 messages from Data Set 2 are successfully received.

Step 3: Verification of §2.2.8.3.3.c (Third Trigger Processing Completed)

Configure the message source to generate Data Set 3.

Verify that at least 10 messages from Data Set 3 are successfully received.

Step 4: Verification of §2.2.8.3.3.c (Third Trigger Processing Completed)

Configure the message source to generate Data Set 4.

Verify that at least 10 messages from Data Set 4 are successfully received.

Step 5: Verification of §2.2.8.3.3.c (Third Trigger Processing Completed)

Configure the message source to generate Data Set 5.

Verify that at least 10 messages from Data Set 5 are successfully received.

2.4.8.3.4 Verification of Receiver Processing of Ground Uplink Synchronization "Trigger" (§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.