RTCA Special Committee 186, Working Group 3
EUROCAE WG-51, SG-1

ADS-B 1090ES MOPS Maintenance

Meeting #26

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Report on Action Item 25-12 regarding
Change Item #29 - Clarify start/end of squittering

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Summary
This Working Paper addresses Change Item #29, "Clarify start/end of squittering" taking into account and complementing the proposed changes related to the use of TYPE code 0 as proposed in WP26-09.

1 Introduction

This Working Paper addresses Change Item #29, "Clarify start/end of squittering". It addresses the different issues as discussed during meeting SC186-WG3/ WG51-SG1 when reviewing WP 25-17 and proposes changes to ED102/DO260 taking into account the proposed changes related to TYPE code zero (WP24-06 + ICAO TSG WP06-04R1+ WP26-09).

2 Result from reviewing WP25-17 during meeting 25

A first working paper (WP25-17) investigated what should happen when altitude remains valid or disappear in the Airborne Position Message. During the review of this WP the meeting agreed on the following points:

- Register 05_{16}:
  - When position is no more available the insertion of altitude satisfies the minimum requirement for continuing to broadcast of the airborne position squitter. The text of the requirement must be improved and the associated test must be adapted.
  - If position and altitude become both not available for 60s the broadcast of airborne position squitter shall be discontinued.
- Register 09_{16}:
  - Extended Squitter Airborne Velocity is now specified with a maximum update interval of 1.3s. The timeout is defined at 2s. This is not compatible with the generic rule requiring twice update interval of 2s whichever is the greater. This issue shall be investigated and corrected if required.
- Interference with TYPE code zero:
  - As there is a possible interference between the termination of the broadcast of Extended Squitter and the transmission of the TYPE code zero the clarifications should take into account proposal to limit transmission of the TYPE code zero as proposed by Don Walker:
    - Type code 0 is only used by Airborne and Surface Position Message, i.e., it should be no more used by Airborne Velocity message.
    - When surface position message is transmitted with Type code 0 its content is always all zero to avoid confusion with altitude transmitted in the Airborne Position message.

3 Summary of current and proposed ES timeout and termination

	Timeout		**Termination**	
Messages	**Existing**	**Proposed**	**Existing**	**Proposed**
Airborne position	2.2.3.3.2.11 a Cleared after 2s except altitude and surveillance status field	Same	2.2.3.3.2.12 a + A.1.5.3 after 60s Continue to be transmitted if altitude is present (A.1.5.3)	continues to be transmitted if altitude remains available, stops if position and altitude disappears for 60s
Surface position	2.2.3.3.2.11 a Cleared after 2s	same + clarify that movement is also cleared	2.2.3.3.2.12 + A.1.5.3 after 60s Continue if movement information is received (*Conflict with format TYPE code = 0!)*	transmission stopped after the timeout Movement/ground track not sufficient to continue broadcast
Airborne Velocity	2.2.3.3.2.11 a Cleared after 2s	Cleared after 2.6s	2.2.3.3.2.12 a + A.1.5.3 after 60s	transmission stopped after the timeout
Aircraft Identification	2.2.3.3.2.11 b Not cleared before 60s	Same = Not cleared	2.2.3.3.2.12 a stets that it shall stop after 60s however continuation tested at 61s in 2.4.3.3.2.4 step 4	never cleared (to be confirmed)
Target State and Status, Operational Status, or Event-Driven	Never 2.2.3.3.2.11 c		Target State and Status + Operational Status are cleared after 60s event driven specific	No change

Extract of current text specifying termination of ES in DO260A :

2.2.3.3.2.12 ADS-B Message Termination

a. The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Airborne Position, Surface Position, Aircraft Identification and Category, Velocity, Target State and Status, and/or Aircraft Operational Status Messages if input data necessary to update the particular ADS-B Message TYPE is not available for a period of 60 seconds, except that transmission termination of Surface Position Messages does not apply to Non-Transponder Devices on aircraft that are on the surface, or on surface vehicles.

Notes:

1. *For the Airborne Position Message, specifically, Altitude Data alone is sufficient to maintain broadcast of the message once the message has been initiated.*

2. *For the Surface Position Message, the receipt of new Position (i.e., Latitude and Longitude, combined), Movement, or Ground Track data is sufficient to maintain broadcast of the message once the message has been initiated.*

Clearing of content:

It is proposed to use the same approach than in ICAO Doc 9871, i.e., the content is cleared when the registers or fields are not updated for a time greater than twice the specified maximum update interval, or 2 seconds (whichever is the greater).

It results in a time of 2.6s for the Airborne Velocity Message.

Note that the usefulness of the clearing of the complete Airborne Velocity Message is questionable as each main parameter (velocity, vertical rate,…) can be coded to indicate that there is no data available. The proposed approach is to keep the current clearing and termination approach for the Airborne Velocity Message.

The Surface Position message is containing position fields to be updated every 200ms and movement/ ground track fields to be update every 1.3s. The new approach considers that the Movement and Ground Track fields are not sufficient to continue to broadcast a non-zero message and therefore the time-out value used remains 2s.

Clearing of Airborne Velocity message is questionable as each main parameters (velocity, vertical rate,…) can be coded to indicate that there is no data available. Nevertheless the proposal has kept the current approach for r the Airborne velocity message.

4 Proposed approach: for timeout and termination requirements:

The following pages contain existing text with suggested changes using **MS revision marks**.

When required some portions of text have been highlighted in yellow to show the differences with WP26-09.

In order to clarify the timeout and termination it is proposed to specify what shall be done register per register in section 2.2.3.3.2.11 (timeout) and 2.2.3.3.2.12 (termination) as follows:

2.2.3.3.2.11 ADS-B Message Timeout

Notes:

1. The messages are cleared to prevent the reporting of outdated position and velocity information.

2. During a register timeout event, the "ME" field of the ADS-B Broadcast Message may contain ALL ZEROs, except for those fields that may be updated due to the receipt of new data.

a. The ADS-B Transmitting Subsystem **shall** clear all ~~56-bits~~but the altitude and surveillance status subfields of the Airborne Position Message~~, Surface Position Message and Airborne Velocity Message~~ if no new position data is received within two (2) seconds of the previous input data update ~~. This timeout requirement **shall** be applied individually for each of the three (3) message types identified.~~

Note: During a timeout event the Format TYPE Code is set to zero (see §2.2.3.2.3.2.3.1).

~~***Notes:***~~

~~*1. These messages are cleared to prevent the reporting of outdated position and velocity information.*~~

~~*2. During a register timeout event, the "ME" field of the ADS-B Broadcast Message may contain ALL ZEROs, except for those fields that may be updated due to the receipt of new data.*~~

b. The ADS-B Transmitting Subsystem **shall** clear all 56-bits of Surface Position Message if no new position data is received within two (2) seconds of the previous input data update.

Note:

1. During a timeout event the Format TYPE Code is set to zero (see §2.2.3.2.4.1.3.1).

2. When position is available the ADS-B Transmitting system manages the movement field and the ground track as any other fields, i.e., if no data is received to update the field for a time greater than twice the specified maximum update interval, or 2 seconds (whichever is greater) the movement field and the ground track will be zeroed and the status bit for ground track will be set to invalid if no new movement respectively /ground track data is received within 2.6s (2 times 1.3s) of the previous input data update.

3. *When position data is not received all bits of the Surface Position Message are zeroed to avoid confusion with altitude data in airborne position message sent with TYPE code 0.*

c. The ADS-B Transmitting Subsystem **shall** clear all 56-bits of Airborne Velocity Message if no data is received within 2.6 seconds of the previous input data update.

Note: The Intent change and the IFR capability flag update are not sufficient to consider that new data have been received (2.2.3.2.6.1.c)

~~b~~d. The ADS-B Transmitting Subsystem **shall not** clear the Aircraft Identification Message (see §2.2.3.2.5) if no new data (neither aircraft type, emitter category, nor identification data) is received within up to 60 seconds of the previous input data update.

Note: *The Aircraft Identification Message is not cleared since it contains data that rarely changes in flight and is not frequently updated.*

ee. The ADS-B Transmitting Subsystem **shall not** clear the Target State and Status, Operational Status, or Event-Driven Messages (see §2.2.3.2.7) if no new data is received within up to 60 seconds of the previous input data update.

Note: *The Event-Driven Messages do not need to be cleared since contents of such messages are only broadcast once each time that new data is received.*

…

2.2.3.3.2.12 ADS-B Message Termination

a. The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Airborne Position Message when position (altitude/longitude) and altitude data are both ~~, Surface Position, Aircraft Identification and Category, Velocity, Target State and Status, and/or Aircraft Operational Status Messages if input data necessary to update the particular ADS-B Message TYPE is~~ no more~~t~~ available for a period of 60 seconds.

Notes:

~~1~~. *For the Airborne Position Message, ~~specifically,~~ Altitude Data alone is sufficient to maintain broadcast of the message once the message has been initiated. When altitude is available, the airborne position message continues to be transmitted after 60s however if the altitude becomes not available for 60s the airborne position message transmission is stopped and the conditions for start-up defined in 2.2.3.3.2.1.2 are necessary to resume the transmission of Airborne Position Message..*

~~. For all other ADS-B Messages, the receipt of new data necessary to update any single parameter of the message is sufficient to maintain broadcast of the message once the message has been initiated~~

b. The ADS-B transmitting Subsystem **shall** terminate the transmission of Surface Position Message if position data necessary to update the message is not available for a period of 60 seconds for position information except that transmission termination of Surface Position Messages does not apply to Non-Transponder Devices on aircraft that are on the surface, or on surface vehicles.

Note~~s~~: *~~2.~~ For the Surface Position Message, the receipt of new ~~Position (i.e., Latitude and Longitude, combined)~~,Movement, or Ground Track data is not sufficient to maintain broadcast of the message once the message has been initiated.*

c. The ADS-B Transmitting Subsystem **shall not** terminate broadcast transmissions of Aircraft Identification and Category Message if input data necessary to update the message is no more available for a period of 60 seconds.

d. The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Airborne Velocity Message if input data necessary to update the fields of the Airborne Velocity Message other than Intent Change Flag and IFR Capability Flag are not available for a period of 2.6 seconds.

Notes:

1. The receipt of new data necessary to update any single field other than the Intent Change Flag and IFR Capability Flag is sufficient to maintain broadcast of the Airborne Velocity Message .

2. Previous versions of these MOPS required velocity squitter to be transmitted for an additional 60 seconds with all zeros including the Type Code field. In the event of a loss of GPS data the airborne position squitter would have barometric altitude in it, the velocity squitter would not. However, a receiver could not determine the difference between these cases, therefore the transmitted altitude was not usable.

e~~b~~. . The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Target State and Status, and/or Aircraft Operational Status Messages if input data necessary to update the particular ADS-B Message TYPE are no more available for a period of 60 seconds.

f. Each ADS-B Message type **shall** be terminated individually and independently of all other ADS-B Messages.

g~~e~~. Class B2 Non-Transponder-Based Transmitting Subsystems on Ground Vehicles **shall** provide an interface capable of putting the unit into a standby condition in which the unit suspends all message transmissions.

Notes: *The Event-Driven Messages do not need to be cleared since contents of such messages are only broadcast once each time that new data is received.*

….

A.1.5.3 Termination of Extended Squitter Broadcast

If input to Register 05_{16} or 06_{16} ~~, 07_{16}, or 09_{16}~~ stops for 60 seconds broadcast of the associated Extended Squitter type will be discontinued until data insertion is resumed.

The insertion of altitude by the transponder will satisfy the minimum requirement for continuing to broadcast the airborne position squitter.

If input to register 09_{16} stops for 2.6s broadcast of the associated Extended Squitter type will be discontinued until data insertion is resumed.

Notes:

1. Until timeout, an Extended Squitter type may contain an ME field of ALL ZEROs.

2. Continued transmission for 60 seconds is required so that receiving aircraft will know that the data source for the message has been lost.

A.1.6.3.2 Broadcast of Format TYPE Code Equal to Zero

Format TYPE Code 0 will only be set by the following events:

1. Airborne Position or Surface Position ~~Extended Squitter Register monitored by the transponder~~ (Register 05_{16} and~~,~~ 06_{16}~~, 07_{16} and 09_{16}~~) has not been loaded by the GFM for 2 seconds. In this case the transponder clears the entire 56 bits of the register that timed out. (In the case of the Airborne Position register, the altitude subfield is only ZEROed if no altitude data is available). Transmission of the Airborne and Surface Position Extended Squitter that broadcasts the timed out register will itself stop in 60 seconds except for the airborne position message when altitude is still available. Broadcast of this Extended Squitter will resume when the GFM begins to insert data into the register.

2. The GFM determines that all navigation sources that can be used for the Extended Squitter airborne or Surface Position Message are either missing or invalid. In this case the GFM can clear the Format TYPE Code and all other fields of the airborne position, surface position~~, or airborne velocity message~~ and insert this zeroed message in the appropriate register. This should only be done once so that the transponder can detect the loss of data insertion and suppress the broadcast of the related squitter

   Note that in all of the above cases, a Format TYPE Code of ZERO contains a message of ALL ZEROs. The only exception is the airborne position format that may contain barometric altitude and surveillance status data as set by the transponder. There is no analogous case for the other Extended Squitter format types, since a ZERO value in any of the fields indicates no information. No other squitter types are broadcast with TYPE code Zero.

In addition the different sub-sections of 2.2.3.2.6 must be checked and adapted as proposed below. The differences with WP 26-09 are highlighted in yellow.

2.2.3.2.6.1 ADS-B Airborne Velocity Message - Subtype=1

a. The Airborne Velocity Message - Subtype=1 is illustrated in Figure 2-7 and shall be transmitted by the Airborne ADS-B Transmitting Subsystem when Velocity Over Ground information is available, and the transmitting device is installed in an environment having *NON*-supersonic airspeed capability.

b. The Supersonic Version of the Airborne Velocity Message (i.e., Subtype=2) shall be used if either the East/West velocity OR the North/South velocity exceeds 1022 knots. A switch to the normal velocity message (i.e., Subtype=1) shall be made if both the East/West and the North/South velocities drop below 1000 knots.

c. The Airborne Velocity Message shall not be broadcast if the only valid data are the Intent Change and the IFR Capability Flags.

(1). Transponder-Based ADS-B Transmitting Subsystems shall suppress the broadcast by loading Register 09_{16} with all "ZEROs" and then discontinuing updating of the register until data input is available again. The Transponder will ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181D (EUROCAE ED-73C)~~.

(2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds~~ as specified in §2.2.3.3.2.11 and §2.2.3.3.2.12.

…

2.2.3.2.6.2 ADS-B Airborne Velocity Message - Subtype=2

a. The Airborne Velocity Message - Subtype=2 is illustrated in Figure 2-7 and shall be transmitted by the Airborne ADS-B Transmitting Subsystem when Velocity Over Ground information is available, and the transmitting device is installed in an environment having a Supersonic airspeed capability.

b. The Supersonic Version of the Airborne Velocity Message (i.e., Subtype=2) shall be used if either the East/West Velocity OR the North/South Velocity exceeds 1022 knots. A switch to the normal Airborne Velocity Message (i.e., Subtype=1) shall be made if both the East/West and the North/South Velocities drop below 1000 knots.

c. The Airborne Velocity Message shall not be broadcast if the only valid data are the Intent Change and the IFR Capability Flags.

(1). Transponder-Based ADS-B Transmitting Subsystems shall suppress the broadcast by loading Register 09_{16} with all "ZEROs" and then discontinuing updating of the Register until data input is available again. The Transponder will ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181D (EUROCAE ED-73C)~~.

(2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2.6 seconds and terminate broadcast ~~after 60 seconds~~, as specified in §2.2.3.3.2.11 and §2.2.3.3.2.12.

…

2.2.3.2.6.3 ADS-B Airborne Velocity Message - Subtype=3

a. The Airborne Velocity Message - Subtype=3 is illustrated in Figure 2-8 and **shall** be transmitted by the Airborne ADS-B Transmitting Subsystem when Velocity Over Ground information is not available, and the transmitting device is installed in an environment having *NON*-supersonic airspeed capability.

b. The Supersonic Version of the Airborne Velocity Message (i.e., Subtype=4) **shall** be used if the airspeed exceeds 1022 knots. A switch to the normal Velocity Message (i.e., Subtype=3) **shall** be made if the airspeed drops below 1000 knots.

c. The Airborne Velocity Message **shall** not be broadcast if the only valid data is the Intent Change and the IFR Capability Flags.

(1). Transponder-Based ADS-B Transmitting Subsystems **shall** suppress the broadcast by loading Register 09_{16} with all "ZEROs" and then discontinuing updating of the Register until data input is available again. The Transponder will ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60seconds, as specified in RTCA DO-181D (EUROCAE ED-73C)~~.

(2). Non-Transponder-Based ADS-B Transmitting Subsystems **shall** ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds~~, as specified in §2.2.3.3.2.11 and §2.2.3.3.2.12.

2.2.3.2.6.4 ADS-B Airborne Velocity Message - Subtype=4

a. The Airborne Velocity Message - Subtype=4 is illustrated in Figure 2-8 and **shall** be transmitted by the Airborne ADS-B Transmitting Subsystem when Velocity Over Ground information is ***NOT*** available, and the transmitting device is installed in an environment having Supersonic airspeed capability.

b. The Supersonic Version of the Airborne Velocity Message (i.e., Subtype=4) **shall** be used if the airspeed exceeds 1022 knots. A switch to the normal Velocity Message (i.e., Subtype=3) **shall** be made if the airspeed drops below 1000 knots.

c. The Airborne Velocity Message **shall** not be broadcast if the only valid data is the Intent Change and the IFR Capability Flags.

(1). Transponder-Based ADS-B Transmitting Subsystems **shall** suppress the broadcast by loading Register 09_{16} with all "ZEROs" and then discontinuing updating of the Register until data input is available again. The Transponder will ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181D (EUROCAE ED-73C)~~.

(2). Non-Transponder-Based ADS-B Transmitting Subsystems **shall** ZERO the Velocity Message after 2.6 seconds and terminate the broadcast ~~after 60 seconds~~, as specified in §2.2.3.3.2.11 and §2.2.3.3.2.12.

Each of the subfields of the Airborne Velocity Message - Subtype=4 is specified in the following subparagraphs.

The associated tests should be modified as follows:

…

2.4.3.2.3 Verification of ADS-B Airborne Position Messages (§2.2.3.2.3)

…

2.4.3.2.3.1.3.1 Verification of Significance of TYPE Code Equal to ZERO (§2.2.3.2.3.1.3.1)

Measurement Procedure:

Step 1: TYPE ZERO Verification - Part 1

Configure the ADS-B Transmitting Subsystem to Airborne status. Provide valid altitude code data and a permanent alert (emergency condition) to the ADS-B Transmitting Subsystem. Connect the GNSS data input and verify that Airborne Position, Velocity and Aircraft Identification Messages are transmitted at the proper rate.

Stop update of the Navigational source of Airborne Latitude and Longitude position information. If the ADS-B Transmitting Subsystem is capable of receiving Airborne position data from more than one Navigation source, verify the following by disconnecting each Navigation source separately. Verify that after 2 seconds, the TYPE code of ZERO is transmitted twice per second. Verify that the remaining ME Bits of the message are ZERO, except for the Altitude subfield, Single Antenna Flag, and Surveillance Status. After 60s verify that the Airborne Position Message continues to be transmitted.

Stop providing valid altitude. After 60 seconds, verify that the Airborne Position Message is no longer transmitted. Connect the GNSS data input and verify that Surface Position and Airborne Position Messages are no longer transmitted.

Repeat above if the Latitude and Longitude sources can be received separately. Stop update of Latitude data while maintaining update of Longitude data and verify that TYPE code of ZERO is transmitted twice per second after 2 seconds from data input disconnection.

Repeat above except stop update of Longitude data while maintaining update of Latitude data and verify that TYPE code of ZERO is transmitted twice per second after 2 seconds from data input disconnection.

Step 2: TYPE ZERO Verification - Part 2

Setup the ADS-B Transmitting Subsystem as in Step 1. Provide valid altitude code data and a permanent alert (emergency condition) to the ADS-B Transmitting Subsystem. Connect the GNSS data input and verify that Airborne Position, Velocity and Aircraft Identification Messages are transmitted at the proper rate.

-Stop update of the Navigational source of Airborne Latitude and Longitude position information. If the ADS-B Transmitting Subsystem is capable of receiving Airborne position data from more than one Navigation source, verify the following by disconnecting each Navigation source separately. Verify that after 2 seconds, the TYPE code is ZERO and the remaining ME Bits are ZERO, except for the altitude data, Single Antenna Flag, and Surveillance Status.After 60s verify that the Airborne Position Message continues to be transmitted.

Stop providing valid altitude. After 60 seconds, verify that the Airborne Position Message is no longer transmitted.

2.4.3.2.4 Verification of ADS-B Surface Position Messages (§2.2.3.2.4)

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2.4.3.2.4.1.3.1 Verification of Significance of TYPE Code Equal to ZERO (§2.2.3.2.4.1.3.1)

Purpose/Introduction:

TYPE code equal to ZERO is broadcast as a result of loss of ADS-B data updates. The following test verifies that the ADS-B Transmitting Subsystem correctly outputs TYPE code equal to ZERO for each ADS-B Position Message type and correctly terminate the transmission when required.

Measurement Procedure:

Setup the ADS-B Transmitting Subsystem to the On-Ground status. Connect the GNSS data input, provide valid non-zero "Movement" and "Heading/Ground Track" data to the ADS-B System, If the ADS-B transmitting Subsystem is capable of receiving "Movement" and "Heading/Ground Track" data from other source than GNSS then provide these data from other source. ~~and v~~Verify that Surface Position and Aircraft Identification Messages are transmitted at the proper rate.

Stop update of the Navigational source of Latitude and Longitude position information. If the ADS-B Transmitting Subsystem is capable of receiving position data from more than one Navigation source, verify the following by disconnecting each Navigation source separately. Verify that after 2 seconds, the TYPE code is ZERO and all the remaining "ME" Bits are ZERO. For Mode S Transponder-Based systems, verify that the Surface Position Message is no longer transmitted after 60 seconds. For Non-Mode S Transponder-Based systems, monitor for 120 seconds and verify that TYPE Code of ZERO is output at the high transmission rate.

2.4.3.2.6 Verification of ADS-B Airborne Velocity Messages (§2.2.3.2.6)

2.4.3.2.6.1 Verification of ADS-B Airborne Velocity Message - Subtype=1 (§2.2.3.2.6.1)

Appropriate test procedures required to validate the correct transmission of the parameters of the ADS-B Airborne Velocity Message – Subtype=1 are provided in §2.4.3.2.6.1.1 through §2.4.3.2.6.1.15.

Purpose/Introduction:

Additionally, the requirement of §2.2.3.2.6.1.c states that: "this message **shall** not be broadcast if the only valid data are the Intent Change and the IFR Capability Flags."

Measurement Procedure:

Configure the ADS-B Transmitting Subsystem to transmit Airborne Velocity 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 Airborne Velocity Messages. Set the ADS-B Transmitting Subsystem to Airborne Status. Provide valid input data and verify that Airborne Velocity Messages − Subtype=1 are being broadcast. Discontinue all of the input data to the data fields except for the Intent Change and IFR Capability flag data. Wait 2.6 Seconds and verify that the ~~next output Airborne Velocity Message − Subtype=1 is set to ALL ZEROs. Verify that after 60 seconds~~ Airborne Velocity Messages ~~− Subtype=1 are~~is no longer being broadcast.

Repeat this procedure for Airborne Velocity Messages of Subtypes "2," "3" and "4."

2.4.3.3.2 Verification of Transmission Rates for Stand Alone Transmitters (§2.2.3.3.2)

…

2.4.3.3.2.1 Verification of Power-On Initialization and Start Up (§2.2.3.3.2.1)

…

2.4.3.3.2.1.2 Verification of Start Up (§2.2.3.3.2.1.2)

Note: *To save time and repeating of tests the tests in this section can be combined with those testing §2.2.3.3.2.2 to §2.2.3.3.2.9 inclusive.*

Equipment Required:

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

Measurement Procedure:

Step 1: Data Available for only One Variable Data Field (§2.2.3.3.2.1.2.a and b)

Ensure that no appropriate valid message data are available for any of the possible ADS-B broadcast messages. Power up the equipment. Verify that no transmissions occur. For ADS-B broadcast message specified in §2.2.3.3.2.2, for each data field in turn, make data available for only that data field. Verify that for each data field, the message is transmitted at the rate specified in §2.2.3.3.2.3 to §2.2.3.3.2.9 inclusive.

Repeat Step 1 for all of the ADS-B broadcast message types specified in §2.2.3.3.2.3 to §2.2.3.3.2.9 inclusive.

Step 2: Data Ceases to be Available After Transmission has been Initiated (§2.2.3.3.2.1.2.c)

Ensure that appropriate valid ADS-B Message data are available for each ADS-B Message type. For each ADS-B Message type in turn, make all data fields unavailable and verify that the broadcast of the relevant message is discontinued when the input data has not been available for a period ~~of 60 seconds~~as specified in 2.2.3.3.2.12.

2.4.3.3.2.2 Verification of ADS-B Airborne Position Message Broadcast Rate (§2.2.3.3.2.2)

Equipment Required:

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

Measurement Procedure:

Step 1: All Data Available (§2.2.3.3.2.2)

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

Step 2: Only Barometric Altitude Data Available (§2.2.3.2.3.1.3.1)

Repeat Step 1 with only barometric altitude data available this time and verifying that the TYPE Code = 0.

Step 3: Data Ceases to be Updated (§2.2.3.3.2.11a)

Establish the broadcast of the ADS-B Airborne Position Message as in Step 1 above. Then stop the input of data (no position and no altitude) for the ADS-B Airborne Position Message.

Verify that the ADS-B Airborne Position Message is broadcast with all data bits being set to ZERO no more than 2.6 seconds after stopping the data input.

Verify that the ADS-B Airborne Position Message is no longer broadcast 60 ±1 seconds after stopping the data input.

2.4.3.3.2.3 Verification of ADS-B Surface Position Message Broadcast Rate (§2.2.3.3.2.3)
Equipment Required:

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

Measurement Procedure:

Step 1: Switching from High Rate to Low Rate & Data Ceases to be Updated (§2.2.3.3.2.3.a(1) and c & §2.2.3.3.2.12)

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

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

Stop the input of data, and for Transponder-Based systems verify that the ADS-B Surface Position Messages are no longer broadcast 60 ±1 seconds after the data becomes unavailable. For Non-Transponder-Based systems verify that TYPE Code of ZERO is output at the "High" transmission rate after 2 seconds. Monitor for 120 seconds and verify that TYPE Code of ZERO continues to be broadcast.

Step 2: Switching from Low Rate to High Rate & Data Ceases to be Updated (§2.2.3.3.2.3.a(2) and c & §2.2.3.3.2.12)

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

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

Stop the input of data, and for Transponder-Based systems verify that the ADS-B Surface Position Messages are no longer broadcast 60 ±1 seconds after the data becomes unavailable. For Non-Transponder-Based systems verify that TYPE Code of ZERO is output at the "High" transmission rate after 2 seconds. Monitor for 120 seconds and verify that TYPE Code of ZERO continues to be broadcast.

2.4.3.3.2.4 Verification of ADS-B Aircraft Identification and Category Message Broadcast Rate(§2.2.3.3.2.4)

Equipment Required:

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

Measurement Procedure:

Step 1: Airborne with No Target State, and Aircraft Operational Status (§2.2.3.3.2.4.a)

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

Step 2: Airborne with Target State, and Aircraft Operational Status (§2.2.3.3.2.4.b)

Ensure that the equipment is set to the "Airborne" condition and that the appropriate valid ADS-B Aircraft Identification and Category data is available.

Provide the equipment with valid Target State Data necessary to establish Target State and Status Broadcast Messages (see §2.2.3.2.7.1 and §2.2.3.3.2.6.1).

Provide the equipment with valid Target State Data necessary to establish Target State and Status Broadcast Messages (see §2.2.3.2.7.1 and §2.2.3.3.2.6.1).

Provide the equipment with valid Operational Status Data necessary to establish Aircraft Operational Status Messages (see §2.2.3.2.7.2 and §2.2.3.3.2.6.2).

Verify that Target State and Status, and Aircraft Operational Status Messages are being broadcast.

Note: It is not necessary to verify the rate of broadcast for the Intent Messages at this time since direct verification of the broadcast rates for these messages is verified in procedures later in this document.

Verify that the ADS-B Aircraft Identification and Category Message is broadcast at an average rate of one message per 5 seconds over a time period of 60 seconds.

Step 3: On the Ground (§2.2.3.3.2.4.c)

Ensure that the equipment is set to the "On the Ground" condition and that the appropriate valid ADS-B Aircraft Identification and Category data is available.

Verify that the ADS-B Aircraft Identification and Category Message is broadcast at intervals that are uniformly distributed over the range of 9.8 to 10.2 seconds as specified in §2.2.3.3.2.4.c.

Step 4: Data Ceases to be Updated (§2.2.3.3.2.11)

Establish the broadcast of the ADS-B Aircraft Identification and Category Message as in Step 1 above. Then stop the input of data for the ADS-B Aircraft Identification and Category Message.

Verify that the ADS-B Aircraft Identification and Category Message continues to be broadcast with the same data that existed prior to stopping the data input for at least 61 seconds after stopping the data input.

2.4.3.3.2.5 Verification of ADS-B Velocity Information Message Broadcast Rate (§2.2.3.3.2.5)
Equipment Required:

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

Measurement Procedure:

Step 1: Data Available (§2.2.3.3.2.5)

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

Step 2: Data Ceases to be Updated (§2.2.3.3.2.11)

Establish the broadcast of the ADS-B Airborne Velocity Message as in Step 1 above. Then stop the input of data for the ADS-B Airborne Velocity Message except for the Intent Change and the IFR Flag.

~~Verify that the ADS-B Airborne Velocity Message is broadcast with all data bits being set to ZERO no more than 2.6 seconds after stopping the data input.~~

Verify that the ADS-B Airborne Velocity Message is no longer broadcast ~~60 ±1~~2.6 seconds after stopping the data input.

2.4.3.3.2.6 Verification of ADS-B Target State and Status, and Operational Status Message Broadcast Rates (§2.2.3.3.2.6)
2.4.3.3.2.6.1 Verification of ADS-B Target State and Status Message Broadcast Rates (§2.2.3.3.2.6.1)

…

Step 6: ADS-B Message Broadcast Sixty Second Timeout – ADS-B Target State and Status Messages (§2.2.3.3.2.11c & §2.2.3.3.2.12)

Interrupt the changing of the input data necessary for transmission of ADS-B Target State and Status Messages (TYPE=29, Subtype=0) with new (valid) data, and after 60 seconds verify that the unchanged data fields are NOT cleared to ZERO.

Stop the input of data, and verify that the ADS-B Target State and Status Messages (TYPE=29, Subtype=0) are no longer broadcast 60 ±1 seconds after the data becomes unavailable.

2.4.3.3.2.6.2 Verification of ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.2.6.2)

…

Step 9: ADS-B Message Broadcast Sixty-Second Timeout – Aircraft Operational Status Messages (§2.2.3.3.2.11.c & §2.2.3.3.2.12)

Interrupt the changing of the input data necessary for transmission of Aircraft Operational Status Messages (TYPE=31, Subtype=1) with new (valid) data, and after 60 seconds verify that the unchanged data fields are NOT cleared to ZERO.

Stop the input of data, and verify that the Aircraft Operational Status Messages (TYPE=31, Subtype=1) are no longer broadcast 60 ±1 seconds after the data becomes unavailable.

Step 10: ADS-B Message Broadcast Sixty Second Timeout – Aircraft Operational Status Messages (§2.2.3.3.2.11.c & §2.2.3.3.2.12)

Replace the Aircraft Operational Status Messages (TYPE=31, Subtype=1) with Aircraft Operational Status Messages (TYPE=31, Subtype=0), interrupt the changing of the input data necessary for transmission of Aircraft Operational Status Messages (TYPE=31, Subtype=0) with new (valid) data, and after 60 seconds verify that the unchanged data fields are NOT cleared to ZERO.

Stop the input of data, and verify that the Aircraft Operational Status Messages (TYPE=31, Subtype=0) are no longer broadcast 60 ±1 seconds after the data becomes unavailable.

5 Recommendations

The meeting is invited to consider the changes proposed in complement to the changes proposed in WP26-09 and to note the need to update ICAO Annex 10 Volume IV (3.1.2.8.6.6), Doc9871 and the transponder MOPS DO181-D/ED73-C to have consistency through all documents.