

RTCA SC-186 WORKING GROUP 3

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Problems with Zero Type Code in Extended Squitter Messages

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Summary

DO-181C, DO-260A, and ICAO Doc 9871 require that Airborne Position, Surface Position, and Airborne Velocity Squitters all continue to be broadcast with TYPE Code Zero for 60 seconds after the source data has timed out. This presents an ambiguous decoding problem for an ADS-B receiver. Honeywell proposes to modify these requirements to only transmit Airborne Position Messages and Surface Position Messages with TYPE Code ZERO. Airborne Velocity Messages would not be broadcast with TYPE Code ZERO. This will permit a receiver to use the pressure altitude delivered in the Airborne Position Message.

1. Introduction

The list of DO-260A MOPS and ICAO Doc 9871 paragraphs listed in section 2 require that Airborne Position, Surface Position, and Airborne Velocity Squitters all continue to be broadcast with TYPE Code Zero for 60 seconds after the source data has timed out. The Airborne Position Message is required to continue to contain the pressure altitude. The Surface Position and Velocity Messages are required to be all ZEROS. This presents an ambiguous decoding problem for an ADS-B receiver. It depends on the TYPE code to distinguish between the incoming ADS-B messages. Therefore, it would not be able to tell a ZERO TYPE Code Airborne Position Message from any other ZERO TYPE Code Message. Honeywell proposes to modify these requirements and only transmit Airborne Position Messages and Surface Position Messages with TYPE Code ZERO. Airborne Velocity Messages will not be broadcast with TYPE Code ZERO. Honeywell will present this issue paper to SC-209, SC-186 WG3, and ICAO TSG proposing to make the following changes to DO-181D, DO-260A, and Doc 9871.

If accepted these requirements changes will drive changes in the corresponding test paragraphs. Honeywell will provide those text changes to the committee as needed.

2. Discussion

An ADS-B 1090 MHz receiver depends on the TYPE code to distinguish between the incoming ADS-B messages. Therefore, it cannot tell a ZERO TYPE Code Airborne Position Message from any other ZERO TYPE Code Message. Honeywell proposes to modify these requirements and only transmit Airborne Position Messages and Surface Position Messages with TYPE Code ZERO. Airborne Velocity Messages will not be broadcast with TYPE Code ZERO. The stated goal of continuing to deliver the pressure altitude will be met. The other stated goal of notifying the receiver that the position source was lost will also be met. There is no stated goal for transmitting a zero velocity message.

The following text is the existing text with the recommended changes included. You can use the MS Word View Markup feature to see the change bars and added/deleted text.

DO-181C Existing Text with Suggested Changes Shown (use MS Word View Markup)

2.2.23.1.3 Extended Squitter Rate

- a. Initialization. At power up initialization, the transponder shall commence operation in a mode in which it broadcasts only acquisition squitters (2.2.16.2.6.1). The transponder shall initiate the broadcast of extended squitters for airborne position, surface position, airborne velocity and aircraft identification when data are inserted into GICB registers 05, 06, 09 and 08 {HEX} respectively. This determination shall be made individually for each squitter type. The insertion of altitude data into register 05 by the transponder (see 2.2.23.1.8) shall not satisfy the minimum requirement for broadcast of the airborne position squitter.

Note 1: This suppresses the transmission of extended squitters from aircraft that are unable to report position, velocity or identity information.

If input to the 05 or 06 register for the airborne or surface position squitter type stops for 60 seconds, broadcast of that extended squitter type will be discontinued until data insertion is resumed. The insertion of altitude by the transponder shall satisfy the minimum requirement for continuing to broadcast the airborne position squitter. After timeout (see 2.2.23.1.4.2), this squitter type may contain an ME field of all zeroes.

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

If input to the 09 register stops for 2 seconds, broadcast of airborne velocity squitter will be discontinued until data insertion is resumed.

Note 3: 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.

When extended squitters are broadcast, transmission rates shall be as indicated in the following paragraphs. Acquisition squitters shall be reported in addition to extended squitters as specified in 2.2.16.2.6.1.c. Acquisition squitters shall always be reported if no extended squitters are reported.

DO-260A Existing Text with Suggested Changes Shown (use MS Word View Markup)

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 0,9 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 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181C (EUROCAE ED-73B).~~
 - (2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2 seconds and terminate 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 “1” is specified in the following subparagraphs.

DO-260A Existing Text with Suggested Changes Shown (use MS Word View Markup)

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 0,9 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 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181C (EUROCAE ED-73B).~~
 - (2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2 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 “2” is specified in the following subparagraphs.

DO-260A Existing Text with Suggested Changes Shown (use MS Word View Markup)

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 0,9 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 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO 181C (EUROCAE ED 73B).~~
 - (2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2 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 “3” is specified in the following subparagraphs.

DO-260A Existing Text with Suggested Changes Shown (use MS Word View Markup)

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 0,9 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 seconds and terminate the broadcast ~~after 60 seconds, as specified in RTCA DO-181C (EUROCAE ED-73B).~~
 - (2). Non-Transponder-Based ADS-B Transmitting Subsystems shall ZERO the Velocity Message after 2 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.

DO-260A Existing Text with Suggested Changes Shown (use MS Word View Markup)

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 Type, ~~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.

The ADS-B Transmitting Subsystem shall terminate broadcast transmissions of the Airborne Velocity Message if input data necessary to update the ADS-B Message TYPE is not available for a period of 2 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.*
 2. *For the Surface Position Message, the receipt of new Position and Integrity (i.e., Latitude, ~~and~~ Longitude, and HIL~~combined~~), Movement, or Ground Track data is sufficient to maintain broadcast of the message once the message has been initiated.*
 3. *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. Each ADS-B Message type shall be terminated individually and independently of all other ADS-B Messages.
 - c. 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:

1. *This interface is intended to be used by a mapping function that will automatically trigger the interface if the Transmitting Subsystem is outside a user adaptable two-dimensional geographic area.*
2. *If required because of spectrum considerations, the two-dimensional geographic area will be defined as the movement area (i.e., runways and taxiways) plus a reasonable buffer area (i.e., 50 foot buffer). Implementations of this feature should be designed such that a particular ground authority can specify a region that conserves spectrum without introducing risk of accidental termination within the movement area. Consideration should be given to precision and accuracy of the geographic region definition.*

3. *As a vendor option, this mapping function may be implemented integral to the Class B2 equipment. In this case, the interface is internal to the unit.*

ICAO Doc 9871 Existing Text with Suggested Changes Shown (use MS Word View Markup)

A.2.4.3 TERMINATION OF EXTENDED SQUITTER BROADCAST

If input to the airborne position or surface position~~register for a~~ squitter type stops for 60 seconds, broadcast of that extended squitter type shall be discontinued until data insertion is resumed. The insertion of altitude by the transponder satisfies the minimum requirement for continuing to broadcast the airborne position squitter.

If input to any other squitter type stops for 2 seconds, broadcast of that extended squitter type shall be discontinued until data insertion is resumed. The insertion of bits that are constant for an aircraft installation does not satisfy the minimum requirement for continuing to broadcast a squitter type.

Note 1.—Until timeout, a squitter type may contain an ME field of all zeros.

Note 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.2.5.3.2 BROADCAST OF FORMAT TYPE CODE EQUAL TO ZERO

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

- 1) An extended squitter register monitored by the transponder (registers 05₁₆, 06₁₆, 07₁₆ and 09₁₆) has timed out (see §A.2.4.2). In this case, the transponder shall clear the entire 56 bits of the register that timed out. In the case of the airborne position register, the altitude subfield shall only be zeroed if no altitude data are available. Transmission of the airborne position or surface position ~~extended~~-squitter ~~that broadcasts the timed out register~~ shall itself stop in 60 seconds. Transmission of all other squitters shall stop after 2 seconds. Broadcast of ~~an~~this extended squitter shall 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 shall clear the format TYPE Code and all other fields of the airborne or surface position message and insert this zeroed message in the appropriate register. This shall only be done once so that the transponder can detect the loss of data insertion and suppress the broadcast of the related squitter.

Note.—The 2 second termination of squitters, other than airborne position and surface position, coincides with the 2 second timeout of the data. This ensures that only airborne position and surface position squitters are ever broadcast with Type Code ZERO.
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 message types, since a zero value in any of the fields indicates no information.

3. Recommendations

WG-3 is requested to consider the changes in section 2 relevant for inclusion in DO-260A.