

Associated Technical Variances

Between

RTCA DO-260 / DO-260A

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SUMMARY

ADS-B as defined in the MOPS is a system for aircraft or surface vehicles operating within the airport surface movement area that periodically transmits its state vector (horizontal and vertical position, horizontal and vertical velocity) and other information. ADS-B is *automatic* because no external stimulus is required; it is *dependent* because it relies on on-board navigation sources and on-board broadcast transmission systems to provide surveillance information to other users.

RTCA SC-186 Working Group (WG) 3 is responsible for the Minimum Operational Performance Standards (MOPS) for ADS-B systems using the 1090 MHz Extended Squitter data link also known as DO-260. This paper delineates associated technical variances associated between the MOPS revisions and its associated FAA TSO updates.

1. Introduction

This paper presents a document history, the relationship to other ADS-B material and identifies the technical variances between the content in RTCA DO-260 titled “Minimum Operational Performance Standards (MOPS) for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B)”, originally published in September 13, 2000 and RTCA DO-260A titled “Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services (TIS-B)” published April 10, 2003 and its related FAA Technical Standard Order (TSO) TSO-C166. Subsequent changes included in the revision to TSO-C166 are also identified as well as the new appendix intended for inclusion to DO-260A as “Change 1”.

The regulatory application of these standards is the responsibility of appropriate government agencies. TSO-C166 titled “Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)” was published in September 20, 2004, and invokes RTCA DO-260A but also supported DO-260 equipment. The Federal Aviation Administration (FAA) did not publish a TSO for ADS-B to invoke RTCA DO-260 alone when it was published.

1.1. 1090 MHz Extended Squitter (ES) Historical Timeline

- DO-242 – ADS-B Minimum Aviation System Performance Standards (MASP) for ADS-B Published 2/18/1998
- DO-260 – 1090 MHz ES MOPS published 9/13/2000
- DO-242A – ADS-B MASP revised 6/25/2002
- DO-260A – 1090 MHz ES MOPS revised 4/10/2003
- TSO-C166 – modifications to both DO-260 and DO-260A published 9/20/2004
- TSO-C166A – eliminates certification of DO-260 systems, and performs further modifications to DO-260A

2. RTCA 1090 MHz ES Working Group

2.1. RTCA DO-260(A) and Relationship to DO-242

RTCA DO-260 was initially published on September 13, 2000. It contains the MOPS for airborne equipment for ADS-B utilizing 1090 MHz ES. DO-260 was essentially defined as transmit-only ADS-B 1090ES equipment. Parenthetically, DO-260 was developed in accordance with information stemming from RTCA DO-242.

Due to RTCA activity in pursuit of a revision to DO-242, RTCA and the International community recognized the need to update the initial 1090ES MOPS (DO-260) to include the items that were in discussion for implementation into the ADS-B MASPS revision. It was necessary to update the ADS-B MASPS on which those standards were to be based prior to updating the information in the MOPS. Consequently, on June 25, 2002, RTCA published the updated ADS-B MASPS as RTCA/DO-242A, and the revision of the 1090ES MOPS was commenced.

2.2. RTCA DO-260(A) and Relationship to DO-289

There is no connection to DO-289 titled “Minimum Aviation System Performance Standards (MASPS) for Aircraft Surveillance Applications (ASA)”, published December 9, 2003. DO-260A was not developed with consideration to DO-289. The basis of the information contained in the link MOPS is DO-242. DO-289 was published after DO-260A publication.

2.3. Technical variances between DO-260 and DO-260A

On April 10, 2003 RTCA published RTCA/DO-260A as the update to the 1090ES MOPS, it replaces RTCA/DO-260 and all of its requirements. Perceptibly, RTCA DO-260A includes many changes from the original MOPS and is harmonized with the new ADS-B MASPS DO-242A. The major changes between RTCA DO-260 and RTCA DO-260A are as follows:

- Correction of typographical errors
- Addition of materials defining TIS-B Message formats
- Addition of Requirements for Enhanced Processing Techniques
- Change of NUCP and NUCV into NIC, NAC, SIL
- Changed the structure of the Operational Status Message Capability Class (CC) and Operational Mode (OM) subfields to reflect changes in ADS-B MASPS (DO-242A)
- Deleted TCP/TCP+1 Messages, added Target State and Status Message, and added placeholders for Target Change Reports to reflect requirements in DO-242A.
- Deleted the Operational Coordination Message
- Updated all messages and report structures dealing with State Vector, Mode Status, ARV and Target State Reports to reflect changes made in DO-242A

2.4. DO-260A “Change 1”

There have been a number of additional changes identified since the publication of DO-260A and TSO-C166. They have been identified as “necessary” and are being captured in both TSO-C166A and published as “Change 1 to DO-260A”. These changes are listed in the appendix of TSO-C166A they include, but are not limited to the following:

- Correction of typographical errors
- Guidance notes in all sections relating to the parameter SIL which explain that if a manufacturer sets the value of SIL statically, it should not be set to ZERO.
- The addition of new sections §2.2.18 and §2.4.18 to define the requirements for the formats and test procedures for the ADS-B Messages that are to be Rebroadcast as a 1090ES ADS-B Message with data from a received Message from an alternate data link.
- Modification of several test procedures that were copied directly from DO-260 that related in DO-260 to the testing of NUC, and were not updated to relate to NIC when DO-260A was published.
- Corrections to test procedures for testing of the preambles in enhanced reception techniques.
- The addition of guidance notes and new requirements for testing cases that have been identified during 1090ES implementations for problems related to longitude zone boundary conditions when calculating position using CPR techniques

3. Technical Standard Order (TSO) issues

Regulatory application of standards is the responsibility of appropriate government agencies. Unfortunately in the United States (U.S.), we (the FAA) did not publish a TSO for ADS-B to invoke RTCA DO-260. The first TSO that was written for 1090ES ADS-B systems was TSO-C166 and it was published on September 20, 2004.

During the development of TSO-C166, while working together with RTCA SC-186 WG 3, a number of discrepancies were identified in the MOPS which needed to be addressed for manufacturers that were building equipment prior to the release of the next MOPS update. These discrepancies were addressed and presented as an Appendix to the TSO. The appendix in TSO-C166 contained the additional changes required to both DO-260 and DO-260A aimed at correcting the MOPS issues.

3.1. TSO-C166 changes to DO-260

The following are the DO-260 discrepancies that were captured in the TSO-C166 Appendix 1 Section 1:

- Changes to the Air/Ground Determination to correct errors discovered during ICAO review of draft UAT SARPs.
- Change the definition of how to encode NUC if HPL is not available
- Direction to manufacturers not to implement any Aircraft Trajectory Intent Messages.
- Direction to manufacturers not to implement any Aircraft Operational Coordination Messages.
- Defined the optional transmission of the TEST Message (TYPE Code=23) for the purpose of transmitting the Mode 3/A (4096) Code.
- Modified all test procedures involved with testing the Air/Ground Determination.
- Added a test procedure if the manufacturer optionally implements transmission of the TEST Message.

3.2. TSO-C166 changes to DO-260A

The following are the DO-260A discrepancies that were captured in TSO-C166 Appendix 1 Section 2:

- Corrected typographical errors.
- Changes to the Air/Ground Determination to correct errors discovered during ICAO review of draft UAT Standards and Recommended Practices (SARPs).
- Addition of the definition of a DF=18, CF=6 as the Rebroadcast of an ADS-B Message from an alternate data link using the same TYPE Codes and Message Formats as are defined for DF=17 ADS-B Messages.
- Renamed the TIS-B Airborne Velocity Message to “TIS-B Velocity Message” throughout.

- Hard wire the Vertical and Horizontal Mode Indicators to ZERO because of inconsistencies with how onboard data sources represent the data associated with these parameters.
- Made changes to the Aircraft/Vehicle Length and Width Code Encoding to correct problems identified during ICAO review of draft UAT SARPs.
- Added notes indicating that it is not necessary to perform a Globally Unambiguous CPR Decode if a participant is already in a Track File as either an Airborne or Surface participant.
- Specified that TIS-B Messages, including the Management Message be reported as transmitted.
- Modified all test procedures involved with preceding changes.
- Specified all corresponding changes in Appendix A.
- Added a new §A.1.7.8 entitled “Globally Unambiguous CPR Decoding of Surface Position.”

3.3. Changes between TSO-C166 and TSO-C166A

There have been no certification submittals for DO-260 compliant 1090 MHz ES “transmit-only” systems under TSO C166 in the U.S. since publication. Due to recent activities, TSO C166 is now being revised to keep pace with ADS-B utilization plans in the U.S. based on the Joint Resource Council (JRC) decision(s). All references to RTCA/DO-260 have been removed. The revised TSO-C166A now only refers to RTCA/DO-260A. In addition to the original TSO C166 changes contained in Appendix 1 Section 2 for RTCA/DO-260A, the following changes have also been added:

- Appendix has been restructured. There is only one section now in the Appendix and it covers DO-260A.
- Fixed typographical errors
- Corrected entries in the “Operation” column of Table 2-6
- Corrected errors in Table 2-51 for Binary and Decimal values for Zero and +100 feet encoding.
- Added a Note in Operational Status Message to caution that SIL not to be set to ZERO.
- Added section §2.2.18 as the definition of Re-Broadcast Messages with changed bit definitions for IMF.
- Changed Test Procedure for TYPE Code –Airborne
- Changed Test Procedure for TYPE Code –Surface
- Fixed a with testing Target State on-the-ground
- Fixed Table 2-188 -NUCp →NIC –NAC –SIL
- Added section §2.4.18 for a Test Procedure for the Re-Broadcast Messages with changed bits for IMF
- Corrected a references in Appendix A
- Added a Note in Appendix A, Target State and Status Message to caution that SIL not to be set to ZERO
- Added a Note in Appendix A, Operational Status Message to caution that SIL not to be set to ZERO
- Correction to problem for Non-Transponder Devices to be consistent with SARPs

- Added section §A.3 as the Appendix A definition of Re-Broadcast Messages with changed bits for IMF
- Removed the 95% column from Table N-4 and deleted Note #3

4. Impacts and Summary

It has been recognized by the international community that systems based solely on the requirements of DO-260 and the initial 1090ES SARPs published in Annex 10, Amendment 77, are not adequate to provide robust receiver/decoder systems for reception of 1090ES ADS-B information. ICAO is in the process of updating the ICAO 1090ES SARPs to include those requirements identified since the publication of RTCA/DO-260A. These updated SARPs are expected to become effective in November 2007. The updated 1090ES SARPs recommend that 1090ES ADS-B receiver systems must be based on the updated requirements which incidentally are the same as RTCA/DO-260A, Change 1 and is also included as the appendix in FAA TSO-C166A.

5. Acknowledgements

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