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Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)

Change 3

DRAFT 1.0

RTCA DO-260A, Change 3
MM DD, YYYY
Modifies RTCA/DO-260A

Prepared by: SC-186

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Foreword

This document was prepared by Special Committee 186 (SC-186) and approved by the RTCA Program Management Committee (PMC) on MM DD, YYYY.

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Executive Summary

An update to the *Minimum Operational Performance Standards (MOPS) for the 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)* systems, published by RTCA on April 10, 2003 as RTCA/DO-260A, and to Change 1 to RTCA/DO-260A, published on June 27, 2006, and to Change 2 to RTCA/DO-260A, published December 13, 2006, is contained herein as **Change 3** to RTCA/DO-260A, and has been produced to reflect changes that have resulted in requirements for 1090ES ADS-B and TIS-B transmitting and receiving systems.

This **Change 3** to RTCA/DO-260A mainly addresses corrections to various test procedures that have come to light was more manufacturers have begun to implement 1090 MHz Extended Squitter transmitting and receiving subsystems. This **Change 3** should not impact ADS-B equipment previously certified using RTCA DO-260A for 1090 MHz Extended Squitter or RTCA DO-282A for the Universal Access Transceiver (UAT).

1090 MHz Extended Squitter Historical Timeline	
Date	**Document / Standard**
February 19, 1998	**RTCA/DO-242** – ADS-B MASPS, initial publication
September 13, 2000	**RTCA/DO-260** – 1090 MHz Extended Squitter (ES) ADS-B MOPS, initial publication
June 25, 2002	**RTCA/DO-242A** – ADS-B MASPS, revised
April 10, 2003	**RTCA/DO-260A** – 1090ES ADS-B and TIS-B MOPS, revised to (1) comply with DO-242A, (2) add the requirements for TIS-B systems, (3) add the requirements for enhanced processing techniques, (4) remove the requirements for transmitting the TCP and Operational Coordination Messages, (5) revise the structure of the Operational Status Message Capability Codes (CC) and Operational Mode (OM) subfields as per DO-242A definitions, and (6) add the requirement for transmitting the TEST Message with TYPE=23, Subtype=7 for the purpose of transmitting the Mode 3/A (4096) code only in the USA.
September 20, 2004	**FAA TSO C166** – had an Appendix with required modifications to both DO-260 and DO-260A, which included, but were not limited to, (1) identifying and issuing corrections for critical errors with the air/ground determination algorithm requirements and test procedures, (2) specified that for DO-260 systems NUC should be based on integrity instead of accuracy, (3) for DO-260A systems the ADS-B Rebroadcast Message was defined for DF=18 and CF=6, (4) corrections were made to the Aircraft/Vehicle Length/Width Codes, (5) a new algorithm was defined for the Globally Unambiguous CPR Decoding of Surface Positions, and (6) numerous minor typographical errors were corrected.
June 27, 2006	**Change 1 to RTCA/DO-260A** – took all of the changes that were originally identified in the Appendix to TSO C166, and makes additional changes including, but not limited to: (1) further defining requirements, formats and test procedures for ADS-B Rebroadcast Messages, (2) defining requirements, test procedures and guidance notes for dealing with problems related to longitude zone boundary conditions when calculating position using CPR techniques, (3) corrections to test procedures for testing of the preambles in enhanced reception techniques, and (4) specifying that any manufacturer not statically set the value of SIL to ZERO.

1090 MHz Extended Squitter Historical Timeline	
Date	**Document / Standard**
December 13, 2006	**Change 2 to DO-260A** – (1) made changes in various text and tables to clarify the references to TIS-B Management Messages, (2) added requirements and test procedures to verify that a newly received aircraft position does not represent an unreasonable offset from the previously received aircraft position, and (3) made changes in several sections to clarify the usage of the NIC and SIL parameters since the development and publication of the STP MOPS indicated that there was a discrepancy in the meaning of those integrity values as calculated for GPS systems versus flight management systems. This clarification to NIC and SIL also required that Change documents were published for DO-242A, DO-282A and DO-289.
MM DD, 2008	**Change 3 to DO-260A** – (1) made changes in required message broadcast Tables 2-3 and 2-4 to indicate the required broadcast of the Mode 3/A code in the TYPE=23, Subtype=7 TEST Message in all appropriate classes of aircraft, (2) replaced Table 2-205 after errors were discovered in CPR calculations during exercising of test procedures, (3) several changes made to bring DO-260A into compliance with the modifications accepted by ICAO for the 1090ES SARPs and the 1090ES Technical Manual (Doc 9871), (4) removal of the restriction of a geographic filter on the broadcast of the Mode A code.

With the publication of this document as "**Change 3 to DO-260A**" several additional changes are being made to RTCA/DO-260A, to Change 1 to DO-260A, and to Change 2 to DO-260A, that were identified as necessary since the time of the publication of Change 2 to DO-260A. These changes include, but are not limited to:

1. Corrections to Tables 2-3 and 2-4 to ensure the required broadcast of the 1090ES TEST Message (TYPE=23, Subtype=7) in all appropriate classes of aircraft.
2. Changes to Table 2-205 made necessary because of errors related to incorrect values used in CPR calculations when the original Table 2-205 was produced.
3. Several changes related to ensuring that the 1090ES MOPS continues to comply with necessary changes made to International Civil Aviation Organization (ICAO) Annex 10 and to the 1090ES SARPs Technical Manual, ICAO Doc 9871.
4. Removal of the restriction of using a geographic filter on the broadcast of the Mode A Code in the 1090ES TEST Message (TYPE=23, Subtype=7) in section §2.2.3.2.7.3.2.
5. Changes to several test procedures

Since the publication of RTCA/DO-260A in April 2003, ICAO has also been in the process of updating the ICAO 1090ES SARPs to include those requirements identified in DO-260A. These updated SARPs have become effective in November 2007. It has also 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, dated 2002, are not sufficient to provide robust receiver/decoder systems for reception of 1090ES ADS-B information. Therefore, the updated 1090ES SARPs require (in Annex 10, Vol. IV, §5.2.2.3), and it is also required by FAA TSO C166A, that 1090ES ADS-B receiver systems must be based on the requirements of the updated 1090ES SARPs (Amendment 82), which are consistent with RTCA/DO-260A, Change 1 to RTCA/DO-260A, Change 2 to RTCA/DO-260A, and now Change 3 to RTCA/DO-260A.

Change 3 to RTCA/DO-260A

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)

This Change document prescribes the Minimum Performance Standards (MPS) for 1090 MHz Extended Squitter (1090ES) Transmitting and Receiving Subsystems, modified as described in this document. The applicable standards for those changes requested in this document is RTCA/DO-260A, "*Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B),"* issued April 10, 2003, Change 1 to RTCA/DO-260A, issued June 27, 2006, and Change 2 to RTCA/DO-260A issued December 13, 2006.

Changes that were specified in Change 1 to DO-260A used change numbers such as (1.1) through (1.116). Changes that were specified in Change 2 to DO-260A used change numbers such as (2.1) through (2.35). This document will use change numbers starting with "3."

In all of the following requested changes, for those items where existing text is requested to change, the changes are highlighted in yellow. In those changes where a totally new section or text is inserted, no highlighting will be indicated.

(**3.1**) In RTCA/DO-260A, section §2.1.12.1, replace Table 2-3 with the following:

Table 2-3: ADS-B Class A Transmitter Equipment To Message Coverage

Transmitter Class	Minimum Transmit Power (at Antenna Port)	Example Operation	MASPS Requirement (RTCA DO-242A)	Minimum Message Capability Required (From Table 2-2)
A0 (Minimum)	70 W	♦ Aid to Visual Acquisition ♦ Conflict Avoidance	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status TEST Message (Subtype=7)
		♦ Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status Extended Squitter A/C Status
A1 (Basic)	125 W	♦ Aid to Visual Acquisition ♦ Conflict Avoidance ♦ Simultaneous Approaches	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status TEST Message (Subtype=7)
		♦ Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status Extended Squitter A/C Status
A2 (Enhanced)	125 W	♦ Aid to Visual Acquisition ♦ Conflict Avoidance ♦ Separation Assurance and Sequencing ♦ Flight Path Deconfliction Planning ♦ Simultaneous Approaches	SV MS TS TC+0	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status Target State and Status TEST Message (Subtype=7) Reserved for TC Message
		♦ Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status Extended Squitter A/C Status
A3 (Extended)	125 W	♦ Aid to Visual Acquisition ♦ Conflict Avoidance ♦ Separation Assurance and Sequencing ♦ Flight Path Deconfliction Planning ♦ Simultaneous Approaches	SV MS TS TC+n	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status Target State and Status TEST Message (Subtype=7) Reserved for TC Message
		♦ Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status Extended Squitter A/C Status

(**3.2**) In RTCA/DO-260A, section §2.1.12.1, replace Table 2-4 with the following:

Table 2-4: ADS-B Class B Transmitter Equipment To Message Coverage

Transmitter Class	Minimum Transmit Power (at Antenna Port)	Example Operation	MASPS Requirement (RTCA DO-242A)	Minimum Message Capability Required (From Table 2-2)
B0 (Aircraft)	70 W [1]	• Aid to Visual Acquisition • Conflict Avoidance	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status TEST Message (Subtype=7)
		• Airport Surface		Surface Position A/C ID and Type A/C Operational Status Extended Squitter A/C Status
B1 (Aircraft)	125 W [1]	• Aid to Visual Acquisition • Conflict Avoidance	SV MS	Airborne Position A/C Identification & Type Airborne Velocity A/C Operational Status Extended Squitter A/C Status TEST Message (Subtype=7)
		• Airport Surface		Surface Position A/C Identification and Type A/C Operational Status Extended Squitter A/C Status
B2 Low (Ground Vehicle)	7 W [1]	• Aid to Visual Acquisition • Conflict Avoidance • Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status
B2 (Ground Vehicle)	70 W [1]	• Aid to Visual Acquisition • Conflict Avoidance • Airport Surface	SV MS	Surface Position A/C Identification & Type A/C Operational Status
B3 (Fixed Obstacle)	70 W [1]	• Aid to Visual Acquisition • Conflict Avoidance • Airport Surface	SV MS	Airborne Position A/C Identification & Type A/C Operational Status

(**3.3**) In RTCA/DO-260A, section §2.2.3.2.1.2, replace all of the text of subparagraph "a," including Table 2-8 and the notes following, as documented in changes identified to ICAO Annex 10, Volume IV, §3.1.2.5.2.2.1, in Working Paper WP B10-18R1 approved by the ICAO Aeronautical Surveillance Panel (ASP) Working Group B during their meeting in Montreal in May 2006.

a. Definition: -- The "CA" field is a 3-bit (Message bits 6 through 8) field used to report the capability of an ADS-B transmitting installation that is based on a Mode S transponder. The "CA" field is used to report the capability and notice of a transponder condition that requires interrogation by the ground of a transponder. It is used in Mode-S downlink format DF=11, i.e., the Mode-S All Call reply and acquisition squitter, and DF=17. Therefore, the codes used in the "CA" field are as specified in Table 2-8:

Table 2-8: "CA" Field Code Definitions

Coding		Meaning
(Binary)	(Decimal)	
000	0	Signifies Level 1 transponder (surveillance only), and no ability to set "CA" Code 7, and either on the ground or airborne
001	1	Reserved
010	2	Reserved
011	3	Reserved
100	4	Signifies Level 2 or above transponder, and the ability to set "CA" Code 7, and on the ground
101	5	Signifies Level 2 or above transponder, and the ability to set "CA" Code 7, and airborne
110	6	Signifies Level 2 or above transponder, and the ability to set "CA" Code 7, and either on the ground or airborne
111	7	Signifies the "DR" field is NOT equal to ZERO (0), or the "FS" field equals 2, 3, 4, or 5, and either on the ground or airborne.

When the conditions for "CA" Code 7 are not satisfied, Level 2 or above transponders in installations that do not have automatic means to set on-the-ground condition **shall** use "CA" Code 6. Aircraft with automatic on-the-ground determination **shall** use "CA" codes 4 when on the ground, and "CA" Code 5 when airborne. Data Link capability reports (RTCA DO-181D, §2.2.19.1.12.5) (EUROCAE ED-73C, §3.21.1.12.e) **shall** be available from aircraft installations that set "CA" Codes 4, 5, 6 or 7.

Notes:

1. *"CA" codes 1 to 3 are reserved to maintain backward compatibility.*
2. *These requirements are consistent with the requirements of ICAO Annex 10, Volume IV, §3.1.2.5.2.2.1, as well as with the requirements of RTCA DO-181D, §2.2.14.4.6 (EUROCAE ED-73C, §3.18.4.5).*

(**3.4**) In RTCA/DO-260A, in section §2.2.3.2.2, insert a new third paragraph with the following informational text which coordinates with text inserted into ICAO Doc 9871 and with this Change document, into Appendix A, §A.1.4.10.6, in order to clarify the connection between the NIC parameter and the format TYPE Code values in 1090ES Messages:

The format TYPE Code differentiates the 1090ES Messages into several classes: Airborne Position, Airborne Velocity, Surface Position, Identification and Category, Aircraft Intent, Aircraft Status, etc. In addition, the format TYPE Code also encodes the Navigation Integrity Category (NIC) value of the source used for the position report. The NIC value is used to allow surveillance applications to determine whether the reported geometric position has an acceptable level of integrity containment region for the intended use. The NIC integrity containment region is described horizontally and vertically using two parameters: the containment radius, R_C, and the Vertical Protection Limit, VPL. The format TYPE Code also differentiates the Airborne Messages as to the type of their altitude measurements: barometric pressure altitude or GNSS height (HAE). The 5-bit encoding for format TYPE Code and NIC values conforms to the definition contained in Table 2-16. If an update has not been received from an on-board data source for the NIC value within the past 5 seconds, then the NIC value is encoded to indicate that R_C is "Unknown."

(**3.5**) In RTCA/DO-260A, section §2.2.3.2.7.2.6, replace the paragraph that follows the initial *Note* with the following:

If an update has not been received from an on-board data source for the NIC ~~Supplement~~ within the past 5 seconds, then the NIC Supplement subfield **shall** be encoded ~~as ZERO (0)~~ to indicate the larger Radius of Containment (R_C).

(**3.6**) In RTCA/DO-260A, section §2.2.3.2.7.2.7, in order to correct typographical errors inside Table 2-71,

(1) on the row for which the Coding of the NAC_P value is a decimal ZERO (0), the meaning should read "**EPU ≥ 18.52 km (≥ 10 NM)**", and
(2) on the row for which the Coding of the NAC_P value is a decimal ONE (1), the meaning should read "**EPU < 18.52 km (10 NM)**."

(**3.7**) In RTCA/DO-260A, section §2.2.3.2.7.3.2.1, in order to address the operational requirement that the Mode A Code be broadcast worldwide, modify the text of this section as described in the following:

Provision **shall** be made for a global parameter to control the transmission of the "TEST" Message with SUBTYPE=7. This parameter **shall** specify one of the following conditions:

a. Inhibit transmission of the "TEST" Message with SUBTYPE=7
b. Enable transmission of the "TEST" Message with SUBTYPE=7

~~c. Enable transmission of the "TEST" Message with SUBTYPE=7 with a geographic filter (§2.2.3.2.7.3.2.2)~~

For this version of these MOPS, the parameter **shall** be set as specified in subparagraph ~~c~~ "b," above.

(**3.8**) In RTCA/DO-260A, delete section §2.2.3.2.7.3.2.2 and Table 2-77 completely.

(**3.9**) In RTCA/DO-260A, section §2.2.3.3.2.3, subparagraph a.(1).(a), make the following edits in order to comply with ICAO Annex 10, Volume IV, §3.1.2.8.7.3.6.6, and changes made to the 1090ES Technical Manual, ICAO Doc 9871, as agreed to by the ICAO ASP and documented in Working Paper WP-ASP02-09:

(a). The broadcast rate **shall** be changed from "High" to "Low" when the navigation source position data has not changed more than 10 meters in ~~a~~ any 30 second ~~sampling~~ interval.

(**3.10**) In RTCA/DO-260A, section §2.3.2.2.8.3, Step 1, make the following edits in order to comply with ICAO Annex 10, Volume IV, §3.1.2.8.7.3.6.6, and changes made to the 1090ES Technical Manual, ICAO Doc 9871, as agreed to by the ICAO ASP and documented in Working Paper WP-ASP02-09:

Step 1: Switching from High Rate to Low Rate (§2.2.3.3.2.3.a(1) and c)

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 ~~a~~ any 30 second ~~sampling~~ 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 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 ~~a~~ any 30 second ~~sampling~~ 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 distributed over the range of 4.8 to 5.2 seconds as specified in §2.2.3.3.2.3.c.

(**3.11**) In RTCA/DO-260A, section §2.3.2.4.3, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.12**) In RTCA/DO-260A, section §2.3.2.4.6, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.13**) In RTCA/DO-260A, section §2.3.2.4.7, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.14**) In RTCA/DO-260A, section §2.4.3.2.7.2.6, replace the second paragraph under the "Purpose/Introduction" with the following:

If an update has not been received from an on-board data source for the NIC ~~Supplement~~ within the past 5 seconds, then the NIC Supplement subfield **shall** be encoded ~~as ZERO (0)~~ to indicate the larger Radius of Containment (R_C).

(**3.15**) In RTCA/DO-260A, section §2.4.3.2.7.3.2.1, revise the sentence as follows:

The test procedures required to validate the requirements of §2.2.3.2.7.3.2.1 are included in §2.4.3.2.7.3.2~~.2~~.

(**3.16**) In RTCA/DO-260A, delete the entire section §2.4.3.2.7.3.2.2.

(**3.17**) In RTCA/DO-260A, section §2.4.3.3.2.3, Step 1, make the following edits in order to comply with ICAO Annex 10, Volume IV, §3.1.2.8.7.3.6.6, and changes made to the 1090ES Technical Manual, ICAO Doc 9871, as agreed to by the ICAO ASP and documented in Working Paper WP-ASP02-09:

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 ~~a~~ any 30 second ~~sampling~~ 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 ~~a~~ any 30 second ~~sampling~~ 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.

(**3.18**) In RTCA/DO-260A, section §2.4.4.3.1.2, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.19**) In RTCA/DO-260A, section §2.4.4.3.4.7.1, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.20**) In RTCA/DO-260A, section §2.4.4.3.4.7.3, xxxxxxxxxxx based on the outcome of the Working Group discussions on the Working Paper presented by Jim Troxel of L-3/ACSS during the teleconference designated as Meeting #23 xxxxxxxxxxxxxx

(**3.21**) In RTCA/DO-260A, section §2.4.17.3.5.8, replace Table 2-205 with the following:

Table 2-205: 12-bit CPR Airborne Position Encoding Values

Angular Weighted Binary Values (degrees)				Even Airborne Encoding		Odd Airborne Encoding	
Latitude	Latitude	Longitude	Longitude	Latitude	Longitude	Latitude	Longitude
Decimal	HEX	Decimal	HEX	HEX	HEX	HEX	HEX
-90.0000	C0000000	-180.0000	80000000	000	800	400	800
-89.9500	C0091A2B	179.5000	7FA4FA50	022	7FA	422	7FA
-89.5000	C05B05B0	178.5000	7EEEEEEF	155	7EF	550	7EF
-89.0000	C0B60B61	175.5000	7CCCCCCD	2AB	7CD	69F	7CD
-87.5000	C1C71C72	-165.0000	8AAAAAAB	6AB	8AB	A8E	8AB
-86.7500	C24FA4FA	-171.5000	860B60B6	8AB	0C1	C86	861
-86.5000	C27D27D2	-172.5000	85555555	955	900	D2E	0AB
-85.8500	C2F37C05	65.7500	2EC16C17	B11	8C4	EE2	5D8
-85.0000	C38E38E4	-142.7500	9A7D27D2	D55	69F	11C	CF7
-84.2500	C416C16C	60.0000	2AAAAAAB	F55	D55	314	AAB
-83.5500	C4962FC9	-60.0000	D5555555	133	000	4EA	2AB
-82.6800	C53490BA	120.0000	55555555	385	555	732	000
-81.7500	C5DDDDDE	-120.0000	AAAAAAAB	600	555	9A2	AAB
-80.2500	C6EEEEEF	144.0000	66666666	A00	99A	D91	333
-79.7500	C749F49F	-144.0000	9999999A	B55	000	EE1	666
-78.4000	C83FB7F2	-121.0000	A9F49F4A	EEF	4D8	26B	A39
-77.4000	C8F5C28F	121.0000	560B60B6	19A	089	50A	B28
-76.5500	C9907F6E	-154.2800	924A2EE0	3DE	6DC	745	DB8
-75.6000	CA3D70A4	154.2800	6DB5D120	666	FFF	9C3	924
-74.7500	CAD82D83	157.5000	70000000	8AB	900	BFD	200
-73.6500	CBA06D3A	-157.5000	90000000	B9A	000	EE0	700
-72.7500	CC444444	-120.0000	AAAAAAAB	E00	555	13C	AAB
-71.5500	CD1EB852	120.0000	55555555	133	000	461	AAB
-70.6500	CDC28F5C	-144.0000	9999999A	39A	666	6BD	CCD
-69.5500	CE8ACF13	144.0000	66666666	689	000	9A0	99A
-68.7500	CF1C71C7	-114.5500	AE8ACF13	8AB	516	BB9	A2E
-67.7500	CFD27D28	114.5500	517530ED	B55	001	E58	AEA
-66.5500	D0ACF135	-67.5000	D0000000	E89	B00	17E	E00
-65.5500	D162FC96	67.5000	30000000	133	800	41D	500
-64.4500	D22B3C4D	-83.0800	C4EBBF60	422	3B0	6FF	762
-63.2500	D305B05B	83.0800	3B1440A0	755	001	A25	C50
-62.2500	D3BBBBBC	-64.2900	D2485CD8	A00	2DA	CC4	5B6
-61.2500	D471C71C	64.2900	2DB7A328	CAB	001	F64	D26
-60.2500	D527D27D	-72.0000	CCCCCCCD	F55	333	203	666
-59.9600	D55C9D78	-120.5000	AA4FA4FA	01B	4B0	2C6	A0B
-59.9550	D55D867C	120.0000	55555555	01F	AAB	2C9	555
-59.9300	D5621392	-119.5000	AB05B05B	030	0AB	2DA	5FA
-58.0000	D6C16C17	-78.7500	C8000000	555	380	7E9	700
-58.5000	D6666666	78.7500	38000000	400	C80	69A	900
-57.9500	D6CA8642	-22.5000	F0000000	577	100	80B	200
-56.8500	D792C5F9	22.5000	10000000	866	000	AED	F00
-55.5000	D8888889	-52.9400	DA5A912E	C00	25B	E77	4B5
-54.6200	D928BB81	52.9400	25A56ED2	E59	000	0C6	DA5
-53.2500	DA222222	-30.0000	EAAAAAAB	200	155	45E	2AB
-51.9500	DB0ECA86	30.0000	15555555	577	000	7C7	EAB

Table 2-205: 12-bit CPR Airborne Position Encoding Values (Continued)

Angular Weighted Binary Values (degrees)				Even Airborne Encoding		Odd Airborne Encoding	
Latitude Decimal	Latitude HEX	Longitude Decimal	Longitude HEX	Latitude HEX	Longitude HEX	Latitude HEX	Longitude HEX
-50.7500	DBE93E94	-75.7900	CA1ADA00	8AB	35E	AEC	6BC
-49.6500	DCB17E4B	75.7900	35E52600	B9A	000	DCF	CA2
-48.2500	DDB05B06	-27.0000	ECCCCCCD	F55	133	17A	266
-47.0000	DE93E93F	27.0000	13333333	2AB	000	4C1	ECD
-45.6000	DF92C5F9	-68.5700	CF3D3663	666	30D	86D	619
-44.2500	E0888889	-180.0000	80000000	A00	000	BF7	800
-42.8500	E1876543	179.5000	7FA4FA50	DBC	70B	FA3	F11
-41.4000	E28F5C29	178.5000	7EEEEEEF	19A	D11	371	522
-40.0000	E38E38E4	175.5000	7CCCCCCD	555	F00	71C	733
-38.5000	E49F49F5	-160.9000	8D950C84	955	70D	B0B	E33
-36.9000	E5C28F5C	-171.5000	860B60B6	D9A	9C1	F3D	161
-35.2500	E6EEEEEF	-172.5000	85555555	200	000	391	7AB
-33.6000	E81B4E82	65.7500	2EC16C17	666	F30	7E5	C44
-31.8000	E962FC96	-142.7500	9A7D27D2	B33	2C7	C9D	91F
-30.0000	EAAAAAAB	59.5000	2A4FA4FA	000	6DE	155	439
-28.0000	EC16C16C	-60.0000	D5555555	555	555	694	800
-25.9000	ED950C84	-66.7000	D091A2B4	AEF	2E2	C16	5D9
-23.6000	EF37C049	-120.0000	AAAAAAAB	111	000	21E	555
-21.1000	F0FEDCBB	41.5000	1D82D82E	7BC	572	8AC	39A
-18.2000	F30ECA86	-144.0000	9999999A	F77	99A	047	000
-14.9000	F56789AC	-121.0000	A9F49F4A	844	D77	8EE	2D8
-10.5000	F8888889	121.0000	560B60B6	400	7E9	477	289
-5.1000	FC5F92C6	6.2500	0471C71C	266	064	2A0	01C
-2.5000	FE38E38E	154.2800	6DB5D120	955	48E	972	DB3
0.0000	00000000	60.0000	2AAAAAAB	000	D55	000	AAB
0.0000	00000000	-157.5000	90000000	000	300	000	A00
90.0000	40000000	-180.0000	80000000	000	800	C00	800
89.9500	3FF6E5D5	179.5000	7FA4FA50	FDE	7FA	BDE	7FA
89.5000	3FA4FA50	178.5000	7EEEEEEF	EAB	7EF	AB0	7EF
89.0000	3F49F49F	175.5000	7CCCCCCD	D55	7CD	961	7CD
87.5000	3E38E38E	-165.0000	8AAAAAAB	955	8AB	572	8AB
86.7500	3DB05B06	-171.5000	860B60B6	755	0C1	37A	861
86.5000	3D82D82E	-172.5000	85555555	6AB	900	2D2	0AB
85.8500	3D0C83FB	65.7500	2EC16C17	4EF	8C4	11E	5D8
85.0000	3C71C71C	-142.7500	9A7D27D2	2AB	69F	EE4	CF7
84.2500	3BE93E94	60.0000	2AAAAAAB	0AB	D55	CEC	AAB
83.5500	3B69D037	-60.0000	D5555555	ECD	000	B16	2AB
82.6800	3ACB6F46	120.0000	55555555	C7B	555	8CE	000
81.7500	3A222222	-120.0000	AAAAAAAB	A00	555	65E	AAB
80.2500	39111111	144.0000	66666666	600	99A	26F	333
79.7500	38B60B61	-144.0000	9999999A	4AB	000	11F	666
78.4000	37C048D1	-121.0000	A9F49F4A	111	4D8	D95	A39
77.4000	370A3D71	121.0000	560B60B6	E66	089	AF6	B28
76.5500	366F8092	-154.2800	924A2EE0	C22	6DC	8BB	DB8
75.6000	35C28F5C	154.2800	6DB5D120	99A	FFF	63D	924
74.7500	3527D27D	157.5000	70000000	755	900	403	200
73.6500	345F92C6	-157.5000	90000000	466	000	120	700
72.7500	33BBBBBC	-120.0000	AAAAAAAB	200	555	EC4	AAB
71.5500	32E147AE	120.0000	55555555	ECD	000	B9F	AAB
70.6500	323D70A4	-144.0000	9999999A	C66	666	943	CCD

Table 2-205: 12-bit CPR Airborne Position Encoding Values (Continued)

Angular Weighted Binary Values (degrees)				Even Airborne Encoding		Odd Airborne Encoding	
Latitude Decimal	Latitude HEX	Longitude Decimal	Longitude HEX	Latitude HEX	Longitude HEX	Latitude HEX	Longitude HEX
69.5500	317530ED	144.0000	66666666	977	000	660	99A
68.7500	30E38E39	-114.5500	AE8ACF13	755	516	447	A2E
67.7500	302D82D8	114.5500	517530ED	4AB	001	1A8	AEA
66.5500	2F530ECB	-67.5000	D0000000	177	B00	E82	E00
65.5500	2E9D036A	67.5000	30000000	ECD	800	BE3	500
64.4500	2DD4C3B3	-83.0800	C4EBBF60	BDE	3B0	901	762
63.2500	2CFA4FA5	83.0800	3B1440A0	8AB	001	5DB	C50
62.2500	2C444444	-64.2900	D2485CD8	600	2DA	33C	5B6
61.2500	2B8E38E4	64.2900	2DB7A328	355	001	09C	D26
60.2500	2AD82D83	-72.0000	CCCCCCCD	0AB	333	DFD	666
59.9600	2AA36288	-120.5000	AA4FA4FA	FE5	4B0	D3A	A0B
59.9550	2AA27984	120.0000	55555555	FE1	AAB	D37	555
59.9300	2A9DEC6E	-119.5000	AB05B05B	FD0	0AB	D26	5FA
58.0000	293E93E9	-78.7500	C8000000	AAB	380	817	700
58.5000	2999999A	78.7500	38000000	C00	C80	966	900
57.9500	293579BE	-22.5000	F0000000	A89	100	7F5	200
56.8500	286D3A07	22.5000	10000000	79A	000	513	F00
55.5000	27777777	-52.9400	DA5A912E	400	25B	189	4B5
54.6200	26D7447F	52.9400	25A56ED2	1A7	000	F3A	DA5
53.2500	25DDDDDE	-30.0000	EAAAAAAB	E00	155	BA2	2AB
51.9500	24F1357A	30.0000	15555555	A89	000	839	EAB
50.7500	2416C16C	-75.7900	CA1ADA00	755	35E	514	6BC
49.6500	234E81B5	75.7900	35E52600	466	000	231	CA2
48.2500	224FA4FA	-27.0000	ECCCCCCD	0AB	133	E86	266
47.0000	216C16C1	27.0000	13333333	D55	000	B3F	ECD
45.6000	206D3A07	-68.5700	CF3D3663	99A	30D	793	619
44.2500	1F777777	-180.0000	80000000	600	000	409	800
42.8500	1E789ABD	179.5000	7FA4FA50	244	70B	05D	F11
41.4000	1D70A3D7	178.5000	7EEEEEEF	E66	D11	C8F	522
40.0000	1C71C71C	175.5000	7CCCCCCD	AAB	F00	8E4	733
38.5000	1B60B60B	-160.9000	8D950C84	6AB	70D	4F5	E33
36.9000	1A3D70A4	-171.5000	860B60B6	266	9C1	0C3	161
35.2500	19111111	-172.5000	85555555	E00	000	C6F	7AB
33.6000	17E4B17E	65.7500	2EC16C17	99A	F30	81B	C44
31.8000	169D036A	-142.7500	9A7D27D2	4CD	2C7	363	91F
30.0000	15555555	59.5000	2A4FA4FA	000	6DE	EAB	439
28.0000	13E93E94	-60.0000	D5555555	AAB	555	96C	800
25.9000	126AF37C	-66.7000	D091A2B4	511	2E2	3EA	5D9
23.6000	10C83FB7	-120.0000	AAAAAAAB	EEF	000	DE2	555
21.1000	0F012345	41.5000	1D82D82E	844	572	754	39A
18.2000	0CF1357A	-144.0000	9999999A	089	99A	FB9	000
14.9000	0A987654	-121.0000	A9F49F4A	7BC	D77	712	2D8
10.5000	07777777	121.0000	560B60B6	C00	7E9	B89	289
5.1000	03A06D3A	6.2500	0471C71C	D9A	064	D60	01C
2.5000	01C71C72	154.2800	6DB5D120	6AB	48E	68E	DB3
0.0000	00000000	60.0000	2AAAAAAB	000	D55	000	AAB
0.0000	00000000	-157.5000	90000000	000	300	000	A00

(**3.22**) In RTCA/DO-260A, Appendix A, section §A.1.2, replace Table A-1, the Notes following the table, and the text of the paragraph that follows the Notes, with the following in order to comply with approved changes to the 1090ES SARPs as defined in ICAO Annex 10 Volume 3, Part 1, §2.1, Amendment 77, and subsequent changes that were approved by the ICAO ASP as documented in Working Papers WPB7-24, SCRSP.1.WP.012.2, SCRSP.1.WP.012.2.appR1, SCRSP.1.WP.53.2.appC, and WP/ASP03-13.

Table A-1: Register Allocation

Register number	Assignment	Maximum update interval
05_{16}	Extended Squitter Airborne Position	0.2 s
06_{16}	Extended Squitter Surface Position	0.2 s
07_{16}	Extended Squitter Status	1.0 s
08_{16}	Extended Squitter Identification and Category	15.0 s
09_{16}	Extended Squitter Airborne Velocity	1.3 s
$0A_{16}$	Extended Squitter Event-Driven Information	variable
10_{16}	Data Link Capability Report	≤4.0 s (see Note 2)
17_{16}	Common usage Capability Report	5.0 s
$18_{16} – 1C_{16}$	Mode S Specific Services Capability Report	see Note 5
$1D_{16}$-$1F_{16}$	Mode S Specific Services Capability Report	5.0 s
20_{16}	Aircraft Identification	5.0 s
61_{16}	Emergency/Priority Status	1.0 s
62_{16}	Target State and Status Information	0.5 s
63_{16}-64_{16}	Reserved for Extended Squitter	
65_{16}	Aircraft Operational Status	2.5 s
66_{16}-$6F_{16}$	Reserved for Extended Squitter	

Notes:

1. *The Register number is equivalent to the BDS B-Definition Subfield (BDS) value §2.2.14.4.20.b of DO-181D.*
2. *For ADS-B implementations on Mode S transponders, the data link capability report (Register 10_{16}) is used to indicate Extended Squitter capability (bit 34) and the contents of this Register are updated within one second of the data changing and at least every four seconds thereafter.*
3. *Register $0A_{16}$ is not to be used for GICB or ACAS crosslink readout.*
4. *The term "minimum update rate" is used in this document. The "minimum update rate" is obtained when data is loaded in one Register field once every "maximum update interval."*
5. *A bit set in one of these Registers indicates that the service loading the Register indicated by that bit has been installed on the aircraft. In this regard, these bits are not cleared to reflect a real time loss of an application, as is done for Register 17_{16}.*

The details of the data to be entered into the Registers assigned for Extended Squitter will be as defined in this Appendix. Table A-1 specifies the minimum update rates at which the appropriate transponder Register(s) will be reloaded with valid data. Any valid data will be reloaded into the relevant field as soon as it becomes available at the Mode S Specific Services Entity (SSE) interface regardless of the update rate. If data are not available for a time no greater than twice the specified "maximum update interval," or 2 seconds (whichever is the greater), then the status bit (if provided) will indicate that the data in that field are invalid, and the field will be zeroed.

(3.23) In RTCA/DO-260A, Appendix A, replace the entire contents of section §A.1.3.2 with the following in order to comply with changes agreed to by the ICAO ASP as documented in working paper WPB11-12, and in the 1090ES SARPs Technical Manual, ICAO Doc 9871:

Numerical data **shall** be represented as follows:

1) Numerical data are represented as binary numerals. When the value is signed, 2's complement representation is used, and the bit following the status bit is the sign bit.

2) Unless otherwise specified, whenever more bits of resolution are available from the data source than in the data field into which that data are to be loaded, the data **shall** be rounded to the nearest value that can be encoded in that data field.

Note: *Unless otherwise specified, it is accepted that the data source may have less bits of resolution than the data field.*

3) When the data source provides data with a higher or lower range than the data field, the data **shall** be truncated to the respective maximum or minimum value that can be encoded in the data field.

4) Where ARINC 429 data are used, the ARINC 429 status bits 30 and 31 are replaced with a single status bit, for which the value is VALID or INVALID as follows:

   a) If bits 30 and 31 represent "Failure Warning, No Computed Data" then the status bit **shall** be set to "INVALID."

   b) If bits 30 and 31 represent "Functional Test" then the status bit **shall** be set to "INVALID."

   c) If bits 30 and 31 represent "Normal Operation," "plus sign," or "minus sign," ~~or "Functional Test"~~ then the status bit **shall** be set to "VALID" provided that the data are being updated at the required rate.

d) If the data are not being updated at the required rate, then the status bit **shall** be set to "INVALID."

For interface formats other than ARINC 429, a similar approach is used.

5) In all cases where a status bit is specified in the data field it shall be set to "ONE" to indicate VALID and to "ZERO" to indicate INVALID.

Note: *This facilitates partial loading of the registers.*

6) When specified in the field, the switch bit **shall** indicate which of two alternative data types is being used to update the parameter in the transponder Register.

7) Where the sign bit (ARINC 429 bit 29) is not required for a parameter it has been actively excluded.

8) Bit numbering in the MB field **shall** be as specified in Annex 10, Volume IV, §3.1.2.3.1.3.

9) Registers containing data intended for broadcast Comm-B **shall** have the broadcast identifier located in the eight most significant bits of the MB field.

Notes:

1. When multiple data sources are available, the one with the highest resolution should be selected.

2. By default, values indicated in the range of the different fields of registers have been rounded to the nearest integer value or represented as a fraction.

3. As used in these MOPS, BDS Code A,B is equivalent to Register Number AB_{16}.

(**3.24**) In RTCA/DO-260A, Appendix A, section §A.1.4.10.6, in order to coordinate with text that has been added to ICAO Doc 9871 to clarify the relationship between the TYPE Code and the NIC value, replace the title of the section and the initial paragraph with the following:

A.1.4.10.6 Navigation Integrity Category (NIC) and NIC Supplement

The first 5-bit field (ME bits 1 – 5, Message bits 33 – 37) in every Mode S Extended Squitter Message contains the format TYPE Code. The format TYPE Code differentiates the 1090ES Messages into several classes: Airborne Position, Airborne Velocity, Surface Position, Identification and Category, Aircraft Intent, Aircraft Status, etc. In addition, the format TYPE Code also encodes the Navigation Integrity Category (NIC) value of the source used for the position report.

The NIC Supplement is a 1-bit (ME bit 44, Message bit 76) subfield that is use in conjunction with the TYPE Code and NIC value to allow surveillance applications to determine whether the reported geometric position has an acceptable level of integrity

containment region for the intended use. The NIC integrity containment region is described horizontally and vertically using two parameters: the containment radius, R_C, and the Vertical Protection Limit, VPL. The format TYPE Code also differentiates the Airborne Messages as to the type of their altitude measurements: barometric pressure altitude or GNSS height (HAE). The 5-bit encoding for format TYPE Code and NIC values conforms to the definition contained in Table A-25. If an update has not been received from an on-board data source for the NIC value within the past 5 seconds, then the NIC value will be encoded to indicate that R_C is "Unknown."

(3.25) In RTCA/DO-260A, Appendix A, Figure A-3, in the format for BDS 0,7, inside the *Note*, make the following edits in order to comply with ICAO Annex 10, Volume IV, §3.1.2.8.7.3.6.6, and changes made to the 1090ES Technical Manual, ICAO Doc 9871, as agreed to by the ICAO ASP and documented in Working Paper WP-ASP02-09:

a) *Switching from high to low rate: Aircraft must switch from high to low rate when the onboard navigation unit reports that the aircraft's position has not changed more than 10 meters in ~~a~~ any 30 second ~~sampling~~ interval.*

(**3.26**) In RTCA/DO-260A, Appendix A, completely replace Figure A-8 with the following, which revises the existing Figure A-8, and adds a new Figure A-8b for defining the format of the ADS-B 1090ES Aircraft Status Message with Subtype=2 for the TCAS RA Broadcast:

Figure A-8a: Aircraft Status
(Subtype 1: Emergency/Priority Status)

BDS 6,1

1	MSB	
2		
3	FORMAT TYPE CODE = 28	
4		
5	LSB	
6	MSB	
7	SUBTYPE CODE = 1	
8	LSB	
9	MSB	
10	EMERGENCY STATE	
11	LSB	
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34	RESERVED	
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
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53		
54		
55		
56		

PURPOSE: To provide additional information on aircraft status.

Subtype Coding:

0 = No information
1 = Emergency/priority status
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state will be coded as follows:

Value	Meaning
0	No emergency
1	General emergency
2	Lifeguard/Medical
3	Minimum fuel
4	No communications
5	Unlawful interference
6	Downed aircraft
7	Reserved

Notes:

1) Message delivery is accomplished once per 0.8 seconds using the event-driven protocol.

2) Termination of emergency state is detected by coding in the surveillance status field of the Airborne Position Message.

3) Subtype 2 message broadcasts take priority over subtype 1 message broadcasts.

4) Emergency State value 1 is set when Mode A code 7700 is provided to the transponder.

5) Emergency State value 4 is set when Mode A code 7600 is provided to the transponder.

6) Emergency State value 5 is set when Mode A code 7500 is provided to the transponder.

Figure A-8b: Aircraft Status
(Subtype 2: Extended Squitter TCAS RA Broadcast)

BDS 6,1

1	MSB	
2		
3	FORMAT TYPE CODE = 28	
4		
5	LSB	
6	MSB	
7	SUBTYPE CODE = 2	
8	LSB	
9	MSB	
10		
11		
12		
13		
14		
15	ACTIVE RESOLUTION ADVISORIES	
16		
17		
18		
19		
20		
21		
22	LSB	
23	MSB	
24	RACs RECORD	
25		
26	LSB	
27	RA TERMINATED	
28	MULTIPLE THREAT ENCOUNTER	
29	MSB THREAT – TYPE INDICATOR	
30	LSB	
31	MSB	
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43	THREAT IDENTITY DATA	
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56	LSB	

PURPOSE: To report resolution advisories (RAs) generated by TCAS equipment.

Subtype Coding:

0 = No information
1 = Emergency/priority status
2 = TCAS RA Broadcast
3 to 7 = Reserved

TCAS RA Broadcast Coding:

The coding of bits 9 to 56 of this Message conforms to the corresponding bits of Register 30_{16} as specified in Annex 10, Volume IV, §4.3.8.4.2.2.

Notes:

1) *Message delivery is accomplished once per 0.8 seconds using the event-driven protocol.*

2) *RA Broadcast begins within 0.5 seconds after transponder notification of the initiation of an TCAS RA.*

3) *RA Broadcast is terminated 10 seconds after the RAT flag (Annex 10, Volume IV, §4.3.8.4.2.2.1.3) transitions from ZERO (0) to ONE (1).*

4) *Subtype 2 message broadcasts take priority over subtype 1 message broadcasts.*

Working Paper 1090-WP23-02 - Draft version 1.0 of Change 3 to DO-260A