UNIVERSAL® AVIONICS
SYSTEMS CORPORATION

Understanding Compliance with Automatic Dependent Surveillance – Broadcast (ADS-B) Out

White Paper

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Executive Summary

Automatic Dependent Surveillance – Broadcast (ADS-B) Out is a key component in the Federal Aviation Administration (FAA) and European Aviation Space Agency (EASA) airspace Next Generation modernization program, known as "NextGen". This document discusses Universal Avionics' guide to ADS-B Out compliance based on analysis of the applicable regulations and associated Advisory Circulars (AC).

In analyzing international ADS-B regulations, researchers at Universal Avionics found the requirements to be similar in most operating environments that require ADS-B Out. The discussion topic of this White Paper will concentrate on the FAA specific regulations and guidance requiring compliance in the National Airspace System (NAS).

What is ADS-B?

ADS-B is a surveillance technology incorporating air and ground aspects that provide Air Traffic Control (ATC) with a more accurate picture of the aircraft's three-dimensional position in the enroute, terminal, approach and surface environments. The aircraft provides the airborne portion in the form of a broadcast of its identification, position, altitude, velocity, and other information.

The ground portion is comprised of ADS-B ground stations which receive these broadcasts and direct them to ATC automation systems for presentation on a controller's display similar in nature to a radar return. ADS-B is automatic because no external interrogation is required. It is dependent because it relies on onboard position sources and broadcast transmission systems to provide surveillance information to ATC.

Benefits of ADS-B

ADS-B allows ATC to monitor and separate aircraft efficiently, and with more precision. Because it uses GPS signals, it expands surveillance services into areas where little or no radar coverage exists.

The technology provides improved situational awareness to pilots and ATC. Providing a flexible and expandable platform to accommodate future air traffic growth, ADS-B is designed to improve the safety, capacity and efficiency of the airspace around the world.

ADS-B Out will be required in the U.S. National Airspace System (NAS) by 1 January 2020.

This includes:

- Class A, B and C
- Class E airspace within the 48 contiguous states and the District of Columbia at and above 10,000 feet MSL, excluding the airspace at and below 2,500 feet above the surface
- Class E airspace at and above 3,000 feet MSL over the Gulf of Mexico from the coastline of the United States out to 12 NM
- Around those airports identified in 14 CFR part 91 Appendix D

ADS-B System Installation Requirements

The minimum required equipment to support ADS-B Out for FAA approval include:

- Extended Squitter Mode S Transponder
- Proper failure annuciation
- TSO-C146c approved Flight Management System (FMS)

Transponder

The Rule published by the FAA requires the ADS-B Out transmission or receiving equipment to be approved using either TSO-C154c (UAT) or TSO-C166b (1090Mhz Extended Squitter Transponder). Extended squitter transponder equipment compliant with TSO-C166b will be required to operate in the Class A airspace in accordance with FAR 91.225.

FAA AC 20-165A covers the Airworthiness Approvals for ADS-B Out systems; the AC covers both of the acceptable types of equipment mentioned. The vast majority of Universal Avionics customers will require the installation of 1090 ES transponders. The text of the AC provides specific information on the installation, test and evaluation of the equipment. The appendices of the AC provide details on the ADS-B Out position sources, latency and message format.

Annunciation

Paragraph 3.7 Pilot Interface, b. Installation Guidance 1 (a), (b) cover failure annunciation. These two paragraphs will affect aircraft equipped with a Radio Control Unit (RCU), and paragraph (a) covers system failure that the current version of the RCU should meet. However paragraph (b) covers ADS-B Function Failure. It says, "If the position source or its interface with the ADS-B equipment fails, then the ADS-B system will not be able to broadcast the required ADS-B data. In this case, the ADS-B equipment has not failed but it cannot perform its function due to a failure to receive the position source data. TSO-C166b and TSO-C154c require this condition to be annunciated. The ADS-B system should distinguish between a position source or interface failure and an ADS-B equipment failure." This requirement will require an RCU software upgrade to (future software version) RCU SCN 1016.0.7, which will be available in the fourth quarter 2013. Universal Avionics will provide a software upgrade that is compliant with RTCA/DO-260B. For specific transponders tested with the RCU, please contact Customer Support.

Navigation

Appendix 4 of AC 20-138C, Airworthiness Approval of Positioning and Navigation Systems, covers Global Navigation Satellite Systems (GNSS) that support ADS-B. The information in this appendix describes bench test procedures that can be used as an acceptable means to establish that the GNSS equipment meets the required outputs described in AC 20-165 (latest revision). This appendix only addresses those ADS-B parameters that require specific tests because the GNSS TSOs (C146 and C129) do not adequately address certain parameters required to support ADS-B Out.

In addition to this, there are two types of installations - referred to as precision and non-precision. The difference between these two types of installations is the use of GPS time. A non-precision installation does not require the use of GPS time while a precision does. For a precision installation (using GPS time), an FMS with SCN 1000.7/1100.7 and PAS SCN 10.3 is required. This version of software will also support installations that do not require GPS time. For installations that do not require GPS time, SCN 1000.7/1100.7 can be used and/or versions of SCN 1000.X and PAS 10.X.

Universal Avionics equipment required to support ADS-B Out must be a TSO-C146c approved FMS with Software Control Number (SCN) 1000.7/1100.7 or later. The current line of WAAS/SBAS-FMS systems are TSO-C146c approved. A TSO-C129a approved FMS or GPS does not output the data required by AC 20-165A or meet the accuracy, latency, and integrity requirements.

Universal Avionics Service Letter No. 2838 describes AC 20-138C Compliance with FMS SCN 1000.0/1100.0–1000.6/1100.6. Note, however the document does not include specific references to future FMS SCN 1000.7/1100.7, scheduled for release later in 2013. SCN 1000.7/1100.7 or later will be required to correctly interface to the version of the Rockwell Collins TDR-94D or equivalent that is ADS-B compliant. Universal Avionics operators seeking ADS-B compliance should contact Customer Support for a complete overview of the specific equipage requirements for thier aircraft.

Regional Regulatory Requirements

Mandated compliance to ADS-B technology is growing. Airworthiness agencies worldwide have issued rules and requirements pertaining to ADS-B equipage, as summarized below.

Country / Authority	Published Material Re: ADS-B Equipage
United States	On 30 June 2010, the FAA issued a new rule contained in Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227. This rule requires ADS-B Out performance when operating in designated classes of airspace within the NAS after 1 January 2020.

Country / Authority	Published Material Re: ADS-B Equipage
Eurocontrol/EASA	AMC 20-24 mandates ADS-B Out in production in January 2015 and for entire European airspace (retrofit) by December 2017. ADS-B approval for non-radar coverage areas requires new transponder standard RTCA DO-260B. AMC 20-24 states DO-260A transponder is sufficient, however Universal Avionics has found that EASA may establish the certification baseline via CRI and require the DO-260B transponder regardless of the existing AMC 20-24. ADS-B in radar coverage areas can be accomplished with a DO-260A transponder.
Nav Canada	Providing reduced separation using ADS-B Out for Hudson Bay between FL350 and FL400 since November 2010.
Australia	• Guidance material: CAO 20.18, Amend Order No. 3, dated December 2009 • Mandates ADS-B Out for upper airspace (≥FL290) in December 2013

Hong Kong	• Guidance material: Airworthiness Notice 102F, Issue 2, 28 February 2011
	• Implement the use of ADS-B Out:
	  • After 31 December 2013 for aircraft flying over PBN routes L642 or M771 between FL290 and FL410
	  • After 31 December 2014 for aircraft flying within Hong Kong FIR between FL290 and FL410
	• Must meet DO-260 (Version 0) requirements of ICAO Annex 10 and ICAO Doc 9871 Chapter 2, or DO-260A (Version 1) requirements of ICAO Doc 9871 Chapter 3
	• Means of compliance per EASA AMC 20-24 or CASA CAO 20.18 Appendix XI

Singapore	• Guidance material: CAAS AIC 14, 28 December 2010 • Implement the use of ADS-B Out after 12 December 2013 within certain parts of the Singapore FIR (≥FL290) • Must meet EASA AMC 20-24 or CASA CAO 20.18 Appendix XI, otherwise must fly at <FL290
Other Asia Pacific Regulatory Agencies	• Expected to follow ADS-B Avionics Requirements template per APANPIRG Conclusion 21/39 • Template states: Must meet EASA AMC 20-24 or CASA CAO 20.18 Appendix XI

Approval Process

On 30 August 2010, the FAA issued a Policy Memo, titled "Approval for ADS-B Out Systems". AC 90-114 requires compliance with this memo. This Policy Memo states that until further notice, ADS-B Out equipment meeting the requirements of TSO-C166b or TSO-C143c shall only be installed as OEM production equipment, OEM service bulletin or Supplemental Type Certificate (STC). It further states that field approvals are not appropriate.

AC 20-165A further states that all ADS-B Out compliant systems must include the transmitter/receiver equipment as well as all interfacing equipment. This means devices driving aircraft position, heading, etc., such as a Universal Avionics FMS must be included in that STC as a part of the complete STC package. A substantial system safety analysis for the entire system must be performed as a part of the STC process, showing that the overall system and its components comply with the requirements and performance standards outlined in AC 20-165A.

In addition to an ADS-B STC for the equipment and its configuration, a Letter of Authorization (LOA) will be required for approval to operate outside of U.S. airspace upon completion of the ADS-B STC. This policy will require that Universal Avionics provide installers with data not normally required for an FMS installation that does not support ADS-B Out. Customers or installers pursuing an ADS-B Out STC should contact Universal Avionics for system safety analysis data required to support the analysis discussed above. The certification package is available to Authorized Dealers on UniNet.

As noted above, operational approvals via LOA are required for ADS-B Out. AC 90-114, FAR 91.225, and 91.227 outline the use of ADS-B equipment and should be reviewed to understand the overall requirements. FAR 91.225 covers where and how ADS-B equipment must be used, and FAR 91.227 stipulates equipment performance requirements. At this time, analysis of EASA requirements vs. FAA requirements shows that meeting FAA requirements will suffice for EASA.

There are subtle differences and draft guidance is being written by EASA which may affect your ADS-B installation. Universal Avionics will monitor EASA requirements for harmonization with FAA to better aid its customers in understanding the requirements for ADS-B Out in various airspaces around the world.

ADS-B Out FAQ

The FAA final rule mandates ADS-B Out only. Is this correct?

Yes, only ADS-B Out is mandated, and only within certain airspace. Title 14 CFR § 91.225 defines the airspace within which these requirements apply.

What equipment is required by the new FAA rule?

The rule specifies ADS-B Out equipment comply with either TSO-C154c (Universal Access Transceiver (UAT)) or TSO-C166b (Mode S Transponder). However, to operate in Class A airspace, aircraft are required to equip with an extended squitter Mode S transponder certified to TSO-C166b. Universal Avionics has determined that only certain products approved to TSO-C146 (AR) "Stand-Alone Airborne Navigation Equipment Using The Global Positioning System Augmented By The Satellite Based Augmentation System," will meet the aircraft position sensor requirements.

Do my current avionics meet the performance requirements of the rule?

Your Universal Avionics Authorized Dealer can help you determine if your current equipment will meet the performance requirements of the rule and can advise you on available options and costs associated with any required upgrades.

What Universal Avionics equipment will be required for ADS-B Out compliance?

You would need to equip with either a TSO-C166b or TSO-C154c certified device, depending on the airspace you wish to access. In addition to this, your FMS will need to be updated to a WAAS/SBAS series FMS with software SCN 1000.7/1100.7 and Precision Approach Subsystem (PAS) 10.3 or later. If the aircraft is equipped with Universal Avionics RCU, the RCU will require RCU SCN 1016.0.7, which is the next release of the software, expected fourth quarter 2013.

What will it cost to purchase and install ADS-B Out equipment?

Contact Universal Avionics or an Authorized Dealer for pricing for installation or upgrading your existing FMS or RCU.

Contact the manufacturer of your transponder for upgrade solutions that may be available.

Do I need to modify my transponder?

Modification of some Mode S transponders to meet the regulations may be possible. Older transponders are probably not upgradable and will require replacement. Whether or not a transponder is upgradable is a question for the transponder manufacturer or supplier to determine.

Must my position source be GPS?

Any position source that meets the performance standards of the rule (14 CFR § 91.227) can be submitted for certification. SBAS TSO C146 ( ) is currently the only available positioning source known to meet all of the requirements as defined in the ADS-B Out rule. Your installer will have to verify that any GPS sensor used for ADS-B Out meets all the data output requirements.

Does the GPS antenna transmit ADS-B data?

No. ADS-B Out data is transmitted by the extended squitter Mode S transponder.

How did implementation of ADS-B affect the airspace in the Gulf of Mexico?

Before ADS-B, surveillance was not available in the Gulf of Mexico at low altitudes or beyond 200 NM from the coast. Now with ADS-B in place, ATC can provide 5 NM separation to low-flying aircraft and to aircraft traversing the Gulf, provided the aircraft have certified ADS-B Out equipage. Other agencies governing various airspaces worldwide are considering or have plans to provide separation services using ADS-B Out.

Is an STC required for ADS-B Out approval?

Yes. On 30 August 2010, the FAA issued a Policy Memo, titled "Approval for ADS-B Out Systems." AC 90-114 requires compliance with this memo. This policy Memo states that until further notice ADS-B Out equipment meeting the requirements of TSO-C166b or TSO-C154c shall only be installed as OEM production equipment, OEM service bulletin or STC. It further states that field approvals are not appropriate. This requirement does not apply to FMS equipment installed by field approval that is not part of an ADS-B Out solution.

Reference List

- RTCA/DO-282B, Minimum Operational Performance Standards for Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B)
- RTCA/D)-260B, Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance-Broadcast (ADS-B)
- TSO C-154c and TSO C-166B
- TSO C195a, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications
- AC 20-165a, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast (ADS-B)
- AC 20-138C, Airworthiness Approval of Positioning and Navigation Systems
- AC 20-172A, Airworthiness Approval for ADS-B in Systems and Applications
- AC 90-114 change 1, Automatic Dependent Surveillance-Broadcast (ADS-B) Operations
- Policy memo dated 30 August 2010 Approval for ADS-B OUT Systems.
- Universal Avionics Service Letter No. 2847, WAAS/SBAS Flight Management Systems Compliance with AC 20-165
- Universal Avionics AC 20-165 Compliance for Legacy Systems

Acroynyms

- ADS-B: Automatic Dependent Surveillance-Broadcast
- AC: Advisory Circular
- AIC: Aeronautical Information Circulars
- AMC: Acceptable Means of Compliance (EASA)
- ATC: Air Traffic Control
- CAAS: Civil Aviation Authority of Singapore
- CAO: Civil Aviation Order (Australia)
- CASA: Civil Aviation Safety Authority (Australia)
- CFR: Code of Federal Regulations
- EASA: European Aviation Safety Agency
- FAA: Federal Aviation Administration
- FMS: Flight Management System
- GPS: Global Positioning System
- ICAO: International Civil Aviation Organization
- NAS: National Airspace System
- NextGen: Next Generation
- OEM: Original Equipment Manufacturer
- SBAS: Satellite-Based Augmentation System
- SCN: Software Control Number
- STC: Supplemental Type Certificate
- TSO: Technical Standard Order
- UAT: Universal Access Transceiver
- WAAS: Wide Area Augmentation System

For more information: www.uasc.com/ads-b

About Universal Avionics

Universal Avionics manufactures and markets an extensive line of advanced avionics equipment. Product lines include the UNS-1 SBAS-enabled (WAAS) Flight Management Systems; the EFI-890R/890H Flat Panel Display; a line of Integrated Cockpit Displays; Vision-1® Synthetic Vision System; Terrain Awareness and Warning System; UniLink® Communications Management Unit; Radio Control Units; Cockpit Voice and Flight Data Recorders; Attitude Heading Reference System (AHRS); and the Application Server Unit which integrates charts, electronic documents and checklists with displays systems. For more information about Universal Avionics, visit www.uasc.com.

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