Australian Government
Civil Aviation Safety Authority

# Advisory Circular

**AC 21-45 v2.1** **APRIL 2014**

# AIRWORTHINESS APPROVAL OF AIRBORNE AUTOMATIC DEPENDENT SURVEILLANCE BROADCAST EQUIPMENT

**CONTENTS**



## 1. REFERENCES

A list of ADS-B documentation references is included in Appendix A of this Advisory Circular (AC).

## 2. PURPOSE

This AC is intended to define the airborne component of the 1090 Megahertz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) data link use in Australia, and provide guidance and advice for the airworthiness approval for the installation of the aircraft equipment proposed to support that use.

## 3. STATUS OF THIS AC

This is a minor amendment to AC 21-45(1) issued in February 2012. The following changes have been made to the document:

- Addition of greater range of suitable pressure altitude data source devices at Section 8.6, Appendix A and C.
- Added that Appendix D will not be subject to further update and will be kept for historical record at Section 9.4 and Appendix D.

***Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.***

***Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.***

***ACs should always be read in conjunction with the referenced regulations.***

***This AC has been approved for release by the Executive Manager Standards Division.***

## 4. ACRONYMS

*Note:* *Please refer to this section if you are unsure of any acronyms used within this document as they may not be spelt out in the first instance in the body of the document.*

| | |
|---|---|
| **AC** | Advisory Circular |
| **ADS-B** | Automatic Dependent Surveillance - Broadcast |
| **AEEC** | Airlines Electronic Engineering Committee |
| **AFM** | Aircraft Flight Manual |
| **ARINC** | Aeronautical Radio, Inc |
| **ATC** | Air Traffic Control |
| **ATSO** | Australian Technical Standard Order |
| **BARO** | Barometric sourced data |
| **CAO** | Civil Aviation Order |
| **CASA** | Civil Aviation Safety Authority |
| **CASR** | Civil Aviation Safety Regulations 1998 |
| **EASA** | European Aviation Safety Agency |
| **ETSO** | EASA Technical Standard Order |
| **EUROCAE** | European Organisation for Civil Aviation Equipment |
| **FAA** | Federal Aviation Administration of the United States of America |
| **FDE** | Fault Detection and Exclusion |
| **GNSS** | Global Navigation Satellite System |
| **GPS** | Global Positioning System |
| **HAE** | Height Above Ellipsoid |
| **HFOM** | Horizontal Figure of Merit |
| **HIL** | Horizontal Integrity Limit |
| **HPL** | Horizontal Protection Limit |
| **ICAO** | International Civil Aviation Organization |
| **JAA** | Joint Aviation Authority of Europe |
| **JTSO** | JAA Technical Standard Order |
| **MASPS** | Minimum Aviation System Performance Standards |
| **MEL** | Minimum Equipment List |
| **MMR** | Multi Mode Receiver |
| **MODE S** | Mode Select (a transponder format to allow discrete interrogation and data link capability/ selective interrogation mode of SSR |

| | |
|---|---|
| **MOPS** | Minimum Operational Performance Standards |
| **MSL** | Mean Sea Level |
| **NAC** | Navigation Accuracy Category |
| **$NAC_P$** | Navigation Accuracy Category for Position |
| **NIC** | Navigation Integrity Category |
| **NUC** | Navigation Uncertainty Category |
| **POH** | Pilot Operating Handbook |
| **RAAO** | Recreational Aviation Administration Organisation that is recognised by CASA |
| **RTCA** | RTCA, Inc (formerly Radio Technical Committee for Aeronautics) |
| **SA** | Selective Awareness |
| **SIL** | Surveillance Integrity Level |
| **SPI** | Special Position Identification |
| **SSR** | Secondary Surveillance Radar |
| **TSOA** | FAA Technical Standard Order Authorisation |
| **TSO** | FAA Technical Standard Order |

## 5. BACKGROUND

**5.1** ADS-B is a surveillance application that periodically transmits aircraft parameters, such as identification, pressure altitude, position and position integrity, via a broadcast data link that is available to any receiver, either airborne or ground-based, within range of the transmitter.

**5.2** ADS-B information is broadcast without any knowledge of which users may be receiving it and without the expectation of an acknowledgement or reply. As an automatic system, ADS-B requires no flight crew or controller action for the information to be transmitted. The surveillance-type information broadcast is dependent on the aircraft's navigation system and the broadcast capability of the source emitter.

**5.3** An ADS-B "out" system consists of the following components:

- a transmitting subsystem that includes message generation and transmission functions at the source aircraft; and
- the data link broadcast medium.

**5.4** The sources of the transmitted information, as well as the user applications, are not considered to be part of the ADS-B system, but their performance needs to be considered when defining overall ADS-B system performance.

## 6. APPLICABILITY

**6.1** This AC is applicable to all Australian aircraft and visiting foreign aircraft transmitting ADS-B information in Australia in accordance with current legislation.

***Note:*** *From 12 December 2013 all aircraft operating at or above FL290 are required to transmit ADS-B information in accordance with either Civil Aviation Order (CAO) 20.18 or 82.1.*

## 7. RELATED AUSTRALIAN READING MATERIALS

- AC 21-15 Supplementary Type Certificate – Certification
- AC 21-36 Global Navigation Satellite System (GNSS) Equipment: Airworthiness Guidelines
- AC 21-601 Australian Technical Standard Order Authorisation
- ATSO-C1004(a) (or later version) Airborne Mode A/C Transponder Equipment with Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmit Only Equipment
- ATSO-C1005(a) (or later version) Airborne Stand-Alone Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmission Capability

***Note 1:*** *Appendix A of this AC contains a list of ADS-B documentation references.*

***Note 2:*** *Access to the above mentioned ACs are available at: http://www.casa.gov.au/*

## 8. FUNCTIONAL REQUIREMENT

### 8.1 ADS-B Avionics

**8.1.1** For an aircraft to be ADS-B capable it requires:

- appropriate data sources; and
- an ADS-B transmitter to broadcast the data in a predetermined standard format.

### 8.2 ADS-B Transmitter

**8.2.1** The ADS-B transmitter needs to comply with the minimum performance standards detailed in RTCA/DO-260, DO-260A or DO-260B Paragraph 2.2 as appropriate for the aircraft type.

**8.2.2** For ADS-B data to be universally usable it needs to be transmitted in the formats and characteristics defined in the following standards:

- ICAO Annex 10 to the Convention on International Civil Aviation, Volumes III and IV, Amendment 85;
- RTCA/DO-260 Change 2 (systems compliant with earlier versions may continue to use HFOM in abnormal situations as described in Paragraph 8.2.10);
- RTCA/DO-260A Change 2; or
- RTCA/DO-260B.

Compliance with RTCA/DO-260B is preferred – noting that this is the requirement being implemented in the United States of America (USA) and Europe.

**8.2.3** To be useable for Air Traffic Control (ATC) surveillance in a "radar like" manner, ADS-B transmitters must transmit the following minimum data set:

- **Position** (in extended squitter surface position message and in extended squitter airborne position message);
- **Position Integrity Information** (e.g. NUC or NIC value transmitted in the "TYPE" code in extended squitter surface position message and in extended squitter airborne position message);
- **Pressure Altitude** (in extended squitter airborne position message, GNSS height may also be transmitted in this message when barometric altitude is not available);
- **Aircraft Identification** (in extended squitter identity and category message); and
- **Version Number,** SIL and $NAC_P$ in aircraft operational status message, if the avionics equipment is RTCA/DO-260A or RTCA/DO-260B compliant.

**8.2.4** To provide a more comprehensive data set to other stations, transmission of the following data is highly desirable, as it is used by the Australian ATC system:

- **SPI Indication** (in Surveillance Status Subfield of ADS-B airborne position messages);
- **Emergency Flag** (in Surveillance Status Subfield of ADS-B airborne position messages);
- **Emergency Priority Status Information** (may be broadcast in Extended Squitter Aircraft Status Message, RTCA/DO-260 or RTCA/DO-260A, or the Target State and Status Message RTCA/DO-260A or RTCA/DO-260B);
- **Velocity Information** (Extended Squitter Velocity Message or Surface Position Message);
- **GNSS height** (GNSS Altitude Difference From Barometric Altitude in Extended Squitter Velocity Message);
- **Vertical rate** (in Extended Squitter Velocity Message); and
- **Aircraft category** (ensure the parameter is correctly set in the extended squitter and category message).

**8.2.5** Additional ADS-B data, defined in ICAO Annex 10, Volumes III and Volume IV, Amendment 85 or RTCA/DO-260 or RTCA/DO-260A may also be transmitted.

**8.2.6** Operators installing systems compliant with RTCA/DO-260B are urged to configure their systems to transmit all available parameters. Utilisation of the failure annunciation output is recommended - refer RTCA/DO-260B Paragraph 2.2.11.5.

**8.2.7** Equipment marked as compliant with ATSO-C1004(a), ATSO-C1005(a) or TSO-C166, are considered capable of transmitting data described above in the correct formats. Later versions of these TSOs are acceptable.

**8.2.8** Transponders marked as compliant with the following standards:

- AEEC – ARINC 718A;
- TSO-C112;
- EUROCAE ED-73B;
- JTSO-2C112a; or
- ETSO-2C112a;

may be capable of transmitting this information in the correct formats. Functional testing of the installation would be required to confirm compliance.

**8.2.9** RTCA/DO-260 compliant ADS-B transmitters use the HPL/HIL data from the GNSS receiver as the highest priority data source for determination of NUC.

**8.2.10** ADS-B transmitters compliant with pre RTCA/DO-260 Change 2 may continue to use HFOM data from the GNSS receiver during periods of HPL non-availability due to operational reasons (e.g. satellite geometry etc.); however, this is considered to be an abnormal situation.

**8.2.11** For RTCA/DO-260A and RTCA/DO-260B compliant transmitters, HPL is used for determination of NIC and HFOM is used for determination of NAC.

**8.2.12** It is desirable but not essential that the flight crew have the ability to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

**8.2.13** It is desirable that the flight crew are able to initiate emergency messages and "ident" functions.

**8.2.14** Transmitter antenna installation, including the need for antenna diversity, needs to comply with the manufacturer's installation instructions for ATC transponders to ensure satisfactory functioning. This is particularly relevant to aircraft above 5700 kg, or with a maximum cruising speed greater than 463 km/h (250 knots).

## 8.3 ADS-B data sources (Essential)

**8.3.1** The following section describes the minimum data necessary for ADS-B transmitters to function in the ATC environment (for more detailed requirements including references see Appendix B of this AC). Each category is essential to ensure the message being transmitted has all the relevant data necessary to enable separation to be calculated. Failure to comply may render the prospective operator unable to obtain the benefits of ADS-B separation.

## 8.4 Positional data

**8.4.1** Accurate positional data is essential for the ADS-B system to operate in a "radar like manner" and be the basis for the allocation of separation between aircraft. Valid GNSS data input provides an acceptable accuracy and integrity for separation purposes with the delivery of position information at a periodic but randomised interval of less than or equal to one second.

**8.4.2** GNSS equipment compliant with TSO-C145, TSO-C146, TSO-C196, or an equivalent standard acceptable to the Civil Aviation Safety Authority (CASA), are suitable for use with ADS-B. Later versions of these TSOs are acceptable.

**8.4.3** Particular navigation packages that do not have a TSOA, but can be demonstrated to achieve the accuracy and integrity values required, may be acceptable to CASA. In assessing the suitability of GNSS avionics that do not have a TSO-C145/146/196 authorisation, CASA may consider the system differences to the standards documented in RTCA/DO-229C or RTCA/DO-316 (or later versions), with particular regard to the following criteria:

- The system is capable of delivering position information with a periodic interval of at least one second; and
- The system can continuously output the HPL value to the ADS-B transmitter; and
- The system has a FDE capability as described in CAO 20.18 Appendix XI Part B 3 (c)(ii)(A); and
- The system addresses selective availability (SA) as described in CAO 20.18 Appendix XI Part B 3 (c)(ii)(C).

## 8.5 Positional integrity data

**8.5.1** HPL integrity data needs to be provided to the ADS-B transmitter from the GNSS receiver on the same interface as the positional data. This data is typically available as ARINC 429 label 130.

**8.5.2** HFOM data will be provided to the transponder on the same interface as the HPL data. HFOM typically uses ARINC 429 label 247.

**8.5.3** A RTCA/DO-260A or RTCA/DO-260B compliant installation will use the HFOM value to calculate NAC.

**8.5.4** In some cases, such as during rare periods of inadequate satellites, HPL may not be delivered to the interface. In this case a RTCA/DO-260 compliant installation may use the HFOM value to generate NUC during the period of HPL non-availability; however, this is considered an abnormal situation.

**8.5.5** In the case of RTCA/DO-260A or RTCA/DO-260B compliant installations the SIL is intended to reflect the integrity of the navigation source of the position information broadcast. Where position integrity is based on HPL, and the SIL cannot be unambiguously determined and set dynamically, CASA recommends that value should be set to 2 (two) or the value recommended by the equipment manufacturer. During periods where HPL is not available the NIC should be set to 0 (zero), and the NAC should reflect the accuracy of the broadcast position.

## 8.6 Pressure altitude

**8.6.1** Pressure altitude provided to transponders is to be in accordance with existing requirements for ATC transponders. It is preferable that 7.62 metre (25 foot) altitude encoding is used. This data is typically available on ARINC 429 label 203.

**8.6.2** Suitable pressure altitude data source may be provided by:

- a barometric encoder (FAA TSO-C88 or later version); or
- a barometric altimeter (FAA TSO-C10 or later version); or
- an air data computer (FAA TSO-C106 or later version); or
- EASA equivalent versions of above TSO standards.

### 8.7 Identity

**8.7.1** Identity information, that is the aircraft flight identification (Flight ID) or aircraft registration mark, is to be provided to the transponder so that the information is identical to the filed flight plan. This information is normally entered by the flight crew prior to each flight utilising either:

- a flight management system; or
- a pilot control panel.

For aircraft which always operate with the same Flight ID (e.g. using the aircraft registration mark as a callsign) this may be programmed into equipment at installation.

### 8.8 ADS-B data sources (Desirable)

**8.8.1 GNSS altitude**. GNSS altitude should be provided from an approved GNSS receiver to the ADS-B transmitter. Typically this data is available as HAE, ARINC 429 label 370 or MSL, ARINC 429 label 076.

**8.8.2 Vertical rate (GNSS or Barometric)**. Vertical rate may be provided from either a GNSS receiver or from a pressure source:

- GNSS vertical rate should be provided from an approved GNSS receiver, and is typically available as ARINC 429 label 165; or
- Barometric vertical rate. Barometric (BARO) vertical rate is typically available as ARINC 429 label 212.

***Note:*** *The most accurate source should be used.*

**8.8.3 Velocity Information.** Ground speed from an approved GNSS receiver in the form of East/West Velocity and North/South Velocity should be provided. This would be typically available as ARINC 429 label 174.

**8.8.4 SPI Indication.** For ATC transponders, the SPI capability is integrated into the transponder functionality and is controlled from the transponder control panel. For non transponder implementations a discrete input or a control panel may be provided to trigger the SPI indication.

**8.8.5 Emergency indicator.** For ATC transponders the emergency declaration capability is integrated into the transponder functionality and is controlled from the transponder control panel. For non transponder implementations a discrete input or a control panel may be provided to trigger the emergency and/or to indicate the type of emergency.

## 9. DESIGN, DEVELOPMENT AND APPROVAL OF AIRCRAFT MODIFICATIONS

### 9.1 Legislative Basis for Acceptable Aircraft Configurations

**9.1.1** CAO 20.18 Paragraph 9B together with CAO 20.18 Appendix XI detail the legislated technical and operational requirements that are to be met by aircraft operating in Australian airspace and wishing to take advantage of the benefits of ADS-B separation. This covers both the preferred methods together with an alternative standard based on existing international requirements.

## 9.2 Compliance

**9.2.1** When utilising this guidance material for the approval of an ADS-B installation, in accordance with either Subpart 21.M or a Supplemental Type Certificate under Subpart 21.E of the *Civil Aviation Safety Regulations 1998* (CASR 1998), the following need to be considered:

- The applicant will need to submit a compliance statement to CASA that shows how the criteria of this guidance material has been satisfied, together with evidence resulting from the activities described in this section.
- Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, safety analysis of the interface between the ADS-B equipment and data sources, equipment cooling verification and ground tests. To support the approval application, design data will need to be submitted showing that the requirements for ADS-B operation have been complied with.
- The safety analysis of the interface between the ADS-B system and its data sources should show no unwanted interaction under normal or fault conditions.

**9.2.2** The Federal Aviation Administration of the USA (FAA) AC 120-86 and AC 20-165 provide additional guidance by providing general information and acceptable methods of compliance for the certification, airworthiness, and operational approval of certain aircraft surveillance systems and selected associated aviation applications.

**9.2.3** A self evaluation checklist intended to assist in determining compliance is included at Appendix C of this AC.

## 9.3 Functional Testing

**9.3.1** Testing of the installed system either on ground or in flight, is intended to confirm:

- system operation;
- that the aircraft derived data in the transmitted messages, including integrity data, is correct; and
- correct functioning of installed system fault detectors.

**9.3.2** Whilst some of the functionality for ADS-B out applications may be demonstrated by ground testing, thorough validation of the installed equipment combination may need a mix of ground and flight tests.

**9.3.3** When a particular ADS-B equipment combination is being fitted to an aircraft the following issues need to be addressed:

- If the equipment combination installation is in accordance with an existing proven design (i.e. OEM fit, approved STC or CASR 21M approved engineering order) then the aircraft may only require transponder test set confirmation and the normal post maintenance check flight to confirm correct function of the installed equipment and overall aircraft operation. Coordination with local ATC may also be required.
- If the proposed equipment combination has not been implemented previously, but sufficient documentary evidence is submitted to prove compliance of the system integration with the performance standards as detailed, then paragraph 9.3.1 of this AC would also apply.

- If the proposed equipment combination installation has not been implemented previously and there is insufficient supporting evidence to show compliance with the published standards, comprehensive use of an ADS-B capable transponder test set to verify operation all data fields is required. Subsequently, coordination may be required with local ATC to allow a one off trial period during which time the ADS-B data transmitted by the aircraft is gathered and analysed to confirm correct functioning of the equipment combination. This would be in addition to the requirements of paragraph 9.3.1 of this AC.

## 9.4 Acceptable Configurations

**9.4.1** Schedules 1 and 2 of Appendix D to this AC provide listings of the currently accepted equipment combinations. These combinations were submitted by operators as part of their application for ADS-B based services and subsequently verified by Airservices Australia. These combinations are not exhaustive, and are a historical record and not subject to further update.

**9.4.2** Recent legislative changes have required a technical review of the performance of existing equipment combinations. Appendix D, Schedule 3 of this AC lists those combinations that are no longer acceptable for use in Australia. This list is not exhaustive and is a historical record and not subject to further update.

## 9.5 Flight Manual

**9.5.1** The AFM or the POH, whichever is applicable, should provide at least a statement that the transponder system(s) complies with the criteria of ICAO Annex 10 Volumes III and IV, Amendment 85 regarding extended squitter and any necessary procedures for expected operations (e.g. the need to enter Identity/Call Sign also known as Flight ID) for use with ATC.

**9.5.2** Crew Operating Instructions for the ADS-B system should emphasise the need to use the ICAO format, as defined in ICAO Doc 4444, for entry of the Flight ID or Registration Mark as applicable to the flight. The shortened format commonly used by airlines (a format used by the International Air Transport Association) is not compatible with the ground systems of the air traffic services.

## 9.6 Minimum Equipment List (MEL)

**9.6.1** The mandatory requirements detailed in CAO 20.18 Paragraph 9B.8 regarding the serviceability of the ADS-B equipment fitted are to be noted in the MEL.

## 9.7 Maintenance

**9.7.1** Maintenance tests should include a periodic verification check of aircraft ADS-B data including the ICAO 24-bit aircraft address (also known as the Mode S address) using suitable ramp test equipment. A check of the ICAO 24-bit aircraft address should be made in the event of a change of the registration mark of the aircraft (this is always necessary following change in State of registration) or whenever a transponder is replaced.

***Note:*** *Australian aircraft are allocated a 24-bit address by the Registrar of Aircraft or relevant RAAO at time of registration.*

**9.7.2** Where possible, maintenance tests should check the correct functioning of system fault detectors.

**9.7.3** The maximum period between ADS-B maintenance tests of the ADS-B transmitter should be the same as for ATC transponders and all transponders fitted to the aircraft should be checked.

## 10. FOREIGN BASED OPERATORS

**10.1.1** CAO 82.1 Paragraph 5.8, CAO 82.3 Paragraph 10.8 and CAO 82.5 Paragraph 10.8 detail the requirements for ADS-B that foreign registered aircraft must comply with if intending to utilise ADS-B services operations within Australian FIR.

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Executive Manager
Standards Division

March 2014

# APPENDIX A

# REFERENCES

## AUSTRALIAN

| Source | Title | Reference | Version | Date |
|---|---|---|---|---|
| CASA | Certification and airworthiness requirements for aircraft and parts | CASR Part 21 | | |
| | Designs of modifications of, and repairs to, aircraft, aircraft engines, propellers and appliances | CASR Subpart 21M | | |
| | Aircraft Equipment – Basic Operational Requirements | CAO 20.18 | | |
| | Supplemental Type Certificate - Certification | AC 21-15 | | September 2009 |
| | Global Navigation Satellite System (GNSS) Equipment: Airworthiness Guidelines | AC 21-36 | | January 2013 |
| | Australian Technical Standard Order Authorisation | AC 21-601 | | July 2005 |
| | Airborne Mode A/C Transponder Equipment with Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmit Only Equipment | ATSO-C1004 | (a) | December 2009 |
| | Airborne Stand-Alone Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmission Capability | ATSO-C1005 | (a) | December 2009 |

## INTERNATIONAL

| Source | Title | Reference | Version | Date |
|---|---|---|---|---|
| ICAO | Aeronautical Communications (Digital Data Communication Systems) | Annex 10 Volume III | Amdt. 85 | November 2007 |
| | Aeronautical Communications (Surveillance Radar and Collision Avoidance Systems) | Annex 10 Volume IV | Amdt. 85 | November 2007 |
| | Aeronautical Surveillance Manual | Doc 9924 | | March 2010 |
| | Manual of the Secondary Surveillance Radar System (SSR) | Doc 9684 | Third Edition | 2004 |
| | Procedures for Air Traffic Services - Air Traffic Management (PANS-ATM) | Doc 4444 | 15th Edition Amdt 2 | 19 November 2009 |
| EUROCAE / RTCA | MOPS for Global Positioning System/Wide Area Augmentation System Airborne Equipment | RTCA/DO-229 | C | 28 November 2001 |
| | Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by data communications | EUROCAE ED 78 or | A | December 2000 |
| | | RTCA/DO-264 | | December 2000 |
| | MASPS for Required Navigation Performance (RNP) Area Navigation | EUROCAE ED-75 | B | December 2003 |
| | | RTCA/DO-236 | B | October 2003 |
| | MASPS for ADS-B | RTCA/DO-242A<br>Change 1 to RTCA/DO-242A | | June 2002 |
| | MOPS for 1090MHz for ADS-B | EUROCAE ED-102 | Initial<br>A | November 2000<br>December 2009 |
| | | RTCA/DO-260 | Initial<br>A<br>B | September 2000<br>April 2003<br>September 2008 |
| | MOPS for Secondary Surveillance Radar Mode S Transponders | EUROCAE ED-73 | C | September 2008 |
| | MASPS for Aircraft Surveillance Applications (ASA) | RTCA/DO-289<br>Change 1 to RTCA/DO-289 | | September 2003<br>December 2006 |
| | MOPS for Air Traffic Control Radar Beacon System/ Mode Select (ATCRBS/Mode S) Airborne Equipment | RTCA/DO-181 | E | March 2011 |
| | MASPS for Surveillance Transmit Processing (STP) | RTCA/DO/302 | | December 2006 |

| Source | Title | Reference | Version | Date |
|---|---|---|---|---|
| | Safety, Performance and Inter-operability Requirements Document for the ADS-B Non-Radar-Airspace (NRA) Applications | RTCA/DO/303<br>ED126 | | December 2006 |
| | MOPS for Global Positioning System/Aircraft Based Augmentation System Airborne Equipment | RTCA/DO-316 | | 14 April 2009 |
| FAA | TSO for Mode S Extended Squitter | TSO-C112 | d | 6 June 2011 |
| | Airborne Navigation Sensors using GPS Augmented by Satellite Based Augmentation System | TSO-C145 | c | 2 May 2008 |
| | Stand Alone Airborne Navigation Equipment using GPS Augmented by Satellite Based Augmentation System | TSO-C146 | c | 9 May 2008 |
| | Airborne Supplemental Navigation Sensors using GPS Augmented by Satellite Based Augmentation System | TSO-C196 | | 21 September 2009 |
| | 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) | TSO-C166 | Initial<br>a<br>b | September 2004<br>December 2006<br>December 2009 |
| | TSO for Altimeter, Pressure Actuated, Sensitive Type | TSO-C10 | b | September 1959 |
| | TSO for Air Data Computer | TSO-C106 | | January 1988 |
| | TSO for Automatic Pressure Altitude Reporting Code–Generating Equipment | TSO-C88 | b | February 2007 |
| | Guidelines for Design Approval of Aircraft Data communications | AC 20-140 | | August 1999 |
| | Aircraft Surveillance Systems and Applications | AC 120-86 | | September 2005 |
| | Airworthiness Approval of Automatic Dependent Surveillance Broadcast (ADS-B) Out Systems | AC 20-165 | | May 2010 |
| EASA | MOPS for SSR Mode S Transponders (Adopts EUROCAE ED-73A).<br>*Note: This JTSO is being updated to version B based on EUROCAE document ED-73B.* | ETSO-2C112a formerly JTSO-2C112a | | 24 October 2003 |
| | ETSO for Altimeter, Pressure Actuated, Sensitive Type | ETSO-C10 | b | 24 October 2003 |
| | ETSO for Air Data Computer | ETSO-C106 | | 24 October 2003 |
| | ETSO for Automatic Pressure Altitude Reporting Code–Generating Equipment | ETSO-C88 | b | 24 October 2003 |
| | Acceptable Means of Compliance | EASA AMC20-24 | | |

# APPENDIX B

# ADS-B 'OUT' DATA

TABLE 1: REQUIRED CHARACTERISTICS OF ESSENTIAL ADS-B OUT DATA

| Item | Parameter | Range | Minimum Resolution | Accuracy Limits | Maximum Data Age at Transmission | Remarks<br>ADS-B transmitter specification |
|---|---|---|---|---|---|---|
| 1 | Identity/Call Sign | 8 characters | N/A | N/A | 60 seconds | ICAO Annex 10, Vol IV, para 3.1.2.9 |
| 2 | Position | Any latitude and longitude on earth | | - | 2 seconds | ICAO Annex 10, Vol IV, para 3.1.2.8.6.6<br>& Vol III, Part I, App to Chap 5 para 2.3.2.3 |
| 3 | Pressure Altitude | -1000 ft to maximum certificated altitude of aircraft plus 5000 ft | 100 ft (Gillham's code) or 25 ft as provided by the source. | As the installed sensor. | 2 seconds | ICAO Annex 10, Vol IV, para 3.1.2.6.5.4. referenced to 1013.25 hPa & Vol III, Part I, App to Chap 5 para 2.3.2.4.<br>Note: Minimum resolution of 25 ft is preferred. |
| 4 | Integrity Value | Value 0-9 | 1 | N/A | 2 seconds | ICAO Annex 10, Vol III, Part I, App to Chap 5 para .2.3.1 |

TABLE 2: REQUIRED CHARACTERISTICS OF DESIRABLE ADS-B OUT DATA

| Item | Parameter | Range | Minimum Resolution | Accuracy Limits | Maximum Data Age at Transmission | Remarks<br>ADS-B transmitter specification |
|---|---|---|---|---|---|---|
| 1 | SPI Indication | | | | | |
| 2 | Emergency Flag | | | | | |
| 3 | Emergency Type Indicator | | | | | |
| 4 | Velocity Information | | - | - | 2 seconds | ICAO Annex 10, Vol IV, para 3.1.2.8.6.6 & Vol III, Part I, App to Chap 5 para 2.3.5 |
| 5 | GNSS Height | | | | | |
| 6 | Vertical rate (GNSS/BARO) | | | | | |

# APPENDIX C

## SELF EVALUATION CHECKLIST

| | |
|---|---|
| ADS-B Transmitter Manufacturer & Model number | |
| GNSS positional source Manufacturer & Model number | |
| GNSS receiver TSO | • TSO C145a or later version<br>• TSO C146a or later version<br>• TSO-C196 or later version<br>• Other |
| If not TSO C145(), TSO C146() or TSO C196() compliant | • Fault Detection and Exclusion YES/NO<br>• Selective Availability aware YES/NO<br>• Confirm outputs HPL or HIL<br>• Is BARO aiding provided to GNSS receiver? |
| Transmitter Message formats compliant with : (Circle one) | • ICAO Annex 10, Volume III and IV Amendment 85 or<br>• DO-260 or<br>• DO-260A or TSO C166 or TSO-C166a<br>• DO-260B or TSO C166b |
| Transmitter characteristics compliant with (Circle one) | • ATSO-C1004b<br>• ATSO-1C74c<br>• TSO-C112d and compliant with RTCA/DO-181e or<br>• ETSO-C112b or<br>• ED73B or DO-181e<br>• ATSO-C1005b |
| HPL is provided to ADS-B transmitter on same interface as GNSS positional data and tested | YES/NO |
| Suitable pressure altitude data source provided to transmitter and tested? | YES/NO<br>TSO-C10b or ETSO-C10b<br>TSO-C106 or ETSO-C106<br>TSO-C88b or ETSO-C88b |
| Uses ship's ATC transponder antenna? | YES/NO |
| If not using ship's ATC antenna, has antenna been mounted in accord with transponder mounting rules? | YES/NO |
| Flight ID source installed and tested? (Circle one) | Programmed/ pilot entry panel/ Flight Management System interface |
| Optional data supported & tested (circle those verified) | • SPI indication<br>• Emergency flag<br>• Ground track / Ground speed Velocity vector<br>• Emergency type indicator<br>• GNSS height<br>• GNSS Vertical rate<br>• BARO vertical rate |

# APPENDIX D

## ACCEPTABLE EQUIPMENT COMBINATIONS

1. The equipment combinations listed in **Schedules 1 and 2 are not exhaustive, and are a historical record and not subject to further update.** The lists were compiled from data obtained from individual applications to Airservices Australia by operators wishing to be included in the ADS-B separation services.

2. Following legislative changes and technical review of the performance of existing transponder combinations **Schedule 3** lists those combinations that are no longer acceptable for use in Australia. **This list is not exhaustive, and is a historical record and not subject to further update**.

3. Aviation Communication & Surveillance Systems (ACSS) XS-950 transponders are not acceptable unless software modification A is incorporated

## SCHEDULE 1 -

ATC Transponder and MMR/GPS Receiver Combinations from Multiple Manufacturers

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| ACSS XS-950 (with software mod A) | 7517800-10005 | Honeywell GR-550 | HG2021GA03 |
| | | | HG2021GC02 |
| | | Honeywell RMA-55B | 066-50029-1161 |
| | | Rockwell Collins GLU-920 | 822-1152-001 |
| | | | 822-1152-002 |
| | | | 822-1152-121 |
| | | | 822-1152-130 |
| | | | 822-1152-131 |
| | | | 822-1152-220 |
| | | Rockwell Collins GLU-925 | 822-1821-430 |
| | 7517800-10007 | Rockwell Collins GLU-920 | 822-1152-001 |
| | | | 822-1152-002 |
| | | | 822-1152-121 |
| | | | 822-1152-130 |
| | | | 822-1152-220 |
| | | Rockwell Collins GLU-925 | 822-1821-001 |
| | 7517800-10009 | Rockwell Collins GLU-920 | 822-1152-001 |
| | | | 822-1152-002 |
| | | | 822-1152-121 |
| | | | 822-1152-130 |
| | | | 822-1152-220 |
| | 7517800-10100 | Rockwell Collins GLU-925 | 822-1821-430 |

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| ACSS XS-950 (with software mod A) | 7517800-11006 | Honeywell GR-550 | HG2021GC02 |
| | | Honeywell RMA-55B | 066-50029-1201 |
| | | Rockwell Collins GLU-920 | 822-1152-002 |
| | | Rockwell Collins GLU-925 | 822-1821-001 |
| | 7517800-11009 | Honeywell GR-550 | HG2021GC01 |
| | | | HG2021GC02 |
| | | Honeywell RMA-55B | 066-50029-1201 |
| | | Rockwell Collins GLU-920 | 822-1152-001 |
| | | | 822-1152-002 |
| | | Rockwell Collins GLU-925 | 822-1821-001 |
| Honeywell TRA-67A | 066-01127-1301 | Honeywell GR-550 | HG2021GP01 |
| | | Rockwell Collins GLU-920 | 822-1152-002 |
| | 066-01127-1402 | Honeywell RMA-55B | 066-50029-1161 |
| | | Rockwell Collins GLU-920 | 822-1152-121 |
| | | | 822-1152-130 |
| | | | 822-1152-131 |
| | | Thales TLS755 | TLS755-01-0101B |
| | | | TLS755-01-0102A |
| | 066-01127-1601 | Honeywell GR-550 | HG2021GC01 |
| | | Honeywell RMA-55B | 066-50029-1101 |
| | | Rockwell Collins GLU-920 | 822-1152-002 |
| | 066-01127-1602 | Honeywell GR-550 | HG2021GC01 |
| | | | HG2021GC02 |
| | | | HG2021GP01 |
| | | Honeywell GR-551 | HG2021GP02 |

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| Honeywell TRA-67A | 066-01127-1602 | Honeywell RMA-55B | 066-50029-1101 |
| | | | 066-50029-1201 |
| | | Litton LTN2001Mk2 | 466200-0104 |
| | | Rockwell Collins GLU-920 | 822-1152-002 |
| | | | 822-1152-003 |
| | | Rockwell Collins GLU-925 | 822-1821-001 |
| | | | 822-1821-330 |
| | | Thales TLS755 | TLS755-01-5101A |
| Honeywell ISP-80A | 965-1694-001 | Rockwell Collins GLU-925 | 822-1821-131 |
| | | | 822-1821-430 |
| Honeywell XS-858A | 7517401-960 | CMC Electronics CMA-2024-1 (This a modular unit normally located in a higher assembly) | 245-604067-100 |
| Rockwell Collins TDR-94 | 622-9352-108 | Rockwell Collins GPS-4000S | 822-2189-001 |
| | 622-9352-409 | | 822-2189-002 |
| | 622-9210-409 | | |
| Rockwell Collins TDR-94D | 622-9210-108 | Honeywell GR-550 | HG2021GD02 |
| | | Rockwell Collins GPS-4000S | 822-2189-001 |
| Rockwell Collins TDR-94D | 622-9210-409 | FreeFlight Systems 1203 | 84327-01-0303 |
| | | | 84327-02-100A |
| | | Universal Avionics Systems UNS-1Lw | 3116-42-1116 |

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| Rockwell Collins TPR-901 | 822-1338-003 | Free Flight Systems 1203 | 84327-50-200A |
| | | Free Flight Systems 1203C | 84327-50-200B |
| | | Honeywell GR-550 | HG2021GC02 |
| | | | HG2021GP01 |
| | | Honeywell RMA-55B | 066-50029-1101 |
| | | | 066-50029-1201 |
| | | Rockwell Collins GLU-920 | 822-1152-002 |
| | | | 822-1152-005 |
| | | Rockwell Collins GLU-925 | 822-1821-001 |
| | | | 822-1821-330 |
| | 822-1338-020 | Rockwell Collins GLU-920 | 822-1152-121 |
| | 822-1338-021 | Rockwell Collins GLU-920 | 822-1152-121 |
| | | | 822-1152-131 |
| | | Rockwell Collins GLU-925 | 822-1152-130 |
| | | | 822-1821-430 |

## SCHEDULE 2 -

ATC Transponder and GPS Receiver Combinations Manufactured by Garmin International

### Table 1 - Transponders - Panel Mounted

| Model | Part Number | Notes |
|---|---|---|
| GTX330 | 011-00455-60 | (1) (2) |
| GTX330 | 011-00455-80 | (1) (2) |
| GTX330D | 011-00455-70 | (1) (2) |
| GTX330D | 011-00455-90 | (1) (2) |

### Table 2 - Transponders - G1000 Avionics Suite

| Model | Part Number | Notes |
|---|---|---|
| GTX33 | 011-00779-20 | (1) (2) |
| GTX33 | 011-00779-30 | (1) (2) |
| GTX33D | 011-00779-21 | (1) (2) |

### Table 3 - GPS Receivers - GPS/NAV/COMM 400W/500W Series Equipment

| Model | Part Number | Notes |
|---|---|---|
| GNS530AW TAWS | 011-01067-XX | (2) (3) (4) |
| GNS530AW | 011-01066-XX | (2) (3) (4) |
| GNS530W TAWS | 011-01065-XX | (2) (3) (4) |
| GNS530W | 011-01064-XX | (2) (3) (4) |
| GNS500W TAWS | 011-01063-XX | (2) (3) (4) |
| GPS500W | 011-01062-XX | (2) (3) (4) |
| GNS430AW | 011-01061-XX | (2) (3) (4) |
| GNS430W | 011-01060-XX | (2) (3) (4) |
| GNC420AW | 011-01059-XX | (2) (3) (4) |
| GNC420W | 011-01058-XX | (2) (3) (4) |
| GPS400W | 011-01057-XX | (2) (3) (4) |

**Table 4 - GPS Receivers - G1000 Avionics Suite**

| Model | Part Number | Notes |
|---|---|---|
| GIA 63W | 011-01105-00 | (2) (5) (6) |
| GIA 63W A2/B2 | 011-01105-01 | (2) (5) (6) |
| GIA 63W | 011-01105-20 | (2) (5) (6) |

**Table 5 - GPS Receivers - GPS/NAV/COM 600/700 Series Equipment**

| Model | Part Number | Notes |
|---|---|---|
| GTN650 | 011-02256-00 | |

***Notes (applicable to Schedule 2 Tables):***

1. *Software version 6.11 or later required (Garmin Service Bulletin 0935 refers).*
2. *Any transponder or GPS can be used in combination as they all support the Garmin RS-232 serial interface that allows GPS position and integrity information to be supplied to the transponder. Generally the G1000 transponders will be combined with the G1000 GPS units, similarly for the non-G1000 transponders and GPS.*
3. *-XX denotes any numbered suffix. All part numbers in each model range are suitable for providing GPS data that can be used for ADS-B.*
4. *Software version 3.20 or later required.*
5. *The unit part number shown in Table 4 matches the part number printed on the nameplate or tag on the equipment itself.*
6. *Software version 5.80 or later required.*

## SCHEDULE 3 -

Review of Currently Approved Combinations

**Table 1: Non-compliant ATC Transponder and MMR/GPS Receiver Combinations – Not recommended for any new installations but may remain in service**

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| Honeywell KT-73 | 066-01164-0101 | Honeywell KLN 94 | 069-01034-0101 |
| | | | 069-01034-0102 |
| | | Honeywell KLN 900 | 066-04034-0102 |
| | | | 066-04034-0104 |
| | | Honeywell KMH 820 | 066-01175-2101 |
| | | | 066-01175-2102 |

***Note 1:*** *The ongoing acceptability of these combinations may be determined by future legislation. Operators utilising these equipment configurations are urged to update.*

***Note 2:*** *The KT-73 transponder does not utilise the HPL but uses RAIM flags and as such is non compliant to the minimum standards described in this AC. This non-compliance results in the KT-73 having a lower ADS-B service availability.*

**Table 2: Non-Compliant ATC Transponder and MMR/GPS Receiver Combinations – Not acceptable for continued use**

| Transponder Manufacture and Model | Transponder Part Number | MMR/GPS Receiver Manufacturer and Model | MMR/GPS Receiver Part Number |
|---|---|---|---|
| ACSS XS-950<br><br>Does not use HPL for calculation of NUC.<br>ACSS have a Service bulletin to upgrade to Mod A. | 7517800-1005/6 : | Any | |
| Any | | Litton LTN2001Mk1<br><br>Does not properly transmit HPL | 465205-0302-0303<br>465205-0402-0303<br>465205-0502-0304 |
| Rockwell Collins TDR-94/94D<br>pre -108<br><br>Rockwell advises that ADS-B should be disabled for these transponders by grounding discrete input P1-59 | | Any | |
| TPR901<br><br>Fitted to Boeing 747-400<br>generates incorrect Flight ID with a trailing “U” character. SB 503 is available to rectify. | 822-1338-003 | Any | |