Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 91-23 v1.1

ADS-B for enhancing situational awareness

Date	October 2023
File ref	D23/439257

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.

Advisory Circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- aircraft owners and operators
- pilots
- air traffic service providers.

Purpose

This AC provides advice to aircraft owners and pilots about enhancing their situational awareness during flight through the use of Automatic Dependent Surveillance - Broadcast (ADS-B) technology

For further information

For further information, contact CASA's Operations Standards and Airworthiness Standards (telephone 131 757).

Status

This version of the AC is approved by the Branch Manager, Flight Standards.

Note: Changes made in the current version are annotated with change bars.

Version	Date	Details
v1.1	October 2023	Updated the list of relevant regulations to include the recently introduced CASR parts. Removed information about surveillance equipment carriage requirements, which simply replicates information already existing in the AIP or the Part 91 Manual of Standards. Updated website information. Editorial amendments, including changes to enhance accessibility.
v1.0	June 2020	Initial AC.

Unless specified otherwise, all subregulations, regulations, divisions, subparts and parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	advisory circular
AD	airworthiness directive
ADS-B	Automatic Dependent Surveillance - Broadcast
ATC	air traffic control
ATS	air traffic service(s)
CAO	Civil Aviation Order
CAP	Civil Aviation Publication (UK)
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CTAF	Common Traffic Advisory Frequency
DF	downlink format
E(TSO)	FAA technical standard order and/or European technical standard order
EC	electronic conspicuity
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IFR	instrument flight rule(s)
LSA	light sport aircraft
MOS	manual of standards
OEM	original equipment manufacturer
RPAS	remotely piloted aircraft system
SDA	system design assurance
SIL	source integrity level
TABS	traffic awareness beacon system
TCAS	traffic collision avoidance system
TSO	technical standard order
VFR	visual flight rule(s)

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Term	Definition
ADS-B IN	The reception of or ability to receive ADS-B transmissions.
ADS-B OUT	The transmission of or ability to transmit position and other information using ADS-B.
Situational Awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future.[1]
surveillance requirements and standards	the surveillance equipment requirements and standards for a particular aircraft or aircraft operation relevantly specified in: a. Civil Aviation Order 20.18. b. The Part 91 Manual of Standards (MOS). c. When the Part 103 MOS comes into effect—that MOS will replace CAO 20.18 for Part 103 aircraft. d. When the Part 131 MOS comes into effect—that MOS will replace CAO 20.18 for Part 131 aircraft.

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Airworthiness directive AD/RAD/47	Periodic Testing of ATC Transponders
Civil Aviation Order (CAO) 20.18	Aircraft equipment — basic operational requirements
CAO 100.5	General requirements in respect of maintenance of Australian aircraft
Part 21 of Civil Aviation Safety Regulations 1998 (CASR)	Certification and airworthiness requirements for aircraft and parts
Part 91 MOS	Part 91 (General Operating and Flight Rules) Manual of Standards 2020
Part 103 MOS	Sport and Recreational Aviation Operations **Note:** As at the publishing of version 1.1 of this AC, this MOS was still being discussed with an Aviation Safety Advisory Panel Technical Working Group before wider consultation at a future date. The date when this MOS will be made into law, and the date when it will become effective, have not yet been determined.

[1] Endsley MR. *Toward a theory of situation awareness in dynamic systems.* Human Factors 1995;37(1):32–64.

Document	Title
Part 131 MOS	Balloons and Hot Air Airships **Note:** As at the publishing of version 1.1 of this AC, this MOS had been publicly consulted with stakeholders but had not yet been made into law. Additionally, the date when this MOS will become effective had not yet been determined.

International standards

Available on the relevant website

Document	Title
(E)TSO-C195	Avionics Supporting Automatic Dependent Surveillance – Broadcast (ADS-B) Aircraft Surveillance Applications (ASA)
EUROCAE ED-194	Minimum operational performance standards (MOPS) for aircraft surveillance applications (ASA) system
FAA AC 20-165B	Airworthiness Approval of Automatic Dependent Surveillance - Broadcast OUT Systems
RTCA/DO-317	Minimum operational performance standards (MOPS) for aircraft surveillance applications (ASA) system
UK CAP 1391	Electronic conspicuity devices[2]

1.4 Forms

CASA's forms are available at https://www.casa.gov.au/search-centre/forms-and-templates

Title
Declaration of capability and conformance – Electronic Conspicuity (EC) device

[2] Published by the Civil Aviation Authority of the United Kingdom, and available at https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=7275

2 Introduction

Pilots have long operated on the principle of 'see and avoid', which essentially means looking out for other airspace users and avoiding them.

While an effective scan is important, **knowing where to look** increases the probability of seeing and avoiding other aircraft. For many years, the primary way to inform pilots about other aircraft (and direct their visual scan) was voice communications – either pilot-to-pilot or from air traffic services.

Recent technological advances mean pilots can utilise electronic traffic alerting within the cockpit, using systems such as FLARM[3], and the traffic display features in tablet applications (apps).

Tablet apps receive traffic information two ways - either through the mobile phone network or by connecting the tablet to an ADS-B receiver.

The ability to electronically *receive traffic information* is understood and being used by many pilots. However, the total system is incomplete because relatively few VFR aircraft are **transmitting position information** in a form that is universally detectable by other aircraft.

While use of the mobile phone network for position information may provide electronic position information, there are issues with this method. For example, aircraft may be operating outside of mobile phone reception and consequently may not receive traffic information. Also, there may be delays in transmission or reception (latency), potentially causing variation between displayed and actual position and therefore creating potential confusion.

All instrument flight rules (IFR) aircraft have ADS-B transmitting equipment (ADS-B OUT). Logically, ADS-B OUT is the ideal way for VFR aircraft to signal their presence directly to other aircraft. In effect, ADS-B turns the 'see and avoid' concept into 'see, BE SEEN, and avoid.'

The technical standards for ADS-B OUT now include a range of equipment options primarily aimed at VFR aircraft. These include transponder-based systems and self-contained systems called Electronic Conspicuity (EC) devices and integrated Traffic Awareness Beacon System (TABS).

The standards also allow technically capable, but non-TSO[4] ADS-B OUT equipment to be installed in a range of sport aviation, experimental and certain other aircraft.

In summary, we want to improve the ability of airspace users to see you.

This AC provides general advice to the operators and pilots about using ADS-B equipment and guidance to owners in choosing the best equipment for their types of operations. There is also some guidance on transponder use and its interaction with ADS-B. While focused on VFR aircraft, there is also useful advice for operators and pilots of IFR aircraft:

[3] FLARM is a traffic awareness and collision avoidance system developed by FLARM Technology Ltd.
[4] TSO means *technical standard order*.

3 What ADS-B OUT options are there for VFR aircraft?

3.1 Surveillance requirements and standards

The requirements and provisions for installing and using ADS-B OUT equipment are specified in a number of legislative documents, including Civil Aviation Order (CAO) 20.18 and at least one MOS. For ease of reference in this AC, the range of different legislative references have been encapsulated in the definition *surveillance requirements and standards*.. Refer to section 1.2 (Definitions) for the meaning of this term.

3.2 Equipment options and benefits

Table 1 summarises the ADS-B OUT equipment options for VFR aircraft together with their respective benefits in terms of being detected by ADS-B IN, by other aircraft equipment like traffic collision avoidance system (TCAS) or by air traffic services:

Table 1: Equipment options and benefits for air-to-air and air-to ground detection

Equipment (descending order of capability)	ADS B IN[5]	TCAS	RPAS sense & avoid using ADS B	ATS surveillance inside radar & ADS B coverage	ATS surveillance outside radar coverage (but inside ADS B cover)
Transponder with IFR capable ADS-B OUT	Yes	Yes	Yes	ATC separation	ATC separation
Transponder with TABS position source; SIL[6]>1	Yes	Yes	Yes	ATC separation	ATC separation
Transponder with TABS position source; SIL =1	Yes	Yes	Yes	ATC separation	Situational awareness only
Integrated TABS; SIL>1	Yes	Yes	Yes	Situational awareness only	Separation possible (would depend on testing and validation)
Integrated	Yes	Yes	Yes	Situational	Situational

[5] The capability of equipment in this column applies to certified equipment or equipment compliant with relevant technical standards. 'Home-made' or uncertified ADS-B IN equipment may vary in receiver performance.

[6] SIL means Source Integrity Limit. SIL is a numeric value between 0 and 3 that indicates the GNSS position source's probability of exceeding the reported integrity value. It is one of the components of a standard ADS-B position message. A SIL number of 2 or 3 indicates that the GNSS position source information is suitable for ATC separation, while a SIL number of 1 indicates that the GNSS position source information is suitable for situational awareness only and is not suitable for ATC separation. SIL is a static (unchanging) value, normally specified by the equipment manufacturer and normally set by the installer at the time of equipment installation.

Equipment (descending order of capability)	ADS B IN[5]	TCAS	RPAS sense & avoid using ADS B	ATS surveillance inside radar & ADS B coverage	ATS surveillance outside radar coverage (but inside ADS B cover)
TABS; SIL=1				awareness only	awareness only
EC device	Yes	No	Yes	Situational awareness only (limited range)	Situational awareness only (limited range)

4 Important considerations

4.1 Pilot distraction

Technology can enhance pilot situational awareness. However, having an information rich source of data on a traffic display or tablet can distract a pilot from the critically important visual scan outside the aircraft.

Pilots must be mindful of distraction and minimise the time spent ‘heads down’.

When a pilot is using any traffic awareness system, they should utilise the information it provides to aid in sighting other aircraft. Often, knowing where to look, both horizontally (direction) and/or vertically (up, down or at the same level) saves critical minutes compared with relying only on a full-sky scan. However, it is essential that once the traffic alert has been announced, the pilot moves their eyes outside the aircraft to spot the traffic that the system has alerted. No ADS-B IN traffic awareness device is intended to operate without effective, external visual sighting. Do not rely solely on the depiction of traffic on the device screen for traffic avoidance action; it is critical that pilots sight other aircraft and maintain visual separation.

Pilots must also remember that some aircraft are not ADS-B equipped and will not detect, or be detected by, an EC or TABS device.

Wherever possible, pilots/aircraft owners should give preference to equipment or apps that provide the traffic information whilst allowing the pilot to maintain an effective lookout. For example, some products are glareshield-mounted and provide visual indications within the peripheral view of the pilot looking out, while others provide aural (voice) indications about traffic.

For example, a VFR aircraft is approaching a regional aerodrome, when its ADS-B IN traffic awareness device announces “Traffic! Two miles, one o'clock, high”. The pilot looks outside, upwards, in the stated direction, and quickly spots a regional turboprop airliner joining a long final for the active runway. The pilot manoeuvres clear of the airliner, whilst monitoring the CTAF and maintaining a visual scan for other aircraft that may not be ADS-B equipped.

4.2 Misconfiguration can affect other users and the air traffic system

ADS-B equipment and aircraft transponders are closely related and use common frequencies in Australia. Misconfigured ADS-B and transponder equipment can send inconsistent, or erroneous information to other aircraft and Air Traffic Control (ATC). Adhering to the guidance provided in this document will minimise the likelihood of safety issues, operational restrictions or inconvenience being caused to other airspace users and ATC by ADS-B equipment in VFR aircraft.

4.3 Transponder/ADS-B carriage requirements

While this AC focusses on ADS-B, it is important for owners and pilots to be aware of requirements for carrying a transponder or ADS-B OUT equipment for different classes of airspace. Accordingly, owners and pilots are advised to familiarise themselves with the carriage and operating requirements as well as optional provisions for transponder or ADS-B OUT equipment specified in the surveillance requirements and standards applicable to their aircraft.

The requirements and options are summarised in section GEN 1.5 of the Australian Aeronautical Information Publication (AIP).

4.4 About Mode A/C Transponders

Mode A/C transponders are obsolete technology that have been replaced or are in the process of being replaced in most parts of the world by Mode S transponder technology.

Australia already requires IFR aircraft to have a Mode S transponder as an essential component of ADS-B OUT equipment. For VFR aircraft, there are circumstances where a Mode S transponder is required, specifically:

- for operations at major capital city aerodromes
- for aircraft manufactured on or after 6 February 2014
- where a VFR aircraft is modified by having its transponder installation replaced.

Aircraft owners who continue to use an older Mode A/C transponder should be aware that older transponders may appear to function correctly and be able to pass routine pressure altitude encoder testing, yet be unserviceable because no longer meets the full performance requirements. For example, CAO 100.5 and airworthiness directive (AD) AD/RAD/47 identifies that transponders using electron tube technology (such as cavity oscillators) may suffer from reply pulse anomalies as the components age. The CAO or AD (as applicable) requires periodic testing for such anomalies and, if detected, requires repair or replacement.

Since the cost of repairing a transponder by replacing its cavity oscillator is significant, the cost-effective solution is likely to be replacement transponder. In this case, a Mode S transponder is the logical choice.

5 ADS-B OUT equipment choices

Owners and operators of aircraft used only for VFR flight in Australia have a wide range of choices in the selection of ADS-B equipment to suit their operations. Purchasers should consider factors relevant to their own needs, including the following:

- aircraft type and airworthiness category, particularly if certified under a standard or experimental certificate of airworthiness, or as an LSA
- whether the aircraft is registered with CASA or a self-administering organisation
- likelihood that the aircraft may be flown under the IFR in future
- classes of airspace, traffic type and density in intended areas of operation
- confirmation that the product satisfies the standards set out in surveillance requirements and standards; and for TABS, EC device or otherwise uncertified items, includes suitable user documentation and declaration of conformity and compatibility
- product physical size, display clarity, pilot preferences for ease of use, support for 'heads-up' alerting including aural indications
- cockpit space, accessibility of portable devices and suitability of cockpit surfaces for a portable device, without impairing the pilot's external vision or field of view
- other portable equipment carried in the aircraft and compatibility between dependent devices, such as tablet computer wireless networking
- for portable equipment, battery life relative to the types of operations envisaged
- cost, product quality and installation and support arrangements.

5.1 Mode S transponders with ADS-B OUT

A Mode S transponder with ADS-B OUT enabled is technically the most effective way of making an aircraft or other air system electronically conspicuous and delivering maximum interoperability with other aircraft as well as the ground ATM environment.

Many Mode S transponders, marketed for use by the GA community, include the capability to transmit ADS-B OUT, but may require a separate GNSS source to be connected to the transponder in order to enable that ADS-B OUT functionality.

Several avionics manufacturers have transponders with an inbuilt GNSS receiver, thus fully enabling ADS-B OUT functionality ‘out of the box’, albeit with a GPS antenna mount requirement.

There are also avionics manufacturers who have cost effective connectivity options for a GNSS source and the connection of that GNSS source to ADS-B OUT-capable transponders, either via their own compatible products or via connection of third party GNSS sources. The number of supported combinations of transponder and GNSS source has increased significantly over the past few years.

CASA encourages all potential purchasers of new Mode S transponders to consider options for enabling ADS-B OUT from their chosen transponder. This will often be cheaper and easier to enable at the time of purchase and installation rather than as an additional installation at a later stage.

For owners of VFR aircraft with existing Mode S transponders, capable of ADS-B OUT but not enabled, options exist for connecting a GNSS position source:

- install an IFR-capable GNSS position source
- install a TABS Class B position source.

It is important for aircraft owners to ascertain whether the existing transponder can be upgraded when deciding to acquire ADS-B OUT capability. For instance, some earlier generation Mode S transponders (particularly those without TSO-C166 or later authorisation) are not capable of transmitting the correct ADS-B position messages and cannot be upgraded. In this regard, CASA encourages owners to review the surveillance requirements and standards for the specific technical requirements for both transponder and position source, to consult with the equipment manufacturer or equipment supplier, and/or review the relevant technical documents.

Aircraft owners may wish to consider whether future use of a VH-registered VFR aircraft is likely to be extended to IFR. It may be less expensive, in the longer term, to install an integrated Mode S transponder, with GNSS position source and ADS-B OUT enabled, from the outset.

5.2 Integrated TABS device

Aircraft operated to the VFR can use an integrated TABS device. TABS devices were designed primarily for those aircraft in USA that were not required to comply with the FAA's stringent ADS-B requirements but want to be ‘seen’ by ADS-B and TCAS. In Australia, it is expected that these devices will provide a level of visibility to ATC as well, for situational awareness purposes.

Refer to the manufacturer's instructions about installing and operating an integrated TABS. The advice in chapter 7.2 provides guidance for obtaining and setting the device's 24-bit code.

5.3 Electronic conspicuity devices

Aircraft operated to the VFR can use lower cost ADS-B EC devices including portable devices. Portable devices have the benefit of being easily transferred between aircraft, if required. It is important that the user understands how the EC device functions, and how to change its operating parameters when transferring the device between aircraft.

- For example: A pilot owns a portable EC device and uses it when conducting private VFR flights in either of two aircraft owned by the pilot. The pilot strictly adheres to the equipment documentation's instructions to change the 24-bit address and other aircraft-specific settings whenever the device is moved between the two aircraft.

5.3.1 EC device limitations/considerations

Airframe shielding. Experience from users and trials, both in Australia and overseas, has shown that the transmit and detection ranges of an EC device can be adversely affected when parts of the aircraft are in the way. This highlights the importance of correct positioning and securely attaching these portable devices in the cockpit, which is extremely important if the device does not have an external antenna. Users should pay careful attention to manufacturer’s advice about positioning and possible shielding of the antenna.

Limited range. Given the relatively low emitted power that these devices produce, users must be aware that their detectability by receiving stations on the ground or in the air may be limited and is dependent on range and positioning of the device on the airframe. Low power EC devices are unlikely to be reliably detected by space-based ADS-B, hence not able to have the same ancillary search and rescue benefits as more powerful ADS-B OUT equipment.

Not visible to TCAS. EC devices are not currently visible to TCAS interrogations, hence the importance or desirability to operate the aircraft's transponder at the same time as the EC device.

Portable EC devices are not useable in pressurised aircraft. Some EC devices are equipped with an internal barometric altimeter sensor. As such, use of these devices in pressurised aircraft could result in inaccurate and misleading information about the aircraft's vertical position. This can jeopardise the safety of both the transmitting aircraft and any aircraft or ground stations receiving the information. For this reason, the technical standards for EC devices with an internal barometric altimeter sensor do not allow use in pressurised aircraft.

5.3.2 EC device - declaration of capability and conformance or statement of compliance

For ADS-B transmissions to be trustworthy, it is necessary to have some assurance of adequate performance. The rules state that an EC device cannot be operated in transmitting mode in Australia unless:

- **The manufacturer** has made a valid declaration of capability and conformance for the device in accordance surveillance requirements and standards .
  - CASA lists on its website[9] some EC devices whose manufacturers are considered to have made valid declarations of capability and conformance.
  - The CASA website[10] also details the procedures for making a declaration of capability and conformance.
- **The manufacturer** has provided the user a statement of compliance certifying that the device meets the relevant surveillance requirements and standards.
- **The pilot in command** of an aircraft that uses an EC device carries the statement or a copy of it on board the aircraft.

CASA requires a new declaration of capability and conformance if modifications or changes affect an EC device's equipment capability or alter a conformance aspect in the existing declaration. For example, a change to an EC device category or a change to the range of ADS-B messages provided by the device. The original declaration remains valid for EC devices built before the change or that do not incorporate the change. Pilots, owners and operators should verify with the manufacturer that any changes they might make to an EC device (including software or firmware updates) do not affect its declaration of capability and conformance.

5.3.3 Simultaneous use of EC devices and transponder installations

Most VFR aircraft already have a Mode A/C or Mode S transponder, which transmits on the same frequency (1090MHz) as EC equipment. Trials conducted overseas have found that simultaneously operating a transponder and an EC device should not cause adverse effects on receivers in other aircraft or ATS surveillance systems.

Accordingly, a transponder and an EC device may be set to simultaneously transmit, but only if the transponder is not itself outputting ADS-B position information. In fact, it is desirable to have both operating simultaneously as the combination enables detection by other aircraft fitted with

[9] https://www.casa.gov.au/operations-safety-and-travel/airspace/communications-navigation-and-surveillance/surveillance-network-and-equipment#ECdevicedeclarationofcapabilityandconformance
[10] https://www.casa.gov.au/operations-safety-and-travel/airspace/communications-navigation-and-surveillance/surveillance-network-and-equipment#Electronicconspicuity(EC)devices

TCAS (TCAS responds to transponder transmissions, but not ADS-B position messages) and detection by aircraft and remotely piloted aircraft (RPAS) fitted with ADS-B IN.

- For example, the pilot of a small VFR aeroplane, flying in Class E airspace, passes below a jet airline aircraft, which is climbing above it on a crossing track. The VFR pilot is operating both the aircraft's Mode A/C transponder and a portable EC device. The airline pilots observe the VFR aircraft's transponder signal, showing its position and altitude, on TCAS. Later, the VFR aircraft approaches a rural airstrip where several gliders, equipped with ADS-B IN traffic awareness devices, are operating. The gliders are alerted to the VFR aeroplane's presence by the output of the EC device, not the transponder.

6 Implementing ADS-B OUT in different aircraft

6.1 Implementing ADS-B OUT on type certified aircraft

ADS-B OUT systems and equipment installed or used in type-certificated aircraft must have a design approval issued under Part 21 of CASR.

Aircraft owners should consult a licensed aircraft equipment installer for advice about such installations.

Portable ADS-B OUT equipment, such as Electronic Conspicuity (EC) equipment is not bound by the same restrictions and may be used in type certified aircraft without requiring a design approval. However portable devices must be mounted and operated strictly in accordance with the manufacturer's instructions.

6.2 Implementing ADS-B OUT in light sport aircraft

For VH-registered light sport aircraft (LSA), ADS-B equipment must be installed using a method specified by the LSA manufacturer using the technical data provided by the original equipment manufacturer (OEM).

For other LSA, installation of ADS-B equipment would be acceptable under any of the following circumstances:

- self-administration arrangements
- by a CAR 30 or Part 145 organisation
- using personnel otherwise authorised to perform the installation of equipment with acceptable maintenance data.

Provided they comply with 0 and 0 above, owners of LSA do not need to use certified equipment.

For uncertified equipment, surveillance requirements and standards require the owner to obtain a statement of compliance from the supplier that identifies that the ADS-B equipment complies with the applicable TSO and complies with relevant surveillance requirements and standards. CASA recommends installers follow best practice guidelines when performing installations, such as provided in the FAA Advisory Circular (AC) 20-165B or a later version as in force from time to time.

Aircraft owners must retain the statement of compliance from the equipment supplier in the aircraft records to assist in resolving in-service issues, should they arise. CASA will be informed if transponder and ADS-B OUT equipment transmits erroneous information. If the equipment, or an installation, is determined to be non-compliant, the operator may be directed to stop operating the equipment, or restricted from entering controlled airspace, until the equipment or installation is brought into compliance. If non-compliance issues are found to be caused by the design of equipment, all users may be so restricted.

6.3 Implementing ADS-B OUT in experimental aircraft and others

This part covers aircraft in the experimental category and certain sailplanes, hang gliders, gyroplanes, weight-shift aircraft and balloons. Surveillance requirements and standards specify the range of aircraft that can install non-TSO authorised ADS-B equipment.

ADS-B OUT equipment installed in these aircraft must meet the ADS-B standards in surveillance requirements and standards applicable to flight rules under which the aircraft is operated.

No CASA approval is required for the ADS-B OUT system installation. Owners of these aircraft may elect to install equipment authorised under a TSO, in accordance with the installation instructions provided by the manufacturer. Alternatively, owners of these aircraft may elect to purchase uncertified equipment.

For uncertified equipment, surveillance requirements and standards require the owner to obtain a statement of compliance from the supplier that identifies that the ADS-B equipment complies with the applicable TSO and complies with relevant surveillance requirements and standards. CASA recommends installers follow best practice guidelines when performing installations, such as provided in FAA Advisory Circular (AC) 20-165B or a later version as in force from time to time.

Aircraft owners must retain the statement of compliance from the equipment supplier in the aircraft records to assist in resolving in-service issues, should they arise. CASA will be informed if transponder and ADS-B OUT equipment found to transmitting erroneous information. If the equipment, or an installation, is determined to be noncompliant the operator may be directed to stop operating the equipment, or restricted from entering controlled airspace, until the equipment or installation is brought into compliance.

7 ADS-B OUT equipment settings

7.1 Setting the correct GNSS position source performance indicators

This part applies to aircraft owners who plan to add a GNSS position source to a Mode S transponder.

The capability of the GNSS position source determines the usefulness of the configuration. If the manufacturer's instructions allow a SIL setting of 2 or more, this enables the capability of a full IFR capable system, which includes the ability to receive ATC surveillance separation based on ADS-B. If the manufacturer's instructions only allow a SIL of 1, this is useful for situational awareness and electronic conspicuity, but does not give the ability to receive ATC surveillance separation based on ADS-B. Equipment requiring or having a SIL of zero (0) is not suitable or useable in Australia, as this setting is used to indicate unsuitable ADS-B equipment. Importantly, aircraft transmitting a SIL of zero is not displayed in aircraft fitted with TSO-standard ADS-B IN equipment. Hence equipment with this setting is not part of the range of acceptable equipment configurations.

The ATC surveillance system will detect the SIL as well as other GNSS performance indicators and, if suitable for ATS surveillance, will display the aircraft with an indication of the aircraft's ADS-B capability. It is vital that the appropriate SIL value is set within the transponder. This avoids any mismatch between aircraft capability and the capability displayed to ATC. Consult your installer and/or the equipment's operating/installation manual for specific details.

For solutions which are transponder based, the SIL setting does not affect the ability of an aircraft operated to the VFR to obtain clearance into Class C airspace. This is because, in Class C airspace, the transponder (not ADS-B OUT) is used by ATC to identify a VFR aircraft and provide surveillance services.

7.2 24-bit address for ADS-B equipment including EC devices

This part applies to all aircraft owners, operators and pilots who purchase or use ADS-B equipment for, or in, a VFR aircraft.

All ADS-B OUT equipment, including EC devices, use a 24-bit address, which may also be termed the 24-bit Mode S or ICAO address. This is different to the transponder mode A code (the familiar 'squawk code') that a pilot enters in a transponder. The 24-bit address usually forms part of an aircraft's certificate of registration and is usually set only once during initial installation of the fixed ADS-B OUT equipment.

As an EC device is designed to be portable and useable in unregistered aircraft, the 24-bit address will be programmable by the user. The operating manual of an EC device will explain how to correctly set and change the 24-bit address.

7.2.1 24-bit address for EC devices used in registered aircraft

If you are using your EC device on a registered aircraft with an existing ICAO 24-bit (or Mode S) address, you must program this address into your EC device. Contact the Civil Aircraft Register <https://www.casa.gov.au/about-us/contact-us/aircraft-registration-enquiries> if you don't know the 24-bit binary address for your aircraft.

Consult the equipment manufacturer's documentation for the correct format to use for your equipment. CASA provides 24-bit addresses in three formats:

Hexadecimal: six digits and/or the letters A to For
Decimal: seven digitsor

- Binary: a sequence of 24 ones and/or zeros.

If your equipment requires octal format, there are many web-based conversion applications available online.

If you need to move the device between registered aircraft, it MUST be reprogrammed with the new aircraft's ICAO 24-bit address as appropriate.

7.2.2 24-bit address for EC devices used in unregistered aircraft

If you are using an EC device on an unregistered aircraft, you need to contact the Civil Aircraft Register <https://www.casa.gov.au/about-us/contact-us/aircraft-registration-enquiries> and provide the following:

- Your contact details
- If applicable:
  - Your aircraft's registration number
  - Aircraft Manufacturer
  - Aircraft Model
  - Aircraft Serial Number
- The details for your EC device, including:
  - Make
  - Model
  - Serial number.

CASA will allocate the EC device a unique ICAO 24-bit binary address to enable it to be used on multiple unregistered aircraft without re-programming. As mentioned in paragraph 0, CASA provides 24-bit binary addresses in several formats. If necessary consult the equipment manufacturer's documentation for the current format to use for your equipment when converting the 24-bit address to the correct format.

7.2.3 Selling portable ADS-B devices

If you sell or dispose of a portable ADS-B device such as an EC device, you should ensure that the 24-bit address is cleared before it leaves your possession.

8 ADS-B IN receiving equipment and traffic displays

Being able to receive ADS-B transmissions from other aircraft and to display that information to the pilot is an essential component of ADS-B technology to enhance a pilot's situational awareness. The capability to receive ADS-B transmissions is generally referred to as 'ADS-B IN'.

ADS-B IN capability can be achieved several ways:

- a Mode S transponder with integrated ADS-B OUT and ADS-B IN capability
- a specific ADS-B IN component permanently installed in the aircraft
- a portable ADS-B IN device carried in the aircraft.

The received ADS-B IN information must be presented in a suitable form to the pilot. The presentation can be as simple as a warning light or sound or as radar-like display of traffic information integrated with other flight information on an electronic display. In many cases, the traffic display solution is an ADS-B IN receiver wirelessly connected to a tablet computer running a suitable app that displays traffic information.

8.1 ADS-B IN installation requirements

There is no requirement to install ADS-B IN equipment in any Australian aircraft. Any suitable and 1090MHz-compatible ADS-B IN receiver is useable in Australia.

Aircraft owners and operators may choose between portable and fixed ADS-B IN equipment, (or no ADS-B IN equipment). Users of portable ADS-B IN equipment should pay careful attention to manufacturer’s advice about positioning and possible shielding of the antenna; the equipment will not operate reliably or effectively if the antenna does not have an unobstructed view of traffic.

However, the same rules for fixed installations of ADS-B OUT equipment equally apply to fixed installations of ADS-B IN equipment. For type certified aircraft, equipment authorised under (E)TSO-C195a or approved as meeting the standards of RTCA/DO-317A or EUROCAE ED-194 (or later versions) would be appropriate.

8.2 Choosing a suitable display of information

Owners and pilots should be mindful about the potential for ADS-B displays to distract or divert the pilot from maintaining a visual scan. CASA advises pilots to give preference to equipment that is easy to interpret, or able to give alerts, without requiring excessive time spent 'heads down' in the cockpit.

Appendix A

Usage scenario descriptions for different ADS-B options

Table A.1 describes – in a flight thread form – the use of an ADS-B system (ADS-B OUT and IN) in a VFR aircraft, including actions by the pilot and other recipients of the information.

Table A.1: Flight thread explanation about the use of an ADS B system (ADS B OUT and IN) in a VFR aircraft

Scenario Description	VFR Aircraft Role or Activity	Other Aircraft Role or Activity	ATC Role or Activity	Envisaged Outcome: TABS position source +Mode S Transponder	Envisaged Outcome: Integrated TABS device	Envisaged Outcome: EC device
Before Flight: Configure equipment.	Set Flight ID and appropriate primary and alternate 4096 code (if in-flight code setting not available). Switch equipment to proper operating mode for flight.	None.	None.	Capable of detection by other aircraft fitted with: • TCAS I or II • Traffic awareness system (TAS) • ADS-B IN • ATC ADS-B ground stations • ATC radar.	Capable of detection by other aircraft fitted with: • TCAS I or II • TAS • ADS-B IN • ATC ADS-B ground stations, for situational awareness only.	Capable of detection by other aircraft fitted with: • ADS-B IN • ATC ADS-B ground stations, for situational awareness only.
VFR aircraft observed on another aircraft's[12] TCAS I or II, TAS or ADS-B IN equipment.	Respond to radio broadcasts.	Operate and monitor TCAS I or II, TAS or ADS-B IN. Respond to TA, RA or other.	None.	Other aircraft fitted with TCAS I or II, TAS or ADS-B IN are alerted and aware of VFR aircraft's presence and avoids collision risk.	Other aircraft fitted with TCAS I or II, TAS or ADS-B IN are alerted and aware of VFR aircraft's presence and avoids collision risk.	Other aircraft fitted with ADS-B IN are alerted and aware of VFR aircraft's presence and avoids collision risk.
VFR aircraft (equipped with ADS-B IN) observes other ADS-B equipped aircraft.	Observe the traffic display, and/or listen to audio alerts. Sight the traffic and	Respond to radio broadcasts.	None.	VFR aircraft is alerted and aware of other aircraft's presence, thus reducing the collision risk.	VFR aircraft is alerted and aware of other aircraft's presence, thus reducing the collision risk.	VFR aircraft is alerted and aware of other aircraft's presence, thus reducing the collision risk.

[12] Airline, business, military, survey, medevac or IFR GA aircraft would be typical examples in this context.

Scenario Description	VFR Aircraft Role or Activity	Other Aircraft Role or Activity	ATC Role or Activity	Envisaged Outcome: TABS position source +Mode S Transponder	Envisaged Outcome: Integrated TABS device	Envisaged Outcome: EC device
	take action to avoid it.					
VFR aircraft observed on another aircraft's [13] ADS-B IN equipment.	As appropriate to the type of activity[14].	Monitor ADS-B IN display or aural indications. Sight the traffic and take action to avoid it	None.	The other aircraft is alerted and aware of VFR aircraft's presence, thus reducing the collision risk.	The other aircraft is alerted and aware of VFR aircraft's presence, thus reducing the collision risk.	The other aircraft is alerted and aware of VFR aircraft's presence, thus reducing the collision risk.
VFR aircraft observed by ATC.	Select appropriate 4096 primary or standby code. Operate SPI function if fitted and requested. Listen to ATC traffic information (directed or broadcast). Respond to ATC if appropriate.	Listen to ATC traffic information (directed or broadcast). Respond to ATC. Attempt to visually sight VFR aircraft. Attempt to contact VFR aircraft by radio if appropriate.	Observe the VFR aircraft target on console display. Read target label. Decide if target is full capability (SIL>=2) or situational awareness (SIL=1) only. Pass traffic information as indicated and appropriate. Provide warning or caution if violating (or likely to violate) controlled airspace.	*In ADS-B and radar coverage:* • Alerted aircraft aware of VFR aircraft's presence and can avoid collision risk. • VFR aircraft may avoid violating controlled airspace.	*In ADS B coverage:* • Alerted aircraft aware of VFR aircraft's presence and can avoid collision risk. • VFR aircraft may avoid violating controlled airspace. *In radar-only coverage:* As above, but only if Mode C-only replies are observed.	*In ADS B coverage:* • Alerted aircraft aware of VFR aircraft's presence and can avoid collision risk. • VFR aircraft may avoid violating controlled airspace. *In radar-only coverage:* None – aircraft will not be observed by ATC.
VFR aircraft seeks to utilise an Air Traffic	Select correct 4096 primary or standby	None	Observe the VFR aircraft target on	*In ADS B and radar coverage:*	*In ADS B coverage:* • ATC provides	*In ADS B coverage:* • ATC provides

[13] Other sport aircraft, such as other gliders, would be typical examples in this context.
[14] In some sport aviation operations, for example between manoeuvring gliders, radio traffic broadcasts and exchanges may not be of assistance in sighting and avoid other aircraft.

Scenario Description	VFR Aircraft Role or Activity	Other Aircraft Role or Activity	ATC Role or Activity	Envisaged Outcome: TABS position source +Mode S Transponder	Envisaged Outcome: Integrated TABS device	Envisaged Outcome: EC device
Service (control service, or flight following advisories).	code; enter discrete code if requested by ATC and supported by equipment. Operate SPI function if fitted and requested. Listen to ATC response, advisories and instructions. Respond to ATC as appropriate.		console display. Read target label. Decide if target is full capability (SIL>=2) or situational awareness (SIL=1) only. SIL>=2: Deliver flight following or control service in accordance with existing provisions. SIL=1: Use target for and/or as aid to procedural or visual separation. All Cases: Provide warning or caution if violating (or likely to violate) controlled airspace.	• ATC delivers flight following, other advisory, or control service. • VFR aircraft receives traffic information or separation service from other traffic (dependent on airspace class). • Risk of collision with other aircraft reduced. Automated ATC safety nets could be activated, or ATC could detect risk • VFR aircraft may avoid violating controlled airspace.	procedural or visual service if possible, or declines. • Other aircraft may be alerted to presence of VFR aircraft. • Risk of collision with other aircraft reduced. Automated ATC safety nets could be activated, or ATC could detect risk. • VFR aircraft may avoid violating controlled airspace. • *In radar coverage:* As above, but only if Mode C replies are observed.	procedural or visual service if possible, or declines. • Other aircraft may be alerted to presence of VFR aircraft. • Risk of collision with other aircraft reduced. Automated ATC safety nets could be activated, or ATC could detect risk • VFR aircraft may avoid violating controlled airspace. *In radar coverage:* None – aircraft will not be observed by ATC.
VFR aircraft emergency.	Select emergency 4096 code. Operate SPI function if fitted and requested. Listen for ATC assistance and traffic	Listen to ATC traffic information (directed or broadcast). Respond to ATC. Attempt to visually sight VFR aircraft.	In all observed cases: • Observe the VFR aircraft target on console display. • Read emergency target label.	*In ADS B and radar coverage:* • VFR aircraft emergency is communicated to ATC. • Emergency	*In ADS B coverage:* • VFR aircraft emergency is communicated to ATC, where the device is EMG capable.	*In ADS B coverage:* • VFR aircraft emergency is communicated to ATC, where the device is EMG capable.

Scenario Description	VFR Aircraft Role or Activity	Other Aircraft Role or Activity	ATC Role or Activity	Envisaged Outcome: TABS position source +Mode S Transponder	Envisaged Outcome: Integrated TABS device	Envisaged Outcome: EC device
	information (directed or broadcast). Respond to ATC as and if appropriate.	Attempt to contact VFR aircraft by radio if appropriate.	• Attempt to contact pilot. • Alert SAR and emergency services. Pass traffic information as indicated and appropriate.	support resources able to be engaged. Position and trajectory of aircraft and location of emergency is known. • Other potentially conflicting aircraft remain clear of area. • Emergency hazard to other aircraft and ground parties reduced.	• Emergency support resources able to be engaged. Position and trajectory of aircraft and location of emergency is known. • Other potentially conflicting aircraft remain clear of area. • Emergency hazard to other aircraft and ground parties reduced. *In radar coverage:* As above, but only if Mode C replies are observed.	• Emergency support resources able to be engaged. Position and trajectory of aircraft and location of emergency is known. • Other potentially conflicting aircraft remain clear of area. • Emergency hazard to other aircraft and ground parties reduced. *In radar coverage:* None - aircraft will not be observed by ATC.
VFR aircraft search and rescue phase initiated.	Pilot of aircraft fails to cancel SARTIME, make required report, or is reported overdue.	Other aircraft may be tasked to assist per existing procedures.	ATC perform communication checks and other SAR procedures. ATC examine recorded ADS B data or “last detected” function on ATC screen to identify	*In ADS B and radar coverage:* • VFR aircraft emergency is communicated to ATC. • Emergency support resources able to be engaged. Position	*In ADS B coverage:* • VFR aircraft emergency is communicated to ATC. • Emergency support resources able to be engaged. Position and trajectory of	*In ADS B coverage:* • VFR aircraft emergency is communicated to ATC. • Emergency support resources able to be engaged. Position and trajectory of

Scenario Description	VFR Aircraft Role or Activity	Other Aircraft Role or Activity	ATC Role or Activity	Envisaged Outcome: TABS position source +Mode S Transponder	Envisaged Outcome: Integrated TABS device	Envisaged Outcome: EC device
			reasonable SAR area.	and trajectory of aircraft and location of emergency is known. • Emergency hazard to other aircraft and ground parties reduced.	aircraft and location of emergency is known. • Emergency hazard to other aircraft and ground parties reduced. *In radar only coverage:* As above, but only if Mode C replies are observed.	aircraft and location of emergency is known. • Emergency hazard to other aircraft and ground parties reduced. *In radar only coverage:* None - aircraft will not be observed by ATC.
VFR aircraft activities monitored by non-ATC ground station(s) including individual receivers, FlightAware, FlightRadar24 and others.	None.	None.	None.	Operating companies, related business and training organisations, flying clubs, relatives and other observers view and/or record aircraft position, track, altitude and other flight details for information and/or analysis. (Range and performance dependent on power output of TABS and EC devices.)	Operating companies, related business and training organisations, flying clubs, relatives and other observers view and/or record aircraft position, track, altitude and other flight details for information and/or analysis. (Range and performance dependent on power output of TABS and EC devices.)	Operating companies, related business and training organisations, flying clubs, relatives and other observers view and/or record aircraft position, track, altitude and other flight details for information and/or analysis. (Range and performance dependent on power output of TABS and EC devices.)

Appendix B

Comparison of technical and performance differences between the various ADS-B options

For the technically minded, the Table B.1 provides more detail about the technical and performance differences between the different options for ADS-B OUT equipment:

Table B.1: ADS-B OUT equipment: Technical and performance differences

Standard	IFR standard GNSS position source + Mode S Transponder	TABS position source + Mode S Transponder +	Integrated TABS device	EC device
Trade-offs	**Best performance/ Highest cost**	**Good performance/ Higher cost**	**Medium performance/ Medium cost**	**Lowest performance/ Lowest cost**
Transponder modal interactions	Transponder replies to interrogation	Transponder replies to interrogation	Transponder replies to some interrogations (not to ATC radar)	No transponder function
Transponder downlink format	Transponder transmits DF17[15]	Transponder transmits DF17	Transmits DF17	Device transmits DF18 only
Transmission power	>125W	>125W	70W (reduced range performance)	≤ 40W (further reduced range performance)
Visible to ATC radar?	Yes	Yes	Unlikely	No
Visible to ATC ADS-B	Yes	Yes – Situational awareness only if SIL=1 Yes – Full capability if SIL≥2	Yes – Situational awareness only (SIL=1)	Yes – Situational awareness only (SIL=1)
Visible to ADS-B certified in?	Yes	Yes	Yes	Yes
Visible to Uncertified ADS-B IN products?	Probably	Probably	Probably	Probably
Visible to drone Sense and Avoid	Yes	Yes	Yes	Yes

[15] DF means Downlink Format

Standard	IFR standard GNSS position source + Mode S Transponder	TABS position source + Mode S Transponder +	Integrated TABS device	EC device
Visible to TCAS	Yes	Yes	Yes	No
Can the product be installed in aircraft with Mode A/C transponder?	No	No	No because TABS replies to interrogations	Yes
Can the product be installed in aircraft with Mode S transponder?	Not applicable	Not applicable	Yes, but probably not a logical configuration. If aircraft has a Mode S transponder, fitting a Class B TABS position source would be better than installing a full integrated TABS.	Yes, but only if the Mode S transponder is not outputting ADS-B position.
Purpose	Ultimate performance	Visibility to ADS-B IN aircraft. Visibility to TCAS. Some visibility to ATC radar and ADS-B.	Visibility to other aircraft. Visibility to TCAS. Visibility to ATC ADS-B coverage.	Visibility to ADS-B IN aircraft. Limited visibility to ATC ADS-B.