



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C166

Effective
Date:

Proposed Technical Standard Order

Subject: TSO-C166, 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)

1. **PURPOSE.** This Technical Standard Order (TSO) tells manufacturers of 1090 MHz ADS-B and TIS-B equipment what minimum performance standards (MPS) their equipment must first meet in order to obtain approval and be identified with the applicable TSO marking.
2. **APPLICABILITY.** This TSO is effective for new applications submitted after the effective date of this TSO. Major design changes to 1090 MHz ADS-B and TIS-B equipment approved under this TSO require a new authorization per Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).
3. **REQUIREMENTS.** New models of 1090 MHz ADS-B and TIS-B equipment that are to be so identified and that are manufactured on or after the effective date of this TSO must meet the MPS in Section 2 of RTCA, Inc. Document No. (RTCA/DO)-260A, “Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Services - Broadcast (TIS-B),” dated April 10, 2003, with the exception detailed in item **3a(3)** below. The 1090 MHz equipment classes applicable to this TSO are defined in Section 2.1.11 of RTCA/DO-260A.
 - a. **Functionality.**
 - (1) The standards of this TSO apply to aircraft equipment intended to transmit or receive broadcast messages about an aircraft’s position (latitude and longitude), velocity, time, integrity, and other parameters. Similarly equipped operators will share these messages with one another; ground-based facilities, such as air traffic services, will also share this information. These message parameters form the basis for various ADS-B and TIS-B reports.

DISTRIBUTION: ZVS-326;A-W(IR)-3;A-X(FS)-3;A-X(CD)-4;
A-FFS-1,2,7,8(LTD);A-FAC-0(MAX);AVN-1 (2 cys)

(2) This TSO supports two major classes of 1090 MHz ADS-B and TIS-B equipment: Class A equipment, which combines a transmit and a receive subsystem; and Class B equipment, which supports transmit subsystems only.

(a) **Class A equipment** includes Classes A0, A1, A2 and A3.

(b) **Class B equipment** includes Classes B0 and B1. Classes B2 and B3 are not for aircraft use. Classes B0 and B1 are the same as A0 and A1, except they do not have receive subsystems.

(3) An exception is taken to the allowed use of two of the parameters included in the “Target State and Status” message (RTCA/DO-260A, section 2.2.3.2.7.1). Inconsistencies have been identified with how existing onboard data sources represent the data associated with the “Vertical Mode Indicator” (RTCA/DO-260A, section 2.2.3.2.7.1.3.5) and “Horizontal Mode Indicator” (RTCA/DO-260A, section 2.2.3.2.7.1.3.10) parameters. Until these inconsistencies are resolved through a future update to the MOPS (RTCA/DO-260A), these two parameters must be encoded as all zeros, indicating “Unknown Mode or Information Unavailable.”

b. Use of ADS-B Reports in Airborne Applications. This TSO addresses only broadcasting messages from transmit subsystems and assembling reports in receiver subsystems. The MPS of this TSO do not address applications that use the information in reports. Manufacturers of 1090 MHz ADS-B and TIS-B equipment must seek design approval for applications. They can get design approval by complying with an appropriate TSO for the subject application or, during installation approval, through the type certification process (in other words, Type Certificate, Supplemental Type Certificate, and so on). In the latter case, 1090 MHz ADS-B and TIS-B equipment approved under this TSO may require installation limitations. These limitations should draw attention to those applications that must be validated as part of the installation approval process.

NOTE: Find industry-recommended practices on how to display ADS-B and TIS-B report information in the following documents:

- RTCA/DO-243, “Guidance for Initial Implementation of Cockpit Display of Traffic Information,” dated February 19, 1998;
- RTCA/DO-249, “Development and Implementation Planning Guide for Automatic Dependant Surveillance Broadcast (ADS-B) Applications,” dated October 6, 1999;
- RTCA/DO-259, “Application Descriptions for Initial Cockpit Display of Traffic Information (CDTI) Applications,” dated September 13, 2000; and
- SAE Aerospace Recommended Practice, “Human Interface Criteria for Cockpit Display of Traffic Information,” ARP5365, dated January 1999.

c. Failure Condition Classification. Failure of the function defined in paragraphs 3 and 3a of this TSO will depend on the equipment’s intended use for the ADS-B and TIS-B report

information. For the least demanding uses, the failure condition classifications for the different classes of 1090 MHz equipment are as follows:

(1) For Class A0 receiver subsystems, an unannounced failure that provides onboard applications with incorrect reports is considered a minor failure condition. A minor failure condition should occur no more than once per 10^3 flight hours.

(2) For all other classes of 1090 MHz ADS-B and TIS-B receiver subsystems, an unannounced failure that provides onboard applications with incorrect reports is considered a major failure condition. A major failure condition should occur no more than once per 10^5 flight hours.

(3) For all classes of 1090 MHz ADS-B transmitter subsystems, an unannounced failure that broadcasts incorrect ADS-B messages to users is considered a major failure condition. An unannounced failure resulting in loss of function is considered minor.

NOTE: The above failure condition classifications are driven by airspace considerations and are therefore independent of the aircraft on which the equipment is to be installed..

(4) To meet at least a design assurance level equal to a minor failure condition, manufacturers must develop software to RTCA/DO-178B, Level D. For a major failure condition, they must develop software to RTCA/DO-178B, Level C.

(5) A manufacturer may develop equipment to a higher design assurance level in anticipation of more demanding applications. For example, if the 1090 MHz ADS-B equipment is capable of broadcasting messages that include information about the status of own-ship Traffic Alert and Collision Avoidance System (TCAS), and this information could be used by other aircraft to make decisions about maneuvering, the failure condition classification for erroneous data of this type could be hazardous/severe-major. Manufacturers should state, and include in the operating instructions and equipment limitations, the hardware and software design assurance levels to which they developed the equipment.

(6) Manufacturers must also state – and include in the operating instructions and equipment limitations – any assumptions about the aircraft installation, software and hardware used in the interface, or procedures required to maintain the design assurance levels.

d. Functional Qualification. The required performance shall be demonstrated under the test conditions specified in RTCA/DO-260A, Section 2.4.

e. Environmental Qualification. The equipment shall be subjected to the test conditions in RTCA/DO-160D, “Environmental Conditions and Test Procedures for Airborne Equipment,” dated July 29, 1997. Their means for verifying equipment performance must be consistent with the test procedures specified in RTCA/DO-260A, Section 2.3.

f. Software Qualification. If the article includes a digital computer, the software must be developed in accordance with RTCA/DO-178B, “Software Considerations in Airborne Systems and Equipment Certification,” dated December 1, 1992.

g. Deviations. The FAA has provisions for using alternative or equivalent means of compliance to the criteria in the MPS of this TSO. Applicants invoking these provisions shall demonstrate that an equivalent level of safety is maintained and shall apply for a deviation per 14 CFR § 21.609.

4. MARKING. Under 14 CFR § 21.607(d), articles manufactured under this TSO must mark as follows:

a. They must permanently and legibly mark at least one major component with all of the information listed in 14 CFR § 21.607(d).

b. In addition to the requirements of 14 CFR § 21.607(d), they must permanently and legibly mark with at least the name of the manufacturer, manufacturer’s subassembly part number, and the TSO number: each separate component that is easily removable (without hand tools), each interchangeable element, and each separate sub-assembly of the article that the manufacturer determines may be interchangeable.

c. They must permanently and legibly mark transmitting and receiving components. The following table explains how to mark components. Find the equipment class in Section 2.1.11 of RTCA/DO-260A, and the receiving equipment type in Section 2.2.6 of RTCA/DO-260A.

If component can:	Mark it with:	Sample marking pattern:
Transmit and receive	<ul style="list-style-type: none"> • Equipment class it supports, and • Receiving equipment type 	Class A0/Type 1
Transmit, but not receive	Equipment class it supports	<ul style="list-style-type: none"> • Class B1, or • Class A3-Transmitting Only
Receive, but not transmit	<ul style="list-style-type: none"> • Equipment class it supports, and • Receiving equipment type 	Class A2/Type 2-Receiving Only

d. If the component includes a digital computer, the part number must include hardware and software identification. Or, manufacturers can use a separate part number for hardware and software. Either approach must include a means for showing the modification status. Note they must differentiate similar software versions, approved to different software levels, by part number.

e. When applicable, manufacturers must identify the component or equipment as a partial system or that the appliance does anything beyond the functions in paragraphs **3** and **3a** of this TSO.

5. DATA REQUIREMENTS.

a. **Application Data.** Under 14 CFR § 21.605(a)(2), the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), FAA, responsible for the manufacturer's facilities, one copy each of the following technical data to support the FAA design and production approval:

(1) Operating instructions and equipment limitations. The limitations must sufficiently describe the operational capability of the equipment. In particular, manufacturers must describe in detail operational or installation limitations that result from specific deviations granted.

(2) Installation procedures and limitations. The limitations must sufficiently ensure the 1090 MHz ADS-B and TIS-B equipment, when installed per the installation procedures, continues to meet the requirements of this TSO. The limitations must identify any unique aspects of the installation. For non-transponder-based 1090 MHz ADS-B equipment, manufacturers must include a limitation that the equipment can not be coinstalled in aircraft with a Mode-S transponder (RTCA/DO-260A section 3.0). Finally, the limitations also must include a note with the following statement:

The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those installing this article, either on or within a specific type or class of aircraft to must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only if performed under 14 CFR Part 43 or the applicable airworthiness requirements.

(3) Schematic drawings, as applicable to the installation procedures.

(4) Wiring diagrams, as applicable to the installation procedures.

(5) List of the components, by part number, that make up the 1090 MHz ADS-B and TIS-B system complying with the standards in this TSO. Manufacturers should include vendor part number cross-references, when applicable.

(6) Instructions, in the form of an Installation Manual (IM) and/or Component Maintenance Manual (CMM), as appropriate, containing information on the periodic maintenance, calibration, and repair for the continued airworthiness of the installed 1090 MHz ADS-B and TIS-B equipment. In the IM or CMM, manufacturers should also describe details of deviations granted, as noted in paragraph **5a(1)** of this TSO.

(7) Material and process specifications list.

(8) The quality control system description required by 14 CFR §§ 21.605(a)(3) and 21.143(a), including functional test specifications for testing each production article to ensure compliance with this TSO.

(9) Manufacturer's TSO qualification test report.

(10) Nameplate drawing giving the information required by paragraph 4 of this TSO.

(11) A list of all drawings and processes, including revision level, necessary to define the article's design. For minor changes, manufacturers only need to provide these revisions to the drawing list on request by the ACO.

(12) An environmental qualifications form as described in RTCA/DO-160D for each component of the system.

(13) If the article includes a digital computer: Plan for Software Aspects of Certification (PSAC); Software Configuration Index; and Software Accomplishment Summary. We recommend that manufacturers submit the PSAC early in the software development process. Early submittal will allow us to quickly resolve issues, such as partitioning and determination of software levels.

b. Manufacturer Data. In addition to the data to be furnished directly to the FAA, each manufacturer must have available for review by the manager of the ACO responsible for the manufacturer's facilities the following technical data:

(1) The functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

(2) Equipment calibration procedures.

(3) Corrective maintenance procedures within 12 months after TSO authorization.

(4) Schematic drawings.

(5) Wiring diagrams.

(6) Material and process specifications.

(7) The results of the environmental qualification tests conducted per RTCA/DO-160D and RTCA/DO-260A, Section 2.3.

(8) If the article includes a digital computer, the appropriate documentation as defined in RTCA/DO-178B, including all data supporting the applicable objectives in Annex A of RTCA/DO-178B, "Process Objectives and Outputs by Software Level".

c. Furnished Data.

(1) One copy of the technical data and information specified in paragraphs **5a(1)** through **(6)** and **5a(12)** of this TSO and any other data or information necessary for the proper installation, certification and use, or for continued airworthiness of the 1090 MHz ADS-B and TIS-B equipment, must accompany each article manufactured under this TSO.

(2) If the appliance accomplishes any additional functions beyond that described in paragraphs **3** and **3a** of this TSO, then a copy of the data and information specified in paragraphs **5a(11)** and **(13)**, for those additional functions, must also go to each person receiving for use one or more articles manufactured under this TSO.

6. AVAILABILITY OF REFERENCED DOCUMENTS.

a. You can buy copies of RTCA Document Nos. DO-160D, DO-178B, DO-243, DO-249, DO-259, and DO-260A from RTCA, Inc., 1828 L Street, N.W., Suite 805, Washington, D.C. 20036; telephone (202) 833-9339, fax (202) 833-9434. You can also obtain copies through the RTCA Internet website @ www.rtca.org.

b. You can buy copies of SAE Document ARP5365 from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001; telephone (724) 776-4970, fax (724) 776-0790. You can also obtain copies through the SAE Internet website @ www.sae.org.

c. You can buy copies of Federal Aviation Regulations 14 CFR Part 21, Subpart O, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402-9325; telephone (202) 512-1800, fax (202) 512-2250. You can also obtain copies from the Government Printing Office (GPO), electronic CFR Internet website @ www.access.gpo.gov/ecfr/.

d. You can obtain Advisory Circular (AC) 20-110L (or current revision), "Index of Aviation Technical Standard Orders," from the U.S. Department of Transportation, Subsequent Distribution Office, DOT Warehouse, M30, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785; telephone (301) 322-5377 or fax (301) 386-5394. You can also obtain copies on the Internet from the FAA's Regulatory and Guidance Library (RGL) @ www.airweb.faa.gov/rgl. On the RGL website, click on "Advisory Circulars." Then, click on "By Number."

David W. Hempe
Manager, Aircraft Engineering Division
Aircraft Certification Service