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

TSO-C154b

Effective
Date: 12/21/06

Technical Standard Order

Subject: Universal Access Transceiver (UAT) Automatic Dependent Surveillance - Broadcast (ADS-B) Equipment Operating on the Frequency of 978 MHz

1. PURPOSE. This Technical Standard Order (TSO) is for manufacturers of Universal Access Transceiver ADS-B equipment and/or UAT Diplexers that are seeking a TSO authorization or letter of design approval. In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your Universal Access Transceiver ADS-B equipment or UAT Diplexer must meet for approval and identification with the applicable TSO marking.

2. APPLICABILITY. This TSO affects new applications submitted after this TSO's effective date. UAT equipment approved under a previous TSO authorization may continue to be manufactured under the provisions of their original approval, as specified in Title 14 of the Code of Federal Regulations (14 CFR) § 21.603(b). Major design changes to UAT equipment approved under previous versions of this TSO require a new authorization under this TSO. See 14 CFR § 21.611(b). We will not accept new applications under previous versions of this TSO after the effective date of this TSO.

3. REQUIREMENTS. New models of UAT ADS-B equipment or UAT Diplexers identified and manufactured on or after this TSO's effective date must meet the MPS in Section 2 of RTCA Document No. (RTCA/DO)-282A, Minimum Operational Performance Standards for Universal Access Transceiver (UAT) Automatic Dependent Surveillance Broadcast (ADS-B), dated July 29, 2004, and Change 1 to DO-282A, dated December 13, 2006. See RTCA/DO-282A, Section 2.1.11 for UAT equipment classes applicable to this TSO**.**

a. Functionality.

(1) The standards of this TSO apply to aircraft equipment intended to transmit or receive broadcast messages containing an aircraft's position (latitude and longitude), position integrity, velocity, and other parameters. Similarly UAT-equipped operators will share these messages with one another and ground-based facilities, such as air traffic services. These message parameters form the basis for various ADS-B reports. See RTCA/DO-242A, Section 3.4, for more information on ADS-B reports.

(2) This TSO supports two major classes of UAT ADS-B equipment: Class A equipment, consisting of transmit and receive subsystems; and Class B equipment, consisting of a transmit subsystem only.

(a) Class A equipment includes Classes A0, A1L, A1H, A2, and A3 as defined in RTCA/DO-282A, Section 2.1.11. We require UAT airborne Class A equipment to transmit and receive ADS-B messages, and deliver ADS-B reports to onboard applications. Class A equipment must also support the reception of the Flight Information Services - Broadcast (FIS-B) during the Ground Uplink segment of the UAT message frame. Data formats for FIS-B uplink services may be found in RTCA/DO-267A.

(b) Class B equipment includes Classes B0 and B1 as defined in RTCA/DO-282A, Section 2.1.11, have the same transmitter characteristics and payload capability as Classes A0 and A1H, respectively, except they do not have receive subsystems. Note, Classes B2 and B3 are not for aircraft use.

(3) The standards of this TSO also support an optional frequency Diplexer. The Diplexer allows the ATCRBS/Mode S Transponder and the UAT equipment developed under this TSO to share antennas.

b. Use of ADS-B Reports in Airborne Applications. This TSO addresses only broadcast 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.

(1) As a manufacturer of UAT ADS-B equipment, you must seek design approval for applications. You may do this by complying with an appropriate TSO for the subject application or, during installation approval, through the type certification or supplemental type certification process. During the certification process, UAT ADS-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.

(2) For industry-recommended practices on how to display UAT ADS-B information, see the guidance in the documents listed below:

- 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 (ARP) 5365, Human Interface Criteria for Cockpit Display of Traffic Information, dated January 1999.

c. Failure Condition Classification. Failure of the function defined in paragraphs **3** and **3a** of this TSO depends on the equipment's intended use. For the least demanding uses, the failure condition classifications for the different classes of UAT equipment are as follows:

(1) For Class A0 UAT receiver subsystems, we consider an un-annunciated failure providing onboard applications with incorrect reports 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 UAT receiver subsystems, we consider an un-annunciated failure that provides onboard applications with incorrect reports, a major failure condition. A major failure condition should occur no more than once per 10^5 flight hours.

(3) For all classes of UAT transmitter subsystems, we consider an un-annunciated failure broadcasting incorrect ADS-B messages, as a major failure condition. Where as, an un-annunciated failure resulting in loss of function, as minor.

> **NOTE:** The above failure condition classifications are driven by airspace considerations, and are 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, develop software to Level D requirements as defined in RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, dated December 1, 1992. For major failure condition, develop software to Level C requirements as defined in RTCA/DO-178B.

(5) You may develop equipment to a higher design assurance level in anticipation of more demanding applications. For example, the failure condition could be hazardous/severe-major, if the UAT equipment broadcasts erroneous messages about the status of "own-ship" Traffic Alert and Collision Avoidance System (TCAS), and other aircraft use this information to make maneuvering decisions. You should include in the operating instructions and equipment limitations, the hardware and software design assurance levels to which you developed the equipment.

(6) The optional UAT Diplexer is a mechanical device with no active components. If you follow the MPS of this TSO, you should manufacture a device whose probability of undetected failure is the same as that of the aircraft's antenna cable/connectors or a coaxial bulkhead feed-through. However, in the total cable loss budget of the aircraft's antenna system, consider the maximum amplitude attenuation of the UAT Diplexer. Include the following limitation in the installation procedures:

> The cable attenuation allowance between the ATCRBS/Mode S transponder output and the antenna input is typically 3.0 dB. It is the responsibility of the installer to ensure the insertion of the UAT Diplexer does not cause this budget to be exceeded.

(7) You must also include in the operating instructions and equipment limitations, all design assumptions pertaining to the aircraft installation, software and hardware used in the interface, or procedures required for maintaining the design assurance levels.

d. Functional Qualification. Show the required performance of the equipment defined in paragraphs **3** and **3a** of this TSO under the test conditions in RTCA/DO-282A, Section 2.4.

e. Environmental Qualification. Test the equipment to the conditions in RTCA/DO-160E, Environmental Conditions and Test Procedures for Airborne Equipment, dated December 9, 2004. The means for verifying equipment performance under varying environmental conditions must be consistent with the test procedures in RTCA/DO-282A, Section 2.3.

f. Software Qualification. If the equipment includes software, develop the software following the requirements in RTCA/DO-178B.

g. Deviations. We provide for alternative or equivalent means of compliance to the MPS of this TSO. If you use these provisions, show that an equivalent level of safety is maintained and apply for a deviation per 14 CFR § 21.609.

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

a. At least one major component must be permanently and legibly marked with all information listed in 14 CFR § 21.607(d).

b. Besides the requirements of paragraph **4a** of this TSO, the following table explains component-specific marking patterns. Find the equipment class in RTCA/DO-282A, Section 2.1.11.

If component:	Mark it with:	Sample marking pattern:
Transmits and receives	Equipment class it supports	Class A0 or Class A3
Transmits, but does not receive	Equipment class it supports	Class B0 or Class B1
Receives, but does not transmit	Equipment class it supports	Class A2 - Receive Only
The optional frequency Diplexer developed under this TSO	• The words "UAT Diplexer" • Maximum amplitude attenuation between the antenna port (A) and UAT port (U) of the Diplexer, and • Maximum amplitude attenuation between the antenna port (A) and transponder port (T) of the Diplexer	UAT Diplexer A/U -0.x dB A/T -0.x dB

c. Also, mark the following permanently and legibly, with at least the name of the manufacturer, manufacturer's subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools);

(2) Each interchangeable element; and

(3) Each subassembly of the article that you determined may be interchangeable.

d. If the component includes software, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means for showing the modification status.

> **NOTE:** Similar software versions, approved to different software levels, must be differentiated by part number.

e. When applicable, identify the component or equipment as a partial system or state the appliance performs functions beyond those described in paragraphs **3** and **3a** of this TSO.

5. APPLICATION DATA REQUIREMENTS. Under 14 CFR § 21.605(a)(2), you as the manufacturer must send the Aircraft Certification Office (ACO) manager, responsible for your facility, one copy of the following technical data to support the FAA design and production approval:

a. Operating instructions and equipment limitations, sufficient to describe the operational capability of the equipment. In particular, you must describe in detail operational or installation limitations that result from specific deviations granted.

b. Installation procedures and limitations that sufficiently ensure the UAT ADS-B equipment or the UAT Diplexer, when installed per the installation procedures, continues to meet the requirements of this TSO. The limitations must identify any unique aspects of the installation. 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. Those installing this article on or in a specific type or class of aircraft 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.

c. If you build a Receive Only class of UAT equipment (see paragraph **4b** of this TSO), you must also include the following statement in the installation limitations:

> Installation of this Receive Only class of equipment is intended for those aircraft in which a UAT ADS-B transmit class of equipment, or other complementary ADS-B link transmit class of equipment (for example, 1090 MHz Extended Squitter ADS-B), is already installed.

d. Schematic drawings, as applicable to the installation procedures.

e. Wiring diagrams, as applicable to the installation procedures.

f. List of the components, by part number, that make up the UAT ADS-B equipment or UAT Diplexer complying with the standards in this TSO. You should include vendor part number cross-references, when applicable.

g. Instructions covering periodic maintenance, calibration, repair, and continued airworthiness of the installed UAT ADS-B equipment or UAT Diplexer. The instructions should also describe details of deviations granted, as noted in paragraph **5a** of this TSO.

h. Material and process specifications list.

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

j. Manufacturer's TSO qualification test report on the results of the testing required by paragraph **3d**.

k. Nameplate drawing giving the information required by paragraph **4** of this TSO.

l. A list of all drawings and processes, including revision level, necessary to define the article's design. For minor changes, follow the directions in 14 CFR § 21.611(a).

m. An environmental qualification form as described in RTCA/DO-160E, Appendix A, for each component developed under this TSO.

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

6. MANUFACTURER DATA REQUREMENTS. Besides the data given directly to the FAA, you must have the following technical data available for review by the responsible ACO:

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

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after TSO authorization.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications. The results of the environmental qualification tests conducted per RTCA/DO-160E and RTCA/DO-282A, Section 2.3.

g. If the article includes software, the appropriate documentation as defined in RTCA/DO-178B, including all data supporting the applicable objectives in RTCA/DO-178B, Annex A, Process Objectives and Outputs by Software Level.

7. FURNISHED DATA REQUIREMENTS. If sending one or more articles to one source (such as an operator or repair station), provide the following for each article manufactured under this TSO:

a. One copy of the data in paragraphs **5a** through **5g** and **5m** of this TSO. Add any other data needed for the proper operation, storage, or continued airworthiness of the UAT ADS-B equipment or UAT Diplexer.

b. One copy of the data in paragraphs **5l** and **5n** of this TSO, if the appliance performs functions beyond those described in paragraphs **3** and **3a** of this TSO.

8. HOW TO GET REFERENCED DOCUMENTS.

a. You can buy copies of RTCA documents referenced in this TSO 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 get copies through the RTCA Internet website at www.rtca.org.

b. You can buy copies of SAE documents referenced in this TSO from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001; telephone (724) 776-4970, fax (724) 776-0790. You can also get copies through the SAE Internet website at www.sae.org.

c. You can buy copies of 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 get copies from the Government Printing Office (GPO), electronic CFR Internet website at www.gpoaccess.gov/ecfr.

d. You can get 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, fax (301) 386-5394. You can also get copies on the Internet from the FAA's Regulatory and Guidance Library (RGL) at http://rgl.faa.gov. On the RGL website, click on "Advisory Circulars."

Susan J. M. Cabler
Acting Manager, Aircraft Engineering Division
Aircraft Certification Service