



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

TSO-C112c

Effective
Date: 12/18/08

Technical Standard Order

Subject: AIR TRAFFIC CONTROL RADAR BEACON SYSTEM/MODE SELECT (ATCRBS/MODE S) AIRBORNE EQUIPMENT

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your air traffic control radar beacon system/Mode select (ATCRBS/Mode S) equipment must first meet for approval and identification with the applicable TSO marking. See Appendix 1 for revision level explanation.

2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.

a. All prior revisions to this TSO are no longer effective. Generally we will not accept applications after the effective date of this TSO. However, we may do so up to six months after it, if we know that you were working against the earlier MPS before the new change became effective.

b. ATCRBS/Mode S equipment approved under a previous TSOA may still be manufactured under the provisions of their original approval.

c. Major design changes to ATCRBS/Mode S equipment approved under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

3. **REQUIREMENTS.** New models of ATCRBS/Mode S equipment identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in RTCA, Inc. document RTCA/DO-181D, *Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment*, dated October 2, 2008, Section 2, and Appendix 2 of this TSO. If the ATCRBS/Mode S airborne equipment includes non-TSO function(s), it must meet the manufacturer's specified performance and test requirements for the non-TSO function (see paragraph 5o). A non-TSO function is any function that is not covered by a TSO-approved

minimum performance standard (MPS) and does not support the hosting article's TSO function(s).

NOTE: If you plan to add non-TSO functionality into the hosting TSO article, you should coordinate this with the responsible ACO well in advance of your TSO application to avoid potential delays to your project.

a. Functionality. This TSO's standards apply to equipment intended to be used in aircraft to provide responses to air traffic control (ATC) ground-based secondary surveillance radar (SSR) and traffic and collision avoidance systems (TCAS) interrogations. The ATCRBS/Mode S equipment may also support additional features as shown in RTCA/DO-181D, Section 1.4.4.

b. Failure Condition Classification. Failure of the function defined in paragraph 3a of this TSO is a major failure condition. Develop the ATCRBS/Mode S equipment to at least the design assurance level equal to this failure condition classification.

c. Functional Qualification. Demonstrate the required performance under the test conditions specified in RTCA/DO-181D, Sections 2.4 and 2.5.

d. Environmental Qualification. Test the equipment according to RTCA/DO-160F, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 6, 2007, using the test conditions specified in RTCA/DO-181D, Section 2.3.

e. Software Qualification. If the article includes a digital computer, develop the software according to RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992. The software design assurance level should be consistent with the failure condition classification defined in paragraph 3b of this TSO.

f. Electronic Hardware Qualification. If the article includes a complex custom micro-coded component, develop the component to the guidance in FAA Advisory Circular (AC) 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware*. The hardware design assurance level should be consistent with the failure condition classification defined in paragraph 3b of this TSO.

g. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609 before submitting your data package.

4. **MARKING.**

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d), except for the following:

(1) Use serial number in place of optional date of manufacture as stated in 14 CFR § 21.607(d)(3)

(2) Label the transponder's functional level, minimum peak output power, and optional additional features in accordance with RTCA/DO-181D, Section 1.4.6.

b. Also, mark the following permanently and legibly, with at least the manufacturer's name, 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.

c. If the component includes a digital computer, 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 to show the modification status.

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

d. Consider identifying deviations granted to the article by marking "Deviation. See installation/instruction manual (IM)" after the TSO number. You can abbreviate the marking to "(Dev. See IM)."

e. When applicable, identify the equipment as an incomplete system or state that the article performs functions beyond those described in paragraph 3a of this TSO.

5. APPLICATION DATA REQUIREMENTS. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified 14 CFR § 21.605(a)(1) and one copy each of the following technical data to support your design and production approval. (Under 14 CFR § 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Operating instructions and equipment limitations in an IM, sufficient to describe the equipment's operational capability. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, and criticality level of software/hardware, classification for use, and environmental categories.

b. Installation procedures and limitations in an IM, sufficient to ensure that the ATCRBS/Mode S equipment, when installed according to the installation procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

The conditions and tests 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 according to 14 CFR part 43 or the applicable airworthiness requirements.

- c. Schematic drawings of the installation procedures.
- d. Wiring diagrams of the installation procedures.
- e. List of components, by part number, that make up the ATCRBS/Mode S equipment complying with the standards prescribed under this TSO. Include vendor part number cross-references, when applicable.
- f. A component maintenance manual (CMM), or IM as appropriate, covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed ATCRBS/Mode S equipment. Instructions should include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph 5a of this TSO.
- g. Material and process specifications list.
- h. The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3), including functional test specifications. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject the item accordingly. (Not required for LODA applicants.)
- i. Manufacturer's TSO qualification test report.
- j. Nameplate drawing with the information required by paragraph 4 of this TSO.
- k. List of all drawings and processes (including revision level) that define the article's design. For a minor change, follow the directions in 14 CFR § 21.611(a). Show any revisions to the drawing list only on our request.
- l. An environmental qualifications form as described in RTCA/DO-160F, Appendix A, for each component developed under this TSO.
- m. If the article includes a digital computer: a 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 allows us to quickly resolve issues, such as partitioning and determining software levels.

n. If the article includes a complex custom micro-coded component: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing; and hardware accomplishment summary. We recommend that you submit the PHAC early in the hardware development process. Early submittal allows us to quickly resolve issues.

o. If the article contains non-TSO function(s), provide the following additional information.

(1) A description of the non-TSO function(s), including key performance specifications, as well as software, hardware, environmental, and other qualification levels.

(2) Interface requirements for the non-TSO function(s) and applicable installation test procedures.

(3) Installation and operating instructions/limitations for the non-TSO function(s).

(4) Instructions for continuing airworthiness applicable to the non-TSO function(s).

(5) Results of test/analysis, as appropriate, to verify that the hosting TSO's performance is not affected by the non-TSO function(s).

6. **MANUFACTURER DATA REQUIREMENTS.** Besides the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

a. 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 TSOA or LODA.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. The results of the environmental qualification tests conducted per 3d of this TSO.

h. If the article includes a digital computer, the appropriate documentation 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.

i. If the article includes a complex micro-coded component, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1.

j. If the article contains non-TSO function(s), the manufacturer must also make available items 6a through 6i as it pertains to the non-TSO function(s).

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

a. One copy of the data in paragraphs 5a through 5f, and 5l of this TSO. Add any other data needed for the proper installation, certification, use, or for continued airworthiness, of the ATCRBS/Mode S equipment.

b. If the article contains non-TSO function(s), also include one copy of the data in paragraphs 5o(1) through (4).

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036. Telephone (202) 833-9339, fax (202) 833-9434. You can also order copies online at www.rtca.org.

b. Order copies of 14 CFR part 21, Subpart O and part 25, from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis, MO 63197. For general information telephone (202) 512-1800 or fax (202) 512-2250. You can also order copies online at www.access.gpo.gov. Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

c. You can find a current list of technical standard orders and advisory circulars on the FAA Internet website Regulatory and Guidance Library at rgl.faa.gov. You will also find the TSO Index of Articles at the same site.



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Appendix 1. TSO Revision Letter Sequencing

1.1 TSO-C112 has not been revised since it was issued on February 5, 1986. However, its European Aviation Safety Agency (EASA) counterpart, ETSO-2C112b, is in its second revision.

1.2 In November 2005 the FAA asked RTCA Inc. to revise RTCA document RTCA/DO-181C (the MPS for ATCRBS/Mode S equipment) to the latest International Civil Aviation Organization (ICAO) Annex 10 Amendment requirements for Mode S transponders. Further, we asked RTCA to harmonize the revision with the EUROCAE Working Group (WG) 49 revision to EUROCAE document (ED) 73B. As a result, the MPS in RTCA/DO-181D and ED-73C are now technically equivalent.

1.3 Therefore TSO-C112 will skip revision levels “a” and “b” to align its revision level with its counterpart ETSO-C112c (when ETSO-C112c is issued by EASA).

1.4 With this alignment, the number “2” in front of the “C” in the previous EASA ETSO designation (such as “ETSO-2C112b”) will be removed, indicating that there are no technical differences between the two technical standard orders.

Appendix 2. Additional Requirements

2.1 Optional Extended Squitter Inhibit

There is no requirement in this TSO to include a control to allow pilot entry to inhibit the transmission of Extended Squitters if Extended Squitter capability is supported as per RTCA/DO-181D, *Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment*, dated October 2, 2008, Section 2.2.23. However, if a pilot entry to inhibit Extended Squitter is provided, the requirements of Section 2.2 of RTCA DO-181D apply, including the loading and servicing of the Extended Squitter related ground initiated Comm-B registers identified in Section 2.2.23, but with the following exceptions:

- 2.1.1 The RF transmission of Extended Squitter messages is disabled when Extended Squitters are inhibited by pilot entry, consistent with the power limit requirements of Section 2.2.3.3 of DO-181D.
- 2.1.2 The transponder is not considered failed, as per Section 2.2.10.2 of DO-181D, when Extended Squitters are not transmitted as a result of Extended Squitter being inhibited by pilot entry.
- 2.1.3 For the purposes of determining whether to transmit the acquisition squitter as per Section 2.2.18.2.6 of DO-181D, acquisition squitters are always transmitted when Extended Squitters are inhibited by pilot entry.

Additionally, appropriate test procedures must be included to demonstrate that the above requirements are met.