



Technical Standard Order

**Subject: TSO-C169, VHF RADIO COMMUNICATIONS TRANSCEIVER
EQUIPMENT OPERATING WITHIN THE RADIO FREQUENCY RANGE
117.975 TO 137.000 MEGAHERTZ**

1. PURPOSE. This Technical Standard Order (TSO) tells persons seeking a TSO authorization or letter of design approval what minimum performance standards (MPS) their Very High Frequency (VHF) communications transceiver (transmitter/receiver) equipment must first meet in order to obtain approval and be identified with the applicable TSO marking. Title 14 of the Code of Federal Regulations (14 CFR) part 21, Subpart O, prescribes the requirements and rules governing TSO Authorizations. This TSO combines the requirements of TSO-C37d, VHF Radio Communications Transmitting Equipment Operating within the Radio Frequency Range 117.975 – 136.000 Megahertz and TSO-C38d, VHF Radio Communications Receiving Equipment Operating within the Radio Frequency Range 117.975 – 136.000 Megahertz, as well as updates the requirements to include 8.33 Kilohertz (kHz) channel spacing capability.

2. APPLICABILITY.

a. This TSO is effective for new applications submitted after the effective date of this TSO. All prior revisions to TSO-C37 and TSO-C38 are no longer effective, and, in general, applications will not be accepted after the effective date of this TSO. However, applications submitted against the previous versions of TSO-C37 and TSO-C38 may be accepted up to six months after the effective date of this TSO, if we know that you were working against the earlier MPS before the new change became effective.

b. VHF communications equipment approved under a previous TSO authorization may continue to be manufactured under the provisions of their original approval, as specified in 14 CFR § 21.603(b). However, major design changes to VHF communications equipment approved under the previous versions of TSO-C37 or TSO-C38 requires a new authorization under this TSO, per 14 CFR § 21.611(b).

3. REQUIREMENTS.

a. Operational Requirements.

(1) New models of VHF communications transceiver equipment that are to be so identified and that are manufactured on or after the effective date of this TSO must meet the

minimum performance standards set forth in RTCA Document No. (RTCA)/DO-186A, “Minimum Operational Performance Standards For Airborne Radio Communications Equipment Operating Within The Radio Frequency Range 117.975-137.000 MHz,” dated October 20, 1995, including Change 1 dated September 29, 1998 and Change 2 dated March 5, 2002, Section 2.

(2) The MPS referenced herein allow for different equipment classes as defined by RTCA/DO-186A, Section 2.1.8. There are seven applicable equipment classes as summarized in Table 1.

Table 1: Equipment Class for VHF Communication Equipment

Equipment Class	Description
C	Receiver used in a 25 kHz channel separation environment having offset carrier operation
D	Receiver used in a 25 kHz channel separation environment not having offset carrier operation
E	Receiver used in an 8.33 kHz channel separation environment not having offset carrier operation
3	Transmitter used in a 25 kHz channel separation environment and intended to operate with a range of 200 nautical miles
4	Transmitter used in a 25 kHz channel separation environment and intended to operate with a range of 100 nautical miles
5	Transmitter used in a 8.33 kHz channel separation environment and intended to operate with a range of 200 nautical miles
6	Transmitter used in a 8.33 kHz channel separation environment and intended to operate with a range of 100 nautical miles

(3) In addition to the requirements specified in RTCA/DO-186A, Section 2.2 for Equipment Class C, the following requirement is also applicable to Equipment Class C:

The receiver muting circuits shall operate satisfactorily in the presence of audio heterodynes resulting from the reception of two or more frequencies in a multi-carrier system. Under such conditions the Receiver Sensitivity specified in RTCA/DO-186A, Section 2.2.3, shall not be worse than 24 microvolts (EMF) (-85dBm).

b. Functionality. The standards of this TSO apply to equipment intended for aircraft VHF amplitude modulated (AM) communications operating in the radio frequency range of 117.975 MHz to 137.000 MHz. This includes 25 and 8.33 kHz channel spacing capabilities. The VHF communication equipment covered by this TSO is primarily intended for Aeronautical Operational Control (AOC) and Air Traffic Services (ATS) safety communications. The equipment developed pursuant to this TSO is envisioned to play an integral role with the aircraft equipment used to communicate tactical and strategic information.

c. **Failure Condition Classification.** Failure of the function defined in paragraphs 3 and 3a of this TSO has been determined to be a major failure condition, and the applicant must develop the system to at least the design assurance level commensurate with this failure condition classification.

d. **Functional Qualification.**

(1) The required performance shall be demonstrated under the test conditions in RTCA/DO-186A, Sections 2.6 and 2.7.

(2) In addition to the performance demonstrated under the test conditions specified in paragraph 3.d(1) of this TSO, Equipment Class C performance shall be demonstrated under the following test condition:

Equipment Required

2 Signal Generators
AF Signal Generator
AF Voltmeter
Oscilloscope
Coupling Network

Measurement Procedure

Connect the equipment as shown in Figure 1 of this TSO. Tune Signal Generator A, 30% modulated at 1 kHz, to a frequency +8 kHz above the selected channel frequency, and set to a level just sufficient to open the receiver muting. This level should not be less than 10 microvolts and the AF output must be audible.

Tune Signal generator B, modulated 30% at 1 kHz, slowly from the selected channel frequency -8 kHz to + 4 kHz with an output level of not less than 24 microvolts, and check that the receiver muting remains open.

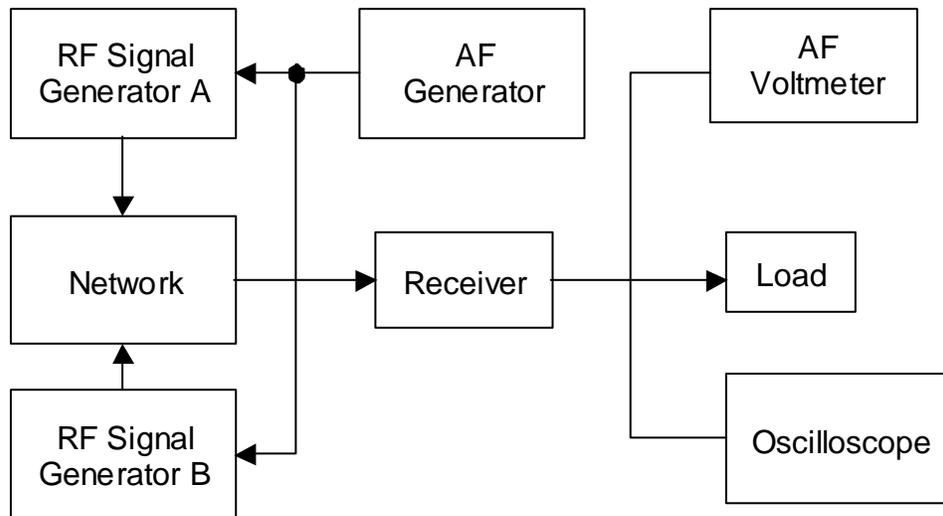


Figure 1

e. Environmental Qualification. The applicable environmental test procedures are in RTCA/DO-160D, “Environmental Conditions and Test Procedures for Airborne Equipment,” dated July 29, 1997, including Change 1, dated December 14, 2000, Change 2, dated June 12, 2001, and Change 3, dated December 5, 2002.

- (1) The applicable environmental performance requirements used during the environmental test procedures are specified in RTCA/DO-186A, Sections 2.4 and 2.5.
- (2) Replace the note in RTCA/DO-186A, Section 2.4.17, with the following text:

Tailor the conducted and radiated RF susceptibility tests in RTCA/DO-160 Section 20 as follows. From 112 MHz to 143 MHz excluding the tuned frequency plus and minus 200 kHz, perform the radiated RF susceptibility tests using a calibrated field strength of 25 millivolts per meter, and perform the conducted RF susceptibility using a calibrated cable bundle current of 40 microamperes. The frequency band of the tuned frequency plus and minus 200 kHz is excluded from this test. Use the calibration and test procedures in RTCA/DO-160 Section 20.4, 20.5, and 20.6 that apply to Category T. For frequencies below 112 MHz and above 143 MHz use a category from RTCA/DO-160, Section 20, appropriate for the intended application of this radio. The tests should be performed with the antenna coaxial cable terminated in a matched load. This exclusion supersedes the exclusion frequencies specified in RTCA/DO-160, Section 20.3.d.

f. Software Qualification. If the article includes software, the software must be developed according to 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 set forth in the minimum performance standards 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 be marked as follows:

a. At least one major component must be permanently and legibly marked with all of the information listed in 14 CFR § 21.607(d), except for the following: the option in 14 CFR § 21.607(d)(2), where the name, type, and part number must be used in lieu of the optional model number; and the option in 14 CFR § 21.607(d)(3), where the date of manufacture must be used in lieu of the optional serial number when that information is critical for maintenance and/or inspections.

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

c. If the component includes a digital computer, the part number must include hardware and software identification. You may also use a separate part number for hardware and software. Either approach must include a means to show the modification status. Note that similar software versions, which have been approved to different software levels, must be differentiated by part number.

d. When applicable, identify the equipment as an incomplete system or that the appliance accomplishes additional functions beyond that described in paragraphs **3** and **3a** of this TSO. Description of additional functions in the installation procedures and limitations of paragraph **5b** of this TSO would qualify as an alternative to marking the component; however, the component must be marked with the drawing number that provides the installation procedures and limitations.

e. Place the additional permanent marking, "(Dev)," after the TSO number if any deviations have been granted. Any deviations that have been granted must be described in the installation procedures and limitations of paragraph **5b** of this TSO. The component must be marked with the drawing that provides the installation procedures and limitations.

f. Equipment Classes must be marked, as defined in RTCA/DO-186A, Section 2.1.8. An example marking which satisfies this requirement is as follows, "Equipment Class: C, E, 3 and 5." Equipment Class markings in the installation procedures and limitations of paragraph **5b** of this TSO would qualify as an alternative to marking the component; however, the component must be marked with the drawing that provides the installation procedures and limitations.

5. APPLICATION DATA REQUIREMENTS. Under 14 CFR 21.605(a)(2), you, as a manufacturer-applicant must give the FAA's Aircraft Certification Office (ACO) manager, responsible for your facilities, one copy each of the following technical data to support our design and production approval:

a. Operating instructions and equipment limitations, sufficient to describe the equipment's operational capability. In particular, operational or installation limitations resulting from specific deviations granted must be described in detail.

b. Installation procedures and limitations. The limitations shall be sufficient to ensure that the article, when installed in accordance with the installation procedures, continues to meet the requirements of this TSO. The limitations shall identify any unique aspects of the installation. Finally, the limitations also shall include the following:

(1) 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 desiring to install this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the TSO standards. The article may be installed only if further evaluation by the applicant, i.e. user/installer, documents an acceptable installation and is approved by the Administrator.

(2) When applicable, identify the equipment as an incomplete system or that the appliance accomplishes additional functions beyond that described in paragraphs 3 and 3a of this TSO, and describe the functions that are intended to be provided by the appliance.

(3) Identify the equipment classes the equipment has been qualified to perform and the functions that are provided by these classes. The description should be written such that an installer of the equipment would know the equipment being installed meets the intentions of the installation.

(4) The hardware and software design assurance requirements may vary dependent upon equipment installation guidelines. The equipment manufacturer should identify in the Installation Manual (IM) and/or Component Maintenance Manual (CMM) the hardware and software design assurance to which the equipment has been qualified. The IM and/or CMM entry should include the following statement, or equivalent:

The [insert radio equipment identification] has been designed to comply with a quantitative probability goal of [insert probability goal (e.g., 1×10^{-5})] and a RTCA/DO-178B level [insert software level (e.g., C)] software development assurance. It is the responsibility of those desiring to install this article either on or within a specific type or class of aircraft to determine that the quantitative probability goal and RTCA/DO-178B software level to which the equipment has been qualified is appropriate for the aircraft installation.

- c. Schematic drawings, as applicable to the installation procedures.
- d. Wiring diagrams, as applicable to the installation procedures.
- e. Equipment specifications.
- f. List of the components, by part number, that make up the system complying with the standards in this TSO. Manufacturers should include vendor part number cross-references, when applicable.
- g. Instructions, in the form of an IM and/or CMM, covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed equipment. Instructions should include recommended inspection intervals and service life. Details of deviations and limitations, as noted in paragraphs **5a** and **5b** of this TSO, may also be described in the IM and/or CMM, or both.
- h. Material and process specifications list.
- i. The quality control system description required by 14 CFR §§ 21.605(a)(3) and 21.143(a) including functional test specifications. This system tests each production article to ensure compliance with this TSO.
- j. Manufacturer's TSO qualification test report.
- k. Nameplate drawing with the information required by paragraph **4** of this TSO.
- l. A list of all drawings and processes (including revision level), to define the article's design. For minor changes, you only need to make the revision to the drawing list available upon request.
- m. An environmental qualifications form as described in RTCA/DO-160D for each component of the system.
- n. 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 will allow timely resolution of issues such as partitioning and determination of software levels.

6. MANUFACTURER DATA REQUIREMENTS. 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:

- 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. The results of the environmental qualification tests conducted per RTCA/DO-160D.

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

7. FURNISHED DATA REQUIREMENTS. One copy of the technical data and information specified in paragraphs **5a** through **5g** of this TSO, and any other data or information necessary for the proper installation, certification and use, for continued airworthiness of the equipment, must accompany each article or multiple articles, if furnished to one source, i.e. operator, repair station, etc., manufactured under this TSO.

8. AVAILABILITY OF REFERENCED DOCUMENTS.

a. You may buy copies of RTCA Document Nos. RTCA/DO-160D (including Changes 1, 2, and 3), RTCA/DO-178B, and RTCA/DO-186A (including Changes 1 and 2) from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036-4001. Copies also can be obtained from RTCA Internet website at www.rtca.org.

b. You may buy copies of Federal Aviation Regulations 14 CFR part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, Washington, DC 20402-9325. You can also get copies from the Government Printing Office (GPO), electronic CFR Internet website @ www.access.gpo.gov/ecfr/ or by telephone (202) 512-1800 or by fax (202) 512-2250.

c. You can get FAA Advisory Circular (AC) 20-110L [or current revision], "Index of Aviation Technical Standard Orders," and AC 20-115B [or current revision], "RTCA, Inc., Document RTCA/DO-178B," from the U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785, telephone (301) 322-4477 or fax (301) 386-5394.

/S/

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