



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

**TSO-C169a**

Effective  
Date: 09/28/07

# Technical Standard Order

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**Subject: VHF Radio Communications Transceiver Equipment Operating Within Radio Frequency Range 117.975 To 137.000 Megahertz**

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 very high frequency (VHF) communications transceiver (transmitter/receiver) equipment must first meet for approval and identification with the applicable TSO marking.

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

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

b. VHF communications transceiver (transmitter/receiver) equipment approved under a previous TSOA may still be manufactured under the provisions of their original approval.

c. Major design changes to VHF communications transceiver (transmitter/receiver) equipment approved under previous versions of this TSO, TSO-C37, or TSO-38 will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

3. **REQUIREMENTS.**

a. New models of VHF communications transceiver (transmitter/receiver) equipment identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in appendix 1, paragraph 1.3 of this TSO.

b. The MPS allow for different equipment classes as defined by RTCA, Inc. document RTCA/DO-186B, *Minimum Operational Performance Standards for Airborne Radio Communications Equipment Operating Within The Radio Frequency Range 117.975-137.000 MHz*, Section 2.1.8, dated November 8, 2005. There are seven applicable equipment classes, summarized below:

**Table of Equipment Classes for VHF Communication Equipment**

<b>Equipment Class</b>	<b>Description</b>
C	Receiver used in a 25 kHz channel separation environment having off-set carrier operation
D	Receiver used in a 25 kHz channel separation environment not having off-set carrier operation
E	Receiver used in an 8.33 kHz channel separation environment not having off-set 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 an 8.33 kHz channel separation environment and intended to operate with a range of 200 nautical miles.
6	Transmitter used in an 8.33 kHz channel separation environment and intended to operate with a range of 100 nautical miles.

**c. Functionality.** This TSO's standards apply to equipment intended for aircraft VHF amplitude modulated (AM) communications operating within 117.975 to 137.000 MHz. This includes 25 and 8.33 kHz channel spacing capabilities. VHF communication equipment covered by this TSO is primarily intended for aeronautical operational control (AOC) and air traffic services (ATS) safety communications.

**d. Failure Condition Classification.** Failure of the function defined in paragraphs **3.a**, **3.b** and **3.c** of this TSO is a *major* failure condition. Develop the system to, at least, the design assurance level equal to this failure condition classification. See appendix 2 of this TSO for additional guidance on design assurance levels and quantitative safety objectives.

**e. Functional Qualification.** Demonstrate the required performance through the test in appendix 1, paragraph 1.4 of this TSO.

**f. Environmental Qualification.** Demonstrate the required environmental performance under the test conditions in RTCA/DO-186B, Sections 2.4 and 2.5. Environmental conditions used in these tests are in RTCA/DO-160E or EUROCAE document ED-14E, *Environmental Conditions and Test Procedures for Airborne Equipment*, both dated December 9, 2004.

**g. Software Qualification.** If the article includes a digital computer, develop the software according to RTCA/DO-178B or EUROCAE ED-12B, *Software Considerations in Airborne Systems and Equipment Certification*, both dated December 1, 1992.

**h. 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 in paragraph **3.d** of this TSO.

**i. 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) 14 CFR § 21.607(d)(2). Use the name, type, and part number. Do not use the optional model number; and

(2) 14 CFR § 21.607(d)(3). Use the date of manufacture. Do not use the optional serial number.

**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.** If any deviations have been granted, consider placing the additional permanent 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 paragraphs **3.a**, **3.b** and **3.c** of this TSO.

**f.** Mark equipment classes as defined in RTCA/DO-186B, Section 2.1.8. A satisfactory marking sample is "Equipment Class: C, E, 3 and 5." Equipment class markings in the installation procedures and limitations section of the IM (see paragraph **5.b** of this TSO) qualify

as an alternative to marking the component. However, you must mark the component with the drawing that provides the installation procedures and limitations.

**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 in 14 CFR § 21.605(a)(1) and one copy each of the following technical data to support our 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 VHF digital link (VDL) Mode 3 communications equipment operating within 117.975 to 137.000 MHz, when installed according to the installation procedures, continues to meet the requirements of this TSO and will meet the airworthiness and operating requirements appropriate for the intended type of aircraft and operation. Include in the limitations:

(1) 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.

(2) Identify the development assurance level(s) used for the functions defined in paragraphs **3.a**, **3.b** and **3.c** of the TSO.

(3) Identify the quantitative safety objectives used for the functions defined in paragraphs **3.a**, **3.b** and **3.c** of the TSO

(4) When applicable, identify the equipment as an incomplete system or that the equipment accomplishes additional functions beyond that described in paragraphs **3.a**, **3.b** and **3.c** of this TSO. Also describe the functions provided by the equipment.

(5) Any unique aspects of the installation, including those relevant to any deviations that may have been granted.

(6) The equipment class(es) that the equipment has been qualified to perform and the functions provided by these class(es). Write the description so an installer of the equipment will know the equipment being installed meets the intentions of the installation.

**c.** Schematic drawings of the installation procedures.

- d. Wiring diagrams of the installation procedures.
  - e. Equipment specifications.
  - f. List of components, by part number, that make up the VHF communications transceiver (transmitter/receiver) equipment complying with the standards prescribed under this TSO. Include vendor part number cross-references, when applicable.
  - g. A component maintenance manual (CMM), covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed VHF communications transceiver (transmitter/receiver) equipment. Include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph 5.a of this TSO.
  - h. Material and process specifications list.
  - i. 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.)
  - j. Manufacturer's TSO qualification test report.
  - k. Nameplate drawing with the information required by paragraph 4 of this TSO.
  - l. 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.
  - m. An environmental qualifications form as described in the environmental qualifications document referenced in paragraph 3.f of this TSO 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 allows us to quickly resolve issues, such as partitioning and determining software levels.
  - o. 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.
- 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. Results of the environmental qualification tests conducted per RTCA/DO-160E or EUROCAE ED-14E.
- h. If the article includes a digital computer, the appropriate documentation defined in RTCA/DO-178B or EUROCAE ED-12B, including all data supporting the applicable objectives in 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 combined with design assurance level, as defined in RTCA/DO-254 or EUROCAE ED-80, Appendix A, Table A-1.

**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 one copy of the data in paragraphs **5.a** through **5.g** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued airworthiness, of the VHF communications transceiver (transmitter/receiver) equipment.

**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](http://www.rtca.org).

b. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4970, fax (724) 776-0790. You can also order copies online at [www.sae.org](http://www.sae.org).

c. Order copies of 14 CFR part 21, Subpart O, from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2250. You can also order copies online at [www.access.gpo.gov](http://www.access.gpo.gov). Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

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

**e.** Order EUROCAE documents from EUROCAE, 17 Rue Hamelin, 75783 Paris Cedex 16, France. Telephone 33 1 45 05 71 88, fax 33 1 45 05 72 30. You can also order copies from the EUROCAE Internet website at [www.eurocae.org](http://www.eurocae.org).

*/s/ David W. Hempe*

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## **APPENDIX 1. DESIGN REQUIRMENTS AND FUNCTIONAL QUALIFICATIONS FOR A VHF COMMUNICATIONS TRANSCEIVER**

**1.1 PURPOSE.** This standard provides the Design Requirements and Functional Qualifications for your VHF communications transceiver.

**1.2 SCOPE.** This standard covers the different equipment classes described in paragraph **3.b** of this TSO.

### **1.3 DESIGN REQUIREMENTS.**

**a.** New models of VHF communications transceiver (transmitter/receiver) equipment must meet the MPS qualification and documentation requirements of RTCA/DO-186B, Sections 2.2 and 2.3.

**b.** In addition, the following requirement also applies to equipment classes C, D, 3 and 4:

The tuning range encompasses 760 assignable 25 kHz channels.  
Channel frequencies extend from 118.000 through 136.975 MHz in increments of 25 kHz.

**c.** In addition, the following requirement also applies to equipment classes E, 5 and 6:

The tuning range encompasses 2280 assignable 8.33 kHz channels.  
Channel frequencies extend from 118.000 through 136.99166 MHz in increments of 8.33 kHz.

### **1.4 FUNCTIONAL QUALIFICATIONS.**

**a.** Demonstrate the required performance via the tests specified in RTCA/DO-186B, Sections 2.6 and 2.7. Perform the following additional tests as applicable to article's equipment classes as described in paragraph **3.b** of this TSO.

**b.** Demonstrate performance to sections 2.6 and 2.7 of DO-186B and paragraph 1-3.b above.

#### **Equipment Required**

Signal generator (Hewlett Packard model 8640B, or equivalent)  
Output level meter (Fluke 8000A, or equivalent)  
6 dB Pad

**APPENDIX 1. DESIGN REQUIREMENTS AND FUNCTIONAL QUALIFICATIONS  
FOR A VHF COMMUNICATIONS TRANSCEIVER, continued**

Measurement Procedure

- Step 1 Connect the equipment as shown in RTCA/DO-186B, Figure 2-6.
- Step 2 Tune the signal generator to 118.000 MHz and the receiver under test to channel ID 118.000.
- Step 3 Apply an RF signal modulated 30% at 1,000 Hz with an output level of 24 microvolts to the receive input.
- Step 4 Check that an AF output is audible.
- Step 5 Repeat steps 3 and 4 with the signal generator tuned to 127.000 and 136.975 MHz and the receiver under test tuned to channel ID 127.000 and 136.975 respectively.
- Step 6 Verify the remaining 757 channels as part of RTCA/DO-178B software verification process.

c. Demonstrate *equipment class E receiver* performance under the following test condition:

Equipment Required

- Signal generator (Hewlett Packard model 8640B, or equivalent)
- Output level meter (Fluke 8000A, or equivalent)
- 6 dB Pad

Measurement Procedure

- Step 1 Connect the equipment as shown in RTCA/DO-186B, Figure 2-6.
- Step 2 Tune the signal generator to 118.000 MHz and the receiver under test to channel ID 118.005.
- Step 3 Apply an RF signal modulated 30% at 1,000 Hz with an output level of 24 microvolts to the receive input.
- Step 4 Check that an AF output is audible.
- Step 5 Repeat steps 3 and 4 with the signal generator tuned to 127.000 and 136.99166 MHz and the receiver under test tuned to channel ID 127.005 and 136.990 respectively.
- Step 6 Verify the remaining 2277 channels as part of RTCA/DO-178B software verification process.

**APPENDIX 1. DESIGN REQUIREMENTS AND FUNCTIONAL QUALIFICATIONS  
FOR A VHF COMMUNICATIONS TRANSCEIVER, continued**

**d.** Demonstrate *equipment class 3 and 4 transmitter* performance under the following test condition:

Equipment Required

Frequency counter

RF power attenuator

Measurement Procedure

- Step 1 Connect the equipment as shown in RTCA/DO-186B, Figure 2-16.
- Step 2 Tune the transmitter under test to channel ID 118.000.
- Step 3 Key the transmitter and measure the output frequency.
- Step 4 Check that the measured output frequency correlates to the frequency-channel pairing plan in RTCA/DO-186B, Section 1.2.
- Step 5 Repeat steps 3 and 4 with the transmitter under test tuned to channel ID 127.000 and 136.975.
- Step 6 Verify the remaining 757 channels as part of RTCA/DO-178B software verification process.

**e.** Demonstrate *equipment class 5 and 6 transmitter* performance under the following test condition:

Equipment Required

Frequency counter

RF power attenuator

Measurement Procedure

- Step 1 Connect the equipment as shown in RTCA/DO-186B, Figure 2-16.
- Step 2 Tune the transmitter under test to channel ID 118.005.
- Step 3 Key the transmitter and measure the output frequency.
- Step 4 Check that the measured output frequency correlates to the frequency-channel pairing plan specified in RTCA/DO-186B, Section 1.2.
- Step 5 Repeat steps 3 and 4 with the transmitter under test tuned to channel ID 127.005 and 136.9990.
- Step 6 Verify the remaining 2277 channels as part of RTCA/DO-178B software verification process.

## **APPENDIX 2. ADDITIONAL GUIDANCE ON DESIGN ASSURANCE LEVELS AND QUANTITATIVE SAFETY OBJECTIVES**

**2.1 PURPOSE.** Although the major hazard classification remains the same regardless of an aircraft installation, design assurance levels and quantitative safety objectives commensurate to the hazard classification may vary for different aircraft installations.

**2.2 DESIGN ASSURANCE LEVELS.** You'll find guidance on establishing design assurance levels for different installations in these publications (or latest versions):

- For a *system*, see SAE International's Aerospace Recommended Practice (ARP) 4754, *Certification Considerations for Highly Integrated or Complex Aircraft Systems*, dated June 27, 1996.
- For *hardware*, see RTCA/DO-254, *Design Assurance Guidance For Airborne Electronic Hardware*, dated April 19, 2000.
- For *software*, see RTCA/DO-178B and EUROCAE ED-12B, *Software Considerations In Airborne Systems and Equipment Certification*, dated December 1, 1992.

**2.3 QUANTITATIVE SAFETY OBJECTIVES.** You'll find guidance on establishing quantitative safety objectives for different installations on aircraft certificated under the provisions of 14 CFR parts 23, 25, 27 or 29 in:

- AC 23.1309-1, *Equipment, Systems And Installations In Part 23 Airplanes*,
- AC 25.1309-1, *System Design And Analysis*,
- AC 27-1, *Certification of Normal Category Rotorcraft*, and
- AC 29-2, *Certification Of Transport Category Rotorcraft*.