



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

TSO-C165a

Effective
Date: 09/30/13

Technical Standard Order

Subject: Electronic Map Display Equipment for Graphical Depiction of Aircraft Position (Own-Ship)

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, (FAA)) tell you what minimum performance standards (MPS) your Electronic Map Display (EMD) for graphical depiction of aircraft position (own-ship) must first meet for approval and identification with the applicable TSO marking.

2. **APPLICABILITY.** TSO-C165a is applicable for new applications after the effective date of this TSO.
 - a. TSO-C165 will remain in effect until March 30, 2015, and after this date we will no longer accept applications for TSO-C165.

 - b. EMD equipment approved under a previous TSOA may still be manufactured under the provisions of its original approval.

3. **REQUIREMENTS.** New models of EMDs identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in RTCA, Inc. Document No. RTCA/DO-257A, *Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps*, dated June, 25, 2003, Sections 2.1 through 2.4 as modified by appendix 1 of this TSO. Specifically, EMDs for use in flight must meet the MPS in Sections 2.1 and 2.2 as modified by appendix 1 of this TSO. EMDs with Airport Moving Map Displays (AMMD) for use on the airport surface must meet the MPS in Sections 2.1, 2.2, and 2.3 as modified by appendix 1 of this TSO. EMDs with Vertical Situation Displays (VSD) for use in facilitating pilot's awareness of the aircraft's vertical flight path must meet the MPS in Sections 2.1, 2.2, and 2.4 as modified by appendix 1 of this TSO. Table 1 summarizes the functional description and applicable MPS requirements for EMD equipment.

Table 1

EMD Functional Description	Applicable Requirements Sections in RTCA/DO-257A (as modified by appendix 1 of this TSO)			
	2.1	2.2	2.3	2.4
In-Flight	X	X		
Airport Surface (AMMD)	X	X	X	
Vertical Situation Displays (VSD)	X	X		X

a. Functionality. This TSO's standards apply to equipment intended to provide graphical depiction of advisory information on the EMD (e.g., navigation, traffic, weather, obstacles, graphical taxi routing, etc.). The EMD is intended to improve flight crew positional awareness of the aircraft own-ship position relative to other items depicted on the EMD.

b. Failure Condition Classifications.

(1) Failure of the functions defined in paragraph 3.a of this TSO for EMDs used for in-flight and VSD equipment (airborne applications) are a major failure condition for malfunctions causing the incorrect depiction of aircraft position (own-ship). Failure of the functions defined in paragraph 3.a of this TSO for EMDs used on the airport surface (ground applications) is a minor failure condition for malfunctions causing the incorrect depiction of aircraft position (own-ship).

(2) Loss of the functions defined in paragraph 3.a of this TSO for EMDs used for in-flight and VSD equipment (airborne applications) is a minor failure condition. Loss of function for EMDs used on the airport surface (ground applications) is a no safety effect failure condition.

(3) Design the system to at least the design assurance level commensurate with the failure condition classifications, as listed in Table 2.

Table 2

EMD Functional Description	Failure Condition Classification for Incorrect Depiction of Aircraft Position	Failure Condition Classification for Loss of Function
In-Flight	Major	Minor
VSD	Major	Minor
AMMD	Minor	No Effect

c. **Functional Qualification.** Demonstrate the required functional performance under the test conditions specified in RTCA/DO-257A, Section 2.6 as modified by appendix 1 of this TSO.

d. **Environmental Qualification.** Demonstrate the required performance under the test conditions specified in RTCA/DO-257A, Section 2.5, using standard environmental conditions and test procedures appropriate for airborne equipment. RTCA/DO-257A requires the use of RTCA, Inc. Document No. RTCA/DO-160D, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated July 29, 1997; however, you may use a different standard environmental condition and test procedure than RTCA/DO-160D, provided the standard is appropriate for the EMD.

Note: The use of RTCA/DO-160D (with Changes 1 and 2 only, incorporated) or earlier versions is generally not considered appropriate and will require substantiation via the deviation process as discussed in paragraph 3.g of this TSO.

e. **Software Qualification.** If the article includes software, develop the software according to RTCA, Inc. document RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992 to at least the software level consistent with the failure condition classification defined in paragraph 3.b of this TSO.

Note: The certification liaison process objectives will be considered satisfied after FAA review of the applicable life cycle data.

f. **Electronic Hardware Qualification.** If the article includes complex custom airborne electronic hardware (AEH) and the failure condition classification is major or greater, develop the component according to RTCA, Inc. Document RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware* to at least the design assurance level consistent with the failure condition classification defined in paragraph 3.b of this TSO. If the failure condition classification is minor, or no effect, an existing design assurance practice may be used to develop the custom AEH. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

Note: The certification liaison process objectives will be considered satisfied after FAA review of the applicable life cycle data.

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 your equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 14 CFR § 21.618.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 45.15(b). The marking must include the 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 easily removable component (without hand tools); and,
- (2) Each subassembly of the article you determined may be interchangeable.

c. If the article includes software and/or airborne electronic hardware, then the article part numbering scheme must identify the software and airborne electronic hardware configuration. The part numbering scheme can use separate, unique part numbers for software, hardware, and airborne electronic hardware.

d. You may use electronic part marking to identify software or airborne electronic hardware components by embedding the identification within the hardware component itself (using software) rather than marking it on the equipment nameplate. If electronic marking is used, it must be readily accessible without the use of special tools or equipment.

5. APPLICATION DATA REQUIREMENTS. You must give the FAA aircraft certification office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR § 21.603(a)(1) and one copy each of the following technical data to support your design and production approval. LODA applicants must submit the same data (excluding paragraph **5.g**) through their civil aviation authority.

a. A Manual(s) containing the following:

(1) Operating instructions and equipment limitations sufficient to describe the equipment's operational capability.

(2) Describe in detail any deviations.

(3) Installation procedures and limitations sufficient to ensure the EMD, when installed according to the installation or operational procedures, still meet this TSO's requirements. Limitations must identify any unique aspects of the installation.

(a) Installation procedures and limitations must include:

- A description of the EMD intended function,
- A description of the data quality characteristics necessary for the EMD article to perform its intended function (Reference RTCA/ DO-200A, Standards for Processing Aeronautical Data, dated September 28, 1998, section 2.3.2),

- A requirement to interface the EMD to a TSO-approved Global Navigation Satellite System (GNSS) sensor for positioning source input,
- A description of how the EMD system meets the total system accuracy requirements of RTCA/DO-257A section 2.3.1 as modified by appendix 1 of this TSO, and,
- A requirement stating the processes for production and updating of aeronautical databases for the EMD system, whether internal or external to the EMD, must meet the requirements of RTCA/DO-200A, or subsequent revisions.

(b) The limitations must include a note with the following statement:

“This article meets the minimum performance and quality control standards required by a technical standard order (TSO). Installation of this article requires separate approval.”

(4) For each unique configuration of software and airborne electronic hardware, reference the following:

- (a) Software part number including revision and design assurance level;
- (b) Airborne electronic hardware part number including revision and design assurance level; and,
- (c) Functional description.

(5) A summary of the test conditions used for environmental qualifications for each component of the article. For example, a form as described in RTCA/DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, Appendix A.

(6) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the EMD.

(7) List of replaceable components, by part number, making up the EMD. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of the EMD. Include recommended inspection intervals and service life, as appropriate.

c. If the article includes software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary.

d. If the article includes simple or complex custom airborne electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).

e. A drawing depicting how the article will be marked with the information required by paragraph 4 of this TSO.

f. Identify functionality or performance contained in the article not evaluated under paragraph 3 of this TSO (i.e., non-TSO functions). Non-TSO functions are accepted in parallel with the TSO authorization. For those non-TSO functions to be accepted, you must declare these functions and include the following information with your TSO application:

(1) Description of the non-TSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming the non-TSO function(s) don't interfere with the article's compliance with the requirements of paragraph 3.

(2) Installation procedures and limitations sufficient to ensure the non-TSO function(s) meets the declared functions and performance specification(s) described in paragraph 5.f.(1).

(3) Instructions for continued performance applicable to the non-TSO function(s) described in paragraph 5.f.(1).

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph 5.f.(1).

(5) Test plans, analysis and results, as appropriate, to verify performance of the hosting TSO article is not affected by the non-TSO function(s).

(6) Test plans, analysis and results, as appropriate, to verify the function and performance of the non-TSO function(s) as described in paragraph 5.f.(1).

g. The quality system description required by 14 CFR § 21.608, including functional test specifications. The quality system should ensure you will detect any change to the approved design adversely affecting compliance with the TSO MPS, and reject the article accordingly. (Not required for LODA applicants).

h. Material and process specifications list.

i. List of all drawings and processes (including revision level) defining the article's design.

j. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph 3.c of this TSO.

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

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 TSO authorization.
- d. Schematic drawings.
- e. Wiring diagrams.
- f. Material and process specifications.
- g. The results of the environmental qualification tests conducted according to paragraph **3.d** of this TSO.
- h. If the article includes software, 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 complex custom AEH and the failure condition classification is major or greater, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1. For simple custom airborne electronic hardware, the following data: test cases or procedures, test results, test coverage analysis, tool assessment and qualification data, and configuration management records, including problem reports.
- j. If the article contains non-TSO function(s), you must also make available items **6.a** through **6.h** as they pertain to the non-TSO function(s).

7. FURNISHED DATA REQUIREMENTS.

- a. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy or on-line access to the data in paragraphs **5.a** and **5.b** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued compliance with the TSO, of the EMD.
- b. If the article contains declared non-TSO function(s), include one copy of the data in paragraphs **5.f.(1)** through **5.f.(4)**.

8. HOW TO GET REFERENCED DOCUMENTS.

- a. Order RTCA documents from RTCA Inc., 1150 18th Street NW, Suite 910, 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 parts from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis, MO 63197. Telephone (202) 512-1800, fax (202) 512-2250. You can also order copies online at www.bookstore.gpo.gov.

c. 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.



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APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR ELECTRONIC MAP DISPLAY EQUIPMENT FOR GRAPHICAL DEPICTION OF AIRCRAFT POSITION

This appendix defines changes to the Minimum Operational Performance Standards (MOPS) for EMD equipment specified in RTCA/DO-257A, *Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps*, dated June, 25, 2003.

RTCA/DO-257A Section(s)	Change
2.2.4	<p>Add a requirement for a process activity monitor:</p> <p>A process activity monitor (watchdog) shall be implemented to detect frozen processes and to remove outdated/frozen information from the screen, or to clearly indicate the invalid data. The process activity monitor shall be able to detect the occurrence of the failure within 5 seconds.</p>
2.2.5, 2.3.5	<p>Add a clarification stating both internal and external databases shall meet section 2.2.5 requirements:</p> <p>Both internal and external EMD databases shall meet the requirements of section 2.2.5.</p>
2.2.5, 2.3.5	<p>Add a clarification stating RTCA/DO-200A compliance requirement is applicable to processes for producing and updating EMD databases.</p> <p>The processes for both producing and updating aeronautical databases shall meet the standards specified in RTCA/DO-200A or EUROCAE/ED-76, or later revision.</p>
2.2.5, 2.3.5	<p>Add a requirement to specify the data quality requirements (DQRs) for the EMD database:</p> <p>Description of the data quality requirements (DQRs) for the EMD database shall be specified (Reference RTCA/ DO-200A, section 2.3.2).</p>
2.2.5, 2.3.5	<p>Add a requirement to monitor and annunciate for corruption of the EMD database:</p> <p>Corruption of the EMD database shall be detected and annunciated to the flight crew clearly and in a timely manner.</p>
2.3.1.1.1	<p>Change the runway database accuracy requirement in 2.3.1.1.1 from 43 meters to the following:</p> <p>The aerodrome database accuracy for runway data elements shall meet medium category data quality as defined in RTCA/DO-272C, <i>User Requirements for Aerodrome Mapping Information</i>, dated September 28, 2011, or EUROCAE/ED-99C, or subsequent revisions.</p>
2.3.1.1.2	<p>Change the taxiway database accuracy requirement in 2.3.1.1.2 from 65 meters to the following:</p>

	When depicted, the aerodrome database accuracy for taxiway data elements shall meet medium category data quality as defined in RTCA/DO-272C or EUROCAE/ED-99C, or subsequent revisions.
2.3.1.1.1, 2.3.1.1.2	<p>Add a clarification to meeting the 36 meter position source accuracy and the RTCA/DO-272C medium category data quality requirements addressing AMMD total system accuracy:</p> <p>The total system accuracy shall be sufficient for the AMMD intended function, and shall not exceed 50 meters (95%). You may reallocate the position source accuracy (36 m) and total database accuracy (5 m) requirements, if the total system accuracy remains less than or equal to 50 meters. The formula for calculating total system accuracy is:</p> $[(\text{Position Source Accuracy})^2 + (\text{Total Database Accuracy})^2 + (\text{Latency Effects})^2 + (\text{Display Errors})^2]^{1/2} + \text{GPS Antenna Offset} = \text{Total System Accuracy}$
2.3.1.2	<p>Add a requirement for the EMD to be able to compensate for GNSS antenna offset:</p> <p>The AMMD shall provide a means to compensate for installation dependent GPS antenna offset (i.e., along track aircraft reference point bias associated with GNSS antenna position relative to the nose of the aircraft).</p> <p><i>Note: Acceptable means of compliance would be through use of system calibration or a limitation on the GNSS antenna installation position in relation to the nose of the aircraft.</i></p>
2.3.1.2	<p>Add a requirement to remove ownship position above 80 knots for ground-use-only systems:</p> <p>AMMD applications limited to the airport surface (ground applications) shall remove the own-ship position symbol at a ground speed above 80 knots. A means to allow lower values is recommended to adjust for actual aircraft performance or to mitigate installation dependent horizontal position latency.</p>
2.6	Include all additional and modified requirements stated above in the applicable test sections.