



Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C215

Effective
Date: {mm/dd/yy}

Technical Standard Order

Subject: *GNSS Airborne Active Antenna Equipment for the L1/E1 and L5/E5a Frequency Bands*

1. PURPOSE. This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of TSO design approval (LODA). In it, we (the Federal Aviation Administration, (FAA)) tell you what Minimum Performance Standards (MPS) your Global Navigation Satellite System (GNSS) airborne active antenna equipment for the L1/E1 and L5/E5a frequency bands must meet for approval and identification with the applicable TSO marking.

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

3. REQUIREMENTS. New models of GNSS airborne active antenna equipment for the L1/E1 and L5/E5a frequency bands identified and manufactured on or after the effective date of this TSO must meet the requirements in sections 2.1 and 2.2 of RTCA, Inc. Document No. RTCA/DO-373A, Minimum Operational Performance Standards *MOPS for GNSS Airborne Active Antenna Equipment for the L1/E1 and L5/E5a Frequency Bands*, dated December 12, 2024.

a. Functionality. This TSO's standards apply to GNSS airborne active fixed reception pattern antenna equipment intended to receive and provide GPS/Galileo L1/E1 and L5/E5a signals to GPS/Galileo dual frequency multi-constellation (DFMC) satellite based augmentation system (SBAS) sensors or systems of all operational classes, and GPS/Galileo DFMC ground based augmentation system (GBAS) sensors or systems that will provide flight path deviation commands to the pilot or autopilot. The standards do not address the use of the signals received through this antenna for other applications. The standards for DFMC SBAS are currently in development and the standards development for DFMC GBAS will follow subsequently.

b. Failure Condition Classifications. There is no standard minimum failure condition classification for this TSO. The failure condition classification appropriate for the equipment will depend on the intended use of the equipment in a specific aircraft. Document the loss of function and malfunction failure condition classification for which the equipment is designed.

Development to a lower development assurance level may be justified and accepted for certain cases, but this will lead to installation restrictions and must be documented in the installation and limitations manual defined in paragraph **5.a.** of this TSO.

c. Threat Condition Classifications.

(1) GNSS spoofing involves the deliberate manipulation of external data to deceive GNSS receivers, causing them to compute incorrect position, navigation, and timing data. If such manipulation constitutes intentional unauthorized electronic interaction, it may cause or contribute to an adverse effect on safety. Document the security threat conditions as defined in RTCA DO-326B/EUROCAE ED-202B, *Airworthiness Security Process Specification*, dated September 26, 2024.

(2) Develop the system to, at least, the security assurance level (SAL) equal to the threat condition effect severity as defined in RTCA DO-356A/EUROCAE ED-203A, *Airworthiness Security Methods and Considerations*, dated June 21, 2018. The appropriate SAL depends upon both the intended uses of the equipment's outputs in a specific aircraft and the aircraft's capabilities to mitigate the security threat conditions through means other than this TSO equipment.

d. Functional Qualification. Demonstrate the required functional performance under the test conditions specified in RTCA/DO-373A, section 2.4.

e. Environmental Qualification. Demonstrate the required performance under the test conditions specified in RTCA DO-373A, section 2.3 using standard environmental conditions and test procedures appropriate for the airborne equipment. You may use a different standard environmental condition and test procedure than RTCA/DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 8, 2010, provided the standard is appropriate for the GNSS airborne active antenna equipment.

Note: The use of RTCA/DO-160D (with Changes 1 and 2 only, without Change 3 incorporated) or earlier versions is generally not considered appropriate and will require substantiation via the deviation process as discussed in paragraph **3.i.** of this TSO.

f. Software Qualification. If the article includes software, develop the software according to RTCA, Inc., document RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 13, 2011, including referenced supplements as applicable. You may also develop the software according to RTCA, Inc., document RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992, if you follow the guidance in AC 20-115D, *Airborne Software Assurance*, dated July 21, 2017. The software development assurance level should be consistent with the failure condition classification defined in paragraph **3.b.** of this TSO and appropriate for the intended installation. Development to a lower development assurance level may be justified and accepted for certain cases, but this will lead to installation restrictions and must be documented in the installation and limitations manual defined in paragraph **5.a.** of this TSO.

g. Electronic Hardware Qualification. If the article includes airborne electronic hardware (AEH), develop the AEH according to RTCA, Inc., Document RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, dated April 19, 2000, and the additional guidance in AC 20-152A, *Development Assurance for Airborne Electronic Hardware*, dated October 7, 2022. The AEH development assurance level should be consistent with the failure condition classification defined in paragraph **3.b.** of this TSO and appropriate for the intended installation. Development to a lower development assurance level may be justified and accepted for certain cases, but this will lead to installation restrictions and must be documented in the installation and limitations manual defined in paragraph **5.a.** of this TSO.

h. Information Security and Protection Qualification. If the article includes security measures, develop the security measure in accordance with, as applicable, guidance and methods of RTCA DO-326B/EUROCAE ED-202B, and RTCA DO-356A/EUROCAE ED-203A.

(1) You must provide information security and protection to GNSS active antenna data priority communications services in the Active Cyber Defense (ACD) or Airline Information Services Domain (AISD), or both (if applicable) in accordance with this TSO.

(2) You must develop the GNSS active antenna to provide partitioning for system protection for equipment intended to mitigate processing of erroneous external data.

i Deviations. We have provisions for using alternate or equivalent means of compliance with 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 pursuant to title 14, Code of Federal Regulations (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).

b. If the article includes software or AEH or both, then the article part numbering scheme must identify the software and AEH configuration. The part numbering scheme can use separate, unique part numbers for the hardware, software, and AEH.

c. If the article implements security measures, then the TSO article must identify SAL.

d. You may use electronic part marking to identify SAL, software, or AEH 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 certification branch 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.h.**) through their civil aviation authority.

a. Manuals containing the following:

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

(2) Detailed description of any deviations.

(3) Installation procedures and limitations sufficient to ensure that the GNSS airborne active antenna equipment, when installed according to the installation or operational procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. The limitations must also include a note with the following statement:

“This article meets the minimum requirements of TSO-C215. Installation of this article requires separate approval.”

(4) For equipment intended to support communication service to ACD or AISD or both, you must include specific installation procedures and limitations to provision for security if the required security measures between ACD and AISD communications specified in paragraph **3.c.** and **3.h.** of this TSO are provided at the overall installation level (either partial or wholly).

(5) For each unique configuration of software and AEH, reference the following:

- (a) Software part number, including revision and development assurance level,
- (b) AEH part number, including revision and development assurance level, and
- (c) Functional description.

(6) 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, Appendix A.

(7) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the GNSS airborne active antenna equipment.

(8) By-part-number list of replaceable components that make up the GNSS airborne active antenna equipment. Include vendor part number cross-references when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the GNSS airborne active antenna equipment continues to meet the TSO approved design. 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 a software accomplishment summary.

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

e. If the article requires considerations for information security and protection to meet paragraphs **3.c.** and **3.h.** of this TSO: the plan for security aspects of certification summary and other supporting documentation, as applicable.

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

g. Identify functionality or performance contained in the article not evaluated under paragraph **3** of this TSO (defined as non-TSO functions). Non-TSO functions can be accepted in parallel with the TSOA. 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, AEH, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) do not interfere with the article's compliance with the requirements of paragraph **3**.

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

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

(4) Interface requirements and applicable installation test procedures to ensure compliance with the non-TSO function(s) performance data defined in paragraph **5.g.(1)**.

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

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

h. The quality manual required by 14 CFR 21.608, including functional test specifications. The quality system must ensure that you will detect any change to the approved design that could adversely affect compliance with the TSO MPS and reject the article accordingly. Applicants who currently hold TSOAs must submit revisions to the existing quality manual as necessary (not required for LODA applicants).

i. A description of your organization as required by 14 CFR 21.605.

j. Material and process specifications list.

k. A list of all drawings and processes (including revision level) that define the article's design.

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

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

Note: The following data for a LODA applicant may be made available for review through its civil aviation authority. Refer to the implementation procedures of the applicable bilateral agreement for specific details regarding access to this data.

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

b. Article calibration procedures.

c. Schematic drawings.

d. Wiring diagrams.

e. Material and process specifications.

f. The results of the environmental qualification tests conducted according to paragraph 3.e. of this TSO.

g. If the article includes software, the appropriate documentation defined in RTCA/DO-178B or RTCA/DO-178C, as specified in paragraph 3.f. of this TSO, including all data supporting the applicable objectives in RTCA/DO-178B/C, Annex A, *Process Objectives and Outputs by Software Level*.

h. If the article includes AEH, the appropriate hardware life cycle data as defined in RTCA/DO-254, Appendix A, table A-1 and any additional data to satisfy the guidance in AC 20-152A, as specified in paragraph 3.g. of this TSO.

i. If information security is implemented in the article, the information security data appropriate to the SAL, as defined in RTCA/DO-326B, table 4-1, as specified in paragraph 3.c. of this TSO, including all data supporting the applicable objectives in RTCA/DO-356A.

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

k. If you use external equipment such as simulators, stimulators, or other similar devices to validate the article's compliance with the requirements in this TSO, you must provide the appropriate documentation showing the equipment's accreditation and suitability for the intended purpose.

7. FURNISHED DATA REQUIREMENTS.

a. When furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy or online 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 continued compliance with the TSO of the GNSS active airborne antenna equipment.

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

c. If the article contains software or AEH, include one copy of the open problem report summary according to the guidance in AC 20-189, *Management of Open Problem Reports*, dated September 16, 2022.

8. HOW TO ACCESS REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA, Inc., 1150 18th Street NW, Suite 910, Washington, DC 20036. Telephone: (202) 833-9339; fax: (202) 833-9434. You can also order copies online at 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.

c. Order copies of regulations from the Superintendent of Documents, Government Publishing Office, PO Box 979050, St. Louis, MO 63197-9000. Telephone: (202) 512-1800, fax: (202) 512-2104 or online at www.gpo.gov. You can also find them online at www.ecfr.gov. You can find a current list of TSOs and advisory circulars on the Dynamic Regulatory System (DRS) at <https://drs.faa.gov/>.

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