

ETSO-C220

GNSS-AIDED INERTIAL SYSTEMS

1 Applicability

This ETSO provides the requirements that GNSS-aided inertial systems providing position outputs that are designed on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 Procedures

2.1 General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 Specific

- a. Some GNSS-aided inertial systems have been approved in accordance with RTCA DO-229() or RTCA DO-316(), Appendix R, which set out the requirements and test procedures for the tightly integrated GPS/inertial system. However, EASA will no longer accept any applications for the development of new articles or for major changes to existing articles using these sets of criteria after 12 months from the effective date of this ETSO.
- b. Some GNSS-aided inertial systems have been approved in accordance with ETSO-C201(), 'Attitude and Heading Reference Systems (AHRS)', with the navigation capability of the product being approved as a non-ETSO function (i.e. the position outputs of the GNSS-aided inertial system making up the AHRS). ETSO-C201() remains effective and is a prerequisite for GNSS-aided inertial systems incorporating attitude and heading functions. However, EASA will no longer accept any new applications for ETSO-C201() that seek the approval of position outputs as a non-ETSO function.
- c. Due to the wide range of possible GNSS-aided inertial systems capabilities, manufacturers shall define the equipment's intended function and demonstrated performance. The word 'system' includes all components or units necessary for the GNSS-aided inertial system to perform its intended function (excluding GNSS receiver functions that meet the requirements of ETSO-C196(), ETSO-C145() or ETSO-C146(), and AHRS functions that meet the requirements of ETSO-C201()).

3 Technical Conditions

3.1 Basic

3.1.1 Minimum Performance Standard

The applicable standard is that provided in RTCA DO-384, 'Minimum Operational Performance Standards (MOPS) for GNSS Aided Inertial Systems', dated 17 December 2020.

3.1.2 Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 Specific

3.2.1 Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

3.2.2 Integrity Protection Limits

Both Advanced Receiver Autonomous Integrity Monitoring (RAIM) and RTCA DO-384 for GNSS-aided inertial systems define ways to compute protection limits with the same integrity and continuity objectives. However, the hypotheses taken into account by RAIM are much more stringent than the hypotheses taken into account by RTCA DO-384.

- a. While RTCA DO-384 relies on the GPS prior satellite failure rate of 10^{-5} /hour for integrity, it does not take into account the temporal effects considered by RAIM, which lead to more pessimistic probabilities of missed detection, to guarantee the integrity risk over the exposure period. For GNSS-aided inertial systems, manufacturers shall evaluate whether RTCA DO-384's temporal error characterisation, satellite mean fault duration and algorithm sampling rate are adequate.
- b. When assigning a probability of misleading information equal to or less than 10^{-7} , manufacturers shall consider additional fault modes or anomalies affecting multiple (two or more) satellites. The GPS Standard Positioning Service (SPS) Performance Standard specifies that the probability of a GPS major service failure on two or more satellites due to a common cause (Pconst) shall not exceed 10^{-8} (consistent with the proposed amendment to ICAO Annex 10, 'Aeronautical telecommunications', Volume I, 'Radio navigation aids'). Manufacturers may use the tests described in RTCA DO-384, Appendix Q, 'Alternate Trajectories', to demonstrate the performance of the GNSS-aided inertial system in detecting, mitigating and recovering from multiple satellite failures.

3.2.3 Gravity Model

The following reference should be considered in addition to the references listed in RTCA DO-384, Appendix O: Needham, T. and Braasch, M., 'Gravity Modeling in GNSS-Aided Inertial Navigation System Safety Considerations', *NAVIGATION: Journal of the Institute of Navigation*, Vol. 69, No 2, 2022, navi.520.

3.2.4 Alternative GNSS Trajectories

If the equipment provides detection and mitigation of the effects of erroneous (or alternative) GNSS trajectories, then the applicant shall test the equipment according to RTCA DO-384, Appendix Q, 'Alternate Trajectories'.

4 Marking

4.1 General

See CS-ETSO, Subpart A, paragraph 1.2.

4.2 Specific

None.

5 Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

[Amdt ETSO/18]