Deviation Request ETSO-C190#2 for an ETSO approval for CS-ETSO applicable to Active Airborne Global Navigation Satellite System (GNSS) Antenna (ETSO-C190)
Consultation Paper

1 Introductory Note

The hereby presented deviation requests shall be subject to public consultation, in accordance with EASA Management Board Decision No 7-2004 as amended by EASA Management Board Decision No 12-2007 products certification procedure dated 11th September 2007, Article 3 (2.) of which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

2 ETSO-C190#2 Active Airborne Global Navigation Satellite System (GNSS) Antenna

2.1 Summary of Deviation

Deviates from RTCA DO-301 by permitting higher input noise temperatures for antennas specified in section 2.3 when a higher gain of the passive radiating element maintains compliance to the gain-to-noise ratio (G/T) specified in section 2.2.5.

2.2 Original Requirement

RTCA DO-301 MOPS for GNSS Airborne Active Antenna Equipment for the L1 Frequency Band

2.3.2 Temperature and Altitude Tests (DO-160E, Section 4.0)

(…)

2.3.2.1 Operating Low Temperature Test

The equipment shall be subjected to the test conditions as specified in DO-160E, Section 4.5.2, and the following requirements of this standard shall be met:

(…)

2. Active Sub-assembly Input Noise Temperature: The input noise temperature shall be less than 310 K over 1575.42 ± 2 MHz and less than 413 K over 1575.42 ± 8 MHz

(…)

2.3.2.2 Operating High Temperature Test

The equipment shall be subjected to the test conditions as specified in DO-160E, Section 4.5.4, and the following requirements of this standard shall be met:

(…)

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2. Active Sub-assembly Input Noise Temperature: The input noise temperature shall be less than 310 K over 1575.42 ± 2 MHz and less than 413 K over 1575.42 ± 8 MHz
(…)

2.3.2.3 Altitude Test
The equipment shall be subjected to the test conditions as specified in DO-160E, Section 4.6.1, and the following requirements of this standard shall be met:
(…)
2. Active Sub-assembly Input Noise Temperature: The input noise temperature shall be less than 310 K over 1575.42 ± 2 MHz and less than 413 K over 1575.42 ± 8 MHz
(…)

2.3.3 Temperature Variation Test (DO-160E, Section 5.0)
The equipment shall be subjected to the test conditions as specified in DO-160E, Section 5.0, and the following requirements of this standard shall be met:
(…)
2. Active Sub-assembly Input Noise Temperature: The input noise temperature shall be less than 310 K over 1575.42 ± 2 MHz and less than 413 K over 1575.42 ± 8 MHz
(…)

2.3 Industry

In the environmental tests specified in RTCA DO-301, there are a number of instances where there is a requirement for monitoring of the noise temperature of the active sub-assembly. The instances are:

- Section 2.3.2.1, Operating Low Temperature Test
- Section 2.3.2.2, Operating High Temperature Test
- Section 2.3.2.3, Altitude Test
- Section 2.3.3, Temperature Variation Test

The limits are: “The input noise temperature shall be less than 310K over 1575.42 ± 2 MHz and less than 413K over 1575.42 ± 8 MHz.”

The intent of this deviation is to permit exceeding these limits as long as the requirement on the gain-to-noise ratio (G/T) is met.

Indeed, the measurement of the input noise temperature in RTCA DO-301 section 2.3 is intended to verify the compliance to section 2.2.5 on the G/T ratio (which is the primary performance parameter):

The active antenna unit G/T ratio at 5 degrees elevation shall be not less than -32.6 dB/K over all azimuth angles, over the frequency range 1575.42 ± 8 MHz and over the full environmental temperature range. Over the frequency range 1575.42 ± 2 MHz, the 5 degrees elevation G/T ratio shall not be less than - 31.6 dB/K over all azimuth angles and over the full environmental temperature range

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RTCA DO-301 section 2.2.3.2 also specifies the minimum gain of the passive radiating element:

> *The passive radiating element gain at 1575.42 MHz and 5° elevation shall be at least -5.5 dBic over all azimuth angles.*

G/T is calculated from the minimum gain of the passive radiating element at 5 degrees elevation (G_A) and the maximum active sub-assembly noise temperature referenced to the active sub-assembly input temperature (T_R) and an assumed level for the sky noise temperature (T_{SKY}). The gain to noise temperature ratio (in dB/K) is calculated as follows;

$$G/T = G_A - 10log_{10}(T_{SKY} + T_R)$$

The sky noise temperature is assumed to have a value of 100K, in accordance with RTCA DO-301, section A.1.

Assuming the minimum antenna gain of -5.5 dBic, then the G/T limits may be calculated:

Frequency Band (MHz)	G_A (dBic)	T_{SKY} (K)	DO-301, Section 2.3.2.1, 2.3.2.2, 2.3.2.3 and 2.3.3 Noise Temperature Monitoring Limit (K) (T_R)	Calculated G/T (dB/K)
1575.42 ± 2	-5.5	100	≤ 310	-31.6
1575.42 ± 8	-5.5	100	≤ 413	-32.6

These noise figure limits can be safely exceeded as long as the gain of the passive radiating element at 5 degrees elevation is shown to be high enough to continue to meet the G/T requirements of RTCA DO-301 section 2.2.5.

As an example, an input noise temperature measured at 348.85 °K associated to a gain of the passive radiating element of at least -4.48 dBic translates in a G/T ratio of -31 dB/K, which meets to requirement of section 2.2.5 (≥ -31.6 dBic).

2.4 Equivalent Level of Safety

An equivalent level of safety is provided by verifying that despite input noise temperature is higher than specified, a higher gain of the passive radiating element maintains the gain-to-noise ratio (G/T) within section 2.2.5 requirement.

2.5 EASA position

We accept the deviation.

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