ETSO-2C204a

ED Decision 2020/011/R (applicable from 25.7.2020)

CIRCUIT CARD ASSEMBLY (CCA) FUNCTIONAL SENSORS USING SATELLITE-BASED AUGMENTATION SYSTEMS (SBASS) FOR NAVIGATION AND NON-NAVIGATION POSITION/VELOCITY/TIME (PVT) OUTPUT

1 Applicability

This ETSO provides the requirements that circuit card assembly (CCA) functional sensors that use satellite-based augmentation systems (SBASs) for navigation and non-navigation position/velocity/time (PVT) output, which are designed and manufactured on or after the date of this ETSO, must meet in order to be identified with the applicable ETSO marking.

ETSO-2C204a is intended as a means for manufacturers of end-use equipment to rationalise their ETSO-C145e applications for Class Beta PVT sensors by using ETSO-authorised SBAS CCAs for partial certification credit.

An ETSO-2C204a article has a limitation that requires the manufacturer of end-use equipment to repeat selected detailed functional tests in the end-use equipment and complete the environmental qualification tests in RTCA document DO-229E (see paragraphs 3.1.2.2 and 3.2.2 below).

2 Procedures

2.1 General

The applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 Specific

None.

3 Technical Conditions

3.1 Basic

3.1.1 Minimum Performance Standard

The applicable standards are those provided for Class Beta functional equipment in RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated 15 December 2016, Section 2, as amended by Appendices 1 and 3 to this ETSO.

Class Beta equipment is defined in RTCA document DO-229E, Section 1.4.

The standards in this ETSO apply to CCAs that are intended to provide PVT information for navigation management unit applications that output deviation commands keyed to a desired flight path, or non-navigation applications such as automatic dependent surveillance — broadcast (ADS-B) or terrain awareness and warning systems (TAWS). In navigation applications, pilots or autopilots will use the deviations output by the navigation management unit to guide the aircraft. In non-navigation applications, the PVT outputs will provide the necessary inputs for the end-use equipment.

3.1.2 Environmental Testing and Test Procedures

3.1.2.1 Environmental Testing

For the applicable environmental standards, see CS-ETSO, Subpart A, paragraph 2.1.

Nevertheless, not all types of environmental test are required for this ETSO standard, as the ETSO article for this ETSO standard is a CCA that will be later integrated into an item of ETSO equipment. Therefore, a minimal set of the environmental test conditions of EUROCAE ED-14/RTCA document DO-160 has been defined (refer to Table 1) in order to verify the performance of the ETSOA article under this minimal set of conditions. The required performance under a particular environmental test is defined in the related test section in RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated 15 December 2016, Section 2.4.

This minimal set is defined in Table 1 below. The chosen test category, associated with the selectable parameters in the test conditions per EUROCAE ED-14/RTCA document DO-160, should be documented in the installation manual as limitations for the installation.

The test sections that are identified as optional are not required for an ETSO-2C204a application. Nevertheless, the ETSO CCA article can be subjected to these test conditions by the applicant on a voluntary basis. If optional sections are not tested, they shall be marked with 'X' in the environmental testing summary.

Table 1 — Environmental Qualification Testing minimum set for ETSO-2C204a

Environmental Test	EUROCAE ED-14/RTCA DO-160 Section	Requirement for ETSO-2C204a
Temperature	4.5	Mandatory If the performance of the module under environmental conditions is dependent on the end-user equipment, it is the responsibility of the applicant to adapt the EUROCAE ED-14/RTCA DO-160 high and low operating temperature values and temperature variation cycles to the intended installation context. For example, in the case of temperature testing (Section 4.0 of EUROCAE ED-14/RTCA DO-160), the temperature of the environment of the CCA (inside an item of equipment) may be much higher or lower than the equipment level condition expressed in the aforementioned Section 4.0. Therefore,

Environmental Test	EUROCAE ED-14/RTCA DO-160 Section	Requirement for ETSO-2C204a
		the applicant may qualify their CCA functional sensor based on a chosen intended environment, and, finally, indicate in the installation manual the temperature range for which the correct operation of the CCA is guaranteed. The dissipation constraints required for the CCA and documented in the installation manual should be considered when establishing the temperature test set-up.
Altitude	4.6	Mandatory
Temperature Variation	5.0	Mandatory As for Section 4.5, if the performance of the CCA under environmental conditions is dependent on the end-user equipment, it is the responsibility of the applicant to adapt the EUROCAE ED-14/RTCA DO-160 high and low temperature values and temperature variation cycles to the intended CCA installation context. As for Section 4.5, for example, in the case of temperature testing (Section 4.0 of EUROCAE ED-14/RTCA DO-160), in which the temperature of the environment of the CCA (inside an item of equipment) may be much higher or lower than the equipment level condition as expressed in Section 4.0 of EUROCAE ED-14/RTCA DO-160, the applicant can qualify their CCA based on a chosen intended environment, and, finally, indicate in the installation manual the temperature range for which the correct operation of the CCA functional sensor is guaranteed.
Humidity	6.0	Mandatory
Shock (operational)	7.2	Optional
Shock (Crash Safety)	7.3	Optional
Vibration	8.0	Optional Note: The CCA technology should be assessed for further vibration qualification (EUROCAE ED-14/RTCA DO-160). This preliminary assessment could consider the technology diversity of the components of the CCA, as well as the integration density and number of layers of the circuit card. The assessment could be confirmed by tests conducted on

Environmental Test	EUROCAE ED-14/RTCA DO-160 Section	Requirement for ETSO-2C204a
		a circuit card that is representative of the CCA technology used in the article under certification. This preliminary assessment of the CCA technology under vibration conditions does not constitute credit for the qualification testing of the CCA when it is integrated into the end-user equipment.
Explosion Atmosphere	9.0	Optional
Waterproof	10.0	Optional
Fluids Susceptibility	11.0	Optional
Sand and Dust	12.0	Optional
Fungus Resistance	13.0	Optional
Salt Fog	14.0	Optional
Magnetic Effect	15.0	Optional
Power Input	16.0	Mandatory for CCA interfaces that are directly connected to the aircraft power distribution system.
Voltage Spike	17.0	Mandatory for CCA interfaces that are directly connected to the aircraft power distribution system. Note: CCA interfaces that are not directly connected to the aircraft power distribution system will be tested after the integration phase as part of the end-user ETSO application or as part of a type-certification programme.
Audio Frequency Conducted Susceptibility — Power Input	18.0	Mandatory for CCA interfaces that are directly connected to the aircraft power distribution system. Note: CCA interfaces that are not directly connected to the aircraft power distribution system will be tested after the integration phase as part of the end-user ETSO application or as part of a type-certification programme.
Induced-Signal Susceptibility	19.0	Mandatory for CCA interfaces that are directly connected to the aircraft wiring. Note: CCA interfaces that are not directly connected to the aircraft wiring will be tested after the integration phase as

Environmental Test	EUROCAE ED-14/RTCA DO-160 Section	Requirement for ETSO-2C204a
		part of the end-user ETSO application or as part of a type-certification programme.
Radio Frequency Susceptibility (radiated and conducted)	20.0	Mandatory for the conducted susceptibility of CCA interfaces that are directly connected to the aircraft wiring. Note: CCA interfaces that are not directly connected to the aircraft wiring will be tested after the integration phase as part of the end-user ETSO application or as part of a type-certification programme.
Emission of Radio Frequency Energy	21.0	Mandatory for the conducted emission of CCA interfaces that are directly connected to the aircraft wiring. Note: CCA interfaces that are not directly connected to the aircraft wiring will be tested after the integration phase as part of the end-user ETSO application or as part of a type-certification programme.
Lightning-Induced Transient Susceptibility	22.0	Mandatory for CCA interfaces that are directly connected to the aircraft wiring. Note: CCA interfaces that are not directly connected to the aircraft wiring will be tested after the integration phase as part of the end-user ETSO application or as part of a type-certification programme.
Lightning Direct Effects	23.0	Optional
Icing	24.0	Optional
Electrostatic Discharge (ESD)	25.0	Optional
Fire, Flammability	26.0	Mandatory for flammability (ED-14/DO-160 Section 26, Category C)

3.1.2.2 Environmental Test Procedures for End User

The end user of this ETSO article will be required to complete the environmental qualification testing after integration of the ETSO-2C204a CCA. In order to allow the end user to properly test the functionality of the SBAS CCA functional sensor in environmental conditions, the applicant for the 'SBAS CCA functional sensor' shall provide the detailed functional test procedures to evaluate the required performance of the SBAS CCA functional sensor in compliance with RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated 15 December 2016, Section 2.4.

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.

A failure of the function defined in paragraph 3.1.1 of this ETSO is a:

— major failure condition for a loss of function and malfunction of en route, terminal, approach lateral navigation (LNAV), and approach LNAV/vertical navigation (VNAV) position data;

— major failure condition for a loss of function of approach localiser performance without vertical guidance (LP), and approach localiser performance with vertical guidance (LPV) position data; and

— hazardous failure condition for a malfunction of approach (LP and LPV) position data that results in misleading information.

3.2.2 Additional Specific

If the SBAS CCA functional sensor can only satisfy the requirements of RTCA document DO-229E when used with a particular antenna, the use of that antenna (by part number) shall be a requirement on the installation.

This requirement shall be included in the installation manual as a limitation.

The applicant shall have all the data necessary to evaluate the geostationary (GEO) satellite bias as defined in RTCA document DO-229E, Section 2.1.4.1.5, available for review by EASA.

If the SBAS CCA functional sensor uses barometric-aiding to enhance the availability of FDE, then the equipment shall meet the requirements in RTCA document DO-229E, Appendix G.

The applicant shall provide to the end user the detailed functional test procedures of the SBAS CCA functional sensor for the end user to complete the environmental testing.

The intended installation environment and the associated installation constraints should be documented in the installation manual.

<u>Limitations</u>

The following specific limitations shall be documented in the installation manual and in the declaration of design and performance (DDP) of the SBAS CCA functional sensor:

— ‘The manufacturer of the end-use equipment, who installs the <insert

equipment model> SBAS CCA functional sensor, is required to perform the testing described in ETSO-C145<latest revision> Appendix 1 with the SBAS CCA functional sensor installed in the end-use equipment.'

— 'The manufacturer of end-use equipment is required to complete full environmental qualification at the end-use equipment level.'

4 Marking

4.1 General

See CS-ETSO, Subpart A, paragraph 1.2.

4.2 Specific

The SBAS CCA functional sensor must be permanently and legibly marked with the operational equipment class (e.g. Class 2), as defined in Section 1.4.2 of RTCA document DO-229E. The functional equipment class (e.g. Beta) defined in Section 1.4.1 of RTCA document DO-229E is not required to be marked.

It is sufficient to declare the proper functional equipment class in the DDP.

5 Availability of Referenced Documents

See CS-ETSO, Subpart A, paragraph 3.

[Amdt ETSO/16]

Appendix 1 to ETSO-2C204a – Addition to RTCA Document DO-229E

ED Decision 2020/011/R

This Appendix describes the modifications and additions to RTCA DO-229E that are required for compliance with this ETSO.

This Appendix adds a new Section 1.8.3, on cybersecurity and GNSS spoofing mitigation, to RTCA document DO-229E, and corrects a long-standing mistake in the Section 2.4 environmental requirements tables. The new section provides information for cybersecurity and GNSS spoofing mitigation to make RTCA document DO-229E consistent with the new RTCA MOPS template and RTCA document DO-253D, Minimum Operational Performance Standards for GPS Local Area Augmentation System Airborne Equipment, dated July 2017.

1.8.3 Cybersecurity and GNSS Spoofing Mitigation.

This section contains information to address intentional interference with the GNSS. Spoofing is caused by RF waveforms that mimic true signals in some ways, but deny, degrade, disrupt, or deceive the operation of a receiver when they are processed. Spoofing may be unintentional, such as effects from the signals of a GNSS repeater, or may be intentional and even malicious. There are two classes of spoofing:

— Measurement spoofing introduces RF waveforms that cause the target receiver to produce incorrect measurements of the time of arrival or the frequency of arrival, or their rates of change;

— Data spoofing introduces incorrect digital data to the target receiver for its use in the processing of signals and the calculation of positioning, navigation and timing (PNT).

Either class of spoofing can cause a range of effects: from incorrect outputs of PNT to receiver malfunctions. The onset of effects can be instantaneous or delayed, and the effects can continue even after the spoofing has ended. Improperly used or improperly installed GNSS re-radiators act like spoofers. Re-radiators, replay and GNSS emulator devices can present misleading information to GNSS equipment and/or could cause lasting effects.

Equipment manufacturers should implement measures to mitigate the processing of erroneous data. Cross-checks of GNSS sensor data against independent position sources and/or other detection monitors using GNSS signal metrics or data checks can be implemented in the antenna, receiver, and/or through integration with other systems at the aircraft level. Data validity checks to recognise and reject measurement and data spoofing should be implemented in the receiver. Additional guidance and best practices related to GPS equipment can be found in the U.S. Department of Homeland Security document 'Improving the Operation and Development of Global Positioning System (GPS) Equipment Used by Critical Infrastructure'[1] and GLOBAL POSITIONING SYSTEMS DIRECTORATE SYSTEMS ENGINEERING & INTEGRATION: INTERFACE SPECIFICATION, IS-GPS-200, Navstar GPS Space Segment/Navigation User Interfaces, Revision H, IRN-IS-200H-003, 28 July 2016.

Aircraft equipment information vulnerabilities (such as cybersecurity risks) have been present for digital systems since the development of the personal computer (PC) in the late 1970s and even longer for RF systems, and the advent of internet connectivity has substantially increased those risks. Typically, access to navigation receivers has been controlled such that they are considered to be

[1] https://ics-cert.us-cert.gov/sites/default/files/documents/Improving_the_Operation_and_Development_of_Global_Positioning_System_(GPS)_Equipment_Used_by_Critical_Infrastructure_S508C.pdf

vulnerable only to RF signals and OEM and/or aircraft operator controlled processes for maintenance and update. In some cases, aircraft GNSS receivers may be field-loadable by approved personnel, requiring physical access and a physical interface to the ground receivers. However, it is expected that not all aircraft in the future will rely on such physical isolation for the security of avionics. Internet and Wi-Fi connectivity have become popular as means for aircraft or equipment manufacturers to update the software of installed avionics, to update databases, or provide an alternate means of communicating with the flight crew or cabin (e.g. in-flight entertainment, weather, etc.).

In most countries, the State provides oversight of safety-of-flight systems (sometimes referred to as ‘authorised services’) which provide information to aircraft, such as ILS, VOR, GNSS and DME, to name a few. However, the State typically does not provide oversight of ‘non-trusted’ connectivity such as the internet, Wi-Fi, or manufacturer-supplied equipment interfaces which permit the input of externally supplied data into aircraft systems. A manufacturer may expose aircraft information vulnerabilities through the design of the equipment, or the equipment may become vulnerable as a result of being connected to a common interface. Therefore, it is important for manufacturers to consider aircraft information security risk mitigation strategies in their equipment design, particularly when the equipment is responsible for an interface between the aircraft and aircraft-external systems.

Apart from any specific aircraft-information-security-related performance requirements that are contained in the MOPS, it is recommended that manufacturers should consider a layered approach to aircraft information security risk mitigation that includes both technical (e.g. software, signal filtering) and physical strategies. From a technical perspective, for example, this could include signal spoofing detection capabilities or more stringent, multi-factored authentication techniques such as passwords, PINs, and digital certificates. And finally, but just as important, manufacturers should consider supply chain risk management; for example, if a manufacturer outsources the development of software code, are the contractor and its staff properly vetted?

Civil aviation authorities (CAAs) have a regulatory interest when an applicant’s design makes use of a non-trusted connection through which the installation can potentially introduce aircraft information security vulnerabilities. This requires the applicant to address not only the information security vulnerabilities and mitigation techniques for the new installation, but to also consider how vulnerabilities could propagate to existing downstream systems. Therefore, manufacturers are recommended to reference their equipment aircraft information security review and mitigation strategies in the installation manual of the equipment so that the applicant can consider them in meeting the regulatory requirements of the installation.

Table 2-14 to Table 2-20

The tables incorrectly reference and label RTCA document DO-160 Sections 16.5.1.2 and 16.6.1.2 regarding ‘2.1.1.7 Acquisition Time’ and ‘2.1.1.9 Reacquisition Time’. Change the table references as follows:

The MOPS initial acquisition time requirement (2.1.1.7) applies to both AC and DC equipment under abnormal operating conditions (DO-160E Sections 16.5.2 and 16.6.2) and the satellite reacquisition time requirement (2.1.1.9) applies to both AC and DC equipment under normal operating conditions (DO-160E Sections 16.5.1 and 16.6.1).

[Amdt ETSO/16]

Appendix 2 to ETSO-2C204a – Addition to RTCA Document DO-229E

ED Decision 2020/011/R

Reserved.

[Amdt ETSO/16]

Appendix 3 to ETSO-2C204a

ED Decision 2020/011/R

This Appendix describes the EASA modifications to RTCA document DO-229E, Section 2.

In Section 2.1.1.2, after the first sentence, add the following:

'The demodulation of data from the GPS signals shall be restricted to the necessary subset of the data defined in Appendix II to IS-GPS-200D, "Navstar GPS Space Segment/Navigation User Interfaces", December 2004, provided on RF link L1. The pseudo-ranging shall be performed on RF link L1 utilising the coarse/acquisition (C/A) code.'

This is to ensure that only the L1 NAV data, for which the SBAS provides corrections and integrity, is used, and that no CNAV data, which is defined in Appendix III to IS-GPS-200D, is used, for which the SBAS does not provide integrity.

[Amdt ETSO/16]