

Deviation Request ETSO-C146eA1#1 for an ETSO approval for CS-ETSO applicable to Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System (ETSO-C146eA1) 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-C146eA1#1 Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System

2.1 Deviation

Summary of the Deviation is:

Deviates from ETSO-C146eA1§3.1, DO-229E and ETSO-C146eA1-Appendix 4, to use IS-GPS-200H instead of IS-GPS-200D, for the demodulation of GPS signals and signal processing, provided that some key features of IS-GPS-200H listed in this deviation request and only these are used.

Complete deviation is detailed hereunder:

Deviates from ETSO-C146eA1 §3.1, DO-229E and ETSO-C146eA1-Appendix 4, to use IS-GPS-200H instead of IS-GPS-200D for the demodulation of GPS signals and signal processing, provided that the following features of IS-GPS-200H and only these are used:

- Signal tracking and data demodulation limited to GPS L1C/A signals from GPS PRN 1 to 32 and to Legacy NAV (LNAV) of Block II, Block IIA, Block IIR, Block IIR-M, Block IIF and GPS III satellites.
- Data demodulation restricted to Legacy NAV (LNAV) data defined in IS-GPS-200H appendix II and to the use of the following bit fields and associated requirements:
 - Default navigation pattern
 - Null navigation pattern
 - bit 25 to 30 of all GPS words: parity

- bit 1 to 8 of all GPS subframes: preamble
- bit 23 of all GPS sub frames: Integrity Status Flag (optional provided Note 1 is fulfilled)
- bit 31 to 48 of all GPS subframes: time of week, alert flag
- bit 50 to 52 of all GPS subframe: subframe ID
- bit 61 to 70 of GPS Subframe 1: week number
- bit 73 to 84 of GPS Subframe 1: URA, Health, IODC MSB
- bit 197 to 204 of GPS Subframe 1: TGD
- bit 211 to 234 of GPS Subframe 1: IODC LSB, TOC
- bit 241 to 264 of GPS Subframe 1: Ephem Af2, Af1
- bit 271 to 292 of GPS Subframe 1: Ephem Af0
- bit 61 to 84 of GPS Subframe 2: IODE, Ephem CRS
- bit 91 to 114 of GPS Subframe 2: Ephem DeltaN, Ephem M0 MSB
- bit 121 to 144 of GPS Subframe 2: Ephem M0 LSB
- bit 151 to 174 of GPS Subframe 2: Ephem CUC, Ephem e MSB
- bit 181 to 204 of GPS Subframe 2: Ephem e LSB
- bit 211 to 234 of GPS Subframe 2: Ephem CUS, Ephem SqrtA MSB
- bit 241 to 264 of GPS Subframe 2: Ephem SqrtA LSB
- bit 271 to 287 of GPS Subframe 2: Ephem TOE, Ephem Fit interval flag
- bit 61 to 84 of GPS Subframe 3: Ephem CIC, Ephem Omega0 MSB
- bit 91 to 114 of GPS Subframe 3: Ephem Omega0 LSB
- bit 121 to 144 of GPS Subframe 3: Ephem CIS, Ephem I0 MSB
- bit 151 to 174 of GPS subframe 3: Ephem I0 LSB
- bit 181 to 204 of GPS subframe 3: Ephem CRC, Ephem Omega MSB
- bit 211 to 234 of GPS subframe 3: Ephem Omega LSB
- bit 241 to 264 of GPS subframe 3: Ephem Omega dot
- bit 271 to 292 of GPS subframe 3: Ephem IODE, Ephem Idot
- bit 60 to 61 of GPS sub frame 4 and 5: Data ID Number
- bit 63 to 68 of GPS subframe 4 and 5: SV ID
- bit 69 to 84 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm e
- bit 91 to 114 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm TOA, Alm DeltaI
- bit 121 to 136 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm OmegaDot
- bit 151 to 174 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm SqrtA

- bit 181 to 204 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm Omega0
- bit 211 to 234 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm Omega
- bit 241 to 264 of GPS subframe 4 and 5 with SV ID = 1 to 32: Alm M0
- bit 69 to 84 of GPS subframe 4 with SV ID = 56: Iono Alpha0, Iono Alpha1
- bit 91 to 114 of GPS subframe 4 with SV ID = 56: Iono Alpha2, Iono Alpha3, Iono Beta0
- bit 121 to 144 of GPS subframe 4 with SV ID = 56: Iono Beta1, Iono Beta2, Iono Beta3
- bit 151 to 174 of GPS subframe 4 with SV ID = 56: UTC A1
- bit 181 to 204 of GPS subframe 4 with SV ID = 56: UTC A0 MSB
- bit 211 to 234 of GPS subframe 4 with SV ID = 56: UTC A0 LSB, UTC TOT, UTC WNT
- bit 241 to 264 of GPS subframe 4 with SV ID = 56: UTC DTLS, UTC WNLSF, UTC DN
- bit 271 to 278 of GPS subframe 4 with SV ID = 56: UTC DTLSF

Note 1: As the new definition in IS-GPS-200H is a superset of the definition in IS-GPS-200D, it is accepted to not decode this Integrity Status Flag bit if only the IS-GPS-200D definition is used i.e. the probability of the URE exceeding 4.42 times URA for more than 5.2 seconds, without an accompanying alert, is less than 1E-5 per hour . In this context, an "alert" is defined as any indication or characteristic of the conveying signal.

2.2 Original Requirement

Section 3.1.1 of the ETSO standard references DO-229E which one refers to IS-GPS-200D in multiple sections, as listed below. Appendix 4 of the ETSO standard also refers directly to IS-GPS-200D.

Here are the different original MPS text:

MPS from ETSO-C146eA1-Appendix 4:

"In Section 2.1.1.2, after the first sentence add:

'The demodulation of data from the GPS signals shall be restricted to the necessary subset of the data defined in Appendix II of 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 utilizing 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 of IS-GPS-200D, is used, for which the SBAS does not provide integrity."

MPS from DO-229E:

DO-229E §1.2.2.1: "Detailed GPS Standard Positioning Service (SPS) information is provided in the GPS SPS Performance Standard, 4th edition, September 2008, and IS-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces", December 2004."

DO-229E §1.8.1.1: "It is also assumed that the GPS signals being transmitted are in conformance with IS-GPS-200D, "Navstar GPS Space Segment / Navigation User Interfaces", December 2004; and, that Selective Availability (SA) is inactive per U.S. government policy."

DO-229E §2.1.1.2: “The equipment shall be designed to process the GPS signals and necessary data described in the IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004, under interference conditions described in Appendix C and under the minimum signal conditions defined in Section 2.1.1.10.”

DO-229E §2.1.1.2, §2.1.1.3.1, §2.1.1.3.3: “If the ionospheric corrections provided by the SBAS are not applied to a pseudorange, then the equipment shall decode the ionospheric coefficients in the GPS navigation message and apply the ionospheric corrections described in the IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004”.

DO-229E §2.1.1.5.5: “The equipment shall designate any GPS satellite as GPS UNHEALTHY if the GPS satellite navigation message meets any of the following conditions:

a) 6 bit health word in subframe 1: all cases where MSB=“1” (ref. 20.3.3.3.1.4 and 20.3.3.5.1.3 of IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004, [...]

d) Bit 18 of the HOW set to 1 (Ref. 20.3.2 of IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004.);[...]

f) Default navigation data [alternating one’s and zero’s] is being transmitted in subframes 1, 2, or 3 (ref. 20.3.2 of IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004);”

DO-229E §2.1.2.2.2: “Note 1: The nominal URA index in IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004, paragraph 20.3.3.3.1.3 can be used to determine range-domain uncertainty by assuming the URA maps into the near-Gaussian distribution”

DO-229E §2.5: “The GPS/SBAS simulator shall operate in accordance with the Navstar GPS Interface Specification (IS-GPS-200D), SBAS standards and recommended practices in ICAO Annex 10 Volume I through Amendment 90, and Appendix A.”

DO-229E §A.3: “a) They must belong to the same family of 1023-bit Gold codes as the 37 C/A codes reserved by the GPS system and specified in the Navstar Global Positioning System Interface Specification (IS-GPS-200D) [1].”

DO-229E §A.5: “1) NAVSTAR Global Positioning System Interface Specification, IS-GPS-200D, 7 December 2004.”

*DO-229E §J.2.3: “c = the speed of light in a vacuum (2.99792458x10⁸ meters/sec, see IS-GPS-200D pg 89)
Tiono = ionospheric correction (seconds, see Section 20.3.3.5.2.5 of IS-GPS-200D).*

phim is the geomagnetic latitude as defined in Section 20.3.3.5.2.5 of IS-GPS-200D.”

2.3 Industry

Interface Specification IS-GPS-200 defines the requirements related to the interface between the space segment of the Global Positioning System and the navigation user segment of the GPS for radio frequency link 1 (L1) and link 2 (L2).

This document is published by the GPS Directorate and is regularly updated to take into account document improvements and evolutions of GNSS signals. The GPS Directorate recommends to use the latest version of IS-GPS-200.

It is proposed to use IS-GPS-200H dated September 2013 instead of IS-GPS-200D dated December 2004 on the entire DO-229E, ETSO-C145e and ETSO-C146e for a new GPS receiver design, as it reflects an up-to-date interfaces of the GNSS signals, including signals which are planned to be available to users in the coming years.

For the use of IS-GPS-200H, equivalent level of safety is demonstrated since the definition and processing algorithms of the GPS L1 C/A signal are unchanged. In particular the ionospheric model defined in Figure 20-4 of IS-GPS-200, and called in DO-229E §2.1.1.2, §2.1.1.3.1, §2.1.1.3.3.

The main changes between issue D and issue H of IS-GPS-200 are related to:

- PRN codes sequences expansion (PRN 38 to 63), applicable to GPS III and subsequent blocks. In the IS-GPS-200H, these “PRNs 38-63 are required per this Table if a manufacturer chooses to include these PRNs in their receiver design”. The deviation request explicitly excludes the use of such extended range of PRNs.
- Planned evolutions of the GNSS signal without impact on the current GPS L1 C/A signal (e.g. GPS IIIA and CNAV data) that are explicitly excluded from the deviation request.

Application of revision H instead of revision D enables to cope with GPS SIS that is actually defined by more recent revision of IS-GPS-200 and to solve the following ambiguities compared to up-to-date signal in space:

- 1) Revision H addresses GPS Block III signals while revision D does not. Application of revision H enables to confirm possibility to use GPS Block III satellite signals in ETSO receivers.
- 2) Revision H addresses how to proceed with dummy satellites, enabling to improve the level of safety of ETSO receivers: “Users shall only use non-dummy satellites as defined via current broadcast almanac. See Section 20.3.3.5.1.2 and/or Section 40.3.3.5.1.2 for the definition of information about dummy satellites in the almanac.”.

2.4 Equivalent Level of Safety

Equivalent Level of Safety is obtained by the following considerations:

- Application of IS-GPS-200H enables to confirm possibility to use GPS Block III satellite signals in ETSO receivers.
- Application of IS-GPS-200H addresses how to proceed with dummy satellites, enabling to improve the level of safety of ETSO receivers.
- The list of features to be used from IS-GPS-200H is kept focused to key features so as to control the impact on airworthiness.

2.5 EASA position

We accept the deviation.