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SIST EN 16605:2025

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Vesolje - Časovni sprejemnik Galileo - Funkcionalne in izvedbene zahteve ter s tem povezani preskusi

Space - Galileo Timing Receiver - Functional and Performance Requirements and associated Tests

Raumfahrt - Galileo Timing Receiver - Funktions- und Leistungsanforderungen und zugehörige Tests

Espace - Récepteur de signaux Galileo pour référence temps - Exigences fonctionnelles et de performances, et essais associés

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Contents

European foreword

This document (EN 16605:2024) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2025, and conflicting national standards shall be withdrawn at the latest by June 2025.

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Introduction

The timing capabilities, which are inherent to all GNSS, constitute a paramount benefit allowing the timing solutions of excellent performance worldwide. Those capabilities have the particularity to be exploited by sectors which are strategic for the functioning of the modern society. These are the critical infrastructures such as Telecommunications, Energy and Finance. While timing represents in itself a small market compared to others if only timing receivers are taken into account, it is an enabler of critical infrastructures, and thus important for the entire European economy and society. In addition to those strategic sectors, timing is also used in a wide variety of applications including metrology, remote sensing and atmosphere research.

The importance of the timing capability has been considered by the European Commission substantial enough to give it the category of a proper Service in itself as part of the Galileo Service portfolio. This has been formalized at the level of an EU Regulation [62].

The Service definition undoubtedly starts by taking into account the needs of its intended users and be flexible to accommodate their evolutions. To that end, stakeholder's consultations and interactions with the user community took place and led to the identification of the need to increase robustness and trust in the timing products. This aspect has then been incorporated as a key feature for the Galileo Timing Service.

With the Service characteristics and associated performance targets specified, the implementation of the Service provision implies putting together all the necessary elements to be able to meet those targets and to ensure that they are maintained over the Service lifetime.

When all is ready, a formal Service declaration informs the users that they can, from then on, rely on it to develop their own applications.

The Galileo Timing Service concept relies on two fundamental pillars:

— dissemination of information dedicated at timing users, packaged in a Timing Service Message as part of the Galileo Signal in Space,

— standard for Galileo timing receivers, to ensure that the information provided is adequately processed as intended and the implementation of local barriers enhancing robustness.

The intent of this document is to specify Requirements and Tests for Galileo timing receivers as part of the Galileo Timing Service. The target users for the standard are all Galileo Timing users, with special focus on critical infrastructures and critical applications. The standard takes into account the specificities of the Galileo Timing Service. This is fundamental in order to ensure the end-to-end performance of the Galileo Timing Service for those users who make use of a receiver developed according to the standard. The Galileo Timing Service covers needs and requirements of timing and synchronization for most users, and it is driven by the critical infrastructure sectors of Energy, Telecom and Finance. The Galileo Timing Service foresees to support various service monitoring levels accordingly, which is reflected in the document.

Finally, it is worth recalling that although GNSS receivers are already being used in timing applications – in particular GPS since it was the first operational GNSS System – there is no associated standard. This will be then a first, with full support from European Commission, which gives testimony of how serious the Timing Service is taken into account at EU level.

1 Scope

This document specifies the functional and performance requirements and associated tests for Galileo timing receivers. The approach for this document is that of a performance based, meaning that no specific algorithm implementation is required. Instead, performance requirements are specified together with a corresponding test suite for verification.

This document is applicable to the Galileo chipset. This document does not apply to other sensors and/or additional processing that a higher synchronization Unit can implement on top of the Galileo chipset.

This document is applicable to the following aspects related to Galileo timing receivers:

— GNSS constellations and frequencies processed: Galileo Dual-Frequency. Other modes are optional, as explained below;

— time scales, including Galileo System Time and Coordinated Universal Time;

— Services Levels, this document covers the 2 levels of Service for GST and for UTC to be provided by Galileo Time Service in the first place. The document also anticipates a third Service Level to be provided in the future, for which an update of the document will be needed;

— user dynamics: fixed users, defined as static users with precise knowledge of the antenna position, is the baseline mode;

— processing of Timing Service Message disseminated by the Galileo System;

— local timing integrity barriers: As a minimum, Time Receiver Autonomous Integrity Monitoring processing (T-RAIM);

— robustness to interferences;

— Galileo Open Service Navigation Message Authentication processing;

— robustness to multipath.

This document does not apply to the processing of GPS constellation but this does not preclude Manufacturers to implement GPS processing within the Galileo timing receivers, even if not addressed in this document. The use of other GNSS constellations is not forbidden by this document but the requirements and tests are defined considering Galileo-only, including those related to the integrity of the timing solution.

This document does not apply to single-frequency modes. This does not preclude manufacturers to implement single-frequency modes within the Galileo timing receivers, even if not addressed in this document, as a back-up of the nominal Dual-Frequency mode, and reversion mechanisms. It is important to remark that the integrity of the timing solution is only specified for Galileo Dual-Frequency mode.

The Galileo timing receivers is only applicable to users operating in static conditions. This document does not apply to moving users.

On top of the functional requirements, performance requirements are specified in this document in terms of different key performance indicators such as:

— accuracy, availability and integrity requirements;

— local barriers, T-RAIM performances.

This document also provides the verification matrix and specifies the test suite to verify the most fundamental requirements of the Galileo timing receivers.

Finally, this document specifies a subclause dedicated to guidelines for the installation and maintenance of the Galileo timing receivers. This is a comprehensive subclause, including provisions for the antenna, cabling and receiver installation, as well as the calibration of time delays.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases (see also [43]) for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
accuracy
degree of conformance of the position, velocity and/or time with the true position, velocity and/or time of the GNSS user

Note 1 to entry: In the case of this document, the focus is placed on the accuracy of an estimated time, it is measured in nanoseconds and is provided as a statistic threshold (e.g. 2-sigma). The concept of accuracy in this document is equivalent to the one in other more general standards such as ISO/IEC Guide 99:2007.

3.1.2
availability
percentage of time that the services of the system are usable by the user

Note 1 to entry: Availability is an indication of the ability of the system to provide usable service within the specified coverage area. Signal availability is the percentage of time that navigation/timing signals transmitted from external sources are available for use. It is a function of both the physical characteristics of the environment and the technical capabilities of the transmitter facilities. Availability is usually expressed in a % of time over a specified period.

Note 2 to entry: Availability = (Number_Epochs_Timing_Service_Available / Total_Number_of_Epochs) * 100

Note 3 to entry: For the particular case of the Availability of the Galileo Timing Service, the Availability concept is used for the availability of the Service Levels 1, 2 and 3 instead of signal availability.

3.1.3
back-up mode
operational mode of the synchronization unit hosting the Galileo timing receiver in which some of the functionality and/or input data are not available for the complete performances to be reached, but can still continue operating under certain functional constraints

3.1.4
Carrier to Noise ratio
C/N0
SNR of a modulated signal consisting of the ratio of the power of the transmitted signal in the passband frequency over the power of the noise per unit bandwidth, expressed in dB-Hz

3.1.5
dynamic mode
unitless specification of the position/time error propagation as an effect of the satellite position and pseudorange geometry towards the receiver, considering that solutions calculated using pseudoranges of close satellites have greater uncertainties compared with solutions calculated using distant satellites

3.1.6
dilution of precision
DOP
dilution of precision is a term used to specify the position/time error propagation as an effect satellite position and pseudorange geometry towards the receiver. Solutions calculated using pseudoranges of close satellites have greater uncertainties compared with solutions calculated using distanced satellites. DOP is unitless

3.1.7
Galileo timing receiver
electronic device, typically a chipset, that processes the Galileo satellite signals captured by an antenna, to provide accurate time information in the form of PPS signal and accompanying messages

3.1.8
generalist RF test laboratory
laboratory in charge of assessing the performances of the Galileo timing receiver thanks to test scenario

3.1.9
GGTO
GPS-Galileo time offset data, broadcasted by Galileo Satellites, usually expressed in nanoseconds

3.1.10
Global Navigation Satellite System
GNSS
acronym designating satellite positioning systems, being the standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage, including GPS, GLONASS, Galileo and Beidou

3.1.11
GNSS-specialized laboratory
laboratory in charge of producing test scenarios for generalist RF test laboratories

3.1.12
Galileo System Time
GST
continuous time scale maintained by the Galileo Central Segment and synchronised with TAI (International Atomic Time) with a nominal offset below 50 ns

3.1.13
holdover
period of time in which two clocks run in an independent way relative to each other after an initial synchronization

3.1.14
holdover device
device within the synchronization unit which allows the holdover mode

3.1.15
holdover mode
operational mode of the synchronization unit hosting the Galileo timing receiver in which the time is running based on non-Galileo SIS timing computation from the last or present Epoch

3.1.16
holdover degradation
time and frequency difference between two clocks after the holdover period

3.1.17
holdover timeout
maximum time allowed for the synchronization unit hosting the Galileo timing receiver to work in holdover mode

Note 1 to entry: The maximum holdover period will depend on the type of local clock – local clock is affected by its own accuracy, accumulating time error with time - as well as the target Service monitoring level - higher Service monitoring level implies more stringent accuracy. The Synchronization Unit hosting the Galileo timing receiver should start counting the holdover time tholdover, from the moment when the switch is performed.

3.1.18
integrity
measure of the trust that can be placed in the correctness of the information supplied by a navigation/timing system, including the ability of the system to provide timely warnings to users when the system should not be used for navigation/timing

3.1.19
interference
source of RF transmission that is within the frequency band used by a communication link, and that degrades the performances of this link

3.1.20
Issue Of Data
IOD
sort of a time stamp on the GNSS data that the receiver gets from the navigation message

3.1.21
jamming
competing signal that prevents the GNSS receiver from decoding the true satellite signal

3.1.22
missed detection
failure in the timing solution, not detected by T-RAIM which does not allow to comply with the intended service level

3.1.23
Maximum Tolerable Error
MTE
maximum timing error with regard to a certain timescale (UTC or GST) that is expected or acceptable for the user

3.1.24
navigation message
message transmitted by the GNSS satellites to the users providing all the necessary information to allow the user to perform the positioning and timing service

3.1.25
performance
extent to which a system is able to meet its output goals

3.1.26
pseudorange
measurement, by the GNSS receiver, of the distance between a satellite antenna and the receiver antenna, biased by the error due to the difference between the satellite clock and the receiver clock

3.1.27
record & replay
test techniques consisting of digitalizing GNSS signals and sensor measurements in real world campaigns so that they can be repeated later in suitable laboratory test benches

3.1.28
safety probability of failure
likelihood of a failure of the timing solution during a certain time interval

3.1.29
Signal Noise Ratio
SNR
ratio between signal power to the noise power, normally expressed in dB

3.1.30
spoofing
transmission of signals intended to deceive PVT processing into reporting false PVT target data

3.1.31
static mode
operational mode in which the center of phase of the omnidirectional antenna(s) connected to the Galileo timing receiver is(are) fixed and the Galileo timing receiver uses an accurately predetermined position of them for the computation of the time solution

3.1.32
synchronization unit
system of the T&S user hosting the Galileo timing receiver which could comprise other components such as e.g. a local clock for Holdover Mode, visual interface with the user, etc

3.1.33
holdover time
t_{holdover}
time interval starting with the instant the synchronization unit hosting the Galileo timing receiver starts operating in the holdover mode until the present, usually expressed in seconds

3.1.34
International Atomic Time
TAI
time reference coordinate calculated by the Bureau International de l'Heure on the basis of the readings of atomic clocks operating in various establishments in accordance with the definition of second, the unit of time of the system of international System of Units (SI), being a coordinate time scale defined in a geocentric reference frame with a unit increment of 1 s realized on the rotating geoid rotating as the scale unit

3.1.35
TDOP
dilution of precision for the timing solution, unitless

3.1.36
test scenario
scenario composed of GNSS SIS data resulting from recording activities to assess a Galileo timing receiver in the desired environments

3.1.37
time error
definition of a failure in timing is provided in 4.3.3

3.1.38
Time Of Day
TOD
sequence describing the hour, minute and second in the current day and which is incremented on the rising edge of the Galileo timing receiver 1PPS

3.1.39
Time Of Week
TOW
number of seconds, in 20 bits, that have occurred since the transition from the previous week. The TOW covers an entire week from 0 to 604799 seconds and is reset to zero at the end of each week

3.1.40
Time To Alert
TTA
maximum allowable time elapsed from the onset of an out of tolerance condition (i.e. timing error greater than MTE) until the equipment enunciates the alert, usually expressed in seconds/minutes

3.1.41
Time To Notify
TTN
notification time required for the system to flag a satellite as don't use and alert the user, usually expressed in seconds/minutes

Note 1 to entry: The difference between TTN and TTA is explained in 4.3.7.

3.1.42
Timing RAIM
T-RAIM
user algorithm that determines the integrity of the GNSS solution, being the timing version of RAIM algorithms applicable to timing receivers