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INTERNATIONAL STANDARD

Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) –
Part 7: Satellite based augmentation system (SBAS) L1 – Receiver equipment – Performance standards, methods of testing and required test results

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The text of this International Standard is based on the following documents:

Draft	Report on voting
80/1104/FDIS	80/1114A/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61108 series, published under the general title *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Satellite based augmentation system (SBAS) is designed to augment Global Navigation Satellite System (GNSS) by broadcasting additional signals from geostationary (GEO) satellites. The basic scheme is to use a set of ground monitoring stations (at precisely surveyed locations) to receive GNSS signals that are processed and transmitted to the master station(s) which formulates the correction messages applicable to users within the service area (i.e. ionospheric errors, satellite position/clock errors, etc.). These corrections are then transmitted to navigation payloads via uplink stations on GEO satellites. The GEO satellites then transmit these corrections in a GNSS-like signal across the service area. An integrity message is also broadcasted enabling receivers to remove errors in the GNSS signal for increased position accuracy and integrity. Users are notified within a few seconds of information that could lead to position error.

SBAS are civil aviation safety-critical system and are designed according to an international standard (SARPs:2023). So far, SBAS have already been commissioned by the US (Wide Area Augmentation System – WAAS), Europe (European Geostationary Navigation Overlay Service – EGNOS), Japan (Michibiki Satellite Augmentation System – MSAS) and India (GPS Aided GEO Augmented Navigation – GAGAN). At September 2022, analogous systems are under commissioning or development in other regions of the world such as BeiDou Satellite Based Augmentation System – BDSBAS in China, System of Differential Correction and Monitoring – SDCM in Russia, Korea Augmentation Satellite System – KASS in Republic of Korea, Southern Positioning Augmentation System – SouthPAN in Australia and New Zealand, Augmented Navigation for Africa – ANGA and the Solución de Aumentación para Caribe, Centro y Sudamérica – SACCSA in South/Central America and the Caribbean.

The maritime community is interested in using SBAS for ocean waters, coastal waters and harbour entrances/approaches in order to fulfil the agreed international operational performance requirements (IMO Resolution A.1046(27)), especially where there is no other augmentation service available (i.e. DGPS/DGLONASS) or in poorly covered environments. Besides, when Ground Based Augmentation Systems (GBAS) are available, SBAS could become either the primary augmentation system or could act as a back-up. SBAS aims at providing satellite clock/ephemeris corrections, ionospheric corrections and integrity information to GNSS signals that meet maritime requirements, enhanced accuracy and integrity information.

IMO MSC.401(95) and IEC 61108-4 (Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment) allow the use of different augmentation signals in shipborne receivers but there is neither an IMO or IEC standard on how to process and implement SBAS signals in shipborne receivers. One of the operational and functional requirements (Module B) of IMO Resolution MSC.401(95) is that the equipment has the facilities to process augmentation data in accordance with the appropriate methods, e.g. Recommendation ITU-R M.823, RTCM 10410, or other relevant standards, already existing or still to be developed in particular for satellite based augmentation system (SBAS) adoption. This document provides the requested standard for SBAS L1 augmenting GPS L1.

Most of recent maritime GNSS receiver models are SBAS compatible but present important differences in their performance since they are not certified according to any specific test standard.

IEC 61108 is a series of IEC standards for "Maritime navigation and radio-communication equipment and systems – Global navigation satellite systems (GNSS)". IEC has published International Standards for the following GNSS systems: IEC 61108-1 for GPS, IEC 61108-2 for GLONASS, IEC 61108-3 for Galileo, IEC 61108-5 for BDS and IEC 61108-6 for IRNSS. In addition, IEC has published International Standard IEC 61108-4 for DGPS and DGLONASS which are Differential Global Navigation Satellite System (DGNSS) enhancing the primary GNSS constellations (GPS and GLONASS).

This document includes the minimum performances for the shipborne receivers, using SBAS L1 signals augmenting GPS L1, in order to be compliant with the IMO Resolution A.1046(27) operational requirements for ocean waters, harbour entrances, harbour approaches and coastal waters, along with the methods of testing and required test results.

Satellite Based Augmentation Systems (SBAS) are available in several regions worldwide to augment GPS L1 frequency by broadcasting additional SBAS L1 signals:

- SBAS are designed according to the same international standard (SARPs:2023).
- GPS L1 signal specification is presented in the GPS Interference Specification (IS-GPS-200).

A description of the GPS Standard Positioning Service Performance Standard (GPS-SPS-PS) is available at https://www.gps.gov.

NOTE A standard including dual-frequency multi-constellation (DFMC) SBAS services will be considered when appropriate.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) –

Part 7: Satellite based augmentation system (SBAS) L1 – Receiver equipment – Performance standards, methods of testing and required test results

1 Scope

This part of IEC 61108 specifies the minimum performance standards, methods of testing and required test results for Satellite based augmentation system (SBAS) shipborne receiver equipment, which uses L1 signals from GPS and satellite based augmentation system (SBAS) in order to improve the estimated GPS position.

This document addresses the use of SBAS L1 to provide augmentation to the GPS shipborne receiver (IMO Resolution MSC.112(73)). This document includes the minimum performances for SBAS L1 maritime receivers to be obtained by the receiver equipment under coverage of SBAS service in order to be compliant with the IMO Resolution A.1046(27) describing operational requirements for ocean waters, harbour entrances, harbour approaches and coastal waters.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60721-3-6:1987, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Ship environment*

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results*

IEC 61108-1:2003, *Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 1: Global positioning system (GPS) – Receiver equipment – Performance standards, methods of testing and required test results*

IEC 61162-1, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IEC 61162-2, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission*

IEC 61162-450, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 450: Multiple talkers and multiple listeners – Ethernet interconnection*

IEC 62923-1, *Maritime navigation and radiocommunication equipment and systems – Bridge alert management – Part 1: Operational and performance requirements, methods of testing and required test results*

IEC 62923-2, *Maritime navigation and radiocommunication equipment and systems – Bridge alert management – Part 2: Alert and cluster identifiers and other additional features*

IEC 62288, *Maritime navigation and radiocommunication equipment and systems – Presentation of navigation-related information on shipborne navigational displays – General requirements, methods of testing and required test results*

RTCA DO-229F:2020, *Minimum Operational Performance Standards (MOPS) for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment.*

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 terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
accuracy
degree of conformance between the estimated or measured parameter of a craft at a given time and its true parameter at that time

Note 1 to entry: Parameters in this context may be position coordinates, velocity, time, angle, etc.

Note 2 to entry: In particular, relative accuracy is the accuracy with which a user can determine position relative to that of another user of the same navigation system at the same time.

[SOURCE: IMO Resolution A.915(22)]

3.1.2
augmentation
any technique of providing enhancement to the GNSS in order to provide improved navigation performance to the user

Note 1 to entry: Satellite based augmentation system (SBAS) is a system providing additional satellite signals in order to enhance the performance of the GNSS service.

Note 2 to entry: Differential Global Navigation Satellite System (DGNSS) is a system providing additional signals from a ground-based station in order to enhance the performance of the GNSS service.

[SOURCE: IMO Resolution A.915(22)]

3.1.3
availability
percentage of time that an aid, or system of aids, is performing a required function under stated conditions. The non-availability can be caused by scheduled and/or unscheduled interruptions

Note 1 to entry: Signal availability is the availability of a radio signal in a specified coverage area.

Note 2 to entry: System availability is the availability of a system to a user, including signal availability and the performance of the user's receiver.

[SOURCE: IMO Resolution A.915(22)]

3.1.4
horizontal alert limit
HAL
maximum allowable horizontal error in the measured position – during integrity monitoring – before an alert is triggered

3.1.5
horizontal accuracy 95 %
95 percentile of the Horizontal Position Error (HPE) distribution, where HPE is the 2D radial error of the instantaneous measured position with respect to the true instantaneous position

Note 1 to entry: This definition corresponds with position error (percentile 95 %) within the document.

3.1.6
horizontal protection level
HPL
radius of a circle in the horizontal plane with its centre being at the true position, which specifies the region assured to contain the indicated horizontal position

Note 1 to entry: It is the horizontal region for which the missed alert requirement can be met.

3.1.7
integrity
ability to provide users with warnings within a specified time when the system should not be used for navigation and the horizontal accuracy is not within the selected accuracy level specified in 4.3.10.1

3.1.8
integrity monitoring
process of determining whether the system performance (or individual observations) allow use for navigation purposes.

Note 1 to entry: Overall GNSS system integrity is described by three parameters: the threshold value or alert limit, the time to alarm and the integrity risk.

Note 2 to entry: The output of integrity monitoring is that individual (erroneous) observations or the overall GNSS system cannot be used for navigation.

Note 3 to entry: Integrity risk is the probability that a user will experience a position error larger than the threshold value without an alarm being raised within the specified time to alarm at any instant of time at any location in the coverage area.

3.1.9
SBAS position
position computed by a GNSS shipborne receiver equipment using GNSS satellite constellation(s) augmented by SBAS

3.1.10
SBAS L1 receiver equipment
all the components and units necessary for the system to properly perform its intended functions, which includes the use case when a shipborne receiver provides a position using GPS satellite constellation augmented by SBAS L1

Note 1 to entry: When the same GNSS shipborne receiver equipment provides a PVT solution not augmented, this document is not applicable.

3.2 Abbreviated terms

BAM	bridge alert management
BDS	BeiDou navigation satellite system
C/A	coarse/acquisition
COG	course over ground
DGPS	differential GPS
EGNOS	European Geostationary Navigation Overlay Service
EUT	equipment under test
Galileo	European global navigation satellite system

GBAS	ground based augmentation systems
GEO	GEOstationary satellite
GIVEI	grid ionospheric vertical error indicator
GNSS	global navigation satellite system
GLONASS	Global'naya Navigatsionnaya Sputnikovaya Sistema
GPS	global positioning system
HDOP	horizontal dilution of precision
ICAO	International Civil Aviation Organization
ICD	interface control document
IGP	ionospheric grid point
IMO	International Maritime Organization
IODF	issue of data fast corrections
IODI	issue of data IGP mask
IODP	issue of data PRN mask
ITU-R	International Telecommunication Union-Radiocommunication
L1	GPS frequency 1 575,42 MHz
MKD	minimum keyboard and display
MT	message type
NavIC(IRNSS)	Navigation with Indian constellation
PDOP	position dilution of precision
PNT	position, navigation and timing
PRN	pseudo random noise
PVT	position velocity time
QZSS	Quasi-Zenith satellite system
RAIM	receiver autonomous integrity monitoring
RF	radio frequency
RTCA	Radio Technical Commission for Aeronautics
RTCM	Radio Technical Commission for Maritime Services
SBAS	satellite based augmentation system
SIS	signal in space
SNR	signal-to-noise ratio
SOG	speed over ground
SPS	standard positioning service
UDRE	user differential range error
UDREI	user differential range error indicator
UTC	coordinated universal time