BRITISH STANDARD

BS EN 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

The European Standard EN 61108-1:2003 has the status of a British Standard

ICS 47.020.70

British Standards

National foreword

This British Standard is the official English language version of EN 61108-1:2003. It is identical with IEC 61108-1:2003. It supersedes BS EN 61108-1:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/80, Maritime navigation and radiocommunication equipment and systems, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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English version

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 61108-1:2003)

Matériels et systèmes de navigation
et de radiocommunication maritimes –
Système mondial de navigation
par satellite (GNSS)
Partie 1: Système de positionnement
par satellite GPS –
Matériel de réception –
Normes de fonctionnement, méthodes
d'essai et résultats d'essai exigibles
(CEI 61108-1:2003)

Navigations- und
Funkkommunikationsgeräte
und -systeme für die Seeschifffahrt –
Weltweite Navigations-Satellitensysteme
(GNSS)
Teil 1: Weltweites Ortungssystem (GPS) –
Empfangsanlagen –
Funktionsanforderungen, Prüfverfahren
und geforderte Prüfergebnisse
(IEC 61108-1:2003)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 80/371/FDIS, future edition 2 of IEC 61108-1, prepared by IEC TC 80, Maritime navigation and radiocommunication equipment and systems, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61108-1 on 2003-10-01.

This European Standard supersedes EN 61108-1:1996.

It includes the following technical changes:

a) it reflects the changes brought about by IMP adopting GPS as part of the carriage requirement on ships defined in SOLAS Chapter V;

b) the new IMO performance standards, resolution MSC.112(73), replaced the previous issue, A.819(19), for new installations on the 1st of July 2002. This second edition of N 61108-1 incorporates revised tests for type approvals to the new performance standard;

c) changes include the need for a data output to the EN 61162 series giving COG SOG and UTC with validity marking, operation during interference conditions and improved failure warnings.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2004-07-01

– latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2006-10-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61108-1:2003 was approved by CENELEC as a European Standard without any modification.

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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

1 Scope

This part of IEC 61108 specifies the minimum performance standards, methods of testing and required test results for GPS shipborne receiver equipment, based on IMO Resolution MSC.112(73), which uses the signals from the United States of America, Department of Defence (US DOD), Global Positioning System (GPS) in order to determine position. A description of the GPS SPS is given in the normative reference – GPS, SPS signal specification – USA Department of Defence – 3rd Edition October 2001. This receiver standard applies to phases of the voyage "other waters" as defined in IMO Resolution A.529(13).

All text of this standard, whose meaning is identical to that in IMO Resolution MSC.112(73), is printed in *italics* and the Resolution and paragraph number indicated between brackets i.e. (M.112/A1.2).

The requirements in clause 4 are cross-referenced to the tests in clause 5 and vice versa.

2 Normative references

The following referenced documents are indispensable for the application 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 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

IMO Resolution A.529(13):1983, *Accuracy standards for navigation*

IMO Resolution A.694(17):1991, *General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO Resolution A.815(19):1995, *Worldwide radionavigation system*

IMO Resolution MSC.112(73):2000, *Performance standards for shipborne global positioning system (GPS) receiver equipment*

IMO Resolution MSC.114(73):2000, *Performance standards for shipborne DGPS and DGLONASS maritime radio beacon receiver equipment*

ITU-R Recommendation M.823-1:1995, *Technical characteristics of differential transmissions for global navigation satellite systems (GNSS) from maritime radio beacons in the frequency band 285 kHz-325 kHz (283,5 kHz-315 kHz in Region 1)*

ITU-R Recommendation M.823-2:1997, *Technical characteristics of differential transmissions for Global Navigation Satellite Systems from maritime radio beacons in the frequency band 283.5-315 kHz in Region 1 and 285-325 kHz in Regions 2 and 3*

ITU-R Recommendation M.1477:2000, *Technical and performance characteristics of current and planned radionavigation-satellite service (space-to-Earth) and aeronautical radio-navigation service receivers to be considered in interference studies in the band 1 559-1 610 MHz*

Global Positioning System – Standard Positioning Service – Performance Specification – USA Department of Defence – 3rd Edition October 2001

3 Terms, definitions and abbreviations

For the purposes of this document, all definitions and abbreviations used are the same as those used in the normative reference of the GPS SPS performance signal specification.

3.1 Definitions

3.1.1
integrity
ability of the system to provide users with warnings within a specified time when the system should not be used for navigation

3.2 Abbreviations

COG – Course Over Ground

DGPS – Differential Global Positioning System

GPS – Global Positioning System

HDOP – Horizontal Dilution Of Precision

PDOP – Position Dilution Of Precision

RAIM – Receiver Autonomous Integrity Monitor

SDME – Speed and Distance Measuring Equipment

SOG – Speed Over Ground

SPS – Standard Positioning Service

USNO – United States Naval Observatory

UTC – Universal Time Coordinated

4 Minimum performance standards

4.1 Object

(M.112/A1.2) *Receiver equipment for the Global Positioning System (GPS) system intended for navigational purposes on ships with maximum speeds not exceeding 70 knots* shall, *in addition to the general requirements contained in resolution A.694(17)*[1]*, comply with the following minimum performance requirements.*

(M.112/A1.3) *This standard covers the basic requirements of position fixing for navigation purposes only and does not cover other computational facilities which may be* provided *in the equipment.*

This standard contains the basic minimum performance standards for use of GPS Standard Positioning Service (SPS) signals for navigational position fixing, including differential corrections, and, in addition, for the determination of speed and direction of the movement of the antenna over the ground.

Other computational activity, input/output activity or extra display functions which may be provided shall not degrade the performance of the equipment below the minimum performance standards set out in this standard.

The GPS receiver equipment shall comply with

– the provisions of IMO Resolutions A.529(13), A.815(19), MSC.112(73) and A.694(17),
– the accuracy requirements of the GPS SPS Performance Standard,
– IEC 61162-1, IEC 61162-2, as appropriate, on digital interfaces, and
– shall be tested in accordance with IEC 60945.

NOTE For high speed craft purposes the EUT has to provide an IEC 61162-2 interface with a position update rate of 2 Hz.

4.2 GPS receiver equipment

(See 5.6.1)

4.2.1 Minimum facilities

(M.112/A2.1) The words "GPS receiver equipment" as used in these performance standards include all the components and units necessary for the system to properly perform its intended functions. The equipment shall *include the following minimum facilities:*

a) *antenna capable of receiving GPS signals;*
b) *GPS receiver and processor;*
c) *means of accessing the computed latitude/longitude position;*
d) *data control and interface; and*
e) *position display and, if required, other forms of output.*

4.2.2 Configuration

The GPS receiver equipment may be supplied in one of several configurations to provide the necessary position information. Examples are:

[1] Refer to Publication IEC 60945.

- stand-alone receiver with means of accessing computed position via a keyboard with the positional information suitably displayed;
- GPS black box receiver fed with operational parameters from external devices/remote locations and feeding an integrated system with means of access to the computed position via an appropriate interface, and the positional information available to at least one remote location.

The above examples should not be implied as limiting the scope of future development.

4.2.3 Quality assurance

The equipment shall be designed produced and documented by companies complying with approved quality systems as applicable.

4.3 Performance standards for GPS receiver equipment

4.3.1 General

(See 5.6.2)

(M.112/A3.1) *The GPS receiver equipment* shall *be capable of receiving and processing the Standard Positioning Service (SPS) and provide position information in latitude and longitude World Geodetic System (WGS-84) co-ordinates in degrees, minutes and thousandths of minutes and time of solution referenced to UTC (USNO). Means may be provided to transform the computed position based upon WGS-84 into data compatible with the datum of the navigational chart in use. Where this facility exists, the display* shall *indicate that co-ordinate conversion is being performed and* shall *identify the co-ordinate system in which the position is expressed.*

(M.112/A3.2) *The GPS receiver equipment* shall *operate on the L1 signal and C/A code*.

4.3.2 Equipment output

(See 5.6.3)

(M.112/A3.3) *The GPS receiver equipment* shall *be provided with at least one output from which position information can be supplied to other equipment. The output of position information based upon WGS-84 shall be in accordance with* International Standards – IEC 61162.

The position information output shall be in accordance with IEC 61162 as follows:

For positioning reporting purposes the following sentences shall be available in any combination.

DTM – Datum reference

GBS – GNSS satellite fault detection

GGA – GPS fix data

GNS – GNSS fix data

RMC – Recommended minimum specific GNSS data

VTG – Course over ground and ground speed

ZDA – Time and date

If a sentence uses a datum other than WGS-84 then the DTM sentence must be used in compliance with IEC 61162.

In addition, for integrating with other navigational aids the following sentences may be available in any combination.

GRS – GNSS range residuals

GSA – GNSS DOP and active satellites

GST – GNSS pseudorange error statistics

GSV – GNSS satellites in view

NOTE GRS, GSA, GST, GSV are required to support external integrity checking. They are to be synchronized with corresponding fix data (GGA or GNS).

4.3.3 Accuracy

(See 5.6.4)

4.3.3.1 Static accuracy

(M.112/A3.4) *The GPS receiver equipment* shall *have static accuracy such that the horizontal position of the antenna is determined to within 100 m (95 %) with horizontal dilution of precision (HDOP) ≤4 (or PDOP ≤6).* Since Selective Availability has been set to zero, the static accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001.

4.3.3.2 Dynamic accuracy

(M.112/A3.5) *The GPS receiver equipment* shall *have dynamic accuracy such that the position of the ship is determined to within 100 m (95 %) with HDOP ≤ 4 (or PDOP ≤6) under the conditions of sea state and ship's motion likely to be experienced in ships.*[2]. Since Selective Availability has been set to zero, the dynamic accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001.

4.3.4 Acquisition

(See 5.6.5)

(M.112/A3.6) *The GPS receiver equipment* shall *be capable of selecting automatically the appropriate satellite transmitted signals for determination of the ship's position with the required accuracy and update rate*.

(M.112/A3.8) *The GPS receiver equipment* shall *be capable of acquiring position to the required accuracy, within 30 min, when there is no valid almanac data.*

(M.112/A3.9) *The GPS receiver equipment* shall *be capable of acquiring position to the required accuracy, within 5 min, when there is valid almanac data.*

(M.112/A3.10) *The GPS receiver equipment* shall *be capable of re-acquiring position to the required accuracy, within 5 min, when the GPS signals are interrupted for a period of at least 24 h, but there is no loss of power.*

(M.112/A3.11) *The GPS receiver equipment* shall *be capable of re-acquiring position to the required accuracy, within 2 min, when subjected to a power interruption of 60 s.*

Acquisition is defined as the processing of GPS satellite signals to obtain a position fix within the required accuracies.

Four conditions of the GPS receiver equipment are set out under which the minimum performance standards shall be met.

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[2] IMO Resolution A.694 (17), IEC 60721-3-6 and IEC 60945.

Condition A

Initialization – the equipment has

– been transported over large distances (>1000 km to <10 000 km) without power or GPS signals or by the deletion of the current almanac; or
– not been powered for >7 days.

Condition B

Power outage: under normal operation the equipment loses power for at least 24 h.

Condition C

Interruption of GPS signal reception – under normal operation the GPS signal reception is interrupted for at least 24 h, but there is no loss of power.

Condition D

Brief interruption of power for 60 s.

No user action other than applying power and providing a clear view from the antenna for the GPS signals, shall be necessary, from any of the initial conditions above, in order to achieve the required acquisition time limits in Table 1.

Table 1 – Acquisition time limits

Equipment condition	A	B	C	D
Acquisition time limits (minutes)	30	5	5	2

4.3.5 Protection

(See 5.6.6)

4.3.5.1 Antenna and input/output connections

(M.112/A4) *Precautions* shall *be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the GPS receiver equipment inputs or outputs for a duration of 5 min.*

4.3.6 Antenna design

(See 5.6.7)

(M.112/A2.2) *The antenna design* shall *be suitable for fitting at a position on the ship which ensures a clear view of the satellite constellation*.

4.3.7 Dynamic range

(See 5.6.8)

(M.112/A3.7) *The GPS receiver equipment* shall *be capable of acquiring satellite signals with input signals having carrier levels in the range of –130 dBm to –120 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna*. Once the satellite signals have been acquired the equipment* shall *continue to operate satisfactorily with satellite signals having carrier levels down to –133 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna.

4.3.8 Effects of specific interfering signals

(See 5.6.9)

The GPS receiver equipment shall meet the following requirements:

a) In a normal operating mode, i.e. switched on and with antenna attached, it is subject to radiation of 3 W/m^2 at a frequency of 1636,5 MHz for 10 min. When the unwanted signal is removed and the GPS receiver antenna is exposed to the normal GPS satellite signals, the GPS receiver equipment shall calculate valid position fixes within 5 min without further operator intervention;

NOTE This is equivalent to exposing a GPS antenna to radiation from an INMARSAT-A antenna at 10 m distance along the bore sight.

b) In a normal operating mode, i.e. switched on, and with antenna attached, it is subject to radiation consisting of a burst of 10 pulses, each 1,0 µs to 1,5 µs long on a duty cycle of 1600:1 at a frequency lying between 2,9 GHz and 3,1 GHz at power density of about 7,5 kW/m^2. The condition shall be maintained for 10 min with the bursts of pulses repeated every 3 s. When the unwanted signal is removed and the GPS receiver antenna is exposed to the normal GPS satellite signals, the receiver shall calculate valid position fixes within 5 min without further operator intervention.

NOTE This condition is approximately equivalent to exposing the antenna to radiation from a 60 kW "S" Band marine radar operating at a nominal 1,2 µs pulse width at 600 pulses/s using a 4 m slot antenna rotating at 20 r/min with the GPS antenna placed in the plane of the bore site of the radar antenna at a distance of 10 m from the centre of rotation.

Advice shall be given in the manual for adequate installation of the antenna unit, to minimize interference with other radio equipment such as marine radars, Inmarsat SES's, etc.

4.3.9 Position update

(See 5.6.10)

(M.112/A3.12) *The GPS receiver equipment* shall *generate and output to a display and digital interface a new position solution at least once every 1 s.*

NOTE For craft meeting the HSC code, a new position solution at least every 0,5 s is recommended.

(M.112/A3.13) *The minimum resolution of position i.e. latitude and longitude* shall *be 0,001 min.*

4.3.10 Differential GPS input

(See 5.6.11)

(M.112/A3.15) *The GPS receiver equipment* shall *have the facilities to process differential GPS (DGPS) data fed to it in accordance with the standards of Recommendation ITU-R M.823 and an appropriate RTCM standard.*

When a GPS receiver is equipped with a differential receiver, performance standards for static and dynamic accuracies (M.112/A3.4 and A3.5) shall be 10 m (95 %) together with integrity monitoring.

An integrated DGPS receiver shall have an ITU-R M.823 compliant data output port for testing or alternatively, a possibility to display Word Error Rate (WER) on the integrated equipment. The WER is the number of incorrect ITU-R M.823 words in relation to total number of words received.

NOTE The standard for the differential GPS receiver is contained in IEC 61108-4 (Maritime navigation and radiocommunication equipment and systems – Global navigation satellite systems (GNSS) – Part 4: Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment – Performance requirements, methods of testing and required test results[3]).

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3 Under consideration.

4.3.11 Failure warnings and status indications

(See 5.6.12)

(M.112/A5.1) *The equipment* shall *provide an indication if the position calculated is likely to be outside of the requirements of these performance standards;*

4.3.11.1 General

(M.112/A5.2) *The GPS receiver equipment* shall *provide as a minimum*:

a) (M.112/A5.2.1) an indication within 5 s if either:
   1) *the specified HDOP has been exceeded; or*
   2) *a new position has not been calculated for more than 1 s;*

   NOTE For craft meeting the HSC Code, a new position solution at least every 0,5 s is recommended.

   3) *under such conditions the last known position and the time of the last valid fix, with explicit indication of this state, so that no ambiguity can exist,* shall *be output until normal operation is resumed;*

b) (M.112/A5.2.2) *a warning of loss of position; and*

c) (M.112/A5.2.3) *differential GPS status indication of*:
   1) *the receipt of DGPS signals; and*
   2) *whether DGPS corrections are being applied to the indicated ship's position*;

d) (M.112/A5.2.5) *DGPS text message display*. The GPS receiver either shall have as a minimum the capability of displaying appropriate DGPS text messages or forwarding those messages to for display on a remote system.

4.3.11.2 Integrity using RAIM

The GPS receiver equipment shall incorporate integrity monitoring using fault detection, for example receiver autonomous integrity monitoring (RAIM), or similar means to determine if accuracy is within the performance standards and provide an integrity indication.

An integrity indication shall be used to present the result of the integrity calculation with respect to the selected accuracy level appropriate for the vessels operational mode. According to IMO Resolution A.815 these accuracy levels shall be user selectable for 10 m and 100 m. Additional accuracy levels for user selection may be provided.

The integrity indication for different position accuracy levels shall be expressed in three states:

– "safe",
– "caution", and
– "unsafe"

for the currently selected accuracy level with a 95 % confidence level.

The integrity status shall be continuously displayed along with an indication of the accuracy level selected. The integrity status and the accuracy level selected, shall be provided to other equipment in accordance with the equipment output requirements in 4.3.2.

The manufacturer may use colours for integrity indication and if so the following colours shall be used:

– "safe" shall be green,
– "caution" shall be yellow, and
– "unsafe" shall be red.

The maximum delay for reaction of the integrity calculation by means of RAIM due to negative changes affecting the integrity status is 10 s.

The integrity status shall be provided to other equipment in accordance with the equipment output requirements in 4.3.2. For receiver equipment which do not provide information by a dedicated display, the provision of the integrity indication status and the selected accuracy level with an appropriate output interface is mandatory.

Conditions for the "safe" state

The result of integrity calculation by means of RAIM shall be stated as "safe", if the integrity calculation can be performed with a confidence level above 95 % for the selected accuracy level and RAIM calculates the probable position error to be within the selected accuracy level. This generally requires at least 5 "healthy" satellites available and in a robust geometry, i.e. the worst 4 satellite geometry is still suitable for navigation.

Conditions for the "caution" state

The "caution" status shall be used to indicate:

– insufficient information to reliably calculate with a confidence level above 95 % for the selected accuracy level, or
– the probability of false alarms >5 %, or
– the probability of not detecting an error condition >5 %.

Those conditions may occur if an insufficient number of satellites are available, for example 4 or 5 with 2 satellites "close" together in azimuth and elevation, causing the geometry to degrade to the point that the RAIM calculation becomes unreliable. Note that the resulting accuracy based on 4 or 5 satellites in use may be within the selected accuracy level, but the RAIM algorithm cannot verify it.

Conditions for the "unsafe" state

The "unsafe" status shall be used if the integrity calculation is performed with a confidence level above 95 % for the selected accuracy level, and RAIM calculates the probable position error exceeding the selected accuracy level. Note that also here a robust geometry is required to reach this confidence level. The "unsafe" state can be reached when satellite range errors degrade the navigation solution, causing the resulting accuracy to be outside the selected accuracy level.

4.3.11.3 GPS integrity status using DGPS

(M.112/A5.2) *The GPS receiver equipment* shall *provide as a minimum* GPS integrity status using DGPS.

If the range-rate correction or the pseudorange correction of a satellite is out of tolerance, the binary code in the ITU-R M.823-2 types 1, 9, 31, and 34 messages will cause the GPS receiver not to use that satellite.

4.3.11.4 DGPS integrity status and alarm

(M.112/A5.2.4) *The GPS receiver equipment* shall *provide as a minimum DGPS integrity status and alarm.*

The following functions shall be performed in either an integrated DGPS receiver or an associated GPS receiver connected to a DGPS radiobeacon receiver.

When in differential mode, the GPS receiver shall present a DGPS integrity indication on a display, or forward those messages for display on a remote system:

a) if no DGPS message is received within 10 s;

b) while in manual station selection mode and the selected station is unhealthy, unmonitored, or signal quality is below threshold;

c) while in automatic station selection mode and the only available station is unhealthy, unmonitored, or signal quality is below threshold.

4.3.12 Output of COG, SOG and UTC

(See 5.6.13)

(M.112/A3.14) *The GPS receiver equipment* shall *generate and output to the digital interface*[4] *course over ground (COG), speed over ground (SOG) and universal time co-ordinated (UTC). Such outputs* shall *have a validity mark aligned with that on the position output. The accuracy requirement for COG and SOG* shall *not be inferior to the relevant performance standards for heading*[5] *and SDME*[6]*,* within the limitations of GPS measurements provided by one antenna, compared to the requirements of those standards. Generation and output of COG and SOG are not intended to satisfy the carriage requirements of SOLAS, Chapter V for Heading Devices and SDME by GPS receivers.

GPS receivers of this standard have limitations in COG accuracy under high dynamic movement. Such limitations shall be described in the manufacturer's operating manual as shown in Table 2.

4.3.12.1 Accuracy of COG

The error in the COG (the path of the antenna position over ground) due to the actual ship’s speed over ground shall not exceed the following values:

Table 2 – Accuracy of COG

Speed range (knots)	Accuracy of COG output to user
0 to ≤1 knot	Unreliable or not available
>1 to ≤17 knots	±3°
>17 knots	±1°

Due to the limitations of GPS receivers of this standard, it is not appropriate to include requirements for COG errors attributed to high dynamic movement. Such limitations shall be in the manufacturer’s operational manual.

4.3.12.2 Accuracy of SOG information

Errors in the SOG (velocity of the antenna position over ground) shall not exceed 2 % of the actual speed or 0,2 knots, whichever is greater.

4 Conforming to the IEC 61162 series.

5 Resolution A.424(XI).

6 Resolution A.824(19).

4.3.12.3 Availability and validity of time information

The GPS receiver equipment shall provide UTC with resolution of 0,01 s on the digital interface. The validity mark of the digital interface for position contained in GGA message of IEC 61162 shall be used for interpretation of validity of digital interface for UTC contained in ZDA message of IEC 61162.

4.3.13 Typical interference conditions

(See 5.7)

(M.112/A3.16) *The GPS receiver equipment* shall *be capable of operating satisfactorily in typical inference conditions.*

For a clarification of this requirement see 5.7.1 and for the associated tests see 5.7.2.

5 Methods of testing and required test results

5.1 Test sites

The manufacturer shall, unless otherwise agreed, set up the GPS receiver equipment to be tested and ensure that it is operating normally before testing commences.

During performance of all tests contained in the test section the following information shall be recorded for later evaluation:

- position;
- course over ground;
- speed over ground;
- time;
- indications and warnings.

Indications and warnings shall be appropriate to the conditions being experienced by the EUT at the time of their display.

5.2 Test sequence

The sequence of tests is not specified. Before commencement of testing, the sequence shall be agreed between the test laboratory and the supplier of the equipment.

Where appropriate, tests against different clauses of this standard may be carried out simultaneously. The manufacturer shall provide sufficient technical documentation to permit the GPS receiver equipment to be operated correctly.

Additional data shall be provided by the manufacturer to cover specific tests which do not form part of the normal user operations, for example means to remove the almanac data, when applicable, for the purpose of testing according to 5.6.5.

5.3 Standard test signals

The aim of the performance tests is to establish that the GPS receiver equipment meets the minimum performance standards set out in Clause 4, by performing practical tests under various environmental conditions. Because of the difficulty of establishing uniformity of performance of GPS signal simulators, over a range of simulators which may be provided by test laboratories and the difficulty of uniformly coupling the simulated signals into varying and unknown GPS receiver equipment architectures, these tests have been based upon using the actual GPS signals.

Other methods of simulating the test signals may be used, provided that the simulator produces signals which have the same characteristics as the satellites, including receiver noise, had good satellite signal reception been used from geometrically well-placed satellites in a normally dynamic constellation.

A "performance check" is defined as a shortened version of the static accuracy test described in 5.6.4.1, i.e. a minimum of 100 position measurements shall be taken over a period of not <5 min and not >10 min, discarding any measurements with HDOP ≥4. The position of the antenna of the EUT shall not be in error compared with the known position by >100 m 95 % using WGS 84 as the reference datum.

Test signal A shall be a sequence of ITU 823 message nine type 9-3s and one type 7 that form a continuous parity loop. The station ID of test signal A shall be an ID of a station that is stored in the almanac. The type 7 message shall give data for station B.

Test signal B shall contain ITU 823 messages – type 9-3 and 3 for station B. The station ID of test signal B shall not be an ID of a station that is stored in the almanac.

5.4 Determination of accuracy

In the determination of the accuracy of position being calculated by the GPS receiver equipment, note must be taken of the geometry of the satellites in use. The HDOP measurement is an indication of the suitability of the constellation in view for use in receiver equipment testing. If the HDOP is ≤4, the test conditions can be considered as suitable. If HDOP is >4 but ≤6, then results may be unreliable. For HDOP > 6, testing shall be delayed until better geometry is established. The aim of the accuracy tests is to establish that the measurement of position calculated by the EUT under static and dynamic conditions is as good as or better than the performance levels set out in this minimum performance standard.

If a simulator is used, the HDOP threshold shall be set at ≤4 or PDOP ≤6.

5.5 Test conditions

5.5.1 Environmental conditions for tests

5.5.1.1 Normal conditions

Normal environmental conditions shall be a convenient combination of +15 °C to +30 °C temperature and 20 % to 75 % relative humidity.

When it is impractical to carry out the test under the conditions stated above, a note to this effect, stating the actual temperature and relative humidity during the tests, shall be added to the test report.

5.5.1.2 Extreme test conditions

Carry out the performance check in the extreme environmental and power supply conditions specified in IEC 60945.

5.5.2 Static test site

The antenna shall be mounted according to the manufacturer's instructions at a height of between 1 m and 1,5 m above the electrical ground in an area providing clear line of sight to the satellites from zenith through to an angle of +5° above horizontal. The position of the antenna shall be known, with reference to WGS 84 to an accuracy of better than 0,1 m in (x, y, z). Maximum cable lengths as specified by the manufacturer shall be used during testing.

All static tests shall utilize actual GPS signals.

5.6 Methods of test and required test results

NOTE The number in brackets is the subclause of the relevant performance standard.

5.6.1 GPS receiver equipment

(See 4.2.1)

The equipment under test (EUT) shall be checked for composition by inspection of the equipment and the manufacturer's documentation.

5.6.2 Position output

(See 4.3.1)

The EUT shall be checked for the form of the position output by inspection of the manufacturer's documentation.

5.6.3 Equipment output

(See 4.3.2)

The EUT shall be checked for conformity to IEC 61162 by inspection of the manufacturer's documentation and protocol tests.

5.6.4 Accuracy

(See 4.3.3)

5.6.4.1 Static accuracy

(See 4.3.3.1)

5.6.4.1.1 GPS

Position fix measurements shall be taken over a period of not <24 h. The absolute horizontal position accuracy shall be within 13 m (95 %), having discarded measurements taken in conditions of HDOP ≥ 4 and PDOP ≥6.

5.6.4.1.2 Differential GPS

Position fix measurements shall be taken once per second over a period of not <24 h. The distribution of the horizontal error shall be within 10 m (95 %). The horizontal position of the antenna shall be known to within 0,1 m in the datum used for the generation of the corrections. The corrections shall be provided by an actual DGPS broadcast in accordance with ITU-R M.823.

5.6.4.2 Angular movement of the antenna

The static tests specified in 5.6.4.1.1 and 5.6.4.1.2 shall be repeated with the antenna performing an angular displacement of ±22,5° (simulating roll) in a period of about 8 s (see IEC 60721-3-6) during the duration of the tests.

The results shall be as in 5.6.4.1.1 and 5.6.4.1.2.

5.6.4.3 Dynamic accuracy

(See 4.3.3.2)

5.6.4.3.1 GPS

The tests for dynamic accuracy are a practical interpretation of the conditions set out in IEC 60721-3-6, Table V, item e), X – direction (surge) and Y – direction (sway). These are stated as surge 5 m/s^2 and sway 6 m/s^2 for all classes of environment. When using a simulator, the simulator characteristics shall accurately represent the signals required.

The results of the test performed by simulation facilities shall be identical with those in a) and b) below.

Alternatively to the use of a simulator, an example of applying these accelerations is given below:

a) a fully locked and settled EUT travelling in a straight line at 48 knots ± 2 knots for a minimum of 1,2 min which is reduced to 0 knots in the same straight line in 5 s, shall not indicate a positional offset >±13 m from the final position 10 s after coming to rest;
b) a fully locked and settled EUT travelling at least 100 m at 24 knots ± 1 knot in a straight line then subjected, for at least 2 min, to smooth deviations either side of the straight line of approximately 2 m at a period of 11 s to 12 s shall remain in lock and follow the actual position to within a lane of 30 m wide centred on the mean direction of motion.

For all methods above, the rest position shall be established by one of the following methods:

a) providing a stationary receiver identical to the EUT alongside the rest point and comparing indicated output positions; or
b) providing the reference inputs from a simulator.

5.6.4.3.2 Differential GPS

The tests for dynamic accuracy are a practical interpretation of the conditions set out in IEC 60721-3-6, Table V, item e), X – direction (surge) and Y – direction (sway). These are stated as surge 5 m/s^2 and sway 6 m/s^2 for all classes of environment.

When using a simulator, the simulator characteristics shall accurately represent the signals required.

The results of the test performed by simulation facilities shall be identical with those in a) and b) below.

Alternatively to the use of a simulator, an example of applying these accelerations is given below:

a) a fully locked and settled EUT travelling in a straight line at 48 knots ± 2 knots for a minimum of 1,2 min which is reduced to 0 knots in the same straight line in 5 s, shall not indicate a positional offset >±10 m from the true position at rest and the indicated position shall settle to within ±2 m of the rest position indication within 10 s of coming to rest;
b) using a simulator, the simulator characteristics shall accurately represent the signals required in 5.6.4.3.2 a).

For the methods above, the true and rest positions shall be established by one of the following methods:

a) for method a) above, the rest position indication shall be determined by averaging the 15 consecutive position indications recorded following the 10 s settling period and the true position at rest shall be measured to an accuracy of 1 m;
b) for method b) above, by providing the reference inputs from a simulator within 1 m.

5.6.5 Acquisition

(See 4.3.4)

5.6.5.1 Condition A – Initialization

The EUT shall be either:

a) initialized to a false position at least 1 000 km and not greater than 10 000 km from the test position, or alternatively, by deletion of the current almanac; or

b) isolated from a power source for >7 days.

A performance check shall be carried out after the time limit contained in Table 1.

5.6.5.2 Condition B – Power outage

The EUT shall be isolated from the power source for a period within 24 h to 25 h.

At the end of the period, a performance check shall be carried out after the time limit contained in Table 1.

5.6.5.3 Condition C – Interruption of GPS signals

During normal operation of the EUT, the antenna shall be completely masked for a period between 24 h and 25 h.

At the end of the period, a performance check shall be carried out after the time limit contained in Table 1.

5.6.5.4 Condition D – Brief interruption of power

During normal operation of the EUT, the power shall be removed for a period of 60 s. At the end of this period, the power shall be restored.

A performance check shall be carried out after the time limit contained in Table 1.

5.6.6 Protection

(See 4.3.5)

5.6.6.1 Antenna and input/output connections

(See 4.3.5.1)

The antenna input of the receiver, if provided, shall be connected to ground for 5 min. After completion of the test and reset of the EUT, if required, the antenna or input/output connections shall be connected normally, and a performance check shall be carried out to ensure that no permanent damage has resulted.

5.6.7 Antenna design

(See 4.3.6)

The antenna of the EUT shall be checked by inspection of the documentation provided by the manufacturer, to confirm that it is suitable for shipborne installation to ensure a clear view of the satellite constellation.

5.6.8 Sensitivity and dynamic range

(See 4.3.7)

5.6.8.1 Acquisition

This is tested by using a simulator.

Method

a) Transmit the simulator signal over a suitable antenna.

b) Adjust the signal power by use of a calibrated test receiver to –125 dBm ± 5 dBm.

c) Replace the antenna of the calibrated test receiver by the receiving unit of the EUT.

d) A performance check shall be carried out.

Required result

The EUT shall meet the requirements of this check, within this signal range.

5.6.8.2 Tracking

The received satellite signals shall be monitored by a suitable test receiver. These signals shall be attenuated down to –133 dBm. Under these conditions, the performance requirements shall be met.

This is tested by using a simulator.

Method

a) Transmit the simulator signal over a suitable antenna.

b) Adjust the signal power by use of a calibrated test receiver to –125 dBm ± 5 dBm.

c) Replace the antenna of the calibrated test receiver by the receiving unit of the EUT.

d) After the start of transmission and tracking with the nominal transmission level condition, gradually reduce transmission level down to –133 dBm.

Required result

The EUT shall continue tracking at least one satellite.

5.6.9 Effects of specific interfering signals

(See 4.3.8)

5.6.9.1 L Band interference

(See 4.3.8 a))

In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation of 3 W/m^2 at a frequency of 1636,5 MHz for 10 min.

The signal shall be removed and a successful performance check shall be carried out within 5 min.

5.6.9.2 S Band interference

(See 4.3.8 b))

In a normal operating mode, using an appropriate signal source, the EUT shall be subjected to radiation consisting of a burst of 10 pulses, each 1,0 μs to 1,5 μs long on a duty cycle of 1600:1 at a frequency in the range of 2,9 GHz to 3,1 GHz at power density of approximately 7,5 kW/m^2. This condition shall be maintained for 10 min with the bursts of pulses repeated every 3 s.

NOTE The peak power density is 7,5 kW/m^2 to be measured at the EUT, this is approximately 4,7 W/m^2 average power at a fixed transmitting antenna.

The signal shall be removed and a successful performance check shall be carried out within 5 min.

5.6.10 Position update

(See 4.3.9)

5.6.10.1 Slow speed update rate

The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 5 knots ± 1 knot. The position output of the EUT shall be checked at intervals of 10 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.

This test may be carried out by using a simulator.

5.6.10.2 High speed update rate

The EUT shall be placed upon a platform, moving in approximately a straight line, at a speed of 50 knots ± 5 knots. The position output of the EUT shall be checked at intervals of 1 s, over a period of 10 min. The output position shall be observed to be updated on each occasion.

This test may be carried out by using a simulator with a speed of 70 knots at intervals of 0,5 s.

The minimum resolution of position, i.e. latitude and longitude shall be checked by observation during 5.6.10.1 and 5.6.10.2 above.

Record the IEC 61162 output of the EUT during this test and confirm that received positions at the end of each interval are in compliance with the real or simulated reference position.

5.6.11 Differential GPS input

(See 4.3.10)

The manufacturer's documentation shall be inspected to:

a) verify that the EUT will correctly process the message protocol of
   1) the RTCM recommended standards for differential NAVSTAR GPS service, or
   2) in the case where maritime radiobeacons are used as the means of communication of the differential corrections, the standards contained in ITU-R M.823, and
b) confirm that
   1) receipt of DGPS signals will be indicated;
   2) that the application of DGPS signals to the output ship's position is indicated; and
   3) the WER information is provided on an output port or at the display.

5.6.12 Failure warnings and status indications

(See 4.3.11)

5.6.12.1 General alarm tests

5.6.12.1.1 Position/HDOP alarm test

This test applies to 4.3.11.1 a) and to 4.3.11.1 b).

a) Set up the EUT in a simulation environment with an HDOP <4. Select a specific EUT HDOP value as an indication threshold >4. Modify the simulator output until its HDOP is greater than the EUT specified HDOP threshold. Observe that an indication is given at the EUT within 5 s.
b) Modify the simulator output until HDOP <4 and observe that the indication is removed.
c) Switch off transmission of simulated signals and observe that the EUT releases an appropriate indication within 5 s.

d) Verify that the last known position and its time stamp are being displayed indicating the "loss of position" condition. Verify that this mode is provided constantly on display and output interface until removal of the error condition at the simulation environment.

e) Switch on transmission of simulated signals and observe that the EUT resumes normal operation.

5.6.12.1.2 Differential GPS status indication test

This test applies to 4.3.11.1 c).

a) Set up the EUT in a simulation environment providing with an HDOP <4. Observe that the status of EUT operation is GPS without using DGPS corrections.

b) Set the EUT differential correction age mask to 30 s (if available).

c) Start transmission of ITU-R M.823 differential corrections. Observe that the indication for DGPS status of EUT operation is given within 40 s.

d) Stop transmission of ITU-R M.823 differential corrections. Observe that the status of EUT operation resumes to GPS without using DGPS corrections within 40 s.

5.6.12.2 Test of integrity monitoring using RAIM

This test applies to 4.3.11.2.

For the purpose of testing of the RAIM functionality, it is recommended that means are provided for real-time display of the actual position error with reference to the simulated position.

5.6.12.2.1 Testing of "safe" and "caution" status

The EUT shall be set up under simulated conditions, providing 8 "healthy" satellites available, acquired and tracked.

a) Select an accuracy level of 100 m.

b) Observe that

   1) RAIM is indicated as "in operation", and

   2) the "safe" status is indicated.

c) Consecutively reduce the number of "healthy" satellites until the "caution" state is raised. Observe that

   1) RAIM is still indicated as "in operation", and

   2) that the status indication switched to "caution" within 10 s of the satellite change that caused it.

d) Increase the number of "healthy" satellites until the RAIM state returns to "safe" state. Observe that

   1) RAIM is still indicated as "in operation", and

   2) the status indication switches to "safe" within 2 min of the satellite change that prompted it.

For each step of the above test sequence observe if the appropriate interface output is provided.

Repeat the above test sequence for a selected accuracy level of 10 m and, if provided, for another accuracy level.

5.6.12.2.2 Testing of "unsafe" status

The EUT shall be set up under simulated conditions, providing 8 "healthy" satellites available, acquired and tracked.

a) Select an accuracy level of 100 m.

b) Observe that

   1) RAIM is indicated as "in operation", and

   2) the "safe" status is indicated.

c) Change the behaviour of at least 1 satellite by varying the satellite clocks with the result that the position accuracy gradually degrades until it will no longer be inside the selected accuracy level with 95 % confidence level.

   Observe that

   1) RAIM is still indicated as "in operation", and

   2) the status indication switches to "unsafe" within 10 s of the actual position error exceeding the selected accuracy level.

d) Change the behaviour of the satellites back to regular behaviour with the result that the position accuracy will be again inside of the selected accuracy level with 95 % confidence level.

   Observe that

   1) RAIM is still indicated as "in operation", and

   2) the status indication switches to "safe" within 2 min.

For each step of the above test sequence observe if the appropriate interface output is provided.

Repeat the above test sequence for a selected accuracy level of 10 m and, if provided, for another accuracy level.

5.6.13 Accuracy of COG and SOG

(See 4.3.12)

Method of tests

The EUT shall be set up on an appropriate mobile unit or simulator and all outputs indicating course over ground shall be monitored.

At a constant forward direction, the forward speed shall be within 0 knots to 1 knot. Ten seconds after being in the range, measurements shall be made for a duration of 2 min. This cycle shall be repeated for all speed ranges of the Table 2 above.

Required results

The test results shall be observed on the display and the approved interface.

For SOG tests, no reading of the speed indicator shall differ from the constant speed being applied at the time by more than 2 % of that speed or 0,2 knots, whichever is the greater.

For COG tests, the differences between the reference direction and measured course over ground of in each test cycle shall not exceed the limits of Table 2.

Validity of COG and SOG information

The quality indicator of the GGA and VTG message of IEC 61162 shall be used for interpretation of validity of COG and SOG.

Method of testing

Check of digital interface with IEC 61162. With the EUT normally operating, preclude invalid position data by reducing the number of received satellites. Investigate the content of the resultant GGA and VTG.

Required result

Observe that the quality indicators of GGA and VTG messages of IEC 61162 turn to invalid. Observe that the COG and SOG information contained in VTG message of IEC 61162 is replaced by null fields.

5.6.14 Output of UTC

(See 4.3.12)

Method of testing

Check of digital interface with IEC 61162. While the EUT is navigating, provoke an invalid position by reducing the number of received satellites to two. Investigate the content of the GGA and ZDA messages provided.

Required results

Observe that the resolution of UTC information contained in the ZDA message is according to IEC 61162 requirements. Observe that the validity flag of GGA message of IEC 61162 turns to invalid. Observe that the ZDA message remains transmitted carrying complete UTC information.

5.7 Typical interference conditions

(See 4.3.13)

5.7.1 Requirements

5.7.1.1 Typical interference conditions

The GPS receiver equipment shall be *capable of operating satisfactorily in typical interference conditions*. Operational situations include static accuracy and reacquisition within 30 s after satellite signals have been masked for 60 s or less by an obstruction, for example a bridge.

Typical GPS interference effects can be characterized as being broadband noise-like interference, Continuous Wave Interference (CWI), or pulsed interference. Much work has been done in the aviation community to define interference levels in these three categories as reported in the *Minimum Operational Performance Standards (MOPS) for Global Positioning System/Wide Area Augmentation System (GPS/WAAS) Airborne Equipment* (RTCA/DO-229B October 6, 1999). The levels defined in this subclause are based upon the interference masks developed within RTCA. These masks are also described in ITU-R Recommendation M.1477.

5.7.1.2 Broadband interference levels

The interference mask for broadband noise-like interference varies as a function of the bandwidth of the interfering signal. This interference effect can be represented by broadband noise centred at 1575,42 MHz. The bandwidth dependent interference mask can be seen in Figure 1.

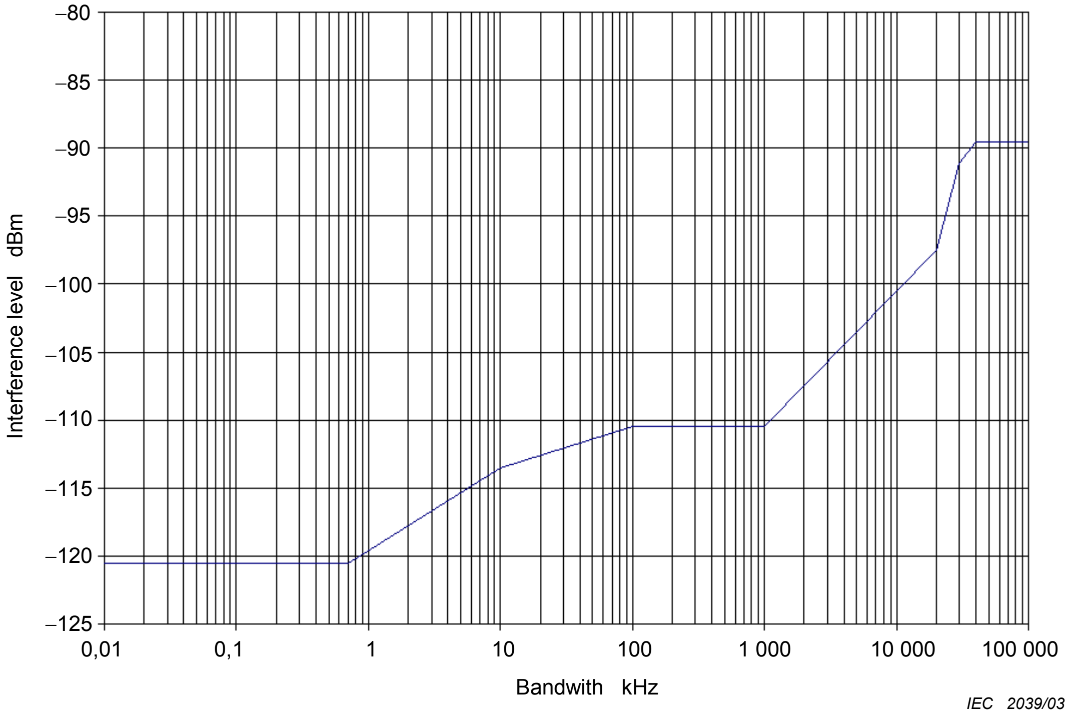

Figure 1 – Broadband interference environment

5.7.1.3 Continuous wave interference (CWI)

Continuous wave interference interacts with the individual C/A code spectral lines found in the GPS signal structure. GPS receivers are typically more susceptible to CWI than to any other type of interference. The CWI mask can be seen in Figure 2.

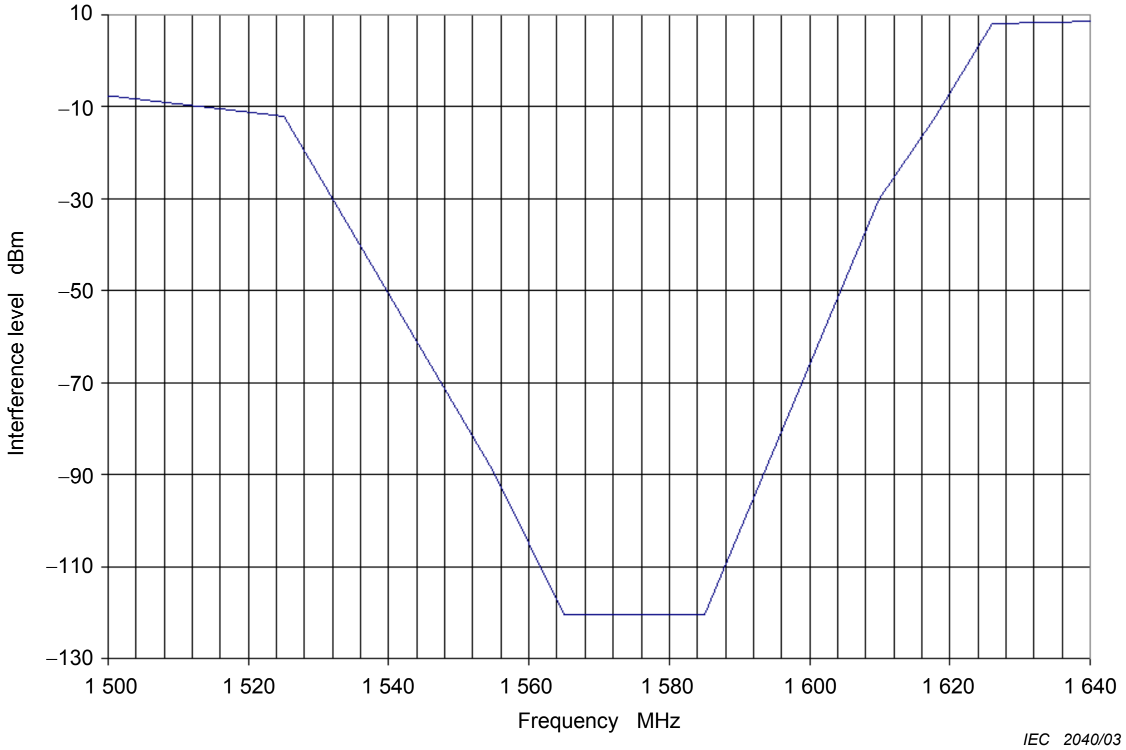

Figure 2 – CW interference mask

5.7.1.4 Pulsed interference

Pulsed interference can occur due to proximity to radars or other RF devices using pulsed waveforms. GPS receivers typically are fairly robust when exposed to low duty cycle pulsed interference. The interference mask for pulsed interference will consist of a pulse modulated carrier (CW) at 1575 MHz, with peak carrier level of –20 dBm and duty factor of 10 % while using a 1 ms pulse width.

5.7.2 Testing

5.7.2.1 Interference test procedures

The interference test procedures presented in this subclause follow closely the procedures used by aviation receiver manufacturers in the self-certification process used to show compliance with RTCA/DO-229B. The procedures have been adapted as necessary to meet the requirements of the IMO GPS requirements.

5.7.2.2 Simulator conditions

The simulator conditions are as follows:

- five GPS satellites;
- one satellite at a maximum level of –120 dBm plus antenna gain at 90° elevation;
- one satellite at a minimum level of –130 dBm plus antenna gain at 5° elevation;
- three satellites at a level of –127 dBm plus antenna gain at 45° elevation.

5.7.2.3 Navigation solution accuracy test

The normalized error associated with the navigation solution, which will be compared with the 10 m, 95 % horizontal accuracy requirement shall be computed using the formula shown below:

$$NE = \frac{4(d_i)}{HDOP_i}$$

where

NE is the normalized error;

d_i is the instantaneous 2-D horizontal position error (meters);

$HDOP_i$ is the instantaneous horizontal dilution of precision.

Scaling the instantaneous 2-dimensional position error (d_i) by 4/$HDOP_i$ provides a means of normalizing the tests to a constant $HDOP$ = 4 and accounts for fluctuations in the satellite coverage due to changing geometries. $HDOP_i$ may be obtained from the receiver under test or calculated. Only those satellites used in the position solution shall be included in the $HDOP_i$ calculation.

5.7.2.4 Navigation solution accuracy test procedures

5.7.2.4.1 Interference conditions

Interference conditions, including broadband noise centred at 1575,42 MHz, continuous wave interference (CWI), and pulsed interference shall be simulated. For the pulsed interference tests, a pulse-modulated carrier (CW) with peak carrier level of –20 dBm and duty factor of 10 % shall be used. The interference values are shown in the three tables below.

Broad-band interference values	
Noise bandwidth (MHz)	Total RMS power (dBm)
1	−110,5

Pulsed interference values	
Frequency (MHz)	Pulse width (ms)
1575,42	1

Continuous wave interference (CWI) values	
Frequency (MHz)	Power (dBm)
1575,42	−120,5
1626,0	+8,0

5.7.2.4.2 Test procedures

a) The equipment under test is subjected to one of the interference sources.

b) The simulator scenario shall be engaged and the satellite signals turned on.

c) The equipment under test shall be powered and initialized.

d) While the EUT is providing position solutions, the interference shall be applied to the equipment under test, and the level of the interference shall be adjusted to the required value.

e) When steady-state accuracy is reached, record a minimum of 100 position and HDOP value as reported by the EUT at a rate of one sample every 2 min.

f) Repeat this cycle for any remaining interference source.

5.7.2.4.3 Required results

Pass/fail determination

If the EUT reports a position with a normalized error greater than 10 m or fails to report a position in more than 5 % of the samples, a test failure is declared.

5.7.2.5 Reacquisition test

Method of test

The reacquisition test is designed to simulate a temporary loss of signal, such as passing under a bridge. To determine the re-acquisition pass/fail criteria, consider a single trial where the EUT provides a valid position fix that is within required accuracy at 30 s from restoration of the satellite signals, and maintains a tracking status for at least the next 60 s. This unit is considered to have passed one trial.

5.7.2.5.1 Re-acquisition test procedures

5.7.2.5.2 Interference conditions

The interference condition to be tested is shown below. This is a broadband noise value centred at 1575,42 MHz.

Noise bandwidth (MHz)	**Total RMS power (dBm)**
1	−110,5

5.7.2.6 Re-acquisition scenarios

5.7.2.6.1 Test procedures

a) The equipment under test is subjected to the broadband interference source.

b) The simulator scenario shall be engaged and the satellite signals turned on.

c) The equipment under test shall be powered and initialized.

d) The EUT shall be allowed to reach steady-state accuracy before the satellites are to be switched off.

e) The simulator RF output shall be removed for 30 s.

f) The simulator RF output shall be restored to the EUT.

g) After 30 s record a position and HDOP value as reported by the EUT. If after 30 s, no position report has been sent from the receiver, record a trial failure and go to step i).

h) Ensure that the receiver continues position reporting for the next 60 s.

i) Go to Step d) and repeat as required. (note that if the simulator scenario is reset, some receivers may require purging of all previous data to enable proper operation. This is due to the persistence of time data in the receiver and the inability of the receiver's software to deal with a backward transition in time).

5.7.2.6.2 Required results

Pass/fail determination

A failure by the EUT to provide a position output after 30 s, reporting a position with normalized error greater than 10 m, or failing to continue position reporting for 60 s after sampling indicates a failure mode, and results in declaring a trial failure. To determine the re-acquisition time pass/fail criteria, the test disposition table shall be used.

5.8 Performance checks under IEC 60945 conditions

Environmental requirements of IEC 60945 appropriate to its category, i.e. "protected" and "exposed", shall be carried out. The manufacturer shall declare any pre-conditioning required before environmental checks.

Performance checks shall be performed for

- initial (cold) start
- acquisition
- tracking (navigation).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60721-3-6	1987	Classification of environmental conditions Part 3: Classification of groups of environmental parameters and their severities Section 6: Ship environment	EN 60721-3-6 [1]	1993
IEC 60945	- [2]	Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results	EN 60945	2002 [3]
IEC 61162	Series	Maritime navigation and radiocommunication equipment and systems - Digital interfaces	EN 61162	Series
IMO Resolution A.529(13)	1983	Accuracy standards for navigation	-	-
IMO Resolution A.694(17)	1991	General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids	-	-
IMO Resolution A.815(19)	1995	Worldwide radionavigation system	-	-
IMO Resolution MSC.112(73)	2000	Performance standards for shipborne global positioning system (GPS) receiver equipment	-	-

[1] EN 60721-3-6 includes A1:1991 to IEC 60721-3-6.

[2] Undated reference.

[3] Valid edition at date of issue.

Publication	Year	Title	EN/HD	Year
IMO Resolution MSC.114(73)	2000	Performance standards for shipborne DGPS and DGLONASS maritime radio beacon receiver equipment	-	-
ITU-R Recommendation M.823-1	1995	Technical characteristics of differential transmissions for global navigation satellite systems (GNSS) from maritime radio beacons in the frequency band 285 kHz - 325 kHz (283,5 kHz - 315 kHz in Region 1)	-	-
ITU-R Recommendation M.823-2	1997	Techhnical characteristics of differential transmissions for Global Navigation Satellite Systems from maritime radio beacons in the frequency band 283.5 - 315 kHz in Region 1 and 285 - 325 kHz in Regions 2 and 3	-	-
ITU-R Recommendation M.1477	2000	Technical and performance characteristics of current and planned radionavigation-satellite service (space-to-Earth) and aeronautical radio-navigation service receivers to be considered in interference studies in the band 1 559 - 1 610 MHz	-	-
-	2001	Global Positioning System – Standard Positioning Service – Performance Specification (USA Department of Defence)		

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