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Navigations- und Funkkommunikationsgeräte und -systeme für die Seeschifffahrt –**Weltweite Navigations-Satellitensysteme (GNSS) –****Teil 3: Galileo-Empfangsanlagen – Leistungsanforderungen, Prüfverfahren und geforderte Prüfergebnisse (IEC 61108-3:2010);****Englische Fassung EN 61108-3:2010**

Maritime navigation and radiocommunication equipment and systems –

Global navigation satellite systems (GNSS) –

Part 3: Galileo receiver equipment – Performance requirements, methods of testing and required test results

(IEC 61108-3:2010);

English version EN 61108-3:2010

Matériels et systèmes de navigation et de radiocommunication maritimes –

Système mondial de navigation par satellite (GNSS) –

Partie 3: Equipement pour récepteur Galileo – Exigences d'exploitation et de fonctionnement, méthodes d'essai et résultats d'essai exigés

(CEI 61108-3:2010);

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Normenstelle Schiffs- und Meerestechnik (NSMT) im DIN

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2010-06-01 angenommene Europäische Norm als DIN-Norm ist 2011-02-01.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN IEC 61108-3:2008-03.

Für diese Norm ist das nationale Arbeitsgremium K 738 „Elektronische Navigationsinstrumente“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom TC 80 „Maritime navigation and radiocommunication equipment and systems“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (maintenance result date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

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- geändert.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der IEC 61108-3 veröffentlicht. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. In Folge von Festlegungen zum DIN-Präsidialbeschluss 01/1978 werden in Abschnitt 3 (*Terms, definitions and abbreviations*) der englischen Sprachfassung gelistete Begriffe ins Deutsche übersetzt (siehe informativer Anhang NA zur Nationalen Norm). Die deutschen Übersetzungen haben nur Empfehlungscharakter und können nur die ungefähre Begrifflichkeit in Deutsch wiedergeben. Unter Experten wird empfohlen, ausschließlich die englischen Fachbegriffe zu verwenden. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

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Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnietsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Nationaler Anhang NA (informativ)

NA.1 Begriffe

Für das vorliegende Dokument gelten nachfolgend im Einzelnen aufgelistete Synonyme zu den im Abschnitt 3 (*Terms, definitions and abbreviations*) der englischen Sprachfassung dieser Norm aufgelisteten Begriffen.

Die deutschen Übersetzungen haben Empfehlungscharakter und können nur die ungefähre Begrifflichkeit in Deutsch wiedergeben. Unter Experten wird empfohlen, ausschließlich die englischen Fachbegriffe zu verwenden, um die Gefahr von Missverständnissen zu reduzieren.

NA.1.1 Deutsche Synonyme

Zuverlässigkeit [en: integrity]

– Leerseite –

Maritime navigation and radiocommunication equipment and systems –
Global navigation satellite systems (GNSS) –
Part 3: Galileo receiver equipment –
Performance requirements, methods of testing and required test results
(IEC 61108-3:2010)

Matériels et systèmes de navigation et de
radiocommunication maritimes –
Système mondial de navigation par satellite (GNSS) –
Partie 3: Equipement pour récepteur Galileo –
Exigences d'exploitation
et de fonctionnement, méthodes d'essai
et résultats d'essai exigés
(CEI 61108-3:2010)

Navigations- und Funkkommunikationsgeräte
und -systeme für die Seeschifffahrt –
Weltweite Navigations-Satellitensysteme (GNSS) –
Teil 3: Galileo-Empfangsanlagen –
Leistungsanforderungen, Prüfverfahren und
geforderte Prüfergebnisse
(IEC 61108-3:2010)

This European Standard was approved by CENELEC on 2010-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 80/590/FDIS, future edition 1 of IEC 61108-3, 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 61108-3 on 2010-06-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

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) | 2011-03-01 |
| – latest date by which the national standards conflicting
with the EN have to be withdrawn | (dow) | 2013-06-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61108-3:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- | | | |
|------------------|------|---|
| IEC 61108 series | NOTE | Harmonized in EN 61108 series (not modified). |
| IEC 61162-2 | NOTE | Harmonized as EN 61162-2. |
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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) –

Part 3: Galileo receiver equipment – Performance requirements, 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 Galileo shipborne receiver equipment, based on IMO resolution MSC.233(82), which uses the signals from the Galileo Global Navigation Satellite System in order to determine position. It takes account of the general requirements given in IMO resolution A.694(17) and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this standard takes precedence. It also takes account, as appropriate, of requirements for the presentation of navigation-related information on shipborne navigational displays given in IMO resolution MSC.191(79) and is associated with IEC 62288.

A description of the Galileo Open Service and Safety of Life Service is given in the Galileo interface control documents (see Bibliography). This receiver standard applies to navigation in ocean waters for the open service and harbour entrances, harbour approaches and coastal waters for the Safety of Life service, as defined in IMO resolution A.953(23).

All text of this standard, whose meaning is identical to that in IMO resolution MSC.233(82), is printed in *italics* and the resolution and paragraph numbers are indicated in brackets i.e. (M.233/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 3-6: 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 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*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

IEC 61162 (all parts), *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

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

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*

IMO resolution A.694(17), General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system (GMDSS) and for electronic navigational aids^{N1)}

IMO resolution A.915(22), *Revised maritime policy and requirements for a future Global Navigation Satellite System (GNSS)*

IMO resolution A.953(23), *World-wide radionavigation system*

IMO resolution MSC.233(82), *Adoption of the Performance Standards for Shipborne GALILEO Receiver Equipment*

ITU-R Recommendation M.823-3, *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*^{N2)}

RTCM 10402 RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.4^{N3)}

3 Terms, definitions and abbreviations

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

NOTE All definitions and abbreviations used are the same as those used in the Galileo performance signal specification.

3.1 Terms and 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

Compass	Beidou-2 GNSS (China)
COG	Course Over Ground
CW	Continuous Wave
dGalileo, dGPS, dGLONASS	Differential Galileo, GPS, GLONASS

^{N1)} Nationale Fußnote: IMO Resolutions werden von der International Maritime Organization einer Unterorganisation der Vereinten Nationen herausgegeben und können über <http://www.imo.org> bezogen werden.

^{N2)} Nationale Fußnote: ITU-R Recommendations werden von der International Telecommunication Union (ITU), einer Unterorganisation der Vereinten Nationen herausgegeben und können über <http://www.itu.int/publications/default.aspx> bezogen werden.

^{N3)} Nationale Fußnote: RTCM Recommended Standards werden von der Radio Technical Commission for Maritime Services (RTCM) herausgegeben und können über <http://rtcm.org> online bezogen werden.

EUT	Equipment Under Test
FDE	Fault Detection and Exclusion
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GLONASS	GLObal Navigation Satellite System
GTRF	Galileo Terrestrial Reference Frame
ITRF	International Terrestrial Frame
HAL	Horizontal Alert Limit
HDOP	Horizontal Dilution Of Precision
HPL	Horizontal Protection Limit
HMI	Hazardous Misleading Information
MDE	Marginally Detectable Error
NB	Narrow Band
pdf	Probability distribution function
PDOP	Position Dilution Of Precision
P_{HMI}	Probability of hazardous misleading error
PVT	Position, Velocity, Time
RAIM	Receiver Autonomous Integrity Monitor
RF	Radio Frequency
RFCS	Radio Frequency Constellation Simulator
RFI	Radio Frequency Interference
SDME	Speed and Distance Measuring Equipment
SIS	Signal in space
SOG	Speed Over Ground
SV	Space Vehicle
TTA	Time-to-alarm
ULS	Up-Link Station
UTC	Universal Time Coordinated
VAL	Vertical Alert Limit
VPL	Vertical Protection Limit
WB	Wide Band

4 Minimum performances standards

4.1 Object

Galileo provides two different services of use for the maritime community.

(M.233/A1.3) *The Galileo Open Service provides positioning, navigation and timing services, free of direct user charges. The Open Service can be used on one (L1, E5a, E5b), two (L1 and E5a or L1 and E5b) or three (L1, E5a and E5b) frequencies.*

(M.233/A1.4) *The Galileo Safety of Life Service can be used on one (L1 or E5b) or two (L1 and E5b) frequencies. Each of the L1 and E5b frequencies carries a navigation data message that includes integrity information. The E5a frequency does not include integrity data.*

(M.233/A1.5) *Galileo receiver equipment intended for navigation purposes on ships of speeds not exceeding 70 knots, in addition to the general requirements specified in IEC 60945, shall comply with the following minimum performance requirements.*

(M.233/A1.6) *These standards cover the basic requirements of position fixing, determination of course over ground (COG), speed over ground (SOG) and timing, either for navigation purposes or as input to other functions. The standards do not cover the other computational facilities which may be in the equipment nor cover the requirements for any other systems that may take input from the Galileo receiver. 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.*

4.2 Galileo receiver equipment

(See 5.6.1)

4.2.1 Minimum facilities

(M.233/A2.1) *The words “Galileo receiver equipment” as used in these performance standards include all the components and units necessary for the system properly to perform its intended functions. The Galileo receiver equipment shall include the following minimum facilities:*

- .1 antenna capable of receiving Galileo signals;*
- .2 Galileo receiver and processor;*
- .3 means of accessing the computed latitude/longitude position;*
- .4 data control and interface; and*
- .5 position display and, if required, other forms of output.*

NOTE If Galileo forms part of an approved Integrated Navigation System (INS), requirements of .3, .4 and .5 may be provided within the INS.

4.2.2 Configuration

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

- stand-alone receiver with means of accessing computed position via a keyboard with the positional information suitably displayed;
- Galileo 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 Galileo receiver equipment

4.3.1 General

(See 5.6.2)

(M.233/A3.1) *The Galileo receiver equipment shall be capable of receiving and processing the Galileo positioning and velocity, and timing signals on:*

- i) *for a single frequency receiver, the L1 frequency alone. The receiver shall use the ionospheric model broadcast to the receiver by the constellation to generate ionospheric corrections;*
- ii) *for a dual frequency receiver, **either** the L1 and E5b frequencies **or** the L1 and E5a frequencies. The receiver shall use dual frequency processing to generate ionospheric corrections;*

A detailed description of the Galileo Navigation Signal Characteristics is given in Annex A.

(M.233/A3.2) The Galileo receiver equipment shall provide position information in latitude and longitude in degrees, minutes and thousandths of minutes;

NOTE Galileo uses Galileo Terrestrial Reference Frame System (GTRF) datum which is a realization of the International Terrestrial Reference Frame (ITRF) system and differs from WGS 84 by less than 5 cm worldwide.

(M.233/A3.3) The Galileo receiver equipment shall provide time referenced to universal time coordinated UTC (Bureau International des Poids et Mesures).

4.3.2 Equipment output

(See 5.6.3)

(M.233/A3.4) The Galileo receiver equipment shall be provided with at least two outputs from which position information, UTC, course over ground (COG), speed over ground (SOG) and alarms can be supplied to other equipment. The output of position information shall be based on the WGS84 datum and shall be in accordance with IEC 61162. The output of UTC, course over ground (COG), speed over ground (SOG) and alarms shall be consistent with the requirements of M.233/A3.16 and M.233/A3.18;

(M.233/A3.17) The Galileo receiver equipment shall have at least one normally closed contact which shall indicate failure of the Galileo receiver equipment;

(M.233/A3.18) The Galileo receiver equipment shall have a bidirectional interface to facilitate communication so that alarms can be transferred to external systems and so that audible alarms from the Galileo receiver can be acknowledged from external systems; the interface shall comply with IEC 61162.

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

- DTM – Datum reference (see IEC 61162-1)
- GBS – GNSS Satellite fault detection (see IEC 61162-1)
- GFA – GNSS Fix Accuracy and integrity (see IEC 61162-1)
- GNS – GNSS fix data (see IEC 61162-1)
- RMC – Recommended minimum specific GNSS data (see IEC 61162-1)
- ZDA – Time and date (see IEC 61162-1)

If a sentence uses a datum other than WGS-84 then the DTM sentence shall be used in compliance with IEC 61162-1.

For alarm reporting purposes the following sentences shall be available.

- ALR – Set Alarm State (see IEC 61162-1)
- ACK – Acknowledge Alarm (see IEC 61162-1)

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

- GRS – GNSS range residuals (see IEC 61162-1)
- GSA – GNSS DOP and active satellites (see IEC 61162-1)
- GST – GNSS pseudo-range error statistics (see IEC 61162-1)
- GSV – GNSS satellites in view (see IEC 61162-1)

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

4.3.3 Accuracy

(See 5.6.4)

4.3.3.1 Static position accuracy

(M.233/A3.5) *The Galileo receiver equipment shall have static accuracy such that the position of the antenna is determined to within:*

- i) *15 m horizontal (95 %) and 35 m vertical (95 %) for single frequency operations on the L1 frequency;*
- ii) *10 m horizontal (95 %) and 10 m vertical (95 %) for dual frequency operations on L1 and E5a or L1 and E5b frequencies.*

NOTE The minimum accuracy requirements specified for dual frequency processing are based on the performance requirements established in IMO resolution A.915(22) and IMO resolution A.953(23) for navigation in harbour entrances, harbour approaches and coastal waters. The Galileo Safety of Life service is expected to be able to provide better accuracy (4 m horizontal 95 % and 8 m vertical 95 %).

4.3.3.2 Dynamic position accuracy

(M.233/A3.6) *The Galileo receiver equipment shall have dynamic accuracy equivalent to the static accuracy specified in 4.3.3.1 above under the sea states and motion experienced in ships as described in IMO resolution A.694(17), IEC 60721-3-6 and IEC 60945.*

4.3.4 Acquisition

(See 5.6.5)

(M.233/A3.9) *The Galileo receiver equipment shall be capable of selecting automatically the appropriate satellite-transmitted signals to determine the ship's position and velocity, and time with the required accuracy and update rate;*

(M.233/A3.12) *The Galileo receiver equipment shall be capable of acquiring position, velocity and time to the required accuracy within 5 min when there is no valid almanac data (cold start);*

(M.233/A3.13) *The Galileo receiver equipment shall be capable of acquiring position, velocity and time to the required accuracy within 1 min when there is valid almanac data (warm start);*

(M.233/A3.14) *The Galileo receiver equipment shall be capable of re-acquiring position, velocity and time to the required accuracy within 1 min when there has been a service interruption of 60 s or less;*

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

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

Condition A

Initialization (cold start) – the equipment has

- been transported over large distances (>1 000 km to <10 000 km) without power or Galileo signals or by the deletion of the current almanac; or
- not been powered for >7 days.

Condition B

Warm start – the equipment has a valid almanac (Power outage and/or interruption of Galileo signal reception for at least 24 h).

Condition C

Brief interruption of power for 60 s.

No user action other than applying power and providing a clear view from the antenna for the Galileo 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
Acquisition time limits (min)	5	1	1

4.3.5 Antenna and input/output connections

(See 5.6.6)

(M.233/A5) 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 Galileo receiver equipment inputs or outputs for a duration of 5 min.

4.3.6 Antenna design

(See 5.6.7)

(M.233/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, taking into consideration any obstruction that might exist on the ship.

4.3.7 Dynamic range

(See 5.6.8)

(M.233/A3.10) The Galileo receiver equipment shall be capable of acquiring satellite signals with input signals having carrier levels in the range of –128 dBm to –118 dBm. Once the satellite signals have been acquired, the equipment shall continue to operate satisfactorily with satellite signals having carrier levels down to –131 dBm.

4.3.8 Protection from specific interfering signals

(See 5.6.9)

The Galileo receiver equipment shall meet the following requirements:

- in a normal operating mode, i.e. switched on and with antenna attached, it is subject to radiation of 3 W/m² at a frequency of 1636,5 MHz for 10 min. When the unwanted signal is removed and the Galileo receiver antenna is exposed to the normal Galileo satellite signals, the Galileo receiver equipment shall calculate valid position fixes within 5 min without further operator intervention;

NOTE 1 This is equivalent to exposing a Galileo antenna to radiation from an Inmarsat Fleet77 antenna at 10 m distance along the bore sight.

- 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 1 600:1 at a frequency lying between 2,9 GHz and 3,1 GHz at power density of about 7,5 kW/m². 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 Galileo receiver antenna is exposed to the normal Galileo satellite signals, the receiver shall calculate valid position fixes within 5 min without further operator intervention.

NOTE 2 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 μ s pulse width at 600 pulses/s using a 4 m slot antenna rotating at 20 r/min with the Galileo 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 ship earth stations, etc.

4.3.9 Position update

(See 5.6.10)

(M.233/A3.15) The Galileo receiver equipment shall generate and output to a display and digital interface (conforming to IEC 61162) a new position solution at least once every 1 s for conventional craft and at least once every 0,5 s for high speed craft;

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

(M.233/A3.7) The Galileo receiver equipment shall have position resolution equal or better than 0,001 minutes of latitude and longitude;¹

4.3.10 Differential Galileo input

(See 5.6.11)

(M.233/A3.19) The Galileo receiver equipment shall have the facilities to process differential Galileo (dGalileo) data fed to it in accordance with the standards of Recommendation ITU-R M.823 and an appropriate RTCM standard, and provide indication of the reception of dGalileo signals and whether they are being applied to the ship's position.

When a dual frequency Galileo receiver is equipped with a differential receiver, performance standards for static and dynamic accuracies (4.3.3.1 and 4.3.3.2) shall be 10 m (95 %) together with integrity monitoring.

When a single frequency Galileo receiver is equipped with a differential receiver, performance standards for static and dynamic accuracies (4.3.3.1 and 4.3.3.2) shall be 10 m (95 %).

An integrated dGalileo receiver shall have an ITU-R M.823 compliant asynchronous full duplex serial input/output port for testing in compliance with IEC 61108-4. The data input/output port shall be supplied for testing purposes only.

NOTE It is intended that the standard for the differential Galileo receiver will be contained in a future revision of IEC 61108-4.

4.3.11 Navigational warnings and status indications

(See 5.6.12)

4.3.11.1 Position

(M.233/A4.1) The Galileo receiver equipment shall also indicate whether the performance of Galileo is outside the bounds of requirements for general navigation in the ocean, coastal, port approach and restricted waters, and inland waterway phases of the voyage as specified in either IMO resolution A.953(23) or Appendix 2 to IMO resolution A.915(22) and any subsequent amendments as appropriate.

The Galileo receiver equipment shall as a minimum:

¹ It should be noted that AIS receivers require 0,0001 minutes of latitude and longitude.

- a) (M.233/A4.1.1) provide a warning within 5 s of loss of position or if a new position based on the information provided by the Galileo constellation has not been calculated for more than 1 s for conventional craft and 0,5 s for high speed craft. Under such conditions the last known position and time of last valid fix, with the explicit indication of the state so that no ambiguity can exist, shall be output until normal operation is resumed;
- b) (M.233/A3.19) provide differential Galileo status indication of:
 - 1) the receipt of dGalileo signals; and
 - 2) whether they are being applied to the indicated ship's position;
- c) display dGalileo text messages. The Galileo receiver either shall have as a minimum the capability of displaying appropriate dGalileo text messages or forwarding those messages for display on a remote system;
- d) provide an indication of the navigational status.

(M.233/A4.2) For receivers having the capability to process the Galileo Safety of Life Service, integrity monitoring and alerting algorithms shall be based on a suitable combination of the Galileo integrity message and receiver autonomous integrity monitoring (RAIM). The receiver shall provide an alarm within 10 s Time to Alarm (TTA) of the start of an event if an alert limit of 25 m Horizontal Alert Limit (HAL) is exceeded for a period of at least 3 s. The probability of detection of the event shall be better than 99,999 % over 3-hour period (integrity risk $\leq 10^{-5} / 3$ h).

The navigational status for different position accuracy levels shall be expressed in three navigational states
safe,
caution and
unsafe.

The conditions for a "Safe" navigational state are as follows:

- a) the estimated error (95 % confidence) along the major axis of the error ellipse is less than the selected accuracy level corresponding to the actual navigation mode, and
- b) integrity is available and within the requirements for the actual navigation mode, and
- c) a new position has been calculated within 1 s for a conventional craft and 0,5 s for a high speed craft

The conditions for a "Caution" navigational state is that integrity has not been available for a period of at least 3 s.

The conditions for an "Unsafe" navigational state are as follows:

- a) the estimated error (95 % confidence) along the major axis of the error ellipse is greater than the selected accuracy level corresponding to the actual navigation mode, and/or
- b) integrity is available but exceeds the requirements for the actual navigation mode for a period of at least 3 s, and/or
- c) a new valid position has not been calculated for more than 1 s for a conventional craft and 0,5 s for a high speed craft.

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

The manufacturers may use colours for navigational status indication and if so the following colours shall be used:

- "Safe" shall be green,
- "Caution" shall be yellow, and
- "Unsafe" shall be red.

A change in the navigational status shall be indicated within 10 s.

For receiver equipment which does not provide information by a dedicated display, the provision of the navigational status indication and the selected accuracy level with an appropriate output interface is mandatory.

4.3.11.2 Integrity monitoring

The Galileo receiver equipment shall incorporate integrity monitoring to determine if the probability of an undetected position failure exceeds the integrity risk limit for the actual navigation mode and provide an integrity indication.

NOTE 1 The Galileo integrity concept is explained in Annex B.

Integrity calculations shall be expressed either in terms of the integrity risk (P_{HMI}) at HAL or the horizontal protection limit (HPL), which is the radius of a circle in the horizontal plane with its centre in the true position which is assured to contain the indicated horizontal position with a probability consistent with the integrity risk level.

NOTE 2 In the RAIM literature this is also referred to as the marginally detectable error (MDE). The protection level is equivalent to the maximum MDE for the satellites used in the position solution.

A receiver capable of receiving the Safety of Life service shall use the Galileo integrity message to determine the integrity status. The accuracy levels shall be user selectable for 10 m and 100 m for general navigation (see IMO resolution A.953(23)), and the corresponding protection levels are 25 m and 250 m respectively. Additional accuracy levels for user selection may be provided.

The integrity monitoring shall be based on the following sources:

- a) Galileo Safety of Life integrity message when available, and
- b) Receiver Autonomous Integrity Monitoring (RAIM).

An integrity indication shall be used to present the result of the integrity calculation with reference to the selected accuracy level appropriate for the vessel's operational mode. The integrity indication refers to the "Safe", "Caution" and "Unsafe" states of the navigational warning indicator.

As a minimum, the source of the integrity status indication, other than for the safe state, should be displayed.

4.3.11.3 Integrity monitoring using RAIM

4.3.11.3.1 General

(M.233/A4.1.2) The Galileo receiver equipment shall as a minimum use receiver autonomous integrity monitoring (RAIM) to provide integrity performance appropriate to the operation being undertaken;

RAIM calculations are undertaken through a combination of failure detection and integrity monitoring, and the RAIM algorithm employed shall be capable of detecting and excluding a faulty range signal from the position solution.

NOTE 1 RAIM is described in Annex C.

The decision thresholds used to detect and exclude a faulty range signal shall be consistent with the IMO integrity and continuity requirements as stated in IMO resolutions A.953(23) and A.915(22).

NOTE 2 dGalileo integrity information should be used to assist RAIM calculations when available.

4.3.11.3.2 Conditions for the safe integrity state

The result of integrity calculation (see Table 2) shall be stated as "safe", if the calculated horizontal protection level (HPL) is less than or equal to the horizontal alert limit (HAL).