
**Ships and marine technology —
Marine gyro-compasses**

*Navires et technologie maritime — Compas gyroscopiques à usage
marin*

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation and ship operations*.

This third edition cancels and replaces the second edition (ISO 8728:1997), which has been technically revised.

Ships and marine technology — Marine gyro-compasses

1 Scope

This International Standard specifies the construction, performance, and type testing for *gyro-compasses required by Regulation 12 of Chapter V of SOLAS 1974* (as amended).

NOTE All requirements that are extracted from the recommendations of IMO Resolutions [Resolution A.424(XI) on performance standards for gyro-compasses] are printed in italics.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 25862, *Ships and marine technology — Marine magnetic compasses, binnacles and azimuth reading devices*

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

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

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

IEC 61924-2, *Maritime navigation and radiocommunication equipment and systems — Integrated Navigation Systems (INS) — Part 2: Modular structure for INS — Operational and performance requirements, methods of testing and required test results*

IMO Resolution MSC.252(83), *Performance standards for alert communications with an Integrated Navigation System*

IMO Resolution MSC.302(87), *Performance standards for bridge alert management*

3 Terms and definitions

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

3.1

gyro-compass

complete equipment including all essential elements of the complete design, including both the gyro-compass as heading sensor and the associated heading transmission system

3.2

true heading

horizontal angle between the vertical plane passing through the true meridian and the vertical plane passing through the ship's fore-and-aft datum line; it is measured from true north (000°) clockwise through 360°

Note 1 to entry: When the gyro-compass equipment is not installed on board ship, this "true heading" is regarded as the true heading of the lubber line. Where a gyro-compass has the facility of introducing a correction by moving the lubber line, the correction is set for the local latitude.

**3.3
settled**

stable situation when *any three readings taken at intervals of 30 min are within a band of 0,7°, with the compass level and stationary*

Note 1 to entry: The settling time is the elapsed time between the time of switch-on at the initial heading error and the third recording of the settle.

**3.4
settle point heading**

mean value of ten readings taken at 20 min intervals after the compass has settled as defined in [3.3](#)

**3.5
settle point error**

difference between the settle point heading as defined in [3.4](#) and the true heading

**3.6
error**

difference between the observed value and the settle point heading as defined in [3.4](#)

**3.7
bearing repeater compass**

device that reproduces the master compass card at a remote location

**3.8
compass card**

graduated dial of the compass which indicates the measured direction of the meridian

**3.9
latitude error**

error to which some gyro-compasses are subject, the magnitude and sign of which depend upon the local latitude

Note 1 to entry: Means are provided for correcting this error.

**3.10
speed error**

error to which gyro-compasses are subject, the magnitude and sign of which depend upon the speed, course, and latitude of the ship

Note 1 to entry: Means are provided for correcting this error.

**3.11
lubber line**

index line situated on the body of a compass against which the compass heading is read

**3.12
master compass**

main compass unit which supplies the heading information to the repeaters and other navigational aids

**3.13
scorsby table**

test machine which independently oscillates a platform about three axes; it is used to simulate the motion of a ship

4 Construction

Gyro-compass units shall conform to the following requirements.

4.1 *The equipment shall be capable of continuous operation under conditions of vibration, humidity, change of temperature and variations of the power supply as specified in 6.10.1 to 6.10.5.*

4.2 For those ships which are required to carry bearing repeater compasses, the construction of these shall be as follows.

- a) The bearing repeater compass shall be designed to be fitted with an azimuth reading device.
- b) A gimbal mechanism shall be provided to enable the bearing repeater compass card to be held horizontally against the ship's motion.
- c) Any bearing repeater compass intended for use on an open deck shall be waterproof.

4.3 *The compass card shall be graduated at equal intervals of 1° or fraction thereof.*

The graduation error shall be less than $\pm 0,2^\circ$.

A numerical indication shall be provided at least at every 10°, starting from 000° clockwise through 360°.

4.4 *Fully adequate illumination shall be provided to enable the reading of all compass cards at all times. Facilities for dimming shall be provided.*

4.5 Both master compass and repeater compasses shall be provided with a lubber line to indicate the ship's heading.

4.5.1 The base or some other fixed extremity of the compass shall be marked or identified in such a way as to facilitate the installation of the compass in a ship, so that the lubber line lies in a vertical fore-and-aft plane of the ship. Where a gyro-compass has the facility of introducing a correction by moving the lubber line, the correction during installation shall be set to zero.

If such marks or identifications are not in the same vertical planes as the uncorrected lubber line, then the horizontal angular relationship between them shall be clearly indicated.

4.6 *Means shall be provided for correcting the errors induced by speed and latitude. Graphical or tabular means of correction can be used.*

4.7 *Steps shall be taken to eliminate as far as is practical, the causes of and to suppress electromagnetic interference between the gyro-compass and other equipment on board.*

4.8 *Mechanical noise from all units shall be so limited as to ensure the hearing of sounds on which the safety of the ship may depend.*

4.9 *The equipment shall be so constructed that it is readily accessible for maintenance purposes.*

4.10 *An automatic alert¹⁾ shall be provided to indicate malfunctions of the system or a power failure in the gyro-compass. The alert shall conform to the presentation and handling requirements of Bridge Alert Management [IMO Res. MSC.302(87)]. A suitable interface shall be provided for alert communications with an Integrated Navigation System [IMO Res. MSC.252(83) and IEC 61924-2].*

The following sentences shall be provided for the alert communications interface:

Sentences transmitted by the gyro-compass:

— ALR, HBT: See IEC 61162-1;

1) The term "alarm" was replaced by "alert" in accordance with IMO Resolution MSC.252(83) and IMO Resolution MSC.302(87).

— ALC, ALF, ARC: See IEC 61924-2.

Sentences received by the gyro-compass:

— ACK, HBT: See IEC 61162-1;

— ACN: See IEC 61924-2.

4.11 Means shall be incorporated for the protection of the equipment from excessive currents and voltages, transients and accidental reversal of power supply polarity.

4.12 If provision is made for operating the equipment from more than one source of electrical energy, arrangements for rapidly changing from one source of supply to the other shall be incorporated.

4.13 The gyro-compass shall be designed to enable heading information to be provided to other navigational aids.

5 Performance requirements

5.1 Accuracy in latitudes up to 60°

5.1.1 Settling time

When switched on in accordance with the manufacturer's instructions, the compass shall settle within 6 h.

5.1.2 Settle point error

5.1.2.1 The settle point error as defined in 3.5 at any heading shall not exceed $\pm 0,75^\circ \times \secant\ latitude$, and the RMS value of the differences between individual heading indications and the mean value shall be less than $0,25^\circ \times \secant\ latitude$.

5.1.2.2 The repeatability of settle point error from one run-up to another shall be within $0,25^\circ \times \secant\ latitude$.

5.1.3 Settling time under operational conditions

When switched on in accordance with the manufacturer's instructions, the compass shall settle within 6 h when rolling and pitching with simple harmonic motion of any period between 6 s and 15 s, a maximum angle of 5°, and a maximum horizontal acceleration of $0,22\ m/s^2$.

5.1.4 Settle point error under general conditions

The repeatability of the settle point error of the master compass shall be within $\pm 1^\circ \times \secant\ latitude$ under the general conditions and including variations in magnetic fields likely to be experienced in the ship in which it is installed.

5.1.5 Residual error in correction

The residual steady-state error, after correction for speed and course influences at a speed of 20 kn, shall not exceed $\pm 0,25^\circ \times \secant\ latitude$.

5.1.6 Effect of alteration of speed

The error due to a rapid alteration of speed of 20 kn shall not exceed $\pm 2^\circ$.

5.1.7 Effect of alteration of course

The error due to a rapid alteration of course of 180° at a speed of 20 kn shall not exceed $\pm 3^\circ$.

5.1.8 Accuracy on a Scorsby table

The transient and steady-state errors due to rolling, pitching, and yawing, with simple harmonic motions of any period between 6 s and 15 s, maximum angles of 20° , 10° , and 5° respectively, and a maximum horizontal acceleration not exceeding 1 m/s^2 , shall not exceed $\pm 1^\circ \times \secant \text{ latitude}$.

5.1.9 Synchronization between the master compass and repeaters

Once the repeaters have been synchronized with the master, the maximum divergence in reading between the master compass and repeaters under all operational conditions shall not exceed $\pm 0.5^\circ$; for the purposes of this requirement, the latitude and speed correction shall be assumed equal to zero.

5.2 Interface

5.2.1 The compass shall provide interface facilities which meet the relevant international standards IEC 61162-1 and/or IEC 61162-2 as amended.

5.2.2 The gyro-compass equipment shall provide an appropriate data source and at least one output of heading information, which is able to comply with the IEC 61162-2. The IEC 61162-2 heading output shall be updated at a rate of once per 20ms. The THS sentence detailed in IEC 61162-1 shall be provided for heading information.

5.2.3 The test of the interface shall meet the performance test specified in [6.8](#) as well as for repeaters.

6 Type tests

6.1 General

6.1.1 Unless otherwise stated in this International Standard, the requirements of IEC 60945 shall apply.

6.1.2 The construction of the gyro-compass shall conform to the requirements specified in [Clause 4](#).

6.2 Settling time test

The master compass shall be securely positioned on a nominally level and stationary base. It shall be energized from nominal value power supplies and started in accordance with the manufacturer's instructions from an initial heading error (high) of 30° or more.

The settling time (see [3.3](#)) shall meet the requirements of [5.1.1](#).

6.3 Settle point error test

When the master compass has settled as defined in [3.3](#), the settle point error (see [3.5](#)) shall conform to the requirements specified in [5.1.2.1](#).

6.4 Settle point heading repeatability test

The master compass shall be started in accordance with the manufacturer's instructions from an initial heading error (high) of 30° or more and shall be allowed to settle.

The settle point heading shall be determined as specified in 3.4. The master compass shall then be switched off for a period of not less than 12 h and not more than 7 days and then started again from an initial heading error (low) of 30° or more and the settle point heading measured again. The master compass shall then be switched off for a period of not less than 12 h and not more than 7 days and then started again from an initial heading error (high) of 30° or more and the settle point heading determined. The three values of settle point heading so obtained shall be recorded and the difference between any two shall not exceed $0,25^\circ \times \secant \text{ latitude}$.

NOTE If this test follows the text described in 6.3, then the “settle” obtained from that text can be used as the first value required by this repeatability test provided that the second “settle” follows a switch off period of not less than 12 h and not more than 7 days.

6.5 Settling time on a Scorsby table

The master compass shall be mounted on a Scorsby table with the master compass fore-and-aft line nominally parallel with one axis of the table which shall be designated the roll axis.

The other nominally horizontal axis at right angles to the first shall be designated the pitch axis.

The compass shall then be switched on in accordance with the manufacturer's instructions with the following nominal simple harmonic table motions:

- roll axis: Peak amplitude $5^\circ \pm 1^\circ$, period $15 \text{ s} \pm 1 \text{ s}$;
- pitch axis: Peak amplitude $5^\circ \pm 1^\circ$, period $6 \text{ s} \pm 1 \text{ s}$.

The settling time measured between switch-on and compass settle as defined in 3.3 shall conform to the requirements specified in 5.1.3.

NOTE Compass readings to determine the settle condition may be taken with the Scorsby table stationary and nominally level, and with a minimum delay before resuming the specified table motion.

6.6 Scorsby test

The master compass shall be settled on the Scorsby table with the table stationary, nominally level and its roll axis aligned north-south within $\pm 1^\circ$.

The compass lubber line shall be aligned to within $\pm 1^\circ$ of the table roll axis. The following nominal simple harmonic motions shall be applied simultaneously to the three axes of the table for 25 min:

- roll axis: Peak amplitude $20^\circ \pm 2^\circ$, period $10 \text{ s} \pm 1 \text{ s}$;
- pitch axis: Peak amplitude $10^\circ \pm 1^\circ$, period $6 \text{ s} \pm 1 \text{ s}$;
- yaw axis: Peak amplitude $5^\circ \pm 1^\circ$, period $15 \text{ s} \pm 1 \text{ s}$.

At the end of 25 min, the table motion shall be stopped, the table returned to its original position and the compass heading recorded without delay.

This test shall be repeated with the roll axis of the motion table aligned at $045^\circ \pm 1^\circ$, at $090^\circ \pm 1^\circ$ and at $315^\circ \pm 1^\circ$. At each of these headings, the compass settle point shall be determined before commencing the table motion and any change of heading indicated by the compass between the settle point heading immediately prior to the motion and the heading at the conclusion of the motion shall be recorded as error due to motion.

In each of the four tests, the error due to the motion shall be less than $\pm 1^\circ \times \secant \text{ latitude}$.

Any horizontal accelerations applied during this test shall not exceed 1 m/s^2 .

6.7 Intercardinal motion test

The master compass shall be securely mounted on a device having the ability to move with nominal simple harmonic motion such that the component of motion in a horizontal plane shall have a peak acceleration of $1,0 \pm 0,1 \text{ m/s}^2$. The direction of motion of the device in the horizontal plane shall be an intercardinal direction to within $\pm 3^\circ$.

When so mounted, the compass shall be settled (see 3.3) and the settle point heading shall be obtained (see 3.4) with the device stationary and nominally levelled. The device shall then be submitted to the motion described previously having a peak acceleration of $1,0 \pm 0,1 \text{ m/s}^2$ with a periodic time of not less than 3s, for a duration of 2 h. Any difference between the compass heading recorded during the motion and the settle point heading prior to the motion will be considered as due to the motion; it shall not exceed $1^\circ \times \secant \text{ latitude}$.

NOTE The master compass heading recorded during the motion should discount any modulation at frequencies equal to or higher than the frequency of the applied motion.

6.8 Repeater accuracy test

This test only applies to compass equipment which includes a repeater compass. The latitude and speed error correction shall be assumed equal to zero. The master compass shall be settled on a level rotary table and the repeater aligned with the master compass. The table and master compass shall be turned at a rate not greater than $5^\circ/\text{s}$, the table being stopped at every 30° and the compass heading and the repeater heading recorded. This procedure shall be repeated in the reverse direction of rotation. The maximum divergence in reading between the master compass and the repeater shall conform to the requirements specified in 5.1.9.

NOTE The exact angle of the table when readings are taken is unimportant since the object of the test is to compare master and repeater heading indications.

If the repeater compass to be tested is intended for use on an open deck, it shall be tested at a temperature of $-20^\circ\text{C} \pm 3^\circ\text{C}$ and again at $+60^\circ\text{C} \pm 3^\circ\text{C}$ having been exposed to the test temperature for 2 h prior to the test. Any climatically controlled system designed as a part of the repeater installation may be switched on for this test.

6.9 Speed correction test

This test applies to gyro-compass units fitted with a correction device for speed and course error.

With the master compass mounted on a level and stationary base and the lubber line of the compass aligned north-south, the master compass shall be settled and the settled point heading recorded.

A speed correction signal of 20 kn shall be applied to the compass equipment and the compass allowed to resettle.

The difference between the settle point heading so obtained and that recorded initially shall agree with the value computed theoretically for the latitude of the test to within $0,25^\circ \times \secant \text{ latitude}$.

If the latitude and speed correction is performed within the heading signal transmission system, then the heading readings required for the purposes of this test shall be taken on a repeater driven by the transmission system on the output signal of the transmission system.

Speed and course error, in degrees, for a compass aligned North–south is

$$\frac{V}{5\pi} \times \text{secant latitude} \quad (1)$$

where

V is the speed in knots.

6.10 General requirement test

For all the environmental tests in the general requirements tests, the datum from which settle point variations shall be measured is the settle point heading obtained in the absence of the particular environmental condition to be applied. Where the gyro-compass includes repeater compasses, at least one repeater compass of the gyro-compass shall be energised and aligned with the master compass at all times during the course of environmental tests. Each remaining repeater compass output shall be connected to a normal load, or to suitable impedance representing a normal load, supplied by the manufacturer.

6.10.1 Voltage variation test

The supply voltage shall be set to 10 % above the nominal value for 3 h, during which time the compass heading shall be recorded at 20 min intervals. The supply voltage shall then be set to a value 10 % below nominal for 3 h, and the compass heading again recorded at 20 min intervals. None of the recorded headings shall depart from the original datum by more than $1^\circ \times \text{secant latitude}$.

6.10.2 Frequency variation test

The supply frequency shall be set to 5 % above the nominal value for 3 h, during which time the compass heading shall be recorded at 20 min intervals. The supply frequency shall then be set to a value 5 % below nominal for 3 h, and the compass heading again recorded at 20 min intervals. None of the recorded headings shall depart from the original datum by more than $1^\circ \times \text{secant latitude}$.

6.10.3 Vibration tests

6.10.3.1 Vibration test of master compass

In all these tests, the direction of the master compass lubber line shall be $+30^\circ \pm 1^\circ$ to the meridian.

The master compass shall be subjected to the vibration described below. Three separate tests shall be carried out, the direction of vibration being:

- a) $+30^\circ \pm 1^\circ$ to the meridian and horizontal;
- b) $-60^\circ \pm 1^\circ$ to the meridian and horizontal;
- c) vertical.

In each case the compass shall be settled initially and then the vibration shall be applied at the lowest frequency, holding the appropriate vibration amplitude for a period of 25 min. At the end of that period, the frequency and amplitude shall be changed to the next value tabulated below and held for a further 25 min. This process shall continue until the entire frequency range has been covered.

Table 1

Frequency Hz	Amplitude mm
5	±0,71
7	±0,71
10	±0,71
14	±0,63
20	±0,31
28	±0,16
40	±0,08

The indicated heading shall be recorded at the end of each period; any difference between these recorded headings and the datum settle point heading shall be not more than $1^\circ \times \secant \text{ latitude}$ during the test.

NOTE Provision may be made to reduce or nullify any adverse effect on the equipment performance caused by the presence of any electromagnetic field due to the vibration unit.

6.10.3.2 Vibration test of compass equipment other than master compass

This equipment, complete with any shock absorbers which are part of it, shall be secured by its normal means of support to the vibration table. It shall then be connected in its normal electrical configuration to the master compass. The master compass shall then be switched on in accordance with the manufacturer's instructions and its settle point heading ascertained and recorded.

The equipment on the vibration table shall then be vibrated vertically at all frequencies between

- a) 5 Hz and 13,2 Hz with an amplitude of 1,0 mm;
- b) 13,2 Hz and 40 Hz with a maximum acceleration of $0,7 \times 9,8 \text{ m/s}^2$;

taking at least 25 min to cover each frequency range.

This whole procedure shall be repeated when the equipment is vibrated in two mutually perpendicular directions in the horizontal plane. There shall be no electrical or mechanical failure during any part of this series of tests.

The indicated heading shall be recorded at the end of each period any difference between these recorded headings and the datum settle point heading shall be not more than $1^\circ \times \secant \text{ latitude}$ during the test.

6.10.4 Temperature test

The compass equipment shall be placed in a chamber at normal room temperature, switched on and allowed to settle. The settle point heading shall be obtained and recorded. The temperature of the chamber shall then be raised to $45^\circ\text{C} \pm 2^\circ\text{C}$ and maintained for a period of 3 h. At the end of this period, the compass heading indication shall again be recorded. The temperature of the chamber shall then be reduced to $0^\circ\text{C} \pm 2^\circ\text{C}$ and maintained at this temperature for 3 h. At the end of this period, the compass heading indication shall be recorded once more. Neither of the recorded heading indications shall differ from the datum settle point heading by more than $1^\circ \times \secant \text{ latitude}$.

NOTE When the temperature of the chamber is being changed it should not alter by a rate which exceeds 45°C per hour.

6.10.5 Damp heat test

The compass equipment shall be placed in a chamber at normal room temperature and humidity, switched on and allowed to settle. The settle point heading shall be obtained and recorded. The temperature and relative humidity of the chamber shall then be raised steadily over a period of $3 \text{ h} \pm 0,5 \text{ h}$ to $40^\circ\text{C} \pm 2^\circ\text{C}$

and a relative humidity of $93 \% \pm 3 \%$. These conditions shall be maintained for a further period of $3 \text{ h} \pm 0,5 \text{ h}$.

The compass indication at the end of this test shall not differ from the datum settle point heading by more than $1^\circ \times \secant \text{ latitude}$.

6.10.6 Other tests

- a) Rain test

NOTE In the case of the rain test, only exposed equipment is tested.

- b) Conducted interference test
c) Radiated interference test
d) Acoustic noise test

In the case of the acoustic noise test, no measurement shall be made at the time of starting the gyro-compass, and only equipment intended for installation in wheelhouse and bridge wings is tested.

6.11 Interface test

The interface facilities shall be subjected to the tests specified in IEC 61162-1 and/or IEC 61162-2. Observe the IEC 61162-2 heading output rate and ensure that it is updated at least once per 20 ms. The interface as well as the repeaters shall meet the performance test specified in 6.8. The interface for the alert communications specified in 4.10 shall be confirmed by the analytical evaluation of manufacture's documentation and operation check.

7 Marking

Each unit of the gyro-compass shall be provided with an indication of the manufacturer, type, serial number, and year of manufacture.

Each unit of the equipment shall be marked with the minimum safe distance at which it may be mounted from a standard and a steering magnetic compass. The safe distance shall be measured in accordance with ISO 25862.

8 Information

Information shall be provided to enable competent members of a ship's crew to operate and maintain the equipment efficiently.

Annex A (normative)

Advice to ship surveyors for installation of gyro-compasses and repeater compasses on board ships

To ensure that the errors induced by the motions specified in [5.1.8](#) are not exceeded in practice, it will be necessary to pay particular attention to the siting of the master compass.

Where *the master compass and/or any repeater compass* are to be used for taking bearings, the horizontal angle between the vertical plane passing through the centre of the compass card, and including the lubber line, and the vertical plane passing through the craft's *fore-and-aft datum line*, should be *within $\pm 0,5^\circ$* when installed.

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Annex B (informative)

Equivalent requirements in ISO 8728 and IMO Resolution

Table B.1

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