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Ships and marine technology — Transmitting heading devices (THDs) —

Part 1: Gyro-compasses

Navires et technologie maritime — Dispositifs de pilotage à transmission de données —

Partie 1: Compas gyroscopiques

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Foreword

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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 second edition cancels and replaces the first edition (ISO 22090-1:2002), of which has been technically revised. It also replaces ISO 22090-1:2002/Cor1:2005.

ISO 22090 consists of the following parts, under the general title *Ships and marine technology — Transmitting heading devices (THDs)*:

— *Part 1: Gyro-compasses*

— *Part 2: Geomagnetic principles*

— *Part 3: GNSS principles*

Annex A of this part of ISO 22090 is for information only.

Ships and marine technology — Transmitting heading devices (THDs) —

Part 1: Gyro-compasses

1 Scope

This part of ISO 22090 specifies the construction, performance, and testing of gyro-compasses as transmitting heading device required by chapter V, SOLAS 1974 (as amended).

A Transmitting heading device (THD) is an electronic device that *provides information about the ship's true heading*.

In addition to the general requirements contained in IMO *Resolution A.694(17)* to which IEC 60945 is associated *and the relevant standard for the sensing part used, the THD equipment* shall *comply with the following minimum requirements*.

Where the IMO performance standards that *apply to the sensing part do not specify a geographical operating area that the THD* shall *operate*

a) at maximum rate of turn 20 °/s and

b) *from 70° latitude south to 70° latitude north as minimum*.

The THDs complying with the requirements contained in this part of ISO 22090 *can be used for heading information as contained in chapter V of the SOLAS Convention*.

However, ships within a speed range of 30 kn to 70 kn should comply with the requirements of IMO Resolution A.821(19).

In addition, such THD should meet the dynamic requirements contained in the HSC Code, chapter 13 for the carriage of a suitable device providing heading information.

NOTE 1 Several technologies can be used to detect and transmit heading information. It is illogical to standardize the detection of the heading separately from the transmission of the heading. Therefore, separate parts of this part of ISO 22090 refer to different technologies. The requirements of this part of ISO 22090 only apply to gyroscopic technology. Other technologies are covered in other parts of ISO 22090.

NOTE 2 All requirements that are extracted from the recommendations of IMO Resolution MSC. 116(73) on performance standards for transmitting heading devices 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, *Marine 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 — Inegrated Navigation Systems (INS) — Part 2: Modular structure for INS — Operational and performance requirements, methods of testing and required test results*

IMO Resolution MSC.116(73), *Performance standards for marine transmitting heading devices (THDs)*

IMO Resolution MSC.252(83), *Adoption of the revised performance standards for integrated navigation system (INS)*

IMO Resolution MSC.302(87), *Adoption of performance standards for bridge alert management*

IMO Resolution A.424(XI), *Performance standards for gyro-compasses*

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*

IMO Resolution A.813(19), *General requirements for electromagnetic compatibility (EMC) for all electrical and electronic ship's equipment*

IMO Resolution A.821(19), *Performance standards for gyro-compasses for high-speed craft*

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
heading
ship's heading to be input to the THD function

Note 1 to entry: It is defined by the direction of the vertical projection of the fore-and-aft line of the ship onto the horizontal plane. When measured relative to the true north, magnetic north, or compass north, it is respectively defined as true heading, magnetic heading, or compass heading, and is usually expressed in degrees as a three-figure group, starting from north, in a clockwise direction around the compass card.

3.3
sensing part
sensing function of detecting any heading information connected to the transmitting part

3.4
transmitting part
device which receives heading information from the sensing part and converts this *to the required accurate signal*

3.5
true heading
horizontal angle between the vertical plane passing through the true meridian and the vertical plane passing through the craft's fore and aft datum line, measured from true north (000°) clockwise through 360°

3.6
transmission and resolution error
error which is caused by the method used to transmit the original information to a receiving device

Note 1 to entry: *Such a method* may *have a limited capability to code any possible value of the information, e.g. step output with 1/6° resolution. This error is* also *caused by the method used inside the THD and at its output to code the information*.

3.7
static error
error caused by any reason and which stays unchanged in value during the operation of the system, measured under static conditions

Note 1 to entry: This error is the same as that defined in 3.12.

3.8
dynamic error
error caused by dynamic influences acting on the system, such as vibration, roll, pitch, or linear acceleration

Note 1 to entry: *This error may have an amplitude and usually a frequency related to the environmental influences and the parameters of the system itself.* This error is the same as defined in 3.13.

3.9
follow-up error
error caused by the delay between the existence of a value to be sensed and the availability of the corresponding signal or data stream at the output of the system

EXAMPLE *The difference between the real heading of a turning vessel and the available information at the output of the system.*

Note 1 to entry: *A follow-up error disappears when the system is static*.

3.10
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.

3.11
settle point heading
mean value of ten readings taken at 20 min intervals after the compass has settled as defined in 3.10

3.12
settle point error
difference between the settle point heading as defined in 3.11 and the true heading

Note 1 to entry: See 3.7

3.13
error
difference between the observed value and the settle point heading as defined in 3.11

Note 1 to entry: See 3.8.

3.14
latitude error
error to which some gyro-compasses are subject and whose magnitude and sign depend upon the local latitude

3.15
speed error
error to which gyro-compasses are subject and whose magnitude and sign depend upon the speed, course, and latitude of the ship

3.16
master compass
main compass unit which supplies the heading information to the transmitting part or other navigational aids

3.17
Scorsby table
test machine which independently oscillates a platform about three axes and is used to simulate the motion of a ship

3.18
intercardinal motion
representing an integral motion of the ship and is used for error test within motion in dynamic simulation test

4 Performance requirements

4.1 Functionality

In this part of ISO 22090, the gyro-compass is specified as the function of THD.

The THD generates a heading signal and outputs a suitable *signal for other devices*.

Any sensing part defined in 3.3 *may be included in the device*.

If *any correcting devices or parameters* have been associated, they shall *be protected against inadvertent operation*.

Manually entered *values used for electronic correction* shall *be indicated by adequate means*.

Gyro-compass units shall conform to the requirements listed in 4.2 to 4.8.

4.2 Continuous operation

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.

4.3 Information

All displays with the exception of the sensor, and all outputs of heading shall *indicate true heading*.

Indication shall be displayed, readable to a tenth of a degree.

4.4 Fore and aft mark

The compass shall be marked to facilitate installation in fore and aft line of the ship.

4.5 Speed error correction

Means shall be provided for correcting the errors induced by speed and latitude. An approved accurate speed source shall be used for automatic speed error corrections.

4.6 Heading information

The THD shall provide true heading information to the other navigational equipment.

Heading information shall be provided as an output with accuracy as defined in Clause 5.

4.7 Status indication

Status shall be indicated that the gyro-compass is ready to use.

4.8 Alert signal

An alert[1)] shall *be provided to indicate malfunctions of the THD or a failure of the power supply*. 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 THD:

— ALR, HBT: see IEC 61162-1;

— ALC, ALF, ARC: see IEC 61924-2.

Sentences received by the THD:

— ACK, HBT: see IEC 61162-1;

— ACN: see IEC 61924-2.

4.9 Interface

4.9.1 The THD shall provide interface facilities which meet the relevant International Standards IEC 61162-1 and/or IEC 61162-2 as amended.

4.9.2 The THD 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 20 ms. The THS sentence detailed in IEC 61162-1 shall be provided for heading information.

5 Accuracy

5.1 General

The THD shall *meet at least the following accuracy at the output of the device under sea conditions as specified in IMO Resolution A.424(XI) or A.821(19) as applicable*.

5.2 Accuracy of transmission data

The transmission error, including the resolution error, shall *be less than ±0,2°*.

1) The term of “Alarm” was replaced by “Alert” in accordance with IMO Resolution MSC.252(83) and IMO Resolution MSC.302(87).

5.3 Accuracy under static condition

5.3.1 Settling time under static condition

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

5.3.2 Static error (settle point error)

5.3.2.1 *The static error* (settle point error) as defined in 3.7 (3.12), at any heading shall *be less than ±1,0°* × secant latitude, and the RMS value of the differences between individual heading indications and the mean value shall be less than 0,35° × secant latitude.

5.3.2.2 The repeatability of settle point error from one run-up to another shall be within 0,35° × secant latitude.

5.4 Accuracy under dynamic condition

5.4.1 Settling time under dynamic condition

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 maximum horizontal acceleration of 0,22 m/s^2.

5.4.2 Dynamic error

The dynamic error amplitude shall *be less than ±1,5°* × secant latitude. *The dynamic error frequency* shall *be less than 0,033 Hz equivalent to a period not shorter than 30 s if the amplitude of the dynamic error exceeds ±0,5°*.

5.4.3 Performance under operational condition

In latitudes of up to 70°N or 70°S in a ship operating within a latitude band of 10°

— the residual steady-state error, after correction for speed and course influences at a speed of 30 kn, shall not exceed ±0,35° × secant latitude,

— the maximum error due to a rapid alteration of speed of 30 kn shall be kept to a minimum, and shall not exceed ±3 °. The horizontal acceleration shall not exceed 2,0 m/s^2, and

— the error due to a rapid alteration of course of 180° up to maximum rate of turn of 20°/s in heading up to a speed of 30 kn shall not exceed ±4,5°. The horizontal acceleration shall not exceed 2,0 m/s^2.

5.4.4 Follow-up error

The follow-up error for different rates of turn shall *be*

— *less than ± 0,5° up to a rate of 10 °/s*, and

— *less than ± 1,5°* up to *a rate of between 10°/s and 20°/s*.

6 Type tests

6.1 General

Where the gyro-compass includes repeater compasses, at least one repeater compass shall be energized and aligned with the master compass at all times during the 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. However, the associated repeater compass is not subject to this test.

The THD shall *be tested for accuracy with the sensing part connected. If the sensing part is so designed that it is included in the transmitting part, the equipment* shall be *tested at all parts*.

Unless otherwise stated in this part of ISO 22090, the requirements of IEC 60945 shall apply.

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 (to east) of 30° or more.

The settling time (see 3.10) shall meet the requirements of 5.3.1.

6.3 Static error (settle point error) test

When the master compass has settled as defined in 3.10, the static error (see 3.7) shall conform to the requirements specified in 5.3.2.1.

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 (to east) of 30° or more and shall be allowed to settle.

The settle point heading shall be determined as specified in 3.11. The master compass shall then be switched off for a period of not less than 12 h and not more than 7 d, and then started again from an initial heading error (to west) 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 d and started again from an initial heading error (to east) of 30° or more and the settle point heading determined. The three values of settle point heading obtained shall be recorded and the difference between any two shall not exceed 0,35° × secant latitude.

NOTE If this test follows the test described in 6.3, the "settle" obtained in 6.3 may 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 d.

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 system 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° ± 1°, period 15 s ± 1 s;

— pitch axis: peak amplitude 5° ± 1°, period 6 s ± 1 s.

The settling time as defined in 3.10 shall conform to the requirements specified in 5.4.1.

NOTE THD 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 ±1°.

The compass fore and aft mark shall be aligned to within ±1° 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° ± 2°, period 10 s ± 1 s;

— pitch axis: peak amplitude 10° ± 2°, period 6 s ± 1 s;

— yaw axis: peak amplitude 5° ± 1°, period 15 s ± 1 s.

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

This test shall be repeated with the roll axis of the motion table aligned at 45° ± 1°, at 90° ± 1, and at 315° ± 1°. At each of these headings, the compass settle point shall be determined before commencing the table motion and any change of heading indication 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, error due to the motion shall be less than ±1,5° × secant 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 m/s^2 ± 0,1 m/s^2. The direction of motion of the device in the horizontal plane shall be an intercardinal direction to within ±3°.

When mounted, the master compass shall be settled (see 3.10) and the settle point heading shall be obtained (see 3.11) 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 m/s^2 ± 0,1 m/s^2 with a periodic time of not less than 3 s, for a duration of 2 h. Any difference between the THD heading recorded during the motion and the settle point heading prior to the motion shall be considered as due to the motion; it shall not exceed 1,5° × secant latitude.

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

6.8 Follow-up error test

6.8.1 The master compass on a level rotary table shall be turned at a rate not greater than 10°/s, to read data both of THD output and angle of the table at, at least 5° intervals during this test.

The maximum follow-up errors shall conform to the requirements specified in 5.4.4.

6.8.2 The table and master compass shall be turned at a rate no greater than 20°/s, to read data both of THD output and angle of the table at, at least, 5° intervals during this test.

The maximum follow-up errors shall conform to the requirements specified in 5.4.4.

6.9 Speed error correction test

With the master compass mounted on a level and stationary base and the fore and aft mark of the compass aligned to north, the master compass shall be settled and the settled point heading recorded.

A speed signal of 30 kn shall be applied to the gyro-compass, and the latter allowed to resettle.

The difference between the settle point heading obtained and that recorded initially shall agree with the value computed theoretically for the latitude of the test to within 0,35° × secant latitude.

6.10 General requirement test

6.10.1 General

For these 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.

6.10.2 Voltage variation test

The supply voltage shall be set to 10 % above the nominal value for 3 h, during which time the THD 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 THD heading again recorded at 20 min intervals. None of the recorded headings shall depart from the original datum by more than 1,5° × secant latitude.

6.10.3 Frequency variation test

In the case of AC supply, the frequency shall be set to 5 % above the nominal value for 3 h, during which time the THD 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 THD heading again recorded at 20 min intervals. None of the recorded headings shall depart from the original datum by more than 1,5° × secant latitude.

6.10.4 Vibration test

6.10.4.1 Vibration test of master compass

In all these tests, the direction of the master compass fore and aft mark shall be +30° ± 1° 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° ± 1° to the meridian and horizontal,

b) −60° ± 1° to the meridian and horizontal, and

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 in Table 1 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 heading and the datum settle point heading shall be not more than 1,5° × secant latitude during the test.

NOTE Provision can 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.

6.10.4.2 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, and

b) 13,2 Hz and 40 Hz with a maximum acceleration of 0,7 × 9,8 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 the recorded heading and the datum settle point heading shall be not more than 1,5° × secant latitude during the test.

6.10.5 Temperature test

The 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 °C ± 2 °C and maintained for a period of 3 h. At the end of this period, the THD heading indication shall again be recorded. The temperature of the chamber shall then be reduced to 0 °C ± 2 °C and maintained at this temperature for 3 h. At the end of this period, the THD heading indication shall be recorded once more. Neither of the recorded heading indications shall differ from the datum settle point heading by more than 1,5° × secant latitude.

When the temperature of the chamber is being changed, it should not alter by a rate exceeding 45 °C/h.

6.10.6 Damp heat test

The equipment shall be placed in a chamber at normal room temperature and humidity, and then be 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 h ± 0,5 h to 40 °C ± 2 °C, and a relative humidity of 93 % ± 3 %. These conditions shall be maintained for a further period of 3 h ± 0,5 h.

The THD indication at the end of this test shall not differ from the datum settle point heading by more than 1,5° × secant latitude

6.11 Electromagnetic compatibility test

The device, with regard to electromagnetic interference and immunity, shall *in addition to IMO Resolution A.694(17), comply with IMO Resolution A.813(19)* and shall be tested in accordance with IEC 60945.

6.12 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 for the alert communications specified in 4.8 shall be confirmed by the analytical evaluation of manufacture's documentation and operation check.

7 Marking and identification

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

Annex A
(informative)

Equivalent requirements in ISO 22090-1 and IMO Resolution

Table A.1

Clause or subclause in ISO 22090-1	Clause or subclause in IMO Resolution MSC. 116 (73)
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[a] Slight differences in text.

Bibliography

[1] ISO 8728, *Ships and marine technology — Marine gyro-compasses*

[2] ISO 16328, *Ships and marine technology — Gyro-compasses for high-speed craft*

[3] IEC 61162-3, *Maritime navigation and radiocommunication equipment and systems — Digital interfaces — Part 3: Serial data instrument network*

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

[5] 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*

[6] International Convention on Safety of Life at Sea (SOLAS) 1974 (amended)

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