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

Part 2: Geomagnetic principles

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

Partie 2: Principes géomagnétiques

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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 22090-2:2004), which has been technically revised. It also replaces ISO 22090-2:2004/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*

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

Part 2: Geomagnetic principles

1 Scope

This part of ISO 22090 specifies the construction, performance, and testing of a device employing only magnetic means as transmitting heading devices 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 which apply to the sensing part do not specify a geographical operating area the THD shall *operate*

a) at a minimum rate of turn 20 °/s and

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

In addition such THDs are intended to 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 the principle of the geomagnetic. Other technologies are covered in other parts of ISO 22090.

NOTE 2 All requirements that are extracted from the recommendation of IMO Resolution MSC.116(73) on performance standards for transmitting heading devices are printed in italics.

A standard magnetic compass with a pickup sensor could be applied as a sensing part of this standard of geomagnetic principle. However the IMO performance resolution MSC.116(73) requires that the THD is intended to be met for the dynamic requirements of the HSC code. Nevertheless, when the THD would be only used other than the HSC, the limit of rate of turn may be 6 °/s instead of 20 °/s.

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 11606, *Ships and marine technology — Marine electromagnetic compasses*

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, *Marine 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.116(73), *Performance standards for marine transmitting heading devices (THDs)*

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

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

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*

3 Terms and definitions

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

3.1
geomagnetic principle
principle of the THDs depending (for its directional properties) upon the magnetism of the earth.

Note 1 to entry: A type to directly detect geomagnetic field is called the electromagnetic-compass-type THD (see ISO 11606), while a type to detect magnetic field via standard magnetic compass is called the magnetic-compass-type THD (see ISO 25862).

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
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°

3.4
magnetic compass
instrument designed to seek the direction of magnetic north in azimuth and to hold that direction permanently

3.5
magnetic sensor
magnetic sensing part which detects the geomagnetic field concerning heading information with or without a magnetic compass and outputs the information to a processor

3.6
processor
device which obtains the ship's magnetic heading information for a transmitting part by adjusting the magnetic deviations

3.7
transmitting part
device which receives heading information from the sensing part and converts this *to the required accurate signal*

3.8
sensing part
sensing function of detecting any heading information connected to the transmitting device

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 the 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
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 caused by the method used inside the THD and at its output to code the information.*

3.11
static error
error caused by any reason and which stays unchanged in value during the operation of the system, measured under static conditions

3.12
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.*

4 Performance requirements

4.1 Functionality

Geomagnetic principles of THDs detect the horizontal component of geomagnetic field and generates a ship's true heading signal for other devices.

In one type of sensor which utilizes a magnetic compass, the performances and requirements of the compass shall conform to the ones referred to ISO 25862 and the other type of the sensor shall fulfil the performance requirements concerning the marine electromagnetic compasses in ISO 11606.

4.2 Information

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

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

4.3 Fore-and-aft mark

On the bottom part of the binnacle and/or the housing of the sensor system, a fore-and-aft mark shall be inscribed to facilitate installation in the fore-and-aft line of the ship. The units shall be installed on the fore-and-aft line of the ship. In magnetic-compass-type THDs, it shall be in the vertical plane passing through the centre of the compass card and the main lubber mark to within ±0,5°.

4.4 Heading information

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

4.5 Electrical wiring

Electrical wiring, such as that for the direct-current power supply and that for connecting the units, shall not produce any perceptible errors in the heading information.

4.6 Non-magnetic housing

The housing of the magnetic sensor system shall be non-magnetic.

4.7 Alert signal

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

An alert output shall be provided as any alert conditions. 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.

4.8 Interface

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

4.8.2 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.

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

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°.*

5.3 Static error (settle point error)

The static errors shall *be less than ±1,0° (95 %).*

5.4 Dynamic error

The dynamic error amplitude shall *be less than ±1,5° (95 %). The dynamic error frequency for test* 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°.*

5.5 Follow-up error

The follow-up error for the rates of turn shall be

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

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

5.6 Settling time requirements to the directional system

In magnetic-compass-type sensors, the directional system shall always settle in the original direction. Following an initial deflection of the card of 90° from the magnetic meridian, the time taken to return finally to within 1° of the magnetic meridian shall not exceed $\sqrt{57\,600 / H}$ s at a temperature of 20 °C ± 3 °C, where H is the horizontal component of the magnetic flux density in microteslas (μT) at the place of testing.

5.7 Correcting the magnetic heading by magnetic variations

In order to get true headings, correcting the magnetic heading for magnetic variations shall be carried out within the errors of 0,5°. The means of correcting magnetic variation may be either automatic or manual.

The values used for electronic compensation should be indicated by adequate means and shall be stored such that values are automatically recovered when switching on.

5.8 Adjusting of magnetic deviations and heeling error

It shall be possible to adjust the coefficients A, B, C, and D so that the residual value of each coefficient is less than ±1°.

5.8.1 Check by bearings

The binnacles shall contain a device for correcting the deviation due to the horizontal components of the ship's permanent magnetism. This device shall be capable of correcting a coefficient A up to ±3°, coefficients B and C of up to at least (720/H)°, coefficient D of up to ±7°, vertical component of the ship's magnetic field (producing the heeling error) of up to ±75 μT, H being as defined in 5.6.

5.8.2 Check by magnetic fields

In electromagnetic-compass-type THDs, each coefficient of residual deviations shall be obtained by the following equations:

$$B = \frac{180°}{\pi} \times \frac{n_N - n_S}{2n'} \quad (1)$$

$$C = \frac{180°}{\pi} \times \frac{n_W - n_E}{2n'} \quad (2)$$

$$D = \frac{180°}{\pi} \times \frac{(n_N + n_S) - (n_W + n_E)}{4n'} \quad (3)$$

where

n_N, n_E, n_S, n_W are the ship's northern magnetic field when the ship's heading is N, E, S, and W respectively;

n' is the mean value of n_N, n_E, n_S, and n_W.

Coefficients A shall be negligibly small in electromagnetic-compass-type THDs.

The compensating devices shall be protected against accidental alterations.

5.9 Means of adjusting the deviation by vertical soft iron of the ship

Means of adjusting the deviation by vertical soft iron of the ship should be provided.

5.10 Protection of correcting devices

Any correcting devices or parameters shall *be protected against inadvertent operation.*

6 Type tests

6.1 General

Type testing shall be carried out before the instruments covered come into regular service. For type testing, only new devices are acceptable.

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 together with all parts.*

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

Tests in a static magnetic field shall be carried out in an authorized test room.

Devices which have passed the type tests and comply with the requirements shall be certified in the language of the test authority and in English.

Copies of the certificate shall be issued on demand. They shall be explicitly marked "copy".

Acceptance of type-test certificates between countries will be a matter for mutual agreement.

6.2 Transmission error test

On a rotating test stand, adjust the heading mark of the THD until the output shows 000,0, then slowly rotate the stand 10°. The readings of the transmission output shall meet the requirements of 5.2.

6.3 Fore-and-aft mark test

In magnetic-compass-type THDs, the examination can be carried out on a rotating test stand with the aid of a plumb line and with the compass in the binnacle.

In electromagnetic-compass-type THDs, the examination shall be verified by visual inspection or electrical measurements.

The results shall fulfil the requirements specified in 4.3.

6.4 Static error test

6.4.1 Magnetic-compass-type THD

The static error applies to the compass without fluxgate sensors. The fluxgate of a THD shall be placed so that the influence on the card heading shall not exceed 1,0° on any heading.

The examination can be carried out on a compass test stand. After having brought the rotation centre of the compass card into the rotation axis of the test stand, the static error can be read at the card graduation by means of a telescope or any other appropriate means, when the vertical plane of the sight passing through the rotation axis has been aligned with the magnetic meridian in advance. This measurement shall be carried out on at least four equidistant headings.

The static error shall be within ± 1,0° (95 %).

If the test is undertaken in the compass bowl, it should be noted that the resulting value includes the deviation due to any magnetic material in the compass and/or in the fluxgate sensor.

6.4.2 Electromagnetic-compass-type THD

After having brought the fore-and-aft line of the sensor housing into the line passing through the centre of the test stand and the zero line orientated north, the static error can be read comparing the output heading with the rotation angle. This measurement shall be carried out on at least four equidistant headings. The test results shall conform with the requirements of the 5.3.

6.5 Follow-up error test

Set up the magnetic sensor on a test platform, and rotate the platform at a rate of 20°/s. The readings of the heading output shall fulfil the requirements specified in 5.5.

6.6 Settling time test

The card, if fitted, is deflected 90°, held there for at least 10 s and then released. The time, in seconds, taken to return finally to within 1° of the magnetic meridian shall not exceed the value required in 5.6. This is repeated on the other side of the meridian and the mean is taken.

6.7 Tests for correcting the magnetic heading by magnetic variations

After indicating the magnetic heading on the display, when a few values of magnetic variations are manually or automatically input to the system, all the true headings indicated shall be within the accuracy of the requirement of 5.7. In the system containing a positioning system, after bringing the system to a position of which the magnetic field is not disturbed, turn the system so that the direction of the fore-and-aft mark from the centre aligns with a distant object of which the true bearing is known. The true heading indication coincidence shall also be within the accuracy of the requirement in 5.7.

6.8 Tests for adjusting magnetic deviations

The sensing part is placed on the test stand and aligned on north or south. An external magnetic force sufficiently far away to create a reasonably even field in the vicinity of the directional element is applied until a deviation of (720/H)° is obtained. This deviation is then corrected by the magnets. The resulting deviation shall not exceed the values required in 5.8.1. Repeat on east and/or west.

The amount of deviation of *D* that can be corrected can be checked by placing the compass and binnacle on a test stand on a quadrennial course, with and without the correctors in position. In the electromagnetic-compass-type sensor, the maximum amount of *D* in 5.8.1 which is to be corrected is measured in the quadrennial course with and without the switch of correction of coefficient *D* in the maximum values. The result shall fulfil the requirement in 5.8.1.

6.9 Tests for the means of adjusting the deviation by vertical soft iron

When the THD is provided with Flinders's bars, they shall be checked visually.

6.10 Dynamic accuracy

Mount the sensing part on a test stand, then the motion tests shall be carried out with the following nominal simple harmonic table motions and record the heading.

— 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 being 15 s ± 1 s.

At the end of the period of 5 min duration tests, the mean values of the recorded heading shall be within ±1,5° of the original heading. The result shall fulfil the requirement of 5.4.

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 for the alert communications specified in 4.7 shall be confirmed by the analytical evaluation of manufacture's documentation and operation check.

6.12 Malfunction test

A visible and audible alert required in 4.7 and THD shall be tested according to the following test procedure:

— malfunctions tests: using the manufacturer's self- check functions;

— power failure tests: main power supply to be off; to confirm an alert output for any alert conditions.

7 Marking and identification

Each unit of the equipment shall be marked with the minimum safe distance at which it may be mounted from a standard magnetic compass. The safe distance shall be measured in accordance with ISO 25862 and IEC 60945.

Each unit of the THDs shall be marked with the following:

— the identification of the manufacturer;

— the equipment type number or identification of the model which was type tested;

— the serial number of the unit;

— the year of manufacture (not necessary if the year of manufacture can be read by the serial number).

The presence of the markings on the unit of the THDs specified above shall be checked by visual inspection.

Annex A
(informative)

Equivalent requirements in ISO 22090-2 and IMO Resolution MSC.116(73)

Table A.1

Clause or sub-clause in ISO 22090-2	Clause or sub-clause in IMO Resolution MSC.116(73)
1 Scope	1.1, 1.2, 1.3 2.1 and 2.2
3.2 heading	3.1
3.3 true heading	3.4
3.7 transmitting part	3.3
3.8 sensing part	3.2
3.9 follow-up error	3.8
3.10 transmission and resolution error	3.5
3.11 static error	3.6
3.12 dynamic error	3.7
4.1 Functionality	4.1.1[a] and 4.1.2[a]
4.2 Information	4.2.1 and 4.2.2
4.7 Alert signal	6
4.8 Interface	4.4[a]
5.1 General	4.3.2
5.2 Accuracy of transmission data	4.3.2.1
5.3 Static error (settle point error)	4.3.2.2
5.4 Dynamic error	4.3.2.3
5.5 Follow-up error	4.3.2.4
5.10 Protection of correcting devices	4.1.3
6.1 General	4.3.1, 5[a]

[a] Slight differences in text.

Bibliography

[1] ISO 22090-1:2002, *Ships and marine technology — Transmitting heading devices (THDs) — Part 1: Gyro-compasses*

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

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

[4] 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*

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

[6] 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*

[7] Code HSC Chapter 13

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