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

Part 3: GNSS principles

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

Partie 3: Principes pour un système global de navigation par satellites

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Foreword

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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 second edition cancels and replaces the first edition (ISO 22090-3:2004), of which has been technically revised. It also replaces ISO 22090-3:2004/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 3:
GNSS principles

1 Scope

This part of ISO 22090 specifies general requirements, construction, performance, and testing of transmitting heading device using GNSS principle as required by chapter V, SOLAS 1974 (as amended).

A transmitting heading device (THD) is an electric 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, the THD* shall *operate*

a) at a 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*.

In addition, such THDs 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 the principle of the GNSS. 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.

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 — Integrated Navigation Systems (INS) — Part 2: Modular structure for INS — Operational and performance requirements, methods of testing and required test results*

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.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*

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

IMO Resolution MSC.191(79), *Performance standards for the presentation of navigation-related information on shipborne navigational displays*

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
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.

3.2
sensing part
sensing function of detecting any heading information, or information of directional source (i.e. GNSS antenna) *connected to the transmitting* part

3.3
transmitting part
device which receives heading information, or information of directional source, from the sensing part and converts this to *the required accurate signal*

3.4
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°

3.5
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: Static error is formed from the statistical mean (i.e. RMS) of the individual course deviations.

3.6
dynamic error
error caused by dynamic influences acting on the system, such as vibration, roll, pitch, yawing or acceleration in one axis

Note 1 to entry: This error can have an amplitude and usually a frequency related to the environmental influences and the parameters of the system itself.

3.7
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 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.*

3.8
settling time
time required from power-on to reach the state that the THD can output heading information with an accuracy specified in 6.3

3.9
settle point error
difference between the settled point heading and the true heading

3.10
Scorsby table
test machine which enables a platform to oscillate independently about three axes.

Note 1 to entry: It is used to simulate the motion of a ship.

3.11
GNSS principles
Global Navigation Satellite System principles
principles of the THDs in order to determine the ship's own heading by measuring an RF carrier phase in the GNSS signals

4 Performance and requirements

4.1 Functionality

The THD is an electronic device which *receives a heading sensor signal and generates a suitable output signal for other devices.*

Any sensor part may be included in the device.

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

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

4.2 Continuous operation

The THD shall be capable of continuous operation under conditions of vibration, humidity, and change of temperature as specified in 6.8.

4.3 Presentation of information

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

4.4 Heading output alignment

The THD shall have a means to align the sensing direction to the ship's fore and aft line.

4.5 Compensation for brief GNSS signal interruption

A brief interruption of GNSS signal for the duration of 60 s shall be compensated so as to maintain the heading accuracy, as defined in 5.3 and 5.4, for 60 s and for continuous operation.

4.6 Settling time

Settling time shall be less than 10 min in a static condition with a fully usable satellite almanac.

4.7 Heading information

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

4.8 Alert signal

An alert shall be provided on the following conditions:

— malfunction of the THD or failure of power supply;

— continuous GNSS signal interruption over 60 s at least.

An alert output shall be provided for 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.

4.9 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 condition 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 error (settle point error) as defined in 3.5 at any heading shall *be within 1,0°* (*95 %*).

5.4 Dynamic error

The additional dynamic error as defined in 3.6 shall be within 1,5° (95 %), under the conditions of 6.5 item a), 6.5 item b), and 4.5.

5.5 Follow-up error

The follow-up error as defined in 3.7 for *different 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*.

6 Type tests

6.1 General

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*. A manufacturer shall clearly document the structure of the transmission error.

The requirement of displays shall be in accordance with IMO Resolution MSC,191(79) and IEC 62288.

6.2 Organization of test conditions

6.2.1 Testing under ambient conditions

For testing at ambient temperature and relative humidity, all tests shall be carried out under normal conditions, as defined in IEC 60945 with a Horizontal Dilution Of Position (HDOP) ≤ 4 (or PDOP ≤ 6) and a minimum of five satellites in view.

6.2.2 Static test site

The sensing part shall be mounted on a table according to the manufacturer's instructions, in an area providing a clear line of sight to the satellites from zenith through to the angle + 5° above horizontal,

with stationary, normally level aligned 000 ± 1°. The heading of the table shall be known to an accuracy of better than 0,1°.

Maximum cable lengths, as specified by the manufacturer shall be used during testing.

All static tests shall utilize actual GNSS signals.

6.2.3 Dynamic test site

Mount the THD according to the manufacturer's instructions on the scorsby table in an area providing a clear line of sight from zenith to the angle + 5° above the horizontal.

The dynamic test shall utilize actual GNSS signals.

6.3 Settling time test

RMS of output headings taken at an interval of 1 min shall be within 1,5° (95 %). Each RMS should be calculated by 1 200 measurements at least.

Mount the THD on the static test site to a known direction.

Record the setting time as specified in 3.8. It shall conform to the requirement specified in 4.6.

6.4 Static error test

The THD shall be settled on the static test site specified in 6.2.2 and the table aligned to an optional direction. Heading measurements shall be taken over a period of not less than 1 h.

The distribution of the 1 000 measurements shall not be in error with the known direction by 1° (95 %).

This test shall be repeated, changing the table direction in steps of 45° ± 5°.

6.5 Dynamic test

Choosing one of the following methods, the dynamic test shall be carried out for a period of at least 5 min.

a) Scorsby test

The THD shall be mounted on the dynamic test site specified in 6.2.3 with the table stationary, normally level and its roll axis aligned north–south within ±1°.

The THD 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 5 min.

— roll axis: peak amplitude 20° ± 2°, period 10 s ± 1 s;

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

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

During the test, output from the THD shall be recorded. The difference between output and reference direction of the scorsby table shall be within ±1,5° (95 %). The installation shall be out of the cardan centre at the maximum distance according to manufacturer's installation instructions.

b) Vehicle test

The THD shall be mounted on the dynamic platform (vehicle or ship) that has the reference heading sensor whose dynamic accuracy is better than 0,2°. The platform shall run satisfying the conditions below:

1) distance run at a speed of 25 kn to 30 kn greater than 1 nm;

2) one 90° right turn at a speed of 10 kn to 20 kn;

3) one 90° left turn at a speed of 10 kn to 20 kn;

4) acceleration from 0 kn to 30 kn within 10 s;

5) slowdown from 30 kn to 0 kn within 10 s.

During the test, both output from the THD and the reference sensor shall be recorded. The difference between the two shall be within ±1,5° (95 %).

6.6 Follow-up error test

The THD on the static test site shall be turned at a rate not greater than 10°/s, to read data both of THD output and angle of the table of at least 5° interval during this test.

The maximum follow-up error shall conform to the requirements specified in 5.5.

The THD on the static test site shall be turned at a rate not greater than 20°/s, to read data both of THD output and angle of the table of at least 5° interval during this test.

The maximum follow-up error shall conform to the requirements specified in 5.5.

6.7 Back-up test

During the dynamic operation test as specified in 6.5 or 6.6, the THD output should be tested according to the following process:

— 10 min GNSS + back-up sensor (then the sensing part shall be completely masked for a period of 60 s)

— 1 min only back-up sensor (GNSS coverage).

The difference between the output at the start and end of the test shall conform to the requirement in 4.5.

6.8 Environmental test

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

The manufacturer shall determine which components of the THD system will be protected or exposed, as defined in IEC 60945.

6.8.1 Back-up test during static condition

During static operation of the THD as required in 6.4, the sensing part shall be completely masked for a period of 60 s. Heading output at the last moment of the test period shall be recorded without delay.

6.8.2 Functional test during temperature (dry heat) test of the transmitting part

Place the transmitting part in a test chamber and connect it through a signal line from the sensing part which is to be mounted at the static site.

During this test, according to the requirement of IEC 60945, the back-up test specified in 6.8.1 shall be carried out at the output of the transmitting part.

6.8.3 Functional test during vibration test of the transmitting part

Place the transmitting part on a vibration table and connect the signal line from the sensing part which to be mounted at the static site.

During this test, according to the requirement of IEC 60945, the back-up test specified in 6.8.1 shall be carried out at the output of the transmitting part.

6.9 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*).

6.10 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.

6.11 Malfunction test

A visible and audible alert required in 4.8 and THD shall be tested according to the following test procedure.

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

— power failure tests: main power supply to be off;

— during the test in 6.8 as masked over 60 s, to confirm an alert output as 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.

