
**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

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 22090-3 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

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 Devices using GNSS principles as 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 the THD shall operate

- a) at a maximum 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 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 one. 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 694, *Ships and marine technology — Positioning of magnetic compasses in ships*

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

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

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*

HSC Code, chapter 13

3 Terms and definitions

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

3.1

heading

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

NOTE 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 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 *This error may 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 the turning vessel and the available information at the output of the system.*

NOTE *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 as 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. 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 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 indicatable 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 a 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 update a heading at least once every 50 ms.

At least one output shall be in accordance with the relevant international marine interface standard: IEC 61162 series as amended.

4.8 Alarm signal

An alarm shall be provided for the following conditions:

- malfunction of the THD;
- failure of power supply;
- continuous GNSS signal interruption over 60 s at least.

An alarm output shall be provided for any alarm conditions.

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 $\pm 0,2^\circ$.

5.3 Static error (Settle point error)

The static error (settle point error) as defined in 3.5 at any heading shall be within $1,0^\circ$ (95 %).

5.4 Dynamic error

The additional dynamic error as defined in 3.6 shall be within $1,5^\circ$ (95 %), under the conditions of 6.5 a), 6.5 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 $\pm 0,5^\circ$ up to a rate of $10^\circ/\text{s}$, and
- less than $\pm 1,5^\circ$ at a rate of between $10^\circ/\text{s}$ and $20^\circ/\text{s}$.

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.

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 $+ 5^\circ$ above the horizontal, with stationary, normally level aligned $000 \pm 1^\circ$. The heading of the table shall be known to an accuracy of better than $0,1^\circ$.

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 $+ 5^\circ$ 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 $1,5^\circ$ (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 settling 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 $45^\circ \pm 5^\circ$.

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 $\pm 1^\circ$.

The THD 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 5 min.

- Roll axis: peak amplitude $20^\circ \pm 2^\circ$, period $6 \text{ s} \pm 1 \text{ s}$.
- Pitch axis: peak amplitude $10^\circ \pm 2^\circ$, period $10 \text{ s} \pm 1 \text{ s}$.
- Yaw axis: peak amplitude $5^\circ \pm 1^\circ$, period $15 \text{ s} \pm 1 \text{ s}$.

During the test, output from the THD shall be recorded. The difference between output and reference direction of the scorsby table shall be within $\pm 1,5^\circ$ (95 %). The installation shall be out of the cardan centre at the maximum distance according to the 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 $0,2^\circ$. The platform shall run satisfying the conditions below:

- 1) distance run at a speed of 25 to 30 kn greater than 1 nm;
- 2) one 90° right turn at a speed of 10 to 20 kn;
- 3) one 90° left turn at a speed of 10 to 20 kn;
- 4) acceleration from 0 to 30 kn within 10 s;
- 5) slowdown from 30 kn to 0 kn within 10 s.

During the test output, both from the THD and the reference sensor shall be recorded. The difference between the two shall be within $\pm 1,5^\circ$ (95 %).

6.6 Follow-up error test

The THD on the static test site shall be turned at a rate not greater than $10^\circ/\text{s}$, 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, all the tests shall be carried out according to the requirement of IEC 60945.

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 via 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 Heading information test

The THD shall update a heading at least once every 50 ms.

6.11 Malfunction test

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

— Malfunction tests:

Using the 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 alarm output for any alarm 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 694 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.

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