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**Ships and marine technology —  
Navigation and ship operations —  
Electronic inclinometers**

*Navires et technologie maritime — Navigation et opérations  
maritimes — Inclinomètres électroniques*

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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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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*.

[Annex A](#) is for information only and [Annex B](#) forms detailed test methods.

## Introduction

An electronic inclinometer is an electronic device that provides information about roll period, roll amplitude, and heel angle of the ship. Electronic inclinometers are intended to support decision-making processes on board in order to avoid dangerous situations as well as assist in maritime casualty investigation. The requirements in this Publicly Available Specification take into account human factors, ergonomic principles, and advances in technology.

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# Ships and marine technology — Navigation and ship operations — Electronic inclinometers

## 1 Scope

This Publicly Available Specification specifies the performance requirements, methods of testing, and test results of electronic inclinometers required by the performance standard, IMO resolution MSC.363 (92) in addition to the general requirements contained in resolution A.694 (17) and is associated with IEC 60945.

The electronic inclinometers provide information about actual heel angle, roll amplitude, roll period to support decision-making process on board in order to avoid dangerous situations as well as to assist in maritime casualty investigation. The electronic inclinometers are mainly composed of a set of sensors, a signal processor, a display, an input device, and an interface to other systems.

It does not apply to the electronic inclinometers installed for purposes, which are outside the scope of this Publicly Available Specification, e.g. monitoring of cargo status.

Where a requirement in this Publicly Available Specification is different from IEC 60945, the requirement in this Publicly Available Specification takes precedence.

NOTE All requirements that are extracted from the recommendations of IMO Resolution MSC.363 (92), performance standards for electronic inclinometers, are printed in italics and the resolution and paragraph numbers are indicated in brackets. (standards.iteh.ai)

## 2 Normative references

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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.

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

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

## 3 Terms and definitions

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

### 3.1

#### **actual heel angle**

*momentary angle of roll referenced to a levelled ship to port or starboard side*

[SOURCE: IMO MSC.363 (92) Paragraph 3.1]

3.2

**analogue type display**

display that shows actual heel angle, roll amplitudes, and roll peak hold values in a continuous way, such as by means of an arrow pointer and graduated scale

3.3

**digital type display**

display that shows actual heel angle, roll amplitudes, and roll peak hold values in the form of numbers

3.4

**display**

means by which the roll behaviour of the ship and the state of the electronic inclinometer system is presented to an observer

3.5

**inspection equipment**

equipment for testing the performance of the electronic inclinometer

3.6

**reset function for roll peak hold value**

function for resetting roll peak hold values to zero and for recording reset date [month, day, and year] and time

3.7

**roll amplitude**

*maximum values of heel angle to port or starboard side*

[SOURCE: IMO MSC.363 (92) Paragraph 3.1]

3.8

**roll period**

*time between two successive maximum values of heel angle on the same side of the ship*

[SOURCE: IMO MSC.363 (92) Paragraph 3.1]

3.9

**roll peak hold value**

maximum values of roll amplitude to port or starboard side from the last reset

3.10

**rolling**

*motion around the longitudinal axis of the ship*

Note 1 to entry: Positive roll is starboard down.

[SOURCE: IMO MSC.363 (92) Paragraph 3.1]

3.11

**zero crossing method**

zero crossing method is the way for measuring wave period by using a zero crossing which is a point where the sign of a measured value (roll angle) changes (e.g. from positive to negative)

## 4 Requirements

### 4.1 General

Users of this Publicly Available Specification shall note that while attempting to implement the requirements, they shall ensure compliance with such statutory requirements, rules, and regulations so as to be applicable to the individual ship concerned.



## 4.2 Functionality

[IMO MSC.363 (92) Paragraph 1.2] *The electronic inclinometers shall in a reliable form*

- a) determine the actual heel angle with the required accuracy,
- b) determine the roll amplitude with the required accuracy,
- c) determine the roll period with the required accuracy,
- d) present the information on a bridge display, and
- e) provide a standardized interface to instantaneous heel angle to the voyage data recorder (VDR).

## 4.3 Information

### 4.3.1 Actual heel angle and roll amplitude

[IMO MSC.363 (92) Paragraph 4] *Electronic inclinometers shall be capable of measuring the actual heel angle and determining the amplitude of the rolling oscillation of the ship over a range of  $\pm 90$  degrees.*

### 4.3.2 Roll period

[IMO MSC.363 (92) Paragraph 5] *Electronic inclinometers shall be capable of measuring the time between the maximum values of the rolling oscillation and determining the roll period over a minimum range of 4 to 40 s.*

If enough precision is not attained, the period may be measured by the “zero crossing method”.

### 4.3.3 Roll peak hold value

Electronic inclinometers may optionally record the roll peak hold values on both sides and present them on any kind of display.

If optional recording of the roll peak hold values is provided, electronic inclinometers shall have a mean of manually resetting the roll peak hold values by a single operator action.

If necessary, the following sentences may be provided for the reset of roll peak hold value:

\$-TXT,01,01,01,EI\_RPHVReset\_yyyy\_mm\_dd\_oo\_nn\_ss\*hh < CR > < LF > (see IEC 61162-1)

where:

- “yyyy” is reset year.
- “mm” is reset month.
- “dd” is reset day.
- “oo” is reset hour.
- “nn” is reset minute.
- “ss” is reset second, and
- “hh” is check sum.
- TXT (See IEC 61162-1).

## 4.4 Display

[IMO MSC.363 (92) Paragraph 7.2] *The actual heel angle to port or starboard shall be indicated in an analogue form between the limits of  $\pm 45$  degrees.*

[IMO MSC.363 (92) Paragraph 7.1.2] *Electronic inclinometers shall display the roll amplitude to both port and starboard side with a minimum resolution of one degree.*

Electronic inclinometers may optionally display the roll peak hold value for both sides, port and starboard, with a minimum resolution of one degree and its reset date/time.

[IMO MSC.363 (92) Paragraph 7.1.1] *Electronic inclinometers shall display the latest roll period with a minimum resolution of 1 s.*

[IMO MSC.363 (92) Paragraph 7.3] *The display may be implemented as a dedicated display or integrated into other bridge systems.*

#### 4.5 Status indication

The electronic inclinometer system shall include status indications that include, but are not limited to the following:

- a) that power is available to the system,
- b) that the system is switched on and is ready to use,
- c) that the system is switched on but there is a fault on one (or more) sensor(s), and
- d) that the system has recorded a measurement of heel angle exceeding a pre-set threshold value.

#### 4.6 Alert

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##### 4.6.1 Operational alert

[IMO MSC.363 (92) Paragraph 8.2] *Electronic inclinometers may optionally provide a warning for indicating that a set heel angle had been exceeded.*

Electronic inclinometers that include a heel angle warning function shall have a method of resetting the warning.

Electronic inclinometers that include a heel angle warning function shall have a method of manually setting the threshold value of heel angle.

The operational alert function shall provide display of the warning and may optionally provide the warning by audible and/or visible means.

The inclinometer system should be capable of supporting an interface with a centralized alarm management system.

ALF sentence is used to initiate a warning on other bridge systems when the actual heel angle exceeds the pre-set threshold.

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

Sentences transmitted by the electronic inclinometers

- ALF and ACN (See IEC 61924-2)

Sentences received by the electronic inclinometers

- ACN (See IEC 61924-2)

The following sentence may be provided for the input of a threshold value of heel angle:

\$-TXT,01,01,01,EI\_RollThresholdAngle\_xx\_deg \*hh < CR > < LF >

where:

- “xx” is the threshold value of heel angle, and
- “hh” is check sum.
- TXT (See IEC 61162-1).

#### 4.6.2 Functional alert

[IMO MSC.363 (92) Paragraph 9.1] *Electronic inclinometers shall internally check and indicate to the user if all components are operative and if the information provided is valid or not.*

[IMO MSC.363 (92) Paragraph 10.2] *Electronic inclinometers shall have a bidirectional interface to facilitate communication, to transfer alerts from inclinometers to external systems, and to acknowledge and silence alerts from external systems.*

An alert shall be provided and be output on the following conditions:

- malfunction of the electronic inclinometer sensor(s),
- failure of the power supply,
- failure of the interface with other important systems (VDR, INS, Alarm management system, etc.), and
- heel angle information displayed is invalid.

The alert shall conform to the presentation and handling requirements of Bridge Alert Management [IMO Res. MSC.302 (87)]. When an Integrated Navigation System (INS) is fitted, 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 electronic inclinometers

- HBT (See IEC 61162-1)
- ALC, ALF, and ACN (See IEC 61924-2)

Sentences received by the electronic inclinometers

- HBT (See IEC 61162-1)
- ACN (See IEC 61924-2)

#### 4.7 Interface

[IMO MSC.363 (92) Paragraph 10.1] *Electronic inclinometers shall comprise a digital interface providing actual heel angle information to other systems like, e.g. the voyage data recorder (VDR), with an update rate of at least 5 Hz. Electronic inclinometers shall also comprise a digital interface providing the displayed information of roll period and roll amplitude (see 4.3).*

[IMO MSC.363 (92) Paragraph 10.3] *The digital interface shall comply with the relevant International Standards IEC 61162-1 and, IEC 61162-2 or IEC 61162-450 or IEC 61162-3 as amended.*

#### 4.8 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 described in IEC 60945.