

# INTERNATIONAL STANDARD

**IEC**  
**60092-504**

Third edition  
2001-03

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## **Electrical installations in ships –**

### **Part 504: Special features – Control and instrumentation**

*Installations électriques à bord des navires –*

*Partie 504:*

*Caractéristiques spéciales – Conduite et instrumentation*

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSTALLATIONS IN SHIPS –**

**Part 504: Special features –  
Control and instrumentation**

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60092-504 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This third edition cancels and replaces the second edition, published in 1994, and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
18/889/FDIS	18/890/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

The contents of the corrigendum of January 2011 have been included in this copy.

## INTRODUCTION

IEC 60092 forms a series of International Standards intended to ensure safety in the design, selection, installation, maintenance and use of electrical equipment for the generation, storage, distribution and utilization of electrical energy for all purposes in seagoing ships.

This part of IEC 60092 also incorporates and co-ordinates, as far as possible, existing rules and forms a code of interpretation, where applicable, of the requirements of the International Maritime Organization, and serves as a guide for future regulations which may be prepared and as a statement of practice for use by shipowners, shipbuilders and appropriate organizations, and by constructors and appropriate organizations.

This standard is based on equipment and practices which are in current use, but it is not intended in any way to impede development of new or improved techniques.

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## ELECTRICAL INSTALLATIONS IN SHIPS –

### Part 504: Special features – Control and instrumentation

#### 1 Scope

This part of IEC 60092 deals with electrical, electronic and programmable equipment intended for control, monitoring, alarm and protection systems for use in ships.

#### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60092. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60092 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*

IEC 60068-2-1, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Tests Fc: Vibration (sinusoidal)*

IEC 60068-2-30, *Environmental testing – Part 2: Tests – Tests Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-52, *Environmental testing – Part 2: Tests – Tests Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60092 (all parts), *Electrical installations in ships*

IEC 60092-101, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-201, *Electrical installations in ships – Part 201: System design – General*

IEC 60092-202, *Electrical installations in ships – Part 202: System design – Protection*

IEC 60092-204, *Electrical installations in ships – Part 204: System design – Electric and electrohydraulic steering gear*

IEC 60092-302, *Electrical installations in ships – Part 302: Low voltage switchgear and controlgear assemblies*

IEC 60092-375, *Electrical installations in ships. Shipboard telecommunication cables and radio-frequency cables. General instrumentation, control and communication cables*

IEC 60092-376, *Electrical installations in ships – Part 376: Shipboard multicore cables for control circuits*

IEC 60092-401, *Electrical installations in ships – Part 401: Installation and test of completed installation*



IEC 60092-501, *Electrical installations in ships – Part 501: Special features – Electric propulsion plant*

IEC 60092-502, *Electrical installations in ships – Part 502: Tankers – Special features*

IEC 60447, *Man-machine interface (MMI) – Actuating principles*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60533, *Electrical and electronic installations in ships – Electromagnetic compatibility*

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

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test. Basic EMC Publication*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4: Testing and measuring techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*

CISPR 16-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 16-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2: Methods of measurement of disturbances and immunity*

IMO Assembly Resolution A.830 (19)1995, *Code on Alarms and Indicators*<sup>1</sup>

NOTE Other informative IMO documents are referenced within the text of this standard.

### 3 Definitions

For the purposes of this part of IEC 60092, the following definitions, having special application to the control, monitoring, alarm and protection equipment, apply. For definitions of general and more particular terms, reference is made to IEC 60050 (IEV) and other normative documents.

#### 3.1

##### **accuracy**

quality which characterizes the closeness of a measured value to the corresponding true value

#### 3.2

##### **alarm functions**

functions intended to alert relevant personnel, by visual and audible means, in the event of any condition requiring their attention

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<sup>1</sup> See IMO 867E:1996, *Code on Alarms and Indicators*, 1995

**3.3  
availability**

ability of an item to be in a state to perform a required function under given conditions at a given time interval, assuming that the required external resources are provided

**3.4  
centralized control**

control of all operations of a controlled system from one central control position

**3.5  
computer-based system**

system that consists of one or more programmable electronic devices with their connections, peripherals and software necessary to carry out automatically specified functions

NOTE The following types of programmable devices could form part of a computer system: main-frame, mini-computer, micro-processor-based computer, programmable logic controller.

**3.6  
control functions**

functions intended to regulate the behavior of equipment or systems

**3.7  
control position (control station)**

group of control devices by which an operator can control the performance of a machine, apparatus, process or assembly of machines and apparatus.

NOTE A control position will generally enable an operator to verify the achievement of the desired conditions by means of an appropriate monitoring system

**3.8  
dependability**

extent to which a system can be relied upon to perform its intended functions under defined operational and environmental conditions

**3.9  
essential services**

functions necessary for the propulsion, steering and safety of the ship and its personnel

**3.10  
fail-to-safe**

principle by which a failure or malfunction of a component of the system causes its output to automatically adjust to a predetermined safe state

NOTE The safe state, according to the application, will be predetermined in terms of priority for the safety of the ship and may generally be taken as the least critical one for the main components and auxiliaries of, for example, the propulsion/manoeuvring plant.

**3.11  
function**

elementary operation performed by the system which, in conjunction with other elementary operations (system functions), enables the system to perform a task

**3.12  
indication functions**

functions intended to inform relevant personnel, by visual and/or audible means, of any equipment or system status

**3.13****integrity**

capability of a system to satisfactorily perform the required functions under all the stated conditions within a stated period of time

**3.14****machinery control room**

room or spaces where centralized controls and measuring and monitoring equipment for main equipment and essential auxiliary machinery are located together with the appropriate means of communication

**3.15****maintainability**

ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

**3.16****monitoring functions**

functions intended to collect data from equipment and systems for the purpose of display and recording

**3.17****protection functions**

functions intended to prevent damage to equipment or systems in the event of a fault

**3.18****reliability**

ability of an item to perform a required function under given conditions for a given time interval

**3.19****safety functions**

functions intended to prevent harm or danger to personnel

**3.20****software**

program, procedures and associated documentation pertaining to the operation of a computer system and including application (user) program, middleware and operating system (firmware) program

**3.21****system**

collection of components organised to accomplish a specific function or set of functions

**3.22****usability**

extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

**4 General requirements****4.1 Dependability**

Systems shall be suitable for the user, the task and the application.

System integrity shall be appropriate for the functions supported, with due regard to factors such as availability, reliability and maintainability.

#### **4.2 Safety**

Systems shall be designed such that risk of harm to persons or the environment is reduced to a level acceptable to the appropriate authority, both in normal operation and under failure conditions. Functions shall be designed on the fail-to-safe principle.

#### **4.3 Segregation**

Systems shall be designed such that failure of one component part or sub-system will not unduly affect any other system, sub-system or component and, as far as is practicable, shall be detectable.

Protection (safety) functions shall be independent of control and monitoring (alarm) functions. As far as is practicable, control and monitoring (alarm) functions shall also be independent.

Standby systems, or other redundancy arrangements, are to be functionally independent.

#### **4.4 Performance**

Systems shall maintain specified levels of performance in operation, and where necessary, under fault conditions.

Repeatability and accuracy shall be adequate for the proposed use and shall be maintained at their specified value during their expected lifetime and normal use.

Systems shall be stable throughout their operational range.

#### **4.5 Usability**

Systems shall be readily usable under all intended operating conditions and shall support effective and efficient operation.

Adequate safeguards against incorrect operation shall be provided.

#### **4.6 Integration**

Where safety of personnel may directly depend on correct system operation or failure, such systems shall not be integrated with, or be mutually dependent upon, any other system, except those providing complementary functions.

Where safety may indirectly depend on system operation or failure, the integrity of the integrated system shall be to the satisfaction of the appropriate authority.

#### **4.7 Development activities**

Activities undertaken in the development process, from initial design through to eventual realisation, and any modifications in use thereafter, shall be planned and structured in a systematic manner, and are to be properly managed. Persons responsible for carrying out these activities shall be competent to do so.

Activities, scopes, responsibilities and competencies shall be documented.

## 5 Environmental type testing parameters

Where equipment or systems are subject to type testing, the test procedures and severities specified in table 1 shall apply.

NOTE Compliance with IMO Res. A.813(19)<sup>2</sup> will require all ship's electrical and electronic equipment to be tested to the relevant electromagnetic compatibility standard.

**Table 1 – Type tests, test procedures and severities**

	Test <sup>a</sup>	Procedure according to	Severity		Other information
1	Visual inspection				Examination of the equipment for: <ul style="list-style-type: none"> <li>– conformity to drawings and design data;</li> <li>– compliance with applicable IEC standards;</li> <li>– quality of workmanship and construction.</li> </ul>
2	Functional test to equipment specification				Standard atmospheric conditions: <ul style="list-style-type: none"> <li>– temperature: 25 °C ± 10 °C</li> <li>– relative humidity: 60 % ± 30 %</li> <li>– air pressure: 96 kPa ± 10 kPa</li> </ul>
3	High voltage test		Rated insulation voltage $U_n$ V	Test voltage AC V	Frequency of test voltage: 50 Hz or 60 Hz.  Separate circuits to be tested against each other.  All circuits connected with each other are to be tested against earth.  Contact pieces are to be tested across their open points of contact.  Printed circuits with electronic components which could be subject to damage may be removed during the test.
			$U_n \leq 65$ $66 < U_n \leq 250$ $251 < U_n \leq 500$ $501 < U_n \leq 690$	$2 \times U_n + 500$ 1 500 2 000 2 500	
			Period of application of test voltage: 1 min		

<sup>2</sup> IMO A.813 (19):1995, *General requirements for electromagnetic compatibility (EMC) for all electrical and electronic ships equipment*

**Table 1** (continued)

	Test <sup>a</sup>	Procedure according to	Severity	Other information																														
4a	Power supply variations	IEC 61000-4-11	<p style="text-align: center;"><b>AC supply</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Combination No.</th> <th style="width: 30%;">Voltage variation (permanent) %</th> <th style="width: 30%;">Frequency variation (permanent) %</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">+6</td> <td style="text-align: center;">+5</td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">+6</td> <td style="text-align: center;">-5</td> </tr> <tr> <td style="text-align: center;">3</td> <td style="text-align: center;">-10</td> <td style="text-align: center;">-5</td> </tr> <tr> <td style="text-align: center;">4</td> <td style="text-align: center;">-10</td> <td style="text-align: center;">+5</td> </tr> <tr> <td></td> <td style="text-align: center;">Voltage transient (duration 1,5 s)</td> <td style="text-align: center;">Frequency transient (duration 5 s)</td> </tr> <tr> <td style="text-align: center;">5</td> <td style="text-align: center;">+20</td> <td style="text-align: center;">+10</td> </tr> <tr> <td style="text-align: center;">6</td> <td style="text-align: center;">-20</td> <td style="text-align: center;">-10</td> </tr> </tbody> </table> <p style="text-align: center;"><b>DC supply</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 50%;">Voltage tolerance continuous</td> <td style="text-align: center;">±10 %</td> </tr> <tr> <td>Voltage cyclic variation</td> <td style="text-align: center;">5 %</td> </tr> <tr> <td>Voltage ripple</td> <td style="text-align: center;">10 %</td> </tr> </tbody> </table> <p>Electrical battery supply:                      +30 % to -25 % for equipment connected to charging battery or as determined by the charging/discharging characteristics, including ripple voltage from the charging device;                      +20 % to -25 % for equipment not connected to the battery during charging.</p>	Combination No.	Voltage variation (permanent) %	Frequency variation (permanent) %	1	+6	+5	2	+6	-5	3	-10	-5	4	-10	+5		Voltage transient (duration 1,5 s)	Frequency transient (duration 5 s)	5	+20	+10	6	-20	-10	Voltage tolerance continuous	±10 %	Voltage cyclic variation	5 %	Voltage ripple	10 %	<p>Each combination shall be tested.</p>
Combination No.	Voltage variation (permanent) %	Frequency variation (permanent) %																																
1	+6	+5																																
2	+6	-5																																
3	-10	-5																																
4	-10	+5																																
	Voltage transient (duration 1,5 s)	Frequency transient (duration 5 s)																																
5	+20	+10																																
6	-20	-10																																
Voltage tolerance continuous	±10 %																																	
Voltage cyclic variation	5 %																																	
Voltage ripple	10 %																																	
4b	Power supply failure	IEC 61000-4-11	Three interruptions during 5 minutes 30 s break time	Verification of the following: – specified action of the equipment on loss and restoration of supply; – there is no corruption of program or data held in programmable electronic systems, where applicable.																														