INTERNATIONAL STANDARD

IEC 60533

Second edition
1999-11

Electrical and electronic installations in ships – Electromagnetic compatibility

Installations électriques et électroniques à bord des navires – Compatibilité électromagnétique

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Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams*.

* See web site address on title page.

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International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS – ELECTROMAGNETIC COMPATIBILITY

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 60533 has been prepared by IEC technical committee18: Electrical installations of ships and of mobile and fixed offshore units.

This second edition cancels and replaces the first edition, published in 1977, and constitutes a technical revision.

The following changes have been made:

– Section 7 "Methods of measurement and suppression techniques" has been deleted. The methods of measurement have been aligned with CISPR 16-1, CISPR 16-2 and the IEC 61000 series. The requirements of IEC 60945 and IEC 60092-101, IEC 60092-204 and IEC 60092-504 have been incorporated as far as possible.
– A new annex A "IMO Resolution A.813 (19) has been added as an informative part.
– A new annex B "General EMC planning procedures" has been prepared as an informative part of this standard.
– A new annex C "Measures to achieve EMC" has been prepared as an informative part of this standard. It contains guidelines and recommendations for organizational and technical measures to achieve EMC.
– Equipment and installation groups A to E have been updated to include "non-electrical items and equipment" and "integrated systems" in annex C.
– Chapter II "Vital interference suppression components" has been deleted. This topic is now sufficiently described in the referenced IEC standards given in annex C.

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

FDIS	Report on voting
18/870/FDIS	18/874/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.

Annexes A, B and C are for information only.

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

The committee has decided that this publication remains valid until 2004-01.

At this date, in accordance with the committee's decision, the publication will be

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

INTRODUCTION

Electrical installations of ships with electric and/or electronic systems need to operate under a wide range of environmental conditions.

The control of undesired electromagnetic emission ensures that no other device on board will be unduly influenced by the equipment under consideration. Suitable limits are specified.

On the other hand, the equipment needs to function without degradation in the normal electromagnetic environment. The limit values for immunity, specified in this standard, have been chosen under this assumption. Equipment which is tested and installed in accordance with this standard meets the relevant IMO requirements. Special risks, for instance lightning strikes, transients from the operation of circuit breakers and electromagnetic radiation from radio transmitters are also covered.

Complex electric and/or electronic systems require EMC planning in all phases of design and installation, considering the electromagnetic environment, any special requirements and the equipment performance.

This second edition is applicable to electromagnetic compatibility of all electrical and electronic installations in ships.

ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS – ELECTROMAGNETIC COMPATIBILITY

1 Scope

This International Standard specifies minimum requirements for emission, immunity and performance criteria regarding electromagnetic compatibility (EMC) of electrical and electronic equipment for ships. It assists in meeting the requirements of IMO resolution A.813 (see annex A).

Equipment which is tested and installed in accordance with this standard meets the relevant IMO requirements.

NOTE 1 The normative part of this standard has been prepared as a product family EMC standard.

NOTE 2 Effects on human beings are not the subject of this standard.

This standard further gives guidelines and recommendations on the measures to achieve EMC in the electrical and electronic installations of equipment groups:

a) group A: radio communication and navigation equipment;

b) group B: power generation and conversion equipment;

c) group C: equipment operating with pulsed power;

d) group D: switchgear and control systems;

e) group E: intercommunication and signal processing equipment;

f) group F: non-electrical items and equipment;

g) group G: integrated systems.

The basic EMC standard for groups A and C is IEC 60945.

NOTE This standard does not specify unsafe operation and basic safety requirements such as protection against electric shock and dielectric tests for equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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 Guide 107: *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*

IEC 60050(161): *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

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 60092-504: *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

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

IEC 61000-1-1: *Electromagnetic compatibility (EMC) – Part 1: General – Section 1: Application and interpretation of fundamental definitions and terms*

IEC 61000-4-1: *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 1: Overview of immunity tests. Basic EMC Publication*

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*

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 measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-16: *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz*

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 disturbance and immunity*

SOLAS, *International Convention for the Safety of Life at Sea, 1974 (as amended)*

IMO Resolution A.813 (19):1995, *General requirements for electromagnetic compatibility (EMC) for all electrical and electronic ship's equipment*

3 Definitions

For the purpose of this International Standard, the following definitions apply. Generic definitions can also be found in IEC 60050(161) and in IEC 61000-1-1.

Additional definitions, not included in IEC 60050(161) but nevertheless necessary for the application of the different tests, are given in the Basic EMC publications.

3.1
electromagnetic compatibility; EMC (abbreviation)
the ability of an equipment or system to function satisfactorily in its *electromagnetic environment* without introducing intolerable *electromagnetic disturbances* to anything in that environment [IEV 161-01-07]

3.2
electromagnetic influence
effect of electromagnetic quantities on electrical and electronic circuits, equipment, systems or human beings

3.3
electromagnetic interference; EMI (abbreviation)
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

NOTE 1 The English words "interference" and "disturbance" are often used indiscriminately.

NOTE 2 In French, the term "perturbation électromagnétique" is also used with the meaning of "brouillage électromagnétique". [IEV 161-01-06]

3.3.1
degradation (of performance)
an undesired departure in the operational performance of any device, equipment or system from its intended performance

NOTE The term "degradation" can apply to temporary or permanent failure. [IEV 161-01-19]

3.3.2
loss of function
loss of function of a device beyond that permissible and where the function can be restored only by technical measures. A special case of loss of function is destruction

NOTE Loss of function may be permanent or temporary:

– technical measures to correct permanent loss require the use of tools or spare parts;

– technical measures to correct temporary loss require simple operator actions such as resetting a computer or reswitching.

3.4
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE An electromagnetic disturbance may be an *electromagnetic noise*, an *unwanted signal* or a change in the propagation medium itself [IEV 161-01-05]

3.5
emitter (of electromagnetic disturbance)
device, equipment or system which gives rise to voltages, currents or electromagnetic fields that can act as electromagnetic disturbance [IEV 161-01-23]

3.6
susceptible device
device, equipment or system whose performance can be degraded by an electromagnetic disturbance [IEV 161-01-24]

3.7
(electromagnetic) emission
the phenomenon by which electromagnetic energy emanates from a source [IEV 161-01-08]

3.8
immunity (to a disturbance)
the ability of a device, equipment or system to perform without *degradation* in the presence of an *electromagnetic disturbance* [IEV 161-01-20]

3.9
coupling
interaction of circuits between which energy can be transferred from one to another

3.10
insertion loss
logarithmic ratio of the magnitude of the power which a load picks up when fed directly from the power source, to the magnitude of the power which the load picks up after inserting a four-pole device (for example a filter) between source and load

3.11
return loss
logarithmic ratio of the reciprocal value of the reflection factor r: $a = 20 \times \lg \frac{1}{r}$; r is the ratio of return wave to forward wave

NOTE $r = 0$, $a = \infty$, if the impedance of protection circuit is matched to the wave impedance of connected cable.

3.12
EMC analysis
compilation and interpretation of EMC data to determine the degree of influence with electrical devices

3.13
electromagnetic interference matrix (EMI matrix)
matrix where emitters of disturbance are set against susceptible device of disturbance. At the crosspoints of lines and columns the extent of electromagnetic interference is noted

3.14
equipment under test (EUT)
equipment (devices, appliances and systems) subjected to EMC (emission and immunity) compliance tests

3.15
equipment or subsystem
a technical device intended to perform a given function, combining a number of sub-units, electrically and mechanically

3.16
integrated system
combination of separate items of equipment interconnected for the intended performance of a given function

EXAMPLE – Integrated cargo monitoring system with sensors and equipment in different zones.

3.17
system
set of devices and/or components which interact according to a design. A device and/or component of a system can be another system (called subsystem). Such devices and/or components (subsystems) may be:

– hardware
  * controlling system;
  * controlled system;
– software;
– human interaction.

NOTE The total ship with its equipment may be considered to be a system.

3.18
ground (earth)
ship's metallic structure and all other metal parts conductively interconnected

NOTE 1 For protective ground (protective earth) see 3.19.

NOTE 2 For EMC purposes interconnections between metal parts equalize the different potentials and require a low impedance in the frequency range considered. The frequency range considered includes the operating as well as the disturbing frequencies. This frequency range and the physical size of the electrical device determines the achievable equalization of potentials and thus the effectiveness of the ground. The ground does not in all cases meet the personnel safety requirements of the protective earth.

NOTE 3 For ships with non-metallic structure all conductively interconnected metal parts (including ground plate if existing) form the common ground (earth).

3.19
protective ground (protective earth)
conductor, necessary as a protective measure against currents dangerous to the human body, which electrically connects the conductive parts of the equipment casing with one or more of the following:

– external conductive parts;
– main grounding (earthing) terminal;
– earth point of power distribution system, if existing;
– metallic casing of other equipment.

3.20
reference ground
conductor whose potential is that to which the potentials of other conductors refer

3.21
type test
EMC test for a sample item of equipment to ascertain that its design meets the requirements expressed in this standard

3.22
port
particular interface of an equipment with the external electromagnetic environment through which disturbances may be suscepted or emitted (see figure 1)

NOTE Conductive interfaces may also consist of cables, grounding bonds, or mechanical interfaces such as pipes and mounting provisions.

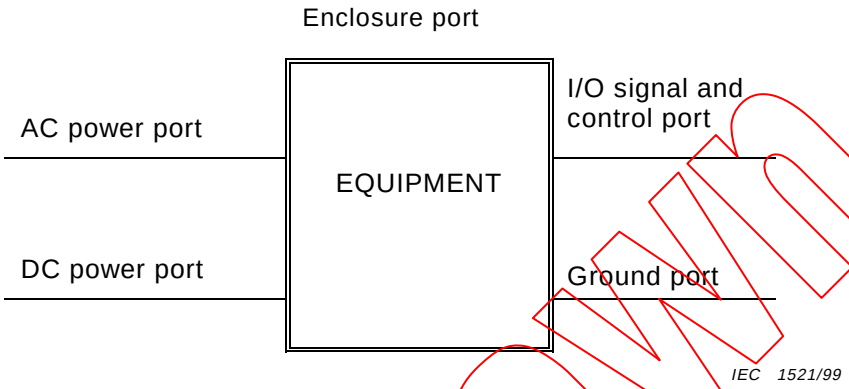

Figure 1 – Examples for ports

3.23
zones
areas characterized by sensitive and/or disturbing devices located therein (see figure 2):

– *deck and bridge zone:* area in close proximity to receiving and/or transmitting antennas and the wheelhouse as well as the control rooms, characterized by equipment for inter-communication, signal processing, radio communication and navigation, auxiliary equipment and large openings in the metallic structure;
– *general power distribution zone:* area characterized by normal consumers;
– *special power distribution zone:* area characterized by propulsion systems, bow thrusters, etc., producing emissions exceeding the limits given in table 3;
– *accommodation zone:* area of ships characterized by equipment, carried on board by passengers, crew and other persons to be operated therein.

3.24
normal consumers
equipment for ships operation such as machinery, control equipment and small static converters

3.25
cable selection
cables of similar signal types and levels are selected and assigned to the same category

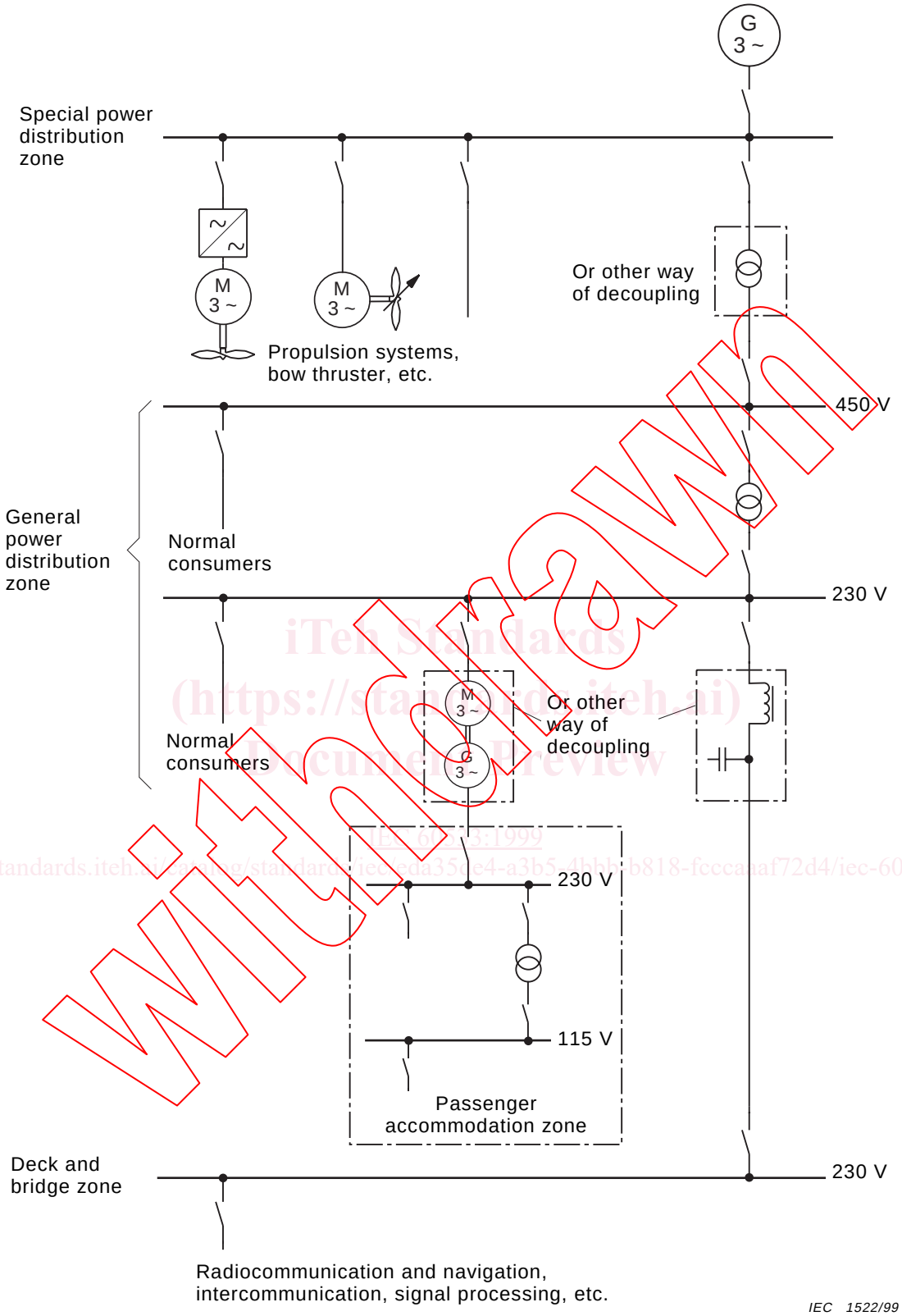

Figure 2 – Schematic diagram of zones (example)