



TECHNICAL REPORT



**Medical electrical equipment –
Part 4-2: Guidance and interpretation – Electromagnetic immunity: performance
of medical electrical equipment and medical electrical systems**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 11.040.01; 33.100.20

ISBN 978-2-8322-3414-3

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	8
0.1 * General	8
0.2 Purpose of this document	8
0.3 How to use this document	8
0.4 IMMUNITY TEST LEVELS	9
1 Scope and object.....	10
1.1 Scope	10
1.2 Object.....	10
2 Normative references.....	10
3 Terms and definitions	11
4 General recommendations	15
4.1 Concurrent and sequential testing	15
4.2 General test conditions.....	15
4.2.1 Configurations	15
4.2.2 Artificial hand.....	15
4.2.3 Power input voltages and frequencies.....	16
5 ME EQUIPMENT and ME SYSTEMS identification, marking and documents.....	17
5.1 Marking on the outside of ME EQUIPMENT or ME EQUIPMENT parts for which the connector testing exemption specified in 8.13.2 c) is used	17
5.2 ACCOMPANYING DOCUMENTS.....	17
5.2.1 General	17
5.2.2 Instructions for use	17
5.2.3 Requirements applicable to ME EQUIPMENT and ME SYSTEMS for which the connector testing exemption specified in 8.13.2 c) is used.....	17
5.2.4 * Technical description.....	17
6 Documentation of the tests	18
6.1 Test plan.....	18
6.2 Test report	19
7 * EMISSIONS	19
8 IMMUNITY recommendations.....	19
8.1 General.....	19
8.2 PATIENT physiological simulation.....	20
8.3 Termination of PATIENT-COUPLED parts	21
8.4 HAND-HELD ME EQUIPMENT and parts intended to be HAND-HELD	21
8.5 Subsystems	21
8.6 PERMANENTLY INSTALLED LARGE ME EQUIPMENT and LARGE ME SYSTEMS.....	21
8.7 Operating modes.....	22
8.8 Non-ME EQUIPMENT	22
8.9 * Environments of INTENDED USE	22
8.10 * Performance criteria	23
8.11 * IMMUNITY TEST LEVELS.....	23
8.12 * IMMUNITY to proximity fields from RF wireless communications equipment	30
8.13 * ESD testing of connectors.....	31
8.13.1 Application of ESD to connectors	31
8.13.2 Exclusions	32

9	Test report.....	33
	Annex A (informative) General guidance and rationale.....	35
	Annex B (informative) Guide to labelling recommendations	40
	B.1 ACCOMPANYING DOCUMENTS, instructions for use	40
	B.2 ACCOMPANYING DOCUMENTS, technical description.....	40
	Annex C (informative) Determination of IMMUNITY TEST LEVELS for SPECIAL ENVIRONMENTS	41
	C.1 General.....	41
	C.2 EM DISTURBANCE level determination.....	42
	C.3 Assessment of EM DISTURBANCE sources	42
	C.4 Test methods	42
	C.5 Test plan.....	42
	C.6 Examples of mitigations and special conditions.....	43
	Annex D (informative) Identification of specific IMMUNITY performance criteria	44
	D.1 General.....	44
	D.2 IMMUNITY performance criteria principles	44
	D.2.1 General	44
	D.2.2 IMMUNITY performance criteria for non-ME EQUIPMENT used in an ME SYSTEM	44
	D.2.3 IMMUNITY performance criteria determination.....	44
	D.3 IMMUNITY performance criteria examples	44
	D.3.1 General examples	44
	D.3.2 Example of immunity performance criteria for a radiological table system.....	46
	D.3.3 Example of immunity performance criteria for ultrasonic diagnostic equipment.....	46
	Annex E (informative) Performance criteria specified by IEC 61000-6-x generic EMC standards	48
	Annex F (informative) Mapping between this document and the elements of IEC 60601-1-2:2014.....	49
	Bibliography	54
	Index of defined terms used in this technical report	56
	Figure 1 – RC element of the artificial hand.....	16
	Figure 2 – * PORTS of ME EQUIPMENT and ME SYSTEMS.....	20
	Figure 3 – Examples of environments (locations) of INTENDED USE.....	25
	Table 1 – Recommended minimum test plan (1 of 2).....	18
	Table 2 – * ENCLOSURE PORT	26
	Table 3 – * Input AC power PORT (1 of 2).....	26
	Table 4 – Input DC power PORT	28
	Table 5 – * PATIENT COUPLING PORT	29
	Table 6 – SIGNAL INPUT/OUTPUT PARTS PORT	30
	Table 7 – Test specifications for ENCLOSURE PORT IMMUNITY to RF wireless communications equipment.....	31
	Table 8 – Parts of connectors to be tested for ESD, based on the connector shell and cover material.....	32
	Table 9 – * Testing of connectors and pins while connected and disconnected.....	32

Table 10 – Test report minimum contents (1 of 2) 33

Table A.1 – Assumptions used in determining IMMUNITY TEST LEVELS specified in
Table 7 (1 of 2) 38

Table B.1 – ACCOMPANYING DOCUMENTS, instructions for use 40

Table B.2 – ACCOMPANYING DOCUMENTS, technical description 40

Table C.1 – Examples of adjusted IMMUNITY TEST LEVELS due to mitigations or special
conditions 43

Table D.1 – Example of IMMUNITY performance criteria for a radiological table and
gantry system 46

Table D.2 – Example of IMMUNITY performance criteria for ULTRASONIC DIAGNOSTIC
EQUIPMENT 47

Table F.1 – Mapping between the elements of IEC TR 60601-4-2 and IEC 60601-1-
2:2014 (1 of 5) 49

Withdrawing

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MEDICAL ELECTRICAL EQUIPMENT –

Part 4-2: Guidance and interpretation – Electromagnetic immunity: performance of medical electrical equipment and medical electrical systems

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 60601-4-2, which is a technical report, has been prepared by IEC subcommittee 62A: Common aspects of electrical equipment used in medical practice, of IEC technical committee 62: Electrical equipment in medical practice.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
62A/1068/DTR	62A/1073A/RVC

Full information on the voting for the approval of this technical report 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 2.

In this technical report, the following print types are used:

- Recommendations and definitions: roman type.
- *Test instructions: italic type.*
- Informative material appearing outside of tables, such as notes, examples and references: in smaller type. Normative text of tables is also in a smaller type.
- TERMS DEFINED IN CLAUSE 3 OF THIS TECHNICAL REPORT OR AS NOTED: SMALL CAPITALS.

In referring to the structure of this technical report, the term

- “clause” means one of the numbered divisions within the table of contents, inclusive of all subdivisions (e.g. Clause 1 includes 1.1, 1.2, etc.);
- “subclause” means a numbered subdivision of a clause (e.g. 1.1, 1.2 and 1.3.1 are all subclauses of Clause 1).

References to clauses within this technical report are preceded by the term “Clause” followed by the clause number. References to subclauses within this technical report are by number only.

In this technical report, the conjunctive “or” is used as an “inclusive or” so a statement is true if any combination of the conditions is true.

The verbal forms used in this technical report conform to usage described in Annex H of the ISO/IEC Directives, Part 2. For the purposes of this technical report, the auxiliary verb:

- “shall” means that compliance with a requirement or a test is mandatory for compliance with this technical report; however, we chose to use it in this technical report only as described in 0.3;
- “should” means that compliance with a requirement or a test is recommended but is not mandatory for compliance with this technical report;
- “may” is used to describe a permissible way to achieve compliance with a requirement or test.

An asterisk (*) as the first character of a title or at the beginning of a paragraph or table title indicates that there is guidance or rationale related to that item in Annex A.

A list of all parts of the IEC 60601 series, published under the general title *Medical electrical equipment*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or

- amended.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Withdrawn

INTRODUCTION

0.1 * General

MEDICAL ELECTRICAL EQUIPMENT and MEDICAL ELECTRICAL SYSTEMS are used in the practice of medicine because they provide needed functions that are associated with the INTENDED USE. If MEDICAL ELECTRICAL EQUIPMENT or a MEDICAL ELECTRICAL SYSTEM does not provide these needed functions because of a lack of IMMUNITY to ELECTROMAGNETIC DISTURBANCES that are expected to occur in the environment(s) of INTENDED USE, this can interfere with the practice of medicine.

This document provides guidance on assessing IMMUNITY, with regard to the INTENDED USE. Based on the INTENDED USE, MEDICAL ELECTRICAL EQUIPMENT and MEDICAL ELECTRICAL SYSTEMS should have adequate IMMUNITY to provide the performance specified by the MANUFACTURER in the presence of ELECTROMAGNETIC DISTURBANCES. See Annex A for more information regarding performance.

Guidance for IMMUNITY with regard to INTENDED USE can be useful for MEDICAL ELECTRICAL EQUIPMENT and MEDICAL ELECTRICAL SYSTEMS for which the BASIC SAFETY AND ESSENTIAL PERFORMANCE do not include the purpose(s) for which the ME EQUIPMENT or ME SYSTEM was purchased. It is important to the OPERATOR or RESPONSIBLE ORGANIZATION and to the delivery of healthcare that these functions operate as intended in the EM ENVIRONMENTS of INTENDED USE.

Examples of performance that might not be BASIC SAFETY or ESSENTIAL PERFORMANCE but that might be INTENDED USE include the following:

- the ability to print an ultrasound image remotely;
- the ability of a scale to accurately measure PATIENT weight;
- accuracy of X-RAY TUBE VOLTAGE in X-ray equipment for radiography and radioscopy, e.g. the error is less than 5 %.

In general in IEC 60601-1-2:2014, the IMMUNITY TEST LEVELS for BASIC SAFETY and ESSENTIAL PERFORMANCE are based on reasonably foreseeable maximum levels of EM DISTURBANCES. In this document, IMMUNITY TEST LEVELS for performance are based on typical levels of EM DISTURBANCES. Rationales concerning test methodology can be found in Annex A of this document and in Annex A of IEC 60601-1-2:2014.

NOTE In general, typical IMMUNITY TEST LEVELS are equal to or lower than reasonably foreseeable maximum levels.

0.2 Purpose of this document

The purpose of this document is to provide a consistent method for evaluating the ability of MEDICAL ELECTRICAL EQUIPMENT or a MEDICAL ELECTRICAL SYSTEM to perform without degradation of performance in the presence of ELECTROMAGNETIC DISTURBANCES.

0.3 How to use this document

This document can be used in conjunction with IEC 60601-1-2 and testing for conformity to both documents can be done at the same time. This allows IMMUNITY testing of BASIC SAFETY, ESSENTIAL PERFORMANCE and performance of the MEDICAL ELECTRICAL EQUIPMENT or MEDICAL ELECTRICAL SYSTEM during one test, concurrently or sequentially. The main difference is the use of performance criteria instead of pass/fail criteria, and differences can also include modes and configurations. For BASIC SAFETY and ESSENTIAL PERFORMANCE, the pass/fail criteria are determined as specified by IEC 60601-1-2. For performance, the criteria are determined by the specifications, instructions and information provided by the MANUFACTURER.

This document uses “recommend” and “should” in place of “shall” in most cases. “Shall” is used where an action is required by other standards or something needs to be done in a

prescribed way in order to be effective. Also, this document has “normative” references. They are “normative” because if you choose to follow the recommendations of this document, they are indispensable for that use. An example of this would be testing for radiated RF IMMUNITY. The test methods of IEC 61000-4-3 would be indispensable for this testing.

0.4 IMMUNITY TEST LEVELS

The IMMUNITY TEST LEVELS specified in this document are typical for the locations of INTENDED USE of MEDICAL ELECTRICAL EQUIPMENT and MEDICAL ELECTRICAL SYSTEMS. However, Annex C provides a method for modifying the specified typical IMMUNITY TEST LEVELS for performance if necessary or for particular environments (e.g. SPECIAL ENVIRONMENTS) for which this document does not specify IMMUNITY TEST LEVELS.

Withdrawn

MEDICAL ELECTRICAL EQUIPMENT –

Part 4-2: Guidance and interpretation – Electromagnetic immunity: performance of medical electrical equipment and medical electrical systems

1 Scope and object

1.1 Scope

This part of IEC 60601 applies to the performance of MEDICAL ELECTRICAL EQUIPMENT or a MEDICAL ELECTRICAL SYSTEM in the presence of ELECTROMAGNETIC DISTURBANCES. Hereafter, MEDICAL ELECTRICAL EQUIPMENT or a MEDICAL ELECTRICAL SYSTEM are referred to as ME EQUIPMENT or an ME SYSTEM.

1.2 Object

The object of this document is to provide guidance on the assessment of the performance of ME EQUIPMENT or an ME SYSTEM in the presence of ELECTROMAGNETIC DISTURBANCES.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE The way in which these referenced documents are cited in normative requirements determines the extent (in whole or in part) to which they apply.

IEC 60417:2002, *Graphical symbols for use on equipment* (available from: <http://www.graphical-symbols.info/equipment>)

IEC 60601-1:2005, *Medical electrical equipment – Part 1: General requirements for basic safety and essential performance*
IEC 60601-1:2005/AMD1:2012 ¹⁾

IEC 60601-1-2:2014, *Medical electrical equipment – Part 1-2: General requirements for basic safety and essential performance – Collateral standard: Electromagnetic disturbances – Requirements and tests*

IEC 60601-1-8:2006, *Medical electrical equipment – Part 1-8: General requirements for basic safety and essential performance – Collateral Standard: General requirements tests and guidance for alarm systems in medical electrical equipment and medical electrical systems*
IEC 60601-1-8:2006/AMD1:2012

IEC 60601-1-11:2015, *Medical electrical equipment – Part 1-11: General requirements for basic safety and essential performance – Collateral Standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment*

¹⁾ There exists a consolidated edition 3.1, including IEC 60601-1:2005 and its Amendment 1:2012.

IEC 60601-1-12:2014, *Medical electrical equipment – Part 1-12: General requirements for basic safety and essential performance – Collateral Standard: Requirements for medical electrical equipment and medical electrical systems intended for use in the emergency medical services environment*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2006, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-3:2006/AMD1:2007

IEC 61000-4-3:2006/AMD2:2010²⁾

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

ISO 7637-2:2011, *Road vehicles – Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only*

²⁾ There exists a consolidated edition 3.2, including IEC 61000-4-3:2006 and its Amendment 1:2007 and Amendment 2:2010.