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General requirements for electronic measuring instruments

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Contents

Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

- **International Recommendations (OIML R),** which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;
- **International Documents (OIML D),** which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by Technical Committees or Subcommittees which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and International Documents are published in French (F) and English (E) and are subject to periodic revision.

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General requirements for electronic measuring instruments

1 Introduction

1.1 The primary aim of this International Document is to provide OIML Technical Committees and Subcommittees with guidance for establishing appropriate metrological performance testing requirements for influence quantities that may affect the measuring instruments covered by International Recommendations.

Furthermore, this International Document can provide guidance to OIML Member States in the implementation of OIML Recommendations in their national laws, in particular in their choice of the severity levels as far as these are not prescribed in the relevant Recommendation, but rather left to national legislation.

1.2 Based on information obtained from IEC and ISO standards and on the experience of experts who participated in its elaboration, this Document advises the Technical Committees and Subcommittees on the selection of the appropriate tests for measuring instruments, while taking into account the operational and environmental factors governing their use.

1.3 The influence quantity tests' range and severity level should be, wherever possible, selected from the levels proposed in this Document, taking into account the conditions of use of the instruments concerned, and the most recent IEC and ISO standards in the given field.

1.4 The OIML Technical Committees and Subcommittees responsible for specific International Recommendations may:

- Establish test procedures and special severity levels (higher or lower) in Recommendations, different from those specified in the Document, that would be more appropriate for specific measuring instruments or environments;
- Utilize the expertise and knowledge of the OIML TCs and SCs or of other organizations to develop special test procedures and conditions not specified in OIML D 11.

2 Scope and field of application

2.1 This International Document specifies the general metrological requirements applicable to measuring instruments and describes tests for verifying the compliance of an instrument with these requirements.

2.2 This Document shall be taken into consideration by the OIML Technical Committees and Subcommittees as a basis for establishing particular influence quantity requirements and tests to be specified in International Recommendations applicable to particular categories of measuring instruments (hereafter in brief: relevant Recommendation).

2.3 The relevant Recommendations may either specify that requirements specified in this Document apply only to devices that are electronic or also to devices which are not strictly electronic.

Notes:

(1) This Document does not cover technical requirements for measuring instruments; these requirements are to be given in the relevant Recommendation. For example, requirements for zero-setting devices, totalizers, etc. are not given in this Document.

(2) This Document does not address aspects such as electrical safety or emission of electromagnetic phenomena from instruments. Guidelines for these aspects should be followed in accordance with the applicable international, regional or national regulations, often detailed in standards.

(3) This Document does not address aspects related to software. At the time of drafting this version of OIML D11, OIML TC 5/SC 2 is preparing a separate document dealing with this subject.

3 Terminology

Some of the definitions used in this International Document are in conformity with the International Vocabulary of Basic and General Terms in Metrology (VIM) [1].

For the purpose of this International Document, the definitions and abbreviations given below apply.

3.1 Electronic measuring instrument

Measuring instrument intended to measure an electrical or non-electrical quantity using electronic means and/or equipped with electronic devices.

Note: For the purpose of this Document, auxiliary equipment, provided that it is subject to metrological control, is considered to be a part of the measuring instrument.

3.2 Electronic device

Device employing electronic sub-assemblies and performing a specific function.

Electronic devices are usually manufactured as separate units and are capable of being tested independently.

Notes:

(1) An electronic device may be a complete measuring instrument (for example: counter scale, electricity meter) or a part of a measuring instrument (for example: printer, indicator).

(2) An electronic device can be a module in the sense that this term is used in OIML Publication B 3 "The OIML Certificate system for Measuring Instruments" [2].

3.3 Electronic sub-assembly

Part of an electronic device, employing electronic components and having a recognizable function of its own. Examples: amplifiers, comparators, power converters.

Note: OIML B 3 [2] contains the following definition of a "module":
Identifiable part of a measuring instrument or of a family of measuring instruments that performs a specific function or functions and that can be separately evaluated according to prescribed metrological and technical performance requirements in the relevant Recommendation.

3.4 Electronic component

Smallest physical entity that uses electron or hole conduction in semi-conductors, gases or in a vacuum. Examples: electronic tubes, transistors, integrated circuits.

3.5 Error (of indication) [VIM 5.20]

Indication of a measuring instrument minus a true value of the corresponding input quantity.

3.6 Maximum permissible error (of a measuring instrument) [VIM 5.21]

Extreme value of an error permitted by specifications, regulations, etc. for a given measuring instrument.

3.7 Intrinsic error [VIM 5.24]

Error of a measuring instrument, determined under reference conditions.

3.8 Initial intrinsic error

Intrinsic error of a measuring instrument as determined prior to performance tests and durability evaluations.

3.9 Fault

Difference between the error of indication and the intrinsic error of a measuring instrument.

Notes:

(1) Principally, a fault is the result of an undesired change of data contained in or flowing through an electronic measuring instrument.

(2) From the definition it follows that in this Document, a "fault" is a numerical value which is expressed either in a unit of measurement or as a relative value, for instance as a percentage.

3.10 Significant fault

Fault greater than the value specified in the relevant Recommendation (see 2.2)

Note: The relevant Recommendation may specify that the following faults are not significant, even when they exceed the value defined in 3.10:

(a) Faults arising from simultaneous and mutually independent causes (e.g. EM fields and discharges) originating in a measuring instrument or in its checking facilities;

(b) Faults implying the impossibility to perform any measurement;

(c) Transitory faults being momentary variations in the indication, which cannot be interpreted, memorized or transmitted as a measurement result;

(d) Faults giving rise to variations in the measurement result that are serious enough to be noticed by all those interested in the measurement result; the relevant Recommendation may specify the nature of these variations.

3.11 Durability error

Difference between the intrinsic error after a period of use and the initial intrinsic error of a measuring instrument.

3.12 Significant durability error

Durability error greater than the value specified in the relevant Recommendation.

Note: The relevant Recommendation may specify that durability errors are not significant, even when they exceed the value defined in 3.12, in the following cases:

(a) The indication cannot be interpreted, memorized or transmitted as a measurement result;

(b) The indication implies the impossibility to perform any measurement;

(c) The indication is so obviously wrong that it is bound to be noticed by all those interested in the result of the measurement; or

(d) A durability error cannot be detected and acted upon due to a breakdown of the appropriate durability protection facility.

3.13 Influence quantity [VIM 2.7]

Quantity that is not the measurand but that affects the result of the measurement.

3.13.1 Influence factor

Influence quantity having a value within the rated operating conditions of a measuring instrument specified in the relevant Recommendation.

3.13.2 Disturbance

Influence quantity having a value within the limits specified in the relevant Recommendation, but outside the specified rated operating conditions of a measuring instrument.

Note: An influence quantity is a disturbance if the rated operating conditions for that influence quantity are not specified.

3.14 Rated operating conditions [Adapted from VIM 5.5]

Conditions of use giving the range of values of influence quantities for which specified metrological characteristics of a measuring instrument are intended to lie within given limits.

3.15 Reference conditions [VIM 5.7]

Conditions of use prescribed for testing the performance of a measuring instrument or for intercomparison of results of measurements.

Note: The reference conditions generally include reference values or reference ranges for the influence quantities affecting a measuring instrument.

3.16 Performance

Ability of a measuring instrument to accomplish its intended functions.

3.17 Durability

Ability of a measuring instrument to maintain its performance characteristics over a period of use.

3.18 Checking facility

Facility that is incorporated in a measuring instrument and which enables significant faults to be detected and acted upon.

Note: «Acted upon» refers to any adequate response by the measuring instrument (luminous signal, acoustic signal, prevention of the measurement process, etc.).

3.18.1 Automatic checking facility

Checking facility that operates without the intervention of an operator.

3.18.1.1 Permanent automatic checking facility (type P)

Automatic checking facility that operates at each measurement cycle.

3.18.1.2 Intermittent automatic checking facility (type I)

Automatic checking facility that operates at certain time intervals or per fixed number of measurement cycles.

3.18.2 Non-automatic checking facility (type N)

Checking facility that requires the intervention of an operator.

3.19 Durability protection facility

Facility that is incorporated in a measuring instrument and which enables significant durability errors to be detected and acted upon .

3.20 Test

Series of operations intended to verify the compliance of the equipment under test (EUT) with specified requirements.

3.20.1 Test procedure

Detailed description of the test operations.

3.20.2 Test program

Description of a series of tests for certain types of equipment.

3.20.3 Performance test

Test intended to verify whether the EUT is able to accomplish its intended functions.

3.20.4 Durability test

Test intended to verify whether the EUT is able to maintain its performance characteristics over a period of use.

3.21 Mains power

Primary external source of electrical power for an instrument, including all sub-assemblies. (Examples: public power (AC or DC), generator, external battery or other DC supply systems).

3.22 Power converter (power supply device)

Sub-assembly converting the voltage from the mains power to a voltage suitable for other sub-assemblies.

3.23 Auxiliary battery

Battery that is:

- Mounted in, or connected to, an instrument that can be powered by the mains power as well; and
- Capable of completely powering the instrument for a reasonable period of time.

3.24 Back-up battery

Battery that is intended to power specific functions of an instrument in the absence of the primary power supply. Example: to preserve stored data.

3.25 Abbreviations

AC	Alternating Current
AM	Amplitude Modulation
ASD	Acceleration Spectral Density
DC	Direct Current
DIS	Draft International Standard
EM	Electromagnetic
EMC	Electromagnetic Compatibility
e.m.f.	electromotive force
ESD	Electrostatic Discharge
EUT	Equipment Under Test
GSM	Global System for Mobile communication
IEC	International Electrotechnical Committee
I/O	Input / Output (refers to ports)
ISO	International Organization for Standardization
MPE	Maximum Permissible Error
N.A.	Not Applicable
OIML	International Organization of Legal Metrology
RH	Relative Humidity
RMS	Root Mean Square

4 Instructions for use of this Document in drafting OIML Recommendations

4.1 The relevant Recommendation shall specify, for each category or subcategory of measuring instruments:

(a) Influence factors, with rated operating conditions and reference conditions,

(b) Disturbances with their limits,

(c) Maximum permissible errors on type evaluation, on initial verification, in service, and on subsequent verification, as well as significant faults, and significant durability errors (wherever applicable).

4.2 The relevant Recommendation may specify additional requirements or adapt the requirements in this Document with a view to limiting the occurrence of the significant faults defined in 3.10.

Note: These requirements may depend on the nature of the measurement (repeatable, non-repeatable, non-interruptible, etc.) or the intended use (trade, direct selling to the public, health, law enforcement, etc.).

4.3 The relevant Recommendation may specify requirements concerning the occurrence of durability errors defined in 3.11 (see note under 4.2).

4.4 Some of the tests described in this Document may be relevant only for specific kinds of instruments. Therefore, a test should be included for a particular kind of instrument only if that instrument is likely to be significantly influenced by the test, under the instrument's specified operating conditions.

4.5 Guidelines for the determination of the test severity levels to be applied in the relevant Recommendation are given in clause 8.

4.6 All normative documents are subject to revision, and the users of this Document are encouraged to investigate the possibility of applying the most recent editions of the referenced normative documents.

Note: The relevant Recommendation shall specify the rated operating conditions, reference conditions and limits of disturbances for the category of instruments concerned. However, the relevant Recommendation may indicate that individual subcategories of measuring instruments may have different rated operating conditions, reference conditions and limits of disturbances.

Rated operating conditions are generally specified as a range (for example: – 10 °C to + 40 °C); reference conditions are generally specified as a single value with a range of variation (for example: 23 °C ± 2 °C).

The reference conditions are preferably specified in accordance with IEC 60068-1 (1988-6), Appendix B (including Amendment 1, 1992-4), Environmental testing. Part 1: General and guidance [3]

5 Requirements for measuring instruments with respect to the application of electronics

Measuring instruments shall comply with the following requirements, notwithstanding all other technical and metrological requirements of the relevant Recommendations, when installed and used in accordance with the manufacturers' specifications.

5.1 General requirements

5.1.1 Measuring instruments shall be designed and manufactured such that their errors do not exceed the maximum permissible errors under rated operating conditions.

5.1.2 Measuring instruments shall be designed and manufactured such that when they are exposed to disturbances, either:

(a) Significant faults do not occur, or

(b) Significant faults are detected and acted upon by means of a checking facility.

Note: A fault equal to or smaller than the value fixed in the relevant Recommendation as defined in 3.10 is allowed irrespective of the value of the error of indication.

5.1.3 The provisions in 5.1.1 and 5.1.2 shall be met durably. Measuring instruments shall be designed and manufactured such that either:

(a) Significant durability errors do not occur, or

(b) Significant durability errors are detected and acted upon by means of a durability protection facility.

5.1.4 The type of a measuring instrument is presumed to comply with the provisions in 5.1.1, 5.1.2 and 5.1.3 if it passes the examination and tests specified in 6.2.

5.2 Application

5.2.1 The provisions in 5.1.2 (a) and 5.1.2 (b) may be applied separately to:

(a) Each individual cause of significant fault; and/or

(b) Each part of the measuring instrument.

5.2.2 The choice of whether 5.1.2 (a) or 5.1.2 (b) is applied is left to the manufacturer, unless the relevant Recommendation specifies otherwise in view of the intended use of the measuring instrument or the nature of measurement (see note under 4.2).

5.2.3 The provisions in 5.1.3 (a) and 5.1.3 (b) may be applied separately to each part of the measuring instrument (for example: analogue and digital parts).

5.2.4 The choice of whether 5.1.3 (a) or 5.1.3 (b) is applied is left to the manufacturer, unless the relevant Recommendation specifies otherwise.

5.3 Electronic measuring instruments equipped with checking facilities

5.3.1 For each function of an electronic measuring instrument, the relevant Recommendation may specify:

(a) The type of checking facility (P, I or N), as defined in 3.18;

(b) The checking frequency, if appropriate;

(c) The method of acting upon a significant fault.

5.3.2 The relevant Recommendation may specify that it shall be possible to determine the presence and correct functioning of these facilities.

5.3.3 The requirements in 5.3.1 and 5.3.2 do not apply to measuring instruments or parts of measuring instruments for which the manufacturer claims compliance with the provisions in 5.1.2 (a) and which are nevertheless equipped with checking facilities.

5.4 Electronic measuring instruments equipped with durability protection facilities

5.4.1 The relevant Recommendation may specify:

(a) Details concerning the operation of the durability protection facilities; and/or

(b) The method of acting upon the detection of significant durability errors.

5.4.2 The relevant Recommendation may specify that it shall be possible to determine the presence and correct operation of these facilities.

5.4.3 The requirements in 5.4.1 and 5.4.2 do not apply to measuring instruments or parts of measuring instruments for which the manufacturer claims compliance with the provision in 5.1.3 (a) and which are nevertheless equipped with durability protection facilities.

5.5 Requirements for battery-powered instruments

5.5.1 Non-rechargeable batteries

Instruments powered by non-rechargeable batteries or by rechargeable batteries that cannot be (re)charged during the operation of the measuring instrument, shall comply with the following requirements:

(a) The instrument provided with new or fully charged batteries of the specified type shall comply with the metrological requirements;

(b) As soon as the battery voltage has dropped to a value specified by the manufacturer as the minimum value of voltage at which the instrument complies with metrological requirements, this shall be detected and acted upon by the instrument. The Recommendation may prescribe the means of action.

For these instruments, no special tests for disturbances associated with the "mains" power have to be carried out.

In the criteria for (categories of) instruments, a minimum period of time shall be stated during which the instrument shall function correctly without renewing or recharging the batteries and (in particular for continuous totalizing measuring equipment) provisions may be prescribed that prevent the loss of stored data.

5.5.2 Rechargeable auxiliary batteries

Instruments powered by rechargeable auxiliary batteries that are intended to be (re)charged during the operation of the measuring instrument shall both:

(a) Comply with the requirements of 5.5.1 with the mains power switched off; and

(b) Comply with the requirements for AC mains powered instruments with the mains power switched on.

5.5.3 Back-up batteries

Instruments powered by the mains power and provided with a back-up battery for data-storage only, shall comply with the requirements for AC mains powered instruments.

In the criteria for (categories of) instruments, a minimum period of time shall be stated during which the relevant function of the instrument shall function properly without renewing or recharging the batteries.

The provisions of 5.5.1(b) and 5.5.2 do not apply for back-up batteries.

6 Type approval

6.1 Documentation

6.1.1 The relevant Recommendation may specify that the documentation submitted with the application for type approval shall include:

(a) A list of the electronic sub-assemblies with their essential characteristics;

(b) A description of the electronic devices with drawings, diagrams and general software information explaining their characteristics and operation;

(c) Mechanical drawings;

(d) Installation and security sealing plan;

(e) Panel layout;

(f) Operating instructions; and

(g) Test outputs, their use, and their relationships to the parameters being measured.

6.1.2 Furthermore, the application for type approval shall be accompanied by a document or other evidence that supports the assumption that the design and characteristics of the measuring instrument comply with the requirements of the relevant Recommendation, in which the general requirements of this Document have been incorporated.

6.2 General requirements

The relevant Recommendation shall include the following examinations and tests to which electronic measuring instruments shall be subjected:

(a) Examination to verify whether the measuring instrument complies with the provisions in 5.1;

(b) Performance tests to verify compliance with the provisions in 5.1.1 and 5.1.2, regarding influence quantities. During these tests the EUT shall be operational (i.e. the power shall be switched on), except if the test procedure in this Document or in the relevant Recommendation specifies otherwise;

(c) Durability evaluation (i.e. tests and/or other means) to verify compliance with the provisions in 5.1.3.

Note: Compliance with the durability requirements may be met by:
- Passing durability tests;
- Incorporating durability protection facilities;
- Incorporating self-calibrating devices;
- Granting provisional type approval and, after a sufficient number of measuring instruments have been functioning for a sufficiently long period of time, granting final type approval;
- No additional requirements if evidence for sufficient durability is gained by other means.

(The relevant Recommendation may specify details according to the intended use of the instrument.)

(d) Examination and tests to verify compliance of the electronic measuring instrument with the provisions in 5.3, 5.4, and 5.5 if applicable.

All measuring instruments of the same category, whether or not equipped with checking facilities and whether or not equipped with durability protection facilities, are subject to the same test program, unless the relevant Recommendation specifies otherwise. The test program shall be specified in the relevant Recommendation, according to the operating conditions of the category of measuring instruments.

6.3 Performance tests

During these tests the measuring instrument shall comply with:

(a) The provisions in 5.1.1, the maximum permissible error being the maximum permissible error on type evaluation; and

(b) The provisions in 5.1.2.

In case a durability test shall be carried out, the performance test shall be carried out before the durability test.

6.4 Durability tests

During performance tests carried out after each durability test, the measuring instrument shall comply with the provisions in 5.1.3.

Note: After each durability test, only performance tests that are relevant to the durability test concerned shall be carried out.

6.5 Test program

The relevant Recommendation may specify details concerning the test program, including:

(a) Which tests shall be carried out;

(b) The order in which the tests are to be carried out (if necessary, taking into account the technology);

(c) Determination of the performance characteristics (initial intrinsic error), prior to all other performance and durability tests;

(d) Determination of the intrinsic error, prior to those performance tests for which the EUT shall comply with the provisions in 5.1.2; and

(e) Evaluation of test results.

6.6 Test procedures

6.6.1 The test procedures of the most common performance tests are specified in clauses 9 - 14.

Annex A provides a general approach to the durability concept.

6.6.2 The relevant Recommendation shall specify:

(a) The necessary details concerning the tests, including those already given in clauses 9 – 14.

Note: As a rule, only one influence quantity shall be varied during a test, while all others shall be kept at their reference values;

(b) The severity levels of the tests in accordance with the classification given in clause 8, where applicable; and

(c) The deviations from the described tests, if necessary (for example, a limited temperature range for a measuring instrument may lead to modification of the static temperature performance test).

6.7 Number of units to be submitted to tests

The test shall be carried out on the number of units specified in the relevant Recommendation.

6.8 Equipment under test (EUT)

As a rule, tests will be carried out on the complete measuring instrument. If the size or configuration of the measuring instrument does not lend itself to testing as a whole unit or if only a separate device (module) of the measuring instrument is concerned, the relevant Recommendation may indicate that the tests, or certain tests, shall be carried out on the electronic devices separately, provided that, in case of tests with the devices in operation, these devices are included in a simulated set-up, sufficiently representative of its normal operation.

Note: The dismantling of the measuring instruments or devices for the tests is not intended.

7 Initial verification

Production measuring instruments shall be in conformance with the approved type.

Initial verification of a measuring instrument may include a procedure to ensure that the individual measuring instruments conform to the approved type.

8 Determination of test severity levels

8.1 Introduction

8.1.1 This chapter is intended as a guide to determine a set of severity levels to be generally applied for tests carried out on electronic measuring instruments.

It is not intended as a classification with strict boundaries leading to special requirements as in the case of an accuracy classification.

Moreover, this guide does not interfere with the liberty of the Technical Committees and Subcommittees to provide for severity levels that differ from those resulting from the guidelines set forth in this Document. Different severity levels may be used in accordance with special limits prescribed in the relevant Recommendations.

8.1.2 The conditions that are most common to electronic measuring instruments can be divided into three groups, which are generally mutually independent:

(a) Climatic conditions;

(b) Mechanical conditions; and

(c) Electrical and electromagnetic conditions.

A given measuring instrument will be used under conditions of a climatic, mechanical, electrical and electromagnetic nature.

Since climatic and mechanical conditions are generally mutually independent, it is not possible to combine them into a single range of classes with increasing severity.

The classification of these conditions given in this subclause will serve as a guide for choosing severity levels for tests.

Notes:

(1) The relevant Recommendation may require that the classification be indicated on the instrument.

(2) This classification and the following tests may also be applied to non-electronic measuring instruments.

8.1.3 Selecting severity levels for a particular category of instruments, the following aspects can be taken into account:

(a) The (typical) climatic, mechanical and electrical environment;

(b) The consequence and the social and societal impact of errors;

(c) The value of goods to be measured;

(d) The practical possibilities for industry to comply with the prescribed level; and

(e) The possibility to repeat a measurement.

8.2 Severity levels for climatic tests [22], [23]

Different classes covering climatic conditions have been selected as described below. Extreme conditions are not included; however, there is a low probability that these severity values will be exceeded.

8.2.1 Temperature

The thermal conditions in which measuring instruments are used vary considerably; they are not only highly dependent on the place on earth, ranging from arctic to tropical regions, but are also considerably dependent on indoor or outdoor environments. Instruments being typically used indoors in one country can be typically used outdoors in other countries (for instance gas meters and electricity meters for domestic environment). Therefore, no classes combining low and high temperature limits have been described in this Document.

In general, the choice of the lower and the upper temperature limits should preferably left to national (or regional) legislation, taking into account the severity levels in 10.1.1 and 10.1.2.

8.2.2 Humidity and water

The following table gives a classification for the severity levels for humidity and water tests:

Table 8.2.2 / 1

Class	Severity level			Description
	Damp Heat			
	Steady state (test 10.2.1)	Cyclic (test 10.2.2)	Water (test 10.3)	
H1	-	-	-	This class applies to instruments or parts of instruments used in enclosed locations. Humidity is not controlled. Humidification is used to maintain the required conditions, where necessary. Measuring instruments are not subject to condensed water, precipitation, or ice formations. The conditions of this class may be found in living rooms, continuously manned offices, certain workshops, and other rooms for special applications.
H2	1	1	-	This class applies to instruments or parts of instruments used in enclosed locations whose humidity is not controlled. Measuring instruments may be subject to condensed water, water from sources other than rain and to ice formations. The conditions of this class may be found in some entrances and staircases of buildings, in garages, cellars, certain workshops, factory buildings and industrial process plants, ordinary storage rooms for frost-resistant products, farm buildings, etc.
H3	1	2	2	This class applies to instruments or parts of instruments used in open locations with average climatic conditions, thus excluding polar and desert environments.

For a comparison of steady-state and cyclic tests, refer to clause 6 of IEC 60068-3-4 [15].

Test 10.3 ("Water") is mainly applicable for instruments or parts of instruments typically being used in the open air and that, in their normal use, can be directly exposed to water, for instance platforms of weighbridges or automatic radar speed measuring instruments.

Therefore, it is advised to prescribe test 10.3 in the relevant Recommendation only for those measuring instruments that can be expected to be typically used under conditions where they can be directly exposed to water (refer to 4.4).

8.2.3 Atmospheric pressure (Test 10.4)

Within the normal variations in atmospheric pressure on earth, only a few categories (physical principles) of measuring instruments are likely to be influenced by changes in the atmospheric pressure. Depending on the physical principle of the instrument, this influence can either be on the zero-indication and/or on the span of the instrument. Therefore, it is advised to prescribe an atmospheric pressure test in the relevant Recommendation only for those measuring instruments that can be, due to their physical measuring principle, expected to be sensitive to variations in atmospheric pressure (refer to 4.4).

8.2.4 Sand and dust (Test 10.5)

This test is mainly applicable for instruments or parts of instruments typically being used in dusty warehouses and in the building industry (for instance production of concrete) or, in some climatic regions, in the open air. Therefore, it is advised to prescribe test 10.5 in the relevant Recommendation only for those measuring instruments that can be expected to be typically used under sandy/dusty conditions (refer to 4.4).

8.2.5 Salt mist (Test 10.6)

This test is mainly applicable for instruments or parts of instruments that are typically used in a salty environment; for instance on board of sea-going vessels or in the cheese industry. Therefore, it is advised to prescribe test 10.6 in the relevant Recommendation only for those measuring instruments that can be expected to be typically used in a humid and salty environment (refer to 4.4).

8.3 Severity levels for mechanical tests (Tests 11.1 and 11.2)

The following table gives a classification for the severity levels for mechanical tests:

Table 8.3 / 1

Class	Severity level		Description
	Vibration (test 11.1)	Shock (test 11.2)	
M1	-	-	This class applies to locations with vibration and shocks of low significance, e.g. for instruments fastened to light supporting structures subject to negligible vibrations and shocks transmitted from local blasting or pile-driving activities, slamming doors, etc.
M2	1	1	This class applies to locations with significant or high levels of vibration and shock, e.g. transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.
M3	2	2	This class applies to locations where the level of vibration and shock is high or very high, e.g. for instruments mounted directly on machines, conveyor belts, etc.

In 11.1, two vibration tests (random and sinusoidal) have been described. In general, it should be avoided to prescribe both tests in OIML Recommendations.

Since real life vibration conditions are dominated by vibration of a random nature, random testing should be the most commonly used method. Therefore, application of the random vibration test is preferred in OIML Recommendations.

The sinusoidal test shall be applied only in those cases were the measuring instrument is expected to be typically subjected to sinusoidal vibrations.

For the selection of the appropriate test (random or sinusoidal) also refer to IEC 60068-3-8 [16]; in particular to (sub)clauses 4.2, 7, 8.3, and 8.4 of that standard.

Sine and random vibration are different physical processes and produce different effects on the specimen. The specification writer should be aware that, due to the physically different processes there is no precise equivalence between sine and random vibration testing. It is strongly recommended not to attempt to transfer severities from sine to random or vice versa.

8.4 Severity levels for electrical tests

The choice of severity levels for electrical tests will depend on the expected environmental conditions and application (see 8.1.3) of the instruments whose models are to be tested for type approval. The environmental conditions, as far as the electrical quantities are concerned, will be determined by the expected environmental influences including:

(a) Influences originating in the power and data lines;

(b) Radiated influences caused by electric and electromagnetic phenomena in the surrounding area;

(c) Influences caused by the actions of personnel.

Each of the above-mentioned influences can be divided into levels of intensity. It is advisable to restrict the number of levels as much as possible.

The following table gives a classification for electrical tests:

Table 8.4 / 1

Class	Description
E1	This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.
E2	This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in industrial buildings.

The relation between the class and the applicable severity levels is given in table 8.4/2.

Table 8.4 / 2			
Severity level for class		Test	
E1	E2	Subclause	Description
2	3	12.1.1	Radiated, radio-frequency, electromagnetic fields (general origin)
3 or 4 (*)	3 or 4 (*)	12.1.1	Radiated, radio-frequency, electromagnetic fields (digital radio telephones)
2	3	12.1.2	Conducted radio-frequency fields
3	3	12.2	Electrostatic discharge
4	5	12.3	Power frequency magnetic field
2	3	12.4	Bursts (transients) on signal, data and control lines
3 (**)	3 (**)	12.5	Surges on signal, data and control lines
1	2	13.4	AC mains voltage dips, short interruptions and voltage variations
2	3	13.5	Bursts (transients) on AC and DC mains
-	1	13.6	Voltage dips, short interruptions and voltage variations on DC mains power
-	1	13.7	Ripple on DC mains power
3 (**)	3 (**)	13.8	Surges on AC and DC mains power lines

(*) Refer to 8.4.1
(**) In IEC 61000-4-5 [31] called "Installation Class"

The conditions have been adapted from basic IEC publication IEC 61000-2-5 (1995-9) [26]

Guidance for the choice of the severity level for some specific electrical tests is given in subclauses 8.4.1 - 8.5.2.

8.4.1 Radiated and conducted, radio-frequency, electromagnetic fields (Test 12.1.1 and 12.1.2)

The frequency ranges in 12.1.1, Table 2 are typical for the fields caused by digital radio telephones.

A 2 W GSM telephone typically produces a field strength of 10 V/m on a distance of 0.6 m.

For an 8 W GSM this distance is 1.1 m.

For more details, please consult table F.1 in IEC 61000-4-3 [29].

For these tests, the choice of the severity level to be applied in the relevant Recommendation is not related to a specific environment, but merely by the possibility to use a mobile telephone in close vicinity of the instrument, the risk of fraud by means of a mobile telephone, and the consequences of an error or disturbance.

8.4.2 Electrostatic discharge (Test 12.2)

Since the human body may be charged to a maximum value of 15 kV in extreme conditions (very low relative humidity combined with synthetic fabrics and use of synthetic footwear), ESD tests of severity level 4 will only be necessary for instruments to be used under circumstances where such conditions are likely to exist. Instruments that will be used in areas where the relative humidity exceeds 50 % should be tested according to severity level 3.

8.4.3 Power frequency magnetic fields (Test 12.3)

This test shall only be prescribed in OIML Recommendations in those cases where, as a result of the physical principle of the measuring instruments, a significant influence of power magnetic fields may be expected (also refer to 4.4).

8.4.4 Bursts (transients) (Tests 12.4 and 13.5)

Depending on the expected use of the instruments, a choice concerning the severity level should be made in the relevant Recommendation.

Severity level 1 applies to instruments operating in well-protected environments (e.g. computer rooms); severity level 2 applies to instruments operating in areas with a normal protection (class E1); and severity level 3 applies to instruments operating in areas without any special protection (e.g. industrial process areas, class E2).

8.4.5 Surges (Tests 12.5 and 13.8)

This test is only applicable in those cases where, based on typical situations of installation, the risk of a significant influence of surges can be expected.

This is especially relevant in cases of outdoor installations and/or indoor installations connected to long signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length).

Therefore, the test for the influence of surges should only be prescribed in the relevant Recommendation for instruments that are connected to a network.

The test is applicable to the power lines, the communication lines (internet, dial up modem, etc.), and other lines for control, data or signal mentioned above (lines to temperature sensors, gas or liquid flow sensors, etc.).

It is also applicable to DC powered instruments if the power supply comes from a DC network (also refer to 4.4).

8.4.6 Mains frequency variation (Test 13.3)

In general the public AC mains supply networks are linked together resulting in negligible variations in the frequency. Only in remote areas and in case of local generators, the frequency changes can be of significance.

Therefore it is advised to prescribe this test in OIML Recommendations only in those cases where as a result of the physical principle of the measuring instruments, the frequency of the AC mains supply can have a significant influence on the performance of the instrument, for instance in case an internal time-base of the instrument is derived from the mains frequency (also refer to 4.4).

8.4.7 AC mains voltage dips, short interruptions and voltage variations (Test 13.4)

Durations of power interruption of a half cycle or less are a characteristic of AC mains power. In order to comply with the provisions of 5.1.1 an instrument shall have an immunity level according to a minimum severity level 2.

Voltage dips and short supply interruptions are unpredictable and, especially in industrial environments, may have a relatively long duration. Therefore it is reasonable to test instruments intended to be used in an industrial environment according to severity level 3 in order to avoid frequent interruptions of instrument performance.

For voltage dips, 3 tests are defined within severity level 2, and 5 tests within severity level 3. All tests within a severity level are applicable, as it is possible that the more severe test causes a fault implying one of the faults described in 3.10 (b), (c), or (d), whereas the less severe test causes a significant fault. In other words: it is possible that the EUT passes the more severe test and does not pass test a or both a and b.

8.4.8 Voltage dips, short interruptions and voltage variations on DC mains power (Test 13.6)

As in practice, DC mains power is almost exclusively applicable in industrial environments, no severity level for class E1 has been proposed in Table 8.4/2.

8.4.9 Ripple on DC mains power (Test 13.7)

As in practice, DC mains power is almost exclusively applicable in industrial environments, no severity level for class E1 has been proposed in Table 8.4/2.

8.5 Instruments powered by batteries

There is a distinction between the tests for instruments powered by:

(a) Disposable batteries;

(b) General rechargeable batteries; and

(c) Batteries of road vehicles.

8.5.1 For the case of disposable and rechargeable batteries of a general nature, no applicable standards are available. These requirements are described in brief in 5.5 and the tests in 14.1.

8.5.2 For instruments powered by the on board battery of a road vehicle, a series of special tests for disturbances associated with the power supply is given in subclause 14.2 of this Document. These tests are based on the standards series ISO 7637 [41-43]. According to clause 4 of ISO 7637-1 [41], this series of standards "provides a basis for mutual agreement between vehicle manufacturers and component suppliers, intended to assist rather than restrict them."

Measuring instruments that are designed to be mounted on board a road vehicle can normally be mounted on any kind of vehicle. Therefore, in 14.2.2 and 14.2.3 of this Document, only the highest severity level is indicated as the preferred level.

For these tests, the choice of the severity level to be applied in the relevant Recommendation is not related to a specific environment, but merely by the impact of a disturbance and, if applicable, to the electromagnetic properties of the specific type of vehicle in which the instrument is used.

9 Performance tests (general)

9.1 Preliminary remarks

The brief descriptions of test procedures in this Document are intended only for information. It is necessary to consult the referenced IEC and ISO Publications before conducting any tests. The terminology of the relevant IEC and ISO Publications has been used in this Document as far as possible.

In the IEC and ISO publications, both terms "specimen" and "equipment under test" may be found; the latter ("EUT") is used in 10 - 14 of this Document.

In most of the standards, referred to in the following chapters of this Document, several severity levels have been given. In order to optimize the harmonization between the OIML Recommendations, a limited number of these severity levels are recommended for application in OIML Recommendations. In this Document, these preferred levels are marked by printing them in bold face.

The following text should be included in all OIML Recommendations that are based on OIML D 11:

> *"Every test is subject to uncertainty.*
>
> *The uncertainty of a measurement is defined as: "parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" [VIM 3.9].*
>
> *The uncertainty of the test method shall be taken into account in the decision on the applicability of the test method."*

The maximum uncertainty of a test method shall be specified in the Recommendation.

At the time of drafting this version of OIML D 11, OIML TC 3/SC 5 "Conformity assessment" is preparing a document about this matter.

9.2 Test considerations

9.2.1 General

All measurements, if relevant, shall be carried out under the installation conditions stipulated by the manufacturer and corresponding to the rated operating conditions.

The OIML Recommendations shall in all cases describe how the instrument shall be tested as well as the permissible changes in the performance of the instrument.

Simulation of any part of the instrument tested should be avoided. If this is not possible, all parts of the instrument that can be affected by the test must play an active role in the measurements.

The following survey table 9.2.1/1 is a general guide on how to evaluate the measurements related to the tests described in this Document (the relevant Recommendation may specify otherwise).

Table 9.2.1 / 1

Evaluation		Sub clause	Exposure
I	MPE	10.1.1	Dry heat
I	MPE	10.1.2	Cold
I	MPE	10.2.1	Damp heat, steady-state (non condensing)
D	NSFa	10.2.2	Damp heat, cyclic (condensing)
D	NSFa	10.3	Water
I	MPE	10.4	Atmospheric pressure
D	NSFa	10.5	Sand and dust
D	NSFa	10.6	Salt mist
I	MPE	11.1	Vibration
D	NSFa	11.2	Mechanical shock
D	NSFd	12.1.1	Radiated, radio-frequency, electromagnetic fields
D	NSFd	12.1.2	Conducted radio-frequency fields
D	NSFa (1) NSFd (2)	12.2	Electrostatic discharge
D	NSFd	12.3	Power frequency magnetic field
D	NSFd	12.4	Bursts (transients) on signal, data and control lines
D	NSFa (1) NSFd (2)	12.5	Surges on signal, data and control lines
I	MPE	13.1	DC mains voltage variation
I	MPE	13.2	AC mains voltage variation
I	MPE	13.3	AC mains frequency variation
D	NSFd	13.4	AC mains voltage dips, short interruptions and voltage variations
D	NSFd	13.5	Bursts (transients) on AC and DC mains
D	NSFa (1) NSFd (2)	13.6	Voltage dips, short interruptions and voltage variations on DC mains power
D	NSFd	13.7	Ripple on DC mains power
D	NSFa	13.8	Surges on AC and DC mains power
I	MPE	14.1	Low voltage of internal battery
I	MPE	14.2.1	Voltage variations of a road vehicle battery
D	NSFd	14.2.2	Electrical transient conduction along supply lines of external 12 V and 24 V batteries pulses 2a, 3a, 3b and 4
D	NSFa	14.2.2	Electrical transient conduction along supply lines of external 12 V and 24 V batteries pulse 2b
D	NSFd	14.2.3	Electrical transient conduction via lines other than supply lines for external 12 V and 24 V batteries

I Influence factor
D Disturbance
MPE Maximum permissible error according to 3.6
NSFa No significant fault shall occur after the disturbance
NSFd No significant fault shall occur during the disturbance
(1) For integrating instruments
(2) For non-integrating instruments

9.2.2 Integrating instruments

Due to the fundamental behavior of an integrating instrument, the following must be taken into account when the measurements and evaluation are described in OIML Recommendations. Integrating instruments are e.g. water, gas, electricity and heat meters and belt weighers. These are instruments where time is needed to obtain the error.

9.2.2.1 Tests using NSFa for evaluation

The following measuring and evaluation sequence is recommended:

(a) Determine the intrinsic error.

(b) Stop the measurements but keep the instruments switched on. However for the damp heat - cyclic test the position "switched on" or "switched off" is specified in the Recommendation, the position "switched off" facilitating condensing.

(c) Read the display and registers of legal interest.

(d) Apply the disturbance.

(e) Read the display and registers of legal interest. The change in the display reading and registers may only alter by one unit or by the significant fault (to be prescribed in the relevant Recommendation).

(f) Perform a second measurement and determine the error.

(g) Calculate the difference between the error of the second measurement and the intrinsic error. This difference shall not be greater than the significant fault specified in the relevant Recommendation.

Notes:

(1) For step 2, it is possible that the test procedure prescribes the EUT being switched off (for instance the damp heat, cyclic test that has been classified as a disturbance).

(2) For step 5, it is sometimes impossible for the instrument to indicate the same result after the application of the disturbance as before (in particular when switched off; also for instance mechanical shocks of clinical thermometers that indicate only in a narrow range).

9.2.2.2 Tests using NSFd for evaluation

The following measuring sequence is recommended:

(a) Determine intrinsic error.

(b) Stop applying the disturbance and stop the measurement. Determine the error.

(c) Calculate the difference between the error of the second measurement and the intrinsic error. This difference shall not be greater than the significant fault specified in the relevant Recommendation.

For test 10.2.2 (damp heat, cyclic) the recommended sequence is:

(a) Determine the intrinsic error.

(b) Continue the measurements.

(c) Apply the test.

(d) Carry out the measurements during the last cycle, starting 1 h after initiation of the increase of the temperature from the lower to the upper temperature and determine the error.

(e) Stop the test after the last cycle.

(f) After the recovery, carry out a measurements and determine the error.

(g) Calculate the difference between the error of the second measurement and the intrinsic error. This difference shall not be greater than the significant fault specified in the relevant Recommendation.

(h) Calculate the difference between the error of the third measurement and the intrinsic error. This difference shall not be greater than the significant fault specified in the relevant Recommendation.

10 Performance tests (climatic)

10.1 Static temperatures

10.1.1 Dry heat						
Applicable standards	IEC 60068-2-2 [5], IEC 60068-3-1 [14]					
Test method	Dry heat (non condensing)					
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high temperature					
Test procedure in brief	The test consists of exposure to the specified high temperature under "free air" conditions for the time specified (the time specified is the time after the EUT has reached temperature stability). The change of temperature shall not exceed 1 °C/min during heating up and cooling down. The absolute humidity of the test atmosphere shall not exceed 20 g/m^3. When testing is performed at temperatures lower than 35 °C, the relative humidity shall not exceed 50 %.					
Test severities	The following severities may be specified:					
Severity levels	**1**(1)	**2**(1)	**3**(1)	4	5	unit
Temperature	**30**	**40**	**55**	70	85	°C
Duration	**2**	**2**	**2**	2	2	h
Note	(1) Preferred severity levels for OIML Recommendations: levels 1, 2 and 3.					
Information to be given in the relevant Recommendation, if applicable	a) Preconditioning b) Details of mounting or supports c) State of the EUT including cooling system during conditioning d) Severity: temperature and duration of exposure e) Measurements and/or loading during conditioning f) Recovery (if non-standard)					

10.1.2 Cold					
Applicable standards	IEC 60068-2-1 [4], IEC 60068-3-1 [14]				
Test method	Cold				
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of low temperature				
Test procedure in brief	The test consists of exposure to the specified low temperature under "free air" conditions for the time specified (the time specified is the time after the EUT has reached temperature stability). The change of temperature shall not exceed 1 °C/min during heating up and cooling down. IEC specifies that the power to the EUT shall be switched off before the temperature is raised.				
Test severities	The following severities may be specified:				
Severity levels	**1**(1)	**2**(1)	**3**(1)	4	unit
Temperature	**+ 5**	**– 10**	**– 25**	– 40	°C
Duration	**2**	**2**	**2**	2	h
Note	(1) Preferred severity levels for OIML Recommendations: levels 1, 2 and 3.				
Information to be given in the relevant Recommendation, if applicable	a) Preconditioning b) Details of mounting or supports c) State of the EUT including cooling system during conditioning d) Severity: temperature and duration of exposure e) Measurements and/or loading during conditioning f) Recovery (if non-standard)				

10.2 Damp heat

10.2.1 Damp heat, steady-state (non condensing)			
Applicable standards	IEC 60068-2-78 [13], IEC 60068-3-4 [15]		
Test method	Damp heat, steady-state		
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high humidity and constant temperature The steady-state test should always be used where adsorption or absorption play the main part. When diffusion but not breathing is involved, either the steady-state or the cyclic test shall be prescribed depending on the type of EUT and its application.		
Test procedure in brief	The test consists of exposure to the specified high level temperature and the specified constant relative humidity for a certain fixed time defined by the severity level. The EUT shall be handled such that no condensation of water occurs on it.		
Test severities	The following severities may be specified:		
Severity levels	**1**(1)	2	unit
Temperature	**30**	40	°C
Relative humidity	**85**	93	% RH
Duration	**2**	4	days
Note	(1) Preferred severity level for OIML Recommendations: Level 1		
Information to be given in the relevant Recommendation, if applicable	a) Preconditioning procedure b) Electrical and mechanical measurements to be made prior to the test c) State of the EUT as introduced into the chamber d) Severity and tolerance: temperature, relative humidity and duration e) Loading during conditioning f) Electrical and mechanical measurements to be made during conditioning and the period(s) after which they shall be performed g) Special precautions to be taken regarding removal of surface moisture h) Recovery conditions (if other than standard) i) Electrical and mechanical measurements to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters		

10.2.2 Damp heat, cyclic (condensing)			
Applicable standards	IEC 60068-2-30 [9], IEC 60068-3-4 [15]		
Test method	Damp heat, cyclic		
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high humidity when combined with cyclic temperature changes Cyclic tests shall be applied in all the cases where condensation is important or when the penetration of vapor will be accelerated by the breathing effect.		
Test procedure in brief	The test consists of exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phases. Condensation should occur on the EUT during the temperature rise. The 24 h cycle consists of: 1) Temperature rise during 3 h 2) Temperature maintained at upper value until 12 h from the start of the cycle 3) Temperature lowered to lower value within 3 h to 6 h, the rate of fall during the first hour and a half being such that the lower value would be reached in 3 h 4) Temperature maintained at lower value until the 24 h cycle is completed. The stabilizing period before and recovery after the cyclic exposure shall be such that all parts of the EUT are within 3 °C of their final temperature. Special electrical conditions and recovery conditions may be specified. For the sequence of the test in case the EUT is an integrating instrument, refer to 9.2.2.2.		
Test severities	The following severities may be specified:		
Severity levels	**1**	**2**	unit
Upper temperature	**40**	**55**	°C
Duration	**2**	**2**	cycles
Information to be given in the relevant Recommendation, if applicable	a) Severity: temperature and number of cycles b) State of the EUT during conditioning c) Details of mounting or support d) Intermediate measurements e) Recovery conditions f) Special precautions to be taken regarding removal of surface moisture g) Electrical and mechanical measurements to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters		

10.3 Water			
Applicable standards	IEC 60068-2-18 [8], IEC 60512-14-7 [18], IEC 60529 [19]		
Test method	Water falling drops and impacting water		
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 when the EUT is subjected to spraying and splashing water		
Test procedure in brief	The EUT is mounted on an appropriate fixture and is subjected to impacting water generated from either an oscillating tube or a spray nozzle used to simulate spraying or splashing water. The stabilizing period before and recovery after the exposure shall be specified in the relevant Recommendation.		
Test severities	The following severities may be specified:		
Severity levels	1	**2 (1)**	unit
Flow rate (per nozzle)	0.07	**0.07**	L/min
Duration	10	**10**	min
Angle of inclination	± 60	**± 180**	°
Note	(1) Preferred severity level for OIML Recommendations: level 2.		
Information to be given in the relevant Recommendation, if applicable	a) Severity: angle of inclination b) State of the EUT during conditioning c) Details of mounting or support d) Intermediate measurements e) Recovery conditions f) Special precautions to be taken regarding removal of surface moisture g) Electrical and mechanical measurements to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters		

10.4 Atmospheric pressure

In the following two subclauses, two tests for determining the influence of atmospheric pressure on measuring instruments have been described. In general, it should be avoided to prescribe both tests in OIML Recommendations.

Either of these tests shall only be prescribed in OIML Recommendations in those cases where, as a result of the physical principle of the measuring instruments, a significant influence of changes in atmospheric pressure can be expected (also refer to 4.4).

The choice of either the test 10.4.1 or 10.4.2 and of the severity level to be prescribed in the relevant Recommendation, is to be made by the responsible OIML Technical Committee or Subcommittee.

10.4.1 Static atmospheric pressure				
Applicable standard		There are no applicable standards (refer to Annex B)		
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of static atmospheric pressure		
Test procedure in brief		The test consists of exposure to different atmospheric pressures.		
Test severities		The following severities may be specified:		
Severity levels		**1**	**2**	unit
Atmospheric	Lower limit	**Ambient pressure – 2.5 kPa (± 0,15)**	**86 (± 1)**	kPa
pressure	Upper limit	**Ambient pressure + 2.5 kPa (± 0,15)**	**106 (± 1)**	
Uncertainty of the recorded pressure		**0.15**	**0.15**	
Information to be given in the relevant Recommendation, if applicable		a) Severity level b) Acceptable influence on the EUT		

10.4.2 Variation of atmospheric pressure			
Applicable standard	There are no applicable standards (refer to Annex B)		
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of changes in atmospheric pressure		
Test procedure in brief	The test consists of exposure to a change in atmospheric pressure.		
Test severities	The following severities may be specified:		
Severity levels	**1**	**2**	unit
Change of atmospheric pressure, relative to ambient pressure	**1 (± 0.1)**	**10 (± 1)**	kPa
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Acceptable influence on the EUT		

10.5 Sand and dust		
Applicable standards	IEC 60512-11-8 [17], IEC 60529 [19], IEC 60721-2-5 [21]	
Test method	Sand and dust	
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under dust-laden atmosphere.	
Test procedure in brief	The test consists of exposure to cyclic temperature variation between 30 °C and 65 °C, maintaining the following conditions: • Relative humidity: less than 25 % • Air velocity: 3 m/s • Particle concentration: 5 g/m^3 • Composition of the particles: as specified in 3.2.1 of IEC 60512-11-8 [17]	
Test severities	The following severities may be specified:	
Severity levels	**1** (1)	2
Number of cycles	**1**	2
Note	(1) Preferred severity level for OIML Recommendations: level 1	
Information to be given in the appropriate Recommendation, if applicable	a) Severity: number of cycles b) State of the EUT during conditioning c) Intermediate measurements d) Recovery conditions e) Electrical and mechanical measurements to be made at the end of the test, the parameters to be measured first, and the maximum period allowed for the measurement of these parameters	

10.6 Salt mist					
Applicable standards	IEC 60068-2-11 [7], IEC 60721-2-5 [21]				
Test method	Salt mist				
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under salt mist atmosphere.				
Test procedure in brief	The test consists of exposure to salt mist atmosphere at 35 °C.				
Test severities	The following severities may be specified:				
Severity levels	1	**2** (1)	3	4	unit
Duration	16	**24**	48	96	h
Note	(1) Preferred severity level for OIML Recommendations: level 2				
Information to be given in the relevant Recommendation, if applicable	a) Severity level (duration) b) State of the EUT during conditioning c) Intermediate measurements d) Recovery conditions e) Electrical and mechanical measurements to be made at the end of the test f) The parameters to be measured first g) The maximum period allowed for the measurement of these parameters				

11 Performance tests (mechanical)

11.1 Vibration

In the following two subclauses, two vibration tests (random and sinus) have been described. In general, it should be avoided to prescribe both tests in OIML Recommendations.

Application of the random vibration test is preferred in OIML Recommendations.

The sinusoidal test shall be applied only in those cases where the measuring instrument is expected to be typically subjected to sinusoidal vibrations.

Guidence for the selection amongst both the tests can be found in IEC 60068-3-8 [16].

11.1.1 Vibration (random)				
Applicable standard	IEC 60068-2-47 [11], IEC 60068-2-64 [12], IEC 60068-3-8 [16]			
Test method	Random vibration			
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of random vibration			
Test procedure in brief	The test consists of exposure to the vibration level for a time sufficient for testing the various functions of the EUT during the exposure. The EUT shall, in turn, be tested in three, mutually perpendicular axes mounted on a rigid fixture by its normal mounting means. The EUT shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use. Where the effect of gravitational force is not important the EUT may be mounted in any position.			
Test severities	The following severities may be specified:			
Severity levels	**1**(1)	**2**(1)	3	unit
Total frequency range	**10 - 150**	**10 - 150**	10 - 150	Hz
Total RMS level	**1.6**	**7**	16	$m \cdot s^{-2}$
ASD level 10-20 Hz	**0.05**	**1**	5	$m^2 \cdot s^{-3}$
ASD level 20-150 Hz	**– 3**	**– 3**	– 3	dB/octave
Duration per axis	2 minutes in each functional mode as defined in the relevant Recommendation or a longer period if necessary for carrying out the measurement			
Note	(1) Preferred severity levels for OIML Recommendations: Level 1 Level 2			
Information to be given in the relevant Recommendation, if applicable	Severity: - Total frequency range - Total RMS level - ASD (acceleration spectral density) level - Number of axes - Duration per axis			

11.1.2 Vibration (sinusoidal)				
Applicable standards	IEC 60068-2-6 [6], IEC 60068-2-47 [11] , IEC 60068-3-8 [16]			
Test method	Sinusoidal vibration			
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of sinusoidal vibration			
Test procedure in brief	The EUT shall be tested by sweeping the frequency in the specified frequency range, at 1 octave/min, at the specified acceleration level with a specified number of sweep cycles per axis. The EUT shall be tested in three, mutually perpendicular main axes mounted on a rigid fixture by its normal mounting means. It shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use. Where the effect of gravitational force is not important, the EUT may be mounted in any position.			
Test severities	The following severities may be specified:			
Severity levels	**1**(1)	**2**(1)	3	unit
Frequency range	**10 - 150**	**10 - 150**	10 - 150	Hz
Max. acceleration level	**2**	**10**	20	ms^{-2}
Number of sweep cycles per axis	**20**	**20**	20	-
Note	(1) Preferred severity levels for OIML Recommendations: Level 1 Level 2			
Information to be given in the relevant Recommendation, if applicable	a) Severity b) Mounting of the EUT c) Pre-conditioning			

11.2 Mechanical shock			
Applicable standard	IEC 60068-2-31 [10]		
Test method	Dropping on to a face		
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of mechanical shocks		
Test procedure in brief	The EUT, placed in its normal position of use on a rigid surface, is tilted towards one bottom edge and is then allowed to fall freely onto the test surface. The height of fall is the distance between the opposite edge and the test surface. However, the angle made by the bottom and the test surface shall not exceed 30°.		
Test severities	The following severities may be specified:		
Severity levels	**1**	**2**	unit
Height of fall	**25**	**50**	mm
Number of falls (on each bottom edge)	**1**	**1**	-
Information to be given in the relevant Recommendation, if applicable	a) Conditioning procedure b) Fitting of cables, covers, etc. c) Edges to be used in the test, where there are more than four bottom edges d) Severity: height of drop onto a face		

12 Performance tests (electrical, general)

12.1 Radio-frequency immunity

12.1.1 Radiated, radio-frequency, electromagnetic fields	
Applicable standard	IEC 61000-4-3 [29]
Test method	Radiated electromagnetic fields
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of electromagnetic fields
Test procedure in brief	The EUT shall be exposed to electromagnetic field strength as specified by the severity level and a field uniformity as defined by the referred standard. The EM field can be generated in different facilities, however the use of which is limited by the dimensions of the EUT and the frequency range of the facility. The frequency ranges to be considered are swept with the modulated signal, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value. The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 s. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately.(1)
Test severities	The severities may be specified according to Tables 12.1.1/1 and 12.1.2/2
Note	(1) Usually, these sensitive frequencies can be expected to be the frequencies emitted by the EUT.
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Climatic conditions c) Wiring to and from EUT d) Duration of the test e) …

Table 12.1.1/1 **Electromagnetic fields of general origin**

	Severity levels	1	**2** (3)	**3** (3)	x(4)	unit
Frequency range	80 - 800 MHz (1) 26 - 800 MHz (2), (5)	1	**3**	**10**	special	V/m
	960 - 1400 MHz	1	**3**	**10**		
Modulation	80 % AM, 1 kHz, sine wave					
Notes	(1) IEC 61000-4-3 [29] only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances are recommended (test 12.1.2). (2) However, for EUT having no mains or other input port available the lower limit of the radiation test should be 26 MHz taking into account that the test specified in 12.1.2 cannot be applied (refer to Annex H of IEC 61000-4-3 [29]). In all other cases both 12.1.1. and 12.1.2 shall apply. (3) Preferred severity levels for OIML Recommendations: Level 2 for residential, commercial and light industrial environment Level 3 for industrial environment More guidance on the selection of the severity levels is given in Annex F of IEC 61000-4-3 [29]. (4) "x" is an open level. The amplitude may be specified in the relevant Recommendation. (5) For the frequency range 26 to 80 MHz, the testing laboratory can either carry out the test according to 12.1.1 or according to 12.1.2. But in case of a dispute, the results according to 12.1.2 shall prevail.					

Table 12.1.1/2 **Electromagnetic fields specifically caused by digital radio telephones**							
	Severity levels	1	2	**3** (1)	**4** (1)	x(2)	unit
Frequency range	800 - 960 MHz	1	3	**10**	**30**	special	V/m
	1 400 - 2 000 MHz	1	3	**10**	**30**		
Modulation		80 % AM, 1 kHz, sine wave					
Notes		(1) Preferred severity levels for OIML Recommendations: The severity level should mainly be selected by the consequences of failure, the expected minimum distance of a radiotelephone to the instrument, and the possibility of fraud by using a mobile telephone. A 2 W GSM telephone typically produces field strength of 10 V/m on a distance of 0.6 m. For an 8 W GSM this distance is 1.1 m. For more details, please consult table F.1 in IEC 61000-4-3, Am. 1 [29]. (2) "x" is an open level. The amplitude may be specified in the relevant Recommendation.					

12.1.2 Conducted radio-frequency fields					
Applicable standard	IEC 61000-4-6 [32]				
Test method	Conducted electromagnetic fields				
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of electromagnetic fields				
Test procedure in brief	Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard. The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.				
Test severities	The following severities may be specified:				
Severity levels	1	**2** (1)	**3** (1)	x (2)	unit
RF amplitude (50 Ω)	1	**3**	**10**	special	V (e.m.f.)
Frequency range (5)	0.15 - 80				MHz
Modulation	80 % AM, 1 kHz sine wave				
Notes	(1) Preferred severity levels for OIML Recommendations: Level 2 for residential, commercial and light industrial environment Level 3 for industrial environment (2) "x" is an open level. The amplitude may be specified in the relevant Recommendation. (3) This test is not applicable when the EUT has no mains or other input port. (4) If the EUT is composed of several elements, the tests shall be performed at each extremity of the cable if both of the elements are part of the EUT. (5) For the frequency range 26 - 80 MHz, the testing laboratory can either carry out the test according to 12.1.1 or according to 12.1.2. But in case of a dispute, the results according to 12.1.2 shall prevail.				
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Climatic conditions c) Wiring to and from EUT d) …				

12.2 Electrostatic discharge							
Applicable standard		IEC 61000-4-2 [28]					
Test method		Electrostatic discharge (ESD)					
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of direct and indirect electrostatic discharges					
Test procedure in brief		An ESD generator shall be used with a performance as defined in the referred standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds. For EUT not equipped with a ground terminal, the EUT shall be fully discharged between discharges. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time. Contact discharge is the preferred test method. Air discharge shall be used where contact discharge cannot be applied. Direct application: In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT. In the air discharge mode on insulated surfaces, the electrode is approached to the EUT and the discharge occurs by spark. Indirect application: The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.					
Test severities		The following severities may be specified:					
Severity levels (1)		1	2	**3** (2)	4	x(3)	unit
Test	Contact discharge	2	4	**6**	8	special	kV
voltage	Air discharge	2	4	**8**	15	special	kV
Notes		(1) In this case “level” means: up to and including the specified level (i.e. the test shall also be performed at the specified lower levels in the standard). (2) Preferred severity level for OIML Recommendations: Level 3 for all environments. (3) “x” is an open level. The amplitude may be specified in the relevant Recommendation. (4) Contact discharges shall be applied on conductive surfaces. Air discharges shall be applied on non-conductive surfaces.					
Information to be given in the relevant Recommendation, if applicable		a) Severity level b) Climatic conditions c) For non-earthed EUTs, procedure for discharging the EUT between two successive electrostatic discharges d) The number of discharges at each point e) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses					

12.3 Power frequency magnetic field

This test shall only be prescribed in OIML Recommendations in those cases where, as a result of the physical principle of the measuring instruments, a significant influence of power magnetic fields can be expected (also refer to 4.4)

Applicable standard		IEC 61000-4-8 [33]						
Test method		Power frequency magnetic field (50 Hz or 60 Hz)						
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of power frequency magnetic field (50 Hz or 60 Hz)						
Test procedure in brief		The test consists of exposure to power frequency magnetic field (50 Hz or 60 Hz)						
Test severities		The following severities may be specified:						
Severity levels		1	2	3	**4** (1)	**5** (1)	x(2)	unit (3)
Magnetic	Continuous field	1	3	10	**30**	**100**	special	A/m
field strength	Short duration (1 s to 3 s)	N.A.	N.A.	N.A.	**300**	**1000**	special	A/m
Notes		(1) Preferred severity levels for OIML Recommendations: Level 4 for residential, commercial and light industrial environment Level 5 for industrial environment (2) "x" is an open level. The field strength may be specified in the relevant Recommendation. (3) The magnetic field strength is expressed in A/m. 1 A/m corresponds to a free space induction of 1.26 µT.						
Information to be given in the relevant Recommendation, if applicable		a) Severity level b) The direction of the magnetic field related to the position(s) of the instrument c) The phase of the magnetic field related to the phase of the power supply of the instrument, if applicable d) The duration of the short duration test e) If applicable: the values of level "x"						

12.4 Bursts (transients) on signal, data and control lines						
Applicable standards	IEC 61000-4-1 [27], IEC 61000-4-4 [30]					
Test method	Electrical bursts					
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions where electrical bursts are superimposed on I/O and communication ports					
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1 000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. For the coupling of the bursts into the I/O and communication lines, a capacitive coupling clamp as defined in the standard shall be used. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.					
Test severities	The following severities may be specified:					
Severity levels	1	**2** (1)	**3** (1)	4	x(2)	unit
Amplitude (peak value)	0.25	**0.5**	**1**	2	special	kV
Repetition rate	5	**5**	**5**	5	special	kHz
Notes	(1) Preferred severity levels for OIML Recommendations: Level 2 for residential, commercial and light industrial environment Level 3 for industrial environment (2) "x" is an open level. The amplitude may be specified in the relevant Recommendation.					
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Climatic conditions c) Signal cables to be exposed to bursts d) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses e) …					

12.5 Surges on signal, data and control lines									
Applicable standard		IEC 61000-4-5 [31]							
Test method		Electrical surges							
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions where electrical surges are superimposed on I/O and communication ports							
Test procedure in brief		A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. At least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.							
Test severities		The following severities may be specified:							
Severity level (Installation class)		0	1	2	**3**(1)	4	5	x (2)	unit
Unbalanced lines	Line to line	N.A.	N.A.	0.5	**1.0**	2.0	2.0	special	kV
	Line to earth	N.A.	0.5	1.0	**2.0** (3)	4.0 (3)	4.0 (3)	special	kV
Balanced lines	Line to line	N.A.	N.A.	N.A.	**N.A.**	N.A.	N.A.	special	kV
	Line to earth	N.A.	0.5	1.0	**2.0** (3)	2.0 (3)	4.0 (3)	special	kV
Notes		(1) Preferred severity level (installation class) for OIML Recommendations (2) "x" is an open level. The voltage may be specified in the relevant Recommendation (3) Normally tested with primary protection							
Information to be given in the relevant Recommendation, if applicable		a) Severity level (installation class according to IEC 61000-4-5 [31]) b) Climatic conditions c) Coupling method d) Set-up of the EUT for this test e) Permissible changes in the performance of the EUT as a result of this test. f) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses							

13 Performance tests (electrical, mains power)

13.1 DC mains voltage variation	
Applicable standard	IEC 60654-2 [20]
Test method	Variation in DC mains power voltage
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of varying DC mains power voltage
Test procedure in brief	The test consists of exposure to the specified power supply condition for a period sufficient for establishing stability.
Test severity	The upper limit will be the DC level at which the EUT has been manufactured to automatically detect high-level conditions. The lower limit will be the DC level at which the EUT has been manufactured to automatically detect low-level conditions. The EUT shall comply with the specified maximum permissible errors at voltage levels between the two levels.

13.2 AC mains voltage variation		
Applicable standards	IEC/TR 61000-2-1 [24], IEC 61000-4-1 [27]	
Test method	Variation in AC mains power voltage (single phase)	
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of varying AC mains power voltage.	
Test procedure in brief	The test consists of exposure to the specified power condition for a period sufficient for achieving temperature stability and for performing the required measurements.	
Test severities	The following severities may be specified:	
Severity levels		**1**
Mains voltage (1), (2)	Upper limit	$\boldsymbol{U_{nom}}$ **+ 10 %**
	Lower limit	$\boldsymbol{U_{nom}}$ **– 15 %**
Notes	(1) In the case of three phase mains power, the voltage variation shall apply for each phase successively. (2) The values of U_{nom} are those marked on the measuring instrument. In case a range is specified, the "-" relates to the lowest value and the "+" to the highest value of the range.	

13.3 AC mains frequency variation		
Applicable standards	IEC/TR 61000-2-1 [24], IEC 61000-2-2 [25], IEC 61000-4-1 [27]	
Test method	Variation in AC mains power frequency	
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of varying AC mains power frequency	
Test procedure in brief	The test consists of exposure to the specified power condition for a period sufficient for achieving temperature stability and for performing the required measurements.	
Test severities	The following severities may be specified:	
Severity levels		**1**
Mains frequency (1), (2)	Upper limit	$\boldsymbol{f_{nom}}$ **+ 2 %**
	Lower limit	$\boldsymbol{f_{nom}}$ **– 2 %**
Notes	(1) The values of f_{nom} are those marked on the measuring instrument. In case a range is specified, the "-" relates to the lowest value and the "+" to the highest value of the range. (2) As the power frequency in interconnected networks varies only in a narrow frequency band around the rated frequency (50 Hz or 60 Hz), this test applies only to special cases, for example: • EUTs to be operated at large power frequency variations • EUTs to be installed in small networks that are isolated from a large interconnected system.	

13.4 AC mains voltage dips, short interruptions and voltage variations							
Applicable standards		IEC 61000-4-11 [34], IEC 61000-6-1 [37], IEC 61000-6-2 [38]					
Test method		Short-time reductions in mains voltage					
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of short time mains voltage reductions					
Test procedure in brief		A test generator suitable to reduce for a defined period of time the amplitude of the AC mains voltage is used. The performance of the test generator shall be verified before connecting the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.					
Test severities		The following severities may be specified:					
Severity levels			1	**2** (1), (2)	**3** (1), (2)	x (3)	unit
Voltage dips	Test a	Reduction	(4)	**0**	**0**	special	%
		Duration	(4)	**0.5**	**0.5**	special	cycles
	Test b	Reduction	N.A.	**0**	**0**	special	%
		Duration	N.A.	**1**	**1**	special	cycles
	Test c	Reduction	N.A.	**70**	**40**	special	%
		Duration	N.A.	**25/30** (5)	**10/12** (5)	special	cycles
	Test d	Reduction	N.A.	N.A.	**70**	special	%
		Duration	N.A.	N.A.	**25/30** (5)	special	cycles
	Test e	Reduction	N.A.	N.A.	**80**	special	%
		Duration	N.A.	N.A.	**250/300** (5)	special	cycles
Short interruptions	Reduction		(4)	**0**		special	%
	Duration		(4)	**250/300** (5)		special	cycles
Notes	(1) Preferred severity levels for OIML Recommendations: Level 2 for residential, commercial and light industrial environment Level 3 for industrial environment (2) For the voltage dips, all tests within the severity level can be applicable (refer to 8.4.7). (3) To be defined by the product committee. For equipment connected directly or indirectly to the public network, the levels must not be less severe than level 2. (4) Test level and durations for voltage dips (t_s) (50 Hz / 60 Hz) (5) These values are for 50 Hz / 60 Hz respectively						
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Performance of the instrument at each of the sub-levels a and b (and c in case of level 2) c) Climatic conditions d) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses e) …						

13.5 Bursts (transients) on AC and DC mains						
Applicable standards	IEC 61000-4-1 [27], IEC 61000-4-4 [30]					
Test method	Electrical bursts					
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions where electrical bursts are superimposed on the mains voltage					
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consist of exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1 000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.					
Test severities	The following severities may be specified:					
Severity levels	1	**2** (1)	**3** (1)	4	x(2)	unit
Amplitude (peak value)	0.5	**1**	**2**	4	special	kV
Repetition rate	5	**5**	**5**	5	special	kHz
Notes	(1) Preferred severity levels for OIML Recommendations: Level 2 for residential, commercial and light industrial environment Level 3 for industrial environment (2) "x" is an open level. The amplitude may be specified in the relevant Recommendation.					
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Climatic conditions c) Signal cables to be exposed to bursts d) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses e) …					

13.6 Voltage dips, short interruptions and voltage variations on DC mains power					
Applicable standard		IEC 61000-4-29 [36]			
Test method		Voltage dips, short interruptions and voltage variations on DC mains power.			
Object of the test		To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of voltage dips, voltage variations and short interruptions on DC mains power			
Test procedure in brief		A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The voltage dips and short interruptions shall be tested on the EUT, for each selected combination of test level and duration, with a sequence of three dips/interruptions with intervals of 10 s minimum between each test event. The EUT shall be tested for each of the specified voltage variations, three times at 10 s intervals in the most representative operating modes. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.			
Test severities		The following severities may be specified:			
Voltage dips	Severity level	**1** [(1)]	2		unit
	Test levels	**40 and 70**	x[(2)]		% of the rated voltage
	Duration [(3)]	0.01; 0.03; 0.1; 0.3; 1; x[(2)]			s
Short interruptions [(4)]	Test condition	High impedance and/or low impedance			
	Test levels	**0**			% of the rated voltage
	Duration [(3)]	0.001; 0.003; 0.01; 0.03; 0.1; 0.3; 1; x[(2)]			s
Voltage variations	Severity levels	**1** [(1)]	2	x[(2)]	
	Test level	**85 and 120**	80 and 120	x[(2)]	% of the rated voltage
	Duration [(3)]	0.1; 0.3; 1; 3; 10; x[(2)]			s
Notes		[(1)] Preferred severity level for OIML Recommendations: level 1 (industrial environments only, refer to 8.4.8) [(2)] "x" is an open level. The severity may be specified in the relevant Recommendation. [(3)] One or more of the test levels and durations specified in each table may be given in the product specification (OIML Recommendation). At least the shortest duration in the table should be tested. [(4)] If the EUT is tested for short interruptions, it is unnecessary to test for other levels of the same duration, unless the immunity of the equipment is detrimentally affected by voltage dips of less than 70 % of the rated voltage.			
Information to be given in the relevant Recommendation, if applicable		a) Severity levels and duration b) Climatic conditions c) Performance level d) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses c) ….			

13.7 Ripple on DC mains power					
Applicable standard	IEC 61000-4-17 [35]				
Test method	Ripple on DC input power port.				
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of ripple on the low voltage DC mains power. This test does not apply to instruments connected to battery charger systems incorporating switch mode converters.				
Test procedure in brief	A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The test consists in subjecting the EUT to ripple voltages such as those generated by rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. The frequency of the ripple is the power frequency or its multiple 2, 3 or 6, as specified in the product specification. The waveform of the ripple, at the output of the test generator, has a sinusoid-linear character. The test shall be applied for at least 10 min or for the period time necessary to allow a complete verification of the EUT's operating performance.				
Test severities	The following severities may be specified:				
Severity levels	**1** (1)	2	3	4	x(2)
Percentage of the nominal DC voltage (3)	**2**	5	10	15	special
Notes	(1) Preferred severity level for OIML Recommendations: level 1 (industrial environments only, refer to 8.4.9) (2) "x" is an open level. The percentage may be given in the relevant Recommendation. (3) The test levels are a peak-to-peak voltage expressed as a percentage of the nominal DC voltage.				
Information to be given in the relevant Recommendation, if applicable	a) Severity levels b) Waveform of the ripple voltage c) Frequency of the ripple d) Duration of the test e) Climatic conditions f) ….				

13.8 Surges on AC and DC mains power lines								
Applicable standard	IEC 61000-4-5 [31]							
Test method	Electrical surges							
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions where electrical surges are superimposed on the mains voltage							
Test procedure in brief	A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. On AC mains supply lines at least 3 positive and 3 negative surges shall be applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. On DC power lines, at least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.							
Test severities	The following severities may be specified:							
Severity level (installation class)	0	1	2	**3 (1)**	4	5	x (2)	unit
Line to line	N.A.	N.A.	0.5	**1.0**	2.0	(3)	special	kV
Line to earth	N.A.	0.5	1.0	**2.0**	4.0 (4)	(3)	special	kV
Notes	(1) Preferred severity level (installation class) for OIML Recommendations: level 3 (2) "x" is an open level. The voltage may be specified in the relevant Recommendation (3) Depends on the class of the local power supply system (4) Normally tested with primary protection							
Information to be given in the relevant Recommendation, if applicable	a) Severity level (installation class according to IEC 61000-4-5 [31]) b) Climatic conditions c) Coupling method d) Set-up of the EUT for this test e) Permissible changes in the performance of the EUT as a result of this test f) If the EUT is an integrating instrument: an exact description of the sequence of the test pulses g) …							

14 Performance tests (electrical, battery-power)

14.1 Low voltage of internal battery (not connected to the mains power)	
Applicable standards	There is no reference to standards for this test.
Test method	Variation in supply voltage
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of low battery voltage
Test procedure	The test consists of exposure to the specified condition of the battery(s) for a period sufficient for achieving temperature stability and for performing the required measurements. If an alternative power source (standard power supply with sufficient current capacity) is used in bench testing to simulate the battery, it is important that the internal impedance of the specified type of battery also be simulated. The maximum internal impedance of the battery is to be specified by the manufacturer of the instrument. Test sequence: Stabilize the power supply at a voltage within the defined limits and apply the measurement and/or loading condition. Record the following data: a) Date and time b) Temperature c) Power supply voltage d) Functional mode e) Measurements and/or loading condition f) Indications (as applicable) g) Errors h) Functional performance Reduce the power voltage to the EUT until the equipment clearly ceases to function properly according to the specifications and metrological requirements, and note the following data: i) Power supply voltage j) Indications k) Errors l) Other relevant responses of the instrument
Test severities	The following severity may be specified:
Severity level	1
Lower limit of the voltage	The lowest voltage at which the EUT functions properly according to the specifications
Number of cycles	At least one test cycle for each functional mode
Information to be given in the relevant Recommendation, if applicable	a) Preconditioning of the EUT b) Measurements and/or loading during conditioning and test c) Number of test cycles d) Maximum allowable variations e) Response of the EUT to low supply voltage; for instance indication or switch off

14.2 Power from external 12V and 24 V road vehicle batteries

Note:

The nominal voltage U_n of the electrical system in road vehicles is usually 12 V or 24 V.

But the practical voltage at the battery-terminals of a road vehicle can vary considerably.

ISO 7637-2 [42], clauses 4.2 and 5, specify reference levels of 13.5 V and 27 V respectively.

It is likely that the future will bring 42 V systems too, but these are not yet included in the ISO 7637-series of standards, nor in ISO 16750-2:2003 [40]. Therefore, no attempt is made to include them in this version of OIML D 11.

14.2.1 Voltage variations								
Applicable standard	ISO 16750-2 [40]							
Test method	Variation in supply voltage							
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high (under charge) and low battery voltage							
Test procedure in brief	The test verifies the equipment functionality in the range between minimum and maximum supply voltage.							
Test severities	The following severities may be specified:							
Nominal battery voltage	U_{nom} = 12 V				U_{nom} = 24 V			Unit
Severity level [1]	A	B	**C** [2]	D	E	**F** [2]	G	
Lower limit	6	8	**9**	10.5	10	**16**	22	V
Upper limit	16	16	**16**	16	32	**32**	32	V
Notes	[1] In ISO 16750-2 [40] called “Code” [2] Preferred severity level for OIML Recommendations: Code C for 12 V batteries and Code F for 24 V batteries. [3] The other tests from ISO 16750-2 [40] are not adopted in this Document.							
Information to be given in the relevant Recommendation, if applicable	a) Preconditioning of the instrument b) Measurements and/or loading during conditioning and test c) Number of test cycles d) Maximum allowable variations e) Response of the EUT to low supply voltage; for instance indication or switch off.							

14.2.2 Electrical transient conduction along supply lines					
Applicable standard	ISO 7637–2 [42] § 5.6.2: Test pulse 2a + 2b § 5.6.3: Test pulse 3a + 3b § 5.6.4: Test pulse 4				
Test method	Electrical transient conduction along supply lines.				
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under the following conditions [4]: - Transients due to a sudden interruption of currents in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a); - Transients from DC motors acting as generators after the ignition is switched off (pulse 2b)[5]; - Transients on the supply lines, which occur as a result of the switching processes (pulses 3a and 3b); - Voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4).				
Test procedure in brief	The test consists of exposure to disturbances on the power voltage by direct coupling on supply lines.				
Test severities	The following severity may be specified:				
Severity levels [1] [2]	III		**IV [3]**		unit
Test pulse	Pulse voltage U_s		**Pulse voltage U_s**		unit
	U_{nom} = 12 V	U_{nom} = 24 V	**U_{nom} = 12 V**	**U_{nom} = 24 V**	unit
2a	+ 37	+ 37	**+ 50**	**+ 50**	V
2b[5]	+ 10	+ 20	**+ 10**	**+ 20**	V
3a	– 112	- 150	**– 150**	**– 200**	V
3b	+ 75	+ 150	**+ 100**	**+ 200**	V
4	– 6	– 12	**– 7**	**– 16**	V
Notes:	[1] In ISO 7637-2 [42], called “test levels”. [2] In ISO 7637-2 [42], the former levels I and II were deleted because they do not ensure sufficient immunity in road vehicles. [3] The text of this standard indicates that this standard is primarily intended as a basis for contracts between manufacturers of motor vehicles and electronic sub-assemblies. As instruments must comply with the provisions in 5.1.1 or 5.1.2 in any type of car, severity level IV is advised for application in OIML Recommendations. [4] No reference has been made to test pulses 1, 5a and 5b, mentioned in the standard. [5] Test pulse 2b is only applicable if the measuring instrument may be connected to the battery via the main (ignition) switch of the car, i.e. if the manufacturer of the measuring instrument has **not** specified that the instrument is to be connected directly (or by its own main switch) to the battery.				
Information to be given in the relevant Recommendation, if applicable	a) Test pulses to be applied b) Severity level c) Minimum number of pulses or test time d) Performance of the EUT during and after the test pulses				

14.2.3	**Electrical transient conduction via lines other than supply lines**						
Applicable standard	ISO 7637-3 [43], § 4.5: Test pulses a and b						
Test method	Electrical transient conduction along lines other than supply lines						
Object of the test	To verify compliance with the provisions in 5.1.1 or 5.1.2 under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b)						
Test procedure in brief	The test consists of exposure to bursts of voltage spikes by capacitive and inductive coupling via lines other than supply lines.						
Test severities	The following severity may be specified:						
Severity levels			I	II	III	**IV** (1)	unit
U_{nom} = 12 V	pulse a	U_s	– 10	– 20	– 40	**– 60**	V
	pulse b	U_s	+ 10	+ 20	+ 30	**+ 40**	V
U_{nom} = 24 V	pulse a	U_s	– 14	– 28	– 56	**– 80**	V
	pulse b	U_s	+ 14	+ 28	+ 56	**+ 80**	V
Notes:	(1) The text of the standard indicates that this standard is primarily intended as a basis for contracts between manufacturers of motor vehicles and electronic sub-assemblies. As instruments must comply with the provisions in 5.1.1 or 5.1.2 in any type of car, severity level IV is advised for application in OIML Recommendations.						
Information to be given in the relevant Recommendation, if applicable	a) Severity level b) Performance of the EUT during and after the test pulses						

ANNEX A
Durability assessment
(Informative)

A.1 Introduction

A.1.1 Objective

The objective of durability assessment is to establish an instrument's capability to perform correctly over a period of time. Since the deterioration of an instrument may occur (i) due to the failure of one of its parts, which may happen at an unpredictable moment during its lifetime, and (ii) gradually due to wear and tear, the objective of durability assessment includes the following two aspects:

- To determine the capability of the instrument to act adequately upon the failure of a part;
- To collect information on the possible occurrence of defects during the lifetime of the instrument as a whole.

A.1.2 Verification of the instrument's capacity to act adequately upon failure of a part

Tests may be carried out to verify the correct performance of durability protection facilities and checking facilities by creating situations that these facilities and facilities are designed to cover, provided that the integrity of the instrument is maintained. Study of the documentation on circuitry may give guidance. The relevant Recommendation may specify the parts that are to be tested. Special attention should be given to parts (electronic or mechanic) whose gradual alteration may be expected during the lifetime of the instrument.

A.1.3 Assessment of the possible occurrence of defects during the lifetime of the instrument as a whole

Information concerning this subject can only be collected by the performance of real endurance tests under conditions that accelerate the instrument's wear and tear resulting from time. The manufacturer may have carried out such tests in order to improve the overall quality of the instrument by reinforcing certain parts, to elaborate other solutions for certain problems, or to set up an adequate maintenance system.

It is recommended that the testing authority requests documentation concerning these tests.

The relevant Recommendation may specify certain endurance tests.

A.2 Characteristics of durability protection

Durability protection in its basic form provides the operator with information concerning the status of the instrument. He may be warned that a certain operation time has elapsed or that the instrument itself has detected a significant durability error and is consequently invited to take corrective actions; alternatively, he may be recommended carrying out certain checking operations.

A proper intake for protection may be the time factor itself, in which case an obvious moment for checking operations is the switching on of the instrument, or for example the switching on of a display or an additional device. Another approach may be the use of timers or operation cycle counters, which would determine other checking times based on the known or estimated frequency of the occurrence of durability errors.

In these cases, the operator may be given a certain lapse of time to carry out his checking operations at a suitable moment; after that time, however, the instrument shall discontinue its operation if the checks have not been done.

In more developed forms of durability protection, the instrument may automatically compare the result of checking operations with stored result values and automatically conclude whether it is in good condition or not. If the self-checking involves the application of physical reference standards (for example in weighing instruments), monitoring of the durability of analogue input transducers will also be possible.

Within the instrument, the circuits warranting durability protection shall represent a logical function with self-checking properties. Since significant durability errors normally need a certain time interval to develop, this self-checking action may be intermittent, and very often an interlock with the switch-on procedure may be sufficient.

Durability protection should not be confused with protection against disturbances and influence factors, although checking facilities sometimes also monitor durability aspects, for example by detecting a significant fault that occurs due to the wearing of a component in the measuring chain. The objective of both requirements 5.1.2 and 5.1.3 is to safeguard the routine measurement operations of the instrument against failures.

The relevant Recommendation may contain prescriptions concerning the means for securing digital signal handling in the case of a self-checking ability. The difference in self-checking frequency (automatic and permanent for some routine operations; intermittent for durability effects) is to be seen as a consequence of speed: a slow evolution of durability errors opposed to the transmission of typically one million information-carrying pulses every second in the digital signal processing.

Where transmission and storage of digital data has been sufficiently protected, the internal function of a typical microprocessor (which processes program instructions as well as arithmetical operations through the same function blocks) may be considered as self-checked by its normal operation.

ANNEX B
Facility for tests on barometric pressure
(Informative)

B.1 Introduction

There are no standards describing a test facility for the evaluation of the influence of small changes in the barometric pressure on the performance of measuring instruments.

As the performance of certain instruments can be influenced by changes in atmospheric pressure, this test makes sense for these instruments. A typical example is the influence on the zero-output of certain designs of load cells, having a low excitation voltage.

Therefore, this Annex gives a brief description for a simple test set-up, primarily designed for testing load cells, but also applicable for other relatively small EUTs with a safe low excitation voltage.

For this test, it should be emphasized that the changes in pressure are very small: the pressure difference between the test chamber and the outer atmosphere will never be more than 20 kPa. So there are no special precautions to be taken with respect to pressure-related safety.

Furthermore, there is no need to control the exact pressure; it will suffice to control the difference between the pressures in the pressure chamber and the atmospheric pressure in the laboratory.

A practical problem in using a small pressure chamber for the testing of electronic measuring instruments is making a simple airtight connection for the cable(s) between the pressure room and the outer atmosphere, without a need to dismantle the connection plug(s).

B.2 Facility for barometric pressure test

It must be clearly emphasized that the facility described below is just one of the possible solutions, though other solutions may be equally acceptable.

In the described facility, the problem of an airtight feed-through for the cables is solved by a water-slot that is used to generate the changes in pressure as well.

The principle of the test facility is depicted in figure 1 and a practical set-up is shown in Figure 2.

The vessel (1) is partly filled with water.

The EUT (2) is placed on a table (3) and prevents the EUT from getting wet.

A transparent vessel (4), with a smaller area than the first one, is placed upside down into the first vessel (1) to form a water seal (5) between the two vessels. Furthermore, there should be a facility (6) that prevents the vessel from floating up. This can be either a bar as shown in Figure 2 or some heavy object.

The pressure in the chamber (7) above the water level in the second vessel can be set by means of a manually operated pump (8) and read on a pressure gauge (9).

The water seal (5) between the two vessels solves the problem of an airtight feed-through for the cables.

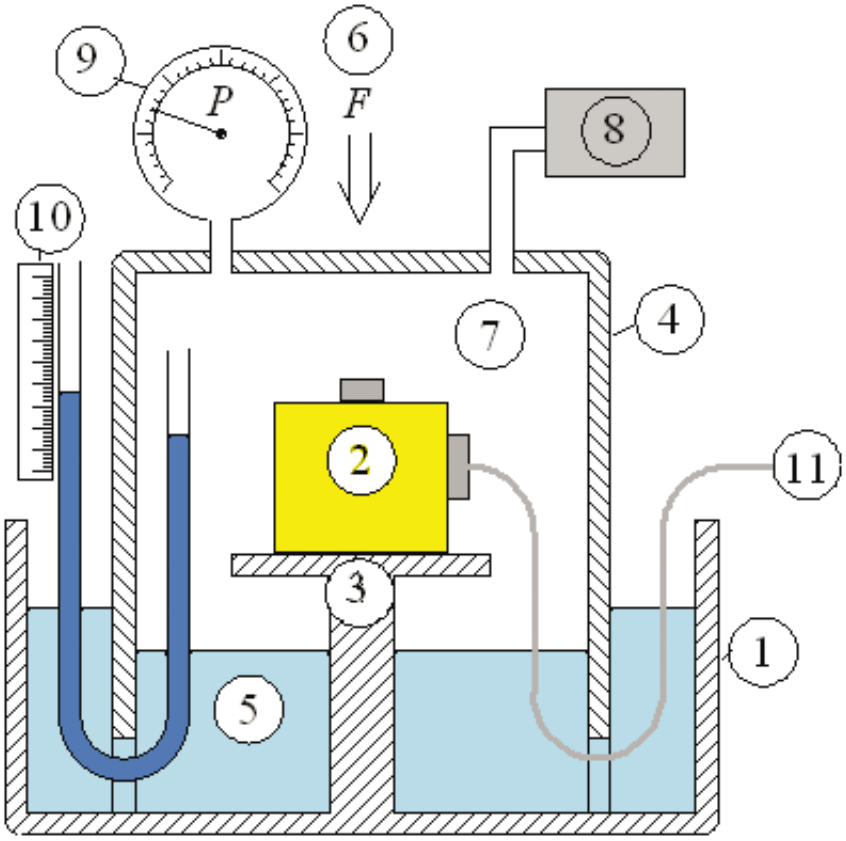
In the practical set-up in the picture in Figure 2, the vessel (1) has a diameter of about 50 cm.

The pressure in the chamber can be increased by either a small hand-pump or by adding a small amount of water.

As an alternative for the pressure gauge (9), a water manometer (10) consisting of a water-filled plastic tube and a ruler can be used.

Warning:

Due to the presence of water and a metal housing, this facility can only be used for situations where only safe low voltages occur, or no electric power at all.



(1) Vessel
(2) EUT
(3) Table
(4) Transparent vessel
(5) Water
(6) Prevention against floating up
(7) Pressure chamber
(8) Pump
(9) Pressure gauge
(10) Water manometer
(11) Cable

Figure B-1 The basic principle

Figure B-2 The practical set-up

ANNEX C
Bibliography and Notes

At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and the users of this Document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

The actual status of the standards referred to can also be found on the Internet:

IEC Publications: http://www.iec.ch/searchpub/cur_fut.htm

ISO Publications: http://www.iso.org/iso/en/CatalogueListPage.CatalogueList

OIML Publications: http://www.oiml.org/publications/ (with free download of PDF files).

In order to avoid any misunderstanding, it is highly recommended that all references to standards in OIML Recommendations and International Documents shall be followed by the version referred to (generally the year or date).

Ref.	Standards and reference documents	Description
[1]	International Vocabulary of Basic and General Terms in Metrology (VIM) (1993)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML
[2]	OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P1)	Gives rules for issuing, registering and using OIML Certificates of conformity
[3]	IEC 60068-1 (1988-6), Appendix B (including Amendment 1, 1992-4) Environmental testing. Part 1: General and guidance	Enumerates a series of environmental tests and appropriate severities, and prescribes various atmospheric conditions for measurements for the ability of specimens to perform under normal conditions of transportation, storage and operational use
[4]	IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part2: Tests, Test A: Cold	Concerns cold tests on both non-heat-dissipating and heat-dissipating specimens
[5]	IEC 60068-2-2 (1974-01), with amendments 1 (1993-02) and 2 (1994-05) Environmental testing Part2: Tests. Test B: Dry heat	Contains Test Ba: Dry heat for non-heat-dissipating specimen with sudden change of temperature; Test Bb: Dry heat for non-heat-dissipating specimen with gradual change of temperature; Test Bc: Dry heat for heat-dissipating specimen with sudden change of temperature; Test Bd: Dry heat for heat-dissipating specimen with gradual change of temperature. The 1987 reprint includes IEC No. 62-2-2A
[6]	IEC 60068-2-6 (1995-03), with Corr. 1 (1995-03) Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal)	Gives a method of test which provides a standard procedure to determine the ability of components, equipment and other articles to withstand specified severities of sinusoidal vibration. Has the status of a basic safety publication in accordance with IEC Guide 104.
[7]	IEC 60068-2-11 (1981-01) Environmental testing - Part 2: Tests. Test Ka: Salt mist With Corr. 1 (1999-12)	Compares resistance to deterioration from salt mist between specimens of similar construction. May be used to evaluate the quality and the uniformity of protective coatings.

[8]	IEC 60068-2-18 (2000-10) Environmental testing - Part 2-18: Tests - Test R and guidance: Water	Provides methods of test applicable to products which, during transportation, storage or in service, may be subjected to falling drops, impacting water or immersion. The primary purpose of water tests is to verify the ability of enclosures, covers and seals to maintain components and equipment in good working order after and, when necessary, under a standardized dropfield or immersion in water. These tests are not corrosion tests and should not be considered and used as such. The effects of a large temperature difference between the water and the specimen, such as increased water ingress resulting from pressure changes, as well as thermal shock, are not simulated. Established water tests in other standards are not intended to simulate natural rainfall and their quoted intensities are too high to be adopted for that purpose. Therefore, in addition to the high-intensity severities, Test R includes an artificial rain test based upon natural conditions but not taking into account high wind speeds generally associated with natural rain. Guidance is given on the applicability of the tests and the severities to be selected.
[9]	IEC 60068-2-30 (1980-01) with amendment 1 (1985-08) Environmental testing Part 2: Tests Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)	Determines the suitability of components, equipment and other articles for use and/or storage under conditions of high humidity when combined with cyclic temperature changes. Amendment No. 1 replaces the third paragraph of Clause 8, Recovery.
[10]	IEC 60068-2-31 (1969-01) with amendment 1 (1982-01) Environmental testing Part 2: Tests Test Ec: Drop and topple, primarily for equipment-type specimens	Determines the effect on a specimen of simple standard treatments which are representative of the knocks and jolts likely to occur during repair work or rough handling on a table or bench. Has the status of a basic safety publication in accordance with IEC Guide 104.
[11]	IEC 60068-2-47 (1999-10) Environmental testing Part 2-47: Test methods Mounting of components, equipment and other articles for vibration, impact and similar dynamic tests	Provides methods of mounting components, and mounting requirements for equipment and other articles, for the families of dynamic tests in IEC 60068-2, that is impact (Test E), vibration (Test F) and acceleration, steady-state (Test G).
[12]	IEC 60068-2-64 (1993-05), with Corr. 1(1993-10) Environmental testing - Part 2: Test methods, Test Fh: Vibration, broad-band random (digital control) and guidance	Determines the ability to withstand specified severities of broad-band random vibration. Applies to specimens which may be subjected to vibration of a stochastic nature by transportation or operational environments, for example in aircraft, space vehicles and land vehicles. Has the status of a basic safety publication in accordance with IEC Guide 104.
[13]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state *(IEC 60068-2-78 replaces the following withdrawn standards:* *IEC 60068-2-3, test Ca and* *IEC 60068-2-56, test Cb)*	Provides a test method for determining the suitability of electrotechnical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the installation period.

[14]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01) Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A gives additional information for cases where temperature stability is not achieved during the test.
[15]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.
[16]	IEC 60068-3-8 (2003-08) Environmental testing - Part 3-8: Supporting documentation and guidance - Selecting amongst vibration tests	Provides guidance for selecting amongst the IEC 60068-2 stationary vibration test methods Fc sinusoidal, Fh random and F(x) Mixed mode vibration. The different steady-state test methods and their aims are briefly described in clause 4. Transient test methods are not included. For vibration testing, the environmental conditions, especially the dynamic conditions for the specimen, should be known. This standard helps to collect information about the environmental conditions (clause 5), to estimate or measure the dynamic conditions (clause 6) and gives examples to enable decisions to be made on the most applicable environmental vibration test method. Starting from the condition, the method of selecting the appropriate test is given. Since real life vibration conditions are dominated by vibration of a random nature, random testing should be the commonly used method, see Table 1, clause 7. The methods included hereafter may be used to examine the vibration response of a specimen under test before, during and after vibration testing. The selection for the appropriate excitation method is described in clause 8 and tabulated in Table 2. In this standard specification, writers will find information concerning vibration test methods and guidance for their selection.
[17]	IEC 60512-11-8 (1995-11) Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 11: Climatic tests - Section 8: Test 11h - Sand and dust	Defines a standard test method to assess the ability of a connector to withstand driving fine sand and dust.
[18]	IEC 60512-14-7 (1997-10) Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 14: Sealing tests - Section 7: Test 14g: Impacting water	Defines a standard test method to assess the effects of impacting water or specified fluid on electrical connecting devices.

[19]	IEC 60529 (2001-02) Ed. 2.1 Degrees of protection provided by enclosures (IP Code) Corr.1 (2003-01) Ed. 2.1 Am1 (1999-11) Amendment 1 Consolidated Edition	Applies to the classification of degrees of protection provided by enclosures for electrical equipment with a rated voltage not exceeding 72.5 kV. Has the status of a basic safety publication in accordance with IEC Guide 104.
[20]	IEC 60654-2 (1979-01), with amendment 1 (1992-09) Operating conditions for industrial-process measurement and control equipment Part 2: Power	Gives the limiting values for power received by land-based and offshore industrial process measurement and control systems or parts of systems during operation. Maintenance and repair conditions are not considered
[21]	IEC 60721-2-5 (1991-07) Classification of environmental conditions - Part 2: Environmental conditions appearing in nature - Section 5: Dust, sand, salt mist	Presents characteristics of dust, sand and salt mist appearing in nature, and describes the influences from these environmental factors to which products are liable to be exposed during storage, transportation and use.
[22]	IEC 60721-3-3 (1994-12) with Amendments 1 (1995-06) and 2 (1996-11) Classification of groups of environmental parameters and their severities - Stationary use at weatherprotected locations Consolidated edition 2.2 (2002-10)	Classifies groups of environmental parameters and their severities to which products are subjected when mounted for stationary use at weatherprotected locations.
[23]	IEC 60721-3-4 (1995-01) with Amendment 1 (1996-11) Classification of groups of environmental parameters and their severities - Stationary use at non-weatherprotected locations.	Classifies groups of environmental parameters and the severities to which a product may be exposed under use conditions, including periods of erection work, downtime, maintenance and repair, when mounted for stationary use at locations which are non weatherprotected.
[24]	IEC/TR 61000-2-1 (1990-05) Electromagnetic compatibility (EMC) Part 2: Environment Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems	Has the status of a technical report, and gives information on the various types of disturbances that can be expected on public power supply systems. The following disturbance phenomena are considered: - harmonics - inter-harmonics - voltage fluctuations - voltage dips and short supply interruptions - voltage unbalance - mains signalling - power frequency variation - DC components
[25]	IEC 61000-2-2 (2002-03) Electromagnetic compatibility (EMC) Part 2-2: Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	This standard is concerned with conducted disturbances in the frequency range from 0 kHz to 9 kHz, with an extension up to 148,5 kHz specifically for mains signalling systems. It gives compatibility levels for public low voltage AC distribution systems having a nominal voltage up to 420 V, single-phase or 690 V, three-phase and a nominal frequency of 50 Hz or 60 Hz. Compatibility levels are specified for electromagnetic disturbances of the types which can be expected in public low voltage power supply systems, for guidance in: – the limits to be set for disturbance emission into public power supply systems; – the immunity limits to be set by product committees and others for the equipment exposed to the conducted disturbances present in public power supply systems.
[26]	IEC 61000-2-5 (1995-9) Electromagnetic compatibility (EMC) – Environment - Classification of electromagnetic environments.	This publication is a technical report intended for guidance, not as a specification, for those who are in charge of writing immunity standards for an equipment or system. Its purpose is to classify electromagnetic environments and help improve the specification of the immunity requirements of an item containing electrical or electronic parts, and consequently obtain electromagnetic compatibility. It also gives basic guidance for the selection of immunity levels. The data are applicable to any equipment, subsystem or system making use of electromagnetic energy and operating in a specific location as defined by this report

[27]	IEC 61000-4-1 (2000-04) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 1: Overview of IEC 61000-4 series	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques. Provides general recommendations concerning the choice of relevant tests
[28]	IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) and amendment 2 (2000-11) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 2: Electrostatic discharge immunity test. Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2	This publication is based on IEC 60801-2 (second edition: 1991). It relates to the immunity requirements and test methods for electrical and electronic equipment subjected to static electricity discharges, from operators directly, and to adjacent objects. It additionally defines ranges of test levels which relate to different environmental and installation conditions and establishes test procedures. The object of this standard is to establish a common and reproducible basis for evaluating the performance of electrical and electronic equipment when subjected to electrostatic discharges. In addition, it includes electrostatic discharges which may occur from personnel to objects near vital equipment
[29]	IEC 61000-4-3 consolidated Edition 2.1 (2002-09) with amendment 1 (2002-08) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 3: Radiated, radio-frequency, electromagnetic field immunity test	Applies to the immunity of electrical and electronic equipment to radiated electromagnetic energy. Establishes test levels and the required test procedures. Establishes a common reference for evaluating the performance of electrical and electronic equipment when subjected to radio-frequency electromagnetic fields.
[30]	IEC 61000-4-4 (2004-07) Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: – test voltage waveform; – range of test levels; – test equipment; – verification procedures of test equipment; – test set-up; and – test procedure. The standard gives specifications for laboratory and post-installation tests.
[31]	IEC 61000-4-5 (2001-04) consolidated edition 1.1 (Including Amendment 1 and Correction 1) Electromagnetic compatibility (EMC)- Part 4-5: Testing and measurement techniques - Surge immunity test	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by overvoltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.

[32]	IEC 61000-4-6 (2003-05) with amendment 1 (2004-10) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 6: Immunity to conducted disturbances, induced by radio-frequency fields	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[33]	IEC 61000-4-8 (1993-06) with amendment 1 (2000-11) Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test Consolidated Edition 1.1 (2001-03)	Relates to the immunity requirements of equipment, only under operational conditions, to magnetic disturbances at power frequency related to: – residential and commercial locations; – industrial installations and power plants; and – medium voltage and high voltage sub-stations.
[34]	IEC 61000-4-11 (2004-03) Electromagnetic compatibility (EMC) - Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.
[35]	IEC 61000-4-17 (1999-06) Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on DC input power port immunity test. Am. 1 (2001-07) Consolidated edition (2002-07) Ed. 1.1	This standard defines test methods for immunity to ripple at the DC input power port of electrical or electronic equipment. This standard is applicable to low-voltage DC power ports of equipment supplied by external rectifier systems, or batteries which are being charged. The object of this standard is to establish a common and reproducible basis for testing, in a laboratory, electrical and electronic equipment when subjected to ripple voltages such as those generated by rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. This standard defines: – test voltage waveform; – range of test levels; – test generator; – test set-up; and – test procedure. This test does not apply to equipment connected to battery charger systems incorporating switch mode converters.

[36]	IEC 61000-4-29 (2000-08) Electromagnetic compatibility (EMC) – Part 4-29: Testing and measuring techniques- Voltage dips, short interruptions and voltage variations on DC input power port immunity tests.	This standard defines test methods for immunity to voltage dips, short interruptions and voltage variations at the DC input power ports of electrical or electronic equipment. This standard is applicable to low voltage DC power ports of equipment supplied by external DC networks. The object of this standard is to establish a common and reproducible basis for testing electrical and electronic equipment when subjected to voltage dips, short interruptions or voltage variations on DC input power ports. This standard defines: – the range of test levels; – the test generator; – the test set-up; and – the test procedure.
[37]	IEC 61000-6-1 (1997-07) Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 1: Immunity for residential, commercial and light-industrial environments	Defines the immunity test requirements in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges, for electrical and electronic apparatus intended for use in residential, commercial and light-industrial environment, and for which no dedicated product or product-family standard exists. Immunity requirements in the frequency range 0 kHz to 400 GHz are covered and are specified for each port considered. This standard applies to apparatus intended to be directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the apparatus and the low-voltage public mains network.
[38]	IEC 61000-6-2 (1999-01) Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments	Applies to electrical and electronic apparatus intended for use in industrial environments, for which no dedicated product or product-family immunity standard exists. Immunity requirements in the frequency range 0 Hz to 400 GHz are covered, in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges. Test requirements are specified for each port considered. Apparatus intended to be used in industrial locations are characterized by the existence of one or more of the following: – a power network exists powered by a high or medium voltage power transformer dedicated for the supply of an installation feeding a manufacturing or similar plant; – industrial, scientific and medical (ISM) apparatus; – heavy inductive or capacitive loads are frequently switched; and – currents and associated magnetic fields are high.
[39]	IEC 61326 (2002-02) Electrical equipment for measurement, control and laboratory use - EMC requirements Corr.1 (2002-07)	Specifies minimum requirements for immunity and emissions regarding electromagnetic compatibility (EMC) for electrical equipment, operating from a supply of less than 1000 V AC or 15000 V DC, intended for professional, industrial process and educational use, including equipment and computing devices for: – measurement and test; – control; – laboratory use; and – accessories intended for use with the above (such as sampling handling equipment), intended to be used in industrial and non-industrial locations. Where a relevant dedicated EMC standard exists, it shall have precedence over all aspects of this product-family standard.

[40]	ISO 16750-2:2003 Road vehicles - Environmental conditions and testing for electrical and electronic equipment Part 2: Electrical loads	Specifies electrical loads and corresponding tests and requirements for the mounting of electric and electronic systems and components on road vehicles. It is applicable to environmental conditions and tests affecting electrical and electronic equipment mounted directly on or in the vehicle. It does not cover electromagnetic compatibility (EMC).
[41]	ISO 7637-1 (2002) Road vehicles - Electrical disturbance from conducting and coupling - Part 1: Definitions and general considerations	Defines basic terms used in the various parts for electrical disturbance by conduction and coupling. Gives also general information relating to the whole International Standard and common to all parts.
[42]	ISO 7637-2 (2004) Road vehicles - electrical disturbance from conducting and coupling – Part 2: Electrical transient conduction along supply lines only	Specifies bench tests for testing the compatibility to conducted electrical transients of equipment installed on passenger cars and light commercial vehicles fitted with a 12 V electrical system or commercial vehicles fitted with a 24 V electrical system. Failure mode severity classification for immunity to transients is also given. It is applicable to these types of road vehicle, independent of the propulsion system (e.g. spark ignition or diesel engine, or electric motor).
[43]	ISO 7637-3 (1995) with correction 1 (1995) Road vehicles - Electrical disturbance by conducting and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	Establishes a common basis for the evaluation of the EMC of electronic instruments, devices and equipment in vehicles against transient transmission by coupling via lines other than supply lines. The test intention is the demonstration of the immunity of the instrument, device or equipment when subjected to coupled fast transient disturbances, such as those caused by switching (switching of inductive loads, relay contact bounce, etc.).

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