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DOCUMENT

OIML D 11:2026

General requirements for measuring instruments – Environmental conditions

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

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 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. OIML Member States shall implement these Recommendations to the greatest possible extent;
- **International Documents (OIML D),** which are informative in nature and which are intended to harmonize and improve work in the field of legal metrology;
- **International Guides (OIML G),** which are also informative in nature and which are intended to give guidelines for the application of certain requirements to legal metrology;
- **International Basic Publications (OIML B),** which define the operating rules of the various OIML structures and systems; and

OIML Draft Recommendations, Documents and Guides are developed by Project Groups linked to Technical Committees or Subcommittees which comprise representatives from OIML Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between the OIML and certain institutions, such as ISO and the IEC, with the objective of avoiding contradictory requirements. Consequently, manufacturers and users of measuring instruments, test laboratories, etc. may simultaneously apply OIML publications and those of other institutions.

International Recommendations, Documents, Guides and Basic Publications are published in English (E) and translated into French (F) and are subject to periodic revision.

Additionally, the OIML publishes or participates in the publication of **Vocabularies (OIML V)** and periodically commissions legal metrology experts to write **Expert Reports (OIML E)**. Expert Reports are intended to provide information and advice, and are written solely from the viewpoint of their author, without the involvement of a Technical Committee or Subcommittee, nor that of the CIML. Thus, they do not necessarily represent the views of the OIML.

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1 Introduction

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

Furthermore, this Document aims to provide guidance to OIML Member States in the implementation of OIML Recommendations in their national laws, in particular in their choice on the applicability and severity of performance requirements, as far as these are not prescribed in the OIML Recommendations, but are 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 OIML Technical Committees, Subcommittees and Project Groups on the prescription of requirements and the selection of the appropriate tests for measuring instruments, while taking into account the operational and environmental factors governing the use of these instruments.

1.3 The range and test level for an influence quantity test should, when possible, be 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. Hence the approach in this Document is to present an overview of validated and internationally accepted test methods. In principle the text of this Document should not be in conflict with these referred standards.

1.4 The OIML Technical Committees, Subcommittees and Project Groups responsible for OIML Recommendations covering specific categories of measuring instruments may

- establish test procedures and special test levels (higher or lower) in such OIML Recommendations, different from those specified in this Document, if that would be more appropriate for specific measuring instruments or environments, and
- utilise the expertise and knowledge of other OIML Technical Committees, Subcommittees and Project Groups or of other organisations to develop special test procedures and conditions not specified in this Document.

2 Scope and field of application

2.1 This Document specifies general metrological requirements applicable to measuring instruments concerning environmental conditions. It also describes tests for verifying the compliance of an instrument with these requirements.

2.2 This Document shall be taken into account by OIML Technical Committees, Subcommittees and Project Groups when establishing performance requirements and tests for a specific category of measuring instruments concerning their sensitivity to influence quantities.

Note 1: This Document does not cover requirements for measuring instruments which are not related to external influence quantities and which are to be covered by the specific OIML Recommendation. For example: requirements for zero-setting devices, totalisers, etc.

Note 2: This Document does not address aspects such as safety or emission of electromagnetic phenomena from measuring instruments. The requirements for these aspects should be taken into account in accordance with the applicable international, regional or national regulations.

Note 3: This Document does not address aspects concerning transportation of measuring instruments while not in operation. Requirements concerning transportation-related durability, handling and maintenance aspects are beyond the scope of this Document.

Note 4: This Document does not address aspects of influences by remote protocols such as software routines. For those aspects, OIML Document D 31 [1] is applicable.

3 Terminology

Unless otherwise stated in the following sub-clauses, the terminology used in this Document conforms to OIML V 1 *International Vocabulary of Terms in Legal Metrology* (VIML) [2], and OIML V 2-200 *International Vocabulary of Metrology – Basic and General Concepts and Associated Terms* (VIM) [3].

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

3.1
measuring instrument

device used for making measurements, alone or in conjunction with one or more supplementary devices

Note 1: A measuring instrument that can be used alone is a measuring system.

Note 2: A measuring instrument may be an indicating measuring instrument or a material measure.

[VIML 0.10] [VIM 3.1]

3.1.1
electronic measuring instrument

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.

3.1.2
measuring system

set of one or more measuring instruments and often other devices, including any reagent and supply, assembled and adapted to give information used to generate measured quantity values within specified intervals for quantities of specified kinds

Note: A measuring system may consist of only one measuring instrument.

[VIM 3.2]

3.1.3
integrating measuring instrument

measuring device that provides a cumulative value of measured quantity, either continuously or over a specific interval of time

3.1.4
non-integrating measuring instrument

measuring device that provides a value for a measured quantity at the time when the measurement occurred

3.2
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 as specified in the relevant OIML Recommendation

[VIML 4.04]

3.3
device

identifiable instrument or part of an instrument or of a family of instruments that performs a specific function or functions

Note: A device may be a stand-alone and complete measuring instrument (for example: counter scale, electricity meter) or a part of a measuring instrument (for example: printer, indicator).

3.4
(measurement) error

measured quantity value minus a reference quantity value

[VIM 2.16]

3.5
indication

quantity value provided by a measuring instrument or a measuring system

[VIM 4.1][VIML 0.03]

3.6
error of indication

indication minus a reference quantity value

[VIML 0.04]

3.7
maximum permissible error (of a measuring instrument)

extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system

[VIM 4.26]

3.8
intrinsic error

error of indication determined under reference conditions

[VIML 0.06]

3.9
initial intrinsic error

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

3.10
fault

difference between the error of indication and the intrinsic error of a measuring instrument

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

Note 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.

[VIML 5.12]

3.11
fault limit

value specified in the applicable OIML Recommendation delimiting non-significant faults

[VIML 5.13]

3.12
significant fault

fault exceeding the applicable fault limit value

Note: For particular types of measuring instruments some faults exceeding the fault limit may not be considered a significant fault. The applicable OIML Recommendation shall state when such an exception applies. For example, the occurrence of one or some of the following faults may be acceptable:

a) faults arising from simultaneous and mutually independent causes 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, memorised 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 applicable OIML Recommendation may specify the nature of these variations.

[VIML 5.14]

3.13
durability error

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

[VIML 5.16]

3.14
significant durability error

durability error exceeding the value specified in the applicable OIML Recommendation

Note: Some durability errors exceeding the value specified may still be considered not significant. The applicable OIML Recommendation shall state when such exception applies. For example, the occurrence of one or some of the following errors may be acceptable:

a) the indication cannot be interpreted, memorised 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.

[VIML 5.17]

3.15
influence quantity

quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result

[VIM 2.52][VIML 0.07]

Note: An influence quantity is not related to the measurand but is a quantity that affects the result of the measurement as indicated by the equipment under test (EUT).

Example: The temperature of a measuring instrument is an influence quantity, but the temperature of the measured object (used as a reference for determining the fault or the error) is not. This influence of the environment on this measured object may need to be taken into consideration as a contributor in the definition of the measurand.

3.15.1
influence factor

influence quantity having a value which ranges within the rated operating conditions of a measuring instrument

Note 1: The rated operating conditions shall be in conformity with the applicable requirements specified in the applicable OIML Recommendation.

Note 2: The variation of an indication as a consequence of an influence factor is considered an error and not a fault.

[VIML 5.18]

3.15.2
disturbance

influence quantity having a value within the limits specified in the applicable OIML Recommendation but outside the specified rated operating conditions of the measuring instrument

[VIML 5.19]

Note 1: These limits to be specified in the applicable OIML Recommendation shall be based on the probability of occurrence of the disturbing phenomenon within the environment of the measuring instrument.

Note 2: A disturbance typically is of stochastic nature.

Note 3: In case the listed rated operating conditions of a measuring instrument do not include a range for the specific influence quantity, the influence quantity is qualified as being a disturbance.

3.16
rated operating condition

operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed

Note: Rated operating conditions generally specify intervals of values for a quantity being measured and for any influence quantity.

[VIM 4.9][VIML 0.08]

3.17
reference operating condition

operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results

Note: Reference operating conditions specify intervals of values of the measurand and of the influence quantities.

[VIM 4.11][VIML 0.09]

3.18
durability

ability of the measuring instrument to maintain its performance characteristics over a period of use[1]

[VIML 5.15]

3.19
checking facility

facility incorporated in a measuring instrument which enables significant faults to be detected and acted upon

[VIML 5.07]

Note 1: Typically, checking facilities detect and act upon

- incorrect functioning of a specific device of the measuring instrument, and/or
- disturbed communication between specific devices of the measuring instrument.

Note 2: "Act upon" refers to any adequate response by the measuring instrument (for example: a luminous signal, an acoustic signal, interruption or blocking of the measurement process, etc.).

3.19.1
automatic checking facility

checking facility that operates without the intervention of an operator

3.19.1.1
permanent automatic checking facility (type P)

automatic checking facility that operates at each measurement cycle

3.19.1.2
intermittent automatic checking facility (type I)

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

3.19.2
non-automatic checking facility (type N)

checking facility that requires the intervention of an operator

[1] Exclusively in phrases where applied as a noun

3.20
durability protection facility

facility incorporated in a measuring instrument that enables significant durability errors to be detected and acted upon

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

3.21
test

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

3.21.1
test procedure

detailed description of the test operations

3.21.2
test program

description of a series of tests for certain types of equipment

[VIML 5.20]

3.21.3
test level

required (simulated) influence quantity value for performing the test

3.21.4
performance test

test intended to verify whether the EUT is able to accomplish its intended functions

[VIML 5.21]

3.21.5
durability test

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

[VIML 5.22]

3.22
mains power
mains

primary external source of electrical power for an instrument, including all sub-assemblies

Examples: Public or local power grid (AC or DC) or external generator.

3.23
power converter

part of an instrument that converts the voltage from the mains power to a voltage suitable for use by other parts of the instrument

3.24
stand-alone battery

non-rechargeable battery or rechargeable battery which shall be (re)charged only when not connected to the EUT

3.25
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 supplying power to the complete instrument for a reasonable period of time

3.26
back-up battery

battery that is intended to maintain power supply for specific functions of an instrument in the absence of the primary power supply

Example: To preserve stored data.

3.27
specimen

instrument, device or module subjected to testing, examination or study and representing a population

3.28
measurement uncertainty
uncertainty of measurement
uncertainty

non-negative parameter characterising the dispersion of the quantity values being attributed to a measurand, based on the information used

Note: See VIM 2.26 for notes on this definition.

[VIM 2.26]

3.29
environmental conditions

influences or disturbances that may occur in the operational surroundings of a measuring instrument and may have an effect on its performance

3.30
cranking

starting an internal combustion engine by turning the crankshaft manually or by means of an electric starter motor

3.31
test generator

device used to simulate specific signals or disturbances for testing the immunity of electrical and electronic equipment to various electromagnetic phenomena

3.32
burst generator

device used to simulate electrical fast transients (EFT) or bursts of fast pulses

3.33 Abbreviations

AC	alternating current
AM	amplitude modulation
ASD	acceleration spectral density
DC	direct current
EFT	electrical fast transient
EM	electromagnetic
EMC	electromagnetic compatibility
e.m.f.	electromotive force
ESD	electrostatic discharge
EUT	equipment under test (specimen being exposed to the test)
GSM	global system for mobile communication
IEC	International Electrotechnical Committee
I/O	input / output (refers to ports)
ISO	International Organization for Standardization
LF	low frequency band (30 kHz – 300 kHz)
MPE	maximum permissible error
n/a	not applicable
NSF	no significant fault shall occur neither during nor after the disturbance
NSFa	no significant fault shall occur after the disturbance
NSFd	no significant fault shall occur during the disturbance
PMR	personal mobile radio
PLC	power line communication
RF	radio frequency
RH	relative humidity
RMS	root mean square
SC	subcommittee
TC	technical committee
VHF	very high frequency band (30 MHz – 300 MHz)
VLF	very low frequency band (3 kHz – 30 kHz)
UHF	ultra-high frequency band (300 MHz – 3 GHz)
UPS	uninterruptible power supply
WHO	World Health Organization

4 Instructions for use of this Document in drafting OIML Recommendations

The general structure of OIML Recommendations is defined in OIML Basic publication B 6-2 [4], Clause 3, which is followed by a description in somewhat more detail. The following clauses concern the elaboration into more detail and instructions on the incorporation of these required elements in an OIML Recommendation.

4.1 Where OIML D 11 clauses, tables, procedures, or requirements are included or referenced in an OIML Recommendation, the OIML Recommendation shall clearly identify the parts of any of the referenced clauses, tables, procedures or requirements that are specifically applicable to that OIML Recommendation.

4.2 The applicable OIML Recommendation shall specify, for each category or subcategory of measuring instruments:

a) expected influence factors, with rated operating and reference conditions;

b) expected disturbances and associated expected maximum intensity (limit of disturbance);

c) maximum permissible errors on type evaluation, on initial verification, in service, and on subsequent verification, as well as fault limit level, and significant durability error level (wherever applicable).

Note 1: The applicable OIML Recommendation may indicate that individual subcategories of measuring instruments may have different rated operating conditions, reference conditions and limits of disturbances.

Note 2: 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).

Note 3: The reference conditions shall preferably be specified in accordance with IEC 60068-1 [5].

4.3 The applicable OIML 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 3.12.

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.).

4.4 The applicable OIML Recommendation may specify requirements concerning the occurrence of durability errors defined in 3.13 (see note to 4.3).

4.5 Some ranges of measuring instruments may be immune to some specific influence quantities due to their design principle. For a particular type of instrument, therefore, it shall only be required to perform the tests for which the instrument is likely to be influenced by the influence quantity during its operation.

4.6 Clause 8 of this Document contains guidelines for determining the test levels to be applied in the evaluation of compliance with the requirements specified in the applicable OIML Recommendation.

4.7 All referenced standards and 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 these standards and documents.

5 Requirements for measuring instruments with respect to their environment

Measuring instruments shall comply with the following requirements, notwithstanding all other technical and metrological requirements of the applicable OIML Recommendation, 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 (fault limit) in the applicable OIML Recommendation as defined in 3.11 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 durably met. 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 applicable OIML Recommendation specifies otherwise in view of the intended use of the measuring instrument or the nature of measurement (see note to 4.3).

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 applicable OIML Recommendation specifies otherwise.

5.3 Measuring instruments equipped with checking facilities

5.3.1 For each function of a measuring instrument the applicable OIML Recommendation may specify

a) the type of checking facility (P, I or N), as defined in 3.19,

b) the checking frequency, if appropriate,

c) the method of acting upon a significant fault.

5.3.2 The applicable OIML 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 Measuring instruments equipped with durability protection facilities

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

5.4.3 The applicable OIML Recommendation may specify that 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 Specification of batteries

Type(s) and capacity(ies) of the batteries allowed to be used in the applicable measuring instruments shall be specified by the manufacturer. Instruments not equipped with allowed batteries are not considered to be of the same type.

5.5.2 Stand-alone batteries

Instruments powered by stand-alone batteries shall comply with the following requirements:

a) instruments provided with new and fully charged batteries shall comply with the metrological requirements;

b) the manufacturer of the measuring instrument shall specify the minimum battery voltage V_{min} at which the instrument complies with the metrological requirements;

c) the instrument shall detect and react appropriately when the voltage is below V_{min}. The relevant OIML Technical Committee, Subcommittee or Project Groups shall establish appropriate action for operation below V_{min};

d) the battery capacity and lifetime shall be in accordance with the application. The applicable OIML Recommendation may prescribe a required minimum lifetime.

For such instruments, tests associated with the mains power variations and interferences need not be performed.

The applicable OIML Recommendation shall specify a minimum set of provisions to prevent the loss of stored data.

5.5.3 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 5.5.2 with the mains power switched off, and

b) comply with the requirements for mains powered instruments with the mains power switched on.

5.5.4 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 mains powered instruments.

In the applicable OIML Recommendation a minimum period of time shall be stated during which the applicable function of the instrument shall function properly without replacing or recharging the batteries.

The provisions of 5.5.2 b) and 5.5.3 do not apply for back-up batteries.

6 Type evaluation

6.1 Application for type evaluation

6.1.1 The applicable OIML Recommendation shall specify the minimum set of documentation to be submitted together with the application for type evaluation.

Note: A non-exhaustive list of documentation that may be required is included in Annex A (informative).

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

6.2 General requirements

6.2.1 The applicable OIML Recommendation shall include the following examinations and tests to verify compliance with the general requirements for measuring instruments:

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;

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

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.

6.2.2 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 applicable OIML Recommendation specifies otherwise. The test program shall be specified in the applicable OIML Recommendation, according to the operating conditions of the category of measuring instruments.

6.3 Instrument performance tests

During performance 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 applicable OIML Recommendation specifies otherwise, and 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.

6.4 Instrument durability tests

6.4.1 If a durability test has to be performed, the performance tests shall be carried out before the durability test. The OIML Recommendation shall specify which performance test(s) shall be repeated after the durability test.

6.4.2 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 applicable OIML Recommendation may specify details concerning the test program, including

a) which tests shall be performed,

b) the order in which the tests are to be performed (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.

Note: Annex B provides a general approach to the durability concept.

6.6.2 The applicable OIML Recommendation shall specify

a) necessary details concerning the tests, including those already stated in clauses 9 – 14,

b) required severity and associated test levels in accordance with the classification set out in clause 8, where applicable, and

c) allowed 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),

d) tests such that only one influence quantity may be varied during a test, while all others shall be kept at their reference values.

6.7 Number of specimens to be submitted to tests

The test shall be performed on the number of specimens as specified in the applicable OIML Recommendation.

6.8 Test arrangement (Equipment under test (EUT))

As a rule, tests shall be carried out on the complete measuring instrument. If the size or configuration of the measuring instrument does not allow for testing the complete EUT or if only a separate device or module of the measuring instrument is concerned, the applicable OIML Recommendation may indicate that the tests, or certain tests, are performed on the devices separately while making use of an instrument simulating setup, sufficiently representing its normal operation.

In such cases the device(s) shall be in operation.

Note: It is not intended to dismantle measuring instruments or devices for the purpose of testing.

7 Initial verification

Detailing requirements for initial verification or conformity to type evaluation is outside the scope of this Document. In applicable OIML Recommendations the applicable requirements for initial verification shall be specified. These may comprise a subset of the requirements and tests provided in this Document.

8 Determination of test levels

8.1 Introduction

8.1.1 This clause is intended as a guideline for OIML Technical Committees, Subcommittees and Project Groups to determine the test levels to verify the sustainable compliance of measuring instruments with their metrological requirements in their applicable operating and storage environment.

This determination is not intended as a classification with strict boundaries necessitating special requirements, such as in the case of an accuracy classification.

Moreover, this guideline does not interfere with the liberty of the Technical Committees, Subcommittees and Project Groups to provide for test levels that differ from those resulting from the other guidelines set out in this Document. Different test levels may be used in accordance with special limitations prescribed in the applicable OIML Recommendation.

8.1.2 The most common parameters determining the environment of measuring instruments can be subdivided into three main groups, which are generally considered mutually independent:

a) those establishing the climatic environment;

b) those establishing the mechanical environment; and

c) those establishing the electric, magnetic and electromagnetic environment.

All measuring instruments will encounter variations in the environment as a consequence of normal changes in magnitude of one or more of the parameters mentioned.

Since, in general, the parameters that determine the environment are mutually independent, an overall single classification based on increasing severity is not possible.

For each of these three main groups, therefore, a separate classification is made. These classifications subsequently serve to choose the adequate test level.

Note: The applicable OIML Recommendation may require that the classification is indicated on the instrument.

8.1.3 When selecting the level of immunity for environmental phenomena and the associated test levels for a particular category of instruments, the following aspects are to be taken into account:

a) the (typical) climatic, mechanical and electromagnetic environment;

b) the consequence and the social and societal impact of an inaccurate measurement;

c) the value of goods to be measured;

d) the potential risk of fraud;

e) the practical possibilities for industry to comply with the prescribed level; and

f) the possibility to repeat a measurement.

8.2 Ambient classification and associated required severity of the climatic tests

Several environmental classes covering most of the different climatic ambient conditions at the locations where measuring instruments are used have been defined as described below. This classification and the associated preferred test levels are presented in Table 1.

Extreme conditions are not included since the probability of occurrence of such conditions is considered low. An incidental occurrence of such an extreme situation shall be interpreted as a disturbance.

Note: IEC 60721-3-3 [6] and IEC 60721-3-4 [7] provide additional information on climatic classification.

8.2.1 Temperature

The ambient temperature of a measuring instrument in use may vary considerably. This is highly dependent not only on the place on earth, ranging from arctic to tropical regions, but also considerably on indoor or outdoor use. Instruments typically used indoors in one country may typically be used outdoors in another country (for instance: residential gas and electricity meters). Therefore, no classification based on temperature ranges has been described in this Document.

In general, the choice of the lower and the upper temperature limits should preferably be left to national (or regional) legislation. When applying tests in order to verify the compliance with the required temperature range, the test levels should be in conformity with those specified in Table 6 and Table 7.

8.2.2 Humidity and water

Table 1 presents the classification of the ambient related to the exposure to humidity and water and indicates the applicable test method and test level index.

Table 1 - Classification based on expected ambient humidity and water exposure

Class	Test level index			Description
	Damp Heat		Water (Table 10)	
	Steady state (Table 8)	Cyclic (Table 9)		
H1	-	-	-	This class applies to instruments or parts of instruments typically used in temperature-controlled enclosed (weather protected) locations. The local humidity is not controlled. Where necessary, heating, cooling or humidification is used to maintain the required environmental conditions. Measuring instruments are not exposed to condensed water, precipitation, or ice formations. These conditions may apply in living rooms, continuously staffed offices, certain workshops, and other rooms for special applications.
H2	1	1	-	This class applies to instruments or parts of instruments typically used in enclosed (weather protected) locations where the local climate is not controlled. Measuring instruments present may be subject to condensed water, water from sources other than rain and ice formations. These conditions may apply in some publicly accessible areas in buildings, garages, cellars, certain workshops, factories, industrial plants, ordinary storage rooms for frost-resistant products, farm buildings, vehicle cabins, etc.
H3	1	2	2	This class applies to instruments or parts of instruments used in open air locations excluding those in extreme climate zones such as polar and desert environments.

Note: A comparison between steady-state and cyclic tests is presented in IEC 60068-3-4 [8].

The test “Water” is mainly applicable to instruments or parts of instruments typically used in the open air and which, in their normal use, could be directly exposed to spraying water (rain, etc.). Examples are platforms of weighbridges or automatic radar speed measuring instruments.

It is, therefore, advised only to require this class of water protection and implement the performance test 0 in Recommendations that are applicable to measuring instruments which typically will be used in an environment where this kind of exposure to water can be expected (see 4.5).

8.2.3 Atmospheric pressure (Test 10.4)

Considering the ranges and variations in global terrestrial atmospheric pressure, only a few categories of measuring instruments due to their physical principles are likely to be influenced by these changes. This influence could either be on the zero-indication of the instrument (offset), on the span (curve) or on both.

It is, therefore, advised only to require the evaluation of performance on atmospheric pressure variation in Recommendations that are applicable to measuring instruments which typically, due to their physical measuring principle, are expected to be sensitive to variations in atmospheric pressure (see 4.5).

8.2.4 Sand and dust (Test 10.5)

The referred test is mainly applicable to instruments or parts of instruments typically used in dusty warehouses and in the building industry (for instance production of concrete) or, in some climatic regions, in the open air.

It is, therefore, advised only to require a measure of protection to withstand this influence and, consequently, implement the performance test 10.5 in Recommendations that are applicable to measuring instruments that can be expected to be typically used in sandy/dusty conditions (see 4.5).

8.2.5 Salt mist (Test 10.6)

The referred test is mainly applicable to instruments or parts of instruments that are typically used in a salty environment. Examples are measuring instruments on board of sea-going vessels or in the cheese industry.

It is, therefore, advised only to require a measure of protection to withstand this influence and, consequently, implement the performance test 10.6 in Recommendations that are applicable to measuring instruments that can be expected to be typically used in a humid and salt environment (see 4.5).

8.3 Ambient classification and associated required severity of mechanical tests

Table 2 presents the ambient classification of measuring instruments concerning exposure to vibration and shocks at their location of operation and indicates the applicable test method and test level index.

Table 2 - Classification based on expected mechanical environment

Class	Test level index			Description
	Vibration (Table 15 and Table 16)	Shock		
		Stationary EUT (Table 17)	Handheld EUT (Table 18)	
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. where measuring instruments are directly mounted on machines, conveyor belts, etc.
M4	-	-	1, 2, 3 or 4	This class applies to handheld devices

In 11.1, two vibration tests (random and sinusoidal) are described. In general, it should be avoided to prescribe both tests in one OIML Recommendation.

Since vibration of a random nature is real life practice, it is expected that a performance test on the sensitivity of measuring instruments to random vibration covers the requirement for withstanding influences from environmental vibrations and should be the most commonly prescribed performance test in OIML Recommendations. The sinusoidal test shall be prescribed and applied only in those cases were the measuring instrument is expected to be typically subjected to sinusoidal vibrations. Therefore, the implementation of the random vibration test is preferable for OIML Recommendations.

For the selection of the appropriate test (random or sinusoidal), refer to IEC 60068-3-8 [9], in particular to (sub-)clauses 4.2, 7, 8.3, and 8.4 of that standard.

It is strongly recommended not to try to convert sine vibration to random vibration or vice versa. There is no simple physical relationship between the two. The impact on the specimen will therefore be different.

Note: Requirements concerning the transportation of a measuring instrument are outside the scope of this Document.

8.4 Classification of EM environment and the associated required severity of electromagnetic tests

8.4.1 General

For the purpose of selecting the most adequate requirements and associated performance tests, a classification is made based on the expected electromagnetic environmental conditions of the measuring instrument and on its application (see 8.1.3).

These conditions depend on the specific environment in which the instrument is expected to be installed (residential, general public, commercial, industrial, etc.), the concept of the measurement system and the use of the measurement system.

A distinction in electromagnetic environment can be made on basis of differences in

- either the kind of potential electromagnetic influence quantity in the environment and its intensity,
- or the available potential entering paths of the influence quantity, which in turn are defined by the concept of measuring instrument or system.

Furthermore, one can distinguish between concepts with a more closed (isolated) structure and those with a more open electromagnetic architecture. In the latter case, the cabling layout of the instrument or system can considerably influence the sensitivity to influence quantities.

For feasibility reasons and while for most instruments the above distinction is not trivial, only three (electromagnetic) classes and the associated requirements and test methods are presented for a limited number of potential sources of influence (which are considered to be the main potential electromagnetic influence quantities).

The following groups of influence quantities are to be considered:

a) those caused by conducted EM phenomena (transmitted through power or data lines); and

b) those caused by radiation of EM phenomena (wireless transmission).

Note 1: All of these influences can originate from various kinds of sources, for example remote instrumentation, action on the part of personnel or atmospheric disturbances.

Note 2: IEC TR 61000-2-5 [10] provides additional information on the classification concerning electromagnetic environment.

Table 3 presents the classification of the ambient of measuring instruments concerning their electromagnetic environment at their location of operation.

Table 3 - Classification based on expected electromagnetic environment

Class	Description
E1	This class applies to measuring instruments used in locations where electromagnetic disturbances correspond to those likely to be found in a residential, commercial and light industrial environment.
E2	This class applies to instruments used in locations where electromagnetic disturbances correspond to those likely to be found in industrial buildings.
E3	This class applies to measuring instruments powered by the battery of a vehicle and exposed to electromagnetic disturbances which correspond to those likely to be found in any environment not considered hazardous for the general public.

Table 4 presents the references to the test method and test level to be applied, taking into account the classification of the electromagnetic environment.

Table 4 - Test method selection based on classification of electromagnetic environment

Test level index for class			Table	Description
E1	E2	E3		
1	1	n/a	Table 19	DC mains voltage variation
3 or 4[(1)]	1 or 2[(1)]	n/a	Table 20	Ripple on DC mains power
1	1	n/a	Table 21	AC mains voltage variation
1	1	n/a	Table 22	AC mains frequency variation
n/a	1	n/a	Table 23	DC mains voltage dips, short interruptions and (short term) voltage variations
1	2	n/a	Table 24	AC mains voltage dips, short interruptions and reductions
2 or 3[(2)]	3	n/a	Table 25	AC mains harmonics
2	2	n/a	Table 26	VLF and LF disturbances on AC and DC mains
2	3	n/a	Table 27	Bursts (transients) on AC
2	3 or 4[(3)]	n/a	Table 27	Bursts (transients) on DC mains
3	3	n/a	Table 28	Surges on AC mains power lines
3	3 or 4[(4)]	n/a	Table 28	Surges on DC mains power lines
2	3	n/a	Table 29	Bursts (transients) on signal, data and control lines
3	3	n/a	Table 30	Surges on signal, data and control lines
4	5	n/a	Table 31	AC mains power frequency electromagnetic field
2	3	3	Table 32, Table 33	Conducted (common mode) currents generated by RF EM fields on AC mains
2	3	n/a	Table 32, Table 34	Conducted (common mode) currents generated by RF EM fields on DC mains
3	3	3	Table 35, Table 36	RF EM fields (general origin)
3 or 4[(5)]	3 or 4[(5)]	3 or 4[(5)]	Table 35, Table 37	RF EM fields (digital radio telephones and portable radio transceivers)
1	2	2	Table 38	Radiated fields in close proximity
3	3	3	Table 39	Electrostatic discharges
n/a	n/a	C or F	Table 41	Voltage variations of a road vehicle battery
n/a	n/a	IV	Table 42	Electrical transient conduction along supply lines of external 12 V and 24 V batteries
n/a	n/a	IV	Table 43	Electrical transient conduction via lines other than supply lines for external 12 V and 24 V batteries
n/a	n/a	I+III	Table 44	Battery voltage variations during cranking
n/a	n/a	A or B	Table 45	Load dump test

(1) See 8.4.2.1

(2) See 8.4.2.5

(3) For burst test, severity level 4 is specified for severe industrial environment like an outdoor area of industrial process equipment.

(4) For surge test, severity level 4 is specified for instruments installed in outdoor areas (class 4) and/or non-densely populated areas (class 5); see annex B of IEC 61000-4-5 [11] for additional guidance.

(5) See 8.4.2.10

The conditions have been adapted from the basic Publication IEC TR 61000-2-5 [10].

8.4.2 Guidance for test level choice

Some extra guidance for choosing the measure of immunity and the associated test level for some specific tests concerning electromagnetic environment is presented in 8.4.2.1 – 8.5.2.

This information is provided as guidance only, giving some background on the choice of tests and the suggested test levels.

8.4.2.1 Ripple on DC mains power (Table 20)

The usual ripple level is 2 % (level 1 in IEC 61000-4-17 [12]) in a well-designed DC-source; however, poorly designed DC sources could have up to 15 % of ripple, therefore for environment class E1, consider 10 % (level 3) of ripple; in countries with high probability of use of poorly designed DC sources consider increasing to 15 % of ripple (level 4). For environment class E2, consider 5 % of ripple. See 8.6 for further explanations.

8.4.2.2 AC mains frequency variation (Table 22)

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

Therefore, it is advised to only prescribe this test in OIML Recommendations in 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 if an internal time-base of the instrument is derived from the mains power frequency (see also 4.5).

8.4.2.3 Voltage dips, short interruptions and (short term) voltage variations on DC mains (Table 23)

Because standard IEC 61000-4-29 [13] does not specify severity levels, no requirements for class E1 and E3 have been suggested. In general, this test only applies to DC mains power networks, which are almost exclusively applied in industrial environments: however, OIML Technical Committees, Subcommittees, or Project Groups need to consider specifying alternative test levels for DC dips and short interruptions, particularly when the manufacturers do not provide a dedicated DC power supply. See 8.6 for further explanations.

8.4.2.4 AC mains voltage dips, short interruptions and voltage variations (Table 24)

Voltage dips in AC mains power supply networks commonly occur. Moreover, interruptions for half a cycle or less are characteristic. A measuring instrument shall withstand and be sufficiently immune to such dips and interruptions in order to comply with the provisions of 5.1.1.

To evaluate compliance with the provisions of 5.1.1, the presented level 2 is considered the minimum test level required.

The occurrence of voltage dips and short supply interruptions, in general, cannot be predicted. Especially in industrial environments these may occur and be persistent.

It is reasonable to require instruments that are intended to be used in an industrial environment to withstand such dips and interruptions and, consequently, require them to be submitted to performance tests up to level 3 in order to avoid the risk of frequent interruption of instrument performance.

When test level 2 applies, three tests shall be performed and when test level 3 applies, five tests shall be performed; all 3 or 5 tests presented in the applicable test level column shall be implemented in the applicable OIML Recommendation since the response or failing of the EUT on one of the tests cannot be predicted from the responses on the other tests.

8.4.2.5 AC mains frequency harmonics (Table 25)

Because of the increased use of small transformers and semiconductor switching devices in power converters, lighting systems, AC/DC converters, UPS systems and rectifiers, the distortions in public power supply networks have increased. Power supply companies are obliged for several reasons to keep the level of disturbance below certain limits.

For harmonisation reasons, for each harmonic an environment dependent compatibility level has been established.

Immunity test levels require a certain margin. In IEC 61000-4-13 [14] a factor 1.5 is used to create this margin.

Immunity requirements and associated tests shall be implemented in OIML Recommendations for measuring instruments which are designed to be connected to an AC mains network.

In the IEC standard, a further subdivision is made in the class E1 environment. Only in a purely residential environment is the test level index 2 considered applicable. For industrial and commercial environments the test level index 3 applies.

Typical environments where relatively high levels of electromagnetic mains power harmonics can be expected are

- heavy industry (for example: chloride production plants), and
- high capacity rectifier stations.

8.4.2.6 VLF and LF disturbances on mains power lines (Table 26)

Because of the increased use of power line communication (PLC) and switching semiconductors in power supply systems, VLF and LF differential mode disturbances tend to interfere with the mains power supply sine wave. Moreover, PLC and semiconductor switching devices tend to interfere with each other.

Especially in cases where the waveform of the mains power line might directly influence the measuring instruments (for instance electrical energy meters) these tests should be applied.

8.4.2.7 Bursts (transients) (Table 27 and Table 29)

The selection of the applicable immunity and the associated test level shall be based on the expected use of the measuring instrument and presented in the applicable OIML Recommendation.

Test level 1 applies to instruments operating in environments that are well protected against electromagnetic interferences (e.g. computer rooms); test level 2 applies to instruments operating in areas with a normal level of protection (class E1); and test level 3 applies to instruments operating in areas without special protection measures (e.g. industrial plants, class E2).

8.4.2.8 Surges (Table 28 and Table 30)

The requirement on immunity to surges is applicable to all situations where the measuring instrument will be connected to the (AC or DC) mains power lines. In general, the requirement also applies where data cabling is connected. The length of all connected network cabling shall be taken into account in the decision on whether there is a need for testing. Only in situations where the interconnecting cabling between devices will never exceed 10 m, testing is not applicable. Where applicable, the requirement and associated tests shall be implemented in OIML Recommendations.

8.4.2.9 Mains power frequency electromagnetic fields (Table 31)

This test shall only be prescribed in OIML Recommendations if a significant influence from external power frequency magnetic fields on the measurement results may be expected, as a consequence of the physical principle of the measuring instruments concerned. This includes instrumentation equipped with touch switches (also refer to 4.5).

This test does not cover the frequency spectrum of harmonics of the power frequency, whose fields are normally more common and intense.

Note 1: The WHO advises a protection level for whole body human exposure (general public) of 80 A/m (50Hz) and of 400 A/m for occupational exposure (workers).

Note 2: Small sources such as many types of the adapters used to power or load battery powered equipment tend to create electromagnetic fields exceeding the 80 A/m level, but these fields tend to diminish very rapidly with distance and only a few centimetres from the source could be reduced to 1 % of the original level.

Note 3: Typical environments where a relatively high-level electromagnetic field strength emanating from the mains power can be expected are

- high and medium voltage mains power lines,
- heavy industry,
- static power converters (transformers), and
- induction cooking.

8.4.2.10 Radiated RF electromagnetic fields and resulting induced RF currents

(Table 32, Table 33, Table 34, Table 35, Table 36, Table 37 and Table 38**)**

The rationale for the advised test levels as presented in Table 33 – Table 38 is as follows:

The frequency range presented in Table 36 is in use for many services. It also covers the VHF and part of the UHF broadcast transmitter bands. The maximum level of field strength which can be expected close to these transmitters may exceed 10 V/m in the general public area, but may be expected not to exceed the maximum exposure levels for human beings (general public) as advised by the WHO and implemented in the national legislation of many countries. Up to 400 MHz this maximum level is 27.5 V/m, increasing linearly with frequency from 400 MHz to about 45 V/m at 1 GHz.

While such high field strengths may be expected in the neighbourhood of fences around transmitter sites, this is not a sufficient argument to select a test level exceeding 10 V/m. The following should also be taken into account:

- in general, the occurrence of a RF electromagnetic disturbance is only incidental; and
- the risk of actual exposure to the unintentional disturbance is greatly diminished as a consequence of the following:
  - the field strength close to a transmitter reduces approximately proportionally to the square of the distance to the transmitter;
  - the optimum coupling (influence) only occurs when polarisation of the source (transmitter) and the sensitive part or element of the exposed object (acting as a receiver) are in parallel and the transmission direction of the transmitter (perpendicular to the polarisation) is in line with that of the receiver.

Unforeseen incidental exposure to the above field strength levels probably therefore only occurs if a mobile measuring instrument in operation passes by such a powerful broadcast transmitter.

The frequency ranges in Table 37 typically apply for PMR transceivers and digital mobile phones.

To get an idea of the applicable field strengths, one should be aware that

- a PMR transceiver may produce 10 V/m at 30 cm distance and may reach 30 V/m at 10 cm distance from the transceiver,
- a 2 W GSM phone typically produces a field strength of 10 V/m (modulated wave) at a distance of 1 m from the transmitter. For an 8 W GSM this distance will be 2 m, and
- a 200 W GSM base station typically produces a field strength of 10 V/m (modulated wave) at a distance of 10 m.

For more details, consult Table G 1 in IEC 61000-4-3, Annex G [15].

The maximum level of field strength which can be expected close to such radiating sources in areas accessible to the general public may exceed the level of 10 V/m, but may be expected not to exceed the maximum exposure levels for human beings (general public) as advised by the WHO. This maximum level of 27.5 V/m up to 400 MHz increases linearly with frequency from 400 MHz to 61 V/m at 2 GHz and is limited to 61 V/m level in the frequency range above 2 GHz.

Therefore, the tests to be applied and specified in the applicable OIML Recommendation cannot be related to only one specific environment. So, in order to verify compliance with the electromagnetic environment of use, the tests shall extend to a frequency range and an intensity level that only depend on

- the possibility of a mobile phone being used in close proximity of the instrument, or
- the location of a base station relative to the instrument,
- the risk of fraud by using a mobile phone as a source of disturbance, and
- the consequences of an error or disturbance.

Currently, various communication standards are established in different frequency bands up to a frequency of 7 GHz. The radio transmission sources are not only mobile radio base stations, but also local transmitters (Wi-Fi access points, etc.) or the instrument itself contains a radio frequency transmitter module for wireless communication. The latter and especially mobile terminals can be operated in the immediate vicinity of the measuring device and are therefore the main source of high electromagnetic field strengths. A detailed overview of frequency bands and electromagnetic field strengths can be found in IEC TR 61000-2-5 [10].

In this edition of OIML D 11 it has been decided to include the test of radiated fields in close proximity in Table 38. This is applicable to measuring instruments used in medical applications only and not to all the measuring instruments. This test is specified in the collateral standard IEC 60601-1-2 [16] because many measuring instruments for medical application can operate very close (and be affected by) RF transmitters. According to IEC 61000-4-39 [17] “close proximity” refers to a separation distance between the source and measuring instrument of less than or equal to 200 mm for frequencies greater than 26 MHz and 500 mm for frequencies lower than 26 MHz.

OIML Technical Committees, Subcommittees, or Project Groups need to be careful when specifying this test and follow recommendations of IEC 60601-1-2 [16], section 8.10 and 8.11, as well as the rationale mentioned in Annex A, clause A.3, sub-clauses 8.10 and 8.11.

8.4.2.11 Electrostatic discharge (Table 39)

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 synthetic footwear), ESD tests of test level 4 are only necessary for instruments intended to be used under circumstances where such conditions are likely to exist. Measuring instruments that will be used in areas where the relative humidity exceeds 50 % should be tested by exposure up to and including test level 3.

8.5 Additional guidance for battery powered instruments

For selecting tests for battery powered measuring instruments, a distinction shall be made based on the kind of battery applied.

These different types are

a) disposable batteries,

b) general rechargeable batteries, and

c) batteries of road vehicles.

8.5.1 In case of disposable and rechargeable batteries of a general nature, at present no international standards are available. The requirements are described briefly in 5.5 and the applicable tests in Table 40.

8.5.2 For instruments powered by the on-board battery of a road vehicle (environmental class E3), a series of special tests simulating disturbances associated with the road vehicle power supply is presented in 14.2. These tests are based on the international standards series ISO 7637 [18–20] and on ISO 16750-2 [21].

According to clause 4 of ISO 7637-1 [21], that 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 may generally be mounted on any kind of vehicle. Therefore, in Table 42 and Table 43, the most severe level of testing specified in the standard is indicated as being the preferred level.

The choice of the test level to be applied is not related to a specific environment, but merely to the impact of a disturbance and, where relevant, to the electromagnetic properties of the specific type of vehicle in which the instrument is used.

The applicability of the test presented in Table 43 "*Electrical transients conduction via lines other than supply lines"* strongly depends on cable length and layout of the I/O lines. If the I/O lines of the applicable measuring instruments are limited to not more than 0.5 m, it is advised not to implement this test.

The capacitive coupling clamp (CCC) method described in ISO 7637-3 [20] is the only acceptable test method. The inductive coupling clamp (ICC) method should be omitted because the test result will strongly depend on the undefined input impedance of the EUT and therefore cannot be claimed to be sufficiently reproducible for metrological purposes.

The test on battery voltage variations while a vehicle starter motor is energised (Table 44), as derived from ISO 16750-2 [21], was included in previous editions of ISO 7637-2 [19] (pulse 4). This is also the case for the "load dump" test (former pulse 5). It should be noted that the latter may need to be implemented because certain regions (for example the European Union) still require load dump transients to be taken into account.

8.6 Additional guidance for instruments supplied by DC sources other than batteries

With the advance of DC power source technology, many manufacturers of measuring instruments are declaring DC voltages as nominal voltages independently of the DC source providing the electricity to their equipment. On the other hand, with the increase of distributed generation sources like micro wind farms and small photo-voltaic (PV) systems, those instruments declared as DC-powered by the manufacturer have to be examined in a careful way.

Traditionally, DC sources provide regulated DC voltages to the loads bringing an environment with less electrical disturbances than AC power networks. For this reason, the severity levels specified for instruments connected to a DC environment are lower than those levels specified to AC environments. However, depending of the DC source's quality and the installation conditions, the electronic instrument could be affected by disturbances in the same way as if it be installed at an AC network.

Sometimes, the manufacturers provide a dedicated AC-DC converter with their products in order to warrant that they will operate as intended. In those cases, the AC-DC converter is part of the measuring instruments and therefore the instrument is considered as AC powered and tested at the AC side with the severity levels of environment E1 or E2 from Table 4.

Nevertheless, some industrial applications need special attention from the relevant OIML Technical Committee, Subcommittee or Project Groups; for instance, when the distance between the AC-DC converter and the instrument is greater than 10 m. In addition, when associated cabling is installed outdoor, the severity levels for burst and surge test need to be carefully evaluated according to reference standards IEC 61000-4-4 [22] and IEC 61000-4-5 [11]. Annex B of IEC 61000-4-5 [11] specifies severity level 4 instead the level 3 specified in Table 4. Instruments installed outdoors on the side of highways are a good example of this case because a highway's environment cannot be classified as E1 or E2.

Another case is when the manufacturer does not supply the AC-DC converter allowing the users to utilise their own DC power source. In this case, it cannot be assumed that any DC power source or converter will provide the correct DC voltage level to the load or that it will be properly regulated or not be susceptible to

electrical disturbances. The following sections give guidance to the relevant OIML Technical Committee, Subcommittee or Project Groups to select the severity levels of Table 4, according to the installation conditions of the measuring instruments supplied by different types of DC sources.

8.6.1 AC-DC converters

As explained above, when the manufacturer provides its own AC-DC converter, it becomes part of the measurement instrument and it is considered as AC powered. However, when the manufacturer left to the user the responsibility to use any AC-DC converter, the worst-case scenario should be assumed; in other words, the instrument could operate even with a poorly designed AC-DC converter (low quality DC input power signal). For such cases, the severity levels identified for DC mains in Table 4 are recommended

Severity levels for E1 environments, in general, consider low power AC-DC converters ($P < 10$ W). E2 severity levels consider industrial AC-DC power converters ($P > 10$ W) which are expected to have higher quality.

Information regarding DC ripple levels is also found in 8.4.2.1.

Surges should not be applied to short lines ($L \leq \underline{10}$ m), therefore, relevant OIML Technical Committee, Subcommittee or Project Groups should analyse the typical distance between the AC-DC converter or DC-source and the measuring instrument. Additionally, consider to increase the surge severity level 3 to level 4 in cases where the DC power lines are aerial.

In the case of EFT Burst, it should not be applied to short lines ($L < 1$ m), therefore, relevant OIML Technical Committee, Subcommittee or Project Groups should analyse the typical distance between the AC-DC converter or DC source and the instrument. Moreover, consider to increase the EFT severity levels in cases where the DC power lines are aerial or close AC distribution lines.

9 Instrument 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 a test.

Terminology used in the applicable IEC and ISO publications is applied in this Document to the widest extent possible.

Some IEC and ISO publications use the term “specimen” instead of “EUT” as used in Clauses 10 – 14 of this Document. In this Document, “specimen” concerns one copy of an instrument (or part of an instrument) and “EUT” concerns the specific copy on which the test is, or will be performed. So, each of the instruments produced that is part of the population of the same type is called a “specimen” of the type. There might for example be a preference to perform examinations on a specimen different from the one used as EUT.

Most of the standards referred to in the following clauses of this Document concern “basic” standards (according to the IEC definition) not specifically linked to a product. This implies that for many tests a choice may be made from a range of test levels. In order to optimise harmonisation between those standards and the relevant OIML Recommendations, all these test levels were copied from these standards into this Document, but only a limited number of these are actually recommended for inclusion in OIML Recommendations. To be able to recognise the preferred test levels, these have been presented in **bold face**.

9.1.1 Measurement uncertainty considerations

Measurement uncertainty evaluation is an important and essential element in all aspects of metrology, including legal metrology. OIML G 19 [23] should be consulted for a general understanding of the terminology and concepts related to uncertainty, and for guidance on how to assess and use measurement uncertainty.

Measurement uncertainty shall be considered in all aspects of measurement and conformity assessment decisions associated with OIML Recommendations. Some guidance on how to assess uncertainty is provided in the following paragraphs.

The following clause concerning measurement uncertainty should be included in OIML Recommendations:

> *"Each test comprises measurements applying harmonised test setups for the verification of compliance with requirements. Measurement uncertainty is an attribute of each measurement. For every measurement result that is reported during testing of a measuring instrument or system within the framework of this OIML Recommendation, the measurement uncertainty associated with the corresponding measured value(s) and determined error(s) of indication shall be known and where relevant shall be reported.*
>
> *Note: Exceptions considered not relevant to be reported in the test report include the uncertainty values associated with individual measured values which are obtained for the purpose of assessing a component of measurement uncertainty associated with the repeatability or reproducibility of the measuring instrument/system and/or testing procedure, or where it is determined on the basis of a previous reported assessment that a component of measurement uncertainty is not significant in a particular measurement application.*
>
> *The uncertainty associated with the test method shall be taken into account in the decision on the applicability of the test method".*

9.1.2 Evaluation of uncertainty in testing

The main reason for evaluating the uncertainty associated with a test result is to ensure with a sufficient probability that a clear decision on compliance to the requirements can be made by taking this uncertainty into account.

In the considerations on uncertainty in testing it shall be taken into account that a test is just an instant observation of the response of one or a few specimen(s) to that test and sometimes for practical reasons even reduced to only a selection of the different manifestations of influencing phenomena. This may require extending the uncertainty margins or to base the value of specific contributors to the uncertainty on well characterised and repeatable measurements performed in earlier stages (pooled uncertainty values).

The test procedure and the test setup may affect the overall uncertainty of the result. Often these are the major contributors.

The contributors to the overall uncertainty of the test result include

- measuring instrumentation uncertainty,
- test setup introduced uncertainty,
- test procedure introduced uncertainty, and
- sample (EUT) introduced uncertainty.

Examples of the above-mentioned contributors are (from temperature test and ESD test):

- thermometer in climate room; pulse waveform of ESD generator;
- homogeneity of temperature in climate room; position of the EUT above a conducting cable;
- curve of climate change; location for the discharge;
- reproducibility of the measurements.

In OIML Recommendations, the overall uncertainty contribution may be stated as a maximum acceptable value.

In addition to stating the overall contribution it may be required in Recommendations to set a maximum acceptable value for some specific uncertainty contributors in order to prevent an unnecessary increase of the overall uncertainty or to avoid unnecessary efforts in the evaluation of the uncertainty of a contributor.

An example of an unnecessary increase of the overall uncertainty is the situation where a mass standard with a relatively high uncertainty is used as a reference.

An example of employing unnecessary efforts is the situation where the actual uncertainty of the mass standards is calculated instead of using the pooled uncertainty provided from its classification.

Specific contributions to the (measurement) uncertainty may be

a) obtained from calibration results of the reference instruments,

b) estimated on the basis of the test method and procedure, or

c) obtained from the reproducibility of test results.

Results of research during the development or from the evaluation of the test method and procedure shall provide the test method related contributions to the overall uncertainty.

9.2 Test considerations

9.2.1 General

In principle, all tests shall be performed respecting the conditions concerning installation stipulated by the manufacturer and the rated operating conditions, unless it is obvious that these will not be relevant to the result of the test.

The applicable OIML Recommendation shall in all cases describe

- the manner in which the instrument shall be tested, and
- the allowed changes in the performance of the EUT.

Simulation of any part of the EUT shall be avoided. If such simulation is unavoidable, all parts of the instrument that could be affected by the test shall play their intended role in the measurements.

Nowadays, many measuring instruments comprise electronic circuits and/or are equipped with electronic devices and, therefore, fulfil the definition of an electronic measuring instrument. For these instruments the tests referred to in 8.4 apply. Measuring instruments which do not fulfil this definition shall only be exposed to the mechanical and climatic tests as referred to in 8.2 and 8.3.

If the electronic measuring instrument only contains passive electronic components, the test on influence quantities in 8.4.2.6, 8.4.2.7, 8.4.2.8, 8.4.2.10 and 8.4.2.11 may not be applicable.

Table 5 may serve as a guideline showing the preferred method of evaluation of the test results in relation to several tests presented in this Document (the applicable OIML Recommendation may differ in the evaluation method).

Note: The value of a specific influence quantity may in some cases exceed the rated operating conditions. Such a particular influence quantity shall be considered as an influence factor when its value lies within the rated operating conditions range, and as a disturbance when the value exceeds these rated operating conditions.

Table 5 - Evaluation method in general applicable to the test

Influence quantity exposure	Table(s)	Evaluation	
Dry heat	Table 6	I	MPE
Cold	Table 7	I	MPE
Damp heat, steady-state (non-condensing)	Table 8	I	MPE
Damp heat, cyclic (condensing)	Table 9	D	NSFa
Water	Table 10	D	NSFa
Atmospheric pressure	Table 11, Table 12	I	MPE
Sand and dust	Table 13	D	NSFa
Salt mist	Table 14	D	NSFa
Vibration	Table 15, Table 16	I	MPE
Mechanical shock – stationary device	Table 17	D	NSFa
Mechanical shock – hand held device	Table 18	D	NSFa
DC mains voltage variation	Table 19	I	MPE
Ripple on DC mains power	Table 20	D	NSF
AC mains voltage variation	Table 21	I	MPE
AC mains frequency variation	Table 22	I	MPE
DC mains voltage dips, short interruptions and (short term) variations	Table 23	D	NSF
AC mains voltage dips, short interruptions and reductions	Table 24	D	NSF
AC mains harmonics	Table 25	D	NSF
VLF and LF disturbances on AC and DC mains	Table 26	D	NSF
Bursts (transients) on AC and DC mains	Table 27	D	NSF
Surges on AC and DC mains power lines	Table 28	D	NSF
Bursts (transients) on signal, data and control lines	Table 29	D	NSF
Surges on signal, data and control lines	Table 30	D	NSF
Mains power frequency magnetic field	Table 31	D	NSF
Conducted (common mode) currents generated by RF EM fields	Table 32	D	NSF
Conducted, common mode disturbances in the frequency range 2 kHz to 150 kHz	Table 33	D	NSF
Conducted, differential mode current disturbances in the frequency range 10 Hz to 150 kHz	Table 34	D	NSF
Radiated RF electromagnetic fields	Table 35, Table 36, Table 37	D	NSF
Radiated fields in close proximity	Table 38	D	NSF
Electrostatic discharge	Table 39	D	NSF
Low voltage of internal battery (not connected to the mains power)	Table 40	I	MPE
Voltage variations from external 12 V and 24 V road vehicle batteries	Table 41	I	MPE
Electrical transient conduction along supply lines of external 12 V and 24 V road vehicle batteries	Table 42	D	NSF
Electrical transient conduction via lines other than supply lines for external 12 V and 24 V road vehicle batteries	Table 43	D	NSF
Battery voltage variations during cranking	Table 44	D	NSF
“Load dump” test	Table 45	D	NSFa

I	Influence factor
D	Disturbance
MPE	Maximum permissible error according to 3.7
NSFa	No significant fault shall occur after the disturbance
NSFd	No significant fault shall occur during the disturbance
NSF	No significant fault shall occur neither during nor after the disturbance

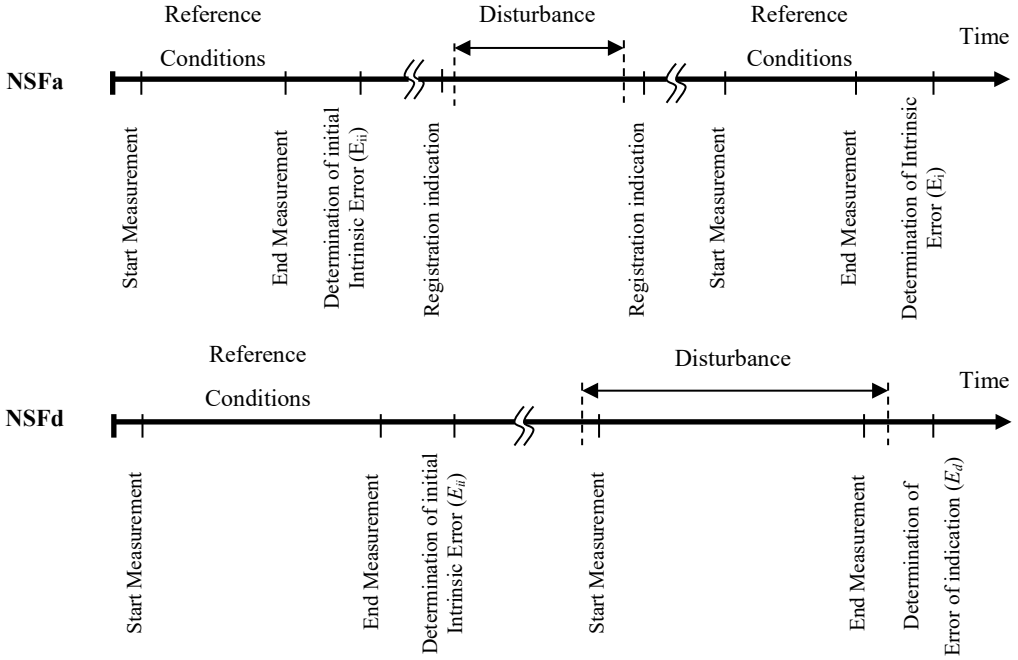
Rationale:

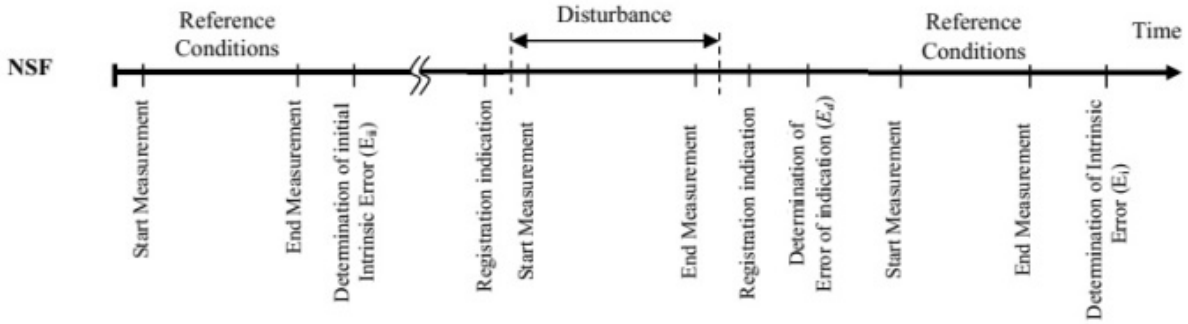
1. The NSFa is designed to check for permanent 'damages' (change in performance) and changes in stored values (registers), while NSFd is designed to check for momentary changes in performance. Note: damages can be physical damages or changes in measurement parameters, such as calibration parameters.
2. NSFa requires that the instrument is NOT measuring during the disturbance. It can be powered on, but the measuring function is not in operation. If the measuring is in operation then it would be a NSFd test.
3. Please note that faults implying the impossibility to perform any measurement and transitory faults being momentary variations in the indication, which cannot be interpreted, memorised or transmitted as a measurement result are not significant faults.
4. Environmental factors that are present for prolonged periods of time, or occur often, are typically considered to be influence factors and are to be evaluated against the MPE, whereas rare and/or short-lasting phenomena are typically considered disturbances needing to be evaluated against NSFa or NSF.

9.2.2 Integrating instruments

As a consequence of the operating principle of integrating instruments the evaluation approach has to be different from that of non-integrating instruments. This implies that more attention to the evaluation sequence is needed when prescribing tests and evaluations for such instruments.

Examples of integrating instruments are: water, gas, electricity and heat meters, as well as continuous totalising automatic weighing instruments (belt weighers). For the evaluation of these instruments, testing and observation over a certain defined period of time of operation is necessary.





NSFa = No Significant Fault shall occur after the disturbance
NSFd = No Significant Fault shall occur during the disturbance
NSF = No significant fault shall occur neither during nor after the disturbance

Figure 1 - Time sequences for the three conditions

9.2.2.1 Sequence during NSFa evaluation

The following test and evaluation sequence is recommended when NSFa evaluation is applicable:

a) Establish the period of time needed per measurement;

b) Start the measurements under reference conditions;

c) Stop the measurements after the period of time established and keep the EUT switched on;

d) Determine the initial intrinsic error (E_{ii});

e) Record all indicated and registered values of interest;

f) Only when applicable: switch off the EUT (see Note 1);

g) Activate the disturbance generator;

h) Stop the disturbance after the period of time required for the test;

i) Switch on the EUT in case the disturbance was applied in “switch off” mode;

j) Record all indicated and registered values of interest (see Note 2);

k) Calculate the change in the display reading and registers. Those changes shall not exceed the fault limit established as prescribed in the applicable OIML Recommendation;

l) Perform a second measurement using the same period of time;

m) Determine the intrinsic error (E_i);

n) Record all indicated and registered values of interest;

o) Calculate the difference between the intrinsic error (E_i) and the initial intrinsic error (E_{ii}). This difference shall not exceed the fault limit specified in the applicable OIML Recommendation.

Note 1: For the damp heat, cyclic test the position “switched on” or “switched off” is to be specified in the OIML Recommendation; the position “switched off” facilitates condensing.

Note 2: After the application of the disturbance it may sometimes not be possible for the EUT to indicate the same result as it did before (in particular when it must be switched off, or when the measurement range does not allow an indication during performance of the test, which may for instance apply when performing mechanical shock tests on clinical thermometers).

9.2.2.2 Sequence during NSFd for evaluation

The following general test and evaluation sequence is recommended when NSFd evaluation is applicable:

a) Establish the period of time needed for a measurement;

b) Start the measurements under reference conditions;

c) Stop the measurements after the period of time established and keep the EUT switched on;

d) Determine the initial intrinsic error;

e) Apply the disturbance;

f) Perform a second measurement;

g) Stop applying the disturbance;

h) Determine the error (E_d);

i) Calculate the difference between the error in the second measurement (E_d) and the initial intrinsic error (E_{ii}). This difference shall not exceed the fault limit specified in the applicable OIML Recommendation.

10 Climate related performance tests

10.1 Static temperatures

Table 6 - Dry heat

Applicable standards	IEC 60068-2-2 [24], IEC 60068-3-1 [25].					
Test method	Exposure to dry heat (non-condensing).					
Applicability	General.					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high temperature.					
Test procedure in brief	The test comprises exposure to the specified high temperature under low air velocity circulation (free air) conditions during the period of time specified (the period specified is the period following the moment at which the EUT has reached temperature stability). The change in 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 tests are performed at temperatures below 35 °C, the relative humidity shall not exceed 50 %.					
The following test levels may be specified:						
Test level index[1)]	**1**	**2**	**3**	4	5	unit
Temperature	**30**	**40**	**55**	70	85	°C
Duration	**2**	**2**	**2**	2	2	h
Note	[1)] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**.					
Information to be presented in the applicable OIML Recommendation, where relevant	a) preconditioning, b) details of mounting or supports, c) state of the EUT including cooling system during conditioning, d) test level: temperature and duration of exposure, e) measurements and/or loading during conditioning, f) recovery (if non-standard).					

Table 7 - Cold

Applicable standards	IEC 60068-2-1 [26], IEC 60068-3-1 [25].					
Test method	Exposure to low temperature.					
Applicability	General.					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of low temperature.					
Test procedure in brief	The test comprises exposure to the specified low temperature under low air velocity circulation (free air) conditions during the period of time specified (the period specified is the period following the moment at which the EUT has reached temperature stability). The change in 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.					
The following test levels may be specified:						
Test level index [(1)]	**1**	**2**	**3**	4	5	unit
Temperature	**+5**	**–10**	**–25**	–40	-50	°C
Duration	**2**	**2**	**2**	2	2	h
Note	[(1)] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**.					
Information to be presented in the applicable OIML Recommendation, where relevant	a) preconditioning, b) details of mounting supports, c) state of the EUT including cooling system during conditioning, d) test level: temperature and duration of exposure, e) measurements and/or loading during conditioning, f) recovery (if non-standard).					

10.2 Damp heat

Table 8 - Damp heat, steady-state (non-condensing)

Applicable standards	IEC 60068-2-78 [27], IEC 60068-3-4 [8].		
Test method	Exposure to damp heat in steady-state.		
Applicability	This test is considered generally applicable where the measuring instrument is expected to be used in a non-controlled climatic environment.		
Object of the test	Verification of 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 instrument and its application.		
Test procedure in brief	The test comprises exposure to the specified high-level temperature and the specified constant relative humidity for a certain fixed period of time as defined by the test level chosen. The EUT shall be handled such that no condensation of water occurs on it.		
The following test levels may be specified:			
Test level index [(1)]	**1**	2	unit
Relative humidity (RH)	**85**	93	%
Duration	**2**	4	24-hour period
Note	[(1)] The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.**		
Information to be presented in the applicable OIML Recommendation, where relevant	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) test level 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.		

Table 9 - Damp heat, cyclic (condensing)

Applicable standards	IEC 60068-2-30 [28], IEC 60068-3-4 [8].		
Test method	Exposure to damp heat with cyclic temperature variation.		
Applicability	Damp heat tests with cyclic temperature variation shall be applied in all cases where condensation is concerned and is potentially of influence or when the penetration of vapour will be accelerated by the breathing effect.		
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high humidity combined with cyclic temperature changes.		
Test procedure in brief	The test comprises exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature while maintaining the relative humidity above 95 % during the temperature change and the low temperature phases and at or above 93 % RH at the upper temperature phases. Condensation is expected to occur on the EUT during the temperature rise The 24 h cycle comprises: 1) temperature rise during 3 hours, 2) temperature maintained at upper value until 12 hours from the start of the cycle, 3) temperature lowered to lower temperature level within a period of 3 to 6 hours, the declination (rate of fall) during the first hour and a half being such that the lower temperature level would be reached in a 3-hour period, 4) temperature maintained at the lower level until the 24-hour period is completed. The stabilizing period before and recovery period after the cyclic exposure shall be such that the temperature of all parts of the EUT is within 3 °C of its final value. Special electrical conditions and recovery conditions may need to be specified. For integrating measuring instrument see 9.2.2 for the appropriate sequence of measurements during the test.		
The following test levels may be specified:			
Level index[(1)]	**1**	**2**	unit
Upper temperature	**40**	**55**	°C
Duration	**2**	**2**	24-hour cycle
Note	[(1)] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.**		
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level: temperature and number of cycles, b) state of the EUT during conditioning, c) details of mounting or support, d) intermediate measurements, e) instrument recovery conditions, f) special precautions to be taken regarding surface moisture elimination, g) measurements to be made at the end of the test, sequence of parameters to be measured, and the maximum time period allowed for and between the measurement of these parameters.		

10.3 Water

Table 10 - Water

Applicable standards	IEC 60068-2-18 [29], IEC 60512-14-7 [30], IEC 60529 [31].		
Test method	Exposure to water falling in drops and impacting (colliding) water.		
Applicability	Applicable when the measuring instrument is expected to be used in open air locations (see 8.2.2).		
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 when the specimen 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 stabilising period before and recovery after the exposure shall be specified in the applicable OIML Recommendation.		
The following test levels may be specified:			
Test level index (1)	1	**2**	unit
Flow rate (per nozzle)	0.07	**0.07**	L/min
Duration	10	**10**	min
Angle of inclination	± 60	**± 180**	°
Note	(1) The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.**		
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level: 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 Table 10 and Table 11, two tests for determining the influence of atmospheric pressure on measuring instruments are 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 instrument, a significant influence due to changes in atmospheric pressure can be expected (also refer to 4.5).

The choice of either test and of the test level to be prescribed in the applicable OIML Recommendation, is to be made by the relevant OIML Technical Committee, Subcommittee or Project Group.

Table 11 - Static atmospheric pressure

Applicable standard		There are no applicable standards (refer to Annex C).		
Test method		Exposure to low and high atmospheric pressure.		
Applicability		Applicable where, based on the physical measuring principle of the measuring instrument the atmospheric pressure is expected to be an influence quantity (see 8.2.3).		
Object of the test		Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of different static atmospheric pressures.		
Test procedure in brief		The test comprises exposure of the EUT to the specified higher and lower atmospheric pressures.		
The following test levels may be specified:				
Test level index		**1**	**2**	unit
Atmospheric pressure	Lower limit	**Ambient pressure – (2.50 ± 0.15)**	**86 ± 1**	kPa
	Upper limit	**Ambient pressure + (2.50 ± 0.15)**	**106 ± 1**	
Uncertainty of the recorded pressure		**0.15**	**0.15**	
Information to be presented in the applicable OIML Recommendation, where relevant		a) test level: pressure range, b) acceptable influence on the EUT.		

Table 12 - Variation in atmospheric pressure

Applicable standard	There are no applicable standards (refer to Annex C).		
Test method	Exposure to variable atmospheric pressure.		
Applicability	Applicable where, based on the physical measuring principle of the measuring instrument, the atmospheric pressure is expected to be an influence quantity (see 8.2.3).		
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of changing atmospheric pressure.		
Test procedure in brief	The test comprises exposure of the EUT to changes in atmospheric pressure and performance of measurements during these changes.		
The following test levels may be specified:			
Test level index	**1**	**2**	unit
Change in atmospheric pressure, relative to ambient pressure	**1.0 ± 0.1**	**10 ± 1**	kPa
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level: pressure change, b) acceptable influence on the EUT.		

10.5 Sand and dust

Table 13 - Sand and dust

Applicable standards	IEC 60512-11-8 [32], IEC 60529 [31], IEC 60721-2-5 [33].	
Test method	Exposure to sand and dust.	
Applicability	Applicable when the measuring instrument is expected to be used in a dusty or sandy environment (see 8.2.4).	
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under a dust-laden atmosphere.	
Test procedure in brief	The test comprises 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 [32].	
The following test levels may be specified:		
Test level index (1)	**1**	2
Number of cycles	**1**	2
Note	(1) The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.**	
Information to be presented in the appropriate Recommendations, where relevant	a) test level: number of cycles, b) state of the EUT during conditioning, c) intermediate measurements, d) recovery conditions, e) electrical and mechanical measurements to be performed at the end of the test, the parameters to be measured, the sequence of the measurements, and the maximum period allowed for these measurements.	

10.6 Salt mist

Table 14 - Salt mist

Applicable standards	IEC 60068-2-11 [34], IEC 60721-2-5 [33].				
Test method	Exposure to salt mist.				
Applicability	Applicable when the measuring instrument is expected to be used in a humid salt environment (see 8.2.5).				
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under salt mist atmosphere.				
Test procedure in brief	The test comprises exposure to salt mist atmosphere at 35 °C.				
The following test levels may be specified:					
Test level index (1)	1	**2**	3	4	unit
Duration	16	**24**	48	96	h
Note	(1) The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.**				
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level: duration, b) state of the EUT during conditioning, c) intermediate measurements, d) recovery conditions, e) electrical and mechanical measurements to be performed at the end of the test, the parameters to be measured, the sequence of the measurements, and the maximum period allowed for these measurements.				

11 Mechanical performance tests

11.1 Vibration

In Table 15 and Table 16 two vibration tests (random and sinusoidal) are described. In general, it should be avoided to require both tests in OIML Recommendations.

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

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

For both tests, selection guidance can be found in IEC 60068-3-8 [9].

Table 15 - Vibration (random)

Applicable standard	IEC 60068-2-47 [35], IEC 60068-2-64 [36], IEC 60068-3-8 [9].			
Test method	Exposure to random vibration.			
Applicability	General.			
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of random vibration.			
Test procedure in brief	The test comprises exposure to vibration 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 in such a way that the gravity vector points in the same direction as it would in normal use. If the measurement principle is such that the effect of the direction of the gravity vector can be considered negligible, the EUT may be mounted in any position.			
The following test levels may be specified:				
Test level index (1)	**1**	**2**	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	For each of the orthogonal directions the vibration exposure time shall be 2 minutes in each functional mode as defined in the applicable OIML Recommendation or for a longer period if necessary for performing the measurement.			
Note	(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**.			
Information to be presented in the applicable OIML Recommendation, where relevant	Test level: - total frequency range, - total RMS level, - ASD (acceleration spectral density) level, - number of axes, - duration per axis.			

Table 16 - Vibration (sinusoidal)

Applicable standards	IEC 60068-2-6 [37], IEC 60068-2-47 [35], IEC 60068-3-8 [9].			
Test method	Exposure to sinusoidal vibration.			
Applicability	Applicable for measuring instruments used in locations where predominantly sinusoidal vibrations may be expected (see 8.3).			
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of sinusoidal vibration.			
Test procedure in brief	The test comprises exposure to vibration for a time sufficient for testing the various functions of the EUT during the exposure. The EUT shall be tested by exposing it to the specified acceleration level and sweeping the vibration frequency in the specified frequency range, at 1 octave/min, for the specified number of sweep cycles per axis. The EUT shall be tested in three, mutually perpendicular main axes while mounted on a rigid fixture by its normal mounting means. The EUT shall normally be mounted in such a way that the gravity vector points in the same direction as it would in normal use. If the measurement principle is such that the effect of the direction of the gravity vector can be considered negligible, the EUT may be mounted in any position.			
The following test levels may be specified:				
Test level index [(1)]	**1**	**2**	3	unit
Frequency range	**10 – 150**	**10 – 150**	10 – 150	Hz
Max. acceleration level	**2**	**10**	20	$m \cdot s^{-2}$
Number of sweep cycles per axis	**20**	**20**	20	-
Note	[(1)] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.**			
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level: frequency range, maximum acceleration, number of cycles, b) mounting of the EUT, c) pre-conditioning.			

11.2 Mechanical shock

Table 17 - Mechanical shock – stationary device

Applicable standard	IEC 60068-2-31 [38].		
Test method	Dropping the EUT onto a rigid surface after tilting.		
Applicability	Devices normally intended to remain fixed or stationary.		
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of mechanical shocks.		
Test procedure in brief	The EUT, standing in its normal position of use on a rigid surface, is tilted along one bottom edge and is subsequently allowed to fall freely back on to the test surface. The height of fall is the distance between the opposite bottom edge and the test surface. However, the angle between the bottom and the test surface shall not exceed 30°.		
The following test levels may be specified:			
Test level index	**1**	**2**	unit
Height of fall	**25**	**50**	mm
Number of falls (on each bottom edge)	**1**	**1**	-
Information to be presented in the applicable OIML Recommendation, where relevant	a) conditioning procedure, b) fitting of cables, covers, etc., c) way of execution of the test in case the bottom is not a rectangle, d) test level: height of drop on to a face.		

Table 18 Mechanical shock – hand held device

Applicable standard	IEC 60068-2-31 [38] free fall				
Test method	Dropping EUT onto a rigid surface				
Applicability	Handheld EUTs.				
Object of the test	Verification of compliance with the provisions for disturbances in XYZ under conditions of mechanical shocks				
Condition of the EUT	Power is to be “on” for the duration of the test				
Test procedure in brief	For handheld EUTs: The test surface shall be smooth, hard, rigid, horizontal, and made of concrete or steel; The specimen shall be allowed to fall freely in its normal attitudes of use, taking into account all 3 spatial axes; The height shall be measured from the part of the specimen nearest to the test surface, when the specimen is suspended prior to letting it fall. The EUT is in operation at nominal measurement conditions. Note: nominal measurement condition refers to that which occurs often in practical use of the EUT. Test sequence: 1) Measurements before disturbance (at reference conditions) 2) The disturbance shall be applied 3) Measurements after disturbance (at reference conditions)				
Test level index	1	2	3	4	
Height of fall versus mass	**25 mm**				Mass < 50 kg
	50 mm	**100 mm**	250 mm	**500 mm**	Mass < 10 kg
	750 mm	**1000 mm**	1500 mm		Mass < 1 kg
Number of falls (on each bottom edge)	6				
Note	(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**.				
Information to be presented in the applicable OIML Recommendation, where relevant	a) conditioning procedure, b) test level: height of drop on to a face. c) Mass of EUT				

12 External wiring and mains power supply related performance tests

Methods for determining the degradation of performance of mains connected EUTs during electrical mains power and external wiring conducted variations and disturbances.

12.1 DC mains variations (within network specification)

Table 19 - DC mains voltage variation

Applicable standard	IEC 60654-2 [39].
Test method	Applying low- and high-level DC mains power voltage.
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to a DC mains power network while in operation and generally only applicable in an industrial environment.
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of DC mains power voltage changes between upper and lower limit.
Test procedure in brief	The test comprises exposure to the specified power supply condition for a period sufficient for achieving temperature stability and subsequently performing the required measurements.
Test level index	1
Test level	The upper voltage limit is the DC level at which the EUT has been designed to automatically detect high-level conditions. The lower limit will be the DC level at which the EUT has been designed to automatically detect low-level conditions. The EUT shall comply with the specified maximum permissible errors at voltage levels between the two levels. Testing may be restricted to the exposure of the EUT to the upper and lower voltage level, subsequently.

Table 20 - Ripple on DC mains power

Applicable standard	IEC 61000-4-17 [12] and IEC 61000-4-1[40].					
Test method	Introducing a ripple voltage on the DC input power port.					
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to a DC mains power network (distribution system) supplied by external rectifier systems while in operation and generally only applicable in an industrial environment (see 8.4.2.1).					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of the introduction of a ripple on the DC mains voltage.					
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 comprises subjecting the EUT to ripple voltages such as those generated by traditional rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. The frequency of the ripple voltage is the applicable power frequency or a multiple (2, 3 or 6) dependent on the rectifier system used for the mains. 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 time period necessary to allow a complete verification of the EUT's operating performance.					
The following test levels may be specified:						
Test level index (1)	**1**	2	3	4	x (2)	unit
Percentage of the nominal DC voltage (3)	**2**	5	10	15	special	%
Notes	(1) The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.** (2) "x" indicates that an alternative test level may be specified in the applicable OIML Recommendation. (3) The values presented are the peak-to-peak voltages expressed as a percentage of the nominal DC voltage.					
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level, b) waveform of the ripple voltage, c) frequency of the ripple, d) duration of the test, e) climatic conditions, f) etc.					

12.2 AC mains variations (within network specification)

Table 21 - AC mains voltage variation

Applicable standards	IEC TR 61000-2-1 [41], IEC 61000-4-1 [40].	
Test method	Applying low- and high-level AC mains power voltage (single phase).	
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation.	
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of AC mains network voltage changes between upper and lower limit.	
Test procedure in brief	The test comprises exposure of the EUT to the specified power supply condition for a time period sufficient for achieving temperature stability and subsequently performing the required measurements.	
The following test level may be specified:		
Test level index		**1**
Mains voltage (1), (2)	Upper limit	$\boldsymbol{U_{nom1}}$ **+ 10 %**
	Lower limit	$\boldsymbol{U_{nom2}}$ **– 15 %**
Notes	(1) For three phase mains power supplies, the voltage variation is applicable for each of the phases successively. (2) The values of U_{nom} are those as marked on the measuring instrument. If a range is specified, U_{nom1} concerns the highest and U_{nom2} concerns the lowest value in the range. If only one nominal mains voltage value (U_{nom}) is specified then $U_{nom1} = U_{nom2} = U_{nom}$.	

Table 22 - AC mains frequency variation

Applicable standards	IEC 61000-4-28 [42], IEC/TR 61000-2-1 [41], IEC 61000-2-2 [43], IEC 61000-4-1 [40].	
Test method	Variation in AC mains power frequency.	
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation.	
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of AC mains network power frequency changes between upper and lower limit.	
Test procedure in brief	The test comprises exposure of the EUT to the specified power condition for a time period sufficient for achieving temperature stability and for performing the required measurements.	
The following test level may be specified:		
Test level index		**1**
Mains frequency (1), (2)	Upper limit	$\boldsymbol{f_{nom1}}$ **+ 2 %**
	Lower limit	$\boldsymbol{f_{nom2}}$ **– 2 %**
Notes	(1) The values of f_{nom} are those as marked on the measuring instrument. If a range is specified, f_{nom1} concerns the highest and f_{nom2} concerns the lowest value in the range. If only one nominal mains frequency value (f_{nom}) is specified, then $f_{nom1} = f_{nom2} = f_{nom}$. (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: ▪ instruments to be operated at large power frequency variations, ▪ instruments to be installed in small networks that are isolated from a large interconnected system.	

12.3 Mains power disturbances

Table 23 - DC mains voltage dips, short interruptions and (short term) variations

<table>
<tr><td colspan="2">Applicable standard</td><td colspan="4">IEC 61000-4-29 [13]; IEC 61000-4-1 [40].</td></tr>
<tr><td colspan="2">Test method</td><td colspan="4">Introducing voltage dips, short interruptions and voltage variations on DC mains power lines using the test setup defined in the applicable standard.</td></tr>
<tr><td colspan="2">Applicability</td><td colspan="4">Applicable for measuring instruments which are temporarily or permanently connected to a DC mains power network while in operation. DC mains power networks are almost exclusively used in industrial environments.</td></tr>
<tr><td colspan="2">Object of the test</td><td colspan="4">Verification of 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.</td></tr>
<tr><td colspan="2">Test procedure in brief</td><td colspan="4">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 EUT shall be exposed to voltage dips, short interruptions, for each of the selected combinations of amplitude and duration, using a sequence of three dips/interruptions and intervals of at least 10 s between each test event.

The most representative operating modes of the EUT shall be tested three times at 10 s intervals for each of the specified voltage variations.

If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measurement time.</td></tr>
<tr><td colspan="6">The following test levels may be specified: (1)</td></tr>
<tr><td rowspan="3">Voltage dips</td><td>Test level index</td><td colspan="2">1</td><td>i (2)</td><td>unit</td></tr>
<tr><td>Amplitude</td><td colspan="2">40 and 70</td><td>x_i</td><td>% of the rated voltage</td></tr>
<tr><td>Duration (3)</td><td colspan="3">0.01; 0.03; 0.1; 0.3; 1; t</td><td>s</td></tr>
<tr><td rowspan="3">Short interrupt-ions</td><td>Test condition</td><td colspan="3">High impedance and/or low impedance</td><td></td></tr>
<tr><td>Amplitude</td><td colspan="3">0</td><td>% of the rated voltage</td></tr>
<tr><td>Duration (3)</td><td colspan="3">0.001; 0.003; 0.01; 0.03; 0.1; 0.3; 1; t</td><td>s</td></tr>
<tr><td rowspan="3">Voltage variations</td><td>Test level index</td><td>1</td><td>2</td><td>i</td><td></td></tr>
<tr><td>Amplitude</td><td>85 and 120</td><td>80 and 120</td><td>x_i</td><td>% of the rated voltage</td></tr>
<tr><td>Duration (3)</td><td colspan="3">0.1; 0.3; 1; 3; 10; t</td><td>s</td></tr>
<tr><td colspan="2">Notes</td><td colspan="4">(1) The test level considered most appropriate and preferable for OIML Recommendations are Test level indexes 1 and 2 corresponding respectively to IEC 61000-4-11 [38] Classes 2 and 3. These are presented in bold face.
(2) “i, x and t” are variables and indicate that alternative test level with alternative characteristics may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice.
(3) One or more values of the presented amplitude and duration may be specified in the applicable OIML Recommendations. The shortest duration in the table should at least be included.</td></tr>
<tr><td colspan="2">Information to be presented in the applicable OIML Recommendation, where relevant</td><td colspan="4">a) amplitude and duration of the simulated disturbances,
b) climatic conditions,
c) performance level,
d) if the EUT is an integrating instrument: an exact description of the sequence of the test pulses,
e) etc.</td></tr>
</table>

Table 24 - AC mains voltage dips, short interruptions and reductions

Applicable standards		IEC 61000-4-11 [44], IEC 61000-6-1 [45], IEC 61000-6-2 [46].				
Test method		Introducing short-time reductions of mains voltage using the test setup defined in the applicable standard.				
Applicability		Applicable for measuring instruments with rated input current of less than 16 A per phase which are temporarily or permanently connected to an AC mains power network while in operation.				
Object of the test		Verification of 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 is to be used which is suitable to reduce the amplitude of the AC mains voltage for the required period of time. The performance of the test generator shall be verified before connecting the EUT. The mains voltage reduction tests shall be repeated 10 times with intervals of at least 10 s between the tests. If the EUT is an integrating instrument, the tests shall be applied continuously during the measurement time.				
One of the following test levels may be specified:						
Test level index (1)			**1**	**2**	i (3)	unit
Voltage dips (2)	Test a	Reduction to	**0**	**0**	x_a	%
		Duration	**0.5**	**0.5**	n_a	cycles
	Test b	Reduction to	**0**	**0**	x_b	%
		Duration	**1**	**1**	n_b	cycles
	Test c	Reduction to	**70**	**40**	x_c	%
		Duration	**25/30** (4)	**10/12** (4)	n_c	cycles
	Test d	Reduction to	n/a	**70**	x_d	%
		Duration	n/a	**25/30** (4)	n_d	cycles
	Test e	Reduction to	n/a	**80**	x_e	%
		Duration	n/a	**250/300** (4)	n_e	cycles
Short interruptions		Reduction to	**0**		x	%
		Duration	**250/300** (4)		n	cycles
Notes		(1) The test level considered most appropriate and preferable for OIML Recommendations are Test level indexes 1 and 2 corresponding respectively to IEC 61000-4-11 [38] Classes 2 and 3. These are presented in **bold face.** (2) For the voltage dips, all tests within the test level may be applicable (see 8.4.2.4). (3) "i", "x" and "n" are variables and indicate that alternative test levels with alternative characteristics may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. For equipment connected directly or indirectly to the public network, the levels shall not be less severe than level 2. (4) Values applicable for 50 Hz / 60 Hz respectively. Measuring instruments capable of operating at both frequencies shall be assessed at each frequency at their respective test level indices.				
Information to be presented in the applicable OIML Recommendation, where relevant		a) amplitude and duration of the simulated disturbances, b) performance of the instrument at each of the tests, c) climatic conditions, d) if the EUT is an integrating instrument: an exact description of the sequence of the test pulses, e) etc.				

Table 25 - AC mains harmonics

Applicable standards	IEC 61000-2-2 [43], IEC TR 61000-2-5 [10], IEC 61000-4-13 [14].					
Test method	Introducing harmonics on the AC mains power lines.					
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation.					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 during conditions where the mains voltage is disturbed by harmonics of its fundamental frequency.					
Test procedure in brief	A test generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure of the EUT to mains harmonic distortions as defined in the referred standard. Harmonic voltages at test levels from 3 % and higher, up to the ninth harmonic, shall be applied using a phase shift of both 0° and 180° with respect to the positive zero-crossing of the fundamental. The test shall be performed up to the 40th harmonic. If the EUT is an integrating instrument, the harmonics shall be continuously applied during the measurement time.					
	Harmonic order *n*	The following test levels [3] may be specified:				
Test level index [1]		1	**2**	**3**	i[2]	unit
Odd harmonics Non-multiples of 3	5	4.5	**9**	**12**	x_n	% of rated voltage
	7	4.5	**7.5**	**10**	x_n	
	11	4.5	**5**	**7**	x_n	
	13	4	**4.5**	**7**	x_n	
	17	3	**3**	**6**	x_n	
	19;23;25	2	**2**	**6**	x_n	
	29	1.5	**1.5**	**5**	x_n	
	31;35;37	1.5	**1.5**	**3**	x_n	
Odd harmonics multiples of 3	3	4.5	**8**	**9**	x_n	
	9	2	**2.5**	**4**	x_n	
	15	-	**-**	**3**	x_n	
	21	-	**-**	**2**	x_n	
	27;33;39	-	**-**	**2**	x_n	
Even harmonics	2	3	**3**	**5**	x_n	
	4	1.5	**1.5**	**2**	x_n	
	6	-	**-**	**1.5**	x_n	
	8 – 40	-	**-**	**1.5**	x_n	
Notes	[1] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** [2] "i" and "x_n" are variables and indicate that an alternative test level may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. [3] For the calculation of the test levels from compatibility levels as specified in IEC TR 61000-2-5 [10] and IEC 61000-2-2 [43] the IEC 61000-4-13 [14] suggested multiplication factor k = 1.5 has been applied.					

Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, b) climatic conditions, c) if the EUT is an integrating instrument: an exact description of the sequence of testing, d) etc.

Table 26 - VLF and LF disturbances on AC and DC mains

Applicable standards	IEC 61000-4-19 [47].						
Test method	Introducing VLF and LF differential mode disturbances on the AC or DC mains power lines.						
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation.						
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of VLF and LF differential mode disturbances on the AC or DC mains network.						
Test procedure in brief	The test comprises exposure of the EUT to the specified disturbances for a time period sufficient for performing the required measurements (1).						
The following test levels may be specified:							
Test level index (2)		1	**2**	3	4	i (3)	unit (RMS value)
Disturbance	Freq. [kHz]						
Differential current	2 – 30	1	**2**	3	4	x_n	A
	30 – 150	0.5	**1**	1.5	2	x_n	A
Differential voltage	2 – 9	0.5	**3**	12	20	x_n	V
	9 – 95	0.5 – 0.1	**3 – 0.6**	12 – 2.4	20 – 10	x_n	V
	95 – 150	0.1	**0.6**	2.4	10	x_n	V
Notes	(1) For details on pulses to be introduced refer to IEC 61000-4-19 [47]. (2) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** (3) "i" and "x_n" are variables and indicate that an alternative test level may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice.						

Table 27 - Bursts (transients) on AC and DC mains

Applicable standards	IEC 61000-4-4 [22].					
Test method	Introducing transients on the mains power lines.					
Applicability	Applicable for electronic measuring instruments which are temporarily or permanently connected to a mains power network while in operation.					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 during conditions where electrical bursts are superimposed on the mains voltage.					
Test procedure in brief	A burst generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. 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 measurement time.					
The following test levels may be specified:						
Test level index (1)	1	**2**	**3**	4	*i* (2)	unit
Amplitude (peak value)	0.5	**1**	**2**	4	*U*	kV
Repetition rate	**100** (3)					kHz
Notes	(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** (2) "*i*" and "*U*" are variables and indicate that an alternative amplitude may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. (3) 100 kHz is recommended however an OIML Recommendation may choose to perform an additional test at 5 kHz					
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, b) climatic conditions, c) if the EUT is an integrating instrument: an exact description of the sequence of testing, d) etc.					

Table 28 - Surges on AC and DC mains power lines

Applicable standard	IEC 61000-4-5 [11].						
Test method	Introducing electrical surges on the mains power lines.						
Applicability	Applicable for electronic measuring instruments which are temporarily or permanently connected to a mains power network while in operation.						
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 during conditions where electrical surges are superimposed on the mains voltage.						
Test procedure in brief	A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to electrical surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and the minimum time interval between two successive pulses are defined in the referred standard. At least 3 positive and 3 negative surges shall be applied. On AC mains supply lines the surges shall be synchronised with the AC supply frequency and shall be repeated such that the injection of surges on all the four phase shifts: 0°, 90°, 180° and 270° with the mains frequency is covered. All surge tests shall be repeated for each severity level lower than the specified test level index applicable for the EUT. This shall ensure that the non-linear characteristics of the EUT are assessed. The injection network circuit depends on the applicable conductor and is defined in the referred standard. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measurement time.						
The following test levels may be specified:							
Test level index [(1)] (installation class)	1	2	**3**	4	5	i [(2)]	unit
AC line to line	n/a	0.5	**1.0**	2.0	[(3)]	U_1	kV
AC line to ground	0.5	1.0	**2.0**	4.0	[(3)]	U_2	kV
DC line to line	n/a	n/a	**1.0**[(4)]	2.0	2.0	U_3	kV
DC line to ground	n/a	n/a	**2.0**[(4)]	4.0	4.0	U_4	kV
Notes	[(1)] The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.** [(2)] "i" and "U_n" indicate that alternative voltage levels may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. [(3)] Depends on the class of the local power supply system. [(4)] The most recent version of IEC 61000-4-5 [11] specifies "n/a" for the level 3 DC tests.						
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level (installation class according to IEC 61000-4-5 [11]), b) climatic conditions, c) coupling method, d) setup 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) etc.						

12.4 Other disturbances introduced through conduction by connected external wiring

Table 29 - Bursts (transients) on signal, data and control lines

Applicable standards	IEC 61000-4-4 [22].					
Test method	Introducing transients on signal, data and control lines.					
Applicability	Applicable for electronic measuring instruments containing active electronic circuits which during operation are permanently or temporarily connected to external electrical signal, data and/or control lines.					
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 during conditions where electrical bursts are superimposed on I/O and communication ports.					
Test procedure in brief	A burst generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load is defined in the referred standard. 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. A capacitive coupling clamp as defined in the standard shall be used for the coupling of the bursts into the I/O and communication lines. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measurement time.					
The following test levels may be specified:						
Test level index [1]	1	**2**	**3**	4	*i* [2]	unit
Amplitude (peak value)	0.25	**0.5**	**1**	2	*U*	kV
Repetition rate	**100[3]**					kHz
Notes	[1] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** [2] "*i*" and "*U*" are variables and indicate that an alternative amplitude may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. [3] 100 kHz is recommended however an OIML Recommendation may choose to an additional test at 5 kHz					
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, 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) etc.					

Table 30 - Surges on signal, data and control lines

Applicable standard		IEC 61000-4-5 [11].							
Test method		Introducing electrical surges on signal, data and control lines.							
Applicability		Applicable for electronic measuring instruments containing active electronic circuits which during operation are temporarily or permanently connected to electrical signal, data and/or control lines that may exceed a length of 10 m.							
Object of the test		Verification of compliance with the provisions in 5.1.1 or 5.1.2 during conditions where electrical surges are superimposed on I/O and communication ports.							
Test procedure in brief		A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to electrical surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and the minimum time interval between two successive pulses are defined in the referred standard. At least 3 positive and 3 negative surges shall be applied. The applicable injection network depends on the kind of wiring 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 measurement time.							
The following test levels may be specified:									
Test level index (Installation class) (1)		0	1	2	**3**	4	5	i (2)	unit
Unsymmetrical lines	Line to line	n/a	n/a	0.5	**1.0**	2.0	2.0	U_1	kV
	Line(s) to ground	n/a	0.5	1.0	**2.0**	4.0	4.0	U_2	kV
Symmetrical lines	Line(s) to ground	n/a	0.5	1.0	**2.0**	4.0	4.0	U_3	kV
Shielded I/O and communication lines	Shield to ground	n/a	n/a	0.5	**2.0**	4.0	4.0	U_4	kV
Notes		(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**. (2) "i" and U_n indicate that an alternative voltage level may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice.							
Information to be presented in the applicable OIML Recommendation, where relevant		a) test level to be applied (installation class according to IEC 61000-4-5 [11]), b) climatic conditions, c) coupling method, d) setup 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 Electromagnetic environment related disturbances

Methods for determining the degradation of performance of the EUT when exposed to electromagnetic fields.

13.1 Mains power frequency electromagnetic field

See 8.4.2.9 for applicability (also refer to 4.5).

Table 31 - Mains power frequency magnetic field

Applicable standard		IEC 61000-4-8 [48].						
Test method		Exposure to power frequency magnetic fields (50 Hz or 60 Hz).						
Applicability		General.						
Object of the test		Verification of compliance with the provisions in 5.1.1 or 5.1.2 while exposed to power frequency magnetic fields (50 Hz or 60 Hz).						
Test procedure in brief		The test comprises exposure to a power frequency magnetic field (50 Hz or 60 Hz).						
The following test levels may be specified:								
Test level index (1)		1	2	3	**4**	**5**	*i* (2)	unit (3)
Magnetic field strength	Continuous field	1	3	10	**30**	**100**	H_{1i}	A/m
	Short duration (1 s to 3 s)	n/a	n/a	n/a	**300**	**1000**	H_{2i}	A/m
Notes		(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** (2) "*i*" and H_{xi} are variables indicating that alternative field strength levels may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. (3) The magnetic field strength is expressed in A/m. 1 A/m corresponds to a free space magnetic flux density of 1.26 µT.						
Information to be presented in the applicable OIML Recommendation, where relevant		a) test level to be applied, 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, d) the duration of the short duration test.						

13.2 Immunity to RF Electromagnetic fields

Table 32 - Conducted (common mode) currents generated by RF EM fields

Applicable standard	IEC 61000-4-6 [49].				
Test method	Injection of RF currents representing exposure to RF electromagnetic fields.				
Applicability	Applicable for electronic measuring instruments containing active electronic circuits and equipped with ports for throughput or connection of external electrical wiring (mains power, signal, data and control lines).				
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 while exposed to electromagnetic fields.				
Test procedure in brief	An RF 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 characteristics of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified before connecting the EUT. If the EUT comprises several devices the tests shall be performed at each extremity of the cable if both of the elements are part of the EUT. The dwell time of the amplitude modulated carrier at each frequency point shall not be less than the time necessary for the EUT to obtain one measurement error, but shall in no case be less than 0.5 s.				
The following test levels may be specified:					
Test level index [(1)]	1	2	**3**	i [(2)]	unit
RF amplitude	1	3	**10**	U_i	V (e.m.f.)
Frequency range [(3)]	0.15 – 80				MHz
Modulation	80 % AM, 1 kHz sine wave				
Notes	(1) The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** (2) "i" and "U_i" indicate that an alternative amplitude may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. (3) In the range from 26 MHz to 80 MHz, the type evaluation authority may decide to choose a transition frequency below 80 MHz when transitioning to the radiated RF field test (IEC 61000-4-3) [15]. Below the selected transition frequency tests will be carried out according to Table 32 and above according to Table 35. In the event of a dispute, the result of the test according to Table 35 prevails.				
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, b) climatic conditions, c) wiring to and from EUT, d) etc.				

Table 33 - Conducted, common mode disturbances in the frequency range 2 kHz to 150 kHz

Applicable standards	IEC 61000-4-19 [47].				
Test method	Introducing conducted, common mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at AC power ports using the test setup defined in the applicable standard.				
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation.				
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of conducted, common mode disturbances in the frequency range 2 kHz to 150 kHz.				
Test procedure in brief	A test generator is to be used which is suitable to generate the AC voltages for the required period of time. The performance of the test generator shall be verified before connecting the EUT. If the EUT is an integrating instrument, the continuous test shall be performed for a duration long enough to test its effect on the EUT.				
One of the following test levels shall be specified:					
For differential voltage testing [3]					
Environmental class	**E1**		**E2**		-
Test level index [1]	1	2	**3**	4	unit
	Open circuit unmodulated test voltage V (r.m.s.)				
2 kHz to 9 kHz [2]	0.5	3	**12**	20	V
9 kHz to 95 kHz [2]	0.5 to 0.1	3 to 0.6	**12 to 2.4**	20 to 10	V
95 kHz to 150 kHz [2]	0.1	0.6	**2.4**	10	V
For differential current testing [3]					
Environmental class	**E1**		**E2**		-
Test level index [1]	1	2	**3**	4	unit
	Unmodulated current in A (r.m.s.)				
2 kHz to 30 kHz [2]	1	2	**3**	4	A
30 kHz to 150 kHz [2]	0.5	1	**1.5**	2	A
Notes	[1] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** [2] The dwell time shall not be less than the time necessary for the EUT to be exercised and to respond but no less than 3 s. From 9 kHz to 95 kHz the logarithm of the level decreases linearly with the logarithm of the frequency. [3] Most electronic equipment is voltage powered, in which case only the differential voltage testing needs to be performed. However, when the EUT is measuring current, only the differential current test needs to be performed.				
Information to be presented in the applicable Recommendation, where relevant	a) performance of the instrument at each of the tests, b) climatic conditions, c) etc.				

Table 34 - Conducted, differential mode current disturbances in the frequency range 10 Hz to 150 kHz

Applicable standards	IEC 62053-41 [50], IEC 62052-11 [51], IEC 61000-4-19 [47].
Test method	Introducing conducted, differential mode disturbances and signalling in the frequency range 10 Hz to 150 kHz at DC power ports using the test setup defined in the applicable standard.
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to a DC mains power network while measuring current (e.g. DC kWh meters).
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of conducted, differential mode disturbances in the frequency range 10 Hz to 150 kHz.
Test procedure in brief	The test is performed with disturbances in the current only with the test conditions and severities specified below.
Test conditions:	Voltage circuits and auxiliary power supply circuits energized with their lower specified nominal voltage.
Test severity:	The differential test current I_{diff} shall be applied to: a) Current port of direct connected meters: i) 10 Hz to 2 kHz: $I_{diff} = 2$ A ii) 2 kHz to 150 kHz: $I_{diff} = 3$ A b) Current transformer port of transformer-operated meters: i) 2 kHz to 30 kHz: $I_{diff} = 0.03 \times I_{max}$ ii) 30 kHz to 150 kHz: $I_{diff} = 0.015 \times I_{max}$ c) Using test wave profiles “CW (Continuous Wave) pulses with pause” and “rectangular modulated pulses” (IEC 61000-4-19 [47] 5.2.2 and 5.2.3) d) With a tolerance for I_{diff} of ± 5% e) Frequency step shall be 1 % f) The dwell time shall not be less than the time necessary for the EUT to be exercised and to respond but no less than 3 s.
Mandatory test points:	10 I_{tr} for direct connected meters and 20 I_{tr} for transformer operated meters.
Acceptance criteria:	NSF, except for the indicating display function, which shall be evaluated according to criteria NSFa.
Information to be presented in the applicable Recommendation, where relevant	a) performance of the instrument at each of the tests, b) climatic conditions, c) etc.

Table 35 - Radiated RF electromagnetic fields

Applicable standard	IEC 61000-4-3 [15]; IEC 61000-4-20 [52].
Test method	Exposure to radiated radio frequency electromagnetic fields.
Applicability	Applicable for electronic measuring instruments containing active electronic circuits.
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of exposure to electromagnetic fields.
Test procedure in brief	The EUT is exposed to electromagnetic fields with the required field strength and the field uniformity as defined in the referred standard. The level of field strength specified refers to the field generated by the unmodulated carrier wave. The EUT shall be exposed to the modulated wave field. The frequency sweep shall be made only pausing to adjust the RF signal level or to switch RF-generators, amplifiers and antennas if 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 point shall not be less than the time necessary for the EUT to obtain one measurement error, but shall in no case be less than 0.5 s. Adequate EM fields can be generated in facilities of different type and setup, the use of which is limited by the dimensions of the EUT and the frequency range of the facility. The expected most critical frequencies (e.g. clock frequencies) shall be analysed separately. (1)
Test levels	Test levels may be specified according to Table 36 and Table 37.
Note	(1) These frequencies can be expected to correspond to the EUT emitted EM field frequencies.
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, b) climatic conditions, c) wiring to and from EUT, d) duration of the test, e) etc.

Table 36 – Radiated RF electromagnetic fields of general origin

Test level index [1]		1	2	**3**	4	i [2]	unit
Frequency range	(26) 80 – 1000 MHz [3] [4], [5]	1	3	**10**	30	E_i	V/m
Modulation	80 % AM, 1 kHz, sine wave						
Notes	[1] The test level considered most appropriate and preferable for OIML Recommendations is presented in **bold face.** [2] "*i*" and E_i indicate that an alternative field strength level may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. [3] The anechoic room method specified in IEC 61000-4-3 [15] is normally only applied above 80 MHz. For the lower frequency range the test methods for conducted radio frequency disturbances are recommended. [4] For an EUT without any cabling to apply the test specified in Table 32, the lower frequency limit shall be 26 MHz (refer to Annex F of IEC 61000-4-3 [15]). In all other cases both tests presented in Table 32 and Table 35 apply. [5] In the range 26 MHz – 80 MHz the type evaluation authority may decide to choose a transition frequency below 80 MHz. Below the selected transition frequency tests will be carried out according to Table 32 and above according to Table 35. In the event of a dispute, the result according to Table 35 prevails.						

Table 37 – Radiated RF electromagnetic fields specifically caused by wireless communication networks

Test level index [1]		1	2	**3**	**4**	i [2]	unit
Frequency range	446 MHz [3]	1	3	**10**	**30**	E_i	V/m
	(0.8 – 3) GHz [4]	1	3	**10**	**30**		
	(3 – 6) GHz [5]	1	**3**	**10**	**30**		
Modulation	80 % AM, 1 kHz, sine wave						
Notes	[1] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face.** [2] "i" and "E_i" indicate that an alternative field strength level may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice. [3] Applicable only for the Europe region. [4] The main test level selection criteria should be the consequences of failure of an instrument located at the expected minimum distance from a radiating source for wireless communication (see 8.4.2.10 and Annex G of IEC 61000-4-3 [15]) and the possibility of fraud by using such a radiating source (for instance a mobile phone or a transceiver). Selection of the level indexed 3 is suggested to apply only when the manufacturer of the measuring instrument specifies a minimum distance allowed between licensed communication transmitters and the measuring instrument. In all other cases the level indexed 4 is to be applied. [5] A rationale is required when specifying the need for testing in this frequency band (3 – 6) GHz (see 8.4.2.10 and IEC TR 61000-2-5 [10]).						

Table 38 - Radiated fields in close proximity

<table>
<tr><td>Applicable standards</td><td>IEC 61000-4-39 [17].</td></tr>
<tr><td>Test method</td><td>Exposure to RF magnetic and electromagnetic fields in close proximity</td></tr>
<tr><td>Applicability</td><td>Applicable for measuring instruments which are exposed to radiated electromagnetic energy from RF transmitters used in close proximity (distance from the emitting source ≤ 200 mm for frequencies greater than 26 MHz, or <500 mm for frequencies less than 26 MHz);</td></tr>
<tr><td>Object of the test</td><td>Verification of compliance with the provisions in 5.1.1 or 5.1.2 when exposure to RF magnetic and electromagnetic fields generated by transmitters in close proximity.</td></tr>
<tr><td>Test procedure in brief</td><td>1) Magnetic Field immunity (9 kHz to 26 MHz)

A loop antenna is passed at a test distance of 50 mm from all the faces of the instrument at specific frequency ranges defined by the relevant OIML Technical Committee, Subcommittee or Project Group.

The following frequency bands can be chosen:

<table>
<tr><th>Frequency band (kHz)</th><th>Linear Steps (kHz)</th><th>Number of Frequency points</th></tr>
<tr><td>9 to 150</td><td>10</td><td>15</td></tr>
<tr><td>150 to 1000</td><td>100</td><td>9</td></tr>
<tr><td>1000 to 26000</td><td>1000</td><td>25</td></tr>
</table>
- Dwell time: No less than 2 s, but enough to obtain one measurement error at each frequency point.
- Modulation: 80 % AM, 1 kHz sine wave.

2) Radiated RF field immunity (380 MHz to 6 GHz)

A horn antenna is passed at a test distance of 100 mm from all the faces of the instrument at specific frequency ranges defined by the relevant OIML Technical Committee, Subcommittee or Project Group. The frequency range is swept at steps of 1 % of the precedent frequency value.

Dwell time: Not less than 1 s, but enough to obtain one measurement error at each frequency point. At least two full cycles of modulation of the disturbance test signal shall be applied at each test frequency.

- Antenna orientation: Vertical and Horizontal.
- Modulation: Pulse Modulation.
▪ Duty cycle: 50 %
▪ Modulation frequency: 2 Hz, 217 Hz or 1 kHz
▪ On/off ratio: 20 dB minimum

Guidance on the applicable modulation frequency is provided in the applicable standard.

It is not intended that the test be applied continuously over the entire frequency range, instead, the relevant OIML Technical Committee, Subcommittee or Project Group must select those frequencies where interference from transmitters in close proximity is expected to occur.</td></tr>
<tr><td colspan="2">One of the following test levels may be specified:</td></tr>
</table>

Test level index [1]	**1**	**2**	3	4	$i^{(2)}$	unit
Magnetic Field immunity (9 kHz to 150 kHz)	1	3	10	30	H_i	A/m
Magnetic Field immunity (150 kHz to 26 MHz)	0.1	0.3	1	3	H_i	A/m
Radiated RF field immunity (380 MHz to 6 GHz)	10	30	100	300	E_i	V/m
Notes	[1] The test levels considered most appropriate and preferable for OIML Recommendations are presented in **bold face**. [2] "i", "H_i" and "E_i" indicate that an alternative field strength level that may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice.					
Information to be presented in the applicable OIML Recommendation, where relevant	a) applicable test frequencies b) amplitude and duration of the simulated disturbances, c) performance of the instrument at each of the tests, d) climatic conditions, e) etc.					

13.3 Immunity to electrostatic discharges

Test to determine the degradation of performance of the EUT when exposed to electrostatic discharges.

Table 39 - Electrostatic discharge

Applicable standard	IEC 61000-4-2 [53].
Test method	Exposure to electrostatic discharge (ESD).
Applicability	Applicable to all electronic measuring instruments.
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 in case of direct exposure to electrostatic discharges or such discharges in the neighbourhood of the EUT.
Test procedure in brief	The test comprises exposure of the EUT to electrical discharges. An ESD generator as defined in the referred standard shall be used and the test setup shall comply with the dimensions, materials used and conditions as specified in the referred standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges per preselected discharge location shall be applied. The time interval between successive discharges shall be at least 1 second. An EUT not equipped with a grounding connection shall be fully discharged between discharges. If the EUT is an integrating instrument, the test pulses shall be applied continuously during the measurement time. Contact discharge is the preferred test method. Air discharge is far less defined and reproducible and shall therefore be used only 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 before activation of the discharge. In such a case the discharge spark occurs in the vacuum relays of the contact discharge tip. On insulated surfaces, only the air discharge mode can be applied. The EUT is approached by the charged electrode until a spark discharge occurs. *Indirect application*: The discharges are applied in the contact mode only on coupling planes mounted in the vicinity of the EUT.

<table>
<tr><td colspan="8">The following test levels may be specified:</td></tr>
<tr><td colspan="2">Test level index [1]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>i [3]</td><td>unit</td></tr>
<tr><td rowspan="2">Test voltage [4]</td><td>Contact discharge</td><td>2</td><td>4</td><td>6</td><td>8</td><td>U_{1i}</td><td>kV</td></tr>
<tr><td>Air [2] discharge</td><td>2</td><td>4</td><td>8</td><td>15</td><td>U_{2i}</td><td>kV</td></tr>
<tr><td colspan="2">Notes</td><td colspan="6">[1] The test level considered most appropriate and preferable for OIML Recommendations is presented in bold face.
[2] In this case “level” means:
a) for air discharge: the tests shall be repeated for each severity level lower than the specified test level for the EUT (i.e. the test shall also be performed at the specified lower levels in the referred IEC standard).
b) for contact discharge: at the specified level only
[3] “i” and U_{ni} indicate that an alternative test voltage may be specified in the applicable OIML Recommendation if accompanied by a rationale for such choice.
[4] Contact discharges shall be applied on conductive surfaces.
Air discharges shall be applied on non-conductive surfaces.</td></tr>
<tr><td colspan="2">Information to be presented in the applicable OIML Recommendation, where relevant</td><td colspan="6">a) test level(s) to be applied,
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.</td></tr>
</table>

14 Battery and non-mains power supply related performance tests

Tests to determine the performance degradation of an EUT powered by batteries as a consequence of specific electrical influence quantities.

14.1 Low voltage of internal battery

Table 40 - Low voltage of internal battery (not connected to the mains power)

Applicable standards	No standard is available.
Test method	Applying low supply voltage levels to the EUT.
Applicability	Applicable to all measuring instruments equipped with stand-alone batteries or rechargeable batteries.
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 during low battery voltage levels.
Test procedure	The test comprises exposure of the EUT to the specific low battery level condition during a period sufficient for achieving temperature stability and for performing the required measurements. The minimum voltage (V_{min}) at which the instrument still complies the metrological requirements and the minimum battery supply voltage level (U_{bmin}) shall be specified by the manufacturer of the instrument. The power supply shall be capable of delivering sufficient current at the applicable voltage levels. The test sequence is as follows: 1) Nominal voltage condition a. Let the power supply stabilise at nominal voltage (V_{nom}) and apply the measurement and/or loading condition. b. Record the actual measurement conditions including date, time and environmental conditions and the power supply voltage. 2) Minimum voltage condition a. Apply the V_{min} b. Perform at least two measurements and record the errors and other relevant performance parameters. c. Verify compliance with 5.1.1 or 5.1.2. 3) Voltages below V_{min} Tests related to operation below V_{min} shall be established by relevant OIML Recommendation. Instruments of the same type having different nominal voltages shall have the above tests conducted at each nominal voltage. Instruments with a nominal voltage range which are intended to operate with different types of batteries shall demonstrate compliance of the low battery condition at the lowest battery voltage level from the set of battery types specified by the manufacturer.

The following test level may be specified:	
Test level index	1
Voltage levels	V_{nom} V_{min} U_{bmin}
Number of test cycles	At least one test cycle for each functional mode.
Information to be presented in the applicable OIML Recommendation, where relevant	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 12 V and 24 V road vehicle batteries

Note 1: The nominal voltage U_{nom} of the electrical system in road vehicles is usually 12 V or 24 V. However, the practical voltage at the battery terminals can vary considerably. ISO 7637-2 [19] specifies reference levels of 13.5 V and 27 V, respectively.

Note 2: 42 V systems are not within the scope of the ISO 7637 series of standards, nor of ISO 16750-2 [21].

Table 41 - Voltage variations from external 12 V and 24 V road vehicle batteries

Applicable standard	ISO 16750-2 [21].								
Test method	Variation in supply voltage.								
Applicability	Applicable to all measuring instruments supplied by the internal battery of a vehicle and charged by use of a combustion engine driven generator.								
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of high (while charging) and low battery voltage.								
Test procedure in brief	The test comprises exposure to the specified maximum and minimum power supply voltage conditions for a period sufficient for achieving temperature stability and performing the required measurements at these conditions.								
The following test levels may be specified:									
Nominal battery voltage	U_{nom} = 12 V				U_{nom} = 24 V				Unit
Test level index [1] [2]	A	B	**C**	D	E	**F**	G	H	
Lower limit	6	8	**9**	10.5	10	**16**	22	18	V
Upper limit	16	16	**16**	16	32	**32**	32	32	V
Notes	[1] In ISO 16750-2 [21] called “Code”. [2] Preferred test level for OIML Recommendations: Code C for 12 V batteries and code F for 24 V batteries.								
Information to be presented in the applicable OIML Recommendation, where relevant	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.								

Table 42 - Electrical transient conduction along supply lines of external 12 V and 24 V road vehicle batteries

<table>
<tr><td>Applicable standard</td><td colspan="4">ISO 7637–2 [19]</td><td>§ 5.6.2: Test pulse 2a + 2b
§ 5.6.3: Test pulse 3a + 3b</td></tr>
<tr><td>Test method</td><td colspan="5">Electrical transient conduction along supply lines.</td></tr>
<tr><td>Applicability</td><td colspan="5">Applicable to all measuring instruments supplied by the internal battery of a vehicle which may at the same time be charged by use of a combustion engine driven generator.</td></tr>
<tr><td>Object of the test</td><td colspan="5">Verification of compliance with the provisions in 5.1.1 or 5.1.2 under the following conditions [4]:
- transients due to a sudden interruption of current 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).</td></tr>
<tr><td>Test procedure in brief</td><td colspan="5">The test comprises exposure to disturbances on the power voltage by direct coupling into the supply lines.</td></tr>
<tr><td colspan="6">The following test levels may be specified:</td></tr>
<tr><td>Test level index [1] [2] [3]</td><td colspan="2">III</td><td colspan="2">IV</td><td rowspan="2">unit</td></tr>
<tr><td rowspan="2">Test pulse</td><td colspan="2">Pulse voltage U_s</td><td colspan="2">Pulse voltage U_s</td></tr>
<tr><td>U_{nom} = 12 V</td><td>U_{nom} = 24 V</td><td>U_{nom} = 12 V</td><td>U_{nom} = 24 V</td><td></td></tr>
<tr><td>2a</td><td>+55</td><td>+55</td><td>+112</td><td>+112</td><td>V</td></tr>
<tr><td>2b [5]</td><td>+10</td><td>+20</td><td>+10</td><td>+20</td><td>V</td></tr>
<tr><td>3a</td><td>–165</td><td>–220</td><td>–220</td><td>–300</td><td>V</td></tr>
<tr><td>3b</td><td>+112</td><td>+220</td><td>+150</td><td>+300</td><td>V</td></tr>
<tr><td>Notes</td><td colspan="5">[1] In ISO 7637-2 [19], so called “test levels”.
[2] In ISO 7637-2 [19], the former levels I and II were deleted because transients in road vehicles do not ensure a sufficient level of immunity.
[3] The referred standard is primarily intended as a basis for contracts between manufacturers of motor vehicles and electronic sub-assemblies. As instruments shall comply with the provisions in 5.1.1 or 5.1.2 in any type of car, test level IV is advised to incorporate in OIML Recommendations.
[4] Test pulse 1 mentioned in the standard is considered not applicable. Former test pulses 4 and 5 are no longer covered by the recent ISO 7637-2. Instead the recent ISO 16750-2 [21] covers the phenomenon of energising starter motor circuits of combustion engines. Refer to Table 43 (pulse 4 of former ISO 7637-2) and Table 44 (pulse 5 of former ISO 7637-2).
[5] Test pulse 2b is only applicable if the electrical power circuitry of the measuring instrument can be interrupted by the master switch of the car and as a consequence is not permanently connected to the battery of the car. This test will therefore be applicable in all situations where the manufacturer of the measuring instrument has not specified that the instrument is to be connected directly to the battery.</td></tr>
<tr><td>Information to be presented in the applicable OIML Recommendation, where relevant</td><td colspan="5">a) test pulses to be applied,
b) test level to be applied,
c) minimum number of pulses or test time,
d) performance of the EUT during and after the test pulses.</td></tr>
</table>

Table 43 - Electrical transient conduction via lines other than supply lines from external 12 V and 24 V road vehicle batteries

Applicable standard	ISO 7637-3 [20], § 3.5.1: fast transient test pulses a and b.						
Test method	Electrical transient conduction along lines other than supply lines.						
Applicability	Only applicable to analogue I/O cabling of measuring instruments installed in vehicles (1).						
Object of the test	Verification of 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.						
	The following test levels may be specified:						
Test level index			I	II	III	**IV** (2)	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) Only the capacitive coupling clamp method shall be applied. (2) 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, test level IV is advised for application in OIML Recommendations.						
Information to be presented in the applicable OIML Recommendation, where relevant	a) test level to be applied, b) performance of the EUT during and after the test pulses.						

Table 44 - Battery voltage variations when starting up a vehicle engine

Applicable standard	ISO 16750-2 [21].							
Test method	Supply voltage variation due to energising the starter motor of a vehicle.							
Applicability	Measuring instruments powered by on board DC battery and which may be in operation while the vehicle engine is started.							
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of starting the vehicle engine (during and after cranking).							
Test procedure in brief	The test comprises exposure to a typical supply voltage characteristic simulating the voltage variation while cranking the engine using a DC electrical starter motor.							
The following test profiles may be specified:								
Nominal battery voltage	U_{nom} = 12 V				U_{nom} = 24 V			Unit
Test profile [1]	**I** [2]	II	**III** [2]	IV	**I** [2]	II	**III** [2]	
U_S	**8**	4.5	**3**	6	**10**	8	**6**	V
U_A	**9.5**	6.5	**5**	6.5	**20**	15	**10**	V
t_8	**1**	10	**1**	10	**1**	10	**1**	s
t_f	**40**	100	**100**	100	**40**	100	**40**	ms
Notes	[1] As specified in ISO 16750-2 [21]. [2] Preferred test profiles for OIML Recommendations.							
Information to be presented in the applicable OIML Recommendation, where relevant	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.							

Table 45 - “Load dump” test

Applicable standard	ISO 16750-2 [21].				
Test method	Supply voltage variation due to disconnecting a discharged battery.				
Applicability	Measuring instruments powered by on board DC battery and which may be in operation while the vehicle engine is running.				
Object of the test	Verification of compliance with the provisions in 5.1.1 or 5.1.2 under conditions of disconnecting a discharged vehicle battery while the charging alternator is running.				
Test procedure in brief	The test comprises exposure to a typical pulse on the supply voltage, simulating the voltage peak due to the impedance of connected loads when disconnecting the battery.				
The following pulse shapes may be specified:					
Nominal battery voltage	U_{nom} = 12 V		U_{nom} = 24 V		Unit
Test pulse shape [1]	**A** [2]	**B** [2]	**A** [2]	**B** [2]	
U_S	**80**	**100**	**150**	**200**	V
R_i	**0.5**	**4**	**1**	**8**	V
t_r	**10**	**10**	**10**	**10**	ms
t_d	**40-400**	**40-400**	**100-350**	**100-350**	ms
Notes	[1] As specified in ISO 16750-2 [21]. [2] Preferred test pulse shapes for OIML Recommendations.				
Information to be presented in the applicable OIML Recommendation, where relevant	a) preconditioning of the instrument, b) test pulses to be applied, c) test level to be applied, d) minimum number of pulses or test time, e) performance of the EUT during and after the test pulse.				

Annex A

Documentation for type evaluation

(Informative)

The applicable OIML Recommendation specifies the documentation to be submitted with the application for type approval which at least includes information concerning the

- principle of operation,
- actual design,
- integrity securing measures,
- software and data management,
- installation requirements,
- operating instructions,
- provisions for testing, servicing and maintenance,
- specific instrument or device depending measures needed, and
- evidence on compliance to the requirements of the OIML Recommendation.

Examples:

concerning the principle of operation:

- specific description/flowchart giving the technical characteristics and the principle of operation.

concerning the actual design:

- design drawings; photographs; panel layout,
- flow diagram of the logic, showing the functions of the constituent devices,
- description of the devices with drawings, diagrams,
- lists of the essential constituent devices, modules and components with their essential characteristics.

concerning the integrity securing measures:

- installation and security sealing plan,
- drawing(s) presenting the security sealing plan and the provisions and location for verification marks,
- drawing of regulatory markings.

concerning software and data management:

- specific information on the software required,
- assessment of metrological relevant software.
  Note: Refer to OIML D 31 [1] for further details.

concerning the installation requirements:

- an assembly drawing with identification of different constituent parts,
- installation practices or operational constraints.

concerning operating instructions:

- user and installer manual,
- for correction devices, a description of the determination and execution of the correction.

concerning provisions for testing, servicing and maintenance:

- availability and location of mounting and connection provisions for testing,
- availability and location of provision for switching to a test service or maintenance mode.

concerning specific instruments and assemblies;

- list of the parts that may influence the metrological behaviour with a description of their constituent materials.

concerning evidence on compliance to the requirements of the OIML Recommendation:

- certificates and test reports,
- declaration of conformity by the manufacturer.

Annex B

Durability assessment

(Informative)

B.1 Introduction

B.1.1 Objective

The objective of the durability assessment is to verify the instrument's capability to operate correctly within the performance criteria over the required period of time.

Since deterioration of an instrument may occur (i) suddenly due to the failure of one of its components, which may happen at an unpredictable moment during its lifetime, or (ii) gradually due to wear and tear, the durability assessment comprises determination of the capability of the instrument to

- act adequately upon the failure of a component,
- collect information on the possible occurrence of defects during its complete lifetime.

B.1.2 Verification of the instrument's capability to act adequately upon failure of a part or component

Tests may be carried out to verify the correct performance of durability protection facilities and checking facilities by creating situations that these facilities are designed to act upon, provided that the integrity of the instrument is maintained. Study of the documentation on circuitry may give guidance. The applicable OIML Recommendation may specify the parts that are to be tested. Special attention should be paid to parts (electronic or mechanic) for which properties may be expected to change gradually during the lifetime of the instrument.

B.1.3 Assessment of the possible occurrence of defects during the lifetime of the complete measuring system

Information concerning this subject can only be collected by performing actual endurance tests simulating the complete lifetime by accelerating the instrument's wear and tear. 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 applicable OIML Recommendation may specify certain endurance tests.

B.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 to carry 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 sophisticated forms of durability protection, the instrument may automatically compare the result of checking operations with stored result values and automatically conclude whether it is still 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 applicable OIML 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 C

Facility for tests on barometric pressure

(Informative)

C.1 Introduction

At the date of publication of this Document no publication is available on a standard method describing a test facility for the evaluation of the influence of minor changes in the barometric pressure on the performance of measuring instruments.

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

This Annex presents a brief description for a simple test setup, primarily designed and designated 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 introduced are very small: the difference in atmospheric pressure between the test chamber and the outer atmosphere will never exceed 20 kPa. So, no special precautions need to be taken with respect to pressure related safety measures.

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

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

C.2 Facility for barometric pressure test

It must be clearly emphasized that the facility described below is just one possible solution. Other solutions may be equally acceptable.

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

The principle of the test facility is depicted in Figure C-1 and a practical setup is shown in Figure C-2.

The vessel (1) is partly filled with water.

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

A transparent vessel (4), having a smaller diameter than the one mentioned before, is placed upside down within the first vessel (1) to form a water seal (5) between the two vessels. Furthermore, there should be a means (6) that prevents the vessel from floating. This could be either a bar as shown in Figure C-2 or some other heavy object.

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

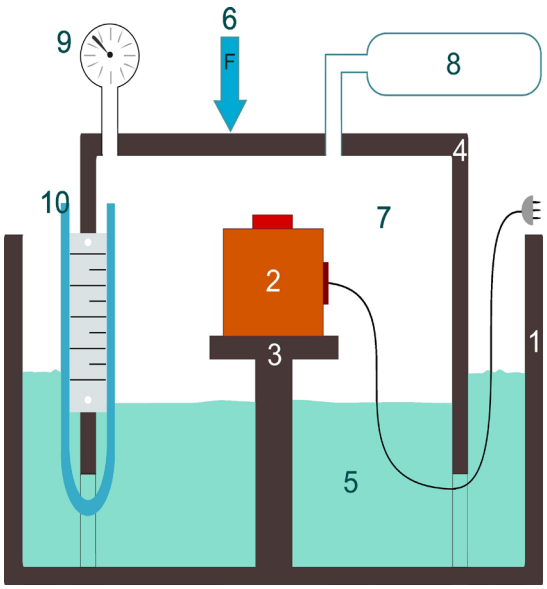
The vessel (1) shown in Figure C-2 a has a diameter of about 50 cm.

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 may be used.

Warning:

Due to the presence of water and a metal housing, this facility may only be used in situations where safe voltages occur (*U* < 50 V, i.e. extra low voltage range), 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

Figure C-1 The basic principle

Figure C-2 The practical setup

Annex D
Comparison table
(Informative)

OIML D 11:2026		OIML D 11:2013		Remarks
Ref.	**Description**	**Ref.**	**Description**	
3.2	Module	3.2	Module	Terminology for "Module" is updated. Improved for clarity.
3.23	power converter	3.23	Power converter (power supply device)	Definition has been updated to eliminate the undefined term: 'sub-assembly'
3.29	environmental Conditions			Terminology for 'Environmental Conditions' is added for clarity.
3.30	cranking			Terminology for 'cranking' is added for clarity.
3.31	test generator			Terminology for 'test generator' is added for clarity.
3.32	burst generator			Terminology for 'burst generator' is added for clarity.
3.33	Abbreviations	3.30	Abbreviations	Abbreviations list updated to include missing or new abbreviations.
Table 2	Classification based on expected mechanical environment	Table 2	Classification based on expected mechanical environment	Table 2 updated to include Shock considerations for hand-held devices. A new table describing the tests for hand-held devices has also been introduced.
Table 4	Test method selection based on classification of electromagnetic environment	Table 4	Test method selection based on classification of electromagnetic environment	Table 4 updated to include new tests and updates to some existing tests
8.4.2.1	Ripple on DC mains power	8.4.2.1	Ripple on DC mains power	Concerns with poorly designed DC sources are addressed.
8.4.2.6	VLF and LF disturbances on mains power lines	8.4.2.6	VLF and LF disturbances on mains power lines	Note has been removed. No longer applicable. Test methods have been established.

OIML D 11:2026		OIML D 11:2013		Remarks
Ref.	**Description**	**Ref.**	**Description**	
8.4.2.10	Radiated RF electromagnetic fields and resulting induced RF currents	8.4.2.10	Radiated RF electromagnetic fields and resulting induced RF currents	This clause was updated to include tests for radiated field in close proximity. A new table describing the tests has also been introduced.
8.6	Additional guidance for instruments supplied by DC sources other than batteries			This is a new section introducing guidance for instruments supplied by DC sources other than batteries. Provides the background and justification for introducing this new requirement.
8.6.1	AC-DC converters			This is a new test concerned with AC-DC convertors. Recommended severity levels for tests are identified for DC mains in Table 4.
Table 5	Evaluation method in general applicable to the test	Table 5	Evaluation method in general applicable to the test	This table has been modified with updated with new tests and evaluation methods. A new evaluation criteria (NSF) is introduced requiring evaluation during and after the disturbance.
9.2.2	Integrating instruments	9.2.2	Integrating instruments	Figure 1 has been updated to include time sequences for NSF evaluation
Table 17	Mechanical shock -stationary device	Table 17	Mechanical shock	Title has been adjusted to account for addition of Table 18
Table 18	Mechanical shock – hand held device			This is a new table introduced to address mechanical shock for hand-held devices.
Table 19 to Table 32		Table 18 to Table 31		Table numbers have been increased by one to account for addition of new Table 18.
Table 27	Bursts (transients) on AC and DC mains	Table 26	Bursts (transients) on AC and DC mains	Tests at 5kHz has been replaced by a test at 100 kHz with an option to perform a 5 kHz test.

OIML D 11:2026		OIML D 11:2013		Remarks
Ref.	**Description**	**Ref.**	**Description**	
Table 28	Surges on AC and DC mains power lines	Table 27	Surges on AC and DC mains power lines	Added requirement to perform tests at lower severity levels.
Table 29	Bursts (transients) on signal, data and control lines	Table 28	Bursts (transients) on signal, data and control lines	Tests at 5kHz has been replaced by a test at 100 kHz with an option to perform a 5 kHz test.
Table 32	Conducted (common mode) currents generated by RF EM fields	Table 31	Conducted (common mode) currents generated by RF EM fields	Added clause to provide clarity on dwell time for applied test frequencies.
Table 33	Conducted, common mode disturbances in the frequency range 2 kHz to 150 kHz			A new test for conducted, common mode disturbances is introduced.
Table 34	Conducted, differential mode current disturbances in the frequency range 10 Hz to 150 kHz			A new test for conducted, differential mode current disturbances is introduced.
Table 35 to Table 37		Table 32 to Table 34		Table numbers have been increased by three to account for addition of new Table 18, Table 33 and Table 34.
Table 35	Radiated RF electromagnetic fields	Table 32	Radiated RF electromagnetic fields	Updated clause addressing dwell time for applied test frequencies.
Table 38	Radiated fields in close proximity			This is a new table concerning tests for exposure to RF transmitters used in close proximity (distance from the emitting source $\leq$ 200 mm for frequencies greater than 26 MHz, or <500 mm for frequencies less than 26 MHz)
Table 39 to Table 45		Table 35 to Table 41		Table numbers have been increased by four to account for addition of new Table 18, Table 33, Table 34 and Table 38.
Table 39	Electrostatic discharge	Table 35	Electrostatic discharge	Notes related to test levels have been updated

OIML D 11:2026		OIML D 11:2013		Remarks
Ref.	**Description**	**Ref.**	**Description**	
Table 40	Low voltage of internal battery (not connected to the mains power)	Table 36	Low voltage of internal battery (not connected to the mains power)	Test procedure and sequence have been modified for clarity and improved process.
Table 42	Electrical transient conduction along supply lines of external 12 V and 24 V road vehicle batteries	Table 38	Electrical transient conduction along supply lines	Test pulse levels have been updated to align with most recent version of ISO 7637-2.
Annex D	Bibliography and notes	Annex D	Bibliography and notes	Identified documents have been updated to reference latest versions. The numerical order of listed references has been adjusted to align with OIML B6-2 guidelines. The identification of the reference numbers within D 11 has been updated throughout the document to reflect the re-numbered list.

Annex E

Bibliography and notes

(Informative)

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: https://webstore.iec.ch

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

OIML publications: http://www.oiml.org/en/publications/ (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 be followed by the edition referred to (generally the year or the date).

Ref.	Standards and reference documents	Description
[1]	OIML D 31:2023 *General requirements for software-controlled measuring instruments*	Specifies the general requirements applicable to legally relevant software-related functionality and security in measuring instruments and gives guidance for verifying the compliance of an instrument with these requirements.
[2]	OIML V 1:2022 *International vocabulary of terms in legal metrology (VIML)*	Provides set of terms and definitions related to various aspects of legal metrology which are dealt with in OIML publications.
[3]	OIML V 2-200:2012 *International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)*. 3rd Edition (Edition 2010 with minor corrections)	Vocabulary, drawn up by Working group 2 of the Joint Committee for Guides in Metrology (JCGM), consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML.
[4]	OIML B6-2:2023 *Directives for OIML technical work. Part 2: Guide to the drafting and presentation of OIML publications*	Provides instructions for the drafting and presentation of OIML publications to ensure that all OIML publications are presented in as uniform a manner as possible.
[5]	IEC 60068-1 Ed. 7.0 (2013-10), *Environmental testing –* Part 1: *General and guidance* Stability date: 2027	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.

Ref.	Standards and reference documents	Description
[6]	IEC 60721-3-3 Ed.3.0 (2019-05) *Classification of environmental conditions* − Part 3: *Classification of groups of environmental parameters and their severities* – Section 3: *Stationary use at weather-protected locations* Stability date: 2027	Classifies groups of environmental parameters and their severities to which products are subjected when mounted for stationary use at weather-protected locations.
[7]	IEC 60721-3-4 Ed. 3.0 (2019-05) *Classification of environmental conditions* − Part 3: *Classification of groups of environmental parameters and their severities* − Section 4: *Stationary use at non-weather protected locations* Stability date: 2027	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-weather protected.
[8]	IEC 60068-3-4 Ed. 2.0 (2023-06) *Environmental testing* – Part 3: *Supporting documentation and guidance* –Section 4: *Damp heat tests* Stability date :2027	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 in electrical and mechanical characteristics. Damp heat tests may also be utilised to check the resistance of a specimen to some forms of corrosion attack.
[9]	IEC 60068-3-8 Ed. 1.0 (2003-08) *Environmental testing* – Part 3: *Supporting documentation and guidance* –Section 8: *Selecting amongst vibration tests* Stability date: 2025	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.

Ref.	Standards and reference documents	Description
[10]	IEC TR 61000-2-5 Ed.3.0 (2017-01) *Electromagnetic compatibility (EMC) –* Part 2: *Environment* − Section 5: *Description and classification of electromagnetic environments* Stability date: 2025	This publication is a technical report intended for guidance 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.
[11]	IEC 61000-4-5:2014+AMD1:2017 CSV Ed. 3.1 (2017-08) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques* – Section 5: *Surge immunity test* Stability date: 2027	Provides the immunity requirements, test methods, and range of recommended test levels for electrical and electronic equipment to unidirectional surges caused by overvoltage from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. It establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.
[12]	IEC 61000-4-17:1999+AMD1:2001+AMD2:2008 CSV Ed. 1.2 (2009-01) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques* – Section 17: *Ripple on DC input power port immunity test* Stability date: 2027	Provides 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. This standard defines: - test voltage waveform, - range of test levels, - test generator, - test setup, - test procedure. This test does not apply to equipment connected to battery charger systems incorporating switch mode converters.
[13]	IEC 61000-4-29 Ed. 1.0 (2000-08) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques* – Section 29: *Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests* Stability date: 2025	Provides 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. This standard defines: - the range of test levels, - the test generator, - the test setup, - the test procedure.
[14]	IEC 61000-4-13:2002+AMD1:2009+AMD2:2015 CSV Ed. 1.2 (2015-12) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques* – Section 13: *Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests* Stability date: 2026	Provides the immunity test methods and range of preferred basic test levels for electrical and electronic equipment with rated current up to 16 A per phase at disturbance frequencies up to and including 2 kHz (for 50 Hz mains) and 2.4 kHz (for 60 Hz mains) for harmonics and inter-harmonics on low voltage power networks.

Ref.	Standards and reference documents	Description
[15]	IEC 61000-4-3: Edition 4.0 (2020-09) *Basic EMC Publication – Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 3: *Radiated, radio-frequency, electromagnetic field immunity test* Stability date: 2025	Provides the immunity requirements of electrical and electronic equipment to radiated electromagnetic energy. It 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 form any source.
[16]	IEC 60601-1-2:2014 2014 +AMD1:2020 CSV Ed. 4.1 (2020-09) *Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral Standard: Electromagnetic disturbances - Requirements and tests*	Applies to the basic safety and essential performance of Medical Equipment (ME) equipment and ME systems in the presence of electromagnetic disturbances and to electromagnetic disturbances emitted by me equipment and me systems. This collateral standard to IEC 60601-1 specifies general requirements and tests for basic safety and essential performance with regard to electromagnetic disturbances and for electromagnetic emissions of ME equipment and ME systems.
[17]	IEC 61000-4-39:Ed 1.0 (2017-03) *Electromagnetic compatibility (EMC) - Part 4-39: Testing and measurement techniques - Radiated fields in close proximity - Immunity test* Stability date: 2025	Specifies immunity requirements for electrical and electronic equipment when it is exposed to radiated electromagnetic energy from RF transmitters used in close proximity. It establishes test levels and the required test procedures. The applicable frequency range is 9 kHz to 6 GHz. It has the status of a basic EMC publication in accordance with IEC Guide 107.
[18]	ISO 7637-1 Ed. 4 (2023-12) *Road vehicles – Electrical disturbance from conducting and coupling –* Part 1: *Vocabulary and general considerations*	Defines basic terms related to electrical disturbances from conduction and coupling used in the other parts of this standard and gives general information common to all parts.
[19]	ISO 7637-2 Ed. 3 (2011-03) *Road vehicles – electrical disturbance from conducting and coupling –* Part 2: *Electrical transient conduction along supply lines only*	Provides test methods and procedures to ensure the compatibility to conducted electrical transients of equipment installed on passenger cars and commercial vehicles fitted with 12 V or 24 V electrical systems. It describes bench tests for both the injection and measurement of transients. It is applicable to all types of road vehicles independent of the propulsion system (e.g. spark ignition or diesel engine, electric motor). Function performance status classification for immunity to transients is also provided.
[20]	ISO 7637-3 Ed. 3 (2016-07) *Road vehicles – Electrical disturbance by conducting and coupling –* Part 3: *Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines*	Provides 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 intention of the test is to demonstrate the immunity of the instrument, device or equipment when subjected to fast transient disturbances coupled from ambient wiring, such as those caused by switching (switching of inductive loads, relay contact bounce, etc.).
[21]	ISO 16750-2 Ed. 5.0 (2023-07) *Road vehicles – Environmental conditions and testing for electrical and electronic equipment –* Part 2: *Electrical loads*	Specifies electrical loads and provides 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).

Ref.	Standards and reference documents	Description
[22]	IEC 61000-4-4 Ed. 3.0 (2012-04) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 4: *Electrical fast transient/burst immunity test* Stability date: 2025	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/bursts 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 setup, - test procedure. The standard gives specifications for laboratory and post-installation tests. This third edition constitutes a technical revision of the second version and improves and clarifies simulator specifications, test criteria and test setups.
[23]	OIML G 19:2017 *The role of measurement uncertainty in conformity assessment decisions in legal metrology*	Provide guidance to OIML Secretariats and Conveners and to members of OIML Technical Committees, Subcommittees and Project Groups, on incorporating the concept of “measurement uncertainty” into OIML Recommendations and other OIML publications used for legal metrology purposes.
[24]	IEC 60068-2-2 Ed 5.0 (2007-07) *Environmental testing –* Part 2: *Test methods –* Section 2: Test B: *Dry heat* Stability date: 2024	Concerns exposure to high temperatures and low humidity (dry heat) tests on both non-heat-dissipating and heat-dissipating specimens and contains the following tests with gradual change of temperature: Bb: for non-heat-dissipating specimens; Bd: for heat-dissipating specimens and Be: for heat-dissipating specimens powered throughout the test.
[25]	IEC 60068-3-1 Ed. 3.0 (2023-06) *Environmental testing –* Part 3: *Supporting documentation and guidance* –Section 1: *Cold and dry heat tests* Stability date: 2027	Provides guidance regarding the performance of cold and dry heat tests. This second edition cancels and replaces the first edition, published in 1974, and constitutes a technical revision. The main changes with regard to the previous edition are as follows: - removal of guidance regarding thermal characteristics of chamber walls; - revision of sections that address environmental chambers that do not use movement of air for temperature control.
[26]	IEC 60068-2-1 Ed. 6.0 (2007-03) *Environmental testing –* Part 2: *Test methods –* Section 1: Test A: *Cold* Stability date: 2024	Concerns exposure to low temperatures (cold) tests on both non-heat-dissipating and heat-dissipating specimens.

Ref.	Standards and reference documents	Description
[27]	IEC 60068-2-78 Ed. 2.0 (2012-10) *Environmental testing –* Part 2: *Tests methods –* Section 78:Test Cab: *Damp heat, steady state* Stability date: 2024	Provides a test method for determining the suitability of electro technical 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. This second edition includes editorial and format changes with respect to the first edition. The test chamber from IEC 60068-3-6 has been introduced.
[28]	IEC 60068-2-30 Ed 3.0 (2005-08) *Environmental testing –* Part 2: *Test methods –* Section 30: Test Db: *Damp heat, cyclic (12 + 12 hour cycle)* Stability date: 2024	Determines the suitability of components, equipment or other articles for use, transportation and storage under conditions of high humidity - combined with cyclic temperature changes and, in general, producing condensation on the surface of the specimen.
[29]	IEC 60068-2-18 Ed. 3.0 (2017-03) *Environmental testing –* Part 2: *Test methods –* Section 18: Test R and guidance: *Water* Stability date: 2026	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 enclosure covers and seals to maintain components and equipment in good working order after and, when necessary, under a standardised drop field or immersion in water. These tests are not corrosion tests and should not be considered or 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 on 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.
[30]	IEC 60512-14-7 Ed. 1.0 (1997-10) *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods* – Part 14: *Sealing tests* – Section 7: Test 14g: *Impacting water* Stability date: 2026	Defines a standard test method to assess the effects of impacting water or specified fluid on electrical connecting devices.

Ref.	Standards and reference documents	Description
[31]	IEC 60529:1989+AMD1:1999+AMD2:2013 CSV Ed. 2.2 (2013-08) *Degrees of protection provided by enclosures (IP Code)* Corr.1 (2003-01) Ed. 2.1 Corr.2 (2007-10) Ed. 2.1 Stability date: 2025	Applies to the classification of degrees of protection provided by enclosures for electrical equipment with a rated voltage not exceeding 72.5 kV.
[32]	IEC 60512-11-8 Ed. 1.0 (1995-11) *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods* – Part 11: *Climatic tests* – Section 8: Test 11h – *Sand and dust* Stability date: 2026	Defines a standard test method to assess the ability of a connector to withstand driving fine sand and dust.
[33]	IEC 60721-2-5 Ed. 1.0 (1991-07) *Classification of environmental conditions* – Part 2: *Environmental conditions appearing in nature* – Section 5: *Dust, sand, salt mist* Stability date: 2024	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.
[34]	IEC 60068-2-11 Ed. 4.0 (2021-03) *Environmental testing* – Part 2: *Test methods* – Section 11: Test Ka: *Salt mist* Stability date: 2027	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.
[35]	IEC 60068-2-47 Ed 3.0 (2005-4) *Environmental testing* – Part 2: *Test methods* – Section 47: *Mounting of specimens for vibration, impact and similar dynamic tests* Stability date: 2029	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).
[36]	IEC 60068-2-64 Ed 2.1 (2019-10) *Environmental testing* – Part 2: *Test methods* – Section 64: Test Fh: *Vibration, broad-band random and guidance* Stability date: 2025	Determines the adequacy of specimens to resist dynamic loads without unacceptable degradation of its functional and/or structural integrity when subjected to the specified random vibration test requirements. Broadband random vibration may be used to identify accumulated stress effects and the resulting mechanical weakness and degradation in the specified performance. This standard is applicable to specimens which may be subjected to vibration of a stochastic nature resulting from transportation or operational environments, for example in aircraft, space vehicles and land vehicles. It is primarily intended for unpackaged specimens and for items in their transportation container when the latter may be considered as part of the specimen itself.
[37]	IEC 60068-2-6 Ed 7.0 (2007-12) *Environmental testing* – Part 2: *Tests* – Section 6: Test Fc: *Vibration (sinusoidal)* Stability date: 2027	Concerns 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.

Ref.	Standards and reference documents	Description
[38]	IEC 60068-2-31 Ed 2.0 (2008-05) *Environmental testing –* Part 2: *Test methods –* Section 31: Test Ec: *Rough handling shocks, primarily for equipment-type specimens* Stability date: 2026	Provides a test procedure for simulating the effects of rough handling shocks, primarily in equipment-type specimens, the effects of knocks, jolts and falls which may be received during repair work or rough handling in operational use. This procedure does not simulate the effects of impacts received during transportation as loosely constrained cargo.
[39]	IEC 60654-2:1979+AMD1:1992 CSV Ed. 1.1 (1979-01) *Operating conditions for industrial-process measurement and control equipment –* Part 2: *Power* Stability date: 2024	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.
[40]	IEC TR 61000-4-1 Ed.1.0 (2016-04) *Basic EMC publication –* *Electromagnetic compatibility (EMC) –* Part 4-1: *Testing and measurement techniques –* Section 1: *Overview of IEC 61000-4 series* Stability date: 2025	Provides 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.
[41]	IEC TR 61000-2-1 Ed. 1.0 (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* Stability date: 2027	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, and DC components.
[42]	IEC 61000-4-28:1999+AMD1:2001+AMD2: 2009 CSV Ed. 1.2 (2009-04) *Electromagnetic compatibility (EMC)* - Part 4-28: *Testing and measurement techniques - Variation of power frequency, immunity test for equipment with input current not exceeding 16 A per phase* Stability date: 2027	Establishes a reference for evaluating the immunity of electric and electronic equipment when subjected to variations of the power frequency. Only conducted phenomena are considered, including immunity tests for equipment connected to public and industrial networks.
[43]	IEC 61000-2-2:2002+AMD1:2017+AMD2:2018 CSV Ed. 2.2 (2018-05) *Electromagnetic compatibility (EMC) –* Part 2 *Environment* − Section 2: *Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems* Stability date: 2027	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.

Ref.	Standards and reference documents	Description
[44]	IEC 61000-4-11 Ed.3.0 (2020-01) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 11:*Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase* Stability date: 2028	Provides 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. It applies to 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 equipment for connection to 400 Hz AC networks. 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.
[45]	IEC 61000-6-1 Ed. 3.0 (2016-08) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 6: *Generic standards* – Section 1: *Immunity for residential, commercial and light-industrial environments* Stability date: 2025	Defines the immunity performance requirements for electrical and electronic apparatus intended for use in residential, commercial and light-industrial environments, both indoor and outdoor and for which no dedicated product or product-family standard exists. Immunity requirements in the frequency range 0 kHz to 400 GHz are covered in relation to continuous and transient conducted and radiated disturbances, including electrostatic discharges 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. This standard also applies to apparatus which are battery operated or powered by a non-public, but non-industrial, low voltage power distribution system if they are intended to be used in the environments described above.
[46]	IEC 61000-6-2 Ed. 3.0 (2016-08) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 6: *Generic standards* – Section 2: *Immunity for industrial environments* Stability date: 2025	Defines the immunity performance requirements for electrical and electronic apparatus intended for use in industrial environments, both indoor and outdoor and 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, and are specified for each port considered. This standard applies to apparatus intended to be connected to a power network supplied from a high or medium voltage transformer dedicated to the supply of an installation feeding manufacturing or similar plant, and intended to operate in or in proximity to industrial locations, as described below. This standard also applies to apparatus which are battery operated and intended to be used in industrial locations. Industrial locations are in addition characterised by the existence of one or more of the following: - industrial, scientific and medical (ISM) apparatus (as defined in CISPR 11); - heavy inductive or capacitive loads are frequently switched; - currents and associated magnetic fields are high.

Ref.	Standards and reference documents	Description
[47]	IEC 61000-4-19 Ed 1.0 (2014-05) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 19: *Test for immunity to conducted, differential mode disturbances and signalling in the frequency range from 2 kHz to 150 kHz, at a.c. power ports* Stability date: 2026	Provides the immunity requirements and test methods for electrical and electronic equipment to conducted, differential mode disturbances and signalling in the range 2 kHz up to 150 kHz at a.c. power ports. These tests are intended to demonstrate the immunity of electrical and electronic equipment operating at a mains supply voltage up to 280 V (from phase to neutral or phase to earth, if no neutral is used) and a frequency of 50 Hz or 60 Hz when subjected to conducted, differential mode disturbances such as those originating from power electronics and power line communication systems (PLC). The immunity to harmonics and interharmonics, including mains signalling, on a.c. power ports up to 2 kHz in differential mode is covered by IEC 61000-4-13 [14].
[48]	IEC 61000-4-8 Ed. 2.0 (2009-09) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 8: *Power frequency magnetic field immunity test* Stability date: 2027	Provides 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 - medium voltage and high voltage sub-stations.
[49]	IEC 61000-4-6 Ed 5.0 (2023-06) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 6: *Immunity to conducted disturbances, induced by radio-frequency fields* Stability date: 2027	Provides the immunity requirements of electrical and electronic equipment to conducted electromagnetic disturbances originating 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.
[50]	IEC 62053-41 Ed. 1.0 (2021-06) *Electricity metering equipment – Particular requirements –Part 41: Static meters for DC energy (classes 0,5 and 1)* Stability date: 2027	Applies to static watt-hour meters of accuracy classes 0,5 and 1 for the measurement of DC electrical energy in DC systems, and it applies to their type tests only.
[51]	IEC 62052-11 Ed. 2.0 (2020-06) *Electricity metering equipment - General requirements, tests and test conditions - Part 11: Metering equipment* Stability date: 2027	Specifies requirements and associated tests, with their appropriate conditions for type testing of AC and DC electricity meters. This document details functional, mechanical, electrical and marking requirements, test methods, and test conditions, including immunity to external influences covering electromagnetic and climatic environments.
[52]	IEC 61000-4-20 Ed 3.0 (2022-02) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 20: *Emission and immunity testing in transverse electromagnetic (TEM) waveguides* Stability date: 2025	Provides radiated immunity test methods for electrical and electronic equipment using various types of transverse electromagnetic (TEM) waveguides. These types include open structures (for example, striplines and electromagnetic pulse simulators) and closed structures (for example, TEM cells).

Ref.	Standards and reference documents	Description
[53]	IEC 61000-4-2 Ed. 2.0 (2008-12) *Basic EMC Publication –* *Electromagnetic compatibility (EMC) –* Part 4: *Testing and measurement techniques –* Section 2: *Electrostatic discharge immunity test* Stability date: 2024	Provides the immunity requirements and test methods for electrical and electronic equipment subjected to static electricity discharges, from operators directly, and from any person to adjacent objects. It additionally defines ranges of test levels which relate to different environmental and installation conditions and establishes test procedures.