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FOREWORD

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

The two main categories of OIML publications are:

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

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

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

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

This publication – reference OIML R 129-2, Edition 20xx – was developed by Project Group 1 of OIML TC 7/SC 5 *Dimensional Measuring Instruments*. It was approved for final publication by the International Committee of Legal Metrology in 20xx and will be submitted to the International Conference of Legal Metrology in 20xx for formal sanction.

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Multi-dimensional measuring instruments

Part 2 - Metrological Controls and Performance Tests

OIML recognises that the ideal legal metrological control strategy for one country or region is not necessarily the ideal for all others. OIML D 16 Principles of assurance of metrological control [8], discusses the factors to consider in order to design and implement more effective control systems. Part 2 of this Recommendation is based on a system with several elements comprising type evaluation and approval, initial verification and metrological supervision.

6 TYPE EVALUATION

A type of instrument is presumed to comply with the requirements of clause s 4.2 and 4.3, if it has passed the examination and tests specified in Annex A.

6.1 DOCUMENTATION

Submission of an instrument to a national metrology service for type evaluation shall be accompanied by sufficient technical information including drawings, specifications, photographs and descriptions to ensure complete understanding of the construction and method of operation of the instrument.

Details of the measurement data contained in the memory and calculation methods shall also be provided.

For electronic measuring instruments the documentation shall include a list of electronic sub-assemblies with their essential characteristics, and a description of the electronic devices with drawings/diagrams and general software information explaining their construction and operation.

6.2 INSTRUMENTS SUBMITTED FOR TESTING

Examination shall be carried out on one or more sample instruments submitted for laboratory tests. If all tests cannot be completed in the laboratory, an examination of a sample instrument on site shall also be carried out.

6.3 LABORATORY EXAMINATION

The instrument shall be examined in conjunction with the submitted documentation to ensure that it complies with the metrological and technical requirements of Sections II and III.

6.4 LABORATORY TESTS

6.4.1 General

Laboratory tests shall be performed in accordance with any limitations of use marked on the instrument or included in any documentation accompanying the instrument.

Test procedures are detailed in Annex A (mandatory), Guidelines on object limitations are given in Annex B (informative).

6.4.2 Test objects

The test shall be carried out using appropriate test objects of various sizes and of stable dimensions. The test objects shall be opaque, rigid and with flat faces and well defined straight edges. Test objects may consist of rectangular boxes with dimensions which are known to an expanded uncertainty (coverage factor $k = 2$) of not more than one-fifth of the mpe. The dimensions shall also be checked to the same uncertainty when used at the extreme values of the influence factors. The dimensions of these objects shall lie within the range of values bounded by the minimum and maximum dimensions measurable by the instrument. All adjacent faces and edges shall be perpendicular to each other.

The dimensions of the test object shall be $N \times d$ where N is a whole number and d is the value of the scale interval. For the different scale intervals, namely 1, 2 or 5×10^n , $N = 10, 20$, etc, would be suitable as a test object for all. This is applicable for type evaluation and verification tests.

Note: It has been proposed to allow test objects to have different dimensions to $N \times d$ if the instrument is provided with a test scale interval at least 5 times smaller than d – see comment #74/NL-29.

Does the PG agree with this proposal?

6.4.3 Acceptable indications

For compliance with the mpes, indications of $N \times d$ and $(N \pm 1) \times d$ are acceptable. Indications of $(N \pm [\geq 2]) \times d$ are not acceptable.

For compliance with the significant fault, a difference of 1 d between indications with and without the disturbance applied is acceptable whereas a difference of more than 1 d is not acceptable.

6.4.4 Tests for influence factors, disturbances and light and acoustic effects

Before a test is conducted and without a test object on the instrument, the instrument shall be in a zero or ready condition. The test object shall be placed in accordance with the manufacturer's instructions. Instruments tested under laboratory conditions shall comply with the mpes (4.1.2) for influence factors (4.2.1) and humidity effects (4.2.2), and comply with the significant fault requirements for disturbances (4.3). Instruments based on light or acoustic techniques shall comply with the mpes (4.1.2) for light and acoustic effects (4.3.4).

6.4.5 Tests for irregular shaped objects

For irregular shaped test objects the smallest dimension for an axis shall be equal to, or greater than, the minimum dimension for that axis. However it must be possible to determine the dimensions of the object to such an accuracy that the smallest rectangular box which fully encloses the object can be calculated within the required uncertainty.

If the instrument is marked with a minimum protrusion to be measured, a test object with that size protrusion shall be used to verify the marked limit.

If a particular irregularly-shaped object is frequently encountered by an instrument then test object/s should be used that test the instrument's measurement capabilities with respect to that frequently encountered object.

Note: The secretariat suggests inclusion of the requirement in the last paragraph, above, as a solution to a potentially infinite array of possible irregular shaped objects test requirements. This requirement is intended to allow construction of suitable test objects in instances where an instrument frequently encounters a particular type of irregularly shaped object.

Do members of the PG agree with this addition?

6.4.6 Tests for different orientations and positions

If the instrument does not depend on a particular orientation of the object, several different orientations shall be tested. Also if the instrument does not depend on the object being placed in a particular position on the measuring plane, several different positions shall be tested.

6.4.7 Tests for automatic instruments

For automatic instruments, tests at the maximum and minimum speeds of relative movement shall be carried out.

6.4.8 Tests for multi-interval instruments

For multi-interval instruments, tests shall be performed for all values of the scale interval, i.e. d_1 , d_2 , ..., d_r .

6.4.9 Tests for different surfaces

Instruments shall be tested with objects of varying surface characteristics to check the limits of such characteristics marked on the instrument or included in the user's manual. Annex B gives guidelines on known surface characteristics to be checked such as color (uniform and non-uniform), contrast of color with measurement plane, reflectivity and absorption of sound and light, transparency, roughness or other.

6.4.10 Tests for interface

If the instrument is provided with an interface through which ancillary devices or other instruments can be connected, the tests shall be carried out with a sample device connected and tests applicable to the interface applied (see 5.5.2). The electromagnetic susceptibility test (see A.3.4) may be carried out on an instrument with only an unterminated cable, 3 m long, connected to the interface.

6.5 INITIAL VERIFICATION

6.5.1 Verification conditions

Initial verification of instruments is normally carried out after installation and under the intended conditions of use. The installation and conditions of use shall be appropriate for the design of the instrument as described in the type evaluation certificate and shall allow the specified performance requirements to be achieved.

6.5.2 Conformity

An instrument shall conform to the type evaluation certificate with respect to its construction and metrological functions.

Devices such as zero adjustment, indicators, printers, etc. shall be checked for correct functioning.

The nameplate shall contain the required information including the type evaluation mark.

Any notices including notices of limitations of use required by the certificate shall be checked to ensure that they are readily available to the operator and processes are in place to ensure that they are adhered to.

6.5.3 Test objects

Test objects shall be available and comply with the requirements of 6.4.2.

6.5.4 Accuracy tests

Accuracy tests shall be carried out in accordance with test A.1.1 at the operating conditions in effect at the time of verification. Acceptable indications for compliance with the mpes specified in 4.1.2 are given in 6.4.3.

6.5.5 Other tests

Other tests as appropriate shall be carried out in accordance with the corresponding tests described in 6.2.4. These tests may include:

- (a) tests for irregular shaped objects (6.4.5);
- (b) tests for different orientations and positions (6.4.6);
- (c) tests for automatic instruments (6.4.7);
- (d) tests for multi-interval instruments (6.4.8); and
- (e) tests for different surfaces (6.4.9).

6.6 Subsequent Verification

Unless national regulations specify otherwise, subsequent verification tests shall be carried out in accordance with accuracy tests specified in 6.5.4 using test objects specified in 6.4.2.

ANNEX A PERFORMANCE TESTS (MANDATORY)

Performance tests carried out under the influence factors, disturbances and humidity effects specified in clauses 4.2 and 4.3, ensure that measuring instruments perform over a range of environmental conditions likely to be met in normal use.

A.1 General

A.1.1 Test Procedure for Instrument Warm up time

Test method	The instrument shall be switched on for a period of time equal to, or greater than, the warm-up time specified by the manufacturer. Power is to be "on" for the duration of each test.
Applicability	General.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.1.
Test procedure in brief	Two test objects shall be used, one near minimum dimensions and one near maximum dimensions. One test shall be carried out for each test object at 0, 5, 15 and 30 min after the dimensions are first displayed after switch-on
Test Level	The results at each dimension for each object shall be compared with the mpes (4.1.2). This shall be checked by carrying out a warm-up time test at reference conditions (4.1.6(d)). The instrument shall be correct (within the mpes) as soon as the values of the dimensions are displayed (5.1.6).
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.

The following tests apply to the various types of electronic instruments using the following principles of operation.

Table A.1 Applicable tests

	Test	Mechanical measuring device	Optical measuring device	Acoustic measuring device	Battery operated
A.2.1	Static temperatures	x	x	x	x
A.2.2	Damp heat	x	x	x	x
A.2.3	AC power variation	x	x	x	
A.2.4	Battery voltage variation	x	x	x	x
A.3.1	Short time power reduction	x	x	x	
A.3.2	Electrical bursts	x	x	x	
A.3.3	Electrostatic discharge	x	x	x	x
A.3.4	Electromagnetic susceptibility	x	x	x	x
A.4.1	Ambient light effects		x		
A.4.2	Acoustic effects			x	

Note: Table A.1 is not all-inclusive, but illustrates the test selection criteria.

A.1.2 Tests for influence factors

Before tests are conducted, and without a test object in the measurement area, the instrument shall be in zero or ready condition. Test objects shall be used such that at least three measurements of at least five dimensions approximately equally spaced between and including at or near minimum and maximum dimensions, shall be carried out for each axis (L , W and H). The tests shall first be carried out under reference conditions (4.1.6(d)) and then at each of the extreme conditions of the influence factors specified in 4.2.1.

Note: Comment #79/NL-32 raises the question of whether only one measurement for each dimension should be made and repeatability should be included as a separate requirement and test.

Do members of the PG agree with this proposal?

When the effect of one influence factor is being evaluated, all other factors shall be held relatively constant at a value close to the reference conditions specified in 4.1.6(d).

The three test results at each dimension and each condition shall be compared with the mpes (4.1.2). If applicable the variation between indicators shall be checked against the permissible difference (4.1.3). Any calculated quantities shall be checked for correct multiplication and rounding (4.1.5).

The effect of influence factors on any interfaces (5.5.6) or electronic sealing provisions (5.4.2) shall also be checked.

A.1.3 Tests for disturbances

Tests for disturbances shall be carried out on all electronic instruments.

Tests using at least one test object shall be carried out, firstly at reference conditions (see 4.1.6(d)) and no disturbance, and then with the applications of each disturbance specified in 4.3. Only one disturbance at a time shall be applied. The disturbances shall be applied during the display mode of the three dimensions (L , W and H). The difference between the tests with and without the disturbance shall be compared with the significant fault (2.3.6). All indicators shall be checked.

The effect of disturbances on any interfaces (5.5.6) or electronic sealing provisions (5.4.2) shall also be checked.

A.1.4 Tests for humidity effects

Before the test is conducted and without a test object on the instrument, the instrument shall be in zero or ready condition.

For the damp heat, steady state test, at least three measurements of at least five approximately equally spaced, dimensions between and including at or near minimum and maximum dimensions shall be carried out at the reference conditions (4.1.6(d)) before and after the application of the damp heat and at the specified damp heat (A.2.2) after 48 h at these conditions.

The three test results at each dimension and at each condition shall be compared with the mpes (4.1.2).

A.1.5 Tests for light and acoustic effects

The tests shall be carried out as specified in A.1.2 under the variation of light and acoustic effects given in A.4.

The three test results at each dimension and at each condition shall be compared with the mpes (4.1.2).

A.1.6 Tests for other effects

Tests for irregularly shaped objects, for different orientations of the object, for the range of relative motion, for multi-interval instruments, for different surfaces and for interfaces if applicable (see 6.4.5 to 6.4.10) shall be carried out under reference conditions (see 4.1.6(d)). The tests as specified in A.1.2 shall be used, except that at least three measurements of at least three dimensions shall be carried out for each axis. All results shall be compared with the mpes (4.1.2).

A.2 Test procedures for influence factors

Additional information for carrying out the test procedures for influence factors is given below. The instrument being tested is referred to as the equipment under test (EUT).

Note: The secretariat suggests that all tests in sections A.2, A.3 and A.4 need to be updated to bring them into alignment with the equivalent tests in OIML D11:2013.

Does the PG agree with this suggestion?

A.2.1 Static temperatures test

A.2.1.1 Test procedure for Dry Heat

Test method	Exposure to dry heat (non-condensing).
Applicability	General.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.2 under conditions of high temperature.
Test procedure in brief	<p>The test comprises exposure to the specified high temperature under “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).</p> <p>Three measurements on every sample are taken using each unit, at every test condition.</p>
Test Level	<p>The EUT shall be tested as specified in A.1.2</p> <ul style="list-style-type: none"> (a) at a temperature of 20 °C following conditioning; (b) at the specified high temperature; (c) at the specified low temperature; and (d) again at 20 °C following conditioning. <p>The change in temperature shall not exceed 1 °C/min during heating up and cooling down.</p> <p>The absolute humidity of the test atmosphere shall not exceed 20 g/m³.</p> <p>When tests are performed at temperatures below 35 °C, the relative humidity shall not exceed 50 %.</p>
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.
References	OIML D11 (2013), IEC 60068-2-1 (14), IEC 60068-2-2 (16) and IEC 60068-3-1 (15).

A.2.1.2 Test procedure for Cold

Test method	Exposure to low temperature.
Applicability	General.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.2 under conditions of low temperature.
Test procedure in brief	The test comprises exposure to the specified low temperature under “free air” conditions during the period of time specified (the period specified is the

	<p>period following the moment at which the EUT has reached temperature stability).</p> <p>Three measurements on every sample are taken using each unit, at every test condition.</p>
Test Level	<p>The EUT shall be tested as specified in A.1.2</p> <p>(a) at a temperature of 20 °C following conditioning;</p> <p>(b) at the specified high temperature;</p> <p>(c) at the specified low temperature; and</p> <p>(d) again at 20 °C following conditioning.</p> <p>The change in temperature shall not exceed 1 °C/min during heating up and cooling down.</p> <p>The absolute humidity of the test atmosphere shall not exceed 20 g/m³.</p> <p>When tests are performed at temperatures below 35 °C, the relative humidity shall not exceed 50 %.</p>
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.
References	OIML D11 (2013), IEC 60068-2-1 (14), IEC 60068-2-2 (16) and IEC 60068-3-1 (15).

A.2.2 Test procedure for Damp heat, steady-state (non-condensing)

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 in a closed location.
Object of the test	<p>Verification of compliance with the provisions in 4.2.2 and A.1.4 under conditions of high humidity and constant temperature.</p> <p>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.</p>
Test procedure in brief	<p>The test comprises exposure to the specified high level temperature and the specified constant relative humidity for a certain fixed period of time.</p> <p>The EUT shall be handled such that no condensation of water occurs on it.</p> <p>Three measurements on every sample are taken using each unit, at every test condition.</p>
Test severity	<p>The EUT shall be tested as specified in A.1.4:</p> <p>(a) at the reference conditions of 20 °C and 50 % relative humidity;</p> <p>(b) at the specified high temperature (40 °C or other) and 85 % relative humidity after 48 h; and</p> <p>(c) again at 20 °C and 50 % relative humidity.</p>
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.
References	OIML D11 (2013), IEC 60068-2-78 (13) and IEC 60068-3-4 [15].

A.2.3 Test procedure for AC Power variation test

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 4.2.1 and A.1.2 under conditions of AC mains network voltage changes between upper and lower limit.
Test procedure in brief	<p>The EUT shall be subjected to AC mains power variations specified in 4.2.1 under constant environmental conditions.</p> <p>Three measurements on the sample are taken using each unit, at every test condition.</p> <p>In case of three phase mains power, the voltage variation shall apply for each phase successively.</p>
Test level	<p>The EUT shall be tested as specified in A.1.2:</p> <ul style="list-style-type: none"> (a) at nominal voltage; (b) at an upper limit of 110 % of nominal voltage and (c) at a lower limit of 85 % of nominal voltage. <p>Note: The nominal voltage marked on the instrument. If a voltage range is marked the upper limit applies to the high level value of the range and the lower limit applies to the low level value of the range.</p>
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.
References	OIML D11 (2013), IEC 61000-4-1 [27] and IEC/TR3 61000-2-1 [24].

A.2.4 Test procedure for DC Power variation test

Test method	Applying minimum supply voltage.
Applicability	Applicable to all measuring instruments supplied by direct current.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.2 during low battery voltage.
Test procedure in brief	<p>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 maximum internal impedance of the battery and the minimum battery supply voltage level shall be specified by the manufacturer of the instrument.</p> <p>If an alternative power supply source is used instead of the internal battery, for instance in bench testing, the internal impedance of the specified type of battery shall also be simulated.</p> <p>The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage.</p>
Test level	<p>The EUT shall be tested as specified in A.1.2:</p> <ul style="list-style-type: none"> (a) at nominal voltage; and (b) at various reduced voltages below nominal voltage.

	The nominal voltage is that specified by the manufacturer.
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2 or alternatively the indication shall be blank.
References	OIML D11 (2013).

A.3 Test procedures for disturbances

A.3.1 Test procedure for short time power reduction test

Test method	Introducing short-time reductions of mains voltage using the test setup defined in the applicable standard.
Applicability	Applicable to all electronic measuring instruments supplied by AC mains voltage.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.2 during low supply voltage.
Test procedure in brief	<p>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.</p> <p>The performance of the test generator shall be verified before connecting the EUT.</p> <p>The mains voltage reduction tests shall be repeated 10 times with intervals of at least 10 s between the tests.</p> <p>If the instrument operates over a range of voltages and the maximum voltage is greater than 20% of the test should be carried out at the voltage minimum and maximum.</p>
Test level	<p>Each test shall be repeated ten times with an interval of at least 10 s. The EUT shall be tested as specified in A.1.3 with the following reductions:</p> <p>(a) 100 % reduction in 8 to 10 ms; and</p> <p>(b) 50 % reduction in 16 to 20 ms.</p>
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the short time power reduction, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013), IEC 61000-4-11 [34], IEC 61000-6-1 [37] and IEC 61000-6-2 [38].

A.3.2 Test procedures for electrical bursts test

Test method	Introducing transients on the mains power lines.
Applicability	Applicable to all measuring instruments supplied by internal battery or AC mains voltage.
Object of the test	Verification of compliance with the provisions in 4.2.1 and A.1.2 during low supply voltage.
Test procedure in brief	<p>The EUT shall be subjected to electrical bursts of voltage spikes. The test shall be conducted under constant environmental conditions.</p> <p>The transient generator shall have an output impedance of 50 W and shall be adjusted before connecting the EUT. At least ten positive and ten</p>

	negative randomly phased bursts of voltage spikes with a double exponential waveform shall be applied. Each spike shall have a rise time of 5 ns and a half amplitude duration of 50 ns. The burst length shall be 15 ms, the burst period (repetition time interval) shall be 300 ms.
Test level	The EUT shall be tested as specified in A.1.3 at the following amplitudes (peak values): (a) 1 kV for power supply lines; and (b) 0.5 kV for input/output control circuits and communication lines (c) with a repetition frequency of the impulses of 5 kHz \pm 20 %.
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the electrical bursts, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013) and IEC 61000-4-4 [30].

A.3.3 Test procedures for electrostatic discharge test

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 4.2.1 and A.1.2 during low battery voltage.
Test procedure in brief	<p>The EUT shall be subjected to both direct and indirect electrostatic discharges under constant environmental conditions.</p> <p>A capacitor of 150 pF shall be charged using a suitable DC voltage source. The capacitor shall then be discharged through the EUT via 330 W to surfaces which are normally accessible to the operator. At least ten discharges shall be applied. The time interval between successive discharges shall be at least 10 s. The EUT shall be placed on a grounded plate which projects beyond the EUT by at least 0.1 m on all sides. The ground connection to the capacitor shall be as short as possible.</p> <p>In the contact discharge mode, to be carried out on conductive surfaces, the electrode shall be in contact with the EUT and the discharge shall be actuated by the discharge switch of the generator.</p> <p>In the air discharge mode, on insulating surfaces, the electrode shall be brought up to the EUT and the discharge occurs by spark.</p>
Test level	The EUT shall be tested as specified in A.1.3 at a test voltage up to and including 6 kV for the contact mode and 8 kV for the air mode.
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the electrostatic discharge, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013) and IEC 61000-4-2 [28].

A.3.4 Electrical Surges Test

A.3.4.1 Test procedures for surges on AC and DC mains power lines

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 4.2.1 and A.1.3 during conditions where electrical surges are superimposed on the mains voltage.
Test procedure in brief	<p>A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT.</p> <p>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.</p>
Test level	<p>At least 3 positive and 3 negative surges shall be applied.</p> <p>On AC mains supply lines the surges shall be synchronized with the AC supply frequency and shall be repeated such that the injection of surges on all the 4 phase shifts: 0°, 90°, 180° and 270° with the mains frequency is covered.</p> <p>The injection network circuit depends on the applicable conductor and is defined in the referred standard.</p> <p>(a) If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measurement time.</p>
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the surge, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013) and IEC 61000-4-5 [31].

A.3.4.2 Test procedures for surges on signal, data and control lines

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 4.2.1 or A.1.3 during conditions where electrical surges are superimposed on I/O and communication ports.
Test procedure in brief	<p>A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT.</p> <p>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.</p>

Test level	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. (a) If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measurement time.
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the surge, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013) and IEC 61000-4-5 [31].

A.3.5 Electromagnetic susceptibility test

A.3.5.1 Test procedures for Radiated RF Electromagnetic fields

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 4.2.1 or A.1.3 under conditions of exposure to electromagnetic fields.
Test procedure in brief	<p>The EUT shall be exposed to electromagnetic radiation under constant environmental conditions. The field strength can be generated using the following methods:</p> <ul style="list-style-type: none"> (a) the strip line is used at low frequencies (below 30 MHz or in some cases below 150 MHz) for small EUTs; (b) the long wire is used at low frequencies (below 30 MHz) for larger EUTs; or (c) dipole antennas, antennas with circular polarization or other antennas placed at least 1 m from the EUT for high frequencies. <p>The specified field strength shall be established prior to the actual testing without the EUT in the field. The field shall be generated in two orthogonal polarizations and the frequency range shall be scanned slowly. If antennas with circular polarization, for example logspiral or helical, are used to generate the electromagnetic field a change in the position of the antennas is not required.</p> <p>When the test is carried out in a shielded enclosure to comply with international laws prohibiting interference to radio communications, the effect of reflected radiation from the shield shall be negated by such means as anechoic shielding.</p>
Test level	The EUT shall be tested as specified in A.1.3 at a field strength of 10 V/m, 80 % AM, 1 kHz sine wave over frequency ranges of 26 MHz to 2 000 MHz for EUT having no mains or other input port available and 80 MHz to 2 000 MHz for EUT having mains or other input port available.
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the electromagnetic susceptibility of the instrument, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013), IEC 61000-4-3 [29] and IEC 61000-4-20 [38].

A.3.5.2 Test procedures for Conducted RF Electromagnetic fields

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 4.2.1 or A.1.3 under conditions of exposure to electromagnetic fields.
Test procedure in brief	<p>The test procedure involves the use of radio frequency EM current, simulating the influence of EM fields coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard.</p> <p>The performance of the test equipment consisting of an RF generator, decoupling devices, attenuators, etc. shall be verified.</p> <p>The functional performance of the EUT is observed (e.g. displayed indications and/or error messages) while at least ten PMB measurements on the sample are taken with the conducted radio-frequency fields applied.</p>
Test level	The EUT shall be tested as specified in A.1.3 at a RF amplitude (50 Ω), 10 V (e.m.f) , 80% AM, 1 kHz sine wave over EM frequency range of 0.15 – 80 MHz.
Acceptance Criteria	If the instrument does not detect and react to a significant fault occurring as a consequence of the electromagnetic susceptibility of the instrument, then the fault shall not exceed the value defined in 2.3.6.
References	OIML D11 (2013) and IEC 61000-4-6 [32].

A.4 Tests for light and acoustic effects**A.4.1 Test procedures for Ambient light test**

Note: Should examples of uneven light consistent with those included with comment #97/NL-42 be included in this document?

Also, should additional test report sheets be included for uneven light?

Test method	Exposure to ambient light variations
Applicability	Applicable for instruments based on light techniques.
Object of the test	Verification of the compliance with the provisions in 4.3.4 and A.1.5.
Test procedure in brief	The EUT shall be subjected to ambient light variations under constant environmental conditions. The EUT shall be tested as specified in A.1.2 at the following levels of illuminance using a normal industrial white light source (for example halogen incandescent lights in a room such as an environmental chamber where the illumination can be controlled).
Test level	<p>(a) 200 lx to 500 lx (reference);</p> <p>(b) 100 lx; and</p> <p>(c) 1 000 lx to 1 500 lx.</p>

	<p>In addition, tests (a) and (c) shall be repeated with uneven illumination.</p> <p>(d) The reference light intensity is considered to be 200 lx to 500 lx.</p> <p>(e) The levels apply where the object to be measured is normally placed. The luminance can be measured with a photographic light meter (photometer) with the light detecting surface pointing towards the light source.</p> <p>(f) The light source for test (a) can be the normal room lighting suitably dimmed.</p> <p>(g) The light source for tests (b) and (c) can be a photographic slide projector with a halogen projection lamp. The angle of projection should be at approximately 45° to the axis of the light measurement transducer of the instrument. The specified levels of illuminance can be achieved by placing the projector at different distances from the instrument. Other light sources can be used.</p> <p>(h) Uneven light can be achieved by using a masked slide in the slide projector so that light and dark areas cover the test object.</p> <p>If the manufacturer specifies special uses for the instrument outside the severity levels given, tests at those levels shall be carried out (for example at 15 000 lx for sunlight)</p>
Acceptance Criteria	<p>All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.</p> <p>Alternative operations may be provided if the instrument can only perform correctly over a limited range of light intensity, for example:</p> <p>(i) the instrument is either made inoperative automatically or a visual or audible indication is provided automatically when outside the limits; or</p> <p>(j) the instrument is provided with a light source to ensure the limited range is maintained. If the light source fails (a) above applies.</p>

A.4.2 Test procedures for Acoustic tests

Test method	Exposure to acoustic noise vibrations.
Applicability	Applicable for measuring instruments with devices based on acoustic techniques.
Object of the test	Verification of compliance with the provisions in 4.3.4 and A.1.5..
Test procedure in brief	The EUT shall be subjected to acoustic noise vibrations under constant environmental conditions.
Test level	<p>The EUT shall be tested as specified in A.1.2 at a sound intensity level of 100 dB at the nominal center frequency (resonant frequency) of the ultrasonic transducer(s) employed on the instrument. The noise source shall be operated for three bursts of 10 s duration.</p> <p>The noise source shall be positioned no closer than 1.5 m from any ultrasonic transducer on the instrument and in no case shall cause damage to the instrument or impede the normal use of the instrument as specified by the manufacturer.</p> <p>The test equipment shall include:</p> <p>acoustic chamber;</p>

	<p>function generator; amplifier; ultrasonic transducer; and sound level meter.</p> <p><i>Note:</i> Several test transducers may be needed to cover the center frequencies of the transducers used in the instruments being tested.</p>
Acceptance Criteria	All functions shall operate as designed. The test results shall comply with the mpes specified in 4.1.2.

ANNEX B GUIDELINES ON OBJECT LIMITATIONS (INFORMATIVE)

B.1 General

Multi-dimensional measuring instruments use a number of technologies to measure the dimensions of an object and thereby determine the volume of the smallest rectangular box which would fully enclose the object. All technologies have a limited ability to measure all objects correctly. These limitations have to be recognized and instruments have to be marked accordingly and/or have appropriate instructions in the user's manual for the operator to follow. The following guidelines give information on known limitations associated with the objects to be measured.

Characteristics of the object which can affect the measurement are:

- (a) shape;
- (b) surface characteristics such as color (uniform and non-uniform), contrast of surface color with the background color of the measuring plane, reflectivity and absorption of sound and light, transparency, roughness and protrusions;
- (c) uniformity of density; and
- (d) orientation and position in the measuring instrument.

Instruments are tested with test objects to determine if they measure within the mpes specified. Test objects have to be of a known shape and size and constructed from a suitable material so that there is a high probability that any errors found are due to the instrument and not to the test objects. It is essential that the dimensions of the test objects are traceable to national measurement standards.

However in practice not all objects are of ideal shape or material, or have dimensions which are easily traceable to national standards. Therefore there may be errors of measurement due to the non-ideal characteristics of the object as well as errors due to the instrument.

This Recommendation requires that the instrument be marked with any limitations of use (or instructions included in a user's manual) and it is therefore necessary for tests to be carried out to justify these limitations. Reliance is also placed on the operator of the instrument to ensure that the limitations are adhered to.

It must be recognized, however, that it is highly improbable that all these precautions will totally eliminate the measurement of unsuitable objects. Features can be built into the instrument to guard against some of the more obvious misuses but it is also essential to train operators and establish good work practices.

Clauses B.2 to B.4 list the known limitations of objects and Table B.1 specifies which limitations apply to the different technologies used for measuring the object.

Table B.1 Applicable object limitations

Applicable clause in Annex B	Principle of operation			
	Reflection of sound (1)	Reflection of light (2)	Cutting a light beam (3)	Mechanical (4)
B.2 Shape	x	x	x	x
B.3.1 Uniform surface color		x		
B.3.2 Non-uniform surface color		x		
B.3.3 Contrast of surface color with background color		x		
B.3.4 Surface reflectivity and absorption of sound	x			
B.3.5 Surface reflectivity and absorption of light		x		

B.3.6 Uniformity of density	x			
B.3.7 Transparency		x	x	
B.3.8 Surface roughness	x	x	x	x
B.3.9 Protrusions of the surface	x	x	x	x
B.4 Orientation and position	x	x	x	x

Examples:

- (1) Ultrasonic unit that transmits and receives sound waves which are reflected from an object.
- (2) Laser or LED unit that transmits and receives light waves which are reflected from an object.
- (3) LED unit that transmits a light beam, and an opposing light sensor that detects when the beam is cut by an object.
- (4) A mechanical wheel device that rolls a wheel along the surface of the object.

B.2 Shape of the object

Some instruments can only measure a rectangular box while others can measure irregular shaped objects and determine the dimensions of the smallest rectangular box which fully encloses the object. Instruments which only measure rectangular boxes shall be so marked.

If an instrument can measure irregular shapes in some, but not all, of the dimensions, the instrument shall be marked that it is only to be used for measuring rectangular boxes.

B.3 Surface characteristics

B.3.1 Uniform color

The surface color of an object only affects instruments which use light as the principle of measurement. Light colored objects are more easily measured than dark objects due to better reflectivity or contrast. Suitable test objects with surfaces varying from shiny white to matt black can be used to determine if the specified limits marked on the instrument are correct.

B.3.2 Non-uniform color

The non-uniformity of surface color of an object means that different intensities of light are reflected from different parts of the object, for example if black tape is wrapped around a white box, or if a shiny plastic invoice sleeve is fixed to a low light reflective surface. Suitable test objects of non-uniform color can be used to determine if the instrument is affected by such variations.

B.3.3 Contrast of surface color with the background color

Some instruments measure by contrasting the surface color of the object against the background color of the measuring plane. The contrast may be a light color against a dark color or a shiny surface against a matt surface. The surface of the background plane has to be chosen to accommodate most objects to be measured. Test objects of varying contrasting color to the color of the measuring plane can be used to determine limits of contrast.

B.3.4 Reflectivity and absorption of sound

Some instruments use sound to measure objects. The sound reflective qualities of an object relate to its density and smoothness. The more dense and smooth the object is, the better reflector it is. The following examples are arranged in order of best to worse reflective properties:

- (a) smooth, flat steel;
- (b) smooth, flat plywood;
- (c) smooth, flat, corrugated cardboard; and

(d) polystyrene foam.

Test objects of polystyrene foam can be used to test the instrument.

B.3.5 Reflectivity and absorption of light

For instruments which use light waves to measure objects, a shiny, smooth, white surface reflects better than a rough, matt, black surface. Also instruments may not perform as well if there is a mixture of surfaces, for example if shiny sealing tape is wrapped around a matt surface or if there is a plastic cover over documents attached to the surface. Additionally, a mixture of light and shadow on the surface may degrade performance. Suitable test objects and light conditions can be used to determine if the instrument is affected by these characteristics.

B.3.6 Uniformity of density

The object being measured may not be uniformly dense. For example if a metal container is inside a polystyrene foam box, sound waves may be absorbed and reflected from the metal. A test object can be constructed to check this feature.

B.3.7 Transparency

Solid objects wrapped in a transparent material such as “bubble plastic” may not be measured correctly by instruments which use light as the measuring technology. A suitable test object can be prepared to check this feature.

B.3.8 Roughness

An object with a rough surface may degrade the measuring performance of an instrument using any of the technologies for the measurement. A test object with rough surfaces can be used to check this characteristic.

B.3.9 Protrusions

Instrument which only measure rectangular boxes are not able to measure protrusions on the surface. Instruments which measure irregular shaped objects measure protrusions but only above a minimum size. Labels, handles or similar small protrusions on rectangular boxes need not be measured by either type of instrument.

Larger protrusions which could occur on irregular shaped objects need to be measured and included in the determination of the smallest rectangular box which fully encloses the object. Therefore the smallest specified protrusion which can be measured by the instrument needs to be tested with a suitable test object.

B.4 Orientation and position of the object on the measuring instrument

Any limitations on the orientation or placement of the object on the measuring plane need to be determined and precautions should be taken to ensure that the limitations are adhered to. For example physical or displayed guides can be used to control the limits. In some cases two sets of guides may be needed for the smallest and largest sizes, for example if the object must always be placed in the center of the measuring plane.