INTERNATIONAL RECOMMENDATION

OIML R 129-2

Edition 2020 (E)

Multi-dimensional measuring instruments

Part 2: Metrological controls and performance tests

Instruments de mesure multidimensionnels

Partie 2: Contrôles métrologiques et essais de performance

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

Foreword **4**

1 Type evaluation **5**

1.1 Documentation 5

1.2 Instruments submitted for testing 6

1.3 Laboratory examination 6

1.4 Laboratory tests 6

2 Initial verification **9**

2.1 Verification conditions 9

2.2 Conformity 10

2.3 Test objects 10

2.4 Accuracy tests 10

2.5 Other tests 10

3 Subsequent verification **10**

Annex A – Performance tests **11**

A.1 General 11

A.2 Test procedures for influence factors 15

A.3 Test procedures for disturbances 19

A.4 Tests for light and acoustic effects 27

Annex B – Comparison table **29**

Annex C - Bibliography **31**

Foreword

The International Organisation of Legal Metrology (OIML) is a worldwide, intergovernmental organisation whose primary aim is to harmonise the regulations and metrological controls applied by the national metrological services, or related organisations, 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 harmonise 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; and

International Basic Publications (OIML B), which define the operating rules of the various OIML structures and systems.

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.

This publication – reference OIML R 129-2, Edition 2020 (E) – was developed by Project Group 1 in the OIML Technical Subcommittee TC 7/SC 5 *Dimensional Measuring Instruments*. It was approved for final publication by the International Committee of Legal Metrology in 2020. It supersedes the previous edition dated 2000.

OIML Publications may be downloaded from the OIML web site in the form of PDF files. Additional information on OIML Publications may be obtained from the Organisation's headquarters:

Bureau International de Métrologie Légale
11, rue Turgot - 75009 Paris - France
Telephone: 33 (0)1 48 78 12 82
Fax: 33 (0)1 42 82 17 27
E-mail: biml@oiml.org
Internet: www.oiml.org

Part 2: Metrological controls and performance tests

The OIML recognises that the ideal legal metrological control strategy for one country or region is not necessarily the ideal for all others. OIML D 16:2011 *Principles of assurance of metrological control* [1] 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.

1 Type evaluation

A type of instrument is presumed to comply with the requirements of R 129-1, 4.2, 4.3 and 4.4, if it has passed the examination and tests specified in Annex A.

1.1 Documentation

1.1.1 General 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.

1.1.2 Software documentation

This Recommendation does not ask manufacturers for extra declarations that the documentation is correct and complete; however, any country may require this declaration, as a part of the specified software examination process.

The manufacturer shall submit all such documentation to allow for a reasonable evaluation of the legally relevant software. This includes:

- a description of the legally relevant software and how the requirements are met:
  - list of the software modules that belong to the legally relevant part;
  - description of the software interfaces of the legally relevant software part and of the commands and data flows via this interface;
  - list of the parameters to be protected and description of the protection means;
- a description of suitable system configuration and minimal required resources (see R 129-1, B.5.1(a));
- a description of the means of securing the operating system (password, etc. if applicable);
- a description of the (software) sealing method(s);
- an overview of the system hardware, e.g. topology block diagram, type of computer(s), type of network, etc. Where a hardware component is deemed legally relevant or where it performs legally relevant functions, this shall also be identified;
- a description of the user interface, menus and dialogues;
- the software identification and instructions for obtaining it from an instrument in use;
- if an audit trail is realised in the software, a description on how to access the audit trail;
- the operating manual;
- a list of commands of each hardware interface of the measuring instrument/component;
- a description of the accuracy of the algorithms (e.g. filtering of A/D conversion results, price calculation, rounding algorithms, etc.);

- a description of the datasets stored or transmitted;
- if detection of significant defects is realised in the software, a list of significant defects that are detected and a description of the detecting algorithm;
- if fault detection is realised in the software, a list of faults that are detected and a description of the detecting algorithm;
- a list of durability errors that are detected by the software and, if necessary for understanding, a description of the detecting algorithms.

1.2 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.

1.3 Laboratory examination

The instrument shall be examined in conjunction with the submitted documentation to ensure that it complies with the metrological and technical requirements specified in R 129-1.

1.4 Laboratory tests

1.4.1 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.

1.4.2 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-third 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. An acceptable tolerance for the product of $N \times d$ is $\pm 1/3\ d$. 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.

Instruments may be equipped with an extended indication device or mode which displays the indication with a scale interval equal to, or less than, 1/5 d. Where an instrument has such a feature, and that feature is used during type evaluation or verification, the dimensions of the test object are not restricted to $N \times d$, provided that the dimensions of the test object are known to at least 1/5 d.

1.4.3 Acceptable indications

For compliance with the mpe, indications where the error of indication is less than or equal to the absolute value of the mpe are acceptable.

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

1.4.4 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 mpe (R 129-1, 4.1.2) for influence factors and humidity effects (R 129-1, 4.2.1), and comply with the significant fault requirements for disturbances (R 129-1, 4.3). Instruments based on light or acoustic techniques shall comply with the mpe (R 129-1, 4.1.2) for light and acoustic effects (R 129-1, 4.4).

1.4.5 Tests for irregular shaped objects

For irregular shaped test objects the smallest dimension of that test object 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.

1.4.6 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.

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.

1.4.7 Tests for automatic instruments

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

1.4.8 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.

1.4.9 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. R 129-1, Annex A, gives guidelines on known surface characteristics to be checked such as colour (uniform and non-uniform), contrast of colour with the measurement plane, reflectivity and absorption of sound and light, transparency, roughness or other.

1.4.10 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 R 129-1, 5.5.2). The immunity to RF electromagnetic fields test (see A.3.5) may be carried out on an instrument with only an unterminated cable, connected to the interface. The length of this cable will be in accordance with the relevant standard referenced in the test procedure.

1.4.11 Software evaluation

The risk associated with the software of multi-dimensional measuring instruments is level I. Validation in accordance with examination level A is adequate for solutions implemented to fulfil requirements at the normal severity level.

Table 1 below provides an overview of the proposed verification and evaluation methods applicable to this Recommendation.

Table 2 below provides an overview of the combination of various software requirements and relevant evaluation methods. The acronyms in Table 2 are defined in Table 1.

Table 1 - Overview of the proposed verification and evaluation methods

Abbreviation	Description	Application	Preconditions, tools for application	Special skills for performing
AD	Analysis of the documentation and evaluation of the design (D 31, 7.3.2.1 [2])	Always	Documentation	-
VFTM	Verification by functional testing of metrological functions (D 31, 7.3.2.2 [2])	Correctness of the algorithms, uncertainty, compensating and correcting algorithms, rules for price calculation	Documentation, specimen	-
VFTSw	Verification by functional testing of software functions (D 31, 7.3.2.3 [2])	Correct functioning of communication, indication, evidence of intervention, protection against operating errors, protection of parameters, detection of significant defects	Documentation, specimen	-

Table 2 - Combination of software requirements and relevant evaluation methods

Requirement (R 129-1)		**Examination level A (Normal examination level)**
6.1	Software identification	AD + VFTSw
6.2	Correctness of algorithms and functions	AD + VFTM
Securing and protecting software, parameters and measurement data and the measurand value		
6.3	Securing and protecting software	AD + VFTSw
	Securing and protecting parameters	AD + VFTSw
	Securing measurement data and the measurand value	AD + VFTSw
6.4	Authentication of the presented measurement results	AD + VFTSw
6.5	Audit trail	AD + VFTSw
6.7	Detection of significant defects	AD + VFTSw
6.8	Support for durability protection	AD + VFTSw
Requirements for specific configurations		
B.1.1 to B.1.3	Separation of parts	AD + VFTSw
B.2	Shared indications	AD + VFTSw
B.3	Storage of data	AD + VFTSw
B.4	Transmission of measurement process information	AD + VFTSw
B.5	Operating system	AD + VFTSw
B.6	Software update	AD + VFTSw

2 Initial verification

2.1 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.

2.1.1 Software verification

For software controlled devices, the verification of the software shall include

(a) an examination of the conformity of the software to verify that it is the certified version (e.g. verify the software identification, verify the integrity of securing and protection),

(b) an examination of the configuration to verify that it is compatible with the declared minimal configuration, if given in the certificate,

(c) an examination of the measuring function, including price calculation if available, and

(d) an examination of the legally relevant parameters (especially the adjustment parameters) to verify that they are correctly set.

2.2 Conformity

An instrument shall conform to the 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.

2.3 Test objects

Test objects shall be available and comply with the requirements of 1.4.2.

2.4 Accuracy tests

Accuracy tests shall be carried out in accordance with test A.1.2 at the operating conditions in effect at the time of verification.

2.5 Other tests

The following tests shall be carried out as applicable, depending on the mode of operation, environment, location, and the intended use of the instrument:

(a) tests for irregular shaped objects (1.4.5);

(b) tests for different orientations and positions (1.4.6);

(c) tests for automatic instruments (1.4.7);

(d) tests for multi-interval instruments (1.4.8); and

(e) tests for different surfaces (1.4.9).

3 Subsequent verification

Unless national regulations specify otherwise, subsequent verification tests shall be carried out in accordance with accuracy tests specified in 2.4, using test objects specified in 2.3. For software controlled devices, software verification shall be carried out as specified in 2.1.1.

Annex A – Performance tests

(Mandatory)

Performance tests carried out under the influence factors, disturbances and humidity effects specified in R 129-1, 4.2, 4.3 and 4.4, ensure that measuring instruments perform over a range of environmental conditions likely to be met in normal use.

A.1 General

A.1.1 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	All multi-dimensional instruments.
Object of the test	Verification of compliance with the provisions in R 129-1, 5.1.7.
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 minutes after the dimensions are first displayed after switch-on.
Test level	The results at each dimension for each object shall be compared with the mpe (R 129-1, 4.1.2). This test shall be performed at reference conditions (R 129-1, 4.1.7(c)).
Acceptance criteria	The instrument shall be correct (within the mpe) as soon as the values of the dimensions are displayed (R 129-1, 5.1.7). All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2.

A.1.2 Repeatability

Test method	Repeatability
Applicability	All multi-dimensional measuring instruments.
Object of test	Verification of compliance with the provisions in R 129-1, 4.2.1 under conditions of repeated measurement.
Test procedure in brief	Before the test is 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 three measurements of 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*) under reference conditions (R 129-1, 4.1.7(c)). Any calculated quantities shall be checked for correct multiplication and rounding (R 129-1, 4.1.6).
Test level	The results at each dimension for each object shall be compared with the mpe (R 129-1, 4.1.2). The instrument shall be correct (within the mpe) for each measurement of each dimension.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2.

A.1.3 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 one measurement 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*). For the following influence factor tests it is permitted to use test objects only near the minimum dimensions:

- static temperatures;
- damp heat, steady-state (non-condensing).

The tests shall first be carried out under reference conditions (R 129-1, 4.1.7(c)) and then at each of the extreme conditions of the influence factors specified in R 129-1, 4.2.1.

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 R 129-1, 4.1.7(c). The test results at each dimension and each condition shall be compared with the mpes (R 129-1, 4.1.2). If applicable, the variation between indicators shall be checked against the permissible difference (R 129-1, 4.1.4). Any calculated quantities shall be checked for correct multiplication and rounding (R 129-1, 4.1.6).

The effect of influence factors on any interfaces (R 129-1, 5.5.2) or electronic sealing provisions (R 129-1, 6.3.1) shall also be checked.

A.1.4 Tests for disturbances

Tests for disturbances shall be carried out on all electronic instruments. The damp heat, cyclic test (A.3.6) is only carried out on instruments intended for use in locations where they may be subject to condensate water.

Tests using at least one test object shall be carried out, firstly at reference conditions (R 129-1, 4.1.7(c)) and no disturbance, and then with the applications of each disturbance specified in R 129-1, 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 (R 129-1, 2.3.7). All indicators shall be checked.

The effect of disturbances on any interfaces (R 129-1, 5.5.2) or electronic sealing provisions (R 129-1, 6.3.1) shall also be checked.

A.1.5 Tests for light and acoustic effects

The tests shall be carried out as specified in A.1.3 under the variation of light and acoustic effects given in A.4.

The test results at each dimension and at each condition shall be compared with the mpe (R 129-1, 4.1.2).

A.1.6 Tests for other effects

Tests for (see 1.4.5 to 1.4.10)

- irregularly shaped objects,
- different orientations of the object,
- the range of relative motion,
- multi-interval instruments,
- different surfaces, and
- interfaces, if applicable

shall be carried out under reference conditions (R 129-1, 4.1.7(c)). The tests as specified in A.1.3 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 mpe (R 129-1, 4.1.2).

A.1.7 Applicable tests

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

Table A.1 - Applicable tests

Test		I/D*	Mechanical measuring device	Optical measuring device	Acoustic measuring device	Battery operated
A.2.1	Static temperatures	I	x	x	x	x
A.2.2 & A.3.6	Damp heat	I/D	x	x	x	x
A.2.3	AC mains voltage variation	I	x	x	x	
A.2.4	Low voltage of internal battery	I	x	x	x	x
A.3.1	AC mains voltage dips, short interruptions and reductions	D	x	x	x	
A.3.2	Electrical bursts	D	x	x	x	
A.3.3	Electrostatic discharge	D	x	x	x	x
A.3.4	Electrical surges	D	x	x	x	x
A.3.5	Immunity to RF Electromagnetic fields	D	x	x	x	x
A.4.1	Ambient light			x		
A.4.2	Acoustics				x	

* I = Influence factor and D = Disturbance

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

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).

A.2.1 Static temperatures

Test method	**Exposure to dry heat (non-condensing) and cold.**
Applicability	All multi-dimensional measuring instruments.
Object of the test	Verification of compliance with the provisions in A.1.3 and R 129-1, 4.2.1 under conditions of high and low temperatures.
Test procedure in brief	The test comprises exposure to the specified high and low temperatures 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). One measurement on every sample is taken using each unit, at every test condition.
Test level	The EUT shall be tested as specified in A.1.3: (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. 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 %. Exposure duration: • at least 2 h (following EUT stabilisation) at specified high temperature; • at least 2 h (following EUT stabilisation) at specified low temperature.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2.
References	OIML D 11 [3], IEC 60068-2-1 [4], IEC 60068-2-2 [5] and IEC 60068-3-1 [6].

A.2.2 Damp heat - Steady-state (non-condensing)

Test method	Exposure to damp heat in steady-state.
Applicability	All electronic multi-dimensional measuring instruments.
Object of the test	Verification of compliance with the provisions in A.1.3 and R 129-1, 4.2.1 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. The EUT shall be handled such that no condensation of water occurs on it. *Note:* One measurement on every sample is taken using each unit, at every test condition.
Test level	The EUT shall be tested as specified in A.1.3: • at the reference conditions of 20 °C and 50 % relative humidity; • at the specified high temperature or 40 °C, whichever is lower and 85 % relative humidity after 48 h; and • again at 20 °C and 50 % relative humidity.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2.
References	OIML D 11 [3], IEC 60068-2-78 [7] and IEC 60068-3-4 [8].

A.2.3 AC mains voltage variation

Test method	Applying low and high level AC mains power voltage (single phase).
Applicability	Applicable for multi-dimensional 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 A.1.3 and R 129-1, 4.2.1 under conditions of AC mains network voltage changes between upper and lower limit.
Test procedure in brief	The EUT shall be subjected to AC mains power variations specified in R 129-1, 4.2.1 under constant environmental conditions. One measurement on the sample is taken using each unit, at every test condition. In case of three-phase mains power, the voltage variation shall apply for each phase successively.
Test level	The EUT shall be tested as specified in A.1.3: • at nominal voltage; • at an upper limit of 110 % of nominal voltage; and • at a lower limit of 85 % of nominal voltage. *Note:* The nominal voltage is that specified by the manufacturer. 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.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2.
References	OIML D 11 [3], IEC 61000-4-1 [9] and IEC/TR3 61000-2-1 [10].

A.2.4 Low voltage of internal battery

Test method	Applying minimum supply voltage.
Applicability	Applicable to all multi-dimensional measuring instruments supplied by internal battery.
Object of the test	Verification of compliance with the provisions in A.1.3 and R 129-1, 4.2.1 during low battery voltage.
Test procedure in brief	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. 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. The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage.
Test level	The EUT shall be tested as specified in A.1.3: (a) at nominal voltage; (b) at various reduced voltages below nominal voltage; and (c) 90 % of the minimum battery supply voltage level. The nominal voltage is that specified by the manufacturer.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2 or alternatively the indication shall be blank.
References	OIML D 11 [3].

A.3 Test procedures for disturbances

A.3.1 AC mains voltage dips, short interruptions and reductions

Test method	Introducing short-time reductions of mains voltage using the test setup defined in the applicable standard.
Applicability	Applicable to all electronic multi-dimensional measuring instruments supplied by AC mains voltage.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 during short time power reduction.
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 instrument operates over a range of voltages and that range is equal to or greater than 20 % of the minimum voltage then the test should be carried out at the voltage minimum and maximum.
Test level	Each test shall be repeated ten times with an interval of at least 10 s. The EUT shall be tested as specified in A.1.4 with the following reductions: (a) reduction to 0 % for 0.5 cycle; (b) reduction to 0 % for 1 cycle; (c) reduction to 40 % for 10/12 cycles; (d) reduction to 70 % for 25/30 cycles; (e) reduction to 80 % for 250/300 cycles; and (f) reduction to 100 % for 250/300 cycles. *Note*: Values applicable for 50 Hz/60 Hz respectively.
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 R 129-1, 2.3.7.
References	OIML D 11 [3], IEC 61000-4-11 [11], IEC 61000-6-1 [12] and IEC 61000-6-2 [13].

A.3.2 Electrical bursts

Test method	Introducing transients on the mains power lines.
Applicability	Applicable to all multi-dimensional measuring instruments supplied by AC mains voltage.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 when an electrical burst is applied to the power line, input/output control circuits and communication lines.
Test procedure in brief	The EUT shall be subjected to electrical bursts of voltage spikes. The test shall be conducted under constant environmental conditions. The transient generator shall have an output impedance of 50 Ω and 1000 Ω and shall be adjusted before connecting the EUT. At least ten positive and ten 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.1.4 at the following amplitudes (peak values): (a) 2 kV for power supply lines; and (b) 1 kV for input/output control circuits and communication lines. With a repetition frequency of the impulses of 5 kHz ± 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 R 129-1, 2.3.7.
References	OIML D 11 [3] and IEC 61000-4-4 [14].

A.3.3 Electrostatic discharge

Test method	Exposure to electrostatic discharge (ESD).
Applicability	Applicable to all electronic multi-dimensional measuring instruments.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 when an electrical discharge is applied.
Test procedure in brief	The EUT shall be subjected to both direct and indirect electrostatic discharges under constant environmental conditions. At least ten discharges shall be applied. The time interval between successive discharges shall be at least 1 second.
Test level	The EUT shall be tested as specified in A.1.4 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 R 129-1, 2.3.7.
References	OIML D 11 [3] and IEC 61000-4-2 [15].

A.3.4 Electrical surges

A.3.4.1 Surges on AC mains power lines

Test method	Introducing electrical surges on the mains power lines.
Applicability	Applicable for electronic multi-dimensional 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 A.1.4 and R 129-1, 4.3 during conditions where electrical surges are superimposed on the AC 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 4 phase shifts: 0°, 90°, 180° and 270° with the mains frequency is covered.
Test level	The EUT shall be tested as specified in A.1.4 at the following amplitudes (peak values): (a) 1 kV for AC line to line; and (b) 2 kV for AC line to ground.
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 R 129-1, 2.3.7.
Reference	OIML D 11 [3] and IEC 61000-4-5 [16].

A.3.4.2 Surges on signal, data and control lines

Test method	Introducing electrical surges on signal, data and control lines.
Applicability	Applicable for electronic multi-dimensional 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 A.1.4 and R 129-1, 4.3 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.
Test level	The EUT shall be tested as specified in A.1.4 at the following amplitudes (peak values): (a) 1 kV for unsymmetrical lines - line to line; (b) 2 kV for unsymmetrical lines - line(s) to ground; (c) 2 kV for symmetrical lines - line(s) to ground; and (d) 2 kV for shielded I/O and communication lines - line(s) to ground.
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 R 129-1, 2.3.7.
References	OIML D 11 [3] and IEC 61000-4-5 [16].

A.3.5 Immunity to RF electromagnetic fields

A.3.5.1 Radiated RF electromagnetic fields

Test method	Exposure to radiated radio frequency electromagnetic fields.
Applicability	Applicable for electronic multi-dimensional measuring instruments containing active electronic circuits.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 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 under constant environmental conditions. 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 shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 s. 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.
Test level	The EUT shall be tested as specified in A.1.4 at a field strength of 10 V/m, 80 % AM, 1 kHz sine wave over frequency ranges of 26 MHz to 3 000 MHz for EUT having no mains or other input port available and 80 MHz to 3 000 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 R 129-1, 2.3.7.
References	OIML D 11 [3], IEC 61000-4-3 [17] and IEC 61000-4-20 [18].

A.3.5.2 Conducted RF electromagnetic fields

Test method	Exposure to radiated radio frequency electromagnetic fields.
Applicability	Applicable for electronic multi-dimensional measuring instruments containing active electronic circuits.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 under conditions of exposure to electromagnetic fields.
Test procedure in brief	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. The performance of the test equipment consisting of an RF generator, de-coupling devices, attenuators, etc. shall be verified. The functional performance of the EUT is observed (e.g. displayed indications and/or error messages) while at least ten measurements are taken with the conducted radio-frequency fields applied.
Test level	The EUT shall be tested as specified in A.1.4 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 R 129-1, 2.3.7.
References	OIML D 11 [3] and IEC 61000-4-6 [19].

A.3.6 Damp heat cyclic (condensing)

Test method	Exposure to damp heat with cyclic temperature variation.
Applicability	All electronic multi-dimensional measuring instruments that are intended to be used in locations where they may be subject to condensate water.
Object of the test	Verification of compliance with the provisions in A.1.4 and R 129-1, 4.3 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 40 °C 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; and 4) temperature maintained at the lower level until the 24 hour period is completed. The stabilising 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.
Test level	The EUT shall be tested as specified in A.1.4 at: 1) 40 °C 2) Duration: 24 hours 3) Number of cycles: 2
Acceptance criteria	After the application of the disturbance and the subsequent recovery: • the instrument shall detect and react to a significant fault occurring as a consequence of the damp heat with cyclic temperature variation; or • the difference between each indication before the test and the associated indication after the test shall not exceed the fault limit defined in R 129-1, 2.3.7.
References	OIML D 11 [3], IEC 60068-2-30 [20], IEC 60068-3-4 [8].

A.4 Tests for light and acoustic effects

A.4.1 Ambient light

Test method	Exposure to ambient light variations
Applicability	Applicable for multi-dimensional measuring instruments based on light techniques.
Object of the test	Verification of the compliance with the provisions in A.1.5 and R 129-1, 4.4.
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.1.5 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	(a) 200 lx to 500 lx (reference); (b) 100 lx; and (c) 1 000 lx to 1 500 lx. In addition, tests (a) and (c) shall be repeated with uneven illumination. The reference light intensity is considered to be 200 lx to 500 lx. 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. The light source for test (a) can be the normal room lighting suitably dimmed. 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 45º 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. Uneven light can be achieved by using a masked slide in the slide projector so that light and dark areas cover the test object. 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.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2. Alternative operations may be provided if the instrument can only perform correctly over a limited range of light intensity, for example:

	(a) the instrument is either made inoperative automatically or a visual or audible indication is provided automatically when outside the limits; or (b) the instrument is provided with a light source to ensure the limited range is maintained. If the light source fails (a) above applies.

A.4.2 Acoustics

Test method	Exposure to acoustic noise disturbances.
Applicability	Applicable for multi-dimensional measuring instruments with devices based on acoustic techniques.
Object of the test	Verification of compliance with the provisions in A.1.5 and R 129-1, 4.4.
Test procedure in brief	The EUT shall be subjected to acoustic noise disturbances under constant environmental conditions.
Test level	The EUT shall be tested as specified in A.1.5 at a sound pressure level of 100 dB at the nominal centre frequency (resonant frequency) of the transducer(s) employed on the EUT. The noise source shall be operated continuously throughout the measurement process using a sinusoidal waveform. For EUTs with multiple transducers, each one shall be subjected to the test separately. The noise source shall be positioned in such a way that it does not cause damage to the EUT or impede the normal use of the EUT as specified by the manufacturer. The noise source shall be directed toward and along the axis of the transducer used in the EUT (insofar as possible given the design of the EUT). The sound pressure shall be measured at the acoustic source with the EUT off. The acoustic source shall be placed at 1 m distance of the transducer used in the EUT. The test shall be conducted in a room large enough that there are no walls or objects other than testing equipment within 2 m of the EUT or acoustic source. The transducer in the EUT and acoustic source shall be at least 1 m from the floor. A small table can be used to support the equipment. The test equipment shall include: • acoustic source; and • sound pressure level meter.
Acceptance criteria	All functions shall operate as designed. The test results shall comply with the mpe specified in R 129-1, 4.1.2. Alternatively, the EUT shall recognise the interference and prevent any measurements from being taken or functions producing results.

Annex B – Comparison table
(Informative)

OIML R 129-2:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
1.1.2	Software documentation			New requirements for software documentation to be submitted for type approval.
1.4.2	Test objects	11.1.4.2	Test objects	The dimensions of the test objects known to an expanded uncertainty – Changed to 1/3 mpe. An acceptable tolerance for the test objects for the product of N × *d* as ±1/3 *d* was specified. Requirements for test objects used on instruments with extended indication device.
1.4.11	Software evaluation			New requirements for software evaluation and evaluation methods.
2.1.1	Software verification			New additional verification requirements for software controlled devices.
3	Subsequent verification	11.3	Subsequent verification	Additional requirements for software controlled devices added.
Annex A	Performance tests	Annex A	Performance tests	Tests amended to align with OIML D 11:2013 [3].
A.1.1	Instrument warm up time			Test added.
A.1.2	Repeatability			Test added.

OIML R 129-2:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
A.1.3	Tests for influence factors	A.1.1	Tests for influence factors	Number of tests at each dimension reduced to one.
A.1.4	Tests for disturbances	A.1.2	Tests for disturbances	Damp heat cyclic test to be carried based on the instrument's intended use and location.
		A.1.5	Tests for humidity effects	Deleted and the requirements split between static temperatures and damp heat condensing tests.
A.3.6	Damp heat cyclic			Damp heat cyclic test to be carried out based on the instrument's intended use location (see OIML R 129-2:2020, A.3.6).
A.3.4	Electrical surges			Test added. Testing for the impact of electrical surges.
A.4.2	Acoustics tests	A.4.2	Acoustics tests	Test amended form the previous version.

Annex C - Bibliography

(Informative)

1. OIML D 16:2011 *Principles of assurance of metrological control*
2. OIML D 31:2019 *General requirements for software controlled measuring instruments* – Specifies the general requirements applicable to software-related functionality in measuring instruments and gives guidance for verifying the compliance of an instrument with these requirements.
3. OIML D 11:2013 *General requirements for measuring instruments - Environmental conditions*
4. IEC 60068-2-1 Ed. 6.0 (2007-03) *Environmental testing – Part 2: Test methods – Section 1: Test A: Cold*
5. IEC 60068-2-2 Ed 5.0 (2007-07) *Environmental testing – Part 2: Test methods – Section 2: Test B: Dry heat*
6. IEC 60068-3-1 Ed. 2.0 (2011-08) *Environmental testing – Part 3: Supporting documentation and guidance – Section 1: Cold and dry heat tests*
7. IEC 60068-2-78 Ed. 2.0 (2012-10) *Environmental testing – Part 2: Tests methods – Section 78:Test Cab: Damp heat, steady state*
8. IEC 60068-3-4 Ed. 1.0 (2001-08) *Environmental testing – Part 3: Supporting documentation and guidance – Section 4: Damp heat tests*
9. IEC 61000-4-1 Ed.3.0 (2006-10) Basic EMC publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 1: Overview of IEC 61000-4 series*
10. 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 signaling in public power supply systems*
11. IEC 61000-4-11 Ed.2.0 (2004-03) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11:Voltage dips, short interruptions and voltage variations immunity tests*
12. IEC 61000-6-1 Ed. 2.0 (2005-3) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 1: Immunity for residential, commercial and light-industrial environments*
13. IEC 61000-6-2 Ed. 2.0 (2005-01) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 2: Immunity for industrial environments*
14. 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*
15. 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*
16. IEC 61000-4-5 Ed. 2.0 (2005-11), Correction 1 on Ed. 2.0 (2009-10) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*
17. IEC 61000-4-3 consolidated Ed. 3.2 (2010-04) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*
18. IEC 61000-4-20 Ed 2.0 (2010-08) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 20: Emission and immunity testing in transverse electromagnetic (TEM) waveguides*

19. IEC 61000-4-6 Ed 4.0 (2013-10) Basic EMC Publication – *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields*

20. 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)*