INTERNATIONAL RECOMMENDATION

OIML R 129-1

Edition 2020 (E)

Multi-dimensional measuring instruments

Part 1: Metrological and technical requirements

Instruments de mesure multidimensionnels

Partie 1: Exigences métrologiques et techniques

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

Foreword

The International Organisation of Legal Metrology (OIML) is a worldwide, intergovernmental organization 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;

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

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Part 1: Metrological and technical requirements

1 Scope

This Recommendation specifies the metrological and technical requirements for the type evaluation of multi-dimensional measuring instruments used to determine the dimensions and/or dimensional volume of an object for the purpose of calculating charges for postage, freight or storage.

The instruments may be used in conjunction with a weighing instrument also used in the determination of charges, in which case the procedure is usually for the dimensional volume to be calculated, a conversion factor applied, and the resulting dimensional weight of the object compared to its weight to establish which quantity (the largest of measured weight or dimensional weight) will be used to determine the charges. In some cases dimensions other than volume are used for determining charges. The Recommendation also includes type evaluation procedures, verification procedures and test procedures.

The requirements of this Recommendation apply to automatic and semi-automatic instruments, but they do not apply (for example) to simple linear measures such as tape measures. The instruments measure the length, width and height of a rectangular box and in some cases determine the dimensional volume of that box. If the object is not in the form of a rectangular box, the volume of the smallest rectangular box (by volume) which fully encloses the object is determined (see 2.2.1).

Instruments may include different measurement devices, each using a different method to measure separate dimensions of an object. The instrument may measure the object whilst there is relative motion between the instrument and the object.

If the multi-dimensional measuring instrument is associated with a weighing instrument, which is also used for determining the charges, the requirements for the weighing instrument are found in the following OIML Recommendations:

(a) OIML R 76 *Non-automatic weighing instruments* [1] for non-automatic weighing instruments; and

(b) OIML R 51 *Automatic catchweighing instruments* [2] for automatic weighing instruments.

The requirements of this Recommendation may also be used, where applicable, for type evaluation and verification of other instruments which measure the dimensions and/or the volume of objects for applications other than for determining postage, freight or storage charges.

2 Terminology

The following terminology includes terms applicable to those instruments covered by this Recommendation and some general terms included in OIML V 2-200:2012 *International Vocabulary of Basic and General Terms in Metrology (VIM)* [3] and OIML V 1:2013 *International vocabulary of terms in legal metrology (VIML)* [4].

2.1 General terms

2.1.1

multi-dimensional measuring instrument

instrument that measures the dimensions of an object and determines the length (L), width (W) and height (H) of the smallest rectangular parallelepiped (rectangular box) which fully encloses that object

2.1.1.1

length (*L*)

linear measured dimension that is oriented 90 degrees relative to the width and height

2.1.1.2

width (*W*)

linear measured dimension that is oriented 90 degrees relative to the length and height

2.1.1.3

height (*H*)

linear measured dimension that is oriented 90 degrees relative to the length and width

2.1.2

device

identifiable instrument or part of an instrument or family of instruments that performs a specific function or functions [OIML D 11, 3.3 [5]]

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

2.1.3

measuring instrument

device used for making measurements, alone or in conjunction with one or more supplementary devices [VIM 3.1]

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

2.1.4

indicator

device that displays the measured dimensions and any associated quantities

2.1.5

ancillary device

device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results [VIML 5.06]

Note 1: An ancillary device may or may not be subject to legal metrological control according to its function in the measuring system or to national regulations.

Note 2: Main ancillary devices are:

- zero-setting device;
- repeating indicating device;
- printing device;
- memory device;
- price indicating device;
- totalising indicating device;
- pre-setting device;
- self-service device.

2.1.6

semi-automatic instrument

instrument requiring the intervention of an operator to carry out the measurements but that automatically determines the results

2.1.7

automatic instrument

instrument that measures without the intervention of an operator

2.1.8

multi-interval instrument

measuring instrument having one dimensional measuring range for each axis which is divided into partial measuring ranges each with different scale intervals, with the measuring range determined automatically according to the dimension being measured

2.1.9

maximum measuring speed (V_{max})

maximum speed at which the instrument will measure correctly

Note: Only applicable to instruments where measurements are affected by means of relative movement between the object and the instrument.

2.1.10

minimum measuring speed (V_{min})

minimum speed at which the instrument will measure correctly

Note: Only applicable to instruments where measurements are affected by means of relative movement between the object and the instrument.

2.1.11

indication

quantity value provided by a measuring instrument or measuring system [VIM 4.1]

2.1.12

measuring area

area in and around the instrument in which it is capable of measuring an object

2.2 Measurement terms

2.2.1

rectangular box (rectangular parallelepiped)

polyhedron having six faces that are parallel in pairs having all dihedral angles as right angles

2.2.2

irregular shaped object

object other than a rectangular box

2.2.3

measured dimensions

length (L), width (W) or height (H), measured by the measuring instrument, of the smallest rectangular box which fully encloses the object

2.2.4

dimensional volume (Dim Vol or DV)

volume of the smallest rectangular box which fully encloses the object, and is the product of the indicated values of length (L), width (W) and height (H) ($DV = L \times W \times H$)

2.2.5

maximum dimension (Max)

maximum measurable dimension for each axis as specified by the manufacturer for the measuring instrument

2.2.6

minimum dimension (Min)

value of the smallest measured dimension for each axis

2.2.7

dimensional weight (Dim Wt or DW)

calculated value obtained by applying a conversion factor to the object's dimensional volume (see 2.2.4) or measured dimensions (see 2.2.3)

2.2.8

conversion factor (F)

factor applied to the volume or dimensions of an object to determine its dimensional weight

2.2.9

scale interval (d)

value, expressed in units of the measured quantity, of the difference between the values corresponding to two consecutive scale marks for analogue indication, or two consecutive indicated values for digital indication

2.2.10

measurand value

quantity value attributed to the measurand

2.3 Performance terms

2.3.1

error of indication

indicated value minus a reference quantity value [VIML 0.04]

2.3.2

intrinsic error

error of a measuring instrument determined under reference conditions [VIML 0.06]

2.3.3

initial intrinsic error

intrinsic error of a measuring instrument as determined prior to performance tests [VIML 5.11]

2.3.4

maximum permissible error (mpe)

extreme value (positive and negative) of the error of indication permitted by specifications, Recommendations, regulations, etc. [adapted from VIM 4.26]

Note: The absolute value of the mpe is the same value without sign.

2.3.5

fault

difference between the error of indication and the intrinsic error of a measuring instrument [VIML 5.12]

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

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

2.3.6

fault limit

value delimiting non-significant faults [VIML 5.13]

2.3.7

significant fault

fault exceeding the applicable fault limit value [VIML 5.14]

Note: The following faults are not considered to be significant, even when they exceed the value defined above:

(a) faults arising from simultaneous and mutually independent causes in the measuring instrument itself;

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

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

(d) faults giving rise to variations in the measurement result so serious that they are bound to be noticed by all those interested in the result of the measurement.

2.3.8

influence quantity

quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result [VIM 2.52]

2.3.9

influence factor

influence quantity having a value within the rated operating conditions of the measuring instrument, specified in this Recommendation

2.3.10

disturbance

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

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

2.3.11

rated operating conditions

operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed [VIM 4.9]

2.3.12

reference conditions

set of specified values of influence factors fixed to ensure valid intercomparison of results of measurements [VIM 4.11]

2.3.13

performance

ability of the measuring instrument to accomplish its intended functions

2.4 Testing terms

2.4.1

test

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

2.4.2

test procedure

detailed description of the tests

2.4.3

test program

description of a series of tests for a certain type of equipment

2.4.4

performance test

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

2.4.5

test object

object whose dimensions are verified by appropriate reference standards and intended to verify the compliance of the EUT with certain metrological requirements

2.5 Software terms

The specific software terminology are as defined in OIML D 31 *General requirements for software controlled measuring instruments* [6].

3 Units of measurement

The following units of measurement and their symbols shall be used:

Table 1 - Units of measurement and their symbols

	Unit	Symbol
Length:	metre	m
	centimetre	cm
	millimetre	mm
Volume:	cubic metre	m^3
	cubic decimetre	dm^3
	cubic centimetre	cm^3

4 Metrological requirements

4.1 Maximum permissible errors and minimum dimension

4.1.1 Scale intervals, minimum dimension

The lower limit of the minimum dimension for all values of the scale interval is given in Table 2.

Table 2 - Scale intervals and minimum dimension

Scale interval (d)	Minimum dimension (Min) (lower limit)
$d \leq 2$ cm	10 d
2 cm < $d \leq 10$ cm	20 d
10 cm < d	50 d

4.1.2 Value of the mpe

The mpe applicable to the measurement by the instrument of any of the three dimensions for initial and subsequent verification is ± 1.0 d.

4.1.3 Value of the fault limit

The value of the fault limit is one scale interval (d).

4.1.4 Maximum permissible variation between indicators

There shall be no difference between the indications when displayed on different digital indicators.

4.1.5 Multi-interval instruments

For multi-interval instruments with scale intervals of d_1, d_2, ..., d_r, the mpe are ± 1 d_1, ± 1 d_2, ..., ± 1 d_r for the applicable range and axis.

4.1.6 Calculated quantities

All calculated quantities included in the transaction shall be derived from the indicated measured dimensions, which are rounded to the nearest applicable scale interval. All calculated quantities shall be in mathematical agreement.

4.1.7 Rules for the determination of errors

The rules for the determination of errors are as follows:

(a) The specifications in 4.1.2 to 4.1.5 apply to all instruments irrespective of their principles of operation. Limitations of use as marked on the instrument may apply, for example with respect to the position, shape and material of the object.

(b) The specifications in 4.1.2 to 4.1.5 are applicable to all indications included in the transaction as appropriate.

(c) The initial intrinsic error is found at reference conditions of 20 ºC ± 5 ºC, ambient atmospheric pressure, nominal voltage and (50 ± 15) % relative humidity.

(d) For instruments that are equipped with an extended indication device or mode which displays the indication with a scale interval equal to or less than 1/5 *d*, and that feature is used during type evaluation or verification, the error of indication is calculated as:

Error of indication = Indication − Known dimensions of the test object

Otherwise, the error of indication is calculated as:

Error of indication = Indication − Nominal dimensions of the test object

4.2 Influence factors

4.2.1 Rated operating conditions

Instruments shall be designed and manufactured such that they do not exceed the mpe when exposed to the following ranges of environmental conditions:

(a) mains power voltage variations: – 15 % to + 10 % of nominal voltage;

(b) air temperature variations at the temperature limits stated in the descriptive markings; if no temperature limits are stated in the descriptive markings – 10 ºC to + 40 ºC applies;

(c) relative humidity of 85 % (non-condensing) at the high temperature limit of the instrument or 40 °C, whichever is lower.

An electronic instrument powered by direct current shall either continue to function correctly or not indicate any quantity when the voltage is below the manufacturer's specified nominal voltage.

If special temperature limits are stated in the descriptive markings, the range shall be at least 30 ºC.

4.3 Disturbances

4.3.1 Disturbance applied to measuring instrument

An instrument shall be designed and manufactured such that, when exposed to disturbances, either:

(a) significant faults do not occur; or

(b) significant faults are detected and acted upon.

Note: A fault equal to, or smaller than, *d* is allowed during the disturbance irrespective of the value of the error of indication prior to the disturbance.

4.3.2 Disturbance applied to devices

The requirement in 4.3.1 may be applied separately:

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

(b) to each part of the electronic instrument.

The choice whether (a) or (b) is applied is left to the manufacturer.

4.3.3 Tests for disturbances; severity levels

Instruments shall withstand the appropriate disturbances when subject to the applicable severity levels.

4.4 Light and acoustic effects

Instruments based on light or acoustic measuring techniques shall remain within the mpe when subjected to the applicable light or acoustic effects, or have provisions for alternative operations if the instrument can only perform across a limited range of the applicable light or acoustic effects.

5 Technical requirements

5.1 General

5.1.1 Fraudulent use

Instruments shall not facilitate fraudulent use, either by accidental or by deliberate means when using the instrument in the normal manner.

5.1.2 Suitability of construction

Instruments shall be of adequately robust construction to maintain their metrological characteristics when properly installed and used in an environment for which they are intended. Instruments shall be constructed so that all controls, indicators, etc. are suitable for operation under normal conditions of use.

5.1.3 Suitability for use

Instruments shall be designed to suit the method of operation and the objects for which they are intended.

5.1.4 Suitability for verification

Instruments shall be constructed so that the performance requirements of this Recommendation can be applied.

If in normal operation the instrument indicates the volume and not the measured dimensions, a test mode shall be provided to display or print out the measured dimensions.

5.1.5 Zero or ready adjustment

Instruments shall be provided with facilities to set the instrument to, and maintain it at, zero or ready condition. This shall only be possible without an object in the measuring area. Either this condition is met automatically for each measurement or the instrument is automatically inhibited from making measurements. For semi-automatic instruments, the zero or ready condition shall be indicated by a zero indication, a ready light or a similar display.

5.1.6 Tare device

(a) The tare function shall only operate subtractively.

(b) The value of the tare scale interval shall be the same as the scale interval of the respective axis and range.

(c) Operation of tare shall be indicated.

5.1.7 Warm-up

As soon as the instrument indicates, prints, stores or transmits the measurement results after the warm-up period following switch-on, the indications shall be within mpe.

5.2 Indicators and printing devices

5.2.1 General

(a) An instrument shall have either
- an indicator which displays the measurement results, or
- a printer which prints the measurement results.

(b) An instrument may also have a device to transmit, store and preserve measurement results so that they can durably be reconstructed from the stored data.

(c) The indication shall be automatically displayed or printed following each step in the process or be readily available by a simple action of the operator, for example by pressing a key.

(d) Other indications such as dimensional weight, weight conversion factors, etc. may be displayed or printed.

(e) For semi-automatic devices, the indications must persist long enough for them to be easily read by an observer.

(f) For automatic devices where the indications do not persist long enough to be observed, a test mode shall be provided to display or print the indications long enough for them to be easily read by an observer.

(g) The indications shall be clearly assignable to a specific object.

(h) When an instrument is fitted with an extended indication device, displaying the indication with a scale interval smaller than d shall be possible only
- while pressing a key, or
- for a period not exceeding 10 s after a manual command by the operator.

(i) Printing and data transmission shall not be permitted while the extended indicating device is in operation. Instruments intended to be used in the presence of a customer shall not have any extended indicating device.

(j) All indications shall be identified either by the full name or by abbreviations (see 5.2.9).

5.2.2 Presentation of indications

Printed and displayed indications shall be reliable, clear and unambiguous and printing shall be indelible. Figures forming the results shall be of a size, shape and clarity for reading to be easy. Printed numbers and symbols shall be at least 2 mm high.

All digits on displays and tickets shall be oriented in the normal viewing position and shall permit reading by simple juxtaposition.

5.2.3 Units of measurement

All printed and displayed indications shall include the name or symbol of the unit of measurement. On tickets, the name or symbol may be printed out by the printer or pre-printed on the ticket.

For each indication of a quantity only one unit of measurement for that quantity shall be used, for example cm only, not m and cm, and the unit of measurement shall be the same for each axis.

5.2.4 Value of the scale interval

The value of all scale intervals shall be in the form 1, 2 or 5×10^n where n is a positive or negative whole number or zero.

The value of the scale interval shall be:

(a) the same for each axis; or

(b) different for one axis from the other two provided that instructions are marked on the instrument specifying any limitations of use; alternatively, a visible warning regarding incorrect usage shall be given; or

(c) variable (for example multi-interval) on one or more axes provided that:

- if all three axes are multi-interval, then $d_{x1} = d_{y1} = d_{z1}$, $d_{x2} = d_{y2} = d_{z2}$, ... , $d_{xr} = d_{yr} = d_{zr}$;
- if two axes are multi-interval, for example x and y, and z is fixed, then $d_{x1} = d_{y1}$, $d_{x2} = d_{y2}$, ..., $d_{xr} = d_{yr}$, and instrument limitations such as object size, placement, etc. are clearly marked to define how to operate the instrument; and
- if only one axis is multi-interval, for example x, and y and z are fixed, then $d_y = d_z$ and instrument limitations such as object size, placement, etc. are clearly marked to define how to operate the instrument.

The requirements in (c) do not apply when the instrument is equipped with a test mode that provides the associated scale interval for each measured dimension.

5.2.5 Decimal numbers

For printed or displayed indications, if the indication is expressed in a decimal form, there shall be at least one zero preceding the decimal mark for values less than one.

For values in decimal form that are not visually displayed (e.g. stored or transmitted electronically), there shall be at least one zero preceding the decimal mark for values less than one, and any number of zeroes preceding the indication for values greater than one.

The decimal mark on tickets shall be printed out with the measured value by the printer, with at least one zero preceding the decimal mark for values less than one.

Only one non-significant zero may be used to the right of the variable numbers for values greater than one. All the decades to the right of the decimal point or comma must be active and the least significant digit should correspond to the scale interval.

5.2.6 Limits of indication

Displaying, storing, transmitting or printing the quantity value of any dimension shall either be inhibited, or an error message shall be included together with the measurement indication, if the axis being measured

(a) is shorter than the minimum dimension marked on the device, or

(b) is longer than the maximum dimension marked on the device plus 9 *d*.

Note: The national responsible body may specify the acceptable option with regards to either inhibiting or allowing measurement indication with an error message.

Displaying, storing, transmitting or printing the quantity value of any dimension shall be inhibited if during the measuring process the entire object is not contained within, or does not pass through, the measuring area of the instrument.

5.2.7 Multi-interval instruments

For each partial measuring range, the following apply:

(a) the value of the scale interval of every partial measuring range must be less than the value of the scale interval of the subsequent partial measuring range ($d_1 < d_2 < d_3 < ... < d_r$);

(b) the maximum dimension of every partial measuring range must be equal to the minimum dimension of the subsequent partial measuring range ($Min = Min_1$, $Max = Max_r$, $Max_1 = Min_2$, etc.);

(c) the minimum dimension of any axis must be equal to the minimum dimension of the lowest partial range of that axis;

(d) the maximum dimension of any axis must be equal to the maximum dimension of the highest partial measuring range of that axis; and

(e) the minimum dimension of any partial measuring range shall be no smaller than the minimum dimension specified in 4.1.1, based on the scale interval of the partial measuring range.

5.2.8 Multi-instrument system

A number of measuring instruments may be connected to one indicating device to form a multi-instrument system.

The indication from each measuring instrument shall be clearly identified with the device on the common indicator.

5.2.9 Displayed, printed and stored information

5.2.9.1 Displayed measurement

Any displayed measurement results shall include at a minimum the measured dimensions.

5.2.9.2 Printed or stored measurement

Any printed ticket or stored measurement result shall include at a minimum

(a) measured dimensions, and

(b) date, transaction number or other identification of the object,

and shall include the following, if used or calculated by the instrument:

(c) dimensional volume (Dim Vol ... L or DV ... L);

(d) weight (Wt) if the instrument includes a weighing instrument;

(e) dimensional weight (Dim Wt ... kg or DW ... kg);

(f) dimensional tare (DT ... kg) or linear tare (LT...cm);

(g) conversion factor (F);

(h) quantity for charging, for example dimensions, vol or DW ... kg;

(i) price rate and price.

Note 1: Icons may be used to identify indications.

Note 2: The price interval and the price rate shall comply with the national regulations applicable for trade.

5.2.9.3 Additional requirements for printed tickets

A printed ticket shall also contain the following printed or pre-printed information:

(a) that the dimensions and/or volume shown are those of the smallest rectangular box that fully encloses the object; and

(b) that the dimensional weight is a calculated value obtained by applying a conversion factor to the object's volume or dimensions.

5.2.10 Availability of indications

Indications must be available to the customer as follows:

(a) When the customer is present during the measurement process, all indications shall be available to the customer at the time of measurement.

(b) When the customer is not present during the measurement process the information outlined in 5.2.9 need not be displayed or printed out at the time of measurement but shall be available on request, e.g. retrievable from a data storage device and shall include the identity of the instrument which produced the measurement.

5.3 Markings

5.3.1 Nameplate

Instruments shall be clearly and permanently marked, either directly on the instrument or on a descriptive nameplate permanently affixed to the instrument, with the following information so that it is clearly visible at all times:

(a) manufacturer's name or mark;

(b) model designation;

(c) serial number of the instrument and year of manufacture;

(d) type evaluation mark;

(e) maximum and minimum dimensions for each axis in the form Max = ... Min = ... ;

(f) if measurements are affected by means of relative movement between the object and the instrument, the maximum and minimum measuring speeds for which the instrument will measure correctly in the form V_{max} = ... m/s, V_{min} = ... m/s;

(g) scale interval(s) for each axis and range (multi-interval) in the form d = ... ; and

(h) temperature limits (if other than − 10 ºC to + 40 ºC).

5.3.2 Technical specifications

Any specifications or limitation of use relating to the instrument or the objects being measured shall be visibly and clearly presented to the operator on the instrument. Such specifications or limitations could include, but not be limited to

(a) special application if used for a purpose other than determining postage, freight or storage charges,

(b) minimum spacing between successive objects,

(c) whether the instrument can measure only rectangular boxes,

(d) whether the box has to be located in a particular position, and

(e) any limitation of the surface characteristics of the objects being measured.

5.4 Verification mark and sealing

5.4.1 Verification mark

Provision shall be made for the application of a verification mark either on a nameplate, a stamping plug or on an adhesive label. The following requirements apply:

(a) the mark shall be easily affixed without affecting the metrological properties of the instrument;

(b) the mark shall be visible without moving or dismantling the instrument when in use;

(c) the part on which the mark is located shall not be removable from the instrument without damaging the mark; and

(d) the size of the space shall be sufficient to contain the marks applied by the verifying authority: for example an area of at least 200 mm^2.

Note: If technical reasons restrict or limit the verification mark(s) to be fixed only in a "hidden" place (e.g. when an instrument – in combination with another device – is integrated in other equipment) this can be accepted if these marks are easily accessible, and if there is a legible notice provided on the instrument at a clearly visible place that provides direction to these marks or if its location is defined in the OIML certificate and OIML test report.

5.4.2 Sealing

Provision shall be made for sealing those devices, software and parameters that have a metrologically significant effect and that determine the measurement result. This may include devices and parameters which affect the configuration of the instrument as well as those which affect the calibration.

Sealing may be by mechanical, electronic, software (audit trail) and/or cryptographic means, making an intervention evident. Mechanical means include those where access to an electronic means of changing the parameters (for example via a keyboard) is prohibited by a mechanical seal. Additional requirements for sealing and protection of software controlled devices are as described in 6.3.

The requirements for applying a mark to a mechanical seal are the same as those for 5.4.1.

For sealing by electronic, software or cryptographic means the following requirements apply:

(a) access by authorised persons shall be protected by some form of physical key or a password or access code (for example a four-digit code);

(b) any access to alter protected parameters shall be automatically recorded (for example by means of a counter which automatically increments when access is initiated);

(c) the record shall be readily accessible by a simple action (for example by display of the counter when a button identified as being for this purpose is pressed, or during the indication check);

(d) the record shall be readily identifiable as such and shall not be easily confused with other indications of the instrument;

(e) a reference record in the same form as the incremental record shall be permanently marked on the instrument to indicate that the parameters have been accessed since the last verification (for example the reference record could be associated with the verification mark);

(f) the record shall not repeat in a sequence of less than 999 alterations. It shall also persist reliably for a period of at least two years (unless it is overwritten by a further alteration); and

(g) the record shall persist through tests for influence factors and disturbances specified in this Recommendation.

5.5 Instrument construction

5.5.1 General

Multi-dimensional measuring instruments shall be constructed so that they comply with the following metrological and technical requirements.

5.5.2 Interfaces for peripheral devices

An instrument may be equipped with interfaces permitting the coupling of any peripheral devices or other instruments.

An interface shall not allow the metrological functions of the instrument and its measurement data to be affected by the operation of the peripheral devices or connected instruments or by disturbances acting on the interface.

If instructions or data can be introduced through the interface into the measuring instrument which alters the parameters that determine the measurement result, the interface shall be sealed as described in 5.4.2.

5.6 Checking facilities

5.6.1 Acting upon significant faults

When a significant fault has been detected, the instrument shall either be made inoperative automatically or a visual or audible indication shall be provided automatically and shall continue until such time as the user takes action or the fault disappears. For automatic instruments the instrument shall be made inoperative automatically.

5.6.2 Indication check

If the failure of an indicator display element can cause a false indication, then the instrument shall have a display test facility which when turning on the power and on demand, shows all the relevant elements of the indication display in both active and non-active states, for a sufficient time to allow the operator to check them.

This is not applicable for displays on which failure becomes evident, e.g. non-segmented displays, screen-displays, matrix-displays, etc.

6 Additional requirements for software controlled devices

The software requirements are based on OIML D 31 [6]. All requirements in this clause apply only to the legally relevant parts of a measuring instrument, e.g. software, parameters, the measured quantity value, and measurement data.

6.1 Software identification

The software of a measuring instrument/component shall be clearly identified. The identification may consist of more than one part, but at least one part shall be dedicated to the legal purpose.

The identification shall be displayed

- on command, or
- during operation, or
- on start-up.

If a software-controlled component has no display, the identification shall be sent via a communication interface, in order to be displayed/printed on another component.

If the software is modified in any way, a new software identification is required.

The software identifiers are legally relevant parameters and shall be secured and protected; see also 6.3.

The software identification, the means of identification (e.g. software version, hash value, checksum) and the means of verification shall be stated in the certificate.

6.2 Correctness of algorithms and functions

The measuring algorithms and functions of a measuring instrument shall be appropriate and functionally correct for the given application (accuracy of the algorithms, price calculation according to certain rules, rounding algorithms, etc.).

It shall be possible to assess algorithms and functions either by metrological tests, software tests or software examination.

National authorities shall be informed of all the functions and parameters, and no hidden or undocumented functions or parameters shall exist.

6.3 Securing and protecting software, parameters, the measurand value and measurement data

A software-controlled measuring instrument shall be constructed in such a way that possibilities for unintentional, unauthorised, or intentional misuse are minimal.

Note: Legally relevant software and parameters shall be protected against accidental or unintentional changes due to human action and corruption due to physical changes (e.g. memory corruption due to aging).

6.3.1

Software shall be protected in such a way that evidence of any intervention (e.g. software updates) shall be available.

Software shall be protected against unauthorised modification, loading, or changes by swapping the memory device.

Note: Updating the software of the measuring instrument or component is allowed if the requirements for updates are fulfilled; see B.6.

6.3.2

Only clearly documented functions maybe activated by the user interface, which do not influence the metrological characteristics of the instrument.

6.3.3

Parameters that fix the legally relevant characteristics of the measuring instrument shall be protected in such a way that evidence of an intervention shall be available.

Displaying or printing of the current legally relevant parameter settings shall be possible.

6.3.4

Measurement data and the measurand value, stored or transmitted, shall be protected against modification. See B.3 and B.4.

The measuring instrument or component shall be fitted with a checking facility to ensure that if a modification or corruption is detected, the measurement data and the measurand value shall be discarded or marked unusable.

6.4 Authentication of the presented measurement results

It shall not be possible to fraudulently simulate legally relevant software for presenting measurement results, using easily available and manageable tools.

See also B.2 in the case of a shared display.

6.5 Audit trail

Audit trails are part of the legally relevant software and shall be protected as such. It shall not be possible to delete the audit trails and it shall not be possible to exchange the audit trails.

The content of the audit trail shall be shown on the display or printed upon command. The certificate shall describe how the audit trail may be displayed or printed.

The storage device for the audit trail shall have a sufficient capacity to ensure that the information is available for at least three successive verifications or inspections. If the limit of the storage has been reached, the oldest data may be overwritten by the new data.

The audit trail shall contain at minimum the following information:

- success/failure of the update procedure;
- time stamp of the event;
- in the case of a software download (see B.6):
  - software identification of the installed version;
  - software identification of the previous installed version;
- in the case of a parameter change:
  - identification of the changed parameter;
  - the old and new values of the changed parameter.

6.6 Requirements for specific configurations of electronic instruments

The specific requirements in Annex B (the mandatory software Annex) apply if the measuring instrument/ component employs any of the technologies specified in Annex B. These requirements shall be satisfied in addition to those described above.

6.7 Detection of significant defects

The detection of significant defects by the checking facilities may be achieved by software.

In such a case, this detecting software is considered to be part of the legally relevant software.

If software is involved in the detection of significant defects, the software-controlled measuring instrument shall be made inoperative automatically, or a visual or audible indication shall be provided automatically and shall continue until such time as the user takes action or the defect disappears.

The documentation to be submitted for type evaluation shall contain all such information necessary for a reasonable evaluation of the legally relevant software. It may include a list of the defects that will be detected by the software and the expected reaction and, if needed for understanding its operation, a description of the detecting algorithm.

6.8 Support of durability protection

If software is involved in durability protection and durability is detected as being jeopardised, the software-controlled measuring instrument shall either initiate measures to ensure further durability, or it shall become inoperable until the user takes action, or the problem disappears.

The documentation to be submitted for type evaluation shall contain all such information necessary for a reasonable evaluation of the legally relevant software. It may include a list of the durability problems that will be detected by the software, the expected reaction and, if needed for understanding its operation, a description of the detecting algorithm.

Annex A - Guidelines on object limitations

(Informative)

A.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 recognised 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 colour (uniform and non-uniform), contrast of the surface colour with the background colour 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 whether they measure within the specified mpe. 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 recognised, 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 A.2 to A.4 list the known limitations of objects, and Table A.1 specifies which limitations apply to the different technologies used for measuring the object.

Table A.1 Applicable object limitations

Applicable clause in Annex A	Principle of operation			
	Reflection of sound (1)	Reflection of light (2)	Cutting a light beam (3)	Mechanical (4)
A.2 Shape	x	x	x	x
A.3.1 Uniform surface colour		x		
A.3.2 Non-uniform surface colour		x		
A.3.3 Contrast of surface colour with background colour		x		
A.3.4 Surface reflectivity and absorption of sound	x			
A.3.5 Surface reflectivity and absorption of light		x		
A.3.6 Uniformity of density	x			
A.3.7 Transparency		x	x	
A.3.8 Surface roughness	x	x	x	x
A.3.9 Protrusions of the surface	x	x	x	x
A.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) Mechanical wheel device that rolls a wheel along the surface of the object.

A.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.

A.3 Surface characteristics

A.3.1 Uniform surface colour

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

A.3.2 Non-uniform surface colour

The non-uniformity of surface colour 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 colour can be used to determine whether the instrument is affected by such variations.

A.3.3 Contrast of the surface colour with the background colour

Some instruments measure by contrasting the surface colour of the object against the background colour of the measuring plane. The contrast may be a light colour against a dark colour, 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 colours to the colour of the measuring plane can be used to determine the limits of contrast.

A.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 from best to worse reflective properties:

(a) smooth, flat steel;
(b) smooth, flat plywood;
(c) smooth, flat, corrugated cardboard; and
(d) polystyrene foam.

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

A.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 whether the instrument is affected by these characteristics.

A.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.

A.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.

A.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.

A.3.9 Protrusions

Instruments 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.

A.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 centre of the measuring plane.

Annex B - Software

(Mandatory)

The specific requirements in this Annex apply if the measuring instrument/component employs any of the following technologies. These requirements shall be satisfied in addition to those described in clause 6.

B.1 Specification and separation of legally relevant parts and specification of interfaces

This requirement applies if the software-controlled measuring instrument/components has/have interfaces for communicating with other devices or components, with the user, or with other software parts besides the legally relevant parts within the measuring instrument/components.

Legally relevant parts of the measuring instrument – whether software or hardware parts – shall not be inadmissibly influenced by other parts of the measuring instrument or by external devices connected to the measuring instrument.

B.1.1 Interfaces

Only clearly documented functions may be activated by the user or communication interface, which do not influence the metrological characteristics of the measuring instrument. See also 5.5.2 (interfaces for peripheral devices).

This implies that there is an unambiguous assignment of each command to all initiated functions or data changes in the component.

The respective parts of the software that interpret commands are considered to be legally relevant software.

Note: Updating the software of the measuring instrument or component is allowed if the requirements for updates are fulfilled.

B.1.2 Separation of components

B.1.2.1

Components of a measuring instrument that perform legally relevant functions or that process measurement data and/or the measurand value shall be identified, clearly defined and documented. They form the legally relevant part of the measuring instrument.

B.1.2.2

If the connection of components is protected by software means, the connection parameters shall be secured and protected in such a way that evidence of an intervention is available. In the case of software protection, it shall be ensured that the component only operates with the components it has been paired with. If the components are not paired, the legally relevant component shall be made inoperative automatically, although an error message may be provided.

B.1.2.3

It shall be demonstrated that the security and protection of the software and the parameters of the components and the protection of measurement data and the measurand value comply with clause 6.

B.1.2.4

If the legally relevant component communicates with other parts, a protective interface shall be used, or the interface into the component shall be sealed.

B.1.2.5

If the source of the measurement data or measurand value is not implicitly identifiable or verifiable, e.g. if there is more than one component or if the component is remotely connected, the component shall supply a unique identification, which shall be included in the measurement result relevant data.

B.1.2.6

Transmission of measurement data and/or measurand value shall comply with B.4.

B.1.3 Specification and separation of software parts

B.1.3.1

All software modules (programmes, subroutines, objects, etc.) that perform legally relevant functions or that process measurement data and/or the measurand value form the legally relevant software part of a software-controlled measuring instrument/component. The requirement applies to this part and the software part shall be made identifiable as described in 6.1.

If the separation of the software is not possible or not needed, the software is legally relevant as a whole.

B.1.3.2

If the legally relevant software part communicates with other parts, a protective software interface shall be used. All communication shall be performed exclusively via this interface. The legally relevant software part and the interface shall be clearly documented. All the legally relevant functions and data domains of the software shall be described, in order to enable a type evaluation authority to decide on correct software separation.

The interface consists of program code and dedicated data domains. Defined coded commands or data are exchanged between the software parts by storing to the dedicated data domain by one software part and reading from it by the other. Writing and reading program code is part of the software interface. Measures shall be taken to ensure that the declared protective software interface shall not be circumvented.

B.1.3.3

There shall be an unambiguous assignment of each command to all initiated functions or data changes in the legally relevant part of the software. Functions that can be triggered through the software interface shall be declared and documented. Only documented commands are allowed to be activated through the software interface. The manufacturer shall state the completeness of the documentation of commands.

B.1.3.4

Information generated by the legally non-relevant software shall be shown on a display or printout in a way that confusions with the information generated by the legally relevant software are avoided.

B.2 Shared indications

A display or printout may be employed for presenting both information from the legally relevant software part and other information. If a display or printout is used for both legally relevant and legally non-relevant information, the legally relevant information shall always be readable, and shall be clearly distinguishable from other information. The information that is not legally relevant shall not inadmissibly influence the legally relevant information.

B.3 Storage of data

If there is a device, whether incorporated in the measuring instrument or being part of the measuring instrument as a software solution or connected to it externally, that is intended to be used for storage of the measured quantity value and/or measurement data, the following additional requirements apply.

Note: The measurement result consists of the measured quantity value and the measurement data.

B.3.1

The measured quantity value and/or measurement data shall be protected to guarantee the authenticity, integrity and, if necessary, correctness of the information concerning the time of measurement. The software that displays or further processes the measured quantity value and/or measurement data shall check the authenticity and integrity of the measured quantity value and/or measurement data after having read them from the storage.

If a modification or corruption is detected, the stored data shall be discarded or marked unusable.

Software modules that prepare data for storing, or that check data after reading, are considered part of the legally relevant software.

B.3.2

The storage device must have sufficient permanency to ensure that the measured quantity value and/or measurement data are not corrupted under normal storage conditions. There shall be sufficient memory storage for any intended application.

B.3.3

If the measurement result is stored, then the measurement result relevant data shall contain the information listed in 5.2.9.1 and 5.2.9.2.

B.3.4

When data storage of the measurement results is required, measurement results must be stored automatically when the measurement is concluded, i.e. when the measurement result used for the legal purpose has been generated.

B.3.5

When the measurement result used for the legal purpose results from a calculation, the measurement result relevant data shall be automatically stored with the measurement result.

B.4 Transmission of measured quantity values and/or measurement data

If the measured quantity value and/or measurement data are transmitted before they are used for legal purposes the following requirements apply:

Note: The measurement result consists of the measured quantity value and the measurement data.

B.4.1

The transmitted data shall be protected to guarantee the authenticity, integrity and, if necessary, correctness of the information concerning the time of measurement. The software that displays or further processes the measured quantity value and/or measurement data shall check the authenticity and integrity of the transmitted data received from a transmission channel. If a modification or corruption is detected, the transmitted data shall be discarded or marked as unusable.

Software modules that prepare data for sending, or that check data after receiving, are considered part of the legally relevant software.

B.4.2

When transferring a measured quantity value and/or measurement data through an open network, it is necessary to apply cryptographic methods. Confidentiality key-codes employed for this purpose shall be kept secret and secured in the measuring instrument, electronic devices, or components involved.

Protection shall be provided in such a way that these keys can only be input or read if a seal is broken.

B.4.3

Transmitted measurement data shall be capable of being traced back to the measurement and measuring instrument/component that generated them.

If the measurement result is transmitted, then the measurement result relevant data shall contain the information listed in 5.2.9.1 and 5.2.9.2.

B.4.4

The measurement shall not be inadmissibly influenced by a transmission delay.

B.4.5

If network services become unavailable, no measurement information shall be lost.

B.5 Operating systems

If an operating system is part of the software-controlled device, the requirements according to B.5.1 to B.5.3 shall be met.

Each of the following operating system requirements shall be addressed on the application level, operating system level or a combination of both. For example, the protective interface may be implemented within the legally relevant application, the operating system, the physical layer, etc.

B.5.1 General

(a) The manufacturer shall identify the hardware and software environment that is suitable. Minimum resources and a suitable configuration (e.g. processor, memory, specific communication, version(s) of operating system, etc.) necessary for securing and protecting the legally relevant software, parameters, measurement data, the measurand value and guaranteeing the accuracy of the measurement shall be declared by the manufacturer.

(b) Technical means shall be provided in the legally relevant software to prevent operation, if the minimal configuration requirements are not met. The system shall be operated only in the environment specified by the manufacturer for its correct functioning.

(c) Communication with legally relevant software shall be made via protective interfaces.

(d) It shall not be possible to inadmissibly influence the legally relevant software, parameters, measurement data and the measurand value through the hardware interfaces of the instrument.

B.5.2 Secure boot

If a secure boot process is needed to ensure protection of the legally relevant software, parameters, measurement data and the measurand value, the following requirements apply:

(a) in order to ensure integrity and authenticity of the legally relevant software, a chain of trust shall be established over the individual components of the boot process.

Note: A chain of trust from the protected hardware to the loaded legally relevant software serves the purpose to ensure the integrity and authenticity of the legally relevant software via mutual authentication of the individual software modules;

(b) the processing of the chain of trust can be interrupted, as long as its integrity is preserved;

(c) the boot configuration shall be protected against unauthorised modifications;

(d) booting via open interfaces shall be prohibited.

B.5.3 Protection during use

(a) The operation of software that is not legally relevant, including the operating system, shall not inadmissibly influence the legally relevant application.

(b) The combination of legally relevant software and operating system shall ensure that the legally relevant display is distinguishable.

(c) The access control shall be configured in such a way that the intended use cannot be inadmissibly influenced.

(d) The administration tasks of the legally relevant software shall be protected.

Note: The term "administration task" addresses all reconfigurations and updates of the operating system.

(e) The configuration of the operating system shall be identifiable.

(f) The configuration of the operating system (including updates to the operating system) shall be protected. Any changes to the configuration (or updates) shall be traceable.

B.6 Software updates

Downloading and installing of legally relevant software is allowed if the requirement in B.6.1 is met and if the requirements in the download procedures described in either B.6.2 or B.6.3 are met.

The required download procedure depends on national regulations.

B.6.1 General

Only versions of legally relevant software that conform to the approved type are allowed to be installed in the measuring instrument. These different versions of the legally relevant software shall be stated in the certificate.

B.6.2 Verified update

Verified update is the procedure of changing software in a verified device or component after which the subsequent verification by a responsible person at place is necessary.

The software to be updated can be loaded locally, i.e. directly on the measuring instrument or remotely via a network. A seal needs to be broken for the update to take effect.

Loading and installation may be two different steps (as shown in Figure 1) or combined into one, depending on the needs of the technical solution.

A person shall be on the installation site of the measuring instrument to check the effectiveness of the update. After the update of the legally relevant software (exchange with another approved version or re-installation), the measuring instrument is not allowed to be employed for legal purposes before a verification of the measuring instrument has been performed and the securing means and physical seal have been renewed.

B.6.3 Traced update

Traced update is the procedure of changing software in a verified device or component after which the subsequent verification by a responsible person on site is not necessary. This means the traced update shall not affect existing parameters or the accuracy of the measurement.

The software to be updated can be loaded locally, i.e. directly on the measuring instrument, or remotely via a network. The software update is recorded in an audit trail; see 6.5.

The procedure of a traced update comprises several steps: loading, integrity checking, checking of the origin (authentication), installation, logging, and activation.

(a) Depending on the needs and on national legal legislation it may be necessary for the user or owner of the measuring instrument to have to give his consent to a traced update. The measuring instrument shall have a feature for the user or owner to express their consent, e.g. a push button, before the update starts. It shall be possible to enable and disable the feature, e.g. by a switch or by a parameter. The configuration of the feature shall be protected in the case of a switch, or secured in the case of a parameter.

If the feature is enabled, each traced update has to be initiated by the user or owner. If it is disabled, no activity by the user or owner is necessary to perform a traced update.

(b) Traced update of software shall be automatic.

(c) Technical means shall be employed to guarantee the authenticity of the loaded software, i.e. that it originates from the owner of the certificate.

Note: A reference for encryption algorithms can be found in ISO/IEC 18033 [7].

(d) Technical means shall be employed to ensure the integrity of the loaded software, i.e. that it has not been inadmissibly changed before loading.

(e) If the loaded software fails the integrity test (B.6.3 (d)) or the authenticity test (B.6.3 (c)), the measuring instrument shall discard the new version and use the previous version of the software, or switch to an inoperable mode.

In this mode, the measuring functions shall be inhibited.

It shall be possible to resume the download procedure, or to show an error.

(f) During an update, the measuring instrument shall either function correctly within the maximum permissible error, or the measuring functions shall be inhibited.

(g) Any existing audit trail information shall be retained; see also 6.5.

B.6.3.1

An audit trail shall be employed to ensure that traced updates of legally relevant software are adequately traceable within the measuring instrument for subsequent verification and surveillance or inspection.

(a) The audit trail shall contain at minimum the following information: success/failure of the update procedure, software identification of the installed version, software identification of the previous installed version, time stamp of the event, identification of the downloading party if available. An entry is generated for each update attempt regardless of the success.

(b) The storage device for the audit trail that supports the traced update shall have a sufficient capacity to ensure the traceability of traced updates of legally relevant software between at least three successive verifications or inspections. If the limit of the storage has been reached, the oldest data may be overwritten by the new data. After having reached the limit of the storage for the audit trail, it shall be ensured by technical means that further downloads are impossible without breaking a seal.

(c) If the audit trail has no more capacity or the user or owner denies consent, the update procedure shall not start at all.

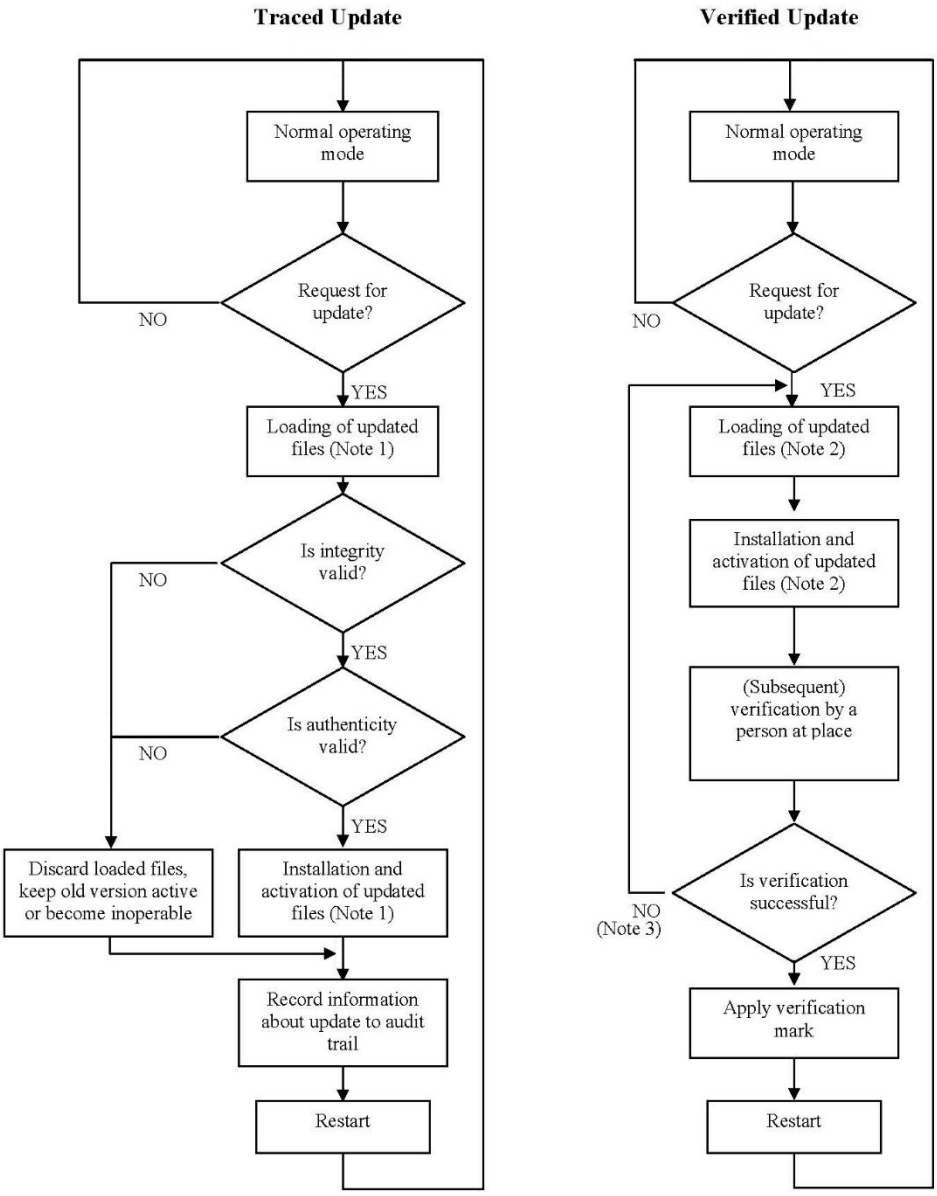

Figure 1 – Software update procedure

Note 1: In the case of a traced update, updating is separated into two steps: "loading" and "installing/activating". This implies that the software is temporarily stored after loading without being activated because it must be possible to discard the loaded software and revert to the old version, if the checks fail.

Note 2: In the case of a verified update, the software may also be loaded and temporarily stored before installation but depending on the technical solution, loading and installation may also be accomplished in one step.

Note 3: Here, only failure of the verification due to the software update is considered. Failure due to other reasons does not require re-loading and re-installing of the software, symbolised by the NO-branch.

Annex C – Comparison table

(Informative)

OIML R 129-1:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
1	Scope	1	Scope	Scope of the Recommendation amended to include the "volume of the smallest box by volume". Scope amended to include use of different measurement devices, each using a different method to measure separate dimensions of an object.
2	Terminology	2	Terminology	Definitions/terminology updated to align with requirements/ formatting specified in OIML B 6-2 [8].
2.1.1	Multi-dimensional measuring instrument	2.1	Multi-dimensional measuring instrument	Includes 'dimensions'.
2.1.1.1	length			Definition added.
2.1.1.2	width			Definition added.
2.1.1.3	height			Definition added.
		2.4	processor	Deleted.
2.1.5	Ancillary device	2.6	Auxiliary devices	Name changed.
2.1.9	Maximum measuring speed			Definition added.

OIML R 129-1:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
2.1.10	Minimum measuring speed			Definition added.
2.1.11	Indication			Definition added.
2.1.12	Measuring area			Definition added.
2.2.1	Rectangular box	2.10	Rectangular box	Definition amended to include “all dihedral angles as right angles” to provide clarity.
2.2.4	Dimensional volume	2.13	Volume	Definition remains the same, name changed.
		2.14	Weight	Deleted.
2.3.6	Fault limit			Definition added.
2.5	Other definitions	2.20 -2.22	Electronic terms	The terms applicable to software controlled instruments shall be as per OIML D 31 [6].
4.1.3	Value of the fault limit			Added.
4.1.6	Calculated quantities	4.5	Calculated quantities	Requirement amended to ensure all calculated quantities are in mathematical agreement.
4.1.7	Rules for the determination of errors	4.6	Rules for the determination of errors	Requirements for instruments with extended indication device added.
4.2.1	Rated operating conditions	5.1	Rated operating conditions for influence factors	Relative humidity added as an environmental condition.
		5.2	Humidity	Deleted. See the remarks for 5.1 (2000 edition).

OIML R 129-1:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
4.4	Light and acoustic effects	5.4	Light and acoustic effects	Provisions added for instruments capable of performing only across a limited range of light or acoustic effects.
		5.5	Tests	Moved to OIML R 129-2.
5.1.3	Suitability for use			Added.
5.1.5	Zero or ready adjustment	6.4	Zero or ready adjustment	Clarification for semi-automatic instruments provided.
5.2.1	General			Requirements for semi-automatic and automatic instruments added to provide clarity.
5.2.2	Presentation of indications	7.2	Clarity of indications	Requirement for printed numbers and symbols to be of minimum dimension.
5.2.4	Value of the scale interval	7.4	Value of the scale interval	Clarity provided regarding the requirements for instruments equipped with test mode that provides scale interval associated with each measured dimension.
5.2.5	Decimal numbers	7.5	Decimal numbers	Requirements clarified.
5.2.6	Limits of indication	7.6	Limits of indication	Flexibility provided for national responsible bodies to specify acceptable options with regard to either inhibiting or allowing measurement indication with error message. Requirements for measurements when the object or a portion of the object being measured is outside the measuring area added.
5.2.7	Multi-interval instruments	7.7	Multi-interval instruments	Requirements clarified.
5.2.8	Multi-instrument system	7.8	Multi-instrument system	Requirements simplified.

OIML R 129-1:2020		OIML R 129:2000		Remarks
Reference	**Description**	**Reference**	**Description**	
5.2.10	Availability of indications			Requirements for indications made available to customers.
		7.10	Stability	Deleted.
B.1.1	Interfaces	10.4	Auxiliary devices interface	The requirements have been moved to Annex B, the mandatory Software Annex.
6	Additional requirements for software controlled devices			New requirements applicable to legally relevant part of software controlled devices.
Annex B	Software			New mandatory Annex with requirements for software controlled measuring instruments.

Annex D - Bibliography

(Informative)

1. OIML R 76:2006 *Non-automatic weighing instruments*
2. OIML R 51:2006 *Automatic catchweighing instruments*
3. ISO/IEC Guide 99; OIML V 2-200:2012 *International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)*
4. OIML V 1:2012 *International Vocabulary of Terms in Legal Metrology (VIML)*
5. OIML D 11:2013 *General requirements for measuring instruments - Environmental conditions*
6. 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.
7. ISO/IEC 18033:2015 *Information technology - Security techniques - Encryption algorithms - Part 1: General*
8. OIML B 6-2:2019 *Directives for OIML technical work. Part 2: Guide to the drafting and presentation of OIML publications*