National Institute of Metrology

APLMF Seminars and Training Courses

# Type evaluation of non-automatic weighing instruments

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## E.1 The CIPM formula

In 1981, the Comité International des Poids et Mesures (CIPM) [39] recommended that the following equation be used to determine, $\rho_a$, the density of moist air:

$$\rho_a = \frac{pM_a}{ZRT}\left[1 - x_v\left(1 - \frac{M_v}{M_a}\right)\right] \qquad (E.1\text{-}1)$$

Where: $p$ = pressure;
$M_a$ = molar mass of dry air;
$Z$ = compressibility;
$R$ = molar gas constant;
$T$ = thermodynamic temperature using ITS-90;
$x_v$ = mole fraction of water vapor; and
$M_v$ = molar mass of water.

An approximate formula may also be used:

$$\rho_a = \frac{0.348\,48\ p - 0.009\ (hr) \times \exp(0.061\ t)}{273.15 + t} \qquad (E.3\text{-}1)$$

Where: the density of air, $\rho_a$, is obtained in kg m$^{-3}$;
the pressure, $p$, is given in mbar or hPa;
the relative humidity, $hr$, expressed as a percentage; and
the temperature, $t$, in °C.

For class $E_1$ weights, the density of air should always be determined based on corresponding measurements. However, the following approximation equation is a way to estimate the air density at laboratories that have no means of determining the air density at the site.

$$\rho_a = \rho_0 \times \exp\left(\frac{-\rho_0}{p_0} gh\right) \qquad \textit{(E.3-2)}$$

Where: $p_0$ = 101 325 Pa;

$\rho_0$ = 1.2 kg $m^{-3}$;

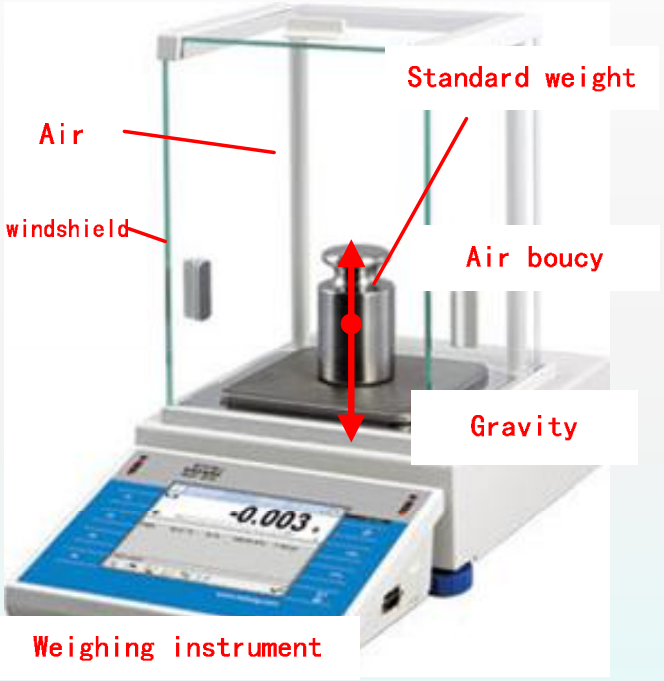
$g$ = 9.81 $ms^{-2}$; and

$h$ = height above sea level expressed in metres.

*OIML R111 Page 76*

## Weighing instrument in legal metrology

Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.




- “mass” is preferably used in the sense of “conventioanl mass” or “conventialnal value of the result of weighing in air”.

# Metrological requirements

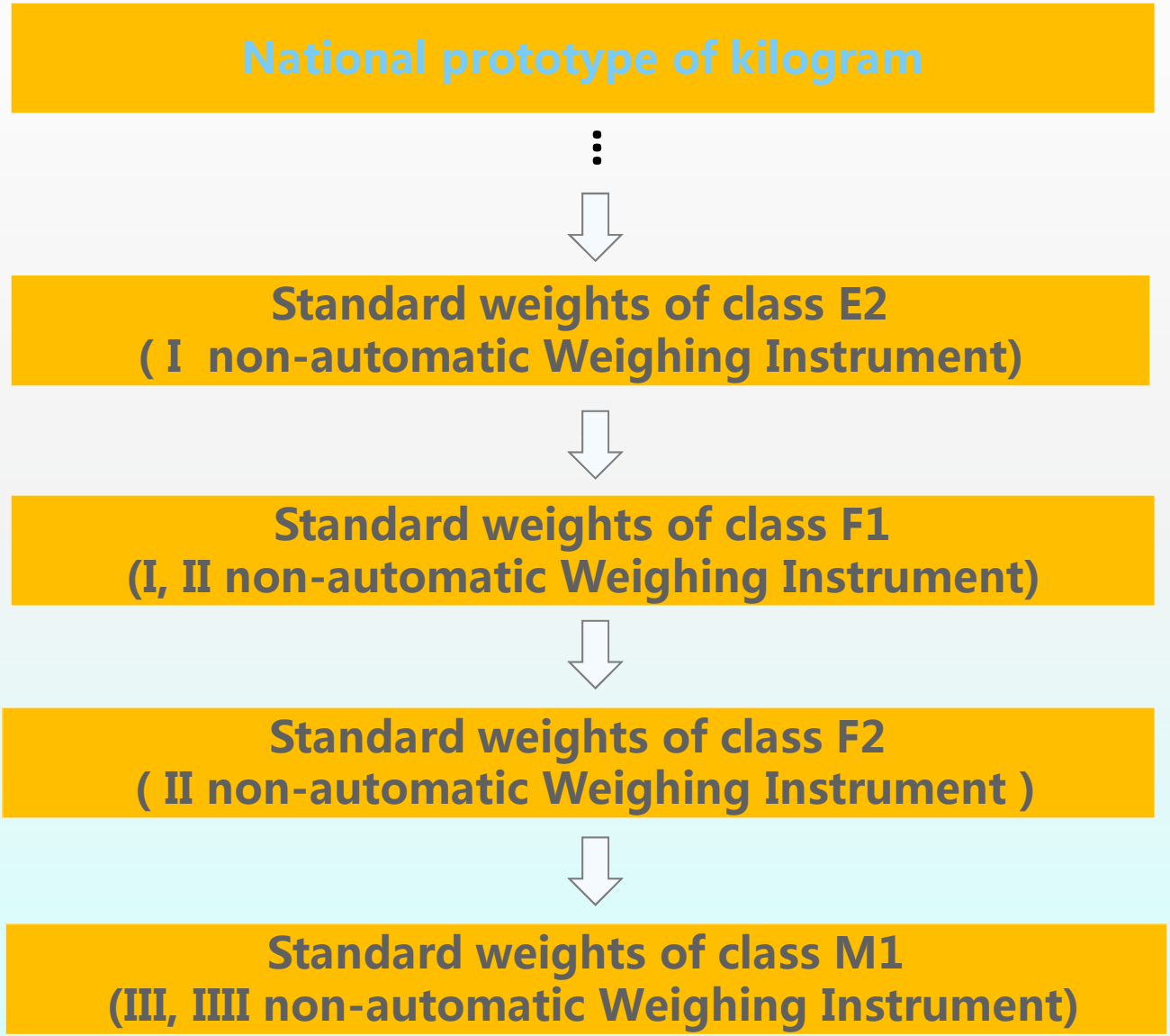
- **3.7 Test standards (*defined in OIML 76*)**
- **3.7.1 Weights**
  - In principle, the standard weights or standard masses used for the type examination or verification of an instrument shall meet the metrological requirements of OIML R 111.
  - They shall not have an error greater than 1/3 of the maximum permissible error of the instrument for the applied load. If they belong to class E2 or better, their uncertainty (rather than their error) is allowed to be not greater than 1/3 of the maximum permissible error of the instrument for the applied load, provided that the actual conventional mass and the estimated long-term stability is taken into account.

# Shape requirements in R111

- **6.3 Weights of 1 g up to 50 kg**
- **6.3.2 The weights of nominal values from 1 g to 50 kg may have the external dimensions shown in the Figures**
- and Tables in Annex A.
  - **6.3.2.1 These weights may also have a cylindrical or slightly tapered conical body (see example in Figure A.1).** The height of the body shall be between 3/4 and 5/4 of its mean diameter.
  - **6.3.2.2 These weights may also be provided with a lifting knob which has a height between 0.5 ´ and 1 ´ the mean** diameter of the body.
- 6.3.3 In addition to the above shapes (6.3.2), **weights of 5 kg to 50 kg** may have a different shape suitable for their method of handling. Instead of a lifting knob, they may have rigid handling devices embodied with the weights, such as axles, handles, hooks or eyes, etc.

# Hierarchy for Verification of Mass and Weighing Metrology

OIML R111



# Next section

## -two important concepts in R76

- Family
- Module

**Family** *Defined in OIML R76 -1 Edition 2006(E) T.3.5*

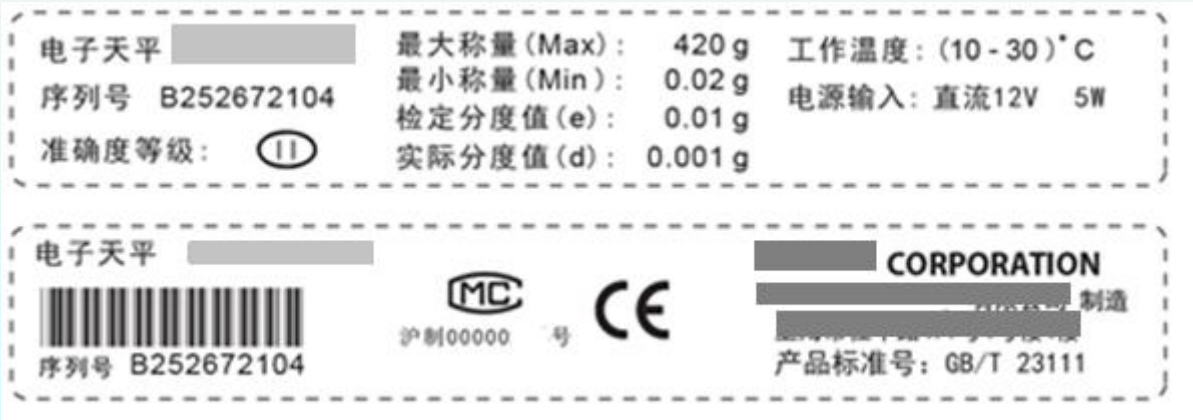
Identifiable group of weighing instruments or modules belonging to the same manufactured type that have the same design features and metrological principles for measurement (for example the same type of indicator, the same type of design of load cell and load transmitting device) but which may differ in some metrological and technical performance characteristics (e.g. Max, Min, e, d, accuracy class, etc.).

## **Family** *Defined in OIML R76 -1 Edition 2006(E) T.3.5*

- Identifiable group of weighing instruments or modules with:
  - the same manufactured type
  - the same design features
  - the same metrological principles for measurement
  - some different metrological and technical performance characteristics

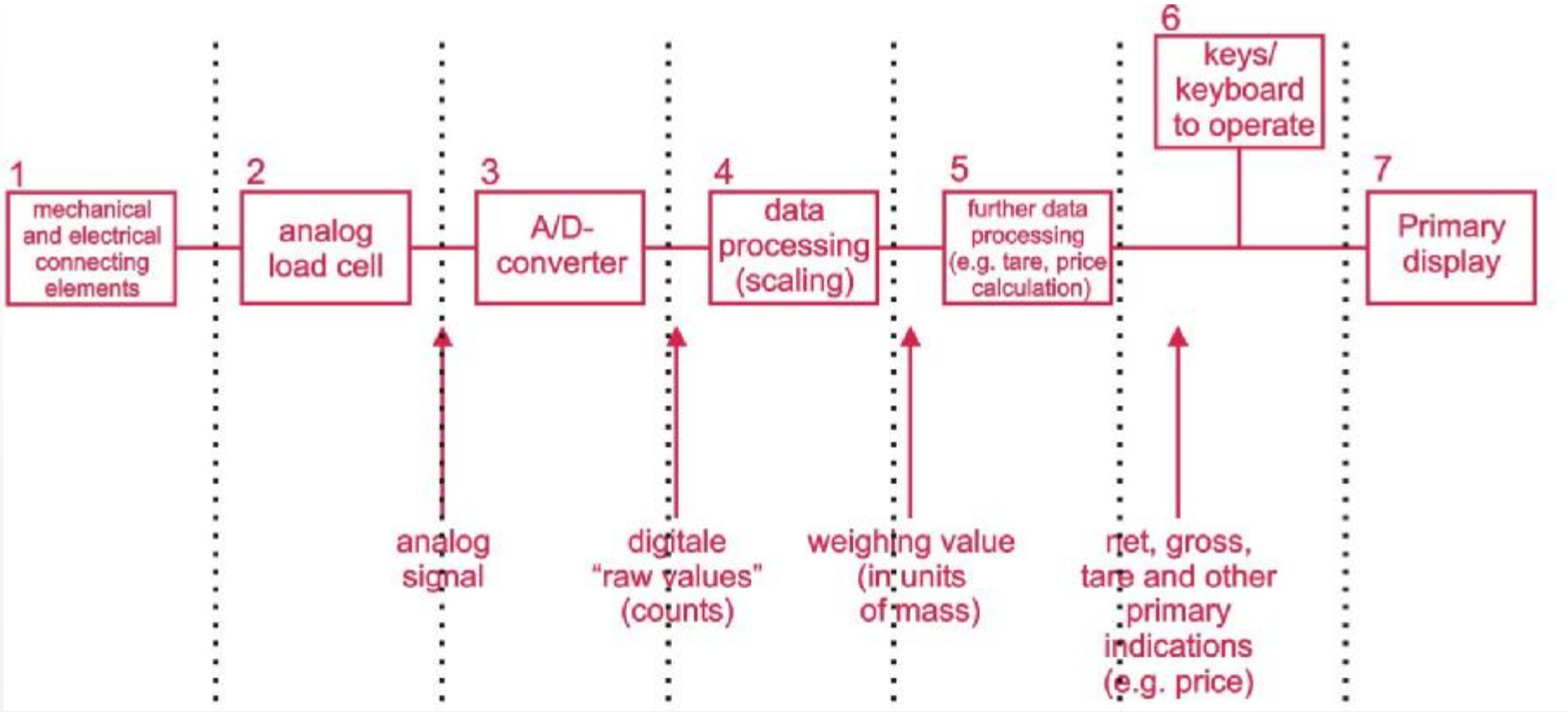
# Example

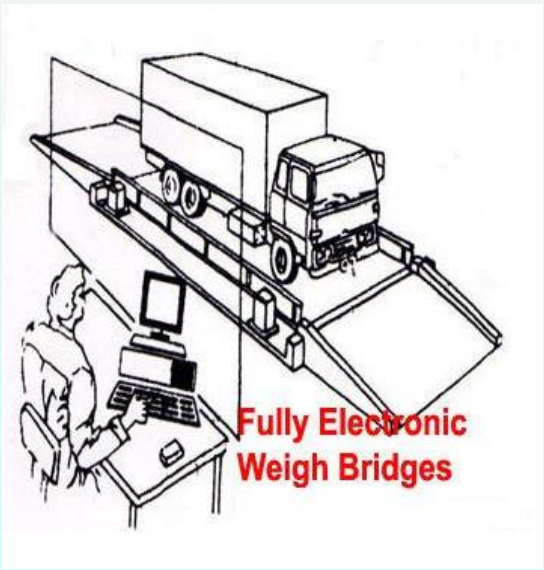
| No. | Type | Max (g) | Min (g) | *e* (g) | *n* | *d* (g) | Class |
|---|---|---|---|---|---|---|---|
| 1 | Type 1 | 220 | 0.02 | 0.01 | 22000 | 0.001 | Ⅱ |
| 2 | Type 2 | 420 | 0.02 | 0.01 | 42000 | 0.001 | Ⅱ |
| 3 | Type 3 | 4200 | 0.5 | 0.1 | 42000 | 0.01 | Ⅱ |
| 4 | Type 4 | 6200 | 0.5 | 0.1 | 62000 | 0.01 | Ⅱ |
| 5 | Type 5 | 6200 | 0.5 | 0.1 | 62000 | 0.1 | Ⅱ |
| 6 | Type 6 | 2200 | 0.5 | 0.1 | 22000 | 0.01 | Ⅱ |

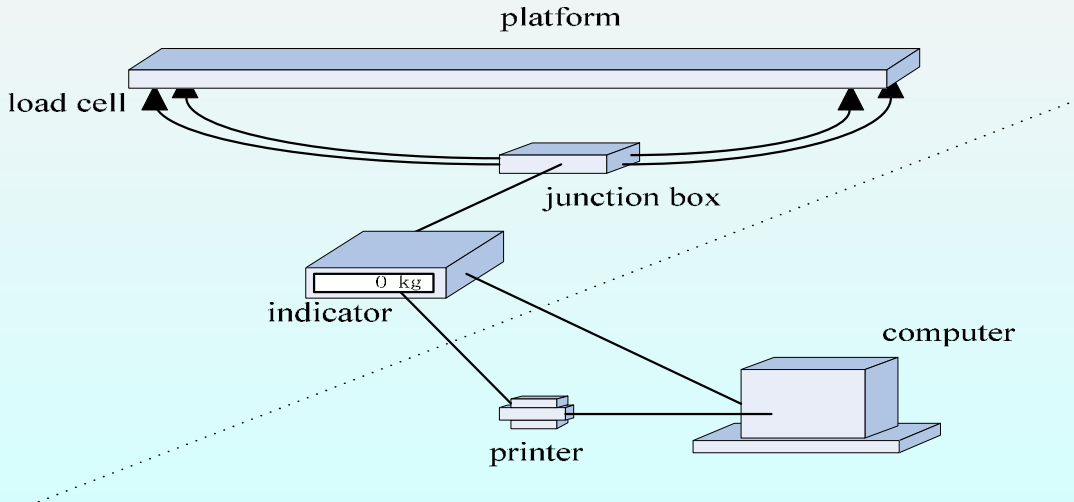


# 3.10.2 Modules (P36 R76)

- Why needs modules?
- Subject to agreement with the approving authority, the manufacturer may define and submit modules to be examined separately. This is particularly relevant in the following cases:
  - where testing the instrument as a whole is difficult or impossible;
  - where modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument; or
  - where the applicant wants to have a variety of modules included in the approved type.



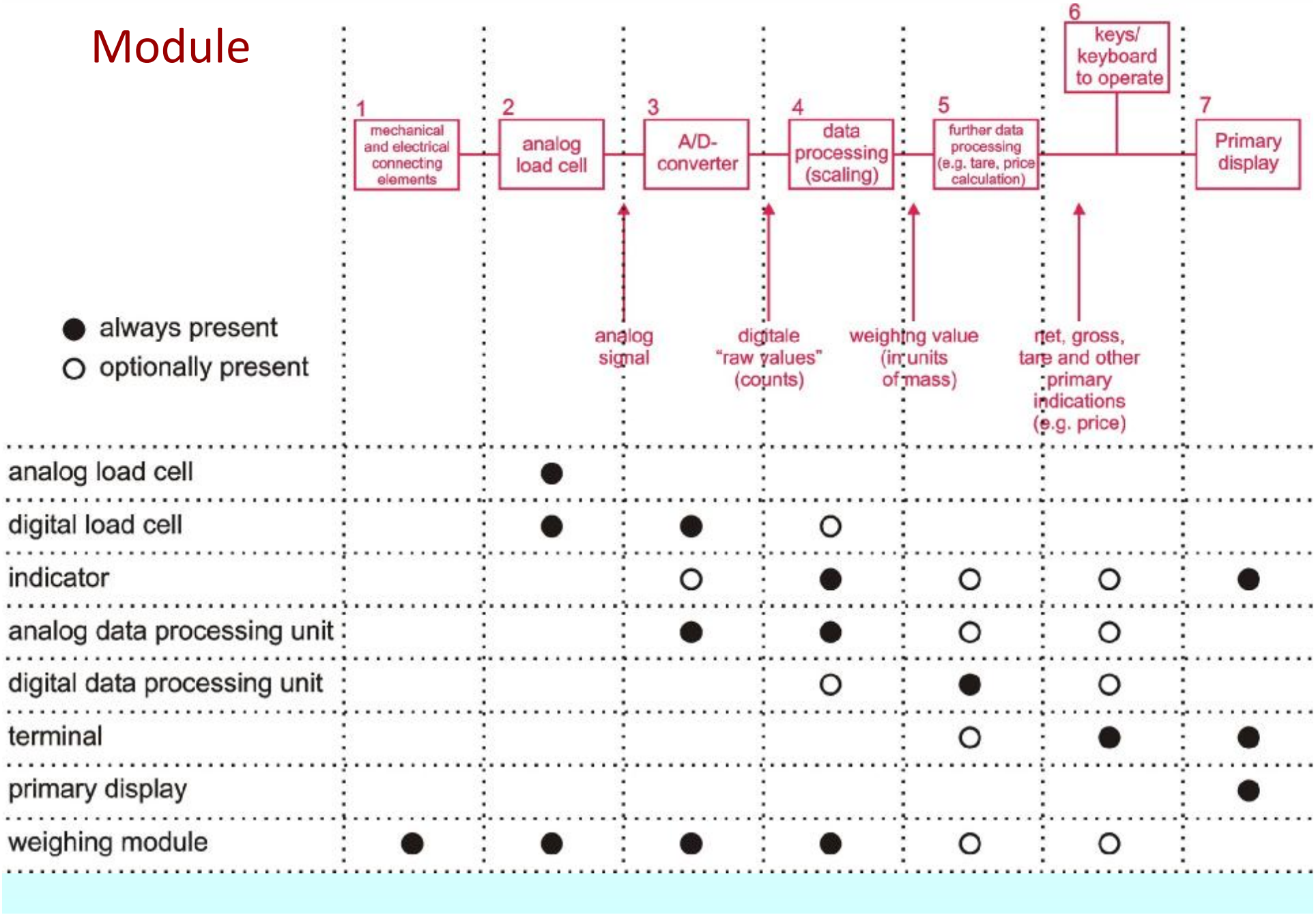




Peripheral devices

Table 7

| Performance criteria | Load cell | Electronic indicator | Connecting elements, etc. |
|---|---|---|---|
| Combined effect* | 0.7 | 0.5 | 0.5 |
| Temperature effect on no load indication | 0.7 | 0.5 | 0.5 |
| Power supply variation | – | 1 | – |
| Effect of creep | 1 | – | – |
| Damp heat | 0.7** | 0.5 | 0.5 |
| Span stability | – | 1 | – |

# Module

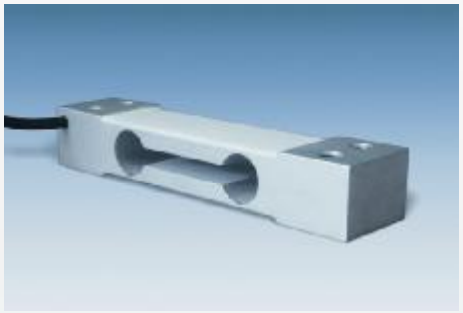

1
mechanical and electrical connecting elements
2
analog load cell
3
A/D-converter
4
data processing (scaling)
5
further data processing (e.g. tare, price calculation)
6
keys/ keyboard to operate
7
Primary display
analog signal
digitale "raw values" (counts)
weighing value (in units of mass)
net, gross, tare and other primary indications (e.g. price)
always present
optionally present
analog load cell
digital load cell
indicator
analog data processing unit
digital data processing unit
terminal
primary display
weighing module

# Module

Identifiable part of an instrument that performs a specific function or functions, and that can be separately evaluated according to specific metrological and technical performance requirements in the relevant Recommendation. The modules of a weighing instrument are subject to specified partial error limits.

# Load cell

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output).




analog load cell : analog load cell

digital load cell: analog load cell + A/D converter + data processing (scaling)

*Note:* Load cells equipped with electronics including amplifier, analog-to-digital converter (ADC), and data processing device (optionally) are called digital load cells (see Figure 1).

Must be equipped with

optional

# Indicator

Electronic device of an instrument that may perform the analog-to-digital conversion of the output signal of the load cell, and which further processes the data, and displays the weighing result in units of mass.

A/D converter

+

data processing (scaling)

+

further data processing

+

keys/keyboard to operate

+

Primary display



Must be equipped with

optional

# Analog data processing device

Electronic device of an instrument that performs the analog-to-digital conversion of the output signal of the load cell, further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument.

A/D converter

+

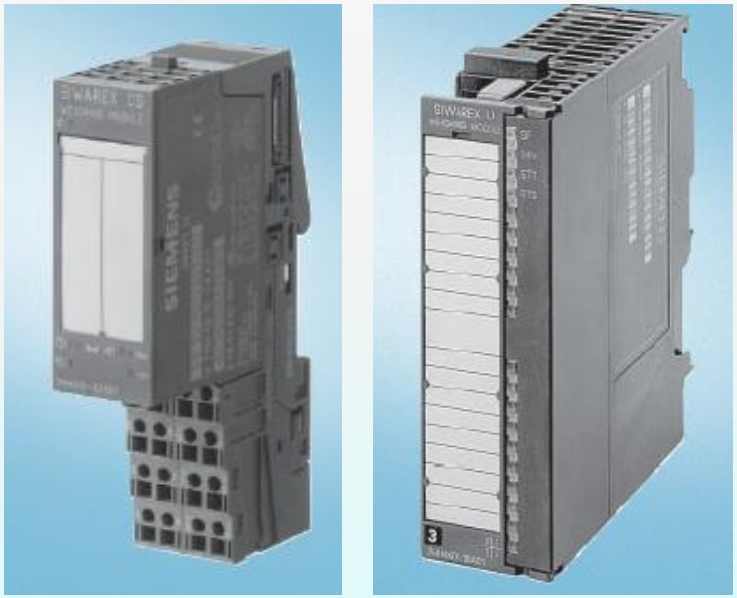
data processing (scaling)

+

further data processing

+

keys/keyboard to operate



Must be equipped with

optional

# Digital data processing device

Electronic device of an instrument that further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument.

data processing (scaling)

+

further data processing

+

keys/keyboard to operate

Must be equipped with

optional

# Terminal

Digital device that has one or more keys (or mouse, touch-screen, etc.) to operate the instrument, and a display to provide the weighing results transmitted via the digital interface of a weighing module or an analog data processing device.

further data processing

+

keys/keyboard to operate

+

Primary display


Must be equipped with

optional

# Digital display

A digital display can be realized as a primary display or as a secondary display :

a) Primary display: Either incorporated in the indicator housing or in the terminal housing or realized as a display in a separate housing (i.e. terminal without keys), e.g. for use in combination with a weighing module.

b) Secondary display: Additional peripheral device (optional) which repeats the weighing result and any other primary indication, or provides further, non-metrological information.

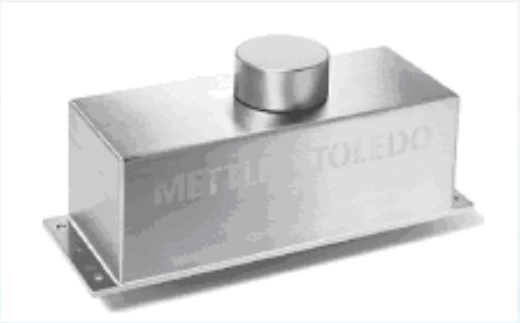
Primary display

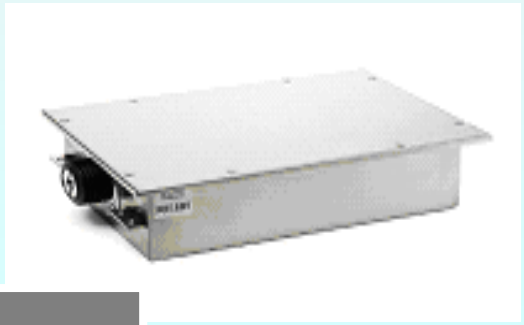
Must be equipped with

optional

# Weighing module

Part of the weighing instrument that comprises all mechanical and electronic devices (i.e. load receptor, load-transmitting device, load cell, and analog data processing device or digital data processing device) but not having the means to display the weighing result. It may optionally have devices for further processing (digital) data and operating the instrument.





mechanical and electrical connecting elements

+

analog load cell

+

A/D converter

+

data processing (scaling)

+

further data processing

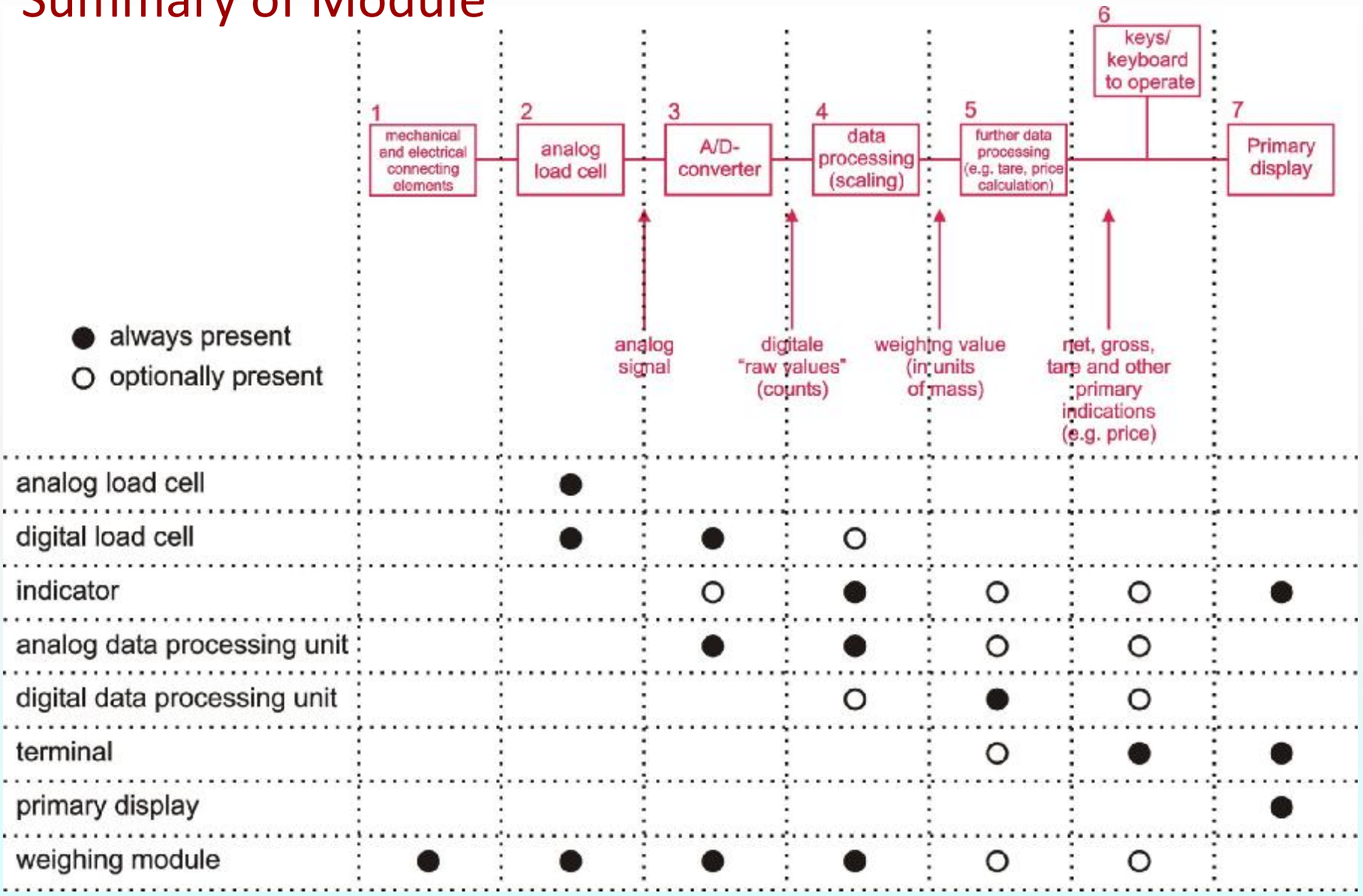
+

keys/keyboard to operate

Must be equipped with

optional

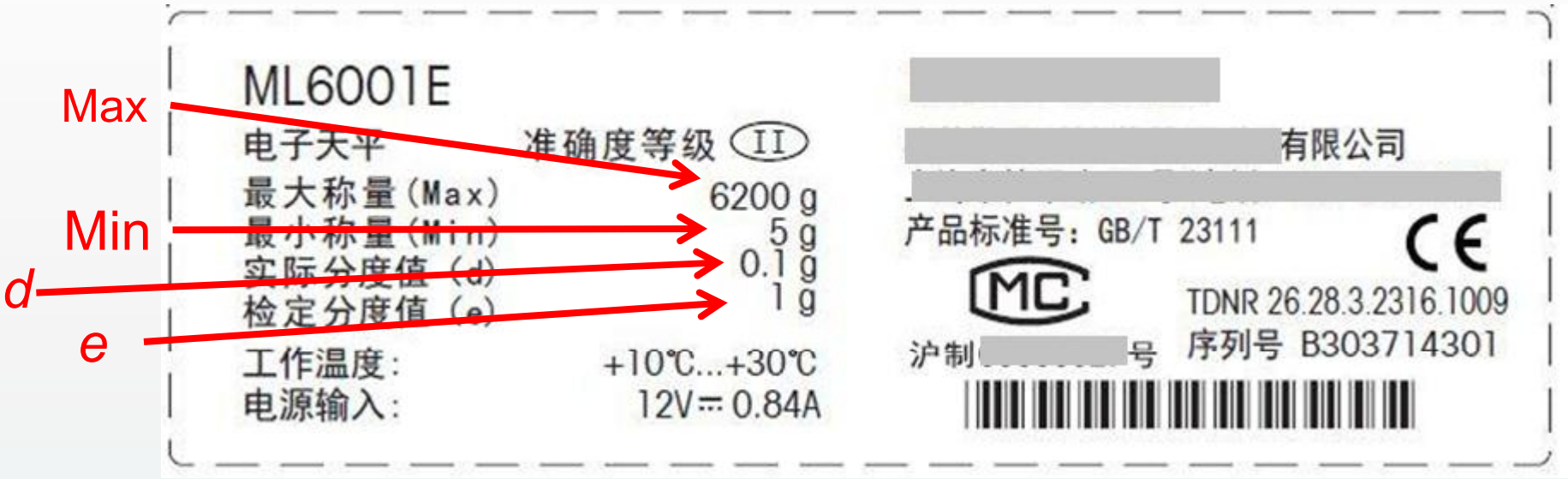
# Summary of Module



# Next section- General characteristics

- Important terms
  - Accuracy classes
  - Maximum capacity
  - Minimum capacity
  - Verification scale interval
  - Number of the Verification scale interval

# Terms and Definition




Describing Marking

# Accuracy classes

Table 3

| Accuracy class | Verification scale interval, *e* | Number of verification scale intervals, *n* = Max/*e* | | Minimum capacity, Min (Lower limit) |
|---|---|---|---|---|
| | | minimum | maximum | |
| Special (I) | 0.001 g ≤ *e** | 50 000** | – | 100 *e* |
| High (II) | 0.001 g ≤ *e* ≤ 0.05 g<br>0.1 g ≤ *e* | 100<br>5 000 | 100 000<br>100 000 | 20 *e*<br>50 *e* |
| Medium (III) | 0.1 g ≤ *e* ≤ 2 g<br>5 g ≤ *e* | 100<br>500 | 10 000<br>10 000 | 20 *e*<br>20 *e* |
| Ordinary (IIII) | 5 g ≤ *e* | 100 | 1 000 | 10 *e* |

- How to classify the accuracy of classes of an instrument with n=600 e=5 g?

**Either is ok.**
**Maximum permissible errors for Instrument of Class III and instrument of Class IIII are different.**

# Accuracy classes

Table 3

| Accuracy class | Verification scale interval, $e$ | Number of verification scale intervals, $n$ = Max/$e$ | | Minimum capacity, Min (Lower limit) |
|---|---|---|---|---|
| | | minimum | maximum | |
| Special (I) | 0.001 g ≤ $e$* | 50 000** | – | 100 $e$ |
| High (II) | 0.001 g ≤ $e$ ≤ 0.05 g<br>0.1 g ≤ $e$ | 100<br>5 000 | 100 000<br>100 000 | 20 $e$<br>50 $e$ |
| Medium (III) | 0.1 g ≤ $e$ ≤ 2 g<br>5 g ≤ $e$ | 100<br>500 | 10 000<br>10 000 | 20 $e$<br>20 $e$ |
| Ordinary (IIII) | 5 g ≤ $e$ | 100 | 1 000 | 10 $e$ |

* It is not normally feasible to test and verify an instrument to $e$ < 1 mg, due to the uncertainty of the test loads.

** See exception in 3.4.4.

- For Class I, minimum of *n*
  - *3.4.4 Minimum number of verification scale intervals*
    - *For an instrument of class I with d < 0.1 mg, n may be less than 50 000.*

# Accuracy classes

Table 3

| Accuracy class | Verification scale interval, $e$ | Number of verification scale intervals, $n$ = Max/$e$ | | Minimum capacity, Min (Lower limit) |
|---|---|---|---|---|
| | | minimum | maximum | |
| Special (I) | 0.001 g ≤ $e$* | 50 000** | – | 100 $e$ |
| High (II) | 0.001 g ≤ $e$ ≤ 0.05 g<br>0.1 g ≤ $e$ | 100<br>5 000 | 100 000<br>100 000 | 20 $e$<br>50 $e$ |
| Medium (III) | 0.1 g ≤ $e$ ≤ 2 g<br>5 g ≤ $e$ | 100<br>500 | 10 000<br>10 000 | 20 $e$<br>20 $e$ |
| Ordinary (IIII) | 5 g ≤ $e$ | 100 | 1 000 | 10 $e$ |

* It is not normally feasible to test and verify an instrument to $e$ < 1 mg, due to the uncertainty of the test loads.

** See exception in 3.4.4.

- The verification scale interval, *e*, is replaced by the actual scale interval, *d*

Table 3

| Accuracy class | Verification scale interval, *e* | Number of verification scale intervals, *n* = Max/*e* | | Minimum capacity, Min (Lower limit) |
|---|---|---|---|---|
| | | minimum | maximum | |
| Special (I) | 0.001 g ≤ *e** | 50 000** | – | 100 *e* |
| High (II) | 0.001 g ≤ *e* ≤ 0.05 g<br>0.1 g ≤ *e* | 100<br>5 000 | 100 000<br>100 000 | 20 *e*<br>50 *e* |
| Medium (III) | 0.1 g ≤ *e* ≤ 2 g<br>5 g ≤ *e* | 100<br>500 | 10 000<br>10 000 | 20 *e*<br>20 *e* |
| Ordinary (IIII) | 5 g ≤ *e* | 100 | 1 000 | 10 *e* |

* It is not normally feasible to test and verify an instrument to *e* < 1 mg, due to the uncertainty of the test loads.

** See exception in 3.4.4.


- $e$=1 g  $d$=0.1 g
- Min = ?  50$e$=50 g  or  50$d$=5 g √

# Terms and Definition

## Maximum permissible error

- Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard massed, with the instrument being at zero at no-load, in the reference position.

# Terms and Definition

## Maximum permissible error, mpe

Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard masses or standard weights, with the instrument being at zero at no-load, in the reference position.

| Maximum permissible errors on initial verification | For loads, $m$, expressed in verification scale intervals, $e$ | | | |
|---|---|---|---|---|
| | Class I | Class II | Class III | Class IIII |
| ± 0.5 $e$ | $0 \le m \le 50\,000$ | $0 \le m \le 5\,000$ | $0 \le m \le 500$ | $0 \le m \le 50$ |
| ± 1.0 $e$ | $50\,000 < m \le 200\,000$ | $5\,000 < m \le 20\,000$ | $500 < m \le 2\,000$ | $50 < m \le 200$ |
| ± 1.5 $e$ | $200\,000 < m$ | $20\,000 < m \le 100\,000$ | $2\,000 < m \le 10\,000$ | $200 < m \le 1\,000$ |

# Terms and Definition

## Maximum permissible error, mpe

- 0 g＜m≤5000 g　　±0.5 g
- 5000 g＜m≤6200 g　　±1.0 g


| Maximum permissible errors on initial verification | For loads, *m*, expressed in verification scale intervals, *e* | | | |
|---|---|---|---|---|
| | **Class I** | **Class II** | **Class III** | **Class IIII** |
| ± 0.5 *e* | 0 ≤ *m* ≤ 50 000 | 0 ≤ *m* ≤ 5 000 | 0 ≤ *m* ≤ 500 | 0 ≤ *m* ≤ 50 |
| ± 1.0 *e* | 50 000 < *m* ≤ 200 000 | 5 000 < *m* ≤ 20 000 | 500 < *m* ≤ 2 000 | 50 < *m* ≤ 200 |
| ± 1.5 *e* | 200 000 < *m* | 20 000 < *m* ≤ 100 000 | 2 000 < *m* ≤ 10 000 | 200 < *m* ≤ 1 000 |

# Metrological requirements

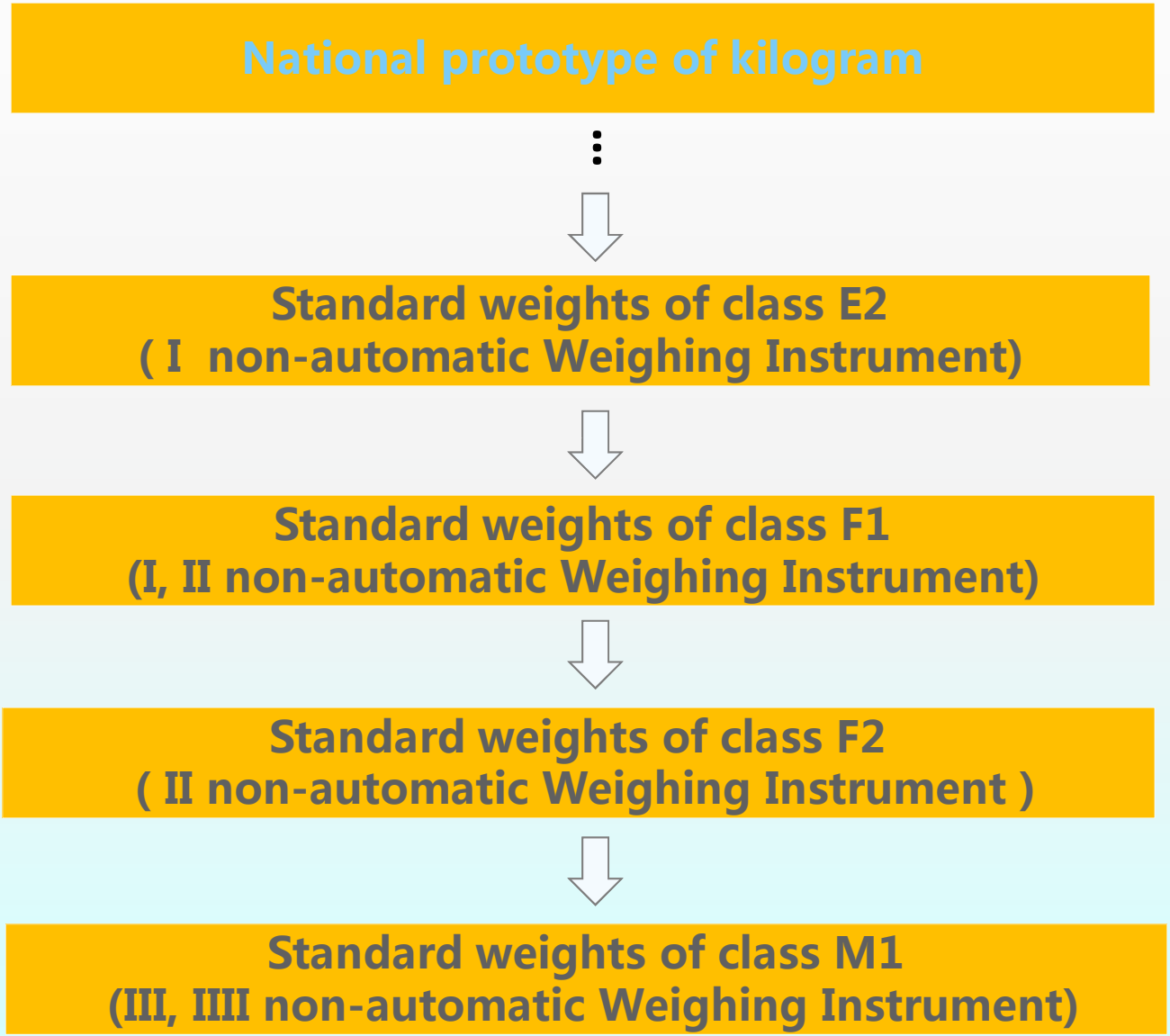
- If no particular working temperature is stated on the descriptive markings of an instrument, this instrument shall maintain its metrological properties within the following temperature limits:

$$-10^{\circ}\ C \sim +40^{\circ}\ C$$

- The ranges within those limits shall be at least equal to:
  - 5 ℃ for instruments of class I;
  - 15 ℃ for instruments of class II; and
  - 30 ℃ for instruments of classes III and IIII.

# Hierarchy for Verification of Mass and Weighing Metrology

OIML R111



# Technical requirements

- 4.1.2.4 Securing of components and pre-set controls
  - Means shall be provided for securing components and pre-set controls to which access or adjustment is prohibited. National legislation may specify the securing that is required.
  - On a class I instrument, devices to adjust sensitivity (or span) may remain unsecured.
  - Acceptable solution:
    - For application of the control marks, the securing area should have a diameter of at least 5 mm.

# Technical requirements

- **4.2.3 Limits of indication**
  - There shall be no indication **above Max + 9 e.**
  - An indication below zero (with minus sign) is possible when a tare device is in operation and the tare load has been removed from the load receptor.
  - It is also possible that negative values down to –20 d are displayed even if there is no tare device in operation, provided these values **cannot be transmitted, printed or used for a price calculation**.

# 7 Marking of instruments and modules

- 7.1 Descriptive markings
  - Note: The descriptive markings given here are by way of example, but variable according to national regulations.
- An instrument shall carry the following markings.

### 7.1.1 Compulsory in all cases

- Manufacturer's mark, or name written in full (A);
- Metrological markings (B):
  - Indication of accuracy class in the form of a Roman number in an oval (see footnote to 3.1.1):

    for special accuracy: 


    for high accuracy: 


    for medium accuracy: 


    for ordinary accuracy: 


  - Maximum capacity in the form: Max …
  - Minimum capacity in the form: Min …
  - Verification scale interval in the form: $e$ = ….

- 7.1.2 Compulsory if applicable(mandary)
  - Name or mark of manufacturer's agent for an imported instrument (C);
  - Serial number (D);
  - Identification mark on each unit of an instrument consisting of separate but associated
  - units (E);
  - Type approval mark (F);

- Supplementary metrological characteristics (G):
  - software identification (compulsory for software-controlled instruments)
  - scale interval, if $d < e$, in the form: $d =$
  - maximum additive tare effect, in the form: T = + …
  - maximum subtractive tare effect if different from Max, in the form: T = – ...
  - counting ratio on a counting instrument according to 4.17, in the form: 1:… or 1/…
  - range of plus/minus indication of a digital comparator instrument, in the form: ±… $u_m$ or –… $u_m$ / +… $u_m$
    ($u_m$ standing for the unit of mass as in 2.1)
  - ratio between weight platform and load platform as specified in 6.5.1, 6.8.2 and 6.9.4;
- Special limits (H):
  - maximum safe load, in the form: Lim = …
    (if the manufacturer has provided for a maximum safe load of more than Max + T)
  - the special temperature limits according to 3.9.2.2 within which the instrument complies with the prescribed conditions of correct operation, in the form: ... °C/ ... °C.

### 7.1.3 Additional markings (I)

Additional markings may, if necessary, be required on an instrument according to its particular use or to certain special characteristics, such as:

- not to be used for direct sales to the public/commercial transactions;
- to be used exclusively for: .....;
- the stamp does not guarantee/guarantees only: .....;
- to be used only as follows: .....

These additional markings may be either in the national language or in form of adequate, internationally agreed and published pictograms or signs.

## 7.1.4 Presentation of descriptive markings

- The descriptive markings shall be indelible and of a size, shape and clarity allowing easy reading.
- They shall be grouped in one or two clearly visible places either on a plate or sticker fixed permanently to the instrument, or on a non removable part of the instrument itself.
- In case of a plate or sticker which is not destroyed when removed, a means of securing shall be provided, e.g. a control mark that can be applied.

As an alternative all applicable markings in 7.1.1 (B) and 7.1.2 (G) above may be simultaneously displayed by a software solution either permanently or on manual command. In this case the markings are considered as device-specific parameters (see T.2.8.4, 4.1.2.4 and 5.5).

The markings: Max …,

Min …,

$e$ = …, and

$d$ = … if $d \neq e$

shall be shown at least in one place and permanently either on the display or near to the display in a clearly visible position. All additional information as mentioned in 7.1.1 (B) and 7.1.2 (G) above may be shown alternatively on a plate or simultaneously displayed by a software solution either permanently or accessed by a simple manual command. In this case the markings are considered as device-specific parameters (see T.2.8.4, 4.1.2.4 and 5.5).

It shall be possible to seal the plate bearing the descriptive markings unless its removal will result in its destruction. If the data plate is sealed, it shall be possible to apply a control mark to it.

**Acceptable solutions:**

a) Marking of Max, Min, *e* ... and *d* if $d \neq e$:

These values are permanently and simultaneously shown on the display of the weighing result as long as the instrument is switched on.

They may be automatically scrolled (displayed alternating one after each other) in one display. Automatically scrolling (but not on manual command) is considered as "permanently".

b) Marking for multi-interval and multi range instruments:

In special cases, some of the markings should be in the form of a table. See examples in Figure 8.

Figure 8

For a multi-interval instrument

| |
|---|
| Max 2/5/15 kg |
| Min 20 g |
| $e$ = 1/2/5 g |

For an instrument with more than one weighing range ($W_1$, $W_2$)

| | $W_1$ | $W_2$ |
|---|---|---|
| Max | 20 kg | 100 kg |
| Min | 200 g | 1 kg |
| $e$ = | 10 g | 50 g |

For an instrument with weighing ranges in different classes

| | $W_1$ (II) | $W_2$ (III) |
|---|---|---|
| Max | 1 000 g | 5 000 g |
| Min | 1 g | 40 g |
| $e$ = | 0.1 g | 2 g |
| $d$ = | 0.02 g | 2 g |

- c) Fixing
  - If a plate is used it shall be secured e.g. by rivets or screws with one of the rivets of red copper or material having qualities recognized as similar or by using non removable control marks.
  - It should be possible to secure the head of one of the screws by appropriate means (e.g. by means of a cap of suitable material inserted in a device that cannot be dismantled or other appropriate technical solution).
  - The plate may be glued or consist of a transfer provided its removal results in its destruction.
  - d) Dimensions of the letters. The height of capital letters should be at least 2 mm.

- 7.1.5 Specific cases
  - 7.1.1-7.1.4 apply in their entirety to a simple instrument made by one manufacturer.
  - When a manufacturer builds a complex instrument or when several manufacturers are involved in making a simple or complex instrument, the following additional provisions shall be applied.

# 7.1.5.1 Instruments having several load receptors and load measuring devices

- Each load measuring device which is connected or can be connected to one or more load receptors, shall bear the descriptive markings relating to these, with:
  - identification mark;
  - maximum capacity;
  - minimum capacity;
  - verification scale interval; and
  - maximum safe load and maximum additive tare effect (if appropriate).

# 7.1.5.2 Instruments consisting of separately-built main parts

- If main parts cannot be exchanged without altering the metrological characteristics of the instrument,
- each unit shall have an identification mark which shall be repeated in the descriptive markings.

### 7.1.5.3 Separately tested modules

For load cells having an OIML R 60 Certificate, the markings according to OIML R 60 apply.

For other modules (indicators and weighing modules) the markings according to Annex C or D apply. Each module shall, however, bear at least the following descriptive markings for identification:

- type designation;
- serial number; and
- manufacturer (mark or name).

Other relevant information and characteristics shall be specified in the respective OIML Certificate (kind of module, fraction $p_i$ of the maximum permissible error, OIML Certificate number, accuracy class, Max, $e$, etc.) and should be written in a document accompanying the respective module.

### 7.1.5.4 Peripheral devices

Peripheral devices that are mentioned in an OIML Certificate shall bear the following descriptive markings:

- type designation;
- serial number;
- manufacturer; and
- other information as far as applicable.

## 7.2 Verification marks

An instrument shall have a place for the application of verification marks.

This place shall:

- be such that the part on which it is located cannot be removed from the instrument without damaging the marks;
- allow easy application of the marks without changing the metrological qualities of the instrument; and
- normally be visible without the instrument having to be moved when it is in service.

*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 in a clearly visible place that points to these marks or if its location is defined in the operation manual, the OIML Certificate and OIML Test Report.

**Acceptable solution:**

An instrument required to bear verification marks shall have a verification mark support, at the place provided for above, which ensures the conservation of the marks:

a) when the mark is made with a stamp, this support may consist of a strip of suitable metal or any other material with qualities similar to lead (for example plastic, brass, etc. depending on national legislation), inserted into a plate fixed to the instrument, or a cavity bored in the instrument; or

b) when the mark is of the self-adhesive type, a space should be provided on the instrument for the application of this mark.

# Acceptable solutions

For application of the verification marks a stamping area of at least 150 $mm^2$ is required.

If self-adhesive stickers are used as verification marks the space for these stickers should have a diameter of at least 15 mm. These marks should be adequately durable for the intended use of the instrument, e.g. by means of suitable protection.

## 8.3 Initial verification

Initial verification may be performed by authorized personnel according to national regulations.

Initial verification shall not be performed unless conformity of the instrument to the approved type and/or the requirements of this Recommendation is established. The instrument shall be tested at the time of installation and ready for use, unless it can be readily shipped and installed after initial verification.