BS EN 12645:2014

BSI Standards Publication

Tyre pressure measuring instruments — Devices for inspection of pressure and/or inflation / deflation of tyres for motor vehicles — Metrology, requirements and testing

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National foreword

This British Standard is the UK implementation of EN 12645:2014. It supersedes BS EN 12645:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/605, Pressure gauges and switches.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Tyre pressure measuring instruments - Devices for inspection of pressure and/or inflation / deflation of tyres for motor vehicles - Metrology, requirements and testing

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Foreword

This document (EN 12645:2014) has been prepared by Technical Committee CEN/TC 301 “Road vehicles”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2015, and conflicting national standards shall be withdrawn at the latest by February 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12645:1998, and additionally to the tyre pressure mechanical measuring instruments, introduces new clauses for the electronic devices (requirements, test methods) and for the metrological control (during type approval, initial and subsequent verification, and in-service control).

This document has been prepared under a mandate (M/457) given to CEN by the European Commission and the European Free Trade Association.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard defines metrological and technical requirements and tests of tyre pressure measuring instruments.

Tyre pressure measuring instruments (often referred to as Tyre Pressure Gauges, [TPG]) are for the inspection of pressure and/or inspection of inflation/deflation of tyres of motor vehicles.

It establishes in the context of motor vehicles tyres, the minimum characteristics of the chain of measurement of tyre pressure measuring instruments intended to inspect or adjust the pressure of tyres inflated by air or nitrogen.

These devices, classified in different categories, are hereinafter referred to by generic term, “tyre pressure measuring instruments”.

This chain of measurement consists of all the elements between the tyre valve and the display device (connector, hose, control device, measurement components, reservoir, preset device etc.).

They indicate the pressure difference (p_e) between the air or the nitrogen in the tyre and the atmosphere.

The field of application established above can be extended to other applications where no specific standard exists.

Because of the influence of tyre pressure on road safety and energy efficiency, periodical verification of tyre pressure measuring instruments is strongly recommended.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 837-1, *Pressure gauges - Part 1: Bourdon tube pressure gauges - Dimensions, metrology, requirements and testing*

EN 837-3, *Pressure gauges - Part 3: Diaphragm and capsule pressure gauges - Dimensions, metrology, requirements and testing*

EN 60068-2-1, *Environmental testing - Part 2-1: Tests - Test A: Cold*

EN 60068-2-2, *Environmental testing - Part 2-2: Tests - Test B: Dry heat*

EN 60068-2-11, *Environmental testing - Part 2: Tests - Test Ka: Salt mist*

EN 60068-2-30, *Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

EN 60068-2-32, *Basic environmental testing procedures — Part 2: Tests — Test Ed: Free fall (IEC 60068-2-32)*

EN 60068-2-47, *Environmental testing - Part 2-47: Tests - Mounting of specimens for vibration, impact and similar dynamic tests*

EN 60068-2-64, *Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance*

EN 60068-3-8, *Environmental testing - Part 3-8: Supporting documentation and guidance - Selecting amongst vibration tests*

EN 60529, *Degrees of protection provided by enclosures (IP Code)*

EN 60654-2, *Operating conditions for industrial-process measurement and control equipment - Part 2: Power*

EN 61000-4-1, *Electromagnetic compatibility (EMC) - Part 4-1: Testing and measurement techniques - Overview of IEC 61000-4 series*

EN 61000-4-2, *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test*

EN 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*

EN 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test (IEC 61000-4-4)*

EN 61000-4-5, *Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test*

EN 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6)*

EN 61000-4-11, *Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests*

EN 61000-4-17, *Electromagnetic compatibility (EMC) - Part 4-17: Testing and measurement techniques - Ripple on d.c. input power port immunity test*

EN 61000-4-29, *Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*

ISO 7637-2, *Road vehicles — Electrical disturbances from conduction and coupling — Part 2: Electrical transient conduction along supply lines only*

ISO 16750-1, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 1: General*

ISO 16750-2, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
air
gases used to inflate tyres of vehicles

EXAMPLE Air or nitrogen.

3.2
tyre pressure measuring instrument
instrument measuring the tyre pressure comprising all the elements from the tyre valve connector up to and including the display device

Note 1 to entry: Often referred to as TPG (Tyre Pressure Gauge).

Note 2 to entry: The elements may include tyre valve connector, hose, control device, measurement components, display device, software, reservoir, etc.

3.3
gauge pressure (p_e)
pressure difference between an absolute pressure and the absolute pressure of the atmosphere

Note 1 to entry: The tyre pressure is the pressure difference between the air in the tyre and the atmosphere and therefore a gauge pressure

3.4
category
subdivision of possible configurations of the measuring instrument

Note 1 to entry: For the purpose of selecting the correct test method, the parts in the measuring chain are defined to be fixed, portable or hand-held. The control device is not relevant in defining the category.

3.5
preset device
device which permits the selection of the (target) pressure and which automatically stops inflation/deflation process when the target pressure is reached

3.6
electronic tyre pressure measuring instrument
tyre pressure measuring instrument with one or more electronic parts in the chain of measurement

3.7
mechanical tyre pressure measuring instrument
tyre pressure measuring instrument without electronic parts in the chain of measurement

3.8
index
means to indicate the tyre pressure value (for example: a pointer with scale or a cursor with scale)

3.9
indication
display of the tyre pressure value

Note 1 to entry: For example a digital display or an index with scale.

Note 2 to entry: Normally a scale is arc shaped.

Note 3 to entry: The display may be an index with scale on a screen.

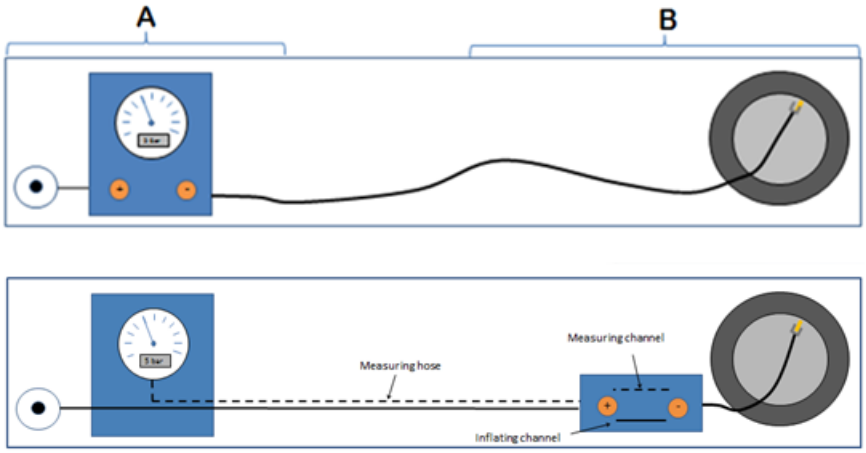
3.10
MPE
acronym often used for “Maximum Permissible Error”

4 Categories

For the purposes of this document, the following categories apply.

4.1
category 1 - Fixed device
tyre pressure measuring instrument where the measuring components and the displaying device are fixed

Note 1 to entry: They are generally connected to a source of air and are equipped with a control device. See Figure 1.



Key

A fixed components

B portable components

Figure 1 — Fixed device

EXAMPLE Wall fixing inflation devices.

4.2
category 2 - Portable device
tyre pressure measuring instrument where the measuring components and the displaying device are portable

Note 1 to entry: They are generally connected to the control device and a reservoir under limited pressure or an integrated compressor or a source of air. See Figure 2.

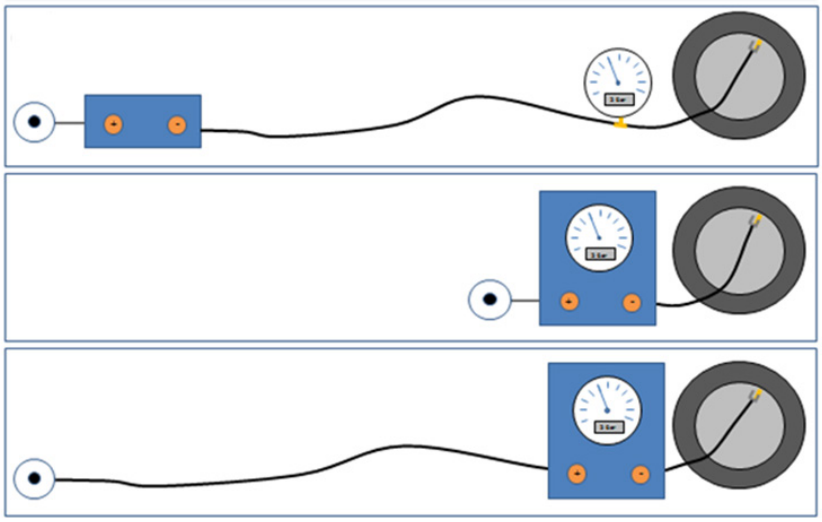


Figure 2 — Portable device

EXAMPLE Inflation terminal.

4.3
category 3 - Handheld device
tyre pressure measuring instrument where the measuring components and the displaying device are handheld

Note 1 to entry: They can be connected to the control device or grouped together with the control device. See Figure 3.

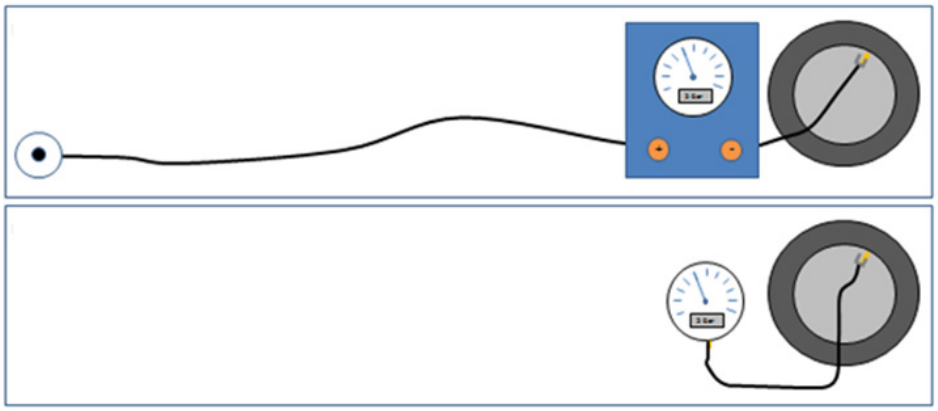


Figure 3 — Hand-held device

EXAMPLE Inflation gun, pressure inspector.

5 Metrological requirements

5.1 Maximum permissible errors

The maximum permissible errors positive or negative given in the tables below are defined as absolute values according to the measured pressure, expressed in kPa or bar.

Table 1 — Maximum permissible errors ± in kPa

Measured pressure in kPa	Maximum permissible errors (MPE) ± in kPa		
	Ambient temperature (t_{amb}) in °C for tyre pressure measuring instruments		
	below 15 °C	from 15 °C to 25 °C	above 25 °C
≤ 400	0,5 * (15 - t_{amb}) + 8	8	0,5 * (t_{amb} - 25) + 8
> 400 to ≤ 1 000	0,5 * (15 - t_{amb}) + 16	16	0,5 * (t_{amb} - 25) + 16
> 1 000	0,5 * (15 - t_{amb}) + 25	25	0,5 * (t_{amb} - 25) + 25

Table 2 — Maximum permissible errors ± in bar

Measured pressure in bar	Maximum permissible errors (MPE) ± in bar		
	Ambient temperature (t_{amb}) in °C for tyre pressure measuring instruments		
	below 15 °C	from 15°C to 25 °C	above 25 °C
≤ 4	0,005 * (15 - t_{amb}) + 0,08	0,08	0,005 * (t_{amb} - 25) + 0,08
> 4 to ≤ 10	0,005 * (15 - t_{amb}) + 0,16	0,16	0,005 * (t_{amb} - 25) + 0,16
> 10	0,005 * (15 - t_{amb}) + 0,25	0,25	0,005 *(t_{amb} - 25) + 0,25

A graphical representation of these two tables is provided in Annex B.

5.2 Hysteresis error

Hysteresis error of tyre pressure measuring instruments shall not exceed the absolute value of the maximum permissible error, given in 5.1 in the column “from 15 °C to 25 °C”.

5.3 Zero

5.3.1 Return of the instrument's indication to zero

If the instrument indicates zero, the ‘real’ indication shall be within MPE or the instrument shall not indicate values below the minimum value of measured pressure.

At atmospheric pressure, the index shall stop at the zero mark or at a predetermined mark clearly differentiated from the scale intervals, within the limits of the maximum permissible error.

5.3.2 Zero setting

An instrument may be equipped with an automatic or semi-automatic zero-setting device. The semi-automatic zero-setting device has to check being at the atmospheric pressure before setting to zero. Manual zero-setting is not allowed except by switching OFF and ON.

NOTE Manual means the operator can influence the result.

5.4 Units

The SI unit of pressure is the pascal (Pa).

Often scales indicate kilopascal (kPa) or bar.

1 bar = 100 kPa.

6 Technical requirements

6.1 Construction

Tyre pressure measuring instruments shall be robustly and carefully constructed to ensure that they retain their metrological characteristics taking into account the rapid pressure increase due to tyre valve matching and inflation/deflation.

They permit the inspection and adjustment of tyre pressure and the filling of unpressurised tyres.

Measuring instruments with a sensing element susceptible for mechanical wear and tear shall be fitted with a protection system in order to prevent the supply pressure arriving up to the sensing element during inflation.

During the inflating and deflating process, it shall be made clear to the user that the value indicated is not the actual value of the tyre pressure, for instance by flashing.

The final tyre pressure on the display shall be read under normal conditions of use.

6.2 Analog indicating tyre pressure measuring instrument

6.2.1 Scale angle

The scale normally covers 270° of arc.

6.2.2 Scale interval

The scale interval graduation is in kPa (bar) and the value of each scale interval is fixed at 10 kPa (0,1 bar). The scale intervals shall be equal over the entire scale.

6.2.3 Scale spacing

The scale spacings, which are not less than 1,25 mm, shall be either virtually equal or only show slight variations. Variation of scale spacing is permitted if the difference between two consecutive scale spacings does not exceed 20 % of the largest value and if the difference between the smallest and largest scale spacings does not exceed 50 % of the largest value.

For linear scales, the scale spacing applies to the visible spacing (for example the scale spacing is magnified with a magnifying glass to give an apparent scale interval of > 1,25 mm).

Every fifth mark shall be distinguished from the others by its greater length; every fifth or tenth mark shall be numbered. The thickness of the marks shall be virtually constant and shall not exceed one fifth (1/5) of the scale spacing.

6.2.4 Index

In the measurement range, the indicating device (index) shall make it possible to read off, directly and accurately, the value of the measured pressure. To this end, the thickness of the part of the index which covers the scale marks shall not be greater than the thickness of the scale marks themselves. The index shall be capable of covering approximately half the length of the shortest scale marks. The maximum distance between the index and the plane of the scale marks shall not be greater than the length of the scale division and shall in no case exceed 2 mm or 0,02 L + 1 mm in the case of circular-dial indicating devices (L being the distance between the axis of rotation of the pointer and its extremity).

6.3 Digital indicating tyre pressure measuring instrument

6.3.1 Scale interval

The maximum value of the scale interval is 10 kPa (0,1 bar). Scale intervals of 1 kPa (0,01 bar) or 2 kPa (0,02 bar) or 5 kPa (0,05 bar) are also allowed.

For metrological control purposes (see Clause 9) the scale interval shall be 1 kPa (0,01 bar) or less.

6.3.2 Readability

The indicating device shall make it possible to read off, directly and accurately, the value of the pressure measured by the user from the normal operating position.

The height of the figures of the indication shall be at least:

— 20 mm for fixed displaying devices, or

— 10 mm for portable displaying devices, or

— 6 mm for hand-held displaying devices.

6.4 Additional constructional requirements

6.4.1 Mechanical tyre pressure measuring instruments

Tyre pressure instruments covered by EN 837-1 or EN 837-3 shall be manufactured in accordance with EN 837-1 or EN 837-3 except for the requirements covered by this document.

The pressure responsive element, the movement, the pointer and the dial shall be installed inside an enclosing case which can be sealed by a securing seal in order to prevent access to the parts mentioned in accordance with 8.2.

The motion of the pressure responsive element and index shall not be obstructed on either side of the zero mark or opposite to a predetermined mark by means of an index stop within a range corresponding to twice the maximum permissible error from 15 °C to 25 °C mentioned in 5.1.

The scale numbering shall directly reflect the value of the pressure to be measured. The use of a factor is not permitted (except of factor mentioned in 5.4).

6.4.2 Electronic tyre pressure measuring instrument

The indication shall be a gauge pressure value (p_e).

The measured value may be provided by an absolute pressure sensor, where the atmospheric pressure shall be compensated, in order to display the tyre pressure (for example by zero setting).

The time to display the first indication when waking up from standby shall be maximum 4 s.

The refresh rate during the measurement shall be minimum 2 Hz.

The tyre pressure measuring instrument shall allow the control of the good performance of the display (checking completeness of the display elements). This is not applicable for displays on which failure becomes evident, e.g. non-segmented displays, screen-displays, matrix-displays, etc.

If there is a malfunction, no value of pressure shall be indicated or a warning shall appear on display. When the battery voltage is decreasing, a warning may appear on the display; the tyre pressure measuring instrument shall still comply with MPE. When the battery voltage is below the operating voltage range, no value of pressure shall be indicated.

When the tyre pressure is higher than the maximum operating pressure, an error message shall appear on the display.

6.4.3 Electronic and mechanical tyre pressure measuring instruments

The pressure measuring instrument shall withstand a pressure of 125 % of the maximum scale value for a short period of time, without its metrological performance being altered.

The manufacturer shall include in the user manual that for the case of missing supply pressure there shall be installed an additional device (for example a non-return valve) to prevent reduction of tyre pressure.

The pressure measuring instrument shall have an inspection mode where the inflation/deflation process is inhibited.

The visibility of the pressure values should be ensured at all conditions of luminous environment.

6.4.4 Preset device

Where it is possible to preset pressure, the maximum difference between the preset value and the measured tyre pressure at the end of the inflating and deflating process shall not exceed MPE. At the end of the inflating and deflating process, a measured pressure shall be available and displayed.

6.5 Operating conditions

6.5.1 Climatic requirements

6.5.1.1 Rated temperature in service

Measuring instruments shall comply with the MPE in 5.1 in the whole temperature range.

The temperature range should be −25 °C up to and including +55 °C.

The manufacturer may specify, on the data plate, another range with a minimum range of −10 °C up to +40 °C.

The tyre pressure measuring instrument is subject to the dry heat requirements according to EN 60068-2-2.

The tyre pressure measuring instrument is subject to the cold requirements according to EN 60068-2-1.

6.5.1.2 Rated storage temperatures

Storage temperatures: −40 °C up to +70 °C.

The measuring instrument shall not change its appearance. Material, coating shall not crack, blister, or change its colour. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.1.3 Humidity

The measuring instrument shall not change its appearance. Material, coating shall not crack, blister, or change its colour.

The tyre pressure measuring instrument is subject to the damp heat, cyclic (condensing) requirements according to EN 60068-2-30. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.1.4 Corrosion requirements

The measuring instrument is subject to the test “test Ka: Salt mist” according to EN 60068-2-11.

The measuring instrument shall not change its appearance. Material, coating shall not crack, blister, or change its colour. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.2 Mechanical requirements

6.5.2.1 Protection against ingress of water and foreign particles (degree of protection)

Minimum protection ratings according to EN 60529:

— for outdoor use: IP44;

— for indoor use: IP31.

The measuring instrument shall not change its appearance. Material, coating shall not crack, blister, or change its colour. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.2.2 Durability of the measuring instrument

The tyre pressure measuring instrument shall be capable of keeping its performance characteristics durable. The tyre pressure measuring instrument is subject to the examination according to 7.7.2. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.2.3 Vibration

The tyre pressure measuring instrument is subject to the vibration (random) requirements according to EN 60068-2-64. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE. The severity of vibration is for use in locations with significant or high levels of vibration and shock, e.g. transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.

6.5.2.4 Free fall

No change in operating within MPE after application of the free fall test.

— Test I, portable components of the tyre pressure measuring instrument: 10 free falls: height 250 mm

— Test II, hand-held components of the tyre pressure measuring instrument : 10 free falls: height 500 mm

Free fall tests are not required for fixed components of the tyre pressure measuring instrument.

The tyre pressure measuring instrument shall not change its appearance. Material, coating shall not crack, blister, or change its colour. After undergoing the disturbance, the tyre pressure measuring instrument shall recover to operate within MPE.

6.5.3 Electromagnetic immunity requirements for electronic tyre pressure measuring instruments (with digital display and/or electronic sensor)

6.5.3.1 Essential requirements

Electromagnetic environments are described below:

— Tyre pressure measuring instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.

— Tyre pressure measuring instruments supplied by a vehicle battery. Such tyre pressure measuring instruments shall comply with the above requirements and the following additional requirements:

  — voltage reductions caused by energising the starter-motor circuits of internal combustion engines;

  — load dump transients occurring in the event of a discharged battery being disconnected while the engine is running.

The following influence quantities shall be considered in relation to electromagnetic environments:

— voltage interruptions,

— short voltage reductions,

— voltage transients on supply lines and/or signal lines,

— electrostatic discharges,

— radio frequency electromagnetic fields,

— conducted radio frequency electromagnetic fields on supply lines and/or signal lines,

— surges on supply lines and/or signal lines.

Other influence quantities to be considered, where appropriate, are:

— voltage variation,

— mains frequency variation,

— power frequency magnetic fields,

— any other quantity likely to influence the accuracy of the devices significantly.

6.5.3.2 Technical requirements

The tyre pressure measuring instrument is subject to the following requirements:

— AC mains voltage variations requirements according to EN 61000-4-1.

— DC mains voltage variations requirements according to EN 60654-2.

— AC mains power requirements according to EN 61000-4-11.

— Bursts on AC and DC mains requirements according to EN 61000-4-4.

— Electrostatic discharge requirements according to EN 61000-4-2.

— Fast transients requirements according to EN 61000-4-4.

— Surges on signal requirements according to EN 61000-4-5.

— DC mains power requirements according to EN 61000-4-29.

— Ripple on DC input power ports requirements according to EN 61000-4-17.

— Surges on AC and DC requirements mains lines according to EN 61000-4-5.

— Radiated radio frequency (go) and/or Radiated radio frequency (drt) requirements according to EN 61000-4-3.

— Conducted disturbances requirements according to EN 61000-4-6.

— Voltage variations (if powered by vehicle battery) and/or Electric transient conduction (if powered by vehicle battery) requirements according to ISO 7637-2.

— Load dump (if powered by vehicle battery) according to 7.8.15.

6.5.3.3 Acceptance criteria

The difference between the indication with the disturbance and the indication without the disturbance shall be less than 8 kPa (0,08 bar) for a tyre pressure at or below 4 bar.

During a disturbance, the following reactions of the tyre pressure measuring instrument are allowed:

— the impossibility to perform any measurement (for example an error message);

— momentary variations in the indication which cannot be interpreted, memorised or transmitted as a measuring result.

6.5.4 Software requirements for electronic tyre pressure measuring instruments

Legally relevant software of a tyre pressure measuring instrument shall be clearly identified, for example with the software version. The identification may consist of more than one part but at least one part shall be dedicated to the legal purpose.

The legally relevant software shall be secured against unauthorised modification, loading, or changes by swapping the memory device. In addition to mechanical sealing, technical means may be necessary to secure tyre pressure measuring instruments having an operating system or an option to load software.

During type testing, it shall be demonstrated that the relevant functions and data of tyre pressure measuring instruments or subassemblies cannot be inadmissibly influenced by commands received via the interface.

When, considering the application, data storage is required, the following requirements apply:

— Measurement data shall be stored automatically when the measurement is concluded, i.e. when the final value used for the legal purpose has been generated.

— When the final value used for the legal purpose results from a calculation, all data that are necessary for the calculation shall be automatically stored with the final value.

— The storage device shall have sufficient permanency to ensure that the data are not corrupted under normal storage conditions. There shall be sufficient memory storage for the data depending on the application.

— The software or/and the procedure for reading-out of the stored values is considered to be part of the legally relevant software.

6.5.5 Mounting position requirements

The nominal mounting position shall be defined by the manufacturer.

A variation of the nominal mounting position of ± 10° shall not give a change of indication of more than 0,5 times the MPE given in 5.1.

6.5.6 Kind of pressure indication requirement

The displayed tyre pressure value shall be a gauge pressure value.

7 Type approval testing to check for compliance with metrological and technical requirements

7.1 General

An examination based upon the requirements set out in Clauses 4, 5 and 6 shall be carried out on two or more tyre pressure measuring instruments, representative of the production.

In order to accelerate the test procedure, the testing laboratory may carry out different test simultaneously on different units. In this case, the testing laboratory shall ensure that all submitted instruments are of same type. Examples of possible test sequences are shown in Annex C.

This examination consists of the following tests carried out using reference pressure measuring instruments the uncertainty of which shall not exceed one fifth (1/5) of the MPEs from the inspected tyre pressure measuring instruments.

Before commencing the tests, examine:

— the possible influence of slow pressure increase (different from real service condition where pressure on sensitive element is reached in less than 1”) on measurement,

and/or

— the possible influence of a too small buffer volume on the pressure stability of the reference pressure measuring instrument.

Recommended solutions are described in Annex D.

The reference instrument shall be traceable to national standard(s).

Reference conditions:

Temperature: 20 °C ± 5 °C

Humidity: 50 % RH ± 20 % RH

Atmospheric pressure: Ambient

7.2 Determination of accuracy error

The test method may be either the comparison of selected indications with applied pressure or the comparison of selected pressures with resultant indications of the tyre pressure measuring instrument under test.

Tyre pressure measuring instrument indication shall be checked at not less than five points (including a point near the upper and the lower limits of the measuring range) distributed evenly over the measuring range.

The tyre pressure measuring instrument shall satisfy the requirements given in 5.1 and 5.3.

7.3 Determination of hysteresis error

This test shall be performed only on instruments which, under normal use, are designed to measure decreasing pressure.

The test consists of taking readings at not less than five points on the tyre pressure measuring instrument (including a point near the upper and lower limits of the measuring range) distributed evenly over the measuring range at increasing and decreasing pressure values.

In the case of decreasing values, the readings shall be taken after the tyre pressure measuring instrument has been kept at a pressure equal to the upper limit of the measuring range for 10 min. The temperature shall remain constant throughout the test.

The value shall not exceed the MPE value given in 5.2.

7.4 Determination of return of instrument’s indication to zero

After the test described in 7.3 check if the instrument indicates zero according to 5.3.

7.5 Determination of error after/during a disturbance or influence

Tyre pressure measuring instrument indication shall be checked approximate at 200 kPa and comply with the requirement in 6.5.3.3 for an electromagnetic disturbance and 5.1 for an influence or other disturbance.

7.6 Climatic tests

7.6.1 Determination of the MPE in the rated temperature in service

The tyre pressure measuring instrument shall be tested in accordance with EN 60068-2-1, test A (cold) and EN 60068-2-2, test B (dry heat) at the following temperatures:

— reference temperature (+20 °C);

— lower limit of the temperature range (if not equal to −10 °C);

— −10 °C;

— 0 °C;

— +40 °C;

— upper limit of the temperature range (if not equal to +40 °C);

— reference temperature (+20 °C).

After having attained thermal equilibrium at each temperature (minimum 2 h), the test described in 7.2 and 7.3 is carried out. The tyre pressure measuring instrument shall satisfy the requirements given in 5.1, 5.2 and 5.3.

7.6.2 Rated storage temperature

A complete, unpressurised tyre pressure measuring instrument shall be placed in a climatic chamber for minimum 24 h at each extreme temperature −40 °C / +70 °C.

At the end of test, inspect immediately for any change in appearance and after at least three hours at reference temperature range, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.6.3 Humidity

For this test, the opening of the air feed line of the tyre pressure measuring instrument is shut.

A cyclic test for humidity is carried out according to EN 60068-2-30:

— 55 °C or 40 °C depending on the temperature range of the tyre pressure measuring instrument;

— number of cycles:2.

At the end of test, inspect immediately for any change in appearance.

After three hours at reference temperature, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.6.4 Corrosion test

For this test, the opening of the air feed line of the tyre pressure measuring instrument is shut.

A salt mist test is carried out in accordance with EN 60068-2-11:

— Duration of the test: 48 h.

At the end of the test, inspect immediately for any change in appearance and operational features. After one hour at reference temperature, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.7 Mechanical tests

7.7.1 Protection against ingress of water and foreign particles (degree of protection)

As specified in EN 60529.

At the end of a test, the tyre pressure measuring instrument tested shall satisfy the requirements of IP44 except for tyre pressure measuring instruments designed for indoor use only where IP31 is allowed.

After one hour at reference temperature, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.7.2 Examination of the durability of the measuring instrument

The tests consist in subjecting tyre pressure measuring instrument in operation to:

a) a pressure of 125 % of the upper limit of the scale range for a period of 15 min;

b) 10 000 cycles of a pressure varying from approximately 20 % to approximately 90 % to 95 % of the upper limit of the scale range at a frequency not exceeding 60 cycles per minute.

After one hour at reference temperature, the tests described in 7.2 and 7.3 are carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1, 5.2 and 5.3.

7.7.3 Vibration (random)

This test shall be carried out in accordance with the following table:

Table 3

Vibration (random)			
Applicable standards	EN 60068–2-47, EN 60068–2-64, EN 60068–3-8		
Test method	Random vibration		
Test procedure in brief	The test consists of exposure to the vibration level for a time sufficient for testing the various functions of the device during the exposure. The tyre pressure measuring instrument shall, in turn, be tested in three, mutually perpendicular axes mounted on a rigid fixture by its normal mounting means. The tyre pressure measuring instrument shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use. Where the effect of gravitational force is not important, the tyre pressure measuring instrument may be mounted in any position. During the exposure, the test described in 7.5 is carried out.		
Test severity	Severity level	2	Unit
	Total frequency range	10 to 150	Hz
	Total Root Mean Square level	7	$m.s^{-2}$
	Acceleration Spectral Density level 10–20 Hz	1	$m^2.s^{-3}$
	Acceleration Spectral Density level 20–150 Hz	−3	dB/octave
Duration per axis	2 min in each functional mode or a longer period if necessary for carrying out the measurement.		

7.7.4 Free fall

This test is done according to EN 60068-2-32:

— test Ed: free fall test: Method 1;

— test surface: concrete;

— height of fall:

  — 250 mm for portable components;

  — 500 mm for hand-held components;

— attitude for the fall: that resulting from carrying the tyre pressure measuring instrument in the hand;

— number of falls: 10.

After the falls, inspect immediately for any change in appearance and the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8 Electromagnetic immunity

7.8.1 AC mains voltage variations

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-1.

During the influence, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.2 DC mains voltage variations

The tyre pressure measuring instrument shall be tested in accordance with EN 60654-2.

During the influence, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.3 AC mains power

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-11, severity level 2.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.4 Bursts on AC and DC mains

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-4, severity level 2.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.5 Electrostatic discharges

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-2, severity level 3.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.6 Fast transients on signal and I/O lines

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-4, severity level 2

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.7 Surges on signal and I/O lines

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-5, severity level 3.

After undergoing the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.8 DC mains power

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-29, severity level 1.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.9 Ripple on DC input power ports

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-17, severity level 1.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.10 Surges on AC and DC mains lines

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-5, severity level 3.

After undergoing the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.11 Radiated radio-frequency electromagnetic fields

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-3, severity level 2.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.12 Conducted radio-frequency fields

The tyre pressure measuring instrument shall be tested in accordance with EN 61000-4-6, severity level 2.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.13 Voltage variations (if powered by vehicle battery)

The purpose of this test is to verify equipment functionality at minimum and maximum supply voltage.

Test method:

Set the supply voltage as specified in Table 4 to all relevant inputs of the tyre pressure measuring instrument.

Table 4 — Supply voltage for system tyre pressure measuring instruments

Nominal voltage	Minimum supply voltage	Maximum supply voltage
12 V	9 V	16 V
24 V	16 V	32 V

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.14 Electrical transient conduction along supply lines (if powered by vehicle battery)

The tyre pressure measuring instrument shall be tested in accordance with ISO 7637-2, test level IV.

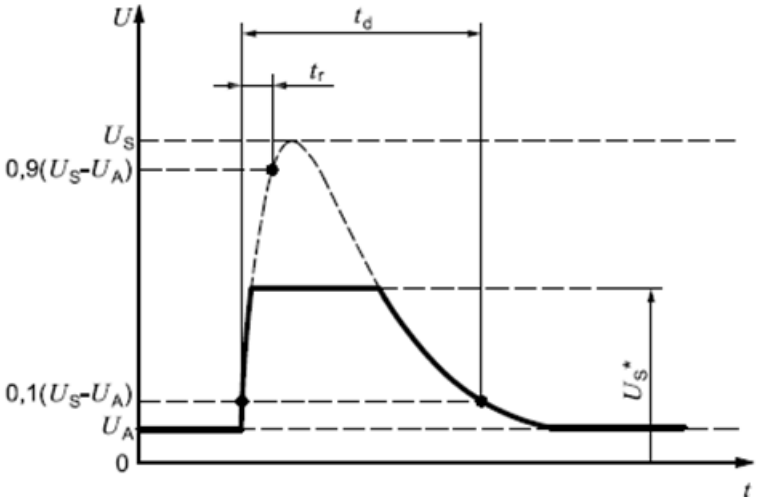
During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.8.15 Load dump (if powered by vehicle battery)

The tyre pressure measuring instrument shall be tested in accordance with the following.

This test is a simulation of load dump transient occurring in the event of a discharged battery being disconnected while the alternator is generating charging current with other loads remaining on the alternator circuit at this moment with centralised load dump suppression.

The pulse shape and parameters for an alternator with centralised load dump suppression are given in Figure 4 and Table 5 below.



Key

t time

U test voltage

t_d duration of pulse

t_r rising slope

U_A supply voltage for generator in operation (see ISO 16750-1)

U_S supply voltage

U_S* supply voltage with load dump suppression

Figure 4 — Test with centralised load dump suppression

The following load dump parameters extracted from ISO 16750-2 are described below:

Table 5 — Load dump parameters

Parameter	Nominal voltage	
	12 V	**24 V**
U_A (V) [a]	14 ± 0,2	28 ± 0,2
U_S (V)	79 ≤ U_S ≤ 101	151 ≤ U_S ≤ 202
U_S* (V)	35	65
R_i (Ω) [a]	0,5 ≤ R_i ≤ 4	1 ≤ R_i ≤ 8
t_d (ms)	40 ≤ t_d ≤ 400	100 ≤ t_d ≤ 350
t_r (ms)	10	10
[a] Use the higher U_S with the higher R_i or the lower U_S with the lower R_i		

Apply at least five pulses at intervals of 1 min.

During the disturbance, the test described in 7.5 is carried out. The tyre pressure measuring instrument tested shall satisfy the requirements given in 5.1 and 5.3.

7.9 Software examination

During the examination, it shall be demonstrated that the relevant functions and data of the tyre pressure measuring instrument or subassemblies cannot be inadmissibly influenced by commands received via the interface.

Perform the following examination:

Validation by Functional Testing of the Software Functions (VFTSw)

Application:

— Validation of e.g. protection of parameters, indication of a software identification, software supported fault detection, configuration of the system (especially of the software environment), etc.

Preconditions:

— Operating manual, software documentation, functioning tyre pressure measuring instrument, test equipment.

Description:

— Required features described in the operating manual, tyre pressure measuring instrument documentation of software documentation are checked practically. If they are software controlled, they are to be regarded as validated if they function correctly without any further software analysis. Features addressed here are e.g:

— Normal operation of the tyre pressure measuring instrument, if its operation is software controlled. All switches or keys and described combinations should be employed and the reaction of the tyre pressure measuring instrument evaluated. In graphical user interfaces, all menus and other graphical elements should be activated and checked.

— Effectiveness of parameter protection may be checked by activating the protection means and trying to change a parameter.

— Effectiveness of the protection of stored data may be checked by changing some data in the file and then checking whether this is detected by the program.

— Generation and indication of the software identification may be validated by practical checking.

— If fault detection is software supported, the relevant software parts may be validated by provoking, implementing or simulating a fault and checking the correct reaction of the tyre pressure measuring instrument;

— If the configuration or environment of the legally relevant software is claimed to be fixed, protection means can be checked by making unauthorised changes. The software should inhibit these changes or should cease to function.

Result:

Software controlled feature under consideration is OK or not OK.

Complementary procedures:

Some features or functions of a software controlled tyre pressure measuring instrument cannot be practically validated as described. If the tyre pressure measuring instrument has interfaces, it is in general not possible to detect unauthorised commands only by trying commands at random; in any case, a

sender is needed to generate these commands. Including a declaration by the manufacturer, may cover this requirement.

7.10 Mounting position

Vary the mounting position ± 10° from the nominal mounting position.

The tyre pressure measuring instrument shall satisfy the requirements given in 6.5.5 for each mounting position.

7.11 Determination of pressure sensor — kind of pressure test

If the kind of pressure sensor is not known, perform the following test:

Set the tyre pressure measuring instrument in the inspection mode. Place the tyre pressure measuring instrument into a pressure chamber. Close all pressure connection lines (tyre pressure, supply pressure and exhaust line). Record the indication of the tyre pressure measuring instrument.

Then reduce the pressure inside the pressure chamber (ambient pressure), for example with 20 kPa.

For an absolute pressure sensor, the indication of the tyre pressure measuring instrument will not change (for the same temperature conditions). In this case, check the correct functioning of zero-setting devices.

For a gauge pressure sensor, the indication will change to a higher value for a lower ambient pressure.

8 Inscriptions and marking

8.1 Inscriptions

8.1.1 Obligatory inscriptions

Tyre pressure measuring instruments shall bear the following inscriptions:

a) On the front side of the tyre pressure measuring instrument or on the dial plate:

   1) the symbol for the quantity displayed: p_e;

   2) the symbol for the unit of measurement: kPa or bar;

   3) where necessary, a symbol or a notice indicating the operating position of the tyre pressure measuring instrument.

b) On the dial, data plate or on the tyre pressure measuring instrument itself:

   1) manufacturer's mark or name;

   2) name of the tyre pressure measuring instrument and model type, serial number of the tyre pressure measuring instrument;

   3) pressure range;

   4) temperature range (if different from –25 °C / +55 °C);

   5) the type approval mark.

8.1.2 Optional inscriptions

Tyre pressure measuring instruments may also carry additional inscriptions authorized by the competent national authority, provided that they do not impede reading of the instrument indication (e.g. European Standard number or year of production).

8.2 Verification marks and sealing

A suitable place shall be provided for affixing verification marks.

A hardware component that is critical for metrological characteristics shall be designed so that it can be secured. Security measures foreseen shall provide for evidence of an intervention.

Software that is critical for metrological characteristics shall be identified as such and shall be secured. Software identification shall be easily provided by the measuring instrument. Evidence of an intervention shall be available for a reasonable period of time.

9 Metrological control

9.1 Type approval

To check compliance with the metrological and technical requirements in Clauses 4, 5, 6 and 8 using the test methods in Clause 7.

If the tyre pressure measuring instrument complies with the requirements, a type-approval document shall be issued. The type-approval document shall contain sufficient information for checking conformity to type including for example the information described in 8.1.2.

9.2 Initial Verification

Examinations for initial verification:

— Check the conformity of the tyre pressure measuring instrument with the approved type.

— The tests described in 7.2 and 7.3 are carried out.

— The tyre pressure measuring instrument is finally sealed and marked according to 8.2.

Verification tests are performed by means of reference pressure measuring instruments whose uncertainty shall not exceed one-quarter (1/4) of the MPEs.

9.3 Subsequent verification

Period and MPE are left to the discretion of each Member State.

The following is recommended:

— The maximum period between two verifications should be two years.

— The MPE should be the MPE for initial verification.

Examinations for subsequent verification:

— Check the conformity of the tyre pressure measuring instrument with the approved type.

— Check the correct operability of the tyre pressure measuring instrument.

— The tests in 7.2 and 7.3 are performed except that instead of five points, three points are selected.

— The tyre pressure measuring instrument is finally sealed and marked according to national regulations as far as needed.

9.4 In-service control

The in-service MPE should be equal to 1,25 times the MPE for initial verification.

Annex A
(normative)

Correspondence between requirements and tests

The following table summarizes the list of requirements and tests.

Table A.1 — Requirements and tests

Criterion	**Requirement (clause)**	**Test (clause)**
Maximum permissible error	5.1, 5.3	7.2
Hysteresis error	5.2	7.3
Rated temperature in service	6.5.1.1	7.6.1
Rated storage temperature	6.5.1.2	7.6.2
Humidity	6.5.1.3	7.6.3
Corrosion	6.5.1.4	7.6.4
Degree of protection (IP)	6.5.2.1	7.7.1
Durability	6.5.2.2	7.7.2
Vibration	6.5.2.3	7.7.3
Free fall	6.5.2.4	7.7.4
Electromagnetic Immunity	6.5.3	7.8
Software	6.5.4	7.9
Mounting position	6.5.5	7.10
Determination of pressure sensor — kind of pressure test	6.5.6	7.11

Annex B
(normative)

MPE graphics

The graphical representation for the Table 1 in 5.1 is shown below:

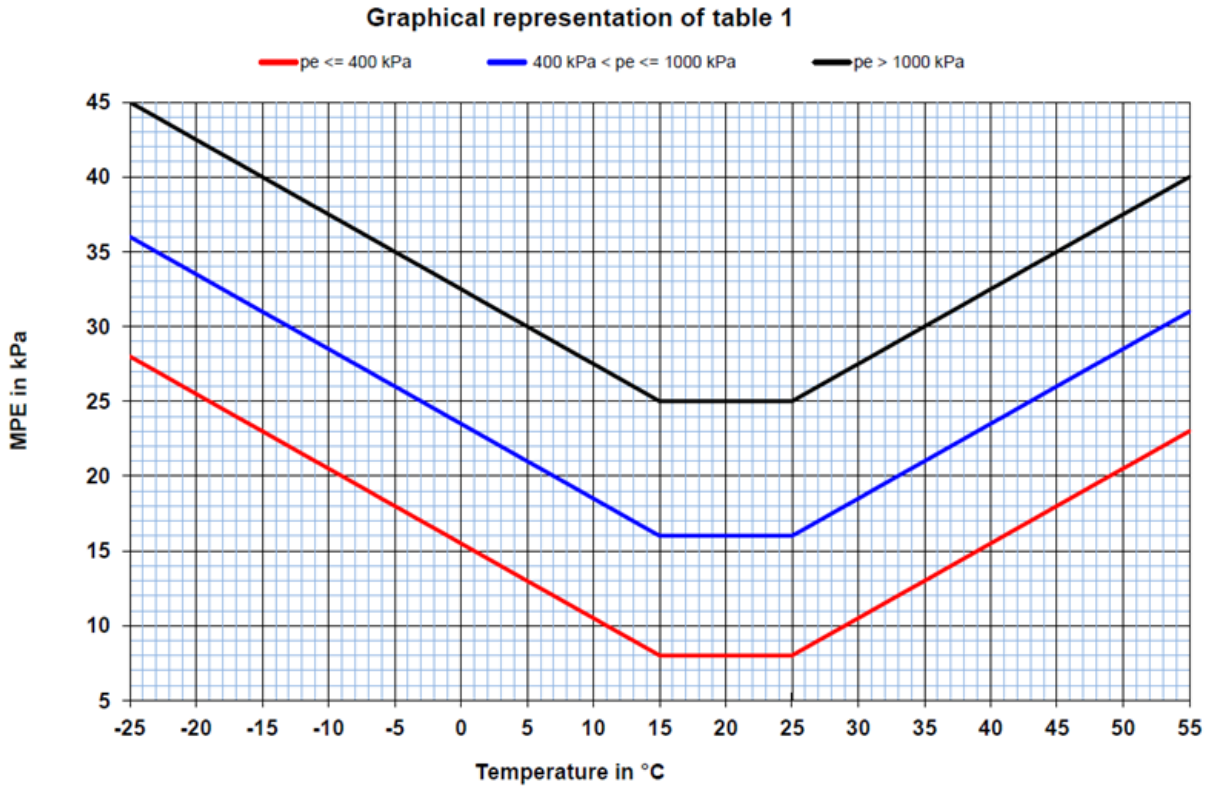


Figure B.1 — Graphical representation of MPE in kPa vs Temperature in °C

The graphical representation for the Table 2 in 5.2 is shown below:

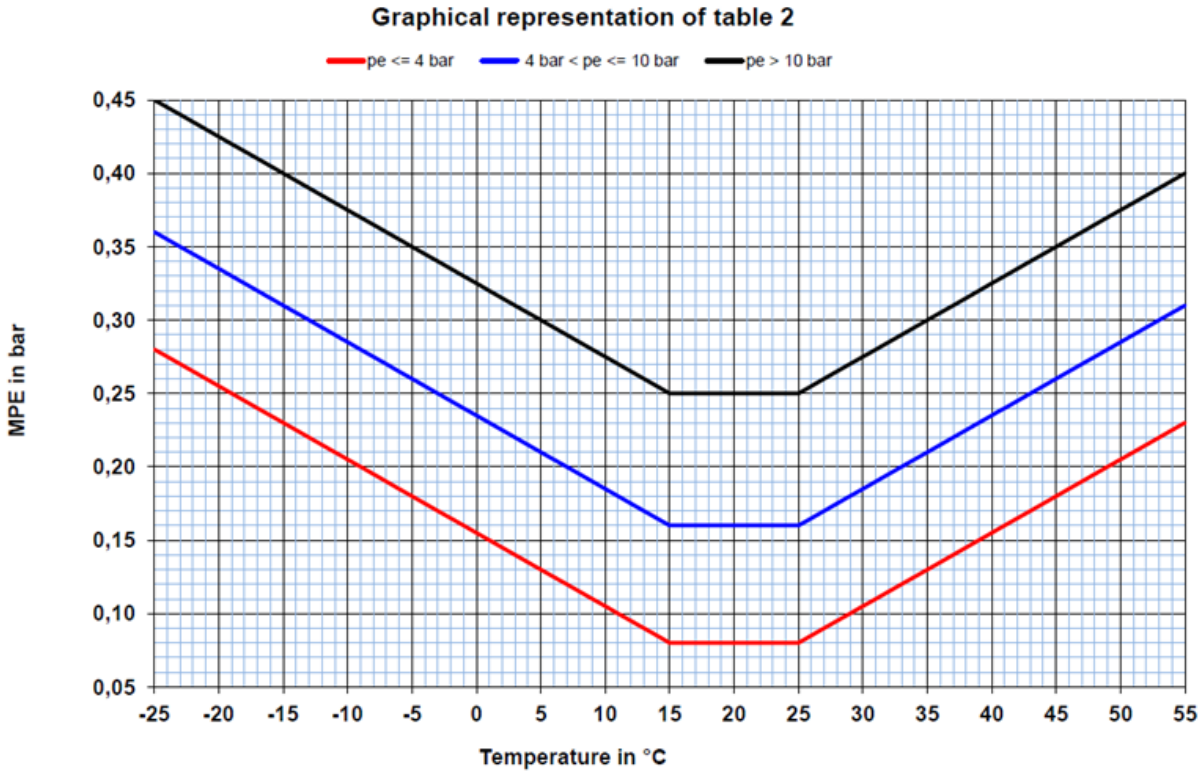


Figure B.2 — Graphical representation of MPE in bar vs Temperature in °C

Annex C
(informative)

Examples of type approval test sequence for multiple samples

Examples of possible test sequences (shown as numbers in the columns) and selection of samples for type approval are shown in the table below.

Table C.1

			Example						
			1		2		3		
Clause	**Test**	**Tyre pressure measuring instrument**	Test Condition	Environmental test	Condition and environmental test	Electrical and electromagnetical test	Test condition	Environmental test	Electrical and electromagnetical test
7.2	Accuracy error	all	1	1	1	1	1	1	1
7.3	Hysteresis	all	1		1		1		
7.4	Return of instrument's indication	all	1		1		1		
7.6.1	Rated temperature in service	all		3	2			3	
7.6.2	Rated storage	all		2	3			2	

	temperature								
7.6.3	Humidity	all		4	7			4	
7.6.4	Corrosion	all		5	9			5	
7.7.1	Degree of protection	all	5		8		5		
7.7.2	Durability	all	2		4		2		
7.7.3	Vibration	all	4		5		4		
7.7.4	Free fall	portable / hand-held	3		6		3		
7.8.1	AC voltage variations	electronic				8			8
7.8.2	DC voltage variation	electronic				8			8
7.8.3	AC Voltage dips	electronic				9			9
7.8.4	Burst on AC and DC mains	electronic				5[1)]			5[1)]
7.8.5	Electrostatic discharges	electronic				4			4
7.8.6	Fast transient on signals	electronic				5[1)]			5[1)]
7.8.7	Surges on signal and I/O lines	electronic				6			6
7.8.8	Voltage dips on DC powers	electronic				9			9
7.8.9	Ripple on DC input powers ports	electronic				10			10
7.8.10	Surges on AC	electronic				7			7

	and DC main lines								
7.8.11	Radiated radio frequency	electronic				2			2
7.8.12	Conducted RF fields	electronic				3			3
7.8.13	Voltage variations	electronic				8			8
7.8.14	Electrical transient	electronic				5[1)]			5[1)]
7.8.15	Load dump	electronic				11			11
7.9	Software examination	electronic				X[2)]			X[2)]
7.10	Mounting position	all	X[2)]		X[2)]		X[2)]		
7.11	Kind of pressure	all	X[3)]		X[3)]		X[3)]		
NOTE 5[1)] dependent on type X[2)] at any time (without test sequences) X[3)] at any time (without test sequences) only for tyre pressure measuring instruments where the sensor type is unknown									

Annex D
(informative)

Recommended solutions for special test conditions

To prevent the possible influence of slow pressure increase (different from real service condition where pressure on sensitive element is reached in less than 1 s) on measurement:

— change the test procedure (e.g. faster pressure increase) or;

— take into account an additional correction specified by the manufacturer or determined by the following test method:

  — Inflate a vessel (i.e. a tank) with reference pressure called p_{ref} starting with the value near the upper limit according to 7.2.

  — Connect the tyre pressure measuring instrument with this pressurized vessel and read pressure p_1.

  — Connect the tyre pressure measuring instrument with the laboratory equipment, apply under normal laboratory conditions p_{ref} and read pressure p_2.

  — If there is a difference, a correction should be applied.

To prevent the possible influence of a leakage on the pressure stability:

— for tyre pressure measuring instruments with pre-setting, the supply pressure line may be closed or connected with a pressure equal to or greater than the applied pressure;

— for all tyre pressure measuring instruments, install a minimum buffer volume of near four litres.

If the above measures are necessary for verification, they shall be mentioned in the type approval document.

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