



BSI Standards Publication

**Light motorized vehicles for the transportation
of persons and goods and related facilities
and not subject to typeapproval for on-
road use — Personal light electric vehicles
(PLEV) — Requirements and test methods**

National foreword

This British Standard is the UK implementation of EN 17128:2020.

BSI, as a member of CEN, is obliged to publish EN 17128:2019 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval.

The UK committee voted against EN 17128:2019 because of concerns that it does not seek to improve safety. In particular, the committee is concerned that certain criteria introduced into the standard are unsuitable and do not cover many state-of-the-art systems available in the marketplace. The committee recommended changes to those clauses it considered to be inconsistent with the rest of the standard.

Specifically, the UK committee is of the following opinions regarding Subclause 10.1:

- In addition to the standards mentioned in paragraph 3, battery charging systems are also recommended to be in accordance with:
 - ☐ BS EN IEC 61558-1:2019 *Safety of transformers, reactors, power supply units and combinations thereof - Part 1: General requirements and tests* (and all BS EN 61558 Part 2 standards that cover battery charging)

or

- ☐ BS EN IEC 62368-1:2020+A11:2020 *Audio/video, information and communication technology equipment – Part 1: Safety requirements.*
- As the BS EN 50272 series has been withdrawn and superseded by the BS EN IEC 62485 series, the text at the start of paragraph 3 should read 'Battery charging systems shall be in accordance with EN IEC 62485 series'.
- In addition to the standards mentioned in paragraph 6, voltage between charging contacts is also recommended to conform to BS EN 61558-1:2005+A1:2009 and BS EN 62368-1:2014+A11:2017 according to the application and/or environment of the charging systems.
- The reference in paragraph 6 to BS EN 61140:2016 *Protection against electric shock – Common aspects for installation and equipment* is unnecessary because protection against electric shock is adequately covered by the other standards referenced in the subclause.

Furthermore, it is the UK committee's opinion that there are deficiencies in Subclause 10.1 regarding information about the power supply used to charge batteries in Personal light electric vehicles (PLEV). As additional points of clarification, the UK committee advises users that:

- PLEV covered by this standard are normally powered by lithium-ion batteries, which are normally charged from a power supply, not a battery charger.
- BS EN 60335-2-29:2004+A11:2018 *Household and similar electrical appliances – Safety – Part 2-29: Particular requirements for battery chargers* provides information on safety requirements for battery chargers, which is important for users to note as some PLEV may contain secondary cells other than lithium-ion.

- The safety requirements for protecting a battery from overcharging are achieved by the battery pack electronics, not the charger.

The UK committee also advises users that:

- It is illegal to use PLEV on UK public roads, footpaths, pavements or cycle tracks, unless users are licenced to do so.
- The requirements of BS EN 17128:2020 do not replace any legal road requirements in the UK regarding the use of PLEV.

The UK participation in this preparation was entrusted to Technical Committee AGI/62 Single track two wheeled motor vehicles/All-Terrain Vehicles (ATVs - Quads).

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

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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EUROPEAN STANDARD

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English Version

Light motorized vehicles for the transportation of
persons and goods and related facilities and not subject
to type-approval for on-road use - Personal light electric
vehicles (PLEV) - Requirements and test methods

Véhicules légers motorisés pour le transport
de personnes et de marchandises, non
homologables pour l'utilisation sur la route,
ainsi que les installations d'utilisation -
Véhicules électriques personnels légers (PLEV)
- Exigences de sécurité et méthodes d'essai

Nicht-typzugelassene leicht motorisierte
Fahrzeuge für den Transport von Personen
und Gütern und damit verbundene
Einrichtungen - Persönliche leichte
Elektrofahrzeuge (PLEV) - Sicherheitstechnische
Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 17 August 2020.

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 17128:2020) has been prepared by Technical Committee CEN/TC 354 "Light motorized vehicles for the transportation of persons and goods and related facilities and not subject to type-approval for on-road use", 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 April 2021, and conflicting national standards shall be withdrawn at the latest by April 2021.

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

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

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

Introduction

This document has been developed in response to an increased demand throughout Europe for light electrically powered vehicles of a type which are excluded from the scope of Regulation (EU) No 168/2013.

This has created the possibility to initiate a European standardization work for personal light electric vehicles. Such standardization will help manufacturers to ensure that safe products are put into the European market, will give to testing institutes common guidelines to assess the products, will initiate confidence to users and also be useful to convince member states to apply harmonized rules for the use of these vehicles with the aim to decrease uncertainty due to different national regulation.

This document will not deal with topics like comfort of the user, quality of the product or ergonomic issues unless there is an impact on the safety of the user.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

1 Scope

This document applies to personal light electric vehicles totally or partially electrically powered from self-contained power sources with or without self-balancing system, with exception of vehicles intended for hire from unattended station.

This document applies to personal light electric vehicles with or without self-balancing system totally or partially electrically powered from self-contained power sources having battery voltages up to 100 VDC, with or without an integrated battery charger with up to a 240 VAC input. This document specifies safety requirements, test methods, marking and information relating to personal light electric vehicles to reduce the risk of injuries to both third parties and the user during intended use, i.e. when used as intended and under conditions of misuse that are reasonably foreseeable by the manufacturer.

This document does not apply to:

- vehicles that are considered as toys;
- vehicles without self-balancing system with a seat;
- vehicles intended for competition;
- electrically powered assisted cycles (EPAC);
- vehicles and/or devices intend for use for medical care;
- electric vehicles having a maximum design speed above 25 Km/h;
- vehicles having a rated voltage of more than 100 VDC or 240 VAC;
- vehicles without an on-board driving operator.

NOTE 1 EN ISO 13482 gives the requirements for vehicles without on-board driving operator.

NOTE 2 See [D.2](#).

NOTE 3 The local regulation could limit the use of the vehicle to a speed lower than 25 km/h.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*

EN 22248:1992, *Packaging — Complete, filled transport packages — Vertical impact test by dropping (ISO 2248:1985)*

EN IEC 55012:-¹⁾, *Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of off-board receivers (CISPR 12)*

EN 55025:2017, *Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of on-board receivers (CISPR 25)*

EN 60068-2-64:2008, *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64)*

EN 60068-2-75:2014, *Environmental testing — Part 2-75: Tests — Test Eh: Hammer tests (IEC 60068-2-75)*

1) Under preparation. Stage at the time of publication: PrEN IEC 55012:2018.

[EN 60335-1:2012](#), Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2010)

EN 60335-2-29:2004, Household and similar electrical appliances — Safety — Part 2-29: Particular requirements for battery chargers (IEC 60335-2-29)

HD 60364-5-52:2011, Low-voltage electrical installations — Part 5-52: Selection and erection of electrical equipment — Wiring systems

EN 60384-14:2013, Fixed capacitors for use in electronic equipment — Part 14: Sectional specification — Fixed capacitors for electromagnetic interference suppression and connection to the supply mains

EN 61000-4-2:2009, Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test (IEC 61000-4-2)

EN IEC 61000-6-1:2019, Electromagnetic compatibility (EMC) — Part 6-1: Generic standards — Immunity for residential, commercial and light-industrial environments (IEC 61000-6-1)

EN 61000-6-3:2007, Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3)

EN 61140:2016, Protection against electric shock — Common aspects for installation and equipment

EN 61558-1:2005, Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests

EN 61558-2-16:2009, Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V — Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units

EN 61851:2001 (all parts), Electric vehicle conductive charging system (IEC 61851)

EN 60204-1:2018, Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1)

EN 62133 (all parts), Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications (IEC 62133)

ISO 6742-1:2015, Cycles — Lighting and retro-reflective devices — Part 1: Lighting and light signalling devices

ISO 6742-2:2015, Cycles — Lighting and retro-reflective devices — Part 2: Retro-reflective devices

[ISO 14878:2015](#), Cycles — Audible warning devices — Technical specification and test methods

EN IEC 62485 (all parts), Safety requirements for secondary batteries and battery installations (IEC 62485)

[ISO 11451-1](#), Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology

[ISO 11452-1:2015](#), Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology

[ISO 11452-2:2019](#), Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 2: Absorber-lined shielded enclosure

[ISO 11452-3:2016](#), Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 3: Transverse electromagnetic (TEM) cell

[ISO 11452-4:2020](#), Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 4: Harness excitation methods

ISO 11452-5:2002, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 5: Stripline*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 **public space**

place that is accessible to the public whether it is in the public domain or privately owned

NOTE Examples are roads, cycle tracks, sidewalks, public squares, parks, stations, airports...

3.2 **private space**

place that is not accessible to the public

NOTE Enclosed or fenced area.

3.3 **driving power**

electric power enabling the vehicle to move

3.4 **personal light electric vehicle** **PLEV**

wheeled vehicle partially or totally motorized used for the transportation of one person in a public and/or private space

NOTE For the purpose of this standard the word “vehicle(s)” is used.

3.5 **self-balancing vehicle**

inherently instable vehicle that dynamically stabilizes in at least one direction (pitch) itself using a control system

Note 1 to entry: PLEV can be stable without the action of the user or a control system can provide a self-balancing function.

Note 2 to entry: Self-balancing PLEV oscillates slightly in order to maintain its balance.

Note 3 to entry: User controls its direction and speed by shifting his centre of gravity, without using any traditional device such as handle, steering, brake pedal, etc.

Note 4 to entry: Self-balancing vehicle controlled using inverted pendulum model is already in the market.

3.6 **intended use**

supposed use according to the manufacturer’s specification, instructions and other information including communication

3.7 **fully-assembled vehicle**

vehicle fitted with all of the equipment required for its intended use

3.8

direct braking system

system actuated directly by the user (for example, a brake handle or a brake pedal)

3.9

indirect braking system

system actuated without voluntary action by the user (for example, braking activated by a gyroscopic system or through the detection of obstacles/anomalies)

3.10

parking device

device to maintain the vehicle in a stationary position

3.11

braking device

device to reduce the speed of the vehicle

3.12

locking mechanism

assembly of components consisting of one or more *locking device(s)* and *one or more operating device(s)*

3.13

locking device

mechanical component that maintains part(s) of the vehicle erected in the position of use or storage (e.g. latch(es), hooks, over centre lock...) which could be deactivated or activated by action(s) on the *operating device*

3.14

operating device

part of the *locking mechanism(s)* designed to be activated by the user through one or several positive action(s)

3.15

folding or unfolding system

mechanism enabling the vehicle to be folded or unfolded in order to change from the configuration of use (unfolded) to the configuration of storage (folded) and vice versa

3.16

no-load current

current for which there is no torque on the driving wheel

3.17

electromagnetic compatibility

ability of a vehicle or one of its electrical/electronic systems to function satisfactorily in its electromagnetic environment without producing intolerable electromagnetic disturbance to anything in that environment

3.18

electromagnetic disturbance

electromagnetic phenomenon which may degrade the performance of a vehicle or one of its electronic/electrical systems

EXAMPLE An electromagnetic disturbance is for example an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[SOURCE: EN 15194:2017, 3.10]

3.19

electromagnetic environment

all electromagnetic phenomena existing in a given point

3.20

reference limit

nominal level to which both the component type-approval of the vehicle and conformity of production limit value refer

3.21

electrical/electronic subassembly

ESA

electrical and/or electronic device or assembly of such units intended, together with all electrical connections and the associated wiring, to form an integral part of a vehicle and perform several specialized functions

3.22

rated voltage

voltage declared by the manufacturer of the vehicle

3.23

continuous rated power

continuous (or constant) output power specified by the manufacturer at which the motor reaches its thermal equilibrium under given ambient conditions

NOTE Thermal equilibrium: the temperature variation of the motor's parts does not exceed 2K per hour.

3.24

integrated charger

charger forming an integral part of the vehicle and the dismantling of which requires the use of tools

3.25

suspension frame

frame incorporating controlled, vertical flexibility to reduce the transmission of road-shocks to the user

[SOURCE: EN ISO 4210-1:2014, 2.47 modified: "user" instead of "rider"]

3.26

braking distance

distance travelled by a vehicle between the commencement of braking and the point at which it comes to rest

[SOURCE: EN ISO 4210-1:2014, 2.10 modified: "vehicle" instead of "bicycle"]

3.27

commencement of braking

point on the test track or test machine at which the brake-actuating mechanism, operated directly by the user's hand or foot or by a test device, starts to move from its rest position

[SOURCE: EN ISO 4210-1:2014, 2.10 modified: "mechanism" instead of "device", "user" instead of "rider", Note 1 deleted]

3.28

braking force

tangential rearward force between the tyre and the ground or the tyre and the drum or belt of the test machine

3.29

visible crack

crack which results from a test where that crack is visible to the naked eye

3.30

fracture

unintentional separation into two or more parts

- 3.31 wheel**
assembly or combination of hub, spokes or disc, and rim, but excluding the tyre
- 3.32 brake**
parts of the braking system where the forces opposing the movement of the vehicle are developed
- 3.33 brake system**
combination of parts consisting of the control, transmission, and brake, whose function it is to progressively reduce the speed of a moving vehicle, bring it to a halt, and keep it stationary when halted, the electric motor can be a part of the system
- 3.34 service brake system**
brake system which is used for slowing the vehicle when in motion
- 3.35 Technical Permissible Maximum Mass TPMM**
sum of the mass of the vehicle in running order and the maximum payload (user, cargo, etc.) as indicated by the manufacturer
- 3.36 mass in running order**
unladen mass to which the mass of the following components are added— all standard (removable) batteries as used for normal operation and indicated in the owner's manual,— additional equipment installed in or fitted to the vehicle by the manufacturer in addition to that needed for normal operation (tool kit, luggage carrier, windscreen, protective equipment, etc.)
- 3.37 partially electrically powered vehicle**
vehicle that needs to be pushed forward by human power to start, to accelerate and/or keep running in addition to the electric power
- 3.38 all wheel integrated braking system**
brake system where the brakes on all wheels are operated by the actuation of a single control
- 3.39 acceleration controlled braking system**
brake system to decelerate the PLEV by means of combination of wheel acceleration and deceleration, which detect and control the attitude of the whole PLEV system including the user
- Note 1 to entry: For vehicles class 3 and 4, the abovementioned brakes are controlled brakes for stop category 1 or 2.
- Note 2 to entry: Stop categories are specified in EN 60204-1:2018, 9.2.2.
- 3.40 deck**
platform supporting the mass of the user standing during use
- 3.41 footrest**
surface provided to support the feet during a seating intended use
- 3.42 pedestrian mode**
speed limit of the vehicle up to 6 km/h

3.43

overspeed

over than 10 % of the maximum designed speed

3.44

overheat

temperature defined by the manufacturer as a threshold beyond which the operating functions are impaired

3.45

insufficient battery power

below the minimum level defined by the manufacturer

3.46

normal operation

functional part of the PLEV, with a fully charged battery is operated in such a way to simulate the riding position and is operated

NOTE The appliance is loaded with a minimum mass of 100 kg or the maximum load specified in the instructions, whichever is higher. The motors are loaded to 66 % of their locked rotor current by adjusting the load on its rotational axis in the forward direction.

4 Classes of vehicles

Various personal light electric vehicles (vehicles) exist covering as many different uses offered to different users based on their age, mass, size and driving experience.

The main classes of vehicle are defined below combined with the main design choices that characterize them.

Table 1 — Classes of vehicle (Design elements)

Classes	With self-balanced system	Maximum design speed (km/h)	Seating position
Class 1	No	Up to 6 km/h	No
Class 2	No	Up to 25 km/h	No
Class 3	Yes	Up to 6 km/h	with or without
Class 4	Yes	Up to 25 km/h	with or without

NOTE Examples of vehicles are given in [Annex E](#).

5 General safety requirements and protective measures

Vehicle shall comply with the specific requirements of all clauses of this standard.

NOTE [Annex A](#) shows the list of hazards considered this document.

For vehicles which are not sold fully assembled, there shall be a maximum of three separate parts requiring assembly (e.g. steering device, wheels and batteries), the necessary tools and detailed assembly instructions shall be provided which specify by a text and diagrams the operations to be carried out as well as the clamping force.

6 Electrical components

6.1 General mechanical strength

The ESA including the battery shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in intended use and foreseeable misuse.

Compliance is checked by:

- Applying impacts to the enclosures of ESA mounted on the vehicles by means of the spring hammer as specified in EN 60068-2-75:2014. The ESA is rigidly supported and three impacts are applied to every point of the enclosure that is likely to be weak with an impact energy of $(0,7 \pm 0,05)$ J.
- Detachable ESA are submitted to free fall on a rigid surface as specified in EN 22248:1992 at a height of 0,90 m in three different positions. The positions shall be one surface, one edge and one corner of the enclosure that are likely to be the most onerous position.

After the test the ESA shall show no damage that could lead to emission of dangerous substances (gas or liquid) ignition, fire or overheating. A temperature rise test shall be performed, in accordance with [6.3.2.2](#). During the test, the temperature rises are monitored continuously and shall not exceed the values shown in [EN 60335-1:2012](#), Table 3 and after the test the ESA shall show no damage or malfunction that could impair the safe use of the vehicles.

Batteries and other electric conductive power supply systems shall be assessed and tested in accordance with EN 62133-1:2017 and EN 62133-2:2017 or other relevant standards.

NOTE Transportation regulations can give additional requirements for general design of the battery and battery pack.

6.2 Electrical power on/off control

An electrical power on/off control shall be fitted to on and power-off the driving power. It shall be apparent, easy to reach and unmistakable. This electrical power on/off control shall be activated voluntarily by the user to enable the driving power.

The electrical power on/off system shall be designed such that, in the event of a malfunction, the vehicle shall still be able to stop or be able to be stopped with a smooth deceleration (as defined in [15.4.2.5](#) Electric failure braking compensation).

The electrical power on/off system shall be located in a position easily reachable by the user with appropriate symbol given in [Annex F](#).

On self-balancing vehicles or vehicles with electric brake, the power -off control shall not disconnect the power while driving: the power -off control shall only work without user on the vehicle.

NOTE The electrical power on/off system is a mechanical solution (key-lock, button, etc.) or an electrical solution (user detection, turn off timer, etc.).

6.3 Electrical cables and connections

6.3.1 General

All electrical connectors shall be selected to prevent the corrosion..

6.3.2 Cable and plugs

6.3.2.1 Requirements

After the test according to [6.3.2.2](#), there shall be no deterioration of the insulation on either assembly.

The cable cross sections shall be selected in accordance with EN 61558-1:2005, EN 61558-2-16:2009, EN 60335-1:2012, EN 60335-2-29:2004, Table 11 or a temperature rise test shall be performed, in accordance with 6.3.2.2 the temperature of the cables and plugs in use shall be at least 5 °C lower than the maximum specified by the manufacturer.

NOTE 1 Cable used only for communication line is excluded.

NOTE 2 the rated current (accordance with EN 61558-1:2005, EN 61558-2-16:2009, EN 60335-1:2012, EN 60335-2-29:2004 Table 11) measured when the vehicle is supplied at rated voltage and operated under normal operation.

6.3.2.2 Test method

At an ambient room temperature (20 ± 5) °C, discharge the fully charged vehicle battery to the discharging limit for the vehicle, and the vehicle is supplied at rated voltage and operated under normal operation:

- measure the cable and plug temperature rises.

6.3.3 Wiring

Wiring shall be checked according to the following sequence at an ambient room temperature (20 ± 5) °C.

- Wireway shall be smooth and free from sharp edges.
- Wires shall be protected so that they do not come into contact with burrs, cooling fins or similar sharp edges that may cause damage to their insulation.
- Holes in metal through which insulated wires pass shall have smooth well-rounded surfaces or be provided with bushings.
- Wires shall be effectively prevented from coming into contact with moving parts.

Compliance with a), b), c) and d) shall be checked by physical inspection.

- Separate parts of the vehicles that can move in normal use or during user maintenance relative to each other, shall not cause undue stress to electrical connections and internal conductors, including those providing earthing continuity.
- If an open coil spring is used to protect wire, it shall be correctly installed and insulated. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them.

Compliance with e) f) shall be checked by inspection and by the following test method:

- If flexing occurs in normal use, the product is placed in its normal operational position and is supplied at rated voltage under normal operation.
- The movable part is moved from an extreme position to the opposite extreme position, so that the conductor undergoes maximum flexion.
- For conductors that are flexed in normal use, flex movable part for 10 000 cycles at a test frequency of 0,5 Hz.
- For conductors that are flexed during user maintenance, flex the movable part for 100 cycles at the same frequency.

6.3.4 Wiring harness

When a wiring harness is installed, it shall be positioned to avoid any damage related to contact with moving parts or sharp edges. All connections shall withstand a tensile force of 10 N in any direction.

6.3.5 Power cables and conduits

Conduit entries, cable entries and knockouts shall be constructed or located so that the introduction of the conduit or cable does not reduce the protection measures adopted by the manufacturer.

Compliance is checked by inspection.

NOTE Guidance for power cables size selection is given in HD 60364-5-52:2011, 5.22.1.2, 523.1523.3 and Table A 52-10.

The insulation of internal wiring shall withstand the electrical stress likely to occur in intended use. The wiring and its connections shall withstand an electrical strength test with the following characteristics.

The test voltage expressed in volts shall be equal to $(500 + 2 \times U_r)$ where U_r is the rated voltage. The test voltage is applied for 2 min between live parts and other metal parts only.

6.3.6 External and internal electrical connections

Electrical connection shall comply with HD 60364-5-52:2011, 526.1 and tested in accordance with HD 60364-5-52:2011, 526.2.

6.4 Moisture resistance

The enclosure of electrical components of a fully assembled vehicles shall comply with and be tested in accordance with IPX4 tested in accordance with [EN 60335-1:2012](#), 15.1.

6.5 Resistance to vibration for electric functions

6.5.1 Requirements

This requirements applies to all PLEV classes 1 to 4.

The vehicle shall withstand a vibration test representing the foreseeable use on roads and public areas.

When tested according to the method described in [6.5.2](#), all electric functions shall be fully maintained. Verification shall be by function test after the vibration test.

6.5.2 Test method

A random vibration test in accordance with EN 60068-2-64:2008 shall be performed.

Install the vehicle to the shaker table so the input vibratory motion is perpendicular to the plane of movement of the vehicle (excitation in vertical axis).

The vehicle shall be fixed at the wheel axles, if necessary, the wheels can be removed. If a fixation at the wheel axles is not possible, the vehicle can be clamped at the deck (footrest) or frame. Any test fixture used shall be as rigid and symmetrical as practicable. The mounting method(s) used shall be noted in the test report.

When necessary to determine resonant frequencies, accelerometers shall be attached to the vehicle to measure and record the equipment's vibration response in the axis of vibration to determine resonant frequencies and amplification factors. Locations selected may include frame structure, handlebar, footrest, batteries or other large components and modules.

The control accelerometer(s) shall be attached to the test fixture as near as practicable to the equipment mounting location. When more than one accelerometer is employed for test level control, the average of the accelerometer control signals of the acceleration power spectral densities (PSD) shall be used as the test level control.

Before the random vibration test, perform a 0,5 g-PK sinusoidal scan from 5 Hz to 500 Hz at a sweep rate not exceeding 1,0 octave/minute. Record plots of response accelerometers at selected position on the vehicle to determine resonant frequencies and amplification factors.

Apply the appropriate test level PSD of [Table 3](#) for 15 h. During this random vibration period, also perform a PSD analysis of the vibration response measurements on the equipment.

Repeat the sinusoidal scan. Any changes in vibration resonant frequencies shall be recorded.

The vibration tests shall be performed under normal ambient environmental conditions with a temperature of +23 °C ± 5 °C (relative humidity < 85 %, normal atmospheric pressure).

The appropriate random vibration test curve shall be selected from [Table 2](#) depending on the wheel size and design of the vehicle. The test curves are given in [Table 3](#) and [Figure 1](#).

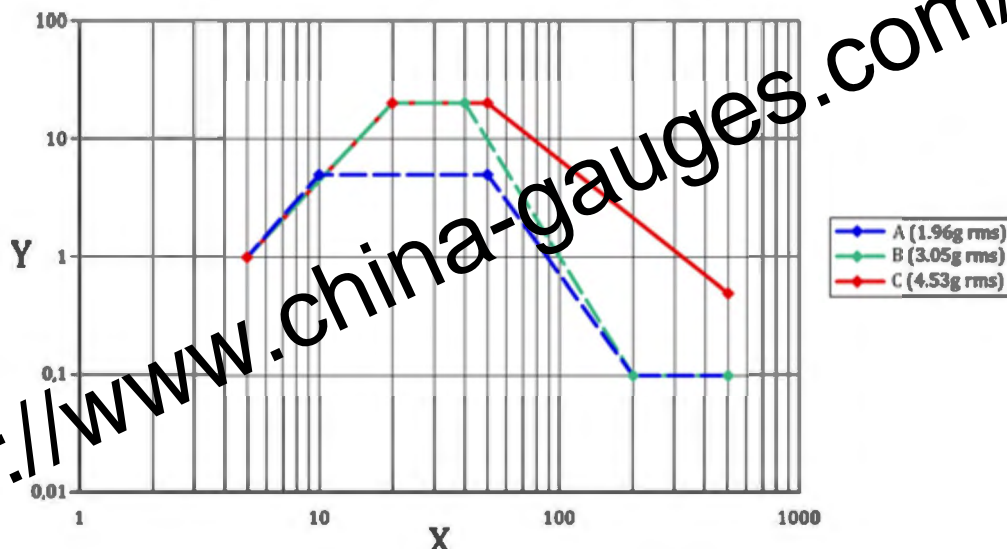
Table 2 — Categorization of vehicle for vibration tests

Design parameters				
Wheel size (outer diameter)	Suspension system			
	yes		no	
	Tire		Tire	
	Pneumatic	Solid rubber / elastomer	Pneumatic	Solid rubber / elastomer
< 10 inch (<254 mm)	A	B	B	C
≥ 10 inch (≥254 mm)	A	B	A	B

Table 3 — Test levels at test curve frequency break points

Acceleration Power Spectral Densities in (m/s ²) ² /Hz							
	5 Hz	10 Hz	20 Hz	40 Hz	50 Hz	200 Hz	500 Hz
A	1	5			5	0,1	0,1
B	1		20	20		0,1	0,1
C	1		20		20		0,5

Total rms: A: 19,2 m/s²; B: 29,4 m/s²; C: 44,4 m/s²



Key
X frequency (HZ)
Y acceleration Power Spectral Density (PSD) $(m/s^2)^2/Hz$

Figure 1 — Random Vibration Test Curves for vehicles

7 Driving power management

7.1 Driving power activation

7.1.1 Requirements

Driving power shall only be provided following at least two independent and dissimilar intentional actions by the user. In addition:

- a) For vehicles of class 1 or 2 with a partially electrically powered vehicle, the driving power shall not be delivered while moving forward at a speed of less than 3 km/h.

Verification shall be by the test of [7.1.2](#).

- b) For vehicles of class 1 or 2, it shall be possible for the user to power-off the driving power at any time during use in accordance with the driving power procedure described by the manufacturer in the instruction manual (see [7.3](#) and [19.4](#)). For vehicles of class 3 or 4, the Driving power management shall not power-off motor power at any specified speed.

Verification shall be by inspection and function test.

- c) For vehicles of class 1 and 2, the cut-off of driving power shall take priority over the maintenance of power assistance (for example, if the user holds his accelerator grip while he is actuating the brake, the power assistance shall be cut off).

Verification shall be by the test of [7.1.2](#).

Compliance with the following requirements shall be checked by the test methods described in [7.1.2](#);

- d) Vehicles of class 3 or 4 shall act as follows:

- 1) Horizontal level foot rests (maintain constant speed),
- 2) Tilt back of foot rest shall result in a progressive controlled braking,

- 3) Foot rest tilt to the front shall result in a progressive controlled acceleration,
- 4) The vehicle shall be self-balancing in all operating states.

Verification shall be by inspection and function test.

- e) When the vehicle approaches the maximum speed of its class, the driving power shall be reduced in such a way that the maximum speed limit will not be exceeded. The driving power shall be managed smoothly and progressively.
- f) In the case where a class 1 or 2 vehicle is equipped with a mechanical brake system, the driving power shall be cut off at the commencement of braking (according to [15.4.2](#)).
- g) In the case where the vehicle is equipped with an electric brake, the driving power management shall be such that braking starts immediately.
- h) For self-balancing vehicles, the driving power shall ensure that the vehicle speed cannot exceed the maximum speed of the vehicle's class.
 - i) In case of overspeed during driving, the following shall apply to vehicles of class 3 or 4:
 - 1) There shall be audible and if possible (in the particular vehicle) visual and other (physical) warnings to alert the user of a system issue.
 - 2) In all cases, the vehicle shall be slowed automatically and brought to a safe speed (lower than the maximum speed).
 - j) In case of overheating of the driving power management during driving, the following shall apply for vehicles of class 3 or 4:
 - 1) There shall be audible and if possible (in the particular vehicle) visual and other (physical) warnings to alert the user of a system issue.
 - 2) In all cases, the vehicle shall be slowed automatically and brought to a safe stop.
 - 3) It shall not be possible to drive the self-balancing vehicle until the vehicle's control system detects that the initiating problem has been corrected.
 - k) In case of insufficient battery power, the following shall apply for vehicles of class 3 or 4:
 - 1) There shall be audible and if possible (in the particular vehicle) visual and other (physical) warnings to alert the user of a system issue.
 - 2) In all cases, the vehicle shall be slowed automatically and brought to a safe stop.
 - 3) It shall not be possible to drive the self-balancing vehicle until the vehicle's control system detects that the initiating problem has been corrected.
 - l) Acceleration Limitation
 - 1) The acceleration of the vehicle shall be smooth without shocks and limited to 2 m/s^2 in order to avoid unstable riding conditions.

NOTE see [D.3](#) and [D.12](#).

7.1.2 Test method

7.1.2.1 Test conditions

- a) The test may be carried out on a test track, a test bench or on a roller.
- b) A test track shall comply with [8.1.2.2](#).

- c) The speedometer shall be accurate to $\pm 2\%$.
- d) The ambient temperature shall be between $5\text{ }^{\circ}\text{C}$ and $35\text{ }^{\circ}\text{C}$.
- e) The maximum wind speed shall not exceed 3 m/s .
- f) The battery shall be fully charged in accordance with the manufacturer's instructions.
- g) The most onerous condition shall be applied (worst speed and gear ratio).
- h) With the vehicle operate under normal operation, but the motors are loaded to 33% their locked rotor current by adjusting the load on its rotational axis in the forward direction.

7.1.2.2 Test procedure

- a) For vehicles class 1 or 2, check that no driving power is delivered while moving forward at a speed of less than 3 km/h . Compliance shall be checked, in accordance with the technology used, either by:
 - 1) when attempting to drive the vehicle forward using the normal controls or procedures for speeds less than 3 km/h , measuring the no-load current or checking the torque delivered to the driving wheel
- b) For vehicles of class 1 or 2 check whether the power assistance is cut-off when the brake is applied. Compliance shall be checked, in accordance with the technology used, by:
 - 1) measuring the no-load current or checking the torque delivered to the driving wheel before and after actuating the direct or indirect braking system.
 - 2) reproducing the power assistance cut-off situation 30 times. The power assistance shall not continue after actuation of the braking system. Power assistance may resume immediately after releasing the braking device.
- c) At the end of the tests, the power assistance cut-off systems shall be made to fail (to simulate, for example, cable detachment or failure of a sensor). It shall no longer be possible to activate the power assistance by any means whatsoever.

NOTE These tests only check compliance with power cut-off requirements. For braking performance see [15.4](#).

- d) With the vehicle at standstill or if the electric power doesn't start at 0 km/h : bring the vehicle in a stable riding position at 6 km/h ($\pm 2\text{ km/h}$) and with the vehicle operate under normal operation, but the motors are loaded to 33% of their locked rotor current by adjusting the load on its rotational axis in the forward direction.

Move the acceleration device to its maximum position and keep it in this position until the vehicle reaches 60% of its maximum speed.

Measure the time from the start until the vehicle reaches 50% of its maximum speed.

Calculate the acceleration.

7.2 Power failure of control system

For class 1 and class 2 vehicles, in the event of an electrical power failure the vehicle shall be able to brake normally or, shall come to a standstill with a deceleration between $(1,5 - 2)\text{ m/s}^2$.

For class 3 and class 4 vehicles, a fault condition in the power control system shall be indicated by a warning signal (visual, audible, vibrating...) on the handlebar, the vehicle itself or to the remote control (see [Clause 17](#)).

In a driving condition the loss of connection to the warning device, on the remote control, shall result in a speed reduction to 6 km/h or less for a Class 4 vehicle; the speed reduction shall happen in a safe

manner without creating additional hazards with corresponding audio notification and tilt back of decks on self-balancing vehicles.

7.3 Unintended or unauthorized use of vehicle

Means shall be provided to prevent an unintended or unauthorized use of the vehicle, e.g. keys, locks, electronic control device.

NOTE see [D.16](#).

8 Speed limitation

8.1 Pedestrian mode

8.1.1 General

Vehicles classes 2 and 4 shall be equipped with a pedestrian mode for limiting the speed to a maximum of 6 km/h

A distinctive and visible warning light shall be provided to indicate both to the user and others in the vicinity of the vehicle when pedestrian mode is in operation. It shall be active only when the pedestrian mode is activated.

Verification shall be in accordance with [8.1.2](#).

8.1.2 Test method

8.1.2.1 Test conditions

- a) The test may be carried out on a test track, a test bench or on a roller.
- b) The speed measuring apparatus and test conditions shall have the following characteristics:
 - 1) accuracy: $\pm 2\%$;
 - 2) resolution: 0,1 km/h.
- c) The ambient temperature shall be between 5 °C and 35 °C.
- d) Maximum wind speed: 3 m/s.
- e) The battery shall be fully charged in accordance with the manufacturer's instructions.
- f) With the vehicle operate under normal operation, but the motors are loaded to 33 % of their locked rotor current by adjusting the load on its rotational axis in the forward direction.

8.1.2.2 Characteristic of the test track

The gradient of the track shall not exceed 0,5 %. If the gradient is less than 0,2 % carry out all runs in the same direction. If the gradient lies between 0,2 % and 0,5 % carry out alternate runs in opposite directions.

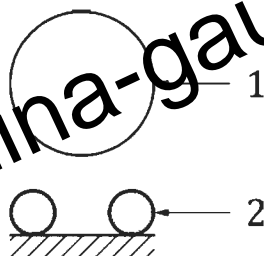
The surface shall be hard, of concrete or fine asphalt free from loose dirt or gravel. The minimum coefficient of friction between the dry surface and the vehicle tyre shall be 0,75.

8.1.2.3 Characteristic of the test bench

The test bench shall simulate normal road conditions.

8.1.2.4 Characteristic of the roller

The test roller shall support with bearing to decrease the resistance, load need to add to the roller to reach rated current (see [Figure 2](#)).



Key

- 1 Wheel
- 2 Roller (Ø 25 cm, add a load to the roller to reach rated current)

Figure 2 — Example of roller (side view of a wheel)

8.1.2.5 Test procedure

- a) Prepare the vehicle by running it for 5 min at 80 % of the speed corresponding to maximum power as declared by the manufacturer, then stop it.
- b) Actuate the mode for limiting the speed to 6 km/h (or less) and check whether the speed operating range of the power assistance is limited to 6 km/h (or a lower value).

NOTE The speed in pedestrian mode is set by the manufacturer according to local regulation.

8.2 Maximum speed with power assistance

8.2.1 Requirements

The maximum speed for which the electric motor gives assistance shall be in accordance with the maximum permitted speed for the class. It may differ by ($\pm 10\%$) of the maximum speed marked on the vehicle given in the instruction manual/sheet and determined according to the test method described in 8.2.2. The maximum speed in this mode shall not exceed 25 km/h.

8.2.2 Test method

8.2.2.1 Test conditions

The test shall be performed in accordance with [8.1.2.1](#), [8.1.2.2](#) and [8.1.2.3](#).

8.2.2.2 Test procedure

8.2.2.2.1 Test for vehicle with 100 % electric propulsion

If performed with a test bench:

- a) Put the vehicle on the bench and bring it to the maximum achievable speed and maintain the speed for 60 s at least;
- b) Measure the vehicle speed by measuring the speed of the test bench. If performed with a test track:
- c) Put the vehicle on the track and bring it to the maximum achievable speed and maintain the speed for 60 s at least;

- d) Measure the vehicle speed.
- e) The measured speed shall not exceed 25 km/h (± 10) % and the maximum speed (± 10) % indicated by the manufacturer in the instruction manual/sheet if lower.

8.2.2.2.2 Test for vehicle partially electrically powered

- a) The test shall be carried out on a bench powered such that the speed of the PLEV can be increased to 120 % of the maximum speed achievable solely under electrical power and the speed of the vehicle shall be measurable in accordance with [8.1.2.1](#);
- b) Put the vehicle on the bench and bring it to the maximum speed achievable solely with vehicle electrical power.
- c) Using the test bench drive increase the vehicle speed to 120 % of the maximum speed achievable solely with vehicle electrical power and maintain for 30 s. The measured speed shall not exceed 25 km/h (± 10) % and the maximum speed (± 10) % indicated by the manufacturer in the instruction manual/sheet if lower.
- d) Disconnect the test bench drive while maintaining the vehicle speed control at maximum achievable setting. Measure the vehicle speed.

8.3 Reverse mode

8.3.1 Requirement

Vehicles with a reverse driving function shall be equipped with a device limiting its speed to 6 km/h when travelling in reverse. If travelling in reverse, an active sound signal shall be audible.

8.3.2 Test method

The test shall be carried out on a test bench as follows:

- a) Prepare the vehicle by running it for 5 min at 80 % of the speed corresponding to maximum power as declared by the manufacturer, then stop it.
- b) Drive the test bench to simulate driving the vehicle in the reverse direction of travel at the maximum achievable speed. Check that the speed operating range of the power assistance is limited to 6 km/h (or a lower value).

9 Electromagnetic compatibility

9.1 Emission

Vehicle class 1 and 2 shall conform to [Annex B](#).

Vehicle class 3 and 4 shall conform to EN 61000-6-3:2007 apply with the following modification.

The vehicle operated as described in [B.2.2.3](#).

NOTE see [D.11](#).

9.2 Immunity

Vehicle class 1 and 2 shall conform to [Annex B](#).

Vehicle class 3 and 4 shall conform to EN IEC 61000-6-1:2019 apply with the following modification.

The vehicle operated as described in [B.4.4](#).

Specific performance criterion for PLEV:

- Class A: all functions of vehicle perform as designed during and after exposure to a disturbance.
- Class B: all functions of vehicle perform as designed during exposure; however, one or more of them may go beyond the specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain class A.
- Class C: one or more functions of vehicle do not perform as designed during exposure but return automatically to normal operation after exposure is removed.

NOTE see [D.11](#).

9.3 Battery charger

As a PLEV is not intended to be used while charging on the electric network, for integrated charger the whole PLEV plus integrated charger shall be tested for EMC according to the applicable standards.

The following European Standards are applicable [EN 55014-1](#), [EN 55014-2](#), EN 61000-3-2, EN 61000-3-3.

10 Charging of batteries

10.1 General

If a vehicle has an integrated and built-in battery charging system (i.e; integrated charger), the user shall be protected against hazards due to accidental contact with the charging connections on the vehicle and its charging systems. For enclosures of charging system, see [6.4](#) Moisture resistance.

Battery charging systems shall be in accordance with EN IEC 62485 series and EN 60204-1 or EN 60335-2-29:2004 as appropriate.

The charging system shall prevent any hazards arising because of overloading, overcharge and overcurrent and over discharge determined according to the test method described in [10.2](#).

10.2 Test method

Component parts in the charging system are faulted as below 1) to 4), one at a time, if the outcome of such a fault is uncertain based upon analysis.

1. open-circuit at the terminal of any component, other than a monolithic integrated circuit.
2. short-circuit of capacitors, unless they comply with EN 60384-14:2013.
3. short-circuit of any two terminals of an electronic component, other than a monolithic integrated circuit. This fault is not applied between the two circuits of an optocoupler.
4. short-circuit is introduced to the charging system across a component or between adjacent PCB tracks at a location expected to produce the most unfavourable results to evaluate the effect of back-feed from the battery.

For each fault condition introduced, the state of the battery before charging is as follows:

A series configured battery shall have a deliberate imbalance. The imbalance is introduced into a fully discharged battery by charging one cell to approximately 50 % of full charge or less.

Conduct the charging test, each cell voltage is continuously monitored to determine if it has exceeded the limit condition. Venting of the cells is permitted.

For vehicles with external battery charging system, charging contacts and plugs shall be designed in a way that accidentally touching live parts is prevented (e.g. caps for plugs and outlets).

Voltage between charging contacts shall conform to appropriate standards according to the application and/or environment of the charging systems, such as EN 60204-1, EN 61140:2016, EN 60335-2-29:2004 and EN 61851:2001 (all parts).

Battery charging currents shall be chosen to be as low as reasonably practicable.

10.3 Safeguarding and complementary protective measures

The following measures shall be applied where appropriate:

- charging systems shall be designed in such a way that the charging connections are only activated when the vehicle is connected to them;
- charging systems shall display the charging status or give a signal when the battery is fully charged;
- charging systems shall be designed in such a way that the correct charging of the battery is automatically supervised, and thus hazards caused by overloading or charging of deeply discharged batteries are prevented.

11 Energy storage within the vehicle

11.1 Requirements

The vehicle as well as the sets of energy storage (i.e. battery) shall be designed and constructed such as to prevent any risk of fire and mechanical deterioration resulting from foreseeable abnormal use. Compliance with this requirement is checked by the test described in [11.2](#).

During the test, the vehicle and the batteries shall not emit any flames, molten metal or release any toxic or flammable gas in hazardous amounts. Protective enclosures shall show no damage when checked visually.

Safety and compatibility of the charger/battery assembly shall be provided in accordance with the charger/battery manufacturer's specifications.

Any exposed person shall be protected from direct or indirect contact with live parts on the vehicle.

The energy storage shall be protected in order to prevent any accidental short circuit. It is necessary to ensure that batteries are protected against any overcharging, a suitable protective device against overheating and short circuits shall be provided.

NOTE Examples of solutions are indicated in [Annex C](#).

11.2 Test method

The test shall be conducted according to EN 62133 (all parts) or, as follows:

- a) Battery terminals are short-circuited using fully charged batteries
- b) Motor terminals are short-circuited; all of the controls are in ON position and batteries fully charged.
- c) The vehicle is operated with the electric motor or drive system locked so as to fully discharge the battery or until the system stops.
- d) The battery is charged for double the recommended charging period or for 24 h, choosing the longest of these two periods.

Verification: there shall be no visible damage for a), b), c) and d) and no overvoltage for d).

12 Structural integrity

12.1 General

12.1.1 Numbers and conditioning of samples

In general, for static, impact and fatigue tests, each test shall be carried out on a new sample, but if only one sample is available, it is permissible to carry out all of the tests on the same sample by following the fatigue, then static and then impact test sequence.

When more than one test is carried out on the same sample, the test sequence shall be clearly recorded in the test report or record of testing.

It should be noted that if more than one test is carried out on the same sample, earlier tests can influence the result of subsequent tests. Also, if a sample fails when it has been subjected to more than one test, a direct comparison with the result of a single test is not possible.

For all strength tests, samples shall be fully assembled.

12.1.2 Test condition tolerances

Unless stated otherwise, tolerances on the nominal values shall be:

- forces and torques 0/+ 5 %
- masses +/- 1 %
- dimensions +/- 1 mm
- angles +/- 1°
- duration +/- 5 s
- temperatures +/- 2 °C
- pressures +/- 5 %

12.1.3 Crack detection

Standardized methods may be used to highlight the presence of cracks when visible cracks are specified as criteria of failure in the tests described in this standard.

NOTE 1 For example, suitable dye-penetrant methods are specified in EN ISO 3452 (all parts).

NOTE 2 See [D.9](#).

12.2 Static load test

12.2.1 Deck/frame

12.2.1.1 Requirement

When tested according to the method described in sub [Clauses 12.2.1.2, 12.2.1.3](#) or [12.2.1.4](#) there shall be no cracks or fractures, or collapse of the structure, or unfolding. Where the construction of the vehicle does not allow the full mass to be applied in normal use to each deck then the maximum mass is divided by two to achieve the test load for each deck.

12.2.1.2 Test method – 2-wheeled single track vehicle

Progressively apply a mass of 100 kg or, when greater, a mass equal to the maximum permissible payload marked on the vehicle in accordance with [19.2.1](#) and multiplied by a safety factor of 2,5 during 1 min with a flat device having a surface of 100 mm × 100 mm to the centre of one or two deck(s) (see [Figure 3](#)).

NOTE 1 The minimum mass of 100 kg represents a maximum permitted payload marked on the vehicle of 40 kg multiplied by a safety factor of 2,5.

NOTE 2 For a permissible payload of 120 kg (according to [19.2.1](#)), the total mass “m” is 300 kg.

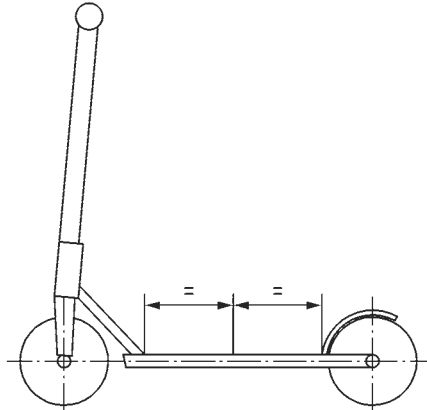


Figure 3 — Centre of the deck

If plastic material is used for the deck or steering system the kick scooter has to be conditioned for at least 6 h at a temperature of $(-5 \pm 1) ^\circ\text{C}$. Start the test within 1 min of removing the PLEV from the conditioning environment and complete it within 5 min.

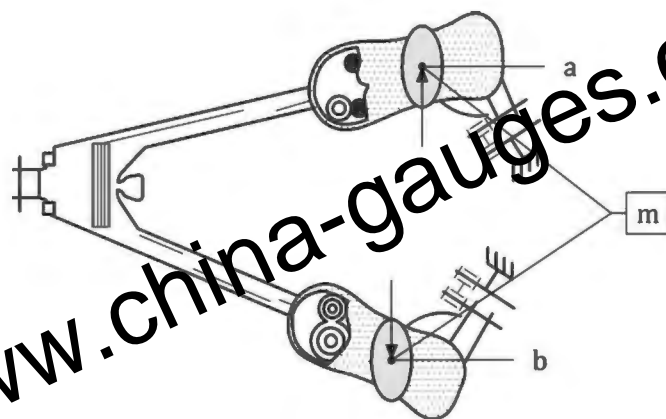
12.2.1.3 Test method – 3-wheeled vehicle

Progressively apply a mass of 100 kg or, when greater, a mass equal to the maximum permissible payload marked on the vehicle in accordance with [19.2.1](#) and multiplied by a safety factor of 2,5 during 1 min with a flat device having a surface of 100 mm × 100 mm to the centre of the two following positions a and b simultaneously (see [Figure 4](#)).

NOTE 1 The minimum mass of 100 kg represents a maximum permitted payload marked on the vehicle of 40 kg multiplied by a safety factor of 2,5.

NOTE 2 For a permissible payload of 120 kg (according to [19.2.1](#)), the total mass “m” is 300 kg.

If plastic material is used for the deck or steering system the 3-wheeled vehicle has to be conditioned for at least 6 h at a temperature of $(-5 \pm 1) ^\circ\text{C}$. Start the test within 1 min of removing the PLEV from the conditioning environment and complete it within 5 min.



Key
 a Position for application force
 b Position for application force
 m total mass

Figure 4 — Positions for application forces

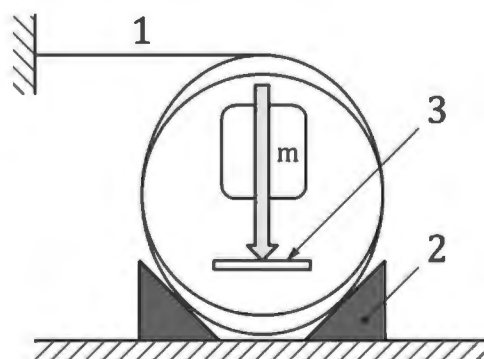
12.2.1.4 Test method – self-balancing vehicle

Progressively apply a mass of a minimum of 100 kg or, when greater, a mass equal to the maximum permissible payload marked on the vehicle in accordance with 19.2.1 and multiplied by a safety factor of 2,5 during 1 min with a flat device having a surface of 100 mm × 100 mm to the centre of each deck (see Figure 5).

NOTE 1 The minimum mass of 100 kg represents a maximum permitted payload marked on the vehicle of 40 kg multiplied by a safety factor of 2,5.

NOTE 2 For a permissible payload of 120 kg (according to 19.2.1), the total mass “m” is 300 kg.

If plastic material is used for the deck or steering system the self-balancing vehicle has to be conditioned for at least 6 h at a temperature of (-5 ± 1) °C. Start the test within 1 min of removing the PLEV from the conditioning environment and complete it within 5 min.



Key
 1 fixing point
 2 wedge
 3 deck
 m total mass

Figure 5 — Position for application forces

12.2.2 Handle bar and steering column

12.2.2.1 Bending test

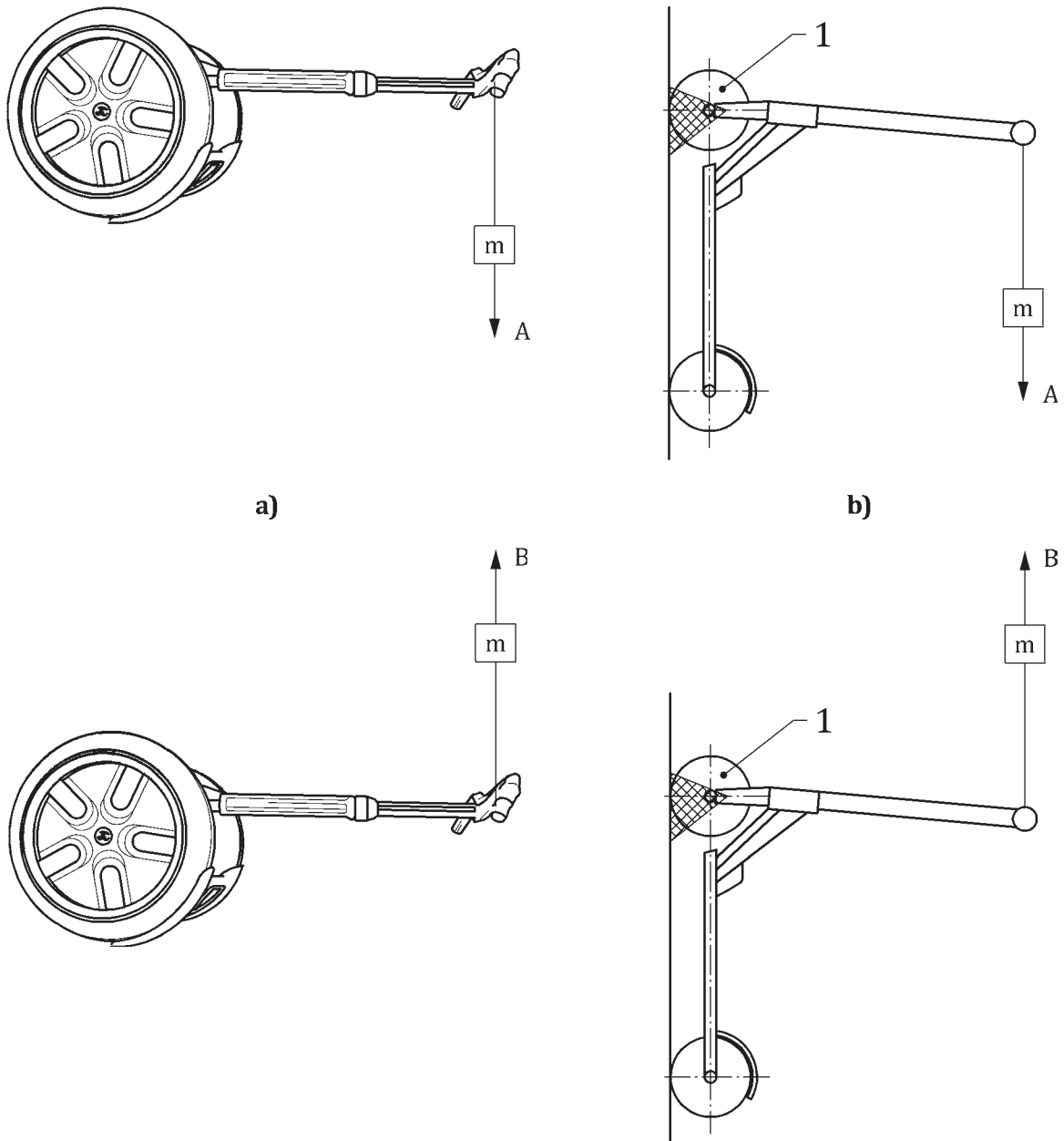
12.2.2.1.1 Requirements

When tested according to the method described in 12.2.2.1.2, there shall be no cracks or fractures, or deterioration of the operation of the handlebar or steering column.

12.2.2.1.2 Test methods

The steering column shall be in maximum high position and centrally loaded with a 50 kg mass, applied in directions A and B, each for 1 min, as shown in Figure 6.

The handlebar shall be in maximum high position and loaded with a 50 kg mass divided in two, for 1 min, as shown in Figure 7.

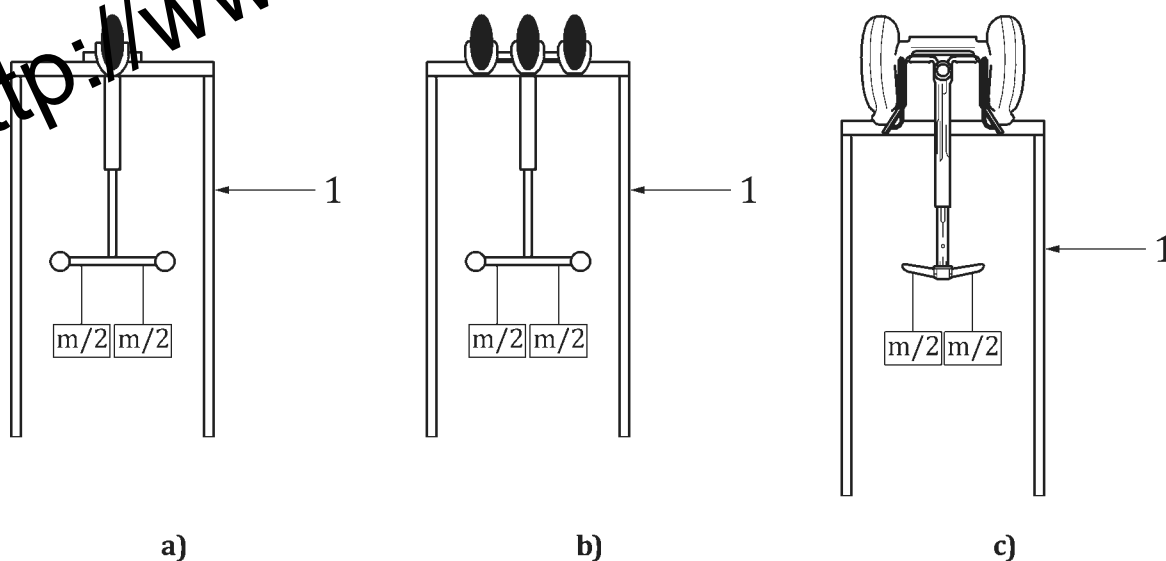


c)

Key

- 1 example of a fixation of the front wheel (the axle is fixed and the kick scooter is free for rotating)
- A Direction A
- B Direction B
- m mass of 50 kg

Figure 6 — Steering column - Bending test in directions A and B



Key

- 1 example of a fixation (the axle is fixed and the wheel is free for rotating)
- m total mass of 50 kg

Figure 7 — Steering column - structural test

12.2.2.2 Vertical loading test

12.2.2.2.1 Requirements

Following the test performed according to the method described in [12.2.2.2.2](#), there shall be no cracks or fractures, or deterioration of the operation of the handlebar or steering column. Nor shall there be any movement of the telescopic part.

12.2.2.2.2 Test method

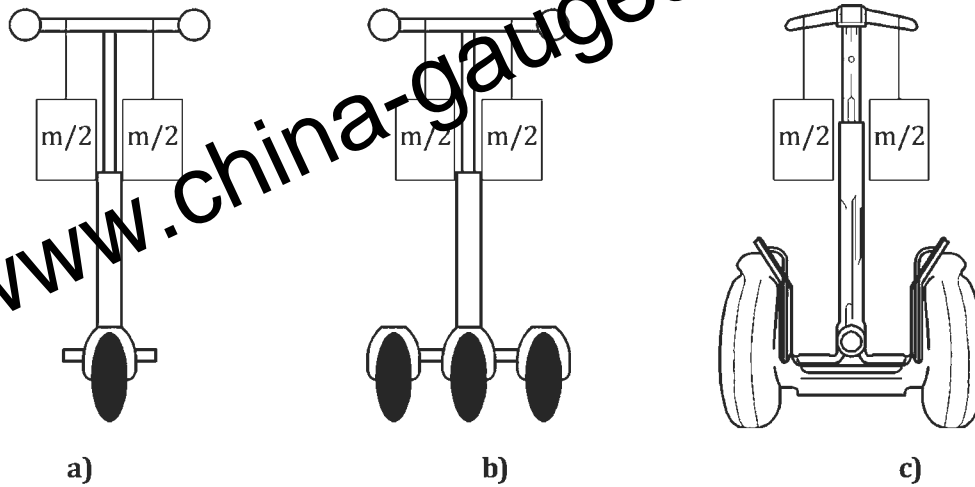
The handlebar shall be assembled in accordance with the manufacturer's instruction manual/sheet.

Draw out the telescopic tube up to half of its adjustment range (± 1 cm) and engage the locking system.

Load the vehicle by applying a mass "m" of 50 kg simultaneously to the centre of each hand grip in directions A as shown in [Figure 8](#).

Maintain the load for 1 min.

Determine whether the head tube has not become separated, the handlebar has not moved, the locking systems are still operational and engaged and whether the operation of the handlebar or steering column has not deteriorated.



Key

m = total mass of 50 kg

Figure 8 — Handlebar - Vertical loading test in direction A

12.2.2.3 Torque test

12.2.2.3.1 Requirement

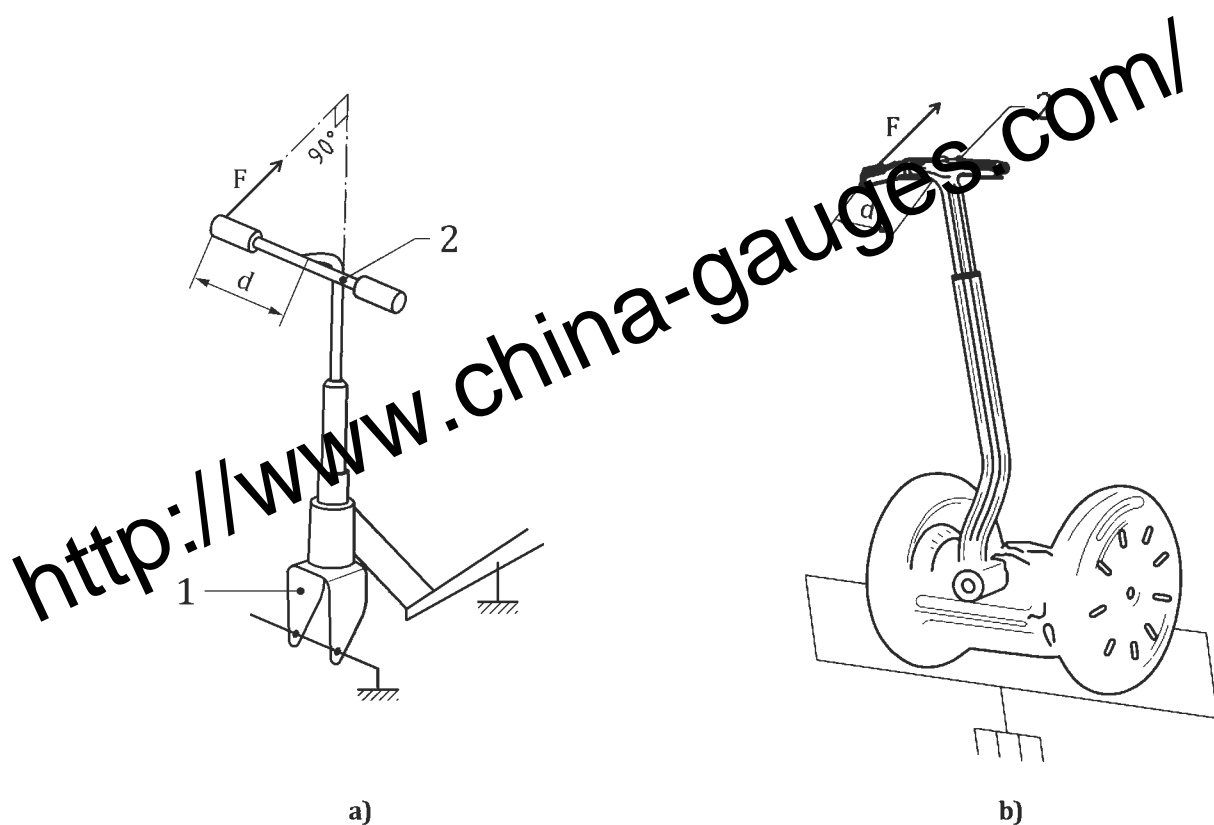
When tested according to the method described in [12.2.2.3.2](#), there shall be no movement of the handlebar stem in relation to the steering tube.

12.2.2.3.2 Test method

If necessary, assemble the handlebar and the steering column according to the manufacturer's instructions.

- Lock the fork in rotation.
- Apply a torque C of 20 Nm once in each direction of possible rotation in a plane perpendicular to the axis of the handlebar/fork assembly. Maintain each torque for 1 min.

NOTE The exact method for applying the torque may vary, and examples are illustrated in [Figure 9](#).



Key

- 1 fork
- 2 handlebar
- F force (applicable at extremity of d)
- d length of 1/2 handlebar
- C $F \times d$

Figure 9 — Handlebar - Torque test

12.2.2.4 Handlebar grips and plugs

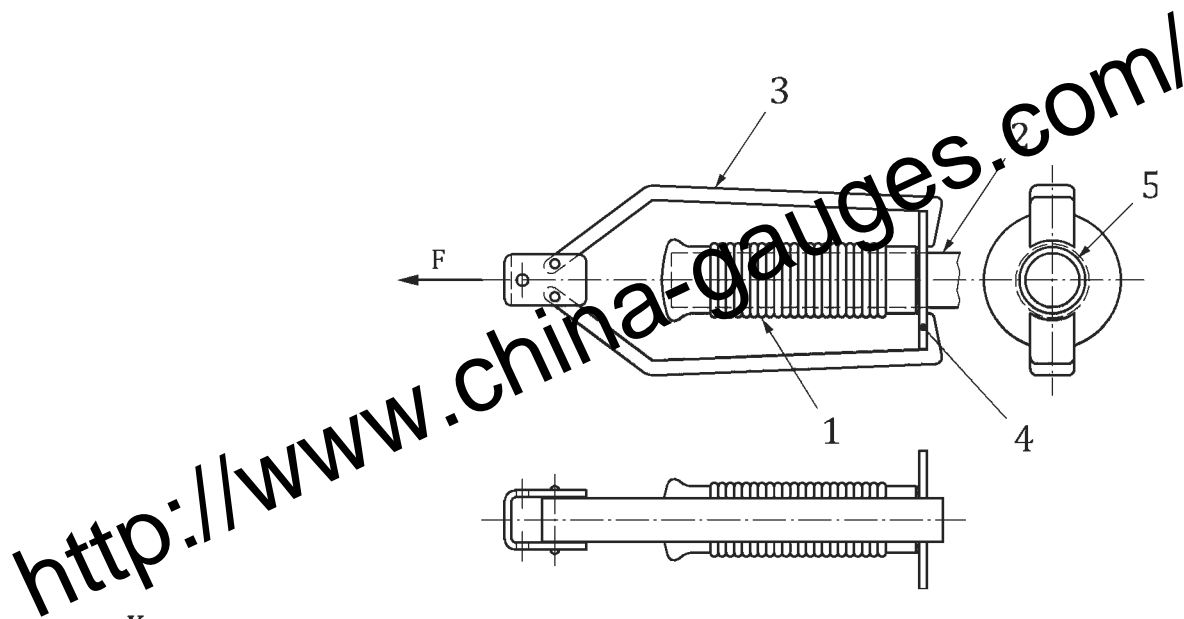
12.2.2.4.1 Requirements

The ends of the handlebar shall be fitted with grips or end plugs. When tested according to the method described in [12.2.2.4.2](#), the grips or plugs shall withstand a dismantling force of 70 N.

12.2.2.4.2 Test method

Leave the handlebar to reach ambient temperature then apply a force of 70 N to the grip or plug in the dismantling direction. Maintain the force for 1 min.

An example of handlebar grip drawing attachment is given in [Figure 10](#).



Key

- 1 handlebar grip
- 2 handlebar
- 3 drawing attachment
- 4 hooking ring
- 5 clearance

NOTE The hooking ring can be divided

Figure 10 — Example of handlebar grip drawing attachment

12.2.2.5 Telescopic handlebar (if fitted)

The handlebar stem shall be provided with one of the two following means to guarantee a safe insertion depth into the steering column:

- a) the handlebar stem shall be provided with a permanent, transverse mark, of a length greater than or equal to the external diameter of the handlebar stem clearly indicating the minimum depth for inserting its rod into the steering column. The insertion mark shall be positioned at least 2,5 times the external diameter of the rod from the lower end of the handlebar stem. The length of the solid section of the handlebar stem below the mark shall be at least equal to the external diameter of the rod;
- b) the handlebar stem shall be provided with a permanent stop to prevent it from being drawn out of the steering column beyond the minimum insertion depth defined in a).

12.3 Frontal impact resistance

12.3.1 Requirements for class 2

When tested according to the method described in [12.3.3](#), there shall be no visible cracks or fractures in any point of the folding mechanism -head tube-handlebar assembly. There shall be no visible cracks or fractures in any part of the frame and there shall be no separation of any elements of the suspension system. The assembly remains operational even if significant clearances are found. These clearances are acceptable if they do not involve the safety of the user. In particular, the locking of the folding system, if any, shall be checked when the scooter is unfolded

If applicable, the folding mechanisms shall remain locked.

12.3.2 Test method for vehicle of class 2

Adjust the handlebar at the maximum height.

The frame is mounted on a rigid fixture by the rear axle attachment points.

The frame is loaded with masses and can turn around the rear axle. The assembly is rotated about the rear axle and then let falling down on the anvil.

M1	M2
5 kg	2x10 kg

As shown in [Figure 11](#), mount the assembly at its rear axle attachment points so that it is free to rotate about the rear axle in a vertical plane.

The sample shall be fitted with the front wheel

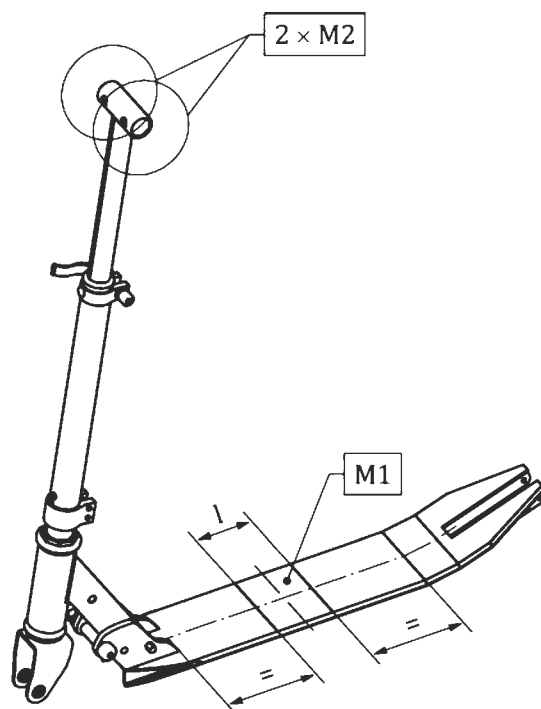
Securely fix mass M1 on the deck. The centre of the mass is aligned with the centre of the deck ([Figure 11](#)). The length of the platform is 100 mm and it shall cover the whole width of the deck.

Securely fix masses M2 on each side of the handlebar (see [Figure 11](#)).

Support the front fork on a flat steel anvil so that the frame is in its normal position of use.

Rotate the assembly around the rear axis until the distance d between the wheel and the anvil is (200 ± 1) mm (see [Figure 12](#)). Then allow the assembly to fall freely to impact on the anvil.

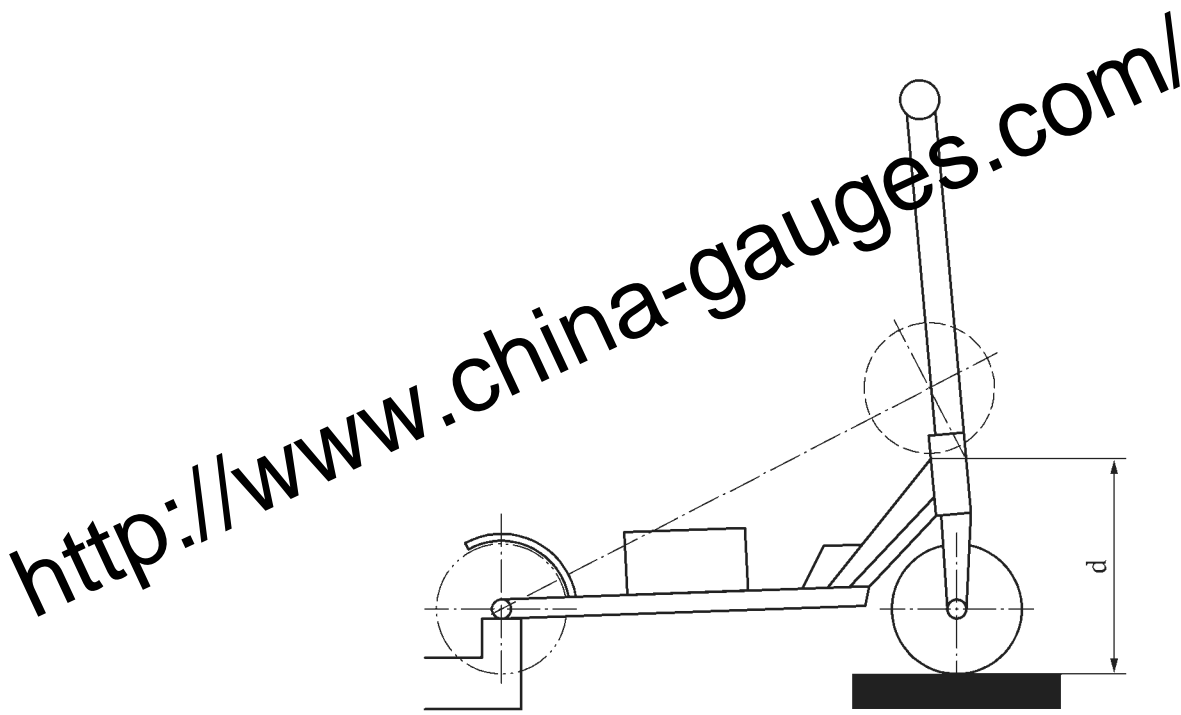
Repeat the test and then check for damages.



Key

M1	Mass M1
M2	Mass M2
l	length

Figure 11 — Falling frame impact test loading



Key

d distance between the wheel and the anvil

Figure 12 — Falling frame - height of fall

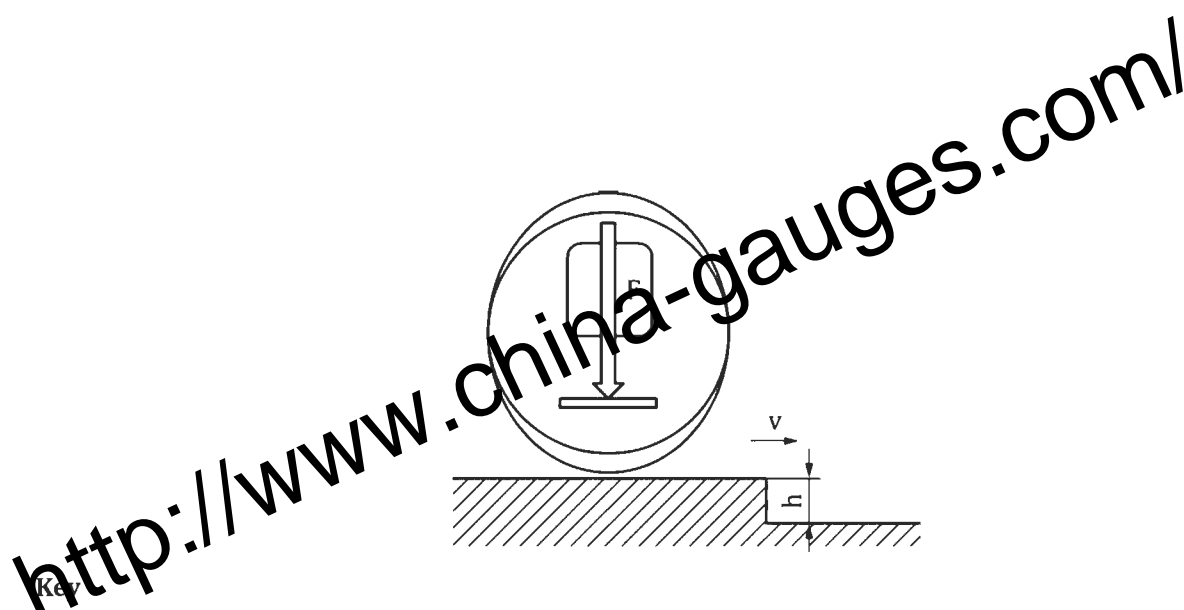
12.3.3 Requirements for class 4

When tested according to the method described in [12.3.4](#), there shall be no visible cracks or fractures in any part of the frame and there shall be no separation of any elements of the suspension system. The assembly remains operational even if significant clearances are found. These clearances are acceptable if they do not involve the safety of the user.

12.3.4 Test method for vehicle of class 4

The vehicle shall jump/drive over at 8-10 km/h of a pavement step down (foreseeable risk) where the step should be limited to 1/4 height of the wheel diameter (see [Figure 13](#)). The test shall be conducted with the mass of the maximum design load separated to the two platforms. If appropriate, tyre pressure shall be adjusted according to the maximum value given by the manufacturer.

Repeat the test and then check for damages.



- Key
- F 1/2 of max design load on each footrest
 - V velocity (8–10 km/h)
 - h 1/4 of the wheel diameter

Figure 13 — Falling impact test

12.4 Fatigue test (dynamic)

12.4.1 General

All types of vehicles fitted with a mechanical linked handlebar shall be subjected to this test.

The head tube/steering clearance/fork link can influence failures during handlebar fatigue tests. For this reason, a handlebar shall always be tested on a complete product. When there is a folding mechanism, this enables the handlebar's strength to be tested at the same time.

In the case of suspension frames where the rigidity of the suspensions can be adjusted, adjust the suspensions to provide maximum stiffness.

In the case of a pneumatic damper for which the air pressure cannot be adjusted, replace the suspension unit with a rigid link, making sure that the end fastening systems and the lateral rigidity accurately simulate the characteristics of the original system.

For suspension frames on which the chain stays do not have pivots but use the bending phenomenon, check that any dampers are adjusted to provide the minimum strength in order to ensure a suitable check of the frame.

When a suspension frame has adjustable supports or links to vary the strength of the scooter against the ground-contact forces or to modify the attitude of the scooter, position these adjustable components to ensure maximum forces in the frame.

12.4.2 Requirements

When tested according to the method described in [12.4.3](#) to [12.4.5](#), there shall be no visible cracks or fractures in any point of the folding mechanism -head tube-handlebar assembly. There shall be no visible cracks or fractures in any part of the frame and there shall be no separation of any elements of the suspension system. The assembly remains operational even if significant clearances are found. These clearances are acceptable if they do not involve the safety of the user. In particular, the locking of the folding system, if any, shall be checked when the scooter is unfolded.

12.4.3 Test method for a 2-wheeled single track vehicle

Use a new product for the test.

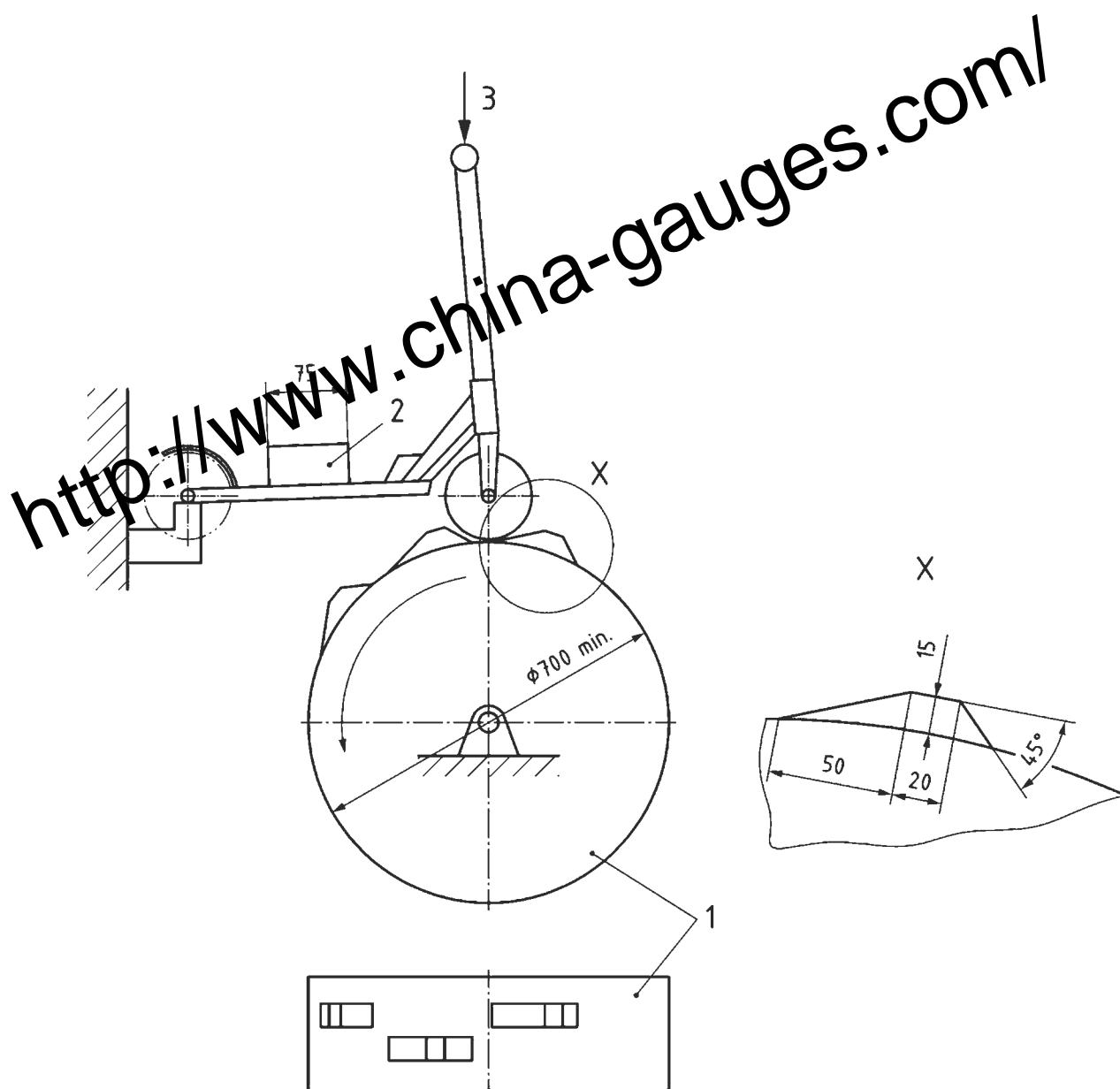
A complete vehicle shall withstand the fatigue test.

This test is carried out on a test apparatus as shown in [Figure 14](#):

- a circumferential speed of 0,8 m/s
- a distance of 25 km
- a diameter of the drum of minimum of 700 mm
- a mass of 100 kg shall be placed centrally on the free space of the deck (see [Figure 3](#))
- a mass of 10 kg shall be placed on the handlebar in maximum extended position
- the distance between the raised sections shall be such that the vehicle passes over one ramp every 1,5 s.

For testing multi-track vehicles, the raised sections shall be displaced so that the wheels do not travel over these raised sections simultaneously. The sections shall be spaced so that each wheel travels over two sections per second.

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Key

- 1 drum
- 2 mass (centre of deck)
- 3 mass (centre of handlebar)

Figure 14 — Test device for fatigue test

12.4.4 Test method for a 3-wheeled vehicle

Use a new product for the test.

A complete vehicle shall withstand the fatigue test.

This test is carried out on a test apparatus as shown in [Figure 14](#):

- a circumferential speed of 0,8 m/s
- a distance of 25 km
- a diameter of the drum of minimum of 700 mm

- a mass of 100 kg shall be placed centrally on the free space of the deck (see [Figure 3](#)).
- a mass of 10 kg shall be placed on the handlebar in maximum extended position.
- the distance between the raised sections shall be such that the vehicle passes over one ramp every 1,5 s.

For testing multi-track vehicles, the raised sections shall be displaced so that the wheels do not travel over these raised sections simultaneously. The sections shall be spaced so that each wheel travels over two sections per second.

12.4.5 Test method for a self-balancing vehicle

12.4.5.1 General

This test consists of 3 steps: (1) setting-up for the test, (2) test motion and (3) inspection. This test utilizes three apparatus: (1) test road, (2) a test load and (3) a supporting device (if necessary for maintaining the position of the vehicle during testing).

The apparatus (1) test road simulates environment of the intended use of the vehicle, and typically employs a test drum or a treadmill.

Determine the specifications of the (2) test load according to the maximum permissible load or according to the weight of intended users.

NOTE This test method refers to [ISO/TR 23482-2](#) (Robotics – Application of [ISO 13482](#) – Part 2: Application guide), which refers to [ISO 7176-8](#) (Wheelchairs – Part 8: Requirements and test methods for static, impact and fatigue strengths).

12.4.5.2 Apparatus

The apparatus required shall include the following:

a) Swept Sinusoidal Vibration test

The vehicle is firmly secured to the platform of the vibration machine in its normal operating position. Supports may be used to maintain the normal operating position but care shall be taken to ensure these do not affect the results of the test.

The vibration shall be a sinusoidal waveform with logarithmic sweep between 7 Hz and 200 Hz and back to 7Hz traversed in 15 min. This cycle shall be repeated 12-times for a total of 3 h.

From 7 Hz to a peak acceleration of 1 gn is maintained until 18 Hz is reached. The amplitude is then maintained as 0,8 mm (1,6 mm total excursion) and the frequency increased until a peak acceleration of 2 gn occurs (approximately 25 Hz). A peak acceleration of 2 gn is then, maintained until the frequency is increased to 200 Hz.

b) Test weight:

The test mass shall be applied to the vehicle by a test dummy or where a dummy is not required by an appropriate mass in accordance with the following:

— Test dummy

A test dummy shall be used when it is necessary to simulate the body mass distribution and kinematics of the user and any accessories (e.g. back pack).

Its mass shall simulate the weight of the self-balancing vehicle user where applicable. The total mass shall be the maximum mass of intended user and any accessories (e.g. back pack).

— Mass

When a test dummy is not required a mass equivalent to the maximum mass of the intended users and any accessories (e.g. back pack) shall be applied.

c) Supporting device

When the self-balancing vehicle is not able to maintain its position on the test road by itself, a supporting device shall be provided. The supporting device shall hold the self-balancing vehicle either directly or through a suitably connected dummy without affecting the outcome of the test.

12.5 Procedure

a) The self-balancing vehicle is positioned on the vibration machine supporting if necessary in accordance with [12.4.5.2](#) and either, as appropriate, with the test load or test dummy applying the load(s) in accordance to [12.4.5.2](#).

b) Visible damage such as fractures, deformation, jiggling, looseness or disengagement of parts, and changes in self-balancing vehicle function shall be recorded.

13 Edges and protrusions

13.1 General

These requirements are intended to address the hazards associated with the users of vehicles falling on projections or rigid components (e.g. handlebars, levers) on vehicle possibly causing internal injury or skin puncture.

NOTE see [D.8](#).

13.2 Sharp edges

Adequate shape shall be given to avoid puncturing of the body.

13.3 Protrusions

Tubes and rigid components in the form of projections which constitute a puncture hazard to the user shall be protected.

Screw threads which constitute a puncture/cut hazard shall be limited to a protrusion length of one major diameter of the screw beyond the internally threaded mating part.

14 Moving parts

14.1 Clearance between moving parts

To prevent crushing of fingers the distance separating accessible moving parts from other moving parts or from fixed parts of the vehicle shall, either be less than 5 mm, or greater than 18 mm in any position. This requirement does not apply to the wheel with its support systems, or to the rear brake/braking system, if any, or to brake actuating levers.

NOTE see [D.7](#).

14.2 Guarding of moving parts

Wheels shall be covered to avoid unintentional contact between a foot of the user and the moving wheel.

14.3 Folding mechanism

14.3.1 General requirement

14.3.1.1 General

Vehicles that can be folded for storage or transportation shall be fitted with one or more locking mechanism(s). The locking mechanism(s) shall comply with the requirements in [14.3.1.3](#).

The function of any operating or locking device shall not be impaired after being tested in accordance with [14.3.1.2](#).

Folding mechanisms shall be designed so that the vehicles can be locked for use in a simple, stable and safe way and folding shall not damage cables.

No locking mechanism shall contact the wheels or tyres during riding, and it shall be impossible to unintentionally loosen or unlock the folding mechanisms during riding.

14.3.1.2 Incomplete deployment

To avoid hazards due to incomplete deployment, at least one locking device shall engage automatically when the vehicle is unfolded for use.

If the locking device is not visible without damaging the vehicle, a second sample may be used.

14.3.1.3 Unintentional release of locking mechanism(s)

To avoid unintentional release, one of the following conditions shall be fulfilled:

- a) there shall be at least one operating device which fulfils the following:
 - 1) the *operating device* shall require at least two consecutive actions, the second being dependent on the first having been carried out and maintained by the user ; and
 - 2) the *operating device* shall not be activated or damaged in one single action during testing in accordance with [14.3.1.3](#);

or

- b) there shall be two separate and independent operating devices which fulfil one of the following:
 - 1) where one operating device is intended to be operated by foot (e.g. by its position, shape, according to the manufacturer's instructions for use.) it shall automatically return to its original status and the locking device shall reengage; or
 - 2) where both operating devices are intended to be operated by hand(s) (e.g. by their position, shape, according to the manufacturer's instructions for use.) they shall both automatically return to their original status and the locking devices shall reengage.

When tested in accordance to [14.3.2](#), the vehicle shall not fold and the *locking device(s)* shall not be released.

14.3.2 Test methods

14.3.2.1 Preconditioning

Operate the *locking devices* 200 times.

14.3.2.2 Unintentional release of the locking mechanism by one single action

Place the vehicle fully deployed and ready for use on a horizontal flat surface.

Apply a force of 150N or a torque of 2,2 Nm to the *locking device*. This force or torque shall be applied to the *locking device* in the direction most likely to open the *locking device* in one single action. The force or torque shall be applied for a period of 5 s.

Folding mechanism shall not be released.

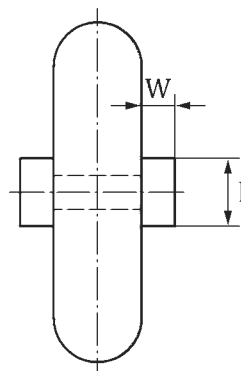
15 Adequate stability (see [D.10](#))

15.1 Footrest/Deck

In case the user is standing permanently, each deck shall be equipped with an anti-slide surface with an area of at least 150 cm².

In case the user is seating normally (not standing) while driving, the footrest shall be anti-slide and shall have a minimum length of 6,5 cm.

In case the user is standing momentarily and the vehicle has an integrated seat, the footrest shall be anti-slide and shall have a minimum length of 6,5 cm and a minimum width of 10 cm (see [Figure 15](#)).



Key

W	width
l	length

Figure 15 — example of decks (top view of a mono-wheel)

15.2 Handlebar adjustment

The handlebar height adjustment system shall be fitted with devices to avoid inadvertent separation or detachment during use.

15.3 Surface

15.3.1 Slippery surface

15.3.1.1 Requirements for wheel adhesion

The wheels shall be constructed from non-slip material. This requirement is considered to be fulfilled if a coefficient of adhesion, μ_0 , of at least 0,30 is achieved in the test according to [15.3.1.2](#).

15.3.1.2 Wheel adhesion test

Wheel adhesion shall be tested by pulling a clean wheel along a steel plate having a fine brushed and degreased surface of arithmetical mean roughness Ra of 1,5 µm to 2,0 µm (see [Figure 16](#)).

A vertical force F₁ of 100 N shall be applied to the wheel which is moved along the steel plate perpendicular to the vehicle's longitudinal axis and perpendicular to the surface brush direction by a horizontal force F₂, applied at the height of the wheel's axis.

The maximum force shall be recorded.

The test shall be repeated 10 times and the mean value of F₂ shall be calculated.

The test shall be carried out at a speed of approximately 1 mm/s.

The coefficient of adhesion shall be calculated according to [Formula \(1\)](#):

$$\mu_0 = \frac{F_2}{m_E \cdot g + F_1} \quad (1)$$

where

- μ₀ is the coefficient of adhesion;
- F₁ is the load applied to wheel, in N;
- F₂ is the adhesive force, in N;
- m_E is the mass of the wheel, in kg;
- g is the standard acceleration due to gravity (g = 9,81 m/s²).

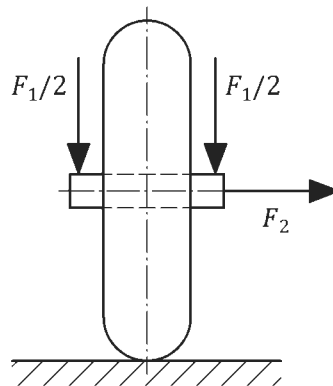


Figure 16 — Adhesion of wheels

15.3.2 Irregular surface

When loaded with a 90 kg mass, the dimensions of the tyres of the vehicle shall be:

- a) For vehicle with aligned wheels or with one front wheel:
 - the front tyre shall have a minimum diameter of 125 mm and a **minimum width of 25 mm**
 - the rear tyre shall have a **minimum width of 25 mm**
- b) For self-balancing vehicle:
 - the tyre shall have a minimum diameter of 125 mm and a **minimum width of 25 mm**

c) For all others vehicles:

- the tyre shall have a minimum diameter of 125 mm or a minimum width of 25 mm

15.4 Braking devices

15.4.1 General

All vehicles shall be equipped with service brake system and, when indicated, a parking brake or parking device as follows:

- Class 1 and 2 single-track vehicles (e.g. vehicle with aligned wheels) shall be equipped with at least one braking device.
- Class 1 and 2 multi-track vehicles (e.g. vehicle with unaligned wheels) shall be equipped with a parking device and one of the following:
 - If there are two rear wheels, the vehicle shall be equipped with a braking device on all rear wheels or an independent front and a combined rear wheels brake. The braking device shall be operated by the actuation of a single control or all wheel integrated braking system,
 - If there is one rear wheel, the vehicle shall be equipped with all wheel integrated braking system or with independent front wheel and rear wheel brakes;
- Class 3 and 4 multi-track vehicles shall be equipped with an acceleration controlled braking system.
- Class 3 and 4 single track self-balancing vehicles shall be equipped with a brake.

NOTE Small support wheels (wheels that are not used for normal driving and do not affect the braking) are not considered as a driving or braking wheels.

When a parking brake or parking device is not required, instructions to avoid the vehicle running away when unattended shall be provided in the owner's manual.

15.4.2 Braking performance

15.4.2.1 General requirements

All vehicle shall meet each of the requirements specified in the following paragraphs unless otherwise indicated.

A vehicle shall have a configuration that enables a user to actuate the braking device by hand with a lever or by foot while being in a normal driving position and with both hands on the steering control.

In case the vehicle is not equipped with a handle bar, the actuation of the braking device shall be performed according to the instructions provided by the manufacturer in accordance with the second sentence of 7.1.1.d). These instructions shall be a part of the user's manual.

15.4.2.2 Hand operated braking system – Strength test

There shall be no failure of the braking system or of any component thereof when tested in accordance with [15.4.3.2](#).

15.4.2.3 Dry stop

When the brakes are tested in accordance with the test procedure set out in [15.4.3.4](#), the following condition shall be met:

- the Mean Fully Developed Deceleration (MFDD) shall be: $\geq 1,7$ (m/s²).

The vehicle speed at the start of braking shall be 90 % of the maximum speed of the vehicle achievable solely by power assistance.

15.4.2.4 Vehicle behaviour during braking

During the tests (see [15.4.3](#)), the following shall not occur in a way which causes the user to have to use his feet, other than for the application of the brake, to control the vehicle:

- a) excessive juddering;
- b) front wheel locking;
- c) vehicle instability (for example, uncontrollable lifting of the rear wheel);
- d) user's loss of control or balance;
- e) excessive side-skidding.

NOTE With certain types of braking systems, it is not possible to entirely avoid some skidding of the rear wheel during braking; this is considered acceptable provided that d) or e) do not occur as a result.

15.4.2.5 Electric failure braking compensation

In the event of an electric braking failure, the vehicle shall be able to brake normally or, shall come to a standstill with a minimum deceleration of 1,25 (+/- 0,25) m/s² as describe in [15.4.3.5](#).

15.4.2.6 Parking device

When required in accordance with [15.4.1](#), the parking device shall make it possible to maintain the vehicle stationary on up or down gradient of 18 % even in the absence of the user. The user shall be able to achieve this parking action from the riding position.

The parking device system shall have a control which is separate from the service braking device controls. The vehicle shall be held in the locked in the parking position by a purely mechanical device.

NOTE Types of parking device are given in [Annex G](#) ([Table G.1](#) and [G.2](#)).

15.4.3 Test methods

15.4.3.1 Braking test force applications

- a) Actuation by hand

The braking actuation forces shall be less than 200 N when measured at 25 mm from the end of the hand lever.

- b) Actuation by foot

After checking that the braking system is correctly adjusted in accordance with the manufacturer's instructions, apply a force to the brake pedal so that the resulting force is vertical to the direction of riding. The vertical force on the brake pedal shall be 700 N, or any other lesser value required to achieve the required performance.

NOTE For vehicles with foot-operated rear wheel brakes, the user's position is allowed to move backwards over the rear wheel.

15.4.3.2 Hand operated brake strength test

The test shall be performed on a fully-assembled vehicle. The brake operating systems shall withstand the applied force.

After checking that the braking system is correctly adjusted in accordance with the manufacturer's instruction manual/sheet, apply a force to the brake lever at the point specified in [15.4.3.1](#). This force shall be 450 N, or any other lesser value required to bring:

- a) the brake lever into contact with the handlebar grip or, where there is no grip, the handlebar;
- b) the brake lever extension to the same level as the surface of the handlebar or into contact with the handlebar.

Repeat the test 10 times for each brake lever or brake lever extension.

15.4.3.3 Brake performance test conditions (classes 2 and 4)

The mass (M) of the vehicle shall be Technical Permissible Maximum Mass (TPMM).

The test track shall be a clean, dry, level surface, with a gradient $\leq 1\%$; with good adherence (e.g. asphalt or concrete) and with the test lane of 1,20 m width.

The ambient temperature shall be between 5 °C and 35 °C. The wind speed shall be no more than 3 m/s.

The user shall be in a position as for normal riding and shall maintain the same position throughout the test. The speed and distance shall be determined using instrumentation having an accuracy of $\pm 1\%$ at the prescribed speed for the test. The mean fully developed deceleration (MFDD) may be determined by other methods than the measurement of speed and distance; in this case, the accuracy of the MFDD shall be within $\pm 3\%$.

Pneumatic tyres shall be inflated in accordance with the manufacturer's instruction manual/sheet for the vehicle loading condition for the test.

Vehicle position and wheel locking:

- The vehicle is positioned in the centre of the test lane for the beginning of each stop;
- Stops are made without the vehicle wheels passing outside the applicable test lane and without wheel locking.

A running-in cycle shall be performed on each brake before the performance tests are carried out.

Actuate the brakes for at least three seconds to obtain steady deceleration whilst the vehicle is riding at a speed of approximately 90 % of the maximum speed achievable solely with power assistance. Repeat this operation 10 times.

All types of brakes shall be subject to this running-in phase.

The following tests shall be carried out to measure the data required to determine MFDD in accordance with [15.4.3.4, Formula \(5\)](#):

- a) If the gradient of the track is less than 0,2 %, the following measurements shall be taken in the order presented:
 - 1) five valid measurements in dry conditions;
 - 2) two preparation tests in wet conditions (results not recorded);
 - 3) five consecutive valid measurements in wet conditions.
- b) If the gradient of the track is between 0,2 % and 0,5 %, the following measurements shall be taken in the order presented:
 - 1) six consecutive valid measurements in dry conditions, alternating the direction of travel with each test;
 - 2) two preparation tests in wet conditions (results not recorded);

- 3) six consecutive valid measurements in wet conditions, alternating the direction of travel with each test.
- c) For each series of five or six consecutive measurements, the test results corresponding to the longest measured stopping distance shall be used in the determination of MFDD in accordance with [15.4.3.4](#) for the tests of [15.4.3.3](#) a) 1) and 2) or b) 1) and b) 3) as appropriate.

A rest period between two successive measurements shall not exceed 3 min.

15.4.3.4 Stop performance calculation (classes 2 and 4)

For the calculation of MFDD, the following formula shall be used:

$$MFDD = \frac{V_b^2 - V_e^2}{25,92 \cdot (S_e - S_b)}, \text{ in m/s}^2 \quad (5)$$

where

MFDD	is the mean fully developed deceleration, in m/s^2 ;
V_b	is the vehicle speed at 0,8 V_1 , in km/h;
V_e	is the vehicle speed at 0,1 V_1 , in km/h;
V_1	is the vehicle speed when user actuates the control, in km/h;
S_b	is the distance travelled between V_1 and V_b , in m;
S_e	is the distance travelled between V_1 and V_e , in m.

15.4.3.5 Electric braking failure compensation test

15.4.3.5.1 Requirement

The requirement of [15.4.2.5](#) shall be achieved.

In case of electric braking failure, the vehicle shall stop with a smooth deceleration regarding [7.2](#).

15.4.3.5.2 Test method for an electrical braking system

This test is not conducted when the vehicle is equipped with a completely mechanical braking system.

- Bring the vehicle to V_{\max} and interrupt the power from the battery.
- Measure the deceleration during the complete stop but excluding the final 0,5 s.
- The test track shall be a clean, dry, level surface, with a gradient $\leq 1\%$; with good adherence (e.g. asphalt or concrete) and with the test lane of 1,20 m width.
- The ambient temperature shall be between 5 °C and 35 °C. The wind speed shall be no more than 3 m/s.

16 Presence awareness

16.1 Lighting

16.1.1 Retro-reflectors

Vehicles shall be fitted with front, side and rear retro-reflector according to ISO 6742-2:2015. The rear reflector shall be red in colour. The front reflector shall be white (clear) in colour. All side reflectors shall be of the same colour, either white (clear) or yellow.

16.1.2 Front and rear lightning

Vehicles of class 2 and 4 shall be fitted with active front and rear lights according to ISO 6742-1:2015 (see [D.12](#)).

The manufacturer shall indicate in the user's manual how an active front and rear light can be fitted to the vehicles of class 1 and 3. The controls for lighting shall be marked in accordance with [Annex F](#).

NOTE 1 Local regulations can be applicable

NOTE 2 see [D.14](#).

16.2 Audible warning to alert persons

An audible device shall be provided to allow a warning to be given to persons in the vicinity of the vehicle.

The audible warning device shall be controlled by a command from a device on the handlebar.

On a vehicle without a handlebar, a warning device which can be carried by the user of a vehicle (remote control) shall be provided with the vehicle. The vehicle shall only be able to start if the remote control is connected either physically and/or via wireless.

The control for the audible warning shall be marked in accordance with [Annex F](#).

The device shall comply with [ISO 14878:2015](#) Class II.

A remote control shall comply with [17.1](#).

17 System failure and malfunction warning devices

17.1 General

The warning symbols audible signal are given in [Annex F](#).

Audible warning devices provided with the vehicle shall be unambiguous and easily perceived. The operator shall be able to check the operation of the audible warning devices at all times.

If the vehicle is equipped with a remote control for any audible warning device required by this standard, the vehicle shall only be able to start if the remote control is connected either physically and/or via wireless.

17.2 Audible/ vibrating signalling

Audible devices required by this standard shall comply with [ISO 14878:2015](#) Class II.

17.3 Loss of connection to the warning system

Loss of connection to the warning system shall be relayed by a warning signal (visual, audible, vibrating,...) on the vehicle or on the remote control.

In a driving condition the loss of connection to the warning device shall result in a speed reduction to 6 km/h for a Class 4 vehicle; the speed reduction shall happen in a safe manner without creating additional hazards and with corresponding audio notification and tilt back of decks on self-balancing vehicles.

18 Hot surfaces

18.1 Requirements

Hot surfaces of the vehicle (temperatures above 47 °C), except brake systems, which are not in continuous contact with the user shall be protected to prevent inadvertent contact.

The seat, handgrips, handgrip levers, footrests and decks are parts that are considered in continuous contact with the user. In no circumstance during the test of 18.2 shall their temperature exceed 43 °C. A durable visible warning shall be fixed as close as possible to the brake if the temperature of the brake system could be above 50 °C (see ISO 7010:2019, symbol W017).

The instruction manual shall contain a notice warning of the possible danger of burns if the brakes are touched after a prolonged or severe use.

Outer surface temperature of cables and connections that can be reached by the user shall not exceed 57 °C while in use on performance test rig.

NOTE 1 Due to the operational requirements of (disc) brakes, the variability of their working temperatures with the type of use, and the fact they are distant from the normal riding position, no temperature limit is defined for these parts.

NOTE 2 see D.4.

18.2 Test method

To be tested by measurement (tolerance ± 2 °C) only if there are heat producing elements in the direct vicinity of the grips, the footrest or the deck.

Put the vehicle on the bench with a fully charged battery. Operate the vehicle under maximum load until 20 % of battery charge remains (maximum warm up). Measure temperature of grips, footrest(s) and deck(s).

19 Product information and marking

19.1 General

The following product information should accompany each product.

All text shall be printed in the official language or at least one of the official languages of the country of sale. If other languages are included, they shall be easy to distinguish, e.g. by separate presentation.

All text shall be clearly legible. Sentences shall be short and of simple construction. The words used shall be uncomplicated and in everyday use.

Information and warnings on the vehicle should preferably be provided in the form of readily understandable symbols or pictograms when available.

19.2 Marking

19.2.1 General

The vehicle shall be legibly, visibly and permanently marked with at least the following:

- the business name and full address of the manufacturer or, where applicable, his authorized representative, importer or organization responsible for its sale;
- designation of the vehicle;

- the mandatory marking;
- reference to this document, i.e. [EN 17128:2020](#);
- designation of series or class with maximum speed (e.g. kick scooter, class 2, 25km/h);
- serial or identification number;
It is recommended that the identification number is in accordance with [ISO 3779](#).
- year of construction, that is the year in which the manufacturing process is completed;
- nominal power expressed in watts (W);
- mass of the most usual configuration, in kilograms (kg);
- maximum permissible payload, user including luggage.

19.2.2 Durability of marking of the frame or chassis

Rub the marking by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked in petroleum spirit.

After the test the marking shall remain easily legible.

It shall not be easy to remove any label nor shall any label show any sign of curling. After rubbing the text shall still be clearly legible.

19.2.3 Battery

Information concerning the battery shall comply with existing corresponding standards.

Additionally, the following information shall appear on the battery:

- the output voltage;
- the charging voltage;
- the power;
- warning on the risks.

19.2.4 Tyres

The maximum pressure for inflatable tyres (if present) shall be marked on the tyre or in the instructions for use.

19.3 Purchase information

19.3.1 General

Information at point of sale could be given on the packaging, on an information sheet in the store or on internet.

19.3.2 Information at point of sale

The following information shall be given:

- Only use the product in accordance with local regulations;
- For which age the vehicle is designed;

- Protective helmet is strongly recommended.

All product information as required in this standard shall be provided in the official language(s) of the country of sale.

Warning sentences shall be written in letters whose upper case shall be at least 2,5 mm in height. The word "WARNING" shall be written in upper case. The word "WARNING!" can be given at the top of a list of warnings:

- **"WARNING! Never use the product close to a water source"**
- **"WARNING! Stop using the product when damaged"**

The information needed to control machinery shall be provided in a form that is unambiguous and easily understood. It shall not be excessive to the extent of overloading the operator.

Visual display units or any other interactive means of communication between the operator and the machine shall be easily understood and easy to use (see [Annex F](#)).

19.3.3 Information on the packaging

In the case where the product is delivered in a package to the final customer, the following information shall appear on the packaging:

- the business name and full address of the manufacturer and, where applicable, his authorized representative,
- the designation: PLEV,
- use warnings:
 - "WARNING! Never use the product out of the spaces authorized by the regulations"**
- the number of this standard followed by the use class, specified as follows: [EN 17128](#) (class xx),
- for which age the vehicle is designed,
- indication of the maximum weight of the user in accordance with manufacturer recommendation, specified as follows: MAX XXX kg,
- indication of the maximum speed according with manufacturer declaration and within the range of permitted speed corresponding with the declared class, specified as follows: XX km/h.

19.4 Instructions for use

19.4.1 General

Instructions concerning safe use of the vehicle shall be provided with the vehicle in the form of instruction sheet, instruction manual, leaflet or other similar physical support.

These instructions shall include at least the following and shall be headed as follows:

"IMPORTANT! Read carefully and keep for future reference"

- The intended use of the vehicle.
- The name or trade mark of the manufacturer, importer or organization responsible for its sale.
- Means to identify the product.
- The description of the propulsion system technology and its detailed method of operation;
- Instructions for initial assembly, folding and erection, when applicable (see [Clause 5](#)).

- Explanation for light indicators.
- Instructions covering all functions of the vehicle, specially driving power assistance start mode (e.g. pushing the vehicle by more than 3 km/h and activating the power assistance mode).
- Instructions for operating parking and/or *braking device(s)*.
- An instruction that the *parking device, if available, shall be engaged when vehicle is not on use.*
- For vehicles fitted with load carrying accessory (ies), details of the maximum permissible load.
- A statement that any load attached to the handlebar will affect the stability of the *vehicle*.
- Instructions for routine inspection, maintenance, cleaning and/or washing.
- A statement that the vehicle shall be used only for one person.
- A statement that accessories and any additional items which are not approved by the manufacturer shall not be used.
- Instruction concerning safe use of the vehicle together with an indication of:
 - 1) the maximum weight of the user in kg,
 - 2) the maximum and if relevant minimum height of the user,
 - 3) the maximum and/or minimum age of the user as appropriate.
- Indication the maximum continuous rated power of the electric motor according with manufacturer declaration, specified as follows: XX W.
- The mandatory marking.
- The user should check the limits of use in accordance with the local regulations (e.g. use in pedestrian areas, on-road).
- Description of the correct methods of use including braking techniques and warning on the extension of braking distances during wet weather.
- Description of intended surfaces (flat, clean, dry, level and if possible, distance from other road users).
- The use of protective equipment such as: hand/wrist, knee, head and elbow protections.

NOTE 1 see [D.5](#)

- The necessary preparations for using the product, for example: the notification that it is necessary to check that the steering system is correctly adjusted, that all connection elements (such as a folding system) are correctly tightened and not broken, and that the brakes and wheels are in good condition.
- Obligation to always wear shoes.
- Others recommendations such as: special precautions for use at dark; not to touch the brake disc.
- The method for adjusting the suspensions if the product has any.
- The maximum permissible mass of the user.
- Warning aiming to draw the user's attention to any damages related to intensive use and to recommend periodic inspections of the frame, fork and suspension attachments (if any). The warning may be formulated as follows:

“WARNING ! As with any mechanical component, a vehicle is subject to high stresses and wear. The various materials and components may react differently to wear or fatigue. If the

expected service life for a component has been exceeded, it may break suddenly, therefore risking causing injuries to the user. Cracks, scratches and discoloration in the areas subject to high stresses indicate that the component has exceeded its service life and should be replaced."

- Traffic in the city has many obstacles to cross such as curbs or steps. It is recommended to avoid obstacle jumps. It is important to anticipate and adapt your trajectory and speed to those of a pedestrian before crossing these obstacles. It is also recommended to get out of the vehicle when these obstacles become dangerous due to their shape, height or slippage.
- An instruction to keep the printed instructions for further reference and to be read carefully before use.

WARNING Keep plastic covering away from children to avoid suffocation.

- For inflatable tyres the maximum pressure shall be marked on the tyre or in the instructions for use.

Additionally, the following recommendations shall be given:

- Take the time to learn the basics of the practice to avoid any serious accident that can take place in the first months;

NOTE 2 Information on practice and safe use could be given by the manufacturer on a website.

- Get closer to your seller so he can refer you to an appropriate training organization.
- Avoid high traffic areas or overcrowded areas.
- In any case, anticipate your trajectory and your speed while respecting the code of the road, the code of the sidewalk and the most vulnerable.
- Notify your presence when approaching a pedestrian or cyclist when you are not seen or heard.
- Cross the protected passages while walking.
- In all cases, take care of yourself and others.
- Do not divert the use of the vehicle.
- This vehicle is not intended for acrobatic use.
- Caution, the brake may become hot in use. Do not touch after use.
- Regularly check the tightening of the various bolted elements, in particular the wheel axles, the folding system, the steering system and the brake shaft.
- Eliminate any sharp edges caused by use.
- Do not modify or transform the vehicle, including the steering tube and sleeve, stem, folding mechanism and rear brake.

Any other relevant information may be added, at the manufacturer's discretion.

Any other valuable information specified by the manufacturer.

NOTE 3 In some countries, specific regulations are applicable regarding e.g.: age, speed limitation, intended use, dedicated areas or transportation of batteries.

19.4.2 Noise emission

19.4.2.1 General

In case of doubt, a-weighted sound pressure levels shall be measured to a maximum 70 dB according to EN ISO 3744:2010, if necessary (see [19.4.2.2](#)).

19.4.2.2 Requirements

The following information shall be inserted in the instructions for use:

- the A-weighted emission sound pressure level at workstations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact shall be indicated;
- the peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relation to 20 μ Pa),
- the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A).

19.4.3 Battery charging

Information for use shall contain instructions for battery charging, in particular:

- recommendations on charging the battery and use of the charger;
- procedure for charging the battery;
- environmental conditions (e.g. outdoor or indoor charging);
- requirement to power-off the vehicle during charging, or into a certain non-operational mode;
- appropriate warnings.

19.5 Instructions on servicing and maintenance

It shall be clearly explained that regular maintenance of the vehicle is a factor of safety. These explanations include the following points:

- list regarding the maintenance that can be performed by the user himself;
- cleaning recommendations;
- description regarding the maintenance and replacement of wear parts; (, wheels, brake pads, cables, etc.);
- a note specifying that the self-tightening nuts as well as the other self-tightening fastenings may lose their efficiency and that they may need to be retightened;

NOTE Average value of 20N/m is given unless other value is provided by the manufacturer.

- lubrication recommendations – locations and frequency of lubrication, recommended lubricant;
- the method for adjusting the brakes and recommendations concerning the replacement of friction components;
- method for adjusting or setting all of the components that would need to be adjusted regularly or after replacement of a part;
- recommendation not make any modifications that are not noted in the manufacturer's instructions;
- information on where the user can find a qualified maintenance shop for items he cannot do by himself (e.g. replacement of wear parts, electronic components, tightening torques ...).

Annex A
(informative)

List of significant hazards

Table A.1, below, lists the main sources of risks and their effects identified for all of the vehicles concerned by the scope of this standard.

Table A.1 — List of main hazards

Element or source of hazards	Circumstances for occurrence of the risk	Clause covering the risk
Electrical hazards		
Battery	Electrocution, fire outbreak or intoxication due to breakage of the battery during normal use	Clause 10
	Electrocution, outbreak of fire or intoxication due to a short circuit or sealing defect of the battery during normal use	
Cabled assembly	Electrocution or loss of a safety function following failure of the wiring	6.3
Safety management by the power assistance management system	Accident due to loss or failure of the power assistance management safety systems	Clause 7
Power assistance management	Failure of the power assistance and its safety management due to electromagnetic interference.	Clause 7
	Start of failure of neighbouring systems due to electromagnetic interference emissions	
Mechanical hazards		
Handlebar and head tube	Fall due to the breakage of an element of the assembly	12.2.2
	Fall due to sudden loss of ergonomic adjustments during use	
Folding/unfolding systems	Fall due to unintentional folding (/unfolding), during use	14.3
Deck	Fall due to breakage of the deck	12.2.1
Wheel + front fork	Fall due to failure of one or more wheels	15.3
Braking system	Accident due to failure or inadequacy of the braking system	15.4.2
General assembly	Cut or pinching of a finger due to unsafe design or production	Clause 14
	Fall due to breakage or unintentional separation of mechanical elements	12.3 , 12.4

Annex B
(normative)

Electromagnetic compatibility of vehicle

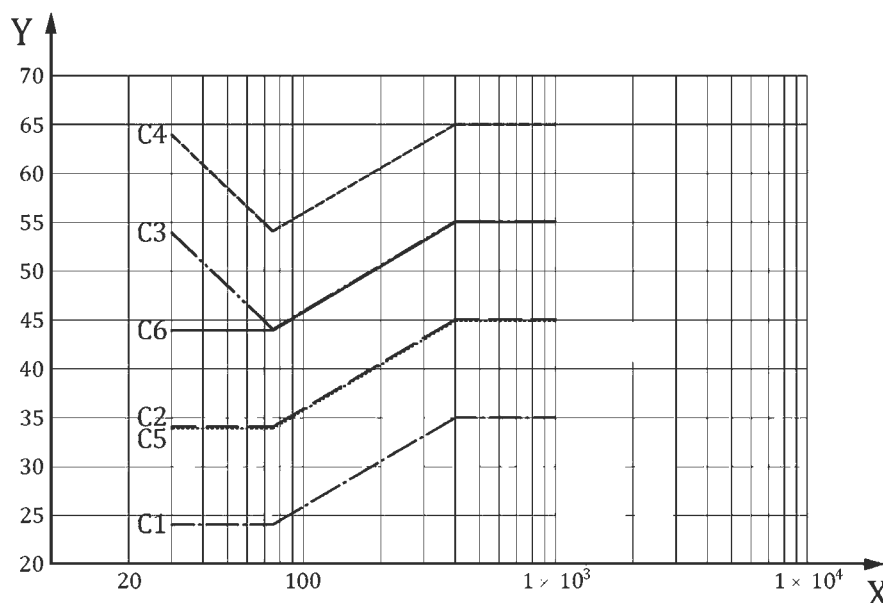
B.1 Conditions applying to vehicle and to electrical/electronic sub-assemblies (ESA)

B.1.1 Requirements

B.1.1.1 General requirements

All vehicles shall be designed and constructed in such a way that, under normal conditions of use, they meet the conditions laid down in this annex.

NOTE An overview of the electromagnetic radiation emission reference limits is given in [Figure B.1](#) and [Table B.1](#).



- Key**
- X frequency f in MHz
 - Y reference limits L in dB [μ V/m)
 - C1 requirements relating to narrow-band radiation emission from vehicle, antenna at 10 m
 - C2 requirements relating to broad-band radiation emission from vehicle, antenna at 10 m
 - C3 requirements relating to narrow-band ESA radiation emission, antenna at 1m
 - C4 requirements relating to broad-band ESA radiation emission, antenna at 1 m
 - C5 requirements relating to narrow-band radiation emission from vehicle, antenna at 3 m
 - C6 requirements relating to broad-band radiation emission from vehicle, antenna at 3 m

Figure B.1 — Overview of electromagnetic radiation emissions reference limits

Table B.1 — Overview of electromagnetic radiation emissions reference limits - Curves characteristics

Characteristic	Value	Band-width	Antenna distance [m]	Value for L [dB(μV/m)] within f [MHz]		
				30 to 75	75 to 400	400 to 1 000
C 1	mean value	narrow-band	10 ± 0,2	24	24+15,13log(f/75)	35
C 2	quasi-peak	broad-band	10 ± 0,2	34	34+15,13log(f/75)	45
C 3	mean value	narrow-band	1,0 ± 0,05	54- 25,13log(f/30)	44+15,13log(f/75)	55
C 4	quasi-peak	broad-band	1,0 ± 0,05	64- 25,13log(f/30)	54+15,13log(f/75)	65
C 5	mean value	narrow-band	3 ± 0,05	34	34+15,13log(f/75)	45
C 6	quasi-peak	broad-band	3 ± 0,05	44	44+15,13log(f/75)	55

However, the measuring methods used in checking the immunity of vehicle to electromagnetic radiation are described in [B.4](#) and [B.7](#).

B.1.1.2 Broad-band radiation from vehicles

B.1.1.2.1 General

The electromagnetic radiation generated by the vehicle type submitted for testing shall be measured by the method described in [B.2](#).

B.1.1.2.2 Vehicle reference limits (broad-band)

B.1.1.2.2.1 If measurements are taken using the method described in [B.2](#), in respect of a vehicle-antenna distance of $(10,0 \pm 0,2)$ m, the radiation reference limit will be 34 dB microvolts/m in the 30-75 MHz frequency band and 34-45 dB microvolts/m in the (75 to 400) MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the (400-1 000) MHz frequency band the limit remains constant at 45 dBμV/m.

B.1.1.2.2.2 If measurements are taken using the method described in [B.2](#), in respect of a vehicle-antenna distance of $(3,0 \pm 0,05)$ m, 10 dB shall be added to the limit.

B.1.1.2.2.3 The test limit of the item is 2,0 dB less than the reference limit for measured value expressed in dB (microvolts/m).

B.1.1.3 Requirements relating to narrow-band radiation emissions from vehicles

B.1.1.3.1 General

The electromagnetic radiation from the vehicle submitted for testing shall be measured by the method described in [B.3](#).

B.1.1.3.2 Vehicle reference limits for vehicle narrow-band radiation

B.1.2.3.2.1 If measurements are taken using the method described in [B.3](#), in respect of a vehicle-antenna distance of $(10,0 \pm 0,2)$ m, the radiation reference limit will be 24 dB in the (30-75) MHz frequency band and (24-35) dB in the (75-400) MHz frequency band. This limit will increase by the frequency logarithm for frequencies above 75 MHz. In the (400-1 000) MHz frequency band the limit remains constant at 35 dBμV/m.

B.1.2.3.2.2 If measurements are taken using the method described in [B.3](#), in respect of a vehicle-antenna distance of $(3,0 \pm 0,05)$ m, 10 dB shall be added to the limit.

B.1.2.3.2.3 The measured values for the vehicle type submitted for testing expressed in dB (microvolts/m), shall be 2 dB below the reference limit.

B.1.1.4 Requirements regarding vehicle immunity to electromagnetic radiation

B.1.1.4.1 Measuring method

Tests to determine the immunity of the vehicle type to electromagnetic radiation shall be conducted in accordance with the method described in [B.4](#).

B.1.1.4.2 Vehicle immunity reference limits

B.1.2.4.2.1 If measurements are taken using the method described in [B.4](#), the field strength reference level shall be 24 V/m r.m.s. in over 90 % of the 20 MHz to 2 000 MHz frequency band and 20 V/m r.m.s. over the whole 20 MHz to 2 000 MHz frequency band.

B.1.2.4.2.2 The vehicle representative of the type submitted for testing shall not display any deterioration in the direct control of the vehicle which might be observed by the user or by any other road user when the vehicle in question is in the state defined in [B.4](#), and when it is subjected to the field strength expressed in volts/m, which shall be 25 % above both of the reference levels in [B.1.2.4.2.1](#).

B.1.1.5 Requirements concerning broad-band ESA radiation

B.1.1.5.1 Measuring method

The electromagnetic radiation generated by the ESA submitted for component type-approval shall be measured by the method described in [B.5](#).

B.1.1.5.2 ESA broad-band reference limits

B.1.2.5.2.1 If measurements are taken using the method described in [B.5](#), in respect of ESA antenna distance of $(1,0 \pm 0,05)$ m, the radiation reference limit will be (64-54) dB (microvolts/m) within the (30-75) MHz frequency band, this limit decreasing by the frequency logarithm, and (54-65) dB (microvolts/m) in the (75-400) MHz band, this limit increasing by the frequency logarithm.

In the (400-1 000) MHz frequency band the limit remains constant at 65 dB μ V/m (1 800 microvolts/m).

B.1.2.5.2.2 The test limit of the item is 2,0 dB less than the reference limit for measured value expressed in dB (microvolts/m).

B.1.1.6 Requirements concerning narrow-band ESA radiation emission

B.1.1.6.1 Method of measurement

The electromagnetic radiation generated by the ESA submitted for component type-approval is to be measured in accordance with the method described in [B.6](#).

B.1.1.6.2 ESA narrow-band reference limits

B.1.2.6.2.1 If measurements are taken using the method described in [B.6](#), in respect of ESA antenna distance of $(1,0 \pm 0,05)$ m, the radiation reference limit will be (54-44) dB (microvolts/m) in the (30-

75) MHz frequency band, this limit decreasing by the frequency logarithm, and (44-55) dB (microvolts/m) in the (75-400) MHz band, this limit increasing by the frequency logarithm.

In the (400-1 000) MHz frequency band the limit remains constant at 55 dB μ V/m (560 microvolts/m).

B.1.2.6.2.2 The test limit of the item is 2,0 dB less than the reference limit for measured value expressed in dB (microvolts/m).

For conformity of production testing do not remove the 2 dB from the reference limit.

B.1.1.7 Requirements concerning ESA immunity to electromagnetic radiation

B.1.1.7.1 Method of measurement

The immunity to electromagnetic radiation of the ESA submitted for component type approval will be tested by means of one of the methods described in [B.7](#).

B.1.1.7.2 ESA immunity reference limits

B.1.2.7.2.1 If measurements are taken using the methods described in [B.7](#), the immunity test reference levels will be 48 V/m for the 150 mm stripline testing method, 12 V/m for the 800 mm stripline testing method, 60 V/m for the TEM cell testing method, 48 mA for the Bulk Current Injection (BCI) testing method and 24 V/m for the Absorber lined Chamber testing method.

B.1.2.7.2.2 The ESAs representative of the type submitted for testing may not exhibit any malfunction which is able to cause any degradation on the direct control of the vehicle perceptible to the user or other road user if the vehicle is in the state defined in [Figure B.1](#) at a field strength or current expressed in appropriate linear units 25 % above the reference limit.

B.2 Method of measuring broad-band electromagnetic radiation from vehicle

B.2.1 Measuring equipment

A peak detector shall be used to measure broad-band electromagnetic radiation.

Limits given in [B.1.1.2.2.1](#) are for quasi-peak detector. It is possible to use peak detector, in this case a correction factor of 20 dB shall be added to this limit.

NOTE The measuring equipment is described in EN IEC 55012:-1.

B.2.2 Test method

B.2.2.1 General

According to EN IEC 55012:-1.

B.2.2.2 Test conditions

According to EN IEC 55012:-1.

B.2.2.3 State of the vehicle during the test

Apply a load in order to test at 75 % \pm 10 % of the continuous rated power declared by the manufacturer.

NOTE 1 The load can be achieved by braking, home trainer.

NOTE 2 For example, the test can be performed when the engine is running alone or when the user on it using the brake.

B.2.2.4 Antenna type, position and orientation

According to EN IEC 55012:-1.

B.2.3 Measurement

According to EN IEC 55012:-1.

B.3 Method of measuring narrow band electromagnetic radiation from vehicles

B.3.1 General

B.3.1.1 Measuring equipment

An average-value detector is used to measure narrow-band electromagnetic radiation.

NOTE The measuring equipment is described in EN IEC 55012:-1.

B.3.1.2 Test method

According to EN IEC 55012:-1.

B.3.1.3 Test conditions

According to EN IEC 55012:-1.

B.3.1.4 State of the vehicle during the tests

Apply a load in order to test at $75 \% \pm 10 \%$ of the continuous rated power declared by the manufacturer.

NOTE 1 The load can be achieved by braking, home trainer.

NOTE 2 For example, the test can be performed when the engine is running alone or when the user on it using the brake.

B.3.2 Antenna type, position and orientation

According to EN IEC 55012:-1.

B.4 Methods of testing vehicle immunity to electromagnetic radiation

B.4.1 General

These tests are designed to demonstrate the insensitivity of the vehicle to any factor which may alter the quality of its direct control. The vehicle shall be exposed to the electromagnetic fields, described in this Annex, and shall be monitored during the tests.

B.4.2 Expression of results

The field strengths shall be expressed in Volts/m for all the tests described in this Annex.

B.4.3 Test conditions

The test equipment shall be capable of generating the field strengths in the range of frequencies defined in this Annex. The control and monitoring equipment shall not be susceptible to radiation fields whereby the tests could be invalidated.

NOTE National (legal) requirements regarding electromagnetic signal can apply on test equipment.

B.4.4 State of the vehicle during the tests

B.4.4.1 The mass of the vehicle shall be equal to the mass in running order.

- a) The engine shall turn the driving wheels at a constant speed predetermined by the testing authority in agreement with the vehicle manufacturer.
- b) All vehicle systems shall be operating normally.
- c) There shall be no electrical connection between the vehicle and the test surface and no connections between the vehicle and the equipment, save where so required by [B.4.4.1 a\)](#) or [B.4.4.2](#).
- d) The test shall be done in at least one of the following conditions:
 - 1) standstill mode;
 - 2) 90 % of the "start up assistance mode";
 - 3) 90 % of the design maximum assistance speed;
 - 4) contact between the wheels and the test surface is not regarded as an electrical connection.

B.4.4.2 Where ESA's are involved in the direct control of the vehicle and where these systems do not operate under the conditions described in [B.4.4.1 a\)](#), the testing authority may carry out separate tests on the systems in question under conditions agreed with the vehicle manufacturer.

B.4.4.3 During the tests on the vehicle, only non-interference-generating equipment may be used.

B.4.4.4 Under normal conditions, the vehicle shall be facing the antenna.

B.4.5 Type, position and orientation of the field generator

B.4.5.1 Type of field generator

- a) The criterion for the selection of the field generator type is the capacity of the latter to attain the prescribed field strength at the reference point (see [B.4.5.4](#)) and at the appropriate frequencies.
- b) Either the antenna(s) or a transmission line system (TLS) may be used as the field generating device(s).
- c) The design and orientation of the field generator shall be such that the field is polarized either horizontally or vertically at frequencies between 30 MHz and 2 000 MHz.

B.4.5.2 Measurement height and distance

B.4.5.2.1 Height

B.4.5.2.1.1 The phase mid-point of all antennas shall not be less than 1,5 m above the vehicle plane.

B.4.5.2.1.2 No part of the antenna radiator elements shall be less than 0,25 m from the vehicle plane.

B.4.5.2.2 Measuring distance

B.4.5.2.2.1 Greater homogeneity of the field may be obtained by placing the field generator as far as technically possible from the vehicle. This distance will normally be in the range 1 to 5 m.

B.4.5.2.2.2 If the test is carried out in a closed installation, the radiator elements of the field generator shall not be less than 0,5 m from any type of radio frequency absorption material and not less than 1,5 m from the wall of the installation in question. There shall be no absorption material between the transmitting antenna and the vehicle under test.

B.4.5.3 Position of the antenna in relation to the vehicle

B.4.5.3.1 Reference point

B.4.5.3.2 The field generator shall be positioned in the median longitudinal plane of the vehicle.

B.4.5.3.3 No part of the TLS, except the vehicle plane, may be less than 0,5 m from any part of the vehicle.

B.4.5.3.4 Any field generator placed above the vehicle shall cover at least 75 % of the length of the vehicle.

B.4.5.3.5 The reference point is the point at which the field strengths are established and is defined as follows:

- a) horizontally, at least two metres from the antenna phase mid-point or, vertically, at least one metre from the TLS radiator elements;
- b) in the median longitudinal plane of the vehicle;
- c) at a height of $(1,0 \pm 0,05)$ m above the vehicle plane;
or
at $(1,0 \pm 0,2)$ m behind the vertical centre line of the vehicle's front wheel in the case of tricycles;
or
at $(0,2 \pm 0,2)$ m behind the vertical centre line of the vehicle's front wheel in the case of bicycles.

B.4.5.4 Position of the vehicle

If it is chosen to subject the rear part of the vehicle to radiation, the reference point shall be established as stated in [B.5.3](#). In this case the vehicle will be positioned with its front part facing in the opposite direction to the antenna and as if it had been rotated horizontally through 180° about its central point. The distance between the antenna and the nearest part of the outer surface of the vehicle shall remain the same.

B.4.6 Requisite test and condition

B.4.6.1 Range of frequencies, duration of the tests, polarization

The vehicle shall be exposed to electromagnetic radiation in the (20-2 000) MHz frequency range.

- a) Measurement shall be made in the (20 to 2 000) MHz frequency range with frequency steps according to [ISO 11451-1](#), with a dwell time of $(2 \pm 0,2)$ s for each frequency.
- b) The vertical polarization described in [B.4.5.1 c\)](#) shall be selected.

- c) All other test parameters are as defined in this clause.

B.4.6.2 Tests to check deterioration in direct control

B.4.6.2.1 A vehicle is deemed to fulfil the requisite immunity conditions if, during the tests carried out in the manner required by this clause, there are no abnormal changes in the speed of the vehicle's drive wheels, there are no signs of operational deterioration which might mislead other road users and there are no other noticeable phenomena which could result in a deterioration in the direct control of the vehicle.

B.4.6.2.2 For the purpose of monitoring the external part of the vehicle and of determining whether the conditions laid down in [B.4.6.2.1](#) have been met, a video camera may be used.

B.4.6.2.3 If a vehicle does not meet the requirements of the tests defined in [B.4.6.2](#), steps shall be taken to verify that the faults occurred under normal conditions and are not attributable to spurious fields.

B.4.7 Generation of the requisite field strength

B.4.7.1 Test method

- a) The "substitution method" shall be used for the purpose of creating the field test conditions.
- b) Substitution method: for each test frequency required, the RF power level of the field generator shall be set so as to produce the required test field strength at the reference point of the test area without the vehicle being present. This RF input power level, as well as all other relevant settings on the field generator shall be recorded in the test report (calibration curve). The recorded information shall be used for type-approval purposes. Should any alterations be made to the equipment at the test location, the substitution method shall be repeated.
- c) The vehicle is then brought to the test installation and positioned in accordance with the conditions laid down in [B.4.5](#). The power required by [B.4.7.1 b\)](#) is then applied to the field generator for each of the frequencies indicated in [B.4.6.1 a\)](#).
- d) Whatever field-definition parameter is chosen in accordance with the conditions laid down in [B.4.7.1 b\)](#), the same parameter shall be used in order to determine the strength of that field throughout the test.
- e) For the purposes of this test, the same field generating equipment and the same equipment configuration shall be used as in the operations conducted in pursuance of [B.4.7.1 b\)](#).
- f) Field strength measuring device:
 - 1) under the substitution method, the device used to determine the field strength during the calibration stage should take the form either of a compact isotropic probe for measuring field strength or of a calibrated receiving antenna;
 - 2) during the calibration phase of the substitution method, the phase mid-point of the field-strength measuring device shall coincide with the reference point;
 - 3) if a calibrated receiving antenna is used as the field strength measuring device, readings will be obtained in three directions at right angles to each other; the equivalent isotropic value corresponding to these measurements shall be regarded as the field strength.
- g) In order to take account of differences in vehicle geometry, a number of reference points shall be established for the relevant test installation.

B.4.7.2 Field strength contour

During the calibration phase (before the vehicle is positioned on the test surface) the field strength shall not be less than 50 % of the nominal field strength at the following locations:

- a) for all field-generating devices, $(1,0 \pm 0,02)$ m on either side of the reference point on a line passing through this point, and perpendicular to the median longitudinal plane of the vehicle;
 - 1) in the case of a TLS, $(1,5 \pm 0,02)$ m on a line passing through the reference point, and situated in the median longitudinal plane of the vehicle.

B.4.7.3 Characteristics of the test signal to be generated

B.4.7.3.1 Peak value of the modulated test field strength

The peak value of the modulated test field strength shall correspond to that of the unmodulated test field strength, the actual value in volts/m of which is defined in [B.1.1.4.2](#).

B.4.7.3.2 Test signal waveform

The test signal shall be a radio-frequency sinusoidal wave, amplitude-modulated by a sinusoidal 1 kHz wave at a modulation rate m of $0,8 \pm 0,04$ (peak value).

B.4.7.3.3 Modulation rate

The modulation rate m is defined as follows:

$$m \geq \frac{\text{NUM} > \text{peak envelope value} - \text{minimum envelope value}}{\text{DEN} > \text{peak envelope value} + \text{minimum envelope value}}$$

The envelope describes the curve formed by the edges of the modulated carrier as seen on an oscillograph.

B.4.8 Inspection and monitoring equipment

For the purposes of monitoring the external part of the vehicle and the passenger compartment and of determining whether the conditions laid down in [B.4.6.2.2](#) have been met, use will be made of a video camera or cameras.

B.5 Method of measuring broad-band electromagnetic radiation from separate technical units (ESA)

B.5.1 General

B.5.1.1 Measuring equipment

A broad peak detector shall be used to measure broad-band electromagnetic emissions.

NOTE The measuring equipment is described in EN IEC 55012:-1.

B.5.1.2 Test method - Test conditions

According to [EN 55025:2017](#) Absorber lined Chamber.

B.5.2 State of the ESA during the test

According to [EN 55025:2017](#) Absorber lined Chamber.

B.5.3 Antenna type, position and orientation

According to [EN 55025:2017](#) Absorber lined Chamber.

B.6 Method of measuring narrow-band electromagnetic radiation from separate technical units (ESAs)

B.6.1 General

B.6.1.1 Measuring equipment

An average value detector is used to measure the narrow-band electromagnetic radiation.

NOTE The measuring equipment is described in EN IEC 55012:-1.

B.6.1.2 Test method

According to [EN 55025:2017](#) Absorber lined Chamber.

B.6.2 Test conditions

According to [EN 55025:2017](#) Absorber lined Chamber.

B.6.3 State of the ESA during the tests

According to [EN 55025:2017](#) Absorber lined Chamber.

B.6.4 Antenna type, position and orientation

According to [EN 55025:2017](#) Absorber lined Chamber.

B.7 Methods of testing the ESA immunity to electromagnetic radiation

B.7.1 General

These tests are designed to demonstrate the insensitivity of the ESA to any factor which may alter the quality of its direct control. The ESA shall be exposed to the electromagnetic fields, described in [B.7](#), and shall be monitored during the tests.

B.7.2 Expression of results

The field strengths shall be expressed in either in mA (BCI) or in Volts/m for all the other tests described in [B.7](#).

B.7.3 Test conditions

The test equipment shall be capable of generating the current or the field strengths in the range of frequencies defined in this Annex, and shall meet the (national) legal requirements regarding electromagnetic signal. The control and monitoring equipment shall not be susceptible to radiation fields whereby the tests could be invalidated.

B.7.4 State of the ESA during the tests

Where ESA's are involved in the direct control of the vehicle and where these systems do not operate under the conditions described in [B.4.4.1 a\)](#), the testing authority may carry out separate tests on the systems in question under conditions agreed with the vehicle manufacturer.

B.7.5 Requisite test and condition

B.7.5.1 Test methods:

ESAs shall comply with the limits ([B.1.1.7.2](#)) for one of the following test methods, at the manufacturer's discretion, within the range of (20 – 2 000) MHz:

- a) stripline test;
- b) bulk current injection test;
- c) TEM-cell test;
- d) absorber lined chamber, only in vertical polarization.

To avoid radiation from electromagnetic fields during tests, it is recommended to carry them out in a shielded area.

B.7.5.2 Range of frequencies, duration of the tests, polarization:

The vehicle shall be exposed to electromagnetic radiation in the (20-2 000) MHz frequency range.

- a) Measurement shall be made in the 20 to 2000 MHz frequency range with frequency steps according to [ISO 11452-1](#), with a dwell time of $(2 \pm 0,2)$ s for each frequency.
- b) All other test parameters are as defined in this clause.

B.7.5.3 Tests to check deterioration in direct control.

B.7.5.4 A vehicle is deemed to fulfil the requisite immunity conditions if, during the tests carried out in the manner required by this clause, there are no abnormal changes in the speed of the vehicle's drive wheels, there are no signs of operational deterioration which might mislead other road users and there are no other noticeable phenomena which could result in a deterioration in the direct control of the vehicle.

B.7.5.5 For vehicle observation purposes, only the monitoring equipment described in [B.4.6.2.2](#) may be used.

B.7.5.6 If a vehicle does not meet the requirements of the tests defined in [B.4.6.2](#), steps shall be taken to verify that the faults occurred under normal conditions are not attributable to spurious fields.

B.7.6 Generation of the requisite field strength

B.7.6.1 Test method

B.7.6.1.1 Stripline test

According to ISO 11452-5:2002.

B.7.6.1.2 BCI test

According to [ISO 11452-4:2020](#).

B.7.6.1.3 TEM cell test

According to [ISO 11452-3:2016](#).

B.7.6.1.4 Absorber line Chamber test

According to [ISO 11452-2:2019](#).

B.7.6.2 Characteristics of the test signal to be generated

B.7.6.2.1 Peak value of the modulated test field strength

The peak value of the modulated test field strength shall correspond to that of the unmodulated test current or field strength, the actual value in mAmps or in volts/m of which is defined in [B.1.1.7.2](#).

B.7.6.2.2 Test signal waveform

The test signal shall be a radio-frequency sinusoidal wave, amplitude-modulated by a sinusoidal 1 kHz wave at a modulation rate m of $0,8 \pm 0,04$.

B.7.6.2.3 Modulation rate

The modulation rate m is defined as follows:

$$m \geq \frac{\text{NUM} > \text{peak envelope value} - \text{minimum envelope value}}{\text{DEN} > \text{peak envelope value} + \text{minimum envelope value}}$$

The envelope describes the curve formed by the edges of the modulated carrier as seen on an oscillograph.

B.7.7 Inspection and monitoring equipment

For the purposes of monitoring the external part of the vehicle and the passenger compartment and of determining whether the conditions laid down in [B.4.6.2.2](#) have been met, use will be made of a video camera or cameras.

B.8 ESD test

ESD test shall be performed according to EN 61000-4-2:2009 at 4 kV for contact discharge and 8 kV for air discharge with immunity criteria B.

Annex C
(informative)

Example of recommendation for battery charging

Safety and quality of battery charging can be significantly improved by detecting the battery temperature during charging.

Most battery charger manufacturers set their chargers to have an optimum ambient temperature of 20 °C to 25 °C. Lower temperatures result in under charge, and higher temperatures result in overcharge.

Whilst it is normal when building battery packs from Ni-Cad, Ni-Mh and Li-ion battery cells, to include temperature sensors, this is not always the case with valve regulated lead acid (VRLA) batteries.

The main reason justifying the introduction of a temperature sensor on VRLA batteries is to protect against one or more cells within the battery pack becoming short circuited. This reduces the terminal voltage and if applicable allows the charger to supply more power than is required, which can lead to dangerous temperatures.

Temperature sensors should be positioned on each battery of the pack and this information should be sent back to the battery charger.

Positive temperature coefficient thermistors should be used. All thermistors should be connected in series between the charger's temperature detection terminal (T) and the battery's negative terminal (-). If a battery or cell of the pack reaches the temperature indicated by the battery manufacturer (for example, 60 °C, 70 °C, etc.), the charger's temperature detection circuit should be adjusted in order to detect this condition and take necessary measures to stop any subsequent increase in temperature.

Annex D (informative)

Rationale

D.1 Introduction

This informative annex has been included with the purpose of providing the rationales for the inclusion of some of the requirements given in this standard.

Where appropriate, relevant clause numbers in the standard are given in this annex and the relevant reference for the annex is given in the normative part of the standard.

D.2 Scope

As this standard is developed under the umbrella of the European Directive n°2006/42/EC, experts had to deal with strong safety requirements coming more or less from the industry. The Machinery Directive had to be analysed and interpreted to take into consideration the use of PLEV by the public and not professional and trained workers.

At the origin, vehicles were designed by manufacturers to be used by adults, but experts noted the evolution of the age range of users. The approach through the risk assessment proposed in standard EN ISO 12100:2010 is rather oriented to an industrial usage and the challenge consisted to adapt the requirements to a domestic panel.

So, the risk assessment covering risks for children use is taken into account in this standard. That's why, many requirements of the present document are coming from other European standards dedicated to children products (e.g. EN 1888 series on strollers, [EN 14619:2019](#) on kick scooters).

According to this approach and considering that this standard does not deal with ergonomic issues, manufacturers decided to inform consumers on the age range (possibility to introduce children users) for which the vehicle is designed.

D.3 Power limits

The fitment of a pedestrian mode has been required in order to ride between pedestrians.

Self-balancing vehicles need at any moment have enough power to control the balance of the vehicle. Limiting the power of a self-balancing vehicle risk the inability to find the balance at any moment.

Non self-balancing vehicles are intended to be used for the last mile and need to be portable so they can be carried while the voyage continues in other transport modes. The portability limits the mass and the size of the batteries and the motor and thus the power. It is estimated that in the timeframe of the next revision this situation will not change.

For the reasons given no power limit is required.

D.4 Thermal hazards

Contact with hot surfaces may cause burns.

D.5 Protective function

Experts will be invited to consider the mandatory or recommended use of protective clothes, especially for vehicle 2 and 4.

D.6 Entrapment hazards

The requirements are intended to address the hazard associated with a finger getting trapped in an opening which might stop the circulation of blood

Reducing the dimensions and the depth of free openings and gaps may avoid any hazard. The shape is also to be considered for assessment of the risk: a bounded circular shape will cause reduction of blood circulation.

D.7 Hazards due to moving parts

Hazards from moving parts are related to products and rigid parts of products that move in use. A finger may be crushed, cut or even severed if the fingers become trapped between parts of a product that move.

Compression points may exist if one component can move relative to another part reducing the distance between the components. This risk is more severe if parts move under loads such as body weight, component weight or the application of powered mechanisms.

Shearing hazards occurs when two parts move relative to each other and act like scissors. This risk is more severe if parts move under loads such as body weight, component weight or the application of powered mechanisms.

D.8 Hazardous edges, corners and protruding parts

Sharp edges and protrusions on the product could cause cuts, lacerations or abrasions to skin. Sharp points could puncture a skin or eye.

D.9 Hazards from inadequate structural integrity

Any major failure of the structure of the product could cause harm to the user, and might cause major injuries.

Static strength requirements and endurance requirements for the attachment devices have been included.

D.10 Hazards due to inadequate stability

Requirements and test methods have been included to ensure an adequate stability is provided for all class of vehicle.

This section deal in particular with braking performance to cover any risk of crash.

D.11 EMC requirements

D.11.1 General

First, there are two types of EMC tests – Emissions and Immunity (and all the tests listed below are common tests required for virtually ALL electronic products to be sold within the EU and elsewhere around the world):

- Emissions – refers to signals generated by or altered by the product being tested, which means these EMC phenomena are being measured, and the values shall fall within certain standard limits.
- Immunity – refers to signals be transmitted (through air) or conducted (through wire) at the product being tested to see how well it is Immune to undesirable operation when under the influence of these potentially harmful (as far as hampering the operation of the product, or causing it to malfunction or operate outside of the operation that the user is commanding at that moment in time) signals.

D.11.2 Riding mode

- There are 3 EMC phenomena which can be experienced during the Riding Mode (because they travel through air) on a vehicle – they are -
- Electrostatic Discharge (ESD) - the common “static shock”, we all receive occasionally - especially in the dry winter months;
- Radiated Field – a radio signal (intentionally generated – or could also be “radio static, or radio noise”) from any type of transmitter – such as a cell phone and cell towers, television and radio broadcast signals, a cordless telephone, Wi-Fi or Bluetooth – as well as interference caused by motors (vacuum cleaners or power drills, for instance);
- Magnetic Fields – which are generated by any wire carrying electrical current, but which may be particularly present around electrical power-transformers (which may be located in closets, ceilings, sub-floors, etc.) and such devices, and which may also be particularly strong in subway/rail stations.

D.11.3 Charging mode

- During Charging Mode – the 3 phenomena above are still also possible, and there are these 4 other added EMC phenomena which can be transmitted down the power line from other devices on the same circuit. These phenomena include -
- Electrical Fast-Transient Bursts – such as generated by repetitive machinery;
- Surge – such as generated by turning on or off other equipment;
- Conducted radio signals – such as radio noise either coupled to the power lines trough air or as generated inside another product and transmitted down its’ power card to the distribution line;
- Voltage Dips/Sags, Short Interruptions, or similar variations – such as from power station switching, voltage demand on the same line, heavy circuit loading, etc.

D.11.4 Both riding and charging modes

- Radiated Emissions - during either Riding Mode or Charging Mode – the vehicle is not allowed to emit radio-waves which may be of sufficient value to disrupt or interfere with valid radio transmission – such as television and radio broadcasts, cell phones, Wi-Fi, and police, fire, ambulance, aircraft, and marine radios (to name a few). In this test, an antenna is used to detect the unwanted radio signals which may be generated by the vehicle in its’ various operating conditions. Class B Emissions are the more stringent, such as for residential, commercial, medical, and light-industrial environments use – where probably most vehicle may be used; Class A Emissions are reserved for heavy-industrial environments only.

D.11.5 Additional EMC (Emissions) requirements

- Conducted Emissions – this is simply the amount of radio-noise any product transmits down its' own power cord, which could affect other products, and therefore shall be measured and regulated.
- Flicker – Flicker is just as it sound, when your old furnace or washing machine demands more power you may see your lights flicker as a result. Because this can affect other items on the power distribution line – it shall be limited, and tests are performed to ensure all products comply.
- Harmonics – Harmonics are more difficult to explain to the non-Electrical Engineer, but are essentially a disruption which may be transmitted in large or small doses to the power distribution system, which among other things can unduly increase the demand on that power generator (especially when combined with many other products also behaving badly in this regard) – thus, they shall be regulated for all products.

D.11.6 Criteria for failure

- There are different schools of thought for setting failure criteria limits, when trying to write a standard for a wide range of vehicle types and uses, and for the range of functions of those vehicles.
- One set of test limits (severity of phenomena) was set here, with different failure criteria for Self-Balancing vehicles features, where such operations may be more critical to user safety.
- Another way to do it would consist in setting different test severity levels for the different types or uses of vehicles; or even for vehicle functions of different criticality.

D.11.7 Immunity to specific radio technologies operating at frequencies of 800 MHz and above

Wireless communication devices are considered to be the most significant sources of interference for MME in the range 800 MHz to 5 GHz. Consequently testing is only required at relevant spot frequencies.

Immunity is assumed to be ensured for a whole band of any wireless technology, or even for a neighbouring band, when testing at one frequency only within that band.

The expected field strengths in V/m radiated by the sources considered above at distances of 3 m, 1,5 m and 1 m were calculated using the formula:

$$Erms = k \times \sqrt{P} / R$$

where

- Erms* is the field strength (V/m);
K = 7 (a constant for free-space propagation in the far field);
P is the radiated power (W);
R is the distance from the source (m).

Also for distances at 0,5 m and 0,2 m using the formula:

$$Erms = \sqrt{30 \times P \times G} / R$$

where

- Erms* is the field strength (V/m);
P is the radiated power (W);
R is the distance from the source (m);
G is the gain, G = 1,5 at 800 MHz and 900 MHz and G = 3 at 1,8 GHz to 5,0 GHz.

The above 'calculated' field strength corresponds to the rms value of field strength of the RF test signal that is subsequently 80 % AM modulated by a 1 kHz sine wave. The test levels specified in the basic standards are for unmodulated signals. The values given in [Table D.1](#) are based upon the formulas given above and corrected to align with EN 61000-4-3 as presented in [Table 1](#).

Most GSM terminals have a nominal maximum ERP of 2 W. The ERP of GSM terminals is often lower than the maximum, except in areas where the terminal is far away from the base station. However a worst case value of 2 W has been used in [Table D.1](#).

The test at 1,8 GHz is considered sufficient to also cover the 2,1 GHz frequency band and the test at 2,6 GHz sufficient to cover the 2,4 GHz to 2,6 GHz band.

Regarding the 2,4 GHz band, there are new technologies (for example, WiMAX) enabling > 1 W transmit power and therefore this band has been chosen for test frequency instead of the 2,4 GHz band.

[Table D.1](#) provides informative guidance for manufacturers on the expected field strengths at various distances from wireless communication devices.

Table D.1 — Guidance on the selection of immunity levels to common wireless communication devices

Approximate protection distance (m)	Calculated RF field strength in V/m for frequencies and protection distances simulating different radio transmission types, assuming a given ERP						
	LTE/UMTS (0,2 W)	GSM 2 W	GSM 1W	WiMAX/3G (1,26 W)	WiMAX (1,26 W)	Wi-Fi (1 W)	Maximum RF field Strength at any frequency
	800 MHz	900 MHz	1,8 GHz	2,6 GHz	3,5 GHz	5 GHz	
3	0,6	1,8	1,3	1,5	1,5	1,3	3
1,5	1,2	3,7	2,6	2,9	2,9	2,6	4
1	1,7	5,5	3,9	4,4	4,4	3,9	6
0,5	3,3	10,5	10,5	11,8	11,8	10,5	12
0,2	8,3	26,4	26,4	29,6	29,6	26,4	30

The protection distance is not the test distance as defined in EN 61000-4-3, but the shortest expected operating distance between the EUT and the interfering wireless communication device

D.12 Driving power management

Up to 60 % and not 100 % is, because you will experience the highest acceleration normally at the beginning. Probably 50 % is even a bit high to find out if it is really a problematic acceleration. Maybe 30 % would be better

Starting from a 'rolling' position in order to avoid variances due to kicking-off the ground to start for partially electrically powered vehicle.

D.13 Vibration hazard

Vibration is not considered to be a significant hazard for these vehicles' users and a test method is not given (according to European Directive n°2002-44 of 2002-06-25). Vibration coming from power driving system are not significant (compare to e.g. non-motorized kick scooters). By design, vehicle have electric motor(s) and not a combustion engine, excentric moving masses are absent and thus there are no vibration generated by the motor(s). This does not mean that the manufacturer of the vehicle is absolved from reducing vibration.

D.14 Lightning

As we are in presence of urban vehicles (or indoor), the most important safety requirement is not to see during the night use (or tunnels) but be seen from other traffic users.

D.15 Noise

Noise is not considered to be a significant hazard for these vehicles' users and a test method is not given (according to European Directive n° 2006/42/EC). No test values are available when drafting this standard. However, only the user of the vehicle is considered by this measurement. Actually, the vehicles on the market are far away of the limit of 70 dB(A).

D.16 Unintended and unauthorized use

The user of the vehicle (authorized to use it) could, during use, make a wrong action inadvertently (e.g. action on the folding mechanism). For this situation, the manufacturer could introduce a device or a combination of two actions to avoid this risk.

Before use, the manufacturer provides a system to start the vehicle to avoid non authorized persons to use it (e.g. children).

D.17 Driving power management

Switching off the power at any time during use, on self-balanced vehicles or vehicles with electric brake, introduce new increased risk.

Emergency stop cannot be used for these kind of vehicles.

Reference to the relevant paragraph of the Machinery Directive:

“1.2.4.3. Emergency stop machinery in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken,”

Annex E
(informative)

Examples of vehicles

- a) example of 2-wheeled
b) example of self-balancing
c) examples of 3-wheeled (one front wheel) and 3-wheeled (one rear wheel)
d) examples of mono-wheel and self-balancing

Key

- 1 Grip
2 Brake lever
3 Accelerator
4 Control/display interfaces
5 Handlebar
6 Electric and/or brake cable
7 Handlebar height adjustment locking system
8 Steering column
9 Head tube
10 Front fork
11 Wheel
12 Frame or Structure
13 Deck
14 Rear fork
15 Main braking assembly
16 Motor
17 Transmission
18 Battery
19 Scooter folding system
20 Stabilizers
21 Handle for transportation
22 Mudguard
23 Knee-high stick

<http://www.china-gauges.com/>



Annex F
(normative)

Light, warning device, on-off symbols

Figures F.1 to F.3 give the symbol to be used for light, warning device and on-off symbols.

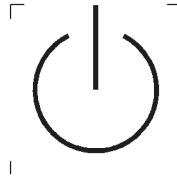


Figure F.1 — Power On/Off symbol



Figure F.2 — Light symbol



Figure F.3 — Electric horn symbol

<http://www.china-gauges.com/>

Annex G
(informative)

Types of parking devices

Table G.1 — Types of vehicles

	Single track/ single axis	Single track/ two axis	Multitrack/ single axis	Multitrack/ single axis	Multitrack/ inde- pendent axis
Category	Self-balanced oneWheel	eKickscooter	Self-balanced (Balanceboard)	Self-balanced Standup roler (e.g. Segway)	Fun mover with one front wheel and two wheels on the back (e.g Trikke)
Introduction on motor	Drive, balancing and brake power is done by the motor(s)	The motor can be fitted to the front/ rear or both axles	Drive, balanc- ing and brake power is done by the motor(s)	Drive, balancing and brake power is done by the mo- tor(s)	The motor can be fit- ted to the front/ rear or both axles
Introduction on brake	Done by switch- ing the motor to generator mode to brake.	Can be done electric only or mixed with me- chanical brake of all flavours	Done by switch- ing the motor to generator mode to brake.	Done by switch- ing the motor to generator mode to brake.	Can be done electric only or mixed with mechanical brake of all flavours
Brake	Electric only/ gyro based actu- ated	Electric only/ throttle based Or Mechanical (manual drum/ disk/ rim) Or Mechanical (hydraulic drum/ disk/ rim) Or Combined front/ rear sep- arated electric/ mechanical Or Combined elec- tric/ mechan- ical on one or two wheels	Electric only/ gyro based actuated	Electric only/ gyro based actuated	Electric only/ throt- tle based Or Mechanical (manual drum/ disk/ rim) Or Mechanical (hydrau- lic drum/ disk/ rim) Or Combined front/ rear separated electric/ mechanical Or Combined electric/ mechanical on one or two wheels
Parking de- vice	optional	optional	optional	yes	yes

Table G.2 — Flavours of brakes

Brakes technology	Disk brake	Drum brake	Rim Brake	mudguard wheel brake	electric brake
Definition	A disk brake is state of the art at vehicles. The brake pad is pushed against the disk brake by manual actuator or hydraulic actuator. The disk brake could have holes/ grooves for better cooling/ better wet braking.	A drum brake is a cheap way for brake systems at vehicles. The brake shoe is pushed against the drum by manual actuator or hydraulic actuator. Brake wear/ adjusting can be done through a service hole.	A rim brake is typically used at bicycles but can be used in other occasions also. A brake arm/ brake calliper pushes a brake pad/ brake shoe against the rim.	The mudguard is a movable part and can be pushed on the wheel to brake it with the friction between mudguard/ wheel.	An electric brake consists of magnets and electric powered/ pulsed coils. They are inside the hub of a wheel and often based on the motor, which operates as a generator /recuperation/ braking) or drive unit depending on the mode selected.
Park brake function	Optional	Optional	No	No	No
Open/ closed to environment	Open	Open	Open	Open	Closed/ sealed
Dry test	Yes	Yes	Yes	Yes	Yes
Wet test (water nozzle)	Yes	Yes	Yes	Yes	No
Temperature difference/ friction	Yes	Yes	Yes	Yes	No

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