



BSI Standards Publication

Cycles — Electrically power assisted cycles — EPAC Bicycles

National foreword

This British Standard is the UK implementation of EN 15194:2017+A1:2023. It supersedes BS EN 15194:2017, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GME/25, Cycles.

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English Version

Cycles - Electrically power assisted cycles - EPAC Bicycles

Cycles - Cycles à assistance électrique - Bicyclettes
EPAC

Fahrräder - Elektromotorisch unterstützte Räder -
EPAC

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European foreword

This document (EN 15194:2017+A1:2023) has been prepared by Technical Committee CEN/TC 333 “Cycles”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2024, and conflicting national standards shall be withdrawn at the latest by August 2025.

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 supersedes A1 EN 15194:2017 A1.

A1 EN 15194:2017+A1:2023 includes the following significant technical changes with respect to EN 15194:2017:

- 4.2.3 “Batteries”: reference to EN standard applicable to batteries of EPAC has been updated with the new latest edition, in line with specific request of National Authority to reinforce Machinery directive requirements,
- Annex A “Example of recommendation for battery charging” has been removed. A1

This document includes Amendment 1 approved by CEN on 22 August 2022.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

A1 This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document. A1

This standard also includes all mechanic requirements applicable to the EPACs and is therefore a stand-alone document.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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, Türkiye and the United Kingdom.

Introduction

This European Standard gives requirements for electrically power assisted cycles (EPAC).

This European Standard has been developed in response to demand throughout Europe. Its aim is to provide a standard for the assessment of electrically powered cycles of a type which are excluded from type approval by Regulation (EU) No 168/2013.

Due to the limitation of the voltage to 48 V d.c., there are no special requirements applicable to the EPAC in regard to protection against electrical hazards.

Following the completion of a risk analysis, the focus in this standard is on EPAC as bicycles for city and trekking. Folding bicycles are included.

This document is a type C standard as stated in EN ISO 12100. The machinery concerned and the extent to which hazards, hazardous situations and hazardous events covered are indicated in the scope of this document.

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

In real life situation an EPAC can fall over to the side causing the battery holder to break without damage to the battery case itself. While the standard contains a strength test for the battery an additional test is required for the situation described. This will be considered at the next revision. The battery holder needs to withstand this realistic and typical situation. Risk assessment carried out by the manufacturer should identify suitable measures to deal with this situation until it can be dealt with in the standard.

1 Scope

This European Standard applies to EPAC bicycles for private and commercial use with exception of EPAC intended for hire from unattended station.

This European Standard is intended to cover all common significant hazards, hazardous situations and events (see Clause 4) of electrically power assisted bicycles, when used as intended and under condition of misuse that are reasonably foreseeable by the manufacturer.

This European Standard is intended to cover electrically power assisted bicycles of a type which have a maximum continuous rated power of 0,25 kW, of which the output is progressively reduced and finally cut off as the EPAC reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.

This European Standard specifies requirements and test methods for engine power management systems, electrical circuits including the charging system for the design and assembly of electrically power assisted bicycles and sub-assemblies for systems having a rated voltage up to and including 48 V d.c. or integrated battery charger with a nominal 230 V a.c. input.

This European Standard specifies safety and safety related performance requirements for the design, assembly, and testing of EPAC bicycles and subassemblies intended for use on public roads, and lays down guidelines for instructions on the use and care of such bicycles.

This European Standard applies to EPAC bicycles that have a maximum saddle height of 635 mm or more and that are intended for use on public roads.

This European Standard is not applicable to EPACs which are manufactured before the date of its publication as EN.

2 Normative references

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

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

Ⓐ EN 50604-1:2016, *Secondary lithium batteries for light EV (electric vehicle) applications – Part 1: General safety requirements and test methods*

EN 50604-1:2016/A1:2021, *Secondary lithium batteries for light EV (electric vehicle) applications – Part 1: General safety requirements and test methods* Ⓐ

EN 55012:2007, *Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of on-board receivers (CISPR 12:2007)*

Ⓐ EN IEC 55016-1-1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-1: Radio disturbance and immunity measuring apparatus — Measuring apparatus (CISPR 16-1-1:2019)* Ⓐ

Ⓐ 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 25:2016)* Ⓐ

EN 60034-1:2010, *Rotating electrical machines — Part 1: Rating and performance (IEC 60034-1:2010, modified)*

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

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

HD 60364-5-52:2011, *Low-voltage electrical installations — Part 5-52: Selection and erection of electrical equipment — Wiring systems (IEC 60364-5-52:2009, modified)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 61000-4-2:2009, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test (IEC 61000-4-2:2008)*

■_{A1} EN ISO 7010:2020, *Graphical symbols — Safety colours and safety signs — Registered safety signs (ISO 7010:2019)* A1

EN ISO 11243:2016, *Cycles — Luggage carriers for bicycles — Requirements and test methods (ISO 11243:2016)*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

■_{A1} EN ISO 13849-2:2012, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation (ISO 13849-2:2012)* A1

ISO 5775-1:2014, *Bicycle tyres and rims — Part 1: Tyre designations and dimensions*

■_{A1} ISO 5775-2:2021, *Bicycle tyres and rims — Part 2: Rims* A1

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 9633:2001, *Cycle chains — Characteristics and test methods*

ISO 11451-1:2015, *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*

■_{A1} ISO 11452-2:2019, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 2: Absorber-lined shielded enclosure* A1

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

■_{A1} ISO 11452-4:2020, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 4: Harness excitation methods* A1

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.

3.1

cycle

vehicle that has at least two wheels and is propelled solely or mainly by the muscular energy of the person on that vehicle, in particular by means of pedals

3.2

bicycle

two-wheeled vehicle that is propelled solely or mainly by the muscular energy of the person on that vehicle, in particular by means of pedals

3.3

electrically power assisted cycle

EPAC

cycle, equipped with pedals and an auxiliary electric motor, which cannot be propelled exclusively by means of this auxiliary electric motor, except in the start-up assistance mode

3.4

city and trekking bicycle

bicycle designed for use on public roads primarily for means of transportation or leisure

3.5

mountain-bicycle

bicycle designed for use off-road on rough terrain, on public roads and on public pathways equipped with a suitably strengthened frame and other components, and, typically, with wide-section tyres with coarse tread patterns and a wide range of transmission gears

3.6

racinq-bicycle

bicycle intended for high-speed amateur use on public roads having a steering assembly with multiple grip positions allowing for an aerodynamic posture, a multi-speed transmission system, tyre width not greater than 28 mm, and a maximum mass of 12 kg for the fully assembled bicycle

3.7

recumbent bicycle

bicycle that places the rider in a laid-back reclining position

3.8

young adult bicycle

bicycle designed for use on public roads by a young adult whose weight is less than 40 kg with maximum saddle height of 635 mm or more and less than 750 mm

3.9

fully assembled bicycle

bicycle fitted with all the components necessary for its intended use

3.10**folding bicycle**

bicycle designed to fold into a compact form, facilitating transport and storage

3.11**bar-end**

extension secured to the end of a handlebar to provide an additional hand-grip and usually with its axis perpendicular to the axis of the end of the handlebar

3.12**brake-lever**

lever that operates a braking device

3.13**disc-brake**

brake in which pads are used to grip the lateral faces of a thin disc attached to or incorporated in the wheel-hub

3.14**braking distance**

distance travelled by a bicycle between the commencement of braking (3.16) and the point at which the bicycle comes to rest

3.15**braking force**

F_{Br}

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

3.16**commencement of braking**

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

Note 1 to entry: On the test track, this point is determined by the first brake-actuating device (front or rear) to operate.

3.17**brake-lever cut-off switch**

device that cuts off the motor assistance while using the brake lever

3.18**composite materials**

component that is entirely or partially made of a non-metallic matrix materials which is reinforced by metallic or non-metallic materials such as short or long fibres, fabric or particles

3.19**composite wheels**

wheel assembly containing any composite material

3.20

continuous rated power

output power specified by manufacturer, at which the motor reaches its thermal equilibrium at given ambient conditions

3.21

thermal equilibrium

temperatures of motor parts which do not vary more than 2K per h

3.22

crank assembly

assembly for fatigue testing consisting of the drive side and the non-drive side crank arm, the pedal spindle-adaptors, the bottom-bracket spindle, and the first component of the drive system

EXAMPLE The chain-wheel set.

3.23

cut off speed

speed reached, by the EPAC, at the moment the current has dropped to zero or to the no load current value

3.24

drive belt

seamless ring belt which is used as a means of transmitting motive force

3.25

dummy fork

test fork manufactured to specific characteristics that can be substituted within a test for either the fork supplied by the manufacturer or where a fork has not been supplied

3.26

electromagnetic compatibility

ability of an EPAC or one of its electrical/electronic systems to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment

3.27

electromagnetic disturbance

electromagnetic phenomenon such as electromagnetic noise, an unwanted signal or a change in the propagation medium itself which may degrade the performance of an EPAC or one of its electronic/electrical systems

3.28

electromagnetic environment

all electromagnetic phenomena present in a given situation

3.29

electromagnetic immunity

ability of an EPAC or one of its electronic/electrical systems to perform without degradation of its performance in the presence of specific electromagnetic disturbance

3.30**electronic/electrical subassembly****ESA**

electronic and/or electrical component, or an assembly of components provided for installation into an EPAC, together with all electrical connections and associated wiring for the execution of several specific functions

3.31**ESA test**

test carried out on one or more specific ESAs

3.32**ESA type in relation to electromagnetic compatibility**

separate technical ESA unit that does not differ from other units in its essential design and construction aspects

Note 1 to entry: For example:

- the function performed by the ESA;
- the general layout of the electronic and/or electrical components;
- direct vehicle control performed by the rider acting on the steering, the brakes and the accelerator control.

3.33**exposed protrusion**

protrusion which through its location and rigidity could present a hazard to the rider either through heavy contact with it in normal use or should the rider fall onto it in an accident

3.34**fork steerer****fork stem**

part of a fork that rotates about the steering axis of a bicycle frame head tube

Note1 to entry: It is normally connected to the fork crown or directly to the fork legs, and is normally the point of connection between the fork and the handlebar stem.

3.35**fracture**

unintentional separation into two or more parts

3.36**full discharge of the battery**

point at which the battery does not deliver any power/energy to the motor, according to the battery manufacturer's specifications

Note1 to entry: It is recommended that the battery cells be never fully discharged and residual current of battery be used by other devices.

3.37**highest gear**

gear ratio which gives the greatest distance travelled for one rotation of the cranks

3.38

hub-brake

brake which acts directly on the wheel-hub

3.39

hub-generator

electric generating device built in the wheel-hub

3.40

integrated charger

charger which is a part of the bicycle and needs tools to be disassembled from it

3.41

electrical control system

electronic and/or electrical component, or an assembly of components provided for installation into a vehicle, together with all electrical connections and associated wiring for the engine electrical power assistance

3.42

lowest gear

gear ratio which gives the shortest distance travelled for one rotation of the cranks

3.43

maximum inflation pressure

maximum tyre pressure recommended by the tyre or rim manufacturer for a safe and efficient performance

Note 1 to entry: If the rim and tyre both indicate a maximum inflation pressure, the maximum inflation pressure is the lowest of the two pressures indicated.

3.44

maximum saddle height

vertical distance from the ground to the point where the top of the seat surface is intersected by the seat-post axis, measured with the seat in a horizontal position and with the seat-post set to the minimum insertion-depth mark

3.45

maximum assisted speed by design

maximum designed speed up to which assistance is provided

3.46

minimum insertion-depth mark

mark indicating the minimum insertion-depth of handlebar stem into fork steerer (fork stem) or seat-post into frame

3.47

narrow-band emission

emission which has a bandwidth less than that of a specific receiver or measuring instrument

3.48

no load current point

current for which there is no torque on the driving wheel

3.49**off-road rough-terrain**

coarse pebble tracks, forest trails, and other general off-road tracks where tree-roots and rocks are likely to be encountered

3.50**pedal tread-surface**

surface of a pedal that is presented to the underside of the foot

3.51**primary retention system**

system that keeps the front/rear wheel securely attached to the frame/fork dropouts whilst riding

3.52**public road**

any designated and adopted road, pavement, path or track on which a bicycle is legally permitted to travel and on most though not all such public roads, bicycles will share use with other forms of transport including motorized traffic

3.53**pulley**

rotating wheel mounted on an axle, that contains around its circumference teeth or groove over which a belt can pass to transmit power

3.54**quick-release device**

lever actuated mechanism that connects, retains, or secures a wheel or any other component

3.55**quick-release pedal****quick-release device**

pedal that contains a device for the attachment of a rider's foot/shoe that can be released by foot-movement alone

3.56**rated voltage**

voltage declared by the manufacturer of the bicycle

3.57**reference antenna**

balanced half-wave dipole tuned to the measured frequency

3.58**reference limit**

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

3.59**rim-brake**

brake in which brake-shoes act on the rim of the wheel

3.60

screw thread locking devices

devices attached or applied to the threads of a nut or bolt so that they do not unintentionally become unlocked

EXAMPLE Lock washers, lock nuts, thread locking compound, or stiff nuts.

3.61

seat-post

component that clamps the saddle (with a bolt or assembly) and connects it with the frame

3.62

secondary retention system

system that retains the front wheel in the fork dropouts when the primary retention system is in the open (unlocked) position

3.63

suspension-fork

front fork incorporating controlled, axial flexibility to reduce the transmission of road-shocks to the rider

3.64

suspension-frame

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

3.65

toe-clip

device attached to the pedal to grip the toe end of the rider's shoe but permitting withdrawal of the shoe

3.66

visible crack

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

3.67

wheel

assembly or combination of hub, spokes or disc, and rim, but excluding tyre assembly

3.68

wheelbase

distance between the axes of the front and rear wheels of an unladen bicycle

3.69

unattended station

hire location that is not supervised by personal

3.70

simulated ground plane

plane used to orient a test part or assembly in a way that represents the cycles alignment to the ground in a fully assembled cycle

3.71**bolted joint**

components joined together with threaded fastener

3.72**anti-tampering measures**

technical requirements and specifications which prevent, as far as possible, unauthorized modifications of the EPAC's drive system which may prejudice functional safety

3.73**maximum performance**

combination of cut-off speed (3.23), maximum assisted speed by design (3.45) and continuous rated power (3.20)

3.74**motor unit**

motor, gearing if integrated and control unit

3.75**aerodynamic extension**

extension (or extensions) secured to the handlebar or stem, to improve the rider's aerodynamic posture

3.76**maximum permissible total weight**

weight of the fully assembled EPAC plus rider and luggage as defined by the manufacturer

4 Safety requirements and/or protective measures**4.1 General**

EPAC shall be designed according to the principles of  EN ISO 12100:2010  for relevant but not significant hazards, which are not dealt with by this document. It includes evaluation of such risks for all relevant components.

Means shall be provided to the user to prevent an unauthorized use of the EPAC e.g. key, locks, electronic control device.

4.2 Electrical requirements**4.2.1 Electric circuit**

The electrical control system shall be designed so that, should it malfunction in a hazardous manner, it shall switch off power to the electric motor without causing a hazardous situation and it requires user interaction to switch on again.

NOTE The mechanical brakes serve as an emergency stop device and provide fast and safe stopping in emergency situations.

4.2.2 Controls and symbols

If symbols are used, their meaning shall be described in the instructions for use. "On" "Off" symbols, lightings symbols, start-up assistance symbols, audible warning device symbols design shall be in accordance with those described in  Annex H and Annex I .

A master control device shall be fitted to switch on and shut off the assistance, which shall be apparent, easy to reach and unmistakable.

This master control device shall be activated by voluntary action to enable all assistance modes (start up and pedalling) before use of the EPAC.

4.2.3 Batteries

A1 The battery shall comply with EN 50604-1:2016 and EN 50604-1:2016/A1:2021.

At the moment of the publication of this standard, EN 50604-1 is only applicable for secondary lithium batteries, and only risks related to these batteries were taken into account. **A1**

4.2.4 Battery charger

Chargers for EPAC are considered to be operated in a residential (household) environment.

NOTE 1 For integrated battery charger with a 230V a.c. input the charger and the EPAC and for external battery charger supplied with an EPAC the requirements of the Low Voltage Directive are applicable.

NOTE 2 For external chargers with d.c. output less than 42,4 Volt, e.g. **A1** EN 60335-2-29:2021/A1:2021 **A1** is applicable.

4.2.5 Electric cables and connections

4.2.5.1 General

All connectors for cable and wire shall be selected to prevent corrosion of electrical contact conductance.

4.2.5.2 Requirements

Cable and plug temperature shall be lower than that specified by the manufacturer of the cables and plugs. Damage to cable and plug insulation shall be prevented.

The cable cross sections shall be selected in accordance to EN 60335-1:2012, Table 11. If these requirements are not met, a temperature rise test shall be performed, in accordance to 4.2.5.3.

NOTE Cables used exclusively for communication lines are excluded.

4.2.5.3 Test method

At an ambient room temperature $(20 \pm 5) ^\circ\text{C}$, discharge the fully charged EPAC battery to the discharging limit specified by the EPAC or ESA manufacturer at the maximum current allowable by the system and record it. Measure the cable and plug temperatures and ensure, by examination, that there is no deterioration of the insulation on either assembly.

The increase of outer surface temperature of parts that can be touched shall be $\leq 60 \text{ K}$ while in use on performance test rig.

4.2.6 Wiring

Requirements on wiring shall be checked according to the following sequence at an ambient room temperature $(20 \pm 5) ^\circ\text{C}$.

- a) Wire ways shall be smooth and free from sharp edges.
- b) 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.
- c) Wiring shall be effectively prevented from coming into contact with moving parts.

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

- d) Separate parts of the EPAC 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 ground 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 d) shall be checked by inspection and by the following test method.

If flexing occurs in normal use, the appliance is placed in its normal operational position and is supplied at rated voltage under normal operation.

The movable part is moved backwards and forwards through the largest angle permitted by its construction, so that the conductor is flexed.

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.

4.2.7 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.

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

The insulation of internal wiring shall withstand the electrical stress likely to occur in normal use.

The wiring and its connections shall withstand the electrical strength test. The test voltage expressed in V shall be equal to $(500 + 2 \times U_r)$ for 2 min and applied between live parts and other metal parts only.

NOTE U_r is the rated voltage.

4.2.8 External and internal electrical connections

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

4.2.9 Moisture resistance

The electrical components of a fully assembled EPAC shall be tested and shall comply with IPX4 requirements according to EN 60529:1991.

4.2.10 Mechanical strength test

The electrical components including the battery shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in normal use. Compliance is checked by:

- Applying impacts to the battery pack mounted on the EPAC by means of the spring hammer as specified in [\[A1\]](#) EN 60068-2-75:2014 [\[A1\]](#). The battery pack 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. After the test the battery pack shall show no damage that could impair compliance with this European Standard;
- Detachable batteries are submitted to free fall on a rigid surface as specified in [\[A1\]](#) EN 22248:1992 [\[A1\]](#) 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 is likely to be weak.

After the test the battery pack shall show no damage that could lead to emission of dangerous substances (gas or liquid) ignition, fire or overheating.

NOTE 1 Other standards and transportation regulation given in national and international regulations, give additional requirements for general design of the battery and battery pack.

NOTE 2 It is advised that the bicycle manufacturer make a risk analysis for the battery and battery holder interface with regard to bicycle tip over. It may be possible for damage to occur to the battery or battery interface when the bicycle falls over (see also the Introduction).

4.2.11 Maximum speed for which the electric motor gives assistance

4.2.11.1 Requirements

The electrical motor assistance shall stop when the EPAC reaches a speed of 25 km/h or lower speed if limited by design.

The maximum speed of the EPAC for which the electric motor gives assistance shall not differ by more than +10 % from the maximum assistance speed indicated in the marking required by Clause 5 when determined according to the test method described in 4.2.11.2.

4.2.11.2 Test method

4.2.11.2.1 Test conditions

- a) The test shall be performed either on a test track, a test bench or on a stand that keeps the motor driven wheel free of the ground.
- b) The speed-measuring device used for the test shall have the following characteristics:
 - 1) Accuracy: ± 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 according to the manufacturer instructions.

4.2.11.2.2 Test procedure

The cut-off speed can be measured by measuring either the motor torque output or the motor current. Other appropriate method the pertinence of which has been demonstrated can be used.

The following example describes the cut-off speed test.

- a) Pre-condition the EPAC by running it for 5 min at 80 % of the maximum assistance speed as declared by the manufacturer.
- b) Record continuously the current and note the speed at which the current drops to a value equal to or less than "no load current point".
- c) While pedalling, ride steadily to reach a speed equal to 1,25 times (if possible by design) the maximum assistance speed as declared by the manufacturer.
- d) Verify that the noted value in b) is the no load current point.

4.2.12 Start-up assistance mode

4.2.12.1 Requirements

An EPAC can be equipped with a start-up assistance mode that operates up to a maximum speed of 6 km/h.

This mode shall be activated by the voluntary and maintained action of the user either when riding without pedalling or when the user is pushing the cycle.

4.2.12.2 Test method

4.2.12.2.1 Test conditions

- a) The test may be performed either on a test track, a test bench or on a stand that keeps the motor driven wheel free of the ground.
- b) The speed-measuring device shall have the following characteristics:
 - 1) accuracy: ± 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 according to the manufacturer's instructions.

4.2.12.2.2 Test procedure

- a) Pre-condition the EPAC by running it for 5 min at 80 % of the maximum assistance speed as declared by the manufacturer, then stop.
- b) Activate the start-up assistance mode and verify that the speed increases up to 6 km/h maximum designed speed or lower value.

- c) Verify that the speed reduces progressively to 0 km/h when the start-up assistance mode is deactivated and that the current drops to a value equal to or less than the no load current point when the motor driven wheel freewheels.
- d) Activate the start-up assistance mode and maintain it for 1 min.
- e) Verify that speed is equal to or less than 6 km/h.
- f) Verify that the start-up assistance mode is activated only when the actuation of the device to initiate it is maintained.

4.2.13 Power management

4.2.13.1 Requirements

- a) When tested by the method described in 4.2.13.2 the recordings shall show that assistance shall be provided only when the cyclist pedals forward. This requirement shall be checked according to the test methods described in 4.2.13.2.3;
- b) assistance shall be cut off when the cyclist stops pedalling forward and the cut-off distance shall not exceed 2 m;
- c) If all braking devices (e.g. levers, back pedal) are equipped with cut-off switches, the cut off distance shall not exceed 5 m;
- d) the power output or assistance shall be progressively reduced (see **Annex A**) and finally cut off as the EPAC reaches the maximum assistance speed as designed. This requirement shall be checked according to the test methods described in 4.2.13.2;
- e) the assistance shall be progressively and smoothly managed (e.g. no hunting);
- f) two independent applying actions shall be required to start the electrical assistance mode (e.g. power switch and forward pedalling activation); a traffic caused stop (e.g. traffic lights) is not subject to this requirement;
- g) after a deactivation of the electrical assistance mode due to any hazardous electric drive malfunction, the electric drive shall not start automatically without rider intervention (pedalling is not considered as rider intervention).

4.2.13.2 Test method – Electric motor management

4.2.13.2.1 Test conditions

- a) The test may be performed either on a test track, a test bench or on a stand which keeps the motor driven wheel free of the ground;
- b) The test track shall be according to 4.2.13.2.2;
- c) The time-measuring device shall have an accuracy of $\pm 2 \%$;
- d) The ambient temperature shall be between 5 °C and 35 °C;
- e) Maximum wind speed shall not exceed 3 m/s;
- f) The battery shall be fully charged according to the manufacturer's instructions;

g) Speed measurement shall have an accuracy of $\pm 2\%$.

The test to ensure the compliance to this clause shall be adapted to the technology used; for example:

— pedal backwards and check the no load current point (see 3.48);

or

— pedal backwards and check that no torque is delivered on the driving wheel.

For the test, the worst case conditions of gear ratio and speed shall be applied. The worst condition for speed is defined as 90 % of cut off speed (see 3.23).

4.2.13.2.2 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 bicycle tyre shall be 0,75.

4.2.13.2.3 Test procedure

- a) Pedal backwards and check that no electric motor assistance is provided. The test to ensure the compliance to this clause shall be adapted to the technology used.
- b) Check the cut off distance:
 - 1) pedal so that the EPAC reach 90 % of the cut off speed;
 - 2) stop pedalling without braking;
 - 3) measure the cut off distance;
 - 4) carry out the test three times; the result is the average of this measurement after rejection of invalid points.
- c) If braking device cut-off switches are fitted, actuate each brake device separately and verify the initiation of the cut off signal while pedalling.

4.2.14 Maximum power measurement — Measurement at the engine shaft

The maximum continuous rated power shall be measured according to  EN 60034-1:2010  when the motor reaches its thermal equilibrium as specified by the manufacturer.

NOTE Thermal equilibrium: temperatures of motor parts do not vary more than 2K per hour.

In circumstance where the power is measured directly at the shaft of the electronic motor, the result of the measurement shall be divided by 1,10 to consider the measurement uncertainty and then divided by 1,05 to include for example the transmission losses, unless the real values of these losses are determined.

4.2.15 Electro Magnetic Compatibility

4.2.15.1 Emission

The EPAC and ESA shall fulfil the requirements of [A1](#) Annex B [A1](#).

4.2.15.2 Immunity

The EPAC and ESA shall fulfil the requirements of [A1](#) Annex B [A1](#).

4.2.15.3 Battery charger

As an EPAC is not intended to be used while charging on the electric network, for integrated charger the whole EPAC plus integrated charger shall be tested for EMC according to the applicable standards based on the European EMC directive.

NOTE The following European Standards are applicable for battery chargers to be used in residential environment: [A1](#) EN 55014-1:2017, EN 55014-2:2015, EN IEC 61000-3-2:2019, EN 61000-3-3:2013 [A1](#).

4.2.16 Failure mode

4.2.16.1 Requirements

It shall be possible to ride the EPAC by pedalling even if the assistance failed.

This requirement shall be checked as described in 4.2.16.2.

4.2.16.2 Test method

- a) Remove or disconnect the battery pack.
- b) Ride the bicycle up to 10 km/h.

4.2.17 Anti-tampering measure

4.2.17.1 General

Anti-tampering measures apply to tampering or modifications that general consumers carry out concerning the control unit, drive unit or other parts of power assisting system by using commercially available tools, equipment or parts.

4.2.17.2 Prevention of tampering of the motor

The following anti-tampering requirements shall be taken into account:

- a) Anti-tampering relevant parameters indicated below shall only be accessible to the manufacturer or authorized persons and changes of software configuration parameters require programming tools that are not commercially available or security protected:
 - 1) maximum speed with motor assistance (all systems),
 - 2) parameters affecting the maximum vehicle speed limited by design,
 - 3) maximum gear ratio (system with middle motors),
 - 4) maximum motor power (all systems),
 - 5) maximum speed of starting up assistance;

- b) Assumable manipulations on the approval relevant configuration shall be prevented or compensated by effective counter measures, i.e. plausibility logics to detect manipulations on sensors;
- c) Closed set of components (i.e. operation only with released battery);
- d) Protection against opening of relevant components without traces (sealing).

4.3 Mechanical requirements

4.3.1 General

4.3.1.1 Definition of brake tests

Brake tests to which accuracy requirements apply, as in 4.3.1.4, are those specified in 4.3.5.3 to 4.3.5.6 inclusive.

4.3.1.2 Definition of strength tests

Strength tests to which accuracy requirements apply, as in 4.3.1.4, are those involving static, impact or fatigue loading as specified in 4.3.5.6 to 4.3.12, 4.3.13 inclusive and 4.3.19.2.

4.3.1.3 Numbers and condition of specimens for the strength tests

In general, for static, impact and fatigue tests, each test shall be conducted on a new test sample, but if only one sample is available, it is permissible to conduct all of these tests on the same sample with the sequence of testing being fatigue, static and impact.

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

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

In all strength tests, specimens shall be in the fully-finished condition.

4.3.1.4 Accuracy tolerances of test conditions for brake tests and strength tests

Unless stated otherwise, accuracy tolerances based on the nominal values shall be as follows:

Forces and torques	0/+5 %
Masses and weights	±1 %
Dimensions	±1 mm
Angles	±1°
Time duration	±5 s
Temperatures	±2 °C
Pressures	±5 %

4.3.1.5 Fatigue test

The force for fatigue tests shall be applied and released progressively, not to exceed 10 Hz. The tightness of fasteners according to manufacturer's recommended torque can be re-checked not later than 1 000 test cycles to allow for the initial settling of the component assembly. (This is considered

applicable to all components, where fasteners are present for clamping.) The test bench shall be qualified to meet dynamic requirements of 4.3.1.4.

NOTE Examples of suitable methods are listed in [A1](#) Bibliography [5] [A1](#).

4.3.1.6 Fatigue test for composite components

For fatigue test for composite components, the initial value of displacement (peak-to-peak value) is taken after 1 000 cycles and before 2 000 cycles.

4.3.1.7 Plastic material test ambient temperature

All strength tests involving any plastic materials shall be pre-conditioned for two hours and tested at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$.

4.3.1.8 Crack detection methods

Standardized methods should be used to emphasize the presence of cracks where visible cracks are specified as criteria of failure in tests specified in this standard.

NOTE For example, suitable dye-penetrant methods are specified in [A1](#) EN ISO 3452-1:2021 [16], EN ISO 3452-2:2021 [17], EN ISO 3452-3:2013 [18] and EN ISO 3452-4:1998 [19] [A1](#). In addition, white paint or surface treatment can be used to aid in detection for composite materials.

4.3.2 Sharp edges

Exposed edges that could come into contact with the rider's hands, legs, etc., during normal riding or normal handling and normal maintenance shall not be sharp, e.g. deburred, broken, rolled or processed with comparable techniques.

NOTE It is advised to refer to [A1](#) ISO 13715:2017 [26] [A1](#).

4.3.3 Security and strength of safety-related fasteners

4.3.3.1 Security of screws

Any screws used in the assembly of suspension systems or screws used to attach bracket attached electric generators, brake-mechanisms and mud-guards to the frame or fork, and the saddle to the seat-post shall be provided with suitable locking devices, e.g. lock-washers, lock-nuts, thread locking compound or stiff nuts.

NOTE 1 The screws used to attach hub-generator are not included.

NOTE 2 Fasteners used to assemble hub and disc brakes will preferably have heat-resistant locking devices.

4.3.3.2 Minimum failure torque

The minimum failure torque of bolted joints for the fastening of handle bars, handlebar-stems, bar-ends, saddle and seat-posts shall be at least 50 % greater than the manufacturer's recommended tightening torque.

4.3.3.3 Folding bicycles mechanism

If provided, folding bicycle mechanism shall be designed so that EPAC can be locked for use in a simple, stable, safe way and when folded no damage shall occur to any 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.

4.3.4 Protrusions

These requirements are intended to address the hazards associated with the users of EPACs falling on projections or rigid components (e.g. handlebars, levers) on EPAC possibly causing internal injury or skin puncture. Tubes and rigid components in the form of projections which constitute a puncture hazard to the rider should be protected. The size and shape of the end protection has not been stipulated, but an adequate shape shall be given to avoid puncturing of the body. Screw threads which constitute a puncture hazard shall be limited to a protrusion length of one major diameter of the screw beyond the internally threaded mating part.

NOTE Handlebar-ends are covered by the paragraph in 4.3.6.2.

4.3.5 Brakes

4.3.5.1 Braking-systems

EPAC shall be equipped with at least two independently actuated braking-systems. At least one shall operate on the front wheel and one on the rear wheel. The braking-systems shall operate without binding and shall be capable of meeting the braking-performance requirements of 4.3.5.9.

No hand shall need to be taken from the handlebar to operate the brake levers.

If additional braking-systems are implemented, they shall meet the brake requirements of 4.3.5.

Brake-blocks containing asbestos shall not be used.

4.3.5.2 Hand-operated brakes

4.3.5.2.1 Brake-lever position

The brake levers for front and rear brakes shall be positioned according to the legislation or custom and practice of the country in which EPAC is to be sold, and EPAC manufacturer shall state in the manufacturer's instructions which levers operate the front and rear brakes (see also Clause 6 i)).

4.3.5.2.2 Brake-lever grip dimensions

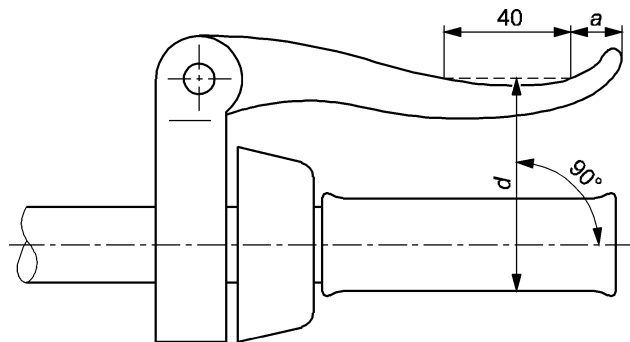
4.3.5.2.2.1 Requirement

The dimension, d , measured between the outer surfaces of the brake-lever in the region intended for contact with the rider's fingers and the handlebar or any other covering present shall over a distance of not less than 40 mm as shown in Figure 1 not exceed 90 mm.

Conformance shall be established by the method detailed in 4.3.5.2.2.2.

The range of adjustment on the brake-lever ought to permit these dimensions to be obtained.

Dimensions in millimetres

**Key**

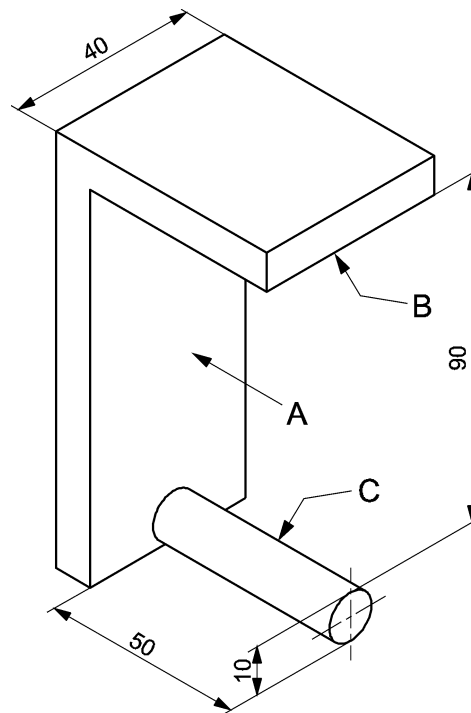
- a distance between the last part of the lever intended for contact with the rider's fingers and the end of the lever
- d brake-lever grip dimension

Figure 1 — Brake-lever grip dimensions**4.3.5.2.2.2 Test method for the brake-lever similar**

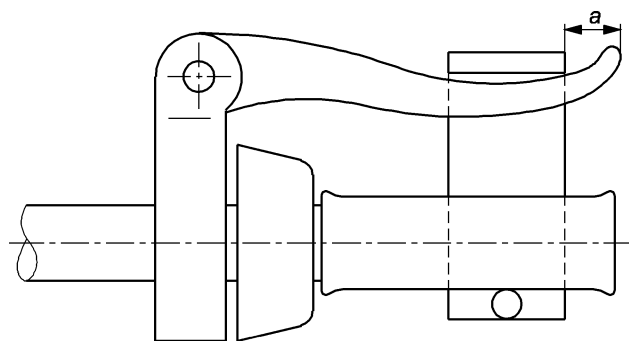
Fit the gauge illustrated in Figure 2 — over the handlebar-grip or the handlebar (when the manufacturer does not fit a grip) and the brake-lever as shown in Figure 3 — so that the face A is in contact with the handlebar or grip and the side of the brake-lever. Ensure that the face B spans an area of that part of the brake-lever which is intended for contact with the rider's fingers without the gauge causing any movement of the brake-lever towards the handlebar or grip. Measure the distance a , the distance between the last part of the lever intended for contact with the rider's fingers and the end of the lever.

The measurement ought to be conducted only on a fully-assembled bicycle.

Dimensions in millimetres

**Key**

- A face A
- B face B
- C rod

Figure 2 — Brake-lever grip dimension gauge**Figure 3 — Method of fitting the gauge to the brake-lever and handlebar (Minimum grip length is shown)****4.3.5.3 Attachment of brake assembly and cable requirements**

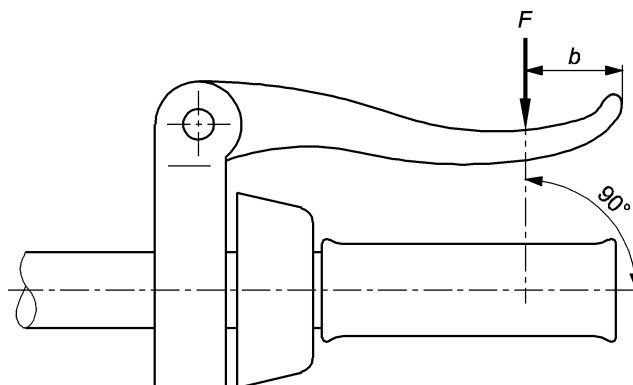
Cable pinch-bolts shall not sever any of the cable strands when assembled to the manufacturer's instructions. In the event of a cable failing, no part of the brake mechanism shall inadvertently inhibit the rotation of the wheel.

The cable end shall either be protected with a cap that shall withstand a removal force of not less than 20 N or be otherwise treated to prevent unravelling.

NOTE See 4.3.3 in relation to fasteners.

4.3.5.4 Brake-levers – Position of applied force

For the purposes of braking tests in this standard, for brake-levers similar to Type A, the test force shall be applied at a distance, b , which is equal to either dimension a as determined in 4.3.5.2.2.2 or 25 mm from the free end of the brake-lever, whichever is the greater (see Figure 4).



Key

F applied force

b = 25 mm or dimension a , whichever is greater

Figure 4 — Position of applied force on the brake-lever type A

4.3.5.5 Brake-block and brake-pad assemblies – Safety test

4.3.5.5.1 Requirement

The friction material shall be securely attached to the holder, backing-plate, or shoe and there shall be no failure of the braking system or any component thereof when tested by the method specified in 4.3.5.5.2.

4.3.5.5.2 Test method

Conduct the test on a fully-assembled bicycle with the brakes adjusted to a correct position with a rider or equivalent mass on the saddle. The combined mass of the bicycle and rider (or equivalent mass) shall be 120 kg.

Actuate each brake-lever with a force of 180 N applied at the point as specified in Figure 4 or a force sufficient to bring the brake-lever into contact with the handlebar grip, whichever is the lesser. Maintain this force while subjecting the bicycle to five forward and five rearward movements, each of which is not less than 75 mm distance.

Then conduct the test described in 4.3.5.7 or 4.3.5.8 as appropriate depending on the style of brake, and then the test described in 4.3.5.9.

4.3.5.6 Brake adjustment

Each brake shall be equipped with an adjustment mechanism either manual or automatic.

Each brake shall be capable of adjustment with or without the use of a tool to an efficient operating position until the friction material has worn to the point of requiring replacement as recommended in

the manufacturer's instructions. Also, when correctly adjusted, the friction material shall not contact anything other than the intended braking surface.

The brake blocks of a bicycle with rod brakes shall not come into contact with the rim of the wheels when the steering angle of the handlebars is set at 60°, nor shall the rods be bent, or be twisted after the handlebars are reset to the central position.

4.3.5.7 Hand-operated braking-system – Strength test

4.3.5.7.1 Requirement

When tested by the method described in 4.3.5.7.2, there shall be no failure of the braking-system or of any component thereof.

4.3.5.7.2 Test method

Conduct the test on a fully-assembled bicycle. After it has been ensured that the braking system is adjusted according to the recommendations in the manufacturer's instructions, apply a force to the brake-lever at the point as specified in Figure 4. This force shall be 450 N, or such lesser force as is required to bring:

- a) a brake-lever into contact with the handlebar grip or the handlebar where the manufacturer does not fit a grip;
- b) brake extension-lever level with the surface of the handlebar or in contact with the handlebar;
- c) a secondary brake lever to the end of its travel.

Repeat the test for a total of 10 times on each brake-lever, secondary brake lever or extension lever.

4.3.5.8 Back-pedal braking system – Strength test

4.3.5.8.1 General

If a back-pedal braking system is fitted, the brake shall be actuated by the operator's foot applying force to the pedal in a direction opposite to that of the drive force. The brake mechanism shall function regardless of any drive-gear positions or adjustments. The differential between the drive and brake positions of the crank shall not exceed 60°.

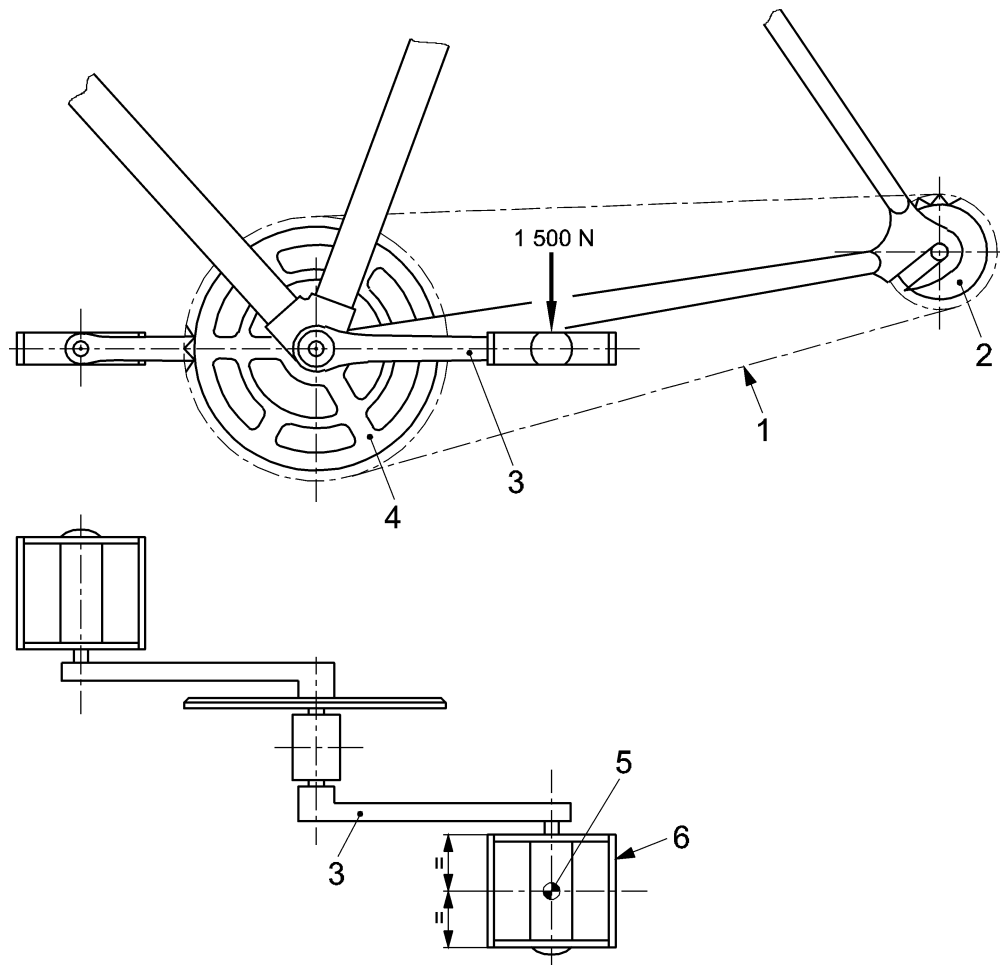
The measurement shall be taken with the crank held against each position with a pedal force of at least 250 N. The force shall be maintained for 1 min in each position.

4.3.5.8.2 Requirement

When tested in accordance with 4.3.5.8.3, there shall be no failure of the brake system or any component thereof.

4.3.5.8.3 Test method

Conduct the test on a fully-assembled bicycle. After it has been ensured that the braking system is correctly adjusted, and with the pedal cranks in a horizontal position, as shown in Figure 5, apply a vertically-downward force to the centre of the left-hand pedal spindle. Increase the force progressively to 1 500 N and maintain fully for 1 min.



Key

- 1 chain
- 2 hub sprocket
- 3 left crank
- 4 cycle chain-wheel and pedal crank
- 5 point of force application
- 6 pedal

Figure 5 — Back-pedal brake test

4.3.5.9 Braking performance

4.3.5.9.1 General

The progressive characteristics of the brake are determined by linearity measurements. A final, simple track test checks for smooth, safe, stopping characteristics.

NOTE See 4.3.5.9.5.6 h) "Test method —simple track test".

Conduct the braking-performance test on a fully-assembled bicycle after the brakes have been subjected to the strength test detailed in 4.3.5.7, 4.3.5.8. Before testing the bicycle, inflate the tyres and adjust the brakes all according to the manufacturer's instructions, but in the case of rim-brakes to the maximum clearance specified by the manufacturer.

4.3.5.9.2 Requirements

Where EPAC is fitted with secondary brake-levers attached to brake-levers, bar-ends or aerodynamic extensions, separate tests shall be conducted for the operation of the secondary brake-levers in addition to tests with the normal levers.

When tested in accordance with 4.3.5.9.5, the bicycle shall fulfil the requirements shown in Table 1.

Table 1 — Calculated braking performance value

Forces in N

Condition	Brake in use	Minimum braking performance value, B_p
Dry	Front only	340
	Rear only	220
Wet	Front only	220
	Rear only	140

NOTE These values are based on the reference mass "m" (100 kg).

4.3.5.9.3 Linearity requirements

When tested by the methods described in 4.3.5.9.5.6 c) 1) and 2), the braking force $F_{Br\ average}$ shall be linearly proportional (within $\pm 20\%$) to the progressively increasing intended operating forces $F_{Op\ intend}$. The requirement applies to braking forces $F_{Br\ average}$ equal to and greater than 80 N (according to [\[A1\]](#) Annex E [\[A1\]](#)).

4.3.5.9.4 Ratio between wet and dry braking performance requirements

In order to ensure safety for both wet and dry braking, the ratio of braking performance wet: dry shall be greater than 4:10.

The methods for calculating this ratio are given in 4.3.5.9.5.6 g).

4.3.5.9.5 Test method

4.3.5.9.5.1 General

The test machine enables the braking distances for both brakes or the rear brake alone to be calculated from measurements of the individual braking forces of the front and rear brakes on a drum or belt.

4.3.5.9.5.2 Symbols

F_{Op} = Operating force (i.e. force applied on brake-lever or pedal)

$F_{Op\ intend}$ = Intended operating force (e.g. 40 N, 60 N, 80 N etc.)

$F_{Op\ rec}$ = Recorded operating force (e.g. 38 N, 61 N, 79 N etc.)

F_{Br} = Braking force

$F_{Br\ rec}$ = Recorded braking force

$F_{Br\ corr}$ = Corrected braking force (Corrected for difference between $F_{Op\ intend}$ and $F_{Op\ rec}$)

$F_{Br\ average}$ = The arithmetic mean of the three $F_{Br\ corr}$ at one level of $F_{Op\ intend}$

$F_{Br\ max}$ = The maximum $F_{Br\ average}$

F_{Br}^D = Dry braking-force

F_{Br}^W = Wet braking-force

4.3.5.9.5.3 Test machine

The test machine shall incorporate a system that drives the wheel under test by tyre contact and a means of measuring the braking-force, and typical examples of two types of machine are illustrated in Figure 6 and Figure 7.

Figure 6 shows a machine in which a roller drives the individual wheels, and Figure 7 shows a machine in which a driven belt contacts both wheels. Other types of machine are permitted, provided they meet the specific requirements listed below and those specified in 4.3.5.9.5.4 and 4.3.5.9.5.5.

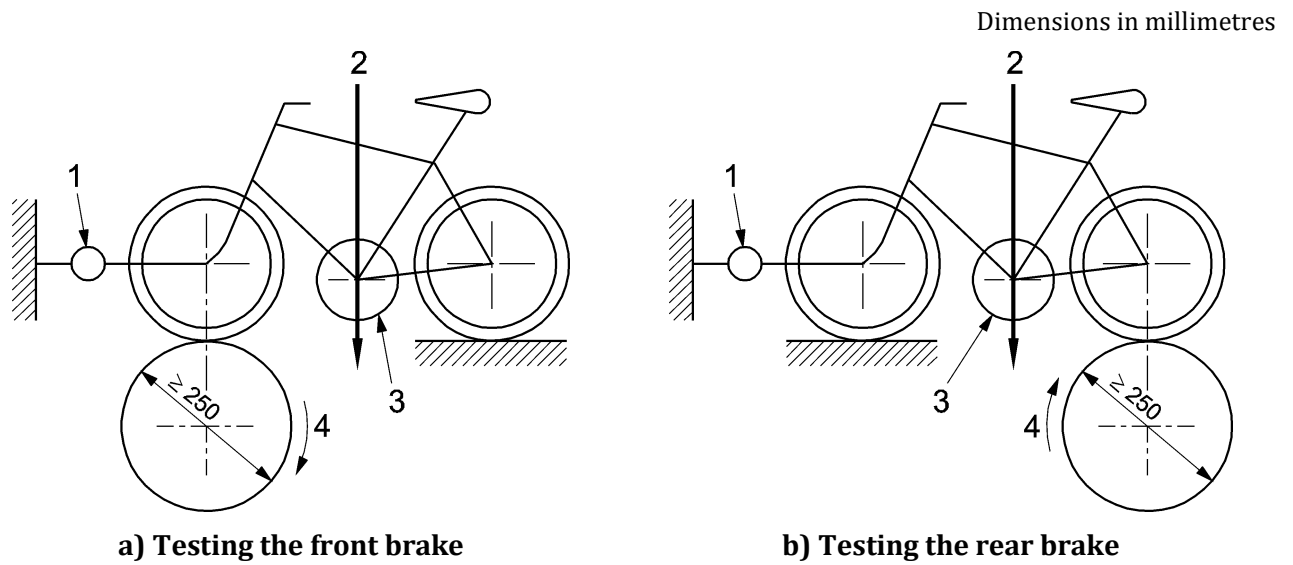
The specific requirements are as follows:

- a) the linear surface velocity of the tyre shall be 12,5 km/h and shall be controlled within $\pm 5\%$;
- b) a means of laterally restraining the wheel under test shall be provided which does not influence the measurement of braking force;
- c) a means of laterally applying forces to the brake-levers at the point specified in Figure 4 shall be provided, with the width of the contact on the lever not greater than 5 mm. In the case of back-pedal brake, a means of applying forces to a pedal is also required.

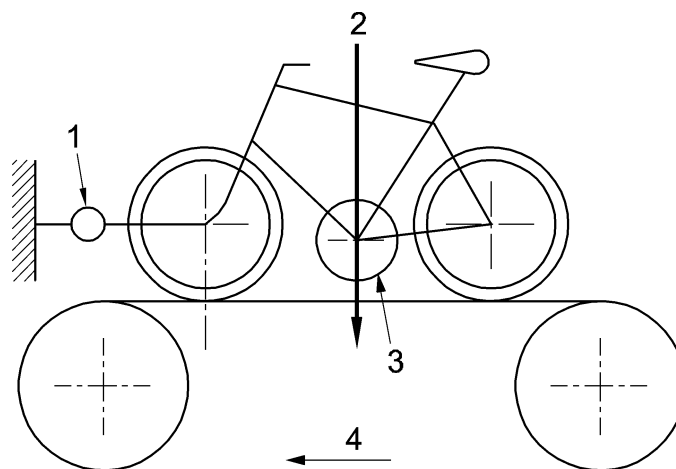
4.3.5.9.5.4 Instrumentation

The test machine shall be instrumented to include the following:

- a) a device to record the surface velocity of the tyre, accurate to within $\pm 2\%$;
- b) a device to record the braking force (see Figures 14 and 15, for example), accurate to within $\pm 5\%$;
- c) a device to record the operating force applied to the hand-lever or pedal, accurate to within $\pm 1\%$;
- d) a water spray system, to provide wetting of the brakes of the bicycle, consisting of a water reservoir connected by tubing to a pair of nozzles arranged as shown in Figure 8. Each nozzle shall provide a flow of water at ambient temperature of not less than 4 ml/s. The wheel shall be suitably enclosed to ensure that, in addition to the rim, any hub- or disc-brake is thoroughly wetted before a test begins;
- e) a system for loading the wheels of the bicycle against the driving mechanism (see 4.3.5.9.5.5).

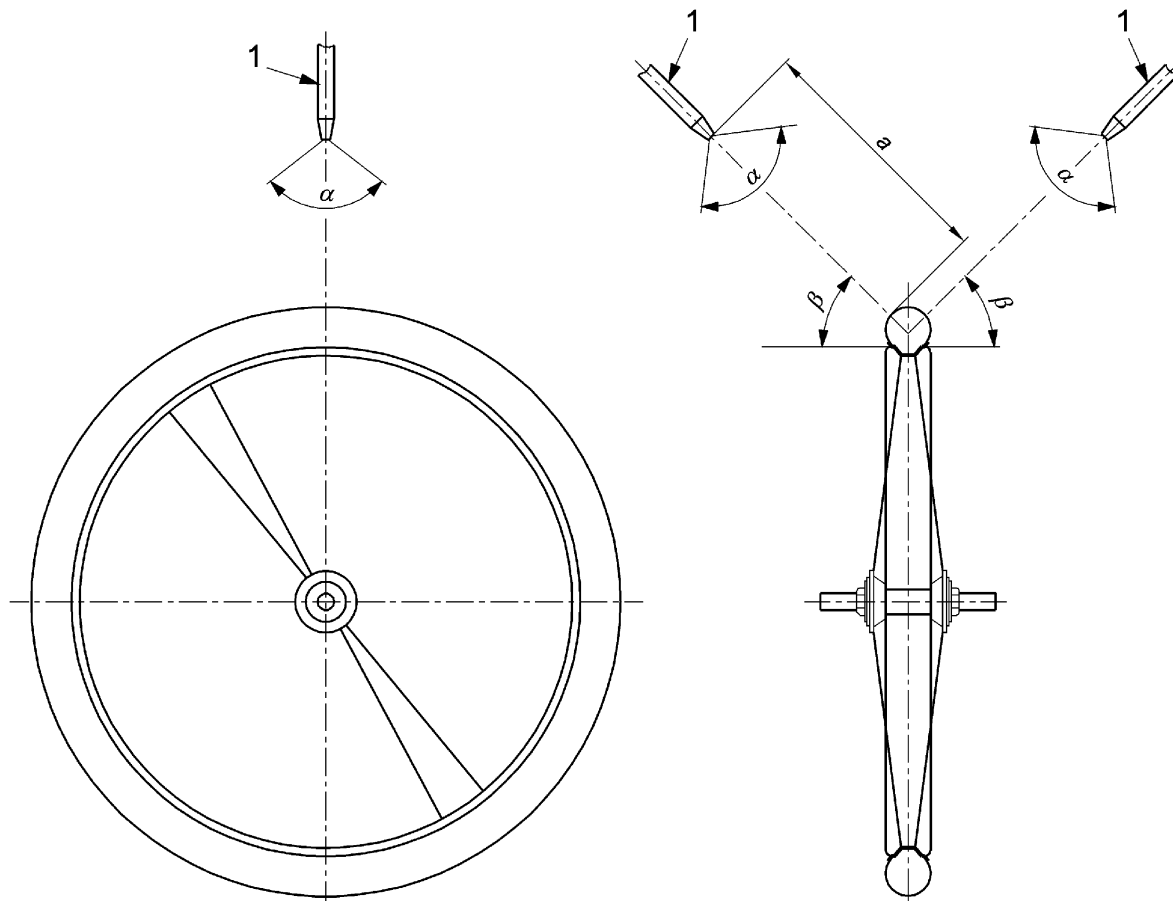
**Key**

- 1 braking-force transducer
- 2 applied force, or
- 3 additional mass
- 4 direction of drum rotation

Figure 6 — Braking performance test-machine-Single drum type**Key**

- 1 braking-force transducer
- 2 applied force, or
- 3 additional mass
- 4 direction of belt travel

Figure 7 — Braking performance test-machine-Driven belt type



Key

- α = 90° to 120°
- β = 30° to 60°
- a = 150 mm to 200 mm
- 1 water nozzles

Figure 8 — Water nozzle arrangement for the wet braking test (Applicable to all types of brake)

4.3.5.9.5.5 Vertical force on the tested wheel

The wheel to be tested shall be forced vertically downwards so that no skidding of the wheel occurs when tested according to 4.3.5.9.5.6 c) 1) and 2).

It is permitted that the necessary force be applied anywhere on the bicycle (wheel-axle, bottom bracket, seat-post, etc.) provided that it is exerted vertically downwards.

4.3.5.9.5.6 Test method

a) General:

Test the front and rear wheels individually.

b) Running-in the braking surfaces:

Conduct a running-in process on every brake before the performance test is performed.

In order to determine the operating force to be used during the running-in process, mount and load the bicycle on the test machine with the belt or drum running at the specified speed and apply an operating force to the brake-lever or the pedal that is high enough to achieve a braking force of $200 \text{ N} \pm 10 \%$. Maintain this operating force for at least 2,5 s, and note the value of the applied operating force.

Repeat the procedure (applying the operating force determined as above accurate to within $\pm 5 \%$) 10 times, or, with more repetitions if necessary, until the mean braking force from anyone of the three latest tests does not deviate by more than $\pm 10 \%$ from the mean braking force from these same three tests.

c) The performance tests:

1) Testing under dry conditions:

For hand operated brakes, with a vertical force applied to the bicycle sufficient to prevent skidding of the tyre on the wheel under test, accelerate the driving mechanism to the specified velocity, then apply the operating-force in a series of 20 N increments from 40 N to either 180 N or to the force necessary to achieve a braking force of at least 700 N, whichever is the lesser. However, if the wheel locks, if any possible brake-overload device is actuated, or if the hand-lever comes into contact with the handlebar, do not increase the force further. For each increment of applied operating force, perform three tests within 1 min. Before applying the next level of operating force, allow the brake to cool for 1 min.

For back-pedal brakes, with a vertical force applied to the bicycle sufficient to prevent skidding of the tyre on the wheel under test, accelerate the driving mechanism to the specified velocity, then apply the operating-force in a series of 50 N increments from 100 N to either 350 N or to the force necessary to achieve a braking force of at least 400 N, whichever is the lesser. However, if the wheel locks, if any possible brake-overload device is actuated, do not increase the force further. For each increment of applied operating force, perform three tests within 1 min. Before applying the next level of operating force, allow the brake to cool for 1 min.

The applied operating forces shall lie within $\pm 10 \%$ of the intended operating forces, shall be applied as specified in Figures 5 and 6 and 4.3.5.9.5.3 c), shall be recorded with an accuracy of $\pm 1 \%$, and shall be fully applied within 1,0 s of the commencement of braking.

For each increment of operating force, record the braking force value, $F_{Br \text{ rec}}$, for a period of between 2,0 s and 2,5 s, with measurement starting 0,5 s to 1,0 s after the commencement of braking. Record $F_{Br \text{ rec}}$ as the average braking force during this measurement period.

The time at which the measurement of the braking force is started shall be related to the speed at which the operating force is applied. If the operating force is fully applied in less than 0,5 s after the commencement of braking, start the measurement after 0,5 s. However, if the operating force is fully applied between 0,5 s and 1,0 s after the commencement of braking, start the measurement when the operating force is fully applied.

2) Testing under wet conditions:

The method shall be as given in 4.3.5.9.5.6 c) 1) with the addition that wetting of the brake system shall commence not less than 5,0 s before the commencement of braking and shall continue until the measurement period has ended.

Water nozzles shall be arranged according to Figure 8.

d) Correction of braking force:

Each recorded braking force, $F_{Br\ rec}$, shall be corrected for any difference between the recorded operating force and the intended operating force. The corrected braking force shall be calculated by multiplying the recorded braking force, $F_{Br\ rec}$, with a correction factor which is the ratio between the intended operating force, $F_{Op\ intend}$, and the recorded operating force, $F_{Br\ rec}$.

EXAMPLE

Recorded braking force $F_{Br\ rec} = 225\text{ N}$

Intended operating force $F_{Op\ intend} = 180\text{ N}$

Recorded operating force $F_{Op\ rec} = 184\text{ N}$

Correction factor = $180/184$

Corrected braking force $F_{Br\ corr} = 225 \times (180/184)$.

e) Test results:

Select from the record the maximum output braking force, $F_{Br\ max}$, for each combination of wheel (front or rear) and each test condition (wet or dry).

The braking performance value shall be calculated using the following formula:

$$B_p = F_{Br\ max} \times \frac{m}{M}$$

where

B_p is the braking performance value (N);

$F_{Br\ max}$ is the maximum $F_{Br\ average}$ (N);

m is the reference mass of EPAC defined as 100 kg for adult bicycle;

M is the maximum permissible total mass specified by the manufacturer if in excess of 100 kg in 6 n) (kg).

Where a manufacturer specifies that his EPAC can carry a mass such that the sum of that mass plus the mass of EPAC is in excess of 100 kg to some value M, apply M as total mass.

f) Linearity

Plot the calculated $F_{Br\ average}$ values (the arithmetic mean of the three corrected braking forces at each level of operating force) against the equivalent operating force values, $F_{Op\ intend}$, in order to assess the linearity against the requirement in 4.3.5.9.3. Plot the results on a graph, showing the line of best fit and the $\pm 20\%$ limit lines obtained by the method of least squares outlined in [A2](#) Annex E [A1](#).

g) Ratio between wet and dry braking For each F_{Op} where $F_{Br\ average}^D$ is $> 200\text{ N}$, determine (using the following formula) whether or not the requirements of have been met:

$$F_{Br\ average}^W: F_{Br\ average}^D$$