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**Cycles — Safety requirements for  
bicycles —**

Part 10:  
**Safety requirements for electrically  
power assisted cycles (EPACs)**

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 149, *Cycles*, Subcommittee SC 1, *Cycles and major sub-assemblies*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

A list of all parts in the ISO 4210 series can be found on the ISO website.

## Introduction

This document combines several countries' safety requirements for Electrically Power Assisted Cycles (EPACs). The commercialization of EPACs has accelerated in the global market, in response to global concerns about CO<sub>2</sub> reduction and energy saving. EPAC technologies for performance, electrical control, battery management and battery charging are currently developing rapidly in a competitive market. It is therefore necessary to standardize the safety of these technologies for EPACs.

This documentation will allow an easy and clear understanding of requirements for different types of EPAC.

This document includes safety requirements for the charging of EPACs. This includes off-board parts and EPAC battery chargers.

This document does not state the limit for the maximum permissible load of the EPAC. The manufacturer is advised to consider amongst other factors the maximum permissible load (luggage plus rider) as well as the intended use of the EPAC. Both have an influence on the mechanical requirements.

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# Cycles — Safety requirements for bicycles —

## Part 10:

# Safety requirements for electrically power assisted cycles (EPACs)

## 1 Scope

This document specifies safety and performance requirements for the design, marking, assembly, and testing of two wheeled electrically power assisted cycles (hereafter EPACs), fully-assembled EPACs and subassemblies, and provides guidelines for information supplied by the manufacturers (i.e. instructions on the use and care of such EPACs).

This document applies to two wheeled EPACs that have a maximum saddle height of 635 mm or more and are intended for private and commercial use with exception of EPACs intended for hire from unattended stations.

This document is intended to cover all common significant hazards, hazardous situations and events listed in 5.3 of EPACs, when used as intended or under conditions of misuse that are reasonably foreseeable by the manufacturer.

This document specifies requirements and test methods for engine power management systems, electrical circuits including the charger for the assessment of the design and assembly of EPACs and sub-assemblies for systems having a Safety Extra Low Voltage (SELV) maximum voltage up to 60 V d.c. including tolerances.

## 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.

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 4210-1, *Cycles — Safety requirements for bicycles — Part 1: Terms and definitions*

ISO 4210-2:2015, *Cycles — Safety requirements for bicycles — Part 2: Requirements for city and trekking, young adult, mountain and racing bicycles*

ISO 4210-4:2014, *Cycles — Safety requirements for bicycles — Part 4: Braking test methods*

ISO 4210-5:2014, *Cycles — Safety requirements for bicycles — Part 5: Steering test methods*

ISO 4210-6:2015, *Cycles — Safety requirements for bicycles — Part 6: Frame and fork test methods*

ISO 4210-9:2014, *Cycles — Safety requirements for bicycles — Part 9: Saddle and seat-post test methods*

ISO 7010:2011, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

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

ISO 11451-2, *Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 2: Off-vehicle radiation sources*

ISO 11452-1, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology*

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

ISO 11452-4:2011, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 4: Harness excitation methods*

ISO 11898-1, *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling*

ISO 11898-2, *Road vehicles — Controller area network (CAN) — Part 2: High-speed medium access unit*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 13849-2, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

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

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

IEC 62133-1:2017, *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 — Part 1: Nickel systems*

IEC 62133-2:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for portable sealed secondary lithium cells, and for batteries made from them, for use in portable applications — Part 2: Lithium systems*

CISPR 12:2007 + A1:2009, *Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of off-board receivers*

CISPR 16-1-1:2015, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1-1: Radio disturbance and immunity measuring apparatus — Measuring apparatus*

CISPR 25:2016, *Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of on-board receivers*

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

### **3 Terms and definitions**

For the purposes of this document, the terms and definitions given in ISO 4210-1 and the following apply.

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

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



### 3.1 cycle

any vehicle which has at least two wheels and is propelled by the muscular energy of the person on that vehicle, in particular by means of pedalling or the possibility of adding assistance provided by electric motor when pedalling

Note 1 to entry: Pedalling also refers to use of hand cranks or other similar devices.

### 3.2 electrically power assisted cycle EPAC

*cycle* (3.1), equipped with pedals and an auxiliary electric motor, which cannot be propelled exclusively by means of this auxiliary electric motor, except in the walk assistance mode

### 3.3 mountain EPAC

*electrically power assisted cycle* (3.2) 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

[SOURCE: ISO 4210-1:2014, 2.30, modified — bicycle has been changed to electrically power assisted cycle.]

### 3.4 braking device cut-off switch

device that cuts off the motor assistance while braking

### 3.5 continuous rated power

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

### 3.6 assisted rate

ratio of between mechanical motor output power and muscular human input-power

### 3.7 thermal equilibrium

temperatures of motor parts which do not vary more than 2 °C/h

### 3.8 assistance cut-off speed

speed at which the motor controller cuts off the assistance of the auxiliary electric motor

### 3.9 walk assistance mode

function by which the user can activate the auxiliary electric motor to propel the EPAC up to a defined maximum speed without pedalling

### 3.10 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

[SOURCE: IEC 60050-161:1990/AMD8:2018, IEV ref. 161-01-07, modified — an EPAC or one of its electrical/electronic systems have been specified.]

**3.11**

**ESA**

**electronic subassembly**

**electrical subassembly**

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

**3.12**

**motor controller**

device or group of devices that serves to govern in some predetermined manner the performance of an electric motor

Note 1 to entry: Means for manual or automatic ON/OFF, selecting the drive direction, regulating the speed, limiting the torque and providing protection against faults.

**3.13**

**fault condition**

condition in which one or more fault is present which could cause hazard

**3.14**

**charging configuration**

sets of physical parameters which are predefined to control a charging process

**3.15**

**battery management system**

**BMS**

local energy management system for the battery system, protecting the battery system from damage, monitoring and increasing the lifetime, and maintaining the functional state

Note 1 to entry: BMS and BCU (according to ISO 12405) do not have the same functions.

**3.16**

**narrow-band emission**

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

**3.17**

**no load current point**

current measured at battery output with no change to the operating status of any auxiliary systems during the test

**3.18**

**safety extra-low voltage**

**SELV**

voltage not exceeding ripple-free 60 V d.c. between conductors and earth, the no load voltage not exceeding ripple-free 60 V d.c.

**3.19**

**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

**3.20**

**maximum permissible load**

maximum permissible weight of rider and luggage as defined by the manufacturer

**3.21**

**proprietary system**

manufacturer-specific system

**3.22****non-proprietary system**

non manufacturer-specific system

**3.23****charger inlet**

inlet on the EPAC or battery side for charging

[SOURCE: IEC 60050-714:1990, IEV ref. 714-03-04, this source is only for “inlet”]

**3.24****charger connector**

connector on charger side for charging

[SOURCE: IEC 60050-151:2001, IEV ref. 151-12-19, this source is only for “connector”]

**3.25****rigid seat-post**

seat-post that cannot be raised or lowered independently of the seat tube clamp, while riding, and does not provide controlled axial flexibility to reduce the transmission of road shocks to the rider.

**3.26****suspension seat-post**

seat-post incorporating controlled, axial flexibility to reduce the transmission of road shocks to the rider

**3.27****dropper seat-post**

seat-post that can be raised or lowered independently of the seat tube clamp while riding

**3.28****suspension dropper seat-post**

seat-post incorporating controlled, axial flexibility to reduce the transmission of road shocks to the rider and incorporating the capability of raising and lowering independently of the seat tube clamp while riding

**4 Abbreviated terms**

See [Table 1](#).

**Table 1 — Abbreviated terms**

Abbreviation	Description	Definition or occurrence
AC	Alternating current	<a href="#">C.3.1.1</a>
ACK	Acknowledge	<a href="#">C.2.5.3.1</a>
ALSE	Absorber-lined shielded enclosure	<a href="#">B.3.4</a>
AM	Amplitude modulation	<a href="#">A.4.6.1</a>
BCI	Bulk current injection	<a href="#">B.2.6.3</a>
BCU	Battery control unit	<a href="#">3.15</a>
BMS	Battery management system	<a href="#">3.15</a>
BPSK	Biphase shift keying	<a href="#">C.2.5.4.1</a>
CAN	Controller Area Network	<a href="#">C.3.1.1</a>
CC	Constant current mode	<a href="#">Table C.10</a>
CCF	Common cause failure	G.2.4.1.2
CDB	Command descriptor block	<a href="#">C.2.6.3.1</a>
CSMA/CR	Carrier Sense Multiple Access with Collision Resolution	<a href="#">C.3.1.2</a>

Table 1 (continued)

Abbreviation	Description	Definition or occurrence
CV	Constant voltage mode	<a href="#">Table C.10</a>
DA	Destination address	<a href="#">Figure C.10</a>
DC	Direct current	<a href="#">C.2.1.1</a>
DFMEA	Design failure mode and effect analysis	<a href="#">5.2</a>
DLC	Data Length Code	<a href="#">C.3.6.2.1</a>
DUT	Device under test	G.2.3.4.2
EMC	Electromagnetic compatibility	<a href="#">6.12</a>
EPAC	Electrically Power Assisted Cycle	Introduction
ESA	Electronic/Electrical subassembly	<a href="#">3.11</a>
FCS	Frame Check Sequence	<a href="#">Table C.9</a>
FMEA	Failure mode and effect analysis	<a href="#">5.2</a>
FTA	Fault tree analysis	<a href="#">5.2</a>
HMI	Human machine interface	<a href="#">Figure C.20</a>
MPU	Micro processing unit	<a href="#">Figure C.1</a>
NDN	Network device number	<a href="#">Table C.10</a>
NM	Network Management	<a href="#">C.3.6.2.4</a>
NRZ	Non-return-to-zero	<a href="#">C.2.5.4.2</a>
PC	Page control	<a href="#">Table C.40</a>
PL	performance level	<a href="#">5.3.2.2.2</a>
PLC	Power line communication	<a href="#">Figure C.1</a>
PM	Pulse modulation	<a href="#">A.4.6.1</a>
PnP	Plug and play	<a href="#">C.2.6.2</a>
PS	Parameter saveable	<a href="#">C.2.6.5.12</a>
RA	Risk assessment	<a href="#">5.2</a>
RF	Radio Frequency	<a href="#">B.3.3</a>
R-map	Risk-map	<a href="#">5.2</a>
rms	root mean square	<a href="#">A.2.6.3</a>
RT	Room temperature	G.2.4.1.3
SA	Source address	<a href="#">Figure C.12</a>
SELV	Safety Extra Low Voltage	<a href="#">Clause 1</a>
SOPC	Sub operation code	<a href="#">Table C.33</a>
SP	Save pages	<a href="#">C.2.6.5.12</a>
TLS	Transmission-line-system	<a href="#">A.4.6.3</a>
ToR	Type of request	<a href="#">C.2.6.5.7.2</a>
VDD	Voltage drain	<a href="#">Figure C.1</a>

## 5 General requirements

### 5.1 Lighting systems, reflectors and warning device

EPACs shall be in accordance with the requirements of ISO 4210-2:2015, 4.20 and 4.21.

## 5.2 Risk assessment

EPAC shall be designed using principles of Risk Assessment (RA) in accordance with ISO 12100.

The following RA methodology may be used, but is not limited to:

- fault tree analysis (FTA);
- failure mode and effect analysis (FMEA);
- design failure mode and effect analysis (DFMEA);
- risk-map (R-map).

EPAC shall be designed in accordance with the principles of ISO 12100 for relevant hazards which are not dealt with by this document. This includes evaluation of such risks for all relevant components.

## 5.3 Significant hazards and safety functions

### 5.3.1 Significant hazards

The following significant hazards of EPACs have been considered in this document:

- a) mechanical hazards: deceleration, acceleration, instability, kinetic energy, rotating elements and moving elements, rough or slippery surfaces, sharp edges;
- b) electrical hazards: electromagnetic phenomena, electrostatic phenomena, overload, short-circuit, thermal radiation;
- c) thermal hazards: explosion, flame, radiation from heat sources, objects or materials with a high or low temperature;
- d) ergonomic hazards: effort, local lighting, posture;
- e) hazards associated with the environment in which the EPAC is used: water (dust).

### 5.3.2 Safety function for control system of EPACs

#### 5.3.2.1 General

The EPAC control system risk shall be assessed in accordance with the series of ISO 13849.

The following methodology may be used, but is not limited to:

- IEC 61508 (all parts);
- R-map.

#### 5.3.2.2 Requirements

##### 5.3.2.2.1 Safety related parts of the mechanical, hydraulic control systems

The necessary performance levels and requirements which are related to the identified hazards are covered by [Clause 7](#).

##### 5.3.2.2.2 Safety related parts of the electrical control systems

The safety requirements of [Table 2](#) shall be necessary for an EPAC. If necessary, the manufacturer shall add more safety requirements and determine the necessary PL or safety level for each of these safety requirements and the related safety functions.