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Safety requirements and test methods for electrical self-balancing vehicles

电动平衡车安全要求及测试方法

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Foreword

This Standard was drafted in accordance with the provisions given in GB/T 1.1-2009.

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This Standard was proposed by China Machinery Industry Federation.

This Standard shall be under the jurisdiction of the National Technical Committee for Standardization of Automation Systems and Integration (SAC/TC 159).

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Safety requirements and test methods for electrical self-balancing vehicles

1 Scope

This Standard specifies the terms and definitions, test conditions, general safety requirements, electrical safety, mechanical safety, environmental reliability, test methods, marking and description of the electrical self-balancing vehicles.

This Standard is applicable to the battery-powered electrical self-balancing vehicles.

2 Normative references

The following documents are essential to the application of this document. For dated references, only the editions with the dates indicated are applicable to this document. For undated references, only the latest editions (including all the amendments) are applicable to this document.

GB/T 2423.22-2012 *Environmental testing - Part 2: Test methods - Test N: Change of temperature*

GB 3565-2005 *Safety requirements for bicycles*

GB/T 4208-2017 *Degrees of protection provided by enclosure (IP code)*

GB 4943.1-2011 *Information technology equipment - Safety - Part 1: General requirements*

GB/T 5169.16-2008 *Fire hazard testing for electric and electronic products - Part 16: Test flames - 50W horizontal and vertical flame test methods*

GB/T 12350-2009 *Safety requirements of small-power motors*

3 Terms and definitions

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

3.1 Electrical self-balancing vehicle

A wheeled manned mobile platform that is based on the inverted pendulum model and the principle of static instability, and is equipped with a rechargeable electric drive system, thus maintaining dynamic balance in an autonomous or manual mode of operation.

NOTE: The electrical self-balancing vehicle is referred to as the self-balancing vehicle for short.

3.2 Safety alarm

An alarm that may be clearly noticed by the user after being sent to the user, when an electrical self-balancing vehicle detects internal faults (such as abnormal battery voltage, balance control unit failure) or dangerous driving actions or abnormal working conditions of the vehicle.

3.3 Footrest tilting function

The function enabled for limiting the user to continue driving in case of overspeed, low-battery driving or overload driving detected in an electrical self-balancing vehicle, thus protecting the safety of the user, by automatically tilting up the front end of the footrest on the self-balancing vehicle.

3.4 Enclosure

A component of the equipment with one or more of the functions specified in 3.5, 3.6, 3.7 or 3.8.

NOTE: One type of enclosures may be inside another type of enclosures (for instance, an electrical enclosure is inside a fire enclosure, or a fire enclosure is inside an electrical enclosure). In addition, one type of enclosures may provide the functions of multiple types of enclosures (for instance, with the functions of both electrical enclosures and fire enclosures).

NOTE: REWRITE the definition in 1.2.6.1 of GB 4943.1-2011.

3.5 Fire enclosure

A component of the equipment, which is designed to minimize the outbreak of fire or spread of flames in the equipment.

[Definition in 1.2.6.2 of GB 4943.1-2011]

3.6 Mechanical enclosure

A component of the equipment, which is designed to reduce the risk of damage caused by mechanical and other physical hazards.

[Definition in 1.2.6.3 of GB 4943.1-2011]

3.7 Electrical enclosure

5.3 Sharp edges

Tubular objects that may cause stab injuries to the users on the outside of the electrical self-balancing vehicles or hard protrusions of equipment components shall be adequately designed (such as obtuse angle design, etc.) to guard against stab injuries to the human bodies.

For threads that may pose a risk of stabbing, the length of the thread beyond its internal attachment shall be limited to the length of a thread outside diameter.

5.4 Safety protection functions

5.4.1 Overspeed protection

The electrical self-balancing vehicle shall have such protection functions as continuous safety alarm beyond the speed limits and continuous tilting function or the like, so as to restrict the user from continued acceleration, thus protecting user safety.

5.4.2 Low-battery protection

The electrical self-balancing vehicle shall be capable of providing low-battery protection, that is, when the power of the electrical self-balancing vehicle's battery pack is lower than the minimum power required by the manufacturer for safe driving, the self-balancing vehicle shall have such protection functions as continuous safety alarm and continuous tilting function or the like, so as to restrict the user from continued driving.

5.4.3 Grade parking performance and protection

The electrical two-wheeled self-balancing vehicle shall have grade parking performance and protection function. After tested according to the method specified in 9.1.3, the electrical self-balancing vehicle shall meet either of the following two states:

a) The self-balancing vehicle gives no safety alarm and without any power failure; meanwhile, its motor has no loss of energy;
b) The self-balancing vehicle enables such protection functions as continuous safety alarm and continuous tilting function or the like, so as to restrict the user from continued driving.

5.4.4 Crash protection

The electrical self-balancing vehicle shall be capable of providing crash protection to prevent the self-balancing vehicle from hurting the user or the third party when its wheel(s) continue(s) to rotate after crash. After tested according

for electrical self-balancing vehicles shall be consistent with the relevant national standards or industry standards.

5.5.2 Charger

The safety requirements for the chargers or power supplies of electrical self-balancing vehicles shall meet the requirements of GB 4943.1-2011 and be compatible with the battery systems of electrical self-balancing vehicles. Compliance shall be checked by reviewing the battery system and charger specifications and the tests in this Standard.

The connectors, which are provided with the chargers and connected to the charging ports on the self-balancing vehicles for charging, shall be designed to prevent misalignment and reverse polarity.

The chargers for outdoor use shall meet the requirements for outdoor use of the relevant national standards or industry standards.

5.5.3 Motor

Motors for the electrical self-balancing vehicles shall comply with the requirements of GB/T 12350-2009 and the motor overload test specified in 9.2.1.

If the motors for electrical self-balancing vehicles are beyond the scope of application in GB/T 12350-2009, such motors shall comply with both the motor overload test specified in 9.2.1 and the motor locked-rotor test specified in 9.2.2.

5.5.4 Fuse

Fuses for the electrical self-balancing vehicles shall meet the requirements of the relevant national standards and be applicable to the current and voltage of the circuit under their protection.

In the case of user-replaceable fuses, the fuse replacement marking shall be placed in the vicinity of each fuse or fuse holder, or on the fuse holder, or it may be clearly visible that which fuse is located elsewhere. Moreover, the rating of the fuse shall be marked as well. In the case of user-replaceable fuses with special fusing characteristics (such as delay or breaking capacity), the type of fuse shall also be indicated. The manual shall also include correct replacement information for the user-replaceable fuses.

5.5.5 Cable and connector

DISCHARGE a fully charged electrical self-balancing vehicle at room temperature. DISCHARGE to the discharge limit specified by the manufacturer at the maximum current allowed by the system. Meanwhile, MONITOR the temperature of the cable and connector. MAKE records accordingly. For any

c) Cables shall be securely fastened to prevent contact between the cables and the moving parts. Where necessary, other mechanical fixings may be added.

After inspection, the product shall comply with a), b) and c).

Detachable parts of an electrical self-balancing vehicle, which will be removed during normal use or maintenance of the equipment, shall not cause undue pressure on the electrical connections and internal conductors, including the conductors that maintain earthing continuity.

6.3 Short-circuit safety requirements

After tested according to the method specified in 9.2.3, the self-balancing vehicle shall not catch fire or explode. Meanwhile, there shall be no rupture and electrolyte leakage on the enclosure.

NOTE: If the self-balancing vehicle's battery pack has passed the short circuit test, and in the case that according to the characteristics of the tested self-balancing vehicle, it has been evaluated that there is no difference between the short circuit test of the entire self-balancing vehicle and that of the battery pack, the short circuit test specified in this Standard may not be carried out.

6.4 Heating requirements

The heating requirements of the electrical self-balancing vehicle shall meet the requirements of 4.5.1 in GB 4943.1-2011.

The materials that are suitable for the structures of the components and the electrical self-balancing vehicle shall be selected so that the temperature of the self-balancing vehicle will not exceed its temperature limit when operating under normal load. After performing the test according to the method specified in 9.2.4, the measured temperature limits of the materials for self-balancing vehicle and the components shall meet the requirements of 4.5.3 in GB 4943.1-2011; the measured temperature limits of the accessible parts in the accessible area of the user shall meet the requirements of 4.5.4 in GB 4943.1-2011. In addition, during the test, the electrical self-balancing vehicle shall not catch fire or explode. Meanwhile, there shall be no rupture and electrolyte leakage on the enclosure.

6.5 Dielectric strength

This requirement applies only to the electrical self-balancing vehicles or their components that are directly connected to the AC grid. The electrical self-balancing vehicles or their components, which are directly connected to the AC grid, shall have adequate dielectric strength and be tested according to the method specified in 9.2.5.

This requirement applies only to the electrical self-balancing vehicles with saddles.

Saddles of the electrical self-balancing vehicles shall meet the requirements of 12.3 and 12.4 in GB 3565-2005.

The saddle strength of the electrical self-balancing vehicles shall meet the requirements of 12.5 in GB 3565-2005.

8 Environmental reliability

8.1 Vibration

PERFORM the vibration test according to 9.4.1. After the test, there shall be no visible crack or rupture in any part of the electrical self-balancing vehicle. Moreover, the self-balancing vehicle shall be able to run properly.

8.2 Drop

PERFORM the drop test according to 9.4.2. After the test, it is allowed to have crack or rupture on the enclosure of the electrical self-balancing vehicle. However, the main load-bearing structure of the manned part on the vehicle body shall not catch fire or explode, with no obvious damage and electrolyte leakage.

For rechargeable electrical self-balancing vehicle with a built-in power supply, a test device with a diameter of 2.5mm and a length of 100mm, as specified by GB/T 4208-2017, shall be used for testing. The test device shall not touch the internal charging circuit.

8.3 Shock

PERFORM the shock test according to 9.4.3. After the test, the electrical self-balancing vehicle shall not catch fire or explode. Meanwhile, there shall be no rupture and electrolyte leakage on the enclosure.

For rechargeable electrical self-balancing vehicle with a built-in power supply, a test device with a diameter of 2.5mm and a length of 100mm, as specified by GB/T 4208-2017, shall be used for testing. The test device shall not touch the internal charging circuit.

8.4 Thermal shock

PERFORM the thermal shock test according to 9.4.4. After the test, the tested self-balancing vehicle shall be able to run properly. Meanwhile, there shall be no rupture and electrolyte leakage on the enclosure.

normal running according to the parameters specified by the manufacturer. Meanwhile, MONITOR the battery voltage and battery temperature.

PERFORM the test until the self-balancing vehicle takes protective measures such as safety alarm, tilting or the like or turns off the power to stop running.

9.1.7 Charge locking

TURN on a not fully charged self-balancing vehicle three times, in order to ensure that the self-balancing vehicle is able to run normally after startup.

USE a standard charger specified by the manufacturer to charge the self-balancing vehicle in off state. During charging, TURN on the self-balancing vehicle three times. If it is unable to start up, the test is over. If it is able to start up normally, TEST whether the self-balancing vehicle is capable of running.

9.1.8 Anti-spinning protection

TURN on the electrical self-balancing vehicle to enter its normal running state. ROTATE the wheel(s) through manual means or test equipment. When using the designed handle assembly to lift up the self-balancing vehicle, RECORD the duration from the wheel spinning starting when the self-balancing vehicle is lifted up to the wheel stalling.

9.2 Electrical safety tests

9.2.1 Motor overload test

Motor overload test is to evaluate the safety performance of the motor under overload.

The motor shall first be installed in a self-balancing vehicle for testing. Meanwhile, MONITOR the temperature of the motor windings. For ease of testing, the motor may be tested alone. However, its cooling conditions shall not be better than the case of the self-balancing vehicle.

The motor first runs at the maximum normal load. Then, INCREASE the load so that the current is properly increased while the motor's supply voltage is maintained at its original value. When the temperature reaches steady-state conditions, INCREASE the load again. In this way, the load is gradually increased in the appropriate gait, until the overload protector is active or the motor windings become open.

DETERMINE the motor winding temperature for each steady-state period. RECORD the maximum temperature, which shall not exceed the limits in Table 1.

9.2.5.2 Test procedure

This test shall be carried out after pretreatment.

This test procedure shall meet the requirements of 5.2.2 in GB 4943.1-2011, among which the peak working voltage is the maximum charging voltage of the electrical self-balancing vehicle.

9.3 Mechanical safety tests

9.3.1 IP code test

The method for testing the degree of protection provided by enclosure of the electrical self-balancing vehicle shall meet the requirements of GB/T 4208-2017.

9.3.2 Static strength test

At room temperature, for a seat-free electrical self-balancing vehicle, APPLY a static load, which is three times the manufacturer-specified upper weight limit, to the center point of the footrest through a support (such as a wooden block, etc.) with a cross-section of 102mm by 254mm. APPLY the load gradually over 5s. HOLD it for 30s.

If the footrest has two or more pieces or consists of multiple parts, the load shall be evenly distributed as described above at the center of each piece or each part.

For an electrical self-balancing vehicle with a seat, a static load, which is three times the manufacturer-specified upper weight limit, shall be applied at the center of the seat surface in the same manner.

9.3.3 Dynamic strength test

9.3.3.1 Pretreatment

Before the test, the tested self-balancing vehicle shall be placed in an environment at a temperature of (23 ± 2) °C and with a relative humidity of (50 ± 5) % or at a temperature of (20 ± 2) °C and with a relative humidity of (65 ± 5) % for 24h.

If the footrests or frames or other load-bearing structural members of the self-balancing vehicles are made of plastic materials (except for decorative parts), the sample shall be placed in an environment at a temperature of at least (-5 ± 1) °C or at the minimum operating temperature claimed by the manufacturer, whichever is lower, for 6h.

9.3.3.2 Test procedure

the solution and the immersion posture of the self-balancing vehicle shall be able to ensure that the entire battery pack of the tested self-balancing vehicle is immersed in solution. The duration of immersion shall be 5min.

After immersion, REMOVE the tested self-balancing vehicle. LET it stand at room temperature for 72h. During the test, always OBSERVE whether there are any anomalies such as fire, explosion, enclosure rupture or electrolyte leakage in the self-balancing vehicle.

After the test, TURN on three times to check whether it is able to normally start up and run. If it is able to normally start up for running, the tested self-balancing vehicle shall be conducted with one charge-discharge cycle according to the parameters specified by the manufacturer.

10 Marking and description

10.1 General

Marking and description include correct information on safe use and maintenance of the electrical self-balancing vehicle. The above information shall not only be used for the normal use and maintenance of users, but also for maintenance personnel. The above information shall give full consideration to the safety of use, maintenance and repair, especially the safety instructions for replacing the battery packs and optional accessories. Marks, symbols and written warnings shall be clear and easy to understand, especially regarding the functions and safety of the electrical self-balancing vehicle. The use of easy-to-understand notations (pictograms) take precedence over written warnings.

10.2 Product nameplate

10.2.1 Nameplate information

The product nameplate of the electrical self-balancing vehicle shall include necessary information that needs to be informed of the user and its specifications:

— product name and model;

— manufacturer’s name or trademark, manufacturer’s address;

— battery capacity and nominal voltage;

— input voltage;

— maximum load;

in case of the charger for outdoor use, the nameplate shall indicate the conditions of outdoor use;

— interface marking and description shall be indicated on the charger of the self-balancing vehicle;

— warning information or icons in the manual shall be read prior to use;

— battery pack warning identifications shall meet the requirements of the relevant battery product standards;

— other appropriate safety warning instructions.

10.4 Manual

The manual of the electrical self-balancing vehicle shall include the relevant instructions necessary for using, maneuvering, maintaining and dismantling the electrical self-balancing vehicle and the usage information, including but not limited to:

— size and weight of the self-balancing vehicle, restrictions on load or load capacity;

— degree of protection provided by enclosure of the self-balancing vehicle;

— ambient temperature limits and conditions for operation, storage and charging of the self-balancing vehicle;

— charging method of the self-balancing vehicle;

— storage, operation and recycling methods of the self-balancing vehicle;

— requirements and methods for turning off or switching the self-balancing vehicle to a certain mode of operation;

— detailed description of the operating environments and usage restrictions for the self-balancing vehicle, including but not limited to environmental conditions and road conditions, such as gradient, speed and payload of the road surface;

— description of the operating environments and potential risks that may cause hazardous situations during the use and driving of the self-balancing vehicle; appropriate training information shall be provided to avoid abnormal operations and accidental operations of users, such as sudden turning, rapid acceleration or rapid deceleration, etc.;

— information on the restrictive conditions of users, such as age, physical

References

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