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NATIONAL STANDARD OF THE
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ICS 25.040.30

CCS J 28

GB/T 34667-2023

Replacing GB/T 34667-2017

General Specifications of Electrical Self-balancing Vehicles

电动平衡车通用技术条件

Issued on: September 7, 2023

Implemented on: April 1, 2024

Issued by: State Administration for Market Regulation;

Standardization Administration of the People's Republic of China.

Table of Contents

Foreword.....	3
1 Scope.....	5
2 Normative References.....	5
3 Terms and Definitions.....	5
4 Classification of Electrical Self-balancing Vehicles	6
5 Technical Requirements.....	7
6 Test Methods	11
7 Inspection Rules.....	20
8 Packaging, Transportation and Storage.....	21
Appendix A (informative) Requirements for Safe Driving Power of Electrical Self-balancing Vehicles.....	23
Bibliography	26

General Specifications of Electrical Self-balancing Vehicles

1 Scope

This document defines the terms and definitions of electrical self-balancing vehicles, specifies the classification, technical requirements, inspection rules, packaging, transportation and storage requirements of electrical self-balancing vehicles, and describes the test methods.

This document is applicable to the design, production and sales of electrical self-balancing vehicles that use batteries as the power source, except for military, police and other special purposes.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 191 Packaging - Pictorial Marking for Handling of Goods

GB/T 2423.1 Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Tests A: Cold

GB/T 2423.3 Environmental Testing - Part 2: Testing Method - Test Cab: Damp Heat, Steady State

GB/T 2423.22-2012 Environmental Testing - Part 2: Test Methods - Test N: Change of Temperature

GB 17799.3 Electromagnetic Compatibility (EMC) - Generic Standards - Emission Standard for Industrial Environments

GB/T 34668 Safety Requirements and Test Methods for Electrical Self-balancing Vehicles

GB/T 40309 Electrical Self-balancing Vehicle - Electromagnetic Compatibility - Emission and Immunity Requirements

SJ/T 11685 Specifications of Lithium-ion Batteries and Battery Packs for Self-balancing Vehicles

3 Terms and Definitions

The following terms and definitions are applicable to this document.

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 steering column

A component used to control the steering of an electrical self-balancing vehicle, which may be equipped with other electronic displays or lighting equipment.

3.3 remote control software

An application software installed on an intelligent mobile terminal to set up, control or monitor an electrical self-balancing vehicle via a wireless connection.

3.4 safety alarm

An alarm (such as: sound, light and vibration, etc.) 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 and balance control unit failure) or dangerous driving actions or abnormal working conditions of the vehicle.

3.5 brake

An action of an electrical self-balancing vehicle to stop or decelerate its wheels by self-induction.

3.6 rated mileage

The mileage accumulated during the period when a fully charged electrical self-balancing vehicle runs at a constant speed of 60% of the maximum speed prescribed by the manufacturer on a flat hardened surface at a total load of 75 kg at room temperature, then travels at the maximum speed that it can reach in the case of failing to run at the speed above due to low power, until the self-balancing vehicle is unable to continue running due to low battery power.

NOTE: rated mileage is in unit of kilometer (km).

4 Classification of Electrical Self-balancing Vehicles

4.1 In accordance with the number of wheels, it may be classified as:

- a) electrical one-wheeled self-balancing vehicle -- an electrical self-balancing vehicle with only one wheel, including two tires on one wheel;
- b) electrical two-wheeled self-balancing vehicle -- an electrical self-balancing vehicle

with two wheels;

- c) electrical multi-wheeled self-balancing vehicle -- an electrical self-balancing vehicle with three or more wheels.

4.2 In accordance with the steering mode, it may be classified as:

- a) electrical self-balancing vehicle with a steering column;
- b) electrical self-balancing vehicle with no steering column.

4.3 In accordance with whether the seat is equipped, it may be classified as:

- a) electrical self-balancing vehicle with a seat;
- b) electrical self-balancing vehicle with no seat.

4.4 In accordance with the charging mode, it may be classified as:

- a) rechargeable electrical self-balancing vehicle with external power supply -- this type of electrical self-balancing vehicle is not directly connected to the AC grid during charging, but connected to AC grid via a charger or external power supply for charging;
- b) rechargeable electrical self-balancing vehicle with built-in power supply -- this type of electrical self-balancing vehicle is directly connected to the AC grid during charging.

5 Technical Requirements

5.1 Main Technical Performance Requirements

5.1.1 General

The design of the main technical performance of the self-balancing vehicle shall firstly satisfy the requirements for safe driving.

In terms of the tyres of the self-balancing vehicle, the minimum diameter is 125 mm and the minimum width is 25 mm.

Refer to Appendix A for the analysis and evaluation of necessary conditions for the safe driving of the self-balancing vehicle.

5.1.2 Maximum speed

In accordance with the maximum speed test in 6.2.1, the maximum speed shall not be greater than 20 km/h.

When the user stands on the vehicle for a long time, each pedal shall be equipped with a non-slip surface with an area of not less than 150 cm².

When the user stands on the vehicle for a short time and the vehicle is equipped with a seat, the non-slip surface of each pedal shall be at least 65 mm in length.

5.2.5 Switch

The electrical self-balancing vehicle shall be equipped with a master control set that is apparent, easy to access and not easy to operate incorrectly to turn on and off the driving power. In addition, this set shall be triggered by the user's autonomous behavior(s).

5.2.6 Foldable mechanism

The foldable mechanism (if any) of the electrical self-balancing vehicle shall be designed to be locked in a simple, stable and safe way. In the course of driving, the locking device shall not touch the moving parts, for example, wheels, etc. When driving, the foldable mechanism shall not have an accidental release, easy release in the case of mis-operation or there is obvious risk of tripping.

The foldable mechanism (if any) of the electrical self-balancing vehicle shall meet the requirements of 6.4.2.

5.2.7 Battery and battery pack

The performance of the battery and battery pack of the electrical self-balancing vehicle shall ensure that the electrical self-balancing vehicle may operate normally under its intended conditions of use.

The performance of lithium-ion battery and battery pack for the electrical self-balancing vehicle shall meet the requirements of SJ/T 11685.

5.3 Safety

The electrical self-balancing vehicle shall have sufficient safety to ensure its normal operation under its intended conditions of use.

The safety of the electrical self-balancing vehicle shall be consistent with GB/T 34668.

5.4 Environmental Adaptability Requirements

5.4.1 Temperature change

In accordance with 6.3.1, carry out the temperature change test. After the test, the self-balancing vehicle shall not lose its normal driving function, and all electrical components shall function normally.

5.4.2 Low-temperature operation

In accordance with 6.3.2, carry out the low-temperature operation test. The self-balancing vehicle shall not lose its normal driving function or suddenly stop running, and all electrical components shall function normally.

5.4.3 High-temperature and high-humidity operation

In accordance with 6.3.3, carry out the high-temperature and high-humidity operation test. The self-balancing vehicle shall not lose its normal driving function or suddenly stop running, and all electrical components shall function normally.

5.4.4 Electromagnetic compatibility

The electromagnetic disturbance produced by the electrical self-balancing vehicle shall not exceed the level allowed by its intended usage occasion(s). The emission of the electrical self-balancing vehicle shall meet the requirements of GB/T 40309 or GB 17799.3.

The electrical self-balancing vehicle shall have sufficient immunity against electromagnetic disturbance to ensure its proper operation in its intended operating environment. The immunity of the electrical self-balancing vehicle should meet the requirements of GB/T 40309 or GB/T 17799.1.

5.5 Durability Requirements

5.5.1 Durability of steering column

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

The steering column shall be conducted with the durability test according to 6.4.1. The steering column of the electrical self-balancing vehicle and its interconnecting pieces with the vehicle body shall have no crack, deformation or fracture. After being electrified, the self-balancing vehicle's steering function shall be normal. Meanwhile, the self-balancing vehicle may run normally.

5.5.2 Durability of foldable mechanism

This requirement applies only to the electrical self-balancing vehicles whose main bearing structures of the steering columns, frames and other manned parts on the vehicle bodies are equipped with foldable mechanisms.

After the foldable mechanism is conducted with the durability test according to 6.4.2, the foldable mechanism of the electrical self-balancing vehicle shall have no crack or fracture and be able to lock properly. Meanwhile, the electrical self-balancing vehicle shall be able to run normally.

5.5.3 Durability of self-balancing vehicle

After the vehicle is conducted with the durability test according to 6.4.3, the main bearing structures of the manned part on the body of the electrical self-balancing vehicle shall have no

of the driver and its equipment shall be 75 kg; when the total weight is less than 75 kg, counterweight shall be applied. If the maximum load of the product is less than 75 kg, then, the total weight of the driver and its equipment shall be equal to the maximum load of the product.

- b) Drivers shall master the driving skills and be familiar with the test methods.
- c) Drivers shall be equipped with helmets, knee pads, elbow pads and other necessary protective equipment.
- d) Drivers shall drive the test vehicles according to the operation methods specified by the manufacturer. Throughout the test, drivers shall try to keep the driving position without significant changes and avoid the operations which are not allowed by the manufacturer.

6.1.3 Test environment

Unless otherwise required by the test items, the test environment shall meet the following conditions:

- a) The temperature shall be within the range of nominal operating temperature of the electrical self-balancing vehicle. Unless otherwise specified, the room temperature specified in this document shall be $(25 \pm 5) ^\circ\text{C}$;
- b) Relative humidity: not greater than 75%;
- c) Atmospheric pressure: 86 kPa to 106 kPa;
- d) During the test, the average wind speed shall not be greater than 3 m/s; the instantaneous wind speed shall not be greater than 5 m/s;
- e) If it is necessary to test outdoors, rain, snow and other weather shall be avoided.

6.1.4 Test vehicle

The test vehicle shall meet the following conditions:

- a) The test vehicle shall be complete and fully charged according to the requirements of the manufacturer;
- b) The test vehicle shall be in accordance with the manufacturer's instructions, so that it can be in normal driving state;
- c) If the test vehicle is mounted with test instrument(s), the impact on the load distribution on each wheel and the windage effect shall be minimized as far as possible.

6.2 Main Technical Performance Test

6.3 Environmental Adaptability Tests

6.3.1 Temperature change test

The test shall be carried out in accordance with the requirements of Chapter 8 in GB/T 2423.22-2012.

Put the power-off self-balancing vehicle into the temperature test chamber. Start the test at room temperature. The low temperature (T_A) is $(-20 \pm 2) ^\circ\text{C}$ or the minimum storage temperature specified by the manufacturer. The high temperature (T_B) is $(60 \pm 2) ^\circ\text{C}$ or the maximum storage temperature specified by the manufacturer. The exposure time t_5 at each temperature is not less than 3 h, the number of test cycles is 8, and the temperature change rate is $(1 \pm 0.2) \text{ K/min}$.

6.3.2 Low-temperature operation test

In accordance with the following procedures, carry out the test:

- a) Fully charge the self-balancing vehicle in accordance with the method specified by the manufacturer. In accordance with the stipulations of GB/T 2423.1, put it into the temperature test chamber;
- b) Lower the temperature of the test chamber at a rate of $1 ^\circ\text{C/min}$ from room temperature to $(-10 \pm 2) ^\circ\text{C}$ or the minimum operating temperature specified by the manufacturer (whichever is lower);
- c) Turn on the self-balancing vehicle and maintain normal driving without load. During this period, the self-balancing vehicle is allowed to have a low-battery safety alarm or completely exhausted battery for 24 h;
- d) At a temperature change rate of $1 ^\circ\text{C/min}$, raise the temperature of the test chamber to room temperature $(25 \pm 5) ^\circ\text{C}$;
- e) Take out the self-balancing vehicle and restore it at room temperature. The recovery time shall allow the temperature to stabilize, at least 1 h. After recovery, in accordance with the method specified by the manufacturer, fully charge it and check whether the self-balancing vehicle can normally work.

After the test, check whether the self-balancing vehicle can run normally and whether the electrical components are functioning normally.

6.3.3 High-temperature and high-humidity operation test

In accordance with the following procedures, carry out the test:

- a) In accordance with the method specified by the manufacturer, fully charge the self-balancing vehicle. In accordance with the stipulations of GB/T 2423.3, put it into the temperature test chamber;

- b) Set the relative humidity of the test chamber to $(93 \pm 3)\%$, and at a rate of $1\text{ }^{\circ}\text{C}/\text{min}$, raise it from room temperature to $(40 \pm 2)\text{ }^{\circ}\text{C}$ or the maximum operating temperature specified by the manufacturer (whichever is higher);
- c) Turn on the self-balancing vehicle and maintain normal driving without load. During this period, the self-balancing vehicle is allowed to have a low-battery safety alarm or completely exhausted battery for 24 h;
- d) At a rate of $1\text{ }^{\circ}\text{C}/\text{min}$, lower the temperature of the test chamber to room temperature $(25 \pm 5)\text{ }^{\circ}\text{C}$;
- e) Take out the self-balancing vehicle and restore it at room temperature. The recovery time shall allow the temperature to stabilize, at least 1 h. After recovery, in accordance with the method specified by the manufacturer, fully charge it and check whether the self-balancing vehicle can normally work.

After the test, check whether the self-balancing vehicle can run normally and whether the electrical components are functioning normally.

6.4 Durability Test

6.4.1 Durability test of steering column

The durability test of the steering column of the electrical self-balancing vehicle shall be carried out according to the following procedures:

- a) Fix the electrical self-balancing vehicle on the test platform, only the steering column may be free to operate according to the normal mode of operation.
- b) Rotate the steering column to its maximum limit of motion in a certain direction according to its normal mode of operation. Let it go back to the initial position. Then, rotate the steering column in the opposite direction to its maximum limit of motion afterwards. Let it go back to the initial position. The force applied shall be subject to the maximum limit of motion of the steering column, and shall not exceed the maximum tension or thrust that the manufacturer provides for the steering column.
- c) Repeat the procedures in b) 10,000 times at a speed of 30 times/min or the speed specified by the manufacturer.
- d) Check the steering column and its interconnecting pieces with the vehicle body. Check whether the self-balancing vehicle is able to run properly.

6.4.2 Durability test of foldable mechanism

Open the foldable mechanism of the electrical self-balancing vehicle from the folding state to the operating state during normal driving, then, fold it to the folding state again, forming a folding cycle.

Visually inspect whether there are safety warning devices, and test the safety alarms, lights and other devices. The details are as follows:

- a) For the self-balancing vehicle with the locking function, turn on the power, move the self-balancing vehicle in locking state, then, check whether there are any safety alarms or relevant signals;
- b) After turning on the power, check whether the stop lamp lights up after braking;
- c) After turning on the light switch, check whether the light is on.

6.6 Inspection of Assembly Requirements

6.6.1 Inspection of general assembly requirements

Perform visual inspection on the appearance. Manually test whether the assembly of each component of the self-balancing vehicle is solid.

6.6.2 Inspection of overall dimensions

Use a tape measure or other measuring tools to measure the product's overall dimensions. The dimensions shall meet the parameter requirements in the instruction manual.

6.6.3 Inspection of electrical assembly requirements

Each electrical component of the electrical self-balancing vehicle shall be installed in place, with correct polarity. All nodes in the circuit must be in good contact with each other. The installation and fixation of the electrical elements shall be solid and reliable. Cables shall be fixed in a reliable manner. If necessary, other mechanical fixings may be added.

6.7 Inspection of Appearance Requirements

In accordance with the requirements of 5.7, perform visual inspection on the product appearance.

7 Inspection Rules

7.1 General

The inspection specified in this document is type inspection.

Unless otherwise specified, the inspection specified in this document is carried out only on the products manufactured within one year.

7.2 Type Inspection

Type inspection is generally carried out when the product design is finalized. However, it shall also be carried out when significant changes in major design, process, components and

Appendix A

(informative)

Requirements for Safe Driving Power of Electrical Self-balancing Vehicles

In addition to relying on the driver's operations, the safe driving of the electrical self-balancing vehicle is also highly dependent on the maximum power that the self-balancing vehicle is able to output. The maximum output power of the self-balancing vehicle depends on the minimum value among the maximum output power of the battery pack P_B , the maximum output power of the motor P_M , and the maximum output power of the controller P_C . Since the maximum output power of the controller P_C may be designed to be variable in relation to operating conditions and difficult to measure, this document assumes that P_C has been reasonably designed to be safe enough to be greater than P_B and P_M . Therefore, the maximum allowable power of the electrical self-balancing vehicle $P_U = \min(P_M, P_B)$, that is, the maximum allowable output power of the self-balancing vehicle $P_{\max}$. In general, the maximum output power of the electrical self-balancing vehicle $P_{\max}$ may be indicated in the instruction manual or on the nameplate.

On the other hand, in order to ensure the safe operation of the electrical self-balancing vehicle under various harsh conditions to the greatest extent, when operating within a reasonable range under harsh conditions, the maximum demanded power of the self-balancing vehicle P_W may reasonably be described as follows: in the case of maximum load nominated by the manufacturer, the driver passing the maximum climbing angle nominated by the manufacturer at a constant speed of 80% of the maximum speed nominated by the manufacturer or without deceleration; the ramp length shall not be less than 2 m; considering the usual service environment (for example, underground garage ramp or urban road, etc.) of the electrical self-balancing vehicle, the climbing angle in this test shall not be less than 10° .

In order to leave a certain safety margin, the maximum climbing angle and the maximum output power nominated by the manufacturer shall be multiplied by a certain safety factor based on the calculated value or the measured limit value. This safety factor may be taken between 0.6 and 0.8.

The methods for calculating the maximum output power of the battery pack P_B , the maximum output power of the motor P_M , the maximum demanded power P_W , and the maximum output power $P_{\max}$, of the entire vehicle as well as their relations are shown in Formula (A.1) to Formula (A.5).

- a) Maximum output power of the battery pack P_B

$$P_B = U_B \cdot I_{B\max} \dots\dots\dots (A.1)$$

Where,

U_B ---the rated output voltage of the self-balancing vehicle's battery pack, expressed in (V);

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