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NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

ICS 03.220.20;93.080.30

CCS R 85

GB/T 23828-2023

Replacing GB/T 23828-2009

Light-emitting diode changeable message signs of motorway

高速公路 LED 可变信息标志

Issued on: March 17, 2023

Implemented on: October 01, 2023

**Issued by: State Administration for Market Regulation;
Standardization Administration of the People's Republic of China.**

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Light-emitting diode changeable message signs of motorway

1 Scope

This document specifies the classification, composition and model, technical requirements, test methods, inspection rules, as well as signs, packaging, transportation and storage for light-emitting diode (LED) changeable message signs of motorway.

This document applies to the production, use and inspection for light-emitting diode changeable message signs of motorway.

2 Normative references

The following referenced documents are indispensable for the application 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.

GB/T 191, *Packaging and storage marks*

GB/T 2312, *Code of Chinese graphic character set for information interchange - Primary set*

GB/T 2423.1, *Environmental testing for electric and electronic products - Part 2: Test methods - Tests A: Cold*

GB/T 2423.2, *Environmental testing for electric and electronic products - Part 2: Test methods - Tests B: Dry heat*

GB/T 2423.3, *Environmental testing - Part 2: Testing method - Test Cab: Damp heat, steady state*

GB/T 2423.10, *Environmental testing - Part 2: Test methods - Test Fc: Vibration (sinusoidal)*

GB/T 2423.17, *Environmental testing for electric and electronic products - Part 2: Test method - Test Ka: Salt mist*

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

GB/T 3681.1, *Plastics - Methods of exposure to solar radiation - Part 1: General guidance*

well as the followings apply.

3.1 LED changeable message signs

The equipment that the full screen uses LED as the light-emitting unit, which can change different traffic information on the display screen through automatic or manual control.

3.2 pixel

The smallest imaging unit of LED variable information signs.

3.3 LED panel

It is composed of one or several display modules, which can be controlled by the display control system to complete the screen display.

[Source: SJ/T 11141-2017, 3.2]

3.4 dotpitch

The center-to-center distance between adjacent pixels.

3.5 half-intensity angle

The minimum angle between the measuring optical axis when the luminous intensity of a single LED is half of its maximum luminous intensity and the measuring optical axis of the maximum luminous intensity.

3.6 angle of deflection

The angle between the measuring optical axis of the maximum luminous intensity of a single LED and the normal optical axis.

3.7 viewing angle

The maximum distance that the observer (normal person, with corrected vision of 1.0 or above) can correctly read the content of the sign within the specified distance, after deviating from the normal direction of the sign surface, under the condition that the ambient illuminance is greater than 50,000 lx on a sunny day and the sun shines on the sign surface.

3.8 static distinguishing distance

The maximum distance that the observer (normal person, with corrected vision of 1.0 or above) can correctly read the content of the sign within the specified viewing angle under the condition that the ambient illuminance is greater than 50,000 lx on a sunny day and the sun shines on the sign surface.

The insulation resistance between the power terminal and the casing of the LED changeable message sign of motorway shall not be less than 100 M Ω .

5.9.2 Electric strength

Apply a sinusoidal AC voltage with a frequency of 50 Hz and an effective value of 1500 V between the power terminal of the highway LED variable information sign and the casing for 1 min. There shall be no flashover or breakdown.

5.9.3 Safety grounding

LED changeable message signs of motorway shall be equipped with safety protection grounding terminals. The grounding terminal is reliably connected to the casing (including the metal casing of the live parts). The connection resistance between the ground terminal and the casing shall be less than 0.1 Ω .

5.9.4 Power adaptability

LED changeable message signs of motorway shall adapt to the requirements of power grid fluctuations, and shall work normally under the following conditions:

- Voltage: AC 220 V $\pm$ 33 V;
- Frequency: 50 Hz $\pm$ 2 Hz.

5.9.5 Contact current

When the LED changeable message sign of motorway is working, the contact current between the power terminal and the ground terminal shall be less than 3.5 mA.

5.9.6 Lightning protection and overvoltage protection

Necessary lightning protection and overvoltage protection measures shall be taken for LED changeable message signs of motorway. The interfaces, components and protective measures adopted shall meet the requirements of GB/T 18802.11.

5.10 Degree of protection for casing

Rainproof and dustproof measures shall be taken for LED changeable message signs of motorway. The protection level of the casing shall not be lower than IP56 according to the provisions of GB/T 4208-2017. The protection level of the casing of the LED changeable message sign of motorway applied in the tunnel environment shall be IP66.

5.11 Electromagnetic compatibility

5.11.1 Surge immunity

It shall meet the requirements of GB/T 9254.2.

5.11.2 Electrostatic discharge immunity

Conduct electrostatic discharge immunity tests on the points and surfaces that operators may touch when using the LED changeable message signs of motorway, as well as user maintenance points. The product shall work normally.

5.11.3 Immunity to radio frequency electromagnetic field radiation

Carry out the radio frequency electromagnetic field radiation immunity test on the four sides of the LED changeable message sign of motorway in normal operation at the vertical polarization and horizontal polarization positions of the transmitting antenna, respectively. The product shall work normally.

5.11.4 Electrical fast transient burst immunity

Conduct electrical fast transient burst immunity test on the power port, signal and control port of the LED changeable message sign of motorway and the grounding wire of the chassis. The product shall work normally.

5.12 Mechanical properties

The structure of LED changeable message signs of motorway shall be stable. After bearing the wind pressure generated by the wind speed of 40 m/s, the deformation shall not be greater than 2 mm, and the performance of the sign board shall not be affected.

5.13 Communication interface and procedures

5.13.1 The interface shall use an Ethernet interface with a rate not lower than 100 Mbit/s. It shall comply with the regulations of 100BASE-TX in IEEE 802.3-2018.

5.13.2 When providing other interfaces and procedures, detailed interface parameters and communication procedures shall be provided for connection with the system.

5.13.3 The connection between the interface and the outside shall be convenient for installation and maintenance. Take waterproof, dustproof and other measures.

5.13.4 The data interaction format adopted by LED changeable message signs of motorway shall comply with the provisions of Annex A.

5.14 Environmental adaptability

5.14.1 Low temperature resistance performance. According to the test method given in 6.14.1, the LED changeable message sign of motorway is tested under the electrified state. The product shall work normally.

5.14.2 Storage performance at low temperature. According to the test method given in 6.14.2, the LED changeable message sign of motorway is tested under the power-off state. After recovery, the product shall start normally, and the logic is correct.

5.16.2 Automatic functions

After being connected to the system through the communication interface, it shall be able to accept the control of the system or the main control unit. Correctly display the corresponding content according to the command of the system or the main control unit and upload the working status to the system or the main control unit.

5.16.3 Manual functions

When deviating from the automatic control of the system, it shall be possible to manually control the displayed content locally or remotely.

5.16.4 Self-test function

It can automatically detect and feed back to the upper computer the fault status and location of pixels, drive modules, etc., the working status of the lightning protector, the status of the door switch, the input voltage of the power supply, the temperature in the chassis, etc.

5.16.5 Dimming function

The LED changeable message sign of motorway shall be equipped with an ambient illumination detection device. The luminous intensity of pixels can be adjusted according to the ambient illuminance to avoid glare when the ambient illuminance is low and affect the visual reading of information. Dimming level shall not be less than 32 levels.

5.16.6 Local storage function

LED changeable message signs of motorway shall have the function of storing pictures, texts and other information locally.

5.17 Information security

5.17.1 Access and visit control

LED changeable message signs of motorway shall have the ability to identify the host computer and users. Only authorized host computers and users can access and manage the controller software.

The upper computer shall have the detection and alarm function of power failure and unauthorized removal of the controller.

5.17.2 Remote security management function

The LED changeable message sign of motorway shall support remote updating of keys, key configuration parameters, key system patches, etc.

5.17.3 Emergency display function

- Welcome to use the ×××× Expressway;
- Heavy fog, and the speed limit is 20 km/h;
- The traffic volume is heavy, and the speed limit is 80 km/h.

6.7.3 Test staff. Divide into two groups. One group is controllers that publish the content of 6.7.2. The other group is the visual recognizers who recognize and read the content, usually three or five people.

6.7.4 Test results. The test results are divided into qualified results and unqualified results. The conclusion of most viewers shall be the final result. For each visual recognizer, when the correct rate of the content of the sign is not less than 90% and the unclear rate is not greater than 50%, it is qualified. If the accuracy rate of the logo content is lower than 90% or the unclear rate is greater than 50%, it is unqualified.

6.7.5 Test plan for static distinguishing distance. The controller combines the contents specified in 6.7.2 into 10 pieces of test information in any order. Display in full screen at intervals of 30 s. The programming sequence and content shall not be notified to the viewer in advance. The viewer recognizes, records, and evaluates the display content of the sign within the specified viewing angle and viewing distance.

6.7.6 Test plan for dynamic distinguishing distance. Choose 3 items from 6.7.2 as test information. Display on the sign before the viewer passes the maximum distinguishing distance of 210 m, ensuring that the viewer has enough time to read the content on the sign before 210 m. Turn off the display immediately within 2 s after the test vehicle passes 210 m. Display 1 message at a time. Conduct three times in total. Record and evaluate test results.

6.7.7 Test plan for viewing angle. The controller combines the contents specified in 6.7.2 into 10 pieces of test information in any order. Display in full screen at intervals of 30 s. The programming sequence and content shall not be notified to the viewer in advance. The viewer reads the display content of the sign at 10 m in front of the changeable message sign under the daytime ambient light condition. Record and evaluate test results.

6.7.8 Pixel light uniformity. When measuring the luminous uniformity of pixels, the number of pixels under test shall not be less than 10% of the total. Measure the normal luminous intensity of the extracted pixels according to the method in 6.2.2. Or use a luminance meter to directly measure the normal luminance of a pixel. Obtain a measure column. Find the mean, minimum, and maximum values of the measured columns, respectively. Calculate the non-uniformity of pixel light emission according to formula (3).

$$P_u = \max \left\{ \frac{|I_{\min} - I_a|}{I_a}, \frac{|I_{\max} - I_a|}{I_a} \right\} \times 100\% \quad \dots\dots\dots (3)$$

adjustable AC power supply. Power frequency is 50 Hz. The test voltages are 187V→200V→220V→240V→253V→230V→210V→187V. After the voltage is adjusted to the first gear and stabilized, turn on and off the power switch of the LED changeable message sign of motorway, respectively.

6.9.5 Frequency fluctuation adaptability. Supply power by adjustable frequency AC power. The power supply voltage is AC 220 V. The test frequencies are 48Hz→49Hz→51Hz→52Hz, respectively. After each frequency is adjusted to the first gear and stabilized, turn on and off the power switch of the LED changeable message sign of motorway, respectively.

6.9.6 The contact current test shall be carried out according to the provisions of GB 4943.1. The input voltage of the LED changeable message sign of motorway is 1.06 times of the rated voltage.

6.10 Enclosure protection level

The enclosure protection level test shall be carried out in accordance with the provisions of GB/T 4208-2017.

6.11 Electromagnetic compatibility

6.11.1 The surge immunity test shall be carried out according to the provisions of GB/T 9254.2.

6.11.2 The electrostatic discharge immunity test shall be carried out according to the provisions of GB/T 17626.2. The test voltage of contact discharge is ± 4 kV. The test voltage of air discharge is ± 8 kV. Apply at least 10 single discharges. The discharge interval is not less than 1 s.

6.11.3 The radio frequency electromagnetic field radiation immunity test shall be carried out according to the provisions of GB/T 17626.3. The test field strength is 3 V/m.

6.11.4 The electrical fast transient burst immunity test shall be carried out according to the provisions of GB/T 17626.4. Apply the 2kV test voltage to the power supply port and the protective ground through the coupling/decoupling network. Apply 1 kV test voltage to the input and output signal and control ports through the coupling/decoupling network. Pulse repetition rate is 100 kHz. Apply the test voltage five times. The duration of each time is not less than 1 min.

6.12 Mechanical properties

6.12.1 It is suitable to use the wind tunnel to simulate the 40 m/s wind speed to carry out the structural stability test of the LED changeable message sign of motorway. When there is no wind tunnel test condition, the simulation test can be carried out with sandbags according to 6.12.2.

6.12.2 The test device of the sandbag test method consists of a base and a support arm, which can support flat and sideways placement of signs. The test is carried out according to the following steps:

- a) Install the panel of the LED changeable message sign of motorway downwards and horizontally on the support arm. Maintain it stable for 10 min. Use the measuring tools specified in 6.3.3 to test the structural size of the sign.
- b) Add sandbags evenly to the back of the LED changeable message sign of motorway. The positive pressure generated by the sandbag on the back projection surface of the sign is 1.5 kN/m^2 . After loading, keep 10 min and remove the sandbag. Immediately test the structural size of the sign.
- c) Install the panel of the LED changeable message sign of motorway upwards and horizontally on the support arm. Maintain it stable for 10 min. Use the measuring tools specified in 6.3.3 to test the structural size of the sign.
- d) Add sandbags evenly on the panel of the LED changeable message sign of motorway. The positive pressure generated by the sandbag on the sign panel is 1.5 kN/m^2 . After loading, keep 10 min and remove the sandbag. Immediately test the structural size of the sign.

6.13 Communication interface and procedure

The test method of communication interface and procedure is divided into two parts: subjective evaluation and objective test. Subjective evaluation is to connect the LED changeable message sign of motorway with the host computer, so as to verify that the LED changeable message sign of motorway and the host computer can realize two-way data transmission. The objective test shall be carried out according to the provisions of GB/T 34428.1 and GB/T 34428.3.

Read the exchange data. Check according to the requirements of Annex A.

6.14 Environmental adaptability

6.14.1 The low temperature resistance performance test shall be carried out according to the provisions of GB/T 2423.1. The temperature is -5°C (or -20°C , -40°C , -55°C). The test time is 8 h.

6.14.2 The low temperature storage performance test shall be carried out according to the provisions of GB/T 2423.1. The temperature is -5°C (or -20°C , -40°C , -55°C). The test time is 8 h. After the test, recover at room temperature for 2 h.

6.14.3 The high temperature working performance test shall be carried out according to the provisions of GB/T 2423.2. The temperature is $+45^{\circ}\text{C}$ (or $+50^{\circ}\text{C}$, $+55^{\circ}\text{C}$, $+70^{\circ}\text{C}$, $+85^{\circ}\text{C}$). The test time is 8 h.

6.14.4 The performance test of heat and humidity resistance shall be carried out

according to the provisions of GB/T 2423.3. The temperature is +40°C. The relative humidity (98±2)%. The test time is 48 h.

6.14.5 The temperature alternating performance test is carried out according to the provisions of GB/T 2423.22 test Na. Keep at high temperature +70°C for 2 h. Transfer to low temperature -40°C within 3 min and keep for 2 h. Transfer to high temperature again within 3 min. In this way, cycle for 5 times.

6.14.6 The mechanical vibration resistance performance test shall be carried out according to the provisions of GB/T 2423.10. The frequency range is 2 Hz ~ 150 Hz. Control by displacement at 2 Hz ~ 9 Hz. The displacement amplitude is 3.5 mm. Control by acceleration at 9 Hz ~ 150 Hz. The acceleration amplitude is 10 m/s². 2Hz→9Hz→150Hz→9Hz→2Hz is a cycle, a total of 20 cycles.

6.14.7 The salt spray corrosion resistance test shall be carried out according to the provisions of GB/T 2423.17. The test time is 168 h.

6.14.8 There are two methods for weather resistance: natural exposure test and artificial accelerated aging test.

The natural exposure test shall be carried out according to the provisions of GB/T 3681.1.

The artificial accelerated aging test is carried out according to the following steps:

- a) Specimen sampling position and preparation conditions. Specimens for aging test shall be taken from the product. When sampling is difficult, a small sample can be used instead. The treatment process of the small sample shall be the same as that of the whole product.
- b) Quantity of specimens. Take 9 pieces of shell and supporting base plate, of which 6 pieces are used for test and 3 pieces are used as reference samples. They are stored in a darkroom. There are 12 pixels. 6 are used for testing, and 6 are used as reference samples, which are stored in a dark room.
- c) The size of the specimen (except pixels): 65 mm × 142 mm.
- d) Test equipment: xenon arc lamp artificial accelerated weather resistance test chamber.
- e) Test conditions. The irradiance of the light source with a wavelength of 290 nm ~ 800 nm is 550 W/m². The spectral irradiance at the spectral wavelength of 340 nm is not greater than 0.50 W/(m²·nm). For specimens on the plane of the specimen holder parallel to the lamp axis, the difference in irradiance between any two points on the surface shall not be greater than 10%. During the test, continuous irradiation and periodic water spraying are adopted. The water spray cycle is 18min/102min (water spray time/no water spray time), that is, every 120

6.17.1 Authorized host computer and user access to LED changeable message signs of motorway shall be able to access and manage the software. Using an unauthorized host computer and users accessing the product shall not be able to access and manage the software.

Simulate power failure of the LED changeable message sign of motorway, unauthorized removal of the controller. Check the alarm status of the upper computer.

6.17.2 Authorized users remotely access the LED changeable message sign of motorway, and remotely update keys, key configuration parameters, and key system patches.

6.17.3 Simulate controller failure of the LED changeable message sign of motorway or communication connection interruption with host computer. Check the product display.

6.17.4 Check the log content of the LED changeable message sign of motorway.

6.17.5 Check the encryption and decryption function of cryptography to protect the confidentiality of sensitive information or communication messages in the communication process. Verify the correctness and effectiveness of the confidentiality protection mechanism for sensitive information or communication messages.

Check the integrity protection of data in the communication process by cryptographic technology. Verify the correctness and effectiveness of the communication data integrity protection mechanism.

6.17.6 Check the compliance of the encryption technology used with the national standard or industry standard. Check the compliance of cryptographic algorithms with national standards or industry standards. Or obtain a certificate from the national encryption management department agreeing to its use. Check the compliance of encryption products with the regulations of the national encryption management department.

7 Inspection rules

7.1 Inspection classification

7.1.1 The inspection of LED changeable message signs of motorway is divided into type inspection and exit-factory inspection.

7.1.2 In one of the following situations, type inspection shall be carried out:

- a) When a new product is trial-formulated and identified or an old product is transferred to a factory for production;
- b) After formal production, if there are major changes in materials, structures, and

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