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**Requirements and testing methods of warning sound for
vehicle reversing**

车辆倒车提示音要求及试验方法

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Table of Contents

Foreword	3
1 Scope	4
2 Normative references	4
3 Terms and definitions	4
4 Requirements	6
4.1 Warning sound requirements	6
4.2 Requirements for warning sound device	7
4.3 Requirements for vehicle warning sound	9
4.4 Warning sound type	10
5 Test method.....	11
5.1 Test equipment	11
5.2 Test site	12
5.4 Performance test of the warning sound device	13
5.5 Sound pressure level test of the warning sound device	17

Requirements and testing methods of warning sound for vehicle reversing

1 Scope

This document specifies the terms and definitions, requirements, test methods for vehicle reversing warning sounds.

This document is applicable to vehicles of categories N₂, N₃, M₂ (maximum design gross mass greater than 3500 kg), as well as category M₃. Other vehicles shall refer to it.

2 Normative references

The contents of the following documents constitute the essential terms of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB/T 3785.1 Electroacoustics - Sound level meters - Part 1: Specifications

GB/T 15173 Electroacoustics - Sound calibrators

GB/T 22157 Acoustics - Specification of test tracks for measuring noise emitted by road vehicles and their tyres

GB/T 28046.4-2011 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads

GB/T 30038 Road vehicles - Degrees of electrical equipment protection (IP-Code)

GB/T 34828 Acoustics - Test methods for the qualification of free-field environments

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Warning sound for vehicle reversing

4.1.1.1 Warning sound shall be intermittent and contain at least one silent component in each cycle.

4.1.1.2 Warning sound shall be one of the following: buzzer tone, broadband tone, 1/3 octave tone or voice combination tone.

4.1.2 Warning sound type requirements

4.1.2.1 Buzzer tone

The buzzer tone emitted by the vehicle when reversing is played in a loop, including a sound with a main frequency, whose frequency range is 1000 Hz ~ 2800 Hz; the playback frequency is 90 times/min $\pm$ 30 times/min.

4.1.2.2 Broadband tone

The broadband tone emitted by the vehicle when reversing is played in a loop, including sounds with multiple frequencies, whose frequencies are at least continuous within 1000 Hz ~ 4000 Hz; the playback frequency is 90 times/min $\pm$ 30 times/min.

4.1.2.3 1/3 octave tone

The 1/3 octave sound played in a loop when the vehicle is reversing has its main energy in one of the seven 1/3 octaves; the power spectrum density remains constant in the 1/3 octave. The center frequencies of the seven 1/3 octaves are 800 Hz, 1000 Hz, 1250 Hz, 1600 Hz, 2000 Hz, 2500 Hz, 3125 Hz, respectively. The playback frequency is 90 times/min $\pm$ 30 times/min.

4.1.2.4 Voice combination tone

The voice combination tone consists of voice and one of the buzzer tone, broadband tone, or 1/3 octave tone. The voice is played after the buzzer tone, broadband tone, or 1/3 octave tone. The voice is "Reverse, please pay attention" and shall be in clear and recognizable Mandarin. The playback frequency is 30 times/min $\pm$ 10 times/min.

4.2 Requirements for warning sound device

4.2.1 General requirements

4.2.1.1 The non-self-adjusting sound device shall contain at least the normal level.

4.2.1.2 The multiple warning device system shall cover at least two sound pressure level modes, one of which is the normal level.

4.2.1.3 The sound emitted by the warning sound device shall reach the minimum sound pressure level within two cycles.

5 Test method

5.1 Test equipment

5.1.1 Meteorological measuring instruments

Meteorological measuring instruments are mainly used to monitor environmental conditions during the test; their accuracy shall meet the following requirements:

- Temperature measuring instruments: $\pm 1\text{ }^{\circ}\text{C}$;
- Wind speed measuring instruments: $\pm 1\text{ m/s}$;
- Air pressure measuring instruments: $\pm 5\text{ hPa}$;
- Relative humidity measuring instruments: $\pm 5\%$.

5.1.2 Acoustic measuring instruments

5.1.2.1 Requirements for acoustic measuring instruments

The sound level meter or other equivalent measuring instruments, which are used for measurement, shall meet the requirements of Class 1 sound level meters specified in GB/T 3785.1. The "A" frequency weighting characteristics and "F" time weighting characteristics described in GB/T 3785.1 shall be used for measurement. When using an instrument that can periodically monitor the A-weighted sound pressure level, the time interval between its readings shall not be greater than 30 ms.

For voice combination warning sounds, the measuring instrument shall be able to measure the sound pressure level of the buzzer warning sound, broadband warning sound, 1/3 octave warning sound, voice warning sound, respectively, that is, the sound pressure waveforms of the measured buzzer warning sound, broadband warning sound, 1/3 octave warning sound, voice warning sound are easy to identify and process.

When measuring frequency, the digital sound recording instrument shall be quantized to at least 16 bits; its average auto-power spectrum shall be determined using a Hanning window and at least 66.6% overlap average, meanwhile cover the relevant frequency band.

5.1.2.2 Calibration of acoustic measuring instruments

Before and after measurement, the sound level meter shall be calibrated according to the manufacturer's requirements using a Class 1 sound calibrator that complies with the provisions of GB/T 15173. Without any adjustment, if the difference between the latter calibration reading and the previous calibration reading exceeds 0.5 dB(A), the results

of the relevant tests after the previous calibration are invalid.

The above calibration work for sound calibrators, sound level meters or other equivalent measuring instruments shall be carried out, by qualified testing institutions in accordance with the relevant standards.

5.2 Test site

5.2.1 Outdoor conditions

5.2.1.1 Outdoor meteorological conditions

During the test, the meteorological conditions shall meet the following requirements:

- Temperature: $-10\text{ }^{\circ}\text{C} \sim 50\text{ }^{\circ}\text{C}$;
- Wind speed: less than or equal to 5 m/s. When the wind speed exceeds 2 m/s, it is recommended that the microphone use a windshield;
- Meteorological equipment shall provide representative data of the test site and shall be placed in an area close to the test area, at a height that is the typical microphone height;
- During the test, there shall be no precipitation in the air (such as rain, hail, etc.); meanwhile the surface of the test site shall be kept dry;
- During the test interval, the values of temperature, wind speed, wind direction, relative humidity, air pressure shall be recorded.

5.2.1.2 Outdoor site conditions

The site meets one of the following requirements.

- a) Test site that meets the requirements of GB/T 22157.
- b) The site shall be an open space with a radius of not less than 50 m. The space shall not have large reflective objects such as walls, rocks, bridges or buildings. The central part used for measurement shall be level, within a radius of not less than 20 m. The site shall be a flat open ground made of concrete, dense asphalt or similar hard materials without obvious pores. It shall not be snow, haystacks, loose soil or other ground with sound absorption characteristics.

5.2.2 Indoor semi-anechoic or anechoic chamber conditions

Anechoic chambers or semi-anechoic chambers shall meet the requirements of GB/T 34828.

5.3 Test method of background noise sound pressure level

When measuring background noise, the measurement shall be continued for at least 10 s. When calculating background noise using a 10 s sound obtained from the measurement, it shall be ensured that the sound is typical background noise and does not contain any transient interference. The measurement shall use the same sound level meter and sound level meter position as in the test process.

When testing in an indoor semi-anechoic or anechoic chamber, the noise emitted by other test equipment, including air handling noise, shall be recorded as background noise.

The highest sound pressure level of the 10 s sound, which is measured from the sound level meter, shall be recorded as the background noise of the sound level meter; the range from the maximum to the minimum value of the 10 s sound shall be recorded.

5.4 Performance test of the warning sound device

5.4.1 Test site

The test of the warning sound device should be carried out in an anechoic room. When it is carried out in a semi-anechoic room or an outdoor site specified in 5.2.1.2, some precautions (such as sound absorption screens) shall be taken, to avoid the influence of ground reflection in the measurement area on the measurement results. The background noise sound pressure level shall be at least 10 dB(A) lower than the sound pressure level to be measured.

5.4.2 Test voltage

When the nominal voltage of the warning sound device is 12 V, the test voltage is 14 V $\pm$ 0.2 V; when the nominal voltage is 24 V, the test voltage is 28 V $\pm$ 0.2 V.

5.4.3 Microphone position

The warning sound device shall be firmly installed on the metal base frame according to the specified installation method. The mass of the base frame shall be at least 10 times that of the warning sound device. It is necessary to ensure that the side reflection and self-vibration of the base frame will not have a significant impact on the test results during the test.

The warning sound device shall be kept at the same height as the microphone, which is 1.20 m $\pm$ 0.05 m. The center line of the maximum sensitivity of the microphone shall coincide with the direction of the maximum sound pressure level of the warning sound device; the offset of the microphone from the center line shall be within the range of $\pm$ 0.02 m.

When measuring the warning sound, play the reference sound. Each measurement time is not less than 5 s. The maximum value during the measurement process is taken as the measurement result. The value shall be rounded off according to the principle of rounding.

For the stepwise self-adjusting warning device, the total sound pressure level measured under each reference sound pressure shall meet the requirements of 4.2.2.2. For the self-adjusting warning device, the total sound pressure level measured under each reference sound pressure shall meet the requirements of 4.2.2.3.

5.4.4.3 Test of voice combination warning sound pressure level

Measure the voice combination warning sound according to the method specified in 5.4.4.1 ~ 5.4.4.2. Measure the sound pressure level of the buzzer warning sound, broadband warning sound, 1/3 octave warning sound, voice warning sound, respectively. The value shall be rounded up according to the principle of rounding up. Compare the two; the result shall comply with the provisions of 4.2.2.4.

5.4.5 Frequency test

Test under the conditions specified in 5.4.1 ~ 5.4.2. Measure 10 cycles continuously. Record the frequency value or frequency range in each cycle. The value shall be rounded up according to the principle of rounding up. For non-self-adjusting warning sound devices or multiple warning device systems, the difference between the measured frequency or frequency range and the rated frequency or frequency range shall not exceed 10%. For stepwise self-adjusting warning devices or self-adjusting warning devices, the speaker used to play the reference sound shall be turned off during measurement; the difference between each cycle shall not exceed 10%.

5.4.6 Frequency test

Test the frequency of the warning sound under the conditions specified in 5.4.1 ~ 5.4.2. The total measurement time shall not be less than 3 minutes. If the last cycle is an incomplete cycle, it shall also be counted as 1 cycle. The result shall comply with the provisions of 4.1.2.

5.4.7 Low temperature resistance test

Place the device in a test chamber at -40 °C and test according to the provisions of 5.1.1.1 of GB/T 28046.4-2011.

5.4.8 High temperature resistance test

Place the device in a test chamber at 85 °C and test according to the provision 5.1.2.1 of GB/T 28046.4-2011.

5.4.9 Reliability test

5.4.9.1 Reliability test requirements

If the test is conducted in an anechoic chamber, the anechoic chamber shall be large enough to ensure the normal dissipation of heat from the warning sound device during the test.

5.4.9.2 Temperature change resistance test

Place the device in a test chamber at 70 °C for 1 hour; in a test chamber at -30 °C for 1 hour; in a test chamber at 50 °C for 1 hour; in a test chamber at -20 °C for 1 hour.

5.4.9.3 Durability test

Place the device in an environment at 25 °C ± 11 °C and run continuously for 50 hours.

5.4.9.4 Vibration resistance test

Place the device in an environment at 25 °C ± 11 °C, with a vibration cycle of 2000 times/min ± 200 times/min and an amplitude of 2 mm ± 0.2 mm, for 30 minutes in each of the three directions of x, y, z.

5.5 Sound pressure level test of the warning sound device

5.5.1 Test site

The vehicle test of the warning sound device can be carried out in an anechoic room or a semi-anechoic room, or in an outdoor site specified in 5.2.1.2.

5.5.2 Vehicle status

The vehicle shall be parked stably at the designated position; the windows shall be closed; the wheels shall be in a straight-line driving position; the battery voltage shall be normal; the air conditioning device shall be turned off.

If the vehicle's fan has an automatic start function, it shall be ensured that the fan does not start during the sound pressure level test.

Other sound-generating devices that affect the measurement results shall be turned off.

5.5.3 Test voltage

The test voltage can be any of the following:

- a) Powered by the vehicle battery only;
- b) Powered by the vehicle battery when the engine is preheated and the vehicle is idling;

corrected according to the requirements of 5.5.7. The corrected value shall be rounded off as the final result according to the principle of rounding off, which shall meet the requirements of 4.3.2.1.

5.5.6.2 Test of stepwise self-adjusting warning device and self-adjusting warning device

Test under the conditions specified in 5.5.1 ~ 5.5.5. After the reversing signal is triggered and the warning sound device starts working, find the maximum sound pressure level height in the range of $0.5\text{ m} \pm 0.05\text{ m}$ to $1.5\text{ m} \pm 0.05\text{ m}$ above the ground. Fix the microphone at the position of the maximum sound pressure level, to measure the sound pressure level. The measurement time shall not be less than 10 s. The maximum value during the test shall be taken as the measurement result. The recorded data shall be accurate to one decimal place.

Turn off the warning sound device and measure the sound pressure level of the background noise at this position. The measurement time shall not be less than 10 s. The maximum value during the measurement shall be taken as the measurement result at this position. The recorded data shall be accurate to one decimal place.

For the stepwise self-adjusting warning device, the maximum value shall be corrected according to the requirements of 5.5.7. The difference between the turning on and off of the warning sound device shall be calculated. The final result shall be rounded off according to the principle of rounding off, which shall meet the requirements of 4.3.2.2.

For the self-adjusting warning device, calculate the difference between the on and off of the warning sound device; round it off as the final result according to the principle of rounding, which shall meet the requirements of 4.3.2.3.

5.5.7 Correction method of sound pressure level

The measured sound pressure level shall be corrected according to Table 6, based on the difference between the maximum and minimum background noise during measurement. For the whole vehicle test of the self-adjusting warning device, if a peak value that is obviously different from the normal sound pressure level is observed during the test, this data shall be discarded.

$$L_{\text{test corr}} = L_{\text{test}} - L_{\text{corr}} \dots\dots\dots (1)$$

Where:

$L_{\text{test corr}}$ - Test correction value, in decibels [dB(A)];

L_{test} - Test value of warning sound pressure level, in decibels [dB(A)];

L_{corr} - Correction value, in decibels [dB(A)].

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