Research on Test Method of Radio Frequency Radiation Anti-interference of Road Vehicles

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Abstract. Based on the comparison and analysis of ISO11452-2 (2004 and 2019), the differences in the testing of radiation immunity Absorber-lined shielded enclosure method are sorted out, and the testing requirements of the newly added High voltage electronic parts components are interpreted.

1.Introduction
ISO 11452-2:2019 "Test Method for Resistance of Electrical/electronic Components of Road Vehicles to Narrow-Band Electromagnetic Energy: Anechoic Chamber Method" was issued in January 2019 and supersedes ISO 11452-2:2004. This standard is used to test the anti-interference ability of automobile electronic parts to narrow-band electromagnetic radiation. Compared with 2004 edition, 2019 edition not only modified the existing contents of 2004 edition, but also added the test layout and method of high-pressure components. This article is a detailed interpretation of the differences between the two versions.

2.Differences in test layout
2.1. Changes of grounding lap mode
The 2004 version specifies the specific requirements for grounding plates. Grounding plate shall be made of at least 0.5mm thick copper, brass or galvanized steel. The minimum width shall be 1000mm, the minimum length shall be 2000mm, or 200mm larger than each side of the whole device, and the larger plate of the two sizes shall be taken. The height of the ground plate (test bed) should be located on the ground (900±100)mm, grounding tablet with shielding chamber shell electric lap, the distance between the joint zone shall not be greater than 300mm, the dc resistance shall not be more than 2.5mΩ.

On the basis of maintaining the standard provisions of the previous version, the 2019 version provides new requirements for the lap joint to the ground, and specifies that the maximum aspect ratio of the connecting belt is 7:1. The requirement for the aspect ratio of the copper belt is to reduce the impact of resonance generated by the grounding plate on the test results. The requirements for the ground joint are also unified with the EMI test standard CISPR 25.

2.2. Test changes in antenna requirements
Version 2004 requires the height of the antenna phase center to be (100±10)mm above the ground plate. Any part of the antenna radiation oscillator is not less than 250mm from the ground. The distance between the radiation oscillator of the antenna and any absorbing material shall be greater than 500mm,
and the distance between the antenna and the wall or ceiling of the shielding shell shall be no less than 1500mm. The distance between the wire harness and the antenna should be (1000±10)mm. Compared with the previous version, the 2019 version does not require the distance between the tail of the horn antenna and any absorbing material.

The biggest change in 2019 is the addition of test methods and test layout for automotive electronic high voltage components, as well as the addition of corresponding test equipment requirements. Requirements for additional test equipment are not included in this standard, but are specified in ISO 11452-1:2015.

3 The new equipment

3.1 High voltage Artificial networks (HV-AN)

For the high-voltage direct current power supply of spare parts (such as 200V to 1500V), it should use the high pressure of 5μH/50Ω artificial network. HV-AN should be installed directly on the ground plate, 50Ω loads connected to the HV-AN each of measurement ports should be. The characteristic of HV-AN impedance |Z| in the range of 0.1MHz ~ 100MHz is shown in fig.2. In the actual test, a deviation of ±20% is allowed. Impedance between P and B side (as shown in fig.1 of 1) measurement, the measurement port (as shown in fig.1 of 3) after 50 Ω load, and between A and B side (as shown in fig.1 of 2) short circuit.

![Figure 1. HV-AN circuit schematic.](image)

**Explanation:**
- L1: 5μH
- C1:0.1μF
- C2:0.1μF
- R1:1 kΩ
- R2:1MΩ (discharging C2 to<50 VDC within 60s)

![Figure 2. HV-AN impedance characteristics.](image)

**Explanation:**
- X Frequency (MHz)
- Y Impedance (Ω)

If two HV-ANs are in the same shielding box and a single HV-AN does not do any shielding, then internal shielding measures as shown in Fig.3 should be taken between HV-ANs.
3.2. Artificial mains network (AMN)

Different from traditional fuel vehicles, the new electric vehicles use electric energy as their energy source. Electric auto parts with charging function. When testing needs through 50 uH/50Ω AMN can be connected to the power supply. AMN should be installed directly on the ground plate, the housing shall be overlapped with the grounding plate, AMN meet 50Ω load metering ports.

3.3. Symmetric artificial network (AAN)

Currently, different types of communication systems and cables are used to communicate between charging stations and components such as chargers. Certain types of wiring and operations must be distinguished. AAN shall be installed directly on the ground plate, and the housing shall be overlapped with the ground plate. AAN's measuring port shall be connected to the corresponding load.

The specific AMN and AAN impedance characteristics are given in Section 4 of CISPR 16-1-2 and will not be detailed in this article.

4. Test method and test layout for DUT with shielded power system

4.1. The grounding plate

Same as requirement 1.1 in this article.

4.2. The power supply

Each DUT power supply lead shall be connected to the power supply though an HV-AN (for DUT with DC HV supply) and/or AMN (for DUT with AC supply).

- DC HV supply shall be applied to the DUT via a 5uH/50Ω HV-AN.
- AC supply shall be applied to the DUT via a 50uH/50Ω AMN.

High-voltage DC power supply should be selected from vehicles. If external high-voltage power supply is used, it should be connected through the corresponding filter. External high-voltage power supply should be shielded in the anechoic chamber. The DC power supply's positive and negative poles (HV+, HV-) and AC power lines can be connected through a separate coaxial cable or a connector system in the same shielding layer.

In the process of using filter for external high-voltage power supply, common mode interference between HV+ and ground parameter or between HV- and ground parameter is likely to be generated to generate resonance.

For chargers, the PE (protective ground) wire of the charger shall be connected to the same ground plate as the AMN PE wire during the test.

4.3. Test harness

Unless specified in the test plan (e.g., using the original vehicle wiring harness), LV and HV wiring harness lengths should be between (1700-2000) mm, and three-phase wires between DUT and the motor should be less than 1000mm. The specific wiring harness layout is shown in fig.4 to fig.9.

The antenna layout requirements are consistent with the low voltage test, and the central point of the
test wire harness is the central point of the low voltage control wire harness. The setup of the load simulator is the same as the 2004 standard.

4.4 Test layout
The 2019 version of the standard adds three types of high-pressure parts test layout, respectively:

1) DUTs with shielded power supply systems.
2) DUTs with shielded power systems with an electric motor attached to the bench.
3) DUTs with shielded power systems and inverter/charger device.

See ISO 11450-2:2019 8.6 layout plan for the specific test layout. The two types of log-periodic antenna test layout, DUT with motor in power system and DUT with inverter/charger, are taken as examples for interpretation.

Fig.4 shows the DUTs test layout with motor. The motor shall be mounted on a low dielectric constant support located on the DUT side, and the motor housing may be connected to a ground plate. The external high-voltage power supply is connected to HV-AN after passing through the filter. The distance between HV and LV power line is 100±10mm. LV power line is on one side close to the test boundary and 100±10mm from the test boundary. The distance between the antenna and the test harness refers to the vertical distance between the antenna reference point and the midpoint (1500±75mm midpoint) of the line segment parallel to the test boundary from the LV power line.

![Figure 4. Log-periodic antenna for DUTs with shielded power systems with an electric motor attached to the bench.](image)

Fig.5 shows the test layout for DUTs with shielded power systems and inverter/charger device. Compared with Fig.4, there is no motor. Just like external high-voltage power supply, the mains power network is connected to AMN through the filter and then to DUT through the three-phase line. Similarly, the spacing between HV, LV and three-phase line pairs is 100±10mm.
5. **Conclusion**

With the development of automobile industry from traditional fuel vehicles to new energy vehicles, the change of product structure has led to the reform of automobile electronic electromagnetic compatibility testing methods. As the third edition of this standard, 2019 is also written to meet the needs of new automobile electronic product testing. The new standard provides more scientific basis for manufacturers' research and development, production and quality control, provides more scientific means for laboratory electromagnetic compatibility testing, and effectively ensures the high performance requirements of radiation immunity in the automotive electronics industry.

**References**

[1] S.ISO11452-1:2015 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology.

[2] S.ISO11452-2:2004 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Absorber-lined shielded enclosure.

[3] S.ISO11452-2:2019 Road vehicles – Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Absorber-lined shielded enclosure.

[4] S.CISPR16-1-2:2006 Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Conducted disturbances.