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Antennas and Reception Systems for Radio Interference - Antenna Measurement - Vehicle Antennas and System

天线及接收系统的无线电干扰 无线测量

车载天线及系统

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Antennas and Reception Systems for Radio Interference - Antenna Measurement - Vehicle Antennas and System

1 Scope

This Standard stipulates the measurement requirements and measurement procedures of radiation characteristics and OTA characteristics of vehicle antenna under complete-vehicle conditions. It includes the requirements for measurement environment and measurement site; antenna pattern; the measurement procedures of reception sensitivity, and power reception and transmission.

This Standard is applicable to the measurement of AM / FM receiving antenna, navigation antenna, vehicle-mounted millimeter wave radar antenna, digital broadcasting antenna, satellite digital broadcasting antenna and keyless antenna in vehicle antenna. Other types of antennas may also be measured with reference to the stipulations of this Standard.

2 Normative References

The following documents are indispensable to the application of this document. 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 14733.10-2008 *Terminology for Telecommunication - Antenna*

GB/T 26256-2010 *Interference, Coexistence and Corresponding Measurement Methods of 2.4 GHz Wireless Telecommunications Equipment*

YD/T 2193-2010 *Measurement Method for Radiated RF (radio frequency) Power and Receiver Performance of WLAN Devices*

YD/T 2868-2015 *Testing Methods of Passive Antennas in Mobile Communication System*

IEEE 145-2013 *IEEE Standard for Definitions of Terms for Antennas*

3 Terms, Definitions and Abbreviations

3.1 Terms and Definitions

What is defined in GB/T 14733.10-2008, GB/T 26256-2010, YD/T 2193-2010, YD/T 2868-2015 and IEEE 145-2013, and the following terms and definitions are applicable to this document.

3.1.1 Antenna

Antenna refers to a device that can effectively radiate or receive radio waves from the space.

NOTE 1: the term antenna is sometimes used for electromagnetic equipment, whose coupling distance is less than the distance associated with the radiation field.

NOTE 2: antenna provides the required coupling between the transmitter or receiver and the medium that transmits the radio waves.

3.1.2 Vehicle antenna

Vehicle antenna refers to a device that is installed on a vehicle to complete the function of radiating or receiving radio waves in a radio transmission and reception system.

3.1.3 Passive antenna

Passive antenna refers to antenna that does not carry any active devices.

[Definition 4, IEEE 145-2013]

3.1.4 Active antenna

Active antenna refers to antenna packaged together with active devices (for example, amplifier or impedance matching electronics).

[Definition 4, IEEE 145-2013]

3.1.5 Active antenna system

Active antenna system refers to an antenna system that integrates antenna transceiver module, low noise amplifier module, power supply module and active impedance matching resistance, etc.

3.1.6 Gain

Gain refers to the ratio of power density of the signal generated by the actual antenna and the ideal radiating unit in the same point in space under the condition of equal input power.

NOTE 1: the unit of gain is dBi;

NOTE 2: gain does not include the loss caused by impedance and polarization mismatch, and does not depend on the system, to which, the antenna is connected.

reception sensitivity of the antenna near the H plane.

3.1.13 Effective isotropic sensitivity

Effective isotropic sensitivity refers to the reception sensitivity value of the terminal being tested in a certain direction, expressed in the minimum forward link power sent by the base station in this direction that can be received by the terminal being tested. This power value is the result obtained through the comparison with the omnidirectional antenna (0 dBi gain).

3.1.14 Antenna radiation diameter

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Antenna radiation diameter refers to the minimum spherical diameter surrounding the radiating part of the antenna.

NOTE: the minimum sphere contains all antenna supporting structures that would affect the radiation pattern.

3.2 Abbreviations

The following abbreviations are applicable to this document.

EIRP: Effective Isotropic Radiated Power

EIS: Effective Isotropic Sensitivity

GNSS: Global Navigation Satellite Systems

HP: Horizontal Polarization

NHPIS: Near-horizon Partial Isotropic Sensitivity

NHPRP: Near-horizontal Partial Radiated Power

OTA: Over The Air

TIS: Total Isotropic Sensitivity

TRP: Total Radiated Power

VP: Vertical Polarization

4 Measurement Parameters

4.1 Overview

d) The wireless communication comprehensive tester is used to simulate the establishment of a connection between the base station and the antenna being tested; it is also used to measure the reception sensitivity;

e) The switch conversion unit is used to switch different paths among the various measurements;

f) The control equipment is used for measurement software and the measurement work of the entire measurement system.

4.3.3 TRP measurement

4.3.3.1 TRP measurement method

In the measurement of TRP, by measuring EIRP at different spherical positions around the antenna being tested, the radiofrequency radiation performance of the antenna is measured. Each frequency band is measured at the maximum transmission power.

The measurement method of TRP includes:

a) The wireless communication comprehensive tester establishes communication links with the antenna being tested through communication antenna.

b) The measuring probe transmits the measurement data to the spectrum analyzer or the power meter through the measurement path for signal analysis. The schematic diagram of the connection of the measurement system is shown in Figure 2.

c) Rotate the rotary table; on the Theta (θ) axis and the Phi (φ) axis of the spherical coordinates, respectively measure the effective radiated power EIRP of each point in the three-dimensional space.

d) TRP is calculated through the measured EIRP and Formula (1):

$$\mathrm{TRP} \cong \frac{\pi}{2NM} \sum_{i=1}^{N-1} \sum_{j=0}^{M-1} [\mathrm{EIRP}_{\theta}(\theta_i, \varphi_j) + \mathrm{EIRP}_{\varphi}(\theta_i, \varphi_j)] \sin(\theta_i) \quad \cdots\cdots\cdots\cdots (1)$$

Where,

M---number of measurement points on the Phi (φ) axis;

N---number of measurement points on the Theta (θ) axis.

5 Measurement of AM / FM Receiving Antenna

5.1 Measurement Requirements

5.1.1 Measurement environment

The antenna being tested shall be working under the following environment:

---Temperature: -40 °C ~ + 70 °C;

---Relative humidity: 20% ~ 75%.

5.1.2 Measurement site

The frequency modulation broadcasting frequency band of the AM / FM receiving antenna is 87 MHz ~ 108 MHz. In addition, a larger volume of the vehicle signifies a larger required space for the measurement environment. Hence, the measurement of the AM / FM pattern shall be performed in the open field.

5.2 AM / FM Receiving Antenna Pattern Measurement

5.2.1 Measurement equipment

5.2.1.1 Rotary table

The rotary table can implement 360° rotation.

5.2.1.2 Antenna

The antennas used for the AM / FM receiving antenna pattern measurement include:

---Reference antenna: antenna used for zero calibration measurement. Dipole antenna, which has uniformly distributed patterns, shall be used.

---Transmitting antenna: directional antenna whose frequency band covers the frequency band of the antenna being tested; the cross-polar isolation of the antenna is less than 30 dB.

5.2.1.3 Basic requirements

The measurement equipment and instruments (for example, signal generator, receiver or vector network analyzer) used for the measurement shall have good stability, reliability, dynamic range and measurement accuracy. The instruments shall have a sweep frequency working mode; the available frequency range of the instruments shall cover the measurement frequency.

5.2.1.4 Signal generator

The signal generator shall satisfy:

---Frequency accuracy: ± 0.3 % ~ ± 0.43%;

---Spectrum purity: harmonic < -20 dBc; non-harmonic < -50 dBc;

---Output power: 0 dBm ~ 30 dBm.

5.2.1.5 Receiver

The receiver shall satisfy:

---Sensitivity: -110 dBm ~ -80 dBm;

---Dynamic range: > 50 dB;

---Frequency accuracy: $\pm 5 \times 10^{-6}$.

5.2.1.6 Signal amplifier

It shall be ensured that the signal amplifier can reach a certain power.

5.2.1.7 Vector network analyzer

The vector network analyzer shall satisfy:

---Resolution: 1 Hz;

---Frequency accuracy: $\pm 5 \times 10^{-6}$;

---Signal source output power: -55 dBm ~ 10 dBm;

---Dynamic range: 130 dB;

---Measurement bandwidth: 1 Hz ~ 30 kHz.

The vector network analyzer may replace the receiver and the signal generator.

5.2.2 Measurement procedures

5.2.2.1 Zero calibration of reference antenna

When performing zero calibration of the reference antenna, both the vertical and horizontal polarization directions shall receive zero calibration. See the main procedures below:

a) The complete-vehicle is located outside the measurement field, and the reference antenna is placed in the middle of the rotary table;

b) The reference antenna is connected to the input end of the receiver; the

the following characteristics:

a) The gain of the antenna shall be accurate and already-known;

b) The structure of the antenna shall be simple and firm;

c) The antenna shall be linearly polarized;

d) The gain of the standard gain antenna shall be determined in accordance with the gain of the antenna being tested; in near-field measurement, the gains of the two should be relatively close to each other.

6.2.3 Measurement procedures

6.2.3.1 Zero calibration of standard gain antenna

When performing zero calibration of standard gain antenna, the main procedures are as follows:

a) Set up the standard gain antenna on the rotary table; determine the minimum envelope radius R_{min} of the standard gain antenna;

b) In accordance with the schematic diagram of calibration layout, connect the radiofrequency cable, as it is shown in Figure 8;

c) Set up the measurement frequency, power and intermediate frequency bandwidth of the signal source and vector receiver;

d) Set up the scanning range and sampling interval of the φ, θ and χ angle;

e) The dual-polarization measurement probe implements the scanning of the θ and χ angle; the azimuth angle of the standard gain antenna is continuously moved to implement the scanning of the φ angle; the vector receiver collects the phase value of the measured signal amplitude, and records it as ($E_{theta/phi}$), expressed in [dB/(°)];

f) The receiver collects the phase value of the measured signal amplitude, and records it as ($E_{theta/phi}$), expressed in [dB/(°)].

The measurement environment shall satisfy the general requirements in 5.1.1.

7.1.2 Measurement site

The measurement site shall satisfy the general requirements in Appendix A.

7.1.3 Power supply

During AC power switching power supply, the voltage floats ± 10% on the basis of the normal power supply voltage, or, configurate an interruptible power supply.

7.2 Vehicle-mounted Millimeter Wave Radar Antenna Pattern Measurement

7.2.1 General

When conducting vehicle-mounted millimeter wave radar antenna pattern or OTA measurement, the millimeter wave radar antenna system shall be measured under simulated loading conditions.

The vehicle-mounted millimeter wave radar antenna pattern may adopt two methods for measurement: cylindrical near-field or spherical near-field. The measurement system includes mechanical scanning system, radiofrequency subsystem, control subsystem and measurement software.

Cylindrical near-field and spherical near-field measurements are mainly different in the mechanical scanning system and the algorithm of the measurement software.

7.2.2 Cylindrical near-field measurement method

7.2.2.1 Cylindrical near-field mechanical scanning system

Cylindrical near-field mechanical scanning system collects data on a cylindrical surface. The probe is installed on a linear guide in the Z axis direction. The antenna being tested is installed on the azimuth rotary table in φ-direction rotation in the coordinate system, as it is shown in Figure 10.

The requirements for the radiofrequency subsystem, control subsystem, measurement software and standard gain antenna are shown in 6.2.2.

sampling criterion.

7.2.3.4 Scanning area

If scanning on a complete sphere, there will be no truncation error. However, it is often difficult to implement scanning within the 4π solid angle corresponding to the entire spherical surface, which will generate truncation errors. The corresponding far field is merely effective within a certain range, the far-field effective angular field is determined through Formula (19):

$$\theta_{FF\pm} = \theta_{NF\pm} - \arcsin\left(\frac{r_0}{R_m}\right) \qquad \cdots\cdots (19)$$

Where,

r_0---the smallest spherical radius surrounding the antenna being tested, expressed in (m);

R_m---the measurement ball radius, expressed in (m);

$\theta_{NF\pm}$---the angular range covered by the near-field scan.

7.2.3.5 Spherical near-field measurement procedure

Conduct the measurement in accordance with 6.2.3. If the frequency band 77 GHz is measured, spectrum-spreading equipment shall be used.

7.2.4 Measurement result

With reference to Appendix B, in accordance with the original data of the test antenna measured by the instrument, perform cylindrical or spherical near field - far field conversion, so as to obtain the far-field pattern of the antenna being tested. Then, process it and obtain the beam width, beam pointing and cross-polarization. Ina accordance with the data of the calibration antenna, calculate the gain of the antenna being tested.

7.3 OTA Measurement of Vehicle-mounted Millimeter Wave Radar Antenna

When performing OTA performance measurement of vehicle-mounted millimeter wave radar antenna, in accordance with 4.3.3, conduct TRP or NHPRP measurement.

8 Measurement of Digital Broadcasting Antenna

8.1 Measurement of Satellite Digital Broadcasting Antenna Pattern

Since digital broadcasting antenna has the same radiation characteristics as AM / FM antenna, its pattern may be measured in accordance with 5.4.

8.2 OTA Measurement of Satellite Digital Broadcasting Antenna

When performing OTA measurement of satellite digital broadcasting antenna, TIS or NHPIS measurement may be conducted in accordance with 4.3.4.

9 Measurement of Keyless Antenna

9.1 Measurement of Keyless Antenna Pattern

Since keyless antenna has the same radiation characteristics as AM / FM antenna, its pattern may be measured in accordance with 5.2.2.

9.2 OTA Measurement of Keyless Antenna

When performing OTA performance measurement of keyless antenna, TRP or NHPRP measurement may be conducted in accordance with 4.3.3, or, TIS or NHPIS measurement may be conducted in accordance with 4.3.4.

10 Measurement Report

Measurement result shall be recorded in a comprehensive measurement report. Table 2 provides a summary list of all required items. The measurement report shall have the following details, so as to provide measurement repeatability:

a) General information, which includes:

   1) General information shall include the location of measurement and the responsible (someone who can undertake the due responsibilities) owner, etc.;

   2) If site confirmation is performed by another party or organization, the party or organization's information shall be provided;

   3) Modes of drawings, photos and part numbers shall be used to describe the configuration of measurement, including the auxiliary equipment;

   4) In addition, the date of measurement shall be provided; on the cover of the report, there shall also be the name and signature of the author and authorizer of the report.

b) In terms of the evaluation of the validity period and restrictions: before measuring vehicle antenna, the validity period of the site shall be proved; special environmental conditions, configuration conditions or restrictions shall be clearly declared.

c) Measurement layout, which includes:

Appendix A

(normative)
Requirements for Measurement Site

A.1 Basic Requirements

The measurement of radiation parameters and OTA parameters of vehicle antenna is required to be performed in an open field or microwave anechoic room. Any site that can satisfy the open field or microwave anechoic room might become an alternative test site.

The test site shall satisfy the following requirements:

a) The size of net space shall satisfy the spatial requirements of the measurement equipment, the installation and setting of the antenna being tested, and the scanning and sampling;

b) The range of the static scanning zone shall be greater than or equals to the smallest sphere containing the antenna being tested;

c) When the antenna being tested is moved along the horizontal axis of the static zone, the fluctuation of the received signals shall not exceed ± 2 dB; when the antenna being tested is moved up and down, left and right along the same plane perpendicular to the ground of the static zone, the fluctuation of the received signals shall not exceed ± 0.3 dB;

d) It shall be ensured that reflections from external objects do not affect the measurement result.

A.2 Requirements for Open Field

The open field shall satisfy the following requirements:

a) The measurement site shall be an open field without electromagnetic wave reflectors; avoid buildings, power lines, fences and trees, and keep away from underground cables and pipes, etc.;

b) If the measurement site uses a climate protective cover, then, the climate protective cover shall be able to protect the entire test site, including the antenna being tested and the system; the used materials shall have radiofrequency transparency, so as to avoid undesired reflections;

c) The measurement site with metal grounding plate should be used; the time domain method may be used to eliminate ground reflection; the measurement facilities and personnel shall be beyond the barrier-free area;

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