ICS 33.100

CCS L 06

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 44119-2024

Measurement method of antenna factor for 1 m method radiated disturbance

辐射骚扰1m法天线系数测量方法

Issued on: June 29, 2024 **Implemented on: January 1, 2025**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

Table of Contents

1 Scope

The document describes a method of measuring the antenna factor for a radiated disturbance measurement distance of 1 m.

It applies to the measurement of biconical antennas, resonant dipole antennas, log-periodic dipole array (LPDA) antennas, double-ridged waveguide horn antennas, standard gain horn antennas and similar antennas.

2 Normative references

GB/T 4365-2003, Electrotechnical terminology - Electromagnetic compatibility.

GB/T 6113.106-2024, Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration.

Dated references apply in the edition cited; undated references apply in their latest edition, including any amendments.

3 Terms and definitions

The terms and definitions of GB/T 4365-2003 and GB/T 6113.106-2024 apply, together with the following.

3.1 antenna: a transducer that converts the guided electromagnetic energy of a feeder into a wave radiated into space, and the reverse. The note states that in this document the term antenna also covers the balun where a balun is a necessary part of normal operation. From GB/T 6113.106-2024, 3.1.1.1.

3.2 antenna factor: the ratio of the electric field strength of a plane wave incident in the direction of the mechanical boresight, that is the main axis of the antenna, measured in free space, to the voltage produced across a specified load connected to the antenna. The note refers to 4.2 for further information and states that antenna factor is also used as a general term, written AF. From GB/T 6113.106-2024, 3.1.2.1.

3.3 antenna gain: the ratio of the radiated power density in a given direction of the antenna to the mean radiated power density.

3.4 balun: a device used between transmission lines for conversion from balanced to unbalanced or from unbalanced to balanced. Note 1 gives as an example the coupling of balanced antenna elements to an unbalanced feeder such as a coaxial cable, and states that a balun may have an inherent impedance transformation other than 1 to 1. Note 2 states that in this document the term also refers to the handle of a biconical antenna, usually shaped as a metal tube or rod. From GB/T 6113.106-2024, 3.1.1.13.

3.5 biconical antenna: a symmetrical antenna formed by two conical radiating elements sharing a common axis and fed from the adjacent apexes of the two cones. Note 1 states that for use in the VHF band a biconical antenna is usually made of two conical wire cages, each cage usually having a cross bar connecting the centre conductor to one of the outer wires in order to remove a narrow band resonance, and that this shorting cross bar affects the characteristics of the antenna above 215 MHz. Note 2 states that in this document a biconical antenna whose end to end length is 1.3 m to 1.4 m, typically 1.37 m, is called a traditional biconical antenna, to distinguish it from small biconical antennas whose upper frequency limit is above 300 MHz. From GB/T 6113.106-2024, 3.1.1.2.

3.6 horn antenna: an antenna formed by a section of waveguide whose cross section increases progressively towards the open end, the open end being called the aperture. The note states that tapered horn antennas of rectangular waveguide are widely used at microwave frequencies above about 1 GHz, that double-ridged waveguide horn antennas, sometimes called DRG horn antennas because of their two ridges, cover a very wide frequency range, and that the main lobe of some of these antennas splits into several lobes at the higher frequencies. From GB/T 6113.106-2024, 3.1.1.5.

3.7 log-periodic dipole array antenna, LPDA antenna: an antenna made up of an array of linear dipoles whose length and spacing increase logarithmically from the tip to the rear of the antenna as the frequency falls. From GB/T 6113.106-2024, 3.1.1.7.

3.8 resonant dipole antenna, tuned dipole antenna: an antenna formed by two collinear straight conductors of the same length placed end to end and separated by a small gap that forms a balanced feed, the length of each conductor being approximately a quarter wavelength so that at a particular frequency, with the dipole in free space, the reactance of the input impedance measured across the gap is zero. The note states that in this document the term linear dipole means two collinear straight conductors, as distinct from the dipoles of a biconical dipole or of an LPDA array. From GB/T 6113.106-2024, 3.1.1.9.

4 Basic principle of the measurement method

4.1 General. Where there is no ground reflection, the antenna factor under far field conditions can be determined and calculated. Moving from the far field to a distance of 1 m, as described in this document, generally changes the antenna factor by 0 dB to 4 dB; for LPDA antennas that change is intended, since it corrects the field strength from the phase centre position at each frequency on the antenna to the tip of the antenna at 1 m from the emitting source. The main factors affecting the antenna factor are the spacing between the antennas, the height of the antenna above the ground plane, the orientation of the antenna with respect to the ground plane, and the size, flatness and conductivity of the ground plane; for a 1 m spacing, however, the measurement method of Clause 5 is designed to reduce the influence of the ground plane.

4.2 Antenna factor. For radiated disturbance measurement an antenna factor AF is to be specified, which converts the voltage U at the input of the measuring receiver, in volts, into the field strength E in volts per metre or into the same quantity as the unit of the radiated disturbance limit, decibels relative to one microvolt per metre; this is Formula (1). If U is in microvolts, the field strength E can be expressed in decibels relative to one microvolt per metre; this is Formula (2).

The 1 m antenna factor is an antenna factor based on a gain measurement, but that antenna factor is measured under the particular condition in which the antenna is actually used in a radiated disturbance compliance measurement, that is at 1 m from the emitting source. The antenna gain in that condition is an apparent gain including mismatch loss, called the 1 m gain, and it therefore differs from the true antenna gain. Formula (3) relates AF to the apparent gain in a 50 ohm system, where G is the numerical gain of the antenna and the wavelength is in metres; the derivation of AF follows Annex A.

4.3 Two identical antennas method. The 1 m gain means that the antenna factor derived from it is intended to determine the field strength at 1 m from the emitting source, which matters in particular for LPDA antennas, where the point at which the field is picked up on the antenna is more than 1 m from the source. Other influences that make the 1 m gain differ from the far field gain are the significant mutual coupling between a pair of identical biconical antennas or horn antennas, and the fact that 1 m is less than the distance required for the far field region in which the antenna establishes a plane wave.

The 1 m gain can be calculated by Formula (4), which uses two identical antennas with their axes aligned and their polarizations matched; for antennas that are not identical, the three antenna method of 4.4 is used. The key to Formula (4) gives the received power and the transmitted power in watts, the numerical gains of the transmitting and receiving antennas, the distance between the antennas in metres and the wavelength in metres. If the two gains are equal, Formula (5) follows. If both the receiving system and the transmitting system are matched, that is at 50 ohm, voltage measurements may replace power measurements, giving Formula (6), whose key gives the numerical gain of the antenna, determined from two voltage measurements and therefore a dimensionless ratio, with the calculation of near field gain covered in 4.6.2, and the port voltages of the receiving and transmitting antennas in volts.

Identical antennas are antennas of the same manufacturer, model and design. If identical antennas are not available, the three antenna method is to be used, and similar antennas do not meet the requirement for identical antennas. Most biconical antennas have wire cage dimensions similar enough, but it also matters that the two antennas have the same balun transformation, most commonly 50 ohm or 200 ohm. Most LPDA antennas are similar enough if they fit within a common template, an isosceles triangle with a base of 0.72 m and a height of 0.63 m; this excludes the less common high gain antennas, which are almost twice that size and would lead to a larger measurement uncertainty. LPDA antennas designed to cover 200 MHz to 1 GHz should meet the template. Antennas whose dimensions differ by not more than plus or minus 2 percent are generally considered identical.

4.4 Three antenna method. The three antenna method allows the antenna factor of a single antenna to be calculated and does not depend on having completely identical antennas. Its requirements are: a) no height scan is needed at a spacing of 1 m and the antennas stay at a fixed height; b) the measurement distance is fixed at 1 m; c) the requirements on the antenna measurement site do not apply, because both antennas are raised either to a height that reduces the ground effect or to 3 m, whichever is the lower.

For this arrangement the ground reflection is negligible or is not detected by the antenna under calibration (AUC). For the fixed distance of 1 m the quantity EmaxD is 16.9 dB, the more so for directional antennas above 1 GHz, and that value can be used in Formula (7) to calculate the antenna factor. The key to Formula (7) gives the frequency in megahertz; the three quantities A1, A2 and A3, each of them twenty times the logarithm of the ratio of transmitted to received port voltage, in decibels; the port voltage of each transmitting antenna and of each receiving antenna in volts; and the antenna factors of antennas 1, 2 and 3 in decibels per metre. Using the three antenna method reduces the influence of any