Simulation Comparison of Directional Antenna and Isotropic Antenna Used in Projectile-carried Communication Jammer

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ABSTRACT

From the aspect of appearance size, gain and directivity, the simulation analysis of isotropic antenna and directional antenna is carried out by HFSS software. The simulation results show that isotropic antenna is suitable for projectile-carried communication jammer.

KEYWORDS

Isotropic Antenna, Directional Antenna, HFSS; Projectile-carried Communication Jammer.

INTRODUCTION

Antenna simulation and design is a complex process. This paper mainly analyzed the performance differences of isotropic antenna and directional antenna in appearance size, gain, directivity and so on through simulation design.

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The simulation platform adopted HFSS [1] [2] [3], a full wave three-dimensional electromagnetic simulation software developed by Ansoft.

DESCRIPTION OF SIMULATION DATA

The simulation variable parameters are the actual size and material parameters of the antenna.

The simulation model is the actual antenna structure and radiation space.

Return loss refers to the reflection generated when the antenna impedance is mismatched, and the return loss [4] [5] in the pass-band shall not be greater than -20dB.

Smith chart is the impedance parameter of the antenna. The impedance of the antenna port and the output port of the module is matched to 50Ω to reduce the return loss of the antenna.

The gain pattern is the gain parameters of the antenna in horizontal and vertical directions, which can represent the gain of the antenna in different directions.

ISOTROPIC ANTENNA SIMULATION

Take 20-300MHz antenna as an example, the parameter requirements are as follows.

The center frequency is \( \sqrt{20 \times 300} \approx 77\text{MHz} \), the antenna is placed along the z-axis, and the center is located at the coordinate origin; antenna material uses ideal conductor, total length is 1/2\( \lambda \), about 1.95m, the radius is 1/200\( \lambda \), about 20mm. The antenna is fed by lumped port, the port distance is 9.75mm, the distance between radiation boundary and antenna is 1/4\( \lambda \). The simulation parameters and simulation model are shown in Figure 1 [6] and Figure 2 [7]:
Figure 1. Simulation variable parameters.

Figure 2. Simulation model.

Figure 3. Return loss.
Figure 4. Smith Chart.

Figure 5. XZ plane gain pattern.
Take 20-300MHz antenna as an example, the parameter requirements are as follows.

The center frequency is $\sqrt{20 \times 300}$ ≈ 77MHz, FR4 plate is used as antenna material. The wavelength $\lambda_g$ in medium is 1.82m, width of radiation unit and direction unit is 0.05$\lambda_g$, about 0.091m, radiation unit length is 0.5$\lambda_g$, about 0.91m, length of leading element is 0.45$\lambda_g$, about 0.82m, leading unit spacing is 0.25$\lambda_g$, about 0.455m, the distance between radiation unit and direction unit is 0.2$\lambda_g$, about 0.364m, the distance between two arms of radiation unit is 0.15$\lambda_g$, about 0.273m, the distance between feed point and radiation unit is 0.25$\lambda_g$, about 0.455m. Lumped port excitation mode is adopted for antenna feeding, the distance between radiation boundary and antenna is $1/4\lambda$.

The simulation parameters and simulation model are shown in Figure 7 and Figure 8.
Figure 7. Simulation variable parameters.

Figure 8. Simulation model.

Figure 9. Return loss.
Figure 10. Smith Chart.

Figure 11. XZ plane gain pattern.
CONCLUSIONS

Although the length of isotropic antenna radiator resonates at 1/4 wavelength, the materials used can be adjusted, and the radiator part can be bent into a special shape and placed in a small space.

Due to the particularity of the structure, different position relations and distances are not allowed to change at will. In the process of change, the overall parameters of the antenna will change a lot. In general, the directional antenna needs to increase the reflection structure behind the radiator, resulting in the large size of the antenna, which is difficult to be miniaturized.

Because of the uncertainty of the target position, the directional antenna can not be used to point to the target area accurately, while the isotropic antenna has no such problem.

Therefore, it is suitable to use isotropic antenna in the projectile-carried communication jammer.

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