Design of an UWB Meter-wave Oblique Polarized Array Antenna

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***Abstract*—According to the airborne meter-wave electronic reconnaissance and interference need, an 150-350MHz 45deg oblique polarized array antenna is designed. The size of the log-periodic antenna is reduced by make fractal to the ordinary log-periodic antenna dipoles and load to the top, which is like a tree. The height of the antenna is also reduced, and the feed parallel lines are wrapped around by dielectric materials. The array is simulated and optimized, and the results show the array can achieve airborne meter-wave broadband wide-angle scan work.**

Keywords- ultral-wideband; log-periodic antenna; fractal; 45deg oblique polarized.

I. INTRODUCTION

In recent years, because of the advantages of finding anti-stealth targets and counterwork anti-radiation missiles, the meter-wave radar has been developed greatly. So, the need of meter-wave radar counter equipment is also growing [1].

Being a popular ultra-broadband antenna, the log-periodic antenna has a lot of advantages like technology maturation, good acclimatization, high power capacitance [2][3], which are suitable for the electronic warfare equipment use. However, the ordinary log-periodic antenna has a large size, which is bigger than the element spacing of a broadband wide-angle scan array, and also, it is not suitable for the airborne platform use. There is a need to miniaturize the design.

According to the airborne meter-wave broadband wide-angle scan antenna array need, the transverse size and longitudinal size of the antenna are reduced by make fractal to the ordinary log-periodic antenna dipoles, load the top and wrap around the feed parallel lines with dielectric materials. A 150-350MHz 45deg oblique polarized antenna array is designed.

II. ANTENNA ELEMENT

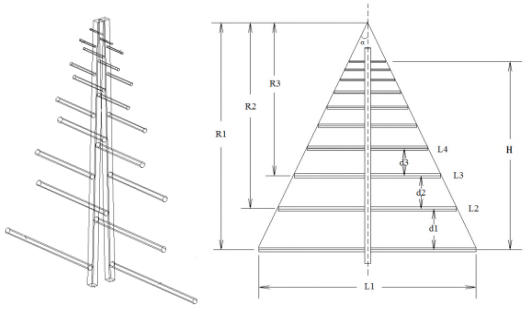

Figure 1. Structure of the ordinary log-periodic antenna.

The ordinary log-periodic antenna is composed of a pair feed parallel lines and some pair radiation dipoles, as shown in Figure 1 [4]. According to the design formula, the size of the ordinary log-periodic antenna is determined by the ratio factor τ, the interval factor σ, and the minimum work frequency [5]. For 150-350MHz work, the high of the parallel lines is not less than 0.8m, and the length of the longest dipole is about 1m. But for the 350MHz scan 45deg work, the element spacing of the antenna array must be less than 0.45m. When the ordinary log-periodic antenna is used for the array, there is too much overlap of the dipoles, which will seriously deteriorate the cross-polarization, the coupling, the sideline level, the gain and other indicators of the antenna. The 0.8m height of the antenna can not meet the installation requirements of the airborne platform.

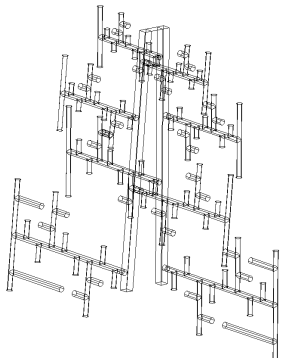

Figure 2. Structure of the tree antenna.

The tree antenna is composed of feed parallel lines, fractal dipoles, and metal sticks, which are loaded to the top of dipoles, as shown in Figure 2. Two metal sticks are added to the dipole in the two thirds of the normal dipole, and the length of each one is 1/3 of the normal dipole, as 19-22 metal sticks shown in Figure 3, which is called the first order fractal dipole. In the same way, we do the fractal again to each section of the first order fractal dipole, which is called the second order fractal dipole, as shown in Figure 3. The length of the dipoles are reduced by the fractal structure, and the lowest work frequency is further reduced by load metal sticks to the top of dipoles, which make the transverse size of the antenna drop to half of ordinary log-periodic antenna. So, the antenna could be the element of an antenna array with scan ±45deg. The length of the feed parallel lines, which is also the height of the antenna, is also reduced to be 53% of the ordinary log-periodic antenna, which is suitable for the airborne platform use.

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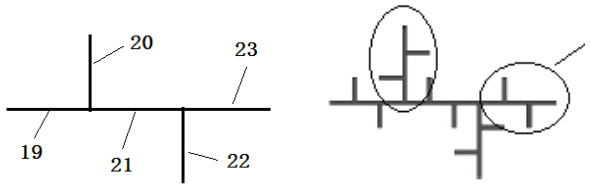

Figure 3. Structure of the first order and second order fractal dipole.

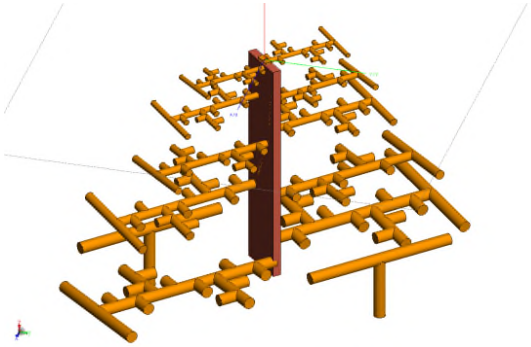

Figure 4. Simulation model of the tree antenna.

The antenna element is simulated and optimized by FEKO software, as shown in Figure 4. The feed parallel lines are wrapped around by dielectric materials, to reduce the antenna port impedance to be easy match, which serve also to support weight. After being optimized, the height of the antenna is 400mm, and the size is 700mm×300mm. Figure 5 shows the Voltage Standing Wace Ratio (VSWR) results of the antenna, and its blow 2 at whole work band. Figure 6 is the normal gain of the antenna.

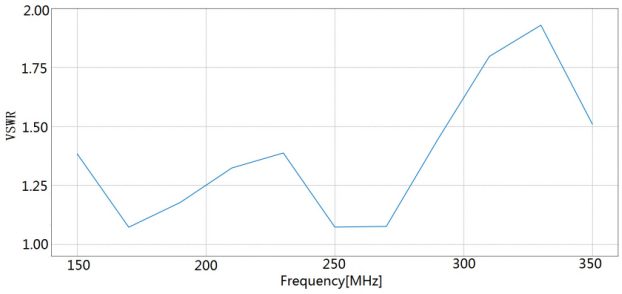

Figure 5. VSWR of the antenna element.

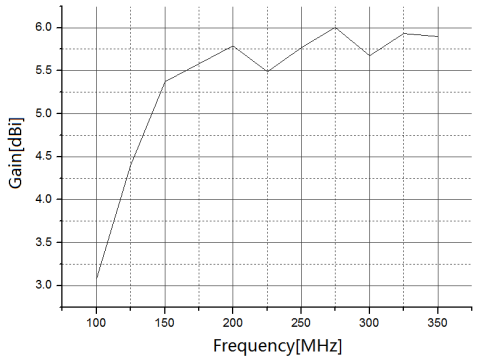

Figure 6. Normal gain of the antenna element.

III. ARRAY ANTENNA

The antenna array is simulated by FEKO software, as shown in Figure 7. The size of the array is 2×6. For 350MHz scan 45deg work with no grating lobe, the horizontal element spacing chooses 400mm. There is no scan in vertical direction, so the vertical spacing could be bigger and is 700mm.

In order to improve the low frequency performance of the antenna array, some parasitic dipoles are added between each antenna elements, and the height is lower than the lowest dipole of the antenna, as shown in Figure 7. The length and height of the parasitic dipole are 270mm and 120mm.

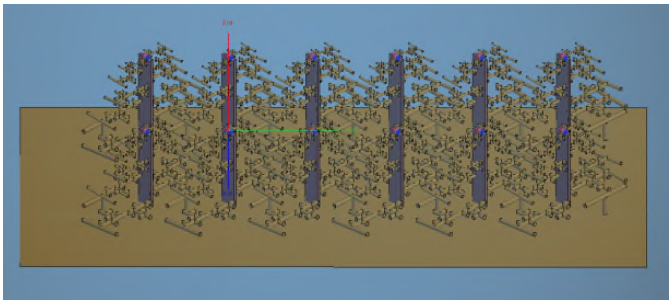

Figure 7. Simulation model of the array antenna.

The antennas are re-optimized. Figure 8 shows the VSWR results of the array, and all are blow 2.4 at whole work band. Figure 9 is the normal gain of the array, and it is bigger than 11.5dBi. Figure 10 shows the lobe pattern of the array at horizontal direction at 150MHz, 250MHz and 350MHz without scan, and Figure 11 shows scan 45deg.

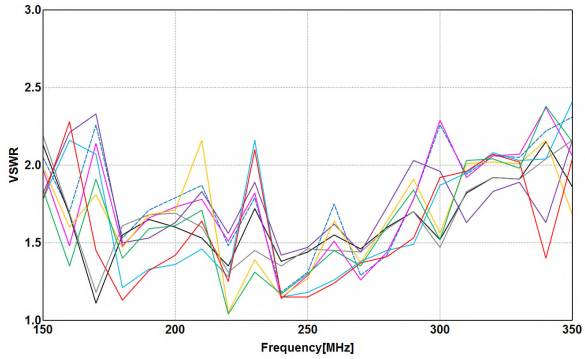

Figure 8. VSWR of the array.

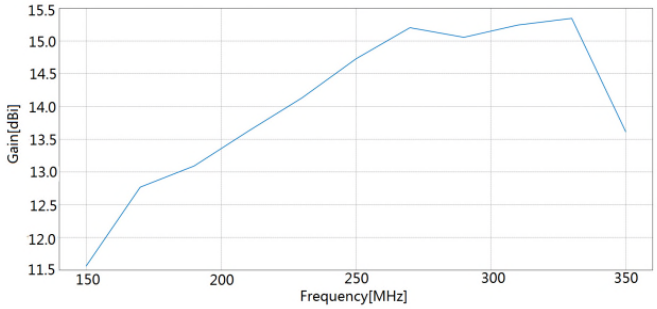

Figure 9. Normal gain of the array.

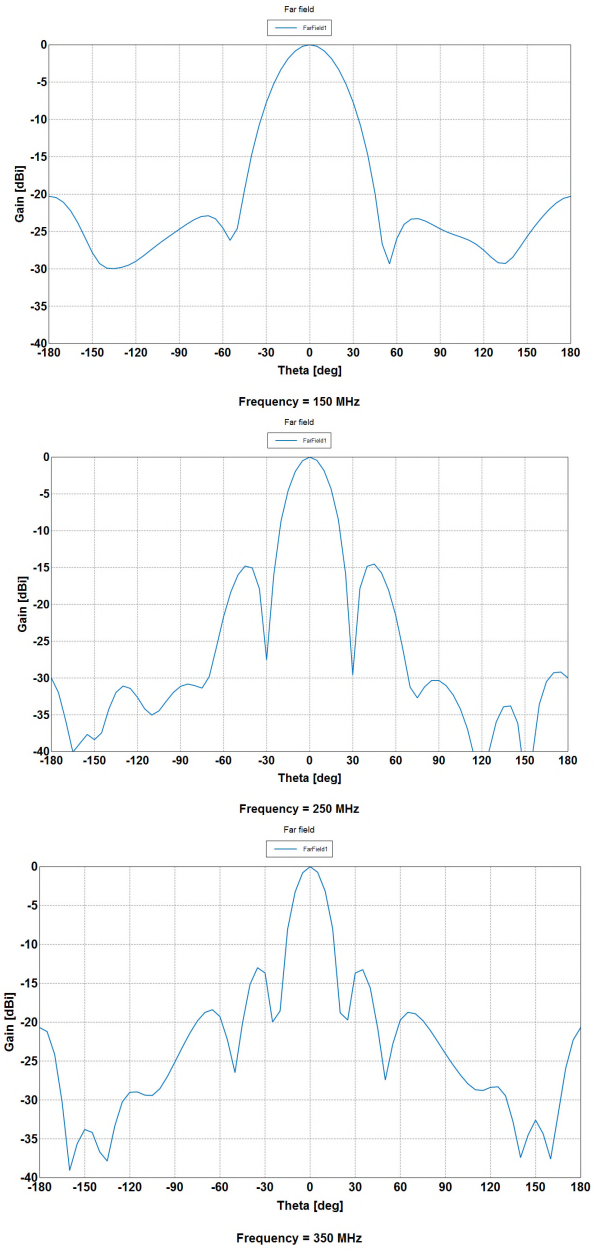

Figure 10. Lobe pattern of the array at horizontal direction without scan.

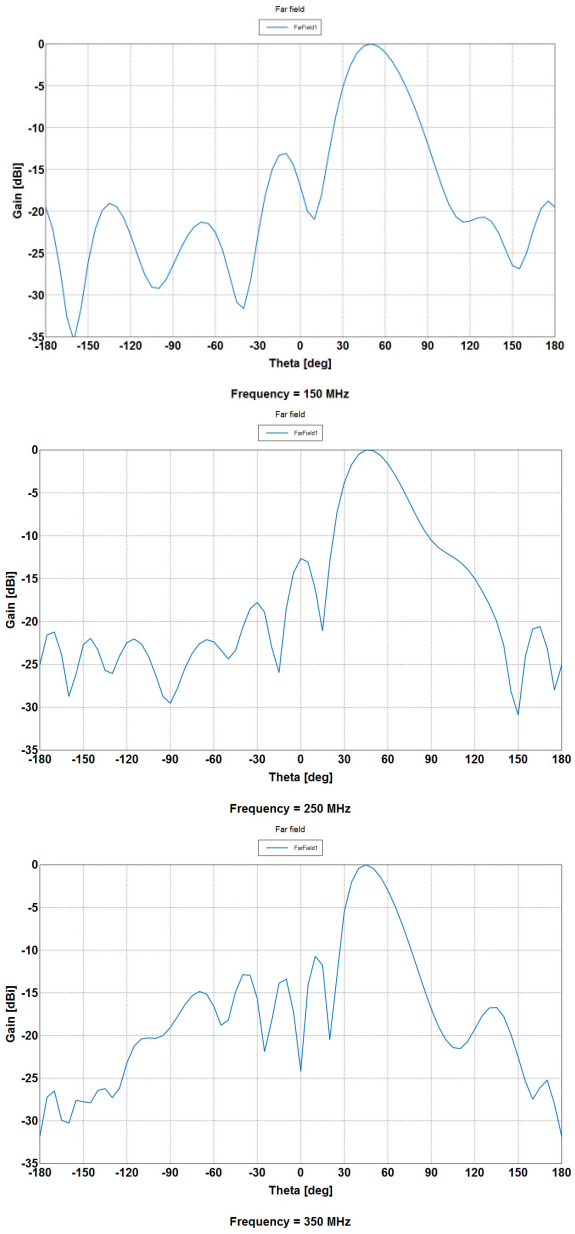

Figure 11. Lobe pattern of the array at horizontal direction with scan 45deg

IV. CONCLUSION

By make fractal to the ordinary log-periodic antenna dipoles, load to the top and wrap around the feed parallel lines with dielectric materials, the transverse size and height of the antenna are half 53% of the ordinary log-periodic antenna, which could achieve the needed size for the airborne meter-wave broadband wide-angle scan antenna. The antenna array is simulated and optimized by FEKO software, and the results showed it meet the needs of the system work.

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