Design Of An UWB Meter-wave Oblique Polarized Array Antenna

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***Abstract*-Accord to the airborne meter-wave electronic reconnaissance and interference need, an 150-350MHz 45deg oblique polarized antenna array is designed. The size of the log-periodic antenna are 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 wrap around by dielectric materials. The antenna element and the array are simulated and optimized by FEKO, and the results shown it can achieve airborne meter-wave broadband wide-angle scan work.**

I. INTRODUCTION

In recent years, because of the advantages of find the anti-stealth targets and counterwork anti-ARM, the meter-wave radar is developed greatly. So the need of meter-wave radar electronic counter equipment is also growing[1].

AS be 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 is suitable for the electronic warfare equipment use. But the ordinary log-periodic antenna has large size, which is bigger than the element spacing of a broadband wide-angle scan array, and also not suitable for the airborne platform use. So it's need to do miniaturized design.

Accord to the airborne meter-wave broadband wide-angle scan antenna array need, the transverse and longitudinal size of the antenna both are reduced by make fractal to the ordinary log-periodic antenna dipoles, load to 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

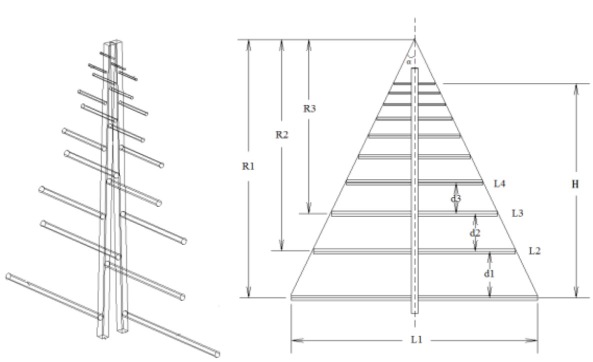

Figure 1. Structure of the ordinary log-periodic antenna.

The ordinary log-periodic antenna is composed by a pair feed parallel lines and some pair radiation dipoles, as shown in Fig. 1[4]. Accord 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 san 45°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 bring seriously deteriorate of the cross-polarization, the coupling, the sideline level, the gain and other indicators of the antenna. And 0.8m height of the antenna could not meet the installation requirements of the airborne platform.

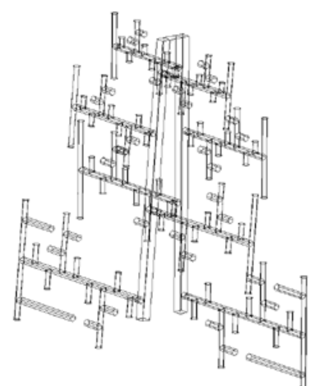

Figure 2. Structure of the tree antenna.

The tree antenna is composed by feed parallel lines, fractal dipoles and metal sticks load to the top of dipoles, as shown in Fig. 2. Two metal sticks are add 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 Fig. 3, which calls the first order fractal dipole. In the same way, do the fractal again to each section of the first order fractal dipole, which calls the second order fractal dipole, as shown in Fig. 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 the half of ordinary log-periodic antenna. So the antenna could be the element of an antenna array with scan ±45°. 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.

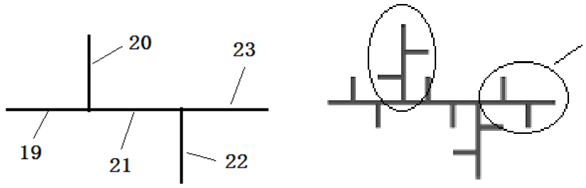

Figure 3. Structure of the first order and second order fractal dipole.

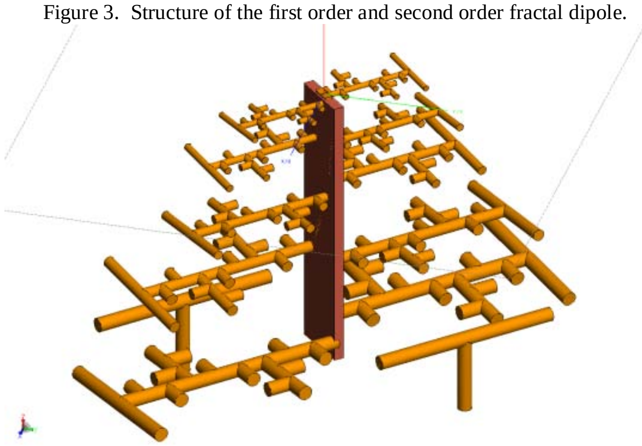

Figure 4. Simulation model of the tree antenna.

The antenna element is simulated and optimized by FEKO, as shown in Fig. 4.The feed parallel lines are wrap around by dielectric materials, to reduced the antenna port impedance to be easy match, which serve also support weight. After be optimized, the height of the antenna is 400mm, and the size is 700mm×300mm. Fig. 5 is the VSWR results of the antenna, and it's blow 2 at whole work band. Fig. 6 is the normal gain of the antenna, which is ⩾5.3dBi between 150-350MHz.

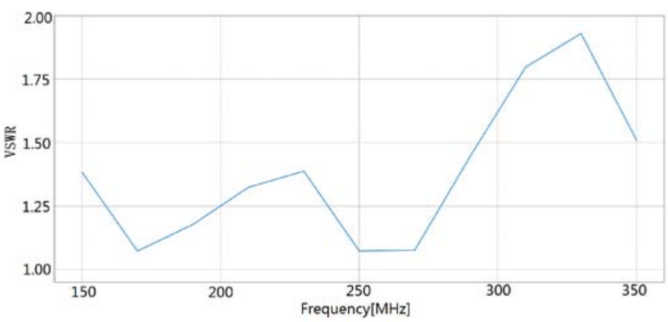

Figure 5. VSWR of the antenna element.

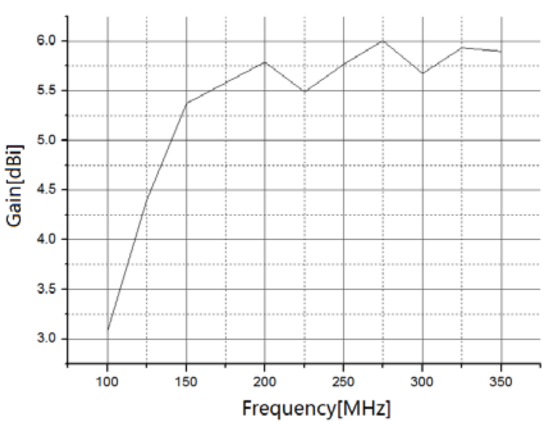

Figure 6. Normal gain of the antenna element.

III. ARRAY ANTENNA

For the broadband antenna array, because of the high coupling between elements, the performance of antenna in the array is difference from the single antenna. The antenna array is simulated by FEKO, as shown in Fig. 7. The size of the array is 2×6, the element spacing of horizontal and vertical are 400mm and 700mm.

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

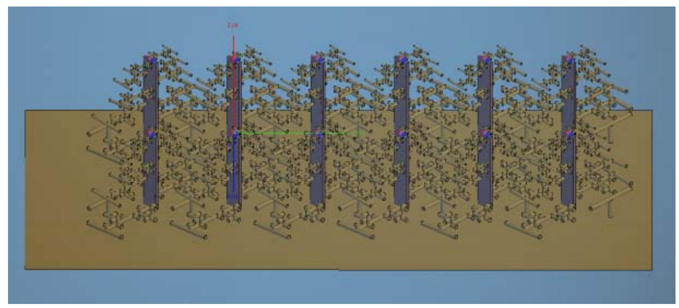

Figure 7. Simulation model of the array antenna.

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

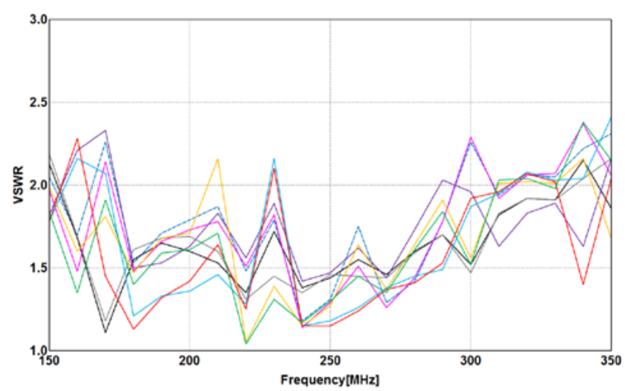

Figure 8. VSWR of the array.

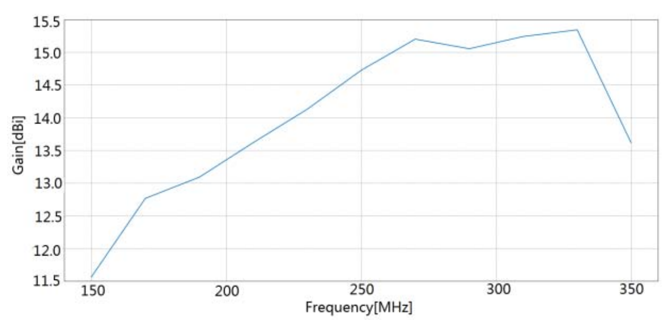

Figure 9. Normal gain of the array.

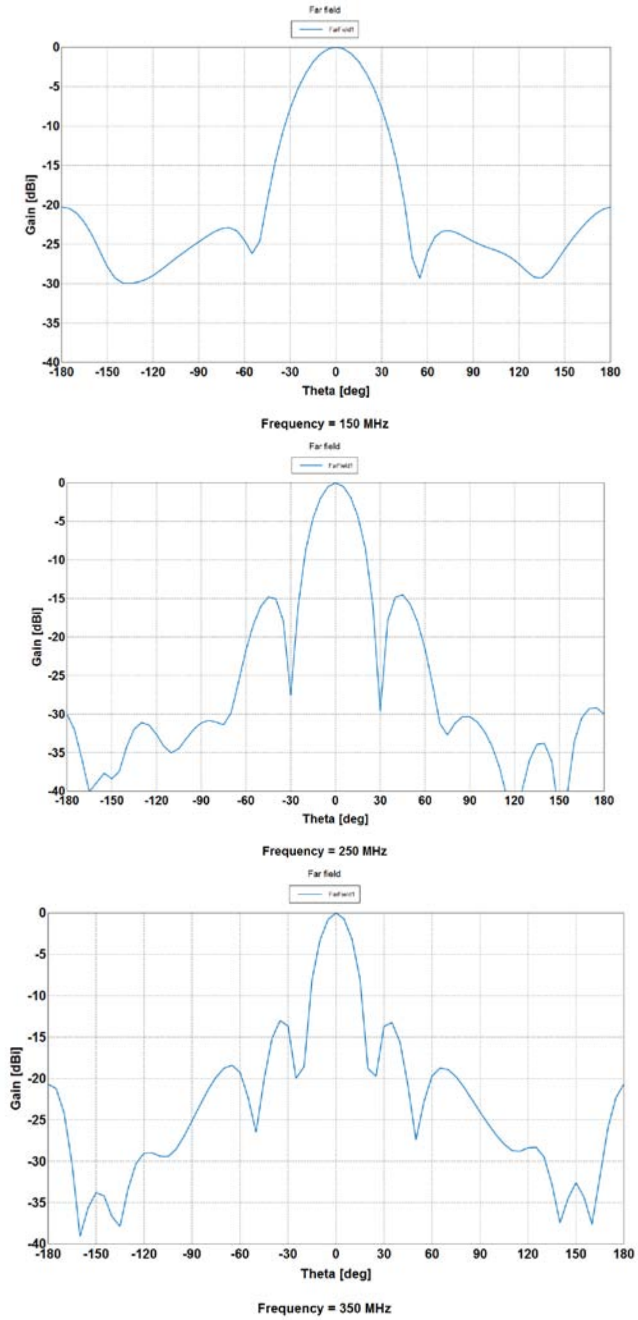

Figure 10. Lobe pattern of the array at horizontal direction without scan.

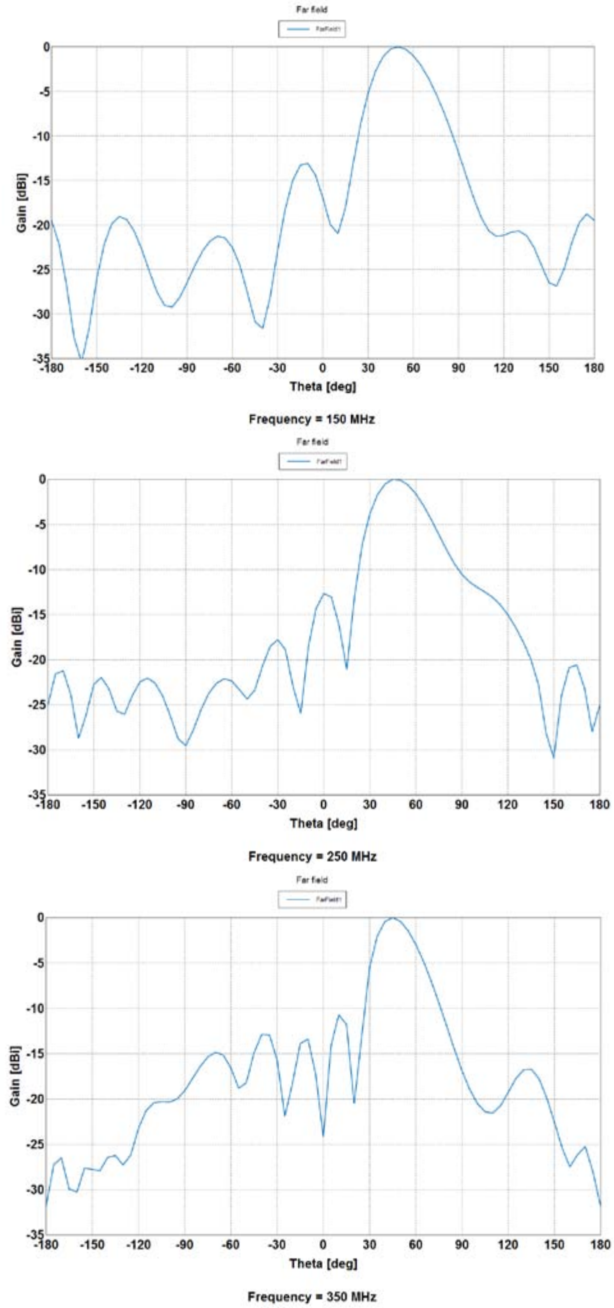

Figure 11. Lobe pattern of the array at horizontal direction with scan 45°.

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 the half 53% of the ordinary log-periodic antenna, which could achieve the airborne meter-wave broadband wide-angle scan antenna array need size. The antenna array is simulated and optimized by FEKO, and the results shown it meet the needs of the system work .

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