

A Design of LPDA Antenna with Patch Dipoles for Airbone Communication

Ying Liu^{1,a}, Yuwen Wang^{2,b}, Yongwei Li^{2,c} and Ting Yin^{2,d}

School of Aeronautics and Astronautics, University of Electronic Science and Technology of China, Chengdu611731, China

Abstract. This article designs a Log-periodic Dipole Antenna(LPDA) for airborne communication. This antenna replaces traditional dipoles with patch dipoles, the feeder adopt gradual changing structure, its working frequency is from 200MHz to 450MHz. Use HFSS which is the special software for high-frequency electromagnetic to calculate, optimize and simulate. The simulation results are in good agreement with the test results. The designed antenna improves its flexibility and reduces profile, it provide a good method for the design of the airborne antenna.

1 Introduction

LPDA(Log Periodic Antenna) is proposed in 1957,it is a kind of directional antenna[1-6],LPDA is a FI(frequency independent)antenna, FI is that the antenna is transformed by a proportional factor τ ,the performance of antenna operating frequency is equal to antenna operating frequency.LPDA has wider bandwidth, which can be designed as 10:1(the ratio of the highest frequency to the lowest frequency),obviously,LPDA belongs to UWB(Ultra Wide Band)antenna[7].The profile of traditional LPDA[8]is relatively high,and its flexibility is not very ideal,but we can replace traditional dipoles with patch dipoles to research airborne antenna.Patch-dipoles LPDA is better to keep correspondence with the wing of aircraft,what's more,its electrical properties is less affected by the deformation of the wing.so we design a patch-dipoles LPDA applied to airborne antenna.

2 The Design of Patch-dipoles LPDA

A patched-dipoles LPDA operating at 200MHz-450MHz was designed for a gain of 10dB.the structure of LPDA[9] is affected by the combination of the scaling factor Tau(τ) and spacing factor Sigma(σ)[10],which can be calculated from carrel curves[11], τ corresponding to the best design is 0.95, σ is 0.17. α is 8.411 degree,N(the numbers of dipoles) is 17.From the operating principle of LPDA,we can know that for obtaining higher gain,we must add the number of dipoles,so we add four dipoles,the number of dipoles of LPDA is 21.

The input impedance of LPDA is about 80ohm,it is easy to match with coaxial cable which characteristic impedance is 75ohm. In the field of military radio communication,the characteristic impedance of the mutual of each communication module is 50 ohm,obviously,LPDA which input impedance is 80ohm connecting with coaxial cable which characteristic impedance is 50ohm will

^a1535354598@qq.com, ^b83211668@qq.com, ^c1014972000@qq.com, ^d996328534@qq.com

cause impedance adaptation and cause VSWR[12] too large,so we need to connect an impedance matching device between the feeder terminal of LPDA and coaxial cable,however,the antenna selected operate at 200MHz to 450MHz,its belong to UWB antenna,it is difficult to design impedance matching device of UWB antenna system,besides,The introduction of he impedance matching device will not only cause the complex structure of the antenna,increase the size of antenna,but aslo bring a certain insertion loss,which affect the efficiency.for solving the difficult problem,the feeder of LPDA antenna we select adopt gradual changing structure,the width of LPDA in high frequency is 2 millimeter,the width of LPDA in low frequency is 20 millimeter,in this way,the input impedance of patch-dipoles LPDA is very close to 50ohm,it match with coaxial cable well.

3 The Structure and Results of LPDA In HFSS

The structure of simulation of LPDA is showed in Fig.1.

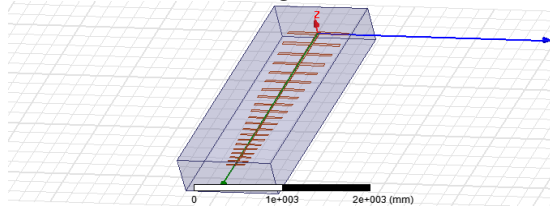


Figure 1. The structure of LPDA

By optimize,we can get the radiation patterns of LPDA antenna which dipoles are 21.The E-plane and H-plane radiation patterns of LPDA operating at 200MHz are showed in Fig.2 and Fig.3. The E-plane and H-plane radiation patterns of LPDA operating at 250MHz are showed in Fig.4 and Fig.5. The E-plane and H-plane radiation patterns of LPDA operating at 300MHz are showed in Fig.6 and Fig.7. The E-plane and H-plane radiation patterns of LPDA operating at 350MHz are showed in Fig.8 and Fig.9. The E-plane and H-plane radiation patterns of LPDA operating at 400MHz are showed in Fig.10 and Fig.11. The E-plane and H-plane radiation patterns of LPDA operating at 450MHz are showed in Fig.12 and Fig.13.From the results of simulation,we can see that the biggest gain at 200MHz is11.34dB,the biggest gain at 450MHz is 10.8dB,in the whole frequency band,LPDA can aslo get high gains.

Name	Phi	Ang	Mag
m1	0.0000	0.0000	11.3381

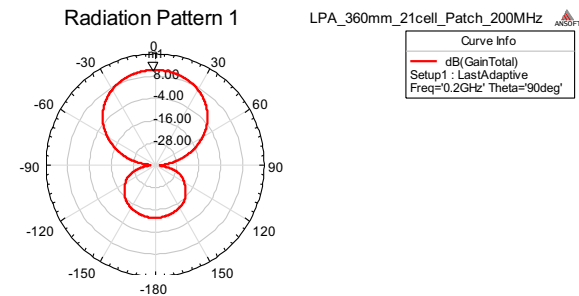


Figure 2. E-plane radiation patterns of LPDA (200MHz)

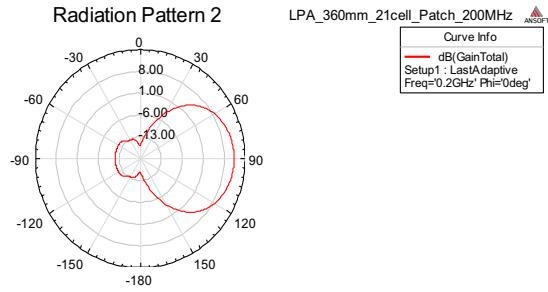


Figure 3. H-plane radiation patterns of LPDA(200MHz)

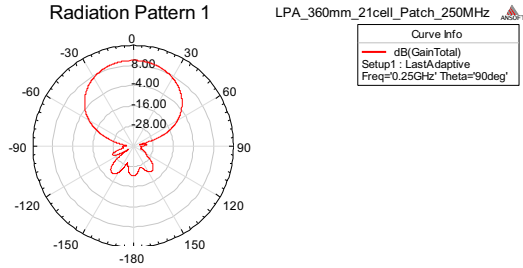


Figure 4. E-plane radiation patterns of LPDA (250MHz)

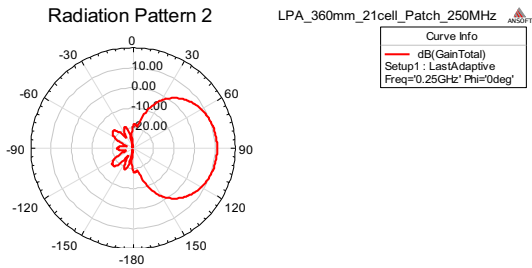


Figure 5. H-plane radiation patterns of LPDA(250MHz)

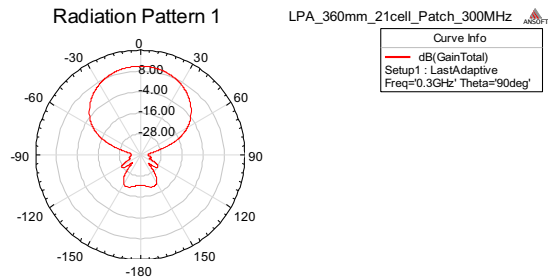


Figure 6. E-plane radiation patterns of LPDA(300MHz)

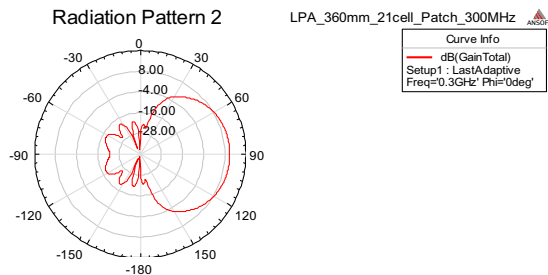


Figure 7. H-plane radiation patterns of LPDA(300MHz)

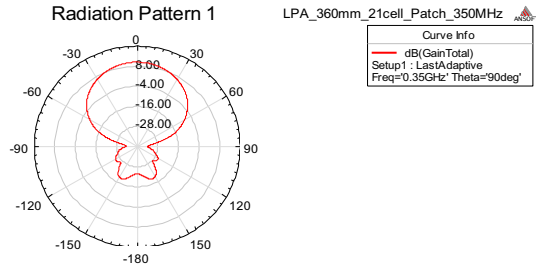


Figure 8. E-plane radiation patterns of LPDA(350MHz)

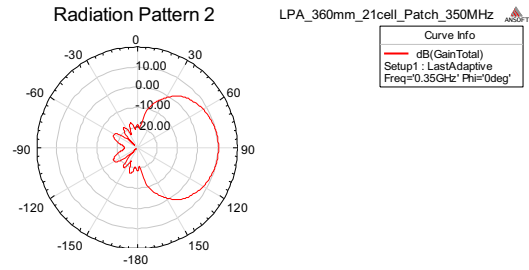


Figure 9. H-plane radiation patterns of LPDA(350MHz)

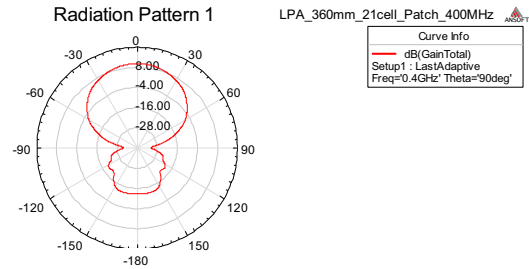


Figure 10. E-plane radiation patterns of LPDA(400MHz)

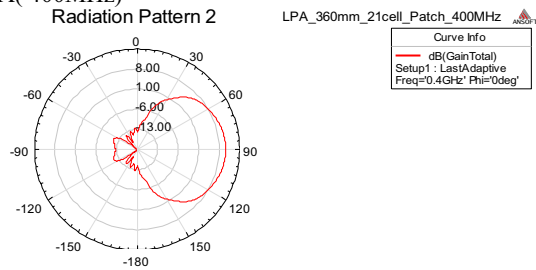


Figure 11. H-plane radiation patterns of LPDA(400MHz)

Name	Phi	Ang	Mag
mf1	0.2000	3.0000	10.8259

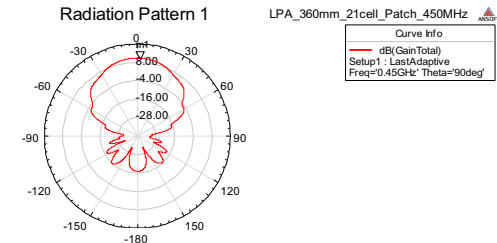


Figure 12. E-plane radiation patterns of LPDA(450MHz)

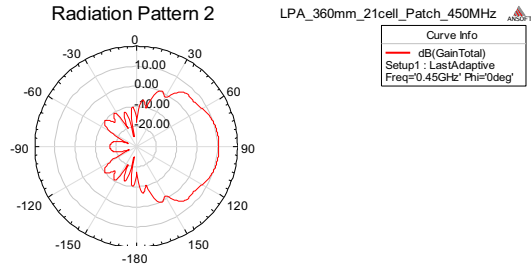


Figure 13. H-plane radiation patterns of LPDA(450MHz)

4 The Physical Design of LPDA

Since the size of LPDA operating at 200MHz to 450MHz is too large,it is not easy to test its electrical properties,for solving this problem,we adopt scaling shrunk simulation measuring method,scaling factor is 4,the size of antenna for the test is 1/4 of the original LPDA antenna,in this way,we can solve many problems caused by the too large size of antenna when we measure antenna.when the scaling factor is 4,the operating frequency of LPDA will be changed into 800MHz to 1800MHz.The physical LPDA is showed in Fig.14.In the laboratory of College of Aeronautics and Astronautics of UESTC,we use Vector Network Analyzer (Type:N5242A) designed by Alilent to measure the scaling LPDA.The reflective characters of LPDA measured is showed in Fig.15.The measurement of antenna is showned inFig.16.From Fig.15,we can see that within the frequency band of 600MHz to 2000MHz,the reflective characters of antenna(scaling factor is 4) is below -10dB,this shows that the antenna(actual size) we designed operating frequency at 150MHz to 500MHz,its reflective characters is below -10dB too.The actual bandwidth of LPDA we designed(150MHz-500MHz) is better than the original bandwidth(200MHz-450MHz).



Figure 14. The physical LPDA

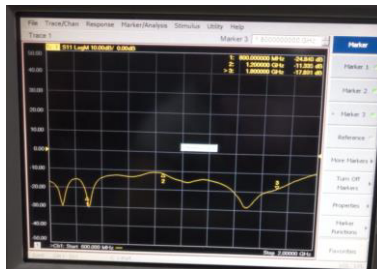


Figure 15. The reflective characters of LPDA



Figure 16. The measurement of antenna

5 Summary

The patch-dipoles LPDA we designed operating at 200MHz to 450MHz has wide bandwidth, high gain, low profile, good flexibility and light weight etc. It provides a reliable choice for airborne antenna, particularly in the antenna of solar powered warning drones in Near Space.

References

1. DuHamel R H, Ore F. Logarithmically Periodic Antenna Designs [C]. IRE International Coventional Record, 2001(6): 139-151.
2. Nguyen C. A Wide-band Microstrip-fed Log-periodic Antenna [C]. Antennas and Propagation Society International Symposium, 2006(1):33-36.
3. Mohammad M T. Wideband Planar Log -periodic Antenna [C]. Antenna technology: Small and Smart Antennas Metamaterials and Applications, 2007.IWAT '07. International Workshop on, 2007:331-334.
4. Orlob C,Dao Q H, Kornek D. Dual-polarized Log -periodic Antenna on a Conical MID Substrate[C]. Antennas and Propagation(EUCAP), Proceedings of the 5th European Conference on, 2011:361-364.
5. D.E.Isbell. Log-periodic dipole arrays[J]. IRE Trans. Antennas Propag., 2011, AP-8: 260-267.
6. R.L.Carrel. The design of log-periodic antennas[J]. IRE Int.Conent.. Rec., 2010, 9(1): 61-75.
7. Praveen Nartam, Abhijeet Gulawani, and Subhajit Chatterjee, "Design of an Ultra wide Band antenna using defected ground structure,"ICCPEIC, pp. 75-79, 2016.
8. Zou Aihua and Xu Changwu, "A small dual stacked log periodic dipole array antenna(LPDA) with improved gain of low frequency for immunity,"APEMC,pp.208-211,2015.
9. Wang Zhefei and Fu Jiahui, "A design of miniaturization LPDA antenna with ultra sideband,"2015 IEEE 6th International Symposium on Microwave, Antenna, Propagation, and EMC Technologies, pp819-821, 2015.
10. Jerin Jose, Tessa Mathew, Annu Thomas, Haripriya N, Mahima Cherian, and D.D.Krishna, "A Cost Effective Hybrid-Log Periodic Dipole Antenna," 2015 Fifth International Conference on Advances in Computing and Communications, pp263-265, 2015.
11. Carrel, R.l, "Analysis and design of the log-periodic dipole antenna," Technical Report, No.52, Antenna Laboratory, University of Illinois 1961.
12. T, Taniguchi and T. Kobayashi, "An omnidirectional and low-VSWR antenna for ultra-wideband wireless systems", Radio and Wireless and Conference, pp.145-148, 2002.