Journal of
Electrical Engineering Science
June 2017, (pp.45-49)
ISSN: 2008-9864

One Sixth Wavelength Printed Monopole Blade Antenna

Amir Mohammad Cheatsaz[1] , Nasrin Amiri*[2]
[1,2] Electrical Engineering Department, South Tehran Branch, Islamic Azad University

Abstract

A Printed Monopole, One Sixth Wavelength Blade Antenna using printing micro strip on substrate that reduces the cost & increases the ease & precision in manufacturing. In this paper, the process of combining conventional blade antenna that cut a desired piece of metal, & alternative the printed version is represented. Due to increase mechanical strength of parasitic element, it has substrate in common with main antenna. A sample of the proposed antenna has been designed & manufactured that measurement and simulation results are in good agreement with each other.

Keywords: blade antenna, microstrip, substrate, printed antenna, monopole.

1. INTRODUCTION

Blade antennas are widely used due to light weight and aerodynamic characteristics suitable for flying in the aviation industry. These Antennas are traditionally made with a metal blade [1] and are mounted on the aircraft body. Small dimensions and low height, which are fraction of wavelength, are an important advantage in aerodynamics of vehicles such as airplanes and cars [2]. One of the blade antenna applications is measuring distance aircraft from ground or other aircrafts, usually two of them are used which one under the plane and the other over the body can be installed, which is also known shark-fin for their appearance [3]. In small dimensions, impedance matching of input port of the antenna which is usually 50 ohms, requires the addition of an element to the antenna as a parasitic element that is made of wire [4]. Todays, printed antennas are considered as low cost, very light weight and easy to build antennas [5]. Most wire antennas like monopoles and dipoles have a printed equivalent [6]. Efforts have been made to convert blade antenna to printed type, each with its own advantages and disadvantages. For example, a broad band printed blade antenna is introduced for the UAV [7], which has a good bandwidth with the impedance matching circuit, but has a relatively large electrical dimension (relative to the center frequency wavelength). In [8], another type of printed antenna is introduced that does not have an integrated structure and as a result has no mechanical strength. In this article, we will introduce the structure of a blade antenna, which in addition of a proper bandwidth, has a metallic type radiation pattern and an acceptable gain. The most important features of this antenna is the placement of a parasitic element on a common substrate with a blade, which can be used on a plane and car at high speed. In the following, the general structure of the antenna is introduced and its simulation results in HFSS and CST software are investigated. A prototype of the

---

*Corresponding Author’s Email: n.amiri@azad.ac.ir

proposed antenna is made that simulation and test results are well-matched.

2. ANTENNA DESIGN THEORY

The overall structure of the blade antenna is depicted in Fig. 1, which is made up of a fiberglass substrate (FR-4) with two conductive layers. The antenna can be divided into two parts of the main element that is connected to the SMA inner conductor and the parasitic element that is grounded. In fact, this antenna is an improved one eight blade antenna [8] with the difference that the main element and its parasitic are printed on a same board, which reduces the design process, time and cost of construction. Another important point is the parasitic element printing on just one side of the substrate.

Its initial design is considering the height of the antenna main element one-eighth wavelength and the length of each gap one-twentieth wavelength, and to improve its performance, based on the requirements, we change parasitic element spacing from the main element, length and height of the gaps. The simulation has been used to approximate the actual results of the lossy conductors and materials.

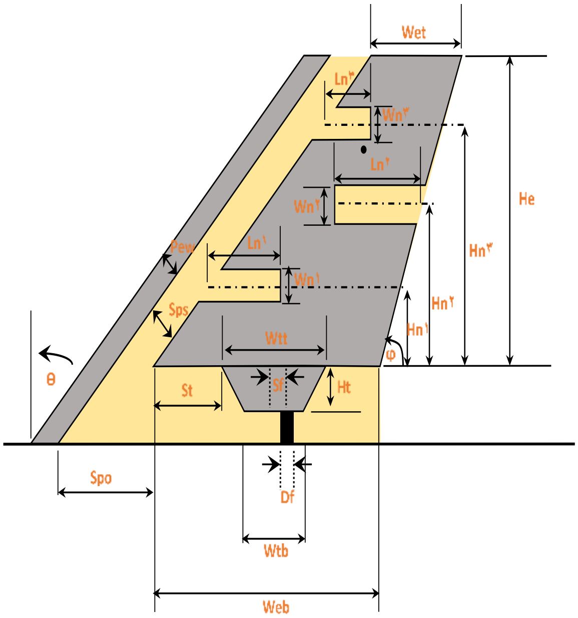


Fig 1. Antenna Schematic.

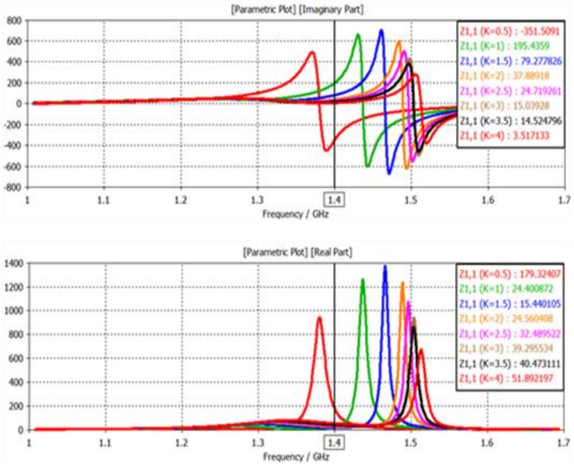


Fig 2. Imaginary and real part of input impedance versus parasitic element spacing.

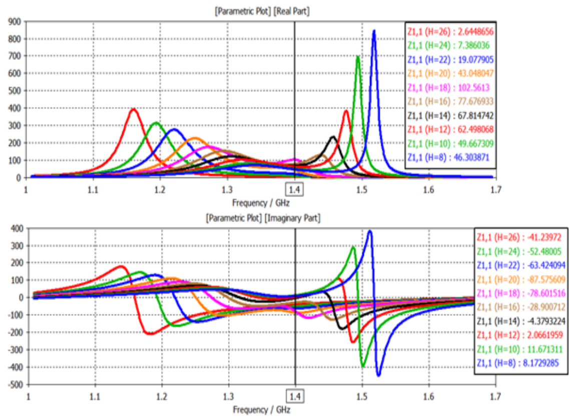


Fig 3. Imaginary and real part of input impedance versus the first gap length.

To match the input impedance of the antenna at a center frequency to the 50 ohms cable, SPS (parasitic element spacing of the antenna main element) is one of the most effective parameters, shown in Fig. 2, its effects on the input impedance.

Based on the diagrams, it can be concluded this parameter has a significant effect on the real part of the input impedance that the distance to the antenna main element is smaller, the input impedance increases.

One of the other parameters that influences the matching of the antenna input impedance is the length of the gaps. For example, Fig. 3 shows the effects of the first gap length (Ln1).

This antenna is designed in the UHF band from 300MHz to 3GHz frequency band with a central frequency of 1.4GHz. Choosing this frequency is based on military information. It has 100MHz bandwidth from 1.34GHz to 1.4GHz (as shown in Fig. 4) and SWR is less than 2dB (shown in Fig. 5).

3. SIMULATION AND TEST RESULTS

The initial design of the blade antenna was simulated using the HFSS and CST softwares based on the data in Table (1) and its substrate FR-4 with 4.4 dielectric constant and 35 micrometers copper thickness. A via between two main element layers that connect them electrically has 0.4mm diameters, 30mm above the grounded plate and 35mm longitudinal distance from the center of the feeding place.

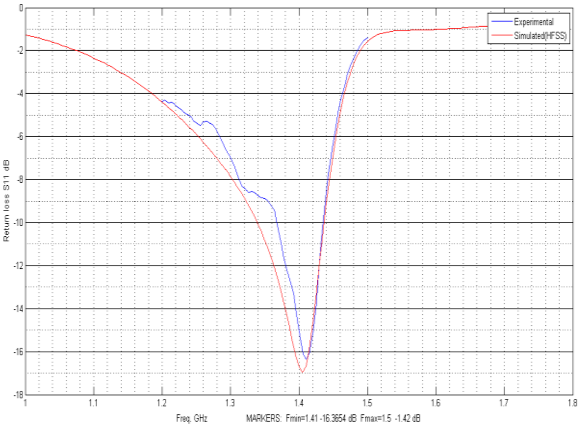


Fig4. Simulation and measurement results of Antenna Return Loss

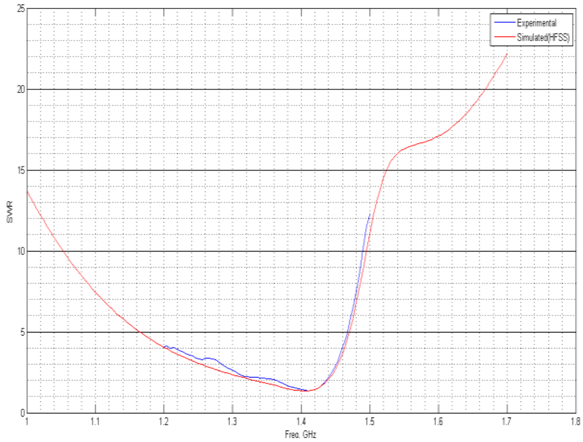
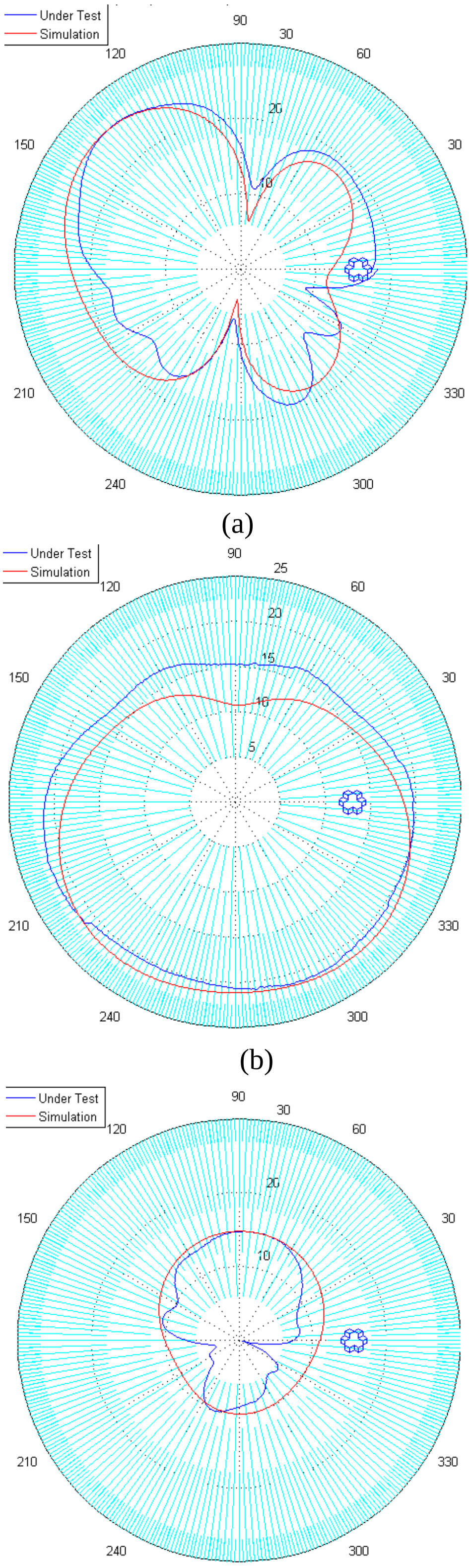


Fig 5. Simulation and measurement results of Standing wave ration

Table 1. ***Dimensions of proposed antenna***

Parameter Name	Value
Web	29.7 mm
Wet	26 mm
He	35 mm
Sf	0 m
Df	1.28 mm
Ɵ	35º
Hn1	21 mm
Hn2	mm 23.3
Hn3	mm 29.6
Ln1	9 mm
Ln2	25.25 mm
Ln3	25 mm
Wn1	mm1/5
Wn2	1.7 mm
Wn3	1.7 mm
Wp	250 µm
Sps	4.1 mm
Wtb	10 mm
Wtt	10 mm
St	0 m
Ht	1 mm
Pew	1 mm
Via_Diameter	400 µm
Metal_thickness	35 µm
Ground_plane_width	107 mm
Ground_plane_length	mm 160.6
Rear_angle	59 º

Fig 6. Fabricated Antenna

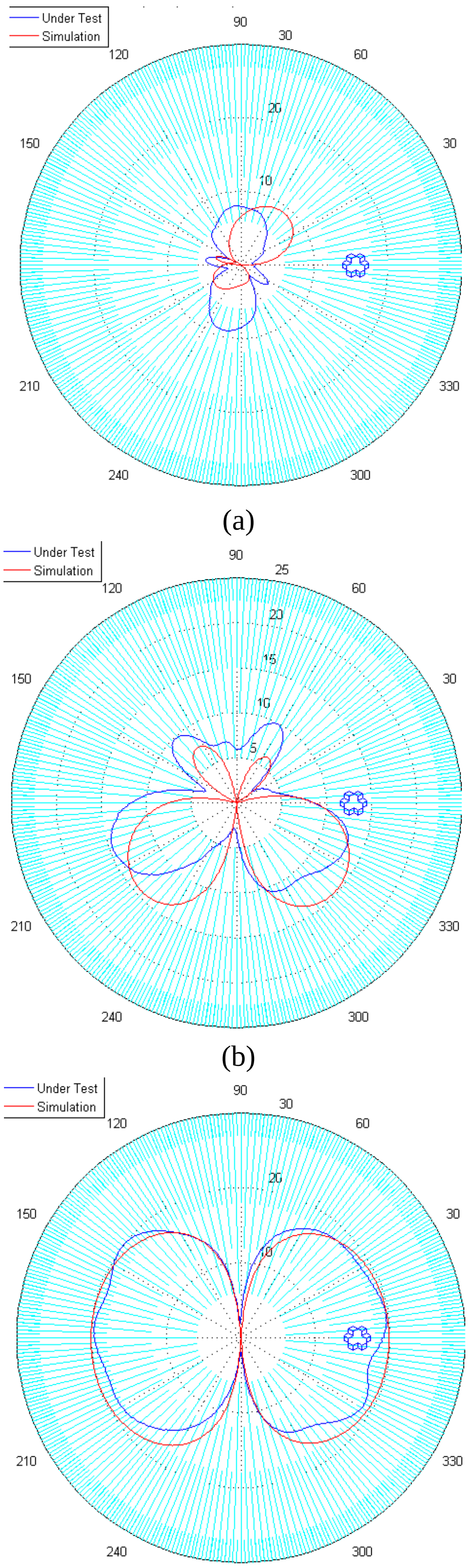


(a)

(b)

(c)

Fi 7. Co-polar pattern at 1.4 GHz, a)E-plane (Horizontal) b) H-plane (Vertical) and c) H-plane (Horizontal)



(a)

(b)

(c)

Fig 8. Cross-polar pattern at 1.4 GHz, a)E-plane (Horizontal) b) H-plane (Vertical) and c) H-plane (Horizontal)

In Fig. 6, an antenna radiation pattern is observed, indicates the antenna is directive and more Gain in the parasitic element direction

In general, a printed one sixth wavelength blade monopole antenna is a good option for use on planes. The height of this antenna can be reduced by maintaining the current structure to one-eighth wavelength. In this antenna, the parasitic element is one of the most influential elements for matching the input impedance to 50 ohms cable.

4. ANTENNA MANUFACTURING

After designing and manufacturing the main part of the antenna turns to the ground plane. For convenience of work, printed board with 35um copper thickness and 16mm substrate thickness of fiberglass are used. The Fabricated Antenna is shown in Fig. 6. The length of the grounded plane is half of the central frequency wavelength and the grounded plane width is 0.75 wavelength of the central frequency which are given in Table (1). After completing the antenna, measuring and obtaining the requested parameter has been tested in the antenna test room of K. N. Toosi University of Technology. Antenna pattern on different cuts and frequencies are shown in Fig. 7 to Fig. 8 which show good agreement between simulation and measurement results.

5. CONCLUSION

In this paper, a printed one sixth wavelength blade monopole antenna was introduced and examined, which has 100MHz impedance bandwidth and 20dB Gain in the direction, and acts in the same radiation pattern such as metallic type with the difference that there is a lighter and integrated structure with a parasitic element that can eventually be in Fig. 12

REFRENCES

[1] O. D. Meliksah Yayan, "Directional Blade Antenna with Tilted Beam," IEEE AP-S, pp. 1440-1441, 2015.

[2] F. a. D. E. Elias Ghafari, "A Vehicular Rooftop, Shark-fin, Multiband Antenna for the GPS/LTE/Cellular/DSRC Systems," IEEE, pp. 237-240, 2013.

[3] T. M. Macnamara, INTRODUCTION TO ANTENNA PLACEMENT AND INSTALLATION, John Wiley & Sons Ltd, 2010.

[4] S. O. H. M. a. I. A. H. Matzner, "Impedance Matching of a Loaded Microstrip Line Using Parasitic Elements," Microwave and Optical Technology Letters 48(6), pp. 1040-1042, 2005.

[5] R. Waterhouse, "Printed antenna suitable for mobile communication handset," Electronics Letters, pp. 1831-1832, 1997.

[6] Y. L. M. I. a. Y. L. Ke Zhang, "Band-Notched UWB Printed Monopole Antenna With a Novel Segmented Circular Patch," IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, vol. 9, pp. 1209-1212, 2010.

[7] T. K. S. A. S. S. Chandana Sairam, "Broadband Blade Antenna for Airborne Applications," IEEE, 2011.

[8] M. O. a. .. Takeichi, "A one-eight-wave blade antenna with metal leading edge," Antennas and propagation Society International Symposium, vol. 12, pp. 225-228, 1974.