High Gain Appendage Loaded Dipole Antenna with Corner Reflector

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Abstract – **A technique for performance enhancement of a simple wire dipole antenna at 2.4 GHz is demonstrated in the proposed article. Initially, the operating bandwidth of the antenna is improved by extending the width, followed by the addition of appendages to the antenna elements. Thereafter, the antenna gain in a specific direction is enhanced with the use of a metallic corner reflector at 90^0. The antenna bandwidth (-10 dB) is improved by up to 30.63% with the appendages. The proposed corner reflector is composed of two conducting plates at an angle of 90^0. The corner reflector is placed at a specific distance from the antenna, and the corresponding parametric study is also included in the paper. With the inclusion of the corner reflector, the gain is increased by up to 32dB in the desired frequency band. Besides, the directivity of the antenna is also enhanced. The proposed antenna is a high gain antenna and is suitable for various wireless communication applications.**

Keywords–Dipole antenna; wideband; appendage; corner reflector; high gain

1.0 Introduction

D**ipole antenna** (also called a **doublet** or **dipole aerial**) is defined as a type of RF (Radio Frequency) antenna, existing of two conductive metals such as rods or wires. The dipole antenna produces a radiation pattern approximating that of an elementary electric dipole. A 'dipole' stands for "two poles" hence the dipole antenna consists of two alike conductive elements such as rods or metal wires. The length of the metal wires is about half of the maximum wavelength (i.e., λ/2) in free space at the frequency of operation. This metal wire creates a gap at the centre, and the two conducting parts are separated by an insulator, these parts are known as an antenna section. These two antenna sections are connected to a feeder or coaxial cable at the end closest to the centre of the antenna. **Note that the wavelength is the interval between two consecutive maximum or minimum points.** The radio-frequency (RF) voltage source is applied to the centre between the two antenna sections of the dipole antenna. This voltage and a current flowing through the two conductive elements generate a radio signal or an electromagnetic wave which is radiated outwards from the antenna. The dipole antenna is one type of transducer, converts electrical signals into radio-frequency (RF) electromagnetic waves and radiates them at the transmitting side and transform RF electromagnetic waves into electrical signals at the receiving side. A wideband antenna has nearly or exactly the same operating attribute over a very wide operating band. It is famous for broadband antennas, where the operating band is large, but the gain of the antenna and/or radiation pattern need not stay the same over the operating band. A corner reflector is primarily utilized for the reflection of waves radiated by the source towards the source of radiation. Corner reflector thus is applicable for Radar, defence applications. The corner reflector is composed of a combination of two metallic plates. The current paper presents a wideband dipole antenna with the use of extended edges. The antenna gain is upgraded with a corner reflector angle of 90^0 and made of metallic plated.

2.0 Design Methods

The design methodof the dipole antenna and the inclusion of appendages are discussed in this section. The design description and method of the metallic corner reflector for the gain enhancement of the dipole antenna is also discussed in this section.

2.1 Design of the Wide band Dipole Antenna

The design of the proposed dipole antenna is started by choosing a wire antenna with two wire sections where wire length is chosen using the following equation.

$$\text{Length of the dipole antenna} = \lambda/2 = c/2f$$

Where, c = velocity of light $=3*10^8$ m/s, f = frequency, in Hertz,λ= wavelength, in meter.

The width of the metallic strip of the antenna is initially chosen 1 mm leading to narrow bandwidth. Later on the width of both the metallic strips of the antenna is increased gradually.Here the wide band dipole antenna is realised using two conducting plate with the height of 27mm and width of 5mm. A non-conducting plate of 5 mm height is used for the gap between two conducting plates. The model is enclosed by a cylindrical model with the height of 170mm and a 130 mm radius as can be seen in Fig. 1 for the purpose of simulation using ANSYS HFSS.

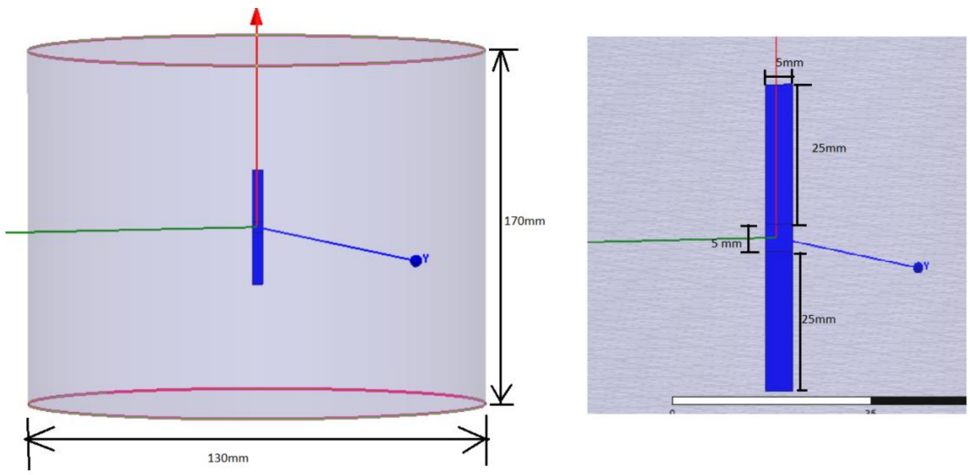
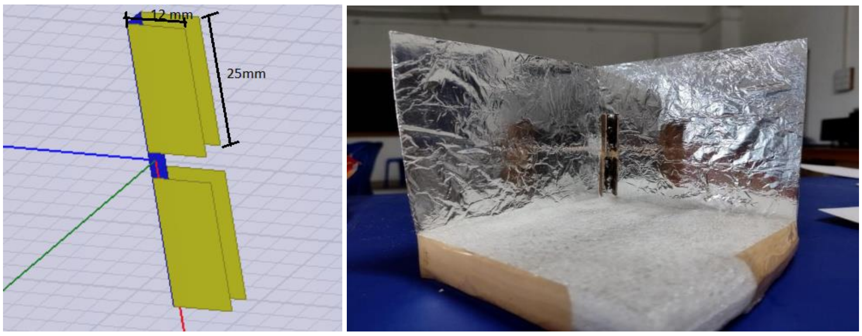


Fig. 1 wide band dipole antenna

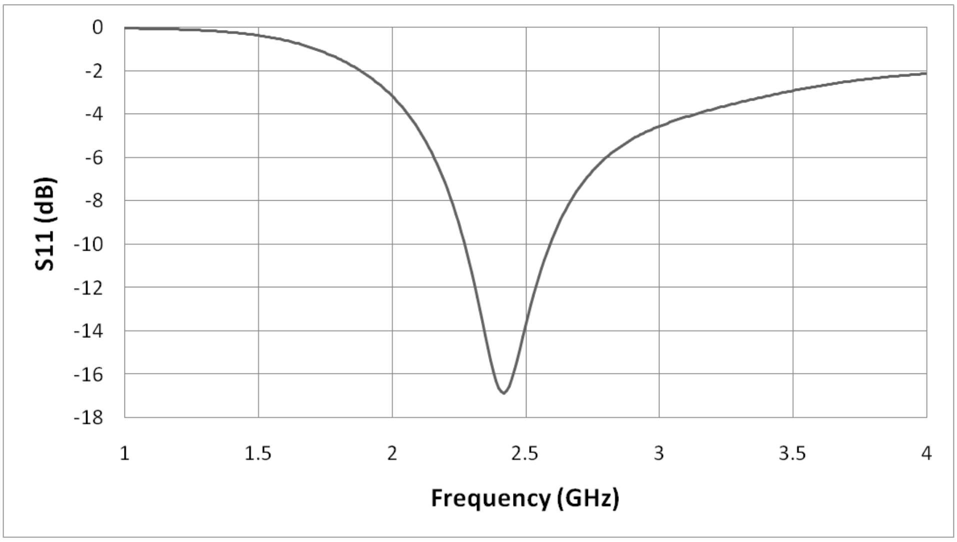
2.2 Characteristics of the Wide band Dipole Antenna:

In order to increase the impedance bandwidth of the antenna some appendages are added at the side edges of antenna. In YZ plane the appendages are added at left and right sides of this antenna, of 12mm width and 25mm(as we can see in fig. 2 along with the fabricated prototype). By using it, the percentage bandwidth is increased from 13.23% to 30.63%(as given in the Table 1 and 2) as can be observed from the antenna characteristics (S11) with as well as without the inclusion of appendages in the Fig. 3. Now as can be seen the percentage bandwidth is greater than 20%.In February 2002, an amendment(part 15) was released by the Federal Communication Commission(FCC),which specifies the rules of UWB transmission and reception. According to it, any signal with fractional bandwidth greater than 20% or having a bandwidth greater than 500 MHz is calledan UWB signal. In this respect, the proposed antenna offers UWB bandwidth.

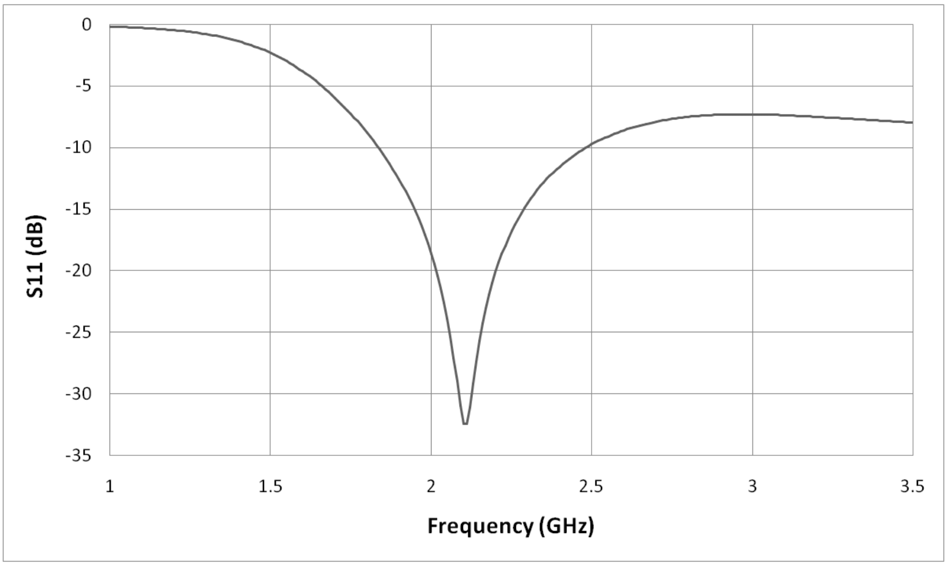


(a) (b)

Fig. 2. Dipole Antenna with appendages (a) schematic (b) fabricated prototype



(a)



(b)

Fig 3 Reflection coefficient of Dipole Antenna (a) without Appendages (b) with Appendages

Table 1: Dimensions and characteristics of the antenna without Appendages

Sl. No.	Height(mm)	Width(mm)	Bandwidth	Percentage bandwidth	Gain(dB)
01	25	5	0.38	13.63%	20.86

Table 2: Dimensions and characteristics of the Antenna with Appendages

Sl. No.	Height(mm)	Width(mm)	Appendages Width(mm)	Bandwidth	Percentage Bandwidth	Gain(dB)
01	25	5	12	0.65	30.63%	21.39

2.3 Characteristics of the Antenna using Corner Reflector:

With the use of appendages on the antenna, a wide percentage of bandwidth but the gain of this antenna increases by just 1dB. However to increasing the gain of this antenna and to getmaximum radiation in one direction with high gain, a corner reflector made of metallic surface can be used in the proposed antenna. Here a corner reflector with the height and width of 130mm is used where the two reflectors are placed at an angle of 90^0(shown in fig. 4). The antenna proposed here is designed by maintaining a distance of 46.48mm from the reflector(shown in Fig 4). By using the reflector, the peak gain value is enhanced by 9-10 dB and highest radiation is achieved at the angle of 112^0 as evident from the radiation pattern in the XY plane (2D plot) in Fig. 5.

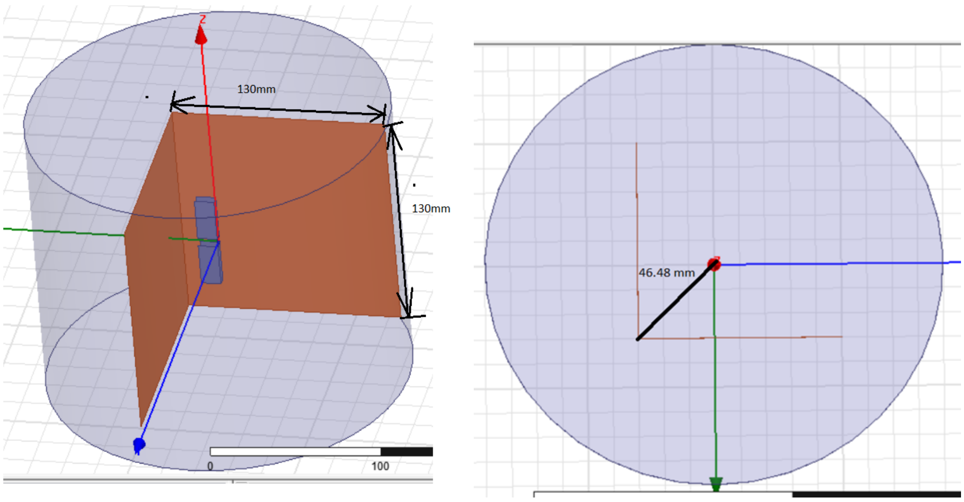
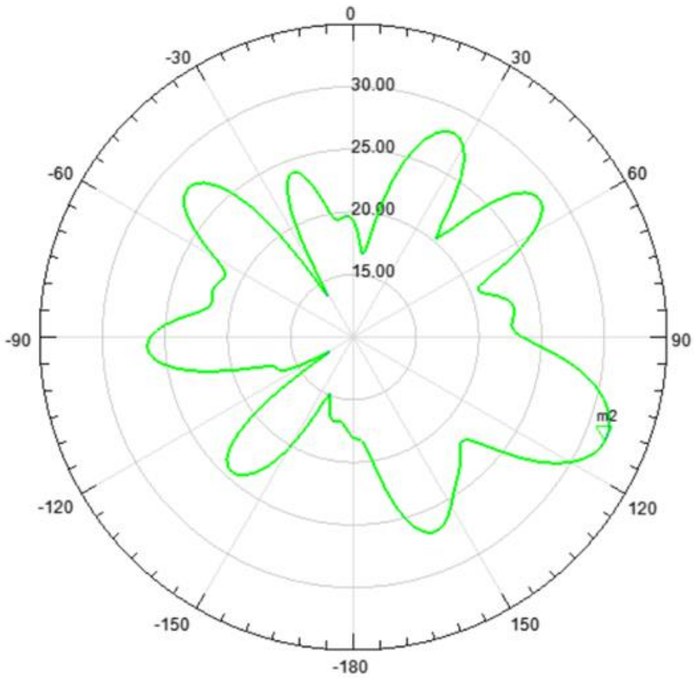
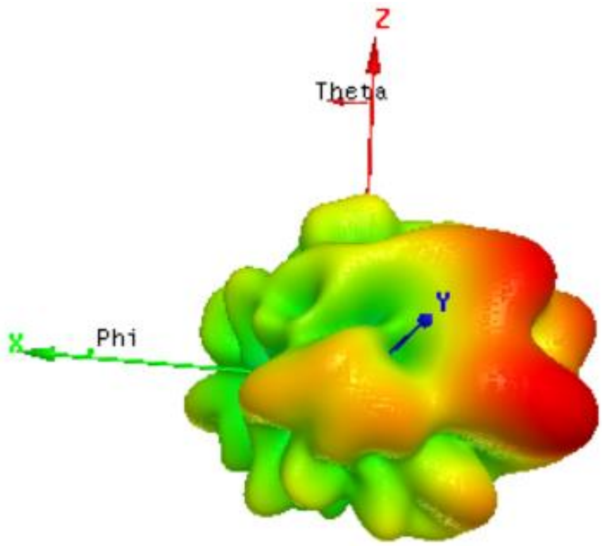


Fig 4Dipole antenna with appendages and corner reflector

By using the reflector, the gain of the antenna is increased by 9-10 dB, leading to the gain of 32dB.The highest radiation with peak gain is achieved at the angle of 112^0as shown in figure 5(a) (2D plot) and (b) (3D plot) respectively.



(a)



(b)

Fig 5 Radiation Plot of the proposed antenna with the inclusion of corner reflector (a) 2D plot in XY plane (b) 3D plot

2.4 Conclusion:

The paper presents a wide band dipole Antenna with the use of Appendages is presented in this paper followed by enhancement of the gain of the antenna by using a metallic Corner Reflector, where both the reflectors are made of conducting sheets. With this proposed design antenna parameters are improved. An impedance (-10 dB reflection coefficient) bandwidth greater than 20%, upto 30% and also more than 30dB gain is achieved by this wide band dipole antenna. The antenna is applicable for high gain wireless communication applications.

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