Design of UWB High Gain Modified Bowtie Antenna for Radar Applications

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***Abstract*— The Ultra-Wideband high gain modified bowtie antenna is presented for radar applications. The proposed antenna is designed by stepped cut microstrip feed in antipodal slotted bowtie antenna with reflector at the bottom side of an antenna to achieve high gain of 4.45dB with S11 is less than -10dB and bidirectional radiation pattern. The overall size of an antenna is 37.5 X 57 X 1.6 mm^3 using FR4 substrate. Finally the simulated results of the proposed antenna is analyzed for agreeing the radar applications.**

Keywords— UWB antenna, gain, bandwidth, radar applications.

I. INTRODUCTION

The recent developments of the radar applications are significantly designed under Ultra-Wide Band frequency(UWB), which was agreed by the Federal Communication Commission's (FCC), which allows the frequency band between 3.1 to 10.6GHz.UWB band antenna has some characteristics like omnidirectional radiation pattern, return loss to be less than -10dB, good impedance matching and satisfying the UWB fractional bandwidth. For high gain and good impedance matching, some parasitic elements can be incorporated in the design of broadband circularly polarized bowtie antenna [1-3].In deploying the antenna for radar applications, satellite applications, the directivity of the antenna is to be improved and therefore single feed with cavity backed antenna is used in the for getting high front to back lobe ratio and also covers the wide band frequency range [4-6].

Bandwidth enhancement and gain improvement is the important parameter in the design of an UWB antenna, aperture coupled with ring type patch is included in the design of bowtie antenna[12].Various microstrip antennas are used with different feeding types like microstrip feed, coplanar feed, coaxial feed, stepped feed is used for bandwidth enhancement and high gain[8,9]. However, the bandwidth enhancement with gain improvement is main challenge in the design of one particular antenna. Many of the antenna designs like vertically printed planar antenna, cavity backed aperture couple antenna[10-14], the main concentration in the design aspects of improving the gain of an antenna.

In the proposed antenna design of antipodal bowtie antenna with plus shaped slotted structure in along with reflector and stepped feed, for achieving the multiple frequency resonation which covers the UWB band and also to improve the gain of an antenna. This antenna is used in the radar applications like medical applications, blind spot detection in the vehicles, the signal penetration with high impulses is used for long distance coverage.

II. ANTENA DESIGN AND CONFIGURATION

The proposed antenna is designed using FR4 substrate for UWB applications. The antenna is made to resonate in Ultra Wideband of frequency with the dimensions of 30.4mm x 57mm.The design procedure begins with the radiating patch with the substrate, the ground plane and a feed line. The antenna is placed on a1.6mm thick FR4 substrate material with the relative permittivity of 4.4, relative permeability of 1, and a dielectric loss tangent of 0.025. This modified antipodal bowtie antenna is designed with two triangles mirror image beside each other one at the top of the substrate and other at the bottom of the substrate. Crossed slot is etched in the both sides of the antipodal bowtie antenna to make some varying current distribution in the lower and middle frequency range. To increase the gain and directivity of the antenna, the metal reflector is placed at the bottom side of the substrate which acts as ground to reduce the backward radiation. The lengths and widths for the frequencies in the band is calculated. The structure of the proposed modified bowtie antenna is shown in fig.1. The stepped microstrip line feed is used for good impedance matching.

A. Calculate the height and width of the bowtie patch

Width of the bowtie: $w= (0.375 \times c \times 1000)/f$ (1)

W3=28.125(f=4GHz)

height of the bowtie: $h= (0.25 \times c)/f$ (2)

h_1=18.75(f=4GHz)

B. Calculate the length and height of the stripline

Length of the stripline: L= dʎg (3)

L1 = 6mm

L2=18.75mm

width of the stripline: w/d=(8e^A)/(e^2A-2) (4)

W_1= 1mm

W_2 = 3mm

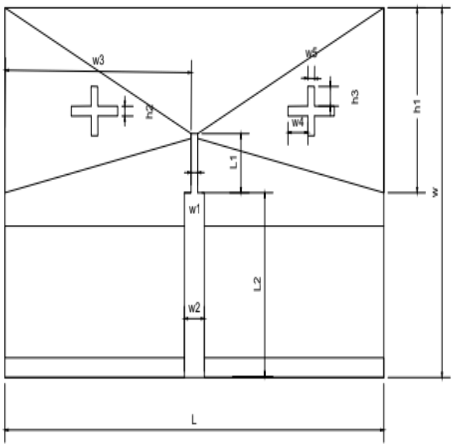

Fig.1 Structure of the proposed antenna

The dimensions of the antenna is shown in the Table 1. in which length, width of the bowtie antenna and the remaining design sizes are parametrically optimized values are mentioned.

TABLE .1 CONFIGURATION OF AN ANTENNA

Label	**W**	**L**	**W1**	**L_1**	**W2**	**L2**
Value(mm)	37.5	57	1	6	3	18.75
Label	**W3**	**h1**	**W4**	**h2**	**W5**	**h3**
Value(mm)	28.125	18.75	8	1	1	5

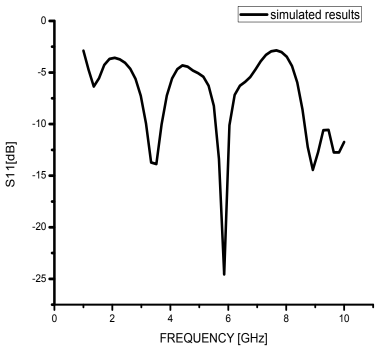

Fig. 2 Return loss of the proposed antenna

Fig 2. The various resonating frequencies like 3.5GHz, 5.8GHz, 8.9 GHz which covers the UWB range of less than -10dB. In the radar applications like vehicle monitoring, the resonating better at some middle band frequency and it covers the minimum bandwidth for getting high gain. Better return loss shows the good impedance matching results.

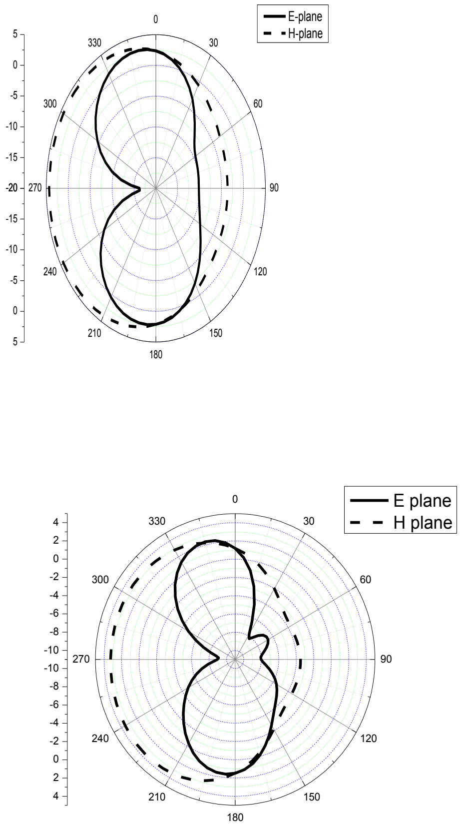

Fig 3. Simulated radiation pattern for E-plane and H-plane at 4GHz and 5GHz

III. RESULTS AND DISCUSSIONS

The proposed antenna is designed using HFSS for radar applications, and the simulated return loss is shown in the fig.2.The simulated radiation pattern of E -plane and H-plane at 4 GHz and 5GHz is shown in Fig 3. H plane pattern is quite directional for the increase in frequency. And the corresponding E-plane pattern is bidirectional and some ripples occurred in the high frequency range. The gain plot for varying the frequency range shown in the fig.4, the reflector is placed at the bottom part of the bowtie antenna which is used in reflecting the signals and hence the better gain of about 4.45dB is achieved in the certain range of frequencies. In this results, high gain between 2.4GHz and 7GHz for high signal penetration from any vehicles for longer distances that can be suitable for traffic applications.

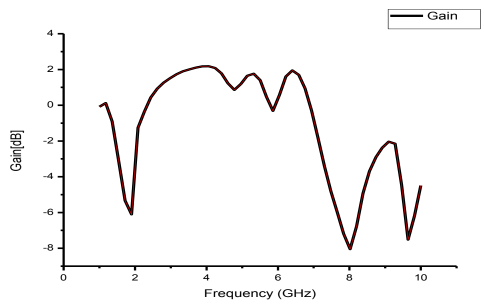

Fig 4. Simulated Gain versus frequency

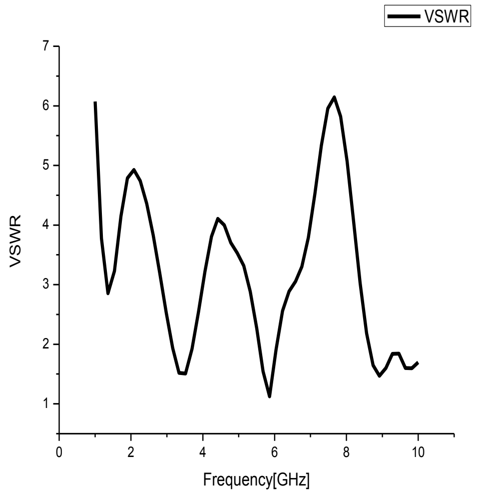

Fig .5. VSWR of the proposed antenna

Voltage Standing Wave Ratio(VSWR) is a function of the reflection coefficient, which describes the power reflected from the antenna and value should be between 1 to 2dB. The VSWR of the antenna is 1.01dB at 5.8GHz. This shows that low power reflection in this middle frequency range.

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