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Design of Bowtie Antenna for Wideband Applications

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Abstract – In Wireless communications antennas plays a major role to direct the field in one all directions. There are different types of antennas available to distinct applications. Here we presented a simple design of Bowtie antenna operating at 2.6GHz for wideband applications, on Rogger RT/duriod 5880 substrate. The basic antenna parameters like gain, radiation pattern, FBR, VSWR, bandwidth is presented. The antenna was designed in Ansoft HFSS software.

Index Terms—Bowtie antenna, Gain, Bandwidth

I. INTRODUCTION

The micro strip patch antennas are attracting the attention due to their advantages like light weight, low cost of fabrication, thin profile and easy of manufacturing. Microstrip antennas have different geometrical structures depending on the demand of application. The present structure of Bowtie consists of two triangular patches arranged such that one is mirror image to another. Both are fabricated on RT/duriod 5880 substrate as shown in figure.

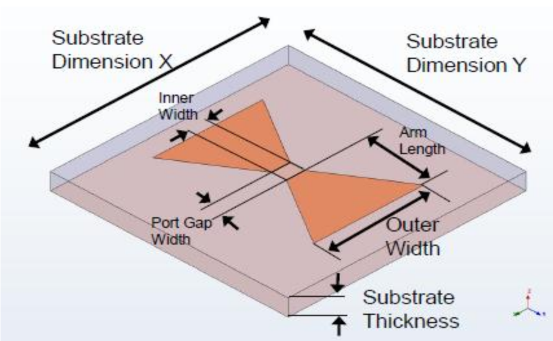

Figure 1: Bowtie Antenna

Bowtie Microstrip antennas have wider band width, higher gain, lower front to back ration, lower cross polarization level and compact in nature than rectangular patch, it is generally a flat version of biconical antenna [2].

II. TRANSMISSION LINE MODEL

Present paper the design of Microstrip bowtie antenna structure was analysed using transmission line model which is considering the antennas whole geometrical and electrical characteristics. Here radiating patch is considered as transmission line of width W with two radiating patches connected at each ends. For an operating frequency of f0 the width W can be estimated as

$$W = \frac{\lambda_0}{2}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where $\lambda 0$ is free space wave length
The Microstrip Bowtie patch has an inhomogeneous configuration (here in present model RT/duriod Dielectric bellow the patch and air above the patch), by introducing a new medium with an effective permittivity ($1 < \varepsilon eff < \varepsilon r$) and it has same electrical characteristics (Impedance and phase velocity) as original medium then the medium will be homogeneous.

For W/h > 1, the effective dielectric constant is

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Where W is width of patch
h is height of substrate
εr is dielectric constant of substrate
Knowing the dimensions of microstrip line, the characteristics impedance can be calculated as

$$Zo = \begin{cases} \dfrac{60}{\sqrt{\varepsilon_{eff}}}\ln\left(\dfrac{8h}{w} + \dfrac{w}{4h}\right) & for \quad \dfrac{w}{h} \le 1 \\[2ex] \dfrac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\dfrac{w}{h} + 1.393 + 0.667\ln\left(\dfrac{w}{h} + 1.444\right)\right]} & for \quad \dfrac{w}{h} \ge 1 \end{cases}$$

At the edges of patch the fringing fields will develops which makes the length of patch higher than its physical length by $2\Delta L$. This is shown in bellow figure.

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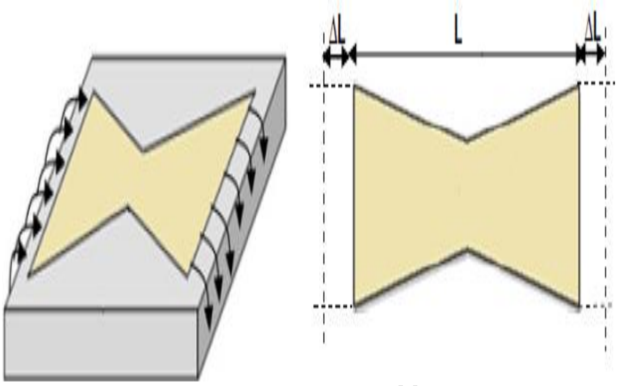


Figure 2: Fringing Fields

The effective length of patch in terms of effective dielectric constant

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

$$L_{eff} = L + 2\Delta L$$

The resonance frequency is

$$f_0 = \frac{c}{2L_{eff}\sqrt{\varepsilon_{eff}}}$$

Where C is the velocity of light in free space

III. ANTENNA DESIGN

The proposed antenna of Bowtie structure was designed on Rogger RT/duriod substrate of height 1.56mm, (whose dielectric permittivity 2.2 and loss tangent 0.0009). The inner width is 0.4mm, outer width is 7.35mm, and port gap is 0.8mm and arm length 16.3mm. This is fed with lumped port.

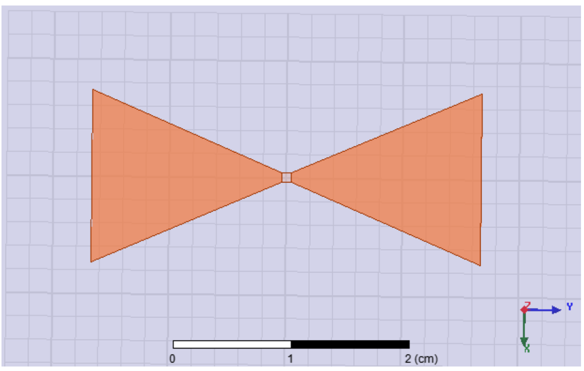


Fig 3: Simulated Model

IV. RESULTS & DISCUSSION

The basic properties that are used to describe the performance of an antenna include impedance, voltage standing ratio, gain, polarization, radiation pattern, bandwidth, antenna efficiency are presented bellow.

A. Return Loss

According to maximum power transfer theorem the maximum amount of power will be transferred when there is a perfect match between devices. Present project maximum power transfer between feed line and antenna takes place when input impedance of antenna must identically match with the characteristic impedance of feed line. If any mismatch in impedance results return of energy back to source called as return loss. To have better results the return loss value should be as low as possible present project the return loss value of -18.8748dB at the operating frequency of 2.6719GHz

B. Bandwidth

The antenna band width is a range of frequencies over which the antenna maintains required specifications, like constant gain. Present project the bandwidth of bowtie antenna is 440.6MHz.

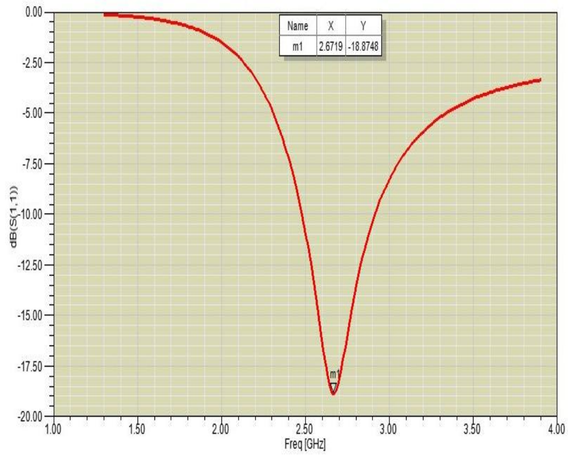


Figure 4: Return Loss

C. Voltage Standing Wave Ratio

The voltage wave on transmission line is the combination of both incident and reflected wave. The ratio between maximum voltage and minimum voltage along transmission line is called VSWR. This VSWR indicate that how closely or efficiently antennas terminal input impedance is matched to characteristic impedance of transmission line. The system operation will be better when VSWR is 2:1 for 50Ω line impedance.

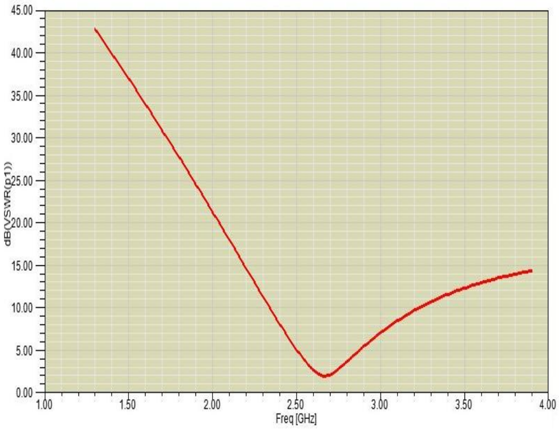


Figure 5: Voltage Standing Wave Ratio

D. Impedance

The impedance locus of bowtie antenna is plotted in smith chart

E. Radiation Pattern

The radiation pattern of antenna describes how an antenna directs the energy it receives or radiates

F. Gain

The gain is measure of overall efficiency of antenna. If an antenna is 100% efficient the gain is equal to directivity.

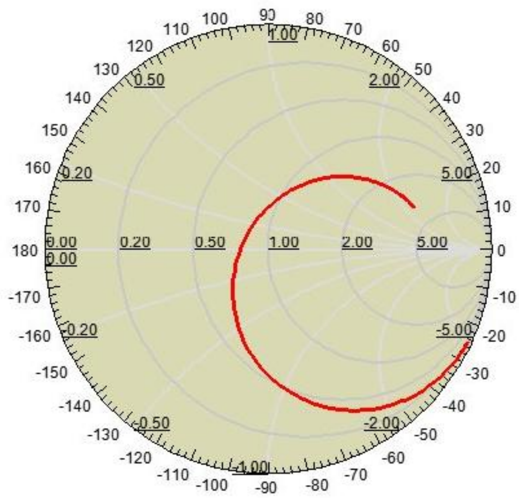


Figure 6: Smith Chart

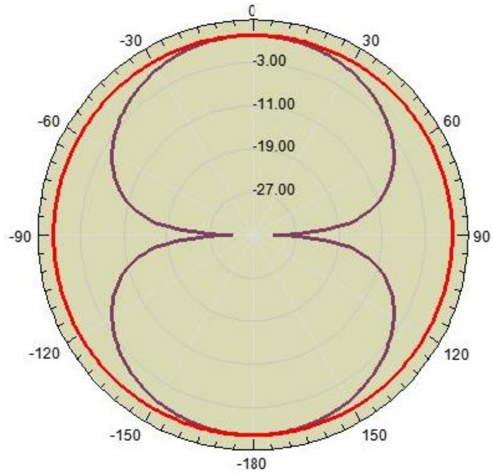


Figure 7: Radiation Pattern

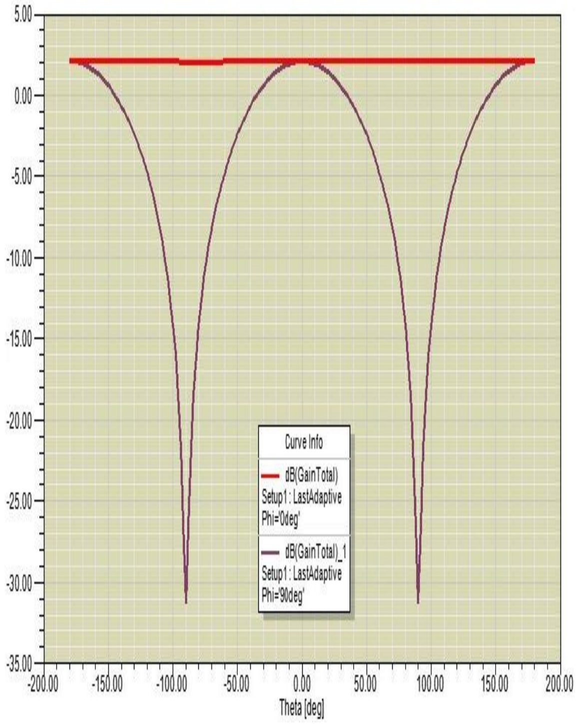
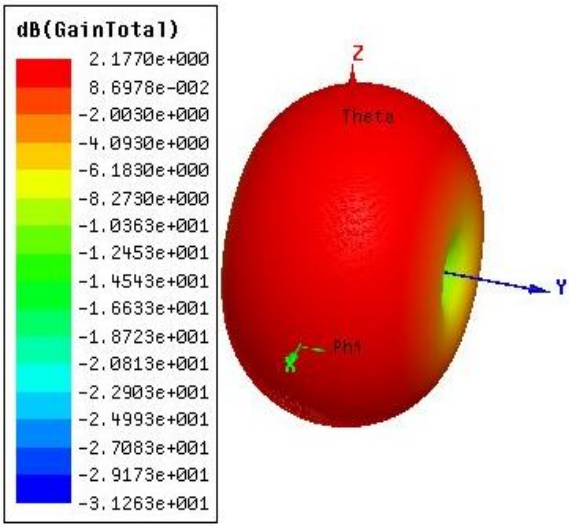


Figure 8: Gain Plotted in 2D graph

G. Gain (polar plot)



F. Port Impedance Vs reflected phase

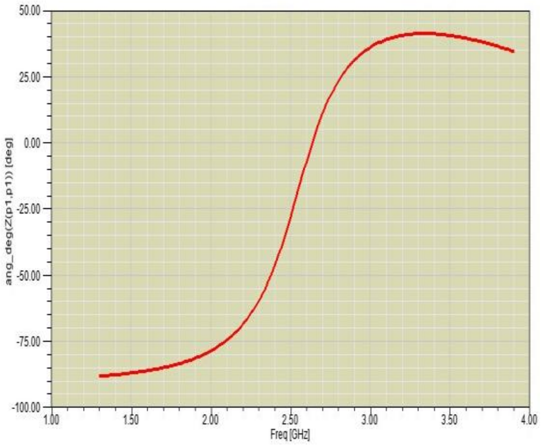


TABLE I
ANTENNA PARAMETERS

S.No	Quantity	Value	Units
1	Max U	0.128295	W/Sr
2	Peak Directivity	1.64931	
3	Peak Gain	1.65081	
4	Peak Realized Gain	1.61224	
5	Radiated Power	0.977521	W
6	Accepted Power	0.976633	W
7	Incident Power	1	W
8	Radiation Efficiency	1.00091	
9	FBR	1.00944	

V. CONCLUSIONS

The bowtie antenna designed in present project is resonating at a frequency of 2.6GHz; this structure was analyzed in transmission line model. Obtained results are well within the range, i.e. the operation of the antenna exhibit minimum return loss, omini directional radiation pattern, wide impedance band width, VSWR<2.

VI. REFERENCES

[1] Constantine A. Balanis; "Antenna Theory, Analysis and Design", John Wiley & Sons Inc. 2ndedition. 1997.

[2] Sawsan SADEK and Zahar KATBAY "Ultra wideband CPW Bowtie antenna" IEEE publications 2009

[3] Stutzman Warren L. and Thiele "Antennas and propagation Magazine", vol.52, Feb 2010.

[4] Girish Kumar and K. P. Ray, "Broadband Microstrip Antennas" Artech House, 2002.

[5] D.M.Pozar "Microwave Engineering", 3rd ed. NewYork, John Wily & Sons, 1998.

[6] J.A.Kong, "Electromagnetic wave theory"., EMW Publishing, 2008, p 268.

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