Dual Director Microstrip Planar Yagi-Uda Antenna for X-Band

Mahesh Kumar Aghwariya[1], P.K.Singhal[2]
Department of Electronics Engineering, Madhav Institute of Technology and Science, Gwalior-474005, India
Email: [1]mahi_wings@ymail.com, [2]pks_65@yahoo.com

Abstract: In this paper, a planar Yagi-Uda antenna based on classic Yagi-Uda dipole antenna is presented which is very useful for microwave wireless applications. This proposed antenna is designed for X- frequency band. This antenna has been developed at supporting dielectric constant of 4.4, supported substrate thickness of 1.6mm and loss tangent of 0.02. The proposed antenna is completely compatible with microwave circuitry and wireless communication system. This antenna is simulated by using IE3D simulation software.

Keywords – IE3D Software; Micro-strip antenna; Planar antenna; Wireless communication.

I. INTRODUCTION

Among the most prevalent antennas, Yagi-Uda antenna is widely used. Initially, the Yagi-Uda antenna was used for domestic application that is for receiving signals for televisions but sooner they also found there application in wireless system [1-3]. In 1928, first paper based on Yagi-Uda is published in an English language journal [4]. However, only limited success has been achieved at adapting this antenna to microwave/millimeter wave operation. Several interesting approaches for this are a microstrip Yagi array based on the microstrip patch antenna [5], and a coplanar-stripline fed printed Yagi–Uda antenna with the reflector element printed on the back of a thick, low-permittivity slab at 60 GHz [6].

In recent years, Yagi-Uda antenna or Yagi-Uda arrays came into existence which consist of a driven element and more than one parasitic element [7].Microstrip Yagi–Uda antenna offers advantages such as simple, compact, low cost , high directivity, high gain and wide bandwidth therefore they are widely used in radio frequencies application. The advantage with antennas are that they can be suitably used for wide range of applications such as wireless communications, satellite communications, pattern combining and antenna arrays. The driver and directors components are almost similar in all designs of antennas and the only difference is of feeding.

II. DESIGN AND PRINCIPLE

In this paper, proposed antenna is modified form of Ryan S. Adams , Benton O'Neil and Jeffrey L. young paper of title "Integration of microstrip circulator with planar Yagi antennas of several directors" [8]. In this design, modifications like substrate thickness (1.6mm) and dielectric constant (4.4) and loss tangent (0.02) were taken into account [9].

Main geometrical structure is identical to base design except the dimension of the element which was changed and also the inclusion additional director was done. The IE3D simulation software was used for the antenna simulation. This design has been developed at frequency of 10.44GHz. Here, figure 1 shows dual director planar micro-strip Yagi-Uda antenna. This antenna have two directors of same length, at some specified distance, the spacing between the directors is independent of the physical length (10).

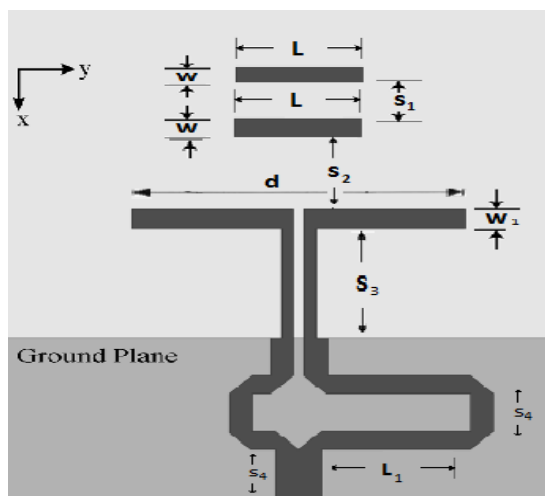

Figure.1 Schematic of dual director planar micro-strip Yagi-Uda antenna

Antenna parameter (millimeter): L=4.8, W=1.0, W1=0.6, S1= 0.87, S2=2.8, S3=3.4, S4=2.4, L1=3

III. RESULT

The proposed antenna was fabricated on PCB after the simulation using IE3D software and then the SMA connector was used for connection of the antenna to the spectrum analyzer. The use of spectrum analyzer is to determine the various parameters of the antenna. The micro-strip feed of 50 ohm was provided to antenna. The radiation pattern of the antenna has been measured across the operating bandwidth. The figure 2 shows the simulated and measured return loss of the proposed antenna. Resonance frequency of the proposed antenna is 10.45GHz. There is slight difference between the simulated and measured results of the antenna because of measuring errors and SMA connector that was used at the time of simulation. Comparison between simulated and measured parameters of the antenna is shown below in the table 1:

Table 1: Simulated and measured value of Yagi-Uda antenna

Parameter	**Simulated**	**Measured**
Frequency (GHz)	10.45	10.3
Directivity (dBi)	4.23	3.26
Gain (dBi)	3.9	3.21
Bandwidth (GHz)	1.47	0.98
Radiation Efficiency (%)	98.45	90.25
Return loss (dB)	-39	-28

Figure 2 shows the graph between frequency and return loss of simulated and measured result. Simulated result of antenna shows return loss of -39dB while measured result of antenna shows return loss of -28dB . Figure 3 and Figure 4 are show radiation pattern and gain respectively.By inspecting graph shown in Figure 4,it is found that gain of Yagi-Uda antenna is 3.9(dBi) . Figure 5 shows the smith chart [11] of the antenna, it shows that the impedance of the antenna is matched with the co-axial cable i.e., 50Ω.

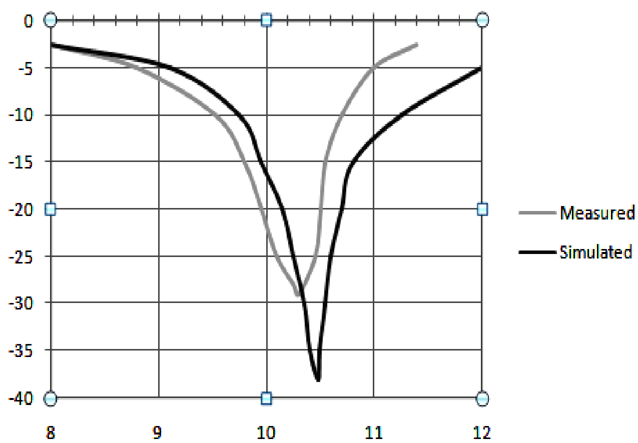

Figure.2 Simulated and measured Return loss characteristics graph.

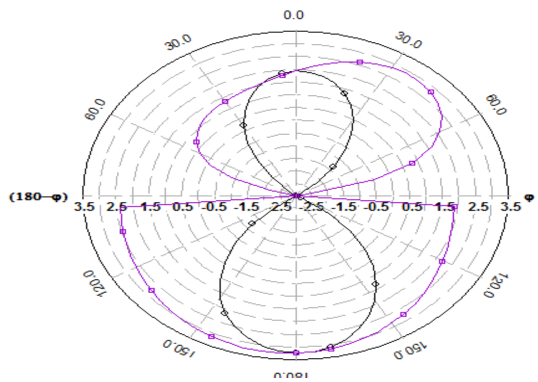

Figure.3 2D Radiation Pattern

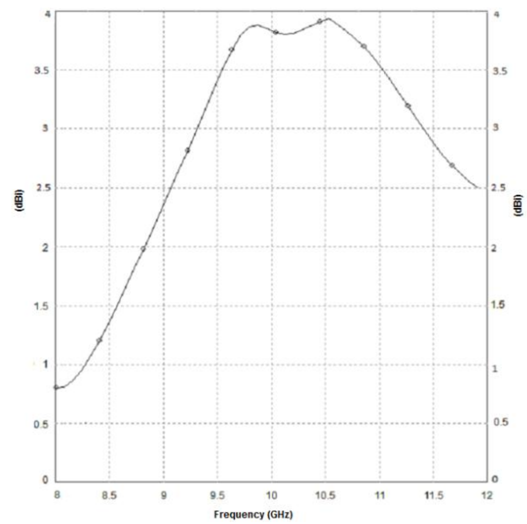

Figure 4.Gain Vs Frequency Graph

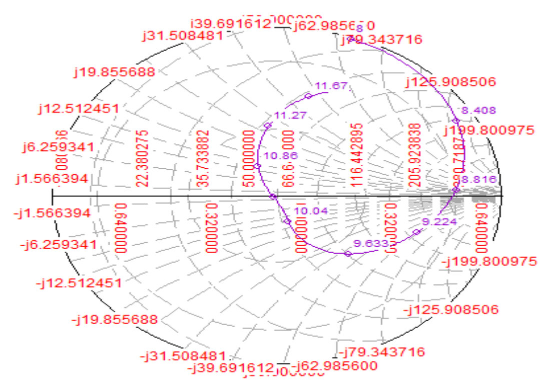
Figure.5 Smith chart display of dual director Yagi Uda antenna

IV. CONCLUSION

The planar dual director Yagi-Uda antenna was concluded as a simple and compact design that is based on classic folded dipole Yagi-Uda antenna. This antenna can also be used as array to improve the directivity. For the excitation purpose, 50 ohm feed was provided. The antenna has been simulated using IE3D software and finally measured. The antenna has wide band width in X-Band and well directive radiation pattern, radiation efficiency of 98.45% and antenna efficiency of 98.41%. Directivity of the antenna is 3.26822dBi and radiated power in whole space is 0.000984122 watt.

It was found that there was not much difference in the simulated and measured results.

Further the functionality of antenna can be improved by varying its gain. The research on this concept is still on progress.

REFERENCES

[1] Chou H.T. , K.T. Hung, and C.Y. Chen, "Utilization of a Yagi antenna director array to synthesize a shaped radiation pattern for optimum coverage in wireless communication," Journal of Electromagnetic Waves and application, Vol. 23, No. 7 ,851-861 2009.

[2] Li, J.-Y and J. L. Guo, "Optimization technique using differential evolution for Yagi-uda antennas." Journal of Electromagnetic Waves and application, Vol.23, No. 4, 449-461, 2009.

[3] Misra, I.S., R. S. chakrabarty, and B. B. Mangaraj , "Design analysis and Optimization of V-dipole and its three-element Yagi-uda array."Progress In Electromagnetic Research, PIER 66, 137-156,2006.

[4] H.Yagi, "Beam transmission of the ultra short waves," Proc. IRE, vol.16, pp. 715–741, June. 1928.

[5] J.Huang and A. C. Densmore, "Microstrip Yagi array antenna for mobile satellite vehicle application," IEEE Trans. Antennas Propagat., vol. 39, pp. 1024–1030, July 1991.

[6] K. Uehara, K. Miyashita, K. I. Matsume, K. H. Hatakeyama, and K.Mizuno, "Lens-coupled imaging arrays for the millimeter and submil-limeter-wave regions," IEEE Trans. Microwave Theory Technol., vol.40, pp. 806–811, May 1992.

[7] Teisbaek, H.B. and K. B. Jakobsen, "Koch –fractal Yagi-uda antenna." Journal of Electromagnetic Waves and Application,Vol. 23, No. 2-3, 149-160, 2009.

[8] Ryan S. Adams , Member, IEEE, Benton o'Neil, and Jeffrey L. Young, "Integration of microstrip circulator with planar Yagi antennas of several directors" IEEE transactions on antennas and propagation, vol. 56, no. 11, November 2008

[9] W. L. Stutzman and G.A. Thiele , Antenna theory and design .New York ; Wiley , 1998

[10] Derek GrAy, Jun Wei Lu, and David V. Thiel., Electronically steerable Yagi-Uda micro strip patch antenna array.

[11] David M. Pozar, "Microwave Engineering", 3rd Edition, John Wiley & Sons, 2004