International Journal of Research in Engineering & Technology (IJRET)
ISSN 2321-8843
Vol. 1, Issue 2, July 2013, 151-154

MICROSTRIP YAGI-UDA ANTENNA AT 2.45 GHz FOR ISM BAND APPLICATION

SATYANDRA SINGH LODHI & P. K. SINGHAL

Department of Electronics, Madhav Institute of Technology and Science, Gwalior, Madhya Pradesh, India

ABSTRACT

This paper propose a novel design of microstrip Yagi-Uda antenna at 2.45 GHz for ISM (industrial, scientific and medical) band application. The proposed antenna consists of pair of reflector, a driven element and three directors. The antenna had achieved directivity of 5.95 dBi, gain of 4.496 dB, return loss of -41.5 dB and high efficiency. It has been fabricated on the FR-4 substrate with dielectric constant of 4.4, loss tangent of 0.02 and substrate height 1.6 mm.

Computer simulation technique (CST) MW studio software was used to simulate the design antenna. The parameter of antenna such as directivity, gain, bandwidth and antenna were analysis and also discussed.

KEYWORDS: Microstrip Yagi-Uda Antenna, Computer Simulation Technique (CST) MW Studio Software, Radiation Pattern, Smith Chart, Printed Circuit Board (PCB), SMA Connector

INTRODUCTION

The Yagi-Uda antenna array generally consists of a reflector, a driven element and one or more director. The driven element of Yagi-Uda antenna is directly excited by the source and current is induced in parasitic element by mutual coupling. The current distribution in driven element and parasitic element control the characteristic of antenna such as directivity, gain, bandwidth and efficiency [1].

In order to enhance the antenna characteristic of a Yagi-Uda antenna a driven element and all the parasitic elements are arranged on the same substrate [2]. To shape the beam of the antenna the parasitic element with open circuit stubs is tited in a desired direction [3]. Nowadays, Yagi-Uda antenna is used for TV application as well as for wireless communication also [4-5]. It also radiates the end fire beam with driven element and several parasitic elements [6].

In this paper the design antenna consist of two reflectors, a driven element and three directors. Three directors were used to increase the gain of antenna. A pair of reflector has been used to increase the directivity of antenna. The ground plane of design antenna is truncated which improve the results.

Antenna efficiency was also increase by the truncated ground plane. The antenna was design at resonating frequency of 2.45 GHz which found many applications for industrial, scientific and medical (ISM) band and in communication system. The designed antenna is simulated by Computer simulation technique (CST) MW studio software [7].

DESCRIPTION OF ANTENNA

The proposed microstrip Yagi-Uda antenna is shown in figure 1. The antenna has been analyzed on FR-4 substrate with dielectric constant of 4.4, loss tangent of 0.02, substrate height 1.6 mm and length of 100 mm and width of 100 mm. The back view of proposed antenna is shown in figure 2.

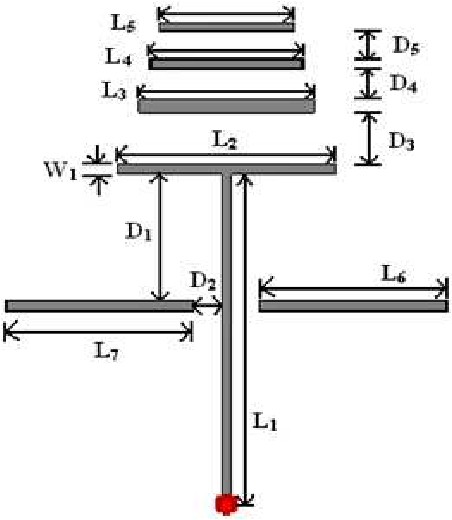

Figure 1: The Design of Proposed Microstrip Yagi-Uda Antenna

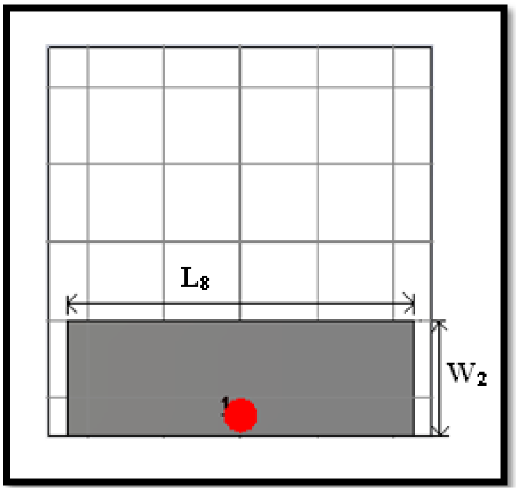

Figure 2: The Back View of Proposed Microstrip Yagi-Uda Antenna

The design microstrip Yagi-Uda antenna consists of pair of reflectors, a driven element and three directors. The ground plane of the antenna is truncated with length and width of 91 mm and 39.8 mm. As the ground plane is truncated the pair of reflector can be easily placed which helps to improve the radiation efficiency. The fabricated layout of proposed antenna is shown in figure 3.The parameter of design antenna is given in table 1.

Figure 3: The Fabricated Layout of Proposed Microstrip Yagi-Uda Antenna

Table 1: Parameter of Design Antenna

Parameter	Dimension (mm)	Parameter	Dimension (mm)
L_1	65	D_1	24
L_2	39.8	D_2	5
L_3	32	D_3	10
L_4	28	D_4	6
L_5	24	D_5	5
L_6	34	W_1	2
L_7	34	W_2	29.6
L_8	91		

L_1 = length of microstrip feed line.
L_2 = length of driven element.
L_3, L_4 & L_5 = length of directors.
L_6 & L_7 = length of reflectors.
D_1 = distance between driven element and reflector.
D_2 = distance between microstrip line and reflector.
D_3 = distance between driven element and director.
D_4 & D_5 = distance between directors.
W_1 = width of patches.
L_8 & W_2 = length and width of ground plane.

RESULTS AND DISCUSSIONS

The Computer simulation technique (CST) MW studio software was used to simulate the proposed microstrip Yagi-Uda antenna. The proposed antenna is design at the resonating frequency of 2.45 GHz. It had achieved the directivity of 5.952 dBi, gain of 4.496 dB and bandwidth of 94.3 MHz. The design antenna had the return loss of -41.5 dB. The comparison of simulated and measured return loss graph is shown in figure 4.

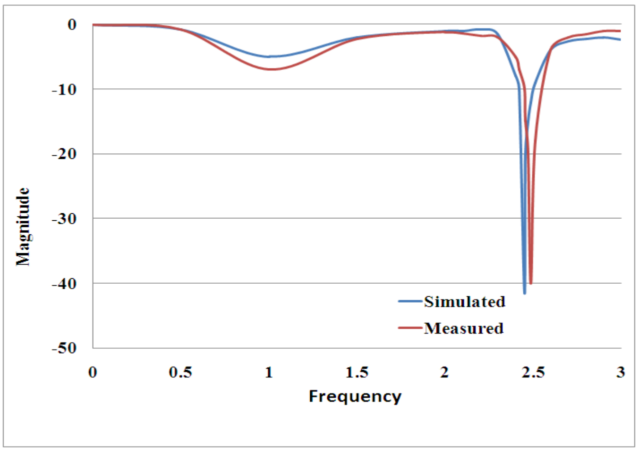

Figure 4: The Return Loss Graph of Proposed Microstri Yagi-Uda Antenna

The directivity and gain of proposed antenna is shown in figure 5 and figure 6.

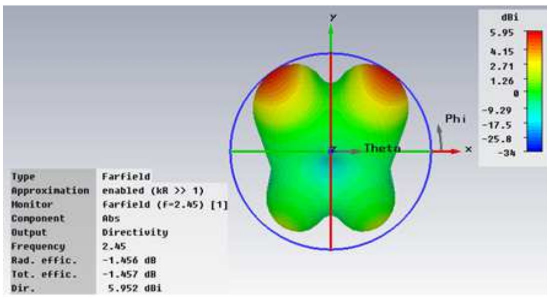

Figure 5: Directivity of Proposed Microstrip Yagi-Uda Antenna at 2.45 GHz

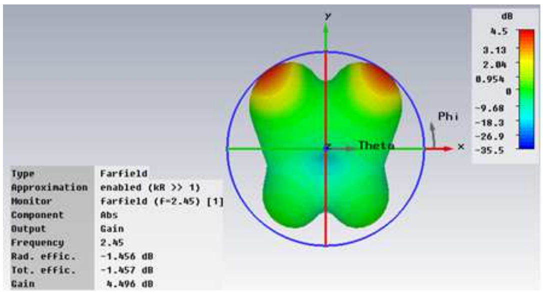

Figure 6: Gain of Proposed Microstrip Yagi-Uda Antenna at 2.45 GHz

The smith chart was used to analyze the impedance matching [8]. The design antenna has been completely matched with the feed point at 2.45 GHz. The smith chart is shown in figure 7.

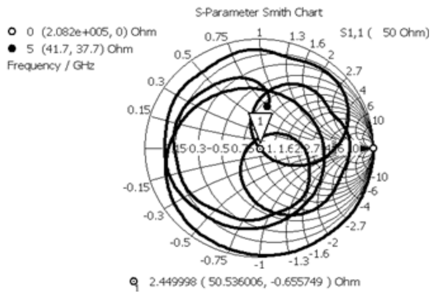

Figure 7: Smith Chart of Microstrip Yagi-Uda Antenna

CONCLUSIONS

In this paper a microstrip Yagi-Uda antenna with two reflectors, a driven element and three directors is proposed and simulated. The proposed antenna had achieved the directivity of 5.95 dBi, gain of 4.49 dB and return loss of -41.5 dB at the resonating frequency of 2.45 GHz with proper impedance matching. The design antenna can be used in many application of ISM (industrial, scientific and medical) band and in communication system such as microwave oven, wireless sensor network, Bluetooth, wireless LANs and in cordless phone.

REFERENCES

1. Ehrenspeck, H. W. and H. Poehler, "A new method for obtaining maximum gain from Yagi antennas," *IEEE Trans. Antennas Propag.*, Vol. 7, No. 4, 379–386, 1959.

2. Chen, C. A. and D. K Cheng, "Optimum element lengths for Yagi-Uda arrays," *IEEE Trans. Antennas and Propagation*, Vol. 23, Jan. 1975.

3. Haneishi, M., et al., "Beam-shaping of microstrip antenna by parasitic elements having coaxial stub," Trans. IECE of Japan,Vol. 69-B, 1160-1161, 1986.

4. Li, J.-Y. and J. L. Guo, "Optimization technique using differential evolution for Yagi-Uda antennas," *Journal of Electromagnetic Waves and Applications*, Vol. 23, No. 4, 449-461, 2009.

5. 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 Electromagnetics Research*, PIER 66, 137-156, 2006.

6. Kraus J. D., *Antenna*, 243-248, 2nd Edition, McGraw-Hill, New York, 1988.

7. http://www.cst.com/content/products/mws/overview.aspx © 2012 CST Computer Simulation Technology AG.

8. David M. Pozar, "Microwave Engineering", 3rd Edition, John Wiley & sons 2004.