Compact Dual Band Linear and Circular Polarized Microstrip Yagi Antenna for S-Band and C-Band Application

[1]Sudheer Dubey, [2]Prof. Sameena zafar
[1]PG Scholar, [2]HOD (Electronics & Communication)
[1, 2]Patel Institute of Engineering & Science, Bhopal
[1]sudheerdubey_1988@yahoo.com[2]hodecpatellcollege@gmail.com

Abstract—*in this paper Compact Dual Band Linear and Circular Polarized Microstrip Yagi Antenna for S-Band and C-Band Application is presented. In recent application size of antenna, impedance bandwidth, Antenna efficiency and different polarization from single antenna is major issues, in this paper we presented antenna which overcome all drawbacks and cable in polarization switching from linear to circular and circular to linear, proposed design consists in stack geometry with one reflector, one driven element and two directors with two orthogonal via hole technique, compactness is done using via hole technique. This proposed design applicable for S-Band and C-Band application. All results validated in IE3D Simulator.*

Keywords—Parasitic Antennas, WiMAX, Wire-Patch, Yagi Antenna. Polarization, S-C-Band

I. INTRODUCTION

In [1], the short cylindrical structure that operates as a director for low-profile smart antennas had been studied from 2.3GHz to 2.45GHz .In literature [2], Hongjiang Zhang,et.al , have given an the design of a low-profile, high-gain Yagi wire-patch antenna array that radiates a directional beam in the azimuthal plane within the frequency band 5.45–5.75 GHz. The most common antenna used for the communication system is yagi uda antenna because it is simpler, easy to design, low cost and high gain [3-4]. With the growth in communication system for many applications such as in radar, medical, industrial and wireless communication there is a need of an antenna which provides a directional beam in particular direction, which is obtained by yagi uda antenna [5]. To reduce the size, cost and power consumption, a folded monopole electronically steerable switched parasitic antenna has been proposed [6], [7]. In [8], a low-profile smart antenna is constructed by using a short mono-cone monopole (lower diameter 4 mm and upper diameter 8 mm) at the centre and 12 parasitic folded monopoles surrounding the Center. Each parasitic folded monopole is loaded by a PIN diode. By controlling the dc voltages applied to the PIN diodes, the radiation pattern of the folded monopole switched parasitic antenna can be steered in the horizontal plane from 0 to 360. Since the folded monopoles act as reflectors and there are no directors employed in the design, the small switched parasitic antenna in [8] reports a gain of 4 dBi. Such an antenna gain is not sufficient for applications in small satellite and air-borne systems. However, it is difficult to increase the gain of the switched parasitic antenna further by adding more reflectors. The Yagi–Uda antenna is a well-known fixed beam parasitic radiator array that can achieve a high gain with one reflector and several directors. The theory behind Yagi–Uda shows that proper designed directors are the key components with which a higher gain can be achieved. Furthermore, the gain of the Yagi–Uda antenna depends on the number of directors used [9]–[10]. To overcome the limitation of a microstrip patch, the monopole wire-patch antenna (WPA) was introduced [11]. Owing to its low height, low cost, high robustness ,and monopole radiation pattern, this antenna is very suitable for practical wireless communications applications, and it is very likely to replace monopole Yagi array [11] due to its low profile.

II. DESIGNING OF ANTENNA

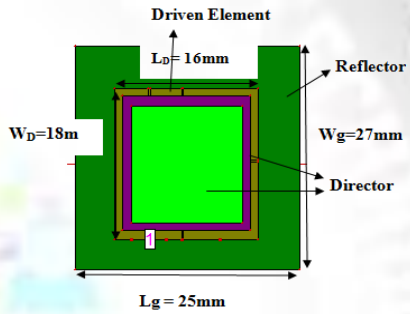

Figure 1: Proposed Antenna Design

Proposed antenna design on the multilayer of FR-4 and air gap, the proposed geometry consists of two Directors, one driven element and one reflector. Distance between elements is .1λ, all dimensions calculate theoretically at 5GHz. all elements placed in stack form. The performance of antenna array is improved by via hole technique. The multiband and antenna efficiency limitation of Yagi antenna is modified in this paper.

III. RESULTS AND DISCUSSION

The results of proposed antenna validated in IE3D Simulator, the performance of antenna in terms of Return losses, Antenna Efficiency, radiating efficiency and radiation characteristics of antenna specified in radiation pattern.

A. *Return losses Vs Frequency*

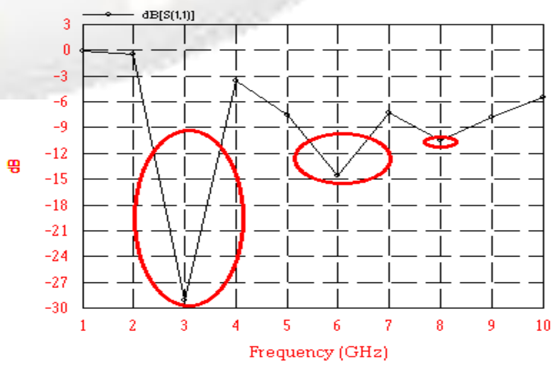

Figure 2: Return loss Vs Frequency

The return losses of antenna with respect to frequency are shown in Fig 2. From Fig 2 we concluded that the return losses obtained up to -28dB and -10dB, impedance bandwidth obtained at two centre frequencies 3GHz and 6GHz respectively. At 3GHz return loss is -28dB, and 40% -10dB, impedance bandwidth from 2.4GHz to 3.6GHz and at 6GHz return loss is -14.7dB, and 17%,-10dB, impedance bandwidth from 5.5GHz to 6.5 GHz. From this analysis we concluded that proposed design achieved 40% impedance bandwidth for S-Band and 17% impedance bandwidth for C-Band frequency spectrum, this design is applicable for S-Band and C-Band application.

B. *Efficiency Vs Frequency*

The antenna and radiating efficiency depicts in Fig 3. From the fig 3 we obtained 92% antenna and radiating efficiency at centre frequency 3GHz and 70% antenna and radiating efficiency at centre frequency 6GHz.

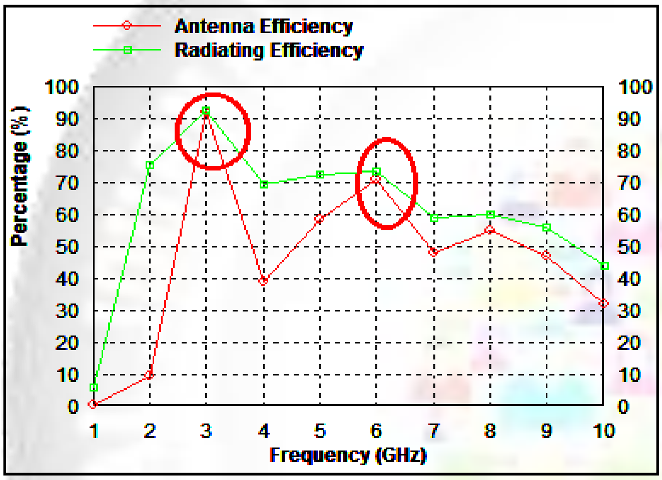

Figure 3: Antenna and Radiating Efficiency Vs Frequency

C. *Axial Ratio Vs Frequency*

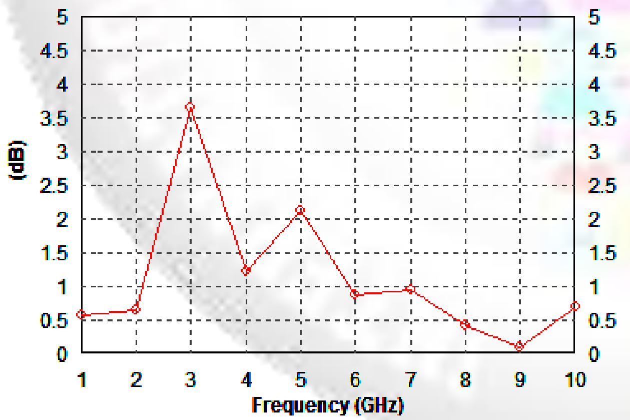

Figure 4: Axial Ratio Vs Frequency

Fig 4 depicts Axial Ratio with respect to frequency , from this analysis we concluded that our proposed design provided linear and circular polarisation, at centre frequency 3GHz axial ratio is 3.75dB, The high value of axial ratio indicates the radiation of antenna is oriented in single direction therefore improvement in efficiency also achieved at 3GHz, at 6GHz axial ratio is .8dB, indicates antenna is circular polarized so that this design is switch from linear to circular polarization and circular to linear polarization. Therefore this design is applicable for linear and circular polarization. The switching in polarization occur due to using two via hole orthogonally,one via hole at the centre and second via hole at the right side bottom corner.

D. *Radiation Pattern*

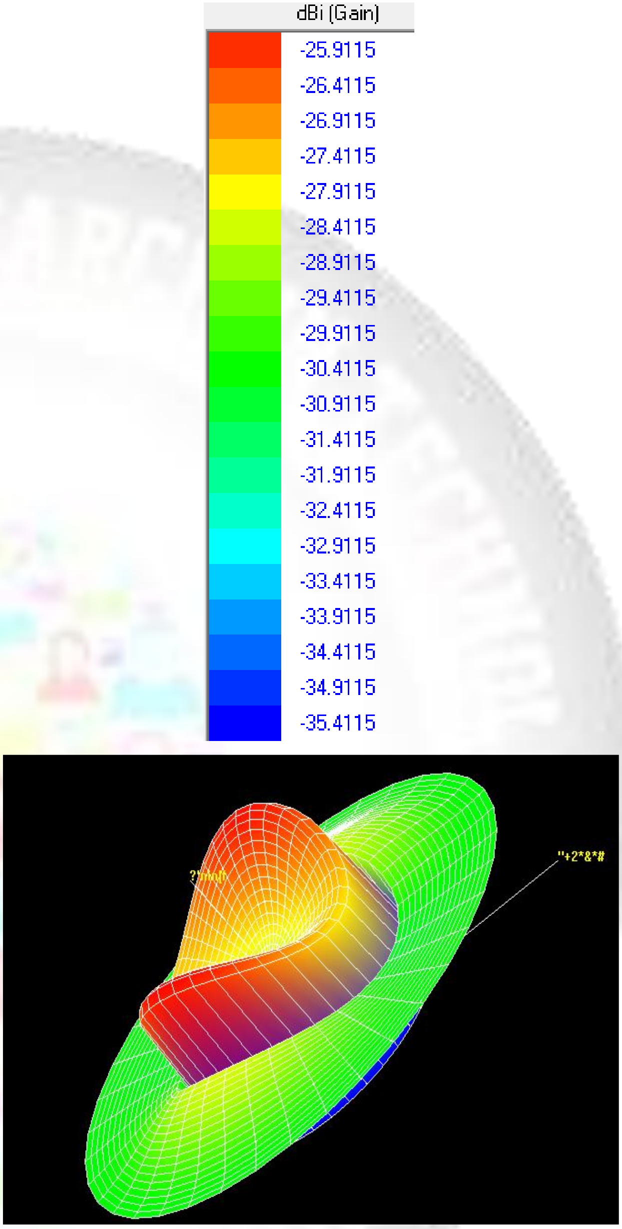

Figure 5: 3D Radiation Pattern

Antenna parameters	**At 3GHz**	**At 6GHz**
Input power	0.00998061 (W)	0.00998061 (W)
Radiated power	0.00918275 (W)	0.00918275 (W)
Impedance bandwidth	40% of S-Band	17% of C-Band
Return loss	-27dB	-14.8dB
Axial ration(dB	3.75	.8
Efficiency	92%	70%
Directivity(dBi)	3.6	4.9

Table-1: Results Summary

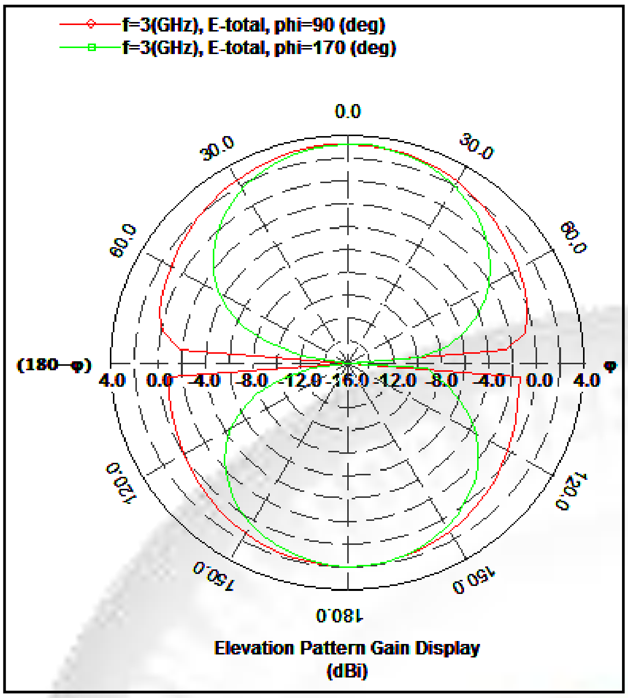

Figure 6: Elevation Pattern at 3GHz

IV. Conclusion

In this paper, a low-profile Compact Dual Band Linear and Circular Polarized Microstrip Yagi Antenna for S-Band and C-Band Application has been presented. As a first step, the driven wire-patch antenna has been presented with two orthogonal via hole one via hole at the centre and second at the right side corner , The antenna is fed through the coaxial probe of an SMA connector. In second step reflector is designed and in third step directors are designed, the spacing between elements .1 λ is choose. The proposed design provides a dual band at 3 GHz and 6GHz centre frequencies with 40% and 17% impedance bandwidth for S-Band and C-Band respectively. We achieved 92% and 70% antenna and radiating efficiency at centre frequency 3GHz and 6GHz respectively. we concluded that due to two orthogonal via hole antenna is cable for linear and circular polarization, at 3GHz linear polarized with axial 3.75dB, and circular polarized at 6GHz with axial ratio .8dB, All simulation results shown in Table-1, all results validated in IE3D Simulator, this design applicable for S-Band and C-Band communication.

References

[1] Haitao Liu,et.al, "Small Director Array for Low-Profile Smart Antennas Achieving Hgher Gain" IEEE Transactions on Antennas and Propagation, VOL. 61, NO. 1, JANUARY 2013

[2] H. Liu, S. Gao, and T. H. Loh, "Compact dual-band antenna with electronic beam-steering and beamforming capability," *IEEE AntennasWirelessPropag. Lett.*, vol. 10, pp. 1349–1352, 2011.

[3] H. Liu, S. Gao, and T. H. Loh, "Low-cost intelligent antenna with low profile and broad bandwidth," *IET Microw., Antennas Propag.*, Jan.2013, in press.

[4] Sun, B.-H., S.-G. Zhou,Y.-F.Wei, and Q.-Z. Liu, "Modified two-element Yagi-Uda antenna with tunablebeams," Progress In Electromagnetics Research, Vol. 100, 175-87, 2010.

[5] Bemani, M. and S. Nikmeh, "A novel wide-band microstrip Yagi-Uda array antenna for WLAN applications," Progress In Electromagnetics Research B, Vol. 16, 389-406, 2009.

[6] J. Lu, D. Ireland, and R. Schlub, "Dielectric embedded ESPAR (DEESPAR) antenna array for wireless communications," *IEEE Trans. Antennas Propag.*, vol. 53, no. 8, pp. 2437–2443, Aug. 2005.

[7] D. C. Nascimento, R. Schildberg, J. C. da, and S. Lacava, "Low-cost Yagi–Uda monopole array," in *Proc. IEEE Antennas Propag. Soc. Int.Symp. (AP-S)*, Jul. 5–11, 2008, pp. 1–4.

[8] S. Lim; and H. Ling, "A two-element, electrically small Yagi antenna,"in*Proc. IEEE Antennas Propag. Soc. Int. Symp. (AP-S)*, Jun. 9–15,2007, pp. 2455–2458.

[9] C. Delaveaud, P. Leveque, andB. Jecko, "New kind ofmicrostrip patch antenna: The monopolar wire-patch antenna," *Electron. Lett.*, vol. 30,no. 1, pp. 1–2, Jan. 1994.

[10] S. Lim, "Design of a multidirectional, high-gain compact Yagi antenna," *IEEE Antennas Propag. Lett.*, vol. 8, pp. 418–420, 2009.

[11] Hongjiang Zhang,et.al,"Low-Profile and High-Gain Yagi Wire-Patch Antenna for WiMAX Applications" IEEE Antennas and Wireless Propagation Letters, VOL. 11, 2012 659