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HIGH GAIN KOCH FRACTAL DIPOLE YAGI-UDA ANTENNA FOR S AND X BAND APPLICATION

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ABSTRACT

In this study, 10 element Triangular Koch fractal dipole (TKFD) on Yagi-Uda with high gain was designed and simulated using 4NEC2 software. First iteration of triangular koch fractal on Yagi-Uda for high gain with 0.042λ at the feeder is considered. The proposed antenna exhibits resonance at 3 and 8:535 GHz and demonstrated 33.2 dBi gain at 3 GHz having Return loss is (-15.5dB) < -10. The characteristic parameters VSWR, S11, HPBW and Fr/B ratio are investigated. The Proposed antenna can be used for a radio-frequency identification (RFID), satellite communication, wireless communication and industrial manufactures uses designed frequency.

Keywords: Fractal, Yagi-Uda, Dipole

I. INTRODUCTION

Usage of monopole in wireless communication has overtaken the dipole type antenna after 1990's. However importance of Yagi-Uda has seen during the world war II for its directivity and high gain. On introducing fractals on antenna it not only exhibits dual/multi band but also in size reduction[1]. Implementing fractals on the proposed Yagi-Uda shows a size reduction of 16%. The size reduction to Euclidean dipole is done according to constrain given by the relation where Lsd is length of the straight dipole and L f d is length of the fractal dipole. In this study, first iteration of triangular koch fractal on 10 element of Yagi-Uda is introduced. We have limited the size reduction in every basis not to go beyond ±35% of the original length. Our antenna is designed to work in the frequency 3 GHz in S band region of IEEE standards [2,3]. T he parameters such as VSWR, S11, HPBW, Fr/B ratio, Radiation pattern, impedance matching and gain are analyzed. And compared results with Euclidean straight dipole.

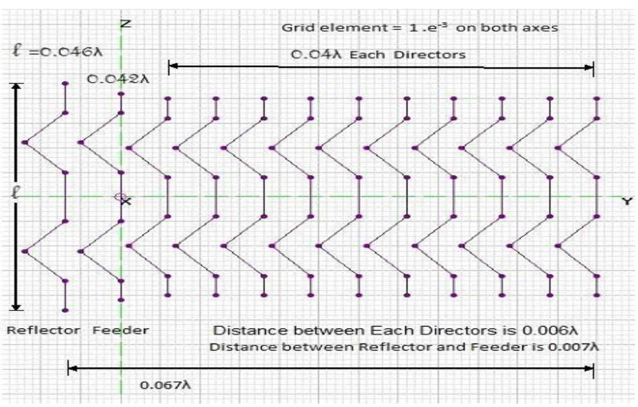

Figure. 1: Geometry of the proposed antenna, where l is wavelength, L0 is 0th order, L is the reduced length

Parameters of the Proposed antenna Simulated Readings

Resonant frequencies 3, 8.535

Reflection Co-efficient 15.27, 11.18

VSWR 1.41, 1.76

Gain 33.2, 14.5

Impedance (Ω) 70, 29

Table. 1: Overview of the Proposed antenna

Parameters of the Proposed antenna	Simulated Readings
Resonant frequencies	3, 8.535
Reflection Co-efficient	15.27, 11.18
VSWR	1.41, 1.76
Gain	33.2, 14.5
Impedance (Ω)	70, 29

II. ANTENNA DESIGN AND SIMULATION

Simulation for 10 element TKFD on Yagi-Uda with 0.042λ on free space is done using 4NEC2 software. The geometry of proposed antenna is constructed with length of the elements and distance between the elements is given by Where, t is the scaling factor, dn Distance between each element ln Length of the dipole. Total length of TKFD is interpreted as L = L0 (4=3)n where L0 is 0th order, n is the it-eration number. Proceeding with initial parameters, after optimization on TKFD Yagi-Uda 0.042λ as feeder over a free space is considered. The feeder element is placed right next to reflector and 8 other director element is placed next to one another[4,5]. Antenna operates at frequency range 3 GHz. Diameter of the wire is set as 0.2mm which has a bandwidth of 1.45 (SWR<2), on increasing diameter of the wire, band- width could be increased. Fig.1 shows geometry of proposed 10 element TKFD on Yagi-Uda antenna.

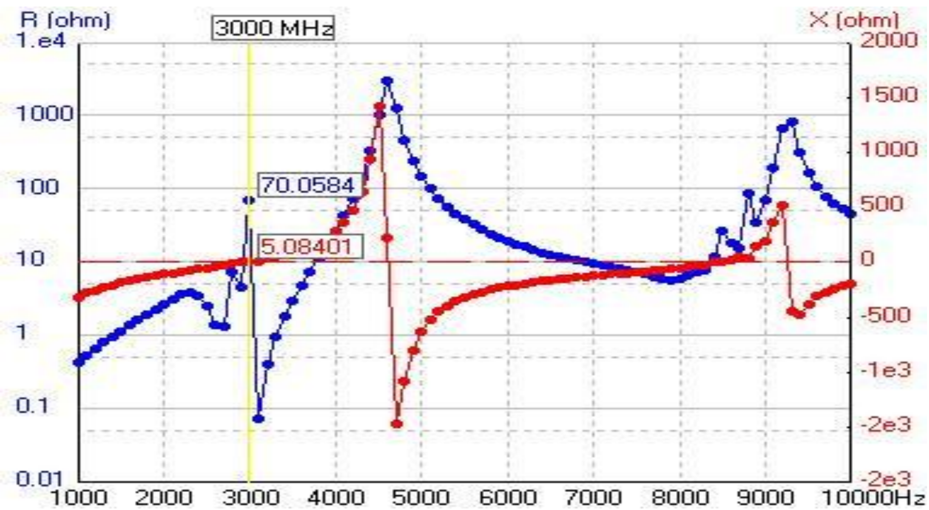

Figure. 2: Impedance Vs Frequency

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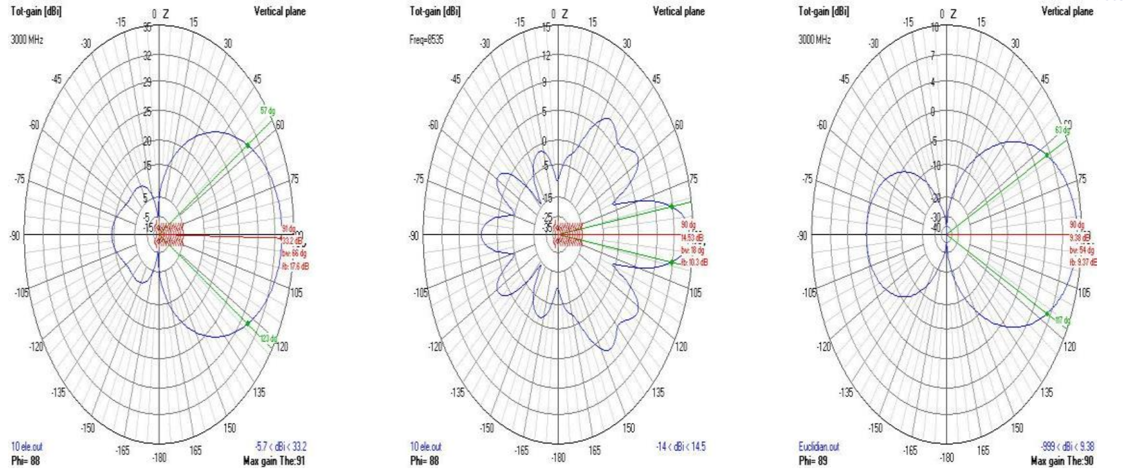


(a) Radiation Pattern at 3 GHz (b) Radiation Pattern at 8.53 GHz (c) Radiation Pattern of Euclidean dipole

Figure.3: Radiation pattern on vertical plane Vs Frequency

III. SIMULATED RESULTS

Characteristic of a proposed antenna parameters such as VSWR, S11, HPBW, Fr/B ratio Radiation pattern, impedance are presented in Table 1. To have accuracy in simulation each part of straight wire in made into 7 segments. At 3 GHz resonance antenna exhibits excellent performance with gain of 33.2 dBi, Return loss (-15.5dB) < -10 and has radiation properties nearly identical to that of Euclidean dipole at that frequency. At 8.53 GHz resonance antenna exhibits excellent performance with gain of 14.5 dBi, Return loss (-11.18dB) < -10 and has radiation properties nearly identical to that of Euclidean dipole at that frequency.

The real and imaginary part of input impedance for the designed antenna on yz plane with physical height 0.042λ at resonant frequency 3 GHz are shown in Fig.2 Resistance at resonant frequency 3 GHz is found to be 70Ω, which matches the value of BNC cable resistance of 70Ω. The value of X (Ω) is 5.08, the value is found to be positive, its due to the inductance effect.

We have the voltage Standing wave Ratio is given by the equation

$$VSWR = \frac{v_{max}}{v_{min}} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

Figure. 4: Ref. co-efficient Vs Frequency

where reflection co-efficient, vmax is the amplitudes of the maximum standing wave and vmin is the minimum standing wave. The value of VSWR at resonant frequency 3 GHz is presented in Fig.4. The Voltage Standing Wave Ratio at resonant frequency is 1.41 < 2, which is nearing to the value of 1. The Return loss is (-15.28dB) < -10

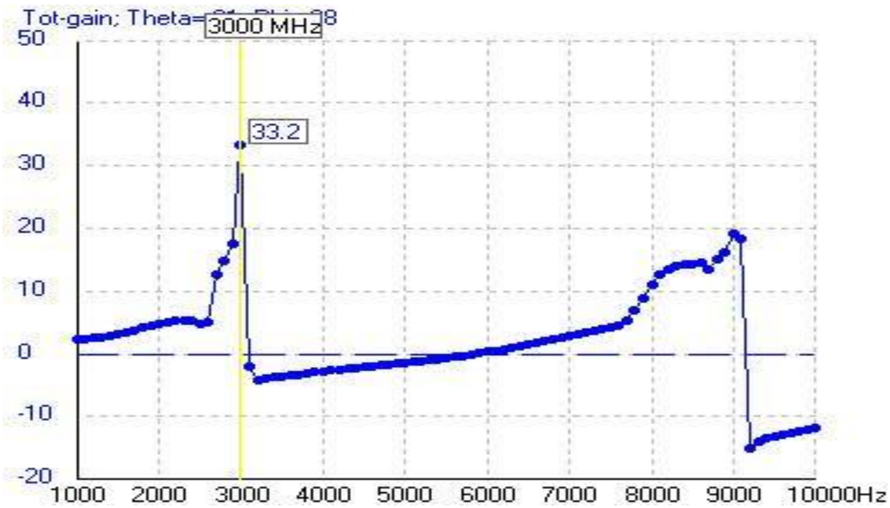


Figure. 5: Total gain Vs Frequency

The total Gain at Resonant frequency with 33.21dB is presented in Fig.5, Fr/back ratio is 17.63 and Fr/rear 17.62 at resonant frequency of 3 GHz are shown in Fig.6. Radiation Pattern at resonant frequencies 3, 8.53 GHz, HPBW and comparison with Euclidean dipole are shown in Fig.3, radiation pattern on horizontal plane is shown in Fig.7 and comparison of 3D radiation pattern is seen in Fig.8.

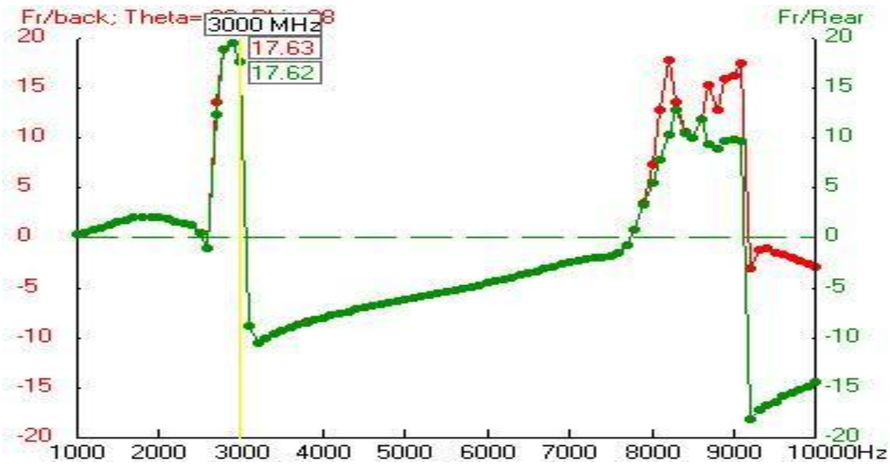
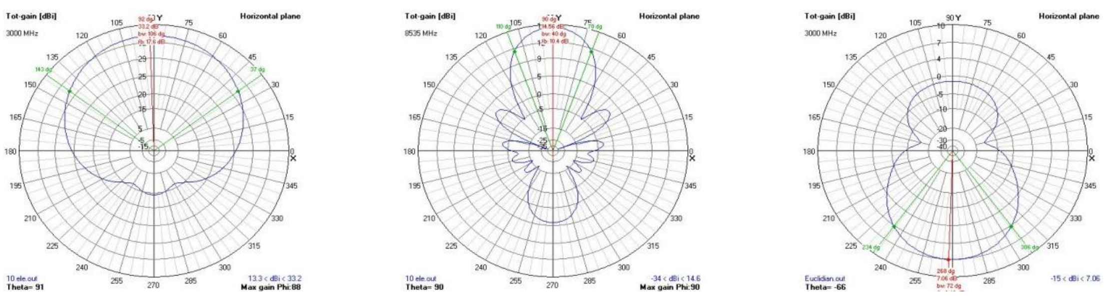
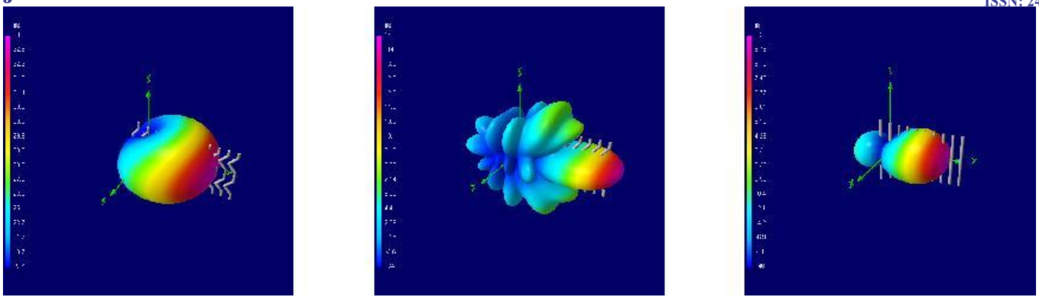


Figure. 6: Fr/back,Fr/rear ratio Vs Frequency



(a) Radiation Pattern at 3 GHz (b) Radiation Pattern at 8.53 GHz (c) Radiation Pattern of Euclidean dipole

Figure.7: Radiation pattern on horizontal plane Vs Frequency



(a) Radiation Pattern at 3 GHz (b) Radiation Pattern at 8.53 GHz (c) Radiation Pattern of Euclidean dipole

Figure. 8: 3D radiation pattern

III. CONCLUSION

The geometry of proposed 10 element TKFD on Yagi-Uda with 0.042λ on free space is simulated and compared with identical Euclidean dipole, results shows that proposed has dual band resonant frequencies. The proposed antenna is designed for a frequency of 3 GHz which applied for RFID application, atmospheric communication and wire-less communication.

On optimizing the length of the feeder and 9 other element of the proposed antenna at the designed frequency of 3 GHz is shown in the given Fig. 1. We also found that on introducing fractals on 10 element TKFD on Yagi-Uda, size reduction, compatibility and shows another resonant frequency at 8.53 GHz. On increasing no. of directors there is increase in gain.

IV. ACKNOWLEDGMENTS

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