Research Journal of Applied Sciences, Engineering and Technology 11(5): 495-500, 2015
DOI: 10.19026/rjaset.11.1853
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: April 27, 2015 Accepted: May 28, 2015 Published: October 15, 2015

Research Article

Compact Koch Fractal Boundary Micro Strip Patch Antenna for Wide Band Applications

G. Asa Jyothi, B.T.P. Madhav, D. Manikantha, V. Swathi, M. Dayananda Saraswathi Rao, M. Akshay, G. Divya Sree and A. Srinivas
Department of ECE, K L University, AP, India

Abstract: There is a lot of demand for the wideband antennas with considerable gain and compactness in size. The modern communication systems need such antennas for reliable data transmission. A novel compact monopole antenna is designed with Koch fractal boundary for wide band applications is presented in this study. The wide band fractal antenna is designed with coplanar wave guide feeding with 50 Ω impedance matching at feed line. The overall size of the antenna is very compact in nature with dimensions 20×15×1.6 mm. The proposed model is constructed initially by taking a basic fractal wide band model operating between 7.8 to 14.5 GHz at higher frequencies with impedance band width of 67%. The proposed antenna covers a wide band between 5-12 GHz with impedance bandwidth of 89%. The proposed antenna characteristics are analyzed with the help of commercial electromagnetic tool HFSS and presented in the study.

Keywords: Compact antenna, coplanar waveguide, impedance bandwidth, koch fractal, wideband antenna

INTRODUCTION

The demands of compact and wide band antennas are increasing day by day with their usage in the advanced communications systems (Madhav *et al*., 2014a; Baliarda *et al*., 2000). The self-similarity property of fractal antennas creating their impact in the design of these wide band antennas (Best, 2002; Li *et al*., 2012; Puente *et al*., 1996). Researchers proposed different models with fractal geometries for multiband and wide band antenna systems for different applications (Madhav *et al*., 2013a).

Koch fractal monopole antennas are mainly used to get the compactness in the design as well as to achieve multiband characteristics. A multiband antenna can be converted into wide antenna by using small changes in the design with respect to the designed specifications (Madhav *et al*., 2014b, c; Madhav *et al*., 2015a; Srinivas *et al*., 2015). By introducing Koch fractal patches instead of triangular patch geometry will increase the operating frequency along the wide band matching (Madhav *et al*., 2015b; Madhav *et al*., 2013b). From the literature, we observed that for Koch fractal monopole shapes offer improved performance over common small antenna and that behavior of the Koch fractal monopole is peculiar to its geometric shape (Madhav *et al*., 2014d, e). In this study we designed a basic fractal monopole antenna to operate between 7.8-14.5 GHz. A proposed model which is modified geometry of previous Koch fractal monopole is also presented in this study. The proposed model consisting of more number of Koch fractal shapes inserted in the basic model radiating element.

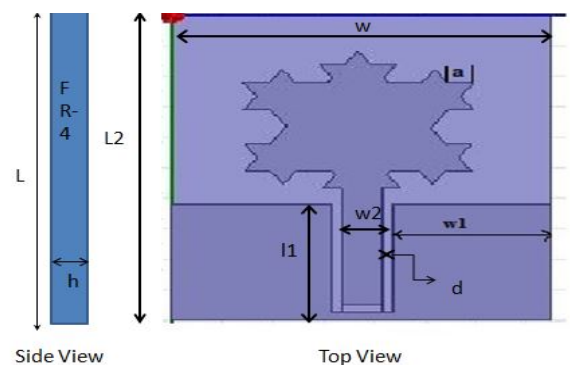


Fig. 1: Basic fractal monopole

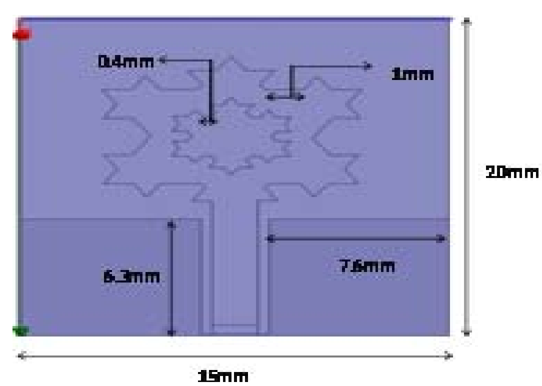


Fig. 2: Proposed fractal monopole

Corresponding Author: G. Asa Jyothi, Department of ECE, K L University, AP, India

Table 1: Antenna dimensions

W	W1	W2	L	L1	L2	d	d1	d2	h
15	6.3	1.6	20	7.6	17.8	0.4	0.7	1	1

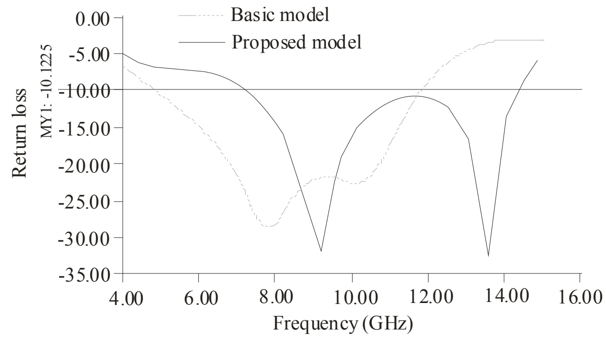


Fig. 3: Return loss vs. frequency

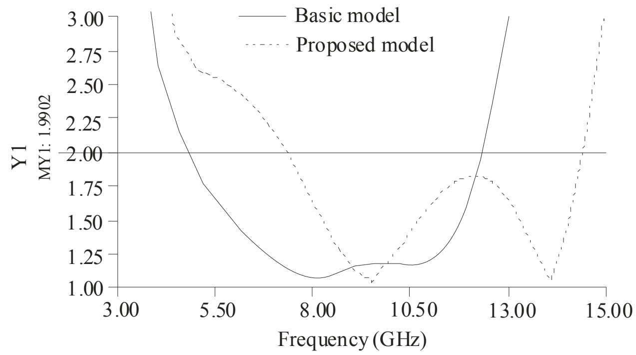


Fig. 4: VSWR vs. frequency

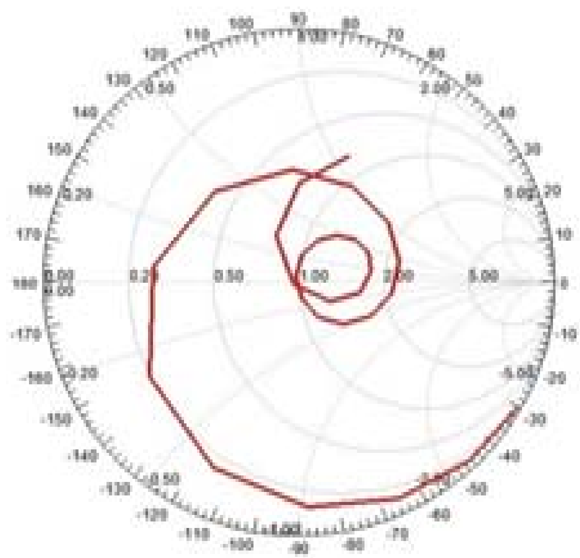


Fig. 5: Input impedance Smith chart

METHODOLOGY

Antenna design and geometry: Figure 1 shows the basic Koch fractal monopole antenna with coplanar wave guide feeding ground plane is taken on the same side of the substrate material along with radiating element. This model is slightly modified by placing more number of Koch fractal iterations on the radiating element as shown in Fig. 2. The dimensional characteristics of these 2 models are presented Table 1. 'The proposed model is fabricated on fr4 substrate with dielectric constant 4.4. The width of the feed line is fixed at 1.6 mm to implement 50 Ω impedance on both model that we design. Finally a standard assembly's connected to measure the antenna parameters with the vector network analyzer.'

RESULTS AND DISCUSSION

The reflection coefficient of the base model and the proposed model are simulated using HFSS tool and presented in Fig. 3. The base model is resonating after 7.8 GHz with an impedance bandwidth of 67%. The proposed model is showing a high impedance bandwidth of 89% and covers the C and X bands. The proposed model is fabricated on fr4 substrate and the measured results are collected from Vector Network Analyzer (ZNB20VNA).

Figure 4 shows the VSWR less than 2 in the operating bands for both the models in addition with return-loss curve results.

Figure 5 shows the input impedance smith chart of the proposed model with good impedance matching at the resonant frequency bands.

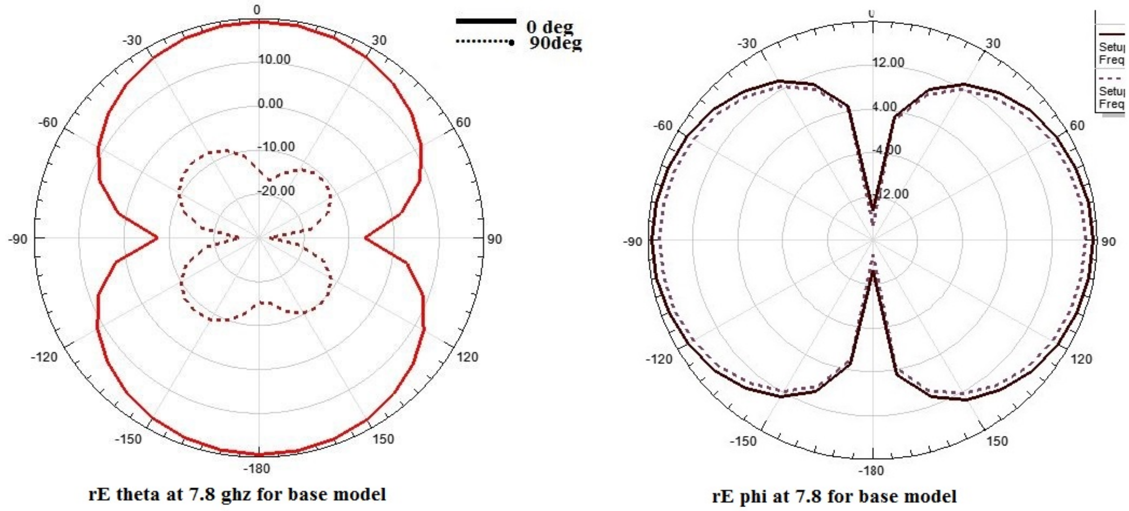
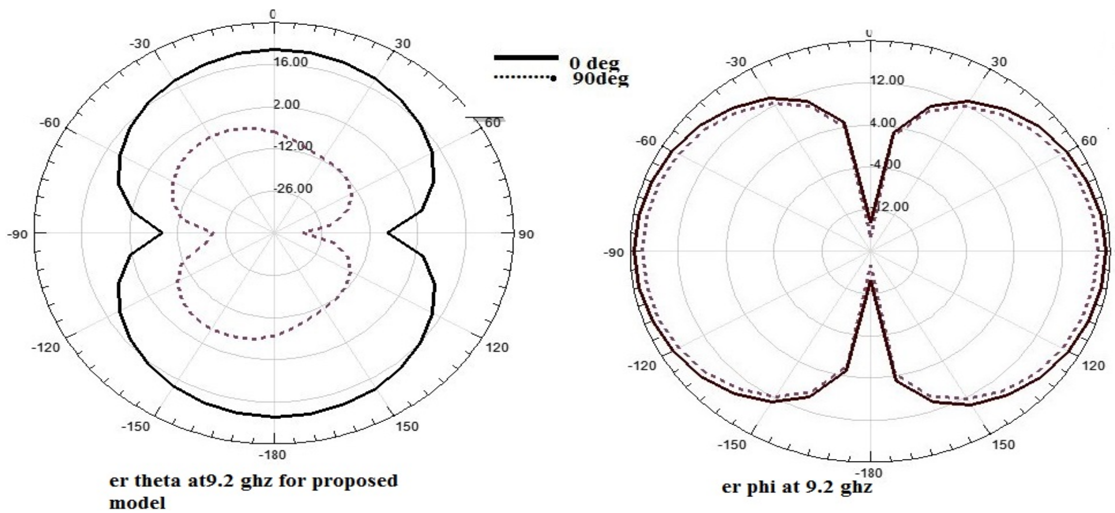
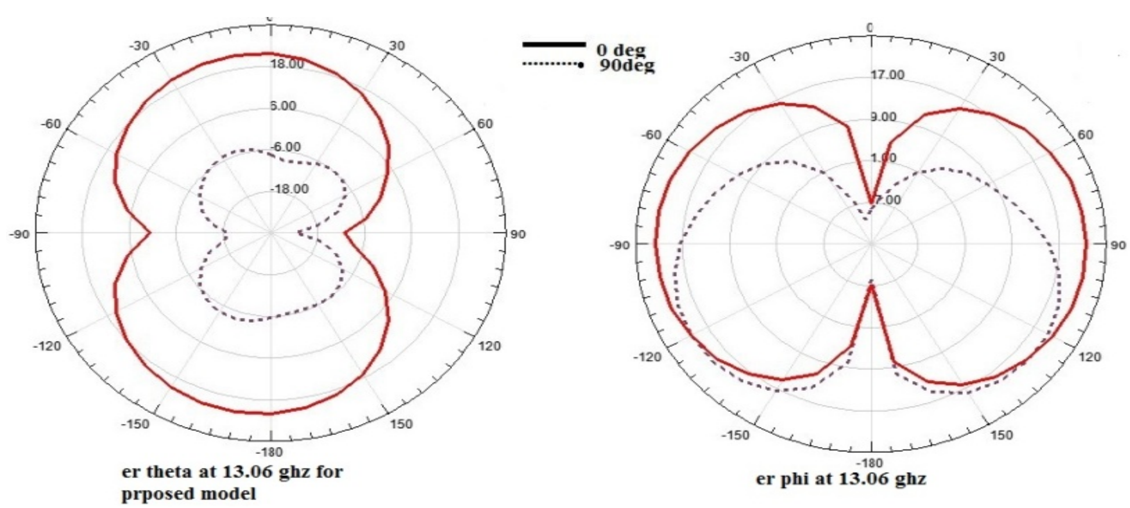


Fig. 6: Radiation pattern at 7.8 GHz



(a)



(b)

Fig. 7: Radiation pattern at; (a): 9.2 GHz; (b): 13.06 GHz

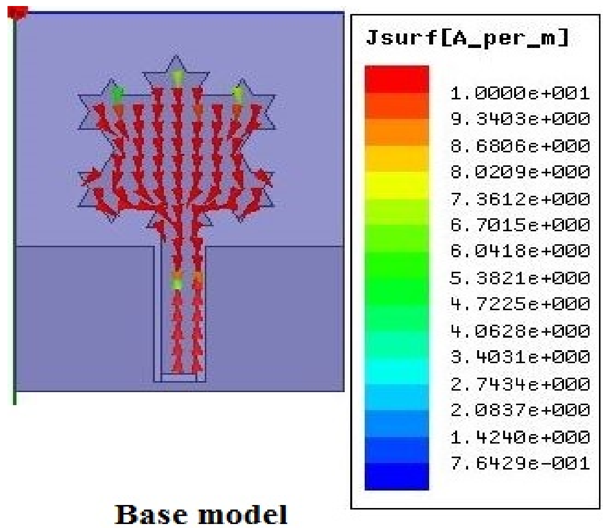


Fig. 8: Current distribution at 7.8 GHz

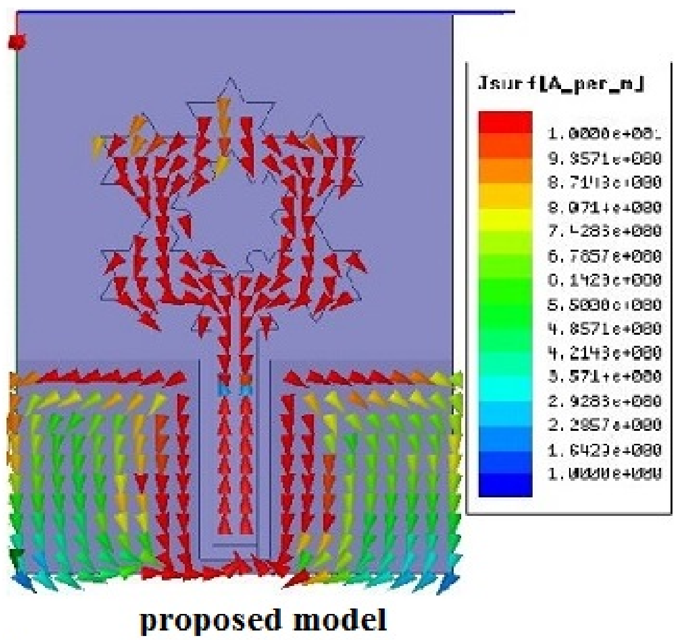


Fig. 9: Current distribution at 9.2 GHz

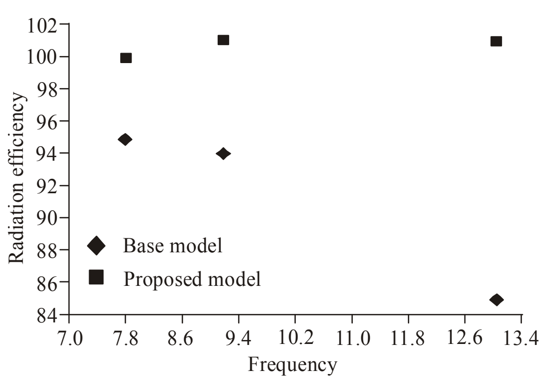


Fig. 10: Radiation efficiency vs. frequency

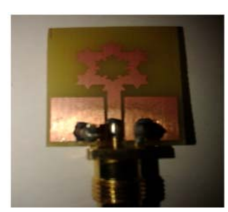


Fig. 11: Prototyped antenna on FR4 substrate

Figure 6 shows the radiation characteristics of the base model at 7.8 GHz. Antenna shows monopole like radiation with low cross polarization at the resonant frequency of 7.8 GHz. Figure 7 shows the radiation pattern of the proposed antenna at 9.2 GHz. A low cross

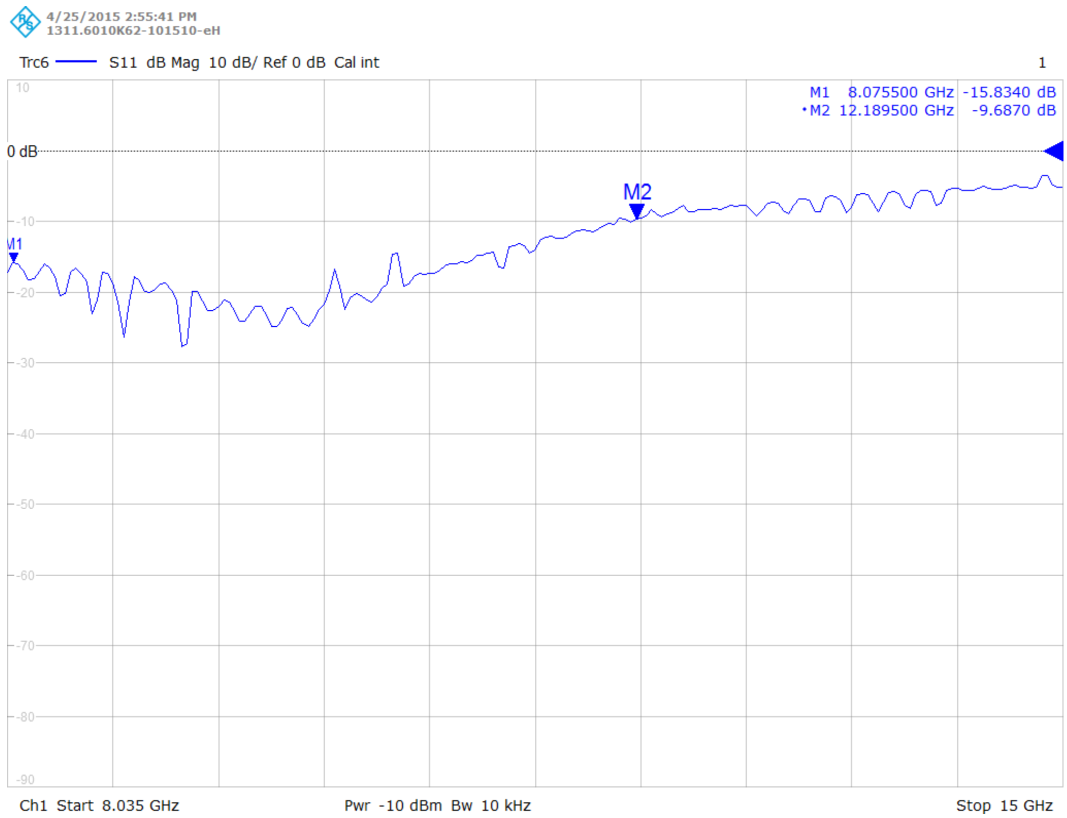


Fig. 12: Measured S11 of antenna with ZNB 20 VNA

polarization in the H-plane of -10 dB is obtained. The proposed model is also showing monopole like radiation in H-plane and eight like radiation with a particular direction in E-plane.

The current distribution over the surface of the antenna models are shown in Fig. 8 and 9. Figure 8 shows current density plot for the base model at its resonant frequency. The current direction on the feed line is towards radiating element and on the radiating element the direction is towards feed line. There is a cancellation of energy at a junction due to the opposite direction of the current elements with equal magnitude and with opposite phase. Figure 9 shows the current distribution over the surface of the proposed antenna. The current density is maximum in and around the feed point but away from the feed point on the ground plane. The intensity seems to be weak.

Figure 10 shows the frequency versus radiation efficiency of the antenna models. The proposed model is showing superior efficiency results compared to base model as shown in the figure.

Prototyped antenna is fabricated on FR4 substrate with thickness 1.6 mm. Figure 11 shows the fabricated antenna photograph taken at LCRC-R and D. Figure 12 shows the measured S11 parameter with ZNB 20 vector network analyzer. The simulation and measurement results are in good agreement with other corresponding to its resonant frequencies.

CONCLUSION

A compact koch fractal antenna is designed to operate at wideband conditions. The proposed antenna is showing wideband characteristics with good radiational characteristics. The efficiency of the antenna is more than 90% at corresponding resonant frequencies. The overall size of the antenna is very compact in nature with dimensions 20×15×1.6 mm. The proposed model is constructed initially by taking a basic fractal wide band model operating between 7.8 to 14.5 GHz at higher frequencies with impedance band width of 67%. The proposed antenna covers a wide band between 5-12 GHz with impedance bandwidth of 89%. The overall performance characteristics of the antenna model is analyzed and presented in this study with measured results from vector network analyzer. Simulation and measurement results are having similar characteristics, which gives motivation to use this model in desired band of operations.

ACKNOWLEDGMENT

Authors like to express their gratitude towards the department of ECE and management of K L University for their support and encouragement during this study. Further Madhav likes to express his gratitude to DST through FIST grant SR/FST/ETI-316/2012.

REFERENCES

Baliarda, C.P., J. Romeu and A. Cardama, 2000. The Koch monopole: A small fractal antenna. IEEE T. Antenn. Propag., 48(11): 1773-1781.

Best, S.R., 2002. On the resonant properties of the koch fractal and other wire monopole antennas. IEEE Antenn. Wirel. Pr., 1: 74-76.

Li, D., F.S. Zhang, Z.N. Zhao, L.T. Ma and X.N. Li, 2012. A compact CPW-FED Koch snowflake fractal antenna for WLAN/Wimax applications. Prog. Electromagn. Res. C, 28: 143-153.

Madhav, B.T.P., D. Ujwala, J. Ravindranath Chowdary, A. Siva Nagendra Reddy, Ch. Kranthi and S. Kumar Bidichandani, 2013a. Design and analysis of new sierpinski carpet fractal antenna. Int. J. Microw. Appl., 2(3): 108-112.

Madhav, B.T.P., H. Khan, D. Ujwala, Y. Bhavani Sankar, M. Kandepi, A. Siva Nagendra Reddy and D. Nagajyothi, 2013b. CPW fed serrated antenna performance based on substrate permittivity. Int. J. Appl. Eng. Res., 8(12): 1349-1354.

Madhav, B.T.P., S. Chhatkuli, A. Manikantaprasanth, Y. Bhargav, U. Dinesh Naga Venkata Sai and S. Feeraz, 2014a. Measurement of dimensional characteristics of microstrip antenna based on mathematical formulation. Int. J. Appl. Eng. Res., 9(9): 1063-1074.

Madhav, B.T.P., G.S. Krishnam Naidu Yedla, K.V.V. Kumar, R. Rahul and V. Srikanth, 2014b. Fractal aperture EBG ground structured dual band planar slot antenna. Int. J. Appl. Eng. Res., 9(5): 515-524.

Madhav, B.T.P., V.G.K.M. Pisipati, H. Khan ad D. Ujwala, 2014c. Fractal shaped Sierpinski on EBG structured ground plane. Leonardo Electron. J. Pract. Technol., 25: 26-35.

Madhav, B.T.P., K.V.V. Kumar, A.V. Manjusha, P. Ram Bhupal Chowdary, L. Sneha and P. Renu Kantham, 2014d. Analysis of CPW fed step serrated ultra wide band antenna on Rogers RT/Duroid substrates. Int. J. Appl. Eng. Res., 9(1): 53-58.

Madhav, B.T.P., M. Kandepi, S. Kanapala, B. Anjaneyulu, N. Anada Rao and K. Vijaya Vardhan, 2014e. Serrated spike antenna performance evaluation based on arlon substrate materials. Int. J. Appl. Eng. Res., 9(1): 117-124.

Madhav, B.T.P., A. Manikanta Prasanth, S. Prasanth, B. Mohan Sai Krishna, D. Manikantha and U. Sharmila NagaSai, 2015a. Analysis of defected ground structure notched monopole antenna. ARPN J. Eng. Appl. Sci., 10(2): 747-752.

Madhav, B.T.P., J. Gogineni, H. Appana, J. Prathusha Chennam, D.S. Sruthi Thota and P. Kotte, 2015b. Analysis of compact coplanar waveguide fed slot antenna with EBG structure. Proceeding of the International Conference on Signal Processing and Communication Engineering Systems (SPACES), pp: 219-225.

Puente, C., J. Romeu, R. Pous, X. Garcia and F. Benitez, 1996. Fractal multiband antenna based on the Sierpinski gasket. Electron. Lett., 32(1): 1-2.

Srinivas, M.S.S.S., T.V. Ramakrishna, B.T.P. Madhav, N. Bhagyalakshmi, S. Madhavi ad K. Venkateswarulu, 2015. A novel compact CPW fed slot antenna with EBG structure. ARPN J. Eng. Appl. Sci., 10(2): 835-841.