LC Model of Corner Arc Slotted Antenna for C, X and Ku Band Applications

Manoj Kumar Garg
Department of Electronics and Communication Engineering, IEC College of Engineering and Technology,
4, Institutional Area, Knowledge Park - I, Surajpur Kasna Road, Greater Noida 201306 UP India
gargnitoo@gmail.com

Abstract – **In this paper, a novel approach of an extracted LC model of corner arc monopole antenna with T-slot at ground plane for C, X and Ku band application is proposed. For extraction of LC model, 50 Ω matching between dielectric component and semi conducting at ground plane where T-slot is embedded is done. The monopole with T-slot antenna achieves wide band of 2.1 GHz to 11 GHz while extracted LC model is 2.1 GHz to 10.8 GHz. The antenna design is simulated and analysed in two different platforms (HFSS and ADS). Moreover, corner arc with small slits on patch provided extended bandwidth of approximately 5GHz within a range of 2.1 GHz to 16.4 GHz. Simulation and experimental results of this antenna shows good radiation behaviour within desired application.**

Keywords: Monopole antenna, UWB, T-slot, Corner arc

I. INTRODUCTION

IN wireless communication, one important key is to design a compact antenna while providing wideband behaviour over the wide operating band. Consequently, different geometries of planar monopoles have been reported [1-2]. Usually UWB system needs to have small low-cost antennas with large bandwidth and omni-directional radiation patterns [3]. In this design, we used rectangular patch with two corner arcs and two slits on it.

This antenna may be used for C, X and Ku band applications. C band which ranges from 4-8 GHz is used for satellite communication and can be used in areas subjected to tropical rainfall. X (8-12 GHz) band is used for radar applications, air traffic control, Defence tracking system etc. [4]. Ku band (12-18 GHz) is primarily used for satellite communication; broadcast applications etc.

One of the new challenges for UWB antenna design is to impose the needs for co-design antenna structure and its circuit model in wireless communication system. For such specific applications require time domain simulator such as SPICE, where general equivalent circuit model of UWB antennas is essential [4]. There are several equivalent circuit models proposed from the aspect of input impedance or admittance matching.

Wang [5] introduced an electric and magnetic antenna model circuit refinement method using degenerated foster canonical forms which consists of a narrow band augmented with a macro model. A circuit topology for rectangular microstrip patch antenna using non-linear curve-fitting optimization technique determines exact parameters value of the equivalent circuit model.

The equivalent circuit of a rectangular narrowband microstrip patch antenna is related to the physical dimensions of the antenna. Geometry of a rectangular microstrip patch antenna used cavity models for its modelling purpose [6]. Most of the microstrip patch antennas are usually modelled as a simple parallel resonant RLC circuit [7]. Literature reports works related to calculation of RLC values in the circuit model [8-10].

For UWB antenna, its radiating element can be seen as several parallel RLC circuit in series due to its matching bandwidth that results in several adjacent resonances [11].This paper gives an idea of an extracted LC model of monopole antenna with T-slot that achieves ultra wideband application. In addition to this, corner arcs with small slits are cut on patch to achieve a wideband of 2.1 GHz to 16.4 GHz.

II. ANTENNA DESIGN WITH ITS EXTRACTED MODEL CONSIDERATION

Figure 1 shows geometry of antennas with front and bottom view. The antenna structure is implemented on Rogers RT Durroid 5880 whose thickness, dielectric with relative permittivity and dielectric loss-tangent are 1.6 mm, 2.2 and 0.0009 respectively. A screw-shaped microstrip feed is used for excitation of antenna. In the top view, two corner arcs, two edge slots and one rectangular slit as a centre is embedded on the patch while T-slot is on semi-conducting ground plane. It is observed that by cutting corner arcs with slits, higher bands are affected and much wider impedance bandwidth is produced. All the dimensions of corner arc monopole antenna with T-slot are shown in Table 1. Additionally, an equivalent model of ground plane is extracted using transmission electromagnetic (EM) software package in ADS. The extracted LC equivalent model of monopole with T-slot is shown in Fig.2.

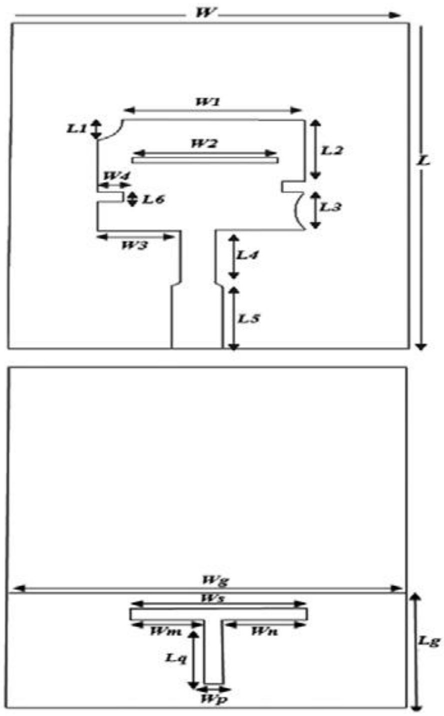


Figure 1. Geometry of corner Arc monopole antenna with T-slot on reverse plan.

TABLE1- DIMENSIONS OF CORNER ARC MONOPOLE ANTENNA

L	34 mm	*W*	36 mm
L1	3 mm	*W1*	15 mm
L2	7.9 mm	*W2*	10 mm
L3	3 mm	*W3*	7.7 mm
L4	6 mm	*W4*	2 mm
L5	5.15 mm	*Wg*	36 mm
L6	0.8 mm	*Wm*	2.25 mm
Lg	10 mm	*Wn*	2.25 mm
Lq	5 mm	*Wp*	0.5 mm

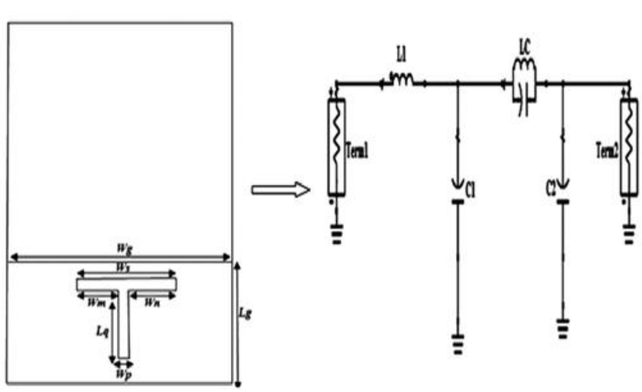


Figure 2. LC Equivalent Model of Monopole antenna with T-slot.

The equivalent circuit consists of inductor L1 series with LC and parallel capacitances C1 and C2 respectively. The equivalent circuit offers (43+j0.12) Ω impedance which is approximately to be (50+j0) Ω offered by ground plane structure. Due to this matching equivalent circuit achieves wide band of operation from 2.1 GHz to 10.8 GHz which is illustrated in Fig. 3. Simulated analysis of monopole with T-slot shows good agreement with results. The fabricated picture of monopole with T-slot is shown in Fig.4.

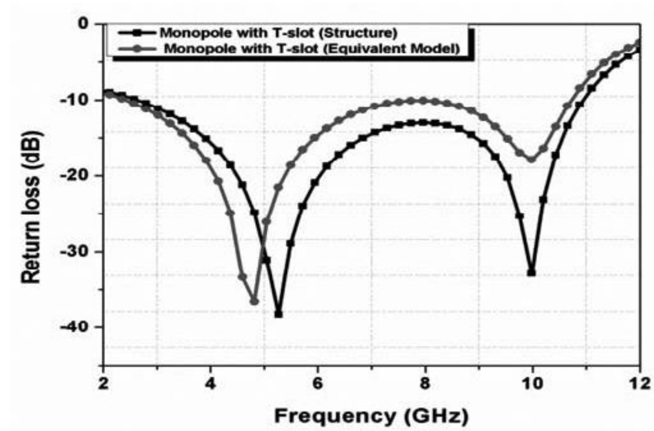


Figure 3. Comparison plot of Monopole with T-slot (Structure and Equivalent model).

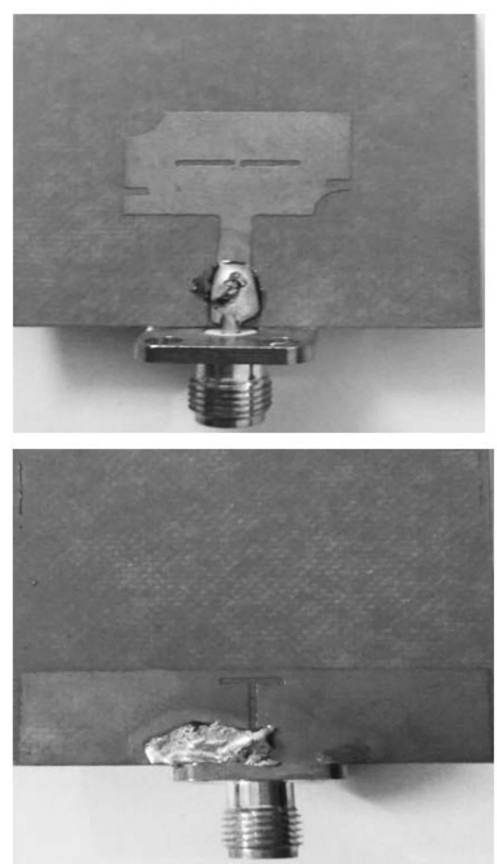


Figure 4. Fabricated picture of Monopole with T-slot.

III. RESULTS AND DISCUSSION

The monopole antenna achieves wide band of 2.1 GHz to 5.3 GHz. By putting T-shape slot on semi-ground plane, ultra wide band from 2.1 GHz to 11 GHz is produced. This is due to changes in surface current distribution pattern along the edges of T-slot. It is found that if cutting slot on conducting plane, higher frequency bands are disturbed and huge bandwidth is produced. The higher wideband of 2.1 GHz to 16.4 GHz is obtained by cutting corner arcs with slits on the patch. This result gives about 5 GHz extension bandwidth addition to ultra wideband application. The return loss variation with frequency is shown in Fig. 5. Three resonating frequencies at 4.2 GHz, 10 GHz and 14.5 GHz are obtained within wideband frequency of operation. The radiation pattern of corner arc monopole with T-slot antenna at 10 GHz is illustrated in Fig. 6.

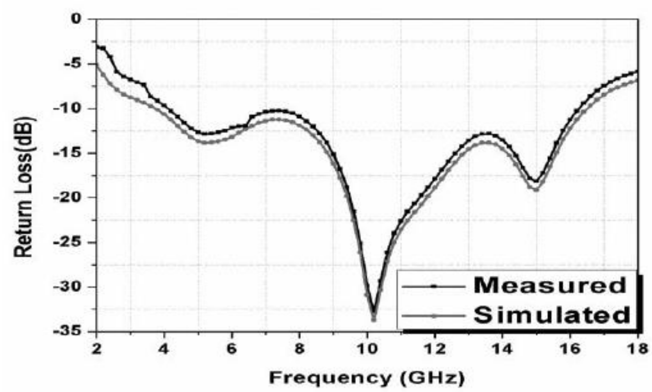
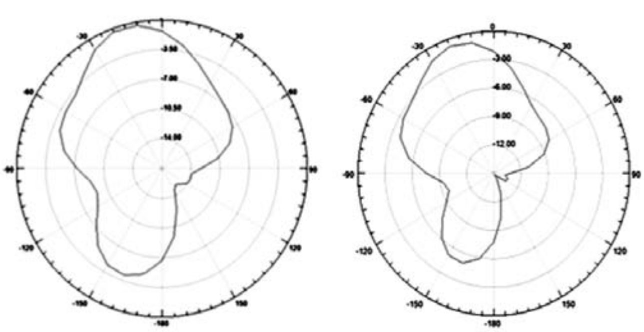


Figure 5. Variation of return loss of Corner arc monopole with T-slot antenna.



(a) *(b)*

Figure 6. Radiation pattern of antenna at 10GHz *(a)* Without and *(b)* With corner arc on patch.

IV. CONCLUSION

In this paper, analysis of corner arc microstrip antenna with T-slot for C, X and Ku band application is proposed. The equivalent model of semi ground plane with T-slot is extracted and shows good agreement with desired result. Moreover, corner arcs with small slits as a centre is cut on patch and improves impedance bandwidth around 5 GHz within range of 2.1 GHz to 16.4 GHz.

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Shri **Manoj Garg** is currently Associate Professor, working as Academic Coordinator in the Department of Electronics and Communication Engineering, IEC College of Engineering and Technology, Greater Noida. He obtained B.Tech from UPTU Lucknow and M.Tech from RTU Kota. Presently he is pursuing PhD in Microwave engineering from Jaypee University Noida (JIIT). He is having 12 years of teaching experience at Graduate and Post Graduate level. His areas of interest are Microwave engineering and Micro-strip patch antenna.