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Design A Dual Band Rectangular Slot Microstrip Patch Antenna For Bluetooth and WLAN Applications Using CLLR Technique

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***Abstract*— In this paper, we proposed a rectangular slot microstrip patch antenna for Bluetooth and WLAN applications. This is a new approach to improve th performance of antenna by miniaturization of the size. The antenna design consists of a rectangualar patch with a central square slot. A rectangular slot is etched on the patched to provide better radiation pattern and impedance bandwidth. Two inverted L shaped folded Capacitive Loaded Line Resonators (CLLRs) are introduced on the left edge of the patch to obtain dual resonant frequencies of 2.44 GHz for Bluetooth and 3.6 GHz for WLAN applications with better return loss of -45.6 dB and -18.99 dB at respective frequencies. The proposed antenna has a compact dimension of 30 mm × 30 mm and is implemented on FR4 Epoxy dielectric substrate with relative permittivity of ε_r = 4.4, thickness h = 1 mm and input impedance of 50 ohms. The geometry and results of the designed antenna were obtained using Ansoft HFSS electromagnetic simulator based on finite element method. The result showed better performance of return loss < -10 dB and VSWR ≤ 2.**

***Index Terms*—Compact, Microstrip patch antenna, Bluetooth, WLAN, CLLR, Resonant frequency, Return loss, VSWR, HFSS**

I. Introduction

In recent years compact antenna with multiband characteristics is topic of interest for research work for application in wireless Communication system. One of the techniques to design a compact microstrip antenna is cutting slots or slits on the radiating patch to increase the length of the patch of the surface current [1-3].

A microstrip patch antenna consist of a radiating patch which is placed above the dielectric substrate and a ground plane is placed on the other side of dielectric substrate Microstrip antennas having several advantages such as light weight, low cost, thin profile, conformal to a shaped surface so it can be used in several applications As in aircraft, satellite and wireless communication [4]. This antenna has main disadvantage as it has narrow bandwidth and for this a large number of techniques are used to increase the bandwidth [5]. The Federal Communications Commission (FCC) specifies the 3.1-10.6 GHz band for UWB commercial usages in 2002. Antenna designs for UWB applications are facing many challenges including their impedance matching, radiation stability, and electromagnetic interference (EMI) problems, especially the compact size design [6].

In previous year, to overcome the demerit of UWB antenna a large number of research have been carried out on the shape of microstrip patch antenna in order to increase the working bandwidth such as I-shaped notch [7], U-shaped, CPW fed fractal patch antenna, diamond shaped monopole antenna [8] and similarly slotting techniques have also used like truncated corners, hexagonal, central patch [9-11]

Since, Bluetooth has been widely used in portable devices such as mobile phones, PDA's and notebooks, etc. covering the 2.4-2.482 GHz band [12]. The IEEE 802.11 standard was proposed in 1997 for WLANs application. After few years, new standard of IEEE 802.11y standard was approved in 2008, new working frequency of WLAN is on the 3.6 GHz for WLAN applications [13].

In this paper, a compact microstrip patch antenna which consists of a squre ring-shaped slot fed by 50Ω. Our aim is to obtain the dual band resonant frequencies at 2.44 GHz and 3.6 GHz for Bluetooth and WLAN applications. For this, we introduced two L-shaped inverted Capacitive Loaded Line Resonators (CLLRs) on the left edge on the ground plane side of the antenna [14-19].

II. ANTENNA GEOMERTY AND DESIGN SPECIFICATIONS

Fig.1. shows the geometry and dimensions of the proposed antenna with rectangular slot on microstrip patch antenna. The antenna is designed on the FR4 Epoxy substrate of relative permittivity ε_r = 4.4 and thickness 1 mm having dimension of 30 mm × 30 mm. A rectangular patch on the front surface of the substrate with size of 15 mm × 12 mm and dimension of slot in patch is 10 mm × 8 mm. To achieve the desired dual band resonant frequencies, a ground plane of size 9.6 mm × 30 mm with two CLLRs deposited at same ground side of the antenna as shown in fig.2.

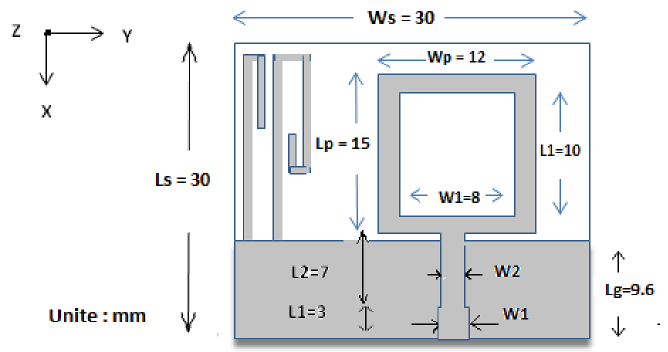


Fig.1. Geometry and dimensions of the proposed antenna [W1 = 2 mm and W2 = 1.6 mm]

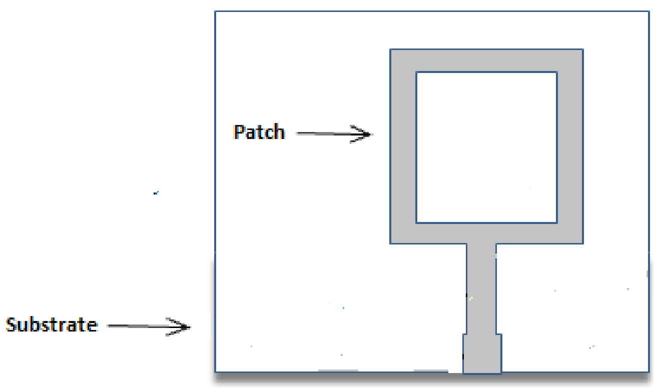
The CLLRs have the equal width and gaps of 0.5 mm. The length of CLLR 1 is 20 +1.5 +8 = 29.5 mm. The lengths are approximately $\lambda_g/4$ for the corresponding resonance [14].

λ_g can be determined by

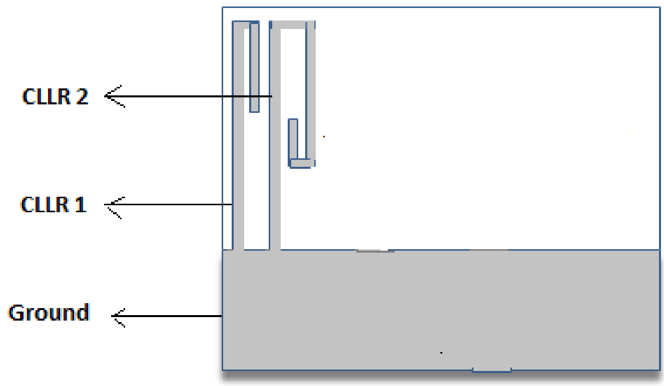
$$\lambda_g = \frac{c}{f\sqrt{\varepsilon_{eff}}} \quad , \varepsilon_{eff} = {(\varepsilon_r + 1)}/{2}$$

Where ε_{eff} and ε_r are effective permittivity and relative permittivity of substrate, c is velocity of light and f is the resonant frequency.

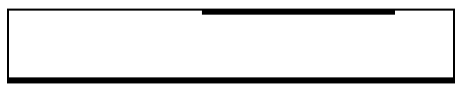
The antenna is fed by a microstrip line of 50-Ohm connected to an impedance transformer to improve the matching property of antenna.



(a) Top view



(b) Bottom view



(c) Front view

Fig.2. Different views of antenna (a) Top view (b) Bottom view and (c) Front view

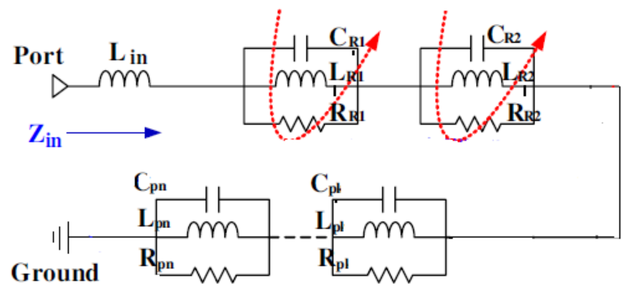


Fig.3. Equivalent circuit model of antenna

III. SIMULATION RESULT AND ANALYSIS

The simulated results of the proposed antenna are illustrated in fig.4. This result clearly indicates that the proposed antenna covers dual resonant frequencies centered at 2.44 GHz and 3.6 GHz with with better return loss of - 45.6 dB and -18.99 dB respectively (VSWR $\leq$ 2) for Bluetooth and WLAN applications. The simulation is done with the help of Ansoft High Frequency Structure Simulator (HFSS) electromagnetic simulator which is based on finite element method technique [20].

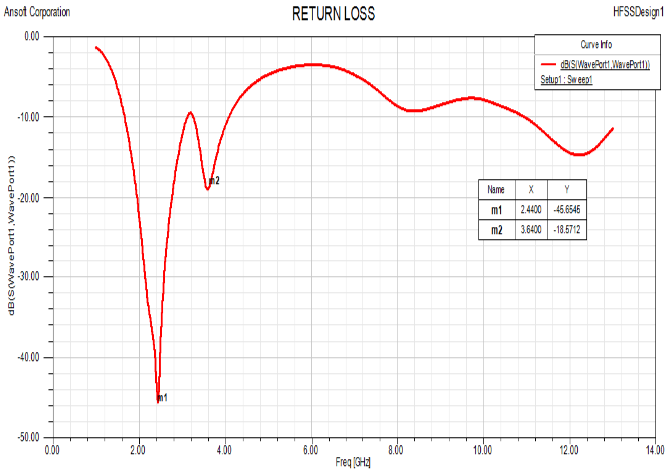


Fig.4. Simulated return loss (S_{11}) of the proposed antenna

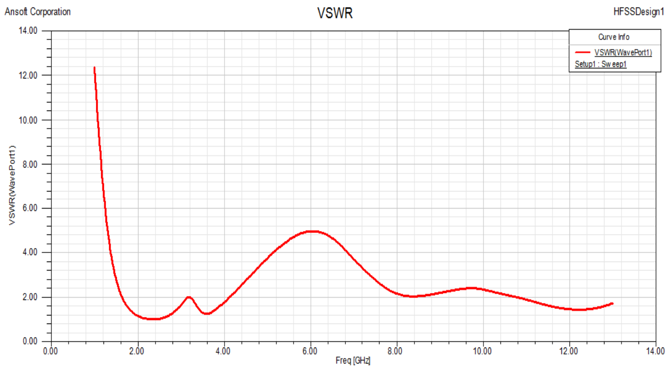
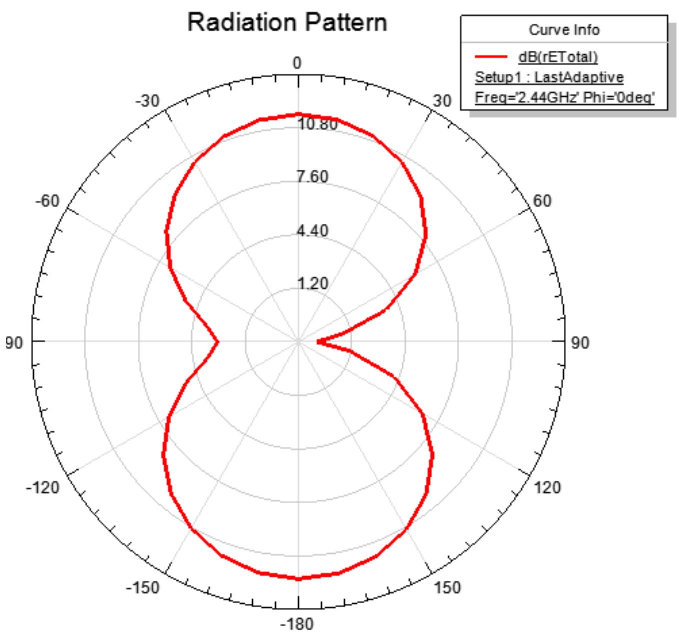
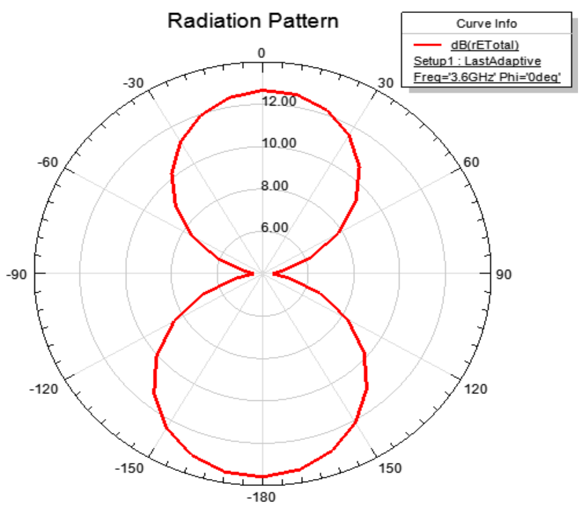


Fig.5. VSWR of the proposed antenna

Fig.4 and Fig.5 shows the simulated results of return loss and VSWR. From the result, it is seen that return losses are < -10 dB at 2.44 GHz and 3.6 GHz frequencies whereas VSWR also < 2 at 2.44 GHz and 3.6 GHz frequencies respectively.

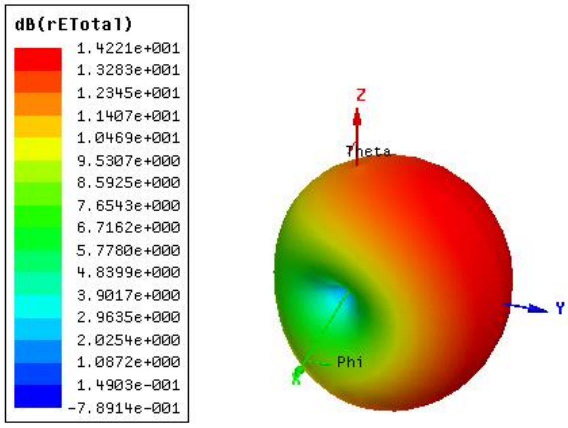


(a) Radiation pattern at 2.44 GHz

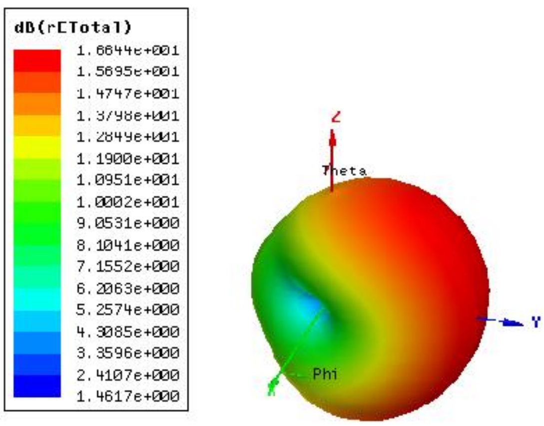


(b) Radiation pattern at 3.6 GHz

Fig.6. Far-field radiation pattern of the proposed antenna (a) at 2.44 GHz and (b) at 3.6 GHz

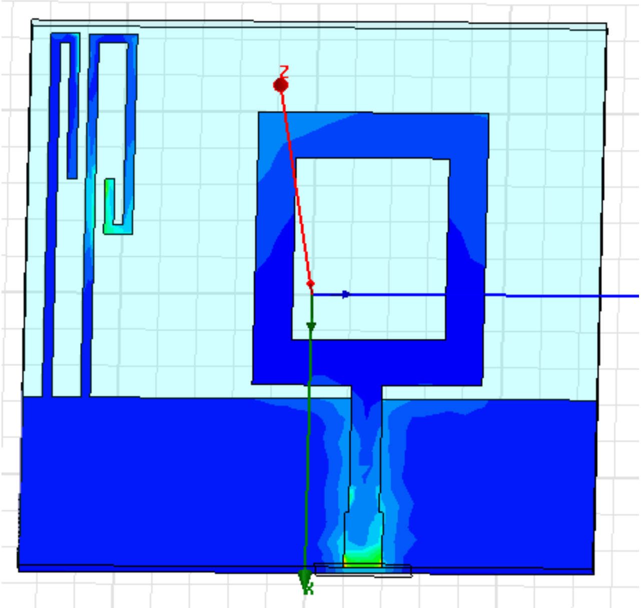


(a) 3-D Polar Far Field pattern at 2.44 GHz

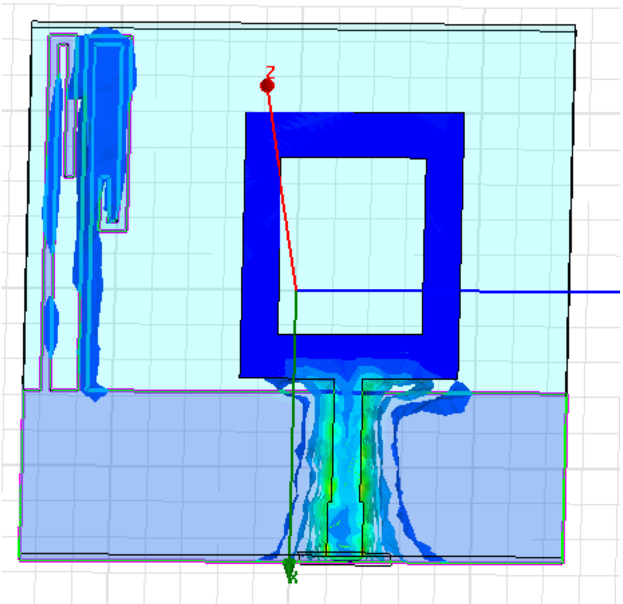


(b) 3-D Polar Far Field pattern at 3.6 GHz

Fig.7. 3-D Far-field radiation pattern of the proposed antenna (a) at 2.44 GHz and (b) at 3.6 GHz



(a) E –field



(a) H –field

Fig.8. Field plot of the proposed antenna (a) E- field and (b) H-field

IV. CONCLUSION

We have designed and simulated the dual band microstrip rectangular slot antenna. By applying two CLLRs and rectangular slot, two different resonant frequencies can be obtained, which was the main objective of this study. From the result analysis, the microstrip rectangular slot antenna almost radiates omnidirectional radiation pattern at 2.44 GHz and 3.6 GHz with excellent return loss, VSWR and gain for Bluetooth and WLAN applications. The proposed antenna has the advantages of simple implementation and low cost due to slot on patch.

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