Compact Broadband Antenna for Wi-Fi Applications

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Abstract

In this paper, we propose a miniaturized broadband antenna to operate at 1.8-2.5GHz useful frequency band of interest. The ground plane containing a rectangular notch is presented below the feed line which results in increased bandwidth. The slots are introduced in different combinations on the proposed antenna that is described, so that the resonant frequency of the antenna can be controlled by the ground slots adjustment independently. From the overall analysis, the dimension of the antenna is done to achieve 20.8dB return loss and over the useful range of frequency it provides 500MHz bandwidth by which we can define it as a broadband antenna for Wi-Fi applications.

Keywords*: Broadband, Miniaturization, Return loss, Wi-Fi frequency, GSM band, Surface current, RF energy.*

1. Introduction

Nowadays mobile phones are prerequisite or requisite for our life. The antenna is the most essential part of the mobile phone and the main key function of the antenna is transmitting and receiving the electromagnetic waves. Literature indicates that earlier antenna was used for the mobile phone which has the larger size and it provide only one operating frequency. The external antenna is placed at the top of the cell phone. However, people mostly prefer to have the planar antennas for transceiver applications. Nowadays manufacturers are trying to fabricate antenna with less side lobes and more bandwidth to meet the requirements of low frequency applications.Nowadays, micro-strip patch antenna are favored because of economical and the better performance. For various application different kind of micro-strip patch were introduced in the literature. For Wireless Local Area Network (WLAN), micro-strip patch antenna was developed in dual-band folded loop. Whereas the measured return loss (S_{11}) of both antennas were measured as -10.3 dB and -20.3 dB respectively [8].

There are several applications of Bluetooth and Personal Communication Service (PCS) and Global Positioning System (GPS) the micro-strip patch antenna has been utilized everywhere. The cell phone antenna radiates the EM energy where paper [6] proposed a harvesting technique which relates to the broadband antenna.

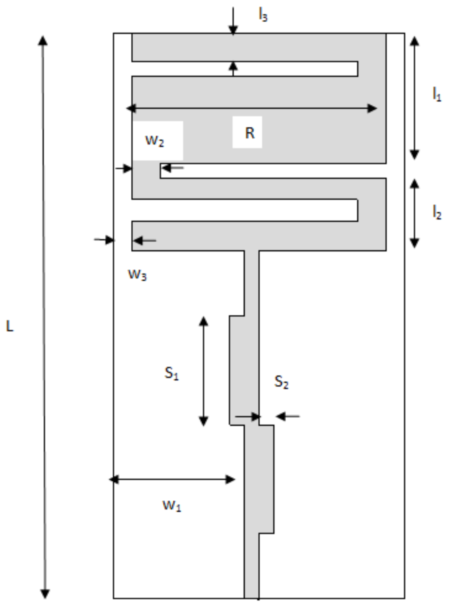
In developing country like India produces the extensive radio frequency (RF) or microwave energy which is close to the transmission tower in the environment. The antenna which we designed is very essential; the reason is the harvestable energy can be affected by the characteristics of the antenna. From [1] various types of the antenna are developed which is used for energy harvesting. Anyhow our proposed antenna is the light weight, and the size is small when compared to the other designed antenna. As discussed in [3] Instead of using the linearly polarized dipole antenna it is better to prefer the circular or dual polarized antenna because it do not need a rigid alignment.

By using the micro-strip patch antenna and printed slot antenna the circular polarization is carried out. This antenna consisting of circular radiating patch and by using the micro-strip feed line it is excited through the coupling of ring slot in ground plane. In [2] the technique called Ambient RF energy harvesting that satisfying the need for battery replacement or recharging in application especially Internet of Things (IOT). As discussed in [4] the operation of harvester at typical ambient RF power level found within urban and semi-urban surroundings. The advantage of PLPDA antenna is that it is of wide band, low profile and light- weight whereas in [7] a broadband bent triangular transmitting aerial is presented for RF energy harvesting application.

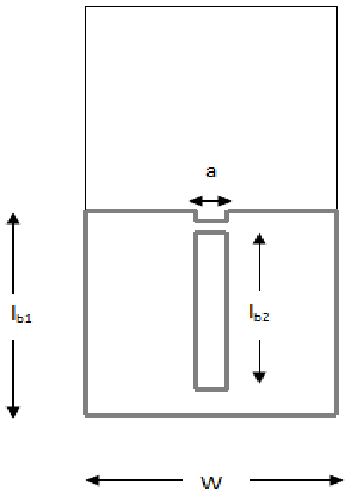
In [4] the performance of the proposed antenna is compared with other asymmetric-slit shapes. The asymmetric-slit configurations are very much useful for size reduced circularly polarized micro-strip patch antennas and array design as in [5].

2. Antenna Design

The antenna we designed consists of radiating element on one side of the substrate whereas the partial ground plane on other side. The substrate used for designed antenna is FR-4 lossy with dielectric constant 4.4, loss tangent 0.02.The thickness of the substrate is 0.8mm. Copper of thickness 0.035mm is used to made radiating patch, ground plane and micro-strip transmission line. A compact 50Ω connector is used between end of the micro-strip line and ground plane. The proposed antenna is simulated using the software called Computer Simulation Technology.



(a)



(b)

Fig.1. Proposed antenna (a) Top view (b) Bottom view

In Fig.1. (a) top view of proposed antenna is shown whereas in Fig.1. (b) the bottom view of antenna is given and the dimensions of proposed broadband antenna design are presented in table I.

Table-1: Description for Antenna Design

Parameters	L	W	h	T	l_1	l_2	l_3	l_{b1}	l_{b2}	l_{b3}	R	s_1	s_2	w_1	w_2	w_3
Value, mm	78	40	0.8	0.035	18	10	4	36	2	30	35	15	2	18	4	2.5

A substrate is taken at a length of L (70 mm) and width of W (40mm). A micro-strip line is formed at the front end and a patch of length l_{b1} (36mm) is formed at the ground plane and then a slot of length l_{b3} (30mm) is formed on the ground plane. The radiation efficiencies which are simulated shows value that is larger than 88% where the gain of the antenna varies.

3. Results and Discussion

The proposed antenna has impedance bandwidth of 522.24MHz that covers GSM 1800 band and Wi-Fi band. For better antenna performance, antenna radiator and ground planes are examined. The final dimension of the antenna is selected where the parameters are measured for proposed antenna at 1.8, 2 and 2.4 GHz frequencies.

The input impedance is the quantity characterized by the opposition conferred by an antenna to an AC. The input impedance obtained at the operating frequency is 45Ω. The operating range of the proposed antenna varies from 1.9 to 2.4GHz.

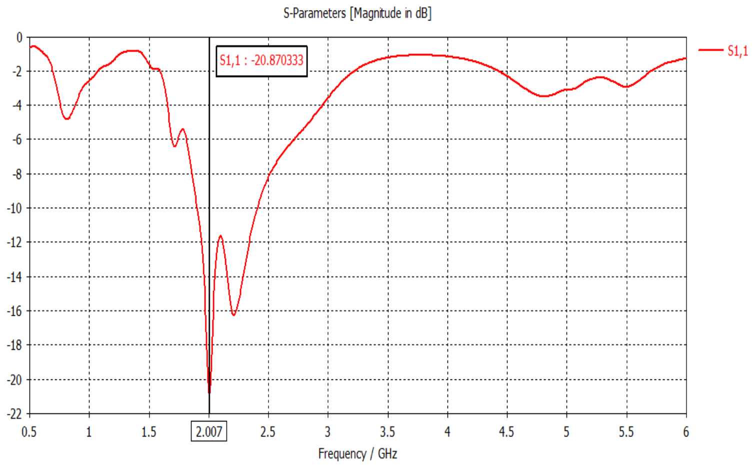


Fig 2. Plot of Return Loss

When return loss increases SWR decreases. The return loss is to measure how the devices are equated. Whenever the return loss is high the match is good. The return loss achieved at the operating frequency is -20.8 dB as shown in Fig.2.

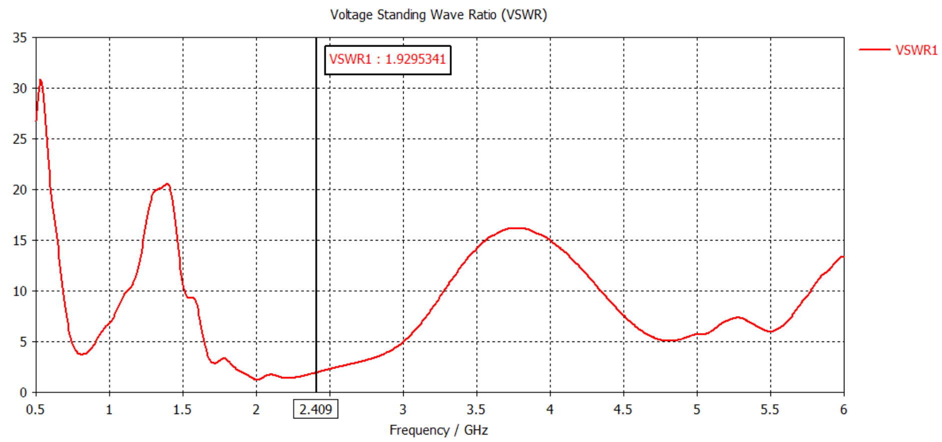


Fig 3. Plot of VSWR

VSWR is the key opener for any system using the transmission lines and it is also used to measure the level of standing wave. The VSWR achieved at the 2GHz operating frequency is 1.19 whereas at 2.4GHz it is maintained below 2 as shown in Fig.3.

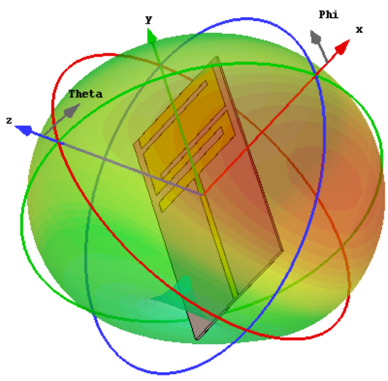


Fig 4. Far-field Directivity

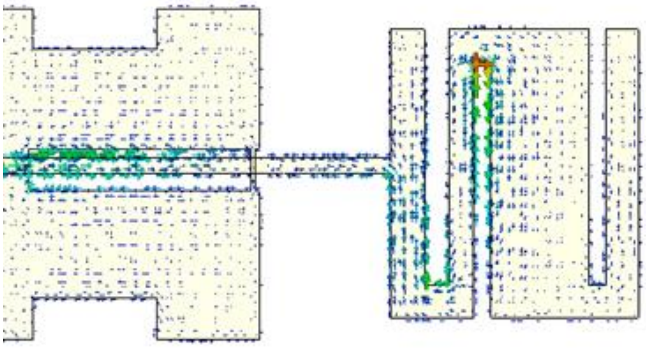


Fig 5. Surface Current

Even though it is a wideband antenna it can provide directivity of 5.2 dBi. Being a broadband antenna having bandwidth of 500MHz, it provides good Return loss and VSWR values.

In any antenna, surface current is an important parameter which majorly affects antenna performance. The surface current should be properly distributed for low loss and high gain of antenna.

4.Conclusion

The proposed antenna is a very good candidate to operate at GSM and Wi-Fi range of frequencies which provides better return loss along with size miniaturization. This broadband antenna can also be used for energy harvesting applications as we have many applications in lower frequency band of interest from 0.9GHz to 3GHz. The bandwidth of proposed antenna is 500MHz from 1.8GHz to 2.5GHz which is compatible to use because of its low VSWR and better return loss characteristics over the entire operating band.

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