International Journal of Computer Applications (0975 – 8887)
Volume 173 – No.6, September 2017

Wideband Multi-Polarized Microstrip Patch Antenna for Wireless Communication

Manisha Gupta
Dept. ECE, ABES Engineering College
Ghaziabad, UP, India

Rakesh Kumar
Dept. ECE, ABES Engineering College
Ghaziabad, UP, India

ABSTRACT
A compact monopole antenna having wide bandwidth with multi-bands as well as dual polarization characteristics for wireless communication is presented. To get impedance matching for the SMA conductor, the antenna is fed up by Micro-strip feeding technique. In this, the antenna is embedded by an L-shaped slots on the ground plane, to improve the bandwidth by excited the addition of resonance. To generate the multiband characteristic, with dual polarization, the inverted E-shaped parasitic structured as a replacement is used in the back of the substrate and upper side of the ground. The measured results show that the proposed dual polarized monopole antenna offers a very high gain 7 dB with 10 dB return loss with multi notched bands, covering all the (3.18-3.66) GHz Wi-MAX, (5.18-6.22) GHz WLAN, (6.89-9.07) GHz X bands.

Keywords
Band Notch; Dual Polarization; L-shaped slot; Micro-strip feeding; Wideband

1. INTRODUCTION
With the increase of application in wireless communications, circularly polarized as well as wideband antenna have become highly desirable due to their many advantages such as light weight, thin profile configuration ,stable radiation characteristics and easy to fabricate as well as multitasking capability .To fulfill the different requirements it is necessary that the same antenna can operate at more than one frequency .So the multiband antennas with dual polarization were developed .Multi frequency operations in a system can be achieved by using a wideband antenna covering a larger bandwidth .The useless interference can be discarded by an capable filtering method provided by wide band antenna.

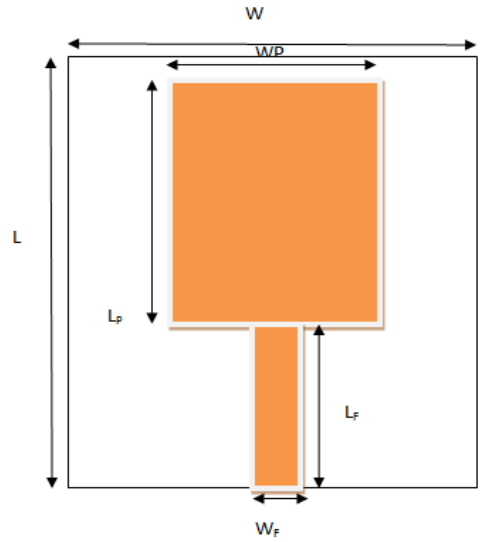
There are many different type of shape of slits or slots are used to generate the wideband multinotch dual polarization functions which have been discussed in [1-10]. In [1] different shapes of slots such as T-shaped and W-shaped are used to obtain the desired multi band notch Characteristics. Many applications having a need of multiband linear and circular polarizations performance within a single antenna [2]. Mostly networks such as WLAN used circular polarization (CP) to improve the polarization effectiveness of link budget [3]. Two semicircle on the base edge of the ground plane and two bevel slots on the upper edge [4] and using a half -bowtie radiation patch with staircase shape [5] are also used for the bandwidth enhancement.

Wide Band antennas are also for the rejection of the electromagnetic interfaces with other existing communication systems, such as (3.18-3.66) GHz- Wi-MAX, (5.18-6.22) GHz- WLAN, (6.89-9.07) GHz-X bands [6]. Other methods such as inverted F shape type radiating patch with L- shape ground having a square on the upper corner [7] and square patch with L and E shaped slits and ground plane with V-shaped protruded strip [8] are also used to enhance the bandwidth or to get ultra-wide bands. A new concept of rectangular filtering dielectric resonator antenna (FDRA) for wide bandwidth and high gain was firstly introduced in [9]. Other wideband antennas with dual or multi notched frequency bands have been shown in [10]–[11]. In these designs, by inserting the proper slits in the radiating patch, changing the position of feed line or the ground plane, two or more rejected bands have been obtained.

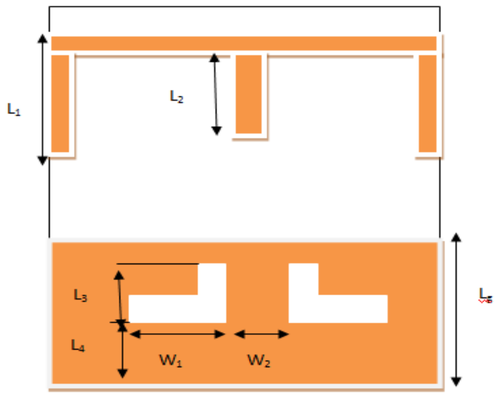
In this paper, a multifunction monopole antenna with multiband, dual polarization is projected. The ground plane is embedded by a pair of L-shaped slots, to get better bandwidth. Using these L-shaped slots, area occupied by these slots on the ground is reduced in comparison of two rectangular slots presented in [12]. We also used E- shape element in which middle is smaller than others two which is electromagnetically coupled to the radiation patch.

2. ANTENNA DESIGN
The simulation of the proposed antenna structure have been done by using finite element method (FEM) software, HFSS. The proposed multifunction monopole antenna is fed by a 50Ω microstrip line is shown in Fig.1, which is printed on an FR4 having dielectric permittivity 4.4. The basic structure of antenna is designed by a rectangular radiating patch, a feed line, and a ground plane. The radiating patch is connected to a feed line on the front side of the antenna as shown in Fig. 1. The conducting ground plane is designed on the back side of substrate. The partially modified ground plane is designed by two L- shape slots to achieve a wider bandwidth. The L-shaped slot consists of one horizontal arm of length and one vertical arm of length connected at their ends. The uniform width (=0.8mm) is used for the L-shaped slot. The distance of the two slots from the lower side of the ground plane is L4 and both slots are separated by a distance (W2), as shown in Fig. 1. A. To realize the proposed WB antenna with multi band notch function as well as dual polarization function, an E- slot having middle arm smaller than others is designed on the back of the substrate and the upper side of the partially modified ground and couples to the radiating patch. The uniform width of 0.8 mm is used in E-shaped slot, except at the bends. The distance between the E-shaped element and upper edge of the substrate is properly selected and fixed at 2 mm, to achieve the required band-notch function.

In this design, only one resonant mode is excited by changing the feed position along the x or y axis, but two different resonant modes (TM01 and TM10) can be obtained by placing the feed position in spaces between x and y axes (or an asymmetric position), simultaneously.



(a)



(b)

Fig. 1. Geometry of the proposed single band-notched UWB antenna: (a) front side of the substrate; (b) back side of the substrate.

The optimum dimensions of the designed antenna are as follows: W=22mm, L= 24mm, WP=10mm, LP=15 mm, WF=1.9mm, LF= 8 mm, L1=9mm, L2=7.1mm, L3=2.2mm, L4=2 mm, W1=6.45mm, W2=1.9mm, W3=22mm and Lg=6mm.

The E-shaped slot is defined by three major elements, L1, L2& W3. At the present design, the horizontal portion of the E-shaped (without middle arm) element is perpendicular to the vertical edges of the radiation patch. The position of higher and lower frequency as well as axial ratio have affected by the small changes in the three arm of E- shape. By choosing properly the length (L1=9mm) we got the proper multiband and by choosing the middle arm (L2=7.1mm) properly we got the axial ratio at 5.1 GHz.

In these structures, at the notch frequency (5.6GHz), the current flows are more dominant around the middle arm of E-shape and between the vertical arm of L-Shape which are oppositely directed between the parasitic element and the radiating patch. Fig. (2) Shows the current distribution of radiation patch, E-Shape and ground plane at the second notch frequency (5.6GHz).

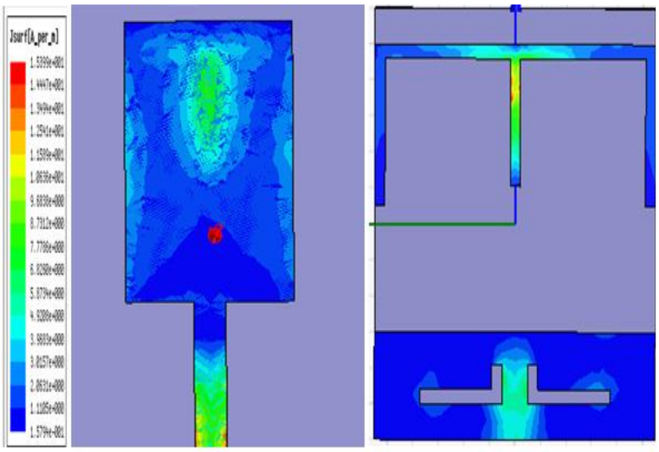


Fig. 2. Geometry of the proposed single band-notched UWB antenna: (a) front side of the substrate; (b) back side of the substrate.

3. RESULT AND DISCUSSION

The antenna was fabricated on a 1mm thick FR-4 substrate with relative dielectric constant of 4.4 and measured using a HFSS analyzer. The return loss of monopole antenna is shown in fig. 2. We get multiple bands in which radiate notches frequencies are 3.5GHz ,5.6GHz, 7.5GHz, 12.5GHz ,which covers the (3.18-3.66) GHz- Wi-MAX ,(5.18-6.22)GHz-WLAN, (6.89-9.07)GHz-X BAND applications. It also gives the notches used for the satellite application (3.66-5.18) GHz-C-band downlink. The overall 10-dB return loss bandwidth ranges from 3 to more than 12 GHz.

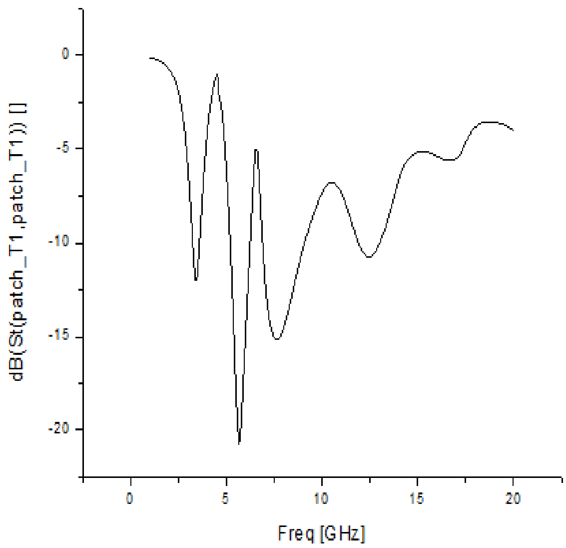


Fig. 3. Simulated Return Losses

The simulated gain of the antenna, from1.5 to 13.5 GHz, are also presented in fig.3. The approx. gain is 7dB, which is a good gain. Both polarization circular as well as linear polarization are used in this monopole antenna. We get the circular polarization at 5.1GHz frequency. The axial ratio graph is shown in fig 4.

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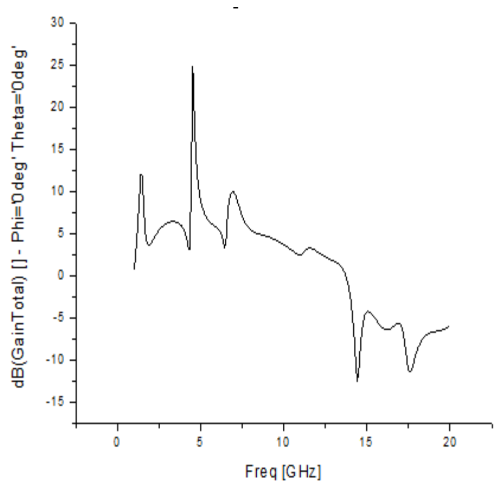

Fig. 4-Simulated Gain

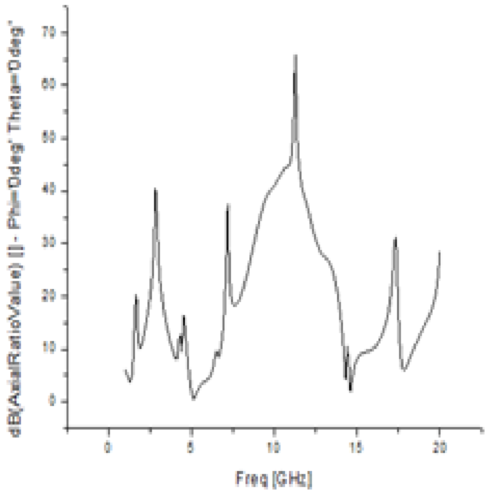

Fig.5 .AXIAL RATIO

Fig.6 shows the measured radiation patterns admitting co-polarization as well as cross-polarization in the H- plane (x-z plane) and E- plane (y-z plane). The main purpose of the radiation patterns is to express that the antenna really radiates over a wide frequency band. It can be seen that the radiation patterns in x - z plane are nearly Omni-directional for the four frequencies.

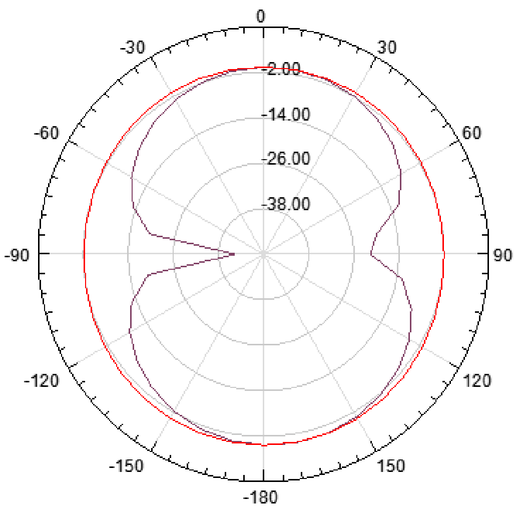

Fig. 6. Radiation pattern at frequency 5.6 GHz (H-E plane)

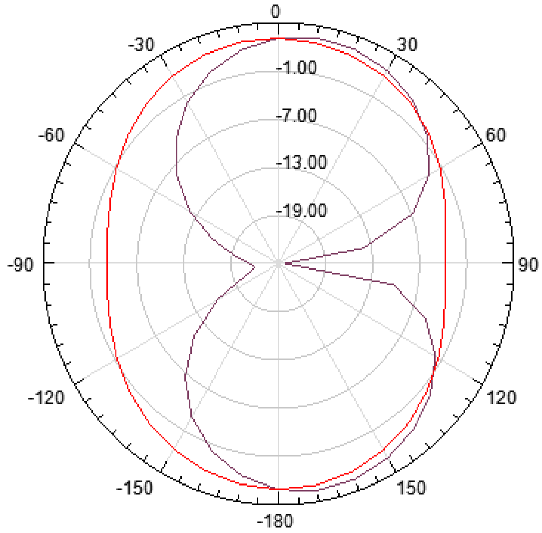

Fig. 7. Radiation pattern at frequency 7.5 GHz (H-E Plane)

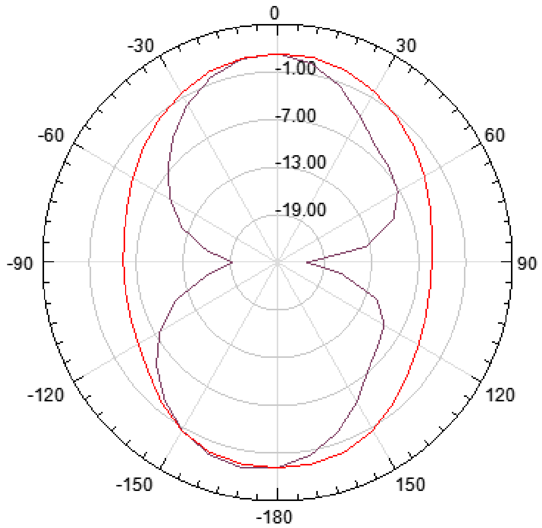

Fig. 8. Radiation pattern at frequency 12.4 GHz (H-E Plane)

4. CONCLUSION

In this paper, a multi-notched and dual polarization characteristics within the single antenna has been proposed for numerous applications. The fabricated antenna has the frequency band from 3 to12 GHz and above with three rejection bands around 3.5–5.18, 6.2–6.8 GHz, and 9.0-11.9 GHz. The wider impedance bandwidth can be generated by designing of two similar L-shaped slots especially at the higher band. Also by designing a modified E-shaped (middle arm is smaller than other two arms) slot on the upper side of modified ground and on the back side of the substrate a multi band, dual polarization characteristics are generated. The proposed antenna has a simple configuration and is easy to fabricate.

This paper shows the simulated results of various microstrip antennas in terms of return loss, Radiation pattern and gain. So, it was concluded that by introducing the slit/slots of different shape or size in Patch or in Ground, multi-frequency band with dual polarization and sufficient gain can be achieved. Simulation results show that the proposed antenna ishighly suited to today's system which uses both long and shorter distance communications.

5. REFERENCES

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