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Dual Band Microstrip Antenna using Shorted Metallic Patches

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 dual band characteristics using shorted metallic patches is presented. To get impedance matching for the SMA conductor, the antenna is fed up by probe feeding technique. The shorted metallic patches are made by square patches which are connected to the ground plane by the shorting pins. SMPs are used to improve the gain of the antenna. The dimensions and position of the SMPs and the position and dimension of the slot with respect to the patch are important and studied in this paper.

Keywords
Dual band Notches; Shorted Metallic patches; Probe feeding;

1. INTRODUCTION
With the increase of application in wireless communications, dual-band microstrip patch 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. In this paper, SMPs are used to increase the gain. Generally there are many methods are used to increase the gain such as using thick substrates, parasitic elements and stacked configuration etc. But here gain is increased by using SMPs around the patch antenna. Dual band is generated by a rectangular slot created in the patch. The dimensions and position of the SMPs and the position and dimension of the slot with respect to the patch are important and studied in this paper. The dimension and position of the probe feeding are also important to generate 50Ώ resistance.

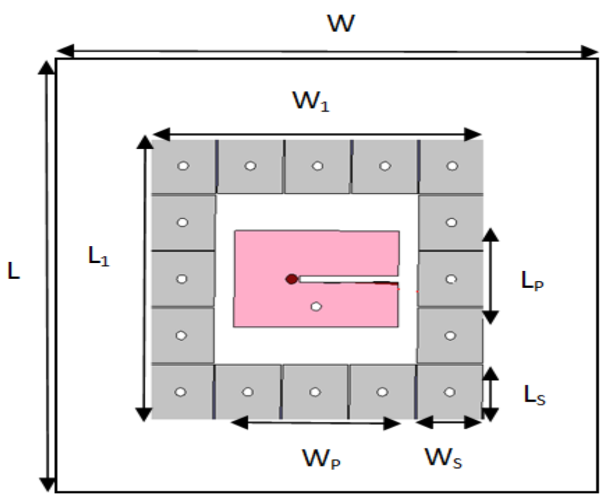
There are many different type of shape of slits or slots are used to generate the dual band functions which have been discussed in [1-10]. In [1] different shapes of slots such as T-shaped and W-shaped are used to obtain the desired multi band notch Characteristics. Many applications having a need of 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, we used a method of SMP to project a monopole antenna with dual-band and linear polarization. The front plane is embedded by many SMPs, to get better gain. Introduction of SMP around the patch antenna causes a shift in its resonant frequency from 5.6GHzto 5.78GHz, in addition to a reduction in its (S11=-10dB) impedance bandwidth.

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 probe feed line is shown in Fig.1, which is printed on an GML 1032 having dielectric permittivity 3.2 and tan δ=0.014. The basic structure of antenna is designed by a rectangular radiating patch, a cylindrical probe feed line, and a ground plane. The conducting ground plane is designed on the back side of substrate. The SMPs and the rectangular patch was designed on GML 1032 substrate of size 80mm×80mm. The square shorted patches have 8mm×8mm side dimensions and the space between the square shorted patches are 0.2mm. The dimension of the middle patch is 14mm×20mm. The SMPs are connected to the ground by the shorting pins. The centre vias has 0.6mm radius. A rectangular slot(12×1mm) is cut in the middle patch due to dual band is generated.

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.



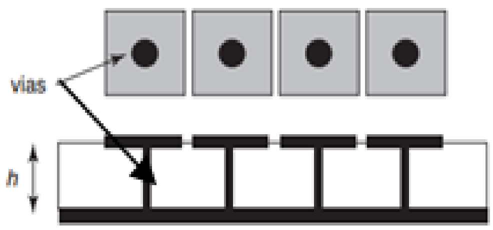


Fig. 1. Geometry of the proposed dual band-notched SMP antenna(front side of the substrate)

The optimum dimensions of the designed antenna are as follows: W=80mm, L= 80mm, WP=20mm, LP=14 mm, WS=8mm, LS= 8 mm, L1=40.8mm, W1=40.8mm.

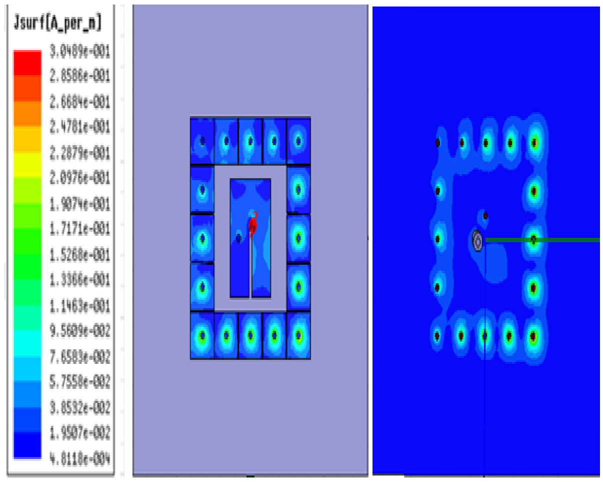


Fig. 2. Surface Current Distribution in the radiating patch and ground plane at 5.6 GHz

If the number of SMP ring layer increases then it results the gain to drop from its maximum value obtained by a single layer. The coupling between the SMP elements causes a reduction in the surface current density on the first layer adjacent to the patch antenna by exciting currents on the second layer. However, the radiation by the second layer does not add co-phasally resulting in a reduction of gain. Consequently, with a single ring layer, it was concluded that the individual SMPs act as a parasitic element in this case, which causes an increase in the overall gain.

This increase in the gain is ascribed to an increase in the antenna aperture area by the surrounding SMP ring. This effect is illustrated by the surface current density plot shown in Fig. 2. The light grey colours display the higher current densities.

3. RESULT AND DISCUSSION

The antenna was fabricated on a 1.59mm thick GML-1032 substrate with relative dielectric constant of 3.2 and measured using a HFSS analyzer. The return loss of monopole antenna is shown in fig. 3. We get dual bands in which radiate notches frequencies are 3.68GHz and 3.98GHz ,which covers the C-BAND applications

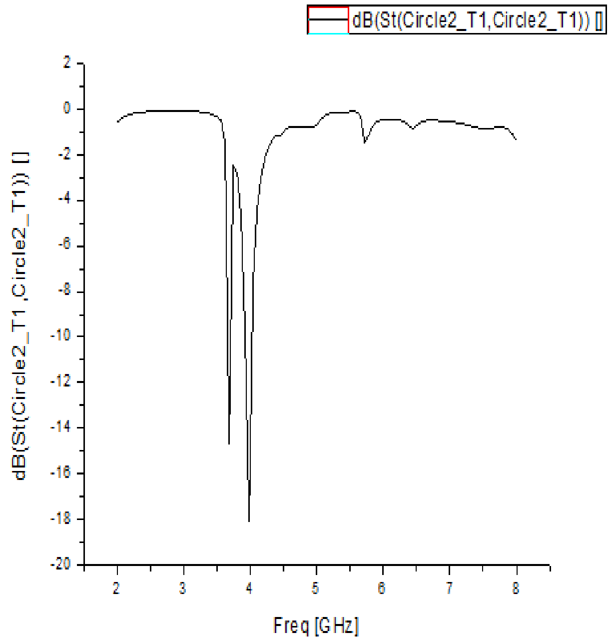


Fig 3. Simulated Return Loss

The simulated gain of the antenna is also presented in fig.4. The approx. gain is 6 dB, which is a good gain. The gain of the dual-band SMP antenna is more than the gain of the single band SMP antenna. The comparison of results in different type of SMP antenna is shown in table 1.

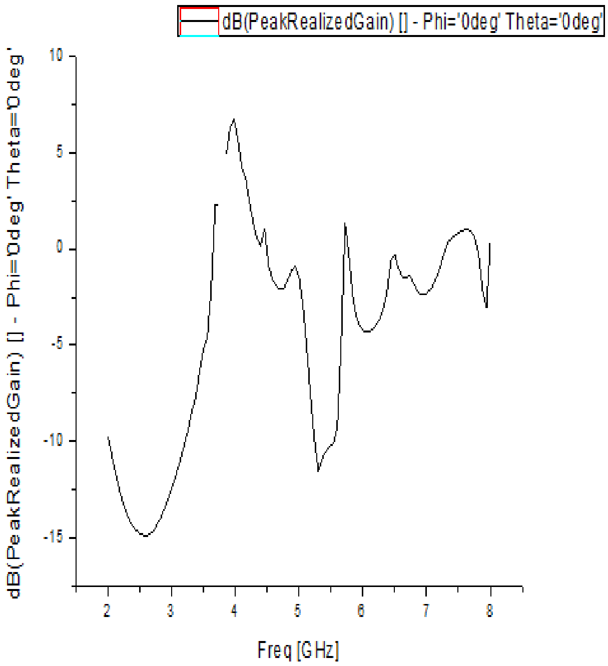


Fig. 4-Simulated Gain

Fig.6shows 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 frequencies.

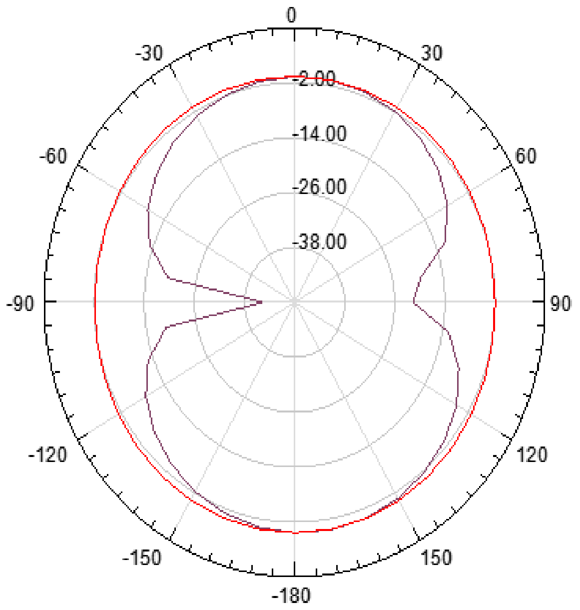


Fig. 5. Radiation pattern at frequency 5.6 GHz (H-E plane)

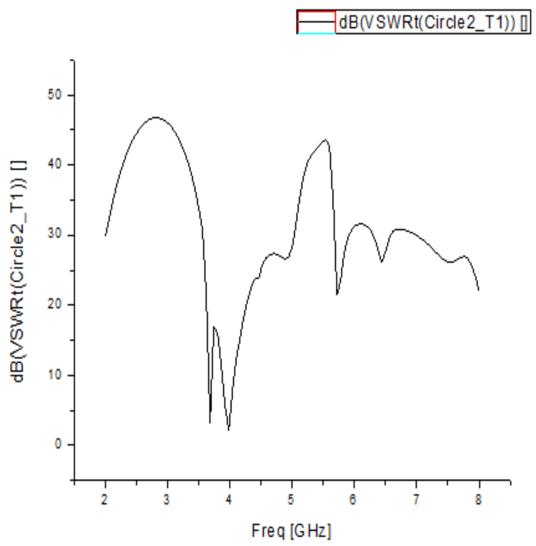


Fig. 6-VSWR

Table 1 shows the comparison between the different structure of the SMP antenna.

Table 1. Comparison of the results of the single and dual band SMP Antenna

S.No.	Structure	Resonant Freq.(GHz)	Return Loss(dB)	Gain (dB)
1	Simple SMP Patch	2.335	-17.9	0.915
2	SMP Patch with Slit Cut	3.79, 6.4	-16.14, -12.39	4.9, 6.6
3	Optimized SMP Patch with Slit Cut	3.68, 3.98	-14.67, -18.09	6

4. CONCLUSION

Various structures of microstrip patch antenna have been analyzed and then antenna is simulated on An soft's HFSS v 13.First the simple patch have been studied and then using the same structure SMP patch was studied. After these analyses, simple silt is cut to achieve dual band with high gain. Results such as return loss, VSWR and radiation pattern were plotted in HFSS v 13 for various structures of antennas. The antenna possess dual band characteristics with resonating frequencies of bands at 3.68 GHz and 3.98 GHz. slit cutting in patch. Therefore, overall gain of antenna was increased and it comes out to be 5.9 dB as compare to simple patch with 3.2dB of gain. This Antenna is worth for multi operations such as communication satellite, weather radar, surface ship radar and wireless network equipment.

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