National Conference on Synergetic Trends in engineering and Technology (STET-2014)
International Journal of Engineering and Technical Research ISSN: 2321-0869, Special Issue

Design of Slotted Microstrip Antenna having high efficiency and gain

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***Abstract*— The simulated antenna characteristics along with radiation pattern and gain are presented. The proposed designed antenna is suitable for dual band application. The simulated result shows that the proposed antenna presents a bandwidth of 38.68% and 22.46% with the maximum antenna efficiency 90%.**

***Index Terms*— Circular slotted, Line Feed, Dual wide band Antenna.**

I. Introduction

Microstrip antennas (MSAs) are gaining popularity amongst the researchers due to its attractive features such as low profile, low cost, light weight, ease of fabrication and compatibility with microwave circuits.[1-4] However, despite of these several advantages, the microstrip antennas suffers from some disadvantages of narrow bandwidth and low efficiency. Various researches have been made to increase the bandwidth of Microstrip antennas, which includes increase of the substrate thickness, the use of a low dielectric constant, slotted patch antennas, introducing the parasitic elements either in coplanar or stacked configuration, the use of various impedance matching and feeding techniques [5-10].The dielectric constant of the substrate is closely related to the size and the bandwidth of the microstrip antenna. Low dielectric constant of the substrate produces larger bandwidth, while the high dielectric constant of the substrate results in smaller size of antenna. **[6--10]**

In the past few years researchers have tried various methods to enhance the bandwidth and it is observed that as the bandwidth is increased the efficiency and gain decreases. To obtain a larger bandwidth along with optimum gain and efficiency and maintaining the size of antenna is a major challenge to the researchers working with microstrip antennas these days [11-15].

In this paper a dual band line feed microstrip antenna with compact size is presented which have bandwidth of around 38.68% and 22.46%.The antenna is suitable for various mobile cellular communication systems where dual band applications is required.

II. Antenna Design

The proposed line-fed wide band circular slotted antenna is presented in Figure1. The ground plane has the dimensions of Lg× Wg and is printed on a substrate of thickness h = 1.6 mm and relative permittivity ε_r = 4.4. A 50 Ω microstrip feed line is employed to excite the proposed antenna having width of W_1 and length L_1, respectively. The optimized design parameters of the proposed patch antenna are shown in table 1. The circular slot is introduced on the patch with glass epoxy substrate provide bandwidth enhancement.

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Table 1. Design parameters of Antenna

Parameters	Antenna-2
W_g	100 mm
L_g	100 mm
L_1	36.7mm
W_1	45.6 mm
L_F	4mm
W_F	25.2mm

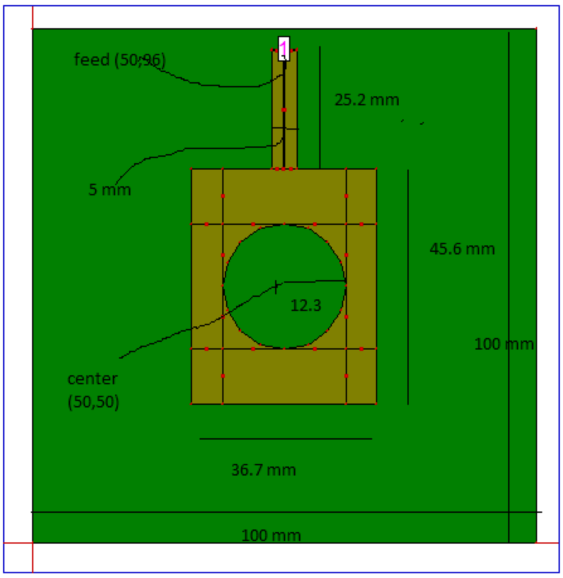


Figure 1: Top view of Proposed Antenna

For an efficient radiator, a practical width that leads to good radiation efficiencies is given by equation (1).For low frequencies the effective dielectric constant is essentially constant. At intermediate frequencies its values begin to monotonically increase and eventually approach the values of the dielectric constant of the substrate. The initial values (at low frequencies) of the effective dielectric constant are referred to as the static values, and they are given by equation (2). Because the dimensions of the patch are finite along the length and width, the fields at the edges of the patch undergo fringing. Due to the fringing effects, electrically the patch of the microstrip antenna looks greater than its physical dimensions. For the principal E -plane (xy -plane),the dimensions of the patch along its length have been extended on each end by a distance Δl ,which is a function of the effective dielectric constant ε_{reff} and the width to height ratio (W/h).

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}} \quad (1)$$

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \quad (2)$$

$$\frac{\Delta l}{h} = 0.412\frac{\left(\varepsilon_{reff} + 0.300\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.813\right)} \quad (3)$$

Since the length of the patch has been extended by Δl on each side; the effective length of the patch is given by equation (4)

$$L = \frac{1}{2fr\sqrt{\varepsilon_{reff}}\sqrt{\mu_o \varepsilon_o}} - 2\Delta l \quad (4)$$

III. Results and Discussions

Figure 2 shows the variation of return loss versus frequency of proposed MSA. From this figure, it is seen that the proposed MSA resonates at 1.2 GHz and 2.25 GHz of frequency.

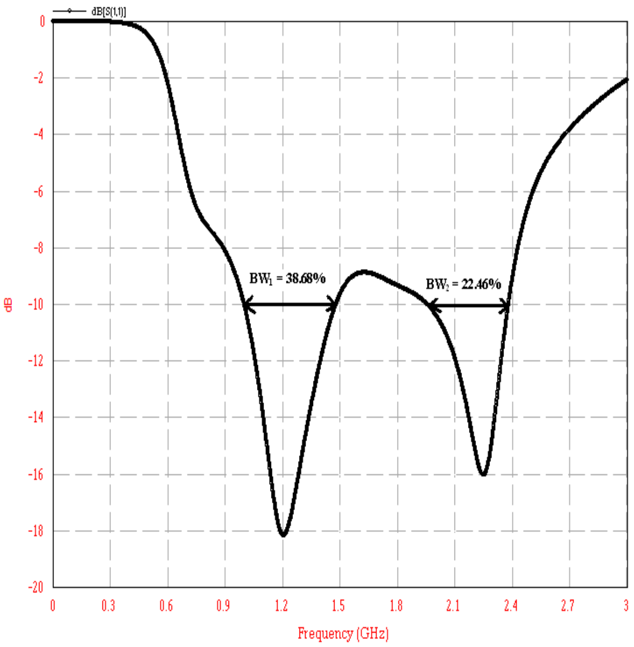


Figure 2: S11 parameter of Proposed Antenna

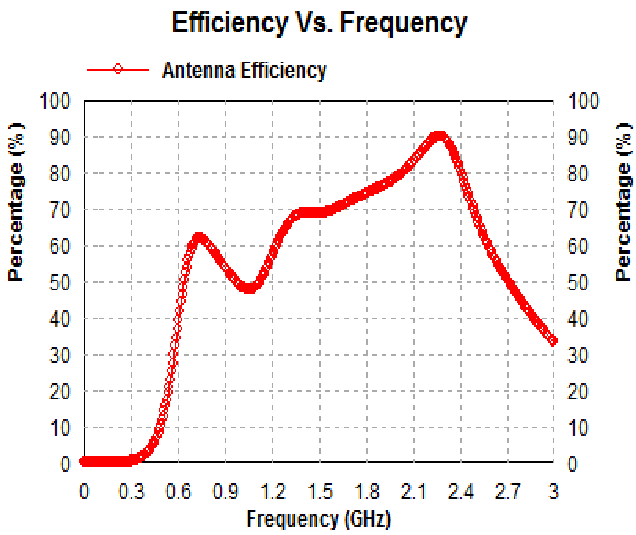
Table 2.Results of Proposed antenna design

Parameters	Obtained Results
Band Width	22.46%. and 38.68%
Maximum Directivity at 3.75 GHz	6 dBi at 2.25 GHz
Maximum Antenna Efficiency	90% at 2.25 GHz

The bandwidth of antenna can be defined as the percentage of the frequency difference over the center frequency [5]. According to these definitions can be written in terms of equations as follows

$$BW(\%) = \left[\frac{f_H - f_L}{f_C}\right]100$$

Where f_H and f_L are the upper and lower cut off frequencies of the resonated band when its return loss reaches -10 dB and f_C is a centre frequency between f_H and f_L respectively. The impedance bandwidth of proposed MSA is found to be 38.68% and 22.46%.



3: Efficiency plot of proposed Antenna

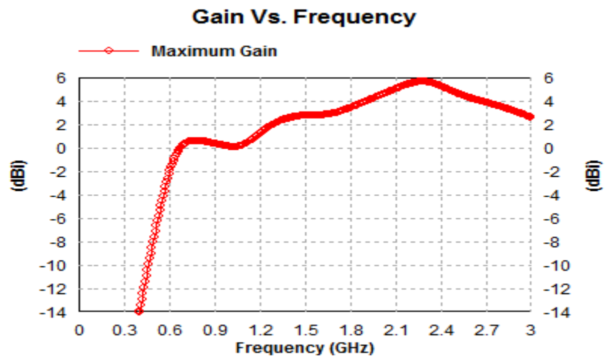


Figure 4: Gain Vs Frequency plot of proposed Antenna

IV. CONCLUSION

The simulated results demonstrate that it has a dual bandwidth of 38.68% and 22.46% with the maximum radiation efficiency 90%, The maximum achievable gain of the antenna is 6 dBi.The developed line feed wide band compact microstrip antenna is suitable for dual band applications.

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