DESIGNING OF FULL GROUND AND SLOTTED GROUND MIMO ANTENNA FOR WIRELESS APPLICATION

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ABSTRACT:

The Use of MIMO antenna is used to increase the capacity of the system. The designed antenna with slotted ground resonates at 5.2 GHz frequency and produce return loss of -21 dB and good isolation in the range 5.1 to 5.3 GHz band. In second case where full ground is considered the antenna resonate at 4.3 GHz and provides -17 dB of return loss with isolation of less than -10 dB. The other antenna parameter like gain, ECC, Radiation pattern are demonstrated and compared for both the cases, full ground and slotted ground. The presented result shows the better isolation achieved for slotting case.

Keywords: **Isolation, MSA, VSWR, ECC, FR-4.**

I. INTRODUCTION

There are three major areas for improving performance of microstrip patch antenna and related simulation software. The papers referred are mainly for wireless application various techniques like simple patch antennas, microstrip patch antennas using slots in patch, microstrip patch antennas using Defected Ground Structure (DGS) for size reduction.

The concept of microstrip antenna with conducting patch on a ground plane separated by dielectric substrate. For different configurations many researcher have described the radiation from the ground plane by a dielectric substrate. The early work of Munson on micro strip antennas for use as a low profile flush mounted antennas on rockets and missiles showed that this was a practical concept used in many antenna system. Various mathematical analysis models were developed for this antenna and its applications were extended to many other fields. In this section, the microstrip antenna literature survey is discussed.

A double L-slot microstrip patch antenna [3] array with a feed technology has been proposed for microwave access and wireless local area network applications. There is a compact antenna with good omnidirectional radiation characteristics for proposed operating frequencies. It can be observed that the peak gain can be higher than 3dBi at 3.5 GHz.

A microstrip patch antenna [4] for dual band WLAN application is proposed. In the paper a dual band L-shaped Microstrip patch antenna is printed on a FR-4 substrate for WLAN systems, and achieves a frequency range from 5.0 GHz to 6.0 GHz with maximum gain of 8.4 and 7.1 dB in lower and higher frequency bands respectively.

A microstrip slot antenna [5] fed by a microstrip line has been proposed in this paper. In this bandwidth of antenna has been improved. This antenna was presented for WLAN and satellite application.

A Broadband patch antenna [6] for WI-MAX and WLAN is developed. In this proposed antenna exhibits wideband characteristics that depend on various parameters such as U-slot dimensions, circular probe –fed patch. This antenna shows 36.2% impedance bandwidth with more than 90% antenna efficiency and is suitable for 2.3 / 2.5 GHz WI-MAX and 2.4 GHz WLAN application.

A dual Wideband printed antenna [7] is proposed for WLAN/WI-MAX application. A microstrip feed line for excitation and a trapezoidal conductor-backed plane used for band broadening. The measured 10dB bandwidth for return loss is from 2.01 to 4.27 GHz and 5.06 to 6.79 GHz, covering all the 2.4/5.2/5.8 GHz WLAN bands and 2.5/3.5/5.5 GHz WI-MAX bands.

This paper [8] has been proposed for describing various feeding techniques. In this a circular polarized patch antenna of shape similar to alphabet 'I' on FR4 substrate for BLUETOOTH applications has been investigated. This paper describes a good impedance matching condition between the line and the patch without any additional matching elements.

A compact rectangular patch antenna [9] has been presented for WI-MAX and WLAN application. This antenna has compact, cost effective, simple structure and suitable for all frequency bands of WI-MAX and WLAN applications.

II. DESIGN PARAMETER

A. CALCULATION OF VARIOUS PARAMETERS OF PATCH

For the design of antenna, there are many analysis methods which are discussed earlier. So, for our antenna we use transmission line analysis method.

B. CALCULATION OF WIDTH (W)

The width of Microstrip patch antenna can be calculated as:

$$w = \frac{c}{2fo\sqrt{\frac{(\varepsilon r+1)}{2}}}$$

Where, c is velocity of light

fo is Resonant Frequency

Ɛr is Relative Dielectric Constant

C. CALCULATION OF LENGTH (L)

(i) Calculation of Effective dielectric constant (Ɛreff)

In length (L) calculation, the first step is to calculate effective dielectric constant.

The effective dielectric constant can be calculated as:-

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

(ii) Calculation of Effective length (Leff)

The effective length can be calculated as:-

$$L_{eff} = \frac{c}{2fo\sqrt{\varepsilon_{reff}}}$$

(iii) Calculation of length extension (ΔL)

The length extension is given by:

$$\Delta L = 0.412h\,\frac{(\varepsilon_{reff}+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{w}{h}+0.8\right)}$$

(iv) Calculation of actual length of patch (L)

The actual length of patch is obtained by:

$$L = L_{eff} - 2\Delta L$$

Let us use a microstrip 50 ohm feed,

$$R_{f,}in(d) = R_{p,}in(0) \times cos^2\left(\frac{\pi d}{L}\right)$$

Where,

$$R_{p,}in(0) = \frac{1}{2(G1 + G12)}$$

G1 = Conductance at entry slot

G12 = Mutual conductance between entry & second slot

Now,

Using approximation,

$$R_{p,}in(0) = \frac{1}{2G1}$$

And,

$$G1 = \frac{I}{120\,\pi^2}$$

Where,

$$I = -2 + \cos(kw) + kw\,Si(kw) + \frac{\sin(kw)}{(kw)}$$

Where,

$$Si\,(kw) = kw - \frac{(kw)^3}{3 \times 3!} + \frac{(kw)^5}{5 \times 5!} - \frac{(kw)^7}{7 \times 7!} \dots \dots$$

$$\text{Since,}\quad K = \frac{2\pi}{\lambda}$$

$$d = \frac{L}{\pi} \cos^{-1} \sqrt{\frac{R_f, in(d)}{R_p, in\,(0)}}\ radian$$

We know that,
Z_f = Impedance of feed line can be calculated as,

D. DESIGN SPECIFICATION

The proposed designed antenna works for frequency 5.2 GHz and 4.3 GHz for slotted ground and full ground. The antenna for two different cases is simulated and discussed. The result obtained is discussed in later section. 2X1 slotted element antenna is designed with identical size.

E. DESIGN PARAMETERS

Here calculated the design parameter for single patch. The proposed designed patch antenna that operates at multiband application on a FR-4 substrate. The FR-4 substrate has a dielectric constant of 4.3 and a height of 1.524mm. The first step is to calculate the length and width of the patch antenna.

Table 1 Design Parameters dimension

Parameter	Dimension	Size (mm)
GND	G_w X G_l X G_h	24 X 22 X 0.07
Substrate	S_w X S_l X S_h	24 X 27 X 1.524
Feed	F_w X F_l X F_h	2.7 X 3X 0.07
Feed1	F_{w1} X F_{l1} X F_{h1}	1.1 X 7 X 0.07
Patch	P_w X P_l X P_h	20 X 16 X 0.07
Gnd slot	Gc_w X Gc_l	1.5 X 18
Overall size of MIMO	O_x X O_l X O_w	48 X 27 X 1.6

The figure 1, given the proposed structure of front view of slotted and full ground antenna. The antenna simulated in tool CST Suit 2012. The length and width of all parameters are given in table 1.

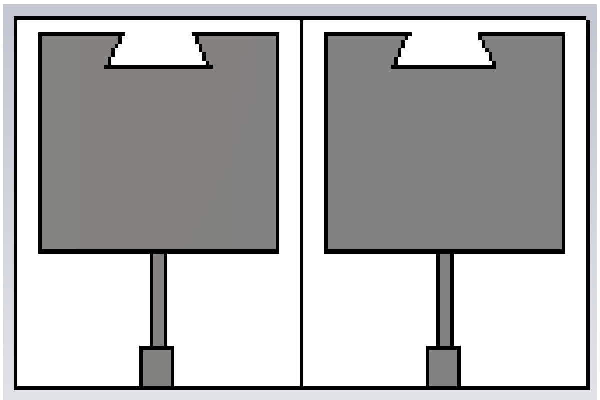


Figure 1 2X1 slotted Patch Antenna

(i) *S-parameter for slotted ground and full ground***:**

The simulation results of above micro strip patch antenna for slotted ground and full ground is given in figure 2 and 3. it is clearly observed that return loss of -21 dB obtained at 5.2 GHz resonant frequency with isolation of less than -20 dB in slotted ground. When full ground is considered the resonant frequency is shift to 4.3 GHz and isolation is less than -10 dB obtained. From the above discussion clearly conclude that better isolation achieved using slotted ground.

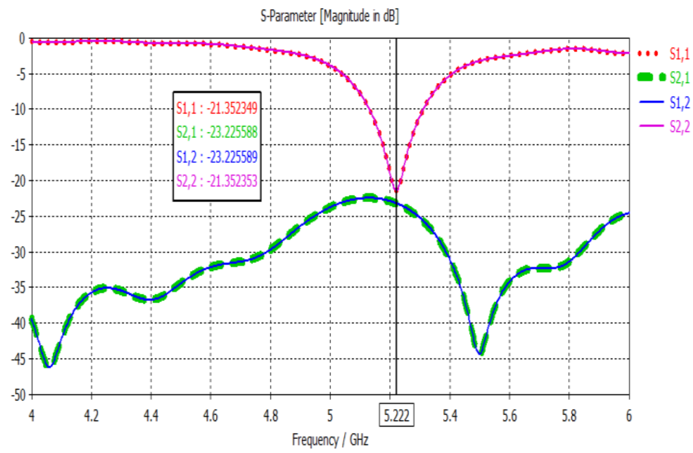


Figure 2 S-parameter of 2X1 MIMO Patch Antenna slotted ground

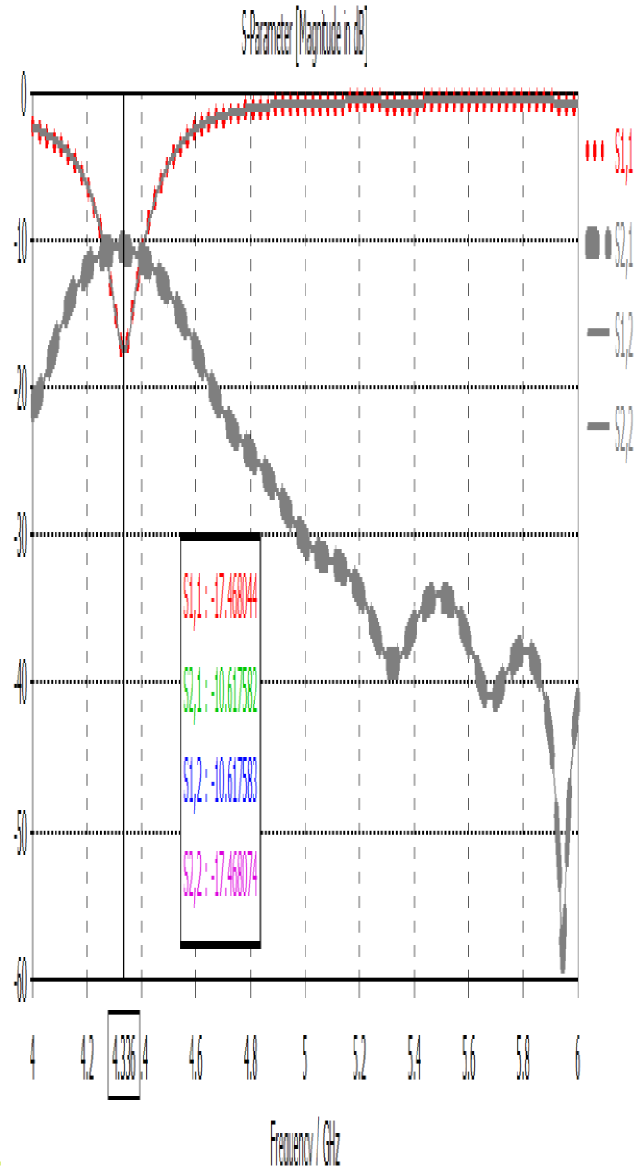
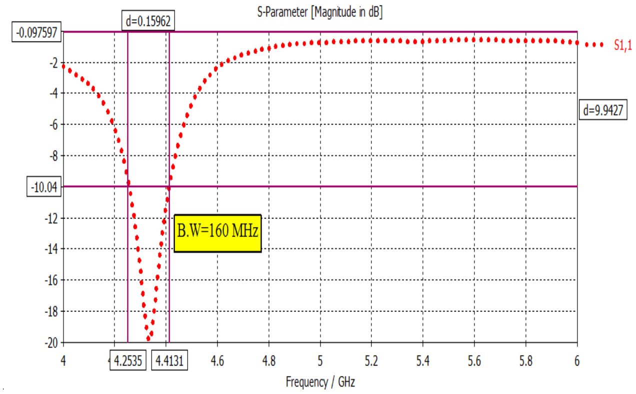


Figure 3 S-parameter of 2X1 MIMO Patch antenna full ground

(ii) Bandwidth Comparison

The bandwidth of antenna is the range of frequency antenna produced desired result. In figure 5.6 and 5.7 represented the bandwidth is 197 MHz in slotted ground and 160 MHz bandwidth in full ground case. Thus better bandwidth is achieved in antenna with slotted ground.



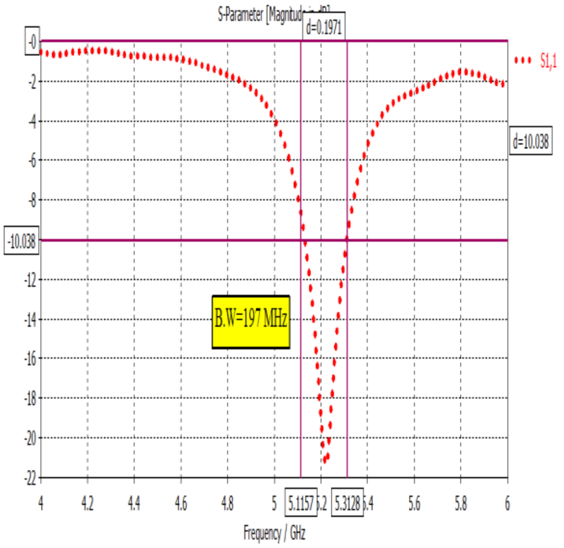


Figure 4 Bandwidth of 2X1 MIMO Patch antenna slotted ground and Figure 5 Bandwidth of 2X1 MIMO Patch antenna full ground

(III) CONCLUSION

The two element slotted patch antenna designed and simulated for full ground and slotted ground. The presented result shows that at full ground the resonant frequency is 4.3 GHz and isolation and return loss is poor as compare to slotted ground which has return loss and isolation is more that -20 dB. At the same time the value of obtained gain is good of full ground antenna as compare to slotted ground. The surface current also compared for both cases. The ECC is also found good in slotted ground antenna as compare to full ground.

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