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Parametric Analysis on a CPW Fed Novel shaped MSA

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Abstract – A CPW fed novel shaped compact antenna is proposed in this abstract. A parametric study is performed on impedance matching by varying the gap between the feed line and ground as well as by varying the height of the patch from the ground. The size of the Antenna is 50mm x 50mm x 1.6mm and it is prototyped on FR-4 substrate material which has a dielectric constant of 4.4.First, CPW-fed conventional slot antenna is designed and then the rectangular shape patch is modified to achieve higher bandwidth. The resonance frequencies are 2.4 GHz for Wi-Fi and 5.8 GHz for WiMAX applications. The proposed antenna provides bandwidth 58 % for 2.4 GHz frequency and 18% for 5.8 GHz frequency which can be used for wireless applications. A parametric analysis is carried out by varying the two gaps:

1. Horizontal gap 'g_1' between the feed line and ground,
2. Vertical gaps 'g_2' between the conducting patch and ground.

The dimensional variation effects on the proposed antenna will be studied in this paper.

Keywords- *CPW Fed, Ansoft Smith Chart, WiMAX*

1. INTRODUCTION

In this paper, a CPW fed MSAon prototyped FR4 epoxy substrate is proposed. Beside the microstrip line, the CPW is the most frequent use as planar transmission line in radio frequency and microwave integrated circuits. The CPW antenna consists of three conductors with the exterior ones used as ground plane.

There are two different feeding techniques to excite this antenna. Microstrip line feed or CPW feed, Microstrip line feed provide wide band operation but CPW has more advantages like ease of integration with monolithic integrated circuits, low dispersion loss, less radiation leakage and low profile.CPW-fed slot antenna is providing good and easy impedance matching to the CPW line. The antenna geometry is presented in section II. A brief discussion on the simulation results and parametric study is presented in section III. Conclusion is presented in section 4

2. GEOMETRY OF PROPOSED ANTENNA

A CPW fed novel shaped compact dual band antenna configuration is shown in figure 1. The proposed antenna has been designed on an inexpensive FR4 substrate of thickness h = 1.6mm and relative permittivity ε_r = 4.4. The size of the antenna is 50 mm x 50 mm x 1.6mm The antenna consists of a novel shape patch, which has dimension of 12 mm × 25 mm.In ground plane wide rectangular slot is cut for good results and easy impedance matching to the CPW line. It is fed by 50Ω CPW-fed line with width of 4mm and distance gap of 0.5 mm. A parametric analysis is carried out by varying the two parameters one is horizontal gap 'g_1' between the feed line and ground, and second one is vertical gaps 'g_2' between the conducting patch and ground. The proposed antenna resonates at two frequencies for the given dimensions. The resonant frequency variations, bandwidth and impedance matching of the antenna depends on the gap between the CPW feed line and ground are presented in this paper.

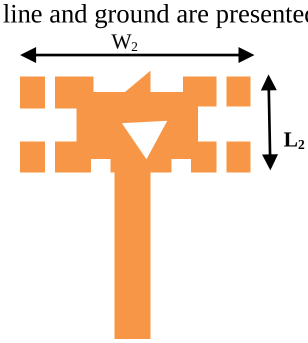

Figure-1 (a) Geometry of proposed patch

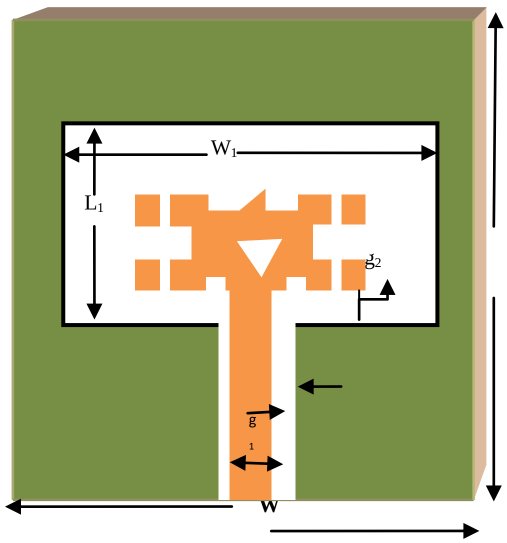

Figure-1 (b) Geometry of proposed antenna

The detail dimensions of proposed antenna are followings:
W=50mm: Width of Substrate
L = 50mm: Length of Substrate
W_1 = 39.84mm: Rectangular slot width
L_1 = 20.5mm: Rectangular slot length
W_2 = 25mm: Patch width
L_2 = 10mm: Patch length
Ws = 4mm: Width of feed line
g_1=Horizontal gap between ground plane and feed line
g_2= Vertical gap between ground plane and patch

3. RESULTS AND DISCUSSION

A. Return Loss

The two resonant frequencies of proposed antenna are 2.4GHz and 5.8GHz. The proposed antenna provides 10dB impedance bandwidth 58% of centre frequency 2.4 GHz and 17% of centre frequency 5.8 GHz, which can be used for Wi-Fi and WI-MAX applications respectively. The antenna resonated at two frequencies which can be used for dual band applications. The return loss values at the resonant frequencies are -14dB and -28.5dB respectively and return loss plot is shown in figure 2.

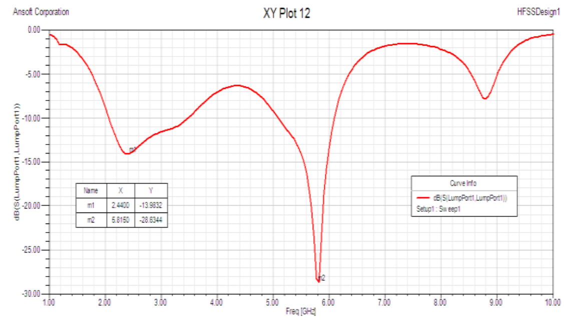

Figure-2 Return Loss plot

The gap 'g_1'between the CPW Feed line and ground is varied and we get the variation in impedance matching which effects the bandwidth and resonant frequencies is observed in figure 3. When width of feed line increase, results impedance bandwidth decrease.

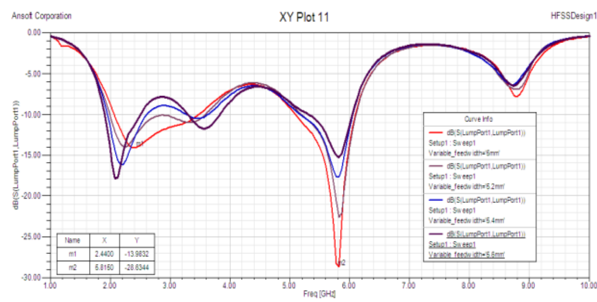

Figure-3 Return Loss versus Frequency for g_1=0.5mm, 0.4mm, 0.3mm and 0.2mm

Table-1 shows simulated results for different gaps g_1=1.5mm, 1.4mm, 1.3mm and 1.2mm and corresponding feed line width. There is perfect impedance matching for g_1 = 1.5mm because this value gives highest bandwidth as table-1 shows. Wide operating band is obtained for this value. There is good impedance matching for g_1=1.4mm, 1.3mm and 1.2mm.The impedance bandwidth is decrease when feed line width increases.

Feed width	Gap 'g_1'	Resonance Frequency Fr_1	Fr_2	S_{11} dB		Impedance Bandwidth (%)	
4mm	1.5mm	2.4	5.8	14	28.5	58	17
4.2mm	1.4mm	2.2	5.8	13.8	22.3	35	16
4.4mm	1.3mm	2.1	5.78	16.3	17.5	31	16
4.6mm	1.2mm	2.0	5.78	17.7	15.3	29	12

Table-1 Parametric Results for different value of 'g1'

Another parametric study is done by varying the gap between patch and ground as a function of 'g_2'.

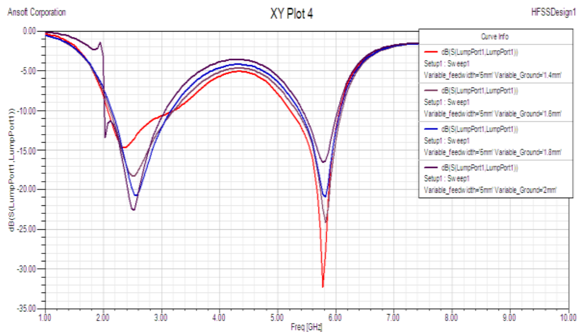

Figure-4 Return Loss versus Frequency for g_2=1.16mm, 0.76mm,0.56mm,0.36mm and 0.16mm

Gap 'g_2'	Resonance Frequency Fr_1	Fr_2	S_{11} dB		Impedance Bandwidth (%)	
1.16mm	2.4	5.8	14	28.5	60	17
0.76mm	2.3	5.76	14.4	32.3	45	15
0.66mm	2.4	5.8	15.6	39.2	46	14
0.36mm	2.5	5.8	20.6	20.83	39	12.
0.16mm	2.5	5.7	22	16	40	11

Table-2 Parametric Results for different value of 'g2'

Table-2 shows simulated results for different gaps g_1=1.16mm, 0.76mm, 0.66mm,0.36 and 0.16 mm and corresponding feed line width. Results in table -2 shows that bandwidth is highest on'g_2'=1.16mm So, there is a perfect impedance matching at gap 'g_2'=1.16mm and for'g_2'=0.76mm,0.66mm,0.36mm and 0.16mm the bandwidth is reduced and less impedance matching is observed.

B. VSWR

An antenna is considered to be perfectly matched when the VSWR value is between 1and 2 .Figure 5 shows the VSWR plot versus frequency for proposed antenna. It is observed that VSWR is between 1 and 2 in the frequency range from 2 GHz to 3.5 GHz and 5 GHz to 6 GHz. The VSWR values at the two resonant frequencies are 1.45 and 1.06 which is less than 2. So design antenna is perfectly matched.

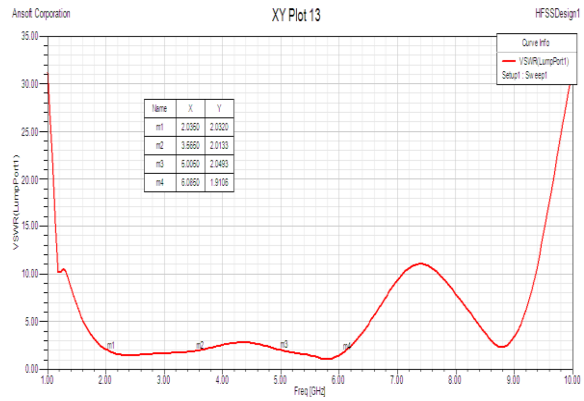

Figure -5 VSWR versus Frequency Plot

C. Input Impedance

The impedance bandwidth for the proposed antenna is 58.% in the operating range 2 GHz to 3.5 GHz and 17% in the operating range 5 GHz to 6 GHz.
The 10dB impedance bandwidth can calculate by equation 1.

$$IBW = \frac{fh-fl}{\text{fr}} * 100\%..............1.$$

IBW: Impedance Bandwidth
fh : High frequency point at 10dB
fl: Low frequency point at 10dB
Fr: Resonance frequency

The input impedance smith chart is shown in figure 6.The input impedance at 2.4 GHz is Z_{in} = 0.807-0.311i and at 5.8 GHz is Z_{in} = 0.966 -0.064i

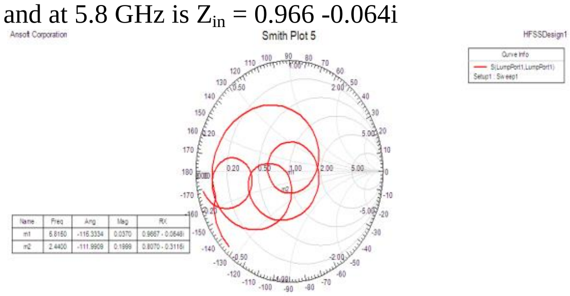

Figure-6 Input Impedance plot

D. GAIN

The gain of an antenna expresses the amount of power transmitted in the direction of peak radiation to that of an isotropic source. It can be as high as 40-50 dBi for very large dish antennas and can be as low as 1.8 dBi for real antennas. Theoretically, it can never be less than 0dBi. The gain of the proposed antenna varies from 3.04 dB to 9.2 dB. The peak gain of the proposed antenna is 9.2 dB at 2.44GHz. The gain at 5.8 GHz is 3.04dB.

Figure-7(a) Polar plot of Gain at 2.44 GHz

E. Radiation Patterns

The total radiation patterns at the two resonant frequencies for Phi=0 degrees and Phi=90 degrees are shown in figure 8.

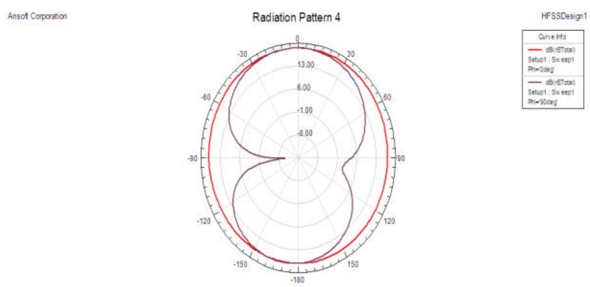

Figure-8(a) Total Radiation plot at 2.4 GHz

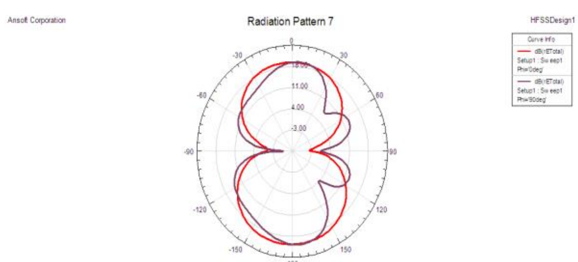

Figure-8(b) Total Radiation plot at 5.8 GHz

4. CONCLUSION

A CPW Fed MSA for wireless application has been proposed and simulated using HFSS software. [6] The size of the antenna is 50mm x 50mm x 1.6mm and it is prototyped on FR4 substrate material which has a dielectric constant of 4.4. The resonance frequencies of design antenna are 2.4 GHz and 5.8 GHz. The 10 dB impedance bandwidth of design antenna is 58% (1.4 GHz) at 2.4 GHz with return loss is -14dB and another band is obtain at 5.8 GHz frequency whose bandwidth is 17% (1 GHz) with return loss -28.5dB. The peak gain of the proposed antenna is 9.2 dB at 2.4GHz.A parametric study is performed on impedance matching by varying the gap between the feed line and ground as well as by varying the height of the patch from the ground.

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