Design of Slotted Two- C Shaped Microstrip Patch Radiating at 3.5 GHz for WiMax Applications.

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Abstract - *WiMax (Worldwide Interoperability for Microwave access) has been established by the IEEE 802.16 working group. WiMax theoretically can have coverage of up to 50 km radius. WiMax technology is replacement for wireless internet access. WiMax has three allocated frequency bands. The low band (2. 5-2.69 GHz), the middle band (3.2-3.8 GHz) and the upper band (5.2- 5.8 GHz). The antenna is very essential element of communication as it is used for a transmitting and receiving electromagnetic waves. Today Communication devices such as mobile phones become very thin and smarter, support several applications and require higher bandwidth where the microstrip antennas are the better choice compare to conventional antennas. In this paper a Two C-Shaped slotted microstrip antenna (Figure 1) is designed and simulated for the WiMax frequency range of 3.2-2.69 GHz.. Extensive simulation results using IE3D simulator will be presented.*

Key Words: Microstrip antenna, slotted antenna, Wi-Max.

1. INTRODUCTION:

Presently there are many other government and commercial applications, such as mobile radio and wireless communications that have similar specifications. To meet these requirements, Microstrip antennas can be used. These antennas are low profile, conformable to planer and non planer surface, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs. When the particular patch shape and mode are selected; they are very versatile in terms of resonant frequency, polarization, pattern and impedance.

2 DESIGN SPECIFICATIONS:

The three essential parameters for the design of a Double C Slot Microstrip Patch Antenna are.

2.1 Frequency of Operation:

The resonant frequency of the antenna must be selected appropriately. The Wi max middle band uses the frequency range from 3.2 GHz - 3.8 GHz. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for design is 3.5 GHz.

2.2 Dielectric Constant of Substrate:

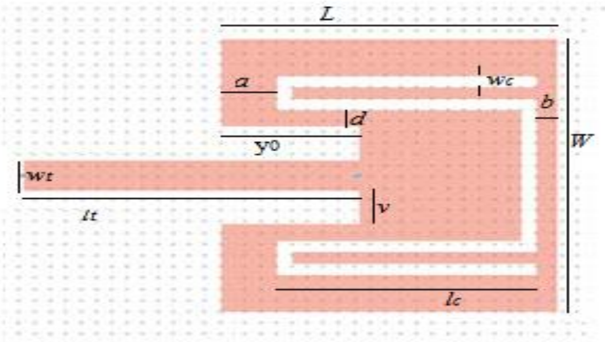
The dielectric material selected for our design is FR4 with glass epoxy substrate which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

2.3 Height of Dielectric Substrate:

For the microstrip patch antenna to be used in cellular phones, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.6 mm. Hence, the essential parameters for the design, fo = 3.5 GHz, dielectric constant = 4.4 and h = 1.6 mm.

3. ANTENNA CONFIGURATION:

The proposed antenna consists of a Two C shaped slot placed within the patch. The dielectric material selected for the design is an FR4 with glass epoxy substrate of height h= 1.6 mm and Dielectric constant = 4.4.



[Fig.1- Two-C Shaped Slotted MSA]

A 50 inset microstripline feed is attached to the microstrip and has a width wt and length lt. The inset length y0 is chosen such that impedance matching is achieved. Length Lt =29.26 mm and width wt = 2.75 mm. The length of the inset feed is y0 = 7.84 mm. The overall initial dimensions of the double C slot patch are - the length L and width W of the patch are 20.43 mm and 20.43 mm. The length lc and width wc are 16.63 mm and 1 mm respectively. d = 1 mm, v = 1 mm, a = 2.88 mm and b = 0.93 mm.

We will conduct a parametric study on the structure of Figure 1 by adjusting the parameter '*v*', the parameter 'd' and the parameter ‘ a’ one at a time and observe the effect on the return loss and matching. Our goal is to achieve a further increase in the resonant frequency so that the antenna radiates in the upper range of the desired WiMax frequency band. At the same time, we try to increase the matching between the inset feed and the patch antenna.

3.1 Change in v:

As we increase the parameter *v*, the resonant frequency is not affected much but the matching is increases.

[Table.1- Variations in parameter V]

Trial	Parameter Variable '*v* (mm)	Resonant Frequency GHz)	Return Loss (S11 in dB)
1	1	3.50	-28.07
2	1.21	3.49	-29.33
3	2.21	3.49	-30.50

3.2 Change in d :

As we increase the parameter d, the resonant frequency is decreases and return loss also decreases.

[Table.2- Variations in parameter d]

Trial	Parameter Variable *d* (mm)	Resonant Frequency GHz)	Return Loss (S11 in dB)
4	1	3.50	-31.8
5	1.4	3.49	-31.4
6	1.7	3.49	-30.9

3.3 Change in a :

As we increase the parameter d, the resonant frequency is increases and return loss decreases.

[Table.3- Variations in parameter a]

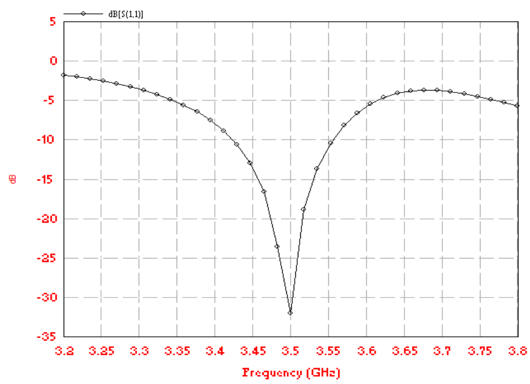
Trial	Parameter Variable a (mm)	Resonant Frequency GHz)	Return Loss (S11 in dB)
7	1.88	3.50	-32.30
8	2.88	3.54	-32.30
9	3.88	3.54	-25.10

4. SIMULATION RESULTS OF MSA:

The software package IE3D is used to model the Two C shaped slotted MSA for Wi-Max frequencies between 3.2 GHz- 3.8 GHz. After simulation on IE3D we get following result.

4.1 Return Loss, S11:

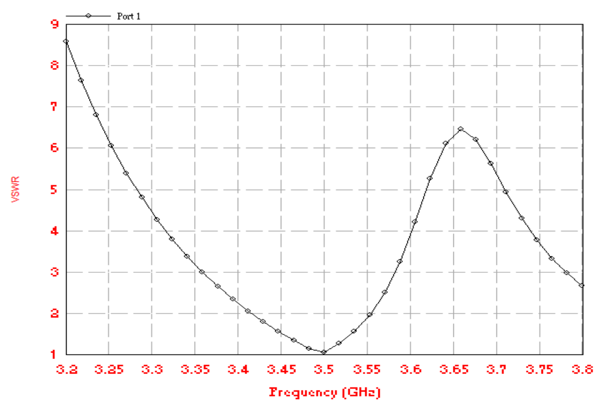
These are the scattering parameters. Return loss or reflection loss is the reflection of signal power from the insertion of a device in a transmission line or optical fiber. It is expressed as ratio in dB relative to the transmitted signal power. We get the resonant frequency of double C slot MSA at 3.5 GHz and return loss -32.30 dB.



[Fig.2- Return loss plot]

4.2 VSWR:

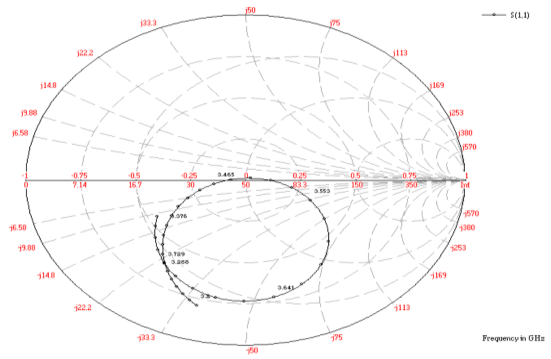
This is the voltage standing wave ratio. A standing wave in a transmission line is a wave in which the distribution of current, voltage or field strength is formed by the superimposition of two waves of same frequency propagating in opposite direction. Then the voltage along the line produces a series of nodes and antinodes at fixed positions. Ideally it should be 1.The value of VSWR should be between 1 and 2 for efficient performance of an antenna. At 3.5 GHz we get VSWR value 1.07 .



[Fig.3- VSWR Plot]

4.3 Smith Chart:

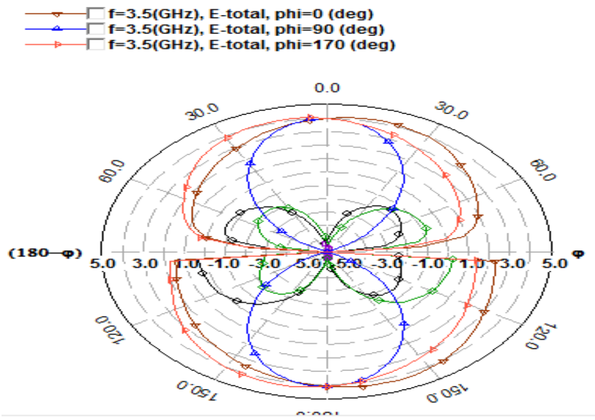
Smith chart is the graphical representation of impedances and admittances Fig. shows smith chart showing perfect impedance matching between microstrip line feed and patch.



[Fig.4- Smith Chart Plot]

4.4 Radiation Pattern:

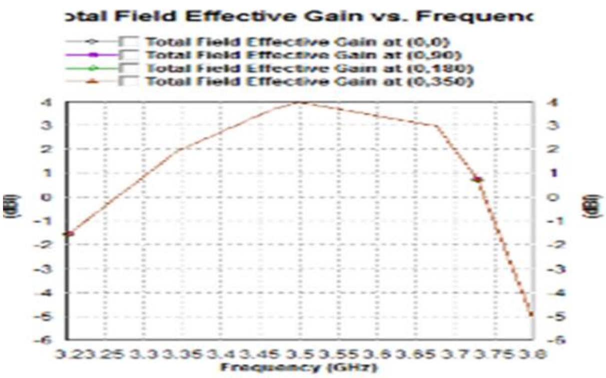
The radiation pattern is defined as graphical representation of radiation properties of the antenna as a function of space coordinates. Fig. shows radiation pattern of MSA .



[Fig.5- Radiation Pattern Plot]

4.5 Gain:

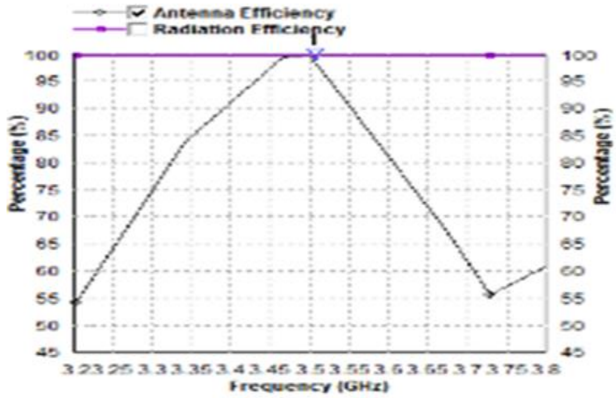
The gain of an antenna is defined as the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically. Gain is nothing but the power radiated by antenna in a particular direction . W get 4 dB gain at 3.5 GHZ.



[Fig.6- Gain Plot]

4.6 Antenna Efficiency:

Antena efficiency of proposed MSA is 98.72 percent .



[Fig.7- Efficiency Plot MSA]

5. CONCLUSION

A slotted Two C-shaped microstrip patch antenna designed and simulated to radiate in the middle band of WiMax frequency range of 3.2-3.8 GHz. The return loss is -32.30 dB and has a VSWR = 1.07 at a resonant frequency of 3.5GHz

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