# IE3D DESIGN OFDOUBLE– C SHAPED SLOTTED PATCH ANTENNA FOR WI-MAX APPLICATIONS

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**ABSTRACT**

*WiMax (Worldwide Interoperability for Microwave access) has been established by the IEEE 802.16 working group. WiMax antennas have high interest in recent years. Researchers are focusing on how to design antennas for WiMax technology. 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). WiMax theoretically can have coverage of up to 50 km radius. Due to its advantages such as low-cost, small size low weight and capability to integrate with Microwave integrated circuits, the microstrip patch antenna is a very good candidate for integrations in applications such as wireless communication systems, mobile phones and laptops. In this paper Two C-slot microstrip antenna is designed and simulated for the WiMax frequency range of 3.2-3.8 GHz. The antenna is fed by Inset feeding technique. The antenna is designed using FR4 as dielectric substrate.The characterization result of return loss, Voltage Standing Wave Ratio are presented consecutively. From the result, it shows that the proposed antenna has the return loss of 36.43dB that corresponds to VSWR of 1.03 at center frequency of 3.5 GHz.The antenna Extensively simulated on IE3D simulation software.*

**Keywords:** Microstrip patch antenna, Inset Feeding, IE3D Simulation software, Bandwidth, Return loss.

## 1. INTRODUCTION:

In high-performance aircraft, spacecraft satellite a missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profiles are constraints, low profile antennas may be required. 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. In addition by adding the load between patch and ground plane such as pins, adaptive elements with variable resonant frequency, impedance, polarization and pattern can be designed.

## 2. DESIGN SPECIFICATION

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

a) ***Frequency of operation (fo):*** The resonant frequency of the antenna must be selected appropriately. The Wimax uses the frequency range from 3.2-3.8 GHz. Hence the antenna designed must be able to operate in this frequency range. The resonant frequency selected for my design is 3.5 GHz.

b) ***Dielectric constant of the substrate (εr):*** 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 [1].

c) ***Height of dielectric substrate (h):*** 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 are:*fo*= 3.5 GHz,$\varepsilon_r$= 4.4,*h* = 1.6 mm

## 3. CONVENTIONAL RMSA DESIGN STEPS:-

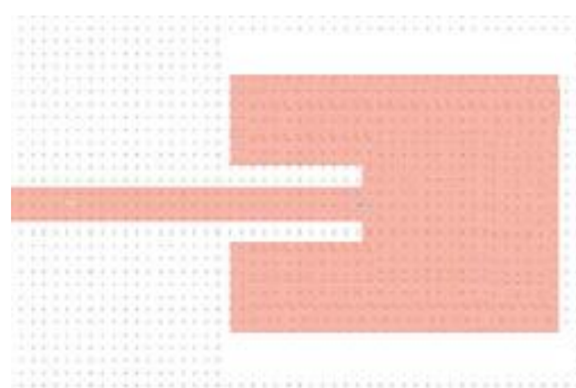

**FIG.1- CONVENTIONAL RMSA.**

***Step 1:*** Calculation of the Width (*W*):The Width of the Microstrip patch antenna is given by equation.

W=(V0/2Fr)√2/(Єr+1) Where λ0= C/F

Substituting $\varepsilon_r$ = 4:4 and fo = 3:5GHz; we get ,

W = 25.80mm

***Step 2:*** Calculation of the Length (L): The Width of the Microstrip patch antenna is given by equation.

L= (λ0/2) – 2 ΔL, and

ΔL/h = 0.41{[(€eff+0.3)(W/h+0.26)]/[€eff-0.25)(W/h+0.8)]}

Putting €eff=4.4, W=25.8mm, h=1.6mm,

L=41.24 mm.

***Step3:*** Determination of Length and width of microstripline feed.

*Lt* =Total length of microstripline feed.

Wt=Width of microstripline feed.

Total length of feed (*Lt*)=length of feed (λ0/4) + Inset length (Y0).

Lt=21.42mm+7.84mm=29.26mm,

Z50 = 377 / √€r ( Wt/h + 2)

Where Z50=impedance of microstripline feed =50,

h= height of substrate=1.6mm,

Wt=2.75mm *(2)*

***Step 4****:* Calculation of the ground plane dimensions

**(***Lg*and*Wg***):**

Lg = 2(6h + L) = 110.12 mm.

Wg = 2(6h + w) = 54.60 mm.

***Step 5:*** Determination of feed point location ( $X_{ff}$,*Y*):

## 4. SIMULATED RESULTS CONVENTIONAL RMSA

**A. S-parameters:** These are the scattering parameters. We get the resonant frequency of double C slot MSA is 3.5 GHz and return loss -16.30 dB as shown in fig.2.

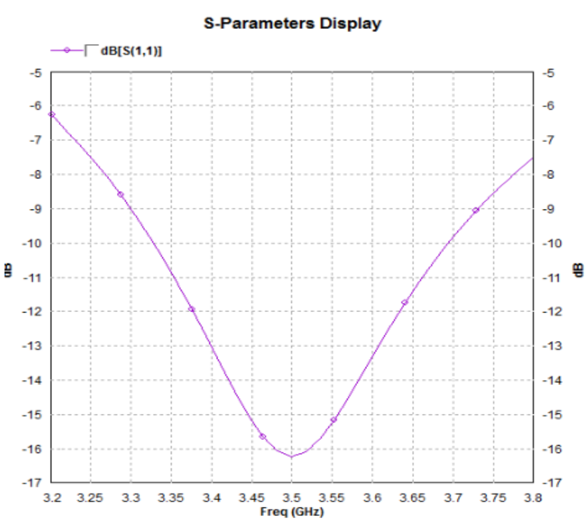


**FIG.2 S PARAMETERS**

*VSWR:* Ideally it should be 1. VSWR bandwidth is taken at 3.From Fig. 3, we get VSWR= 1.33 at 3.5 GHz.

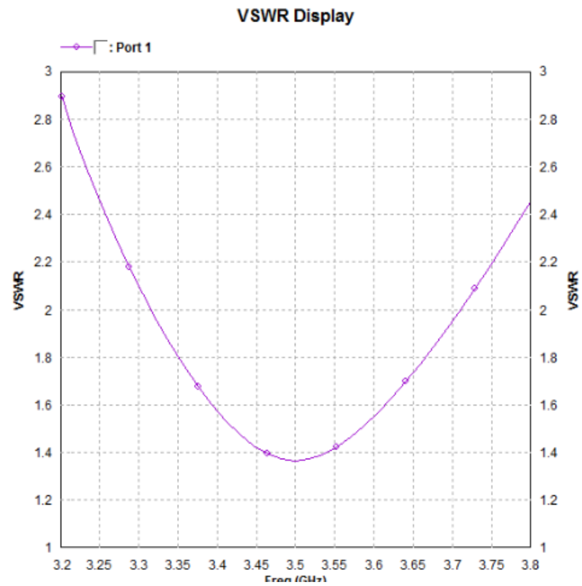


**FIG.3 VSWR**

## 5. DOUBLE C SLOT MICROSTRIP PATCH DESIGN STEPS:-

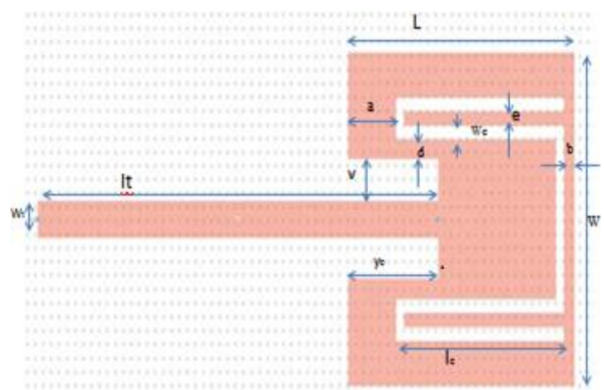


**FIG 4. DOUBLE C SLOT ANTENNA.**

***Step 1:*** Calculation of the Width (*W*):The Width of the Micro strip patch antenna is given by equation.

W=λ0/2√€r Where λ0= C/F

Substituting $\varepsilon_r$ = 4:4 and fo = 3:5GHz; we get W = 20:43mm

***Step 2:*** Calculation of the Length (L): The Width of the Micro strip patch antenna is given by For square micro strip patch antenna W=L

**L=20.43mm.**

***Step3:*** Determination of Length and width of microstripline feed.

*Lt* =Total length of microstripline feed.

Wt=Width of microstripline feed.

Total length of feed (*Lt*)=length of feed (λ0/4) + Inset length (Y0).

Lt=21.42mm+7.84mm=29.26mm,

Z50 = 377 / √€r ( Wt/h + 2)

Where Z50=impedance of microstripline feed =50 ,

h= height of substrate=1.6mm

Wt=2.75mm *(2)*

***Step 4****:* Calculation of the ground plane dimensions

**(***Lg*and*Wg***):**

Lg = 2(6h + L) = 2((6*1.6)+ 20.43) = 60.06mm (3)

Wg = 2(6h + L) = 2((6*1.6) + 20.43) = 60.06mm (4)

***Step 5:*** Determination of feed point location ( $X_{ff}$,*Y*):

A microstripline feed is to be used in this design. The center of the patch is taken as the origin and the feed point location is given by the co-ordinates (Xff, *Y* ) from the origin.

***Step 6:*** Determination of Inset length(Y0 ) = 11.27 mm.

***Step 7:*** Determination of width (wc) & length(lc) of slot.

**Step 8:** Determination of parameter a &b (Parametric study of different parameter)

## 6. ANTENNA CONFIGURATION

The proposed antenna is shown in Figure 1.It consists of a Double C-slot placed within the patch. In this paper several parameters have been investigated and a parametric study on the structure is made in order to obtain the best possible size and position of the slots. The dielectric material selected for the design is FR4 with glass epoxy substrate of height h= 1.6 mm and *Єr*= 4.4. A 50 Ω inset microstripline feed is attached to the microstrip and has a width *w*t and length *l*t. 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 length L and width W are chosen such that impedance matching is achieved of the patch so selected length and width are19.97 mm and 18.49mm respectively.

The overall dimensions of the Double C-slot patch are

- The length L and width W are chosen such that impedance matching is achieved L=19.97mm and W= 18.49 mm
- The length *lc*and width *wc*are 17.31 mm and 1 mm respectively.
- *d* = 1 mm, *v* = 1.23 mm, *a* = 1.98 mm and *b* = 1.14 mm.

We will conduct a parametric study on the above structure by changing the parameters a ,d ,b, W, L and *v* one at a time and observe the effect on the RL and matching.

## 7 .FINAL ANTENNA DESIGN

We have experimented with various parameters of the antenna and the C-slot in order to achieve the resonant frequency within the WiMaxfrequency band of 3.2GHz to 3.8GHz and to achieve appropriate matching between the insets feed line and the patch antenna, simultaneously.

Now, we select trial 8 so,the antenna has the following initial parameters: *L* = 19.97 mm, *W* = 19.42 mm, *lc*= 17.31 mm, *wc*= 1 mm, *a* = 1.98 mm, *b* = 1.14 mm, *d* = 1 mm, *v* = 1.23 mm, *wt* = 2.75 mm, *y0* = 7.848 mm The distance between the double slots is always 1 mm.

## 8. SIMULATED RESULTS FOR DOUBLE C SLOT MSA

**A. S-parameters:** These are the scattering parameters. We get the resonant frequency of double C slot MSA is 3.5 GHz and return loss -37.07 dB as shown in fig.5.

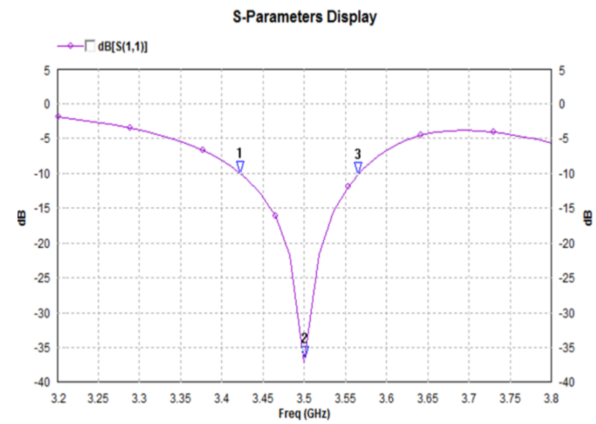


**FIG.5 S PARAMETERS**

*B.VSWR:* Ideally it should be 1. VSWR bandwidth is taken at 2.From Fig. 6, we get VSWR= 1.07 at 3.5 GHz.

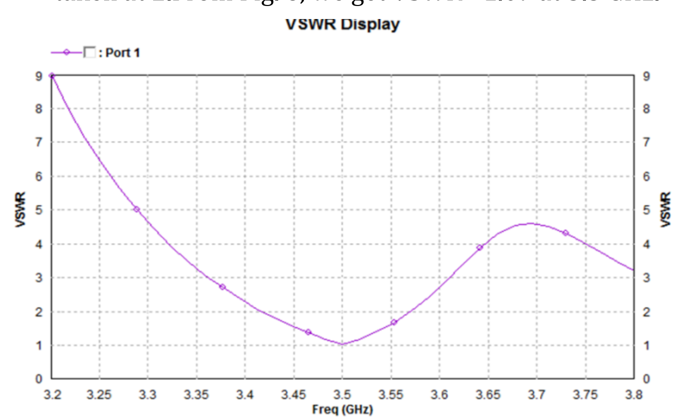


**FIG.6 VSWR**

## 9. MEASURED RESULTS FOR DOUBLE C SLOT MSA

**A. S-parameters:** These are the scattering parameters. We get the resonant frequency of double C slot MSA is 3.5 GHz and return loss -36.43 dB as shown in fig.5.

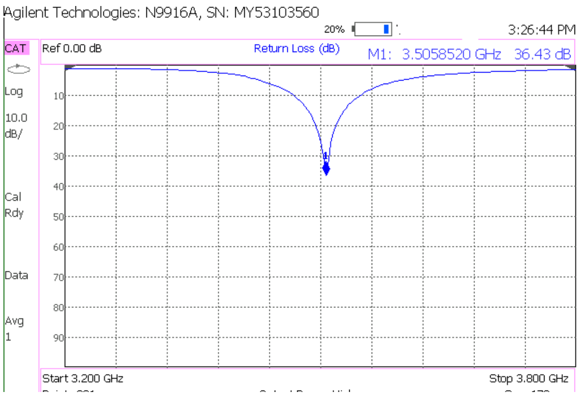


**FIG 7 S PARAMETERS**

*B.VSWR:* Ideally it should be 1. VSWR bandwidth is taken at 2.From Fig. 7, we get VSWR= 1.03 at 3.5 GHz.

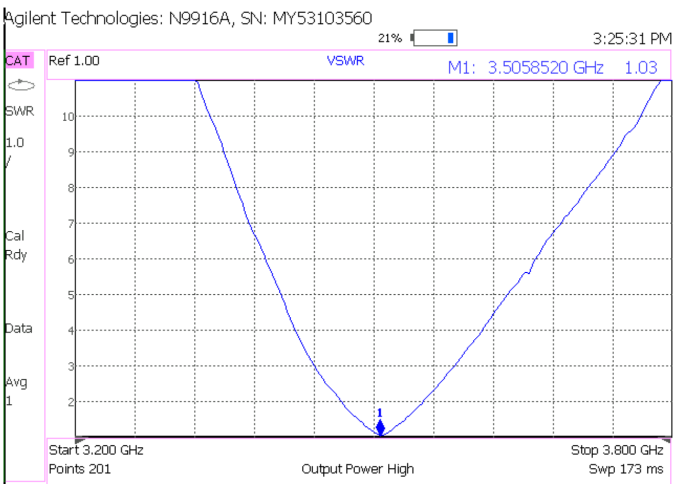


**FIG.8 VSWR**

## X. CONCLUSION

A double C-slot antenna has been proposed to radiate in the upper limit of WiMax frequency range of 3.2-3.8 GHz. The return loss is - 36.43 dB,Return loss bandwith is 120 MHz and has a VSWR = 1.03 at a resonant frequency of 3.5 GHz,

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