# Designing of Circular Micro-Strip Patch Antenna by WI-MAX

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***ABSTRACT: Micro strip antennas have become very popular in the fields of cell and cell communications, following RFID programs with the appearance of various simulation devices. Novice MSA prototypes are being practiced in considered one-of-a-kind patch configurations, thought at known microwave frequencies of interest regarding exceptional substrate or high-quality strate mixtures. The overall efficiency patterns of the 3.5 GHz round patch micro strip reported antenna suitable for Wi MAX packages are investigated in this research.***
***Antenna, Microstrip, Mobile, and so forth.***

## 1. INTRODUCTION

In propagation, the antenna acts as a transducer by converting electric power currents to em-waves, and when a sign is acquired, the antenna works as a transducer by converting em-waves to electric currents. Antennas are very important in the function of contact. Antenna types include the parabolic reflector, patch antenna, slot antenna, folded dipole antenna, and others. Each antenna type is suitable for its intended purpose and location.

There are several various kinds of antennas in use these days, including the spherical micro strip patch antenna. CMP A is made up of a circular shape that radiates information on one portion of the substrate with an amazing aspect of the floor plane. CMPA has been fed with a rich resource of methods such as feeding elements and feeding coaxial probe. CMPA has been developed to utilize Rogers RT/duroid5880 (r= 2.2, h= 1.588 mm), Rogers RT/duroid5880 (r= 2.2, h= 2.87 mm), and FR4 epoxy substrates (r= 4.4, h= 2.87 mm) independently for each feeding method. The round patch antenna cavity model is evaluated in text books[1-4], and Anders G. Derneryd[2] backs it up. At 10 GHz, Manoj singh et al[6] used a substratum material with a relative permittivity (r) of 3.02 and a thickness (h) of 0.762 mm in a micro strip line feed (place feed) spherical patch antenna design. The constructed antenna has a crossover absence of -24 dB (measured) at 10 GHz. The antenna recorded a return deficit of -29.29 dB at 10.022 GHz after being designed and simulated using an HFSS method using comparable measurements, as stated in the literature[6]. F.A bound et al[8] presented a hole position model assessment of the circular patch antenna supplied by coaxial probe method, CMPA resonant frequencies found utilizing substrate material with.65 relative permittivity and 1.5875 mm thickness, and remarkable radius values. DebatoshGuha[9] reported theoretical and experimental values of CMPA resonant frequencies (supplied by probe feed) using a substrate material with a relative permittivity of.65 and a thickness of one.5875 mm with remarkable radius values. The CMPA was designed and simulated with the assistance of HFSS, utilizing substrate fabric with a relative permittivity of.65 and a thickness of 1.5875 mm, fed with probe feed, and the antenna simulation results are almost identical to those found in the literature[9]. The round patch antennas fed by coaxial probe were simulated with the help of HFSS, and the simulated results of the above antennas are provided, including skip again failure, VSWR, radiation types, and a benewiwireless comparison between element feeding and spherical patch antenna coaxial probe feeding.

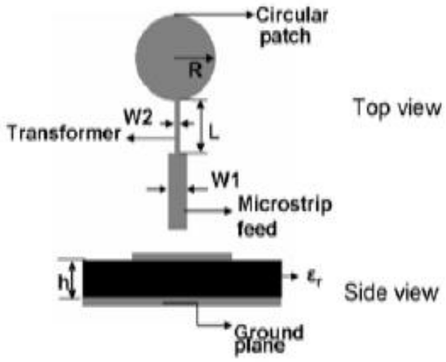



*Figure. 1 Edge feeding of CMPA*

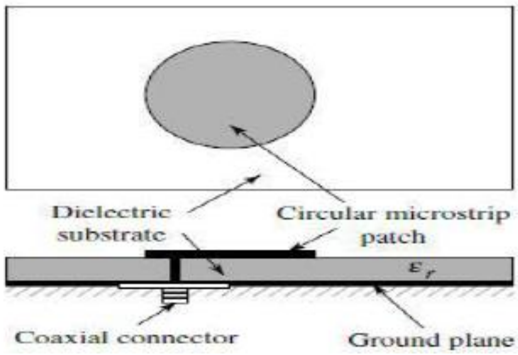



*Figure. 2 Coaxial probe feeding of CMPA*

In the whole space model assessment, the spherical patch antenna designs the parameters of the circular micro strip patch antenna for the dominating TM11 mode. The parameters are [1, 7-11]. Radius of the Patch (a) In the CMPA setup, the patch radius is the simplest parameter to monitor the resonant frequency. The radius of a patch (a) may be determined using the formula

$$a = \frac{F}{\sqrt{1 + \frac{2h}{\pi . \varepsilon_r . F\left[\ln\left(\frac{F\pi}{2h}\right) + 1.7726\right]}}}$$

Where $F = \frac{8.791 \times 10^9}{f_r . \sqrt{\varepsilon_r}}$, h is height of substrate, εr= dielectric constant of substrate.

### 1.1 Effective radius of patch (aeff):

Because of fringing areas, the patch measurements tend electrically to be more than patch body dimensions. It is necessary to determine the powerful radius of the patch (aeff) by way of

$$a_{eff} = a\sqrt{1+q}$$

Where a is radius of patch.

Width of line:The width of micro strip line can be determined by

$$\frac{W1}{h} = \begin{cases} \frac{8e^{A}}{e^{2A}-2} \; for \; \frac{W1}{h} < 2 \\ \frac{2}{\pi}\left[B-1-(2B-1)+\frac{\varepsilon_r-1}{2\varepsilon_r}\left\{\ln(B-1)+0.39-\frac{0.61}{\varepsilon_r}\right\}\right] for \; \frac{W1}{h} > 2 \end{cases}$$

$$A = \frac{Z_0}{60}\sqrt{\frac{\varepsilon_r+1}{2}} + \frac{\varepsilon_r-1}{\varepsilon_r+1}\left(0.23+\frac{0.11}{\varepsilon_r}\right), \quad B = \frac{377\pi}{2Z_0\sqrt{\varepsilon_r}},$$

Z0 is Line Impedance. The distance of fifty ⁇ traces (W1) and transformer line width (W2) can be measured by using the above equation length of the sector wave transformer: until the width of the zone wave transformer is identified, the span of the field wave transformer can be estimated by means of the above equation period.

$$L = \frac{\lambda_d}{4} = \frac{\lambda_0}{4\sqrt{\varepsilon_{r,eff}}}$$

where, $\varepsilon_{r,eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{12h}{W2}\right)^{-0.5}$.

λ0 is free space wavelength, λdis wave length in dielectric substrate.

Conductance due to radiation losses (GR):Conductance due to Radiation losses (GR) can be determined by

$$G_R = \frac{2.39}{4.\mu_0.\mathrm{h}.f_r.Q_R}$$

where, , $Q_R = \frac{4.a.(\alpha_{11}^{2}-1).\varepsilon_r^{\frac{3}{2}}}{\mathrm{h}.\alpha_{11}^{3}.F(\frac{\alpha_{11}}{\sqrt{\varepsilon_r}})}$

εr is dielectric constant, α11= 1.84118, a is radius of circular patch.

Conductance due to dielectric losses (GD):The conductance due to dielectric losses (GD) can be given by

$$G_D = \frac{2.39.\tan\delta}{4.\mu_0.\mathrm{h}.f_r}$$

Conductance due to conduction (Ohmic) losses (GC):The conductance due to conduction losses (GC) is given by

$$G_C = \frac{2.39.\pi.(\pi.\mathrm{f}_r.\mu_0)^{-\frac{3}{2}}}{4.\mathrm{h}^2.\sqrt{\sigma}}$$

Whereσ is conductance of copper material (conductor used in design)Total conductance (GT)The combination of radiation losses, dielectric losses and ohmic losses is total conductance i.e.

$$\mathbf{G_T = G_R + G_D + G_C}$$

Equivalent dielectric constant: An equivalent dielectric constant can be given by

$$\varepsilon_{req} = \frac{1+\varepsilon_r}{2}$$

Input resistance at resonance (R(ρ)):Input resistance at resonance can be given by

$$R(\rho) = \frac{J_n^{\,2}\left(ka\frac{\rho}{a_e}\right)}{G_T\left(\varepsilon_{req}\right).J_n^{\,2}\left(ka\right)}$$

Where, ρ = Feed distance from center of patch, n=1, k= 2π/λd, J1 (ka) = 0.5819, ka = 1.841,

$$G_T\left(\varepsilon_{req}\right) = G_R(\varepsilon_{req}) + G_D + G_C$$

### 1.2 CMPA with edge feeding:

The patch antenna round micro strip fed by micro strip line feed (edge feed) is checked in Fig.2. The area wave transformer should be placed between the micro strip feed and the edge of the circular patch to maintain the impedances between them secure. W1 is the micro strip line diameter, W2, L is the width and length of the transformer of the zone wave, h is the substrate peak, R is patch radius.

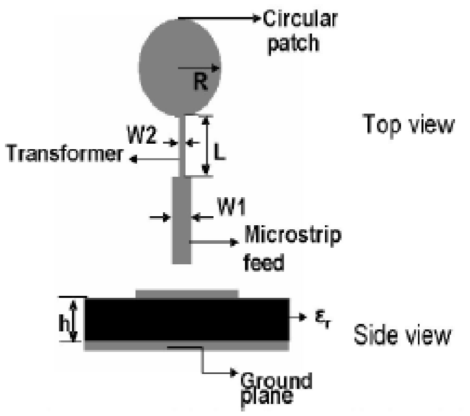



*Figure.3 Circular patch with edge feed.*

RT Duroid5880 (εr=2.2, h=1.588 mm) design calculations for CMPA are given under
Phase 1: Radius (a) willpower:
The patch radius is determined by replacing h= 1.588 mm, εr= 2.2, F=1.693 with the calculated radius rate (a) of 1.597 cm in the equation.
Phase 2: Micro Strip Line Width (W1)
The micro strip line width (W1) is obtained by replacing h=1.588 mm, εr = 2.2, Z0= 50 ⁇ with the measured micro strip line price (W1) = 4.883 mm in the equation.
Phase 3: Conductance would power due to radiation losses (GR) The conductance due to radiation losses (GR) is obtained by removing µ0 = 1.256 ⁇ 10-6, h = 1.588 mm, fr = 3.five GHz, a = 15.ninety seven mm, εr = 2.2, alpha11 = 1.841 The measured conductance fee due to radiation losses (GR) is .479 ⁇ 10-3Siemens in the calculation.
Phase 4: Conductance willpower due to dielectric losses (GD) The conductance due to dielectric losses (GD) is obtained in the equation by replacing µ zero = 1.256 ⁇ 10-6, h = 1.588 mm, fr = 3.5 GHz and tan δ = 0.0009 (2.7). 7.703 ⁇ 10-5Siemens is the measured conductance price attributed to dielectric losses (GD).

Phase 5: conductance due to conduction losses (GC) The conductance due to conduction losses (GC) is obtained with the procedure of replacing μ zero = 1.256 ⁇ 10-6, h = 1.588 mm, fr = 3.5 GHz and σ = 5.8 ⁇ 107Siemens/m in the equation (2.eight). The estimated conductance charge is 6,022-10-5 Siemens due to conduction losses (GC).
Phase 6: Conductance commitment due to common losses (GT) The full conductance due to fashionable losses (GT) is acquired by replacing GC= 6.022 ⁇ 10-5Siemens, GD= 7.703 ⁇ 10-5Siemens and GR= 2.479 ⁇ 10-3Siemens in the equation (2.nine). The behavioural fee related to general losses (GT) is two.616-10-3Siemens.
Phase 7: Self-control of the λ/4 transformer (ZC) impedance: The impedance of the λ/four transformer is obtained by replacing Z0=50 and Zin= Rin (at resonance) = 1/ GT = 382.26 in the equation (2.4). 138.242 is the impedance of the area wave transformer (ZT).
Phase 8: λ/4 transformer width willpower (W2): The width of the λ/four transformer antenna is obtained by substituting h=1.588 mm, εr = 2.2, Z0 = 138.24 ⁇ in the equation (2.three). The measured charge is 0,622 mm for the width of the wave area transformer line (W1).
Phase 9: Time of the transformer λ/4 (L): The length of the transformer λ/4 is obtained by replacing the resource λzero = 85,714 mm, = 1,706 with the equation λzero = 85,714 mm (2.5). The measured fee for the length of the λ/4 transformer (L) is 16.405 mm, r eff All measurements of the CMPA fed through part feed are seen in Fig.4 for substrates utilizing RT/Duroid5880 (εr=2.2, h=1.588 mm).

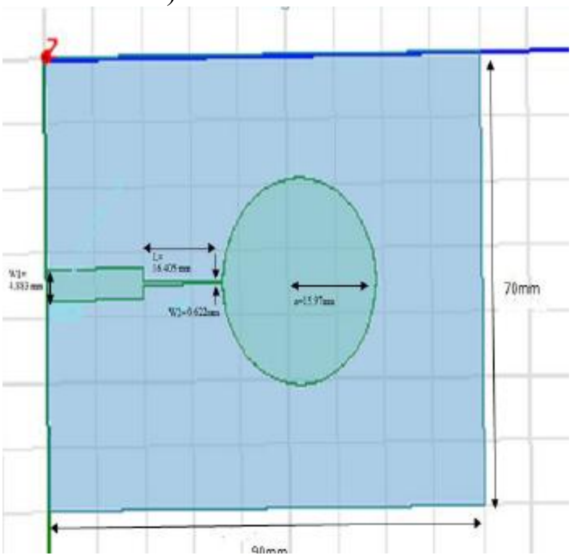



*Figure4 Edge feeding of CMPA with all dimensions*

The patch parameters for substrates RT/Duroid5880 (εr=2.2, h=2.87 mm) and FR4 epoxy (εr=2.2, h=2.87 mm) were similarly designed using equations 1-9 above. However, with the help of utilizing certain measurements, the defined design frequency will not be implemented. The scale that can be taken to acquire a frequency of 3.5 GHz is seen in Desk 1. The patch antenna measurements for three impressive substrates are shown in Table 1..

**Table1Patch parameters for CMPA with edge feeding for three substrates.**

| patch parameter | RT/Duroid5880 ($\varepsilon_r$=2.2, h=1.588 mm) | RT/Duroid5880 ($\varepsilon_r$=2.2, h=2.87 mm) | FR4 epoxy ($\varepsilon_r$=4.4, h=2.87 mm) |
|---|---|---|---|
| patch radius (mm) | 16.2 | 15.7 | 11.1 |
| Quarter wave transformer length (mm) | 16.41 | 16.41 | 12.595 |
| quarter wave transformer width (mm) | 0.609 | 1.104 | 0.456 |
| 50 ohm line width (mm) | 4.883 | 8.825 | 5.49 |

## 1. Numerical results:

The CMPA was designed and simulated on the RT/Duroid5880 (r=2.2, h=1.588 mm) in accordance with Table 2.1's format requirements, and the simulation results are shown in Figs. five through nine.

The power ratio at the reception save you because of the incident wave to the intensity considered via load is shown in returned loss by transfer reduction.

Return on Investment Loss

The location of the reflection coefficient.

The total of the reflected signal proportionate to the incident signal is the coefficient of

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

reflection.

Where, ZL= input impedance of antenna, Z0= characteristic impedance of feed line. The return loss is calculated by using equation.The return loss versus frequency plot is shown in Fig.5 for CMPA fed by edge feed.

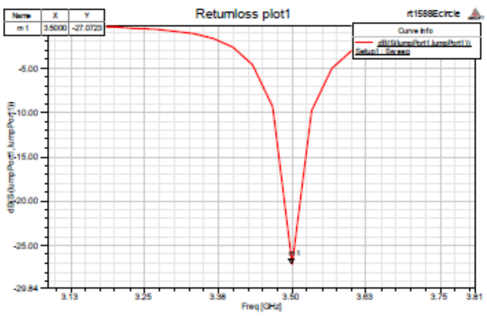



*Figure.5 Return loss versus Frequency plot for CMPA with edge feeding.*

VSWR: It is the measure of mismatch between load and transmission line.

$$\mathrm{VSWR} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

The VSWR is calculated by using equation (2.12). The return loss versus frequency plot is shown in Fig.6 for CMPA with edge feeding.

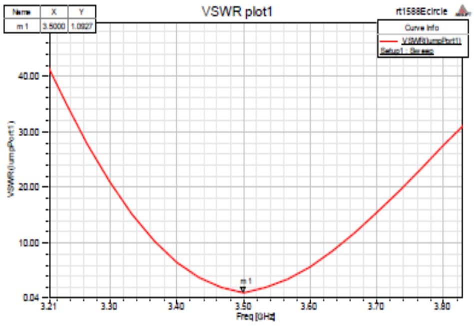
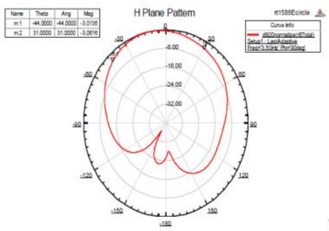



*Figure.6 VSWR versus Frequency of CMPA with edge feeding*

E plain: miles represented by a plane parallel to the E-vector and containing the highest radiation path. In the critical beam, the angular distance between -three dB components may be taken as -three dB beam duration. The CMPA E plane pattern with component feed is proven to be Fig.7. A beam diameter of -3 dB is obtained at 760. With the help of using a plane parallel to the H-vector (orthogonal to E-plane) and containing the direction of most radiation, H is undeniable: it is well defined.




The -3 dB beam width of 75$^0$ is obtained.

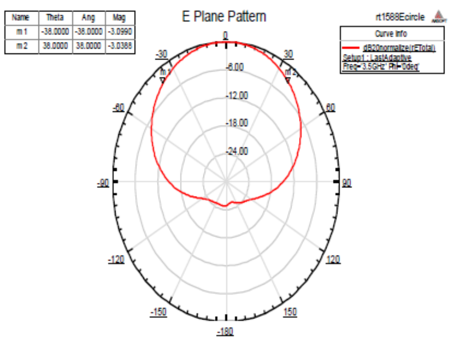



*Figure7 E plane pattern of CMPA with edge feed.*

The gain pattern of CMPA with edge feed is shown in Fig.6The maximum gain of 7.496 dB is obtained

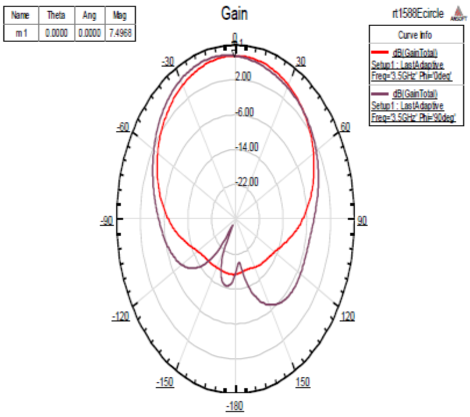



*Figure.8Gain pattern of CMPA with edge feed.*

In similar manner, the simulations have been carried out for Rogers RT/Duroid880 (εr= 2.2, h=2.87 mm) and FR4 epoxy (εr =4.4, h =2.87 mm). The simulation results are summarized for these three substrates in Table 2.2 for 3.5 GHz.

**Table Results of CMPA with edge feeding for three substrates**

| Parameter | RT/Duroid5880 ($\varepsilon_r$=2.2, h=1.588 mm) | RT/Duroid5880 ($\varepsilon_r$=2.2, h=2.87 mm) | FR4 epoxy ($\varepsilon_r$=4.4, h=2.87 mm) |
|---|---|---|---|
| Gain (dB) | 7.496 | 7.173 | 3.623 |
| Return loss (dB) | -27.07 | -26.64 | -20.07 |
| Bandwidth (MHz) | 11.4 | 16.4 | 49.5 |
| VSWR | 1.09 | 1.09 | 1.22 |
| Beam width in E plane | $76^0$ | $78^0$ | $78^0$ |
| Beam width in H plane | $75^0$ | $70^0$ | $66^0$ |

A CMPA with quarter wave transformer feed was finished with a transfer back loss of -18 dB and recorded -24 dB[6] at 10 GHz after simulation. HFSS simulated a CMPA using the same measurements and produced a transfer back loss of -29 dB at 10.02 GHz.

## 2. CONCLUSION

This economic split contains the results of CMPA with regard to position feeding and coaxial feeding methods. Coaxial feeding had a higher rate of return failure than side feeding from desk 2.four. The CMPA's fed through coaxial probe were taken for the following pages.

## 3. FUTURE PERSPECTIVE

For the virtual values, a first-rate arrangement with possible values is provided. The antenna findings may include transportation with simulated consequences of improved settlement.

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