ANALYSIS AND DESIGN OF CIRCULAR MICROSTRIP PATCH ANTENNA WITH WI-MAX APPLICATION

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ABSTRACT
The micro strip antennae have become pretty famous within the fields of cell and cell communications, further to RFID programs with the appearance of diverse simulation equipment, inexperienced designs of MSA's in considered one of a kind patch configurations are being practiced, thinking about exceptional substrate or high-quality strate mixtures at recognized microwave frequencies of interest. In this dissertation, investigations are carried on the overall performance trends of round patch micro strip published antenna at 3.5 GHz that's suitable for Wi MAX packages.

Keywords*:* Antenna, Micro strip, mobile etc.

INTRODUCTION

The antenna acts a transducer via the use of converting electric powered currents to em-waves in transmission, by using converting em-waves to electric currents in case of reception of sign. Antennas play a critical characteristic inside the task of communications. A number of the antenna kinds are parabolic reflector, patch antenna, slot antenna and folded dipole antenna and so on. Each form of antenna is good in its residences and utilization. There are masses of diverse forms of antennas in use these days spherical micro strip patch antenna: CMP A consists of round shape radiating detail on one component of the substrate having the floor aircraft on awesome facet, CMPA has been fed with the useful resource of methods, which might be element feeding and coaxial probe feeding. CMPA has been designed the usage of substrates Rogers RT/duroid5880 (εr= 2.2, h=1.588 mm), Rogers RT/duroid5880 (εr= 2.2, h=2.87 mm) and FR4 epoxy (εr= four.4, h=2.87 mm) separately for each feeding techniques. Cavity model evaluation of round patch antenna is given in text books [1-4], is given through Anders G. Derneryd [2]. Manoj singh et al [6] has mentioned a format of micro strip line feed (place feed) spherical patch antenna the usage of substrate material with relative permittivity (εr) of three.2 and thickness (h) of 0.762 mm at 10 GHz. The designed antenna has cross again lack of -24 dB (measured) at 10 GHz. A CMPA has been designed and simulated with the aid of way of way of HFSS with equal dimensions said in literature [6], the antenna has given a return lack of -29.29 dB at 10.022 GHz. F. A bound et al[8] has given hole place model assessment of round patch antenna fed with the aid of way of coaxial probe, measured resonant frequencies of CMPA the use of substrate material with relative permittivity of .65 and thickness of 1.5875 mm with awesome radius values. Debatosh Guha [9] has given the theoretical and experimental values of resonant frequencies of CMPA (fed via probe feed) the use of substrate material with relative permittivity of .sixty five and thickness of one.5875 mm with awesome radius values. The CMPA using substrate cloth with relative permittivity of .65 and thickness of 1.5875 mm, fed thru the use of probe feed has been designed and simulated with the aid of HFSS, the antenna simulation effects are in close to agreement with literature [9]. The round patch antennas fed by using coaxial probe were simulated with the aid of HFSS, the simulated outcomes of above antennas are given such as skip again loss, VSWR, Radiation styles, benewiwireless assessment has been made among element feeding and coaxial probe feeding of spherical patch antenna.

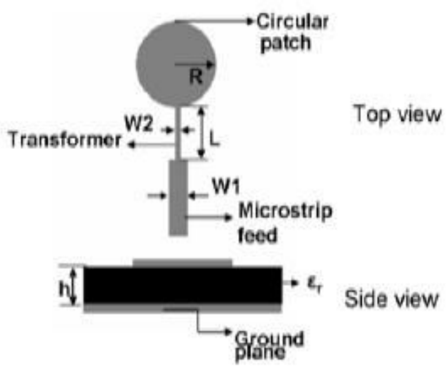


Figure. 1 Edge feeding of CMPA

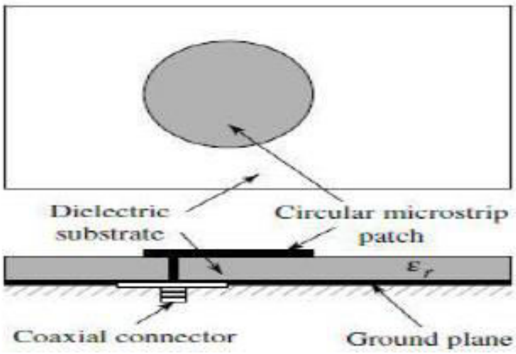


Figure. 2 Coaxial probe feeding of CMPA

The spherical patch antenna designs the parameters of round micro strip patch antenna are taken form whole space model assessment for the dominant TM11mode. The parameters are [1, 7-11]. Radius of patch (a) In CMPA layout radius of patch is simplest parameter to govern the resonant frequency. Radius of patch (a) can be determined through

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

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

Effective radius of patch (aeff):

Due to fringing fields, electrically the patch dimensions appear like more than bodily dimensions of patch. The powerful radius of the patch (aeff) can be decided 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 impedance of line. The width of fifty Ω traces (W1) and width of transformer line (W2) may be calculated by means of the usage of above equation period of sector wave transformer: once width of zone wave transformer is discovered, duration of region wave transformer can be decided via

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

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

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

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

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

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

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

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

Where σ 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

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

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

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

CMPA with edge feeding:

The round micro strip patch antenna fed by micro strip line feed (edge feed) is verified in Fig.2. Region wave transformer may be located in among micro strip feed and edge of round patch to healthy the impedances amongst them. W1 is the width of micro strip line, W2, L are width and duration of zone wave transformer, h the peak of substrate, R is radius of patch.

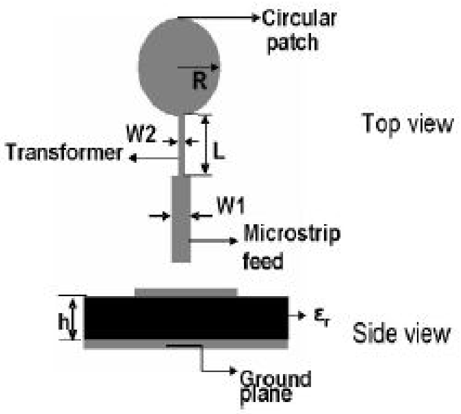


Figure.3 Circular patch with edge feed.

Design calculations for CMPA using RT Duroid5880 (εr=2.2, h=1.588 mm) are given under

Step 1: willpower of Radius (a):

The radius of patch is calculated thru substituting h= 1.588 mm, εr = 2.2, F=1.693 in equation the calculated rate of radius (a) is 1.597 cm.

Step 2: width of micro strip line (W1)

The width of micro strip line (W1) is received thru substituting h=1.588 mm, εr = 2.2, Z0= 50 Ω in equation the calculated price of micro strip line (W1) = 4.883 mm.

Step 3: power of will of conductance due to radiation losses (GR) The conductance due to radiation losses (GR) is acquired through the use of substituting μ0 = 1.256×10-6, h = 1.588 mm, fr = 3.five GHz, a = 15.ninety seven mm, εr= 2.2, α11= 1.841 in equation the calculated fee of conductance because of radiation losses (GR) is .479×10-3Siemens.

Step 4: willpower of conductance due to Dielectric losses (GD) The conductance because of dielectric losses (GD) is received via substituting μ zero = 1.256×10-6, h = 1.588 mm, fr = 3.5 GHz and tan δ = 0.0009 in equation (2.7). The calculated price of conductance due to dielectric losses (GD) is 7.703×10-5Siemens.

Step 5: conductance because of conduction losses (GC) The conductance because of conduction losses (GC) is received with the resource of manner of substituting μ zero = 1.256×10-6, h = 1.588 mm, fr = 3.5 GHz and σ = five.8×107Siemens/m in equation (2.eight). The calculated fee of conductance due to conduction losses (GC) is 6.022×10-5Siemens.

Step 6: dedication of conductance due popular losses (GT) the complete conductance due to trendy losses (GT) is acquired through substituting GC= 6.022×10-5Siemens, GD = 7.703×10-5Siemens and GR= 2.479×10-3Siemens in equation (2.nine). The fee of conductance because of general losses (GT) is two.616×10-3Siemens.

Step 7: self-control of impedance of λ/4 transformer (ZC): The impedance ofλ/four transformer is obtained thru substituting Z0=50 Ω and Zin= Rin (at resonance) =1/ GT = 382.26Ω in equation (2.4). The impedance of area wave transformer (ZT) is 138.242Ω.

Step 8: willpower of λ/4 transformer width (W2): The width of λ/four transformer antenna is acquired with the resource of manner of substituting h=1.588 mm, εr = 2.2, Z0 = 138.24 Ω in equation (2.three). The calculated fee of width of region wave transformer line (W1) is 0.622 mm.

Step 9: Period of the λ/4 transformer (L): The duration of the λ/4 transformer is received with the resource of substituting λzero = 85.714mm, = 1.706 in equation (2.5). The calculated fee of length of the λ/4 transformer (L) is 16.405 mm, r eff The CMPA fed thru component feed with all dimensions are proven in Fig.4 for substrate the use of RT/Duroid5880 (εr=2.2, h=1.588 mm).

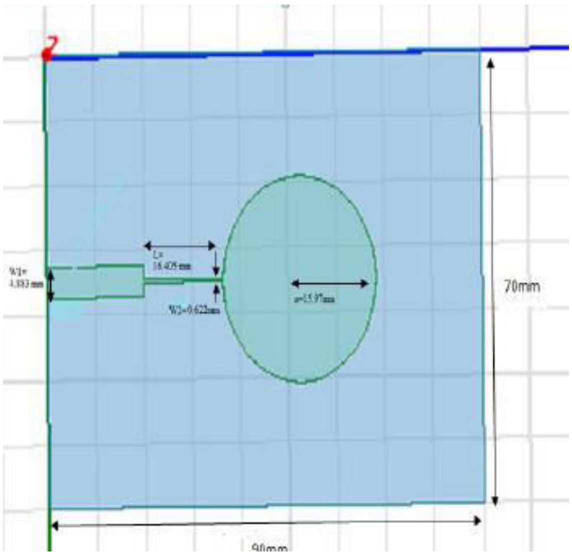


Figure 4 Edge feeding of CMPA with all dimensions

In similar way the patch parameters have been designed for the substrates RT/Duroid5880 (εr=2.2, h=2.87 mm) and FR4 epoxy (εr=2.2, h=2.87 mm) the usage of above equations 1-9. However, the specified design frequency cannot be executed with the aid of using those dimensions the scale which can be taken for acquiring a frequency of 3.5 GHz are shown in desk 1. Table 1 represents the dimensions of patch antenna for three awesome substrates.

Table1 Patch parameters for CMPA with edge feeding for three substrates.

patch parameter	RT/Duroid5880 (ε_r=2.2, h=1.588 mm)	RT/Duroid5880 (ε_r=2.2, h=2.87 mm)	FR4 epoxy (ε_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

Numerical results:

As consistent with format specifications referred to in table 2.1, the CMPA the use of RT/Duroid5880 (εr=2.2, h=1.588 mm) is designed and simulated, the simulation effects has been given Figs.five-9.

By pass decrease returned loss: It suggests the ratio of power at the receiving save you due to the incident wave to the strength pondered thru load.

$$\text{Return loss} = -20\log|\Gamma|$$

Where Γ is reflection coefficient.

Reflection coefficient is the amount of reflected signal which is relative to the incident signal.

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

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.

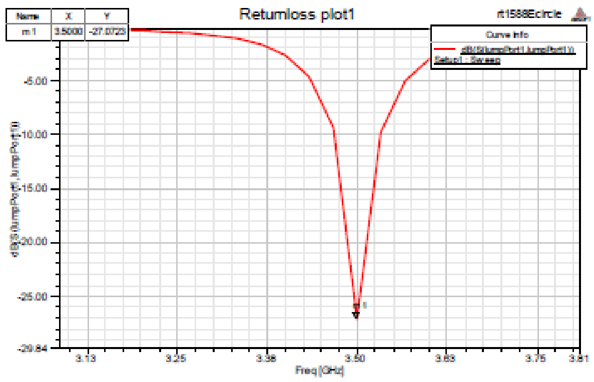


Figure.5 Return loss versus Frequency plot for CMPA with edge feeding.

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

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

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.

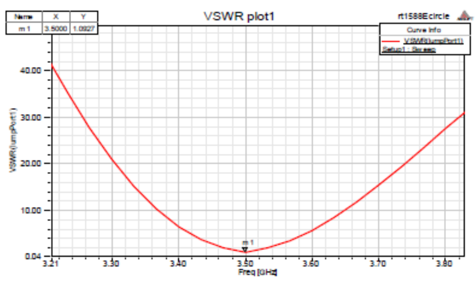
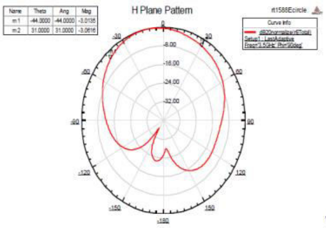


Figure.6 VSWR versus Frequency of CMPA with edge feeding

E plain: it's miles described thru a plane parallel to E-vector and containing the course of maximum radiation. The angular span between -three dB elements in essential beam can be taken as -three dB beam width. The E plane pattern for CMPA with part feed is proven Fig.7. The -3 dB beam width of 760 is obtained. H undeniable: it's far described with the aid of using a plane parallel to the H-vector (orthogonal to E-plane) and containing the course of most radiation.



The -3 dB beam width of 75⁰ is obtained.

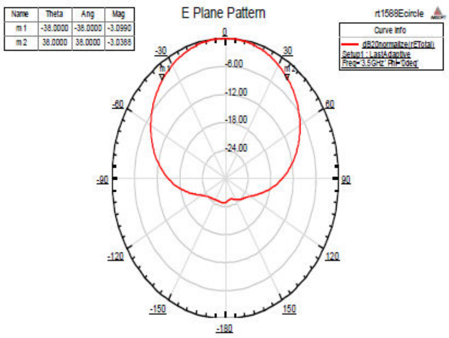


Figure7 E plane pattern of CMPA with edge feed.

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

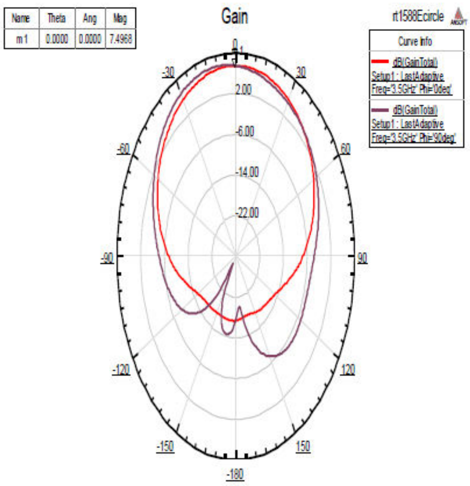


Figure.8Gain pattern of CMPA with edge feed.

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 (ε_r=2.2,h=1.588 mm)	RT/Duroid5880 (ε_r=2.2, h=2.87 mm)	FR4 epoxy (ε_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	76⁰	78⁰	78⁰
Beam width in H plane	75⁰	70⁰	66⁰

A CMPA with quarter wave transformer feed is completed move back lack of -18 dB after simulation and measured -24 dB [6] at 10 GHz, CMPA with same dimensions had been simulated through HFSS and it has given a pass back loss of -29 dB at 10.02 GHz.

Discussions:

On this economic break the outcomes of CMPA with location feeding and coaxial feeding techniques are located. From desk, desk 2.four the coaxial feeding offers better go back loss than side feeding. CMPA's fed thru coaxial probe were taken for next coming chapters.

FUTURE SCOPE

The simulated values are given a first-rate agreement with theoretical values. The fabricated antenna results might take transport of better settlement with simulated effects.

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