DESIGN, SIMULATION AND FABRICATION OF INSET MICROSTRIP PATCH ANTENNA AT 5GHZ

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ABSTRACT-In this paper, an inset microstrip antenna is designed, simulated and fabricated at frequency 5 GHz.Substrate GML 1000 (lossy) with dielectic constant 3.2 and tangent loss 0.002 was taken. The design and simulation of the microstrip antenna were performed using CSTMW studio software. Further, antennawas fabricated and tested. Measured and simulated results are compared and presented in terms of return loss, e-plane and h-plane.

***Keywords*-Microstrip patch antenna1000, S11 parameters, VSWR, e and h plane.**

INTRODUCTION

Microstrip or patch antennas are becoming increasingly useful and very widespread within the mobile phone market because they can be printed directly onto a circuit board operated on microwave frequencies (>1 GHz). These are narrowband wide beam antennas with benefits like, low cost, have a low profile, monolithic, easy to match by controlling, insert position and are easily fabricated. It may be in variety of shapes, but rectangular and circular are the most common.To design a rectangular microstrip patch antenna there are some essential parameters which are important to know,the operating frequency of the antenna, Dielectric constant of substrate (ε_r),height of the dielectric substrate (h),height of the conductor (t),calculation of width and length of the patch (W) and width and length of the ground plane and the substrate.

ANTENA DESIGN

There are various methods to analyse the microstrip patch antenna,the transmission line model, cavity models and method of moment. The transmission line model is easiest of among all.To design the microstrip inset feed line the input impedance is usually 50 Ω and the width of the feedline W_0 is 1.85 mm.The geometry of the patch antenna consists of ground and substrate with dimension (50 x 50) mm^2.Patch antenna is printed on substrate on 0.762 mm thick GML 1000 substrate with dielectric constant 3.2 and loss tangent 0. 002.Initially, theoptimum value of width is calculated by

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

where,f_r is the resonant frequency and ε_r is the dielectric constant. The effective dielectric constant due to fringing effect is given as

$$\varepsilon_{r\,eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\sqrt{1 + 12\frac{h}{W}}\right)^{-1} \quad (2)$$

where, h is the height or thickness of the substrate.
The extension of length ΔL is given as,

$$\Delta L = h\,(0.412)\frac{(\varepsilon_{r\,eff} + 0.3)}{(\varepsilon_{r\,eff} - 0.258)}\frac{\left(\frac{w}{h} + 0.264\right)}{\left(\frac{w}{h} + 0.8\right)} \quad (3)$$

L_{eff} is given as,

$$L_{eff} = L + 2\Delta L \quad (4)$$

For a given effective lengthresonance frequency, is given as:

$$f = \frac{c}{2L_{eff}\sqrt{\varepsilon_{r\,eff}}} \quad (5)$$

Where, is the speed of light,3x10^8 m/s.The input impedance should be accurately known soas to get good match between the element and the feedcan be designed. The input impedance at the feed is given by:

(6)

$$R_{in}(y = y_0) = R_{in}(y = 0)cos^2\left(\frac{\pi}{L}y_0\right)$$

The return loss (RL) is a parameter whichindicates the amount of power that is lost to the loadand does not return as a reflection. Aswaves are reflected leading to the formation of standingwaves, when the transmitter and antenna impedance donot match. Hence the return loss is a parameter similarto the VSWR to indicate how good the matching betweenthe transmitter and the antenna has taken place.

The RLis defined as

$$RL = -20\log10[\Gamma]dB \quad (7)$$

Where,Γ is input reflection coefficient andit is a measure of reflected signal at the feed-point of theantenna.

DESIGNED ANTENNA PARAMETERS CALCULATIONS

Microstrip patch antenna designed at 5 GHz.The calculations are done with the help of the above mentioned equations.We are taking GML 1000 as dielectric material with dielectric constant 3.2 and height of the subatrate 0.762,loss tangent = 0.002.

Antenna designed parameters	Antenna parameters calculated values
$\varepsilon_r = 3.2$ h = 0.762 mm f =5 GHz tan δ=0.002	W=20.70 mm ε_{eff}=3.0161 ΔL=0.370 mm L=16.56 mm L_{eff} = 17.3 mm

SIMULATED AND TESTED RESULT FROM DESIGNED ANTENNA

The inset microstrip antenna with above mentioned specifications has been designed on CST MW software 2017.the properties of antennas such as bandwidth, S-parameters, VSWR, near field and far field. Figure 1, shows inset microstripantenna. In simulation result, return loss comes below -10 dB i.e. return loss value is about -24 dB at 5 GHz and VSWR = 1.92 with gain 4.58 dB with directivity 7.77 dB.

For practical measurement of return loss of the designed inset microstrip patch antenna was connected to vector network analyser through co-axial cable. From the result on VNA, it is clear that at 5GHz frequency the return losses are -25 dB i.e. very close to the simulated values. So, the designed antenna is working properly with gain 5.514 dB. Figure 2, 3 and 4 shows the comparison of simulated and measured value with respect to return loss, e-plane and h plane (polar plot).

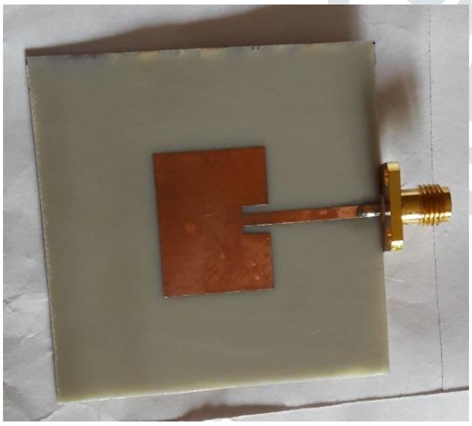

Figure 1: Inset microstrip antenna

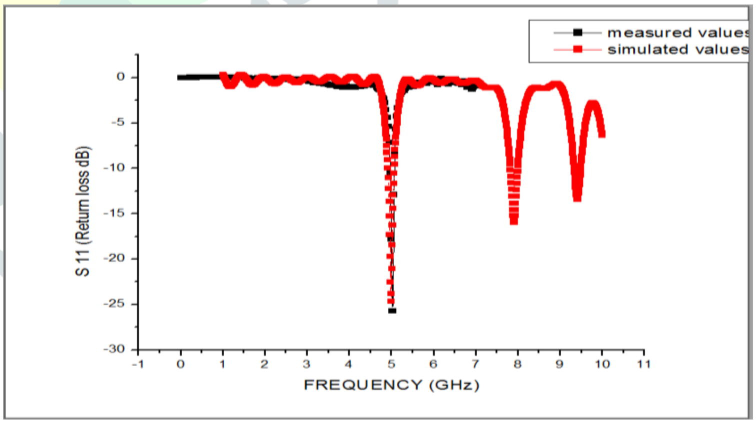

Figure 2: Comparison of S parameters for measured and simulated values

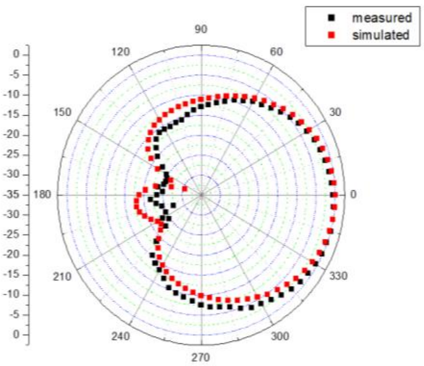

Figure 3 :Comparison of E-plane

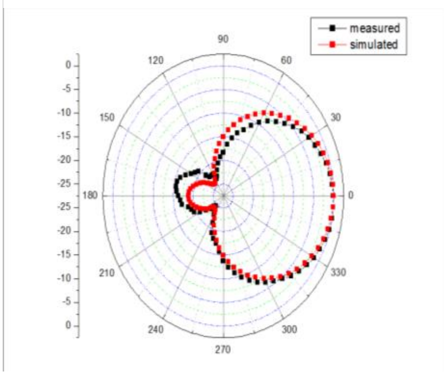

Figure 4:Comparison of H-plane

CONCLUSION:

The main aim of this paper is to design and test microstrip patch antenna (printed circuit board of type GML 1000 with dielectric constant 3.2 and thickness of 0.762 mm of double clad coper). The dimensions are of the patch are 20.07 mm (width) and 16.56 mm (length) and 0.154 GHz bandwidth. The microstrip antenna isdesigned by CST software on size 50x50(length and width) and 1.7 µm (0.017 mm) height. The thin film was obtained with i-cad software followed by the fabrication steps. After fabrication feed point was decided to polarize linearly and then connected sub miniature type-A (SMA) female RF connector of type radial R12540300 with the center conductor of diameter 1.27 mm. This has been soldered on Microstrip patch at a point where 50 Ω's impedance is achieved. The ground plane is also soldered with the outer conductor of co-axial. And then the center conductors are checked to not have short circuit with the ground plane by an om meter for no short circuit. The antenna has been tested for impedance, bandwidth and return loss measurement by using a vector network analyzer. The test has been conducted for VSWR, return loss, impedance, gain and radiation pattern.

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