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Proximity Coupled Micro-Strip Antenna for Bluetooth Application

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Abstract: This This paper presets a design and analysis of proximity coupled feeding microstrip antenna(PCMSA) to operate at 2.42GHz frequency for Bluetooth application. The antenna is fabricated using FR4 substrate with a dielectric constant of 4.4. The impedance bandwidth, gain, return loss of the proposed antenna: 4.669%, 3.515dB and -17.237dB. There is a good agreement between the simulated and measurement results are found. The simulating is done by IE3D tool.
Keywords: Microstrip, proximity coupled, bandwidth and antenna.

I. INTRODUCTION

The proximity-coupling in which non-contact is made between the feed-line and the element is a feeding mechanism. In contrast to the edge- and probe-fed geometries, the proximity-coupled feeding mechanism has inherently greater bandwidth [1]. In the year 1981, H. G. Oltman and D. A. Huebner researched electromagnetically coupled microstrip dipoles [2]. Many works have been devoted to enhancing the bandwidth of proximity-coupled microstrip antennas, such as appending parasitic radiator [3]–[5], impedance matching network [1], [6], L-probe feeding [7], [8], U-slot patch fed by U-shaped or double U -shaped stub [9]–[11], V-slot patch fed by Y-shaped stub [12], tooth-like-slot-patch [13], and an H-shaped slot in the ground plane [14]–[16], etc.

In this paper, proximity coupled microstrip antenna is designed; optimized by varying the length and width of the feed line to get the good response.

II. ANTENNA DESIGN AND ANALYSIS

The reference proximity coupled microstrip antenna (PCMSA) as shown in figure 1. The PCMSA is designed by using two substrate made up of FR4, each substrate of thickness 1.6 mm which are placed one above the other. The dimensions of designed antenna are as follows: h_1=1.6mm, Ly=29mm, Wx=29mm, L_f=24.41mm, W_f=3.021mm and h_2=1.6mm. The ground plane of dimension of the PCMSA is 38.6 x 43.8 mm2. The signal feeding patch is placed between two substrates and it is connected to SMA connector with impedance of 50Ω.

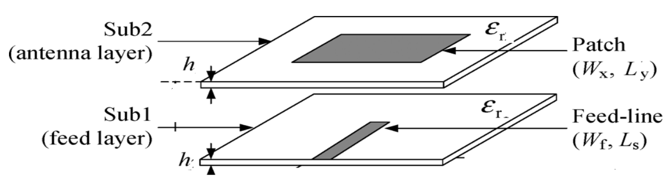

Fig 1: Configuration of Proximity coupled microstrip

The top view of the substrate 1 and the top view of the substrate 2 practical Proximity coupled microstrip antenna (PCMSA) show in fig 2.

a) Top view of substrate 1 b) Top view of substrate 2

Fig 2: Practical of Proximity coupled microstrip antenna

The dimension of microstrip antenna is calculated by using the following formula.
Calculation of the Width (Wp): The width of the Microstrip patch antenna is given as,

$$W_p = \frac{v_o}{2fr}\sqrt{\frac{2}{\mathcal{E}r+1}}$$

Calculation of Effective dielectric constant ($\mathcal{E}_{reff}$):

$$\mathcal{E}_{reff} = \frac{\mathcal{E}r+1}{2} + \frac{\mathcal{E}r-1}{2}(1+12\frac{h}{W})^{1/2}$$

Calculation of the Effective length (L_{eff})

$$L_{eff} = \frac{vo}{2fr\sqrt{\mathcal{E}r}}$$

Calculation of the length extension (ΔL)

$$\Delta L = 0.412h\frac{(\mathcal{E}_{reff}+0.3)(\frac{W}{h}+0.264)}{(\mathcal{E}_{reff}-0.258)(\frac{W}{h}+0.8)}$$

The design specification is shown in table 1.

Table1: Design specifications

Parameter	Specification
Resonant frequency	2.4GHz
Dielectric constant	4.4
Height of the substrate	1.6mm
Length of the patch	29mm
Width of the patch	29mm
Length of the feedline	24.41mm
Width of the feedline	3.021mm

Calculation of actual length of patch (L_p)

$L_p = L_{eff} - 2\Delta L$

The optimization of antenna is done by analysing the performance of microstrip antenna by varying the feeding length and width.

III.RESULT AND DISCUSSION

The return loss variation of PCMSA is plotted with respect to feed strip length variation shown in fig 3.

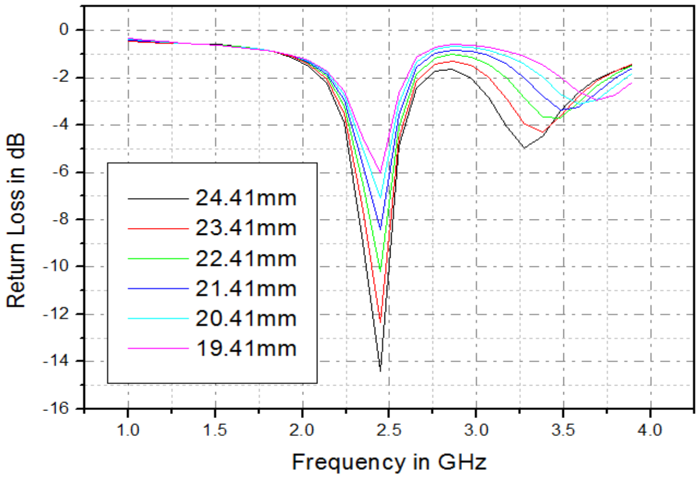

Fig 3: Return loss variation width feed strip length Variation

The return loss variation of PCMSA is plotted with respect to feed strip width variation shown in fig 4.

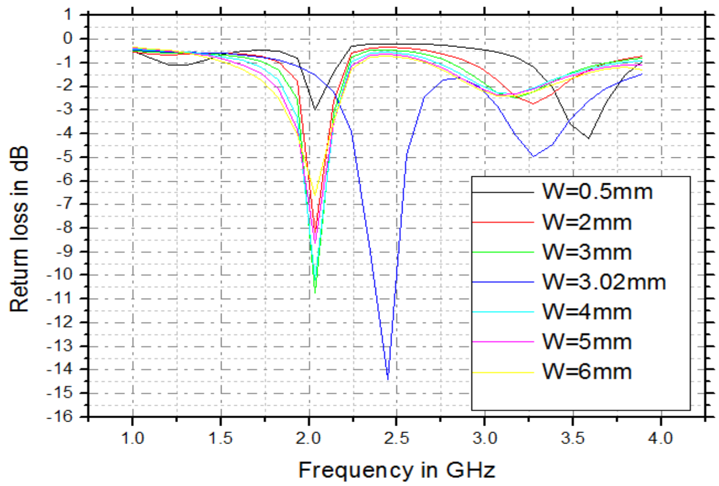

Fig 4: Return loss variation width feed strip width Variation

From the fig 3 and fig 4 its clearly shows the Proximity coupled microstrip antenna will gives a good response for the feed strip length of 24.41mm and width of 3.021mm. The simulated and practical results of the optimized antenna show in fig 5.

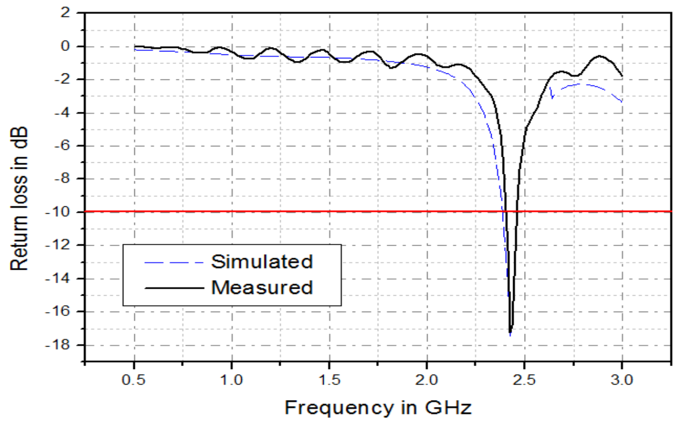

Fig 5: Return loss versus frequency of Proximity coupled microstrip antenna

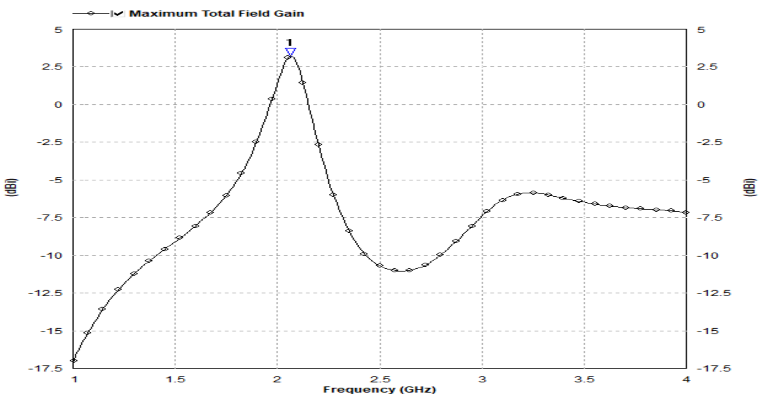

Fig 6: Gain versus frequency of PCMSA

The performance characteristic behaviour in terms of return loss of simulated and practical PCMSA with shown in figure 5. The simulated gain response with respect to frequency is shown in figure 6. The return loss, gain and bandwidth values are summarized in table 2.

Table 2: Results of the Proximity coupled microstrip antenna Simulated and practical results

	Frequency (GHz)	Return loss (dB)	Bandwidth (MHz)	%Bandwidth	Gain (dBi)
Simulated PCMSA	2.425	-14.41	121.86	4.948	3.515
Measured PCMSA	2.42	-17.46	113	4.669	-

IV. CONCLUSIONS

The proximity coupled microstrip antenna (PCMSA) is designed and optimized by varying the width and length of the feed strip line. The optimized PCMSA is operating at resonant frequency of 2.42GHz, return loss of -17.46dB, Bandwidth of 113MHz and gain 3.515dBi. The simulated results are good agreement with the measured results.

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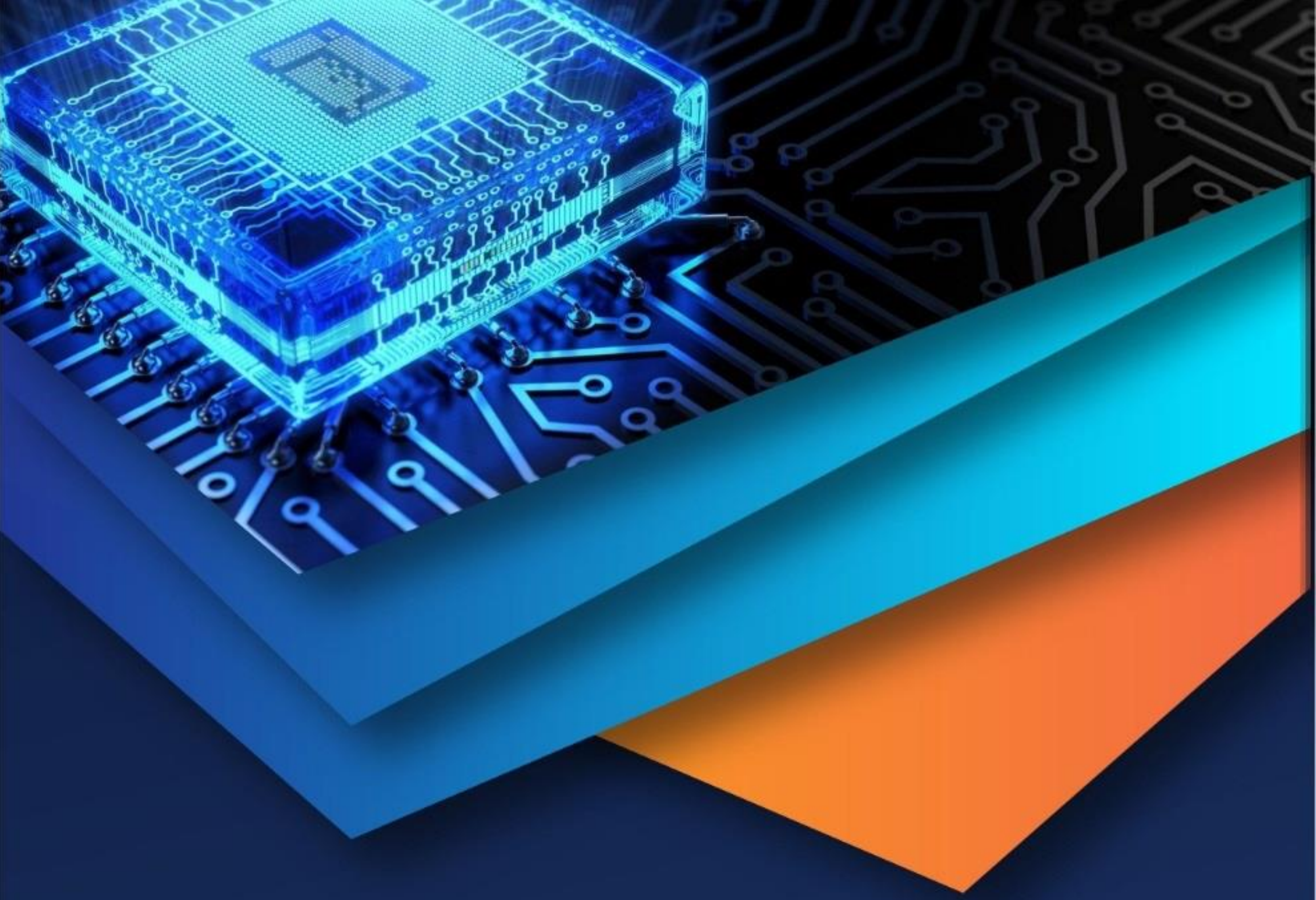

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