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Design of dual band microstrip antenna

Ajinkya D. Dhumale
ajinkyadhumale@gmail.com
Pune Institute of Computer Technology, Pune, Maharashtra

Pallavi B. Chandole
pallavichandole25@gmail.com
Pune Institute of Computer Technology, Pune, Maharashtra

Chirag
chirag.ciel@gmail.com
Pune Institute of Computer Technology, Pune, Maharashtra

Amol S. Ingole
amol.ingole@yahoo.com
Pune Institute of Computer Technology, Pune, Maharashtra

ABSTRACT

In the given paper a microstrip rectangular patch antenna is designed for dual frequency band applications in the ISM band and WiMAX band. The antenna contains a rectangular patch with two rectangular slots positioned on the surface of the patch which is mounted upon a grounded substrate made of FR4 epoxy. The dimensions of the patch and positioning of the rectangular slots are determined through standard antenna formulae and simulation-based optimization techniques in Ansoft HFSS (High-Frequency Structural Simulator – a computer software dealing with 3D electromagnetic models)[5].

Keywords: *Microstrip, ISM, WiMAX, Rectangular Patch, HFSS.*

1. INTRODUCTION

In the recent times, the cost and size factor is dominant in the field of wireless communications and microstrip antenna takes the upper hand in comparison to other antennas in this given field alongside it also provides compact and planer configuration and ability to work on high-frequency applications. The proposed dual band antenna design given has lots of practical uses, especially for mobile devices. These antenna operates on two bands or frequencies and can either work on these different frequencies one at a time or simultaneously.

The advantage of dual band antennas is their ability to provide a strong, stable wireless connection in often difficult to reach locations. The two most common frequencies used in these antennas are 2.4 GHz (802.11g/N) and 3.6 GHz (802.11y). The 3.6 GHz option has the higher frequency and subsequently, a smaller range. However, this higher frequency also allows the 3.6 GHz antenna to handle more information at any one time. The 2.4 GHz option inversely has a lower frequency, allowing the antenna to cover greater distances as well as penetrate surfaces more efficiently. Thus a dual band antenna can use both frequencies at once or switch between the two frequencies depending on which option provides a stronger connection in the given area. The dual band also provides us an alternative to avoid signal interference among different devices operating in the similar frequency range and therefore dual band antennas are a stable, easy way to connect between our day to day things [3].

2. ANTENNA DESIGN

The first step is to design the antenna consisting of a patch printed on a grounded substrate. For the proposed antenna, the substrate has a thickness h=1.6 mm and a relative permittivity $\epsilon r = 4.4$ for FR-4 Epoxy dielectric [4]. A 50Ω microstrip line is designed with a width of 3mm The length and width of the patch are L=27.13 mm and W=38.03 mm and the length and width of the substrate are L=70 mm and W=70 mm respectively.[1] The given dimensions of the antenna are calculated using following formulae[6],

a) Width of Patch

$$W = \frac{C}{2f_r\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

W= 38.03mm

b) Dielectric Constant

$$\epsilon_{\text{reff}} = \frac{\epsilon_{r+1}}{2} + \frac{\epsilon_{r-1}}{2.\sqrt{1+12\frac{h}{W}}}$$

$$\epsilon_{\text{reff}} = 4.78$$

c) Length Extension

$$\frac{\Delta L}{h} = 0.412 \times \frac{(\varepsilon_{\text{reff}} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{\text{reff}} - 0.258)(\frac{W}{h} + 0.8)}$$

where, $\varepsilon_{\text{reff}}$= effective dielectric constant

$\frac{W}{h} > 1$

$\Delta L = 0.72\text{mm}$

d) Effective Length

$$L = \frac{c_0}{2f_0\sqrt{\varepsilon_{re}}}$$

L= 27.13mm

e) Feed point position for 50ohm

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

where Rin ($y=y_o$) is 50 Ohms and Rin (y=0)

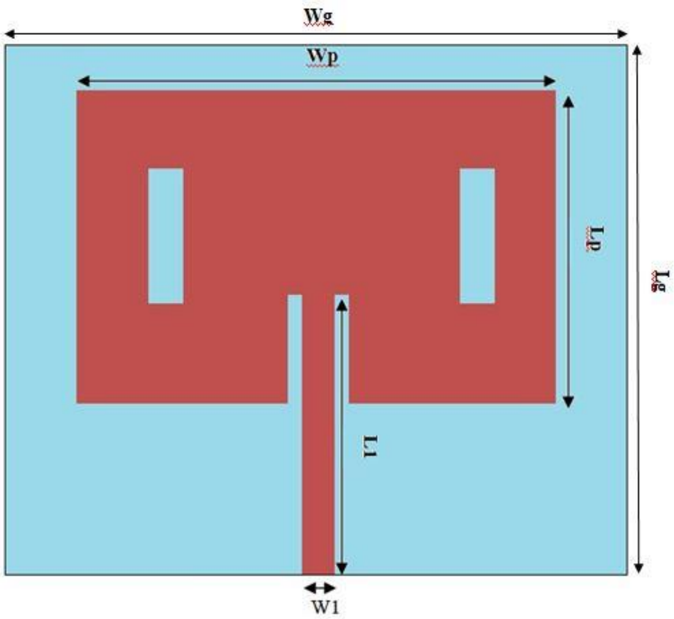

Fig.1 Geometry of Antenna

Table 1.1 Design Parameters of Antenna

Antenna Parameters	Dimensions (in mm)
Lg (Length of Substrate)	70mm
Wg (Width of Substrate)	70mm
Lp (Length of Patch)	27.13mm
Wp (Width of Patch)	38.03mm
L1 (Length of feed line)	35mm
W1 (Width of feed line)	3mm

3. ANTENNA SIMULATION AND RESULTS

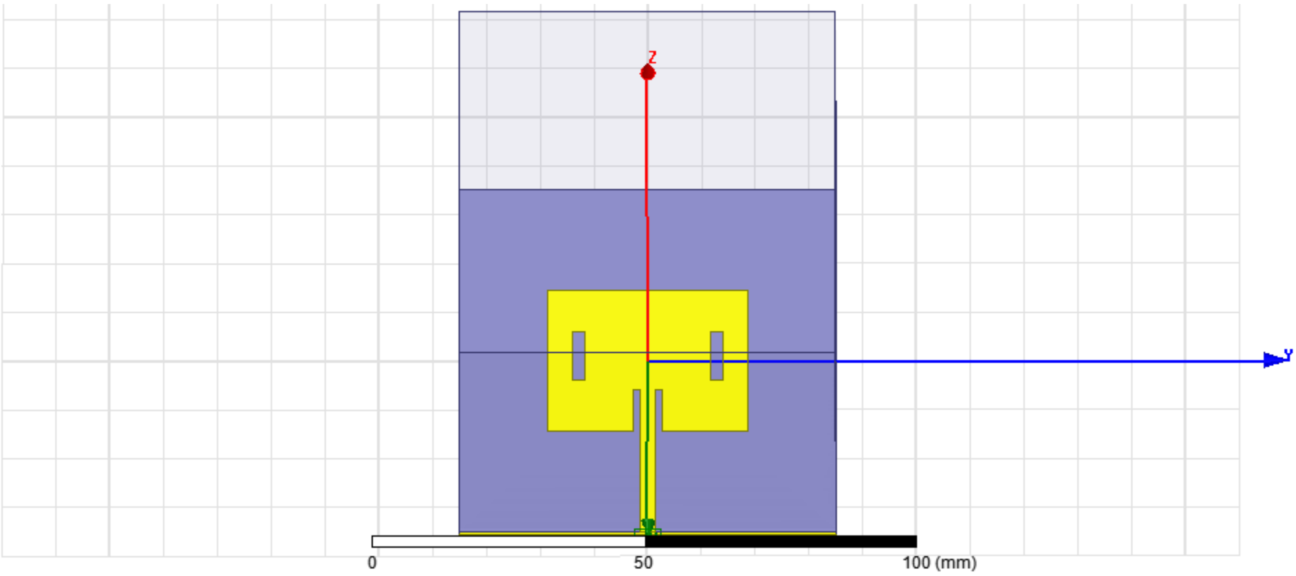

Fig.2 Simulated Dual Band Antenna

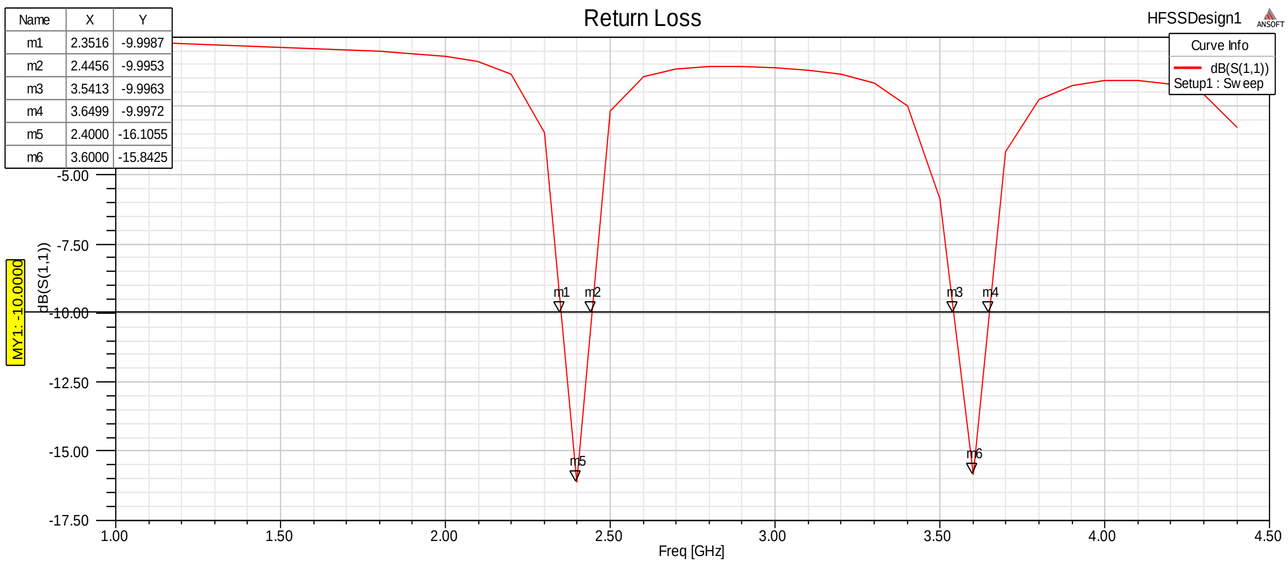

Fig.3 Return Loss vs Frequency

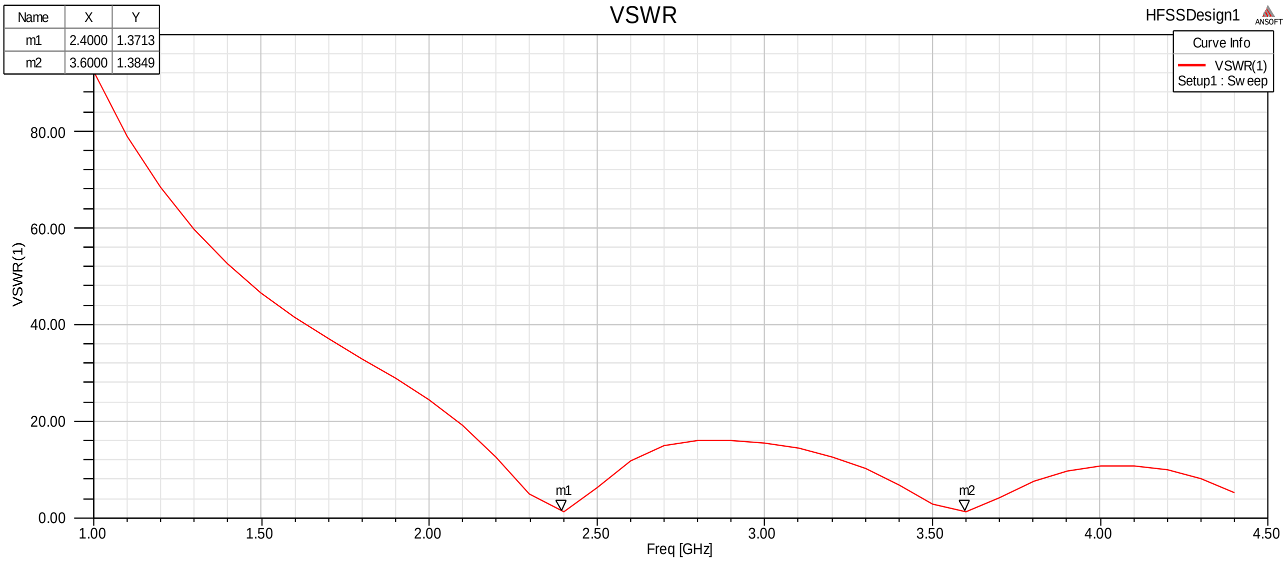

Fig.4 VSWR

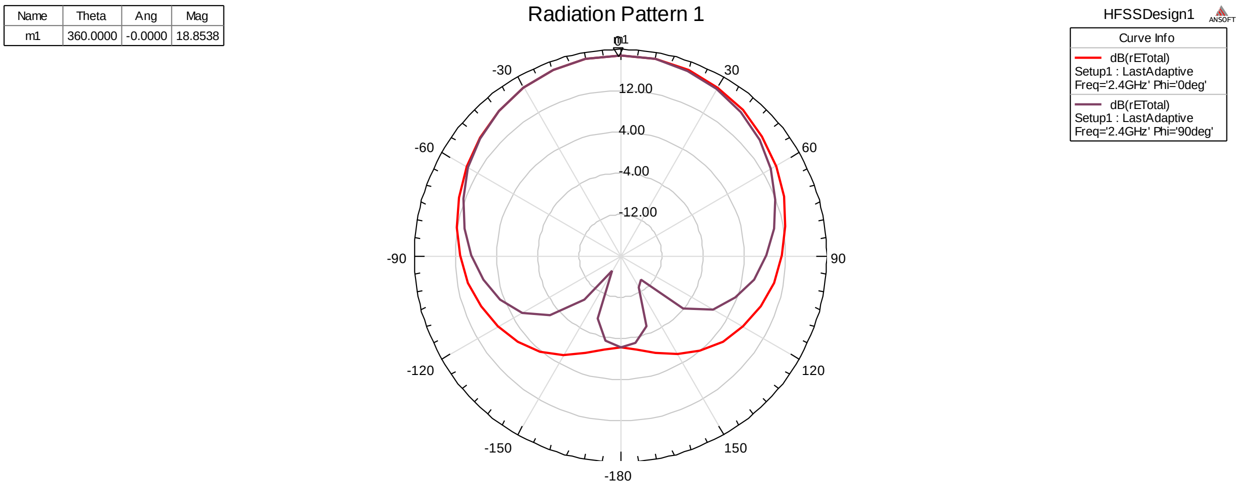

Fig.5 2D Radiation Pattern

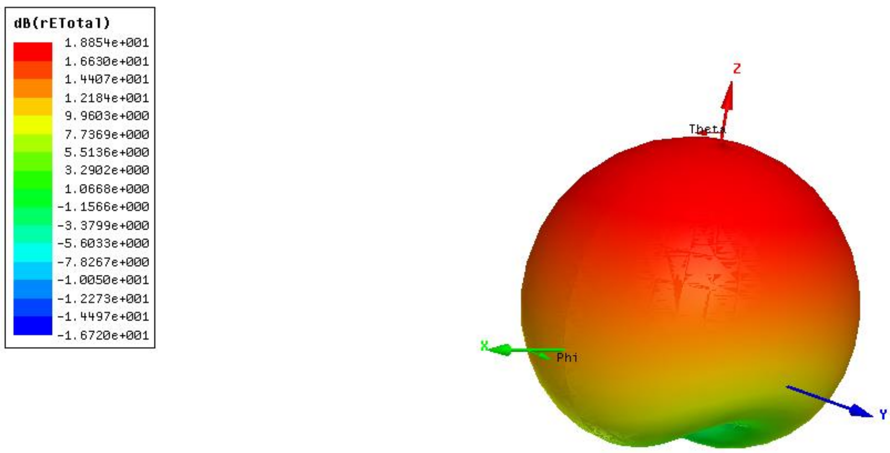

Fig.6 3D Radiation Pattern

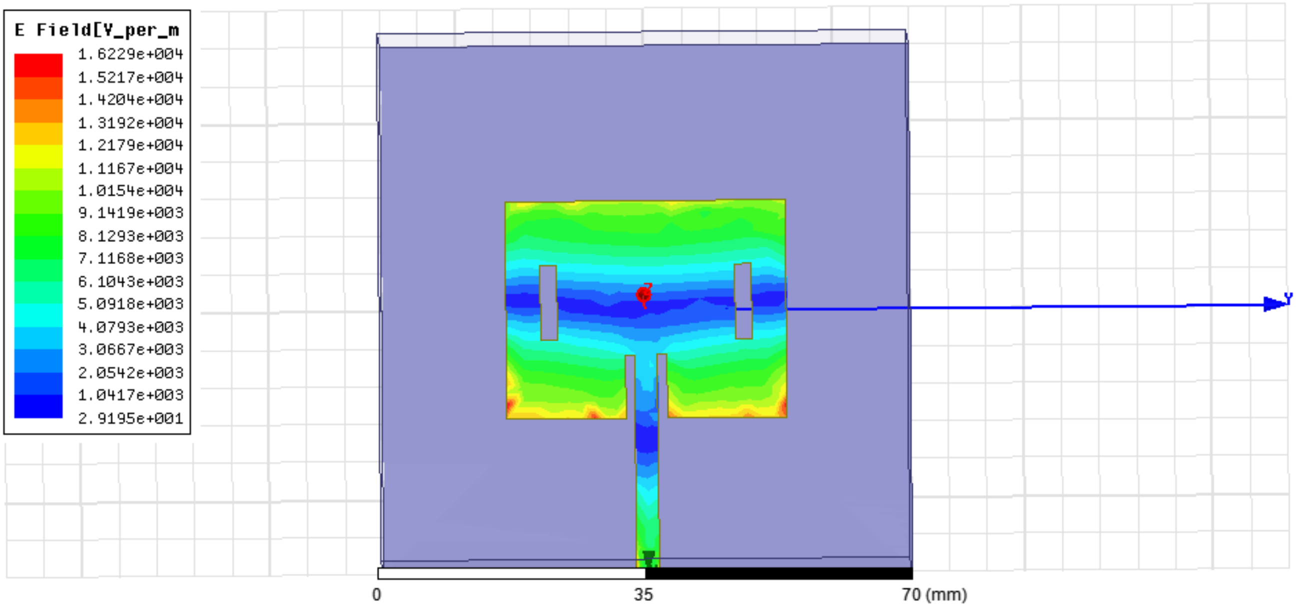

Fig.7 Current Distribution of Simulated Dual Band Antenna

Table 1.2 Simulated Results of Antenna

Frequency	2.4Ghz & 3.6Ghz
Return Loss (2.4Ghz)	-16.1055
Return Loss (3.6Ghz)	-15.8425
VSWR (2.4Ghz)	1.3713
VSWR (3.6Ghz)	1.3849

4. EXPERIMENTAL OBSERVATIONS

The proposed antenna is fabricated and tested in the laboratory using R&S®ZVL Vector Network Analyzer (VNA).[2] It is the only instrument to combine the functions of a network analyzer, spectrum analyzer, and power meter in a single box, and will thus tremendously increase your work efficiency. Manufactured antenna with front view and back view are shown in Fig.8(a) and Fig.8(b).

Fig.8(a) Front view

Fig.8(b) Back view

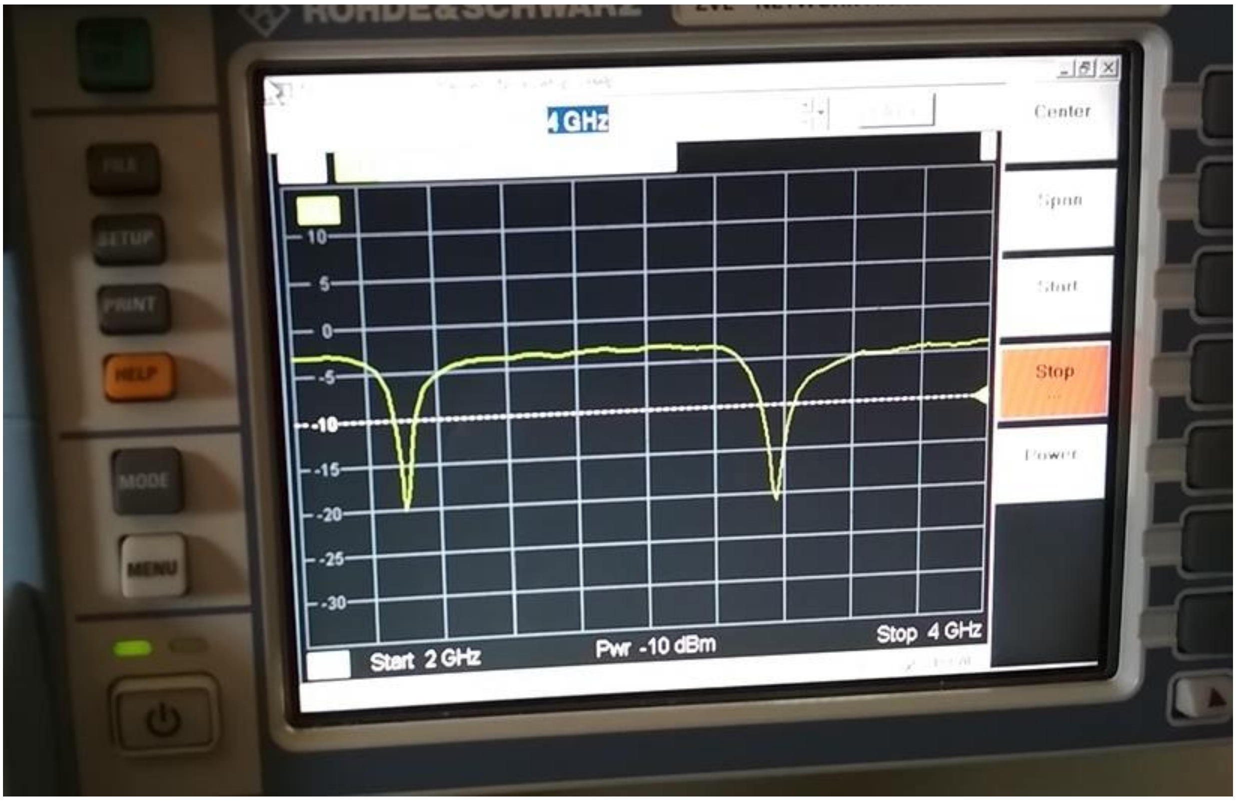

Fig.9 Return Loss on VNA

Fig10 VSWR on VNA

5. CONCLUSION

In the given paper the proposed antenna is designed for dual band of frequencies of 2.4 GHz and 3.6 GHz . The proposed antenna is a rectangular patch microstrip antenna with two rectangular slots on the patch and a ground substrate of FR-4 Epoxy. Given antenna design is realized through simulation, optimization and testing features provided by Ansoft HFSS 13(High-Frequency Structural Simulator) software. There are many aspects that affect the performance of the antenna such as dimensions, the shape of patch, slots, feeding technique, substrate. Design parameters shown in table1.1 and results are shown in table 1.2.

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7. REFERENCES

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