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Design of Rectangular Patch Antenna using ISM Band

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Abstract— **In this paper an inset fed rectangular shaped microstrip patch antenna is designed. The designed antenna structure is further simulated using Agilent ADS(Advance Design System) simulation software. The patch is designed with RT Duroid 5880 substrate of having dielectric constant of 2.2 and thickness of 1.6 mm. The simulation result proves the theoretical aspects for ISM Band.**

Keywords— RT Duroid 5880 ;inset fed; microstrip patch.

I. INTRODUCTION

Antenna is a device designed for radiating or receiving radio waves. The microstrip antennas also referred to as microstrip patch antennas (MSA) have several advantages like small size, light weight, low cost, low volume and easy to fabricate using printed circuit technology over conventional microwave antennas and therefore are widely used in many practical applications like aircraft, spacecraft, satellite, missile, mobile, GPS, RFID, Wi-Max and Radar etc. The radiating elements and the feed lines are usually photo etched on the dielectric substrate. MSAs suffer from disadvantages like low radiation efficiency, low gain, high Q, narrow impedance bandwidth etc.

All of the parameters in a rectangular patch antenna design (L, W, h, permittivity) control the properties of the antenna. As such, this page gives a general idea of how the parameters affect performance, in order to understand the design process. First, the length of the patch L controls the resonant frequency as seen here. This is true in general, even for more complicated microstrip antennas that weave around - the length of the longest path on the microstrip controls the lowest frequency of operation. Equation (1) below gives the relationship between the resonant frequency and the patch length:

$$l = \frac{1}{2 f_c \sqrt{\epsilon_o \epsilon_r \mu_o}} \qquad (1)$$

Second, the width W controls the input impedance and the radiation pattern. The wider the patch becomes the lower the input impedance is. The permittivity of the substrate controls the fringing fields - lower permittivities have wider fringes and therefore better radiation. Decreasing the permittivity also increases the antenna's bandwidth. The efficiency is also increased with a lower value for the permittivity. The impedance of the antenna increases with higher permittivities. Higher values of permittivity allow a "shrinking" of the patch antenna. Particularly in cell phones, the designers are given very little space and want the antenna to be a half-wavelength long. One technique is to use a substrate with a very high permittivity. Equation (1) above can be solved for L to illustrate this:

$$B = \frac{\epsilon_r - 1}{\epsilon_r^{\,2}} \frac{W}{l} h \qquad (2)$$

Hence, if the permittivity is increased by a factor of 4, the length required decreases by a factor of 2. Using higher values for permittivity is frequently exploited in antenna miniaturization. The height of the substrate h also controls the bandwidth - increasing the height increases the bandwidth.

II. ANTENNA DESIGN

The design of inset fed rectangular patch antenna with its dimensions is shown below:

Fig 1: Design of rectangular patch antenna.

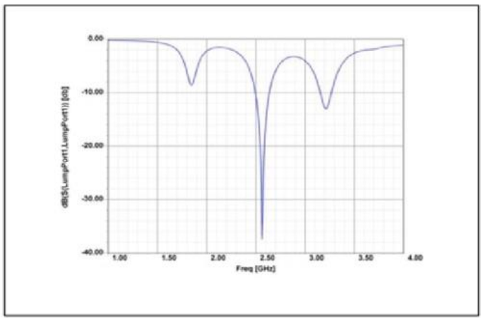
Table 1: Dimensions of Inset fed Rectangular patch antenna

Solution frequency	2.45 GHz
Patch dimension along x	48.4 mm
Patch dimension along y	40.49 mm
Substrate thickness	1.6 mm
Substrate dimension along x	82.2
Substrate dimension along y	120.83
Inset distance	12.215
Inset gap	2.465

Feed width	4.93
Feed length	37.298

III. RESULT

The return loss of inset fed rectangular patch antenna according to the base paper consulted is -38dB.



The return loss of inset fed rectangular patch antenna has been obtained -21.966 dB.

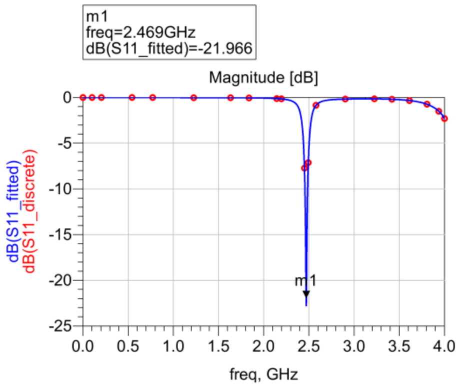


Fig 2: Figure shows the return loss of inset fed rectangular patch antenna.

Radiation pattern of inset fed rectangular patch antenna showing the polar plot of gain and radiated power is shown below. The gain obtained by the polar plot is 7.05257dB and the radiated power is 0.00193318W.

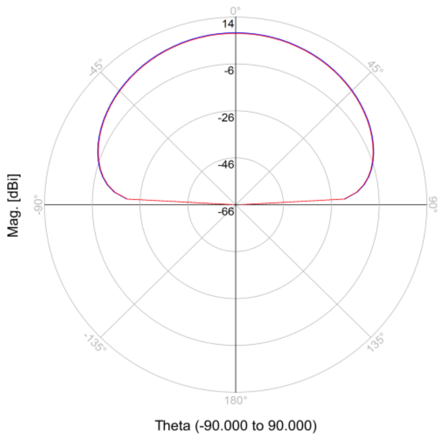


Fig 3: Polar plot of gain.

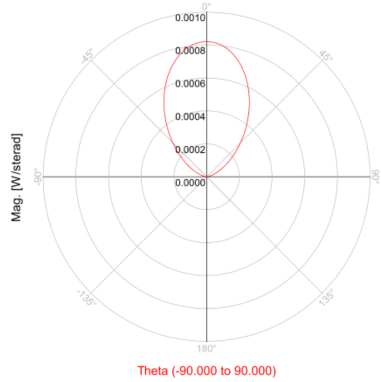


Fig 4: Polar plot of radiated power.

The radiation pattern of inset fed microstrip patch antenna as obtained in 3D structure can be shown as in fig.5. This structure is in the shape of an apple and the far field cut can be shown as:

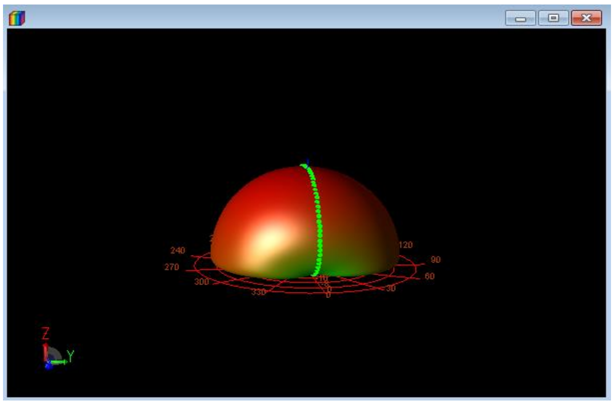


Fig 5: Far field cut shown in radiation pattern.

The antenna parameters thus obtained by the analysis of inset fed rectangular patch antenna is shown in table below. these parameters are obtained by analysing the antenna on Agilent ADS software.

Table 2: Antenna parameters

Power radiated (watts)	0.00192318
Effective angle (steradians)	2.31339
Directivity (dB)	7.378785
Gain (dB)	7.55257

IV. CONCLUSION

An inset fed rectangular patch antenna is designed and simulated over Agilent ADS simulation software. The simulated result shows that the designed antenna structure is suitable to operate in ISM frequency band. The return loss of designed antenna compared to the return loss of antenna designed in base paper, is slightly low. To improve the results further optimization has to be done.

V. ACKNOWLEDGEMENT

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