Design and Simulation of Microstrip Patch Antenna for RFID Application

Rasi Shamalbhai Bhatol

Abstract—This paper presents a new design of a microstrip patch antenna. The slotted antenna is presented for RFID applications. The antenna is simulated using Ansoft HFSS and area of the antenna is 7.92mm x10.92mm. The FR4 substrate is used in this antenna. This is a very compact, high efficiency and simple microstrip patch antenna. This Antenna increases the gain and reduces the complication of design greatly while compared to other slot geometries. This slot can also reduce the size of the patch. The proposed antenna is designed for the 5.8 GHz ISM band.

Index Terms—Rectangular Microstrip Slotted Antenna (RMSA), High Frequency Simulation Software (HFSS).

I. INTRODUCTION

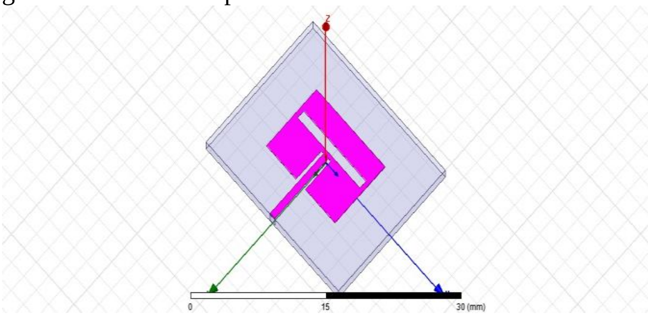
The Wireless technology advancements have given birth to radio frequency identification (RFID) systems, which have generated momentous interest among scientists, researchers and industry. RFID technology enables identification of location and information exchange of isolated objects via radio waves. It has been commercialized in areas of logistics, manufacturing, transportation, health care, and mobile communications [2]. The tremendous growth of microstrip antenna has seen in the field of RFIDs. The reason for this is the flexible, low profile, light weight and small size nature of the structure and a low production cost. Microstrip patch antenna having one of the major disadvantages of narrow bandwidth. However, RFID applications do not need much bandwidth so it turns out to be an advantage. Because the antenna rejects the signals that are out of the band and accordingly the quality factor increases.

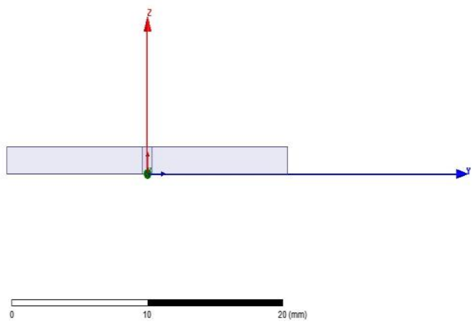
The microstrip patch antenna is one of the most exciting and fascinating development in antenna and electromagnetic (EM) history [2]. It divided into the category of printed antennas such as slots, tapered slots, and dipoles. The resonant dimension of the antenna depends on the shape of the patch conductor. It is obvious that the substrate properties such as dielectric constant εr and its height play important role in the antenna performance. The main advantage of patch antenna is its size which is relatively small compared to other radiators. Because of minimal thickness of the material the microstrip patch antenna allows to be easily integrated into the skins of various objects.

The major limitation of the patch antenna is its poor bandwidth and efficiency. This paper is focused to the methods which can increase the bandwidth of the patch antenna. This mainly controlled by the characteristics of the parallel plate transmission line controls the narrow frequency band of the antenna. The bandwidth of the antenna can be increased by increasing the thickness h of the parallel plate, by use of high dielectric constant substrate, by increasing the inductance of the transmission line by cutting holes or slots in it and by adding reactive component to reduce VSWR. Because of the less power loss and reduced complexity, the method of cutting slots is widely accepted. An antenna patch with a proper slot is broadband unlike the ones without slot. The most common and experimented slot shapes on the patch are L, S, U, E etc. This slotted antenna reduces the complexity, and it is portable because of the small size.

II. PROPOSED ANTENNA STRUCTURE

The geometry of the proposed antenna with the dimension of 7.92mm x 10.92mm is shown in Figure1. It is etched on a substrate of dielectric constant ε_r=4.4 and thickness h=1.6mm with tangent loss 0.09. Figure1 (a) shows the prospective layout of the antenna with respect to the coordinate system. Figure1 (b) shows the front view of the structure which comprises one elements separated by a slot. The slot element is designed as a rectangular shape with (9.92mm×1mm) dimensions. The antenna is excited using an offset 50 ohm microstrip line as shown in Figure 1 (c) which represents the top view of the structure. The feed line dimensions can be calculated theoretically with the equations. The excitation given here is a wave port excitation.





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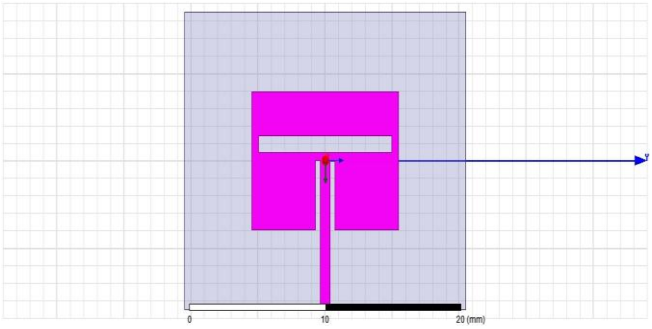

Figure: 1 (a) perspective view of the proposed antenna Entire structure (b) front view (c) Top view.

III. THE ANTENNA DESIGN

The design procedure for microstrip patch antenna is carried out step by step is given below.

The width W of the rectangular patch is given in terms of the speed of light c and the frequency f_0 by, [5]

$$W = \frac{c}{2 * f_0}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

Eq. 2 is used to calculate the effective length of the rectangular patch, [5]

$$L = \frac{c}{2 f_0 \sqrt{\varepsilon_{eff}}} - 2\Delta L \qquad (2)$$

There is a fringing effect described by L, [5]

$$\Delta L = 0.412h \frac{(\varepsilon_{eff} + 1)(\frac{W}{h} + 0.264)}{(\varepsilon_{eff} - 0258)(\frac{W}{h} + 0.8)} \qquad (3)$$

The value of the effective dielectric constant ε_{eff} is given by, [5]

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}(1 + 12\frac{h}{W})^{\frac{1}{2}} \qquad (4)$$

In the above formula, h is the height of the dielectric substrate, r is the relative dielectric constant for the substrate and ε_{eff} is the effective dielectric constant. Eq. 5 is used to calculate the length of the radiating patch, [5]

$$L_{eff} = L + 2\Delta L \qquad (5)$$

IV. SIMULATION RESULT AND DISCUSSION

For the simulation and analysis of the antenna structure the An soft HFFSv15 is used. Simulation process involves setting up of the optimum geometric dimension to satisfy the desired centre frequency, as well as the bandwidth requirement for specified return loss requirements in each band. The simulation was iteratively conducted until the desired results were found. Radiation patterns, gain, return loss and the VSWR are generated and measured Here,

The following sections describe the details of simulated results. Measurement of return loss is most important because our main interest is to reduce the size of the antenna and make it light by the slot and get the good return loss.

The peak gain of the antenna measured at the 5.8GHz frequency. Figure:2 shows the measured antenna gain versus frequency, gain total verses theta graph. The gain at 5.8GHz frequency is approximately 1.27dBi.

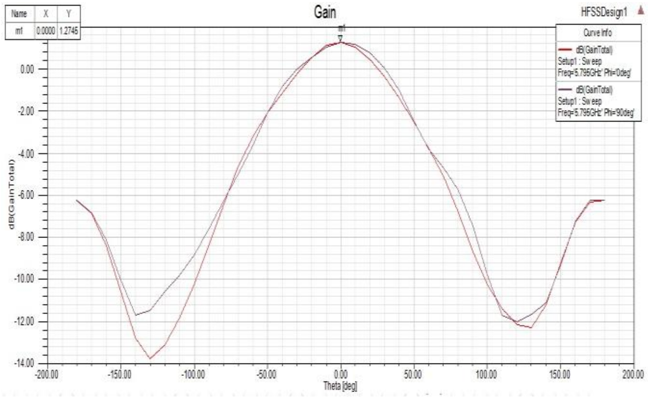

Figure: 2 Gain of the proposed antenna

The following figure: 3 show the simulated return loss and VSWR plots of the proposed Slotted antenna with the slot on the patch. The return loss of -14.21db get by this antenna the Figure 4 shows the VSWR for this proposed antenna and it is up to1.48. To achieve the maximum results, the gap distance between the Patch & the ground plane are adjusted and length of the micro-strip feed line 50 ohm need to be controlled.

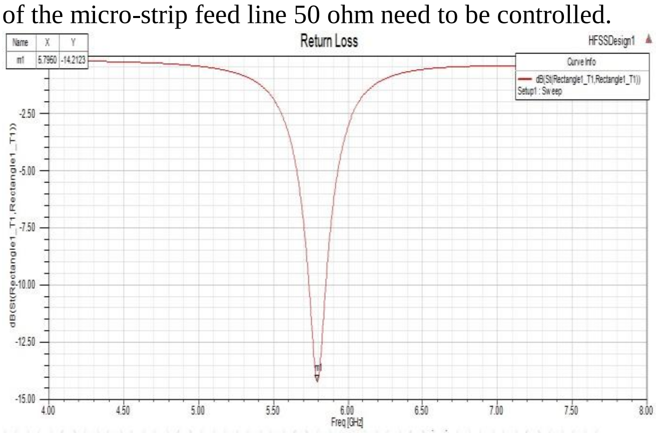

Figure: 3 Returnloss of the proposed antenna

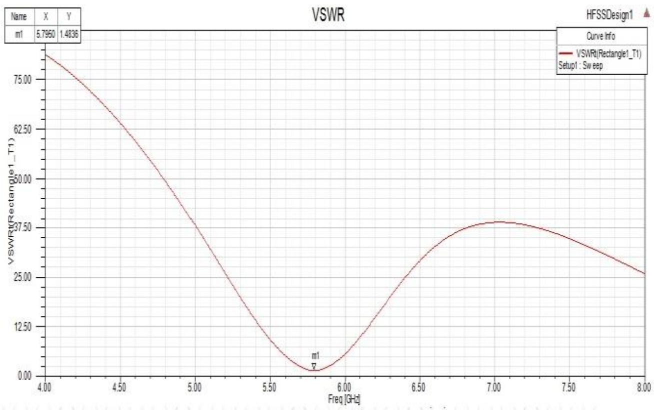

Figure: 4 VSWR of the proposed antenna

The simulated radiation patterns of the proposed antenna operating at 5.8 GHz frequency is shown in figures 5. It is found that the antenna has omnidirectional radiation pattern. This pattern is suitable for the rfid applications.

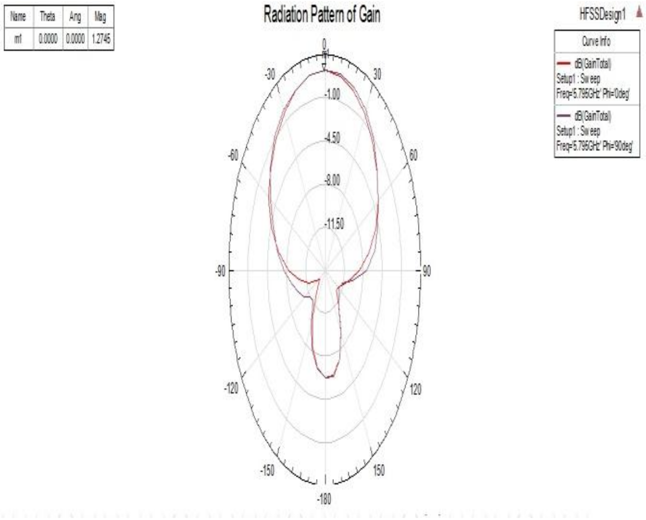

Figure: 5 Radiation pattern of the gain of proposed antenna

V. CONCLUSION

A study of construction and experimental verification of Rectangular Micro-strip Slotted Patch Antenna structure for the operation in the ISM band is presented. The size of antenna is reduced by the slot and the results are obtained. Simulation results showed that the antenna offers good response covering the operating bandwidths for ISM, RFID, WLAN and Wi-Fi operations. In spite of the compact size, the simple antenna demonstrates acceptable reflection coefficient, close to omnidirectional patterns over this band..Here we designed Slotted Patch antenna for ISM band which has applications in various fields. Designed patch has less return losses and large band width which are required for the applications designed. The Designed Antenna resonates at frequency of 5.8GHz with return loss of less than -14.21db.

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