

# Design of Cylindrical Shape Microstrip-Fed Antenna at 2.45 GHz for RFID Applications

Leeza Bansal  
M.Tech. Scholar  
HCTM, Kaithal

Davinder Parkash  
Assoc. Prof. ECE Dept.  
HCTM, Kaithal

## ABSTRACT

In this paper, a monopole antenna based on microstrip-fed for RFID frequency is proposed. The given antenna is composed of a cylindrical patch. The antenna exhibits single band, which creates an impedance bandwidth of 0.32 GHz. The research, simulation and design of single band antenna operates at 2.45 GHz. The fundamental parameters such as return loss, gain, radiation pattern, current distribution are obtained. A parametric study of proposed antenna has been carried out by varying some parameters. Simulation tool, based on method of moments has been used to analyze and optimize the antenna.

## Keywords

Radio frequency identification (RFID), Microstrip line, Cylindrical Patch

## 1. INTRODUCTION

In recent years, RFID has been widely used in service industries as an automatic identification tool [1]. A basic RFID system comprises a radio-scanner unit, called reader, and a set of remote transponders, denoted as tags, which include an antenna and a microchip transmitter with internal read/write memory [2, 3]. Several frequency bands have been standardized for this technology, low frequency (LF, 125-134 kHz), high frequency (HF, 13.56MHz), ultra-high frequency (UHF, 860-960MHz) and microwave (2.45 GHz and 5.8GHz). The systems using the UHF band and 2.45GHz band are believed suitable for long-distance communication utilizing a passive type RFID [5, 6]. However, because the UHF band overlaps with the frequency of a cellular phone, the UHF band is not preferable. Therefore, the 2.45GHz band is preferred [4].

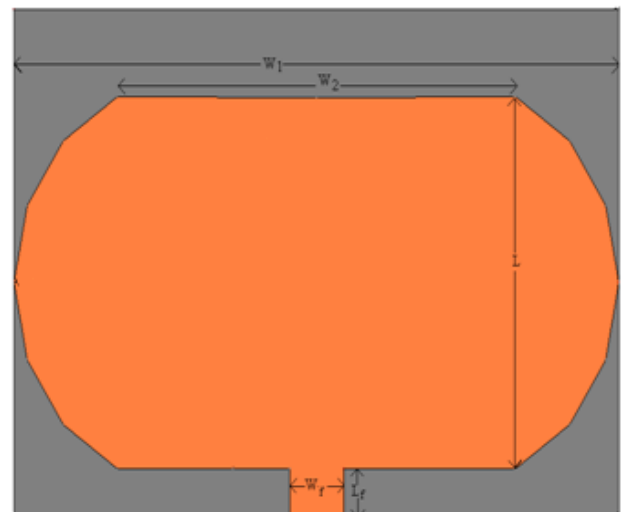
Several papers have been published on designing RFID antennas [7-10]. In [7], a miniaturized printed dipole antenna with the V-shaped ground is proposed for RFID readers operating at the frequency of 2.45GHz. A compact folded printed dipole antenna for UHF RFID reader is presented in [8].

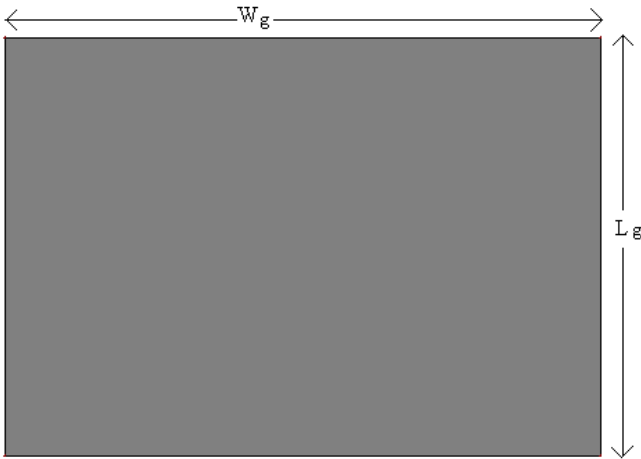
A dualband antenna RFID tag is presented in [9] that allow operation in the 900 MHz band as well as in the 2.45GHz band. In [10], a triple band printed dipole tag antenna is proposed for RFID. The triple band printed dipole is designed to operate at 0.92GHz, 2.45 GHz and 5.8 GHz. Several papers have been published on RFID antennas for both active and passive tags. At the same time, there exist many papers on practical analysis and design of particular classes of antennas used for other applications [11, 12].

In this paper, a cylindrical shaped antenna is presented which covers 2.45 GHz band which is the operating band of RFID application. The details of the proposed antenna design and the simulated results are presented and discussed next.

## 2. ANTENNA DESIGN

A cylindrical shaped patch is designed for the RFID (2.45 GHz) frequency range and placed on a conventional ground plane. The geometry of the proposed antenna is shown in Figure1. The total size of the proposed antenna is 23.1 mm x 45 mm. As shown in the Figure, the antenna consists of a cylindrical patch. The antenna mainly constructed with the above described patch and fed by microstrip feeding. The total size of this antenna with ground plane is 31.6 mm x 45 mm x 1.6 mm. The ground plane is symmetrical at the base line of the feeding strip line. The size of cylindrical patch is adjusted to obtain optimum bandwidth. To obtain the optimal parameters of the proposed antenna for RFID application, IE3D, full-wave commercial EM software that can simulate a finite substrate and a finite ground structure, is used. By properly adjusting the dimension of antenna and feeding structure the characteristics of the proposed antenna is improved. Figure 1 shows the geometry of proposed antenna. In which (a) part presents the complete geometry and (b) part presents the back view that is ground of the microstrip patch antenna.





**Figure 1: (a) Front View of proposed antenna (b) Back View**

The optimized dimensions of antenna are set as follows:

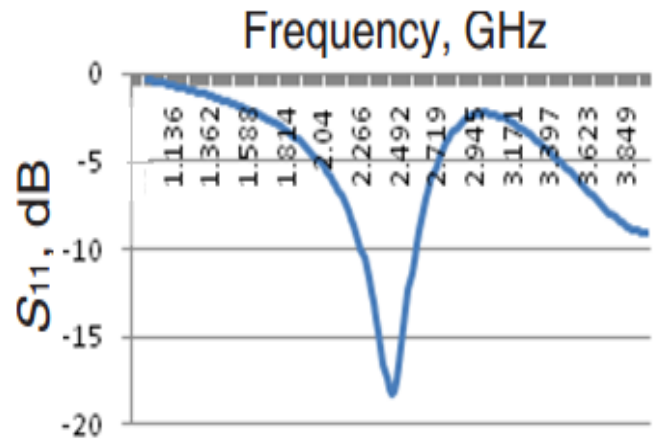
**Table 1: Parameters of the proposed antenna**

Parameter	Dimensions (in mm)
L	23.1
W <sub>1</sub>	45
W <sub>2</sub>	29.55
L <sub>g</sub>	31.6
W <sub>g</sub>	45
L <sub>f</sub>	3.025
W <sub>f</sub>	4

The feeding is provided by the rectangular strip of dimensions 3.025 x 4 mm<sup>2</sup> in the proposed antenna. With the aid of simulation by IE3D Simulator which is based on the method of moment (MOM), the antenna is optimized. The details of simulated performance are described briefly in next section.

### 3. SIMULATION RESULTS AND DISCUSSIONS

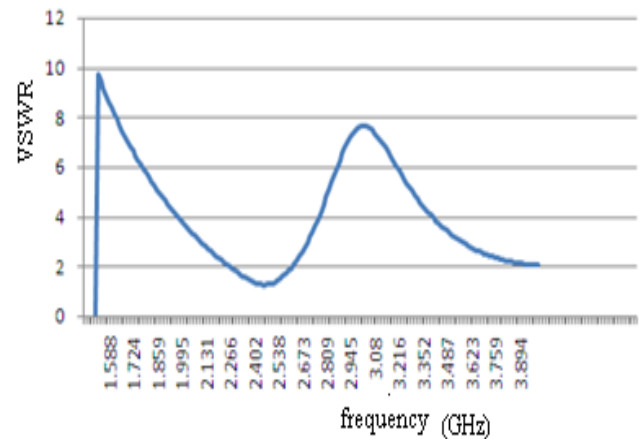
The design evolution of the proposed antenna and its corresponding simulated return losses are presented in Figure 2. It shows the simulated results of the proposed optimised antenna, which are in a good agreement. The band has a -10 dB impedance bandwidth of 320 MHz (2.28-2.6 GHz) for the simulated results.



**Figure 2: Return loss of proposed antenna**

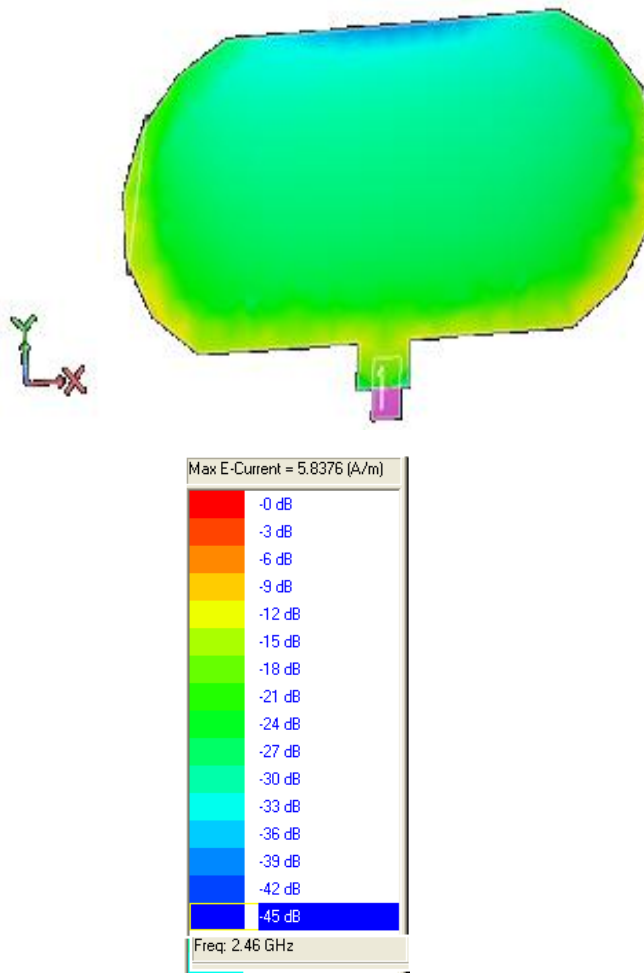
It has been examined that proposed design covers the RFID band from 2.28 -2.6 GHz.

Fig 3 shows the VSWR of proposed antenna. VSWR of 1.27 is obtained at 2.46 GHz.



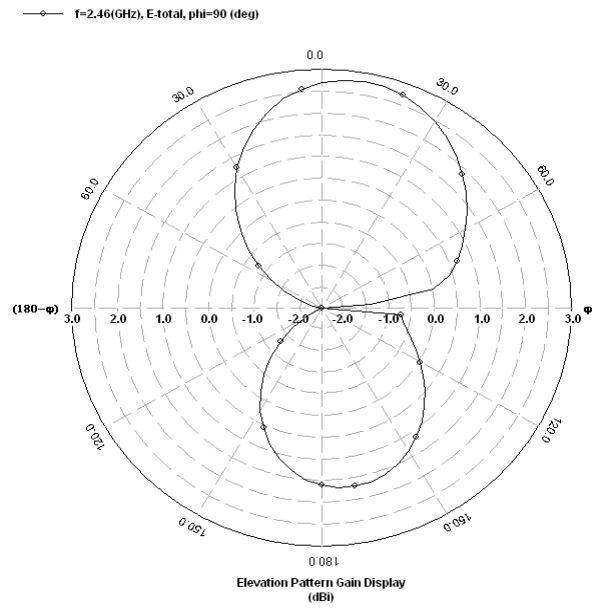
**Figure 3: VSWR of proposed dual band antenna**

In figure 4, the current distribution pattern shows that how much of the current is flowing in the proposed structure. Maximum current in the proposed antenna is 5.8376 at 2.46 GHz. The 3D current distribution plot gives the relationship between the co-polarization (desired) and cross-polarization (undesired) components. It gives a clear picture as to the nature of polarization of the fields propagating through the patch antenna.

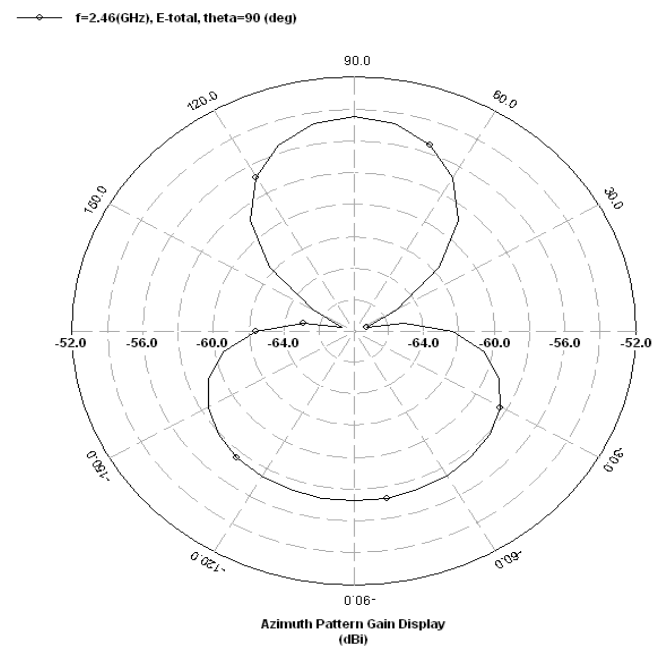


**Figure 4: Current Distribution of proposed antenna at 2.46 GHz**

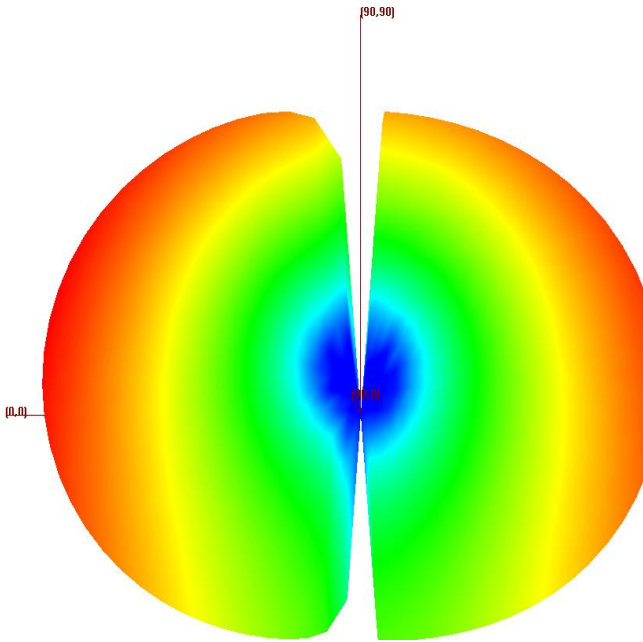
In figure 5(a) and 5(b) simulated 2D radiation pattern for elevation and azimuthal plane at resonant frequency 2.46GHz is shown. These patterns are desirable for RFID applications. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space coordinates. Three dimensional radiation pattern is obtained by combining elevation pattern and azimuth pattern. Figure 6 shows three dimensional radiation pattern of proposed antenna.



**Figure 5(a): Elevation pattern at 2.46 GHz**



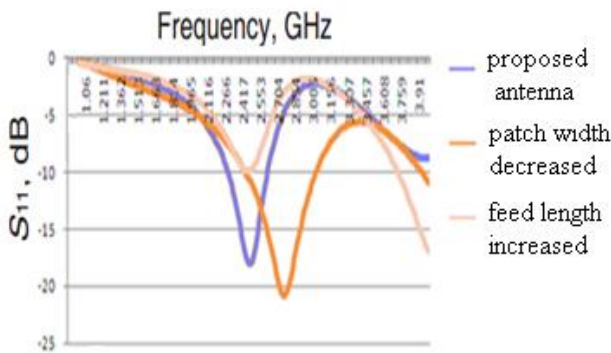
**Figure 5(b): Azimuth pattern at 2.46 GHz**



**Figure 6: 3-Dimensional Pattern of Proposed Antenna**

#### 4. PARAMETRIC STUDY

Figure 8 shows the parametric study of the proposed antenna. It demonstrates that many parameters affect the performance of the proposed antenna. The parametric study is carried out by simulating the antenna with one geometry parameter slightly changed from the reference design while all the other parameters are fixed. The parametric study showing the case when patch width is decreased, there was no impedance bandwidth in working bands but return losses are more than -10 dB. Also when feed length is increased then again there was no impedance bandwidth in working bands.



**Figure 8: Parametric comparison of return loss of antenna**

#### 5. CONCLUSION

A design of microstrip fed monopole antenna for RFID tag applications has been proposed. It covers RFID band from 2.28-2.6GHz. A single band operation has been obtained and good radiation characteristics have been observed at 2.46 GHz. The proposed antenna has been designed and simulated for resonant frequency at 2.46 GHz. Effects of varying dimensions of key structure parameters on the antenna and various parameters like gain, VSWR, current distribution, radiation pattern and their performance are also studied. These characteristics are very attractive for some wireless communication systems for a variety of applications.

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