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A Compact Microstip Slot Antenna for RFID/WLAN Application

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ABSTRACT

In this paper analysis and design of compact microstrip slot antenna is proposed for RFID/WLAN applications. Antenna is designed using FR4 substrate with overall dimension of 20x15mm^2 and dielectric constant of 4.4. The proposed antenna has resonant frequency of 5.8GHz. The fundamental parameters of the antenna such as bandwidth (19.13%), return loss (>10dB), gain (3.3dBi), radiation pattern and polarization are obtained. All meets the reasonable antenna standards. Simulation tool, based on the MOM (Method of Moment-ZELAND IE3D version 15.10) has been used to analyze and optimize the proposed antenna.

Key words: Microstrip slot antenna, Wide band, RFID, WLAN, Antenna parameters.

1. INTRODUCTION

Radio frequency identification (RFID) systems have been widely used recently in supply chain management by retailers and manufacturers to identify and track goods. Most RFID systems consist of a reader/writer and a tag [8]. The reader transmits RF power to the tag, which then sends a unique coded signal back to the reader, while the writer can change the information contained within the tag. Several frequency bands have been assigned to the RFID applications, such as 125KHz,13.56,869,902- 928 MHz,2.45 and 5.8GHz.As the operating frequency for RFID systems rises into the microwave region, the antenna design becomes more accurate and essential [9,10]. In addition to the requirements of the impedance and radiation performances, the conformal structure and compact size are the main concerns within the design process. In this paper microstrip fed slot antenna with RF performance suitable for RFID tag operate at 5.8GHz has been presented here.

Because of the low profile and compact size of the planar and printed antennas [1], there is a strong preference to this type of antennas for applications such as WLAN, UWB, LTE and RFID [2]. Several dual-band and wideband printed and planar monopole antennas [3]-[5] were designed to meet the needs of these applications.The increasing need for security and visibility of goods and assets in manufacturing companies, and distribution and supply chains has lead to the development of automatic identification systems [1]. Auto-ID and data capture procedures allow identification, data collection, and information storage about assets and goods. Auto–ID technology is implemented in several different ways, including barcodes, lasers, voice recognition, and, biometrics [2].These techniques suffer from limitations like the need for LOS with the interrogator (lasers and barcodes), low data Storage capacities (barcodes), and need for human intervention (voice recognition and biometrics). RFID was developed to overcome these limitations. RFID provides an Auto-ID technology that can operate without a LOS, can store large amounts of user data using integrated technology [3]. RFID proves useful when traceability through process or life cycles is required; data errors are high in material identification or handling [9]; and where business systems need more information than automatic identification technologies like bar coding can provide [10-12] .The RFID concept has been around for decades. The recent reductions of size and cost related to integrated circuits have greatly expanded the range of feasible applications [4]. However, unlike integrated circuits, antennas cost and size has not kept track with Moore's law. Today, antenna and sensor technology is a limiting factor [6]. The requirements of reader and tag antennas are not unlike those for much communication systems. They are driven by the applications and the regulations [5]. Microstrips fed slot antenna results are discussed and it is able to cover 5.2GHz – 6.3 GHz spectrum for RFID applications and this structure and results are discussed in sections 2 &3.

2. ANTENNA DESIGN AND STRUCTURE

In this model, a finite ground plane antenna with dumbbell like slots on the patch is designed. The width and length of ground plane and patch are 20×15mm^2 and 15×10 mm^2 respectively, which are obtained by mathematical design formulae is explained later. The overall dimensions of 20×15 × 0.8 mm^3, which is reduced by 91.81% than that of antenna [11] .On checking the dimensions of antenna with different resonant frequencies, here we had taken the resonant frequency as 6 GHz, which is given optimum dimensions of proposed antenna. The proposed structure exciting strip is embedded with two dumbbell shaped slot, here we take all the slots are of identical dimensions the slot with dimension 2x2mm^2, which yields the optimum result .This slots are useful for avoiding the surface wave effect produced by finite ground plane. Here we are employing the simple line feed for providing excitation which is far superior comparing with other feeding mechanisms.

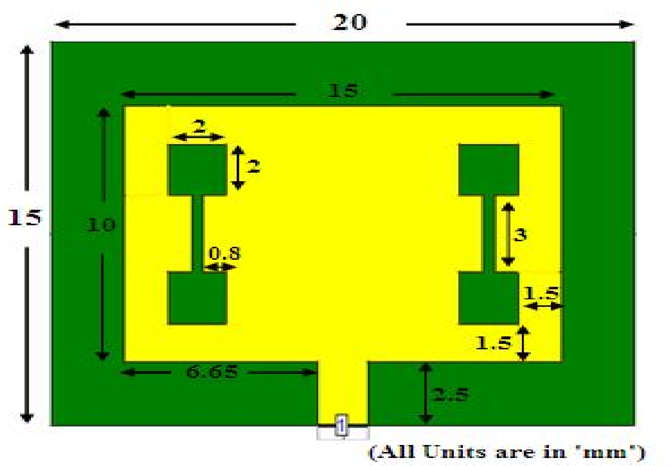


Figure 1: Geometry of Proposed Antenna

The proposed antenna is realized on 0.8 mm-thick FR4 substrate with permittivity 4.4 and loss tangent of 0.002**.** The antenna fed by 50Ω microstrip feed line with the width of 1.7mm and length of 2.5 mm as shown in the Figure 1. In the design of microstrip antenna, first we have to represent resonant frequency, dielectric constant, and height of substrate h. By using these values in designing formulae we will get dimensions of the antenna. The design formulae of micro strip patch antenna are shown in below.

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{reff} \mu_0 \varepsilon_0}} - 2\Delta L \qquad (1)$$

$$W = \frac{1}{2 f_r \sqrt{\mu_0 \varepsilon_0}} \sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (2)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{-1}{2}}; \frac{W}{h} > 1 \qquad (3)$$

$$\frac{\Delta L}{h} = 0.412 \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad (4)$$

$$Z_0 = \frac{120\pi}{\sqrt{\varepsilon_{reff}}\left[\frac{W_0}{h} + 1.393 + 0.667\ln\left(\frac{W_0}{h} + 1.444\right)\right]}; \frac{W_0}{h} > 1 \qquad (5)$$

$$W_G = W + 6h \qquad (6)$$

$$L_G = L + 6h \qquad (7)$$

3. SIMULATION RESULTS AND DISCUSSION

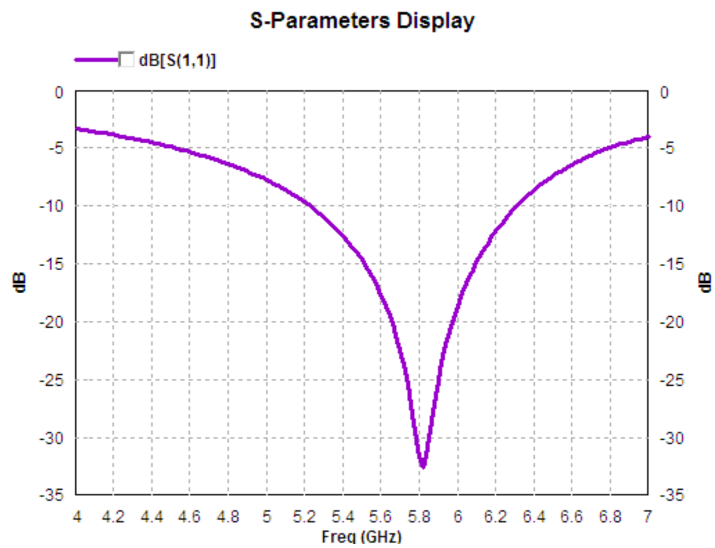


Figure 2: Return loss versus frequency of proposed antenna

The simulation of the proposed antenna is done using Zeland IE3D 15.10. Figure 2 shows the simulated return loss characteristics of the proposed antenna. The optimum return loss of antenna is -10dB down. From Figure 2, return loss -10 dB down from 5.2 GHz to 6.3 GHz which is of about 1.1GHz band width sufficient for wide band of operation. The antenna has maximum return loss of -33 dB at the resonant frequency 5.8 GHz. This return loss had given good match for RFID/ WLAN applications. The antenna bandwidth is greatly improved by adjusting dimensions of slots on the radiator.

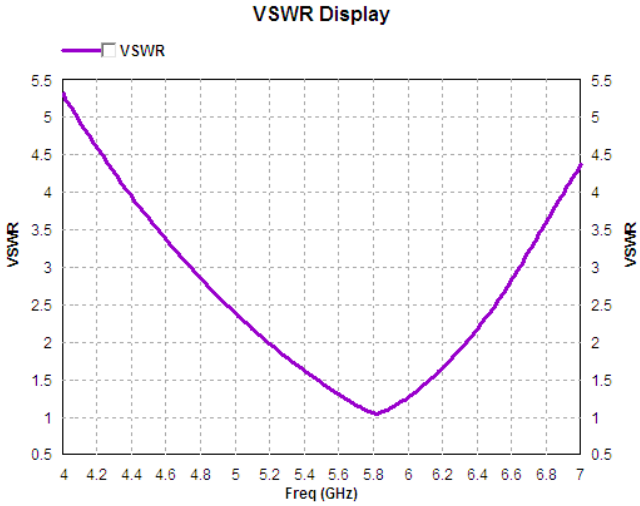


Figure 3: VSWR characteristics of proposed antenna

Figure 3 shows the simulated VSWR of the proposed antenna. The desirable VSWR of any antenna is 2:1. The antenna has VSWR 2:1 down from 5.2 GHz to 6.3 GHz in wide band of operation. The antenna has maximum VSWR of 1.02 at the resonant frequency 5.8 GHz.

From Figure 4, it's clear that at 5.8 GHz the current is perturbed across the microstrip feed line more comparing with remaining part so it causes the resonance at the particular frequency. From Figure 4, we can see that the back side conducting ground and radiating patch with slot has almost uniform current distribution, this is the cause of resonance and wider band with during 5.8 GHz.

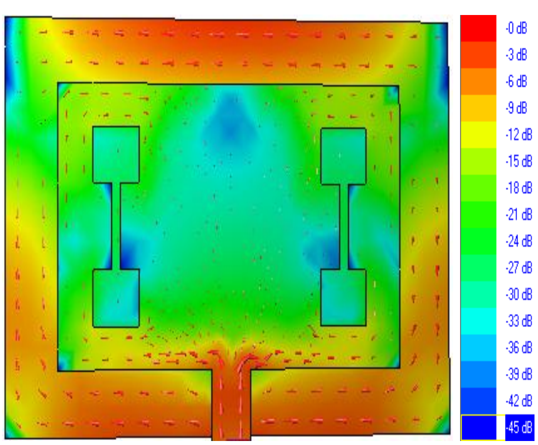
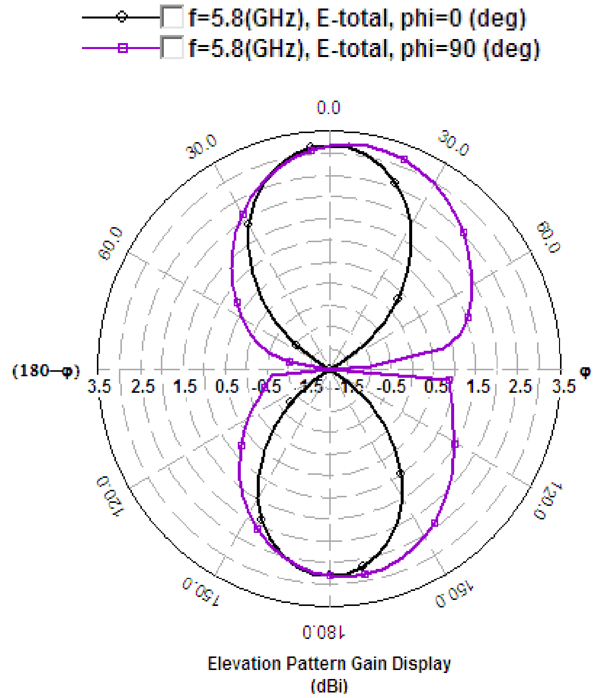
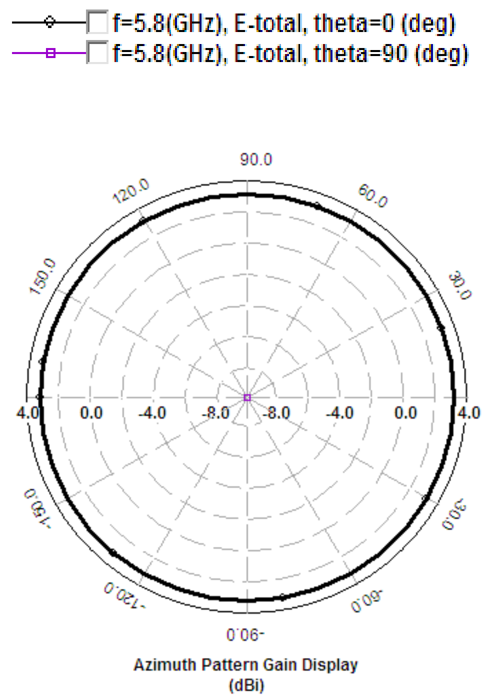


Figure 4: 3D Current Distribution of Proposed Antenna at 5.8GHz

Figure 5 shows the simulated radiation patterns of proposed antenna with Elevation and azimuthl at frequency of resonance with respect to gain by using ZELAND IE3D Electromagnetic solver. The simulated radiation patterns of antenna in the E-plane (XZ-plane) and H-plane (YZ-plane) for resonant frequencies 5.8 GHz,. The patterns and other curves are obtained at the time of simulation. We observed good radiation patterns by taking 20 cells per wavelength.



(a)



(b)

Figure 5: (a) 2D Elevation radiation pattern of proposed antenna at 5.8GHz (b) 2D Azimuthal radiation pattern of proposed antenna at 5.8GHz

Finally, Figure 6 shows the simulated gain of the proposed antenna. The antenna has peak gain of 3.3dBi and the average gain of 2.8dBi from 5.2 GHz to 6.3 GHz, which is very suitable for RFID/WLAN applications.

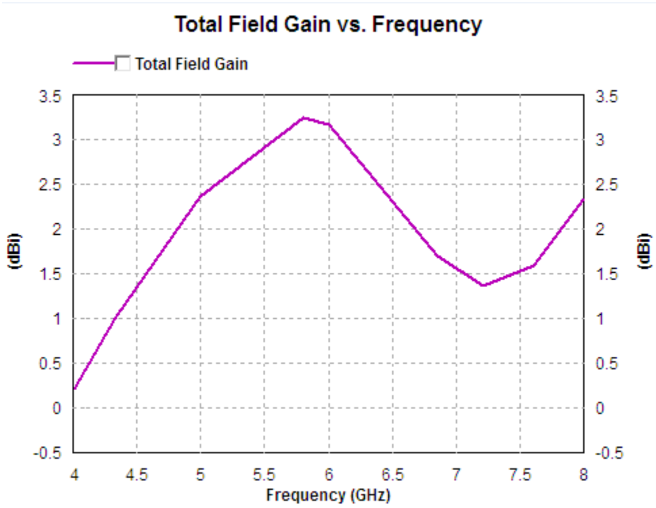


Figure 6: Proposed Antenna Gain characterstics

4. CONCLUSION

A compact microstrip dumbbell like slot antenna for RFID/WLAN applications has been designed and simulated using Zeland IE3D 15.10 electromagnetic solver. The simulation results presented have shown that broad impedance bandwidth and good radiation characteristics in wide band of operation and yield compact dimensions comparing with existing geometries present in the literature. The proposed antenna has wide band width of about more than 500 MHz which is suitable for WLAN/RFID Applications.

REFERENCES

1. K.L. Wong, **"Compact and Broadband Microstrip Antennas"**. New York, NY: John Wiley and Sons
2. K.Manikandan, S.Raghavan and T.Shanmuganantham, **"CPW Fed Tapered SlotAntenna for 5 GHz Band Applications**",International Journal of Microwave and OpticalTechnology , U.S.A., Vol. no. 3, No.1, pp.22 –26,Jan'2008
3. T.Shanmuganantham, K. Balamanikandan, and S.Raghavan, **"CPW-Fed Slot Antenna for WidebandApplications,"** International Journal of Antennas and Propagation, Vol. 2008, pp.1 - 4, Hindawi Publication, U.S.A., 2008
4. K. L. Wong and W. H. Hsu**, "Broadband triangularMicrostrip antenna with U-shaped slot**,**"** *Electron.Lett.*, vol. 33, pp. 2085-2087, 1997
5. K. F. Tong, K. M. Luk, K. F. Lee, and R. Q. Lee**, "A broad-band U-slot rectangular patch antenna on a microwave substrate**," *IEEE Trans. On Ant. Prop.*,vol. AP-48, no. 6, pp. 954-960, June 2000
6. Rainee N. Simons**, "Coplanar Waveguide Circuits, Components, and Systems".** New York, NY: JohnWiley & Sons, Inc., pp. 1-6, pp. 422-424, 2001
7. Strassner, B., and Chang, K.: **"Integrated antenna system for wireless RFID tag in monitoring oil drill pipe"**. *IEEE* Antennas and Propagation Society Int.Symp., Columbus, OH, USA, 2003, Vol. 1, pp.208–211
8. Foster, P., and Burberry, R.: **"Antenna problems in RFID systems"**. *IEEE* Colloquium on RFID Technology, London, UK, 1999, pp. 31–35
9. Marrocco, G.: **"Gain-optimized self-resonant meander line antennas for RFID applications"**, *IEEE* Antennas Wirel. Propag. Lett., 2003, 2, (21), pp.302–305
10. Yu-De Lin and Syh-Nan Tsai, **"Coplanar waveguide-fed uniplanar bowtie antenna,"** *IEEE Trans. On Ant. Prop.*, vol. AP-45, no. 2, pp. 305-306, Feb. 2000
11. Dmitry E. Zelenchuk, and Vincent F. Fusco, **"Planar High-Gain WLAN PCB Antenna"**, *IEEE* antennas and wireless propagation letters, vol. 8, 2009
12. Hala elsadek **"Microstrip antenna for mobile wireless communication systems"** Electronic research institute, Microstrip Department Cairo, Egypt, intech journals, vol.7, April 2011.