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Folded monopole antenna for passive RFID tags

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Abstract

A dual band monopole antenna for passive RFID tags is presented, simulated with suitable bandwidth and gain for RFID application. The monopole is optimized using HFSS to obtain dual band characteristics. This paper presents a dual-band monopole antenna suitable for passive RFID applications which operates at 2.45 GHz and 5.8 GHz. This antenna is designed with low cost and low profile substrate to achieve a reasonable gain. This antenna has a total area of 38×28mm and is mounted on an FR4 substrate with a thickness of 1.6mm, dielectric permittivity constant 4.4, and loss tangent of 0.025.

Keywords: Monopole antenna, RFID, Passive tag

1. Introduction

RFID technology is one of the most prominent growing upcoming technology using radio waves [4]. The technology has been implemented for tracking, identification of objects and various other commercial and industrial purposes. RFID emerges as 'Friend or Foe' during Second World war in 1940's by propagating a radio signal, transmitter placed on their plane, reflects the signal which identified as friend aircraft. Later, comes with the barcode. As the barcode failed to respond in NLOS, RFID makes its prominent role.

RFID comprises of reader, middleware, tag and antenna [3]. RFID is classified as Active/chipped and Passive tags.The silicon chip used in active tags requires power to operate which makes a drawback for low cost applications. The passive tags work with coupling and backscattering. The reader sends the data/information as Radio signals, the tag receives and encodes the signature by changing the frequency of wave and scatters the EM signature back to reader for further digital processing. RFID operates in frequency of 130KHz, 13.5MHz, 900MHz, 2.4GHz and 5.8GHz. Various types of antenna design operating in single and multi-band has been proposed [1, 7, 9, 2, 5, 6, 8].

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Thus, the antenna required should be compact, less weight, easy to fabricate and low cost. So, the compact monopole antenna with high efficiency and wide band width is adoptable for RFID applications. In this paper, a new design of a compact dual band monopole antenna is proposed (Fig. 1). The proposed antenna is simple with single dielectric and radiator with Defected ground.

2. Antenna design

The radiating patch is fabricated on low cost dielectric substrate FR-4 substrate of relative permittivity 4.4 and thickness 1.6 mm, the microstrip feed of width 'wf" is used for excitation. The dual band monopole antenna is obtained by single radiating element with modification in ground. By a proper modification of the ground plane, the two resonant modes are obtained with good input impedance matching. The microstrip feed-line width is fixed at 3 mm.

Table 1: The parameter values of the proposed antenna design

Parameter	**Dimensions (mm)**
W	38
L	28
Wf	3
Lp	39
Wg	14
g	0.5

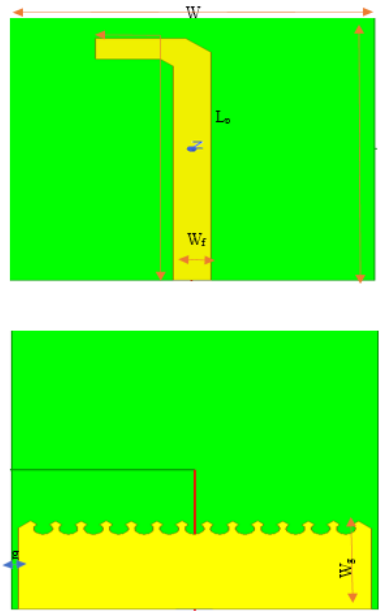

Figure 1: (a)Top view (b) bottom view of antenna

3. Results and discussions

Initially a single monopole of length 34mm is simulated. Later, the structure is modified to achieve the dual band characteristics. The modified structure is presented in Fig.2.

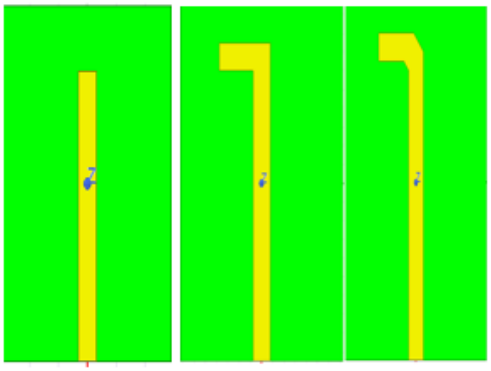

Figure 2: (a) design 1 (b) design 2 (c) design 3

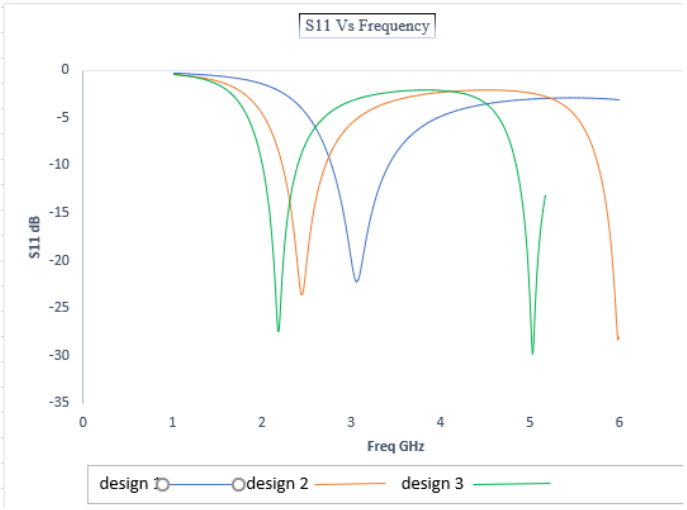

Figure 3: S_{11} of (a) design 1 (b) design 2 (c) design 3

It is observed that the upper- frequency bandwidth (5.6–6 GHz), resonating at 5.8 GHz and the lower frequency bandwidth (2.2–2.65 GHz) with a resonance at 2.4 GHz. The optimized length Lp is set to resonate around 39mm.

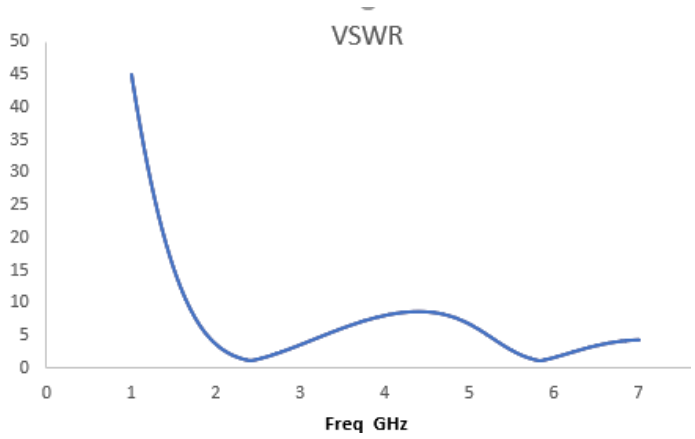

Figure 4: VSWR of design 3

The current flows in under arm of main resonating element in 2.4GHz whereas for 5.4GHz the

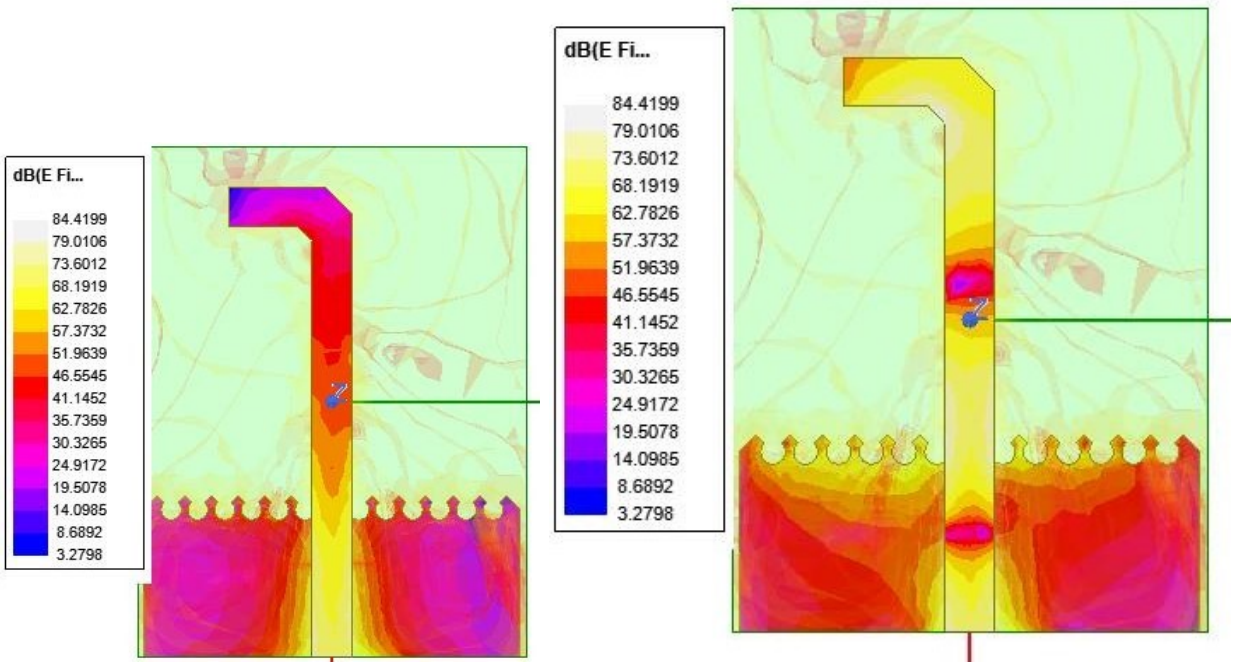

Figure 5: Surface current distribution (a) 2.4GHz (b) 5.8GHz

modified ground contribute resonate at dual band.

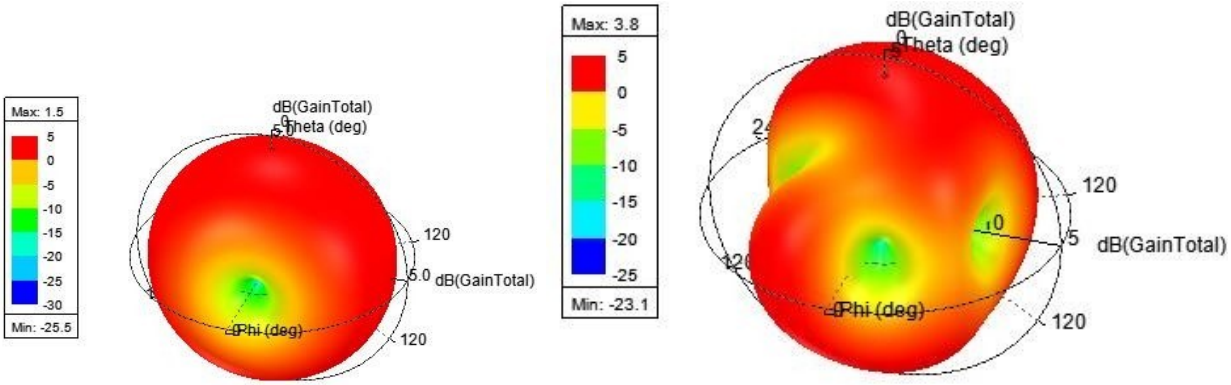

Figure 6: Gain at (a) 2.4GHz (b) 5.8GHz

The gain is observed to increase smoothly with the frequency. The maximum gain obtained at 2.45 GHz and 5.8 GHz is 5 dBi. The proposed antenna provides appropriate gain characteristics required for the operation in the RFID applications.

4. Conclusion

In this paper, dual band monopole antenna is proposed with omni-directional radiation pattern and suitable gain using single resonant patch and modified ground. The impedance-bandwidth of the antenna spans from 2.2- 2.6GHz and 5.6-6GHz with good radiation characteristics.

References

[1] M.S. Bell, *RFID Technology and Applications*, Cambridge University Press: London, UK, 2011.

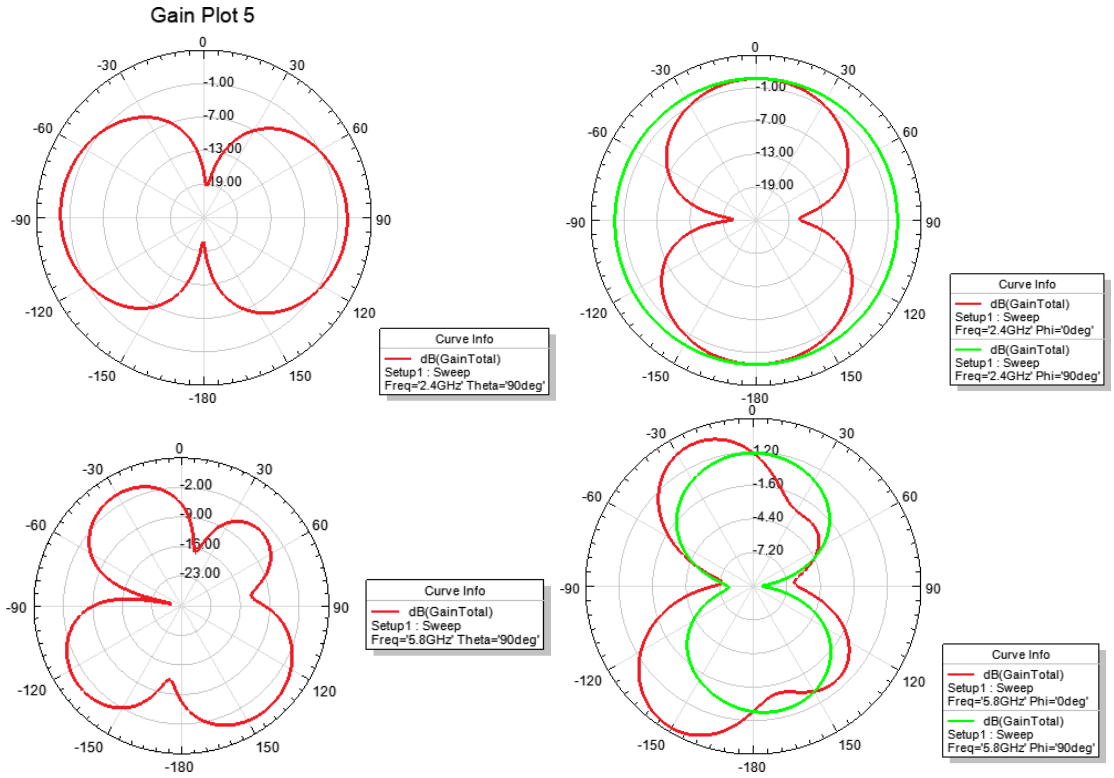

Figure 7: 8 Radiation pattern of Azimuthal and Elevation plane (a) 2.4GHz (b) 5.8GHz

[2] L. Chang, H. Wang, Z. Zhang, Y. Li and Z. Feng, *Compact single feed dual-mode antenna for active RFID tag application*, IEEE Trans. Antennas Propag. 63 (2015) 5190–5194.
[3] V. Chawla and D.S. Ha, *An overview of passive RFID*, IEEE Commun. Mag. 45 (2007) 11–17.
[4] K. Finkenzeller, *RFID Handbook: Radio-Frequency Identification Fundamentals and Applications*, 2nd ed.; Wiley, New York, NY, USA, 2004.
[5] W.C. Liu and C.C. Huang, *A CPW-fed L-shaped slot planar monopole antenna for triple-band operations*, Microwave Opt. Technol. Lett. 44(6) (2005) 510–512.
[6] Q. Liu, J. Shen, J. Yin, H. Liu and Y. Liu, *Compact 0.92/2.45-GH dual-band directional circularly polarized microstrip antenna for handheld RFID reader applications*, IEEE Trans. Antennas Propag. 63 (2015) 3849–3856.
[7] K. Siakavara, S. Goudos, A. Theopoulos and J. Sahalos, *Passive UHF RFID tags with specific printed antennas for dielectric and metallic objects applications*, Radioengin. 26 (2017) 735–745.
[8] B. Wang and W. Wang, *A miniature tri-band RFID reader with high gain for portable devices*, Int. J. Microw. Wirel.Technol. 9 (2017) 1163–1167.
[9] Y. Zeng, Z.N. Chen, X. Qing and J.M. Jin, *A directional, closely spaced zero-phase-shift-line loop array for UHF near-field RFID reader antennas*, IEEE Trans. Antennas Propag. 66 (2018) 5639–5642.