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SIR based Broadband Dipole Antenna for LTE/ WiMAX/ WLAN Applications

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Abstract

A planar SIR based broadband dipole antenna operating from 1.99 GHz to 3.78 GHz is proposed in this paper. The antenna covers LTE (2.2-3.8 GHz), WiMAX (3.3-3.7 GHz), 2.4 GHz Bluetooth, WLAN and ISM application bands. The proposed structure has simple and compact design with omnidirectional radiation pattern for 2.4 and 3.5 GHz bands with a peak gain of 3.1 dBi. The structure has an overall size of 52 x 24 x 1.6 mm^3.

1. Introduction

Antennas with simple and compact structure having broad bandwidth have great interest due to the rapid growth in wireless communications. Number of antennas that can operate in WLAN, WiMAX, UMTS, Bluetooth, ISM bands etc are discussed in the literature. Researches focus on antennas with wide bandwidth that can operate in more than one service bands. Different techniques are used to enhance the bandwidth of antenna which includes increasing the width of the antenna, decreasing the dielectric constant or by increasing the thickness of antenna [1] [2]. Many researches focus on stacked and coupled resonator models to enhance the bandwidth of patch antennas [3] [4]. The use of fractal [5] and DGS structures for improving the bandwidth is also discussed in [6] [7].

Stepped Impedance resonator has been used in many applications such as filters and amplifiers due to their simple structures. SIR can act as band reject filter based on their resonant properties with better control in higher harmonics [8] [9].

This paper proposes an SIR based antenna that can be operated in the frequency range of 1.9 GHz to 3.78 GHz that have great applications in wireless communication. The antenna consists of two symmetrical SIR on either side of the substrate faced opposite to each other.

2. Antenna Design and Geometry

The geometry of the proposed SIR based dipole antenna is shown in the Figure 1. The antenna is designed operate at 2.45 GHz as per the SIR theory. The resonant frequency of an SIR is determined by the impedance ratio K and length ratio α. Impedance ratio K is defined as

$$K = Z_2/ Z_1 \qquad (1)$$

where Z_1, Z_2 are the impedance of two sections of SIR with width W_1 and W_2 respectively.
The length ratio

$$\alpha = \theta_2/(\theta_1 + \theta_2) \qquad (2)$$

θ_1, θ_2 are the electrical length corresponding to line of length L_1 and L_2. The calculated values of k and α are 0.1283 and 0.5 respectively for the resonance at 2.45 GHz. The fundamental frequency of an SIR can be determined from the K and α values [10].

The proposed antenna consists of symmetrical SIR etched on either side of the substrate. The antenna is coaxially fed with SIR etched on the top and bottom of substrate as shown in figure 1.

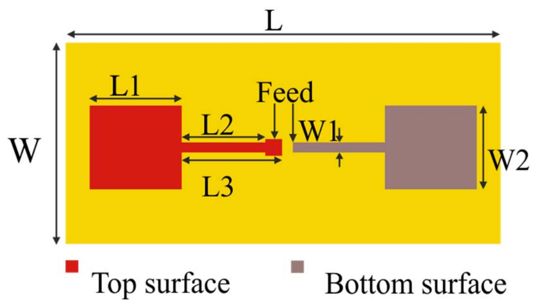


Figure 1. Geometry and dimension of proposed antenna. W = 24 mm, L = 52 mm, L1 = 12 mm, L2 = 10 mm, L3 = 10 mm, W1 = 1.2 mm, W2 = 10 mm.

The structure is simulated and optimized using Ansys HFSS and is fabricated on a low cost FR4 substrate of thickness 1.6 mm and with permittivity $\varepsilon_r = 4.4$ and tan δ = 0.002. The structure has an overall size of 52 x 24 x 1.6 mm^3.

3. Results and Discussions

Antenna measurements are conducted using Agilent PNA E8362B vector network analyzer and measurements are taken inside the anechoic chamber.

The measured reflection coefficient of the antenna is shown in figure 2. The measured -10 dB impedance bandwidth is from 1.99 GHz to 3.78 GHz with a fractional bandwidth 61.89 %.

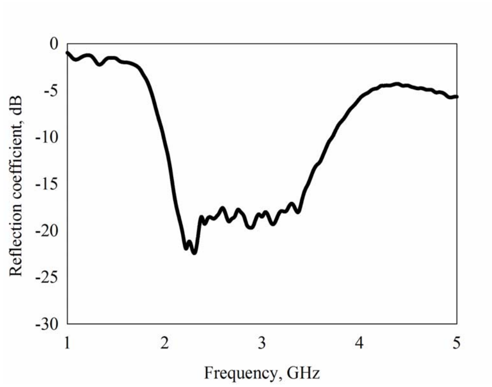


Figure 2. Reflection coefficient of the proposed SIR based dipole antenna.

The calculated value of fundamental frequency of the SIR using equations is 2.45 GHz and the measured results are well matched with the theory.

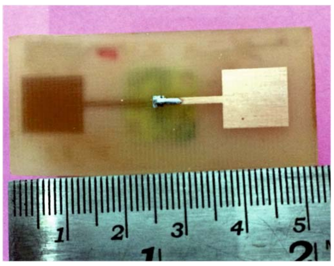
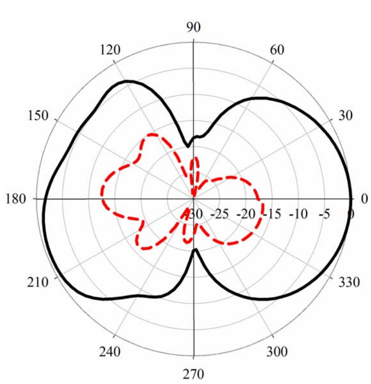
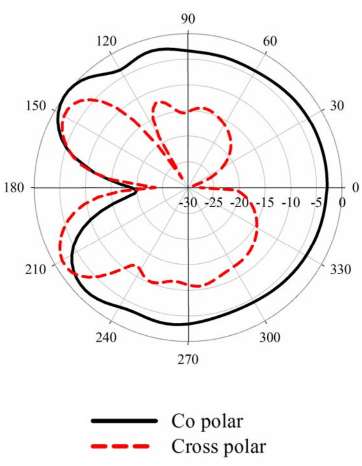


Figure 3. Photograph of the fabricated antenna

The measured radiation pattern at 2.4 GHz for E and H plane is shown in the figure 4.



(a)



(b)

Figure 4. Measured radiation Pattern at 2.4 GHz.
(a) E plane pattern. (b) H plane pattern

From the figure 4 it is observed that the pattern is nearly omnidirectional at 2.4 GHz. Slight discrepancy in the omnidirectional pattern is due to presence of connector in the back side of the antenna, which can be eliminated if the antenna is integrated in the circuit.

Figure 5 depicts the gain of the antenna measured using real time compact benchtop antenna measurement equipment RFXpert (RFX). At 2.4 GHz, SIR based antenna has peak gain of 3.1 dBi.

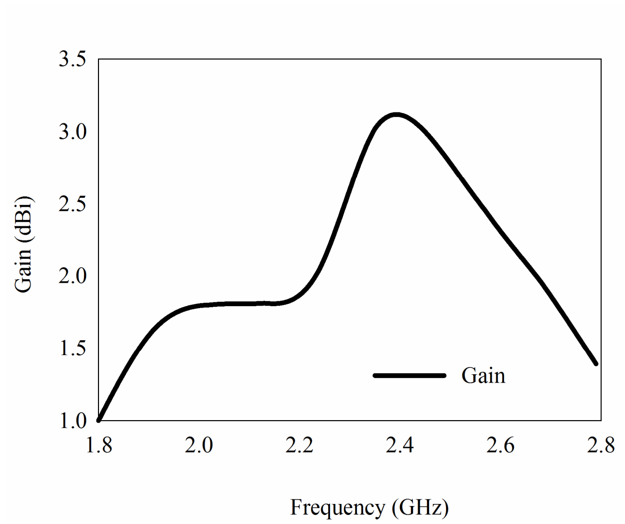


Figure 5. Gain of antenna measured using RFXpert

The broadband SIR based dipole antenna for LTE (2.2-3.8 GHz), WiMAX (3.3-3.7 GHz), 2.4 GHz Bluetooth, WLAN and ISM band applications are demonstrated. The proposed antenna resonance can be easily tuned by slightly changing the SIR parameters.

4. Acknowledgements

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