A New Dual Feed PIFA Diversity Antenna

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Abstract

A new wideband, very low profile (3 mm height), PIFA antenna is proposed. Design: It utilizes two collinear feeds, ground plane slots (to reduce mutual coupling) and modified top radiating plate (to improve the impedance matching). Results: The proposed antenna has a 10-dB impedance bandwidth 2.25-3.2 GHz. It covers several important wireless applications such as 2.4 GHz WLAN, Bluetooth, four LTE bands (bands 7, 38, 40 and 41) and S-DMB band 2.63-2.655 GHz. Conclusions: Both simulated and measured results are presented to quantify and validate the antenna performance, the results shows that this design can be a good candidate for MIMO applications..

Aims.

- To find a low profile, wideband and dual feed PIFA antenna for MIMO and diversity applications.
- To find suitable isolation technique that helps both feeds isolations and antenna bandwidth.

Background

MIMO technology becomes a core of recent wireless communication technologies. By using multiple antennas at both communication ends two goals are achieved : better system reliability and more system capacity.

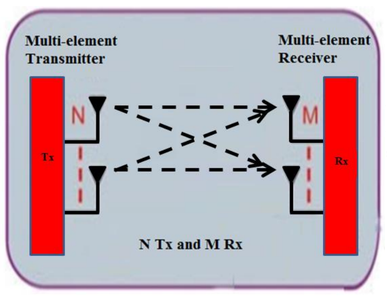

Fig. 1
MIMO system configuration

Antenna design approaches for MIMO:

a) Multiple element antennas (MEA)
b) Compact, single antenna element with more than one feed.. This approach is preferable for small devices to save space but with the expense of increasing mutual coupling level that require isolation suitable technique.

The performance of MIMO antenna system is usually characterized by the following parameters:

a) Envelope correlation coefficient (ECC) between received signals of different antennas. It should be less than 0.5.
b) Branch power ratio (k): a measure of power balance between antennas in MIMO system. It should be between 0 and 3 dB.
c) Diversity gain: ability of MIMO system to immune signal fading, it can be calculated using ECC .

Antenna Design

The geometry of the proposed antenna is depicted in Fig. 2. To improve impedance matching for Feed 2, the top plate is modified by creating a small strip as shown in Fig. 2 (a). To enhance Feed 1 radiation, Slot 2 is created (Fig. 2 (b)). For feeds isolation, two techniques are used; the first one is linked to the arrangement of the feeds, they are arranged in a collinear way to provide less mutual coupling compared to parallel or orthogonal case. The second one, is by creating L-shaped ground plane slot between antenna feeds (Fig. 2 (b)), it represents a band stop resonator.

The design is optimized using CST Microwave studio via a parametric approach. The optimized antenna has the following main dimensions: L_g = *100* mm, W_g = *40* mm, L = *20* mm, W = *40* mm, X_{f1} = *7* mm, X_{f2} = *38* mm, W_{f1} = *5* mm, W_{f2} = *2* mm, d_f = *26* mm, X_{sh} = *40* mm, Y_{sh} = *16.5* mm, W_{sh} = *0.5* mm, h =*3* mm, t = *1.5* mm, L_t = *9* mm, W_t = *3.5* mm, Y_t = *3* mm, X_t = *18* mm, X_{s1} = *18* mm, W_{s1} = *5.5* mm, L_{s1} = *19* mm, W_{s2} = *7* mm, L_{s2} = *13.5* mm, Y_{s2} = *12* mm, L_{s3} = *18* mm, W_{s3} = *6* mm and Y_{s3} = *13* mm.

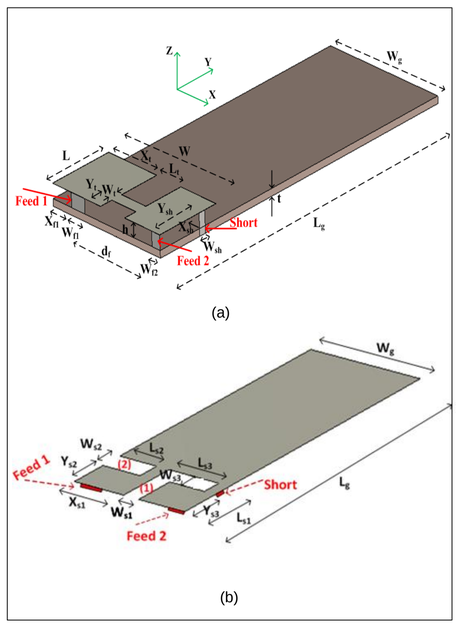

Fig. 2
Geometry of the proposed antenna (a) Antenna structure (b) Modified ground plane

Results

The prototype of the proposed antenna shown in Fig. 3 is fabricated and tested. The simulated and measured S-parameters results in Fig. 4 shows that the antenna has a measured 10 dB impedance bandwidth from 2.25 GHz to 3.2 GHz with an isolation level better than 14 dB. Pattern diversity can be shown from measured radiation patterns of both XZ and YZ planes in Fig. 5 and Fig. 6, respectively..

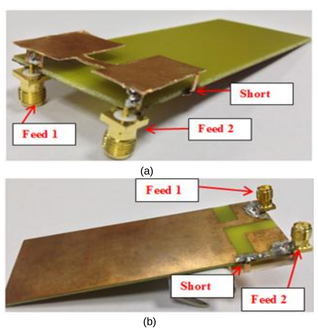

Fig. 3
Simulated S-parameter results

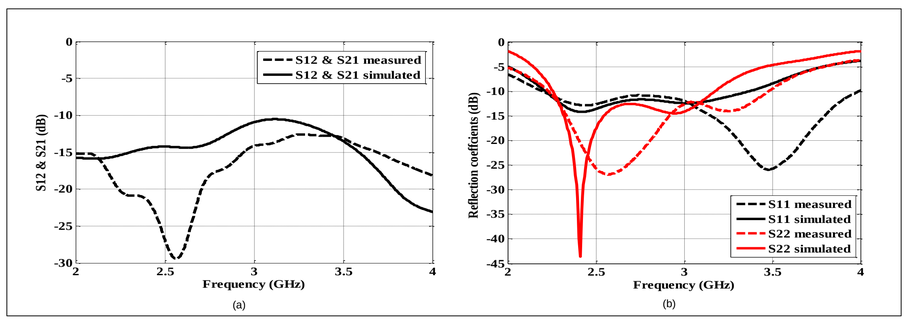

Fig. 4
Calculated envelope correlation coefficient

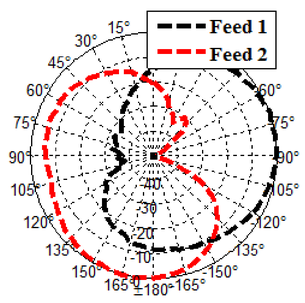

Fig. 5
Measured radiation pattern in XOZ plane @ 2.4 GHz

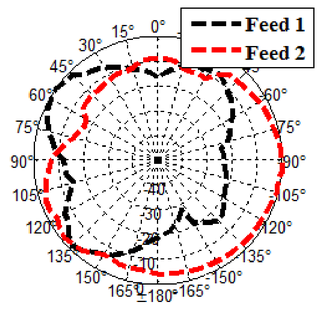

Fig. 6
Measured radiation pattern in YOZ plane @ 2.4 GHz

For diversity performance, the proposed design satisfied both diversity conditions. The first parameter is the envelope correlation coefficient (ECC), Fig. 7 shows the simulated and measured ECC which are in a good agreement and less than the critical value 0.5. The second condition which is a measure of power balance between antenna feeds, it is defined by mean effective gains ratio. The calculated value is about 0 dB which is also satisfied. Finally, the effectiveness of this proposed diversity antenna to resists the multipath channel fading is quantified by diversity gain. The design has an acceptable diversity gain as shown from Fig. 8.,

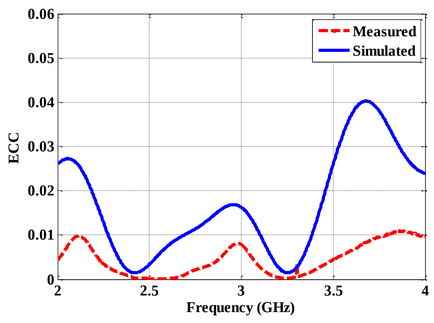

Fig. 7
Envelope correlation coefficient

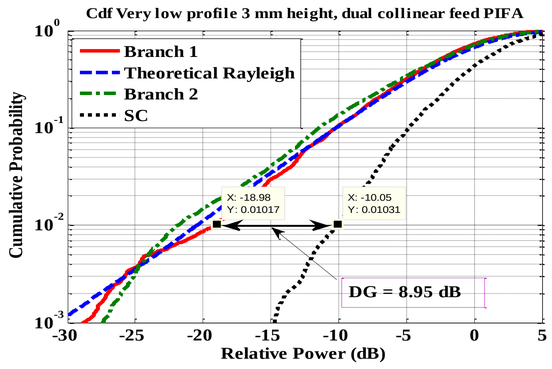

Fig. 8
Measured apparent diversity gain

Conclusions

In this work, a new wideband, very low profile (height = 3 mm) diversity PIFA antenna has been presented as a diversity and MIMO antenna for handset applications over the frequency band 2.25-3.2 GHz. The antenna utilizes a new feed arrangement that produces lower level of mutual coupling. The underling theory behind the design has been discussed. The low profile design was achieved with the aid of ground plane slots. The isolation has been achieved via band stop filter formed by an L-shaped ground plane slot. It is has been investigated using numerical simulation tool and measurement validation. The results have shown that this novel antenna is an excellent candidate for mobile hand-portable applications.