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DIFFERENTIAL FED MIMO ANTENNA FOR WIDE BAND APPLICATIONS

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ABSTRACT

This paper presents a differential fed monopole antenna with Multi Input Multi Output (MIMO) configuration. Two models are proposed for wide band communication systems with defected ground structure on the other side of the substrate. The basic model and the proposed modified model are showing excellent radiation characteristics in the wide operating band. The simulation results are carried with commercial electromagnetic tool HFSS and the antenna parameters are analysed a presented in this work. The proposed antenna is prototyped on FR4 substrate with dielectricconstant 4.4 and the measured results on network analyser arecompared with simulation results for validation.The polarization purity when compared with base model; the proposed model is showing better results especially at high frequency bands.

Keywords: differential fed antenna, MIMO (Multi Input Multi Output), wideband antenna, defected ground structure, radiation characteristics, polarization.

1. INTRODUCTION

Due to many advantages like great capacity, low-cost, the Ultra-wide band (UWB) has been paid much attention in the communication systems. The frequency band for commercial UWB systems is 3.1-10.6 GHz. Basically the UWB antennas have features of simple structure, wide impedance bandwidth and constant gain in desired direction [1-4]. Planar antenna is generally the best because of its compact size and easy integration with RF circuits and hence various planar UWB antennas like circular monopole antenna, rectangular aperture antenna, open slot antenna, fractal bow-tie dipole antenna and so-on are presented. The radiation pattern of these antennas deviate from the broadside direction in the high frequency band which may cause the mistake for UWB applications that require stable radiation pattern [5-8]. To solve such problems, many techniques are implemented to improve radiation pattern of the UWB antenna. However, although the radiation pattern at high frequencies is improved to some extent, the cross-polarization of the antennas is in high level in the H-plane, thus the polarization purity still need to be improved.

A wideband antenna is one with approximately or exactly the same operating characteristics over a very wide passband. It is distinguished from broadband antennas, where the passband is large, but the antenna gain and/or radiation pattern need not stay the same over the pass band. Multiple Input And Multiple Output, or MIMO is a method for multiplying the capacity of a radio link using multiple transmit and receive antennas to exploit multipath propagation [9]. MIMO has become an essential element of wireless communication standards including IEEE 802.11n (Wi-Fi).At one time, in wireless, the term “MIMO” referred to the, mainly theoretical, use of multiple antennas at the transmitter and the receiver. In modern usage, “MIMO” specifically refers to a practical technique for sending and receiving more than one data signal with the same radio channel simultaneously via multipath propagation. MIMO is fundamentally different from smart antenna techniques developed to enhance the performance of a single data signal, such as beam forming and diversity [10-14].An antenna is prototyped is designed and fabricated to validate the proposed designed strategy. It is known that the designed antenna exhibits a wideband performance from 3 to 12 GHz.

2. ANTENNA DESIGN AND GEOMETRY

Figure-1 shows the sign antenna models for wide band communication systems using HFSS tool. The basic model is constructed by taking 2 half circle monopole radiating elements in opposite direction on one side of the substrate. The other side of the substrate consisting of ground plane which is etched at a particular location as shown in figure. The ground plane is also consisting of slots on 4 corners of the ground plane. The basic model is modified with addition of small semi circles on top side of the both monopole radiating elements. The proposed structure is also consisting of a U-shaped slot on the feedline. The ground structure for both the models are almost same with respect to dimensional characteristics are concerned. The antenna overall dimension is around 22x30x1.6 mm. The complete antenna dimensional parameters in mm are present in Table-1.

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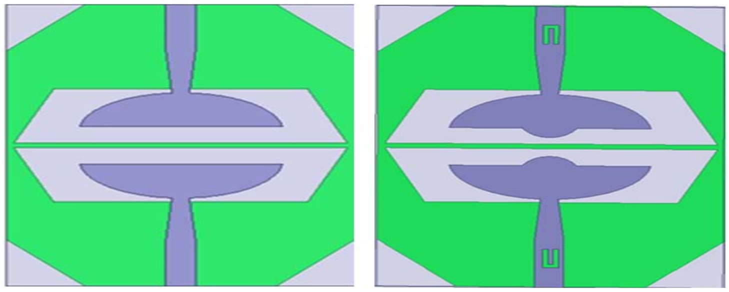

Figure-1. MIMO Antenna models, (a) Model 1, (b) Model 2.

Table-1. Antenna dimensions in mm.

Parameter	W	H	Ws	Wr	Lr	Rc	wg	g	Gp	Re	Rei
Value(mm)	22	30	21	0.5	5.75	5	0.5	0.5	4	6.4	4
Parameter	Lf	Wf	Lt	Wt	P	Q	R	S	T	M	
Value(mm)	9.5	1.86	4.5	1.1	2	2	1	1	0.5	1.73	

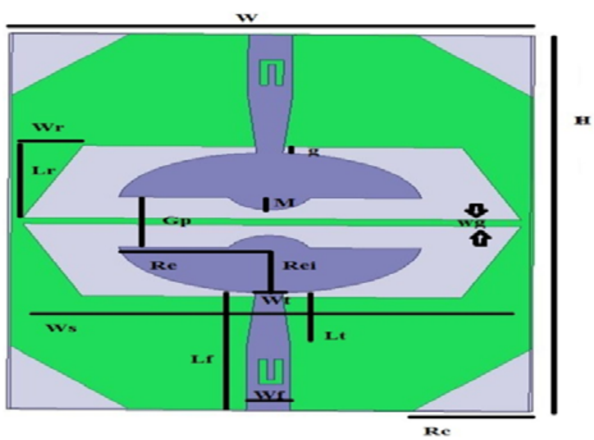

Figure-2. Proposed MIMO antenna dimensional characteristics.

Figure-2 shows the proposed antenna structure with dimensions in conjunction with antenna dimensions in table 1.A narrow strip is added along with symmetrical line of antenna, which divides the slot hexagon into 2 trapezoidal slots. That strip acting as a virtual ground plan will somewhat reduce the asymmetrical effect. The 4 corners of the ground plane are also etched to maintain the impedance matching at higher frequency band.

3. RESULTS AND DISCUSSIONS

The proposed antenna models are designed and simulated using HFSS tool and the results are analysed and presented in this section. Figure-3 shows the reflection coefficient characteristics of the designed antenna models. Antenna model 1 is resonating in the wide band with bandwidth of 14 GHz and an impedance bandwidth of 120%.

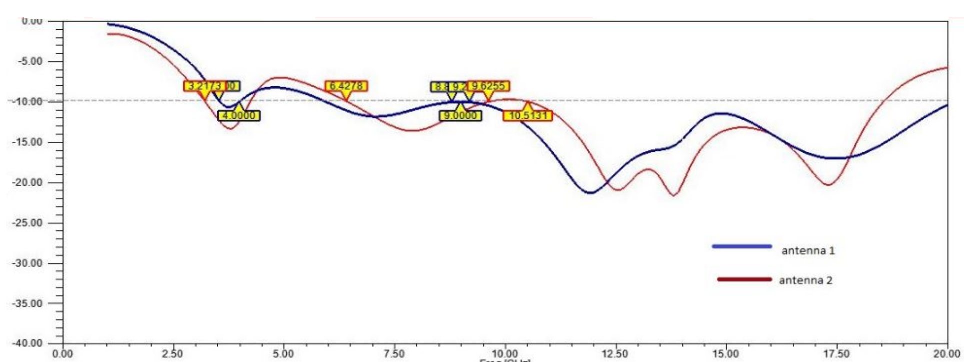

Figure-3. ReturnlossVs Frequency.

Antenna model 2 is resonating in the wide bandwith bandwidth of 15.5GHz with impedance bandwidth of 136%.The improvement in the bandwidth is achieved by changing the shape of the radiating element.

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The proposed antenna is also providing notch band characteristics in the WLAN band whereas base model failed to match the desired band fully.

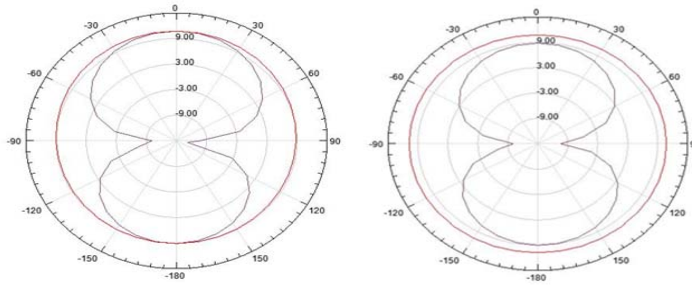

Figure-4(a). Radiation Pattern of Antenna Model 1 in E and H-Plane.

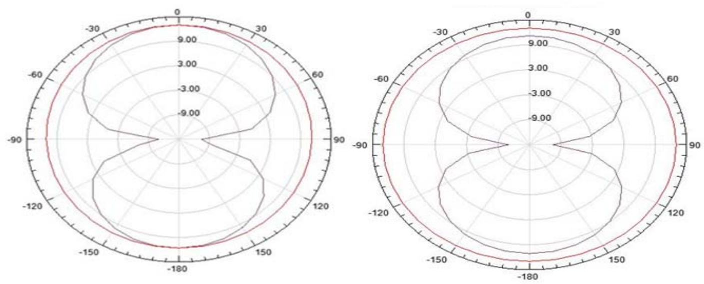

Figure-4(b). Radiation Pattern of Antenna Model 2 in E and H-Plane.

Figure-4 shows the radiation characteristics of both the designed models in E-plane and H-plane. The radiation pattern gives the information regarding orientation of radiation over the defined area. Antenna model 1 is showing monopole like radiation in E-plane, dipole like radiation in H-plane. Antenna model 2 is providing omnidirectional radiation pattern in H- plane with low cross polarization a dipole like radiation in the E-plane.

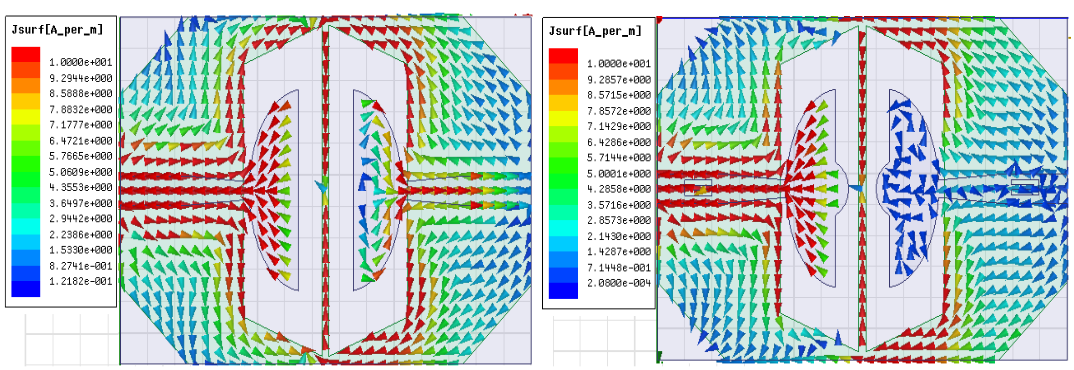

Figure-5. Current distribution of Antenna Model 1 and 2 at 3 GHz.

Figure-5 shows the current distribution of the antenna models at 3GHz. It is been observed that in the base model the most of the current distribution is focussed around trapezoidal slot ground plane and on the feed line of the first monopole element which is oriented in Y-direction. Antenna model 2 is showing current distribution more on the centre symmetrical strip line rather than ground plane edge. In both the models, monopole element placed on the right side (i.e., orthogonalelement) is not contributing much in the radiation when compared to left side element.

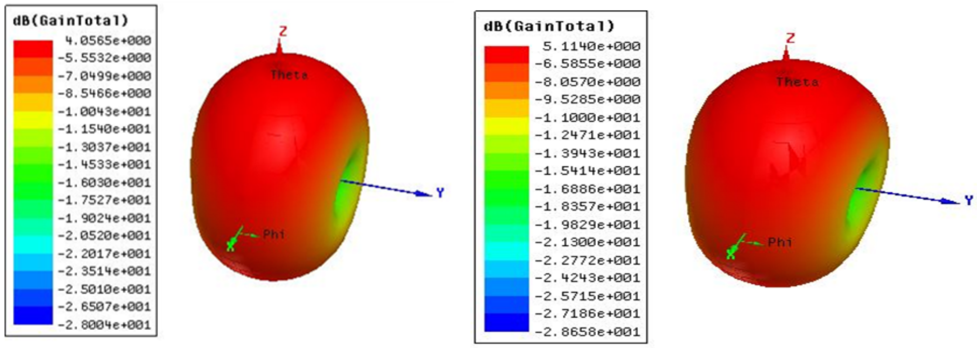

Figure-6. Three dimensional gain of Antenna Models at 3 GHz.

Figure-6 shows the gain characteristics of the designed antenna models in 3 dimensional view. Both these models are giving almost omnidirectional radiation in XZ plane as shown in figure 6.A maximum peak realised gain of 4db is attained for antenna model 1 and 5.1db is attained for antenna model 2.

Figure-7. Fabricated MIMO Antenna on FR4 substrate.

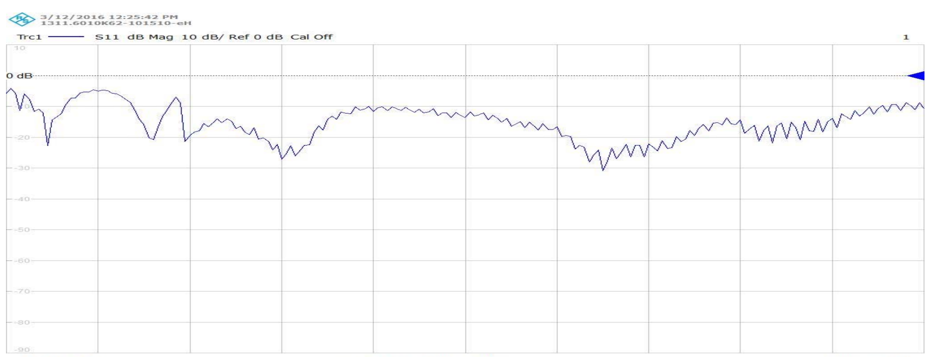

Figure-8. Measured S11 of Fabricated Antenna Model on ZNB 20 VNA.

4. CONCLUSIONS

Wideband MIMO antenna models are designed with dimensions of 22 X 30 X 1.6 mm on FR4 substrate. First model is providing wideband characteristics and the second model is notching WLAN operating band. The proposed model is notching certain frequency band by placing U-slot on the feed line. A huge bandwidth of 15.5 GHz is obtained with impedance bandwidth of 136%. The proposed antenna model is sowing excellent radiation characteristics with peak realized gain of more than 5 dB. Prototyped antenna is showing measured results comparatively equal to simulated results obtained from HFSS.

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