A Dual Band Decoupling Network for Two Coupled Antennas in MIMO applications

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ABSTRACT

The proposed Two Dual band monopole antennas, is composed of two branches, at the center frequencies of the lower and upper bands, 2.45 and 5.25 GHz, respectively. The network between the radiating strips helps to improve the impedance matching and decouple the antennas. The antenna is printed on the top side of a 1.6-mm FR4 substrate (ε_r= 4.6) while a ground plane, with a size of 80 × 55 mm, is etched on the bottom side. The antenna was simulated using ADS (Advanced Design System) Software and S-parameters of the proposed dual-band antennas were measured. The antenna, with $|S_{11}| < -10$ dB, covers the whole WLAN bands from 2.33-2.93 GHz and 4.59-5.52 GHz. The simulated and measured scattering parameters at 2.45 and 5.2 GHz had shown an isolation improvement.

Keywords/ Index Term— ADS, Monopole antenna, 2.45 and 5.25 GHz.

1. INTRODUCTION

In this paper a decoupling network was designed to decouple the two coupled antennas. The Coupled Resonator Decoupling network (CRDN) was designed and connected in shunt between the coupled antennas. The network can effectively reduce the couplings between two coupled dual-band antennas in two bands simultaneously. The measured scattering parameters of two coupled antennas with and without the Decoupling network prove that the isolation between the two antennas in both the low and high bands can be improved.

2. TWO DUAL BAND MONOPOLE ANTENNAS WITHOUT DECOUPLING NETWORK

The two identical printed dual-band monopoles are designed as shown in Fig-1 using ADS Software. Transmitting and receiving antennas are placed close to each other on a 1.6-mm-thick FR4 substrate. The separation distance DA = 9.8 mm. The simulated S parameters for the antennas are shown in Fig-2.

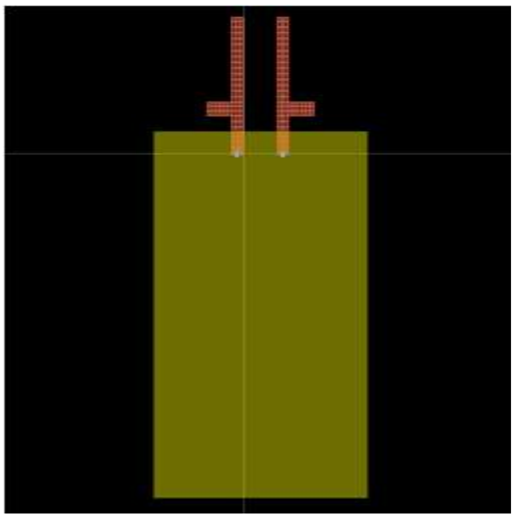

Fig-1: Two Dual-Band Monopole Antennas in ADS.

The return loss of |S11| at 2.45GHz is -0.849 and at 5.25GHz is -0.893, |S21| at 2.45GHz is -13.577 and at 5.25GHz is -22.022. Antenna Parameters are measured for both 2.45 and

5.25 GHz. The value of Power radiated, Effective angle, Directivity, Gain are measured is shown in Fig-3 and Fig-4.

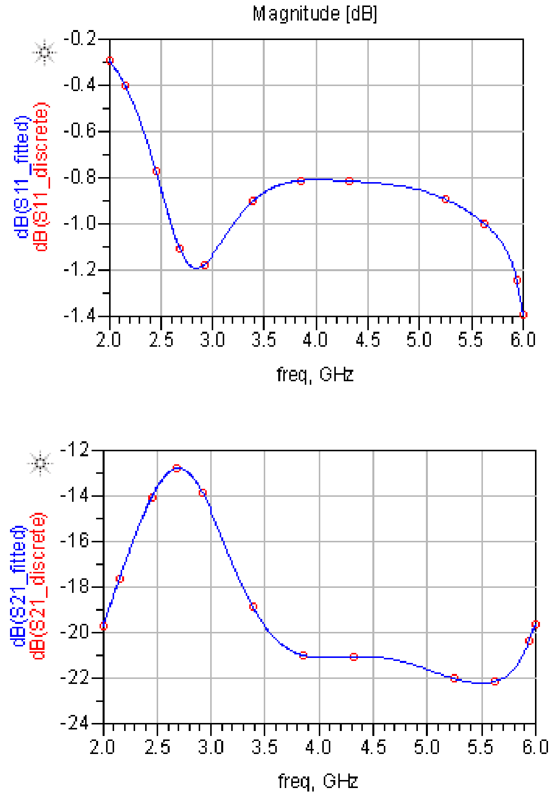

Fig-2: Simulated S parameters of coupled antennas

Antenna Parameters

Power radiated (Watts)		0.000128794
Effective angle (Steradians)		2.7087
Directivity(dBi)		6.66449
Gain (dBi)		-3.84083
Maximim intensity (Watts/Steradian)		4.75483e-05
Angle of U Max (theta, phi)	0	0
E(theta) max (mag,phase)	0.185811	-95.7912
E(phi) max (mag,phase)	0.0360575	84.2173
E(x) max (mag,phase)	5.96334e-05	-100.872
E(y) max (mag,phase)	0.189277	84.2091
E(z) max (mag,phase)	0	0

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Fig-3: Antenna Parameters for 2.45GHz

Antenna Parameters

Power radiated (Watts)		0.000237726
Effective angle (Steradians)		2.33398
Directivity(dBi)		7.31113
Gain (dBi)		-0.368438
Maximim intensity (Watts/Steradian)		0.000101854
Angle of U Max (theta, phi)	70	270
E(theta) max (mag,phase)	0.277026	-26.6618
E(phi) max (mag,phase)	0.000126063	-88.9927
E(x) max (mag,phase)	0.000126063	-88.9927
E(y) max (mag,phase)	0.0947484	153.338
E(z) max (mag,phase)	0.260319	153.338

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Fig-4: Antenna Parameters for 5.25GHz

3. TWO DUAL BAND MONOPOLE ANTENNA WITH DECOUPLING NETWORK

The same way two dual-band monopole antennas are designed with Decoupling network. The CRDN is designed using ADS Software. The designed two dual-band monopole antennas with decoupling network are shown in Fig-5. The isolation between the antennas should be high for good performance, so the coupling should be minimized. The level of coupling from antenna 1 to antenna 2 depends on the gains of the individual antennas in the particular directions and loss over the total path length, as well as the reflectivity of the surfaces at which the reflection occur. The coupling is conveniently expressed in dB. The simulated S parameters for the antennas with Decoupling network are measured as in Fig-6.

The return loss of |S11| at 2.45GHz is -1.119 and at 5.25GHz is -0.720, |S21| at 2.45GHz is -20.49 and at 5.25GHz is -22.21. Antenna Parameters are measured for both 2.45 and 5.25 GHz. The value of Power radiated, Effective angle, Directivity, Gain are measured is shown in Fig-7 and Fig-8. The simulated scattering parameters of coupled and decoupled antennas are measured using ADS. By comparing it can be seen from S-parameters in the bands of interest, the designed CRDN significantly reduces the mutual couplings of the original coupled antennas in the two designated frequency bands (2.45 and 5.25 GHz) as compared to those of the original coupled antennas. The simulated and measured scattering parameters of the coupled dual-band antennas are measured using ADS.

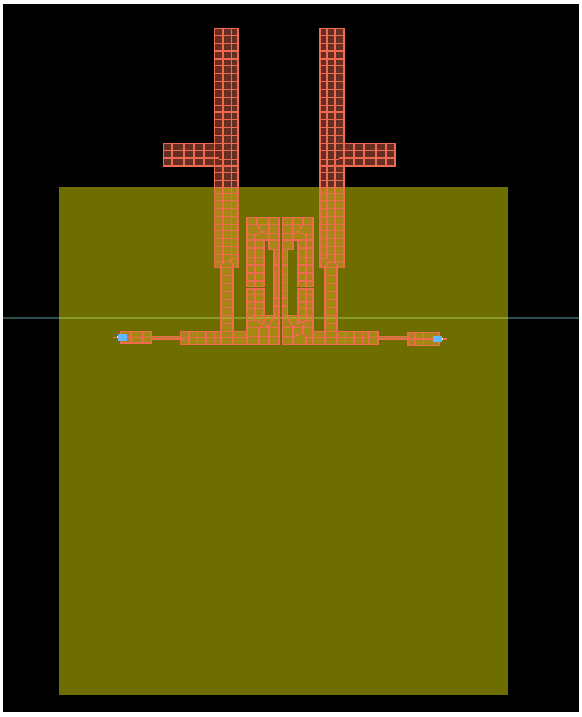
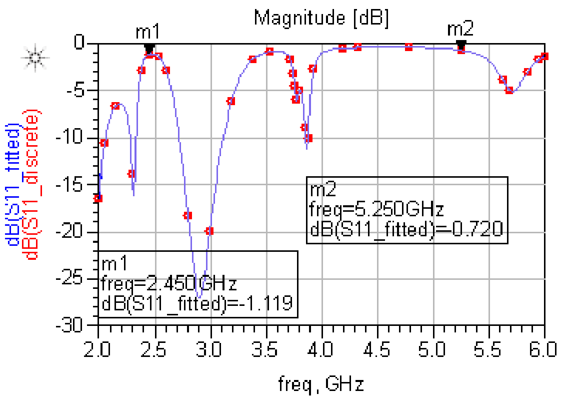


Fig-5: Two Dual Band Monopole Antennas with Decoupling Network in ADS



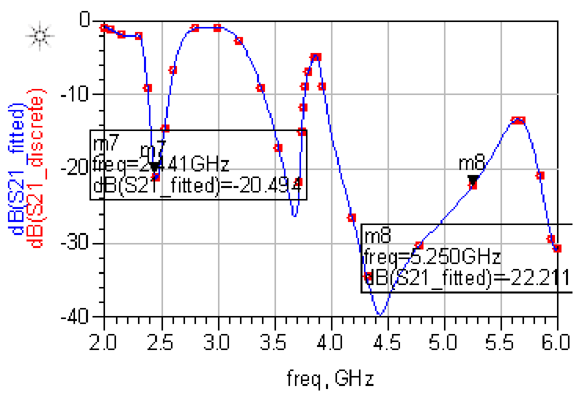
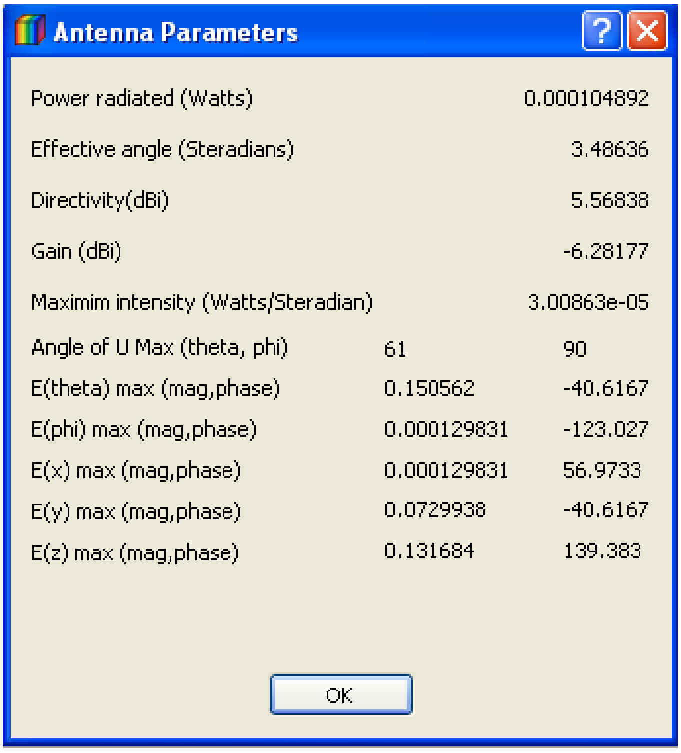


Fig-6: Simulated S parameters of coupled antennas

The resultant value of coupled antennas with and without decoupling network is measured. The results of various parameters are shown in Table-1



Antenna Parameters

Power radiated (Watts)		0.000104892
Effective angle (Steradians)		3.48636
Directivity(dBi)		5.56838
Gain (dBi)		-6.28177
Maximim intensity (Watts/Steradian)		3.00863e-05
Angle of U Max (theta, phi)	61	90
E(theta) max (mag,phase)	0.150562	-40.6167
E(phi) max (mag,phase)	0.000129831	-123.027
E(x) max (mag,phase)	0.000129831	56.9733
E(y) max (mag,phase)	0.0729938	-40.6167
E(z) max (mag,phase)	0.131684	139.383

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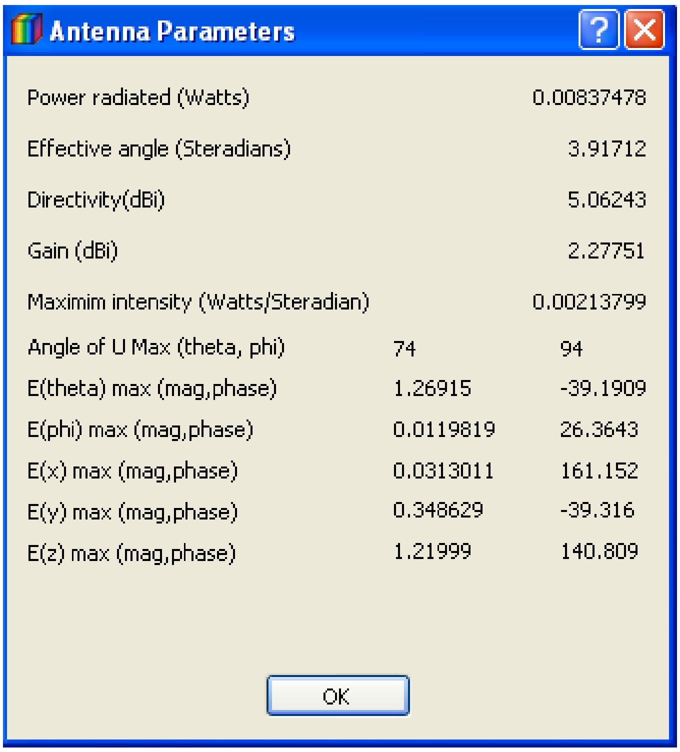
Fig-7: Antenna Parameters for 2.45GHz



Antenna Parameters

Power radiated (Watts)		0.00837478
Effective angle (Steradians)		3.91712
Directivity(dBi)		5.06243
Gain (dBi)		2.27751
Maximim intensity (Watts/Steradian)		0.00213799
Angle of U Max (theta, phi)	74	94
E(theta) max (mag,phase)	1.26915	-39.1909
E(phi) max (mag,phase)	0.0119819	26.3643
E(x) max (mag,phase)	0.0313011	161.152
E(y) max (mag,phase)	0.348629	-39.316
E(z) max (mag,phase)	1.21999	140.809

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Fig-8: Antenna Parameters for 5.25GHz

TABLE-I

Table-1: Result values of antennas with and without decoupling

	Without Decoupli ng	Without Decoupling	With Decoupling	With Decoupling
	At 2.45 GHz	At 5.25 GHz	At 2.45 GHz	At 5.25 GHz
Gain	-3.840	-0.368	-6.2812	2.2757
Directivity	6.664	7.311	5.5683	5.0624
Efficiency	8.902	17.062	5.9	35.2
Power radiated	0.000128	0.00023	0.000104	0.00837
Return loss				
$\|S_{11}\|$	-0.849	-0.893	-1.119	-0.720
$\|S_{12}\|$	-13.577	-22.022	-21.202	-22.211
$\|S_{21}\|$	-13.605	-22.007	-20.49	-22.211
$\|S_{22}\|$	-0.857	-0.900	-1.122	-0.785

4. CONCLUSION

A Dual-Band Decoupling network is proposed in this project. This Decoupling network reduces the coupling between the antennas effectively and increases the isolation. By comparing the results the Decoupling network effectively reduces the coupling between the antennas. The values of Gain, Directivity, Efficiency, Power radiated, Return loss are shown in Table. I. Good results are achieved with Decoupling network at 5.25 GHz.

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