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Analysis and Design of Closely Packed Printed Semicircular Monopole MIMO Antenna

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Abstract: *The isolation and the ECC (Envelope Correlation Coefficient) between two or more antennas are Very important in the MIMO systems because each antenna is required to independently operate in order to ensure the performance of the MIMO antenna systems. In this paper two element printed semicircular monopole (PSCMA) array is proposed. The distance between the PSCMA elements is less than 0.25λ. A broad impedance matching bandwidth up to 1.8 GHZ (4.5 to 6.3GHZ) is achieved. The decoupling level improved up to -35 dB at 6 GHZ. The proposed antenna structure is found to provide good MIMO (Multiple Input Multiple Output) diversity performance. The approach is proven by both simulation and measurement.*
Keywords*: *- Antenna geometry, Simulation result, antenna measurement result.

I. Introduction

Modern communication technology especially in MIMO applications such as Wi-Fi, FMC, UMA the role of multiple antenna is becoming more popular. Day by day most electronic devices are becoming compact. So advanced technology need to pack antennas closely. MIMO technologies help to provide high-speed data transmission and high channel capacity. Due to limited space for antenna implementation which cause various mutual coupling problems that degrade the performance of antenna, special decoupling techniques are required for closely packed antennas. Several methods to improve mutual coupling and matching have been reported. In [1] a slit is carved on the ground to reduce mutual coupling between two closely packed antennas. In [2] A two-port compact printed monopole antenna array with decoupling structure based on partially extended ground plane applicable for small terminals is presented. The distance between the printed monopole elements is less 0.25λ. A broad matching and decoupling bandwidth up to 1.5 GHz (5.1–6.6 GHz) is achieved.

In [3] the idea of capacitively loaded loops (CLL) magnetic resonators in order to de correlate two monopole antennas is introduced. Although the coupling had been reduced in [3], the antenna elements were not well-matched. In [4] to [5] matching and decoupling networks between the radiating elements and input ports are implemented. For this approach, Eigen mode excitation and multiport conjugate matching are two general theories mostly adopted. The problem of such a method is that the Operating bandwidth is limited at least for one of the inputs. Additionally, the matching and decoupling network is complex and lossy, which increases the fabrication expense and affects the radiation Efficiency.

In [6] [7], parasitic elements are used to reduce mutual coupling. In [6] by adding parasitic elements a double-coupling path is introduced and it can create a reverse coupling to reduce mutual coupling. This technique is sensitive to phase relationships, which are related to relative positions between parasitic elements, and relative positions between active element and parasitic element. However, the parasitic elements are not viable in compact devices. Various regular shaped printed monopole antennas for different feed positions are reported in paper [8].According to paper [8] PCMA's, and PEMA's gives maximum impedance matching band width compared to other category of PMA's.

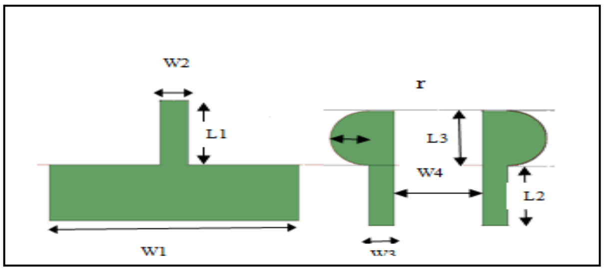


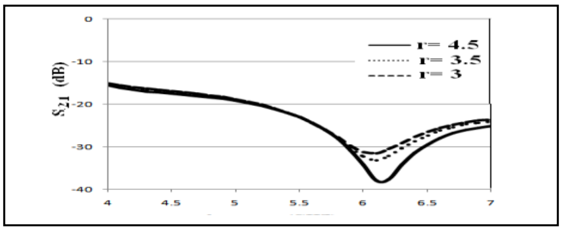
Fig. 1 Two port printed semicircular monopole array w1=35, w2=4, w3=3, w4=10.4, L1=11.5, L2=10, L3=9, r=4.5 Unit millimeters.

In this paper a compact two element printed semicircular monopole antenna (PSCMA) array is proposed. Mutual coupling of two port array is achieved by using PEG (partially extended ground) structure of paper [2]. The proposed structure uses two printed monopole antennas as shown in fig. 1. The antenna array operate around 4.5 GHZ to 6.3 GHZ. Achieved matching and decoupling band width is wider and structure is much simpler as compared to other techniques.

II. Antenna Geometry

The geometry of the proposed PSCMA with partially extended ground structure which is longer than the printed semicircular monopole array (PSCMA) is as shown in fig.1.PEG acts as a reflector toward the antenna and isolates the two radiating element [2]. However reflections from the reflector degrade the performance of the antenna. In this paper performance of antenna is improved by using PSCMA's. Patches are fabricated on dielectric substrate FR4, with dielectric constant 4.4 & tan δ= 0.02 which are very cost effective. The structure is modelled on IE3D simulator. To check the performance of PSCMA structure simulations of the printed semielliptical monopole array (PSEMA) with different primary radius (3mm, 3.5mm) of semi ellipse are also performed.

Fig. 2 Simulated S_{11} of the geometry shown in Fig. 1 for different primary radius (r) of semi ellipse.



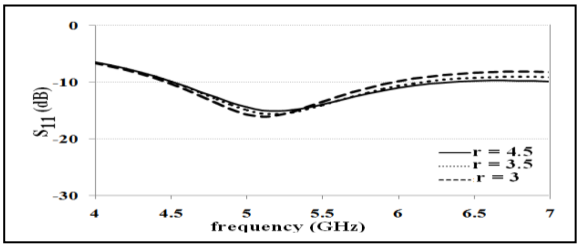
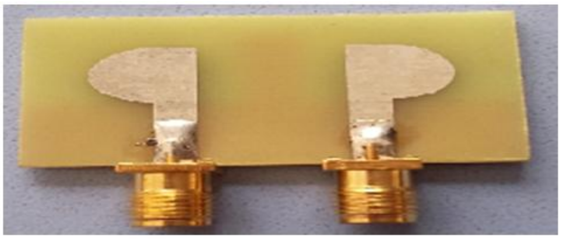
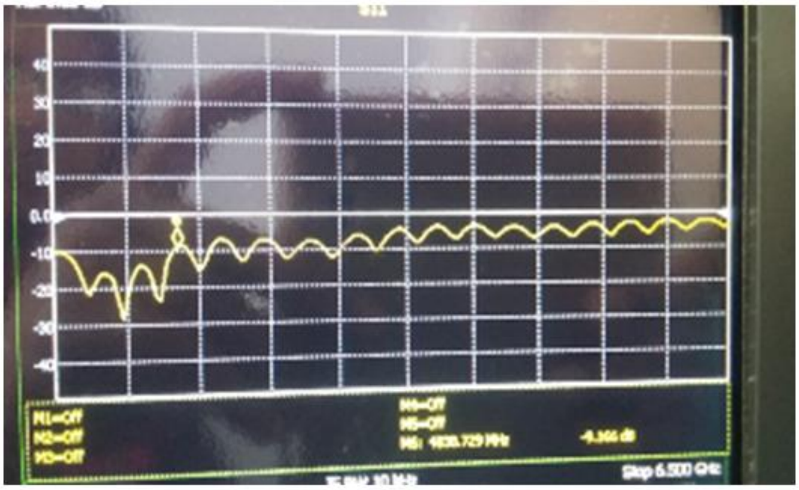


Fig. 3 Simulated S_{21} of the geometry shown in Fig. 1 for different primary radius (r) of semi ellipse.

Simulated results of S_{11} and S_{21} parameters for various primary radius of semi ellipse are shown in figure 1 and figure 2 respectively. It is observed that the impedance matching bandwidth for r = 3 is ------------- GHZ and coupling between the two PSEMA is ----------------- dB To improve matching Bandwidth and decoupling between two monopoles, simulation is carried out for r =3.5 and r = 4.5. However increasing the primary radius of semi ellipse from 3 to 4.5, is found an efficient approach to improve the matching and decoupling between the two monopole. The matching bandwidth is improved to 1.8 GHZ for r = 4.5. Also decoupling is improved from -------dB to -37 dB at 6 GHZ for r = 4.5.

III. Antenna Fabrication And Measured Result:





IV. Conclusion

Decoupling as well as impedance matching of a two port printed monopole array was successfully improved by implementing semicircular monopole array. The advantages of presented structure is that the PSCMA helps to improve decoupling as well as impedance matching. Also PCMA gives good diversity performance. The structure is much simpler and the cost complexity of the design are very low. Various performance parameters such as impedance matching bandwidth, decoupling for different radius of semielliptical monopole are calculated & presented**.**

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