A CPW-Fed Rectangular MIMO Antenna

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Abstract:

This paperwork contains multiple input and multiple output (MIMO) antenna which uses Co-planar Waveguide (CPW) feeding system, for the frequencies of 2.5/5 GHz. Multiple-input multiple-output means placing multiple antenna elements to improve the efficiency and capacity and used in communications. . And it has higher data rate and multipath propagation. The proposed design of antenna contains elements which are identical and placed parallel to each other. The antenna is printed on the FR4(flame resistant 4) substrate, which is cost-effective dielectric substrate. The antenna has good impedance matching. The antenna design in this paper has envelop correlation coefficient (ECC) which is less than 0.001 and Diversity gain is greater than 9.99dB. The proposed antenna is used for MIMO applications due to high diversity value, low ECC, low reflection coefficient, and the components have low mutual coupling.

Keywords: ECC, DG, MIMO, CPW

1. Introduction

Nowadays, wireless communication networks usage is rapidly increasing, so for efficient communication we are going for MIMO antennas. MIMO has many advantages includes multipath fading, capacity of channel, high transmission rate when compared to single antenna design. The channel capacity increases by using multiple antennas at transmitter and receiver and high Signal to Noise ratio (SNR) to achieve good communication. In year 2002, the FCC authorized the use of 3.1-10.6 GHz frequencies for Ultrawide Band applications [1]. The antennas are combined to reduce the errors, optimize speed of data by sending data to travel through many paths at same time. MIMO creates more stable connection and less congestion. For increasing antenna efficiency, meta-material approaches are published. Meta-material is unique structure with distinct electromagnetic properties, used in super lens modelling [2].

Antenna is designed on CPW fed because it has wide bandwidth and also it has minimum loss compared to micro-strip antennas [3]. Compared with conventional micro strip lines, coplanar waveguide has advantage of easier fabrication and flexibility. MIMO antennas will continuously upgrades and expand its usage in massive applications, as in future the wireless industry accommodates more antennas, devices, and networks. It has more coverage, high network capacities. There are many MIMO systems with different techniques, includes our proposed design. In [4] which is similar to our proposed MIMO antenna, the elements of antenna are placed parallel to one another. There are other techniques like EBG structure, DGS structure and using of Meta-material structure to minimize the mutual coupling between the antenna elements.

For achieving high isolation, split ring resonator's single negative property is used like complementary split ring resonator [5]. The antenna in [6] is combination of rectangles that has turnings and truncations which increase dual band performance, and efficiency of antenna [6]. The easiest way to get high degree of isolation for MIMO antenna is to keep distance between antenna elements. For improving mutual coupling a decoupling structure is used and in other case we place a resonator between elements for better isolation [7]. In this paper[7], they designed an slot antennas, using two different excitations. One is mictrostrip line, and other is CPW fed. CPW feeding technique is where signal and ground currents are etched on same layer. The CPW has many advantages includes, wide band characteristics, efficiency. So, CPW fed antenna is most effective and has many applications.

In this paper, we proposed a multiple input multiple output (MIMO) antenna which is fed by coplanar waveguide (CPW). This model consists two symmetrical elements placed parallel to each other and ground is placed at the end of the elements. This entire structure is placed on FR4 substrate, covers a frequency of 2.5/5 GHz. It provides good isolation, low envelop correlation coefficient, and high diversity gain. It is designed for good applications of MIMO antenna.

2. Antenna Design:

For designing antenna, firstly we need to select frequency, and selection of substrate with height and dielectric constant. We also consider length and width, feed. Our proposed antenna operating frequency range is 2.5/5GHz. The antenna design which is proposed in this paper, is CPW fed. The design of antenna is showed in figure 1. It is made up on FR4 substrate which has dielectric permittivity of 4.3 and the dimensions of our proposed antenna is 90 x 50 x 1.6 mm^3. The design has two identical elements with turnings and perform dual band performance of antenna [8]. The $s_{1,1}$ of one antenna element is less than -23dB ($s_{1,1}$ < -23dB), and another element has less than -20dB ($s_{1,1}$ <-20dB). The ground present between antenna elements provide more isolation between two elements.

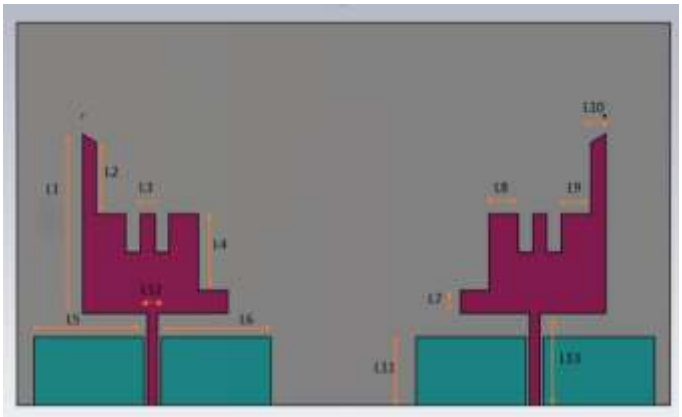

Fig. 1 Antenna Design

The antenna parameters of our design are shown in below table:

TABLE. 1 ANTENNA DIMENSIONS

PARAMETER	DIMENSIONS(mm)	PARAMETER	DIMENSIONS(mm)
L1	28	L7	3.5
L2	11	L8	4
L3	2	L9	4
L4	12	L10	2
L5	15	L11	10
L6	15	L12	1.5

3. Results and Discussion:

The proposed is simulated by the use of CST microwave studio and the corresponding s-parameters are shown in figure 2. The $s_{1,1}$ of one antenna element is less than -23dB ($s_{1,1}$ < -23dB), and another element has less than -20dB ($s_{1,1}$ <-20dB). The S-parameters will explain the input-output relationship between ports in antennas. Along with s-parameters, we also simulate the results of VSWR, Envelope correlation coefficient, and Diversity gain. If ECC is less, then the design is accurate and if diversity is nearer to 10, then the results are accurate.

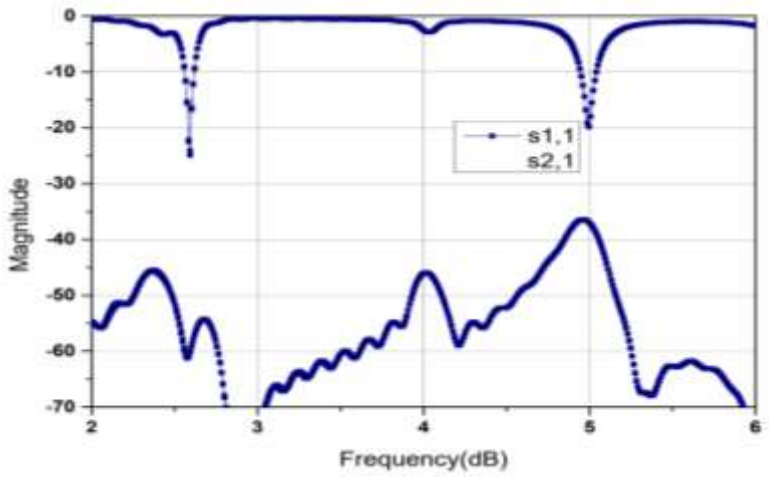

Fig. 2. Reflection coefficient graph

The (ECC), Envelope correlation coefficient is calculated to determine the correlation between the antenna elements. Diversity gain is gain in the reception quality. For our proposed antenna the correlation coefficient is 0.001 and shown in figure. 3. The diversity gain(DG) of our proposed antenna is 9.99dB and shown in figure. 4.

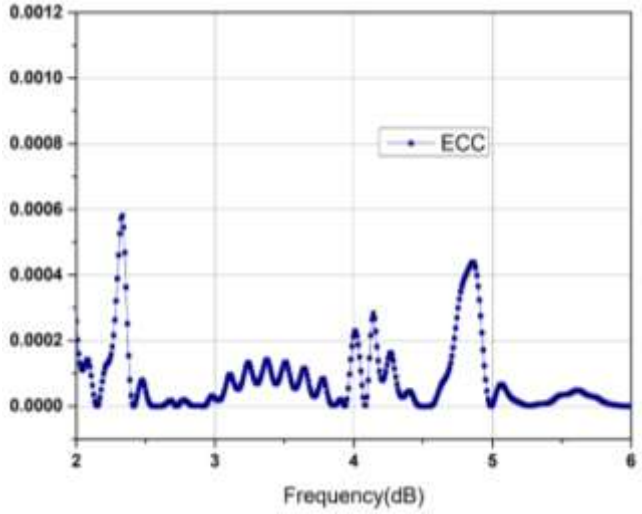

Fig. 3. Envelope correlation coefficient

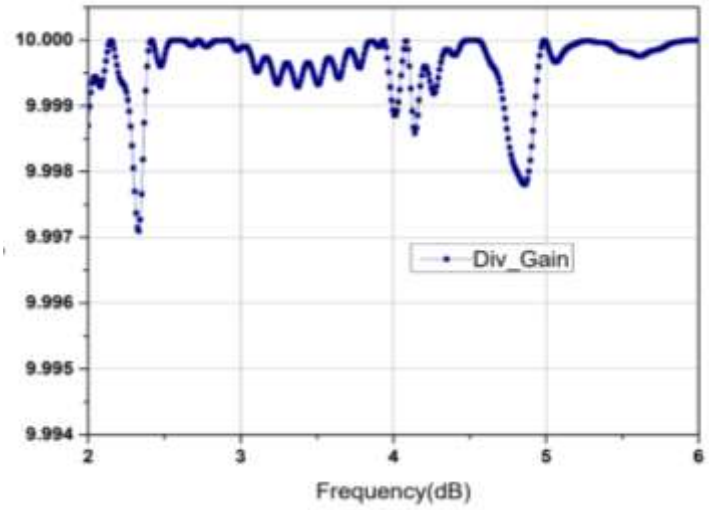

Fig. 4. Diversity Gain

VSWR (Voltage standing wave ratio) is a value which indicates how much power is transmitted from a source. A VSWR value under 2 is considered for most antenna applications, because it is highly accepted for impedance mismatch. For our proposed antenna, the VSWR value is less than 2. So, the power will efficiently transmit from source. The gain of antenna is represented in far fields and the far fields with respect to our proposed antenna design is shown in figure. 5 and figure. 6 for 2.5 GHz and 5 GHz respectively.

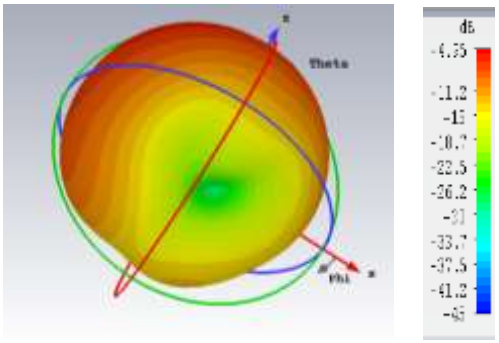

Fig. 5. Gain of antenna at 2.5GHz

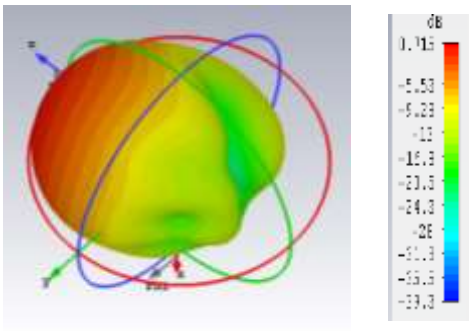

Fig. 6. Gain of antenna at 5 GHz

4. Conclusion:

In this paper, a CPW fed MIMO antenna is designed for frequency range of 2.5/5GHz on FR4 substrate used for several applications. The size of antenna is 90 x 50 x 1.6 mm^3, and s-parameters are less than -20dB. This proposed design has good VSWR, and gain of antennas are -4.95 dB and 0.715 dB respectively. The bandwidth of our proposed antenna is 48.4MHz and 68.1MHz with respect to resonating frequency. The simulation results achieve good impedance matching, isolation, and gain. The diversity gain of our antenna is 9.999 and the envelope correlation coefficient value is less than 0.001. The proposed design has multiple applications in communications.

References:

1. E. Thakur, N. Jaglan, S. D. Gupta, and B. K. Kanaujia, A Compact Notched UWB MIMO Antenna with Enhanced Performance, 91 (2019).
2. Xu, H. X., Wang, G. M., Qiaaaa, M. Q., et al. (2013). Metamaterial lens made of fully printed resonant type negative-refractive index transmission lines. Applied Physics Letters, 102, 193502-1–193502-5.
3. R. Chair, A. A. Kishk, K.-F. Lee, C. E. Smith, and D. Kajfez, Microstrip Line and CPW Fed Ultra Wideband Slot Antennas wijv9kn ith U-Shaped Tuning Stub and Reflector, Prog. Electromagn. Res., 56 (2006) 163–182.
4. Youngki Lee, Deukhyeon Ga, Jaehoon Choi, "Design of a MIMO Antenna with Improved Isolation Using MNG Metamaterial", International Journal of Antennas and Propagation, vol. 2012, Article ID 864306, 7 pages, 2012. https://doi.org/10.1155/2012/864306.
5. A. Kumar, A. Q. Ansari, B. K. Kanaujia, and J. Kishor, "High Isolation Compact Four-Port MIMO Antenna Loaded with CSRR for Multi-band Applications," Frequenz, vol. 72, no. 9-10, pp. 415-427, April 2018.
6. Vyshnavi Das S.K, T Shanmuganantham, “Design multiband microstrip Patch Antenna for IoT Application”, IEEE International Conference on Circuits and Sysytems (ICCS), 978-1-5090-6480-9, 2017.
7. J. H. Xun, L. F. Shi, W. R. Liu, G. X. Liu and S. Chen, "Compact Dual-Band Decoupling Structure for Improving Mutual Coupling of Closely Placed PIFAs," IEEE Antennas and Wireless Propagation Letters, vol. 16, pp. 1985-1989, 2017.
8. Vyshnavi Das S.K, T Shanmuganantham, “Design of Polygon Shaped Patch Antenna for IoT Application”, International Conference on Communication, Networks and Computing (CNC), (In press) ,(2018).