Design of Novel Nine Shaped Multiband MIMO Antenna for Different Applications

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ABSTRACT

Multiple antenna systems are also well-known as Multi Input Multi Output (MIMO) systems which increases the capacity and reliability of any communication. The system with MIMO offers high quality of service and helps in achieving reduction in Bit Error Rate (BER) and it also have advantages like beam steering and diversity. MIMO purposefully signifies the practical technique for transmitting and receiving many data signals randomly through a single channel by multipath propagation. The microstrip antennas are widely used for communication systems due to their small size. Currently this antenna is commercially used for mobile communication and satellite communication and many other wireless applications. Micro strip MIMO is a complicated technology by using multiple antennas to overcome multipath fading propagation problem. Microstrip antenna is also known as patch antenna. In this project multiband novel nine shaped microstrip MIMO antenna is implemented. And the antenna design must produce satisfactory isolation and decoupling. The proposed antenna will operate at several frequencies. The major parameters associated with a MIMO antenna are Return loss (S11), Gain, Directivity, VSWR, Envelope Correlation Coefficient (ECC) and Diversity Gain (DG) and the implemented antenna should improve the gain, directivity and reflection coefficient and should be minimum.

Keywords: *Multi Input Multi Output (MIMO), Long Term Evolution (LTE), Voltage Standing Wave Ratio (VSWR), Return Loss(S11), Directivity, Envelope Correlation Coefficient (ECC) and Diversity Gain (DG).*

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1. INTRODUCTION

The Patch antennas are always in great demand for utilization in communication systems due to their dense size, less weight, and economical which offers acceptable harmony for encapsulated antennas in handheld terminals. Patch antennas are most widely used in evident applications like spacecraft, satellite and aircraft where the performance, installation, size, weight does matters, because patch antenna is one of the best applicants to meet up these requirements. Multi Input Multi Output is a wireless technology that increases the data capacity of a RF radio by using multiple transmitting and receiving antennas.

In a MIMO system, one data is transmitted through multiple antennas over the same path in the same bandwidth. Because each signal reaches the receiving antenna through a different path, resulting in more definitive data. Currently this antenna is commercially using like mobile communication, wireless radio other than government custody. Micro strip antenna is also known as patch antenna. The shape of the patch to be determined by the application requirement and demand, most commonly used shapes are square, rectangular. The main drawbacks of patch antennas are the low posture efficiency, low power level, poor polarization purity, narrow frequency bandwidth, and underprivileged scan.

Further noise or interference, and lost signals also. By transmitting the identical data on numerous streams, the MIMO antennas introduce redundancy into data transmission that single antenna setups (SISO: Single In, Single Out) can't provide. The designed MIMO antenna system goes in good terms with 4th generation by covering most of the LTE bands. MIMO technology can be used in LTE and LTE advanced radio networks for enhancing network efficiency. MIMO can be used in IoT, car applications and mobile applications.

LTE abbreviated as *Long-Term Evolution*, and it was initiated as a project in 2004 by telecommunication body known as the Third Generation Partnership Project (3GPP). An abrupt improvement of mobile data usage and publishing of new applications such as MMOG (Multimedia Online Gaming), mobile TV, Web 2.0, streaming contents have the 3rd Generation Partnership Project (3GPP) to work on the Long-Term Evolution along the way towards fourth-generation mobile. The major goal of LTE is to provide a high data rate, low latency and packet optimized radio access technology bearing flexible bandwidth distributions. Concurrently its network architecture has been developed to support packet switched traffic with smooth mobility and great quality of service as a primary goal. The patch antenna is designed like a 9 shaped antenna using epoxy FR4 substrate. The FR4 substrate is selected because of its easy availability and it is low-price.

2. METHODOLOGY

The proposed methodology has been designed in a simulation tool, which describes the antenna and MIMO parameters, the type of substrate to be selected with an appropriate dielectric constant. Simulation Tool has been to be CST (Computer Simulation Technology). Computer Simulation Technology is a software used for electromagnetic design and analysis in the high-frequency range by the analyzers. It is an integrated design environment an acronym for Multiple-In, Multiple-Out, MIMO communication transmits the identical data as many signals concurrently through numerous antennas, while still using one radio channel. This antenna is in a form of diversity, which utilizes multiple antennas to enhance signal quality and durability of radio frequency link. The data is divided by collective data streams at the transmission point and reunited on the receive side by a distinct MIMO radio designed with the identical number of antennas. The receiving one is designed to allow the time difference between receptions of each signal, any that contains tools for wide range of frequencies. Due to its compatibility, CST can solve any high-frequency field problem. It is considered as good software for the efficient and fast analysis of the design of filters, antennas, transmission lines, connectors, circuit boards, etc.

3.DESIGN

3.1 Single Proposed Antenna Design: According to our proposed design, the patch antenna is nine shaped as shown in a below figure using epoxy FR4(lossy) substrate. The substrate material is chosen as FR4 because of its easy availability and it is economical. The design of antenna is on substrate has dimensions of 26×36 mm2 and thickness T of substrate is 1.6 mm, with loss tangent of 0.02 and the dielectric constant is of 4.4. Below table characterizes all the measurements of the proposed design on the below fig 1. The material used to design both patch and feed line is Perfect Electric Conductor (PEC). The T in below table indicates the thickness of individual element**.**

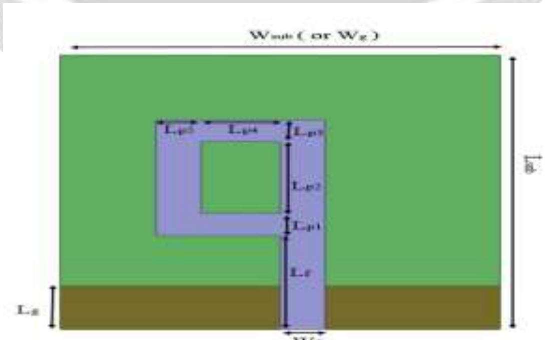


Fig1: Single proposed antenna design

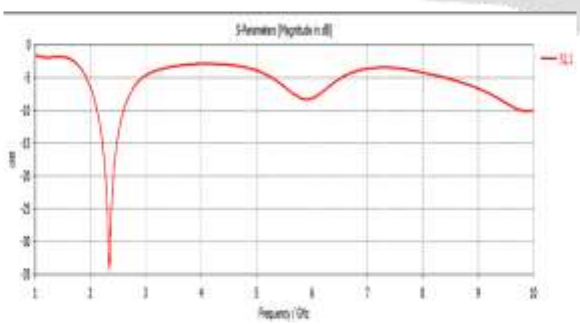
Table 1: Single antenna measurements

Component	Material	Parameter	Value(mm)
Substrate	FR4	L_{sub}	36
		W_{sub}	26
		H_{sub}	1.6
Ground Plane	pec	L_g	6
		W_g	30
		T	0.05
Patch	pec	L_{p1}	3
		L_{p2}	10
		L_{p3}	3
		L_{p4}	5.4
		L_{p5}	3.06
		T	0.05
Feed Line	pec	W_f	3.06
		L_f	13
		T	0.05

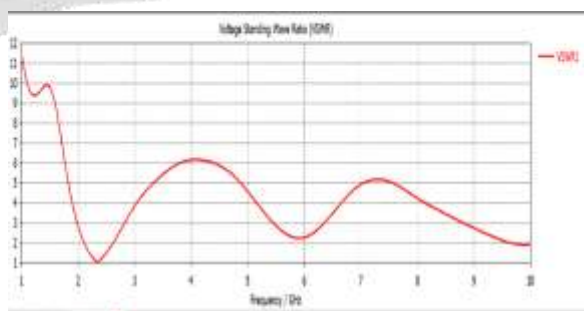
3.2 Single Antenna Output Results:

The VSWR must be less than 2 along the band in which it operates for an operative achievement of antenna. That the proposed antenna is capable of producing a desired result. Additionally, apparent difference between both simulated designs in low frequencies is a problem which still be necessary to authenticate experimentally.

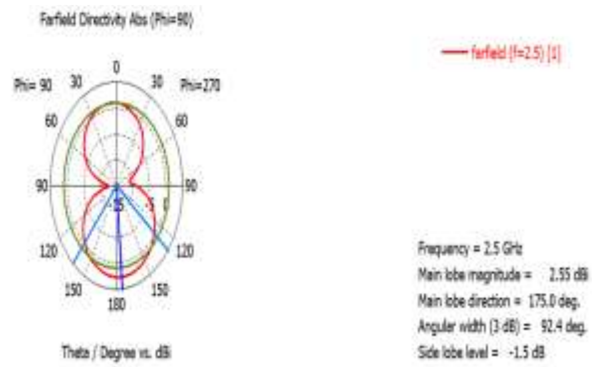
S Parameter

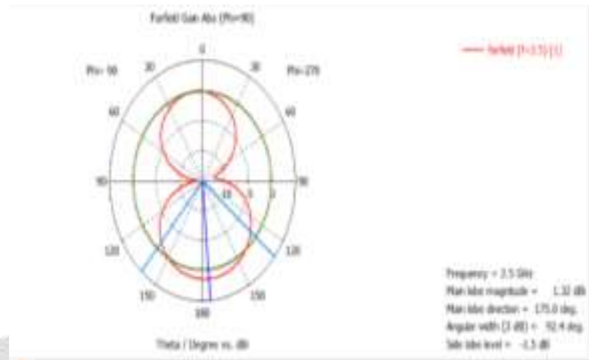


VSWR



Farfield Directivity **Farfield Gain**





3.3 Double Antenna Design 1:

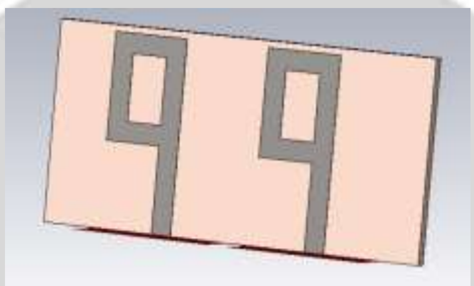


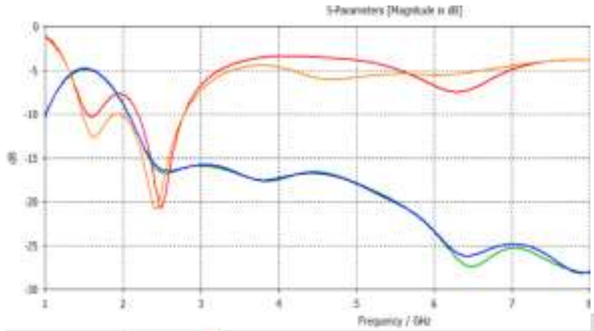
Fig 2 Double antenna design

Table 2: Double antenna measurements

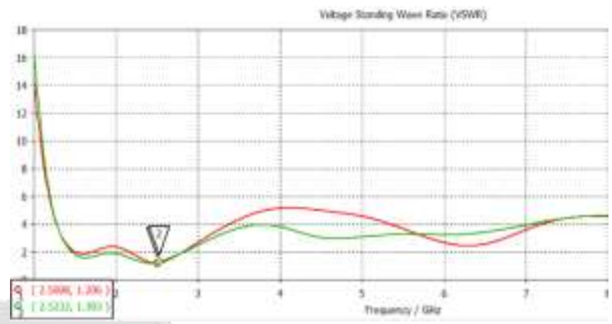
Component	Material	Parameter	Value(mm)
Substrate	FR4	L_{sub}	58
		W_{sub}	32
		H_{sub}	1.6
Ground Plane	pec	L_g	58
		W_g	6
		T	0.05
Feed line	pec	W_f	3.06
		L_f	12
		T	0.05
Patch	pec	L_P	11.52
		W_P	16
		T_P	0.05
Inner patch	pec	L_P	5.4
		W_P	10
		T_P	0

3.4 Double Antenna Output Results:

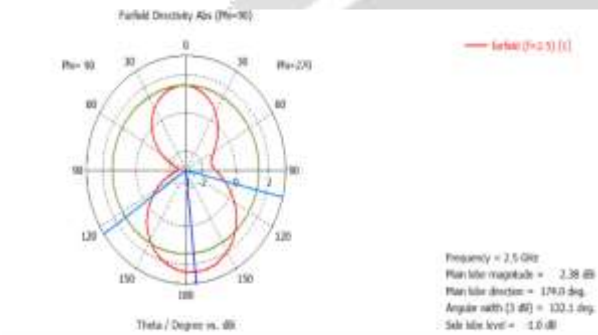
S Parameter



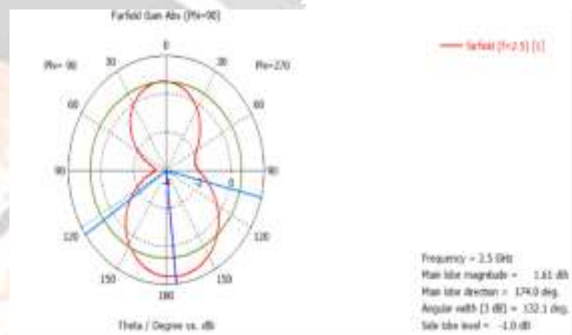
VSWR



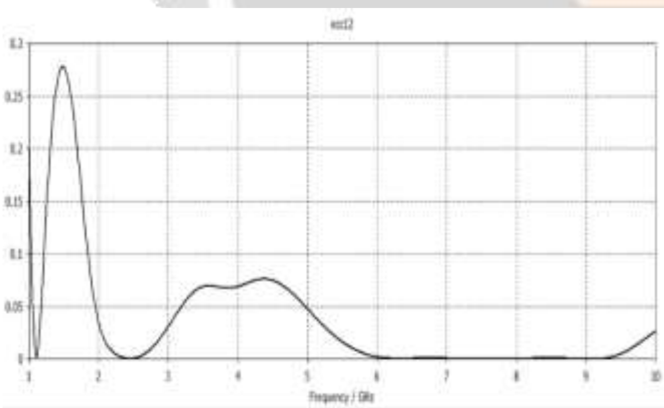
Farfield Directivity



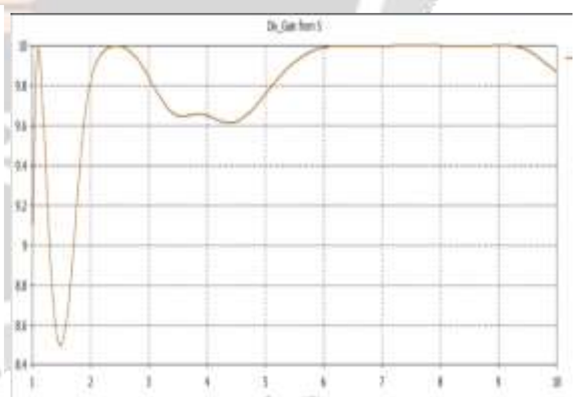
Farfield Gain



Envelope Correlation Coefficient



Diversity



3.5 Double Antenna Design 2

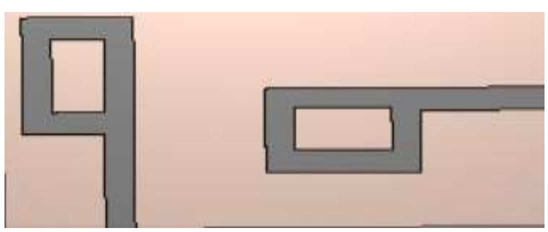


Fig 3 Orthogonal antenna design.

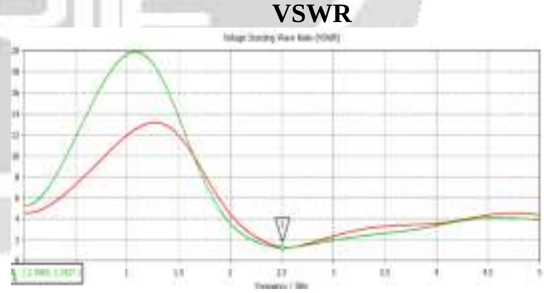
Table 3: Orthogonal antenna measurements

Component	Material	Parameter	Value(mm)
Substrate	FR4	L_{sub}	58
		W_{sub}	28
		H_{sub}	1.6
Ground Plane	pec	L_{g1}	23
		W_{g1}	6
		T_{g1}	0.05
		L_{g2}	6
		W_{g2}	22
		T_{g2}	0.05
Feed line	pec	W_{f1}	3.06
		L_{f1}	13
		T_{f1}	0.05
		W_{f2}	13
		L_{f2}	3.06
		T_{f2}	0.05
Patch	pec	L_{P1}	11.52
		W_{P1}	16
		T_{P1}	0.05
		L_{P2}	16
		W_{P2}	11.52
		T_{P2}	0.05
Inner patch	pec	L_{p1}	5.4
		W_{p1}	10
		T_{p1}	0
		L_{p2}	10
		W_{p2}	5.4
		T_{p2}	0.05

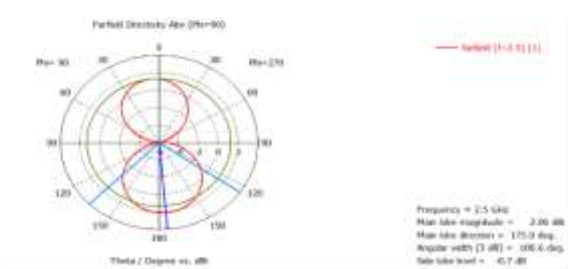
3.6 Orthoganl Antenna Output Results

S Parameter

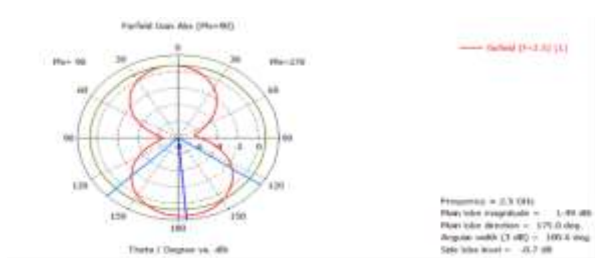
VSWR



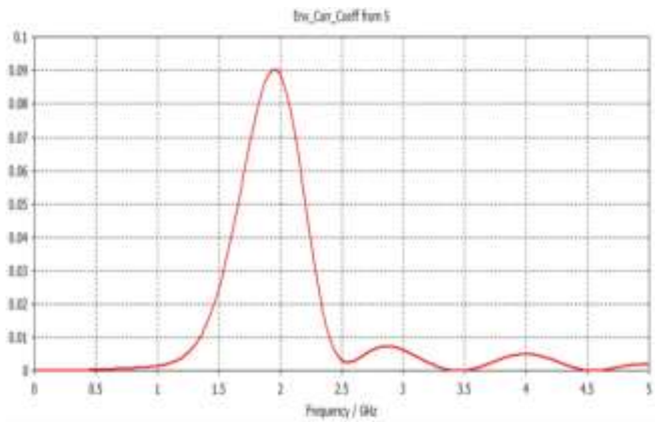
Farfield Directivity



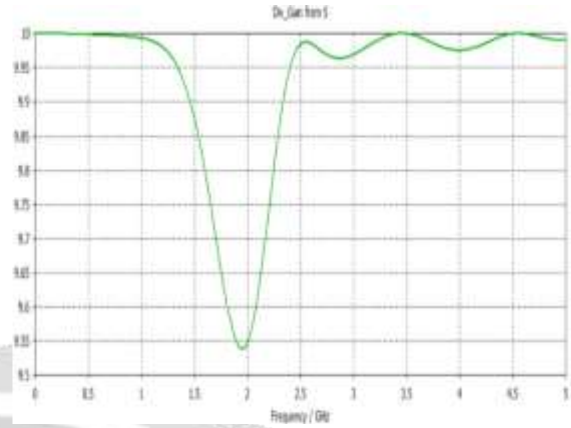
Farfield Gain



Envelope Correlation Coefficient



Diversity



4. RESULT

The results of our proposed antenna design were achieved using CST Microwave Studio Software. The antenna's achievements are estimated with reference to impedance, S parameter, Gain and VSWR. The reasonable radiating frequency of an antenna is depicted by two evaluating parameters of antenna like "RETURN LOSS" and "VSWR". If the S parameter of an antenna at a particular frequency is greater than the -10dB then it implies that maximum power fed to antenna is rejected.

The S parameter should be less than –10db and VSWR should be less than 2 for a good radiating element. To describe the achievement of an antenna Gain is one of the best useful measures to detail the performance. Although the Gain of the antenna is familiarly associated to the Directivity, which considers the efficiency of the antenna including its directional capabilities. In contrast, Directivity, which measures only the directional properties of the antenna.

5. CONCLUSION

The simulation of the proposed antenna was done through CST software. The radiation pattern at 2.5 GHz is proposed and VSWR is 1.30. In this project we used trail & error method to get successful output results.

The proposed antenna is encouraging to be inculcated within the different portable devices in diverse wireless applications due to the frequency of operation and less area occupied. More than two elements can be designed with proper distance between the elements which can be used for wide number of applications. Different techniques can be used to enhance the overall performance of the design. More over different shapes other than 9 can also be designed for particular applications.

6. REFERENCES

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