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Design of a novel UWB-MIMO antenna with DGS structure

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Abstract
Two compact coradiator multiple-input–multiple-out (MIMO) antennas operating in the UWB frequency band with dual polarization are proposed. Different from traditional MIMO antennas, the radiator is shared by two antenna elements, which greatly reduce the overall size of the MIMO system. High isolation between the two antenna elements is achieved by etching a T-shaped slot in the radiator and extending a stub on the ground. Dual polarization can be realized by exciting the pentagonal radiator with perpendicular feeding structure. The simulated results of current and electric-field distribution show the dual-polarization characteristics of the diversity system. The objective of this paper is to design the UWB-MIMO antenna with DGS structure and then compare the performance parameters.

Keywords
IE3D software, DGS structure, UWB-MIMO Microstrip Antenna

I. Introduction

Ultra wideband (UWB) is a very promising technology for short range wireless communications providing the opportunity of high data rate communications[1]. UWB radio has proved itself a suitable candidate for its low power and low cost design. However ,very low transmitted power in UWB systems limits the applications to short range or to moderate data rate[2]. Therefore, it is crucial to find some solution that will make the best possible use of radiated and received power, for the feasibility and future commercial success of UWB communication systems[3]. In this context, research is carried out and MIMO has been found one of the best solutions. MIMO technique in UWB systems will improve link robustness of UWB or data rate. But some challenges arise in designing of the MIMO antenna systems for UWB applications.

These challenges include the reduction of the mutual coupling and the correlation between the elements of the antenna systems[4]. UWB communication systems have the promise of very high bandwidth.

- It provides reduced fading from multipath.
- It provides low power requirements .
- The main concept behind UWB radio systems is that they transmit pulses of very short duration as opposed to traditional communication schemes which send sinusoidal waves.
- The role that UWB antennas play in all of this is that they have to be able to transmit these pulses as accurately and efficiently as possible.

II. Materials and Parameters

Here microstrip has been used due to its light weight, thin size and patch can be of any shape. UWB-MIMO patch microstrip antenna has been selected for investigation. UWB-MIMO patch is etched on dielectric substrate i.e. FR4 substrate whose thickness is 1.524mm and dielectric constant is 4.4 and the loss tangent .02. FR4 in comparison has a higher dielectric constant which results in a smaller patch size.

A. Parameters

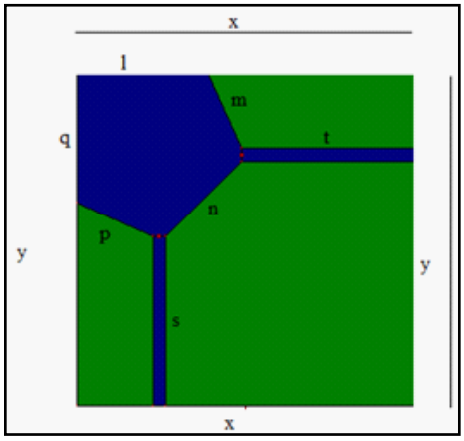

Fig.1: Antenna design parameters

Table 1 : Parameters of antenna

Sr. No.	Points	x-coordinate	y-coordinate
1.	l	15.5mm	0mm
2.	m	4mm	-9.019mm
3.	n	-9.019mm	-9.019mm
4.	p	-8.981mm	4.038mm
5.	q	0mm	15.5mm
6.	t	19mm	0mm
7.	s	0mm	-19mm

The antenna ground is finite and the overall volume is 40mm*40mm. The MIMO system consists of two antenna elements but only one pentagonal radiator, which is fed by two perpendicular tapered microstrip. The layout of shared radiator is to reduce the volume of diversity antenna. The diversity antenna is symmetric by the axis of . To reduce the mutual coupling between two ports, a metal branch is extended on ground plane, which can be viewed as a reflector, to reduce the electromagnetic coupling. Besides, the metal branch can decrease the current on the ground flowing between the two antenna elements. In addition, a T-shaped slot is etched in the radiator to increase isolation between the two elements.

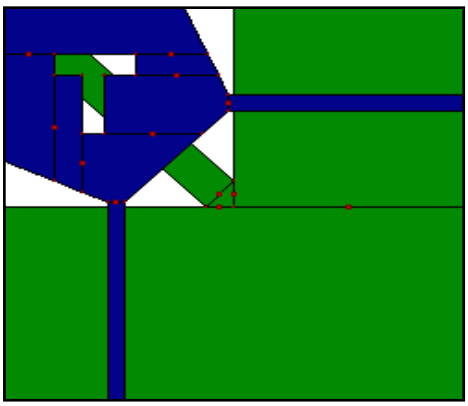

Fig.2 : Proposed antenna with T-shaped slot

Table 2. Comparison between different isolation techniques

TECHNIQUE	ISOLATION (in dB)	RADIATION PATTERN (wrt H-plane)	BANDWIDTH (in GHz)	GAIN VARIATION (in dBi)	SIZE (in mm^2)
Inverted-Y shaped stub	15	Omnidirectional	3.1-10.6	< 2.5	40 × 68
Fork Shaped Structure	17	Omnidirectional	4.4-10.7	< 2.5	40 × 68
Cantor set Fractal UWB antennas	20	Omnidirectional	4.5-10.6	< 2.5	40 × 68
Stepped Impedance Resonators	23	Omnidirectional	3.1-10	< 2	35 × 40
Closely-packed UWB MIMO diversity antenna	26	Omnidirectional	3.1-5.15	< 2	48 × 25
T-shape slot	44	Omnidirectional	2.4-2.48	< 2.5	40 × 68

B. DGS Structures

In this for the improvement we implement DGS structures in the design of the antenna. A Defected Ground Structure (DGS) is an etched lattice shape, which is located on the ground plane. DGS has arbitrary shapes and is located on the backside metallic ground plane. DGS is realized on the bottom plane with one island placed at both sides of the microstrip line on the upper plane. DGS is realized on the bottom plane with one island placed at both sides of the microstrip line on the upper plane. DGS has simple structure and potentially great applicability to design microwave circuits such as filters, amplifiers and oscillators. The characteristics of the defected ground structure are:

- Disturbs shielding fields on the ground plane.
- Increases
- effective permittivity.
- Increases effective capacitance and inductance of transmission line.
- Has one-pole LPF characteristics (3dB cutoff and resonance frequency).
- Size reduction for the component.

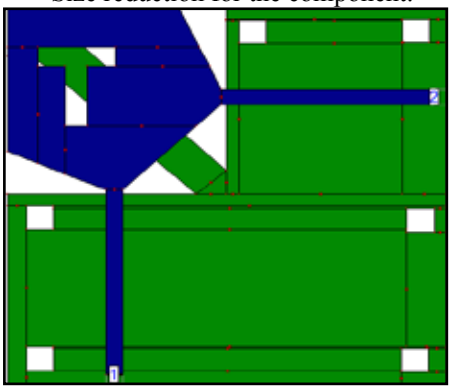

Fig.3 : Antenna design using DGS structure

III. Results

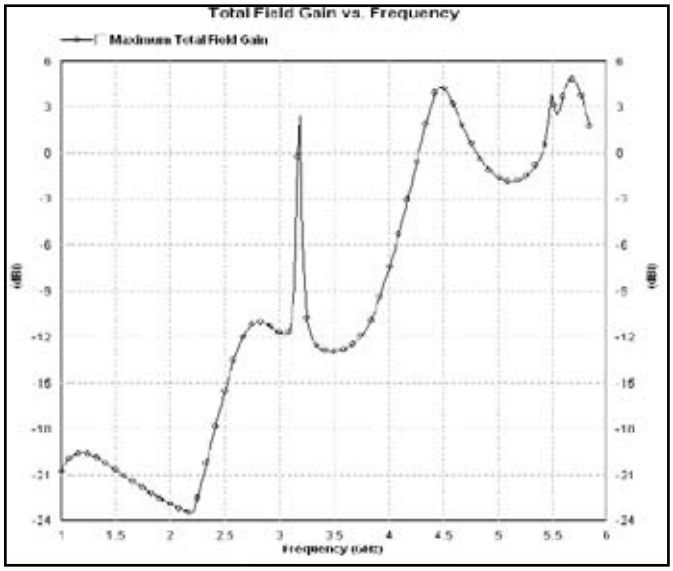

Fig.4 : Gain of antenna without DGS structure

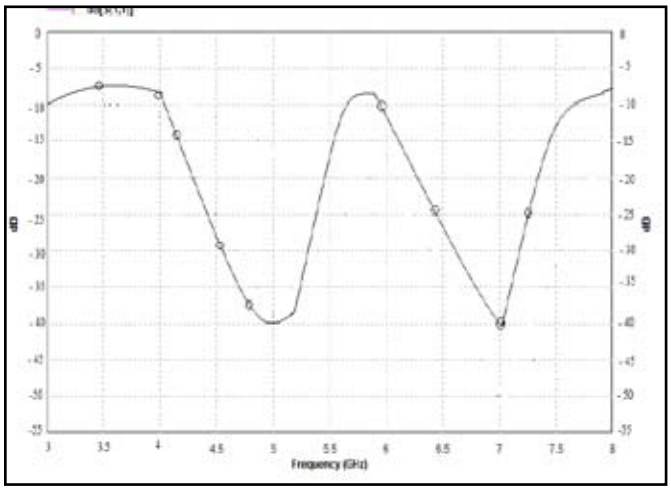

Fig.5 : Return loss of antenna without DSG structure

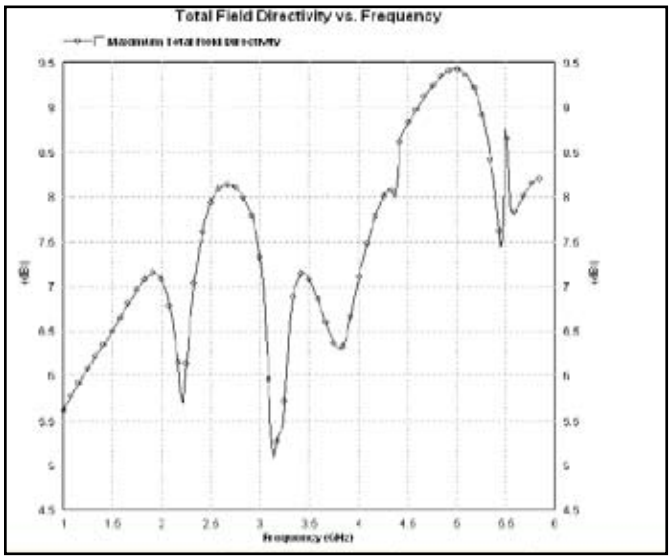

Fig.6 : Directivity of antenna without DGS structure

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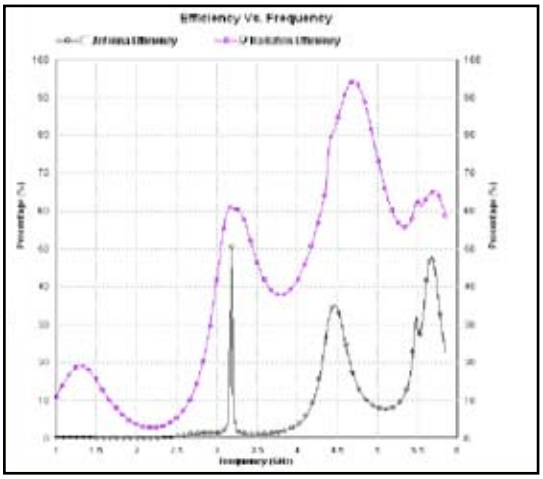

Fig.7 : Efficiencies of antenna without DGS structure

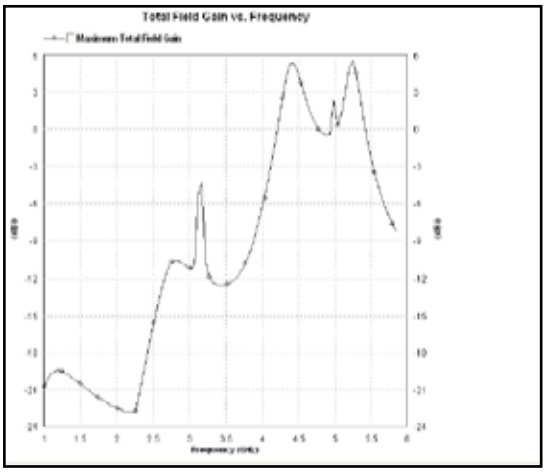

Fig.8 : Measured antenna gain with DGS structure

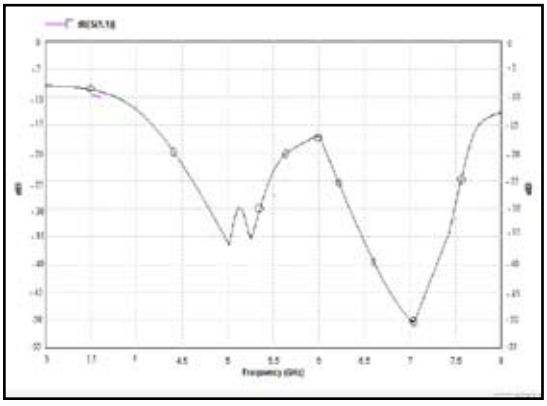
Fig.9 : Return loss of antenna with DGS structure

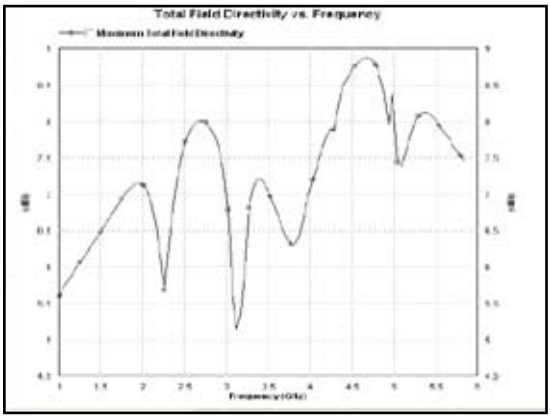

Fig.10 : Directivity of antenna with DGS structure

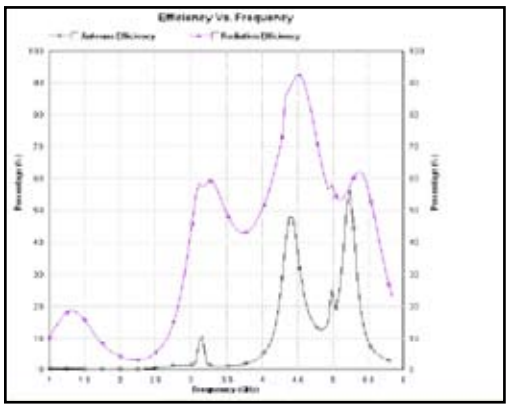

Fig.11: Efficiencies of antenna with DGS structure

IV. Conclusion

A method of using co-radiator in diversity antenna designing has been proposed and two UWB-MIMO antennas with two elements have been presented in this paper. High isolation between two ports has been achieved by etching a T-shaped slot in the radiator and extending a stub from ground. The shared radiator is fed by two perpendicular feeding structures, which result in dual polarizations of the system. The simulated current distribution and far-field electric field have also demonstrated that the UWB-MIMO antenna with dual polarization characteristics. The diversity performance of the UWB-MIMO antenna have also been studied and presented in this paper. Furthermore by employing DGS structure into antenna performance is increased.

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Author Profile

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