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Compact MIMO Antenna for UWB Applications

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Abstract:- **A compact planar multiple-input-multiple-output (MIMO) antenna with only 24 × 38 mm^2 size for ultra wideband (UWB) applications is presented. The proposed antenna contains two square shaped antenna elements, a T-shaped stub with vertical slot cut to reduce mutual coupling among the antenna elements. The performance of antenna is studied in terms of impedance matching, mutual coupling between the two input ports, VSWR and correlation coefficient. The simulated results shows the antenna has an impedance bandwidth from 2.3 to 12 GHz for S11 ≤ -10 dB and a low envelope correlation coefficient of less than 0.001 throughout the frequency band. The value of isolation between the two antenna elements is more than -22 dB in the whole band. The WCDMA, WLAN, WiMax and UWB bands are covered by the proposed UWB MIMO antenna.**

Index Terms—Band notch, multiple-input-multiple-output (MIMO), small antenna, ultra wideband (UWB).

I. Introduction

ULTRAWIDEBAND (UWB) technology gained lots of concerns and remarkable developments due to its high data rate and low-spectral-density radiated power. the Federal Communications Commission (FCC) allotted the unlicensed frequency band from 3.1 to 10.6 GHz as the UWB communication, UWB technology gained lots of concerns and remarkable. The Federal Communications Commission (FCC) discharged the business operations for a ultra wideband range from 3.1-10.6 GHz, which is utilized to keep away from the obstruction between the current a remote correspondences and Ultra wideband (UWB) correspondence framework. The Federal Communications Commission control necessity of –41.3dBm/MHz, 5 equivalent to 75 nano watts/MHz for Ultra wideband framework. There are many advantages that Ultra wideband gets a remote correspondence. One is power phantom thickness (PSD) which expanded impedance and weakness to the next framework. Another is bigger channel limit which expanded data transfer capacity.

UWB systems using huge bandwidths already have high data rates, so MIMO technology can be used for fade countermeasure through diversity gain. The basic concept of MIMO/diversity is to use multiple antenna elements to transmit or receive signals with different fading characteristics, since the system reliability will be increased by combination of received signals as different signals will face different fading However, UWB communication systems also suffer from the multipath fading problem. Multiple-input-multiple-output (MIMO) technology utilizes multiple transmitting and receiving antennas to provide multiplexing gain and diversity gain, which significantly reduces multipath fading and increases transmission capacity but placing multiple antennas in a small space will cause strong mutual coupling among the MIMO antennas.

MIMO can be implemented by three ways: beam forming, spatial multiplexing and diversity techniques. The limitations to exploit the diversity arise when the antennas are placed in close vicinity. So, it is required to decorrelate their patterns, or in other words, mutual coupling should be minimized. Another challenge is the enhancement of isolation between the access ports of MIMO antennas.

Different techniques have been concocted to enhance isolation between the components of a narrowband MIMO antenna. Great isolationn is accomplished by including parasitic components, which can make a reverse coupling to lessen mutual coupling. Moreover, the utilization of electromagnetic band-crevice (EBG) can stifle surface wave spread and therefore enhance the isolation between emanating components. However this method occupies significant areas. Other isolation enhanced techniques such as incorporating a protruded ground between the antennas, Using Decoupling and Matching Networks, using Defected Ground Structure (DGS) inserting stubs into the ground can likewise be utilized..

II. ANTENNA DESIGN

Fig. 1 shows the geometry of the proposed MIMO antenna. As shown in Figure, the antenna has two square shaped elements, denoted as PM 1 and PM 2 which have a very compact area of only 10×10mm^2. The proposed geometry is employed by using single patch antenna due to its advantages of compact size and wide impedance bandwidth.

The radiator of a UWB monopole antenna could be of many shapes, for example, rectangular, roundabout ring molded, elliptical, which, when all is said in done, don't give huge contrasts in execution. Notwithstanding, the span of the radiator must be sufficiently vast to permit a long current way to create a low resonance for accomplishing a low-cutoff frequency of lower than 3.1 GHz for the UWB. Along these lines, size estimation has been one of the significant difficulties in the plan of UWB antennas. Planning the ultrawide data transfer capacity for a UWB antenna is not such an issue and can be accomplished through coordinating utilizing drawing a ground opening under the encourage line, altering the hole between the ground and the radiator, and decreasing the feed line as utilized are used as a part of our MIMO antenna.

In our MIMO antenna shown in Fig. 1, for straightforwardness, we utilize square-formed radiators for the planar monopole components.

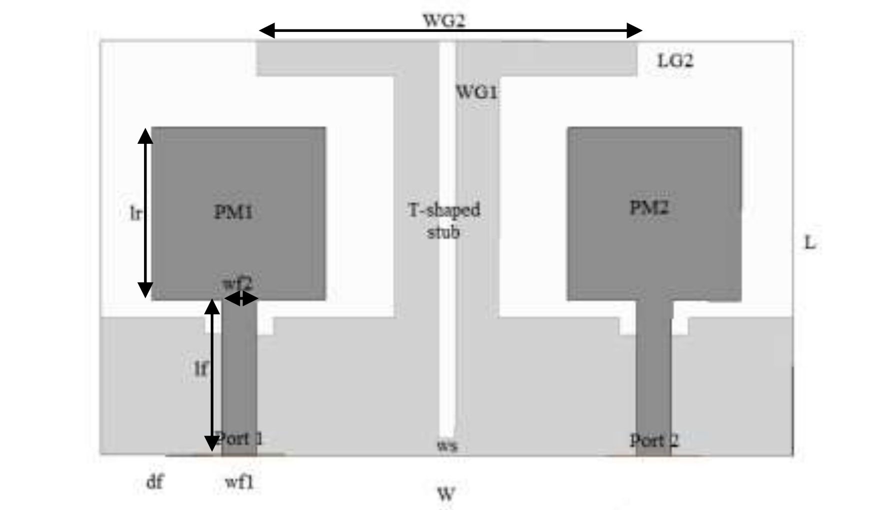


Fig. 1. Geometry of proposed antenna (dark gray: top side, light gray: bottom side).

In Fig. 1, the T-shaped ground stub distending vertically between the monopole components is utilized to enhance matching of the antenna. A long ground opening is cut vertically on the T-shaped ground for better isolation between the two input ports.

The antenna has a symmetrical structure, so the two input ports have indistinguishable impedance. This makes the outline strategy essentially less demanding in light of the fact that the antenna can be planned with either port excited. The MIMO antenna is designed using the HFSS software on a Rogers R3203 substrate with a dielectric constant Ɛr of 3.02, a loss tangent of 0.004, and a thickness of 0.8 mm. The configuration of the design are listed in Table I.

TABLE I
DIMENSIONS OF PROPOSED ANTENNA (UNIT: mm)

WG1	2.5
WG2	22
LG2	2
lr	10
lf	9
wf2	2
df	6
wf1	2
ws	1
W	38
L	24

III. STUDY OF MIMO ANTENNA

The T-shaped ground stub in the MIMO antenna shown in Fig. 1 has two fundamental capacities: giving better matching for the antenna and improving isolation by reflecting radiation from the radiators. A T-shape is used because the size of the antenna can remain compact and the T-shaped ground stub can also serve as reflector. With the T-shaped stub utilized, a resonance is created at about 3 GHz, which lowers down the low-cutoff frequency to about 2.3 GHz. Mutual coupling S21 is also likewise essentially stifled at high frequencies.

In Fig. 1, the ground slot cut on the T-shaped ground stub plays an important role in enhancing isolation. Fig. 2 demonstrates the simulated S11 and S21 of the MIMO antenna with and without having the ground slot. Because of the symmetrical structure of the antenna, S22 and S12 are same as S11 and S21, individually, so we just show S11 and S12 in Fig. 2.

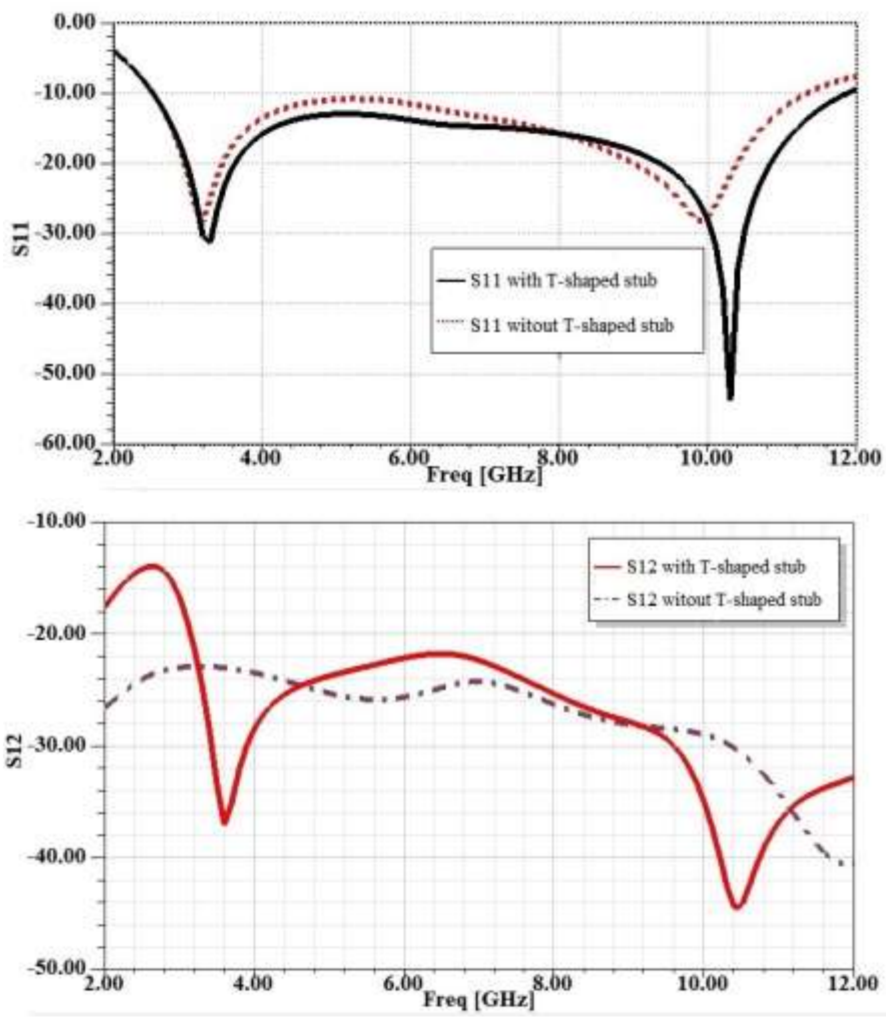
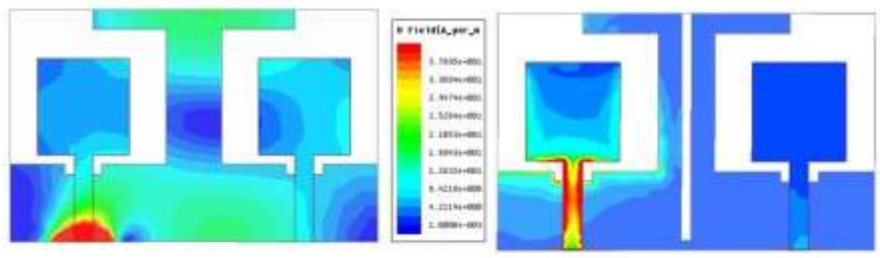


Fig. 2. S parameters of antenna with and without T-shaped ground stub

It can be seen that the simulated impedance bandwidth (for S11 < −10 dB) of the antenna with and without the ground slot don't differ much and are from 2.5 GHz to more than 11 GHz. Be that as it may, without utilizing the ground slot, the mutual coupling between the two input ports of the antenna is greater than −22 dB (i.e., S21 > −22 dB) in the frequency underneath 3 GHz, which is not sufficiently low for good execution . With the utilization of the ground space, a resonance at around 3.6 GHz is produced, letting S21 down to underneath −22 dB from 2.3 GHz to more than 12 GHz (which covers the whole UWB).

Current distribution is further used to concentrate on the impacts of the ground slot on isolation. Fig. 6 demonstrates the present circulations of the MIMO antenna with and without the ground slot at a lower recurrence of 3.5 GHz when port 1 is excited and port 2 is 50-Ω terminated. It can be seen from Fig. 3(a) that without the ground space, strong current is coupled from PM 1 through the T-shaped ground stub to PM 2 and afterward to port 2, bringing about high mutual coupling between the two ports. At the point when a ground slot is cut on the T-shaped ground stub, Fig. 3(b) demonstrates that more current focuses on the left part of the T-shaped ground cut, and the measure of current coupled to PM 2 and afterward port 2 is a great deal less, lessening mutual coupling between the two ports. In this way, the slot gives high isolation between the two ports.



(a) (b)

Fig. 3. Current distributions at 3.5 GHz: (a) without and (b) with ground slot.

The proposed antenna measure voltage standing wave ratio (VSWR) is under 2. The voltage standing wave ratio is relying upon return loss. In the event that the VSWR is lessened then it is outstanding that return loss is underneath -10dB. The VSWR is utilized for better impedance coordinating. The impedance matching is one that implies 100% precise results are obtained. The impedance matching can also avoid the interference exiting between wireless system and ultra wideband system. It is seen that when the proposed antenna utilized mix of a T- shaped stub and ground slot, VSWR is under 2 at general working band.

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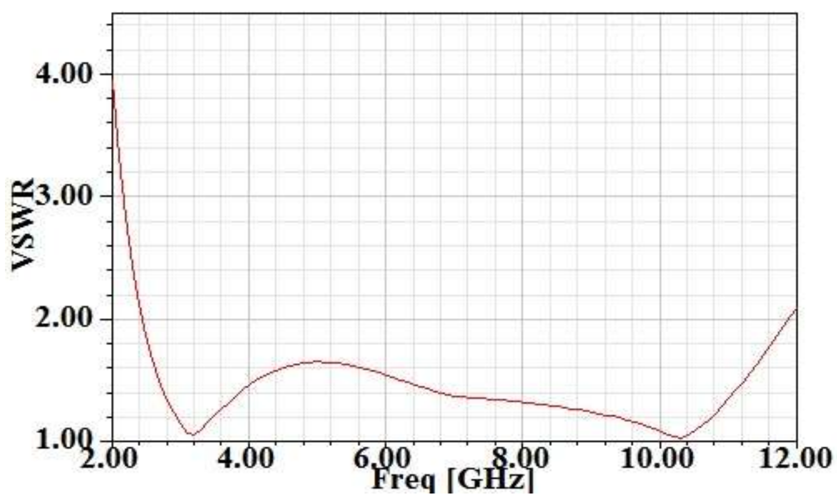

Fig. 4. VSWR of Proposed Antenna

The diversity performance of the MIMO antenna is studied using the envelope correlation coefficient calculated from the equation using S-parameters.

$$\rho_e=\left|\frac{S_{11}^*S_{12}+S_{21}^*S_{22}}{\sqrt{1-|S_{11}|^2-|S_{21}|^2}\ \sqrt{1-|S_{22}|^2-|S_{12}|^2}}\right|^2$$

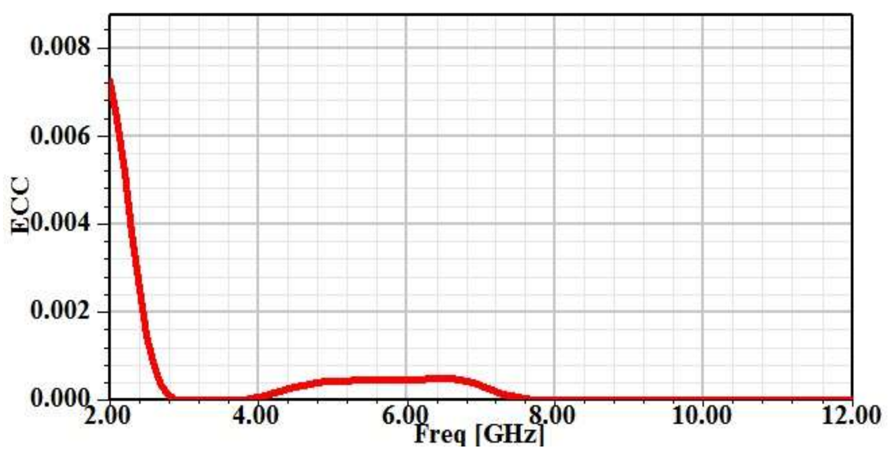

Fig. 5. ECC of Proposed Antenna

The measured correlation coefficient is below 0.06 throughout the UWB. This indicates very low correlation between the two ports and hence good diversity performance

IV. CONCLUSIONS

A MIMO antenna with a small size of mm for convenient UWB applications has been proposed. The antenna consists of two PMs put oppositely to each other to accomplish great isolation between the input ports. Two long ground stubs put nearby the emanating components and a short ground strip associating the two ground planes together are utilized to upgrade the segregation. Simulated results have demonstrated that the MIMO antenna can work in the whole UWB band from 3.1 to 10.6 GHz with mutual coupling of under -15 dB between the two ports. The utilization of the antenna for pattern diversity has additionally been considered. results have demonstrated that the MIMO antenna can accomplish an envelope connection coefficient of under 0.001 over the UWB. All outcomes demonstrate that the MIMO antenna is a potential candidate for compact UWB applications.

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