Reduction of Mutual Coupling for UWB MIMO Antenna with a Broadband Balance T-Line

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Abstract: A broadband balance T- type line is proposed to decrease the Mutual coupling of a smaller ultra-wide band (UWB) multiple-performance Multiple-Input-Multiple-Output receiving antenna. With the decoupling technique presented in this research, the UWB MIMO receiving antenna described covers the 3.1 – 9.4 GHz band with a decoupling of more than 17 dBs. The proposed broadband balance T-line is actually set in the margin area between two MIMO components and can be placed on the copper ground. A margin (radio antenna range) of 20*10 mm2 is achieved. The UWB MIMO receiving antenna is simulated and S-Parameters, radiation patterns are found to add productivity.

1 INTRODUCTION

MIMO (Multiple Input Multiple Output) antenna arrays innovation has always been of interest for researchers, due to its huge focal points of multitrack decline and expansion of the channel capacity. Almost all everyday gadgets, like PC, printers, and cameras all include ultra-wide band MIMO radio antennas which are connected to offer a high rate of information within a short range.

The execution of radio antenna structure in a compact device is influenced by the mutual broadband coupling between the ultra-wide band MIMO components. In addition, the improvement of wideband segregation is an exceptional test problem, particularly in the lower UWB band.

To date, several techniques have been introduced for reducing mutual coupling of UWB MIMO antenna. A parasitic element was placed between the monopole elements (Zhang, et al., 2009). A capable technique for mitigation of coupling effect was first proposed by (Diallo, et al., 2006), while (Liu, et al., 2013) applied different polarization with a metal strip. The reduction of broadband mutual coupling (Li, et al., 2015) Electro-Band Gap (EBG) were etched on the ground plane, by using a metal stripped with a circular disc inserted between UWB MIMO antenna elements (Zhang & Pedersen, 2016). However, the challenge to mitigate mutual coupling effect with a predictable broadband line still exists.

In this research, a T-type broadband line is used between the two antenna elements for reduction of coupling effects as shown in Figure 1a and Figure 1b. The planned ultra-wide band antenna can cover the frequency band 3.1 – 9.4 GHz with decoupling effect of more than 17 dBs. The suggested T-type neutralization line employed above the ground plane, an antenna area of 20*10 mm2 acting as a small clearance is achieved in the considered antenna.

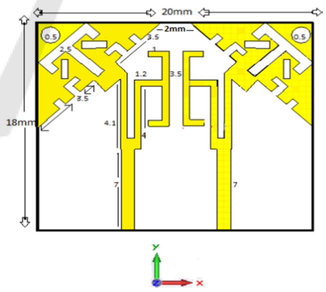

Figure 1a: Geometrics of the Antenna.

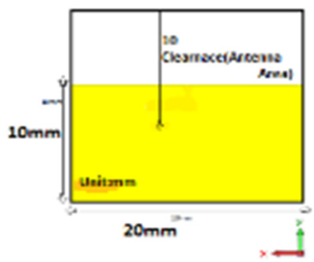

Figure 1b: Geometrics of the Antenna.

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This technique helped the overall reduction in mutual coupling and size of the antenna which can improve the its performance, especially in the lower band. This research focuses on designing an antenna using Computer Simulation Technology (CST) and comparing S-parameters with and without T-type broadband line with the existing antennas as shown in Figure 2.

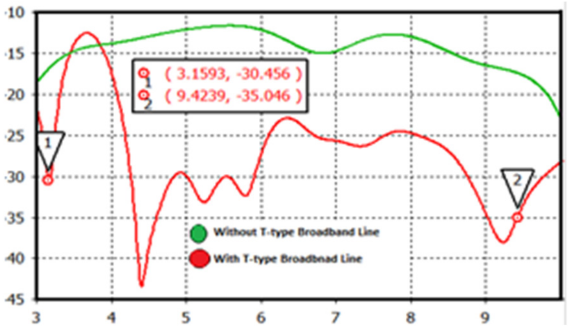

Figure 2: Simulated S-Parameters of ultra-wide band MIMO antenna comparing without T-type broadband line to with T-type broadband line.

S-parameters, far-field effect and size is compared with existing UWB antenna with the recently designed antennas. In this research, all numerical calculations are carried out using CST (Studio, 2014). Table 1 shows different parameters like width, length, radius and thickness of the substrate feed line T-type broadband line.

Table 1: Different parameters of the substrate feed line T-type broadband line.

Item	Length	Width	Thickness	Radius
Substrate	18mm	20mm	0.9mm	-
Ground	10mm	20mm	0.028mm	-
Feed Line	7mm	1.5mm	0.028mm	-
Triangle	8.5mm	-	0.028mm	-
T-Line	3.5mm	1mm	0.028mm	-
Circle	-	-	0.028mm	0.5mm
U-shaped	4.1&4mm	1mm	0.028mm	-

The broadband line is composed of two metal strips that are connected to T-type metal strips as shown in Figure 1, which helped in the reduction of mutual coupling between the antenna elements. The ground plane of the antenna with no slot is composed of copper annealed (lossy metal). The ground plane without any slot are composed of copper annealed (lossy metal).

The S-parameters simulated in this work for the proposed ultra-wide band MIMO radio antennas are given in Figure 2. The intended MIMO receiving apparatus covers the 3.1 – 9.4 GHz band with a shared coupling of significantly less than 17 dBs. As a correlation, the parameters without the broadband balance, the line is also given, and with the planned decoupling system, the segregation between two MIMO components of UWB can be productively improved by 12 – 22 dBs. In addition, the capacitance between the equilibrium line and the ground will grow which is due to a substantial part of the equilibrium line being above the ground plane.

Since the broadband balance line is associated with two MIMO components, it will eventually marginally increase the Q-element of the MIMO radio antenna components and will somewhat decrease the data transfer capability. (Zhang, et al., 2013). In any case, the transfer speed of the proposed UWB MIMO cable can in any case effectively cover the lower ultra-wide band of 3.1 – 9.4 GHz.

In general, due to high radiation capacity, the connection between components of MIMO antennas are low mostly when the antenna that receives MIMO operate in a high, e.g. greater than 1.7 GHz, recurrence band. (Vaughan & Andersen, 1987). While varying qualities in the upper band, the aggregate efficiencies of the components of the MIMO receiving apparatus are shown in Figure 3 with the limits of execution of MIMO. The proposed broadband balance line can effectively upgrade disconnections between MIMO components so that the aggregate productivity of the receiving ultra-wide band MIMO antenna receives the possibility of advancement. The addition reproduced to the efficiencies of the proposed MIMO ultra-wide band receiving apparatus with a broadband as well as without a broadband (NL) balance line are shown in Figure 4.

The aggregate change of competition with the broadband T-type line is clearly seen. It shows that even in the large space between elements, the proposed dissociation strategy can work productively.

To demonstrate the viability of decoupling, the current allocations of the present MIMO ultra-wide band radio antenna proposed with broadband balance line and without a broadband balance line are shown in Figure 5. The current allocations are gained when Port 1 (the MIMO component on the left side as shown in Figure 3) is energized at 3.3, 4 and 4.7 GHz. The coupling current from port 1 when flows towards port 2 in case of with broadband balance line can suffocate significantly, which causes the lower common couplings.

The current allocations at the rear of the proposed MIMO UWB receiving apparatus at a frequency of 4 GHz are given in Figure 3. Within the ground plane, the current is extremely important. For different frequencies in the range of 3.1 – 9.4 GHz, the currents are also important. In fact, this region is used for radio frequency circuits, where circuits affect the non-side in the execution of the receiving cable. In this research, we have used it to establish the encouraging link to diminish the impacts of the link in the MIMO proposal that receives the execution of the cable.

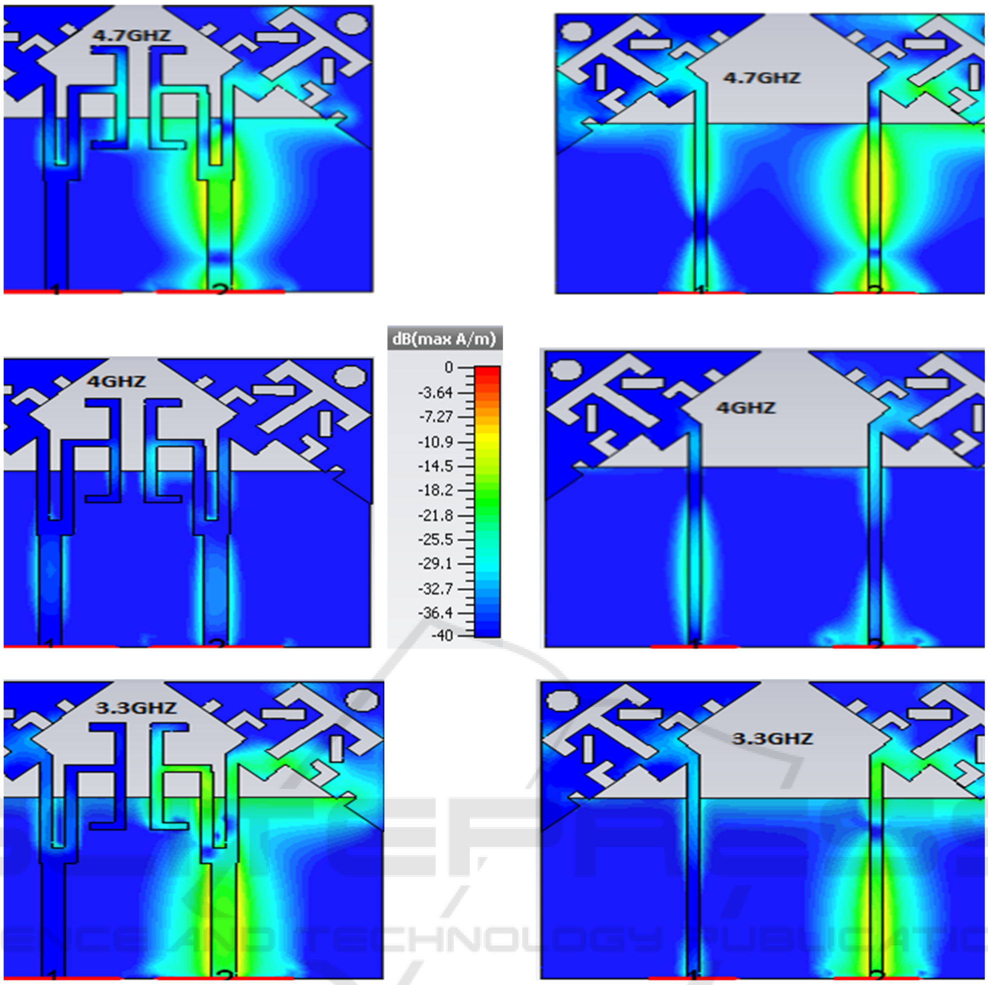

Figure 3: Proposed ultra-wide band MIMO Antenna current distributor with and without T-type broadband line.

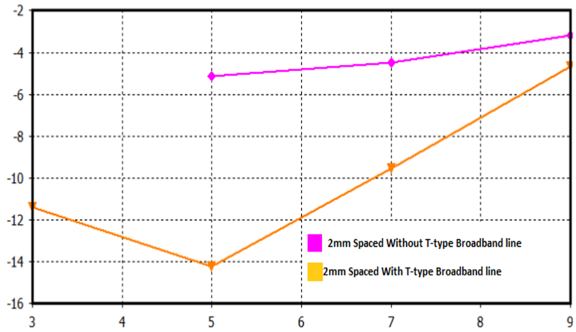

Figure 4: Simulated total efficiency of proposed ultra-wide band MIMO with and without T-type broadband Line.

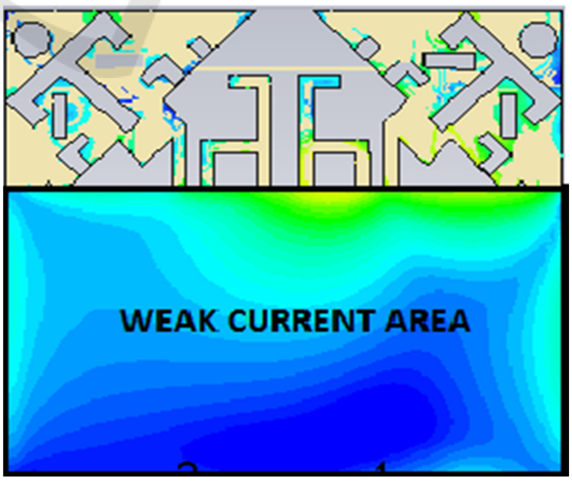

Figure 5: Current distribution on Ground for proposed ultra-wide band MIMO Antenna (colour slab is same as shown in Figure 3).

2 RESULTS

When comparing antenna's area clearance, isolation in dB and bandwidth in GHz for our introduced antenna versus the existing antenna as shown in Table 2 below. It can be observed that the antenna's area clearance is the least, isolation is average which is very good and the bandwidth coverage is also from 3.1 – 9.4 GHz.

Table 2: Comparing antenna clearance, isolation and bandwidth of proposed antenna with existing antennas.

Reference	**Antenna Area Clearance Size mm2**	**Isolation (dBs)**	**Bandwidth (GHz)**
(Zhang, et al., 2009)	35*27.25	16	3.1-10.6
(Liu, et al., 2013)	32*26	15	3.1-10.6
(Li, et al., 2015)	60*40	20	3-6
(Zhang & Pedersen, 2016)	35*16	22	3.1-5
This work	20*10	17	3.1-9.4

3 CONCLUSIONS

In this research, an ultra-wide band Multiple Input Multiple Output antenna has been designed which is smaller than another previous antenna. It mitigates the coupling effect more efficiently and covers a range of frequencies from 3.1 GHz to 9.4 GHz with the isolation of 17 dBs. The clearance size area of proposed antenna is 20*10 mm2, this clearance area is by far the least according to the current antennas commercially available, which can be used in situations where a small antenna is required. The current circulation and parametric revision was explored and the decoupling effect was removed from the new proposed T-Type as compared to other previous design antenna in which the broadband line exists.

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