International Journal of Electrical and Electronic Engineering & Telecommunications

ISSN 2319 – 2518 www.ijeetc.com
Vol. 6, No. 2, April 2017

Research Paper

IMPROVED RETURN LOSS AND REDUCTION OF MUTUAL COUPLING OF MICROSTRIP MIMO ANTENNA FOR C-BAND APPLICATIONS

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A novel to two elements compact The MIMO (Multiple Input Multiple Output) of exploitation of the antenna system 5.0 to 8.0 GHz is proposed for wireless applications. The antenna system developed at 7.7 GHz resonance, giving a bandwidth of 25% (based on S11 < -10dB). An effective technique is proposed to reduce the mutual coupling developed in the antenna System by the use of a simple element microstrip patch in between the antennas. By using the proposed method, the mutual coupling is reduced to approximately -35 dB to the resonance frequency and the maintenance of the whole less of mutual coupling -20 dB in the operating band. Also, envelope correlation coefficient (ECC) between the two antennas is calculated.

Keywords: MIMO, Antenna system, C-band, Mutual coupling

INTRODUCTION

Today the world is revolving around with technology that to speed and accuracy. So to catch that speed we jumped from 3G to 4G technology. To aspire high data rates, high speed, to overcome losses in data i.e accuracy we are using 4G technology in our data systems. Mostly we are using 4G technology in communication systems.

The heart of the communication system is to be antenna. If we accurate the antenna or speed up the antenna then we get good and well done result in our communication system. So to get good result and go for advanced antenna that is MIMO (Multiple Input and Multiple Output) i.e single substrate we are designed two different antennas with same shape and Inter linked with each other for communicating. In that one is to input to the signal i.e that catches the data from surroundings and give it to the signal that act as a output of the signal. Because of using two

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antennas data is to be overlapping and data traffic is to be too less compared to SISO antenna (Single Input Single Output). The major problem is to mutual coupling between of multiple antennas. Whatever, it may be the great challenge is to be developing mutual coupling between multiple number of antenna elements in a small and compact space. The mutual coupling is to be formed due to radiational interaction from closely spaced antennas and also due to surface current flowing through ground plane (Han and Choi, 2009). The physical cause and foremost important cause is to be mutual coupling between a pair of identical microstrip antennas in (Nikolic *et al*., 2005) what are the impacts of mutual coupling on channel capacity of a MIMO system is discusses in detail in (Abouda and Haggman, 2006).

Through out of the current research on MIMO antenna design is to be focused on reducing the effect of mutual coupling and to develop various techniques to reduced and get more efficient result. The main and important cause behind this mutual coupling is to surface current. By introducing another technique instead of ground surface current distribution, (Chou *et al.*, 2008) mutual coupling between the MIMO antennas is to be reduced. The another technique is to be EBG structure (Yu and Zhang, 2003; Caminita *et al*., 2009; and Farahani *et al*., 2010). EBG structure occupies the more space and also complicated. In (Kakoyiannis and Constantinou, 2010) another technique is to be introducing a defect on the ground plane between the antennas.

In (Habashi *et al.*, 2011), the mutual coupling has been minimized by added some structure at ground plane, because the radiation pattern is to be degraded. In (Farsi *et al*., 2012) the mutual coupling is to be reduced between a pair of simple rectangular patch antennas is by introducing a simple U-section in between the antennas, with less impedance matching. In present research, by adding microstrip element between two antennas then mutual coupling is to be reduced. By introducing rectangular strip patch between the antennas to reduced mutual coupling by more than -33db without affecting or changing any other characteristics like return loss, impedance band width and radiation pattern. The design of the basic antenna signal is discussed in section 2 and the antenna signal with reduced mutual coupling is presented in section 3.Total simulation are carried out using CST simulator.

DESIGN OF BASIC MIMO ANTENNA SYSTEM

The geometry of the antenna MIMO proposed is shown in Figure 1. The antenna is an antenna printed monopoly with plan of reduced mass. The surface of each antenna is 53 × 40 mm^2 and the project area of MIMO system is 150 × 70 mm^2. Edge to Edge the separation between the antennas in the MIMO system is taken as d = 30 mm (0.45 λ_0). The antennas are fed with a microstrip power supply with dimension L_F = 3 mm as shown in Figure1. The parameters of the antenna are shown in the Table 1. The basic idea of the form of the antenna system is derived from the Form E popular patch antenna (Yang *et al*., 2001) and the dimensions of the antenna are optimized so that it resonates to 6.8 GHz frequency in the band 5.0 GHz to 7.8GHz. This band of operation is suitable for many wireless applications in the C-band (4 to 8 GHz) and specifically for the adherence of applications

Figure 1: The Proposed MIMO System

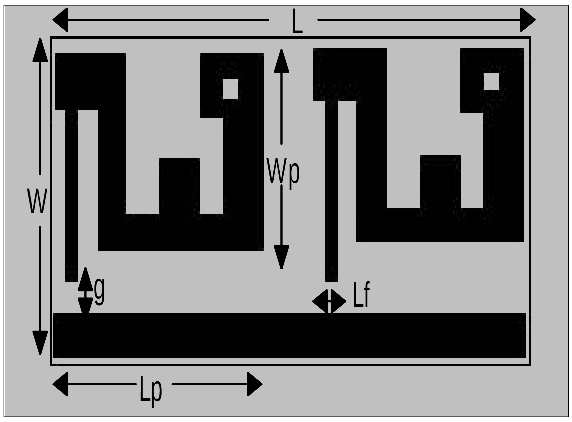


Table 1: Dimensions of the Proposed MIMO System

Design Parameters	Value (mm)
L	150
W	70
L_p	53
W_p	40
L_f	3

Figure 2: The Return Loss of the Proposed System

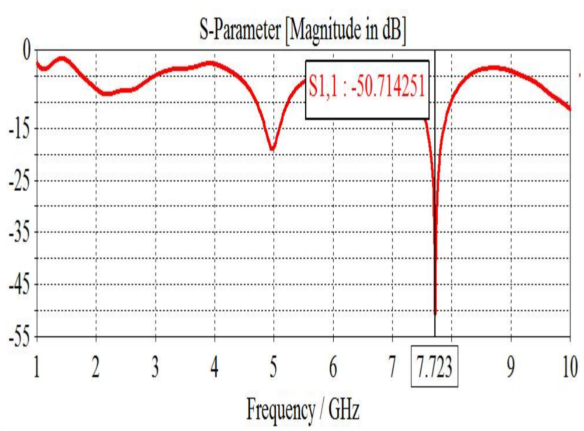


Figure 3: Mutual Coupling of MIMO System

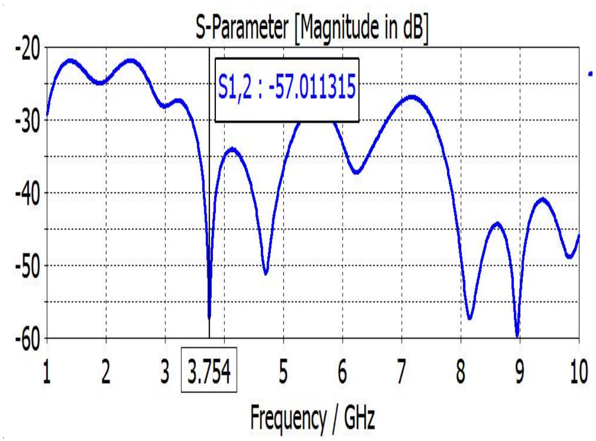
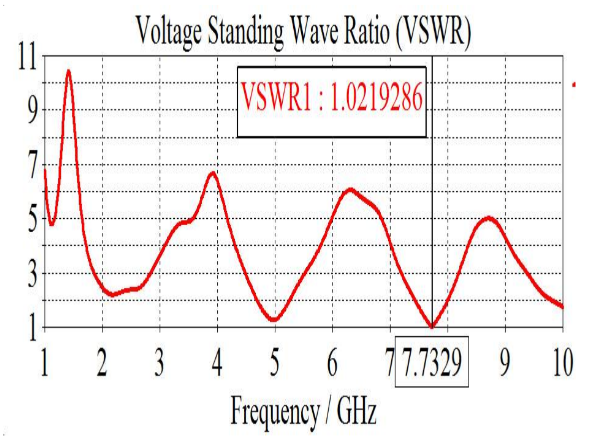


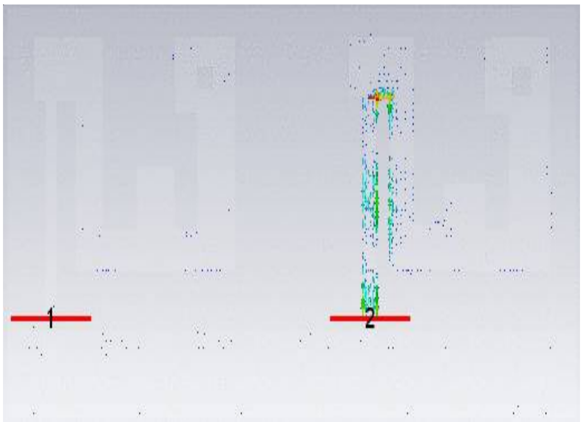
Figure 4: The VSWR of MIMO system



of emergency services (Read) as specified by the electronic communications committee (ECC). The antenna system is developed on a substrate of FR4 = 4.5, permittivity εr loss tangent of 0.02 and a thickness of h = 1.52 mm

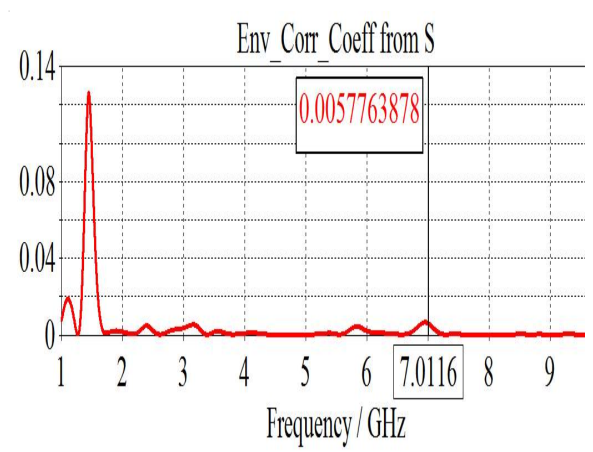
The value of the permittivity of the substrate is relatively high, so that the surface waves are reduced to the minimum give a better isolation between the antennas. The behavior of resonance of the antenna is optimized for the field dimension W_g = 13 mm using the simulator of the CST. The simulation of the parameters of the S-parameters of MIMO antenna proposed is shown in Figure 2. The antenna system gives the loss of return around 50 dB at the resonance frequency of 6.8 GHz, with a bandwidth of 25% in the frequency band 5.0 GHz to 8.0 GHz. In the present study, the emphasis is on the mutual coupling and is located be -35 dB to the resonance frequency. The surface of the current distribution of MIMO system proposed is shown in Figure 5.

Figure 5: Surface Current Distribution of the Proposed MIMO Antenna System



The reason for the reduction of the mutual coupling between the antennas and the basic idea to arrive to the form of the proposed antenna can be understood by the analysis of the surface of current distribution in Figure 5. The amount of coupling between the two antennas in a MIMO system depends on the directions of the intensity circulating on the surface of the antenna. If the current flows in the same direction on the adjacent sides of the two antennas, the coupling is no more. Similarly, if the currents are in the opposite direction, the mutual coupling induced is reduced (Mak *et al*., 2008). In the proposed system of MIMO antenna, the surface currents on the right arm of the first antenna and on the connecting element placed between the antennas are flowing in opposite directions as shown in Figure 5, thus reducing the mutual coupling. The performance of the proposed antenna is also evaluated with the help of another important parameter known under the name of the coefficient of correlation of the envelope (ECC), which is defined with the help of Eq. (1) (Blanch *et al*., 2003). This parameter is useful for assessing the diversity performance of a system MIMO. The ECC is calculated for the MIMO systems, i.e., without the element of connection between the antennas and is represented in Figure 6.

Figure 6: Envelope Correlation Coefficient of the Proposed Two Element MIMO system



The plot, it can be seen that the envelope correlation coefficient is very low, at the resonance frequency, which indicates the good isolation between the two antennas in the MIMO system. The ECC has obtained the value at the resonance frequency for the MIMO system without patch 0.012 and these values are more small compared to the value obtained in the ECC (Li *et al*., 2014), which is around 0.15. The measured radiation patterns of the

Figure 7: Directivity of the Proposed Two Element MIMO System at Phi=0

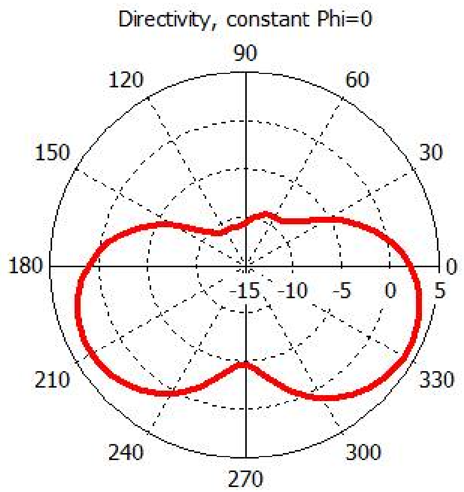
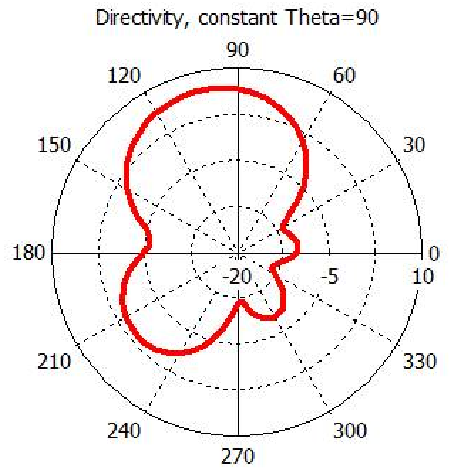


Figure 8: Directivity of the Proposed Two Element MIMO System at Theta=90



developed MIMO antenna system without patch element between the antennas are shown in Figure 7.

$$\rho = \frac{\left|S^*{}_{11}S_{12} + S^*{}_{21}S_{22}\right|^2}{\left(1-\left|S_{11}\right|^2-\left|S_{21}\right|^2\right)\left(1-\left|S_{22}\right|^2-\left|S_{12}\right|^2\right)}$$

CONCLUSION

In the present work, an element of the system MIMO novel two with the improvement of the insulation is proposed and carried out physically. The mutual coupling in the antenna system developed MIMO is analyzed without the element of connection between the antennas. The system MIMO with connecting element between the antennas is shown to improve the isolation of 14 dB. This network of antennas MIMO to 7.7 GHz with an echo of a bandwidth of 25 per cent in the frequency range 5.0 GHz – 8.0 GHz and with a reduction of mutual coupling -35 dB to the resonance frequency and the maintenance of the whole less of mutual coupling -20 dB in the operating band. The development of the system MIMO with mutual coupling reduces can be used in many wireless applications in C-band.

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