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Implementation of Multiband Mimo Antenna For Wireless Applications

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Abstract: *MIMO (Multiple Input Multiple Output)is an antenna technology for wireless communications on which multiple antennas are used at both the transmitter and the destination(Receiver). This paper is presented with two element compact dual band MIMO antenna system which acts as an array system. The antenna system have two monopole radiating elements. Each monopole radiating element has two arms one is longer and the other is smaller. The antennas resonate at 2.58and 5.4GHz bands. High isolation between antenna elements is achieved done by using isolation techniques such as cross slots, Extended ground plane and parasitic element. Two rectangular slots suppress surface waves. It acts as a band stop filter. Parasitic element direct beam in direction and reduce coupling between space and upper band.EBG structures represent a class of periodic structures, which exhibits frequency band pass and band-stop bands for the surface waves propagating along the structure. Due to this feature they offer the capability to block surface waves excitation in the operational frequency range of the phased arrays. Thus isolation between antenna elements are increased and mutual coupling between antenna elements reduced. At lower band current distribution is more at slot and extended ground plane so little current couples from one to other element. At higher band magnitude of surface current is more at Parasitic element than other elements which reduce mutual coupling between antennas and isolates antennas. Current distribution at 2.58GHz and 5.4GHz bands with and without isolation techniques are taken. The radiation pattern of two antenna elements are also taken. Then the longer arm of monopole resonate at 2.08-3.08GHz lower frequency bands while the smaller arm L shaped arm resonate at 4.8-6GHz higher bands. Return loss from port 1 to 1,S_{11}<-9.5dB is obtained over 2.08-3.08GHz band and 4.8-6GHz band which are suitable for 3/4G,WiFi, Bluetooth, Wi-MAX & WLAN applications. Antenna return loss is the difference between forwarded and reflected power where antenna efficiency is the measure of electrical losses occurs. Isolation values S_{12}<-13.5dB over the lower 2.08-3.08GHz band and S_{12}<-30dBover the upper 4.8-6GHz band respectively. The design and simulation of antenna structure is done with the help of HFSS software.*

I. Introduction

MIMO (Multiple Input Multiple Output) is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several forms of smart antenna technology, the others being MISO (Multiple Input Single Output)and SIMO(Single OutputMultiple Input). In conventional wireless communications, a single antenna is used at the source, and another single antenna is used at the destination. In some cases, this gives rise to problems with multipath effects. When an EM field is met with obstructions such as hills, canyons, buildings, and utility wires, the wavefronts are scattered, and thus they take many paths to reach the destination. The late arrival of scattered portions of the signal causes problems such as fading, cut-out (cliff effect), and intermittent reception (picket fencing). In digital communications systems such as wireless Internet, it can cause a reduction in data speed and an increase in the number of errors.

The use of two or more antennas, along with the transmission of multiple signals (by multipath wave propagation, and can even take advantage of one for each antenna) at the source and the destination, eliminates the trouble caused this effect .MIMO technology has aroused interest because of its possible applications in DTV, wireless local area network WLANs, metropolitan area networks MANs, and mobile communications. Significant attentions have been paid to mitigate the above mentioned interferences in a multiple antenna system by introducing different methods like the neutralization line , etching slots on the ground, EBG structure , and parasitic elements A two-port compact printed monopole antenna array is proposed with a novel and simple decoupling structure based on extended ground plane. The decoupling techniques described in the literature above are restricted to single band operation although they feature excellent decoupling capability. A dual-band MIMO antenna with high isolation is proposed by introducing two transmission lines on the top surface of the substrate and etching two slots in the ground. Compact dual band antenna with T-shaped stub and two rectangular slots inserted in the ground is reported, which significantly reduces the mutual coupling between the two ports at the lower frequency band.In a dual-band MIMO antenna with high port isolation by using an array of printed CLLs on the antenna is proposed. To achieve low mutual coupling between the nonresonant coupling elements, two sets of cross slots etched on the two edges of the ground plane are added.High port isolation for WLAN application (2.58/5.4 GHz) is achieved by introducing a T-shaped junction on the top surface of the substrate and etching two slots on the ground.A MIMO antenna consisting of two 90◦ angularly separated semicircular monopoles with steps is proposed for Bluetooth, Wi-Fi, Wi-Max and UWB applications wherein step-like structures introduced in the monopoles and modified and extended ground plane result in improving the impedance bandwidth and isolation up to 20 dB . In this paper, a compact dual-band MIMO antenna with high isolation for 3G, Wi-Fi, Bluetooth, 4G, Wi-MAX and WLAN applications is proposed. High isolation is achieved by using isolation technique.

II. Implementation

2.1 Implementation theory

Figure 2.1 shows the geometry with detailed dimensions of theproposed dual-antenna.Two element antenna system is taken on substrate with dimensions of 44×38 mm^2.It is printed on 1.6mm FR4 substrate with relative permittivity of 4.4and loss tangent of 0.02.The MIMO antenna system consists of two symmetric monopoles placed15mm apart. Each monopole have two arms.Longer arm of the monopole resonates at lower frequency band (2.08–3.08 GHz) whilethe smaller L-shaped arm resonates at higher frequency band (4.8–6 GHz).The resonant frequencies are 2.58 and 5.6 GHz respectively.

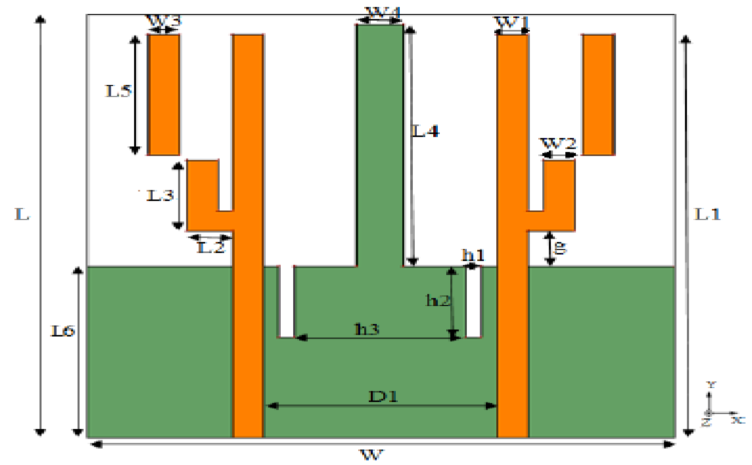

Fig 2.1: Antenna geometry.

Table 2.1: Dimensions of the proposed antenna

Parameters	L	W	L1	L2	L3	L4	L5	D1
Dimension (mm)	44	38	41	3	7	24	12	15
Parameters	W1	W2	W3	W4	h1	h2	h3	L6
Dimension (mm)	2	2	2	2	1	7	11	18

Dimensions of the proposed antenna are given in above Table2.1.The value of 'g' is taken as 3.5 mm. Two required bands can be controlled independently by changing the dimensions of two arms of monopoles [1]. Significant attentions have been paid to mitigate the interferences in a multiple antenna system, which is termed as the antenna decoupling problem [2]. The mutual coupling is decreased by using ground slots (GS), extended ground plane (EGP) and parasitic elements (PE). The two rectangular slots in the ground plane, act as a band stop filter (LC circuit) which suppress surface waves. The slot technique is explained as a slow wave structure, which An LC filter is a basic circuit that forces the electricity to pass through an Inductor (denoted by L) and Capacitor (denoted by C) to form an electrical resonator. In effect the Inductor filters out high frequency noise, and the Capacitor filters out low frequency noise, result in a nice clean line of electricity. The slots increase the path length and thus decrease mutual coupling. The slot technique is explained as a slow wave structure, which can decrease the wavelength of the signal and thus increase the separation between antenna elements.

Researchers have found that mushroom-like EBG structures are able to suppress surface wave propagation and thus reduce mutual coupling between radiating elements. Additionally researchers have found that the defected ground structure (DGS) is also able to provide a band stop effect due to the combination of inductance and capacitance .The EBG materials offer a unique way to control the excitation.[3]It has been applied to antenna designs to suppress harmonics, cross polarization of a patch antenna, and to increase the isolation of a dual-polarized patch antenna.

By adding parasitic elements a double-coupling path is introduced and it can create a reverse coupling to reduce mutual coupling.[4]. A wideband printed dual-antenna system for mobile terminals can presented. The dual-antenna, consisted of two symmetrical antenna elements and a NL, is printed on a printed circuit board. The antenna element is an F-like monopole with a grounded branch. The working mechanism of the dual-antenna is analyzed based on the parameters and the surface current distributions.[5]. .Dual band isolation is achieved by using an array of printed CLLs on the top side of the board for high band isolation improvement and a complementary CLL structure on the GND plane of the antenna for lower band isolation improvement[6]. The compactness of antenna arrays is highly restricted due to the mutual coupling effect between radiation elements, which degrades the arrays performances with respect to impedance matching, radiation efficiency, and antenna diversity[7]. A Multiple printed on the same substrate, leading to a fully planar structure. The length of the dipole for the lower band is shortened by a capacitive loading at each end of the dipole, offering a compact antenna configuration[8].

A new type of compact dual-band directional antenna is proposed for 2.4/5-GHz wireless access point and RFID reader applications. The dual-band antenna consists of a longer dipole for the lower band and a pair of shorter dipoles for the upper band.[9]. A space between antennas of about less than 0.5λ up to several λ (depending on which kind of environment is considered). This is not always compatible with the limited volume available on a wireless terminal.[10] Further, the parasitic element is placed near to vertical arm of each antenna element to direct the beam in one direction and thus to reduce the coupling through space and surface waves over the upper band. Then S_{11}<-9.5dB is obtained over 2.08-3.08GHz band and 4.8-6GHz band which are suitable for 3/4G,WiFi, Bluetooth, Wi-Max & WLAN applications. Antenna return loss is the difference between forwarded and reflected power where antenna efficiency is the measure of electrical losses occurs. Isolation values S_{12}<-10dB over the lower 2.08-3.08GHz band and S_{12}<-50dBover the upper 4.8-6GHz band respectively.

III. Simulated Results And Discussion

Figure 3.1 shows S_{11} and S_{12} without isolation using two antennas with HFSS software. Here in outside radiation boundary is taking which provides radiation.

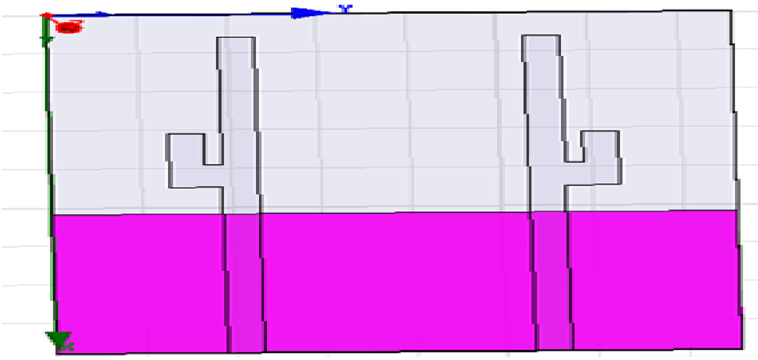

Fig 3.1: S_{11} and S_{12} without isolation using two antennas

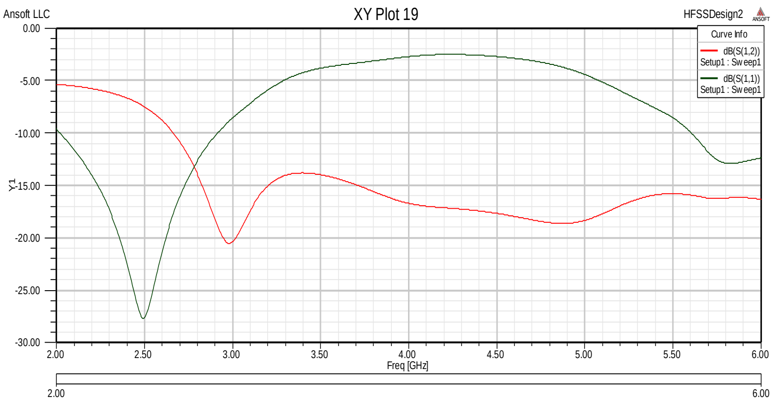

Fig3.2 : S_{11} and S_{12} without isolation

In the above figure S_{11}<-9.5dB over 2-2.9 GHz and 5.65-6 GHz respectively.S_{12}<-5dB over 2-3GHz and 4.8-6GHz.Here isolation between the antenna elements are very less since no isolation techniques are applied.

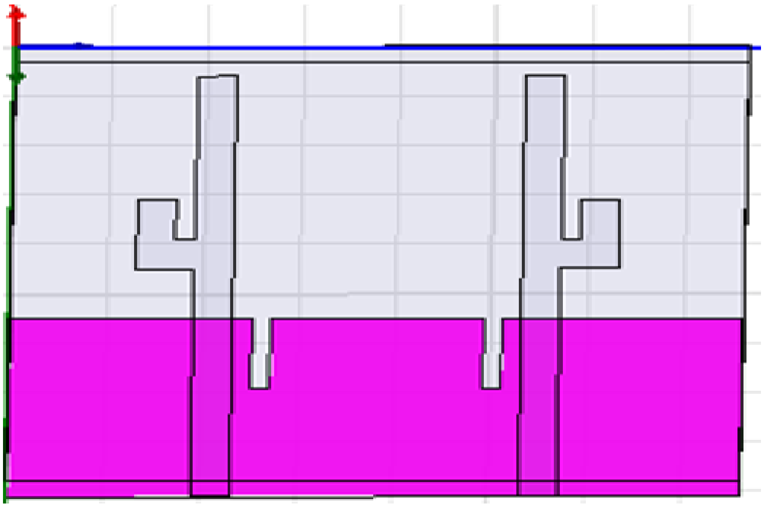

Fig 3.3 : S_{11} and S_{12} with isolation using two ground slots

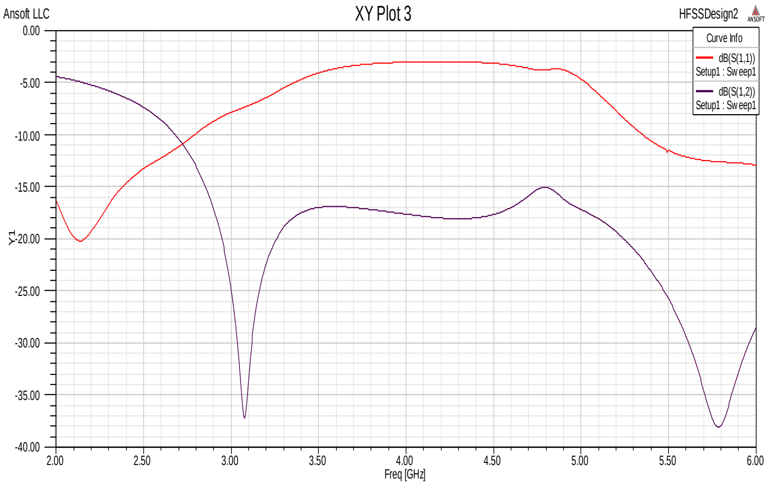

Fig 3.4: S_{11} and S_{12} with isolation two ground slots

In the above shows S_{11}<-9.5dB over 2-2.80GHz and 5.4 -6GHz.S_{12}<-10dB over 2.8-3.1 GHz and 5.50-6.0GHz.Hre the isolation is improved than earlier.

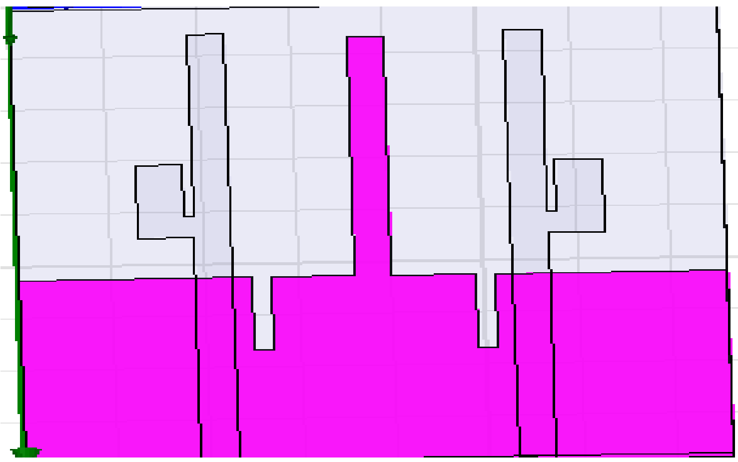

Fig 3.5: S_{11} and S_{12} with isolation of two ground slots ,Extended ground plane

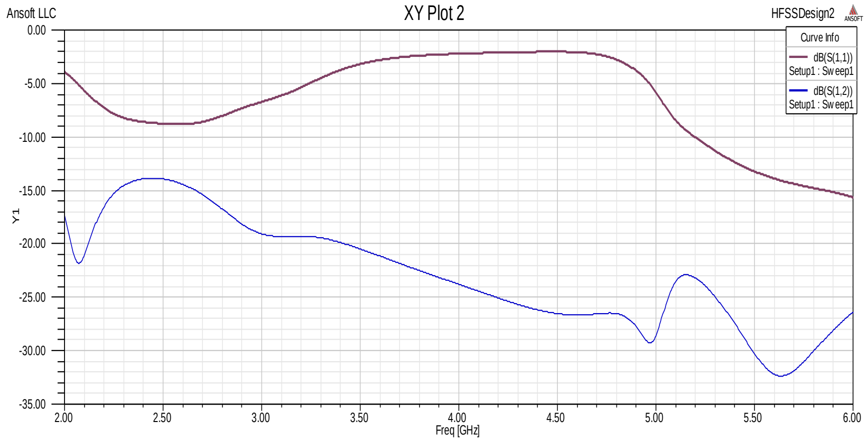

Fig 3.6: S_{11} and S_{12} with isolation of two ground slots ,Extended ground plane
S_{11}<-9.5dB over 2.4-2.7 GHz and 5.2-6GHz.S_{12}<-13dB over 2.4-2.6 GHz and S_{12}<-20dB over 5-6 GHz. Here again the isolation is improved.

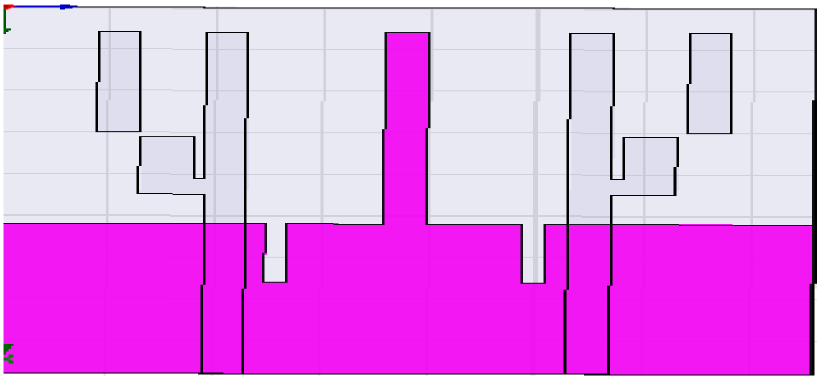

Fig 3.7: S_{11} and S_{12} with isolation of two ground slots , Extended ground plane, parasitic element

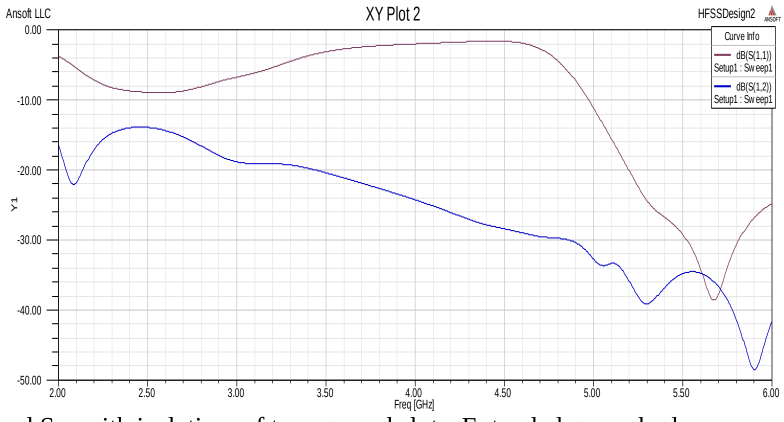

Fig 3.8: S_{11} and S_{12} with isolation of two ground slots ,Extended ground plane, parasitic element.

S_{11}<-9.5dB over 2.4-2.7 GHz and 5.5-6GHz.S_{12}<-13.5dB over 2.4-2.6 GHz and S_{12}<-30dB over 5.5-6 GHz. HERE again the isolation is improved. Here also the isolation increased.

IV. Conclusion

A compact dual-band MIMO antenna for 3/4G, Wi-Fi, Bluetooth, Wi-Max and WLAN application is proposed. $S11 < -9.5$ dB and isolation >13.5 dB and 30 dB in the lower and upper band respectively is obtained using two ground slots, extended ground plane and by employing parasitic elements. The antennas resonate at 2.58and 5.4GHz bands.

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