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DESIGN OF TRIANGULAR SHAPED LTE, BLUETOOTH INTEGRATED UWB MIMO ANTENNA WITH NOTCHED C BAND

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Abstract:

The proposed UWB (ultra-wideband) MIMO (multiple input multiple output) antenna with band notched properties rejects c-band (4-8GHz).The antenna consists of two triangular shaped symmetrical elements which are placed perpendicular to each other to reduce mutual coupling .By adding a parasitic element in ground plane, isolation is further enhanced to -18.9dB. The proposed structure covers almost entire UWB (3.1-10.6GHz) with Bluetooth (2.4-2.48 GHz), LTE (2.3-2.4 GHz) wide impedance bandwidth from 2-10.8GHz. TARC and ECC are calculated and presented with good MIMO characteristics. These characteristics indicate that this antenna is a good candidate for most of the wireless and UWB medical applications.

Keywords: ultra-wideband, isolation, multiple-input-multiple-output (MIMO), parasitic elements.

Introduction

In recent years, the demand for UWB increased due its wide spectrum of applications. The UWB technology has become a promising technology for data communication and localization due to its high data transmission rates, low power consumption as well as high-precision ranging. Typical narrow band systems within the UWB work alongside UWB in same wireless environment. Other wireless standards, such as IEEE 802.11a or HIPERLAN/2 operating in the 4.9–5.9 GHz [5] leads to electromagnetic interference between the bands, which reduce the quality of the data in the system. So, in recent times much research is done on interference suppression .The design methods of band-rejected antennas may include, integrating a filter at the input end of the antenna and loading narrow-band resonant elements on the antenna. Adding filter at the input port of antenna complicates the circuit and more space is needed. By adding resonant elements on the antenna, the size is reduced as there is no need for separate filter. Due to short range of UWB because of low transmitted power MIMO (multiple input multiple output) are introduced to achieve high data rates and overcome multipath fading problem. Main challenge faced by MIMO antenna is achieving good isolation.

By introducing CSRR (complementary split ring resonator) and parasitic element in the antenna better isolation is possible with multiple resonant frequencies. In [10], the combined effect of ground plane deformation and slots embedded within the radiator was employed to build an UWB antenna with band-notch characteristics. However, the use of embedded slots within the radiator had the negative impact on the gain of the antenna. In this paper we propose, UWB MIMO antenna with parasitic element in ground plane, along with CSRR for the main purpose of isolation enhancement. By placing two radiating elements orthogonal to each other. There is a reduced mutual coupling between the radiating elements.

2. Antenna Geometry

The geometry of proposed MIMO antenna has a compact size of 40×35 mm^2. Two triangular shaped antenna elements each with side length of 11.9 mm are placed on a substrate ARLON-TC350 having a dielectric constant of 3.5.Two rectangular trunks are etched from triangular patch one with dimensions 2.5×0.9 mm^2 (right) other with dimension of 2.9×1.5mm^2 (left).Rectangular slit each with dimension of 2×1mm^2 is etched from partial ground plane as shown in fig: 3

Apart from CSRR [7] in ground plane a parasitic element of dimensions 15×3mm^2 is placed in ground plane just below the radiating patch antenna element to improve isolation. The detailed dimensions are mentioned in table: 1 Two truncations on each antenna element are truncated to improve bandwidth by providing additional resonance [2]-[4]. A rectangular slit 2×1mm^2 is etched in the ground plane under each feed line to improve impedance matching.

Table-1 : Dimensions of the antenna.

Parameters	Values(mm)	Parameters	Values(mm)	Parameters	Values(mm)
substrate	ARLON-TC350	G	1.6	p	15
Z	50Ω	F	16.6	w1	2.5
Ɛ	3.5	Wf	1.5	w2	2

L	40	S1	11.9	l1	1.5
W	17.5	S2	12.7	l2	1
L	3.5	W	6	W1	0.4
W2	1.4	W3	0.4		

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W	17.5	S2	12.7	l2	1

3. Antenna Design

$$L.F = \frac{7.2}{0.945T + g}[4]$$

LF=lower resonant frequency (GHz)

T =length of the side (cm)

g=gap between patch and partial ground plane (cm)

Single antenna element as shown in Fig.1 is taken and studied effects of partial ground, slit in the ground plane, truncated patch. The truncations in the slit increased number of resonant frequencies as shown in Fig.3.1

4. UWB Mimo Antenna with CSRR and Parasitic Element

CSRR behaves as an electric dipole that can be excited by external electric flux. When a CSRR is applied in MIMO system, the presence of the open rings leads to an effective negative permeability at the resonant frequency, where signal propagation is inhibited. Therefore, a good isolation is achieved. By introducing parasitic resonator near the patch it creates an opposite coupling field that reduces impact of the field radiated by one antenna there by reducing near field coupling [9]. Before adding parasitic element there is only single path mutual coupling (i.e.) between the two antenna elements. But, by adding parasitic element in ground plane between patches two coupling paths are created. One is original coupling path between the two elements; the other is double coupling path. Firstly, radiation is coupled from first patch to parasitic element. Secondly from parasitic element to second patch. The double coupling path creates negative coupling which suppress the original single path coupling, thereby improving isolation [9].

5. Results and Discussion

MIMO parameters are also measured with TARC (total active reflection coefficient) and ECC (Envelope correlation co-efficient). TARC is defined as the square root of the ratio of the sum of the power available at all the ports minus the radiated power to the total available power. TARC is a real number between 0 and 1. When the TARC value is zero, this means that all the available power is radiated. The available power is the sum of powers available on all the ports of the antenna system. TARC curves are used to obtain the effective operating bandwidth of the antenna system. We have achieved TARC of 0.16. The correlation coefficient is a measure that describes how the communication channels are isolated from each other .This metric deals with the radiation pattern of the antenna system. The square of the correlation coefficient is known as the envelop correlation coefficient. We achieved ECC value of 0.0030 which is very low and implies good isolation.

$$TARC = \sqrt{\frac{((S_{11} + S_{12} \times e^{j\theta})^2 + (S_{22} + S_{21} \times e^{j\theta})^2)}{2}}$$

$$ECC = \frac{|(S_{11}{}^{*}S_{12} + S_{22}{}^{*}S_{21})|^2}{(1-(|S_{11}|^2 + |S_{21}|^2))(1-(|S_{22}|^2 + |S_{12}|^2))}$$

The return loss of the MIMO antenna is -30dB with better isolation greater than -18.9 dB after additio of parasitic element,as shown in Fig3.2& Fig.3.3

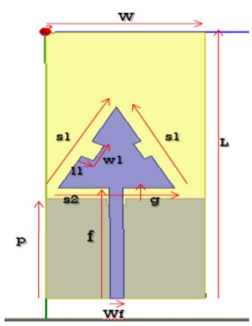

Fig.1.Single element.

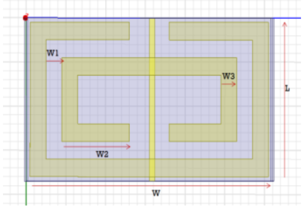

Fig.2.CSRR.

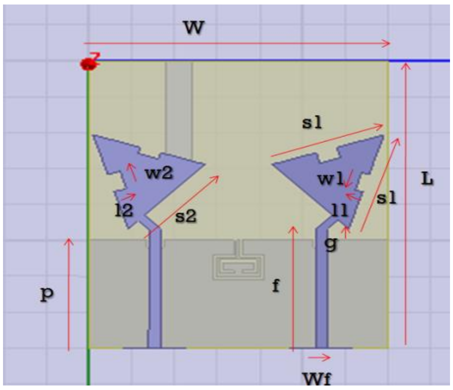

Fig.3.Front side of antenna.

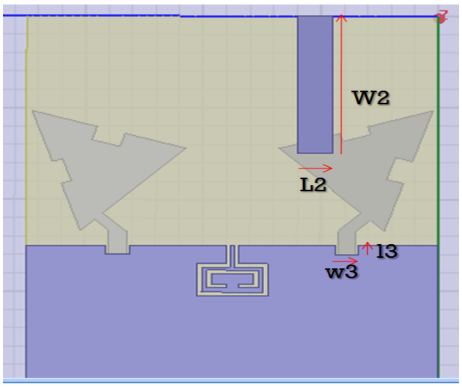

Fig.4.Back side of antenna showing parasitic element.

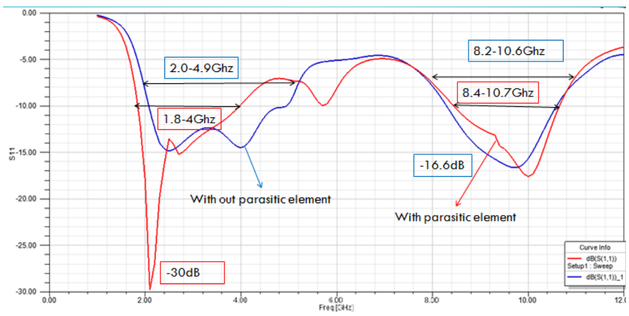

Fig.3.1. Return loss with and without parasitic element.

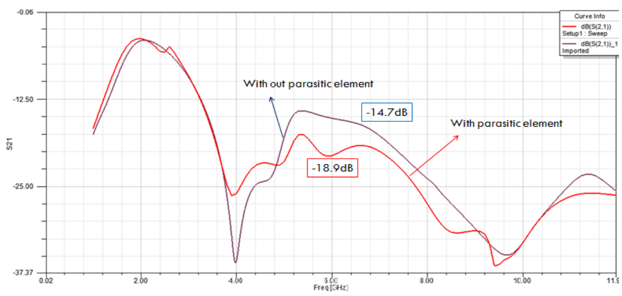

Fig.3.2. Isolation comparison with and without parasitic element.

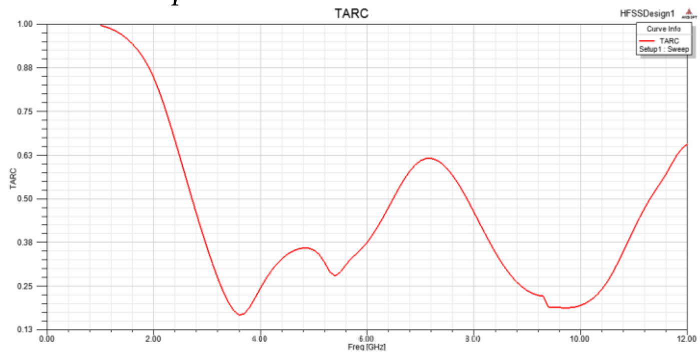

Fig.3.3.TARC.

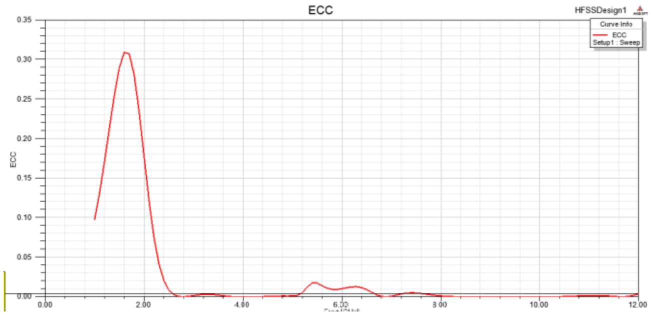

Fig.3.4.ECC.

6. Conclusion

The proposed antenna is successfully designed and simulated, which operates in ultra-wide bandwidth (3.1-10.6GHz), Bluetooth (2.4-2.48GHz), LTE (2.3-2.4GHz) frequencies varying from (2-10.9GHz) with notched C-band (4-8GHz). A MIMO triangular patch antenna is designed and a parasitic element is planted in ground plane behind one of the radiating patches. By planting parasitic element in ground plane, isolation is gradually improved with most of the band having isolation greater than -18.9dB. This is due to reduced near field coupling. The measured results of S-parameters, 3-D radiation patterns, TARC (<0.16), VSWR (1.19) and ECC (0.0030) s are presented and can meet the requirements of multi-antenna systems.

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