Split Ring Resonator in UWB Antenna with Band Notched Characteristics

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Abstract – *Compact size UWB antenna system for cognitive applications. The proposed antenna consists of two split ring resonators - antenna elements, a T- shaped ground stub, a vertical slot cut on the T- shaped ground stub and two strips on the ground plane. Results show that the antenna can operate from 3.1 to more than 15 GHz with a notched band in 4.1, 7.4, 9.0, 12.2GHz. The split ring resonator used in this structure increase the wide band characteristics . Instead of using switches The two strips on the ground plane are used to achieves the band notched characteristics The proposed antenna has better results of S-Parameters for ultra wide band (UWB) operation and band notched operation. The proposed UWB antenna with the "Taconic RF-35 (tm)" substrate with thickness 1.6mm and simulated using ANSOFT HFSS 13.0 software.*

Keyword : *UWB, Split Ring Resonator, T-shaped ground plane*

I. INTRODUCTIONS

MIMO (Multiple inputs Multiple outputs) for UWB antennas are very important to improve the performance of cognitive applications [1]. Fig 1 shows that the system is works under multiple transmit and multiple receive antenna (MIMO) channel, the spectral efficiency is very higher while compare to single – antenna channels[2].

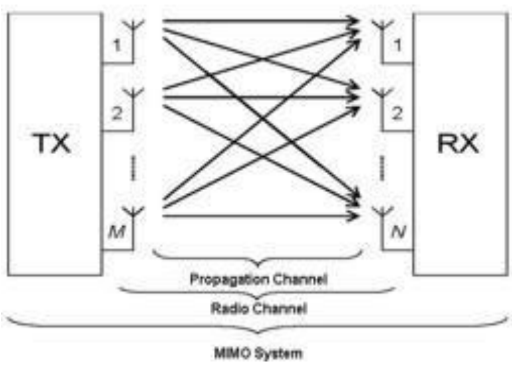

Fig 1: MIMO ANTENNA

According to the federal communication commission (FCC) [3] in the united state is the required that needs of healthcare provision a Cognitive Radio (CR) is a radio that can change its transmitter parameters based on interaction with the environment in which it operates UWB, it is also known as digital pulse wireless [4]. Wireless technology for transmitting data over a wide spectrum of frequency bands. UWB has two of applications radar, voice and data transmission [5]. UWB communication systems are reduced fading from multipath and very high bandwidth. The role that UWB antennas play important role able to transmit this pulses as accurately and efficiently and also it have a low power requirements [6].

II. ANTENNA CHARACTERISATION PARAMETER

1)Peak value of the envelope: the peak value of the analytic envelope is measure for the maximal value
2)Gain in frequency domain : it is defined like in narrow band systems
3) Envelope width : it describes the widening of the radiated impulse and is define of the magnitude (FWHM)
4) Ringing : the ringing T_t of a UWB antenna is undesired and caused by multiple reflections in the antenna
5) Transient gain: g_t is an integral quality measure that characteristic the ability of an antenna to radiated the power
6) Group delay : the group delay of an antenna characteristics the frequency depends on the time delay.

UWB antenna principles are,

1. Travelling wave structures
2. Multiple resonance antenna
3. Electrically small antennas
4. Frequency independent antennas
5. Self complementary antennas

III. THEORY

Split ring resonator is also known as metamaterial. Meta material this word is a combination of "meta" and "material" Meta is Greek word which means altered or changed [11]. That electromagnetic properties are altered. They are typically man made material. The metamaterial is defined as "a material which gains its properties from its structure rather than directly from its composition". Two typical metamaterial structures one is periodic structure and another one is non-periodic structure. The gap between inner and outer ring acts as a capacitor while the rings themselves acts as an inductor, resulting in an LC resonant circuits

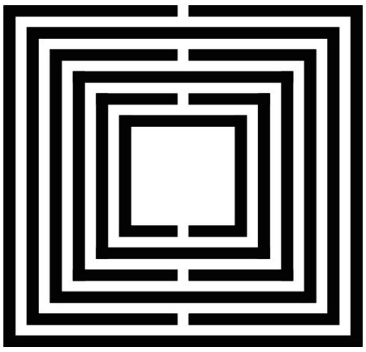

Fig 2: Structure of Split Ring Resonator

Metamaterial opens a door for designing sensor with specified sensitivity. Metamaterials provide tools to significantly enhance the sensitivity and resolution of sensors. Metamaterial sensors are used in agriculture, biomedical etc. In agriculture the sensors are based on resonant material and employ SRR to gain better sensitivity, In bio medical wireless strain sensors are widely used, nested SRR based strain sensor have been developed to enhance the sensitivity .

Metamaterial are expected to have an impact across the entire range of technologies where electromagnetic radiation are used and will provide a flexible platform for technological advancement. Among metamaterials, negative refractive index materials or left-handed materials have drawn special attention in microwaves.

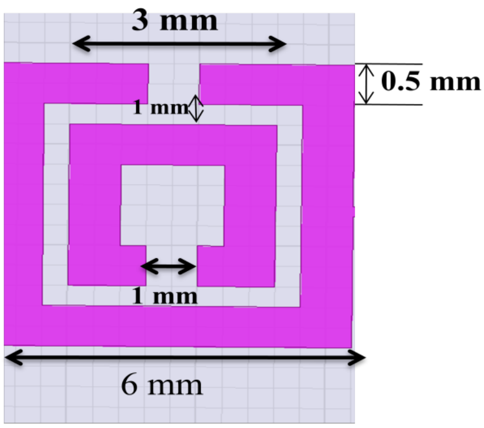

Fig 3: Geometry of Split Ring Resonator

The structure is similar to a metamaterial. Fig 3 shows that the split ring resonator structure is act as patch. It has two rings inner and outer rings. The length of the inner and outer ring is 1 mm .The space between the inner and outer ring is 1mm.

IV. ULTRA WIDE BAND ANTENNA STRUCTURE

In proposed antenna improves the band width up to 15 GHz and band notched characteristics act as four band by using the two strip line in the ground plane .

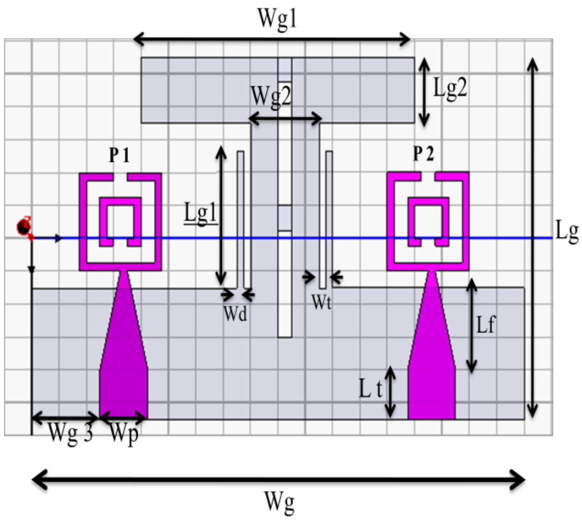

Fig 4 : Geometry of UWB antenna

The structure is similar to a metamaterial. The two split ring resonator are used. Split ring resonator structure is act as patch located at a two ports. Fig : 4 shows that the two split ring resonator i.e) P1 and P2 The radiator of an UWB antenna could be many shapes such as hexagonal split ring resonator, circular split ring resonator, pentagon split ring resonator and many normal shapes are rectangular, elliptical, and circular-ring shaped[7],[8],[9].

DIMENSIONS OF PROPOSED ANTENNA UNIT (mm)

Wg	Wg1	Wg2	Wg3	Wd	Wt
36	20	5	5	0.5	0.5
Wp	Lg	Lg1	Lg2	Lf	Lt
3.5	22	8.3	4	6	3

The antenna is fabricated on a 1.6 mm thick (i.e.) h =1.6 mm Taconic RF-35 substrate.
Here the essential parameters for the design
$\varepsilon_r = 3.5$
h=1.6 mm tan
$\delta = 0.002$.

V. RESULT AND DISCUSSION

The proposed wide band antenna is designed to operate in 3.1 to 15.0 GHz have been simulated by using the simulator Ansoft HFSS 13 (High Frequency Structure Simulator) The UWB antenna is simulated with Taconic- RF35 substrate which has 1.6 mm thick and a relative permittivity ε_r of 3.5 .

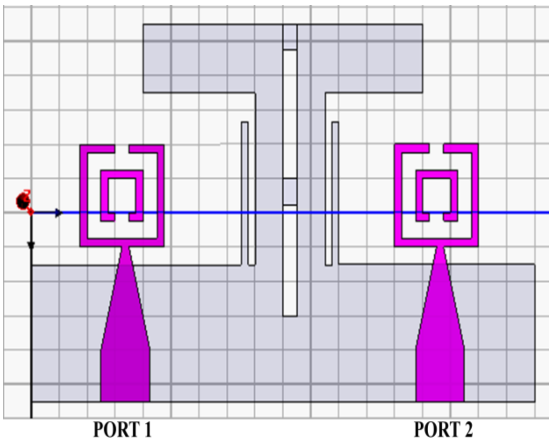

Fig 5: View of proposed antenna

The length of each port line is 3 mm. Simulation results show that the impedance matching for the proposed antenna is strongly depends on the location of the split ring resonator, T-shaped ground plane, and two strip lines. Thus the impedance bandwidth is widened by maintaining width and length of the UWB antenna structure. Figure 5, Shows the proposed antenna.

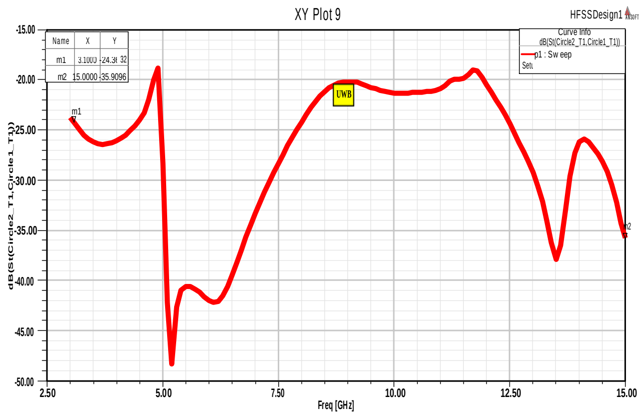

Fig 6: Simulated output UWB band

Fig 6 shows that UWB band are simulated S – parameters S_{12} & S_{21}

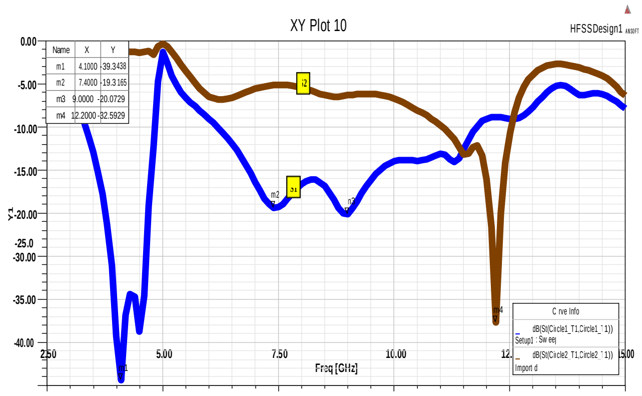

Fig 7: Simulated output band notched characteristics

Fig 7: shows that Band notched characteristics are S_{11} & S_{22} by using MIMO antenna instead of using switches

SIMULATED RESULTS BY USING HFSS.

S- parameters	Simulated result	Db
UWB (S_{12}, S_{21})	Below -10 dB in 3.1 to 15	-45
S_{11}	Below 10 dB in 4.1, 7.4, 9.0	-39, -19, -20
S_{22}	Below -10 dB in 12.2	-32

VI. CONCLUSIONS

In this paper a MIMO antenna integrated with split ring resonator. The bandwidth is increased up to 15 GHz. A T-shaped ground stub with a slot is used between the split ring resonator elements to reduce mutual coupling to below −15 dB. Two ground strips are used to create a deep band notch from **4.1, 7.4, 9.0, 12.2 GHz** to suppress interference in the WLAN band , fixed satellite band. Results indicate that the MIMO antenna is suitable for portable UWB MIMO applications.

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