Pattern Reconfigurable Mimo Antenna

S.A. Amutha Jeevakumari
Department of Electronics and Communication Engineering,
Adhiparasakthi Engineering College,
Melmaruvatur, India
jeepriyam@gmail.com

Dr.V.Nagarajan
Department of Electronics and Communication Engineering,
Adhiparasakthi Engineering College,
Melmaruvatur, India.
nagarajanece31@gmail.com

***Abstract*— Radiation pattern reconfiguration is a new technique for antenna design as it enables the antennas to adapt to different propagation. Multi Input Multi Output (MIMO) antennas are recently more focused in mobile communication. In this paper, a novel dual feed pattern reconfigurable MIMO antenna is designed without using switches. To implement the design, a circular Defected Ground Structure (DGS) with concentric split ring (SR) is employed beneath the signal plane. The signal plane comprises of octagonal ring pattern with orthogonal dual feed arrangement. The operation of the antenna is well analyzed with its reflection coefficient and radiation pattern. The proposed antenna is resonating at same frequency with different radiation pattern. The prototype is designed to be utilized in LTE700 and GSM900 bands respectively.**

Key words: **MIMO, Reconfigurable antenna, DGS, Split Ring, Pattern.**

I. INTRODUCTION

Modern wireless communication systems have multiple standards so that they require modern antenna systems with multiple capabilities. The reconfigurable antenna becomes a popular solution due to their selectivity for operating frequency, radiation pattern, polarization, or combinations of the above [1]. Reconfigurable antennas are becoming widely used in future wireless applications. A reconfigurable antenna is an antenna capable of modifying dynamically its frequency, polarization and radiation properties in a controllable and reversible manner. Based on application, they can change their geometries and behavior to adapt to changes in desired conditions [8]. Radiation pattern reconfiguration is a new technique for antenna design as it enables the antennas to adapt to different propagation and user scenarios. Reconfigurable antennas are used to cover different wireless services like military scanning applications, multiband RFID detection, etc.

The reconfigurable antenna becomes a popular solution due to their selectivity for operating frequency, radiation pattern, polarization, or combinations of the above [6]. Reconfigurable antennas have gain tremendous research interest for many different wireless applications such as cellular radio system, radar system, satellite communication, airplane, and unmanned airborne vehicle (UAV) radar, smart weapon protection. A reconfigurable antenna can be a single antenna or an array [5].

Radiation pattern reconfigurable antenna is based on the intentional modification of the spherical distribution of radiation pattern. Beam steering is the most extended application and consists in steering the direction of maximum radiation to maximize the antenna gain in a link with mobile devices. Pattern reconfigurable antennas are usually designed using movable/rotatable structures or including switchable and reactively-loaded parasitic elements. Radiation pattern reconfigurable antenna provides a steerable main beam between several directions or angles. The angle diversity is achieved by controlling the capacitance value of the varactor diode or parasitic element manipulation using switches [6].

Multiple Input Multiple Output (MIMO) Wireless communication is beginning to revolutionize wireless communications. MIMO utilizes multiple transmit and receive antennas to increase capacity and hence improve overall bit rate throughput [4]. MIMO provides significant increases in capacity without requiring any additional transmit power or spectrum and is therefore breaking traditional barriers. New wireless systems such as 802.11n, B3G and WiMAX will all have MIMO capabilities. Because of the large size of MIMO antennas techniques are needed to try and reduce their size for use in portable handsets. One approach is to develop reconfigurable techniques that allow them to reconfigure into other antennas. MIMO antennas are recently more focused in mobile communication. A reconfigurable antenna for MIMO systems is an attractive solution for handheld devices to maintain good communication link capacity [7].

To take advantage of MIMO system, mobile phones are required to have two or more antennas at the same frequency bands. According to the LTE standard, multiple antennas in the mobile handsets are used for downlink only, with uplink working with only one transmitting antenna. With the release of LTE Advanced (LTE-A) in 2013 onwards, antennas in the mobile handsets are used for the uplink as well. This change called for improvement on the antennas which in turn increases complexity and design difficulties in the already cramped chassis of an LTE capable Smartphone.

In this paper, a novel dual feed MIMO reconfigurable antenna is designed. To implement the design, a circular Defected Ground Structure (DGS) with concentric split ring (SR) is employed beneath the signal plane. The signal plane comprises of octagonal ring pattern with orthogonal dual feed arrangement. The antenna prototype has the dimension of $0.66\lambda \times 0.66\lambda$, where the octagonal ring is of 0.34λ. The dual band has been achieved by the periodic property of split ring employed within the circular DGS in the ground plane. The operation of the antenna is well analyzed with its

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radiation patterns and reflection coefficient. The prototype is designed to be utilized in LTE700 and GSM900 bands respectively.

II. ANTENNA CONFIGURATION AND DESIGN

The front view of the proposed MIMO antenna shown in Fig.1 has the dimension of 0.66λ × 0.66λ, where the octagonal ring is of 0.34λ. Fig. 2 shows the rear view of the antenna prototype. The signal plane comprises of octagonal ring pattern with orthogonal dual feed arrangement. The dual band has been achieved by the periodic property of split ring employed within the circular DGS in the ground plane. The proposed Pattern reconfigurable MIMO antenna is resonate at same frequency 1.2066 GHz. FR4 material used as substrate with finite ground. Patch on a substrate in octagonal pattern and Dual port coaxial feed in orthogonal directions. Empirical calculations incorporated in the designing to attain perfect matching and 50Ω impedance is maintained. The calculations are based on the transmission line model [2].

The effective dielectric constant of the substrate is given as

$$\varepsilon_{eff} = (\varepsilon_r + 1)/2 + (\varepsilon_r - 1)/2\,[1 + 12\,(H/W)]^{-1/2} \qquad (1)$$

Port 1 as input radiation pattern and reflection coefficient are measured and port 2 as input radiation pattern and reflection coefficient are measured. For both port 1and 2, MIMO antenna is resonate at same frequency. Without using switch, Pattern reconfiguration is achieved using MIMO configuration.

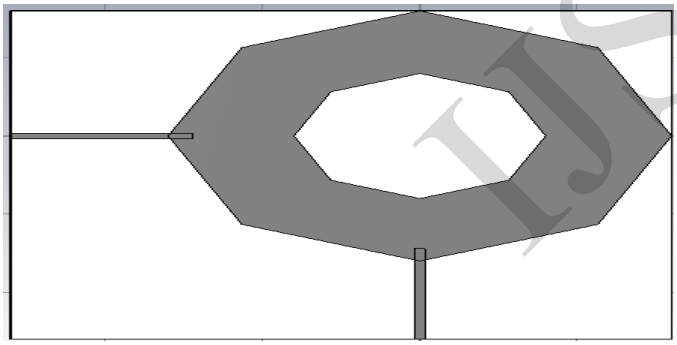


Fig. 1: Front View

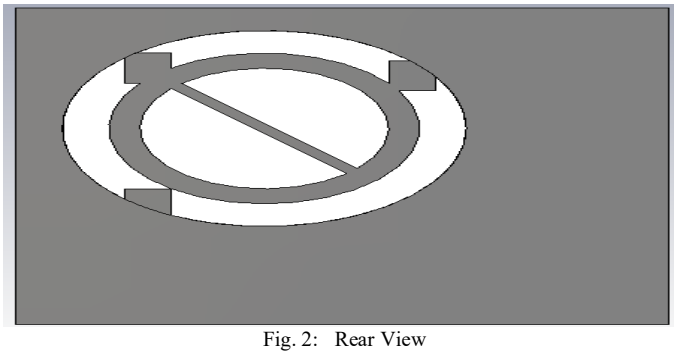


Fig. 2: Rear View

III. SIMULATION RESULTS

The proposed pattern reconfigurable MIMO antenna resonates at same frequency 1.2066 GHz. With port 1 as input, radiation is on 6 faces, each on 60 degree sequence a direction such as 30, 90, 150, 210, 270, and 330 respectively as shown Fig.4. Radiation pattern has main lobe magnitude is 14.5 and direction is 30 degree. The corresponding reflection coefficient is -30 dB as shown in Fig. 3. With port 2 as input, radiation is on 6 faces, each on 60 degree sequence a direction such as 0, 60, 120, 180, 240, and 300 respectively as shown Fig.6. Radiation pattern has main lobe magnitude is 15.8 and direction is 60 degree. The corresponding reflection coefficient is -30 dB as shown in Fig. 5. Without using switch, Pattern reconfiguration is achieved using MIMO configuration.

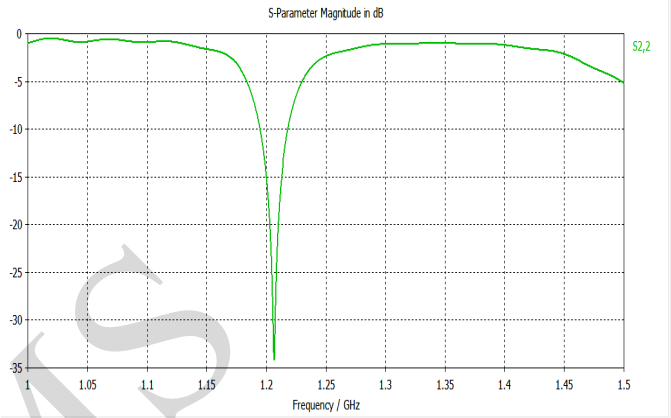


Fig. 3: Reflection Coefficient (pot 1 as input)

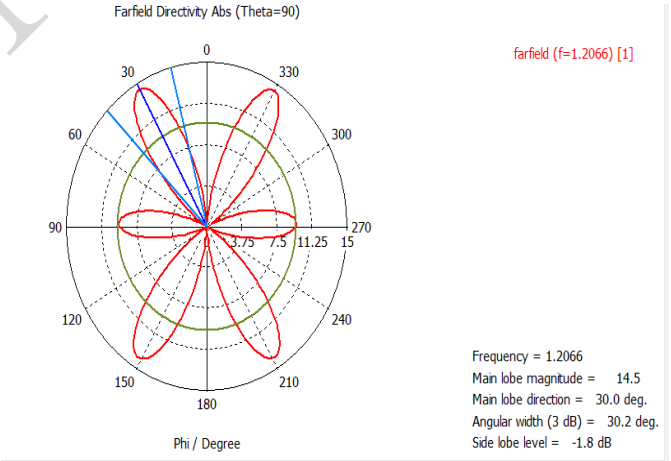


Fig. 4: Radiation Pattern (port 1 as input)

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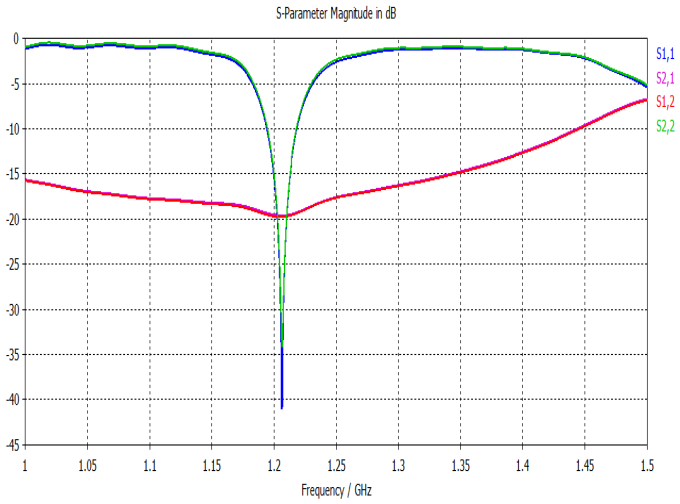


Fig. 5: Reflection Coefficient (pot 2 as input)

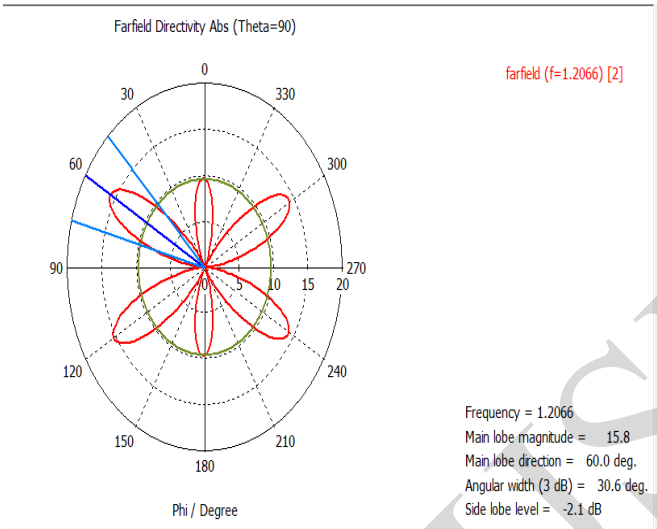


Fig. 6: Radiation Pattern (port 2 as input)

IV. CONCLUSION

A novel dual feed MIMO reconfigurable antenna is designed. To implement the design, a DGS with concentric SR is employed. The signal plane comprises of octagonal ring pattern with orthogonal dual feed arrangement. The antenna prototype has the dimension of 0.66λ × 0.66λ, where the octagonal ring is of 0.34λ. The dual band has been achieved by the periodic property of split ring employed within the circular DGS in the ground plane. The operation of the antenna is well analyzed with its reflection coefficient and radiation patterns. Without using switch, pattern reconfiguration is achieved using MIMO configuration. The prototype is designed to be utilized in LTE700 and GSM900 bands respectively.

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