A Reconfigurable UWB Multiple-Input Multiple-Output Antenna

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***Abstract*—**This work presents a reconfigurable ultra-wideband (UWB) multiple-input multiple-output (MIMO) antenna. The presented antenna covers 440 MHz to 5 GHz (11:1) frequency range while keeping its size compact for MIMO applications. The ultra-wideband functionality is obtained by integrating a UWB monopole antenna together with a tunable matching network via two different signal paths from a single feed point. The tunable section covers 440 MHz to 700 MHz frequency range while the UWB antenna operates over the rest of the band. Two identical UWB antennas are orthogonally placed on the same substrate to achieve polarization diversity and construct MIMO configuration. Reflection coefficient for entire operation region and MIMO diversity parameters are presented.

Keywords—reconfigurable antenna; compact UWB; MIMO

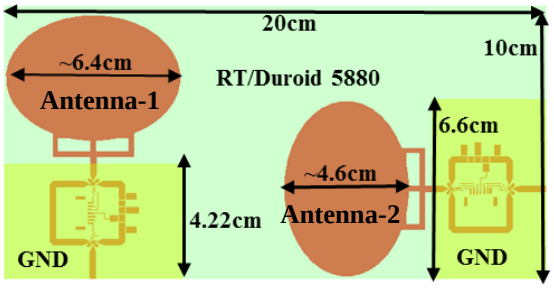
I. INTRODUCTION

In 2016, wireless data traffic reached 13.7 trillion MB and data usage has increased 238 percent between 2015 and 2016 [1]. In order to satisfy ever growing massive data traffic and high data demand, ultra-wide band (UWB) systems have been introduced. Although UWB technology achieve higher data rates with lower power, they suffer, like most other wireless systems, from multipath fading. However, Multiple-input multiple-output (MIMO) systems are capable of reducing multipath fading and increasing channel capacity. Performance of a MIMO system is determined by the correlation of the received signals of the antenna elements used. Employing multiple antennas in a limited space may cause severe coupling and degrade the overall performance of the system. Therefore, low correlation, high isolation and compactness are highly desired in MIMO systems. The combination of UWB antennas in a MIMO system will not only satisfy ever increasing high data transfer but also make the system immune to multipath losses and enable efficient spectrum utilization.

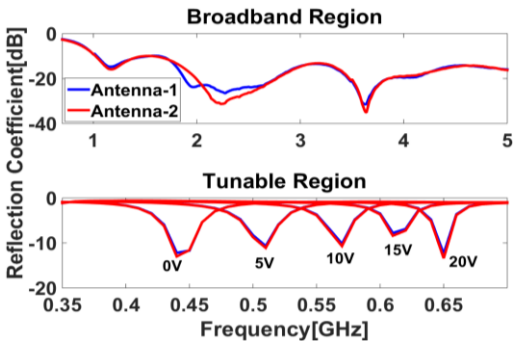
In this paper, a compact reconfigurable UWB MIMO antenna is presented. First, a reconfigurable UWB antenna is designed. Then it is used to construct a MIMO antenna system. MIMO diversity performance is calculated from simulation results.

II. RECONFIGURABLE UWB MIMO ANTENNA DESIGN

The working principle of the reconfigurable UWB antenna follows the work presented in [2]. The UWB antenna which covers 1-5 GHz frequency range is connected to a discrete switch (PE42422) to create two different paths. An additional switch is used to combine these two paths to have a single input/output port. A tunable matching network is employed in one of the paths and varactor tuned (SMV2203-40LF) matching circuity is designed to match the antenna to 50 Ohm



(a)



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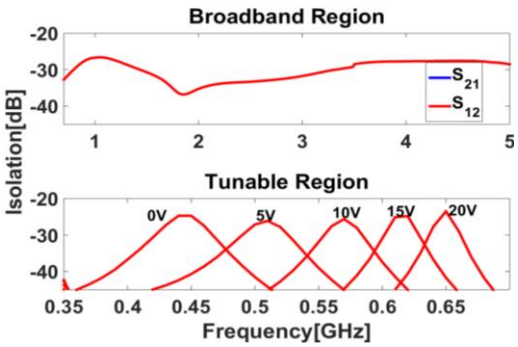
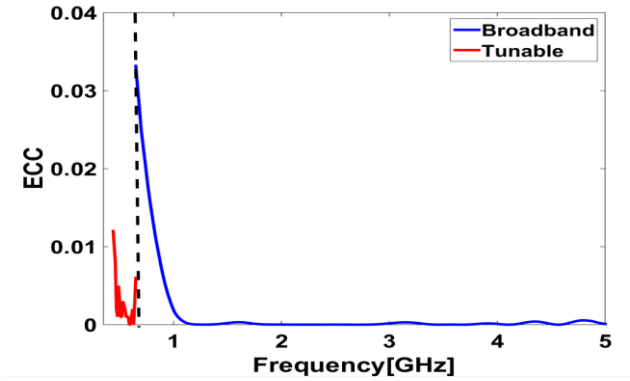


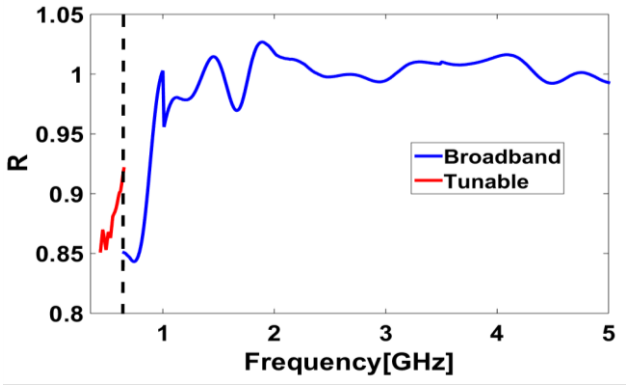
(c)

Fig.1 (a) Schematic of a reconfigurable UWB MIMO antenna (b) Simulated reflection coefficient of the broadband and tunable operation region (c) Simulated isolation of the tunable and broadband operation region.

for the lower frequency band. Two reconfigurable UWB antennas are orthogonally placed on a 31-mil thick RT/Duroid 5880 substrate to achieve polarization diversity. Fig. 1(a) shows the two-antenna design with dimensions. Fig. 1(b) shows



(a)



(b)

Fig.2 (a) Envelope correlation coefficient of the tunable and broadband operation region (b) Mean effective gain ratio of the tunable and broadband operation region.

the broadband and tunable performance of the reconfigurable UWB MIMO antenna. It is clear that return losses for both antennas are identical in the tunable region and quite similar in the broadband region. On the other hand, high isolation between two UWB antennas is achieved by placing both antennas orthogonal to each other and using separate grounds. As seen in Fig. 1(c), the isolation between the two antennas is less than -25dB in the entire band. MIMO diversity parameters such as envelope correlation coefficient (ECC) and mean effective gain (MEG) are calculated [3-4]. ECC is an indicator of how two antenna's radiation patterns are independent and as a rule of thumb, ECC less than 0.5 is considered reasonable. MEG is another diversity parameter which is defined as the ratio of the mean received power to the mean incident power and accepted MEG ratio of both antennas should be close to 1. As seen in Fig.2 (a), the proposed reconfigurable UWB MIMO antenna elements have low correlation (ECC < 0.5). Fig.3 (b) demonstrates that the MEG ratio (R) of these antennas is close to 1.

III. CONCLUSION

A reconfigurable UWB MIMO antenna system is designed and its diversity parameters are presented. The operation frequency of the UWB antenna is expanded by a tunable matching network while keeping its size compact. The proposed antenna offers diversity and reconfigurability which are desirable for future wireless communication systems. And it can be used to construct a 2x2 (2 receive and 2 transmit antennas) MIMO system.

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