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# Metamaterial Eight Port MIMO Antenna for Wideband Application

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**ABSTRACT:** In this project an eight port MIMO antenna is designed. First a single antenna is designed with the Roger RT/ Duroid 5880 substrate of consistence of 0.254 mm with a partial ground plane. This ground plane improve the performance of an antenna. A strip patch is introduced with two L- shaped stub one is from the right top of the strip and another at left side of the strip. The unit cell size metamaterial consist of two ellipse connected by a strip is placed above the substrate. Further this single antenna is modified to eight port MIMO antenna. The proposed antenna is a good candidate for smart devices and sensors.

**KEYWORDS:** Multiple Input Multiple Output, Metamaterial, Eight Port Antenna.

## I. INTRODUCTION

MIMO Antenna is a wireless communication technology that uses multiple antennas at both the transmitter and receiver to ameliorate the system performance . In this design metamaterial is used to upgrade the performance. Metamaterial is the one in which the electromagnetic property can be altered beyond the material nature. In eight port MIMO antenna metamaterial is used to enhance the performance of miniaturized antenna . Roger RT 5880 substrate is a high frequency lamination material used for designing PCB. In eight port MIMO antenna circular polarization is used to avoid cross polarization interference in designed antenna

## II. MIMO ANTENNA

A MIMO (Multiple-Input Multiple-Output) antenna array consists of multiple antennas at both the transmitter and receiver ends of a communication system. MIMO technology issue in wireless communication systems to improve the data transmission rate ,capacity and reliability of the system by using multiple antennas to transmit and receive multiple data streams simultaneously. In a MIMO antenna array, each antenna at the transmitter and receiver ends issued to transmit and receive multiple data streams simultaneously. The signals transmitted by each antenna combine constructively at the receiver end, which improves the signal strength and reduces the effects of interference and fading. MIMO antenna arrays are typically used in modern wireless communication systems, such as 4G LTE, 5G, and Wi-Fi. These systems use advanced signal processingalgorithmstoimprovethecapacityandreliabilityofthecommunication link by exploiting the spatial diversity provided by the multiple antennas. MIMO antenna arrays come in different configurations, such as SIMO (Single- Input Multiple-Output), MISO (Multiple-Input Single-Output), and spatial multiplexing MIMO. The choice of the MIMO configuration depends on the specific application and the available resources.

## III. PROPOSED EIGHT PORT MIMO ANTENNA

In this project an eight port MIMO antenna is designed. First a single antenna is designed with the Roger RT/ Duroid 5880 substrate of consistence of 0.254 mm with a partial ground plane. This ground plane ameliorate the performance of an antenna. The dimensions of the proposed MIMO antenna array are  $0.285\lambda \times 0.11\lambda \times 0.001\lambda$  at 20 GHz, where  $\lambda$  is the free-space wavelength. A strip patch is introduced with two L- shaped stub one is from the right top of the strip and another at left side of the strip. The unit cell size metamaterial correspond of two cirque connected by a strip is placed above the substrate. Further this single antenna is modified to eight harborage MIMO antenna. The isolation, gain of the antenna, and higher axial bandwidth ratio are improved by the introduction of a metamaterial-inspired element. MIMO parameters are also bandied in terms of Envelope correlation measure (ECC), diversity gain (DG), and mean

effective gain (MEG) to further probe the performance of the MIMO antenna.

To understand the characteristics of the MIMO Antenna, it is essential to assess its diversity characteristics in terms of ECC, DG, and MEG. In general, the value of the diversity gain for MIMO antenna lies between 0 and 1 and can be

$$DG = \frac{mt(R^2)}{\|R\|_{Fr}}$$

expressed by

The MEG analyzes the gain between antenna elements while taking into account real propagation conditions. MEG for port I is given by

$$MEG_{port i} = 0.5\eta_{i,rad} = 0.5 \left[ 1 - \sum_{j=1}^K |S_{ij}|^2 \right]$$

Where K and  $\eta_i$  indicate the number of antennas and radiation efficiency, respectively.



Fig 1 Single Antenna Design

Table 1 Comparison between Proposed Eight Port MIMO Antenna With Metamaterial and Without Metamaterial

ANTENNA DESIGN	GAIN	ISOLATION LOSS
Without Metamaterial	5	-45.09
Proposed Antenna With Metamaterial	7.7	-58.04

#### IV. SIMULATION RESULTS

The low-profile, single-layer wide band metamaterial-inspired circularly polarized (CP) multiple input multiple-output (MIMO) antenna array. An 8×8 antenna array is manufactured on the Rogers RT/Duroid 5880 substrate with a partial ground plane. The dimensions of the proposed MIMO antenna array are  $0.285\lambda \times 0.11\lambda \times 0.001\lambda$  at 20 GHz, where  $\lambda$  is the free-space wavelength. The isolation, gain, and higher axial bandwidth ratio are significantly improved by the introduction of a metamaterial-inspired element. Fig 2 shows the simulated proposed antenna.

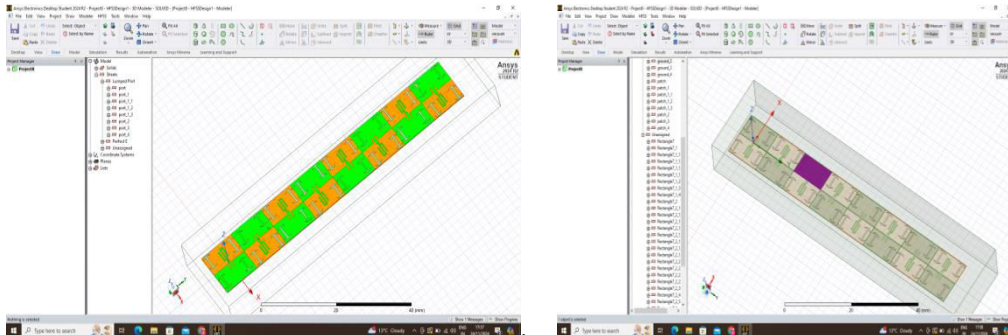


Fig 2: Front and back view of proposed antenna design Fig 3 Shows antenna gain of proposed antenna

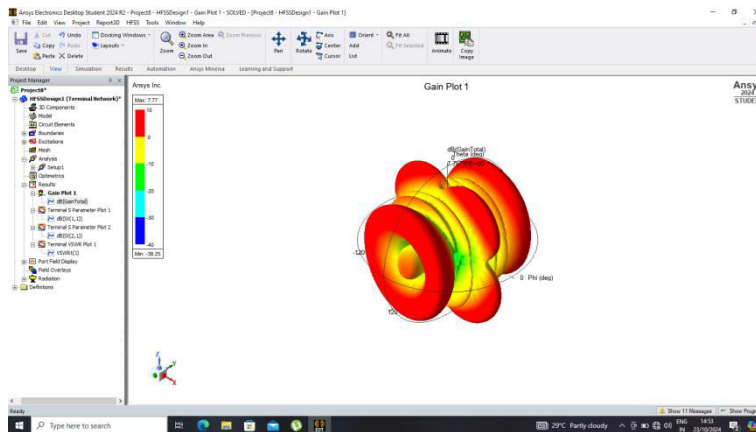


Fig 4 Shows the VSWR of proposed antenna

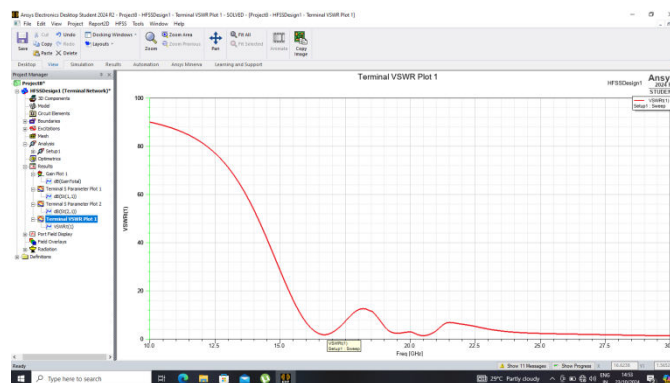


Fig 5: Shows the S11 and S12 parameter of proposed antenna

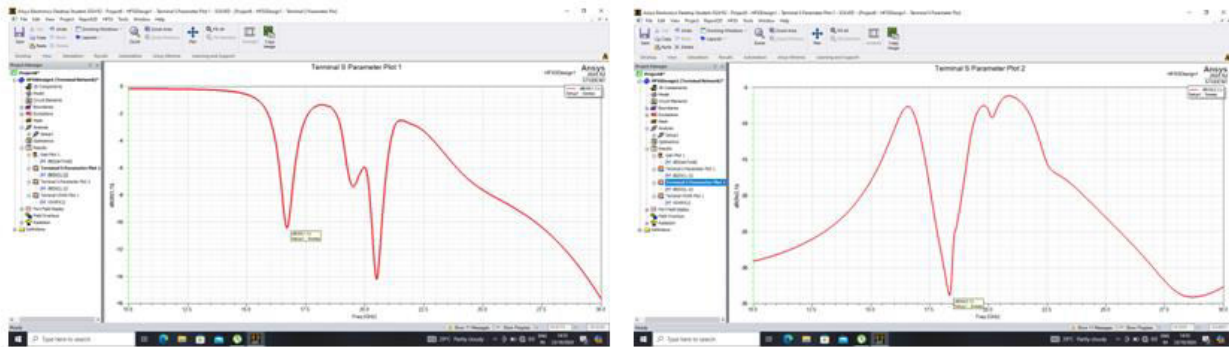


Fig 6: Shows the isolation loss of proposed antenna

Antenna proposed in this design operates at 20 GHz having an antenna parameters such as isolation loss (-58.04dB), reflection coefficient (-10.4dB), transmission coefficient (-30.9dB), gain (7.7dB), and VSWR (1.3). The simulated results shown that the isolated MIMO antenna can reduce mutual coupling, improve impedance matching, high efficiency, enhance isolation between the elements.

## V. CONCLUSION

In this project, a very compact CP octa-element MIMO antenna with multiple unique metamaterial-inspired unit cells is presented. The enhanced mutual coupling reduction and circular polarization are achieved by employing the meta surface to tickle the current fields and generate the current distribution on the MIMO antenna's elements. Antenna proposed in this design operates at 20 GHz. Measured antenna parameters including isolation loss (-58.04dB), reflection coefficient (-10.4dB), transmission coefficient (-30.9dB), gain(7.7dB), and VSWR(1.3) matched the simulation results rather well. A low cost and simple fabrication characterize the proposed antenna. This confirms that the antenna functions in the 5G NR smart devices and sensors.

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