Design of CPW-Fed Monopole Multiband Trident Shape Antenna for 5G Communication

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Abstract : In this paper a trident shaped monopole multiband antenna fed with coplanar waveguide is demonstrated. This antenna comprises a diamond shape on a trident shaped radiating patch. The antenna has a dimension of 20x18x1.6mm^3 and the antenna radiates in the frequency range of 6GHz to 30GHz with VSWR less than 2 which is highly beneficial for 5G communication. Here a time-domain analysis of the antenna is used. The antenna structure is configured on FR-4 substrate. The parameters like return loss and farfield pattern are presented.

Keywords **--- Coplanar Wave Guide (CPW), Trident Shape, Monopole Antenna, 5G Applications.**

1 INTRODUCTION

Our world runs on information technology and the ability to link and interact. Telecommunication has become the back- bone of today's digital economy, allowing enterprises, governments, societies, and families to communicate and exchange knowledge seamlessly. Higher multi-Gbps top details, speeds, ultra-low idleness, more consistent quality massive structured capability, increased connectivity, and a more consistent client participation to more clients are expected to be delivered by 5G remote innovation[1].Higher execution and advanced proficiency open the door to previously untapped customer interactions and new business interfaces[2].

A coplanar waveguide CPW-fed antenna has a few advantages over miniaturized direct strip fed. Micro size coplanar strip fed have a narrow bandwidth, less scattering, and less backward radiation misfortune. For a communication frame, planar monopole antenna provides different necessary highlights such as double band or multiband, broad bandwidth, and less cross polarization effect. Usually, the design includes the radiation parameters and geometry of multiband structure. The antennas, such as monopole antenna and CPW-fed PMA, are designed to meet the requirements for compactness, high BSR, less SLR, and good impedance matching element between the TL and free space [3].

This paper contains four parts. Part 1 includes an introduction about the proposed antenna. Part 2 explains antenna design and its geometrical structure. Part 3 provides the result and analysis of proposed antenna. At last part 4 is the conclusion of proposed antenna.

2 DESIGN OF ANTENNA

The antenna is designed through computer-generated software [4]. Fig.2.3. shows the geometry and boundaries of a trident-shaped antenna fed by a CPW. The built antenna is around 20x18x1.6mm^3. The table shows the structure of the designed antenna. Here the designed antenna is designed through three steps. The corresponding S-parameter is shown in Fig. 3.1. In the first step we are designing a circular shaped antenna. A single layer FR-4 substrate with a thickness of 1.6mm and a standard scale of 20x18x1.6mm ^{3} was used to build this antenna.

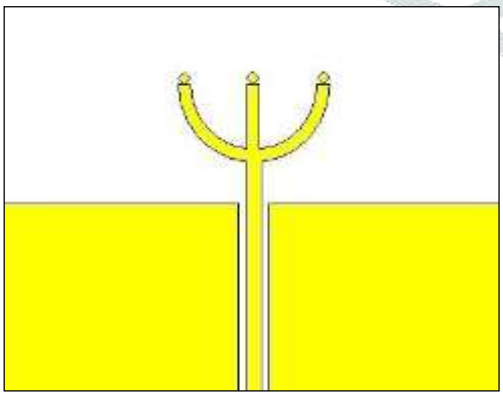

Fig.2.1. Front view of designed antenna.

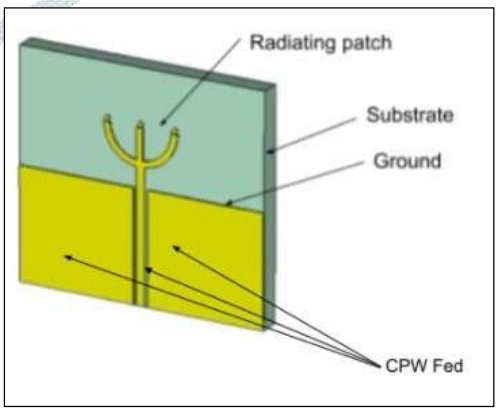

Fig.2.2. 3D view of trident antenna.

Fig. 3. Ant-1

Fig. 4. Ant-2

Fig. 5. Ant-3

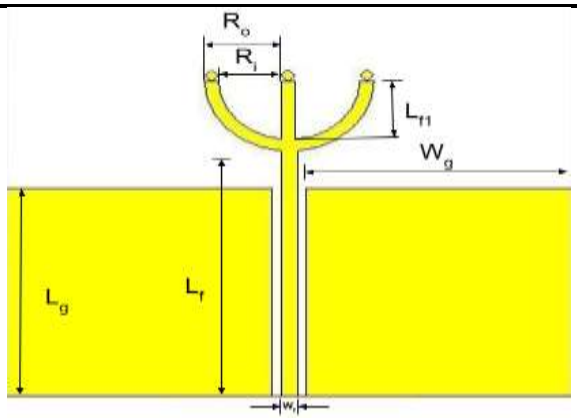

Fig. 2.3.Top view of trident antenna

Table.2.1.The antenna's dimensions.

Dimensions	Values(mm)	Dimensions	Values(mm)
L_g	8.9	L_{f1}	2.5
W_g	9.4	R_o	3
L_f	11	R_1	2.5

A circular radiating patch used for getting the CP polarization [7].The CPW fed simple CMA designed with the VSWR value less than 2 in the step 1. In the second step, we introduced a ring shaped antenna by etching away a small portion from the circular patch antenna [5]. In the final designing step, we are designing a trident shaped antenna by making the ring as a semi ring and introduced a simple RA strip at the centre. A diamond-shaped patch radiator is located above the step3 design, used to reduce antenna RL, improve frequency tuning, and increase bandwidth. [8].

3 RESULTS AND DISCUSSION

3.1. Return Loss and VSWR

The loss of power due to the mismatch between the Z_o of TL and Z_{in} of antenna is known as return loss [9]. It is measured in decibels (dB). The antenna resonates at 8GHz, 16GHz, 25GHz, and 32GHz frequencies with 31.6dB, 18dB, 14dB, 34.2dB are the values of the return loss respectively. The higher value of RL indicated the designed antenna act as an efficient radiation [10].

The ratio of the highest voltage to the lowest voltage in a standing wave sample over the length of a transmission line structure is known as VSWR. VSWR stands for voltage Standing wave ratio [6]. The value of VSWR should be one in ideal case, less than or equal to two is acceptable for the 5G requirement. The output SWR depicts the reflected and incident signal from the antenna and FS, as well as the input SWR indicated the antenna to transmission line impedance matching. The higher the antenna is matched to the transmission line and the more energy is transferred to the antenna, the lower the VSWR. In this case, the antenna does not mediate any energy. It is more effective. 1.14, 1.29, 1.30, 1.14 are the VSWR at 8GHz, 16GHz, 25GHz, 32GHz respectively.

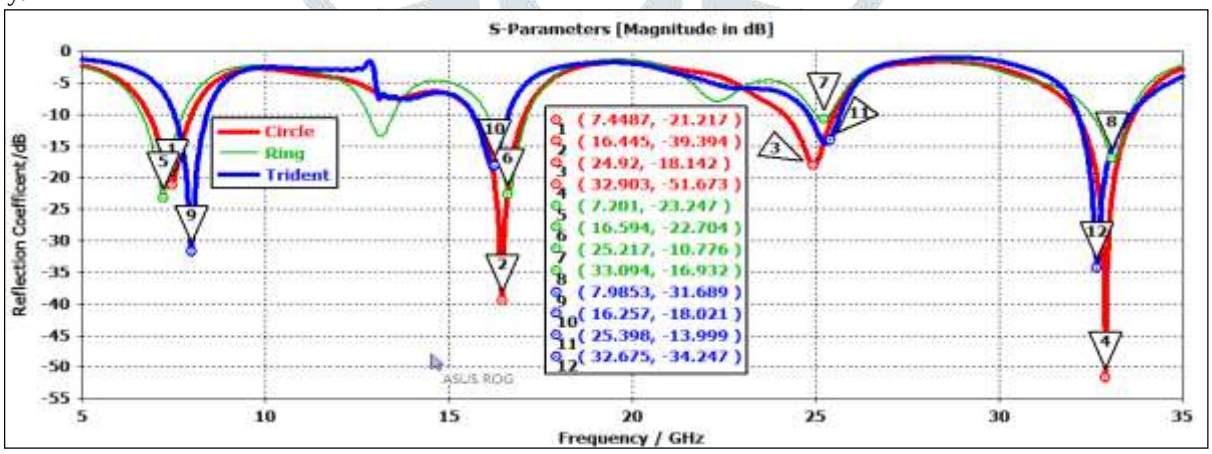

Fig. 3.1. Return loss Vs frequency plot of trident antenna

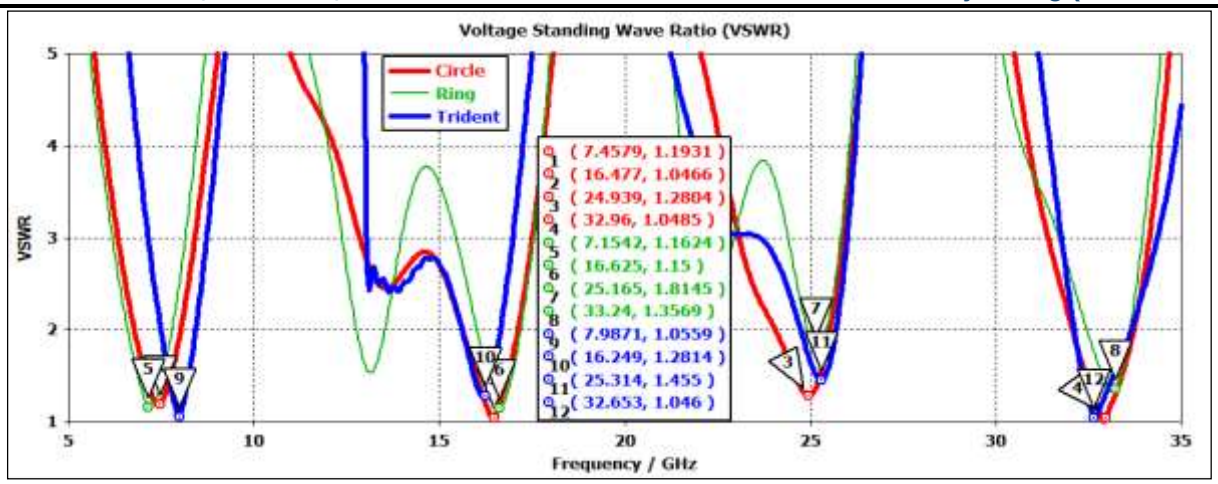

Fig. 3.2. VSWR plot of trident antenna

3.2. Antenna Gain and Field pattern

The radiation pattern indicates the direction power density that an antenna radiates. The gain indicates the power transmitted by an antenna in a specific direction [7].The gain of designed TSMA is 2.5dBi, 4dBi, 6.7dBi, and 5.5dBi at 8GHz, 16GHz, 25GHz, and 32GHz respectively. The Fig.(3.3-3.5) shows the gains of the antenna at their corresponding frequencies.

Electric fields (also known as E-fields) and magnetic fields (also known as H-fields) are orthogonal energy fields in a TEM modes [9] [10]. Fig. (3.6-3.9) represents the electric and magnetic field plots of the antenna. Here electric field is in V/m and the magnetic field is in A/m. Here red line represents E-field and green line represents H-field.

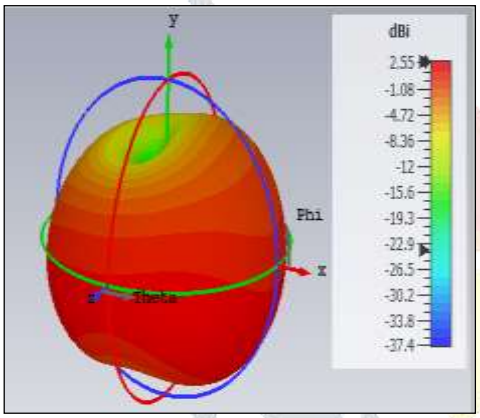

Fig.3.3. Antenna gain at 8GHz

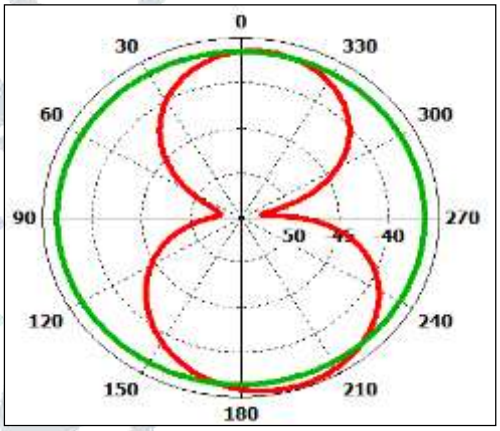

Fig. 3.6. Electric and Magnetic field at 8GHz

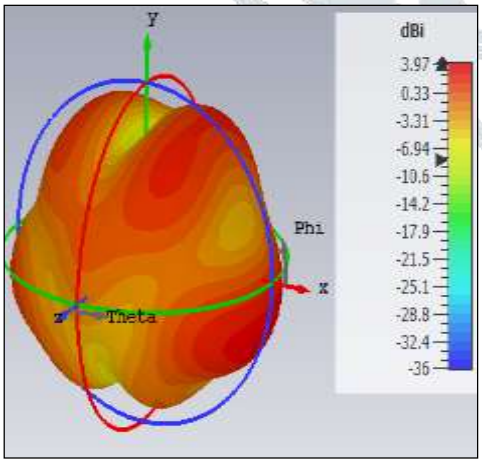

Fig.3.4. Antenna gain at 16GHz

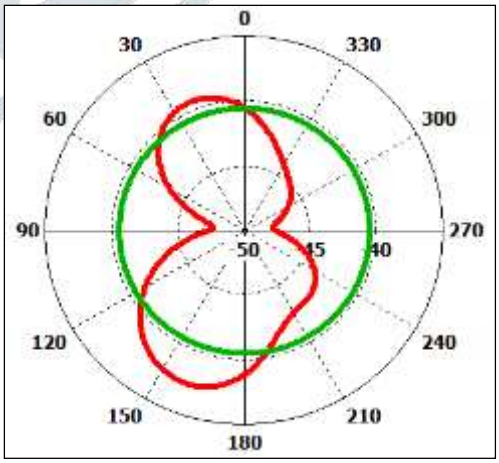

Fig. 3.7. Electric and Magnetic field at 16GHz

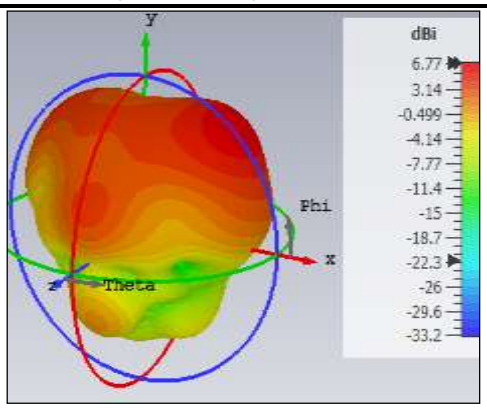

Fig.3.4. Antenna gain at 25GHz

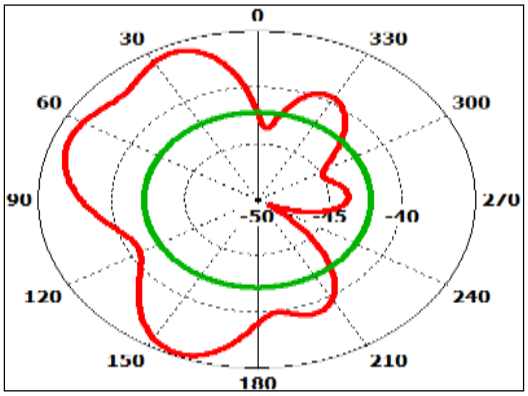

Fig. 3.8. Electric and Magnetic field at 25GHz

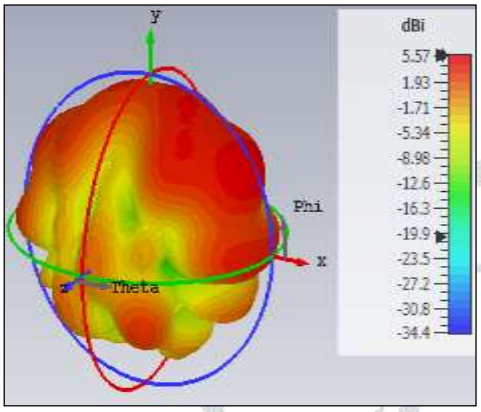

Fig.3.5. Antenna gain at 32GHz

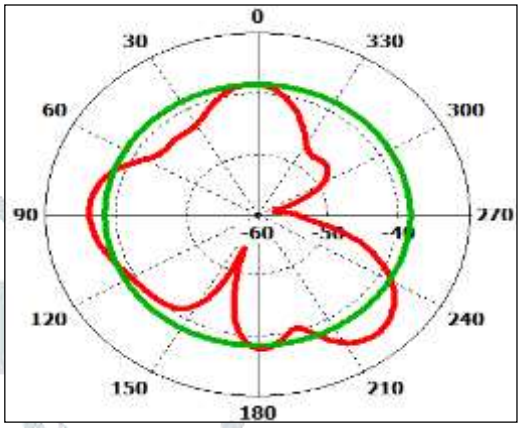

Fig.3.9. Electric and Magnetic field at 32GHz

4 CONCLUSION

A trident shaped CPW-fed monopole multiband antenna is proposed. Overall dimension of the designed antenna is 20x18x1.6mm^3. The proposed antenna is nearly in Omni-directional pattern at the lowest frequency band so that it can be used for monopole antenna applications. The standard result of RL and VSWR value, which makes the designed antennas are the best candidate for the machine to machine communication and 5G applications.

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