CPW Fed Inverted E Slot Monopole Antenna Design for 5G Applications

[1]Aswanth Mohanan, [1]Ajeesh K, [1]Adithya R B P, [1]Bijubal N B and [2]Sajith K

[1]Student in Dept. of ECE, [2]Assistant Professor in Dept. of ECE
Dept of ECE
GEC Wayanad, Kerala-670644

Abstract : This paper discusses the study of coplanar waveguide fed inverted E slot antenna (IESMA). The antenna is designed by FR-4 substrate εr=4.3. The antenna resonates at 3GHz, 7GHz, 16GHz, 25GHz, 28GHz frequencies. The highest obtained reflection coefficient is -43dB and VSWR 1.01. The dimension of the antenna is $18\times18\times1.6mm^3$.IESMA is stimulated in a time-domain solver and is highly useful for IoT and 5G applications.

***Keywords* - IESMA, Return Loss, VSWR, Monopole Antenna, CPW fed, Substrate**

1 INTRODUCTION

Civilization and technology drastically increased in past decades. As a result of advancement, we are at a new era "Fifth-generation"(5G) before reaching the era of 5G, there was 4G,3G. In the all-new generation, they have better improvement from the previous generation in the case of 4G the dense utilization of network creates problems. The 5G network provides more opportunity and functionality in many areas. The main advantages of 5G are they provide higher bandwidth, low latency, and dense connection. This era also focuses on miniaturization and compactness to make the device smaller and compact and provide the same function as they offer before. So this paper study about design of IESMA that resonates in multiple frequencies so that we can use a single antenna in different applications and reduce the number of antennas used. The antenna also focuses on cost-effectiveness and availability the antenna is designed using FR-4 substrate of dielectric constant (εr=4.3) and loss tangent=0.02. CPW fed is given to antenna they provide low radiation loss, loss dispersion, and uniplanar configuration [1], [2].IESM antenna is a monopole antenna which shows that the antenna has an Omni-directional radiation pattern since the IESMA radiated in broadside direction like a figure of eight in polar coordinate also non-direction at end-fire direction [9]. The microstrip fed monopole with circularly polarized antenna introduced in reference [3].

The first part explains the introduction, the second about designing IESMA and the third part about the results of the IESMA, and the last part is the conclusion and future scope of IESMA.

2 DESIGN OF IESMA

An antenna is designed using FR-4 substrate of a×b=18mm×18mm dielectric constant εr=4.3. The antenna is divided into three fraction substrates, patch and CPW fed. The CPW fed consists of ground and a fed line.Fig.2.1 shows the layered arrangement of IESMA. The design of the antenna is dividing into two major design steps. Fig.2.2 indicated the step1 design is the CPW fed rectangular patch antenna with a width and length is 18mm×18mm and thickness of 1.6mm.The rectangular patch, an inverted E slot is made with an area of $k\times e=10\times2\ mm^2$. Both the patch and substrate are designed using copper. The fed is of dimension g×f=0.8mm×12.5mm and the ground is of dimension c×d=1.5mm×8.3mm. Fig.2.3 shows the structure of IESMA. The detailed dimensions are given in Table.2.1.

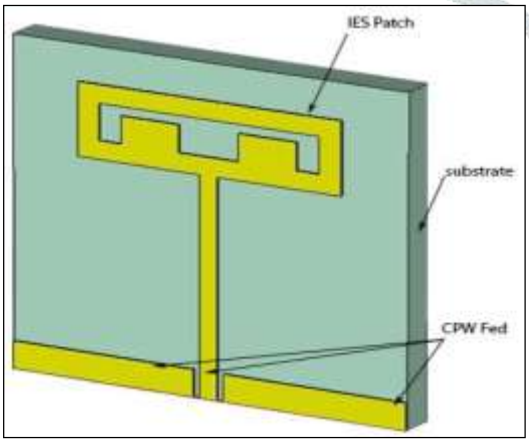

Fig. 2.1.layered arrangement of proposed antenna

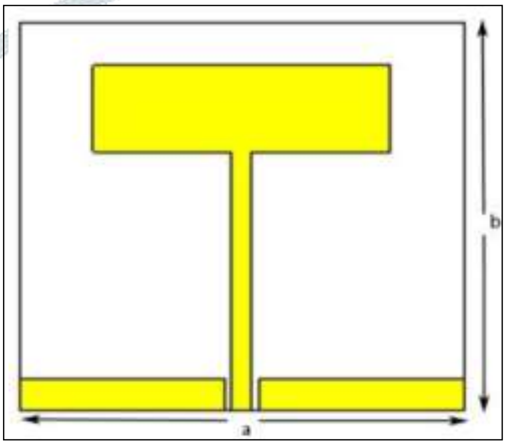

Fig.2.2.CPW fed Rectangular patch antenna

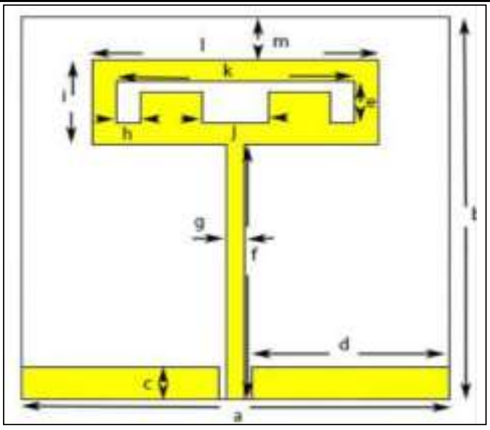

Fig.2.3.Dimensions of IESMA

Table.2.1. Dimensions of IESMA

Antenna dimension	Values (mm)	Antenna dimension	Values (mm)
a	18	g	0.8
b	18	h	1
c	1.5	i	4
d	8.3	j	2.7
e	2	k	10
f	12.5	l	12

3 RESULTS AND DISCUSSIION

3.1 Return loss

The loss of power due to the mismatch between the Z_o of TL and Z_{in} of an antenna is known as return loss [5], [6]. For better performance the value of return loss be lesser value 10dB [3], [4].Fig.3.1 shows that antenna resonant at following frequencies 3GHz,7GHz,16GHz,25GHz, and 28GHz with return loss of the 15dB,18dB, 26dB, 18dB, and 43dB respectively.

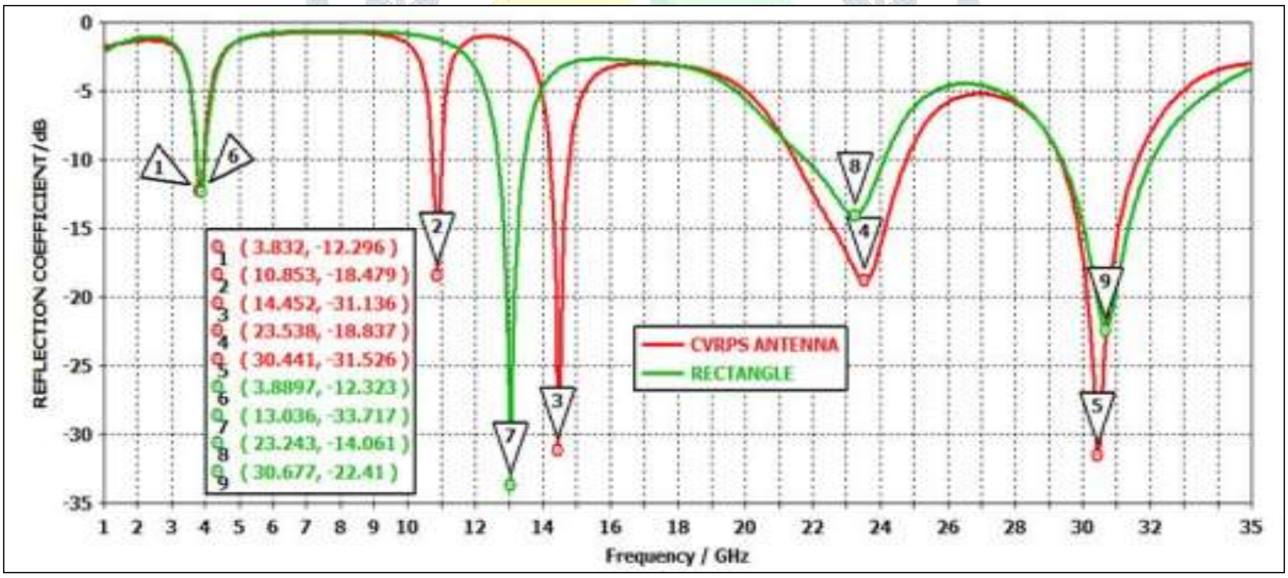

Fig. 3.1.Graph of return loss of IESMA

3.2 VSWR

Voltage standing wave ratio (VSWR) is the ratio between the maximum voltage and minimum voltage. Also known as standing wave ratio (SWR) [3], [4]. VSWR value below 2 is considered suitable for most antenna applications [5]. Fig.3.2shows that 1.38, 1.32, 1.10, 1.3, 1.01 are the VSWR value at 3GHz, 7GHz, 16GHz, 22GHz, 25GHz, and 28GHz respectively

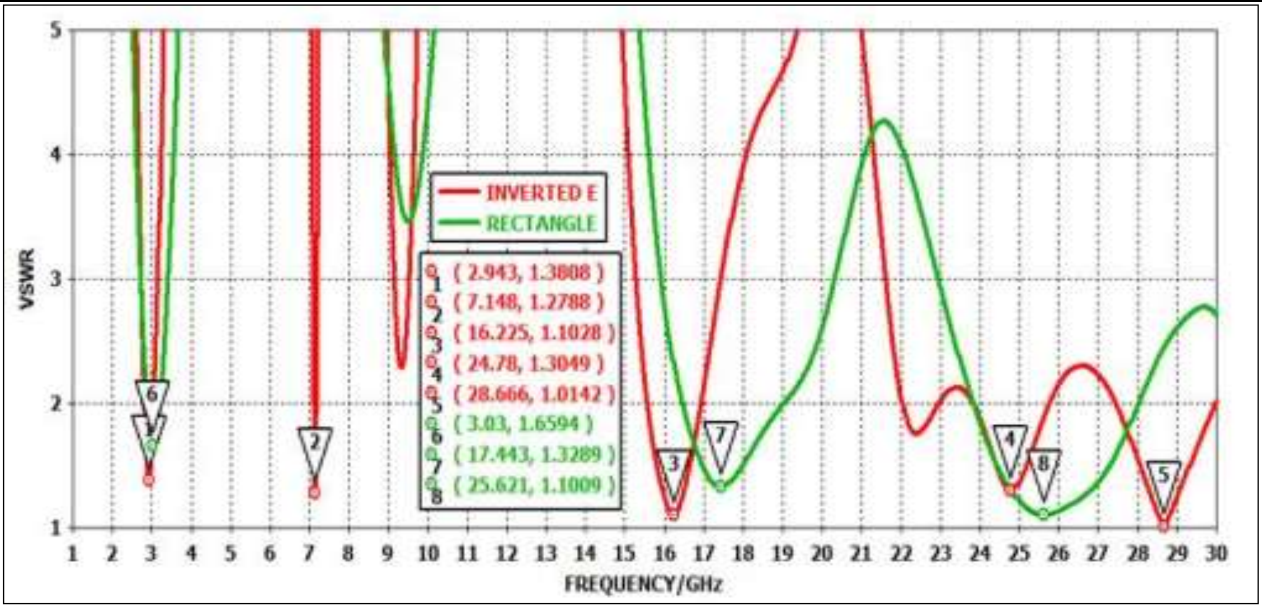

Fig.3.2.VSWR plot of IESMA

3.3 Antenna Gain and Field Pattern

The radiation pattern indicates the direction of the pointing vector concerning the spatial angle theta or phi. The Gain indicates the power transmitted by an antenna in a specific direction [7], [8]. 2.1dBi, 4.3dBi, 5.2dBi, 5.1dBi, 5.4dBi are the gains at 3GHz, 7GHz, 16GHz, 22GHz, 25GHz, and 28GHz respectively. Fig.(3.3-3.7) shows the corresponding gains at their respective frequencies. Fig.(3.8-3.12) represents the magnetic and electric field plots of the antenna. The magnetic field is measured in A/m and the electric field in V/m. At the lowest frequency, we obtain an Omni-directional pattern which implies that the antenna is monopole [9].

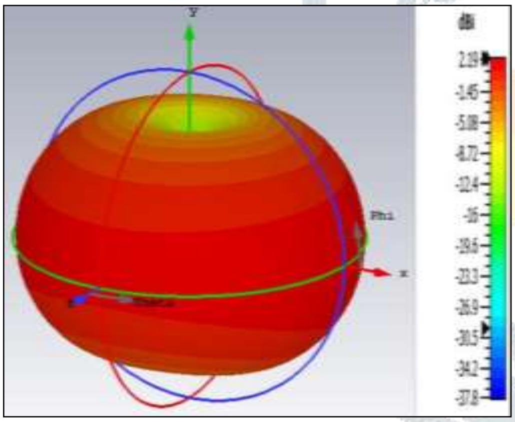

Fig. 3.3.Gain at 3GHz

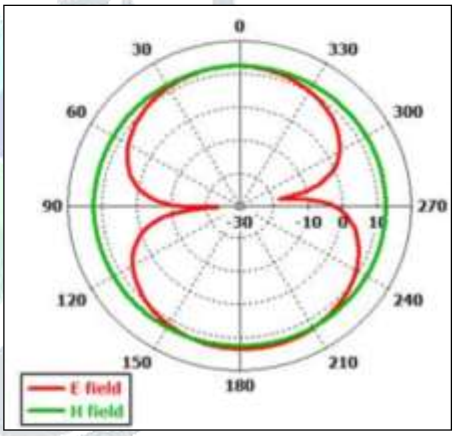

Fig. 3.8.Electric and Magnetic plot at 3GHz

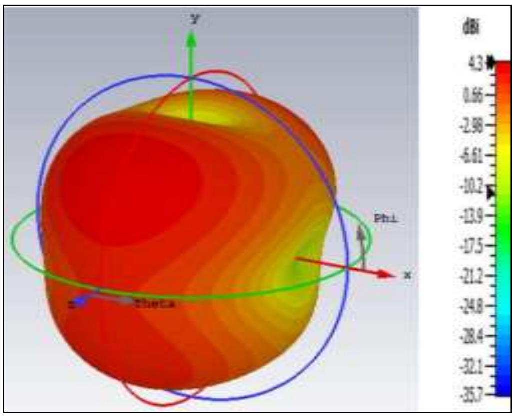

Fig. 3.4.Gain at 7GHz

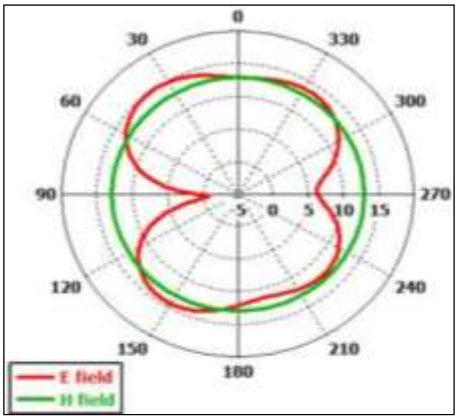

Fig.3.9.Electric and Magnetic plot at 7GHz

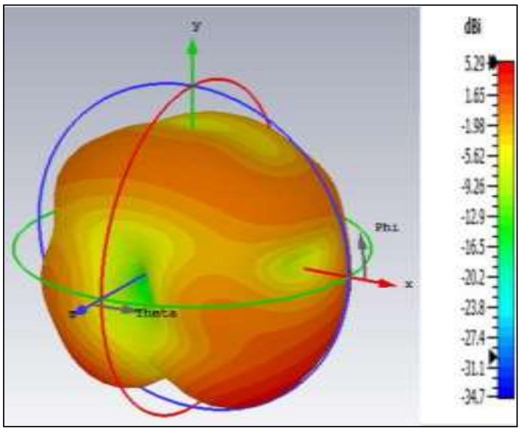

Fig. 3.5.Gain at 16GHz

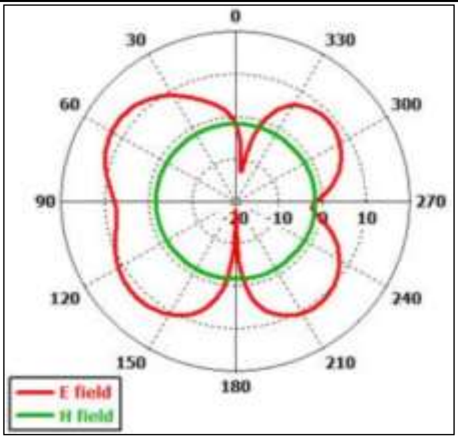

Fig. 3.10.Electric and Magnetic plot at 16GHz

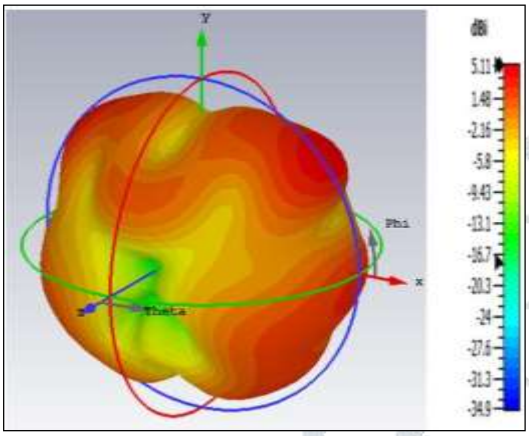

Fig. 3.6.Gain at 25GHz

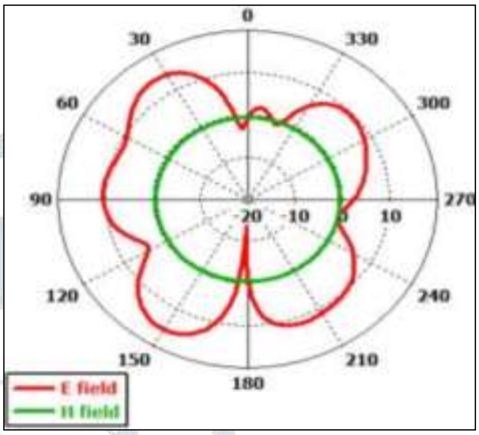

Fig. 3.11.Electric and Magnetic plot at 25GHz

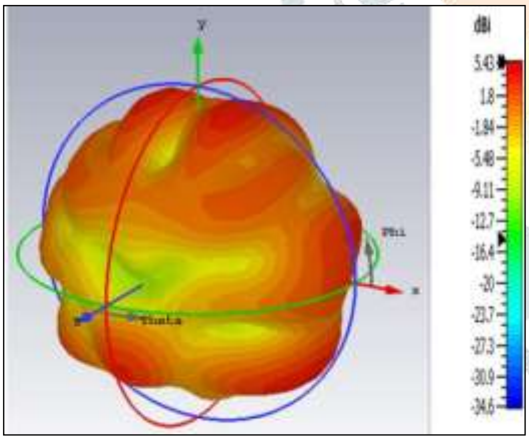

Fig. 3.7.Gain at 28GHz

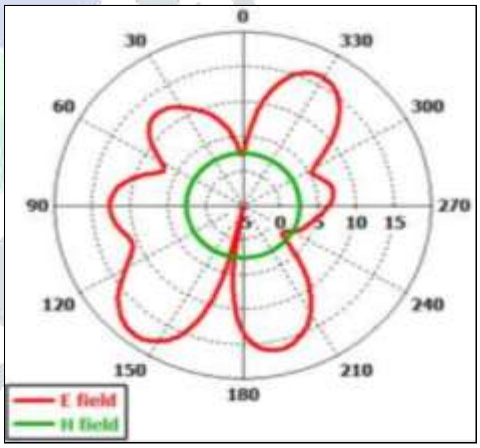

Fig. 3.12.Electric and Magnetic plot at 28GH

4 CONCLUSION

The co-planar waveguide fed IESMA has been designed and analyzed. The inverted E slot in the patch enhanced the radiation performance as concerning the CPW fed rectangular patch antenna. The overall volume of the IESMA is 18×18×1.6mm^3, which makes the antenna compact in size and low profile. The designed IESMA is a multi-band radiator with simulated results of the gain, RL, and VSWR are indicated the designed IESMA more suitable for IoT and 5G applications.

ACKNOWLEDGMENT

The authors would like to thanks Dr. Sajith K (Assistant Professor, Dept. of ECE), Dr. Anitha V S (Principal), Dr. V. Suresh Babu (Dean of Academics), Dr. Ajayan K R (Head, Dept. of ECE), and the Faculty Members (Dept. of ECE) of GEC Wayanad, Kerala, India, for their guidance and motivation towards the successful completion of this project work.

REFERENCES

[1] Fang X, Wen G, "Compact Wideband CPW-Fed Meandered-Slot Antenna with Slotted Y-shape Central Element for Wi-Fi, WiMAX, and 5G Applications", IEEE- Transactions on Antennas and Propagation, vol. 66, pp.7395 - 7399, December 2018.

[2] Zhendong Ding, Dan Zhang, "Broadband Antenna Design with Integrated CB-CPW and Parasitic Patch Structure for WLAN, RFID, WiMAX, and 5G Applications", IEEE Access, vol. 8, pp.42877-42883, March 2020.

[3] Colaco.J, Lohani.R, "Design and Implementation of Microstrip Circular Patch Antenna for 5G Applications", International Conference on Electrical Communication and Computer Engineering (ICECCE), June 2020.

[4] R. K. Goyal and U. Shankar Modani, "A Compact Microstrip Patch Antenna at 28 GHz for 5G wireless Applications", 3rd International Conference and Workshops on Recent Advances and Innovations in Engineering (ICRAIE), March 2018.

[5] S. Verma and L. Mahajan, "A small microstrip patch antenna for future 5G applications", 5th International Conference on Reliability, Information Technologies and Optimization (ICRITO), December 2016.

[6] Sajith.K, T.Shanmuganantham, "Design of SRR Loaded CB-CPW Fed Diamond Shaped Patch On-body Antenna for ECG Monitoring Applications", IEEE International Conference on Current Trends toward Converging Technologies, December 2017.

[7] Sajith.K, T. Shanmuganantham, "SRR Loaded H-Shape Antenna for ECG Monitoring", 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies, Jul. 2019.

[8] Sajith.K, T.Shanmuganantham, "SRR Loaded and CB-CPW fed Octagonal Shape Antenna for Wearable Applications", IEEE International Conference on Circuits and Systems, December 2017.

[9] Sajith.K, T.Shanmuganantham, "A Novel SRR Loaded Asymmetrical CPW Fed ISM Band Wearable Antenna for Health Monitoring Applications", IEEE Applied Electromagnetic Conference, December 2017.