A New PIFA Antenna For Future Mobile and Wireless Communication*

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Abstract. In this work, a new antenna will be presented in the form of F-inverted working at 28Ghz frequency is proposed for 5G wireless communications. This antenna has been designed based on an FR-4. with shaped slots on the patch and interdigital slots in the ground for bandwidth enhancement. The PIFA antenna has an operating frequency of 28 GHz with S11,-39.0885 dB, while the peak gain is 7.85dBi. Therefore, it is suitable for applications of 5G wireless communications with good matching and return loss characteristics. The proposed design model and performance evaluation of the PIFA antenna has been executed by CST Microwave Studio and HFSS.

Keywords: PIFA antenna· 5G wireless communication· 6G.

1 Introduction

The world has known many developments in the wirelss communication networks, and the world's current focus is on the 5th industrial revolution (5G). The approaching advancement of correspondence technology, 5G can satisfy the large need of the network capacity. Higher recurrence can convey high data rate as examined in. The goal of 5G is to create a society that is "too connected" by incorporating more and more data. This will benefit the networks. To dynamically allocate resources to meet the various needs of a large number of highly diverse connections. 5G technology allows for significantly larger administration allotments in hitherto unexplored mm-wave regions of space while also lowering infrastructure costs. Furthermore, 5G has a larger total limit in terms of concurrent users in both permitted , such as when Wi-Fi and cellular are combined. [1][2].

Because of the growing rise of mobile communication systems, new antennas for base and mobile station applications have become necessary. To ensure durability, mobility, and high efficiency, wireless communication demand antennas with a low profile, low weight, high gain, and ease of fabrication; PIFA is

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the architecture of the best antenna. But one of the main issues is the restricted bandwidth of PIFA antennas [3]. Via an antenna or broadband configure a range of internal antenna types has recently been added, including a PIFA antenna, a fractal, and a monopole antenna. The work reported in [4] a PIFA antenna with a compact form factor that works at mm-wave frequencies (28 GHz) has been disclosed, the PIFA antenna is designed to have a gain of 4.5 dBi, an impedance B.W of 1.55 GHz, and a radiation efficiency of 94%. Authors in [5] Proposed T-slot shape of the patch, the built antenna can be incorporated into for 5G communication devices. This antenna has two operating frequency of 2.34 GHz and 25.4 GHz while the peak gain is about 2.82dB and 9.65dB. Authors in [6] proposed an antenna that can support increased data rates in accordance with 5G regulation ,the task at hand is to design a small antenna in the millimeter band of the spectrum, focused around 28GHz, with a 5G network in mind. The Writer in [7] both configurations were compared. First, the simulation was applied to microstrip antenna, and then added an upper layer by varying the height to enhance impedance matching and optimizing the performance of the antenna .The single PIFA creates a wide transmission capacity that covers the required 28 GHz recurrence, and the plan can be made MIMO PIFA. The correlation of the S21 results uncovers the examination of common coupling.

Proceeding from the above, it can be noted that the appropriate frequency for the fifth generation is 28Ghz , in this article, we describe the design process and a model of a simple PIFA with a new structure in patch antenna; the FR-4 in the substrate and interdigital slot in ground plan, the operating band is 28.12 GHz evaluated by simulated results with Ansoft HFSS and CST.

2 Geometry of proposed antenna

2.1 Geometry PIFA antenna

The configuration of a PIFA antenna has been shown in Fig.1; the antenna is designed on the dielectric substrate FR-4 with relative permittivity ε_r of 4.4 and a thickness of 0.5 mm. The suggested antenna is supplied between the ground plane and the patch part through an axial probe feed. The PIFA device antenna consists ground plan with an interdigital slot. The excitation is launched through a 50 Ohm coaxial line, which has a radius R= 2.8 mm. TTo give the antenna frequency variety. Table 1 shows the dimensions of all sections of the planned antenna. The measurements of the ground plane are a2=48 mm and a2=28 mm and the thickness 0.035 mm . The patch antenna has the dimensions of all parameters in Table 1. As shown in Fig.1, to improve PIFA antenna efficiency parameters, the ground plane of the antenna is modified with the addition interdigital slot Fig.1.

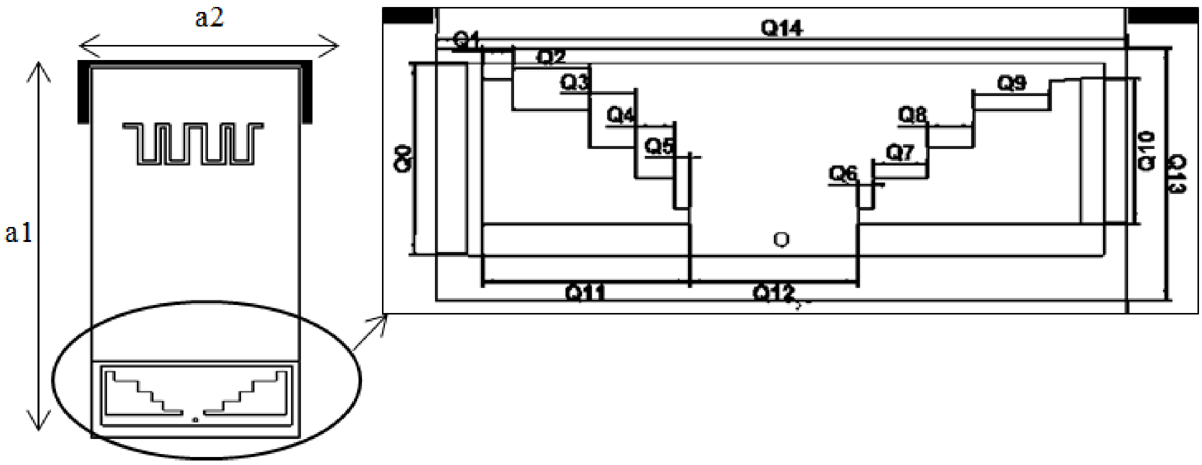

Fig. 1. Proposed antenna structure (all dimensions are in mm).

Table 1. Dimension of PIFA antenna.

Parameters	Dimensions
Q1	2mm
Q2	5mm
Q3	3mm
Q4	2.5mm
Q5	3.98mm
Q6	3.98mm
Q7	3.5mm
Q8	3mm
Q9	5mm
Q10	9.5mm
Q11	16.48mm
Q12	5.54mm
Q13	12.5mm
Q14	45mm

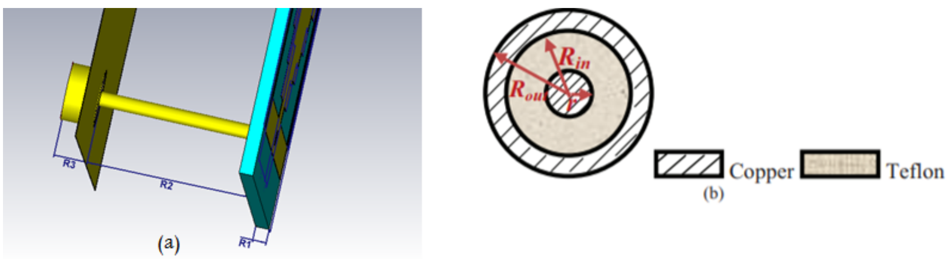

Fig. 2. Simulation : (a) CST model (b) cross section of cable .

Table 2. Dimension of PIFA antenna.

Parameters	Rin	Rout	R1	R2	R3
Values	0.45Mmm	1.745mm	0.84mm	10.5mm	2.04mm

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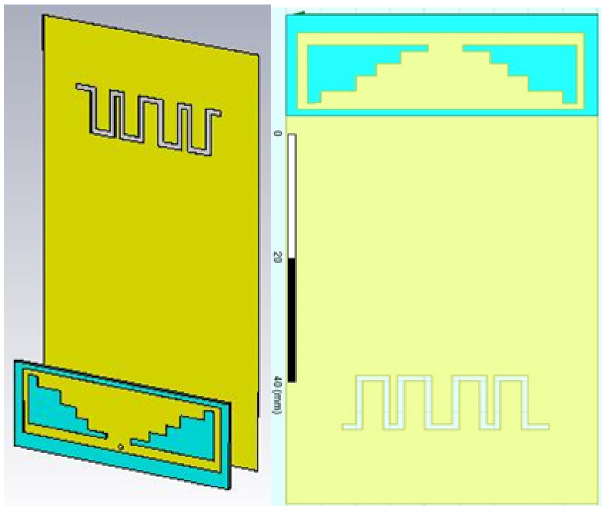
2.2 Simulation results in CST and HFSS

Return loss

The antenna is design and functionality was tested using CST Microwave Studio (CST MWS) and HFSS, a widely used full wave electromagnetic simulator. At each frequency point, the antenna was evaluated by the time domain solver.



(a) (b)

Fig. 3. Proposed antenna structure (a)CST (b)HFSS[10][11].

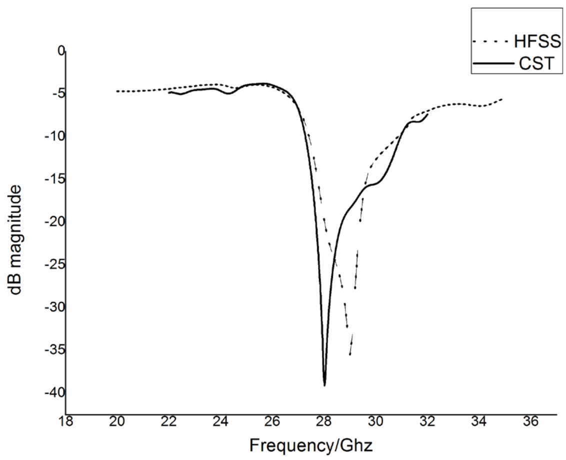


Fig. 4. Comparison between S-parameters in HFSS V13 and CST V19 [12].

The simulated reflection coefficient as seen in Fig.4.That is something we can see

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the reflection coefficient is –39.051885 dB at 28.12GHz. The antenna operating bandwidths, defined by a 10 dB return loss, are 3.6795 (27.281 to 30.942 GHz) and the comparison between HFSS and CST values are similar.

Efficiency radiation

Radiation effectiveness is another significant boundary to depict how proficiently a receiving wire communicates and gets RF signals, which is characterized as the prportion of the all out power transmitted by a radio wire to the complete info power got from the generator.it, can be clearly in Fig.5 the efficiency close to 100% (0dB).

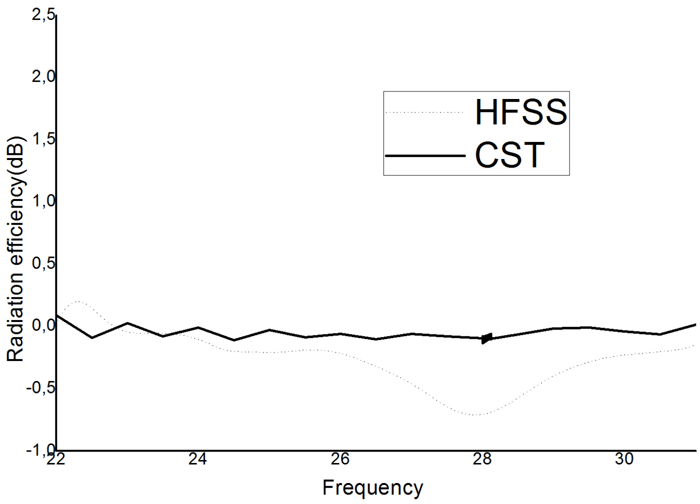

Fig. 5. Efficiency radiation .

VSWR

The reflection coefficient, which specifies the power reflected from the antenna, determines the VSWR. We see that the VSWR value varies, and that the value is definitely greater than 1, as shown in Fig.6.

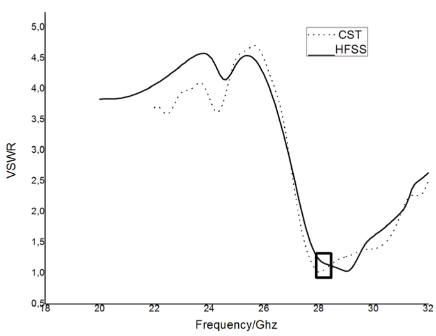

Fig. 6. Voltage standing wave ratio of PIFA .

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Gain of antenna

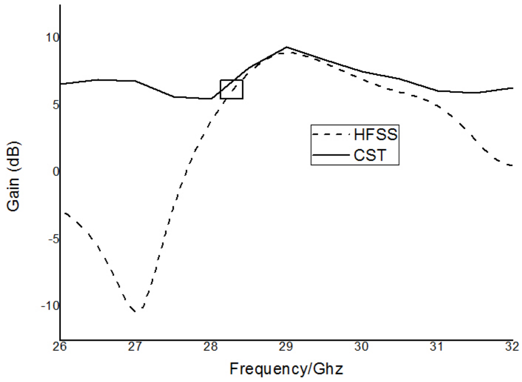

Fig. 7. Simulated gain variation of the proposed antenna .

The antenna is maximum computed gain at 28.12GHz, is 7.85dB shown in Fig.7. Fig.8 shows the simulation far field radiation patterns for the proposed antenna in two orthogonal planes (the E and H planes) at 28,12GHz.

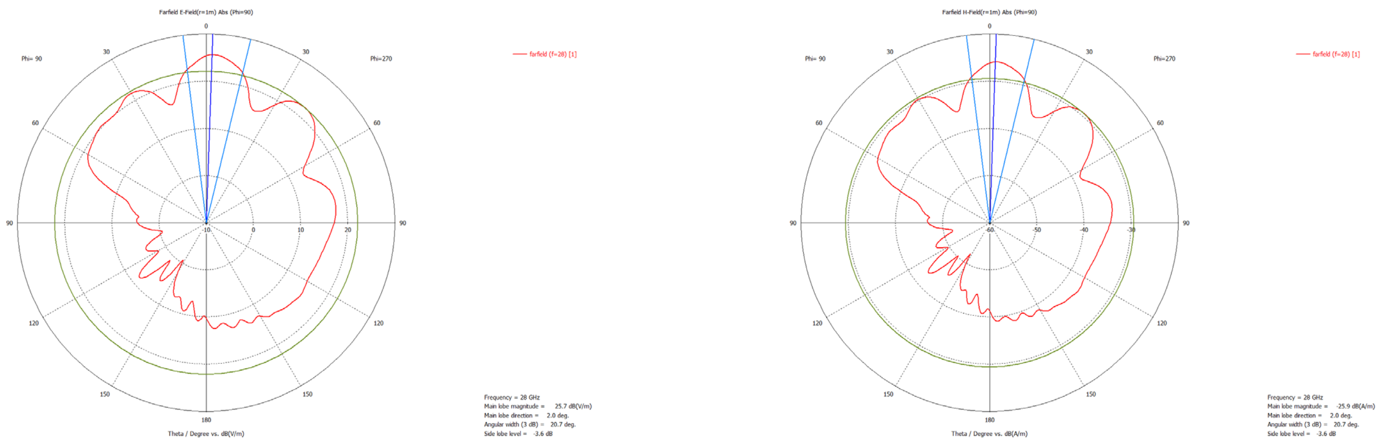

Fig. 8. Simulated Radiation Pattern of the PIFA antenna .

Note from the table 3 that the comparison of articles gives preference to the PIFA antenna proposed .Both the comparison return loss or bandwidth or gain or ease of creating a structure and we can change the value of resonance frequency by switch Q12 on patch antenna .

Table 3. Comparison study with existing works.

Articles	Bandwidth	Frequency	Gain	Structure
[4]	0.807 Ghz	28 Ghz,2.5 Ghz	13dBi	Complex
[6]	1.55Ghz	28 Ghz	4.5dBi	Simple
[8]	4 Ghz	28 Ghz	4.05dBi	Simple
[7]	3.38 Ghz	28 Ghz	9dBi	Complex
[9]	2.08 Ghz	30 Ghz	10.2dBi	Simple
Antenna proposed	3.6795 Ghz	28.12Ghz	7.85dBi	Simple

3 Conclusion

This paper has provided a broad and deep look at future wireless, for single band 28 GHz, It will almost certainly be an element of 5G wireless communication. The maximum return loss -39.051885 has been achieved with a good radiation pattern at 28.12 GHz resonant frequency. The maximum Gain 7.85 dB,finaly VSWR 1.0225583 . The proposed antenna is applicable for single band applications in 5G wireless communication systems . The proposed antenna is very easy to fabricate, and is fed by a coaxial cable which makes it very attractive for current and future cellular phones applications.Frequency values can be changed from the Q12 value as well as the value of Gain and directivity. Development of mobile network technology, rapidly growth and now the world are looking towards 6th generation (6G). 6G will utilize the terahertz (THz) signal for transmission. THz signal builds transmission capacity and data rate. In addition, it will give transfer speed multiple times higher than 5G sign, i.e., mm Wave. 6G will have a data rate of 1 TBPS or more. 5G and B5G follow 2-dimensional corre-spondence structure, while the 6G will follow 3-dimensional. 6G will offer the 3D types of assistance with the help of edge technology [13].

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