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# Design and Development of Novel Dipole Antenna for 5G Indoor Base station Applications

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## ABSTRACT

The need for indoor wireless applications is increased as there is a great demand in wireless personal communication devices. Therefore, in this paper a base station antenna is proposed for the 5G indoor applications. The proposed antenna has a novel dipole structure made of copper material. In this research work FR4 substrate with dielectric permittivity of 4.4 and height of the substrate is 1.6 mm is used for manufacturing the proposed antenna. The proposed antenna having 24.50 mm length and 24 mm width dimension. The proposed antenna is designed and developed with an integral based solver simulation software called CST Microwave studio v2020 and obtained VSWR < 1.5, Return loss of -28.64 dB and Bandwidth of 90 MHz, gain of 4.63 dBi at the resonant frequency of 3.25 GHz. The proposed antenna is well suitable for the 5G indoor base station applications.
**Keywords :** 5G, Micro Patch Antenna, Novel Dipole, Wireless Communication.

## I. INTRODUCTION

Antenna plays a vital role in the development of communication technologies such as 5G wireless mobile communication services. There is a huge increase of smart devices such as mobile phones, tablets, wireless head phones, and smart watches in the consumer electronics market. Apart from this there is a great demand available for the smart home technologies and industries 4.0 which demands the needs for the indoor wireless access points. Therefore, in this paper a 5G base station antenna is proposed for the indoor applications. Micro patch antennas are low profile antennas which are easy for design and fabrication [1]. In literature review fundamentals of designing Patch antenna have been studied using [2-4], The rectangular patch antenna for operating in 5.8 GHz Wi-Fi applications presented in [5]. The rectangular patch antenna for operating in 5.5 GHz Wi-Max applications presented in [6]. A metamaterial antenna for 4G WiMAX application presented in [7]. A triple-band dual-polarized indoor base station antenna for 2G, 3G, 4G and Sub-6 GHz 5G applications presented in [8]. A novel dual-band dual-polarized filtering antenna with high selectivity is proposed for 5G Sub-6 GHz base station applications in [9]. A cross dipole antenna for 4G and Sub-6 GHz 5G base station applications presented in [10]. A dual-polarized magneto-electric dipole antenna with gain improvement at low elevation angle for base station is presented in [11]. A dual-band dual-polarized base station antenna for the fifth-generation (5G) mobile system is presented in [12]. A dual-band dual-polarized antenna array is presented for 5G base station application is presented in [13]. A beam shaping technology, based on arrays of parasitic elements, is presented for the modulation of radiation patterns of existing 4G or 5G base station antennas presented in [14]. The design and enhanced bandwidth performance of a dual-sleeve monopole antenna for indoor base station application is presented in [15]. In this paper a novel dipole structure is developed over a low cost FR4 ground plane using copper material. CST Microwave studio v2020 is used in this research process of developing the proposed antenna.

## II. ANTENNA DESIGN

The front view of the proposed antenna is shown in Fig.1. The front view consists of a novel dipole structure which is designed by using 0.045 mm thickness copper with electrical conductivity of 5.8e+007. The back view is given in Fig.2. The back view consists of a full ground structure made of copper material. The proposed antenna is designed on the low cost FR4 material with the characteristics of thickness 1.6 mm with permittivity of 4.3 and loss tangent 0.02. Discreate feeding with 50-ohm input impedance is used in the excitation of the proposed antenna.

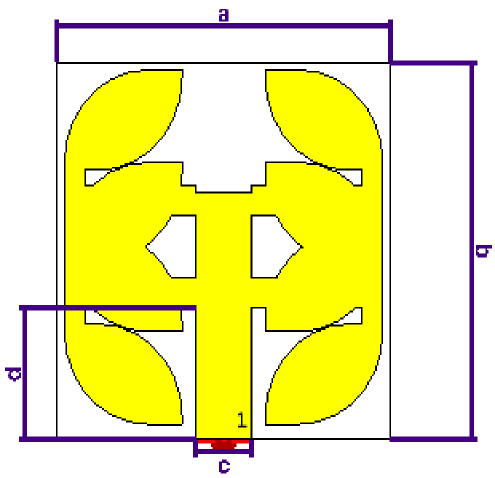


Fig.1 Top view of the proposed antenna

The top view of the proposed antenna consists of novel dipole structure in which discreate feed is used for the excitation. The length of the feed is 8.50 mm and the width of the feed is 4 mm. The dimensions of the proposed antenna are optimised using the simulation software. All dimensions used in front view have been presented in Table 1.

TABLE 1
GEOMETRICAL PARAMETERS OF FRONT VIEW OF THE PROPOSED ANTENNA

| Parameter | Dimension (mm) |
|---|---|
| a | 24 |
| b | 24.50 |
| c | 4 |
| d | 8.50 |

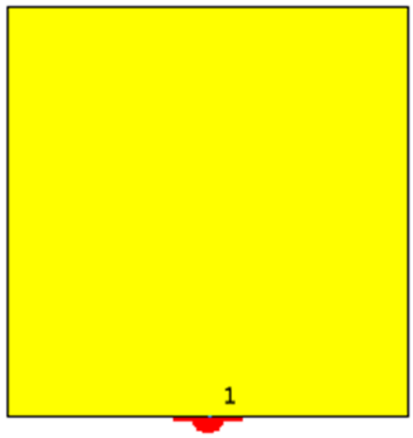


Fig.2 Back view of the proposed antenna

The back view of the proposed antenna consists of full ground structure which is made up of copper material.

## III. RESULTS AND DISCUSSION

The proposed antenna is designed and simulated in CST Microwave studio v2020 and its results were discussed below.

### 3.1 Return Loss

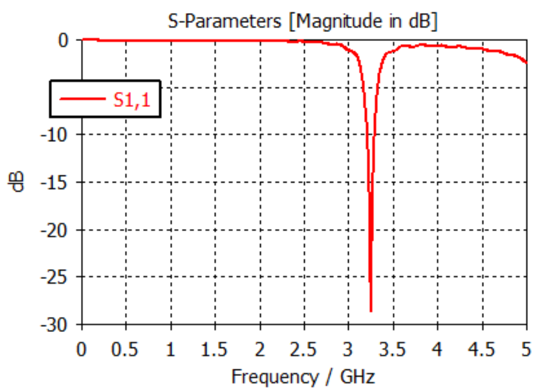


Fig.3 Return Loss

The return loss obtained -28.64 dB at 3.25 GHz for the proposed antenna which is given in Fig.3. The bandwidth achieved is 90 MHz in the operating frequency range.

### 3.2 VSWR

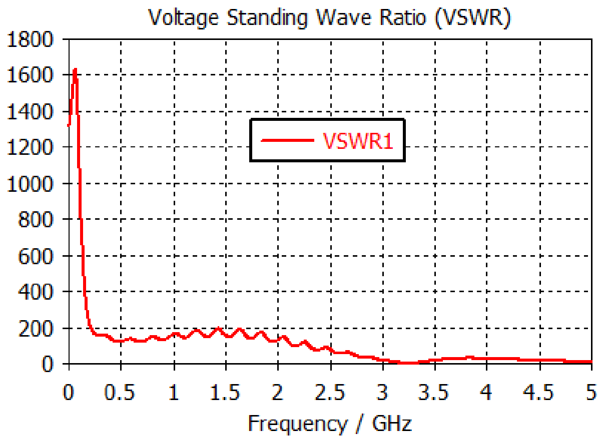


Fig.4 VSWR

The minimum Voltage Standing Wave Ratio VSWR obtained 1.07 at 3.25 GHz for the proposed antenna which is given in Fig.4.

### 3.3 Front to Back Ratio

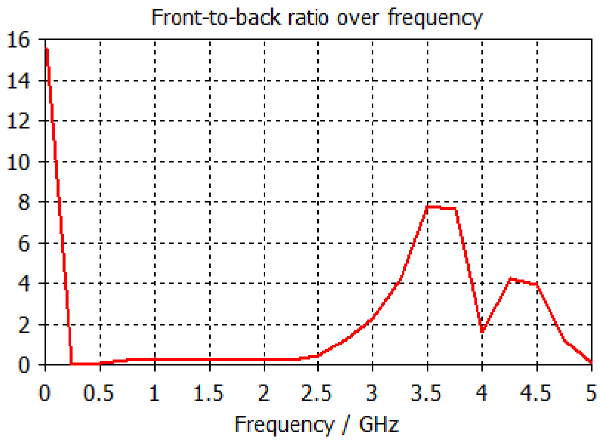


Fig.5 Front to Back Ratio

Front to Back Ratio is the ratio of power gain between the front and rear of a directional antenna. Front to back ratio for the proposed antenna is 0.45 at 3.25 GHz which is given in figure 5.

### 3.4 Surface current a distribution

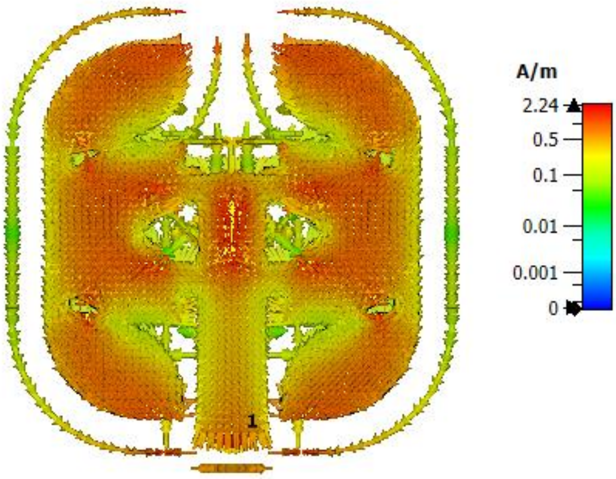


Fig.6 Surface current a distribution

Surface current a distribution at 3.25 GHz is given in figure 6.

### 3.5 Farfield Plots

Farfield Plots for Gain, Directivity for the proposed antenna presented in this section.

### 3.5.1. Farfield Gain at 3.25 GHz

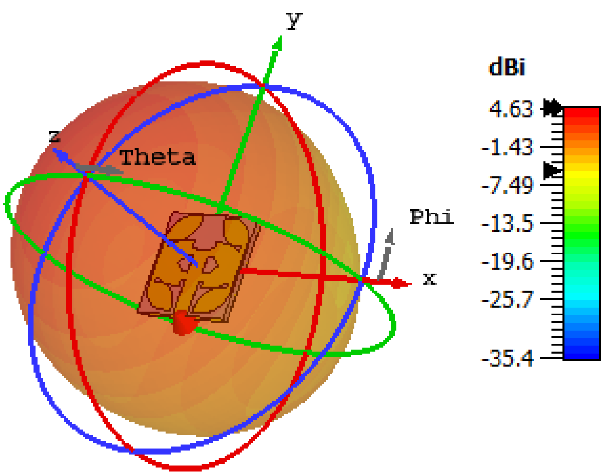


Fig.7 Farfield Gain at 3.25 GHz

### 3.5.5. Farfield Directivity, Abs Phi=0

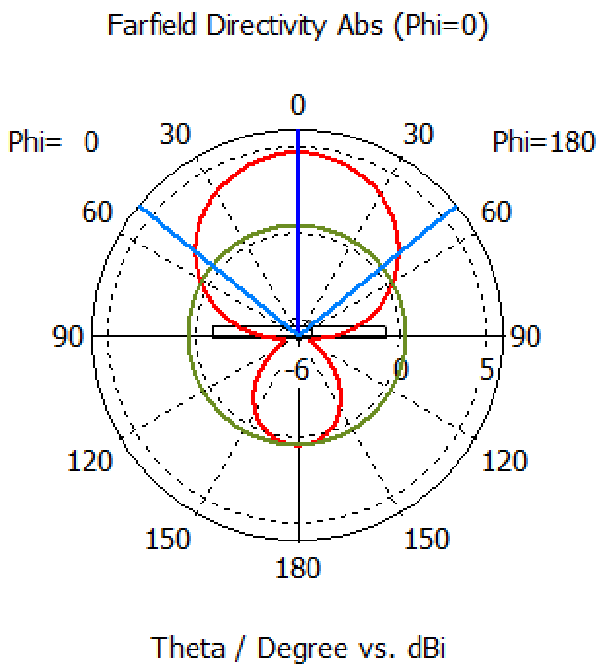


Fig.8 Farfield Directivity, Abs Phi=0

### 3.5.6. Directivity, constant Phi=90

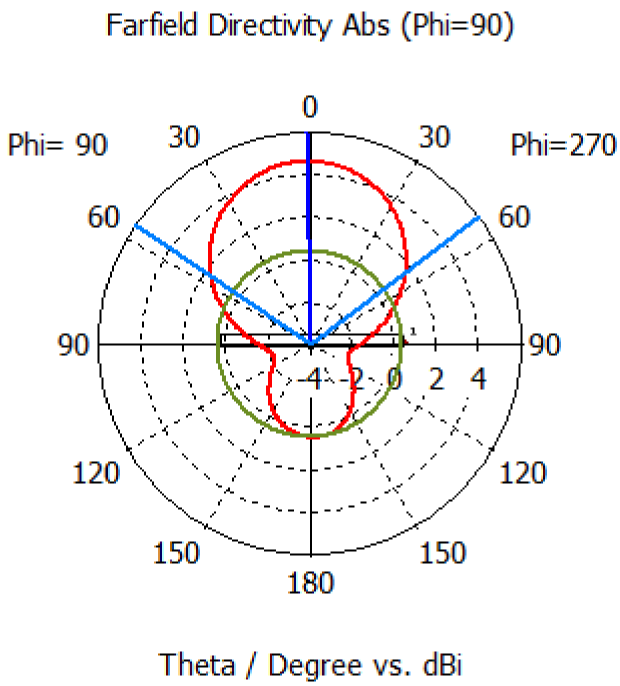


Fig.9 Directivity, constant Phi=90

### 3.5.7. Farfield Directivity Plot at Theta=0

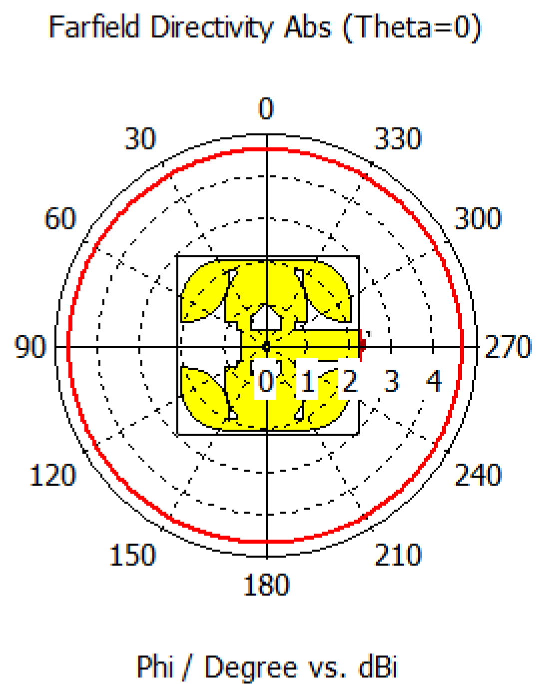


Fig.10 Farfield Directivity Plot at Theta=0

### 3.5.8. Farfield Directivity Plot at Theta=90

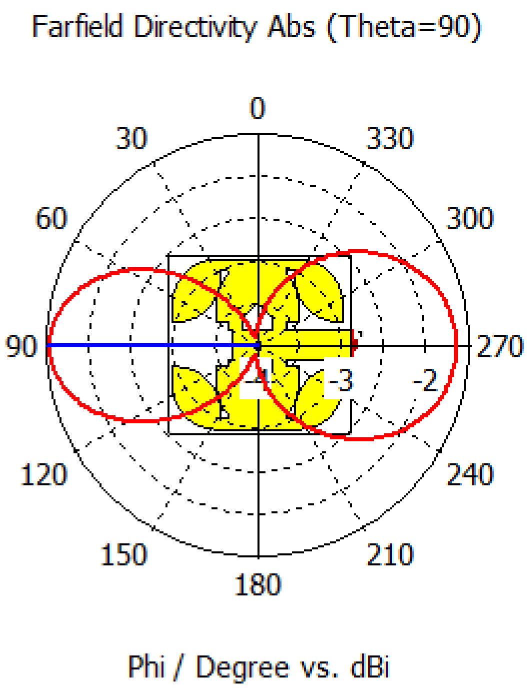


Fig.11 Farfield Directivity Plot at Theta=90

**3.6 E Field**

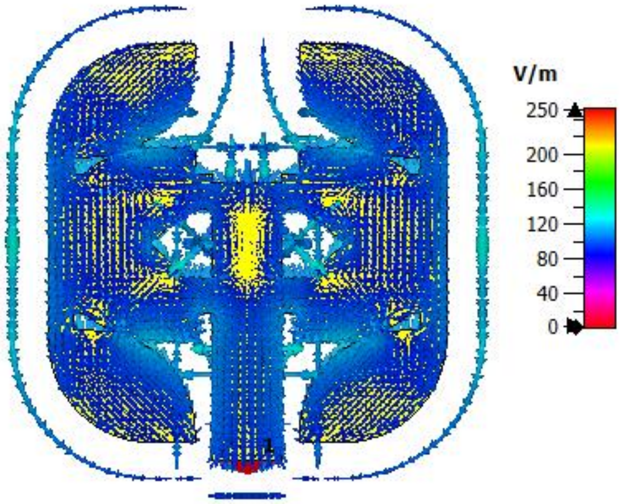


Fig.12 E Field

**3.7 H Field**

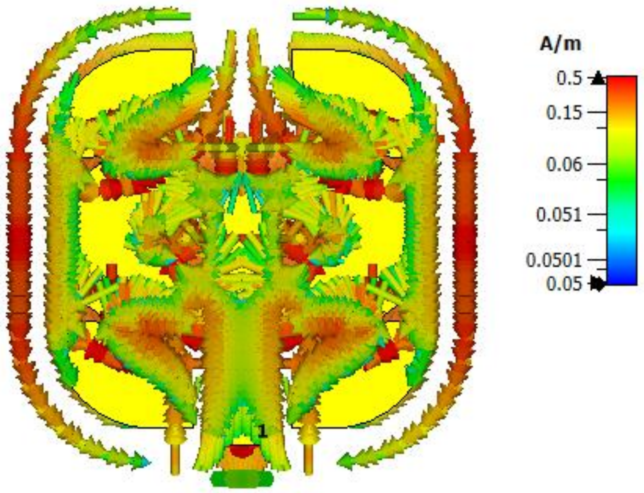


Fig.13 H Field

The overall results achieved by the proposed antenna have been presented in Table 2.

TABLE 2
OVERALL RESULTS

| Parameter | Value |
|---|---|
| Operating Frequency | 3.25 GHz |
| Return Loss | -28.64 dB |
| VSWR | 1.07 |
| Bandwidth | 90 MHz |
| Gain | 4.63 dBi |
| Front to Back Ratio | 0.45 |

## IV. CONCLUSION

The proposed antenna achieved resonant frequency at 3.25 GHz along with a compact dimension of 24*24.50 mm and gain of 4.63 dBi, return loss of -28.64 dB and the bandwidth of 90 MHz. The proposed antenna is suitable for 5G indoor wireless applications.

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