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High Gain Dual Parasitic Patch Loaded Wideband Antenna for 28 GHz 5G Applications

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Abstract – This work presents the design of a high gain wideband antenna for 28 GHz band application. The antenna structure was inspired from a conventional circular patch which is modified using consecutive loading of two parasitic patch. The presented antenna offers a wideband to completely cover the globally allocated band spectrum for 28 GHz 5G applications. Moreover, the broad side radiation pattern, relatively compact size and high gain makes the proposed work potential candidate for future 5G applications.

Keywords — Wideband antenna, parasitic patch loaded, 28 GHz spectrum, 5G, high gain.

I. INTRODUCTION

5th generation of communication, 5G, arises as a potential candidate to nullify the demand of high data rate transfer required by exponentially expanding pool of users connected to internet. 5G promises to provide data rate up to 20 Gbps simultaneously to millions of users resulting in possibility to launch hologram [1]. The potential band spectrum for 5G are sub-categories in to three major sections namely known as Sub-1-GHz (lower band), Sub-6-GHz (middle band) and mm-wave (upper band) [2]. However, the lower and middle bands are not strong candidate due to over allocation by already existing technology. Thus, researchers divert their attentions towards mm-wave band spectrum [3]. As a result of that numerous works reporting the antenna design for mm-wave applications were proposed in literature [4].

However, due to the low absorption rate and lesser attenuation against rain and other climate change, 28 GHz band spectrum arises as a more potential candidate among other bands [4]. Thus, designing of a high gain and wideband antenna for 28 GHz band become natural demand. Researchers adopted various techniques to design high gain wideband antennas that are not limited to usage of Defected Ground Structure (DGS) [4], array configuration [5], meta-material loading [6] or loading of parasitic patches [7]. Among them DGS suffers with increased backward radiation, array configuration had large size along with high level complexity and meta-material loaded antennas are not suitable for low profile devices. Parasitic patch loaded antennas were the optimal solution for the compact size devices. However, the size limitation constrains the researcher to further decrease the size of antenna while keeping high performance in term of bandwidth, gain and efficiency.

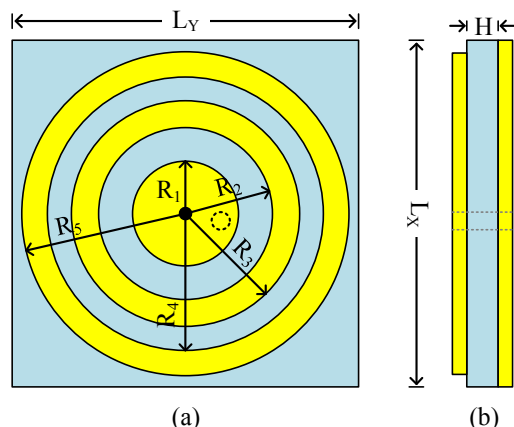


Fig. 1. Geometry of proposed wideband antenna (a) Front-view (b) side-view.

II. ANTENNA DESIGN AND CHARACTERIZATION

Fig. 1 depicts the geometrical structure of the proposed work. The wideband antenna was embedded on the top side of the ROGERS RT/droid 5880 with thickness of H . The radiator was fed with coaxial feeding as shown by dotted circle in Fig. 1(a). The back side is fully covered with copper, acting as a ground plane and reflector for Electromagnetic wave, as shown in Fig. 1(b). The optimized value of various parameters of proposed work is as follow:

$L_Y = 12$; $L_X = 12$; $H = 1.524$; $R_1 = 1.75$; $R_2 = 2.75$; $R_3 = 3.75$; $R_4 = 4.5$; $R_5 = 5.5$. (units = mm)

The antenna design methodology was initiated by designing a conventional circular patch antenna using the equations provided in [8]. The circular patch results in a narrowband range 25.8 – 27.7 GHz, as illustrated in Fig. 2. Afterwards, band enhancement was performed by utilizing parasitic patch loading to cover complete 28 GHz band spectrum (24.5 – 29.5 GHz) allocated globally [9]. Unlike conventional methods, where an array of parasitic patches or metamaterials were loaded to enhance the gain and bandwidth of the antenna [10]. A single circular patch was utilized along with the radiator, this patch introduces additional mutual coupling with radiator resulting in enhanced bandwidth. The modified antenna now offers a broadband of 3.6 GHz (25 – 28.6 GHz), however, the band is insufficient to completely cover globally allocated 28

GHz band. Thus, another parasitic patch was loaded resulting in widening of $|S_{11}| < -10$ dB impedance bandwidth due to additional coupling. The optimized antenna offers a wideband of 7.1 GHz ranging 23.7 – 30.8 GHz, that correspond to 27% impedance bandwidth with respect to central frequency of 27 GHz, as shown in Fig. 2.

The far-field parameters of the proposed antenna is depicted in Fig. 3. It can be seen clearly that the presented wideband antenna offers a slightly tilted radiation pattern in both principal E-Plane ($\Phi = 0^\circ$) and H-plane ($\Phi = 90^\circ$) as depicted in Fig. 3(a). The peak gain and efficiency versus

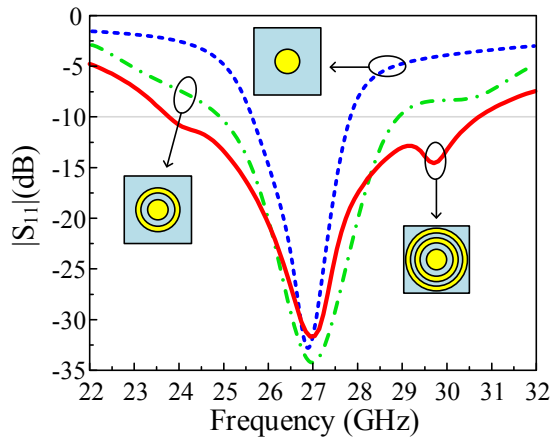


Fig. 2. Return loss graph of the steps performed to design proposed wideband antenna.

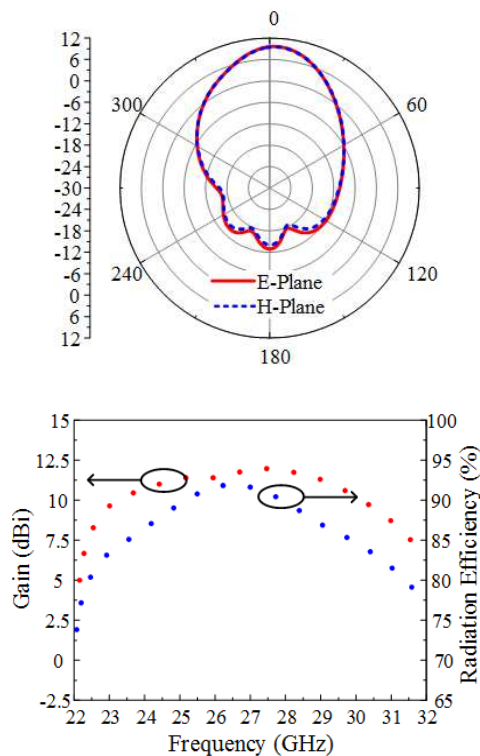


Fig. 3. E- and H-planes radiation patterns at the resonating frequency of 27GHz along with gain and efficiency curves.

frequency plots were illustrated in Fig. 3(b). It can be observed that antenna offers a high gain of > 10 dBi in operational band along with high radiation efficiency of $> 85\%$, as shown in Fig. 3 (b).

III. CONCLUSION

A compact wideband antenna for 28 GHz 5G applications was presented in this paper. The antenna was designed using pair of parasitic patches loaded consecutively around a conventional patch antenna. The resultant antenna offers a 7.1 GHz wide impedance bandwidth ranging from 23.7 GHz to 30.8 GHz. Moreover, the antenna offers a broadside radiation pattern along with high gain of greater than 10 dB throughout the band of interest. Furthermore, a good combination of compact size, wideband, high gain and efficiency makes the proposed work a potential candidate for upcoming 5G applications operates using 28 GHz band spectrum.

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