

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 3, March 2019

Design and Analysis of Wide Band Antenna for 5G Wireless Communications

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ABSTRACT: This paper presents the design and analysis of reconfigurable extended band coverage wide band antenna for 5G communication. The proposed antenna is operating at 28GHz frequency range and its structure is matched permanently over very high frequency ranges including 4.25GHz, 7.055GHz, 12.48GHz, and 15.26GHz as well as for the extended 5G communications spectrum reallocation. The antenna that is being designed is compatible with mobile terminals.

KEYWORDS: wide band antenna, Reconfigurable, 5G communication.

I. INTRODUCTION

Wireless communication is information or power transfer between two or more points not connected by an electrical conductor. Due to low cost device and mobility, wireless communication systems have progressed too fast in notebooks and cell phones over the past decade. Antenna plays a major role in wireless communication in the transfer of information. For designers of fixed and mobile wireless communication systems, the antenna design for high speed multimedia connectivity represents a challenging activity. The arrival of these new frequency bands adds new challenges for the designers of these antennas. Mainly the compatibility with the already existing bands like 2G, 3G and 4G are required. The rapid growth of communication system towards 5G communication that operates on very high frequency bands requires the need of antenna that operates at wideband, to cover mobile and wireless services and also to reduce the complexity of the system. There are many types of antenna that has been used to obtain wide operating bands. In this we have made use of meander monopole antenna to obtain wideband operating frequencies. Meander monopole antennas are derived from single monopole antenna. They show lower noise and higher efficiencies when compared to that of a single monopole antenna, as smaller capacitive reactance are replaced by smaller inductive reactance and also consequently with a small inductor resistance. A meander monopole antenna consists of horizontal and vertical strips that is found advantageous when compared to that of a single monopole antenna. This monopole antenna is a radio antenna consisting of a straight rod shaped conductor that is often mounted over a conductive surface, called a ground plane. The driving signal to the transmitter is applied in case of a transmitting antenna, whereas in case of a receiving antenna the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feed is connected to the monopole and the other side is connected to the ground plane which is connected to the ground. This contrasts with dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna. Sometimes monopole antennas are printed on dielectric substrate to make it less fragile and also they may be fabricated easily using the printed circuit board designing technologies. Such antennas are referred to as printed monopole antennas. They are suitable for several applications like RFID, WLAN and so on. As the monopole is a resonant antenna, for radio waves the rod functions as an open resonator, oscillating with standing waves of voltage and current along its length.

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In modern communication system the wider bandwidth multiband and low profile antenna are of greater demand for both commercial and military applications where it is required to have a single antenna that can be reconfigured dynamically on multiple frequency bands. This paper mainly focuses on a meander monopole antenna that operates at very high frequencies. The working and design of this antenna is done using CST studio suite simulation tool. The rest of the paper is structured as follows: section II contains the design of the antenna followed by some results and comparisons in section III. Some concluding comments are given in section IV.

II. ANTENNA DESIGN

The antenna is designed using CST studio suite design software, its geometry is based on the coupling between the fed monopole antenna and the parasitic element. As mentioned above the monopole antenna is designed to possess a meandering structure with few horizontal and vertical strips. The designed antenna has a compact design of 40 mm × 32mm × 3mm and it is placed on a FR-4 substrate of dimensions 130mm × 70mm × 0.8 mm. The various parts of the designed antenna is shown in Fig.1. And the designed antenna is shown in the Fig.2.

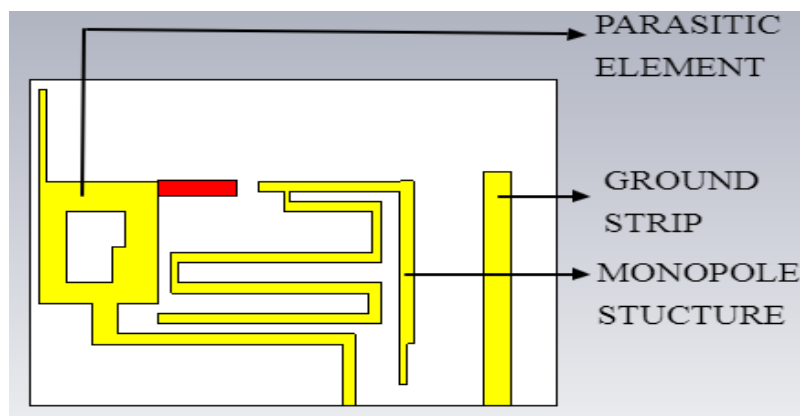


Fig.1. Parts of the designed antenna

The designed antenna is shown in the Fig.2. and the dimensions of the monopole antenna and the parasitic elements are also give.

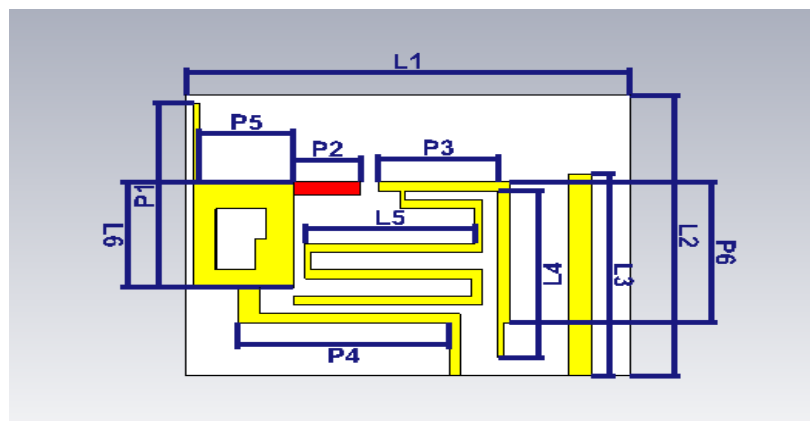


Fig.2. Designed antenna

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The driven element is at the centre and is fed by a 50Ω micro strip line, and the overall length of the monopole is equal to a quarter wavelength at 0.9GHz frequency and is nearly 84mm. a parasitic element made of copper (annealed) is kept on the top of the substrate. A parasitic element is mostly unavoidable in case of an antenna because, it helps to modify the radiation pattern of the radio waves that is being emitted by the driven element. All these waves are sent as a beam in one direction thereby increasing the directivity of the antenna. An additional resonance is created with the help of this parasitic element, and this shorted parasitic element is connected to the ground plane. On the right side a ground strip is used in order to cover the 4.25GHz frequency range. A new resonance is obtained at 15.26GHz frequency range due to optimization of the shape of the meander monopole antenna. A ground strip made of copper (annealed) is added in order to optimize the structure of the antenna. The coupling between the meander monopole and the parasitic element is made with the help of a strip (red) that is placed in between the monopole structure and the parasitic element. The parasitic element is very much essential as it increases the directivity of the antenna even at very high frequencies. The antenna is designed on mm scale and each of its dimensions plays a vital role in the functioning of the antenna. The dimensions of the antenna is summarized in the following table:

Symbol	Dimension(mm)
L1	40
L2	32
L3	23
L4	19
L5	15.30
L6	12
P1	21
P2	6.00
P3	10.80
P4	19
P5	8.50
P6	4.00

III.RESULTS AND COMPARISONS

The s parameter which describes the response of a network is used here to analyse the performance of the given antenna. In order to find out how much power is reflected from the antenna S11 curve (return loss) is being considered. From this it is found that the antenna is resonating at four different frequencies. The proposed antenna operating at the frequencies of 4.25GHz, 7.055GHz, 12.48GHz, and 15.26GHz provides better impedances of 57.16Ω, 47.495Ω, 45.337Ω, 46.92Ω and a VSWR of the antenna are 1.157, 1.052, 1.121, and 1.066 respectively. The S11 curve which describes the frequencies at which the antenna resonated and also the gain in dB at those resonating frequencies are also show in Fig.3 and the impedances at the resonating frequencies are also shown in Fig.4.

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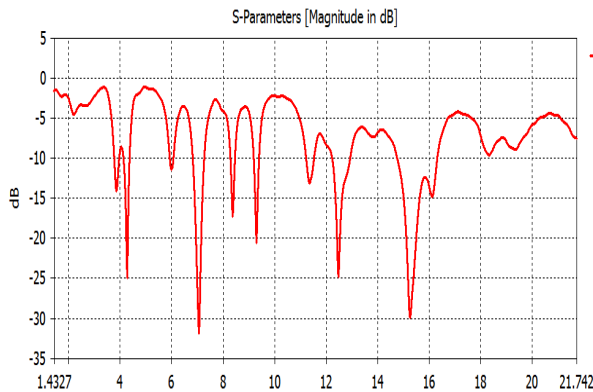


Fig .3. s11 curve

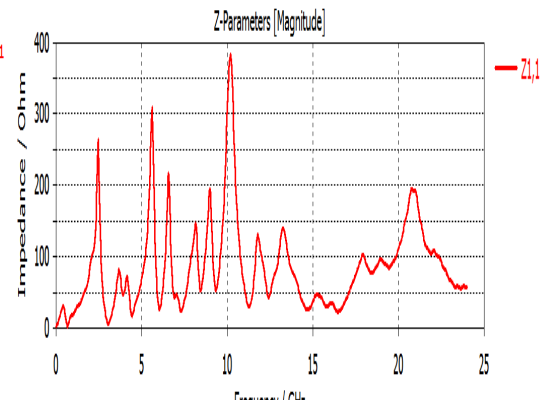


Fig.4.impedance curve

The maximum directivity of 8.076dBi is obtained at 12.48GHz frequency, with side lobe level at -0.7dB. The far field directivity abs polar plot is shown in Fig .5.

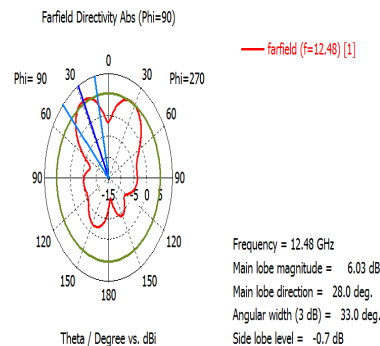


Fig.5. Far field directivity abs plot

The above polar plot is shown only for the maximum directivity and its respective frequency. The radiation pattern at different frequencies are studied and it is found suitable for mobile and other wireless communication systems. The VSWR measured at the frequencies are found to have the optimum value ranging between 0 and 2 which makes it suitable for a wireless communication systems.

IV. CONCLUSION

A wideband antenna is proposed for today's mobile communication and future spectrum reallocation are designed and the output are analysed and verified. The antenna that is being designed has a very compact size which makes it suitable for mobile phones. This wideband is achieved only with the help of the meander monopole antenna structure.

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