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A Microstrip Patch Antenna with DGS in Ka Band for 5G Applications

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***Abstract*—Presented paper includes the investigation and simulation of an antenna that works for the frequency range of Ka band. This antenna is simulated by defecting the ground because of this; it is called as DGS antenna. Ka band uses mmwave frequencies or can be said that this band contains high frequencies. 5G contains high frequency bands and can be ranges in low, high and medium spectrums over wide areas. Mmwave rage and sub6GHz ranges are comes under 5G bands. These bands include the low and high range frequencies. 5G provides high data rates and high coverage. This band is used in many applications like radars that are used in closed range targets; aircrafts of military, in satellite communication, as detector of speed in vehicles. Satellite communication needs high data rates and larger bandwidth. This band provides rage of frequencies to meet the requirements by using multiple beams. By using multiple beams the frequency gets reused, due to this phenomenon there is boost in capacity and coverage. All the dimensions of antenna, results like gain, VSWR, return loss etc. are presented in this paper.**

Keywords*—mmwave, frequency reuse, VSWR, gain, return loss, DGS

I. INTRODUCTION

This paper is based on application of 5G in the Ka band. Ka band ranges from 27-40GHz and include many applications like mentioned in the abstract of this paper. This range of frequency lies in the mmwave category of frequencies. This range of frequency has the downlink and uplink frequencies that are necessary part of satellite communication to pass the signals from downward to upward and vice versa.

To design any antenna or design of antenna, research regarding the project is required. To fulfill design of the proposed antenna, literature survey is a main part that is included in this paper. [2] and [3] are the basic microstrip antenna with some slots near feed. [2] Has an antenna that operates at 28 GHz with a gain of 6.72 dB with 5.5 x4.5 x0.5 mm3 on RT Duroid 5880 substrate. [3] Has an antenna that operates on 27.95 GHz with a dimension of 7.23 x 6.28 x 0.5 mm3 on RT Duroid 5880 substrate. [1], [4] and [6] presents the antennas that have a basic structure and then for further results these basic structures are modified to gain the results.

[1] Has an antenna whose substrate is Fr4 and operates at 28 GHz. This antenna is further modified in different dimension with many slots on the patch and the resulted gain is 6.63 dB. [4] Has an antenna that is simulated on Fr4 substrate and operates at 28 GHz frequency. The modified antenna has 15x15x0.203 mm3 and then this structure is converted in MIMO structure of 2 elements. [6] Has a slotted antenna and operates at 28 GHz and has a peak gain of 5.92dB. The modified design has dimensions of 7x7x0.8 mm3 and used substrate is fr4 with 4.4 dielectric constant.

[5] Presents a design of antenna that has array structure and operates between 27-29.1 GHz. Substrate of this antenna is RT Duroid 5880. This antenna firstly had microstrip feed line and then modified in aperture coupled feed then it again modified and it has a different feed line than the conventional feed line.

[7] Presents an antenna on RT Duroid substrate with DGS structure. This antenna is generally a basic microstrip antenna with a slot on the patch and the ground is also made defective to achieve the results. This antenna has dimensions 5x5x0.5 mm3 with 7.6 dB gain.

II. PROPOSED ANTENNA

This antenna has a patch of 7.60 x 5.20 mm2. The overall size of antenna is 22 x16 x1.6 mm3. Substrate material of this antenna is lossy Fr4 with 4.4 dielectric constant. Feed size is 3.2 x 6.8 mm2. This antenna has 2 cylindrical cuts on the both the right and left sides on the top of antenna with inner radius of 1mm. A small cut is made in the patch of antenna. The ground of this antenna is made defective with the help of a rectangular cut in the bottom side of antenna. These all defects in the patch and ground provide the results in the Ka band range of frequencies.

These are the mathematical expressions to design the antenna.

Width of the patch is calculated by using this given formula

$$W = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Here f_r = Resonate frequency

ε_r = Dielectric constant

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