Design and Performance Evaluation of Dual Band Antenna for 5G Mobile Communication

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Abstract*—In the existing paper, the slot antenna operating at frequencies which are below 30GHZ for previous generations of mobile communication is presented. It shows that interference is maximized due to decrease in band width. In this paper, design and performance evaluation of dual band slot antenna for 5G mobile communication is presented. The proposed antenna is highly directional, radiation pattern and stable gain in the desired band is used to to increase the antenna bandwidth and also interference between 5G and other communication devices. The proposed antenna is going to be operated in 2 different bands Q band, V band operating at 49GHZ and 66GHZ respectively. This antenna has been designed and simulated on HFSS using Neltec substrate with dielectric constant of 3.2.

Keywords: 5G Communication, Dual frequency, milli meter wave, Microstrip antenna.

I. Introduction

In present world, Mobile industry is growing very fast which has been started from 1G and now 4G deployed in the market for commercial use. The main difference between the different generations of mobile communication is the data rate which is increases rapidly from Kbps to Mbps and now aiming to Gbps. Due to spectrum scarcity and very high energy consumption; the fourth generation of mobile communication has already been launched. High data rates and mobility that could not be resolved even by 4G and has to move on for upcoming generations and these are becoming major challenges for wireless system designers. The research is going on fifth generation wireless system (5G) to resolve the above challenges and may be deployed in the market beyond 2020. The 5G technology will be in huge demand in near future due to its advanced features. It will provide high bit rate and better coverage area as compared to 4G [3]. The 5G communications may shift wireless signals to a higher frequency range from 30 to 300 gigahertz (GHz), and it will reduce the wavelength from centimeter(Cm) to millimeter(mm).Millimeter waves can take advantage of micro cells and pico cells technologies. They produce a large amount of bandwidth and help in wireless traffic congestion.

A. Micro-strip antenna

The micro-strip antenna is the widely used antenna and it also defined as printed antenna. It comprises of a metallic patch, a ground plane and a substrate. The patch is kept on the top and substrate is placed in between ground and patch. Feeding is given to the patch by utilizing micro-strip line feed technique[1-3]. Micro-strip antennas are having some unique advantages like less cost, ease of fabrication, easy integration with circuit components and less fabrication cost using modern printed circuit boards, make these antennas as most used [4-5].

B. Multi frequency antenna

Compact multi functioning antennas are more important for present day applications which are suitable for satellite, missile and air craft applications [6]. A single antenna can be used for multi-frequencies such that antenna can switch among the single, dual and triple frequencies. Ease of installation, size, low production cost, low profile and reliable antennas are very necessary for satellite communications [7,8].

Multi frequency antennas can be obtained by two types of techniques. One is multi-resonating technique and other is reactive loading technique. In multi resonating antennas, multi frequencies are obtained by using multiple radiating elements and can also be obtained by using staked patch antennas with different shapes of antenna like circular, rectangular, triangular and annular shapes [9].

Micro-strip is a type of electrical transmission line and which is used to transmit electromagnetic wave or microwave-frequency signals from one point to other point [5]. It is low profile antenna, easy to fabricate and comfortable on curved surfaces. Micro-strip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. This kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planer structure. However increase the thickness of the dielectric substrate being used surface waves and spurious feed radiation also increases, which hampers the bandwidth 2-5% of the antenna. This feed radiation also leads to undesired cross polarized radiation. In addition, if we start to operate in higher frequency range the antenna size will become smaller and fabrication become challenging. The directivity and the beam width of the antenna can be improved

In this paper, design and performance evaluation of a dual-band slot antenna for 5G mobile communication is presented. The proposed antenna has a directional radiation pattern and stable gain in the desired band. It's also supports co-polarization and cross-polarization.

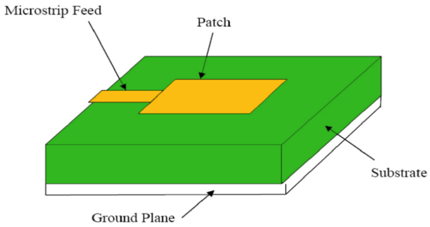
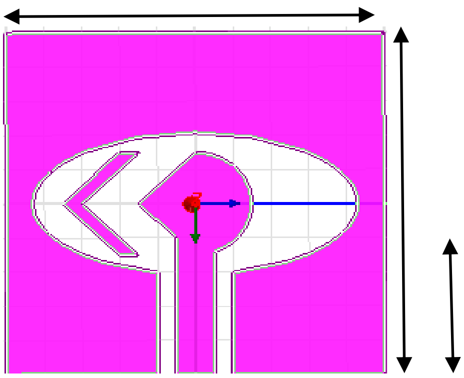


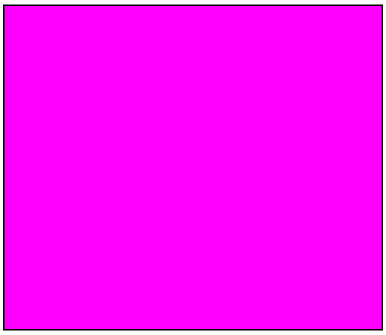
Fig.1. Rectangular microstrip patch antenna.

VI. ANTENNA DESIGN AND GEOMETRY

On the basis of several parameter studies, the proposed antenna geometry is illustrated in fig. 2. The proposed antenna of size of 10 x 10 mm2, is built on a 0.762 mm-thick Neltec NH9320 substrate with dielectric constant of εr = 3.2 and loss tangent tanδ=0.0024[1]. The dimensions of the proposed antenna are given in table1.



(a)



(b)

Fig.2.Prototype of antenna
(a) Top View (b) Bottom View

Parameters	Description	Size
L	Length of substrate	10mm
W	Width of substrate	10mm
L_f	Length of feed line	4mm
W_f	Width of feed line	1mm
A	Major axis of elliptical slot	4.150mm
B	Minor axis of elliptical slot	2.075mm
R	Radius of sector patch	1.5mm

An elliptically shaped aperture is etched in the radiating patch to enhance the antenna bandwidth. A sector disk is used as a radiating patch and to reduce interference between the 5G and other system, a π shaped slot is etched off in the feed line to create a notch band of 30-300 GHz.

III. SOFTWARE USED

The software used is ANSYS HFSS (High Frequency Structural Simulator). It is standard software for simulating full wave, 3D and Electro Magnetic fields. It is useful in the design of high speed electronic devices and high frequency used applications due to its high computing performance. Advanced hybrid methods are used here to solve a wide range of radar, satellite, microwave, RF and high speed digital application.

IV. RESULTS AND DISCUSSION

The proposed antenna firstly, radiates at 49.300GHz frequency with return loss 39.7605dB and with gain of 25dB along with VSWR of 0.478. It results in another frequency of operation at 66.800GHz frequency with return loss -25.3681dB and with gain 19dB along with VSWR of 0.938.

Return loss occurs due to power reflections in transmission line due to discontinuity or mismatch load or device. Return loss characteristics of proposed antenna are shown in the Fig.3. The antenna is operating at two frequencies as shown in Fig at 49.300GHz and 66.800GHz respectively.

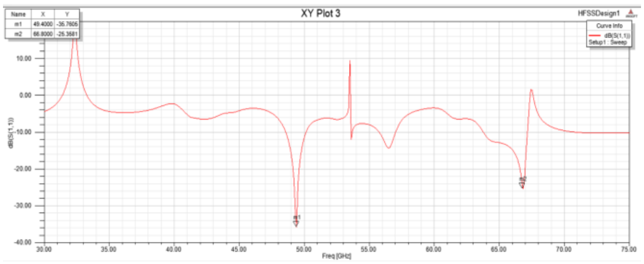


Fig.3.Simulated Return Loss of antenna.

The VSWR(Voltage Standing Wave Ration) measures voltages of standing waves occurred due to mismatches in impedance matching to load in transmission lines. The VSWR values below or equal to 2dB for resonating frequency are acceptable. The VSWR pattern for proposed antenna is has good conducting properties with VSWR less than 2 shown in Fig 4. The VSWR values at 49.300GHz and 66.800GHz are 0.478 and 0.938 respectively.

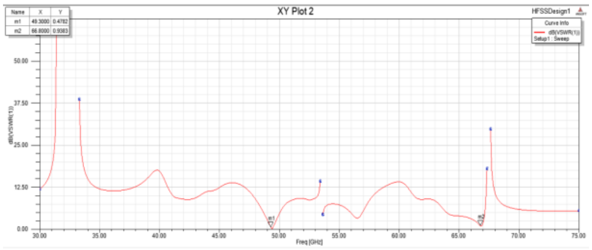


Fig.4.Simulated VSWR of antenna.

Fig.4. shows the characteristics of the simulated VSWR of proposed antenna. It is observed that the input impedance of the presented antenna is matched properly as the bandwidth covers the required band at 30-300GHz as VSWR ≤ 2.

The gain of the antenna is the ratio of power radiated from far field to power produced due to hypothetical losses in isotropic antenna on antenna beam axis. The gain of the antenna in terms of dB as a function of various frequencies at 49.300GHz and 66.800GHz are 25dB and 19dB respectively.

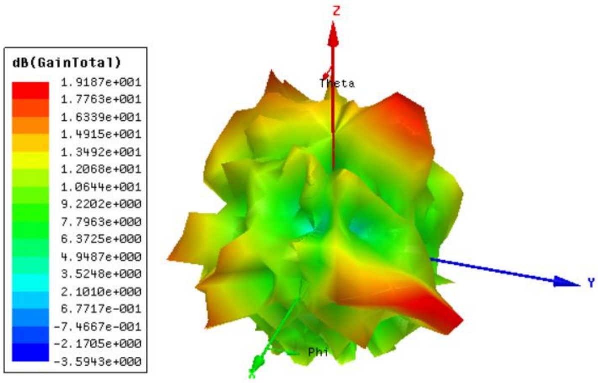


Fig.5.3D Polar plot operating at 66.800GHz with 19dB.

Radiation pattern refers to strength of fields in a particular direction of antenna. A defected ground structure improves the radiation parameters.

The radiation pattern's for proposed antenna is shown in Fig.6 and Fig.7. The directivity tells about radiation pattern directivity which is a function of angle, but angular variation is shown in radiation pattern. An antenna radiating in all direction will have 0dB directivity.

The result of radiation pattern at 49.300 GHz gives the highest peak at 30 degree. As of this, the radiation pattern is getting high due to increase in antenna bandwidth.

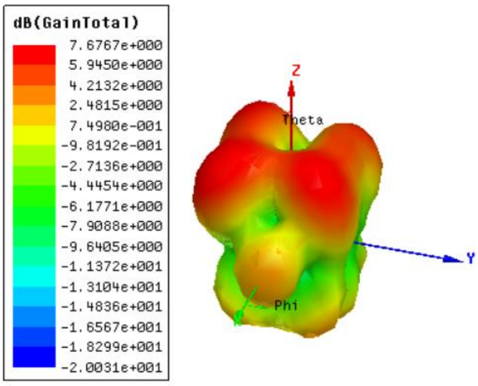


Fig.4.3D Polar plot operating at 49.300GHz with 25dB.

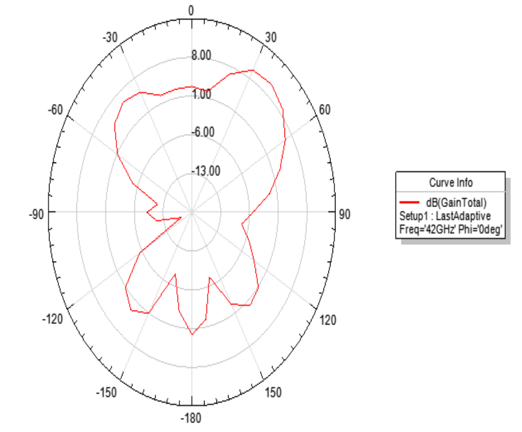


Fig.6. Radiation pattern at 49.300GHz with 25dB gain.

The result of radiation pattern at 66.800 GHz gives also the highest peak at 30 degree. As of this, the radiation pattern is getting high due to increase in antenna bandwidth.

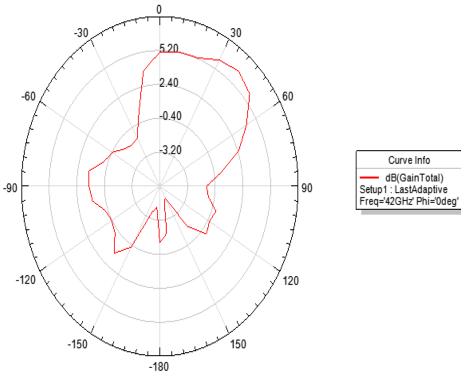


Fig.7. Radiation pattern at 66.800GHz with 19dB gain.

V. CONCLUSION & FUTURE SCOPE

A new type of dual-band slot antenna for the 5G mobile communication is presented. Designed result shows that 5G antenna for mobile communication operating at 49.300GHz and 66.800GHz respectively. The simulated antenna shows good result in terms of return loss, VSWR and radiation pattern. The frequency increase in 5G intends to reduce dimensions of an antenna, which will bring a new challenge for designer. The design illustrated the direction beam which makes it a good candidate for 5G and other high frequency applications. Further aim is to build an array with this element to improve the directivity for the application in the frequency range.

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