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Design of Multiband Microstrip Antenna For 5G Wireless Communication

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***Abstract* - In this paper, a microstrip Antenna has been designed to produce multiple frequency bands and 5G spectrum communication. The microstrip Antenna has been inset fed and multiple slots are developed to produce an lossless connection and larger bandwidth for faster transmission.**

I.INTRODUCTION

Wireless technology is growing enormously at current digital world for the various features in the mobile phones, TV broadcasting and satellites which require long-distance communication with high data rate and modern design. The antenna is a mean of radiating or receiving the radio waves, the devices communicate across multiple frequencies that require interfaced communication, usually wireless applications lie in the band starting from 900 MHz to 5.8 GHz, in particular, systems with WiMAX and WLAN frequencies above 2.5 GHz and 2.4/5.2 GHz are highly desirable due to their wide availability worldwide. Microstrip antennas are suitable for many applications as they are low profile, light weight, surface - compatible and cheap to manufacture using printed circuit technology with narrow bandwidth, the advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite link antennas, global positioning systems (GPS), radar for missiles and communication devices.

II. ANTENNA DESIGN

The suggested Antenna has been designed on glass epoxy substrate material (εr=4.4). The Width of the patch

(W) = $\frac{\lambda}{2}\left(\sqrt{\frac{2}{\varepsilon_r+1}}\right) \rightarrow$ (1)

Effective length (L_{eff}) = $\frac{c}{2f\sqrt{\varepsilon_{eff}}}$

Length of the patch(L) = $L_{eff}-2\Delta L \rightarrow$ (2)

Extension in the length(ΔL) = $0.412h\frac{(\varepsilon_{eff}+0.3)}{(\varepsilon_{eff}-0.258)}\frac{(W/h+0.264)}{(W/h+0.8)}$

Effective Dielectric length (ε_{eff}) = $\frac{\varepsilon_r+1}{2}+\frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$

f = Resonance Frequency (its value is 2.4 GHz)
h = thickness of substrate (its value is 3.6 mm)
ε_r = relative Permittivity of the dielectric substrate (its value is 4.4)
c = the Speed of light: 3 x 10^8 m/s
$\lambda = c/f = 3\times10^8/2.4\times10^9 = 0.125$ m or 125 mm
Calculate above equations (1) and (2)
Obtained Width of the patch W=38mm,
Length of the patch L=27.9 mm.
TheWidth of the feed is same as the width of strip line i.e., W=2.8mm
Length of the feed L=33mm
In our design we chosen the one of the Most cost-efficient substrates is FR_4 which is known as Flame Retardant, it is safe from flammability and dielectric losses of FR_4 are high.

III. ANTENNA DESIGN STEPS

First the antenna designed to resonate at 2.42GHz. The dimension of the patch, substrate and ground were calculated using TL equations. The copper material used for designing patch and ground layer. The substrate used is FR4 Epoxy material having dielectric constant of 4.4. The inset feed mechanism is used to match the impedance of the patch and the feed line to 50ohm. Then the symmetrical cut along the axis of the patch is made and its dimensions are optimized to generate the multiband resonance without affecting the fundamental band. If the symmetrical nature is slightly disturbed then there is a shift in frequency, absence of a frequency and reflection coefficient is decreases. Hence the symmetrical cut plays a vital role in part of multiband resonance. The fork shaped patch resonates at 1.4GHz, 2.42GHz, 3.89GHz and 5.13GHz which is suitable for application such as L band, WIFI / Bluetooth, Wi-max and WLAN etc. the antenna has good gain and reflection coefficient at all the desired bands. The VSWR for all the multiple bands lie between 1 and 2. The gains of the antenna is 4.752dB. The antenna has return loss of -26.5385dB, -20.1009dB, -34.6143dB and -26.1228dB at 1.4GHz, 2.42GHz, 3.89GHz and 5.13GHz respectively.

IV. ANTENNA STRUCTURE

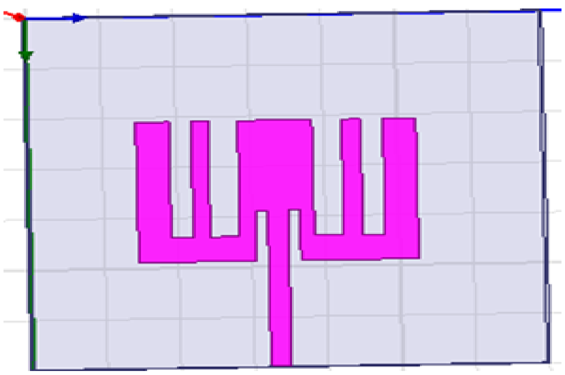

Fig 01:Top view of Antenna

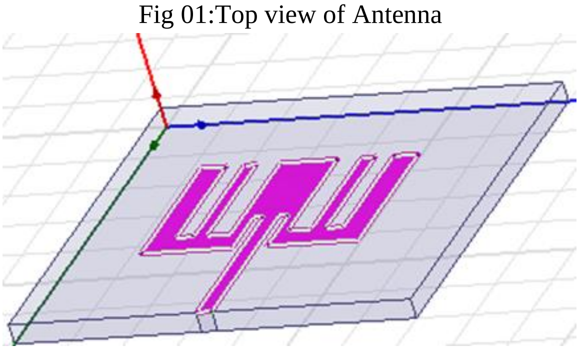

Fig 02:Cross sectional view

It has more substrate thickness; the surface wave is directly proportional. The bandwidth limit for radiation is 2 to 5 percent. It is easy to manufacture.it is one of the easier methods to manufacture because it is a simple strip that connects to the patch and can therefore be considered as a patch extension. By controlling the position, it is easy to model and match. The drawback of this method is that the thickness of the substrate increases, it increases the surface wave and spurious feed radiation, limiting the bandwidth.

V.SIMULATION RESULT

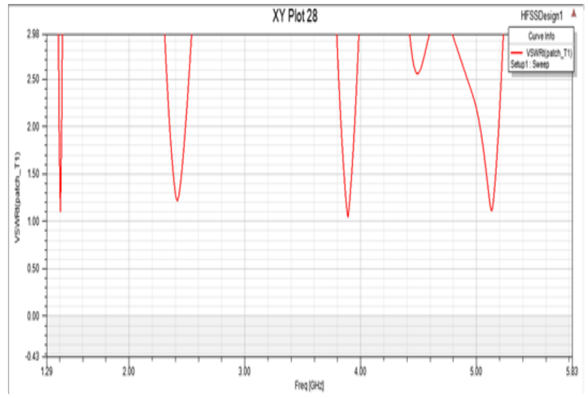

Fig 03 :VSWR vs Frequency

The VSWR VS Frequency plot represents all the desired multiband resonance are found to be between 1 and 1.50.

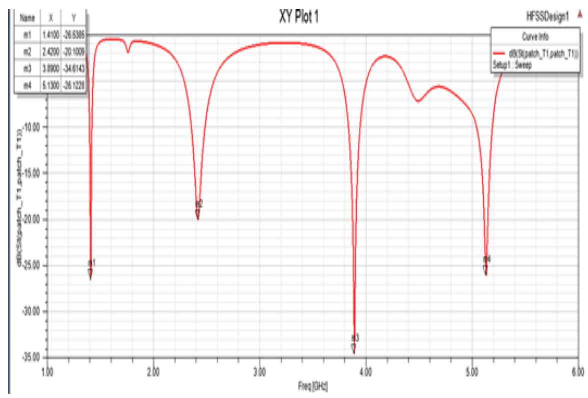

Fig 04:Return loss vs Frequency

Return loss is the ratio of returned / reflected signal to the incident signal in a transmission line or optical fiber. This discontinuity can be a malfunction with the terminating load or with an inserted device in the line.

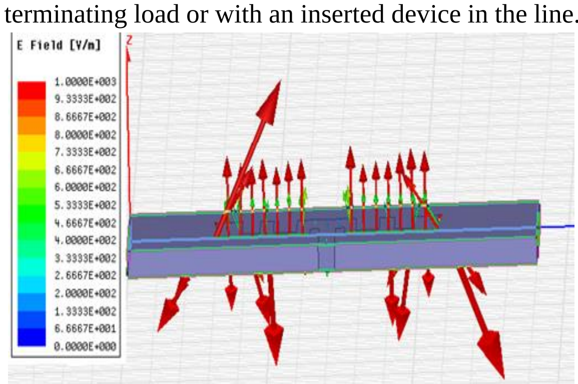

Fig 05:Electric Field

An antenna's gain is essentially a measure of the overall effectiveness of the antenna. If an antenna is 100% efficient, its directivity would be equal to its gain.

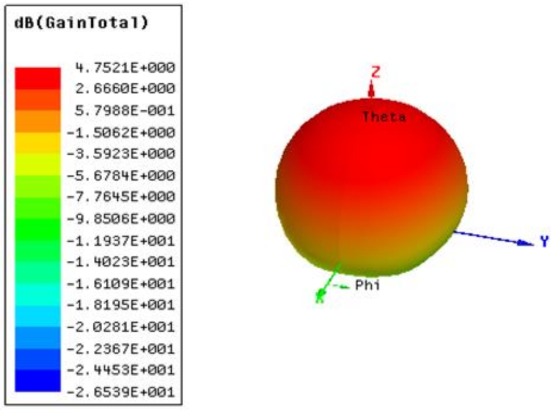

Fig 06:Gain Plot

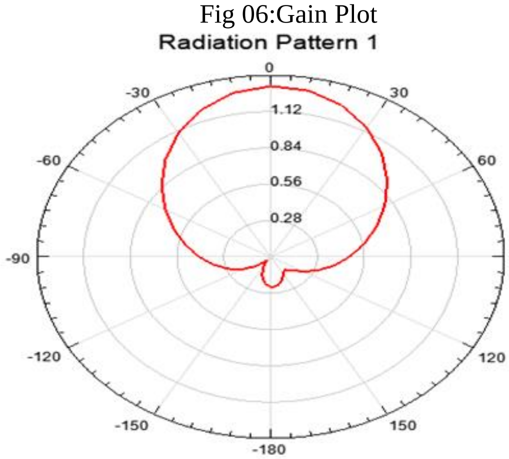

Fig 07:Radiation Pattern in E Plane

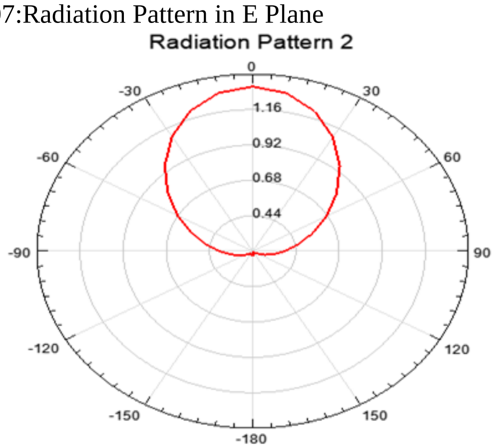

Fig 08:Radiation pattern in H plane

The radiation pattern is a graphical representation of the relative field strength that the antenna transmits or receives shows side lobes and back lobes.

VI. CONCLUSION

A rake shaped Multiband micro strip patch antenna is designed for 5G wireless communication. The copper material acts as a patch and ground and FR4 epoxy act as a substrate (di electric) material. The substrate material has a dielectric constant of 4.4. The antenna dimensions are obtained from transmission line equations. The antenna is designed to resonate at 1.4GHz, 2.42GHz, 3.89GHz and 5.13GHz which is suitable for application such as L band, WIFI / Bluetooth, Wi-max and WLAN etc. The antenna designed has a good reflection coefficient at all the desired frequency and VSWR lies between 1 and 1.50. The antenna provides optimal gain and bandwidth. Therefore, Multi band microstrip antenna is successfully proposed, simulated and fabricated for WLAN and Wi-MAX applications.

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