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Wideband Sub-6 GHz Micro strip Antenna: Design & Fabrication

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Abstract

In this paper, wideband micro strip antenna has been presented for Sub-6 GHz applications. The proposed antenna is designed using partial ground architecture. This antenna is designed with a 40x30x1.6 mm dimensions and fabricated on the Fr-4 substrate. The proposed antenna maintains the return loss less than -10 dB from 3 GHz to 5.64 GHz. The proposed gain is changing from 1.73 to 3.22 dB and radiation efficiency is having maximum value of 90%. The radiation pattern shows the characteristics of end fire antenna.

Index Terms.

Sub-6 GHz, Partial Ground, Micro strip Antenna, Gain, and Efficiency.

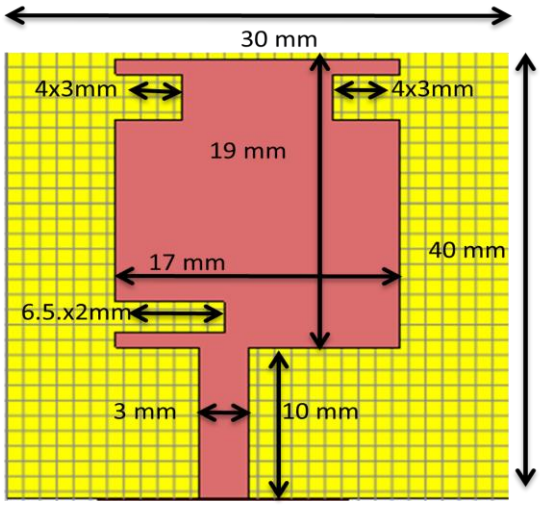
Introduction.

The Sub-6 GHz communication system has demanded high speed wireless data service to fulfill the increasing transfer rate for various applications. Considering radio wave propagation and available bandwidth, the bands between 3 GHz and 5 GHz have been promoted for 5G services in many countries such as 3.4~3.8 GHz in Europe, 3.1~3.55 GHz and 3.7~4.2 GHz in USA, 3.3~3.6 GHz and 4.8~4.99 GHz in China [1]. A micro strip antenna consists of a thin metallic conductor which is bonded to thin grounded dielectric substrates. The size miniaturization of a micro strip patch antenna is crucial in many of the modern day practical applications, like that of WLAN [3], [4], Wi-Fi [5], and Bluetooth [6]. Patch antennas play a very significant role in today's world of wireless communication systems. A micro strip patch antenna is relatively simple in construction but having problem like lower gain and lower power handling capacity which can be overcome by using different methods. One technique is using an array configuration for the elements which is a collection of homogeneous antennas oriented similarly to get greater directivity and gain in a desired direction. The inset-fed micro strip antenna provides impedance control with a planar feed configuration [7].

Antenna design & parameters.

Initially the Simple patch was designed using Fr-4 substrate with dimension of (13x17x1.6mm). Then a slot was cut in the opposite of feed line and using parametric shift in x as well as y direction simulation was done, again a symmetrical cut was made in other side and simulation was done by moving both slot position in Y direction, further one more slot was created with different dimension and results were obtained by shifting its parameters in x and y directions. After simulation of different designs the proposed design provides the better results. The substrate dimensions are taken (30x40x1.6mm) and Patch dimensions are taken (17x19 x1.6 mm). There are 3 slots in the patch in which the above 2 slots are symmetrical having dimensions of (4x3mm) at the distance of 1 mm from Y max position. The 3rd slot which is above feed line is

having dimensions of (6.5 x 2mm) at the position of 7.5 mm. The dimension of feed line is taken (10 x 3mm). Ground is taken up to 10 mm from Y min of Substrate. The proposed antenna is given below.

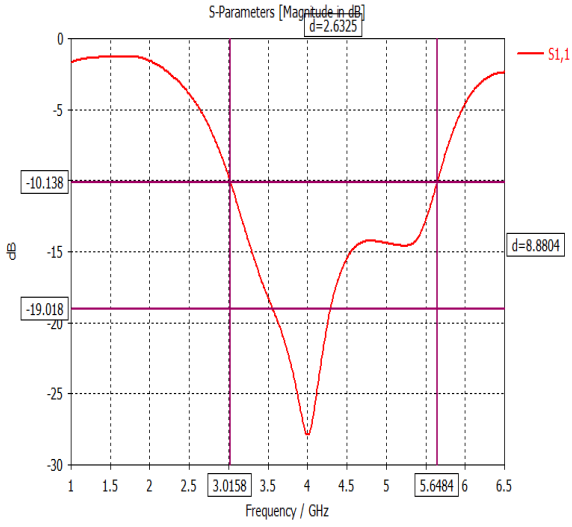


Simulation Results.

The simulation is done on CST STUDIO SUITE 2018.

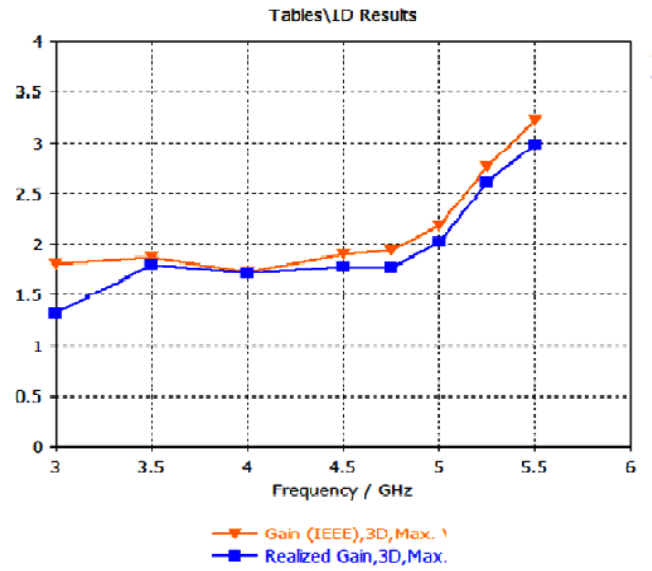
1. **Return loss.**

The S_{11} parameter is below -10.00 dB for 3.00 to 5.64 GHz frequency range and at 4 GHz center frequency it is -26.5 dB.



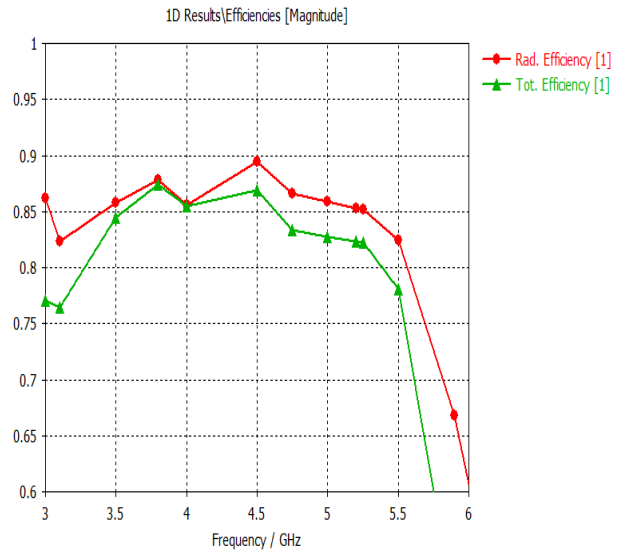
2. **Gain.**

The value of Gain is 1.73 dB at 4 GHz and 3.22 dB at 5.5 GHz frequency. The value of gain is increasing at higher frequency. In the given graph gain and realized gain both are shown.

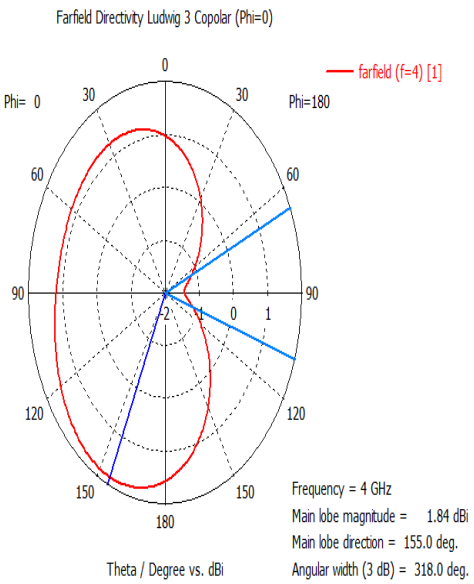


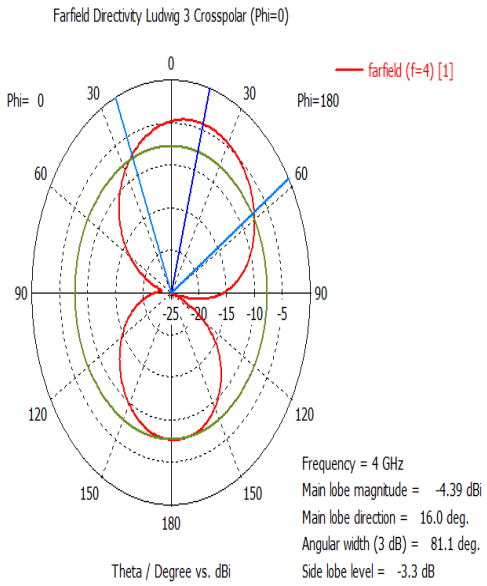
3. **Efficiency.**

The efficiency is low at lower frequency but it is increasing at higher frequency and reaches up to 90 %.



4. Radiation Pattern.





Radiation Pattern is showing that antenna is linearly polarized and maintaining more than 20 dB magnitude difference between Co-polar / Cross polar radiation pattern.

5. Result Comparison Table.

Ref.	No. of Element	Patch Size in (mm)	BW (GHz)	Substrate used	Gain	**Efficiency**
7	Single	17.30x10.4x1.6	5.8	FR4	5.6 dBi	NA
11	Single	50x19.75x0.8	2.5-4.8	FR4	1.8-2.9 dB	60-90
12	Single	47x19x0.8	3.2-5.2	FR4	2.1–4.1 dBi	NA
13	Single	Semi Circular ring r=4.7	4.8-5	FR4	NA	NA
This work	Single	40 x 30 x 1.6	3 – 5.64	FR4	1.7-3.2 dB	74-90

From the above table, following points can be summarized.

- The size of proposed antenna is between size used in Ref. 11, 12 & 7.
- Bandwidth is wider than others and covering full Sub 6 GHz range of 5 G.
- Gain and efficiency is better than that antenna reported in Ref. 11.
- The S_{11} is below -10 dB for entire range 3 to 5.6 GHz and it achieves value of -26.5 dB at resonating frequency (at 4 GHz).
- The simulated Co polar/Cross polar plots having main lobe magnitude more than 20 dB for all frequencies.

Conclusion.

This paper has introduced a design for a micro strip antenna for Sub-6 GHz antenna for 5G applications. The proposed antenna maintains value of S_{11} below -10 dB for entire range 3 to 5.6 GHz and it achieves value of -26.5 dB at resonating frequency (at 4 GHz). The maximum gain is achieved up to 3.2 dB.

The efficiency is very good at higher range of selected band. The radiation pattern shows that it is a linearly polarized antenna. The proposed antenna is suitable for different Sub-6 GHz applications like Wi-Fi, Internet of Things and Machine to Machine (M_2M) communication.

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