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A millimeter wave patch antenna with slots and tapered feed for 5G applications

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Abstract
In this paper, a novel structure of micro strip antenna for the millimeter-wave is proposed. 42 GHz resonant frequency is initially taken to design the structure (one of the frequency bands used for the 5G applications). In this work optimization of the slots of C shape in the patch as well as an optimization on the tapering in the feed line has been done. The reported return loss of the proposed structure at the resonant frequency (42GHz) is -31.60dB. The reported gain at the correspondence frequency is 6.44dBi. The value of gain is sufficiently high for the 5G communication system. The antenna shows an improvement in impedance bandwidth after the modifications.
The material Rogers RT 5880LZ with dielectric constant 1.96 is taken to design the structure. It is a low-loss material.

Keywords: Antenna, 5G applications, slots

1. Introduction
With the very fast development in the technology of wireless communication the demand for micro strip antenna increased. Further, the high data rate transfer and low-cost fabrication of mm-wave have been in demand for commercial purposes [1]. The millimeter-wave band (3-300GHz) provides the basic ground for the fifth generation (5G) [2]. The frequency bands 24.25-27.5GHz, 37-43.5GHz, 45.5-47GHz, 47.2-48.2GHz, and 66-71GHz of the millimeter-wave are used for the deployment of 5G networks. The Rogers RT 5880LZ with a dielectric constant of 1.96, is best for the millimeter-wave because the dielectric constant is low and has low water absorption [2].

2. Antenna Design and Analysis
The overall dimension of the designed antenna is 5 X 5.5 mm^2 respectively, as shown in figure1. The substrate Rogers RT 5880LZ is used for the structure with a dielectric constant of 1.96 and a height of 1.27 mm. A micro strip feeding line is used for providing the feeding to the design. To achieve 50 Ω impedance, perfect matching is calculated according to [3].
The rectangular patch is of the dimensions of 3.5×2 mm^2.
The various slots dimensions marked in figure 1 of the proposed structure are given underneath:

A=1.5 mm, B=2.5 mm, C=0.5 mm, D=1.5 mm, L=0.25 mm, P=0.25 mm

The return loss is decreased due to the slots and the bandwidth is increased. For future improvement in return loss and bandwidth second type c slot is inserted. The gain is also enhanced.
Now for some other improvements e. g. gain and impedance bandwidth and tapering of feed were optimized. Four rectangles are cut away from both sides of the feed line. Two rectangles are equal in size which is 0.5×2mm^2. And the other two rectangles are equal in size which is 0.25×1mm^2.

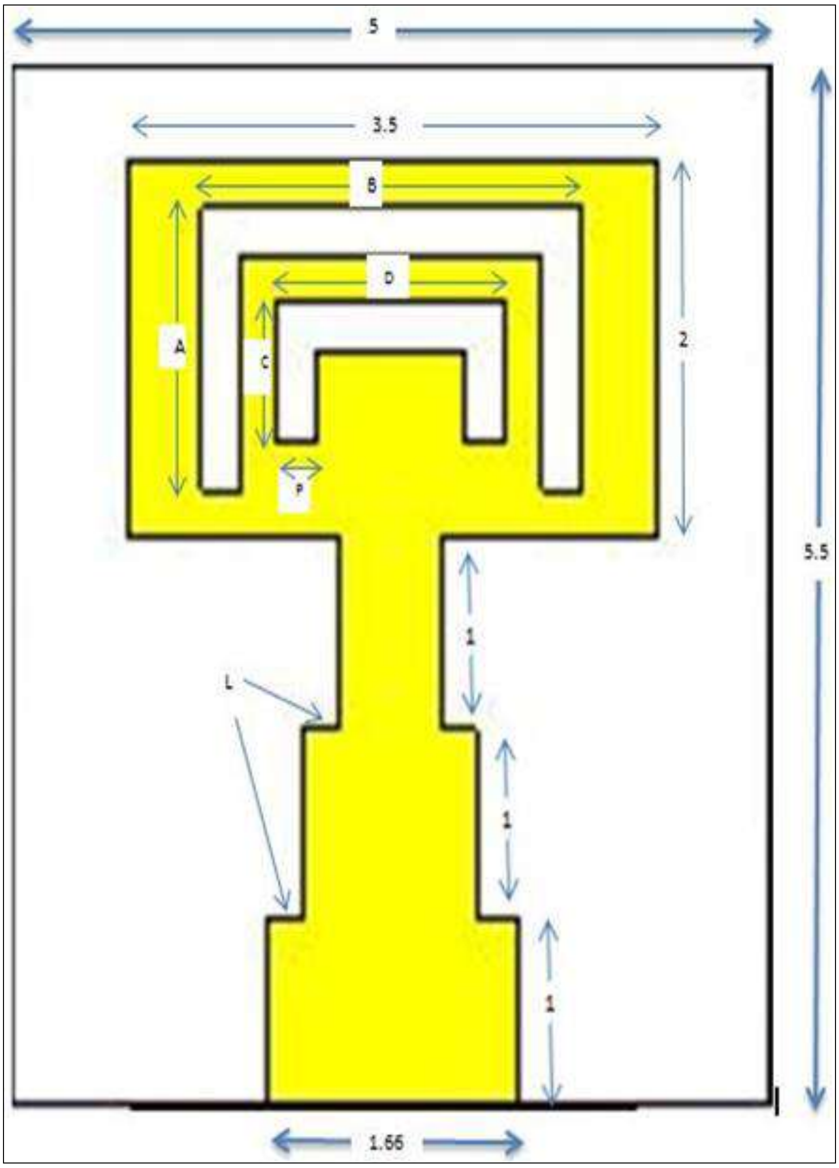

Fig 1: Front view after optimization in the patch and feed line

3. Results and Discussion

The CST (Computerized Simulation Technology) is used for the simulation. The return loss (S11) versus the frequency curve is shown in figure 2. For the proposed structure return loss is -31.60dB at the resonant frequency of 42 GHz. The impedance bandwidth is calculated from this curve of reflection coefficient and frequency.

The bandwidth which is calculated is 7.47GHz (39.73GHz to 47.2GHz). The bandwidth is calculated from higher frequency and lower frequency.

Bandwidth = higher frequency- lower frequency.

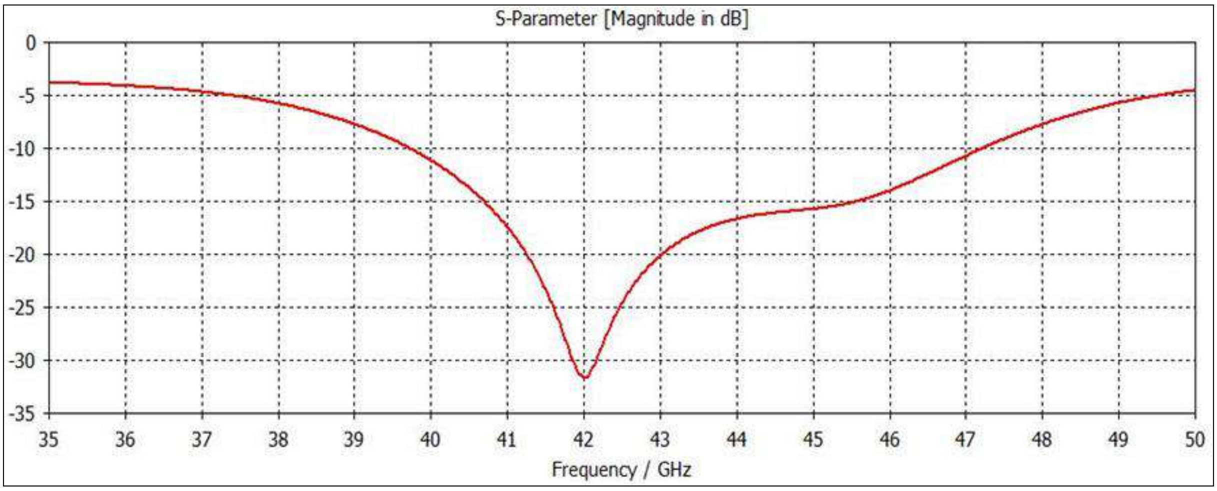

Fig 2: S11 versus frequency plot of the

Figure 3 shows the curve for VSWR variations with frequency. The value of VSWR is lower than 2 for the resonant frequency 42 GHz which shows that there is good matching between the antenna structure and the feed line.

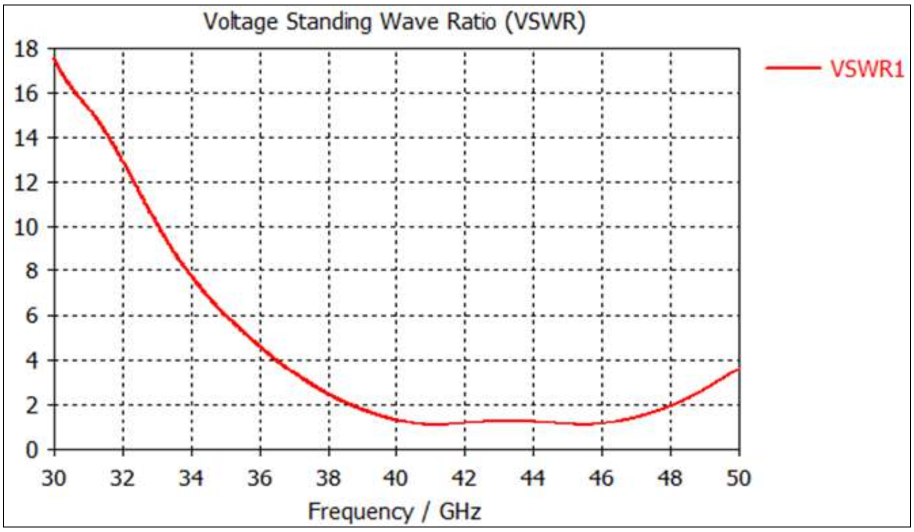

Fig 3: Plot of VSWR of the designed antenna

Figure 4 shows the plot between the gain and the frequency. According to the plot, the antenna shows a gain 6.44dBi.

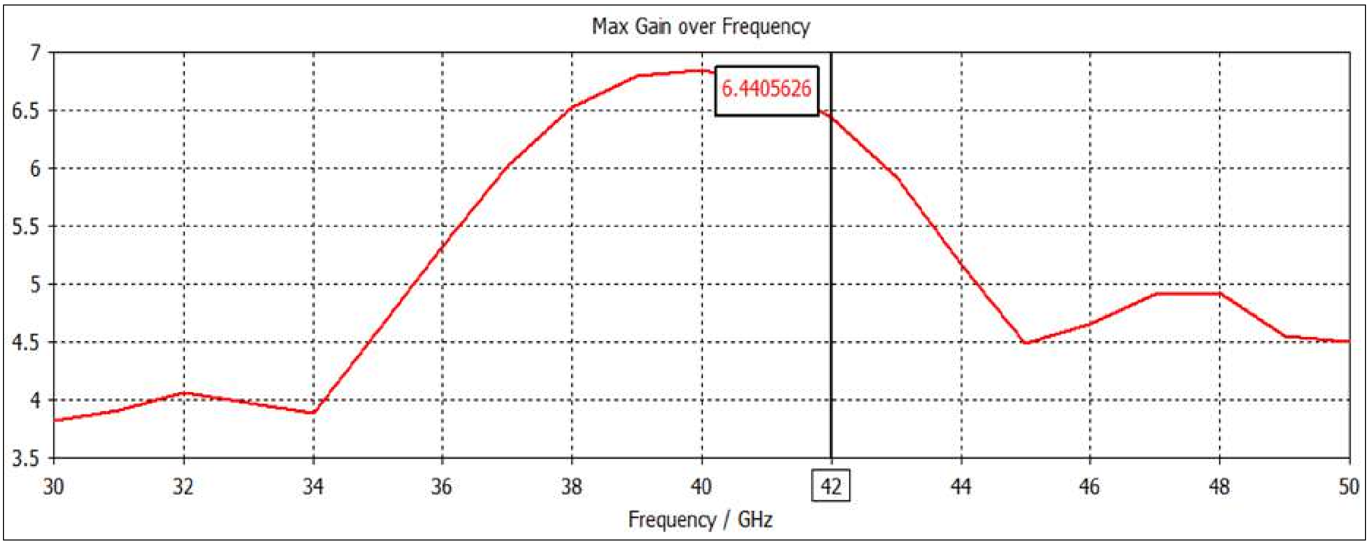

Fig 4: Plot between gain and frequency

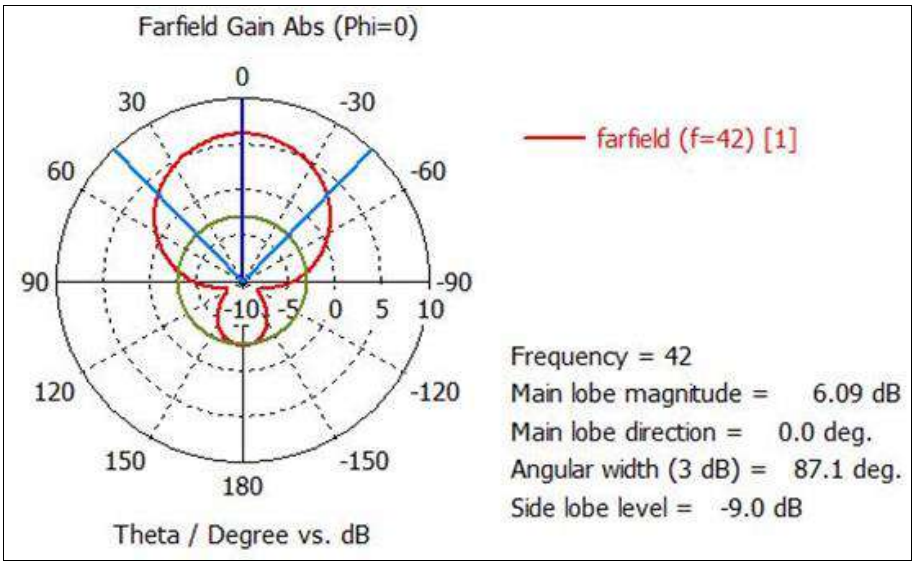

Fig 5: Radiation Pattern

Figure 5 shows the curve for radiation pattern at the frequency at which the antenna resonates.

4. Conclusion

In the proposed paper, a simple micro strip patch antenna is used for 5G wireless communication. This antenna gives a 42GHz frequency. The return loss at the resonant frequency is -31.60dB. The impedance bandwidth is 7.47GHz. The proposed antenna gives a good gain 6.44dBi, bandwidth, and directivity, which shows the antenna is suitable for 5G communication.

5. References

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