A T-SHAPED RECTANGULAR MICROSTRIP SLOT ANTENNA FOR MID-BAND AND 5G APPLICATIONS

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Abstract

A T-shaped rectangular Microstrip slot antenna for mid-band applications like 5G bands n48, n77, n78 and other satellite communication applications are portrayed. The proposed antenna has dimension of $35 \times 30 \times 1.6 \text{ mm}^3$ and the structure consists Coplanar Waveguide (CPW) with miniaturized size of antenna. The proposed design is embedded on FR4 lossy substrate with dielectric constant of 4.3 and thickness of 1.6 mm. A rectangular slot is etched with dimension of $23 \times 13 \text{ mm}^2$ in which T-shape patch is inserted. The current distribution, gain, directivity, impedance and other simulated results are also presented. The gain and directivity at the resonance frequency of 3.637 GHz is 3.66 dB and 3.9 dBi respectively. Maximum current is around 125 A/m and antenna has a bandwidth of around 1.7 GHz

Keywords - T-shaped, slot antenna, satellite, 5G.

1. Introduction

Microstrip antenna is frequently used antenna for microwave frequencies. Let it be our Wi-Fi broadband or any other communication system like satellite, Microstrip antennas are highly preferred.

Mostly we use the slot antenna to obtain the wide bandwidth by T-shaped Microstrip antenna as this structure of antenna can achieve better impedance match over a wide frequency range through the simple feed structure and also can be easily implemented [1].

Using T-shaped antenna, we are trying to achieve the 5G bands like n48, n77, n78, n79. Compared to other shapes like inverted F, U-shape, L-shape, K-shape the T-shape slot antenna has many advantages. Most importantly, it can achieve circular polarization smoothly and attains a wide frequency band range at a very low cost [2].

In this paper we have designed a rectangular slot antenna which is embedded on FR4 lossy having dielectric constant of 4.3 and thickness of 1.6 mm [3].

The dimension of the substrate is $35 \times 30 \text{ mm}^2$ and thickness of 1.6 mm with CPW feeding. Parameters such as S_{11} , VSWR, impedance, gain, directivity and surface current are studied.

2. Antenna Structure

A. Design of proposed antenna

The structure proposed is T-shaped patch in between a rectangular slot and the side edge patch as shown in the Fig.1. The antenna overall has dimension of $35 \times 30 \text{ mm}^2$ and thickness of substrate FR4 is 1.6 mm.

Fig.1 Proposed Antenna structure.

The rectangular slot is $23 \times 13 \text{ mm}^2$ and CPW feeding is implemented where both the patch and ground are on the same plane. The T-shaped stub is raised with addition of a small rectangular brick of dimension $10.8 \times 4 \text{ mm}^2$.

3. Simulation Results

Antenna referred is designed on simulation software name Computer Simulation Technology (CST) Microwave Studios. Simulation results consisting of various antenna parameters such as S_{11} , VSWR, Gain, Directivity, etc.

Fig.2 S-parameter results.

The above Fig.2, shows the s-parameter graph in which we can observe frequency band pattern. The observed frequency band range from 2.9-4.66 GHz with resonance at 3.637 GHz. The bandwidth is around 1.7 GHz. This wide frequency band is used in various applications like 5G communication, mobile communication and WLAN.

Fig.3 VSWR results at various resonance frequency.

The above Fig.3 depicts the Voltage Standing Wave Ratio (VSWR) at the resonant frequencies. The observed value is around 1.13. VSWR measures how efficiently the input power is transferred to the load.

Fig.4 Impedance at 3.637 GHz.

Fig.4 depicts the impedance at 3.637 GHz resonant frequency. Ideally, the impedance must be matched at 50 ohms and in this antenna, we have tried to reach to that value.

Fig. 5 Surface Current Distribution at 3.637 GHz.

Surface current distribution of the antenna has maximum value of 125 A/m. The directions of the current shows that the antenna can achieve circular polarization. Circular polarization allows the antenna to catch all types of frequencies which passes near to the position held.

Fig.6 Gain and Directivity results at 3.637 GHz.

A 3D view of simulated gain and directivity at 3.637 GHz is portrayed in the Fig.6. At this frequency the gain and directivity of around 3.66 dB and 3.9dBi respectively is achieved. Gain and directivity is impressive at this

resonance frequency because of the radiation pattern as shown in Fig.9 below.

Fig.7 Gain and Directivity at 3.8 GHz.

Now we will have a look at gain and directivity measurements at 3.8 GHz frequency. Here we can see in Fig.7 that gain and directivity achieved is approximately around 3.76 dB and 4.01dBi respectively. This frequency has application in 5G n48, n77 and n78 band with 3.355-3.7 GHz, 3.3-4.2 GHz and 3.3-3.8 GHz respectively as uplink and downlink frequency covering around 500 MHz bandwidth.

Fig.8 Gain and Directivity at 4.5 GHz.

Another frequency of 4.5 GHz has attained gain of 4.14 dB and directivity of 4.42dBi, depicted in the Fig.8. Gain and Directivity is higher as compared to previous frequencies. This frequency is allotted for 5G in various Asian countries like China and Japan. The 5G n79 bands have uplink frequency of 4.4 GHz and downlink frequency 5 GHz.

Fig.9 Radiation pattern at constant phi and theta at 3.8 GHz and 4.5 GHz

4. Conclusion

The proposed T-shaped rectangular slot antenna was analyzed and its parameters and results behavior were studied. Frequency band range of 2.9-4.66 GHz was observed in the reflection coefficient results with resonance at 3.637 GHz. The gain and directivity are 3.66 dB and 3.9 dBi. The surface current is 125 A/m. The 5G bands n48, n77 and n78 are attained. The frequencies attained are useful for satellite communication and other telecommunication purpose.

References

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