

Mushroom Structure Micro Strip Antenna Array for Ku band Applications

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Abstract – In this paper, we developed a Mushroom Type structure micro strip patch antenna array. The presented Micro strip antenna array designed for Ku band applications. The configuration of array antenna in the form of a set of a rectangular patches, fed coaxially. The antenna designed is printed on a partial ground plane and belongs to the class of printed antennas, having a wide range of beneficial properties and cheap manufacturing costs. The proposed patch antenna covers the bandwidth from 9.5GHz to 12.5 GHz, i.e. Ku-band. A nearly 10dBi Constant peak gain is obtained .This antenna maintains the advantages of wide bandwidth, flat and high gains, and a low profile less than $\lambda_0/13$ thickness substrate.

***Index terms* – patch antenna for high band width, high gain.**

INTRODUCTION

Micro strip patch antennas has been widely researched and employed in many devices due to its attractive advantages of low profile, ease of fabrication ,conformability to a shaped surface, compatibility with integrated circuit technology and etc.[1]. However conventional micro strip antenna suffers from the drawback of narrow

bandwidth, which restricts its applications in wireless communications.

A variety of methods were employed to broaden bandwidth of micro strip patch antennas, such as increasing substrate thickness [2], cutting slots inside the patch [3] , employing aperture-coupled feeding network [4], building shorting walls [5], applying parasitic strip around the patch [6], using hybrid-coupling method [7], and stacking patches on multilayered substrate [8].Thereforementioned methods are effectives for broadening the bandwidth of micro strip patch antennas, but they bring out new challenges in other aspects such as size reduction, gain improvement, planar structure, and good radiation performances.

A low profile high band width patch antenna was presented in [9], and an impedance bandwidth of 25% was obtained because of dual resonance modes were excited simultaneously. A low profile LTCC-based meta material-mushroom antenna array fed by substrate integrated waveguide (SIW) was proposed, and an impedance bandwidth from 56.3 to 65.7 GHz was attained [10].Loading mushroom-like rectangular patches on the top of a planar slot antenna, a dual-band antenna was achieved for wireless local area network (WLAN) applications [11].However, most of the

above-mentioned antennas are constructed on multi-layered substrate.

Based on our patch antenna structure is loaded along with the two radiating edges of a conventional patch on the same substrate, and detailed mechanism analysis is presented in this letter. The conventional TM_{10} mode and a new quasi- TM_{30} mode are simultaneously excited, resulting broad bandwidth.

ANTENNA DESIGN

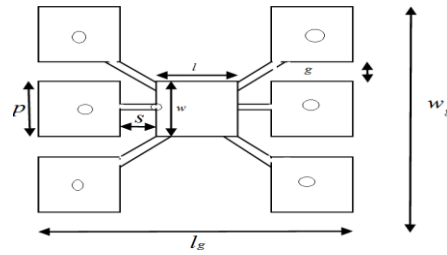
In this work we are proposing a new rectangular patch antenna with mushroom structure, fed coaxially. This antenna structure is made with the FR4 substrate with a thickness of 1.5mm and relative permittivity of 4.4. The antenna is printed on a partial ground plane and suitable for Ku band applications.

Table 1. Design specifications of the proposed antenna

Parameters	Value (mm)
Length of substrate	32
Width of substrate	20
Length of patch	4.9
Width of patch	4.9
Height of substrate	1.5

The resulting patch antenna array has been found to possess a compact size of 32 mm x 20 mm as shown in the table 1, and suitable for Ku band applications.

The geometrical configuration of proposed patch antenna is described in below Figure, which comprises three parts: a main radiating patch and two radiating arrays symmetrically placed along with the two radiating edges of the main radiating patch, a ground plane with size of $l_g \times w_g$.



The proposed antenna plays an important part in radiating energy to free space at low operating frequencies. In that case, few energy is transmitted to the mushroom-type structure can be neglected.

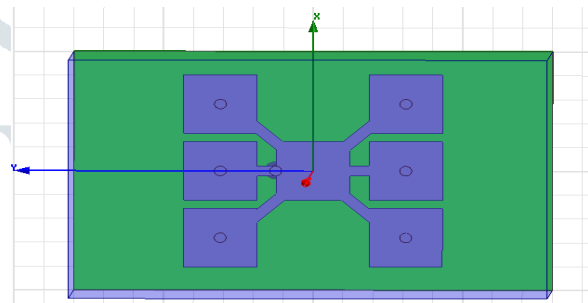


Fig. 2. Overview of the proposed antenna.

The electric field distributions at two resonant frequencies are studied in order to indicate the effectiveness of the patch structure. The simulated current distributions and electric field distributions at frequency 11.5Ghz. Therefore, energy can be radiated to free space through two coupling and two edges of patch antenna.

The effective dielectric constant of the substrate ΔL is given by

$$\epsilon_{\text{eff}} = (1 + 12)^{-1/2}$$

$$\Delta L = 0.412h$$

$$W_p = N_p - g$$

Where ϵ_{eff} denotes the effective dielectric constant of the substrate ΔL represents the extended length, W_p is the width of the mushroom-Type structure. The resonant frequency for quasi-TM₃₀ mode is calculated by

$$\beta_{mp}N/3 + 2\beta_e \Delta L = \Pi$$

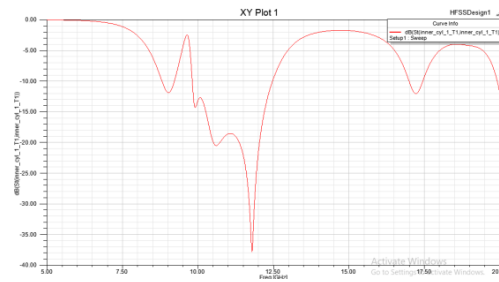
The resonant frequency of TM₃₀ mode is about to thrice of the TM₁₀ mode. By using mushroom type structure the resonant frequency of quasi-TM₃₀ mode is closed to the TM₁₀ mode.

EXPERIMENTAL RESULTS

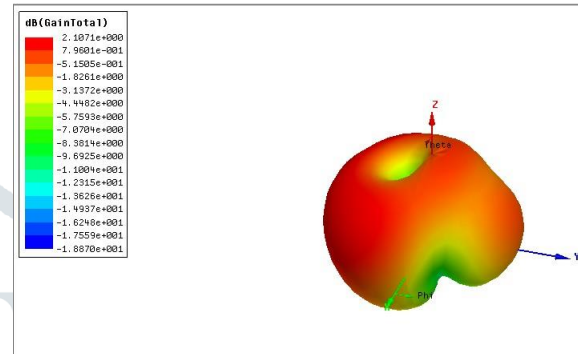
The proposed antenna the HFSS software, the parameters are as follows:

The measured results show that the proposed patch antenna operates from 9.5 to 12.5 GHz.

The below figure shows the frequency response and simulated return losses of the proposed patch antenna, with this we obtain the band width of nearly 3 GHz which is between the range of 9.5 to 12.5 GHz.



Radiation pattern of the proposed antenna:



CONCLUSION

In this letter a broadband and high gain micro strip patch antenna is designed by using mushroom type structure along with two radiating patch arrays of main radiating patch, we achieved wide impedance bandwidth characteristic. The proposed antenna exhibits stable radiation pattern over the entire operating frequency with flat high gain around 10dBi. The main advantage is easy fabrication, high gain flatness.

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