

# Waveguide Excited Microstrip Antenna for 5GHz WLAN Applications

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**ABSTRACT:** This paper presents a waveguide fed circular patch microstrip antenna for 5GHz wireless applications. The proposed antenna describes a new feeding technique using rectangular waveguide. This antenna is fabricated over a double sided FR4 substrate of 1.6mm thickness with a dielectric constant of 4.3. The antenna analysis is carried out by matlab software. The return loss and radiation pattern of proposed antenna is explained. It is demonstrated that the proposed antenna can be used for 802.11a WLAN applications due to 5GHz resonant frequency.

**KEYWORDS:** Waveguide, circular patch microstrip antenna, WLAN, matlab, return loss, radiation pattern.

## I. INTRODUCTION

In the recent years, the rapid developments of wireless communication technology led into the design of microstrip patch antenna due to its low profile, small size, low cost and ease of fabrication [1]. These microstrip antennas are well suited for wireless LAN applications. The WLAN protocol employs two standards: IEEE 802.11b of 2.4GHz frequency and IEEE 802.11a of 5GHz frequency. The 802.11a standard support high speed WLAN with less interference [4] [5].

Microstrip antenna with a special feeding technique is presented here to achieve 5GHz frequency wireless applications. In this antenna a rectangular waveguide is used as the feeding element. The waveguide excited microstrip patch antenna consists of a radiating patch on one side of the dielectric substrate and the other side is the feeding face which is connected to the mouth of the rectangular waveguide. Impedance Matching is often necessary to reduce reflections caused by a mismatch between the waveguide and the load. The impedance matching is achieved by making a small rectangle in the feeding side as an iris [2]. This iris acts as a matching load to radiate maximum energy. The conventional microstrip antenna shows narrow bandwidth. The waveguide feeding technique is used to achieve wide bandwidth. This antenna is analysed by using matlab software which works on moments method.

## II. RELATED WORK

Microstrip antennas are becoming widespread within wireless communication because of its low profile, light weight and ease of fabrication. Different techniques are developed to operate at 5GHz WLAN applications with improved bandwidth. Circular and rectangular patch antennas are designed for 5GHz wireless applications [7]. A microstrip-fed compact antenna with omnidirectional radiation patterns in the azimuth plane is proposed which covers the required universal 5GHz bandwidths for WLAN [8]. Microstrip line fed rectangular microstrip patch antenna has been developed for C band applications with a resonant frequency of 5GHz [9]. The proposed antenna can be used for 5GHz WLAN applications. Due to waveguide feeding technique the bandwidth can be improved.

## III. ANTENNA DESIGN

The proposed waveguide coupled microstrip patch antenna (WCMPA) [3] is fabricated on double sided FR4 glass epoxy laminate of thickness 1.6mm and dielectric constant of 4.3. The outer dimension of the patch antenna is 72mm x

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47mm which is same as the outer dimension of the C band rectangular waveguide. The feeding side consists of a rectangle with a dimension 34.84mm x 15.79mm which is same as the inner dimension of the rectangular waveguide. The size of the rectangular iris in the feeding side is 21.04mm x 9.47mm. The radiating side consists of a circular patch with a radius of 8.05mm.

The circular patch radius [1] [6]:

$$r = \frac{F}{\left\{ 1 + \frac{2h}{\pi \epsilon F} \left[ \ln \left( \frac{\pi F}{2h} \right) + 1.7726 \right] \right\}^{1/2}}$$

Here  $h$  is the thickness of the glass epoxy laminate,  $\epsilon$  is the dielectric constant.  $F$  is given by:

$$F = \frac{8.79 \times 10^9}{f_r \sqrt{\epsilon}}$$

Here  $f_r$  is the resonant frequency of the patch antenna. The resonant frequency in this design is 5GHz.

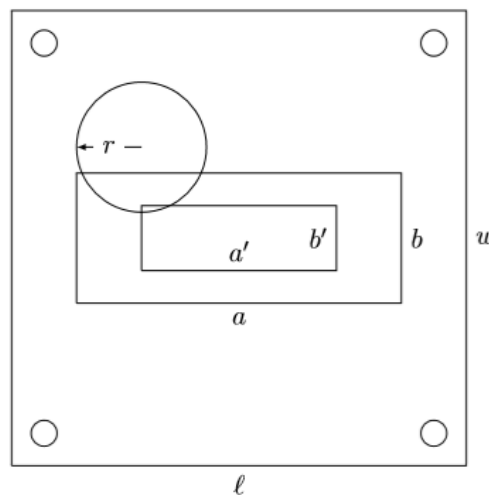


Figure1: Structure of the WCMMPA

The structure of the waveguide coupled microstrip antenna is presented in the figure1. In this figure  $l, w$  are the outer dimensions and  $a, b$  are the inner dimensions of rectangular waveguide,  $a', b'$  are the dimensions of iris, and  $r$  is the radius of circular radiating patch.

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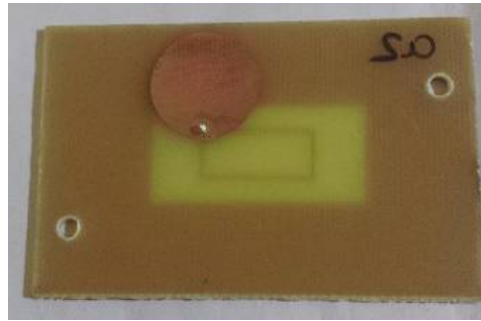


Figure2: Radiating side of the proposed WCPMA

Figure 2 shows the radiating side of the proposed waveguide excited microstrip antenna. The circular patch radius is 8.05mm for a resonant frequency of 5GHz.

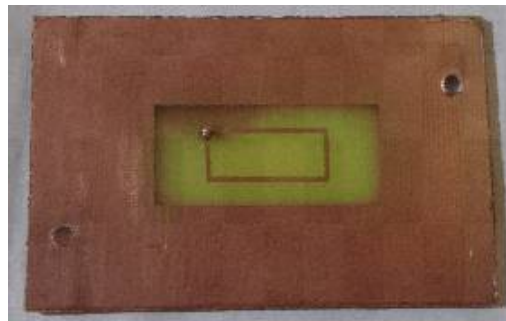


Figure3: Feeding side of the proposed WCPMA.

Figure 3 shows the feeding side of the proposed waveguide excited microstrip antenna. The antenna is fixed directly to the mouth of a rectangular waveguide. The dimension of etched portion is same as the inner dimensions of waveguide. The iris inside the waveguide acts as a load to match the impedance.

### IV. RESULTS

Figure 4 shows the simulated and the measured reflection coefficient versus frequency of the proposed antenna. This antenna is designed for a resonant frequency of 5GHz. Maximum return loss obtained by simulation is -46.23dB at a resonant frequency of 5.06GHz. Experimentally observed return loss from vector network analyser is -49.7dB for a resonant frequency 5.03GHz. At the resonant frequency of any antenna the real part of the impedance is  $50\Omega$  and the imaginary part is nearly zero. The impedance obtained for the proposed antenna is  $50.526\Omega$ . The bandwidth obtained for this antenna by simulation is 0.95GHz and experimentally observed bandwidth is 0.98GHz.

The current distribution of the proposed antenna also presented here. The circular radiating patch fixed at 90 degree from the feeding plated through hole. It is found that the maximum current distribution is obtained at an angle of 89.5 degree by simulation using matlab. Experimentally maximum current distribution obtained at an angle of 90 degree. The beamwidth obtained by simulation is 10 degree and measured beamwidth is 9 degree. The proposed antenna is found to be highly directional. Figure 5 shows the simulated and the measured 2D current distribution verses angle of rotation.

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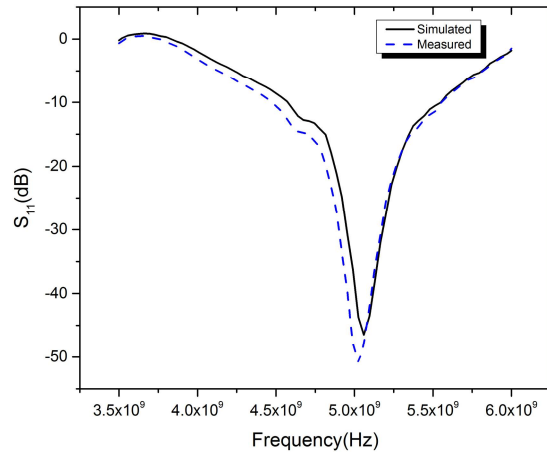


Figure4: Simulated and measured return loss versus frequency

Figure4 shows the plot of return loss versus frequency by simulation using matlab and measured from vector network analyser.

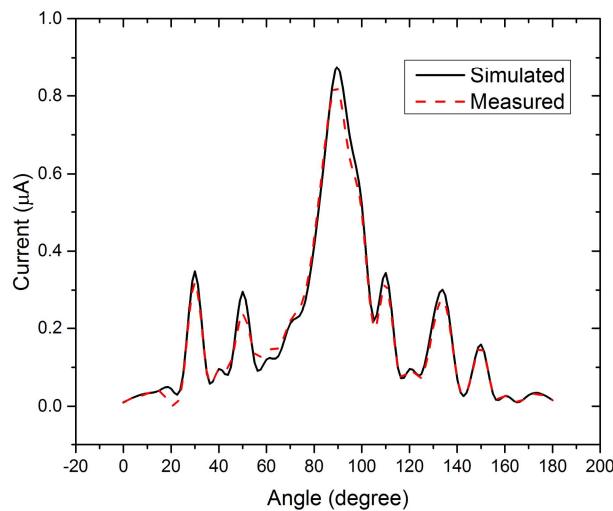


Figure5: Simulated and measured 2D current distribution.

Figure5 shows the plot of current distribution for different orientations. Simulated result is obtained from matlab.

## V. CONCLUSION

A new type of antenna is presented by using rectangular waveguide as the feeding element. The above result shows that the proposed antenna resonates from 4.6GHz to 5.55GHz. Thus a wideband microstrip antenna for high speed wireless applications is designed and simulated. The maximum return loss obtained at 5.06GHz frequency which is the

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IEEE 802.11a standard frequency for high speed wireless applications. The study reveals that wide bandwidth is achieved with waveguide feeding technique. The above current distribution plot shows that the proposed antenna radiates maximum current at the angle same as the orientation of circular patch. So beam steering can be achieved by changing the orientation of the radiating patch.

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