Design of Rectangular Patch Antenna with Double Slot for Wireless Applications

M. Priyaah
PG Student
Department of ECE
Bannari Amman Institute ofTechnology
Sathyamangalam, Erode, Tamilnadu, India
priyaah.co14@bitsathy.ac.in

P. Hamsagayathri
PG Student
Department of ECE
Bannari Amman Institute of Technology
Sathyamangalam, Erode, Tamilnadu, India
hamsagayathri.co14@bitsathy.ac.in

Dr. P. Sampath
Associate Professor
Department of ECE
Bannari Amman Institute of Technology
Sathyamangalam, Erode, Tamilnadu, India
sampathece@bitsathy.ac.in

Abstract — Patch antenna find wide use in wireless applications. In this paper rectangular patch with double slot is proposed for dual band wireless applications. The substrate used here is FR4 (εr = 4.4). The center frequency for IEEE 802.11y and IEEE 802.11p are 3.6 GHz and 5.9 GHz respectively. In this proposed antenna we obtain dual operating frequency as 3.609 GHz and 5.965 GHz. The size of the proposed antenna is 32 mm x 34 mm, the gain of the antenna are 3.04 dBi and 5.95 dBi, the directivity of the antenna is 5.67 dBi and 8.21 dBi. The antenna is designed using ADS software and the simulation results were discussed.

Keywords: patch antenna, gain directivity.

I. Introduction

Patch antenna are widely preferred for wireless applications due to its low profile, easy to fabricate, easy to feed and also easy to use in array or incorporate with other microstrip elements. Patch antenna has the disadvantage of restricted bandwidth but it can be improved by increasing the height of the height of the patch, increasing the substrate thickness, decreasing the permittivity of the substrate etc. Our proposed method is applicable for multiband application. The proposed rectangular patch antenna find wide application in high power data transfer equipment and wireless application in vehicular environment. IEEE 802.11y enables high power data transfer equipment to operate using 802.11a protocol. The equipment operates at 3600 – 3700 MHz band. It is licensed band and users have to pay additional fee for each high power base station that they deploy.

The client devices and the operator don't require a license, but the devices must receive an enabling signal from licensed base station before start transmitting. The US 3650 MHz rules allow the registered station to operate at higher power than the traditional Wi-Fi. Applications of IEEE 802.11y are back haul for municipal Wi-Fi networks, industrial automation and controls, campus and enterprise networking, fixed point to point links, fixed point to mobile links and wireless community networks or wireless user groups. IEEE 802.11p is mainly used for wireless access in vehicular environments (WAVE), a vehicular communication system. It enhances the 802.11 and support Intelligent Transportation Systems (ITS) applications.

It includes the data exchange between vehicle to vehicle and vehicle to roadside infrastructure in the licensed ITS band of 5.9 GHz. 802.11p can be used for dedicated short-range communication which finds application such as toll collection, vehicle safety services, and commerce transactions via cars. This rectangular patch antenna with dual slot can radiate two frequencies, 3.609 GHz and 5.965 GHz and it can be used in high power data transfer equipment and wireless access in vehicular environment respectively.

II. Antenna Design

Fig. 1(a) shows a rectangular patch with height (34 mm) and width (32 mm). Fig.1 (b) shows a rectangular patch with single U slot. Fig. 1(c) shows a rectangular patch with double U slot.

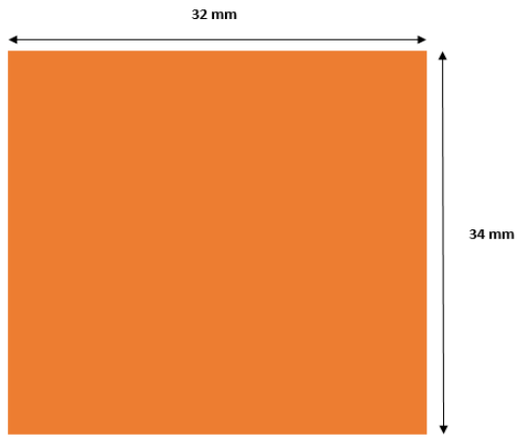

Fig. 1(a)

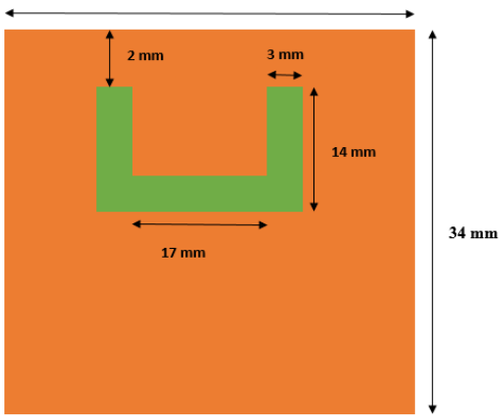

Fig. 1(b)

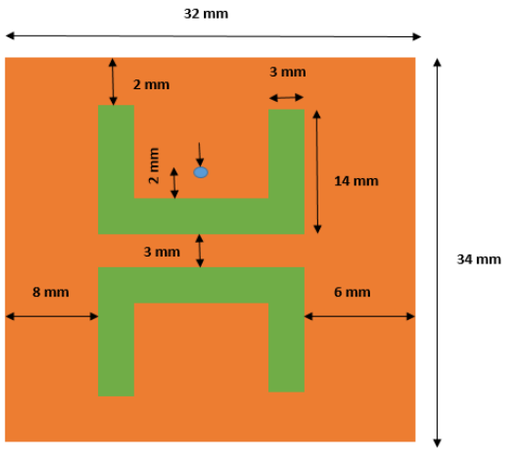

Fig. 1(c)

III. Design Parameters

The various design parameters of antenna are width (W), effective permittivity (εreff), effective length (Leff), delta length (ΔL), and actual length (L). Table 1 provides the list of design parameters of antenna.

FORMULA USED:

Width (W)

$$(W) = \frac{c}{2 f_c \sqrt{\frac{\varepsilon_r + 1}{2}}}$$

Effective permittivity (εreff):

$$(\varepsilon_{reff}) = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r + 1}{2}\left[1 + \frac{12h}{W}\right]^{-\frac{1}{2}}$$

Effective length (Leff):

$$(L_{eff}) = \frac{c}{2 f_c \sqrt{e_{reff}}}$$

Delta length (ΔL):

$$(\Delta L) = 0.412 \times \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

$$(L) = L_{\text{eff}} - 2\Delta L$$

TABLE I. List of Design Parameters of Antenna

Patch Size	32 mm x 34 mm
Slot size	17 mm x 14 mm
Substrate used	FR4
Dielectric constant (εr)	4.4
Loss tangent	0.001
Substrate thickness	1.6 mm

IV. Simulation Results

The proposed antenna as shown in the Fig.1(c) is simulated using ADS software. All simulated are given below:

A. Return loss

Return loss obtained after the simulation of proposed antenna is -13.887 dBi for 3.609 GHz and -12.243 dBi for 5.965 GHz.

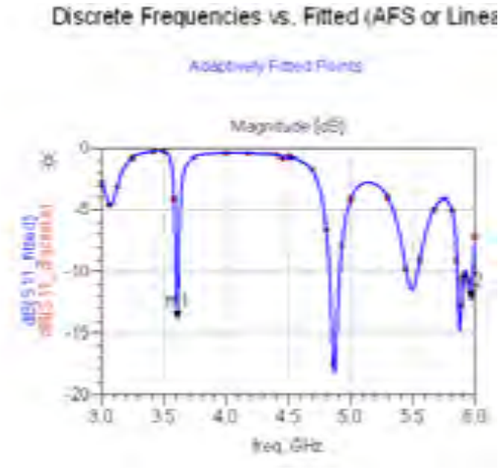

Fig. 2. Return loss curve for proposed antenna

B. Antenna parameters

Antenna parameters obtained after the simulation of designed antenna is given below,

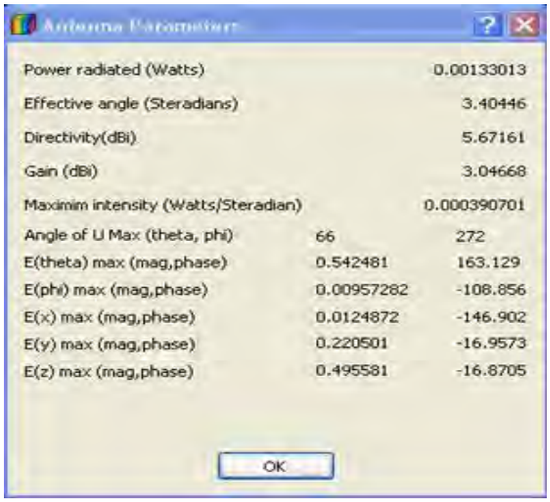

Fig. 3. Antenna parameters for the frequency 3.609 GHz

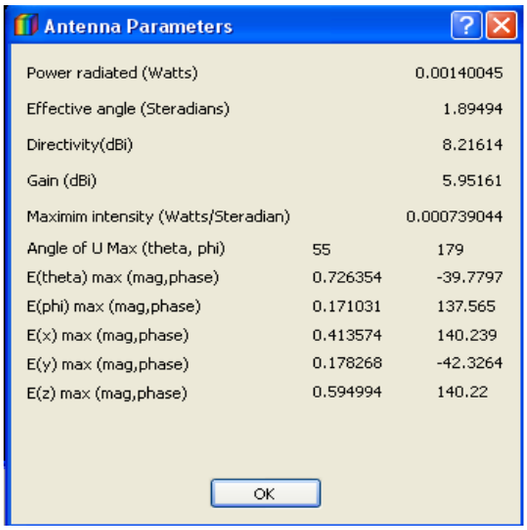

Fig. 4. Antenna parameters for the frequency 5.965 GHz

V. Conclusion

The proposed paper explains the simulation of rectangular patch antenna with double slot for multi band applications. The gain of the proposed antenna is 3.04 dBi for a frequency of 3.6 GHz and 5.95 dBi for a frequency of 5.9 GHz. The directivity of the proposed antenna is 5.67 dBi for a frequency of 3.6 GHz and 8.21 dBi for a frequency of 5.9 GHz. This antenna has been simulated for the center frequency of 3.9 GHz and 5.9 GHz and is suitable for wireless applications.

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