EFFICIENT U-SHAPED DUAL PORT RECTANGULAR MICROSTRIP PATCH ANTENNA FOR WLAN APPLICATIONS

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ABSTRACT

An efficient U-shaped slot dual port rectangular micro strip patch antenna is presented for supporting two different WLAN bands at (2.3-2.5)GHz and (2.7-2.9)GHz due to its dual-port structure which uses FR4 as a substrate material. In order to reduce the transmission coefficient between the two ports of antenna a coupling sleeve-arm and an inverted T-shaped slot are used. The U-shaped slot along with the finite ground plane is used to achieve an excellent impedance matching to increase the bandwidth. At the same time, This U-slot is reduce loss and measured the VSWR and Radiation pattern in the simulation result.The simulated return loss, isolation, radiation pattern,gain and directivity are obtained using Ansoft Simulation Software High Frequency Structure Simulator [HFSS]

Keywords-*Flame Retardant(FR4);Voltage Standing Wave Ratio(VSWR); Isolation; Wireless local Area Network(WLAN); Ansoft Simulation Software High Frequency Structure Simulator [HFSS].*

1.INTRODUCTION

Nowadays, Wireless Communication systems are becoming increasingly popular. There have been ever growing demands for Micro strip antenna designs that possess the following highly desirable attributes: small size, low cost and ease of fabrication. The basic structure of the proposed antenna consists of 3 layers. The lower layer, which constitutes the ground plane, covers the partial rectangular shaped substrate with a side of (29.47X38.04) mm. The middle substrate, which is made of FR4 epoxy resin, has a relative dielectric constant 4.4, height 1.5 mm and loss tangent 0.02.The patch is called as upper layerand it covers rectangular top surface. The rectangular patch has sides (29.47X38.04) mm that covers the middle portion of the substrate.

In existing system they have designed U-shaped slotted antenna for WLAN applications at the frequency range 2.45GHz.In the proposed system Dual-Port U-Shaped Slot[1] Rectangular Micro strip Patch Antenna designed for 2.4GHz WLAN[7] applications. This antenna is capable of supporting two different WLAN bands at (2.3-2.5)GHz and (2.7-2.9)GHz due to its dual-port structure. In dual port antenna, port 1 supports the frequency band of (2.3-2.5)GHz while port 2 covers the frequency band of (2.7-2.9)GHz[3]. Also, it is depicted. The transmission between the two ports of the antenna is satisfactorily low, especially at the operating frequency bands.

But in the proposed system due to the fact that two ports of the dual port antenna connected directly to the same patch isolation between these two ports is very poor. So to avoid this isolation problem sleeve-arm and an inverted T-shaped slot are used. The sleeve-arm is coupled fewer than one of the feed-line and the inverted T-shaped slot is cut on the ground plane beneath the other feed-line. The proposed antenna structure proper isolation between two ports at both operating frequency bands is achieved.

Slot antennas were used in the frequency range from 300MHz to 24GHz. They are widely used because of two reasons one is it can be mounted on any type of surface and its radiation pattern is mostly omnidirectional.The microstrip line feed is easy to fabricate, simple to match by controlling the inset position and rather simple to model. Also if the substrate thickness increases surface waves and spurious increases which limit the bandwidth of the antenna.Generally the thickness depends on the type of the substrate used. For FR-4 substrate, thickness used is 0.8 or 1.5mm in common.

The U-shaped slot along with the finite ground plane is used to achieve an excellent impedance matching to increase the bandwidth. Being such advantages, a slot of U-shaped on the rectangular shaped patch antenna is considered for our design. The U-slot introduces a capacitive component to counteract the large input inductance when thick substrate is used. Because of these characteristics they are mostly used in aerospace, mobile and satellite communication.

2.PROPOSED ANTENNA CONFIGURATION

Here the center frequency f_o is taken as 2.4 GHz with lower bound frequency f_{low} as 2.2 GHz and upper bound frequency f_{high} as 2.90 GHz. The antenna was designed for the application of wireless LAN that uses operating frequency 2.4GHz.Dielectric material FR-4 substrate with dielectric constant 4.4 and loss tangent 0.02 was used. Substrate height was taken 1.5 mm to minimize inductive impedance and surface waves.

2.1Calculation of Patch Dimensions :

Width of the patch of conducting patch material can be calculated using the below formula

$$W = \frac{c_0}{2f_0}\sqrt{\frac{2}{(1+\varepsilon_{rr})}}$$

Where, c_0 is the free-space velocity of light i.e. 3×10^8 m/s

ε_r is the dielectric constant of material here 4.4.

The value of the effective dielectric constant is given by[9]

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

Where h and W are the height and width of substrate material for an antenna respectively.

Length of the patch can be calculated as:

$$L_{eff} = \frac{c_0}{2f_0\sqrt{\varepsilon_{reff}}} - 2dL$$

The dL is the length extension due to the fringing field and can be calculated using the equation :

$$dL = 0.412h\,\frac{(\varepsilon_{reff}+0.3)(\frac{w}{h}+0.264)}{(\varepsilon_{reff}-0.268)(\frac{w}{h}+0.8)}$$

2.2Calculation of Ground Dimensions :

The ground dimension for the antenna can be calculated as below:

Width of the ground is given as: $W_g = W + 6h$

Length of ground is given as: $L_g = L + 6h$

2.3Calculation of U -SLOT parameter :

Slot thickness E and F is given by,

E=F=wavelength of light / 60

Slot width D is given by,

$$D = \frac{C_0}{2f_{low}\sqrt{\varepsilon_{reff}}} - 2[L+2\,(\Delta L) - E]$$

where c_0 is the speed of light.

Slot height C is given by,

$$C=D*0.75$$

The height of slot from base H is given as,

$$H = L - E + 2(\Delta L) - \frac{1}{\sqrt{\varepsilon_{eff}}}\left[\frac{C}{f_{high}} - 2\,(C+D)\right]$$

where c is speed of light.

2.4The feed point location :

The feeding probe point location can be located at the point (X_f, Y_f) in the x-y coordinates. The location points are given below. They had achieved low input impedance or good matches between the transmission line and the port.

$X_f = \frac{L}{2\sqrt{\varepsilon_{eff}}}$

$Y_f = \frac{W}{2}$

Where X_f and Y_f are the desired input feed point at x-axis and y-axis respectively.

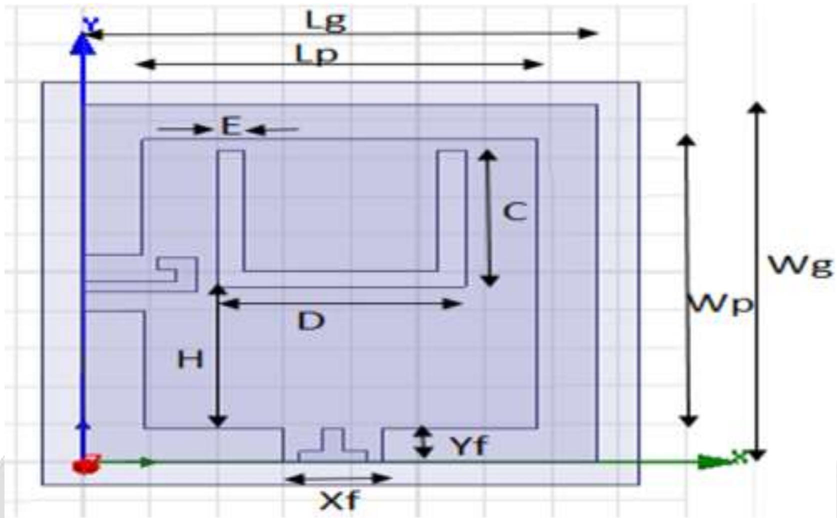


Fig.No.2.1 Dual-port U-slot rectangular patch antenna

Table.No.2.1 Design Parameters

Normal Patch Readings	
Width (W) (mm)	38.04
Length (L) (mm)	29.47
Width of Ground(Wg) (mm)	47.04
Length of Ground (Lg)(mm)	38.47
Feed point location (original) (mm) (1)	(7.277,4.5)
Feed point location (original) (mm) (2)	(4.5,7.277)
U Slot Patch Readings	
Slot Width (D)(mm)	-23.89
Slot Height(C)(mm)	-17.91
Height of Slot From Base (H)(mm)	23.2
Slot Thickness (E=F) (mm)	2.08
Feed point taken (after iterations)(mm)	(7.277,4.5)

3. MATERIAL AND METHOD

In this project FR4 material is used as a substrate for micro strip patch antenna. This material is a composite material which composed of woven fiberglass cloth with an epoxy resin binder that is flame resistant. FR-4 acts as a good electrical insulator in both dry and humid conditions with good mechanical strength.

In this micro strip patch antenna a thin layered copper material is laminated on both sides of an FR-4 glass epoxy panel. This method of processing is called copper clad laminates. This process can also be produced in multiple layers which is called multilayer circuitry. Also in which the thickness of substrate material and copper layer thickness should be different.

4. RESULT AND DISCUSSION

Generally for two port antenna, two ports are excited, the antenna will have a main radiation direction towards both left upper space and right upper space. It can be seen that the radiation patterns excited by ports 1 and 2 were complementing to each other.

4.1Simulated S Parameters

Two ports are excited with a 50Ω (Ohm) load. The simulated S_{11} (return loss) is shown in the figure 4.1The observed reflection coefficients or return loss,S11 <-10dB is -14.0567dB obtained at 2.4GHz.The observed reflection coefficients or return loss, S22 <-10dB is-6.4837dB obtained at 2.4GHz.

a **b**

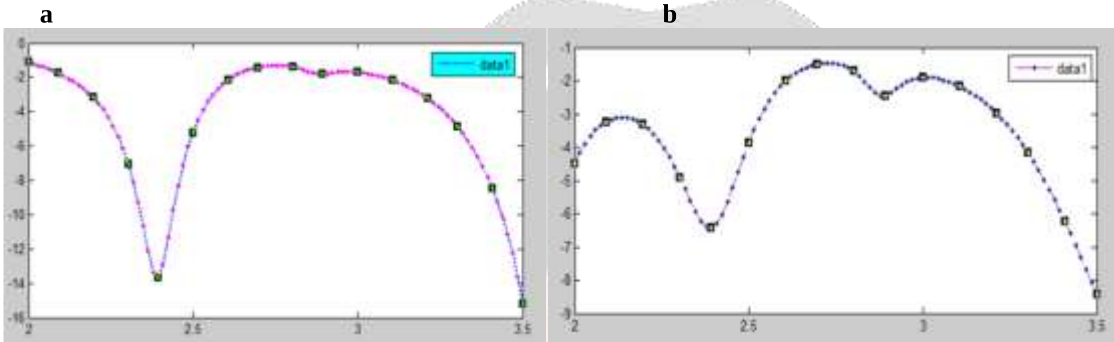


Figure 4.1(a) Simulated S_{11},(b)S_{22} Parameter

Two ports are excited with 50Ω load, The simulated S_{12} (isolation) is shown in the figure 4.2. This much isolation is achieved by etching U-shaped slot over the ground plane along with two slots directly beneath the microstrip feed line.The observed isolation is found to be -37.2271dB at the resonating frequencies 2.4GHz.

a **b**

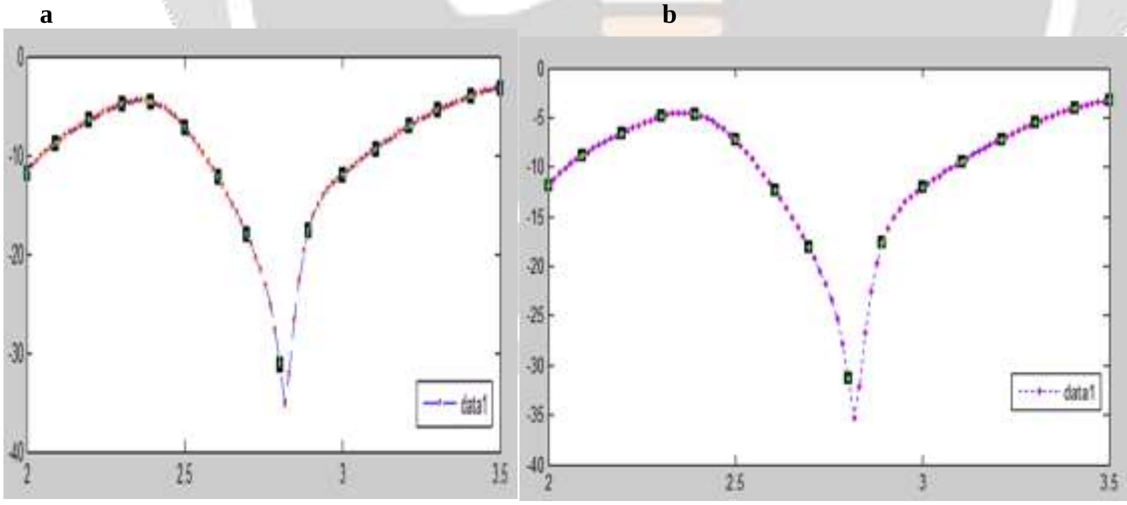


Figure.4.2(a)Simulated S_{12},(b)S_{21}Parameter

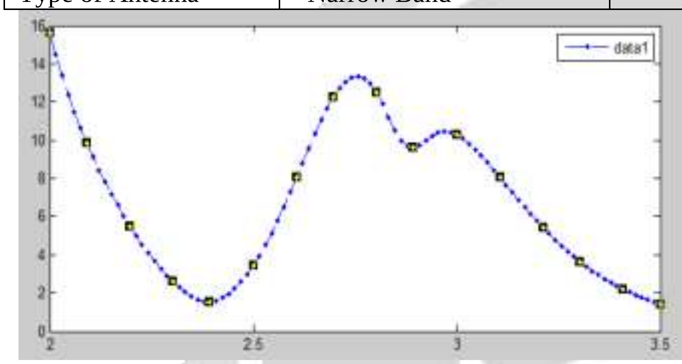
Two ports are excited with 50Ω load, The simulated S_{21} (isolation) is shown in the figure 4.2. The observed isolation is found to be -37.2271dB at the resonating frequencies 2.4GHzand 2.8GHz

4.2VSWR

VSWR is used to measure the power reflected from the antenna.In this proposed antenna obtained
VSWR value 1 at 2.4GHz. It indicates that no power reflected is reflected from the antenna.

a **b**

PARAMETERS	SINGLE PORT ANTENNA	DUAL-PORT ANTENNA			
		S_{11}	S_{12}	S_{21}	S_{22}
Return Loss (dB)	-16.900	-14.0567	-37.2271	-37.2271	-6.50
Reflection Coefficient	0.44	0.198	0.013	0.013	0.47
VSWR	1.012	1.493	1.026	1.026	2.77
Impedance	49.9834	49.99	49.99	49.99	49.99
Mismatch Loss (dB)	0.20	0.17	0.073	0.073	0.17
Fractional BW (%)	8	8	8	8	8
Gain (dB)	4.01	4.301	4.301	4.301	4.301
Reflected Power (%)	2.67	3.2	0.02	0.02	22.0
Reflected Power (dB)	-12.89	-14.06	-37.72	-37.72	12.5
Non Reflected Power	0.68	0.960	0.99	0.99	0.77
Bandwidth (dB)	0.18	0.2	0.2	0.2	0.2
Antenna Q factor	11	12	12	12	12
Dimension of Design	4.55mm	1.5mm			
Type of Antenna	Narrow Band	Narrow Band			



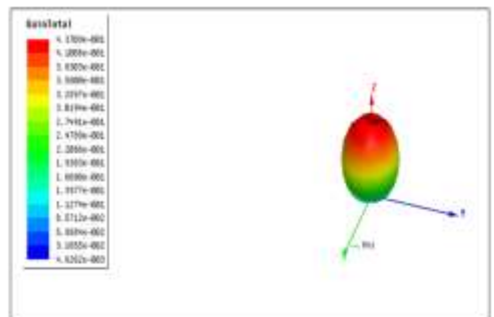


Figure 4.6 (a) VSWR, (b)3D Polar Plot

Table.No.2.2Comparison Of Existing And Proposed Antenna

5. CONCLUTION

U-slot dual-port rectangular patch antenna at 2.4/2.8GHz for WirelessLAN applications are succesfully simulated using HFSS. Results have shown that , increased bandwidth, measured the return loss,radiation pattern,3D polar plot, Directivity and VSWR .The dual-port antenna can also be integrated with a power amplifier (PA) and a low noise amplifier forming a dualport microstrip Active Integrated Antenna (AIA) which can be used as a full-duplex transceiver at its operating WLAN frequency bands.

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