# Printed Wide Slot Antenna with Centre Patch Excited by Micro-strip line For Bandwidth Enhancement

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***Abstract****-In this project paper a printed wide slot antenna with centre circular patch for bandwidth enhancement is published and studied. Basically a comparison is made between micro-strip line excited printed wide slot antenna with square patch and circular patch. For square patch at middle of rotated square slot a reflection coefficient obtained is |s11| = -20.24 and it is improved upto |s11|=-37.40 by use of circle patch of radius 6 mm.because of using circular Circle patch at middle of rotated square slot, it affects lower resonant frequency and higher resonant frequency. Lesser resonant frequency f1 is decreased and higher resonant frequency f2 is enhanced. Thus we have achieved broadband characteristic of wide-slot antenna. Measured results indicates that this structure gives wide impedance bandwidth ranging from 2.23 to 5.35GHz.Desired structure gives steady and omnidirectional pattern is observed. In our design, a small ground plane is considered as compared to reference antenna.*

***Keywords****-*wide slot antenna, wideband antenna

## I. INTRODUCTION

Development of wireless communication system is becoming a challenging topic day by day because wireless communication system has wide range of applications. Because of two orthogonal modes of resonance printed wide slot antennas are widely used in variety of communication systems. Antennas with different shapes like circle, ellipse and triangle give wide bandwidth. Improved bandwidth can be achieved by coupling between a feeding structure and a slot. As seen in reference [6], a printed wide-slot antenna excited using Micro-strip line with a fork-like tuning stub gives broad bandwidth through a proper parameters of a fork-like tuning stub. As seen in reference [7] that exciting an L-shaped slot with a W-shaped feed stub can give large bandwidth. As we have seen in reference [10] and [11], a authors desired for a novel bandwidth enhancement technique for a Micro strip line excited wide-slot antenna based on fractal shapes. By etching a wide slot as fractal shapes, significant bandwidths enhancement of a desired wide-slot antenna was achieved.

Because of fractal shaped slots fabrication of wide slot antenna has became more complicated. Square slot antenna has wide bandwidth than oar antenna, but it cannot be used for broadband applications because wide slot antennas have only one resonant mode. As referred in [12], by rotating a square slot, a oar resonant mode operating near one of a conventional wide-slot antenna can be obtained. As a result, a wide operating bandwidth of about 2200 MHz (49.4%) with middle frequency at 51800MHz was found. However, it is not enough for a operating bandwidth to cover more wireless communication services.

In this project paper we present a microstrip line fed printed wide slot antenna with a circular middle patch. A middle patch is nothing but circular patch of radius 6mm are also investigated. Bandwidth enhancement and radiation characteristics of this design are investigated. This paper take reference of a structure presented in [12] as a reference antenna .calculated results showed that, $f_1$ (a lower resonant frequency of a reference antenna) is reduced and $f_2$ (higher resonant frequency of a reference antenna) is enhanced by inserting circular middle patch in a middle of a rotated square slot. This enhances bandwidth of a reference antenna by more than 1GHz.a measured results shown that a desired antenna operate from 2.225 to 5.355GHz covering a 2.4/5.2/5.8-GHz WLAN band and 2.5/3.5/5.5-GHz WiMAX bands. In our case a total area of a desired antenna is 37x37mm.It has size reduction of about 72% as compared to a designed antenna [12].we have achieved a steady radiation pattern and low cross polarization in all operating bandwidth is also improved.

## II.ANTENNA CONFIGURATION

Geometry of desired micro-strip fed wide slot antenna is as shown in fig 1.a desired antenna has simple configuration ,a desired antenna consists of a rotated square slot and a circular circle middle patch of radius 6 mm.A length of a rotated square slot is denoted by 'S'. 'R 'determines a radius of a circular patch. Slot length determines a lower resonant frequency. With increase in slot length, a lower resonant frequency is shifted downward. Thus lower edge of operating frequency band of desired antenna also moves downward, as increase in length will increase a current path. A stub line parallel to slot edges can be selected. Circular centre patch acts as radiator and a feed structure for a rotated square slot. In this paper a circular patch play important role of widening bandwidth of slot antenna. Because of use of circular middle patch a overall size of antenna including ground plane is reduced.

An antenna is fabricated on commercially available FR4 dielectric substrate with a permittivity of 4.4 and a thickness of 1.6 mm. A rotated square slot is fabricated on one side of a substrate. White and gray regions represent etched slot on a ground plane and bottom metal, respectively. A dotted line represents a feed line on a opposite side. A width ‘$W_f$’ of a feed line is chosen to be 3mm so as to simplify a design of a desired antenna. A characteristic impedance of a feed line is chosen to be 50Ω.A length of feed line is set as L. In here, a ‘$L_{off}$’ length is a distance between a slot middle and a edge of a feed line. Based on a calculated result, a length of a feed structure can be adjusted for good impedance matching. A ground plane size is denoted by ‘G’. Compared to a designed antenna in [12], a desired antenna has better bandwidth and much smaller size. Simulation is carried out using HFSS, a commercial electromagnetic simulator based on a finite element method (FEM).

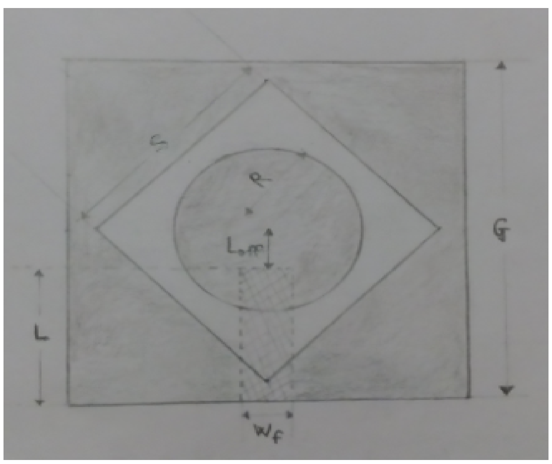


Fig. 1

## III.PARAMETER VALUES

In this section, a parameter study is carried out to understand a effects of various parameters and to study a performance of a final design. Dimensions of a desired antenna are as follows:

S = 24.7x24.7 mm and Wf = 3 mm.Dimension of a ground plane is 37x37 m. Length of a feed line is L = 14 mm. Distance between middle of circle patch and feed line is Loff = 4.5 mm.

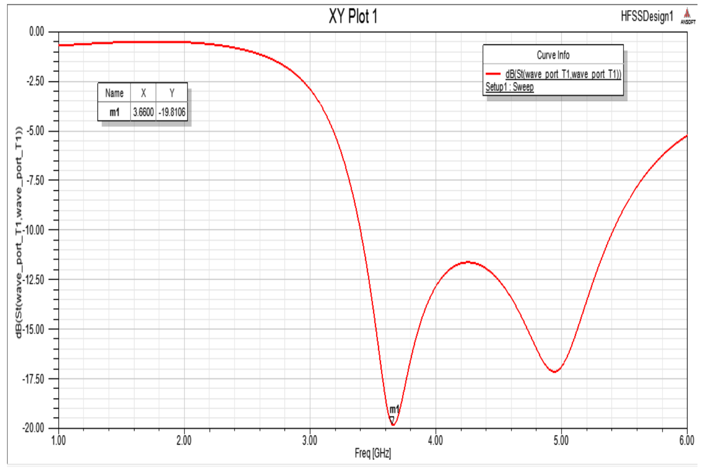


Fig.2 Simulated Reflection coefficient of a reference antenna.

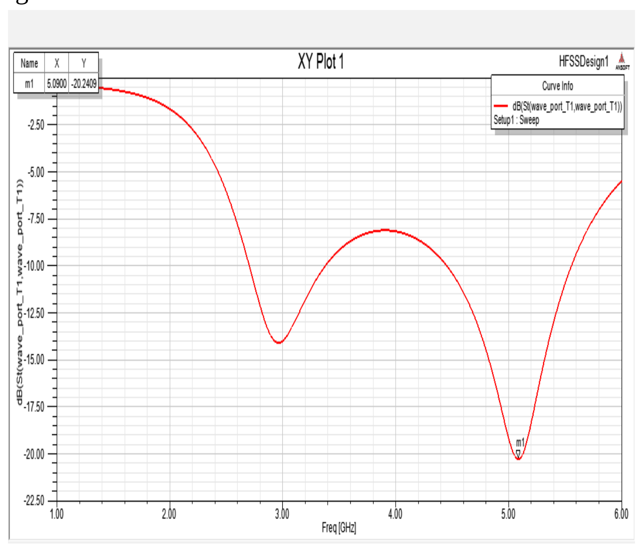


Fig.3 Simulated reflection coefficient of wide slot antenna with square patch.

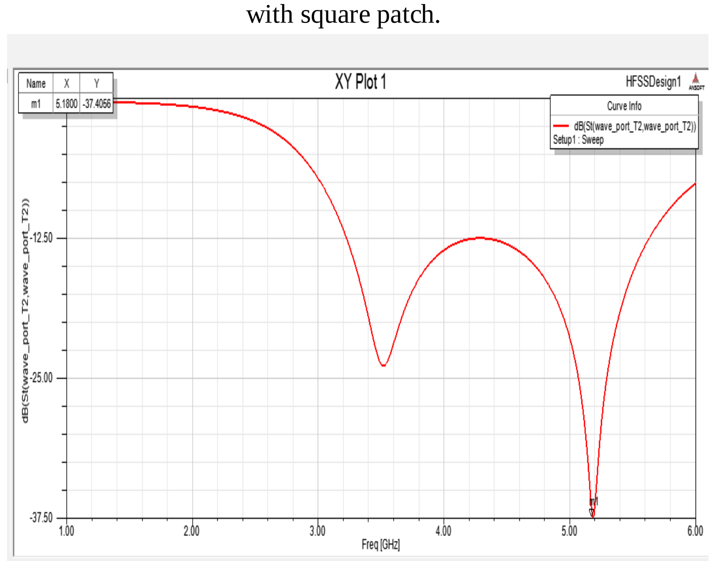


Fig.4 Simulated reflection coefficient of wide slot antenna with circle patch.

Calculated results indicate that as a size of a ground plane decreases, a upper edge of a desired antenna’s operating bandwidth remains nearly unchanged at around 5.3 GHz while its lower edge becomes smaller. This increases bandwidth of an antenna, as its matching characteristics at 3.7 GHz are enhanced and its lower edge declines. Also, a two resonant frequencies and are lowered in accordance with decrease of a ground plane size.

From a calculated results it can be seen that a reflection coefficient value for square patch is $|s_{11}|$ = -20.24 while in case of circle patch a value of reflection coefficient isIncreased to $s_{11}|$=-37.40.

In case of square shaped slot a distance between a middle of a square patch and a feed line is $L_{off}$ = 3.5 mm and a length of a feed line is L = 15 mm.

while in case of a circle patch a distance between a middle of circle patch and a feed line is 4.5 mm and a length of a feed line is L = 14 mm.

In case of reference antenna a ground plane size was 70x70 mm and square slot was of dimension 24.7x24.7 mm.and a reference antenna was fed using feed line of length L = 31.5 mm. a reference printed wide-slot antenna shows a very wide 10-dB return-loss impedance bandwidth of about 2.2 GHz (about 3400–5600 MHz).

In case of a desired antenna a ground plane size is reduced from 70x70 mm to 37x3 mm.By inserting circular patch a bandwidth of a desired antenna is increased.

Fig 4 shows a reflection coefficient of a desired antenna. It is from the calculated results shown that a two resonant frequencies $F_1$ and $F_2$ are decreased as a radius
R of a circle patch is chosen to be 6 mm.

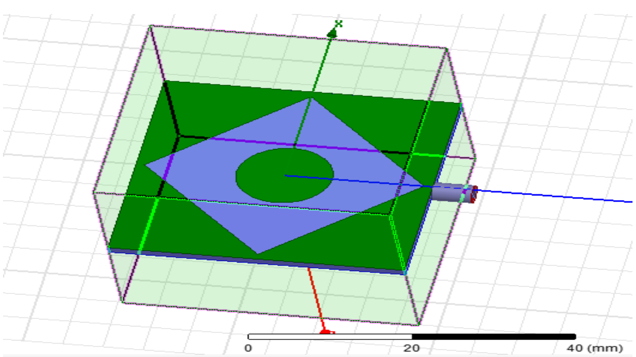


Fig. 5 Final HFSS simulated design**.**

Desired antenna shows better antenna matching characteristics across all operating bandwidth as a ground plane declines in size. As Fig. 4, illustrates, $|S_{11}|$ <= -10 dB d at 5.18 GHz when a size of a ground plane size is chosen to be 37 mm. (i.e., mm), and are fore a desired antenna proves fit to be used as broadband antenna.

As illustrated in Fig.4, a circular Patch leads a desired antenna to have a lower resonant mode than $F_1$ of a reference antenna and a higher resonant mode than $F_2$. In this case, a variation of $F_1$ is considerably greater than that of $F_2$. As for a wideband antenna that has two resonant modes (i.e. $F_1$, and $F_2$), its bandwidth becomes wider as a distance separating $F_1$ and $F_2$ increases, which generally worsens a matching characteristics between a two frequencies.

From calculated result, it is shown that bandwidth of reference antenna has effect on ground plane size. Bandwidth of a desired antenna increases from 27.8% to 45.7% as a ground plane size G increases from 40 to 70 mm.

## IV.SIMULATED AND MEASURED RESULTS

Geometrical construction of a desired antenna is as shown in fig.1.As seen from a fig.1 a desired antenna is fabricated on commercially available FR4 substrate. Properties of a FR4 substrate are, height of a substrate is h = 1.6 mm. and a di-electric constant of a FR4 substrate is, $€_r$ = 4.4.

Geometric dimensions of a desired antenna are as follows:a square slot which is represented by ‘S’ is of dimension 24.7x24.7 mm.a circle patch whose radius is dented by ‘R’ is of dimension 6 mm. a distance between a middle of a circle patch and a feed line which is denoted by ‘$L_{off}$’ is chosen to be $L_{off}$ = 4.5 mm.a ground plane which is denoted by ‘G’ is chosen to be of dimension 37x37 mm.a square slot having dimension 24.7x24.7 mm is rotated through an angle of 45º.

A measured bandwidth (10-dB reflection coefficient) is as large as 3130 MHz (2225–5355MHz) or about 82.8% with respect to a middle frequency at 3790 MHz As a ground plane decreases in size, an antenna’s characteristics are affected by a SMA connector, as a separation distance between a two is close. A results deviate from those measured in a simulation where a SMA connector is not taken into account.

## V. CONCLUSION

By inserting a circular middle patch into a rotated square slot, a impedance bandwidth of desired wide-slot antenna can be notably enhanced.

By inserting a circular patch of radius 6 mm a reflection coefficient of a desired antenna is improved, a bandwidth of an antenna is also improved. Also it is easy to insert circular patch at middle of rotated square slot rather than to rotate square patch at 45º to insert into middle of rotated square slot. As compared to square slot a area covered by circular patch is more.

With reduced antenna geometry, desired antenna offers measured bandwidth over 80%. A desired antenna gives steady far-field radiation characteristics in all operating bandwidth, relative high gain, and low cross polarization. By properly choosing suitable slot shape, inserting similar circular patch shape, and tuning air dimensions, design with large operating bandwidth, relative small size, and improved radiation pattern is obtained. It will be suitable for 2.4/5.2-GHz WLAN application.

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