Design a Wireless Antenna for Smart TV Application

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Abstract- **This paper present the dual U-shape microstrip patch antenna feed by the transmission line. The proposed antenna is designed by FR4 substrate and ground plane area 22mmx28mm. A Rectangular Defected Ground Structure is introduced to increase the main lobe radiation pattern for the directional antenna. The slot is used to increase the gain of the antenna. The wireless antenna purpose can be used for Bluetooth in smart TV application.**

Keywords: **Duel U-shape, Patch antenna, Bluetooth, Defected Ground Structure (DGS), Smart TV, Slot Antenna**

I. INTRODUCTION

Televisions play important role in worldwide society as an entertainment media, communication among people or for online interfaces. Television is used not only for watching movies but also can be used as computer. Now days there are many cables connection such as HDMI, speaker, DVDs, games, ear phone, camera and network are connecting to TV. The new environment is switching from cable to cable less is introduced using wireless applications in idea to reduce cost and user friendly to all. In this domain, antennas establish a basic element allowing the transmission of the electromagnetic waves in free space. A 2.45GHz antenna is designed for Bluetooth application with the bandwidth (2.44-2.48Ghz) as a receiver antenna to connect the wireless devices around the TV.

In this paper the focus is designing the Bluetooth receiver antenna for TV. The microstrip antenna[4] are probably the most widely used type of antenna today due to their advantages such as light weight, low volume, low cost, compatibility with integrated circuits and easy to install on the rigid surface. Wireless antenna is designed using FR4 lossy with dielectric constant of 4.3 with 1mm substrate thickness has been chosen because of its low cost and convenient availability. The idea of the antenna is taken from [3] triple band U-slots patch antenna for WiMAX mobile application and it has been improved with reducing the size of the antenna and thickness in order to get the required frequency.

The radiation pattern is study in order to get the maximum gain and radiation pattern at main lobe. The main lobe and side lobe radiation pattern is analyzed to ensure the antenna will have good receiving wanted signal and ignore unwanted signal from different direction to avoid interference to other circuit in the television.

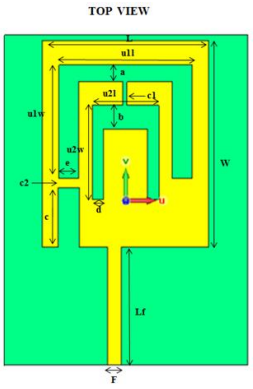


Fig. 1(a) Patch antenna

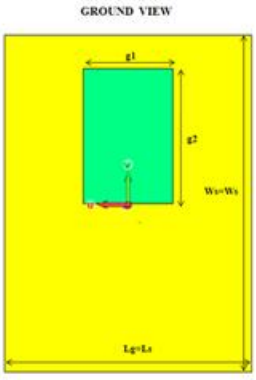


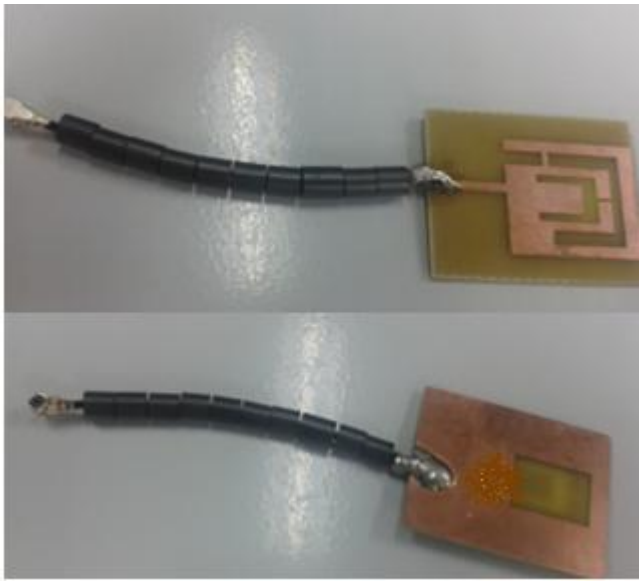
Fig. 1(b) DGS

In order to reduce the shape of the antenna, the RDGS [4],[5] method is used. DGS is realized by introducing a shape defected on the ground plane thus will disturb the shielded current distribution depending on the shape and dimension of the defect. It will influence the input impedance and the current flow of the antenna; hence it improved the radiation pattern of main lobe antenna and reducing the side lobe radiation pattern.

II. ANTENNA SIMULATION AND RESULT

A. Antenna structure

The antenna consists of two U-slot antennas with 1 C1 slot and 1 bridge. The antenna is fabricated on the substrate FR4 with 0.5-oz copper, whole dimension of 22x28 mm^2.,0.97mm height and dielectric constant of 4.3 with 50 ohm imput impedance. The optimal physical parameters of the proposed antenna is summarized in a table I and illustrated in Fig. 1(a) and (b). The DGS type slots (RDGS) is etched into the ground plane, exactly below the center of the u slot2 and C1 is to eliminate the unwanted radiation pattern at the desired frequency. The effect of the parameter changing has been simulated and study.



Picture 1. Antenna connected to wireless RF cable and absorber

TABLE I
PARAMETER FOR 2.45GHz PROPOSED ANTENNA

Parameter	**L**	**Ls,Lg**	**W**	**Ws,Wg**
Design size (mm)	14.5	22	20.5	28
Parameter	**b**	**c**	**d**	**e**
Design size (mm)	2	5	1	1.8
Parameter	**c2**	**u1l**	**u1w**	**u2l**
Design size (mm)	1	12	9.6	6
Parameter	**g2**	**g2**	**c1**	
Design size (mm)	11.2	11.2	0.4	

B. Parameter study

The slot C2 and feed thickness was study and simulated the effect to the antenna. From table II and Fig3 shows that the effect of the changing of width slot and feeding width affected the return loss of the antenna.

TABLE II
CHANGING THE WIDTH OF C2

C2(mm)	**Return loss (dB)**	**Resonance Frequency (Ghz)**	**Gain (dbi)**
1	-30	2.45	3.97
1.5	-45	2.45	4.15
2	-43	2.43	4.16
3	-40	2.44	4.16

From the table II shows that the clot C2 width can improve the gain and the return loss of the antenna. The best width for C2 is 1.5 mm with the gain of 4.15dbi.

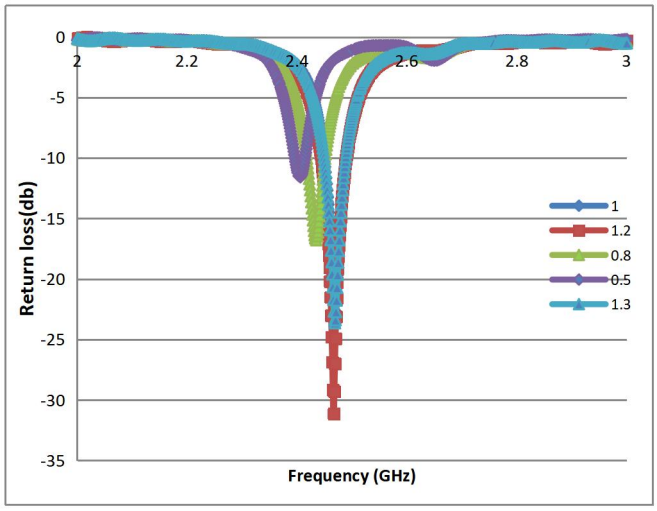


Fig 3. Simulated return loss with different feeding width

From the Fig3 shows that the effect of feed thickness can improve the return loss of the antenna. From the simulations result shows that when feed thickness is 1.2mm the return loss give the result of ~-33dbm which is very good.

C. Return loss measurement result

The Fig4 shows that the return loss of the double U-slot antenna simulated using CST microwaves studios is equal to -22db at frequency 2.45GHz. The measurement result is shifted to left 40Mhz with the return loss equal to -16dbm. This antenna was measured in the lab using vector network analyzer. The antenna fabrication dimension might be the reason frequency is shifted to the left.

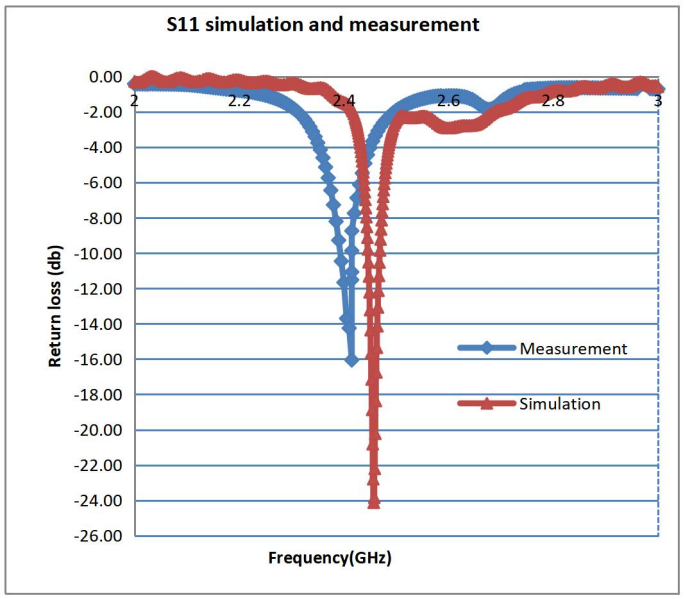


Fig 4. Simulated return loss with measurement Return loss

The antenna is connected to the SME connector during the return loss measurement. The different return loss might be due to the loss of the SME connector. The measurement calibration should be calculate and added into the result.

III. DEFECTED GROUND STRUCTURE

The radiation pattern has been study in this project. The defected ground structure purposed is based on rectangular slot where the design parameters 8x11.2mm are the length and width of the slot was structured at the center of the U slot antenna ground plane . the defect in the ground plane of the microstrip can give rise to increasing effective capacitance and inductance of the antenna The comparison between the double u slot antenna with DGS and without DGS is simulated and the result is show as below.

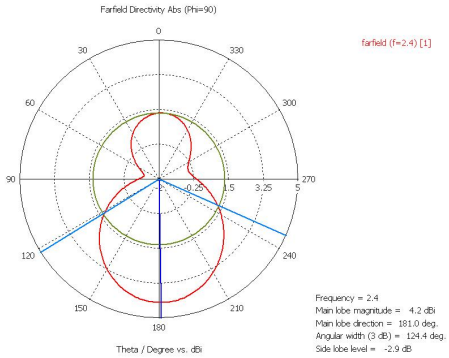


Fig 5a. Simulated H-Plane radiation pattern without DGS

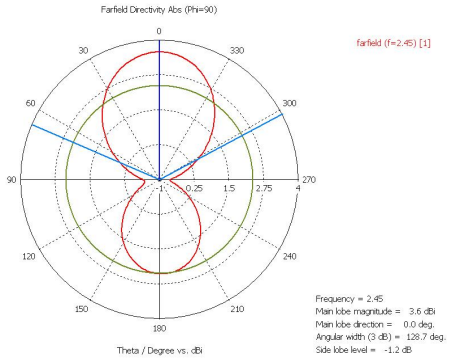


Fig 5b. Simulated H-Plane radiation pattern with DGS

It shows that, with DGS, it can remove unwanted radiation pattern and increased the main lobe radiation pattern. Below Table III is the comparison result after implement DGS and without DGS.

TABLE III
SIMULATION RESULT OF DIFFERENT GROUNDING

Grounding type	Return loss (dB)	Resonant Freq (GHz)	Gain (dbi)	Main lobe angle(°)	VSWR
Normal	-5.4235	2.35	4.2	181	3.3064
DGS	-22.78	2.4611	3.6	0	1.5477

Beside of the radiation pattern, it reduces the VSWR and the simulation result give the value of VSWR approximately to 1 which minimized the power reflected from the antenna. It meets the VSWR requirement for the frequency <3.0Ghz should less than 3. The return loss of the DGS antenna is better compare to none DGS antenna, which mean the mutual coupling of the DGS antenna at frequency of 2.45 is improved.

IV. CONCLUSIONS

The wireless Bluetooth antenna is successfully design with frequency 2.45GHz frequency as well as the required bandwidth and gain 3% and 3.97dbi respectively. The radiation pattern with the implementation of DGS has been studied. It is proven that the DGS can increased the gain and reduce the unwanted radiation pattern. It also reduces the VSWR nearly to 1. The designed directional microstrip antenna which focuses on front plane radiation pattern is very suitable for the TV to receive the signal from the one touch remote sensor and SD glass. With the small antenna dimension size leads to low fabrication cost is the best choice for the smart TV blue tooth built in antenna.

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