

# DESIGN AND ANALYSIS OF LINE FEED CIRCULAR MICROSTRIP PATCH ANTENNA WITHOUT SLOT AND WITH LOADED S- SLOT FOR C AND X-BANDS APPLICATION.

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**Abstract - This paper presents design, simulation and comparative study between un slotted and S-slotted inset line feed circular micro strip patch antenna .The un-slotted circular patch antenna resonated at 9.7 GHz with return loss-10.08dB but S-slotted antenna exhibited resonance at 8.9GHz frequency with return loss11.123dB, covering C-Band and X-Band. The design and simulation process has been carried out through C.S.T. Microwave Studio. The characteristic properties of antenna such as bandwidth, return loss, VSWR have been investigated, analyzed and compared for both**

**Key Words:** Un- slotted circular micro strip patch antenna, S-slotted circular micro strip patch antenna, CST

## 1. INTRODUCTION

An antenna is the basic and key element of all kinds of the wireless networking and communication. According to the IEEE standard, "Antenna is assumed as a device of transmission and reception of radio waves" [2]. Recently, the evolution in the wireless system leads to a lot of innovations in the microstrip patch antenna. Microstrip patch antenna technology has achieved its quick development in the late 1970s. By the early 1980s fundamental microstrip antenna component were fairly well established in terms of design and modeling. The microstrip patch antenna has more advantages over other microwave antennas in the area of portability because of its low profile, low cost fabrication, light weight, easy to install and integrate with feeding networks. Due to simplicity and compatibility microstrip patch antennas are being used at large scale in various microwave frequency spectrum to serve commercial and technological purposes [2-5]. But with these features and quantum merits patch antennas faces some drawbacks like narrow band width (NBD), low efficiency and low gain [2-4]. Therefore these antennas have very narrow band width characteristics as it limits the frequency range over which the antenna can perform [2]. However, the bandwidth and the size of an antenna are reciprocal and self-contradictory properties, that is in improvement of one of the characteristics normally results in degradation of the other.

As a result, it fetched the attention of inventors, investors and scientists to prompt and motivate more research into improvements in related fields. Researchers have made multifold efforts to overcome these challenges through various mechanisms. One, out of these mechanism, to achieve desirable resonant frequency and improved band width, is modification in figuration of different shapes of patch like S-shape, L-shape, E-shape with various dimensions [5-7]. Another mechanism to improve band width is modification in the shape of patch by cutting slots in it, like U-Slot, V-Slot, E-Slot and S-Slot [9-11]. Thus patch and slot are two different parameters and constants affecting as a hole performance of nan antenna fairly [11]. Therefore, keeping these modifications in view, patch of the proposed antennas is slotted properly in S-shape, which have offered an appreciable increase in band width over more than >400 MHz. Inset line feed circular patch antenna with S-shaped slot consist of S-slotted circular patch, supported on a grounded dielectric FR-4 sheet of thickness  $h=1.6\text{mm}$  and dielectric constant 4.3 [13]. The main purpose and object of this paper is to compare and analyze of band width (WB) characteristics properties under -10 dB return loss at resonant frequencies 8.9GHz and others characteristics such as voltage standing wave ratio (VSWR), directivity, gain, efficiency etc. of the proposed antennas which have been incorporated into two quietly different shapes of S-slot and without slot.

### 1.1 ANTENNA GEOMETRY AND DESIGN:

For line feed circular micro strip patch antenna, the height of substrate FR-4 is 1.6mm and relative permittivity  $\epsilon_r$  is 4.3. The inner and outer radii of patch are  $r_i=0.0\text{mm}$  and  $r_o=8.0\text{mm}$ . The length and width of substrate FR-4 are  $L=58.32\text{mm}$  and  $W=75.2\text{mm}$ . respectively. Perspective views of the proposed antennas are shown in fig-1

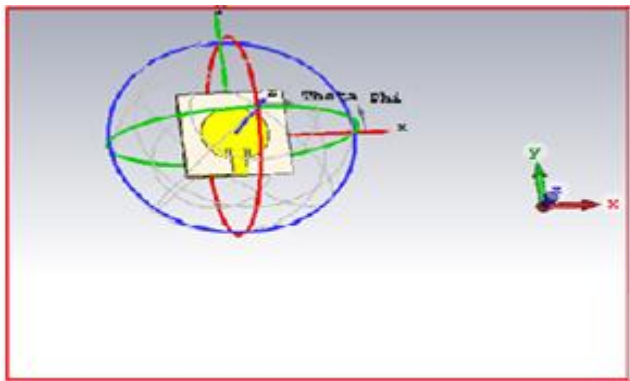


Fig-1a Antenna Geometry (A)

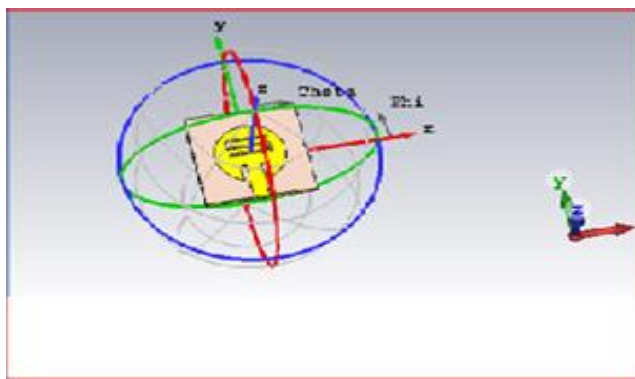


Fig-1b Antenna Geometry (B)

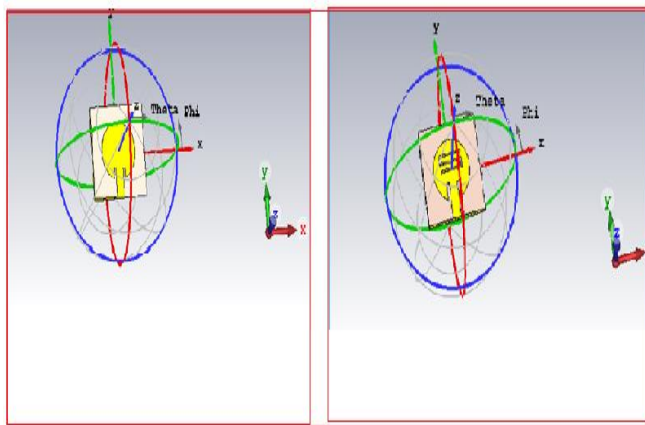


Fig-1c Antenna Geometry (A-B Combine)

Table -1: Design Specification Of Proposed Antenna

Antenna	Dimensions	Value	Material
LFCP	Patch Inner radius	$r_i = 0$ mm	Copper
	Patch Outer radius	$r_o = 8.8$ mm	
	Patch thickness	$t = 0.036$ mm	
	Substrate height	$h = 1.6$ mm	
	Substrate width	$W = 75.2$ mm	

Slot -S	Substrate length	$L = 58.32$ mm	FR-4
	Ground width	$W = 75.2$ mm	copper
	Ground length	$L = 58.32$ mm	
	Ground thickness	$t = 0.036$ mm	
	Feed line width	$W_f = 3.261$ mm	Air
	Feed line length	$l_f = 20.0$ mm	
Vertical expansion of letter-S	5mm		
	Horizontal expansion of letter-S	5mm	Air
	Thickness of strip	0.5mm	

## 2. SIMULATIONS AND RESULTS:

**2.1 RETURN LOSS:** After designing the antennas by CSTMWS 2018, simulation function has been carried out. Plots for simulated return loss of circular patch antenna without slot and with slot-S have been shown in fig-2 and fig-3 respectively. Magnitude of reflection coefficient have been found to be -10.05dB at 8.78 GHz of circular microstrip patch antenna without slot and -11.1dB at 8.9GHz of circular microstrip patch antenna with slot -S. At -10dB the bandwidth has been found 26.7MHz which covers 29.3% bandwidth at resonant frequency 8.7GHz for circular microstrip patch antenna without slot. Whereas at -10 dB the bandwidth has been found to be 26.9 MHz which covers 30% bandwidth at resonant frequency 8.9GHz for circular microstrip patch antenna with slot-S.

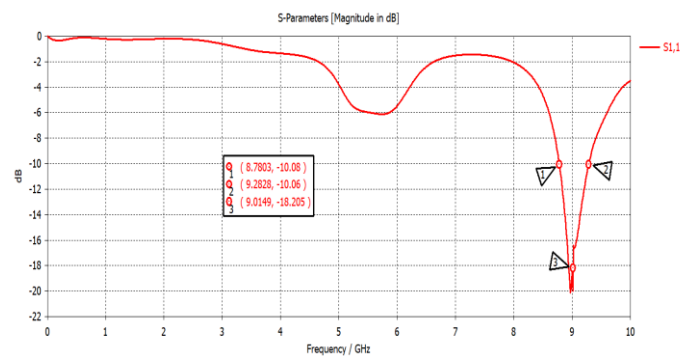
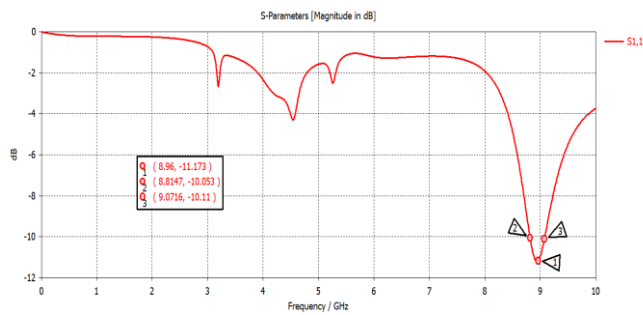
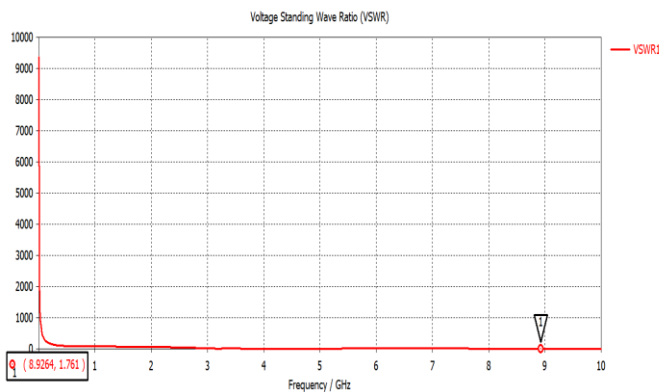


Fig -2 Return loss of line feed Circular microstrip patch antenna without slot.

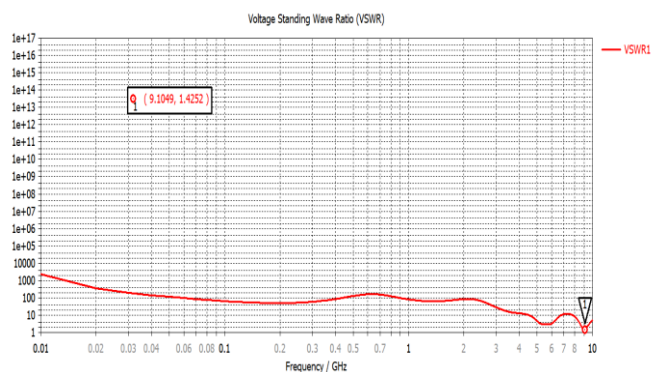


**Fig-3 Return loss of lie feed Circular microstrip patch antenna with slot-S**

**2.2: VSWR:** Plots for VSWR of line feed circular microstrip patch antenna without slot and with S- shaped slot have been shown in fig-4 and fig-5 respectively. Magnitude of VSWR for line feed circular microstrip patch antenna is found as 1.761 at resonant frequency 8.9GHz which is in good agreement and very close to an ideal value of 1 for an impedance matching. Whereas for line feed circular microstrip patch antenna with S-shaped slot it has been found to be 1.4252 at resonant frequency 9. 10GHz. Which is in good agreement and close to an ideal value of 1 for impedance matching also?

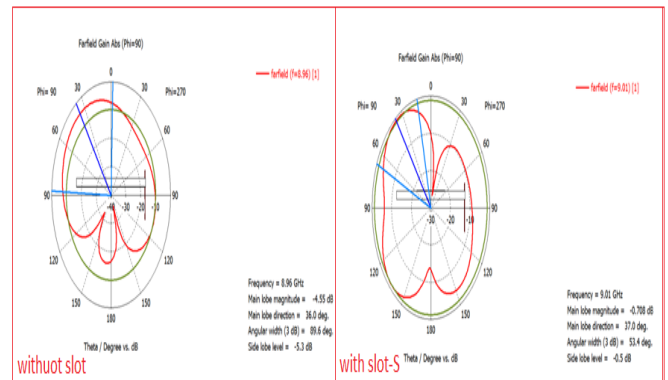


**Fig-4 VSWR plot for Circular microstrip patch antenna without slot**



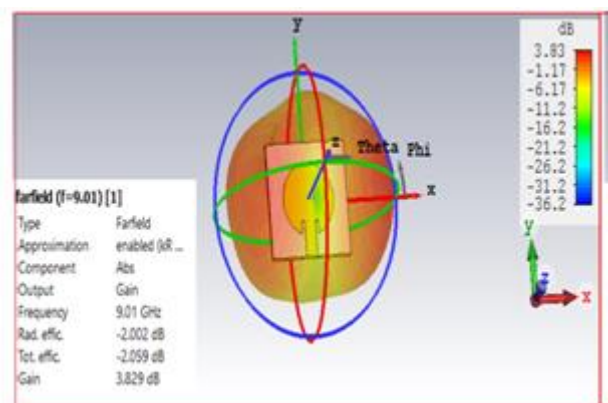
**Fig-5 VSW plot for Circular microstrip patch antenna without slot**

**2.3 FARFIELD DIRECTIVITY :** Polar plots for line feed circular microstrip patch antenna without slot and with S-shaped slot are shown in fig-6. For line feed circular microstrip patch antenna without slot, Main lobe magnitude is around-0.708 dBi and Angular width is obtained as 51.4 degree whereas for line feed circular microstrip patch antenna with S-shaped slot main lobe magnitude is-4.55dBi and Angular width is obtained as89.6 degree.



**Fig-6 Polar plot for farfield directivity of line feed circular microstrip path antenna without slot and with slot.**

**2.4 RADIATION PATTERN :** The 3D-plots for radiation pattern of gain for line feed circular microstrip patch antenna without slot and with S-shaped slot are shown in fig 7. For line feed circular microstrip patch antenna without slot, gain is 3.829dB and radiation efficiency is obtained as 97.23% nearly at resonant frequency 8.9 GHz and for line feed circular microstrip patch antenna with S-slot gain is 3.612dB and radiation efficiency is 84.27% at resonant frequency 9.1 GHz.



**Fig7: 3D -plot of radiation pattern for circular patch without slot.**

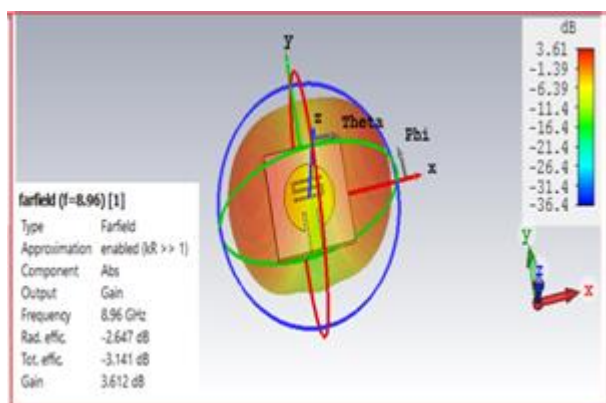


Fig7b-. 3D -plot of radiation pattern for circular patch with S- slot .

Table 2: summary of simulated result:

Prameter	Un-slotted CMPA	S-slotted CMPA
Resonant frequency	8.7GH	8.9 GHz
Return loss	- 10.05dB	-11.1dB
Band width-10 dB	26,7MHz	26.9
Band width%	29%	30%
VSWR	1.761	1.425
Gain	3.829dB	3.612dB
Directivity	-0.708dBi	4.55dBi
Radiation efficiency	97.3%	84.2%
Main lobe direction	51.4degree	89.6degree
Main lobe magnitude	-0.708dBi	4.55dBi

From above table , it is well vivid that S-Shape slotted inset line feed hexagonal microstrip patch antenna has overall better results than un- slotted inset feed line circular microstrip patch antenna. More negative value of return loss gives the better results. Hence S-Shape slotted circular microstrip patch antenna show better results in comparison to un- slotted circular microstrip patch antenna Less than value 2 and near to 1, better is the VSWR. The S-slotted antenna shows a slightly higher resonant frequency, better return loss, wider bandwidth, lower VSWR, and higher directivity compared to the un-slotted antenna. However, the un-slotted antenna exhibits higher gain, better radiation efficiency, and a narrower main lobe with a lower main lobe magnitude. The specific antenna design and performance goals will determine which type of antenna is more suitable for a particular application.

### 3. Conclusion

The comparison between un- slotted and S- slotted circular microstrip patch antenna is done on the expence of simulation results obtained from CSTMW Studio. It, therefore ,concluded that both the antennas configuration show good results in view of Returnloss ,VSWR, Gain and Radiation efficiency for C and X bands applications. However, in view of Return loss, Bandwidth, VSWR and Gain, S-Shape slotted circular microstrip patch antenna shows better performance, whereas un- slotted circular microstrip patch antenna shows better performance in view of main lobe direction and radiation pattern.

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## BIOGRAPHIES



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