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# Effect of Slot Parameters and Feed Inset on CPW-Fed Slot Dipole Antennas- Analysis

D Sriram Kumar[1] G Surya Prakash[2] C P Mohammed Rafi[3]

Department of Electronics and Communication Engineering,
National Institute of Technology,
Trichy, Tamilnadu, India-620015
[1]srk@nitt.edu
[2]gurusuryaprakash@gmail.com
[3]cprafi@gmail.com

***Abstract*: In this paper the effect of slot parameters (slot length and width), feed inset on the resonant frequency ($f_c$) and bandwidth of a CPW-Fed slot dipole antenna with feed taper is compared with that of a CPW - Fed dipole slot antenna.**

***Index terms:* CPW - Fed, Slot antenna, Substrate, Tapering angle, Bandwidth, Feed inset.**

## I. INTRODUCTION

The planar microwave technology (Coplanar Waveguide) introduced by C P Wen sparked a great interest in researchers all over the world in an attempt to design antennas ,filters, etc., based on this technology, so that cost effective components can be obtained without compromising on the efficiency. CPW antenna slot type or patch type or feed types are becoming increasingly important in many military and commercial applications. Its important feature is the CPW -feed and antenna are on the same plane i.e., on the same side of the substrate, thereby facilitating connection of lumped shunt elements and active devices and eliminating the need for via holes. In particular the CPW-fed slot antennas have been widely used for wireless applications since they exhibit a larger bandwidth with bi-directional radiation patterns and also they are compatible with monolithic integrated circuits and active solid-state devices.

In this paper the various parameters affecting the bandwidth and resonant frequency of CPW fed slot antennas are reviewed in an attempt to make designing CPW- Fed slot antennas more efficient for a given application. [2] presents effect of slot and feed inset parameters on the bandwidth and resonant frequency of a CPW- Fed slot dipole antenna. [1] presents a CPW- Fed slot antenna with an additional tapering for the CPW feed and the variation of bandwidth and resonant frequency with the substrate and slot parameters (slot length, slot width), the tapering angle for the CPW- feed.

This paper compares the above results and presents the effect of Feed - inset on the CPW-fed slot antenna [1]. The study resulted in an interesting result that can be utilized in achieving reconfigurability by just varying the feed inset.

## II. ANTENNA DESIGN

The geometry of antenna [1] is shown in Figure 1(a). CPW feed dimensions of a=0.3mm and b=3mm were selected corresponding to the 50 Ω connector. The antenna was built on a RT-duroid substrate with dielectric constant 2.2. The geometry of the antenna [2] is shown in figure 1(b). This antenna was constructed on a GaAs substrate with dielectric constant of 12.9, loss tangent 0.0016, and thickness h= 0.42mm and a 50 Ω CPW Feed (20:30:20 gap: width: gap).

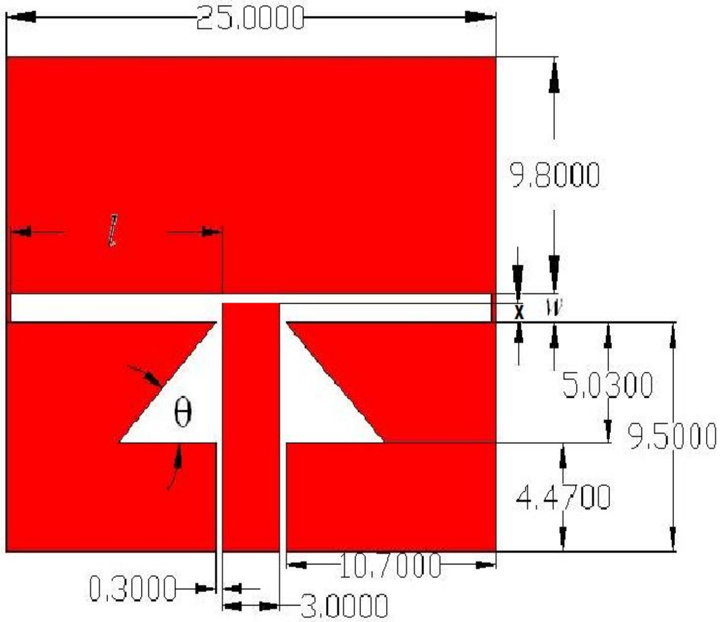


Fig. 1(a): Geometry of the Antenna [1]

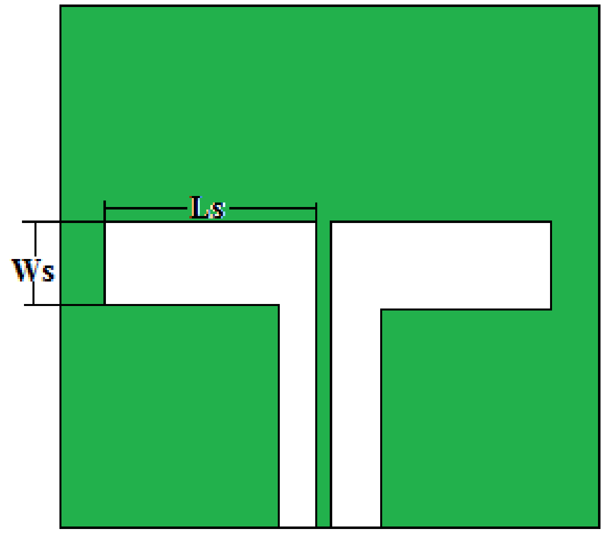


Fig. 1(b): Geometry of the Antenna [2]

## III. RESULTS AND DISCUSSION

### A. *Effect of slot length l*

[1] Presents the effect of slot parameters on the CPW- Fed slot dipole antenna with feed tapering. The tabular column IV in the paper [1] presents the resonant frequency as well as the 10dB return loss bandwidth for various values of slot length ranging from 0.3mm to 10mm. It is seen that the resonant frequency is decreasing linearly with the slot length and also that there is only marginal variation in the matching conditions at the input.

So even if the dipole antenna has a tapered feed the same behavior is obtained as the one without the feed taper. So by selecting the tapering angle in [1] to be 0 deg, the behavior of the antenna obtained will be similar to that of [2]. It can be once again established that the slot length affects only the resonant frequency of the antenna given, other parameters are not changed simultaneously with the slot length. So the resonant frequency can be fine- tuned with the slot length.

Further study on other parameters shows that the resonant frequency can also be changed by changing other parameters like feed inset while maintaining the 10dB return loss. This fact can be used to achieve reconfigurability of the antenna.

### B. *Effect of slot width w*

The Slot width w of [1] is varied from 0.2mm to 1.6 mm and the corresponding values for the 10dB Bandwidth, Resonant Frequency and the Return loss are presented in Table 1. The constant parameters for the experiment are dielectric constant $\varepsilon_r$ (2.2), slot length l (10.8mm), tapering angle θ (75.5$^o$) and substrate thickness h (1.5mm) constant.

It is seen that even for a short variation in the slot width, there is a tremendous effect on the 10dB bandwidth as well as on the resonant frequencies of the antenna. The return loss increases with slot width to some extent and then decreases. For w=0.2mm the return loss is -12.08dB and for w= 1.6 it is -27.45dB. If we consider the return loss at 5.882 GHz ,we can see that the 10dB return loss increases with the slot width to -17.11dB and then it decreases. Hence it can be deduced that the return loss at a particular resonant frequency first increases with slot width and then it decreases. So the return loss can be optimized by choosing appropriate values of the slot width. A similar behavior of the dipole antenna was also observed in [2].

Table 1: Effect of Slot Width w

| Slot Width (mm) | Bandwidth(GHz) | Resonant Frequency(GHz), Return Loss (dB) |
|---|---|---|
| 0.2 | 5.73- 6.52 | 5.882, -12.08 |
| 0.6 | 5.73-7.82 | 6.207, -13.4 |
| 0.8 | 5.21-8.20 | 5.882, -17.11 |
| 0.9 | 5.43- 8.21 and 17.95- 18.26 | 7.179, -15.3 and 18.46, -13.55 |
| 1.1 | 5.19-6.7 | 5.64, -18.11 |
| 1.4 | 5.128- 9.231 and 17.65 – 18.86 | 7.692, -21.29 and 18.46, -13.81 |
| 1.6 | 5.128- 10.26 and 17.44- 18.21 | 7.692, -27.45 and 17.95, -18.13 |

Return loss for some slot width values are presented in figure (2).

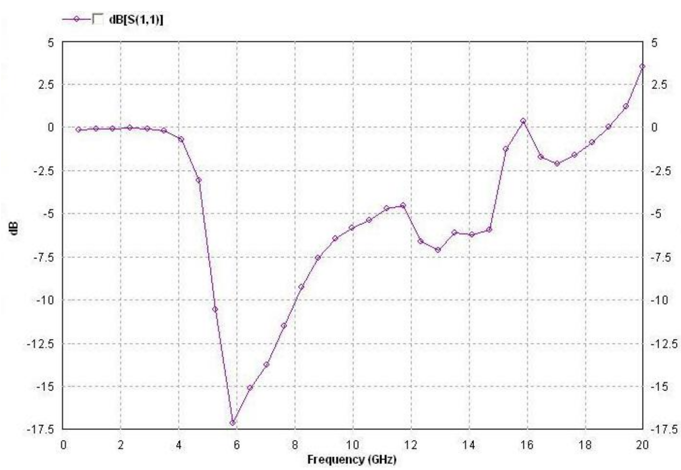


Fig. 2(a): $S_{11}$ (dB) for w=*0.8mm*

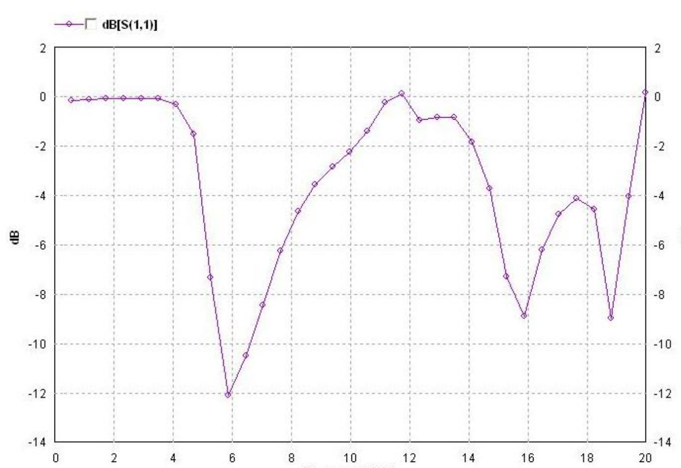


Fig. 2(b): $S_{11}$ (dB) for w=*0.2mm*

*C. Effect of feed inset x*

The effect of feed inset x is analyzed by keeping dielectric constant $\varepsilon_r$ (2.2), slot length l (10.8mm), slot width *w* (1.2mm), tapering angle θ (75.5$^o$) and substrate thickness h (1.5mm) constant. The feed inset x is varied from 0 to 1.2 mm (inductively coupled) by an increment of 0.2 mm and the corresponding bandwidths and resonant frequencies are given in Table 2. Feed inset of 0.2mm is capacitively coupled. The return loss and E pattern for some frequencies are presented in figure (3). [2] shows that the increasing feed inset reduces the input impedance matching drastically as well as the resonant frequency. The results obtained for the variation of resonant frequency with the feed inset is also similar to that of [2] and it is also observed that there is some pattern with the variation of the antenna return loss along with the variation of resonant frequency.

There are two values of the feed inset for which the return loss values obtained at two different resonant frequencies is almost getting reversed i.e., for the inset value 0.6mm, the return loss at 3.87 GHz is -25dB and at 14.33GHz it is only -14dB and for feed inset of 1.0mm the return loss obtained is -6dB at 3.87GHz and is -15.3dB at 14.33 GHz. This shows that if we choose appropriate values of feed inset, we can obtain similar performance of the antenna in terms of the return loss at two different resonant frequencies.

Table 2: Effect of feed inset *x*

| Feed inset (mm) | Bandwidth(GHz) | Resonant Frequency(GHz), Gain (dB) |
|---|---|---|
| 0 | 14- 14.5 | 14.5, -12.5 |
| 0.4 | 3.6- 4.1 and 14-14.66 | 3.87, -17.1 and 14.33, -13 |
| 0.5 | 14- 14.66 | 14.33, -14 |
| 0.6 | 3.6- 4.1 and 14-14.66 | 3.87, -25 and 14.33, -14.6 |
| 0.8 | 3.7- 3.9 and 14-14.66 | 3.87, -12 and 14.33, -15.3 |
| 1.0 | 14- 14.66 | 14.33, -19 |
| 1.2 | 5- 9 | 5.66, -18.5 |

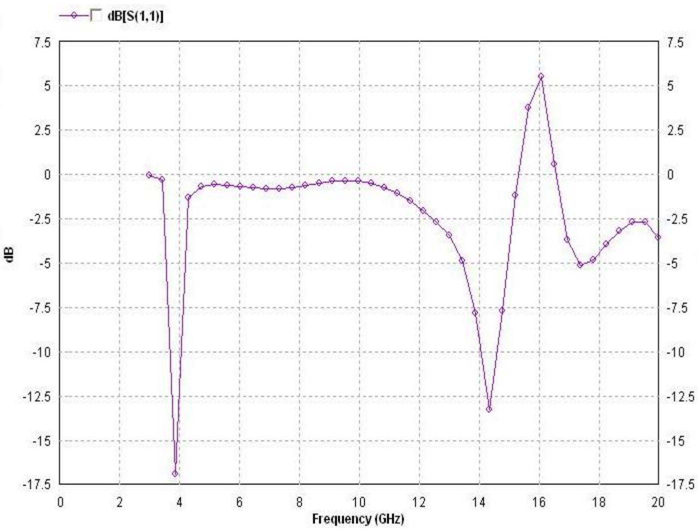

Fig. 3(a): $S_{11}$ (dB) for *x=0.4mm*

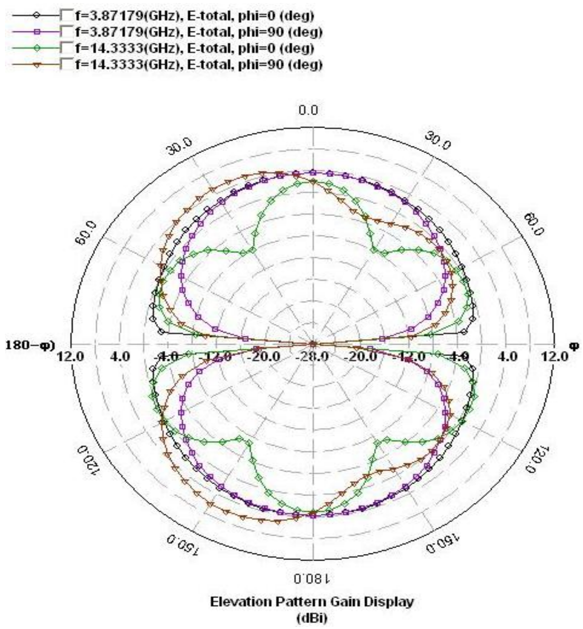

Fig. 3(b): Radiation Pattern gain (dBi) display for *x= 0.4mm*

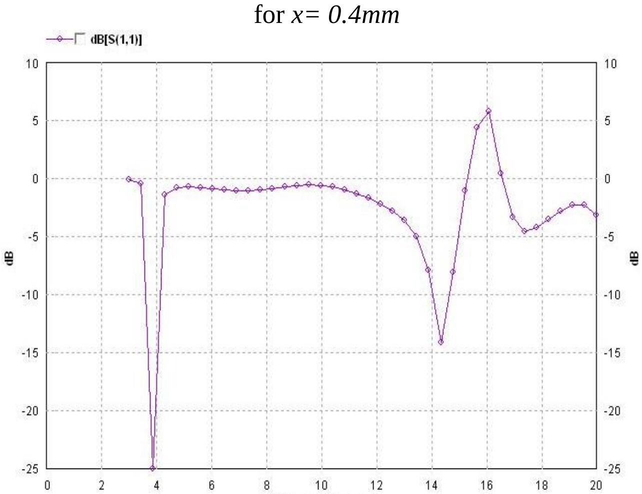

Fig. 3(c): $S_{11}$ (dB) for *x=0.6mm*

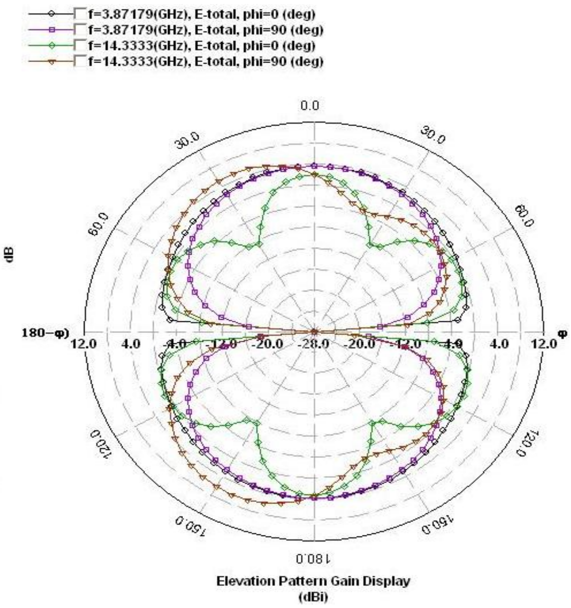

Fig. 3(d): Radiation Pattern gain (dBi) display for *x= 0.6mm*

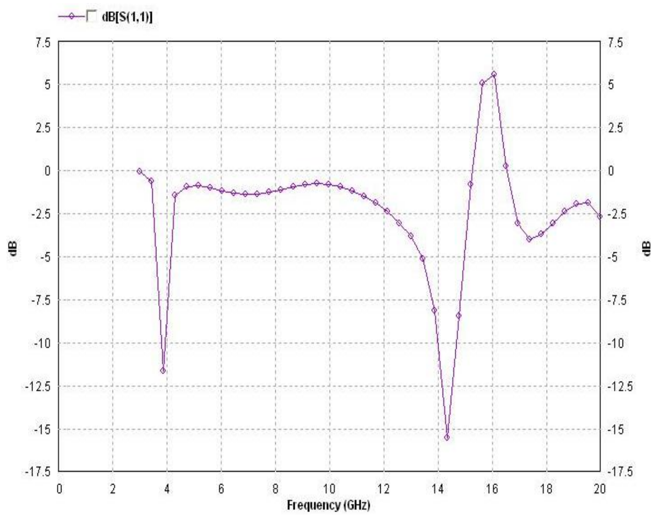

Fig. 3(e): $S_{11}$ (dB) for *x=0.8mm*

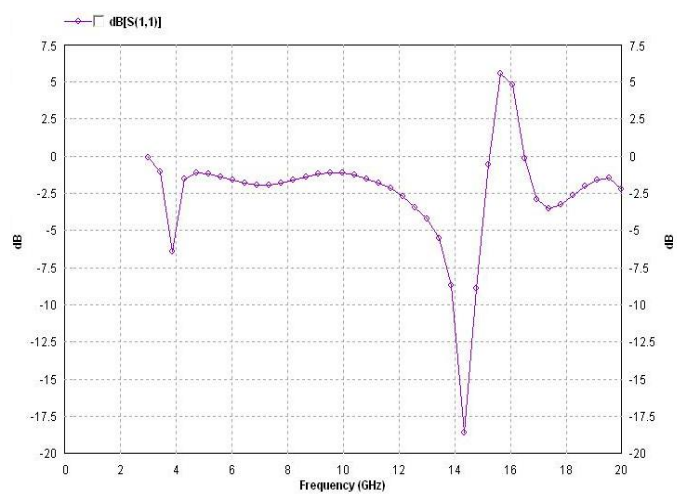

Fig. 3(f): $S_{11}$ (dB) for *x=1.0mm*

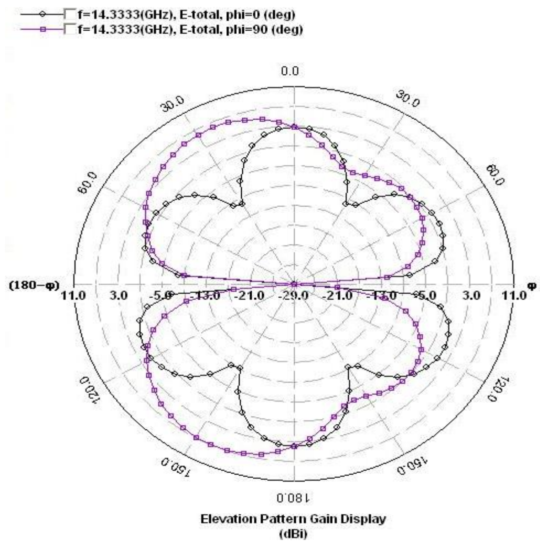


Fig. 3(g): Radiation Pattern gain (dBi) display for *x= 1.0mm*

## CONCLUSION

It can be concluded that the slot parameters namely slot length and slot width have different effects on the characteristics of the dipole antenna.

Slot length mainly determines the resonant frequency which decreases linearly with slot length and also that there is only marginal variation in the matching conditions at the input. Also the 10dB return loss bandwidth can be deduced to be increasing with the slot length.

The slot width has predominant effect on the input matching conditions [2] while it is worth noticing that the resonant frequency changes only slightly. The return loss increases with slot width to some extent and then decreases.

The feed inset has tremendous effect on the characteristics of the antenna [1] in terms of resonant frequency and the return loss. Figure (3) shows the variation of return loss for two different feed insets wherein the resonant frequency is 3.87 GHz for feed inset of 0.6mm and it is 14.33 GHz for feed inset of 1.0mm. These show that the antenna[1]can be effectively used for 3.87 as well as for 14.33 GHz by suitably modifying the CPW feed inset x.

So, if the dipole antenna uses a feed taper, then we can obtain similar characteristics as that of the normal dipole antenna but with a change in the values of the resonant frequency as well as the 10 dB return loss bandwidth.

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