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3D Design & Simulation of a Z Shape Antenna with a CPW Tx Line

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ABSTRACT : *This paper presents design of à new Z shaped antenna with a cpw (coplanar waveguide) transmission line. In this proposed research paper, the impedance increases with a pair of Z shape combined design on the FR-4 substrate and ground plane. The main features of the Z antenna are the compact dimensions and band-operating characteristics that are obtained without modifying the radiator or the ground plane. The antenna consists of a linear patch as radiator, a partial CPW-ground plane, and a slotted conductor-backed plane. Impedance matching for dual-band operations is achieved by a pair of mirror square-shaped slots at the conductor-backed plane. This antenna size is very compact with 28.8 mm × 37.2 mm × 1.6 mm and covers 1.696 GHz to 2.646 GHz and can be used for GSM and WLAN applications. Our designing aim is to describe radiation pattern both 3D and normal and discuss obtained gain.*

KEYWORDS – *Microstrip, Coplanar waveguide, Impedance, HFSS, Bandwidth.*

I. INTRODUCTION

In recent years demand for small antennas on wireless communication has increased the interest of research work on compact microstrip various kind of shaped antenna design among microwaves and wireless technology. To support the high mobility necessity for a wireless telecommunication device, a small and light weight Z shape antenna is likely to be preferred. For this purpose compact Z shaped antenna is one of the most suitable applications. The development of Z shaped antenna for wireless communication also requires an antenna with more than one operating frequencies. This is due to many reasons, mainly because there are various wireless communication systems and many telecommunication operators using various frequencies. However, the general Z shaped patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to cover the demanding bandwidth is necessary [1]. But overhead those drawbacks Z shaped antenna is now most popular antenna. In the design of a Z shape antenna with a coplanar waveguide, the shape of the Z antenna patch, the ground plane, and the geometry of the ground plane slots are of great importance. Proposed Z shaped have included rectangular ones. Different methods, such as the truncated slot on the antenna patch, have been pro-posed for increasing impedance bandwidth .Recently, some coplanar waveguide (CPW) Z antennas have been reported. In most reported antennas, up to now, the slots have been used for improving the lower frequency of the band and enhancing the upper frequency of the band. In this paper, a novel CPW-fed Z antenna without slot on the patch or ground plane is proposed with a Z-shaped form. In this antenna, using a pair of Z-shape combined (ESC) design on the patch, a proper control on the upper and lower frequencies of the band can be achieved. In addition, on the ground plane, a pair of ESC form is located for improving impedance matching and optimizing gain [2]. Coplanar waveguide is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave-frequency signals. On a smaller scale, coplanar waveguide transmission lines are also built into monolithic microwave integrated circuits. Conventional coplanar waveguide (CPW) consists of a single conducting track printed onto a dielectric substrate, together with a pair of return conductors, one to either side of the track. All three conductors are on the same side of the substrate, and hence are coplanar. The return conductors are separated from the central track by a small gap, which has an unvarying width along the length of the line. Away from the central conductor, the return conductors usually extend to an indefinite but large distance, so that each is notionally a semi-infinite plane.

The advantages of coplanar waveguide are that active devices can be mounted on top of the circuit, like on microstrip. More importantly, it can provide extremely high frequency response since connecting to coplanar waveguide does not entail any parasitic discontinuities in the ground plane. One disadvantage is potentially lousy heat dissipation. However, the main reason that coplanar waveguide is not used is that there is a general lack of understanding of how to employ it within the microwave design community.

II. DESIGN AND EQUATIONS

The dielectric constant of the substrate is closely related to the size and the bandwidth of the Z shape antenna. Low dielectric constant of the substrate produces larger bandwidth. The resonant frequency of Z shape antenna and the size of the radiation patch can be similar to the following formulas while the high dielectric constant of the substrate results in smaller size of antenna [3].

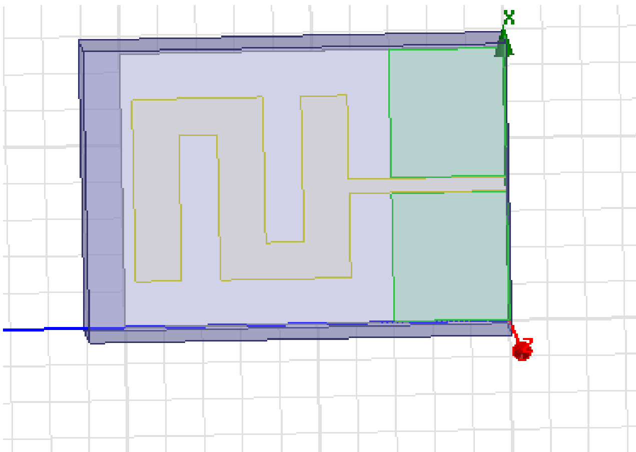

Figure 1: Z shape antenna

Figure 1 shows the geometry of the design of Z shape with a coplanar waveguide transmission line in which the Length of ground plane of Antenna is 38.4 mm and Width is 46.8 mm, L & W of the patch is 28.8 mm & 37.2 mm.

The patch width, effective dielectric constant, the length extension and also patch length are given by

$$w = \frac{C}{2f\sqrt{\varepsilon r}}$$

where *c* is the velocity of light, e is the dielectric content of substrate, *f* is the antenna working frequency, W is the patch non resonant width, and the effective dielectric constant is e given as,

$$\varepsilon_{eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{H}{W}\right]^{-\frac{1}{2}}$$

The extension length Δ is calculates as,

$$\frac{\Delta L}{H} = 0.412\frac{(\varepsilon_{eff} + 0.300)\left(\frac{W}{H} + 0.262\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{H} + 0.813\right)}$$

By using above equation we can find the value of actual length of the patch as,

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta L$$

III. SIMULATION RESULTS AND TABLE

The antenna simulation pattern is a measure of its power or radiation distribution with respect to a particular type of coordinates. We generally consider spherical coordinates as the ideal antenna is supposed to radiate in a spherically symmetrical pattern [4]. However antennae in practice are not Omni directional but have a radiation maximum along one particular direction. Z shape antenna is a broadside antenna wherein the maximum radiation occurs along the axis of the antenna [5].

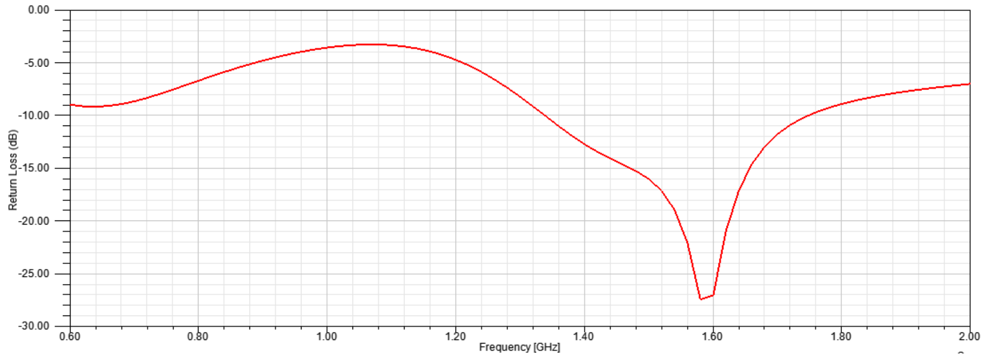

Figure 2: Graph of Return loss.

In Figure 2 presents the graph of the return loss. It is clearly shown that lowest return loss is found at 1.60 GHz. And highest return loss found at 1 GHz frequency. Overall average return loss is not very effective.

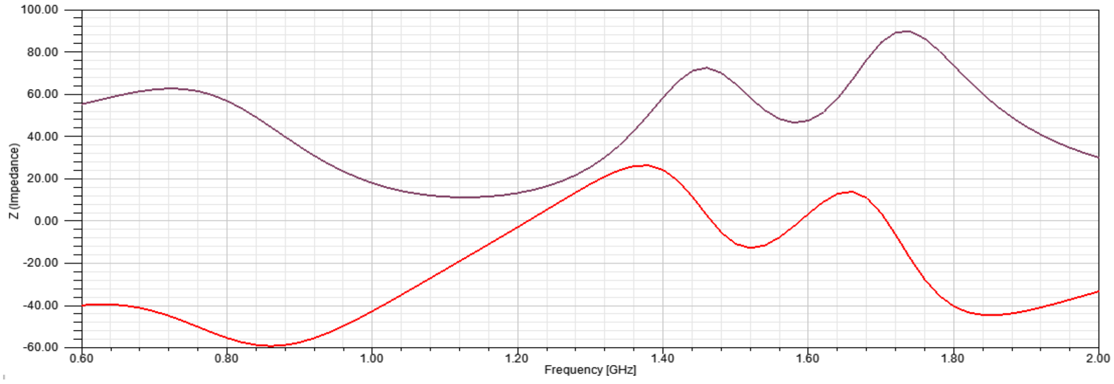

Figure 3: Frequency Vs Imaginary Impedance Graph.

In figure 3 describe the Impedance graph. There are two lines. One of them the upper one represents Imaginary Impedance graph and other one presents Real Impedance graph. We got Imaginary values are the highest in every frequency rather than real impedance graph. When frequency is 1.70 GHz found the highest impedance values for both graph.

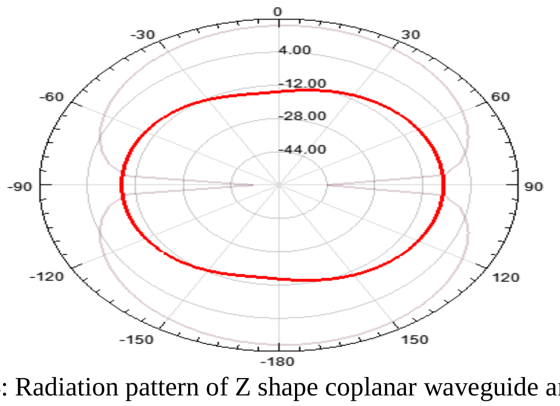

Figure 4: Radiation pattern of Z shape coplanar waveguide antenna.

In figure 4 describe the radiation graph. There are two lines. One of them the upper one light color graph represents Z shape antenna with coplanar waveguide and other one presents dark red graph represents with using coplanar waveguide. We got without coplanar values are the highest in every angel rather than other graph.

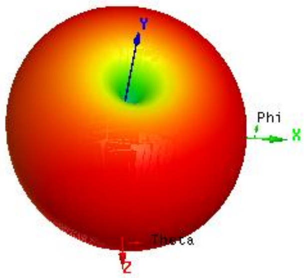

Figure 5: 3D pattern of Z shape antenna.

Figure 5 presents basic 3d pattern of Z shape antenna with using coplanar waveguide transmission line.

	Theta [deg]	rETotal [V] Setup : LastAdaptive Freq='0.9GHz' Phi='0deg'
1	-180.000000	447.377879
2	-175.000000	440.121530
3	-170.000000	431.593863
4	-165.000000	421.963485
5	-160.000000	411.437042
6	-155.000000	400.249550
7	-150.000000	388.653887
8	-145.000000	376.910252
9	-140.000000	365.276345
10	-135.000000	353.998841
11	-130.000000	343.306583
12	-125.000000	333.405660
13	-120.000000	324.476369
14	-115.000000	316.671854

We found at least 73 values from our simulation here we submit 14 values as a sample.it is clearly shown that it follow per 90 degree cycle that means per 90 degree its values at the nadir point and after that complete 90 degree it is in crest point.

IV. CONCLUSION

This thesis detailed the various aspects associated with the modelling of Z shape antenna with coplanar guide transmission line. One of the goal was introduction of HFSS as a simulation tool for electromagnetic analysis. An effort was understanding of the design process in HFSS, which aid the reader in building any simulation in HFSS [6]. In this paper a compact size Z shaped antenna has been designed having good impedance matching as well as high antenna; efficiency of about 95% is achieved. The proposed antenna has larger impedance bandwidth of 43.578% covering the frequency range from 1.696 GHz to 2.646 GHz which is suitable for PCS-1900, GSM and WLAN (802.11b) applications. Obviously there are some limitations of Z shape antenna some of them are listed below:

- Its effective dielectric constant is lower.
- Layout is very compact.
- Shunt element is quite low.

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