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# Comparison of Different Parameters of the Edge Feed and the Inset Feed Patch Antenna

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**Abstract**

A microstrip antenna consists of a dielectric substrate sandwiched between two conducting surfaces, the antenna plane and the ground plane. The simplified design of the rectangular microstrip patch antenna with edge feed. In edge fed antenna, as there is no perfect matching between the transmission line and the patch impedance because of which more amount of power will be reflected back as a result of which VSWR value would be high. To improve the impedance matching between the transmission line and the patch, we go for another type of feed called inset feed, where in the power accepted by the antenna would be more because of perfect impedance matching and hence VSWR would be low

**Keywords:** Microstip, Edge feed, Inset feed, Patch antenna VSWR

## INTRODUCTION

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch [1, 2, 3 and 4].

### Feed Techniques

The four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

### Microstrip Feed Line

In this type of feed technique, a conducting strip is connected directly to the edge of the microstrip patch and strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure.

The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching.

However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna [1, 2]. The feed radiation also leads to undesired cross polarized radiation.

### Co-Axial Feed

The Coaxial feed or probe feed is a very common technique used for feeding microstrip patch antennas In the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane.

The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, a major disadvantage is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ($h > 0.02\lambda o$). Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems [1, 2]. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the microstrip line feed and the coaxial feed suffer from numerous disadvantages. The non-contacting feed techniques which have been discussed below, solve these issues.

### Aperture Coupled Feed

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. The Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane.

The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to symmetry of the configuration. The amount of coupling from the feed line to the patch is determined by the shape, size and location of the aperture. Since the ground plane separates the patch and the feed line, spurious radiation is minimized. Generally, a high dielectric material is used for bottom substrate and a thick, low dielectric constant material is used for the top substrate to optimize radiation from the patch [1, 2]. The major disadvantage of this feed technique is that it is difficult to fabricate due to multiple layers, which also increases the antenna thickness. This feeding scheme also provides narrow bandwidth.

### Proximity Coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. There are two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%) [3, 4], due to overall increase in the thickness of the microstrip patch antenna. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual performances.

Matching can be achieved by controlling the length of the feed line and the width-to-line ratio of the patch. The major disadvantage of this feed scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, there is an increase in the overall thickness of the antenna [6, 7].

The equivalent circuit of different feed techniques for microstrip patch antenna array [2, 4].

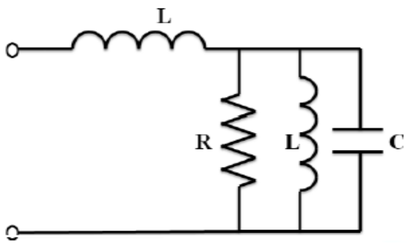


**Figure 1:** Microstrip line probe

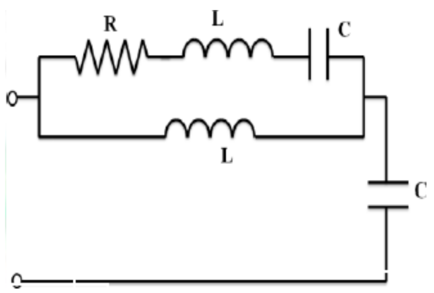


**Figure 2:** Aperture-coupled

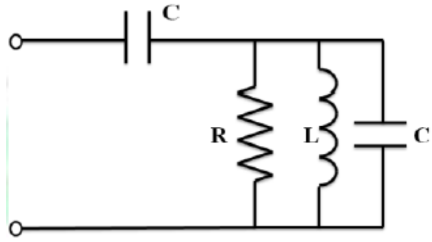


**Figure 3:** Proximity-coupled

In most of the microstrip patch antennas the feed line impedance is 50Ω whereas the radiation resistance at the edge of the patch is on the order of a few hundred ohms depending on the patch dimension and the substrate used. The performance of the antenna is affected due to this mismatch since the maximum power is not being transmitted. A matching network must therefore be implemented on the feed network, in order to minimize reflections, thereby enhancing the performance of the antenna

A typical method used for achieving such an antenna is by providing an inset feed. The inset feed offers the advantage of being planar and easily etched as well as providing adjustable input impedance through inset geometry changes [3]. To obtain the impedance Z at the inset length of patch the input resistance of is multiplied by factor of

$\cos^2 \frac{\pi x_0}{l}$.

$$Z = z_0 * \cos^2 \frac{\pi x_0}{l} \quad (1)$$

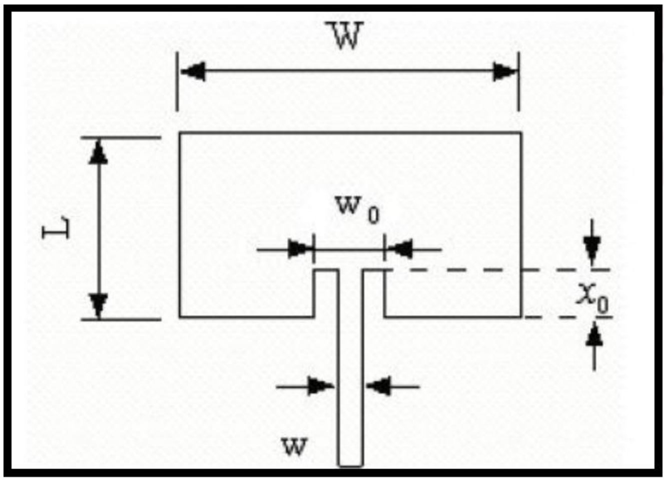


**Figure 4:** Microstrip line fed inset patch antenna

The antenna is designed for the same frequency as of the edge feed antenna described above and dielectric constant also remains the same. Only the notch width g has to be calculated which is given by [5]

$$f_r = \frac{c}{\sqrt{2 * \varepsilon_{reff}}} \frac{4.6 * 10^{-14}}{g} + \frac{f}{1.01} \quad (2)$$

$$g = \frac{c}{\sqrt{2 * \varepsilon_{reff}}} \frac{4.65 * 10^{-12}}{f} \quad (3)$$

$$w_0 = 2g + w \quad (4)$$

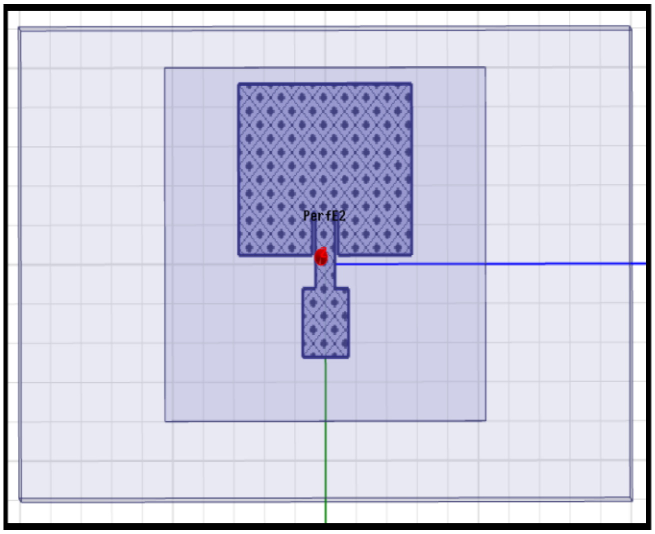


**Figure 5:** Design of rectangular microstrip patch antenna with inset fed in HFSS software

The simplified design of the rectangular microstrip patch antenna with inset feed is shown in the figure 4.

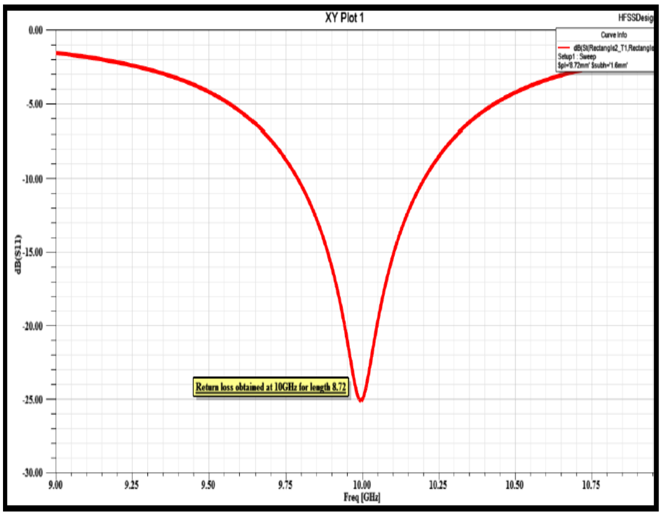


**Figure 6:** Plot of Return loss

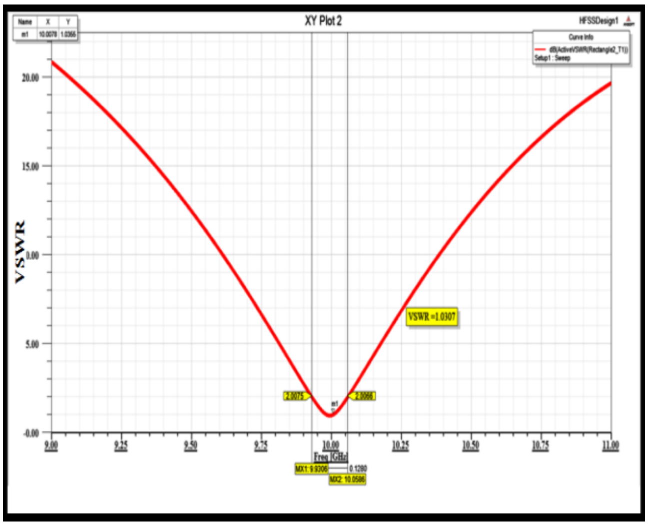


**Figure 7:** Plot of VSWR.

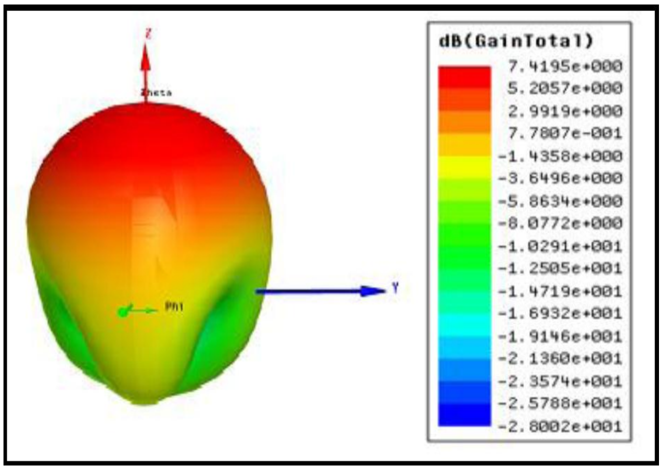


**Figure 8:** 3D polar plot of Gain

**Table 5.1:** Comparison of different parameters of edge and inset feed antenna

| Parameters | Value obtained for edge feed | Value obtained for inset feed |
|---|---|---|
| Gain(dB) | 8.14 | 7.4 |
| VSWR | 1.274 | 1.0307 |

## CONCLUSION

The VSWR obtained for the rectangular inset feed patch antenna is 1.0307 which shows impedance matching between the feed line and the patch is extremely good and impedance bandwidth of about 2.56% is obtained and return loss of about 25dB is obtained for the above designed model at f=10GHz. For 3D polar plot shows the gain obtained from the modeled Rectangular inset feed antenna. The obtained gain of the antenna is 7.4dB.

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