

# A Comparative Analysis of Two Different Directional Antennas for WLAN Applications

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**ABSTRACT:** In today's modern world microstrip patch antennas are preferred over other antennas because of their compatibility to be fit in mobile, aircraft, satellite owing to very small size. Hence design and development of superior and cost effective microstrip antenna has become an active research area. In this work, the performances of two different directional antennas are compared which has different dielectric materials and feeding techniques. The first antenna uses Roger's R04003C as its dielectric material and coaxial probe feeding technique. While the second antenna uses Arlon AD10 (tm) as its substrate and aperture coupled feeding mechanism. This paper also explains the required designing parameters of the antenna and parametric analysis such as return loss, gain and radiation efficiency are found and compared in order to find the better performing antenna.

**KEYWORDS:** microstrip patch antenna, directional, mobile, satellite, dielectric, feed techniques.

## I. INTRODUCTION

In recent years, the radio or wireless communication has become popular. The need of wireless communication has increased rapidly demanding quality of services, security, handover, high throughput, and high speed networking for extremely efficient compact devices. In the RF and microwave studies, it says that microstrip patch antenna are considered as a smart solution for compact and cost effective wireless communication systems that are used in many applications for long time. Thus nowadays microstrip antenna is getting more importance in wireless communication.

Many of the researchers are focusing on microstrip antenna because of their small size, light weight, ease of integration, low cost and convenient feeding mechanisms. By early 1980s basic microstrip antenna elements and arrays were established in terms of design and modelling. They are mostly known for their versatility in terms of possible geometries that makes them applicable in different situations. Microstrip patch antenna consists of a radiating patch on one side and a dielectric substrate which has a ground plane on other side. The patch is generally made up of conducting material such as copper and gold. However microstrip patch antenna has a drawback of narrow bandwidth. So cutting notches and slots in patches, using different dielectric materials, using different patch shapes can be done to enhance the bandwidth.

This paper reviews two different directional microstrip patch antenna having different dimensions, dielectric substrates and feeding mechanisms. This study shows if the dielectric constant is increased the gain and return loss are decreased. The feed of the antenna is optimized to get above 98% radiation efficiency. The comparative study of two directional antennas gives better values for various parameters.

## II. FEEDING MECHANISM

### A. COAXIAL FEEDING TECHNIQUE

The coaxial or probe feed is a very common technique which is used for microstrip patch antenna feeding. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch. The outer conductor is connected to the ground plane as shown in the figure 1.

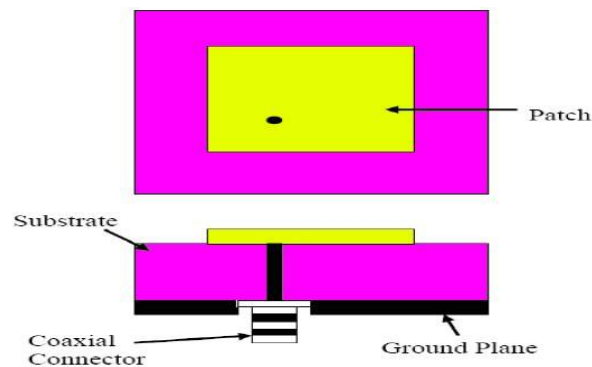


Fig 1: coaxial feed

In order to match with its input impedance the feed can be placed at any desired location inside the patch and this is the major advantage of the coaxial feed and it is easy to fabricate and has low spurious radiation. But it has narrow bandwidth as its disadvantage.

### B. APERTURE COUPLED FEEDING TECHNIQUE

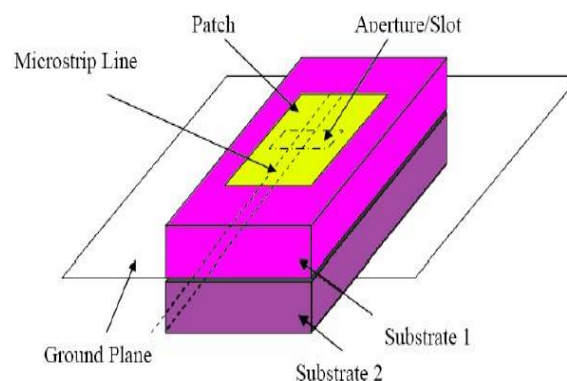


Fig 2: Aperture coupled feeding

In this feeding mechanism, the radiating patch and the microstrip feed line are separated by the ground plane. Through a slot or an aperture in the ground plane the coupling is made between the patch and the feed line. The amount of coupling from the feedline to the patch is determined by the shape, size and location of the aperture. Spurious radiation is minimized since the ground plane separates the patch and the feed line. But the fabrication is difficult due to multiple layers which also increases the antenna thickness.

### III. ANTENNA DESIGN EQUATIONS

Both the existing and proposed antenna can be design by using following equations and can find the values for dimensions of antenna. The slot length and width are important parameters to control the performance of antenna.

1. Calculation of width (W):

$$W = \frac{c}{2f_r \sqrt{\frac{(\epsilon_r + 1)}{2}}} \text{ --- (1)}$$

Where 'c' is the speed of the light ( $3 \times 10^8$  m/s) and 'f<sub>r</sub>' is the resonant frequency of the antenna.

2. Calculation of effective dielectric constant ( $\epsilon_{reff}$ ):

$$\epsilon_{reff} = \frac{(\epsilon_r + 1)}{2} + \frac{(\epsilon_r - 1)}{2} \left[ 1 + 12 \frac{h}{W} \right]^{-\frac{1}{2}} \text{ --- (2)}$$

3. Calculation of effective length (L<sub>eff</sub>):

$$L_{eff} = \frac{c}{2f_r \sqrt{\epsilon_{reff}}} \text{ --- (3)}$$

4. Calculation of length extension ( $\Delta L$ ):

$$\Delta L = \frac{0.412 * h * (\epsilon_r + 0.3) \left( \frac{W}{h} + 0.264 \right)}{(\epsilon_{reff} - 0.258) \left( \frac{W}{h} + 0.8 \right)} \text{ --- (4)}$$

Here  $\Delta L$  depend son effective dielectric constant and width to height ratio (w/h).

5. Calculation of actual length (L):

$$L = L_{eff} - 2\Delta L \text{ --- (5)}$$

By using the above design equations the following parameters value are calculated.

**Table 1**Antenna dimensions

Parameters	Values in mm	
	Antenna 1	Antenna 2
Substrate material	Roger's R04003C	Arlon AD10(tm)
Feeding technique	Coaxial probe feed	Aperture coupled feed
Substrate	63.9x37.2	64x38
Slot	40.63x3.94	40x3.2
Strip	17.84x2.51	40x1.5
Feed line length	1.96	39
Taper	0.24	0.5
Taper to short split length	4.86	5

### IV. ANTENNA CONFIGURATION

Both the antennas consist of a microstrip slot on a single dielectric medium. A reflecting ground plane is employed to achieve a unidirectional radiation pattern.

**A. GEOMETRY OF ANTENNA 1:**

In this existing antenna the slot and complimentary microstrip stub is etched on a 0.81mm thick Rogers RO4003C which has adieletric constant of 3.38 and a loss tangent of 0.0029. The antenna is fed with a standard EZ 141 coaxial cable with a centre conductor diameter of 0.91mm and a dielectric diameter of 2.99mm. The operating frequencies of this antenna are 2.45 GHz, 3.5GHzand 5.775 GHz [1].

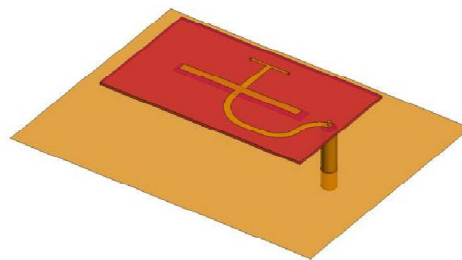


Fig 3: Simulated structure Antenna 1

**B. GEOMETRY OF ANTENNA 2:**

In this proposed method the directional antenna is etched on the dielectric substrate of Arlon AD10(tm) which has the dielectricconstant of 4.1 and a loss tangent of 0.003. The antenna uses an aperture coupled feeding mechanism. The operating frequencies of this proposed antenna are 4.4 GHz, 5.2 GHz, 6 GHz and 7 GHz.

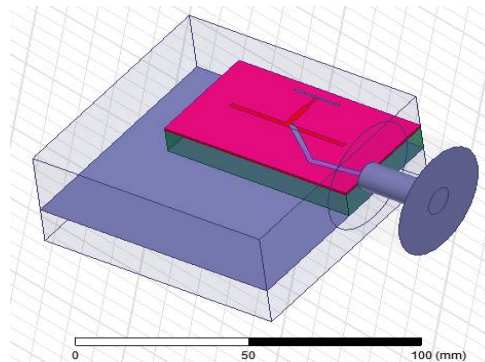


Fig 4: Simulated structure of Antenna 2

**V. RESULT ANALYSIS**

The existing antenna was designed and simulated using FEKO software package while the proposed antenna was designed and simulated using HFSS software tool. These two antennas were operating at different frequencies but in this paper the WLAN frequency, 2.45 GHz of Antenna1 and 5.2 GHz of Antenna 2 parameter values are compared.

**Table 2** Comparison of two antenna parameters

Parameters	Antenna 1	Antenna 2
Resonant frequency	2.45 GHz	5.2 GHz
Return loss	-17 dB	-28 dB
Gain	9.2 dB	7.7719 dB
Radiation efficiency	95%	99.1%

## VI. CONCLUSION

In this paper, the designing of two different directional microstrip patch antenna were investigated and also the comparative analysis is done to enhance the performance of those two antennas. After the comparison, it concludes that the second antenna has improved results. Though the first antenna has high gain, the return loss and radiation efficiency is high for second antenna which is the main factor for better performance but in future work the gain of the second antenna will be improved. Thus the comparisons of two different directional antenna for WLAN applications were studied.

## REFERENCES

- [1] "High Gain Directional Antenna for WLAN and WiMAX Applications", Marno van Rooyen, Johann W. Odendaal, Senior Member, IEEE and Johan Joubert, Senior Member, IEEE in *Antennas and Wireless Propagation Letters*, 2016.
- [2] B. Kelothu, K. R. Subhashini, and G. LalithaManohar, "A Compact High-Gain Microstrip Patch Antenna for Dual Band WLAN Applications," in *Students Conference on Engineering and Systems (SCES)*, Allahabad, Uttar Pradesh, Mar. 2012, pp. 1–5.
- [3] S. Su and C. Lee, "Low-Cost Dual-Loop-Antenna System for Dual-WLAN-Band Access Points," *IEEE Trans. Antennas Propag.*, vol. 59, no. 5, pp. 1652–1659, May 2011.
- [4] X. He, S. Hong, H. Xiong, Q. Zhang, and E. M. M. Tentzeris, "Design of a Novel High-Gain Dual-Band Antenna for WLAN Applications," *IEEE Antennas Wirel. Propag. Lett.*, vol. 8, pp. 798–801, 2009.
- [5] V. Paraforou, D. Tran, and D. Caratelli, "A dual-band supershaped annular slotted patch antenna for WLAN systems," in *The 8th European Conference on Antennas and Propagation (EuCAP 2014)*, The Hague, Apr. 2014, pp. 2365–2367.
- [6] Yeom, J. M. Kim, and C. W. Jung, "Dual-band slot-coupled patch antenna with broad bandwidth and high directivity for WLAN access point," *Electron. Lett.*, vol. 50, no. 10, pp. 726–728, May 2014.
- [7] Altair Engineering Inc., "FEKO Comprehensive electromagnetic solutions," 2015.
- [8] W. Hu, Y.-Z. Yin, P. Fei, and X. Yang, "Compact triband square-slot antenna with symmetrical L-strips for WLAN/WiMAX applications," *IEEE Antennas Wireless Propag. Lett.*, vol. 10, no. pp. 462–465, May 2011.
- [9] L. Dang, Z. Y. Lei, Y. J. Xie, G. L. Ning, and J. Fan, "A compact microstrip slot triple-band antenna for WLAN/ WiMAX applications," *IEEE Antennas Wireless Propag. Lett.*, vol. 9, pp. 1178–1181, Dec. 2010.
- [10] C.-M. Wu, C.-N. Chiu, and C.-K. Hsu, "A new non-uniform meandered and fork-type grounded antenna for triple-band WLAN applications," *IEEE Antenna Wireless Propag. Lett.*, vol. 5, no. 1, pp. 346–349, Dec. 2006.
- [11] X. Li, X.-W. Shi, W. Hu, P. Fei, and J.-F. Yu, "Compact triband ACS-fed monopole antenna employing open-ended slots for wireless communication," *IEEE Trans. Antennas Propag.*, vol. 12, pp. 388–391, Mar. 2013.
- [12] H. Huang, Y. Liu, S. Zhang, and S. Gong, "Multiband metamaterialloaded monopole antenna for WLAN/WiMAX applications," *IEEE Antennas Wireless Propag. Lett.*, vol. 14, pp. 662–665, Feb. 2015.
- [13] C. Zhou, G. Wang, J. Liang, Y. Wang, and B. Zong, "Broadband antenna employing simplified MTLs for WLAN/WiMAX applications," *IEEE Antennas Wireless Propag. Lett.*, vol. 14, pp. 595–598, Apr. 2014.