

Elevation plane $\Phi = 0^\circ$ (Phi 0°). Figures 1(a) and 1(b) show the Azimuth (Theta 90°) and Elevation 0° radiation patterns for 2450MHz while Figures 1(c) and 1(d) show the Azimuth and Elevation 0° radiation patterns for 4900MHz to 5780MHz.

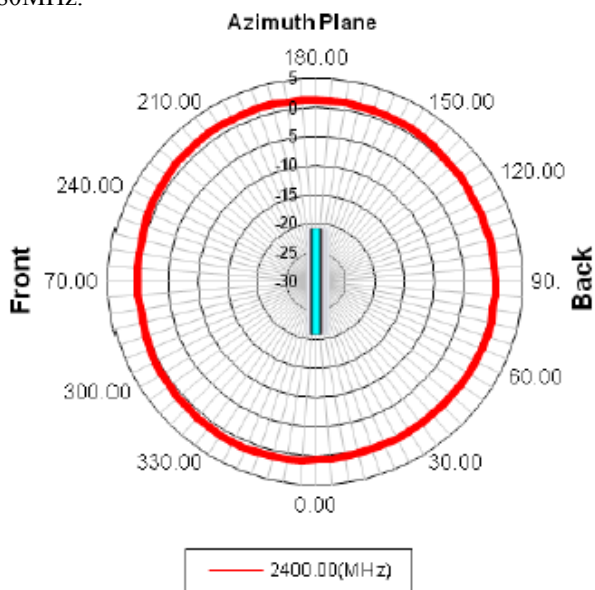


Figure 5(a)
Phi 0 Degree Plane

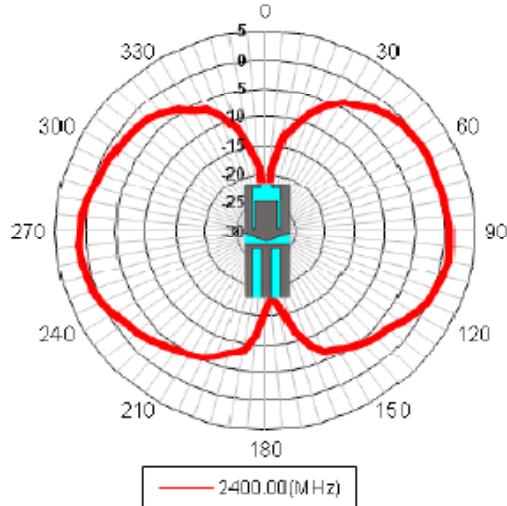


Figure 5(b)
Azimuth Plane

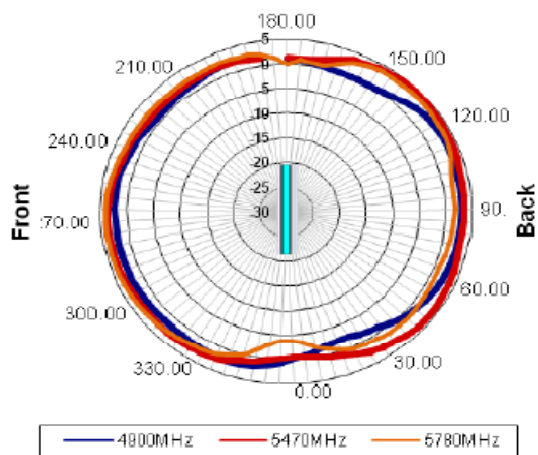


Figure 5(c)

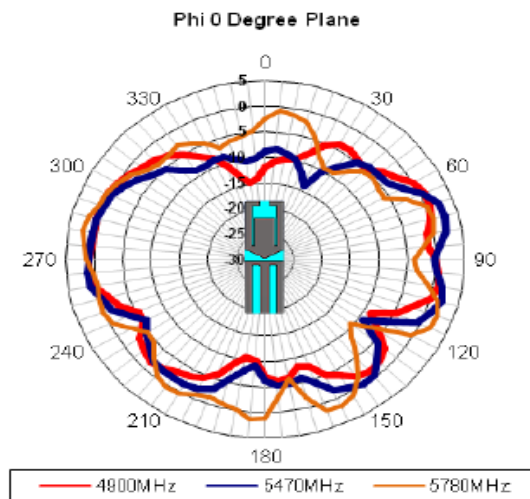


Figure 5(d)

The radiation pattern for the Azimuth plane for both low and high bands is considered to be Omni-directional. Therefore, the proposed antenna is able to detect the signal coming from every direction. It can be observed that, the radiation patterns of the Azimuth plane for both low and high bands are considered Omni-directional compared to the conventional dipole radiation characteristic because it generally radiates power uniformly in one plane with a directive pattern shape in a perpendicular plane, where this pattern is usually termed as “donut shaped”. The antenna has a surface peak gain of 2.28 dBi for low band and 6.25 dBi for high band, which is much higher than the existing techniques, meaning that the proposed antenna has good directional characteristic, which enables to radiate or receive equally well in all directions. It can be also observed from Figure 1 that, the radiation patterns of Elevation 0° on the horizontal lane for both bands are very directive as those are squinted vertically, where there is a present of side lobes. Upper portion slots from the antenna must be carefully tuned to avoid the antenna radiation pattern from squinting downward and also to make the radiation patterns tilt at horizontal. The feeding network might also have some influences on the gain variation. The antenna is configured to achieve of about 2 dBi gains for 2.4GHz and about 3 dBi to 6 dBi for 5GHz band. The proposed antenna is designed with relatively small size and can be easy to manufacture as compared to manufacture of back-to-back dipole antennas that utilize a double-sided printed circuit board. Referring to Table 1 below, the low band frequencies of 2.4GHz until 2.5GHz have an average efficiency of 82% while 89% for the high band frequencies of 4.9GHz until 5.875 GHz.

Table 1: Performance Analysis of the proposed Antenna

Frequency in MHz	Azimuth ($\theta=90^\circ$)		Elevation ($\phi=0^\circ$)		Elevation ($\phi=90^\circ$)		-10dB bandwidth in %
	Max. Gain in dB	Avg. Gain in dB	Max. Gain in dB	Avg. Gain in dB	Max. Gain in dB	Avg. Gain in dB	
2400	1.36	0.71	1.31	-4.60	1.91	-4.52	20%
2450	1.73	0.47	1.66	-4.09	1.99	-4.24	
2500	1.42	-0.21	1.75	-3.94	1.66	-4.30	
4900	3.11	1.48	1.17	-4.17	2.91	-4.13	
5150	3.12	1.38	1.20	-4.67	2.96	-5.08	
5350	3.74	2.31	1.31	-4.23	3.84	-4.19	

5470	4.42	2.79	2.65	-3.81	4.95	-3.38	33%
5710	4.10	1.20	3.77	-1.57	4.82	-1.82	
5780	4.17	2.03	2.50	2.25	4.15	-1.81	
5875	2.71	0.48	5.16	-1.38	6.21	-1.76	

Table 2: Performance Analysis of the proposed Antenna

Frequency in MHz	SWR	S11 (Return Loss) in dB	Impedance (Real) in ohms	Impedance (Imaginary) in ohms
2400	1.2952	-17.00dB	40.112	6.0979
2500	1.5314	-13.559	57.597	21.757
4900	1.2236	-19.952	54.389	9.5837
5150	1.4649	-14.489	49.763	-19.158
5350	1.3351	-16.864	38.134	-4.4182
5470	1.0412	-33.891	48.109	594.01mΩ
5725	1.5684	-13.100	40.619	-18.175
5875	1.5739	-13.936	32.080	-3.8105

The reduction of efficiency at the lower frequency band could be further improved by using a more expensive microwave substrate rather than a standard low-cost FR-4. The typical gain for low band and high band is 1.94 dBi and 6.25 dBi, which is sufficient enough to cover a wide range.

4. Conclusion & Future Scope

This study proposes a new dual-band Omni-directional antenna configuration for WLAN usage. The configuration has several desirable features, such as planar configuration, small footprint, and single layer fabrication. This paper describes the design in detail and provides sufficient parametric study results, as well as simulation and actual measurement results to validate the antenna performance. Both the simulated and the measured results show similar characteristic. With the proposed design, the achieved bandwidth of the prototype antenna is measured at 20% and 33% at low band and high band, respectively, operating over frequency ranges from 2400–2500 MHz and 4900–5875 MHz, for an acceptable VSWR ratio of 2:1. The enhanced bandwidth is achieved with parasitic elements, only by optimizing the length of the radiating elements, thus providing better bandwidth while maintaining the structural compact size. Despite of using low-cost substrate, high antenna efficiency has been obtained in this study. The overall dimension of the antenna is **51mm×16mm**; hence, this antenna can be easily integrated in embedded systems and is suitable for the IEEE standard (802.11b/g and 802.11a) of WLAN or other wireless applications. The antenna proposed in this study has not only dual-band characteristic but also has wide band characteristic at frequency of 5GHz.

The radiation pattern for the Azimuth plane has shown omni directional characteristic with peak gain of **1.73 dBi** and **2.71 dBi** at low band and high band, respectively. Most importantly, the proposed antenna provides a fair Omni-directional coverage judging from the average gain on the Azimuth plane, which is **0.48 dBi** at 5.875 GHz according to Table 1. Despite of using low-cost substrate, high antenna efficiency has been obtained in this study. The overall dimension of the antenna is 51mm×16mm; hence, this antenna can be easily integrated in embedded systems and is

suitable for the IEEE standard (802.11b/g and 802.11a) of WLAN or other wireless applications.

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