International Journal of communication and computer Technologies, ISSN: 2278-9723

Available at http://www.ijccts.org

Proximity Coupled Microstrip Antenna for Bluetooth, WIMAX and WLAN Applications

[1]S. Rohini, [2]M. Sharanya, [3]A. Vidhya, [4]S. Viji and [5]P. Poornima
[1]Electronics & Communication Engineering, VSB Engineering College, Karur, [2]Electronics & Communication Engineering, VSB Engineering College, Karur.[3]Electronics & Communication Engineering, VSB Engineering College, Karur. [4]Electronics & Communication Engineering, VSB Engineering College, Karur. [5]Assistance Professor of Electronics & Communication Engineering, VSB Engineering College, Karur

Received: 03-07-2017, **Revised:** 16-09-2017, **Accepted:** 23-11-2017, **Published online:** 30-012-2017

Abstract

This paper presents a new design of a multiband microstrip antenna with a proximity coupled feed for operating in the LTE2300 (2300–2400 MHz), Bluetooth (2400-2485 MHz), WiMAX (3.3-3.7 GHz), and WLAN (5.15-5.35 GHz, 5.725-5.825 GHz) bands. In addition, it also covers 6-dB impedance bandwidth across the UMTS (1920–2170 MHz) band. The proposed antenna consists of a corner-truncated rectangular patch with a rectangular slot, meandered microstrip feed, and defected ground plane. The antenna is fabricated using 0.8 mm thick FR4 substrate with a dielectric constant of 4.4 and has a small size of only 27x24 mm2. The antenna shows a stable gain over the operating bands and good radiation characteristics. The simulated and measured results are shown to have good agreements.

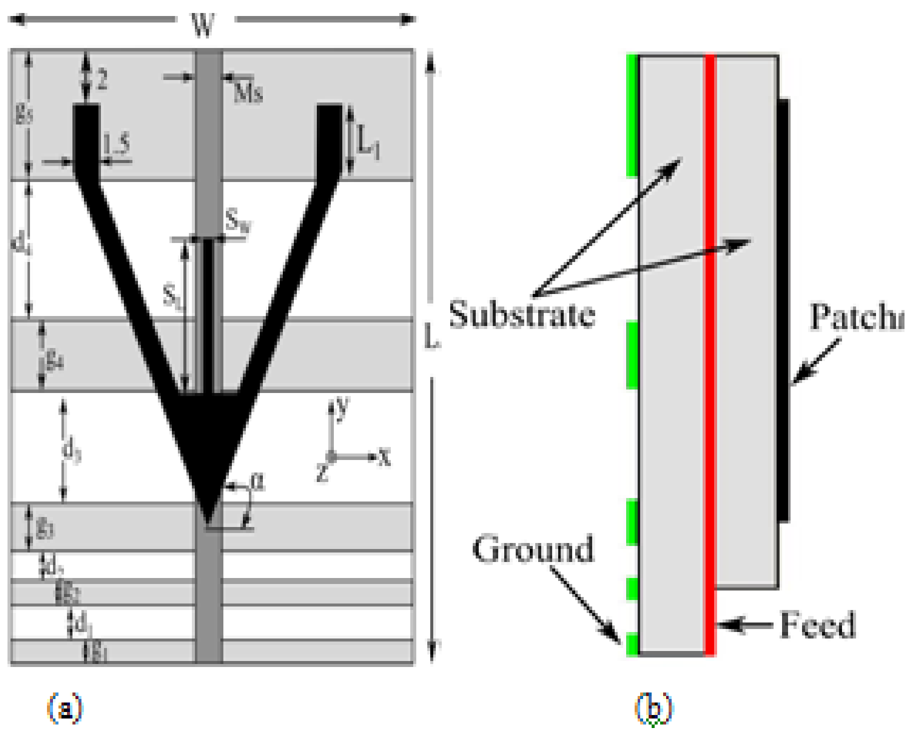
Index Terms--- Micro Strip Antenna, Proximity Coupled, Multiband.

I. INTRODUCTION

Due to rapid progress in communication system in recent years, communication technology needs antenna having light weight, low profile, superior performance and broadband operation. Wi-MAX, WLAN technologies are most rapidly growing in the area of modern wireless communication. These technologies give users the mobility to move around within a large coverage area and still be connected to the network. For the home user, wireless has become popular due to ease of installation and accessibility. So, there is continuously increasing requirements of efficient and high performance antenna. Microstrip patch antenna can full-fill these requirements. Broadband antennas are preferred to avoid using multiple antennas for different operating frequencies. Recently, with the increasing demand of Fourth Generation (4G) devices in the market, wireless communication antennas are also required to cover 4G Long-Term Evolution (LTE) frequency bands, such as Time-division LTE (TD-LTE) 2500 (2555-2575 MHz), TD-LTE 2600 (2575-2635 and 2635-2655 MHz). However, it’s a challenging task to design an antenna that will simultaneously cover TD-LTE, Bluetooth, WLAN, WiMAX bands for various communication services. The planar monopole antenna is one of the promising candidates often adopted to realize multiband operation. Complementary split-ring resonators have been used in monopole antenna to get multiband performance. While several strips are introduced in the radiating patches of a monopoleto generate multiple resonant modes. Other multiband antennas are Planar Inverted-F Antenna (PIFA) where radiating elements are modified by introducing slots to create multi-resonant paths for multiple frequency bands. Using open arms and ground slots of Coplanar Inverted-F antenna, multiband was achieved. Compact Inverted-F antenna is reported. However, fabrication of such three dimensional structure is difficult.An advantage of proximity coupling is that it provides large bandwidth and low spurious radiation. The use of proximity coupling further allows flexible feed line design. A proper feed line can then be chosen to excite the preferred resonating modes and for the impedance matching. Very few multiband antennas fed by proximity coupling are designed. Moreover, a corner-truncated rectangular patch with a rectangular slot at its centre is used for impedance matching. This antenna covers all the standards of Bluetooth, WiMAX, and WLAN bands.

II. ANTENNA DESIGN AND ANALYSIS

The configuration of the proposed multi-band antenna is shown. The antenna is designed by using two FR4 layers having a thickness of 0.8 mm each. The relative permittivity of the substrate is 4.4. Length of the upper layer is slightly smaller than the lower layer in order to keep a provision for connection of inner conductor of a SMA connector. In order to optimize the antenna dimensions, simulations are carried out using the 3D full-wave software MATLAB. Simulation starts with the mid-layer micro strip feed and the bottom plane parasitic strips. The width of the buried micro strip feed line corresponds to 50 Ω. Initially, the upper substrate layer is placed without the top plane V-shape patch. Metal on the bottom of the upper layer is fully etched out.



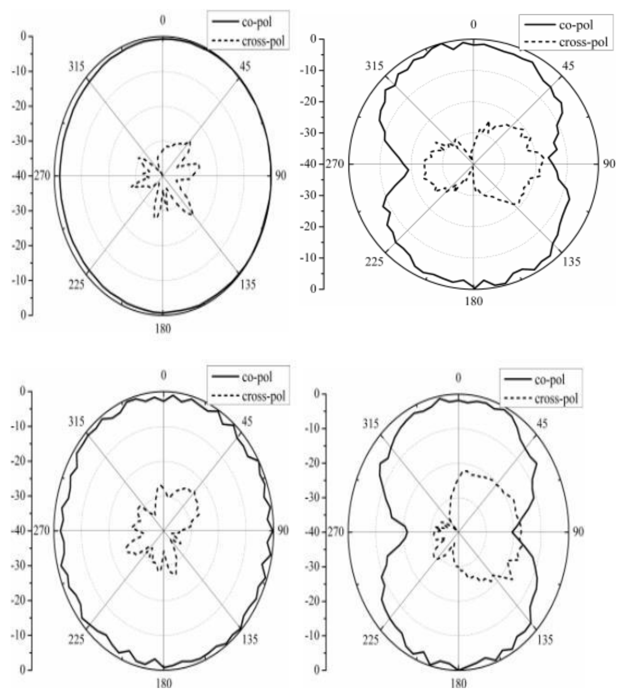
Configuration of the Proposed Antenna (a) top (Bottom Layer, Mid-Layer and top Layer Metal Parts are shown by Gray, Hashed, and Dark Portions), and (b) Side View.

In the bottom plane, the metal strip having width g1 is used as ground. Resonating parasitic structure with four strips having width g2, g3, g4, and g5 have been used in the bottom plane. The far end of the microstrip feed line is open-circuited. It behaves as a quarter wave monopole for the Bluetooth band. Its dimension is taken as λg/4, where λg is the buried microstrip line guided wavelength at 2.4 GHz. The widths of the parasitic strips of the bottom plane are optimized to minimize the input mismatches. The corresponding |S11| is shown in Fig. 2. Next, the V-shaped patch is introduced at the top plane. The width of the middle section where two arms of the V-shape patch joins is wider than the rest part. Therefore, it behaves as a stepped-impedance resonator and provides two more resonating frequencies at 3.7 GHz, and 5.1 GHz. Its dimensions are optimized to obtain the desired resonating frequencies. To obtain another resonance frequency for the WLAN band, an additional rectangular strip is introduced in the middle of the V-shaped patch. As shown, this modification produces one more resonating mode at 5.7 GHz. But at the same time, it shifts the previous bands to 3.5 GHz and

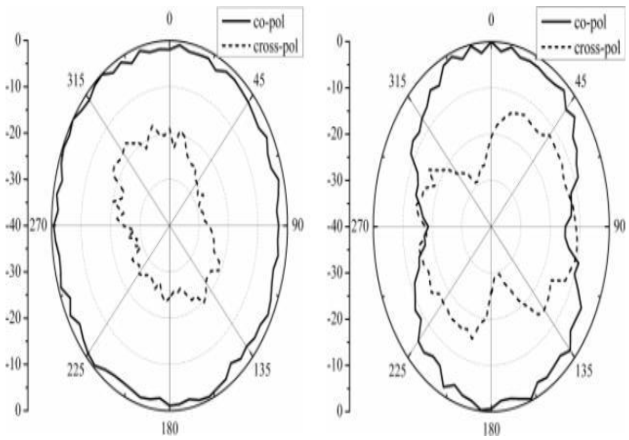
5.2 GHz, respectively. None the less, together with the V-shape patch, it helps to cover the whole WLAN band. So, proximity coupling is used for the WiMAX and WLAN bands while a resonant quarter wave monopole for the Bluetooth band. The impedance matching over the band can be controlled by the width SW. Impedance matching also can be controlled by the bottom plane strip g4. Other parasitic strips are used for fine tuning of input impedances simultaneously at the Bluetooth, WiMAX, and WLAN bands. The position and size of the strips are so chosen that the antenna can cover all the bands of interest keeping its size small. The effect of d2, d3 and g5 variations is shown. Keeping the other dimension fixed, the lower resonance frequency corresponding to the WLAN band decreases with an increase in d2 and decrease in d3. As a result, the bandwidth increases. It is observed that the bands of Bluetooth and WiMAX can be controlled simultaneously by tuning the width g5 with a minor change in the WLAN band. The final antenna parameters are W = 24 mm, L = 27 mm, L1 = 3 mm, Ms = 1.1 mm, SW=0.6 mm, SL = 7 mm, α = 63°, g1 = 1 mm, g2 = 1 mm, g3 = 2 mm, g4 = 3 mm, g5 = 5.5 mm, d1 = 1.5 mm, d2 = 1.5 mm, d3 = 5 mm, d4 = 6.5 mm. The simulated average current distributions on the proposed antenna and the SMA feed at 2.4 GHz, 3.5 GHz, 5.2 GHz and 5.7 GHz are shown in Fig. 6. Surface current distribution on the top patch and feed line at 2.4 GHz confirms that the feed line behaves as a quarter wavelength monopole having maximum current density at the feed end. No resonant mode is excited on other strips and top patch. On the other hand, at 3.5 GHz, 5.2 GHz, and 5.7 GHz surface current distributions show different resonant modes on the top patch. Strong surface current density on the middle strip of the V-shape patch indicates its role in obtaining the resonance at 5.7 GHz. Also the presence of strong surface currents on the microstrip feed line suggests that it should be considered as a part of the resonator. In all the cases, the current density on the outer surface of the outer conductor of the SMA is small. As a result, it is observed that the effect of returning ground current on the input matching levels is minimal.

III. Results and Discussion

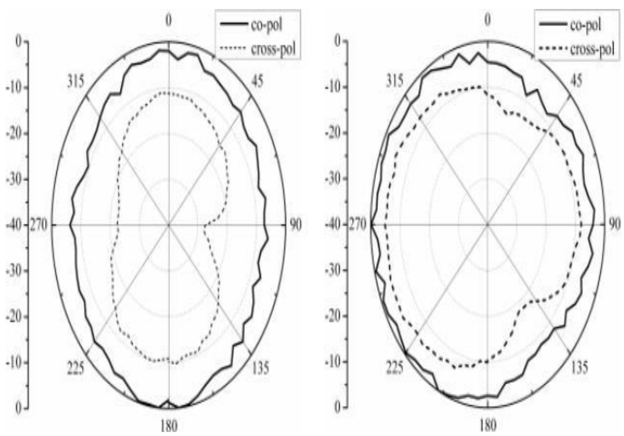
A photograph of the fabricated antenna with the dimensions as listed above. The measured and simulated result for the reflection coefficient of the proposed antenna is shown in Fig. 8. The reflection coefficient magnitude was measured using an Agilent N5242A vector network analyzer. As shown in the figure, measured -10 dB input matching bandwidth cover 2.4-2.55 GHz, 3.35-3.65 GHz and 5-5.95 GHz. The simulated results are in close agreement with those by measurement.



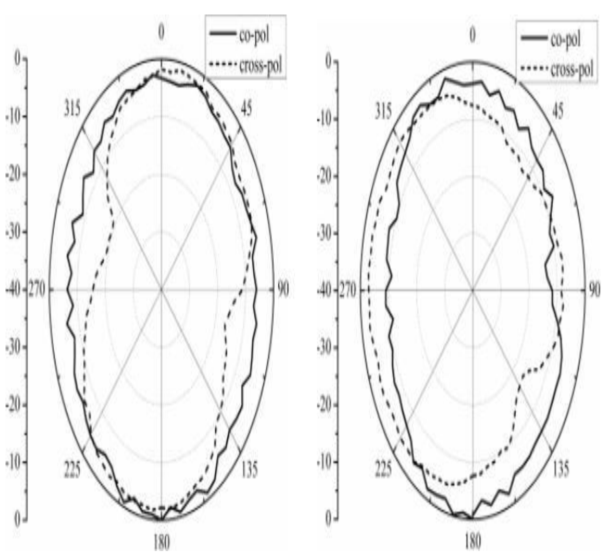
(a) (b)



c)



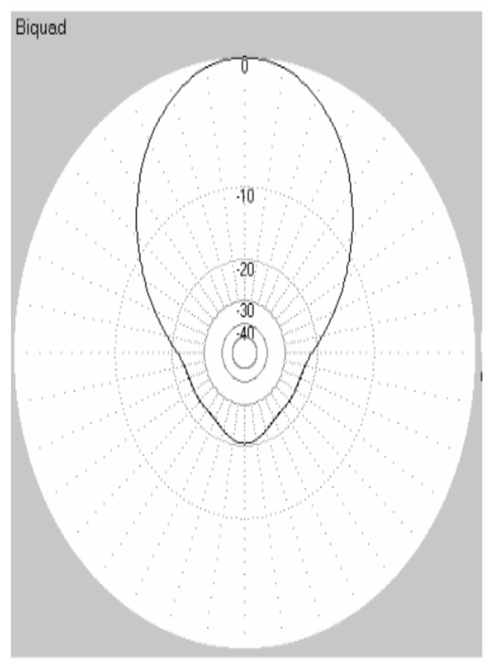
(d)

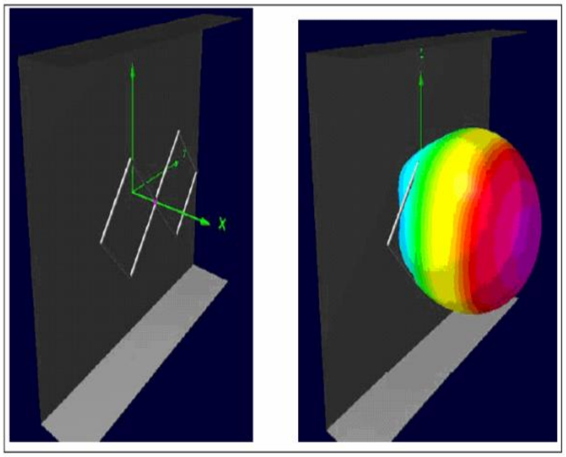


(e)

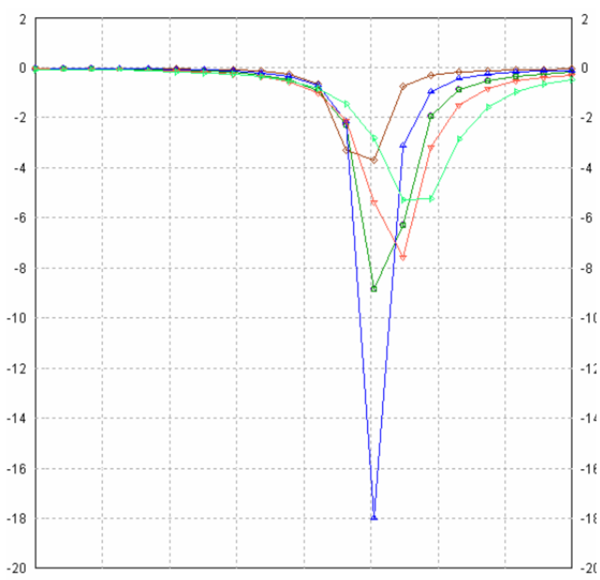
Measured radiation pattern in H-plane (xz-plane, left) and E-plane (yz-plane, right) at (a) 2 GHz (b) 2.4 GHz (c) 3.5 GHz (d) 5.25 GHz (e) 5.725GHz.

The measured far-field normalized radiation patterns of the proposed multiband antenna at different operating frequencies are shown in Fig. 9. It is observed that the radiation patterns look like those of a dipole placed along y-axis. Low level of cross-polarization is obtained. The radiation patterns remain consistent over all the operating bands. The measured and simulated gain and radiation efficiency of the antenna are shown in Fig. 10. The gain of the antenna was measured at far field in an anechoic chamber using the substitution method. The antenna gain shows a stable performance over the proposed bands. Slight mismatch above 5 GHz is attributed to the small returning ground current present on the outer surface of the SMA feed.





2D Radiation Pattern Antenna3d Radiation Pattern of Antenna



Return loss

IV. Conclusion

A novel configuration of small size multiband microstrip antenna is presented that exhibits simultaneous operation at UMTS, LTE, Bluetooth, WIMAX, and WLAN bands. The multiband behaviour has been achieved due to slotted ground plane and meandered microstrip feed. The radiation patterns are almost omnidirectional. These features make the antenna a good candidate for the modern wireless communication applications. Good agreement between the simulated and measured results is obtained. The size of the antenna is almost equal to multiband antenna proposed and is compact in size as compared with previous works. It is easy to fabricate also. It provides WLAN band separately at 5.2 GHz and 5.8 GHz, which is not observed.

References

[1] Basaran, S. C., Ulgur Olgun, and Kubilay Sertel. "Multiband monopole antenna with complementary split-ring resonators for WLAN and WiMAX applications." *Electronics Letters* 49.10 (2013): 636-638.

[2] Yoon, Joong Han, Young Chul Rhee, and Yeon Kil Jang. "Compact monopole antenna design for WLAN/WiMAX triple-band operations." *Microwave and Optical Technology Letters* 54.8 (2012): 1838-1846.

[3] Mehdipour, Aidin, et al. "Compact Multiband Planar Antenna for 2.4/3.5/5.2/5.8-GHz Wireless Applications." *IEEE Antennas and Wireless Propagation Letters* 11 (2012): 144-147.

[4] Lu, Jui-Han, and Wen-Chieh Chou. "Planar dual U-shaped monopole antenna with multiband operation for IEEE 802.16 e." *IEEE Antennas and Wireless Propagation Letters* 9 (2010): 1006-1009.

[5] Lu, Jui-Han, and Wen-Chieh Chou. "Novel design of planar multi-band u-shaped monopole antenna with compact operation for WiMAX application." *Microwave Conference Proceedings (APMC), 2010 Asia-Pacific*. IEEE, 2010.

[6] Lu, J-H., and B-J. Huang. "Planar multi-band monopole antenna with L-shaped parasitic strip for WiMAX application." *Electronics Letters* 46.10 (2010): 671-672.

[7] Zuo, Shaoli, Yingzeng Yin, and Zhiya Zhang. "A coupling-fed multiband antenna for WLAN/WiMAX applications." *Microwave and Optical Technology Letters* 52.6 (2010): 1283-1286.