Design of Novel Microstrip Patch Antenna for Dongle Applications

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Abstract — A novel couple-fed dual-bands MIMO antenna isproposed for WLAN 2.4/5.2/5.8 GHz bands. The MIMO antenna system consists of two parallel folded branch monopoles with an edge-to-edge separation of 0.2 mm. The antenna elements are printed on an FR4 substrate and are located at the top edge of the ground plane. Size of the antenna is 20 mm (W) × 11 mm (L). The isolation is achieved by introducing a round off-set structure at the end of the coupled feeding-line. Measured results show that antennas have good impedance matching and port isolation. Since we have not introduced any isolation enhancing structure, the MIMO antenna appeared to have a built-in decoupling mechanism. When one end was fed, the current distributions on the other feed line was reduced in magnitude by a self generated counter current occur at the round off-set structure area. That is, the self generated counter current has contributed the needed isolation between the two antennas.

Keywords:- Couple-fed, Off-set, MIMO, decoupling, isolation

I. INTRODUCTION

Planar multi-antennas structure and a small ground are very attractive for wireless local area network applications. On the other hands, the non-contact feeding such as proximity coupling and aperture coupling have become a popular type of solutions to broaden antenna band-width. In particular, proximity coupling is one of the most utilized methods in microstrip antenna design. Recently, the use of multi-element antennas, such as multiple-input multiple-output (MIMO) antenna, was one of the effective ways to improve reliability and to increase the channel capacity of the communication systems. For multi-channel wireless communication systems, it is essential that the designed multi-antenna would have high isolation between the antenna ports. Several methods ofimproving antenna port isolation had been reported, including incorporating a protruded ground plane between the antennas inserting slits into the ground , arranging antenna shorting portions facing each other, manipulating radiation polarization of the antennas, using differential ground path, using strip resonator as a wave-strapstylesarebuilt-in.

In this article, we proposed a built-in isolation/decouplingmethod to improve the performance (such as throughput) of two-antenna system for WLAN 2.4/5-GHz bands applications.

The proposed MIMO antenna consists of two parallel folded and couple-feed monopole antennas. The antenna occupies a small area of 11 mm (L) × 20 mm (W). The antenna and the ground are printed on the two-layered FR4 substrate with the dimensions 20 mm (W) × 56 mm (L). The antenna is excited at dual radio frequency (RF) ports for 2400~2484/5150-5835

MHz bands operations. To improve the isolation characteristic, the isolation/decoupling mechanisms were studied and presented.

II. ANTENNA CONFIGURATION

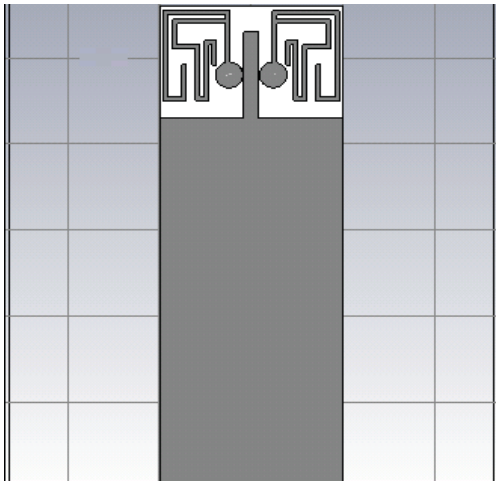
Figure 1 shows the geometry and photo of constructed prototype for the proposed two-monopole-antenna system,which includes two branchfolded coupled monopoles etched on the front layer and two direct-excited monople etched on the bottom layer of a 0.8-mm-thick FR4 substrate with dimensions 20 mm (W) × 56 mm (L). More details of the two monopoles are given in figure 2. The antennas are fed by two 50microstrip lines of width 1.5 mm on the bottom FR4substrate, which is suitable for a general USB dongle. The coupled feeds have different structure[12], that have a round off-set coupled feed at the end of the feeding-line. The twomonopoles are printed on the top layer of the ground planemonopoles are printed on the top layer of the ground planeand designed in a clearance area (no grounding layout and electric components therein) of size 20 mm (W) × 11 mm (L).The two monopole are also identical in size and symmetrically placed with respect to the PCB center line. Accordingly, it is expected that the performance of each monopole should be the same...

In this design, the dual-frequency operations obtained by loading a meandered branch wire, which denselymeandered to achieve a compact configuration and a very low profile. One end of the strip is nearby the coupled feeding line, and the other end, the branch strip is folded internal of the monopole. The total length of

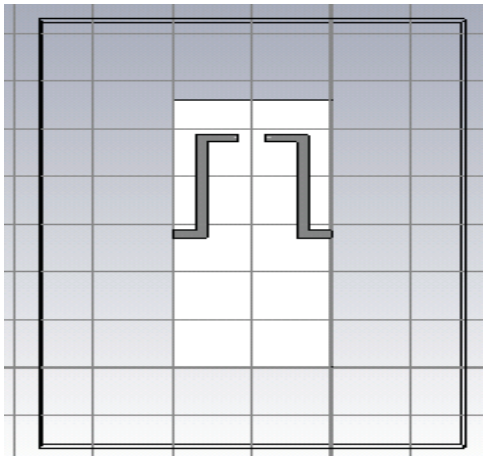
branch 1 and 2 (point A to C and point B to D) are about 34 mm, whereas that of branch 3 and 4 (point A to E and point B to F) are about 32 mm designs, respectively. It is observed from experiments that, the branch antennas are verified, the lower band at about 2440 MHz can be excited with impedance.

MIMO technology has been proposed for several years, which significantly improves the performance of wireless communication systems . In these systems, antennas play an important role, since antenna's features are inherently included in the communication channel between the transmitter and the receiver. Especially, mutual coupling between antenna elements not only affects the antenna efficiency but also influences the correlation. At the base station, low mutual coupling is easy to be realized where element separations are always many wavelengths. However, for mobile terminals, acquiring low mutual coupling will be difficult owing to limited volume.

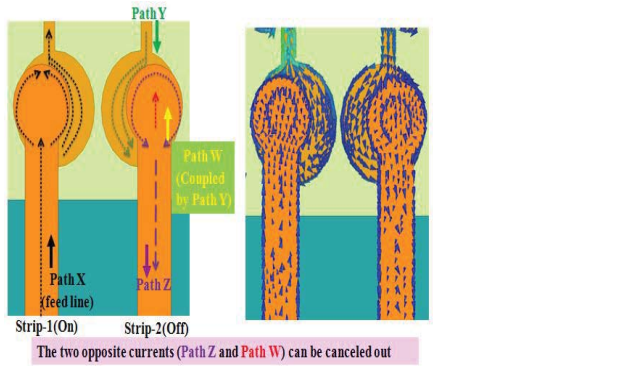
In addition, a capacitive coupling feed is proposed to assist bandwidth to easily cover the 2.4/5 GHz bands operation .The capacitive feed is basically composed of a round section connecting the feeding-line, the feeding capacitor is formed from a truncated micro-strip transmission line with the round section and all its open edges by terminal or edge capacitances. The Total length of the feeding strip is chosen to be 4.18 mm on the top side of the bottom FR4 substrate. The distance between the two feeding portions is set to 0.2 mm for good impedance and isolation matching. In this design, the feeding strip excites two different surface current paths and thus two opposite surface current can be suppressed by each other, which may have contributed the needed isolation between the antennas. For multi-channel wireless communication systems, it isessential that the designed multi-antenna would have high isolation between the antenna ports. Several methods of improving antenna port isolation had been reported, including incorporating a protruded ground plane between the antennas, inserting slits into the ground, arranging antenna shorting portions facing each other , manipulatingradiation polarization of the antennas , using differential ground path , using strip resonator as a wave-strap, adding a decoupling neutralization line, and soon.



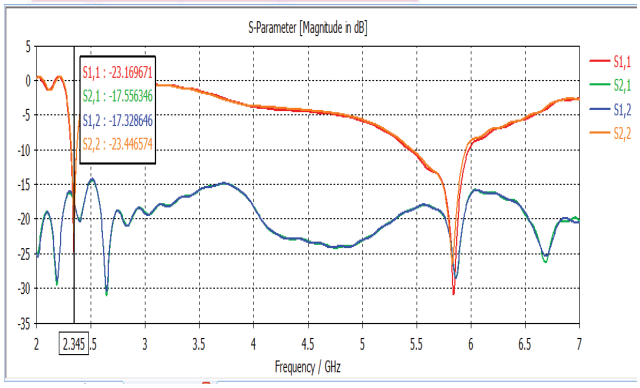
Front view



Back view



Current Distribution



S-Parameters

III. RESULTS AND DISCUSSION

Figure shows the measured reflection coefficients (S11 monopole 1) and the isolation (S21) between the two monopoles. The isolation is only presented by the curves of S21 due to the symmetrical structure of the proposed design. Generally, the measured S11 of the proposed antennas over
the 2.4/5-GHz (2400-2484/5150-5835 MHz) bands are below -7.5dB (about VSWR of 2.5), which meets the demanded bandwidth specifications for WLAN (2.4/5.2/5.8 GHz bands) operations.

IV. CONCLUSION

A printed two monopole-antenna system with built-indecoupling mechanism has been proposed and tested in the 2.4/5.2/5.8-GHz bands. The antenna system is of coupled feeds and occupies on a cleared area of 11 mm (L) × 20 mm (W) off from the PCB general ground plane. In this case, the antenna feeding network can be placed on the ground plane for practical applications. Unlike the conventional MIMO antennas which require complicated structure to facilitate decoupling (isolation), the antenna port correlation coefficient as shown is less than about 0.02 without any additional isolation enhancing structure in between. The return loss coefficients were also studied and measured in a reverberation chamber. The antenna impedance matching for both the operating bands has resulted in VSWR of below 2.5. The surface currents were obtained from simulation, and were studied in detail in orderto understand their impacts on the performance of the antenna system.

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