

Multiband MIMO Antenna with a Band Stop Filter for High Isolation Characteristics

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Introduction

A multiple-input multiple-output (MIMO) antenna system is a well-known technique to enhance the performance of wireless communication systems. Channel capacity of a MIMO antenna system is much larger than that provided by a conventional wireless system [1, 2]. However, it is very challenging to place multiple antennas closely into a small and slim mobile handset while maintaining good isolation between antenna elements since the antennas are strongly coupled with each other and even with the ground plane by sharing the surface currents distributed on it. So far, many researchers have been trying to find new techniques for isolation improvement between antenna elements inside mobile handsets. Although several techniques have been reported for high isolation characteristics by employing photonic band gap (PBG) structure [3], defected ground structure (DGS) [4] and spur-line and coplanar stripline (CPS) structure [5], it is still quite difficult for antennas to obtain good isolation at long term evolution (LTE) bands in that two antennas are very closely located due to the limited antenna space in a mobile handset.

In this paper, we propose the method to improve the isolation performance of two-antenna systems for LTE terminals. The proposed multiband MIMO antenna consists of two dual-band PIFAs which provide wideband characteristics. In order to improve the isolation characteristic at the LTE band, a band stop filter was inserted at the corner of each antenna element. The inserted band stop filter is to suppress the surface currents at the specific frequency band. The designed multiband MIMO antenna has been successfully implemented and experimental results are presented and discussed.

Antenna Design and Experimental Results

The geometry of the proposed multiband MIMO antenna for 4G system is shown in Fig. 1. A wide folded patch structure along with the strong coupling between feeding and shorting lines through the slot reduce the size as well as widen the bandwidth in low frequency band near 750 MHz. The overall size of the radiating element is $36 \times 12 \times 8 \text{ mm}^3$. Two same elements are placed at the top and bottom sides of a FR4 ($\epsilon_r = 4.4$) substrate having volume of $48 \times 108 \times 0.8 \text{ mm}^3$, which simulates the ground plane of a practical bar type mobile handset. In order to improve the isolation characteristic at the LTE band, a band stop filter was inserted at the corner of each antenna element.

The S-parameter characteristics with and without the inserted band stop filter are given in Fig. 2. It is shown that simulated s-parameter characteristics are similar to those of measurement. Without the band stop filter, the MIMO antenna has the isolation characteristic of about 2 dB at LTE band and higher than 15 dB at mobile-worldwide interoperability for microwave access (M-WiMAX) band. When the band stop filter is

added, the simulated isolation characteristic at LTE band is increased by 15 dB as shown in Fig. 2. Simulation was carried out with the aid of the commercially available simulation software MWS [6] to optimize the geometric parameters of the proposed antenna. The two antenna elements have very narrow bandwidth of 30 MHz at the LTE band and sufficient bandwidth at the WCDMA/HSDPA/M-WiMAX band, respectively. The additional study is required to widen the bandwidth at the LTE band and to enhance antenna gains and radiation efficiencies at the LTE band.

The measured radiation patterns of the designed multiband MIMO antenna are shown in Fig. 3. Although MIMO antenna elements usually have different directivity for each element, the radiation patterns of the designed antennas resemble each other. From the data in H (xz)-plane, it is confirmed that the antenna has omni-directional radiation patterns in all frequency bands. The simulated and measured gains are shown in Table. 1. The measured peak gains of two antenna elements are -7.5 dBi and -6.4 dBi at the LTE band, 3.5 dBi and 2.9 dBi at the WCDMA /HSDPA band and 4.2 dBi and 3.5 dBi at the M-WiMAX band, respectively.

Conclusions

In this paper, an internal multiband MIMO antenna with high isolation characteristic for LTE/WCDMA/HSDPA/M-WiMAX applications was proposed. A band stop filter is added at the corner of each radiating elements in order to enhance the isolation characteristic at LTE band. The fabricated antenna has the isolation of about 24 dB at the lower band and higher than 13 dB at the higher band. The measured peak gains of two antenna elements are -7.5 dBi and -6.4 dBi at the LTE band, 3.5 dBi and 2.9 dBi at the WCDMA/HSDPA band and 4.2 dBi and 3.5 dBi at the M-WiMAX band, respectively. The simulated and measured results show that the proposed multiband MIMO antenna could be a good candidate for 4G mobile systems.

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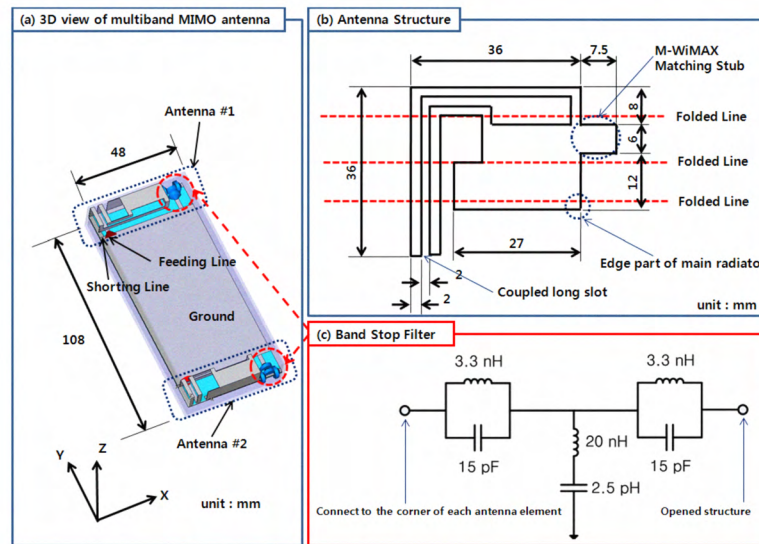


Figure 1. Geometry of proposed multiband MIMO antenna for 4G systems

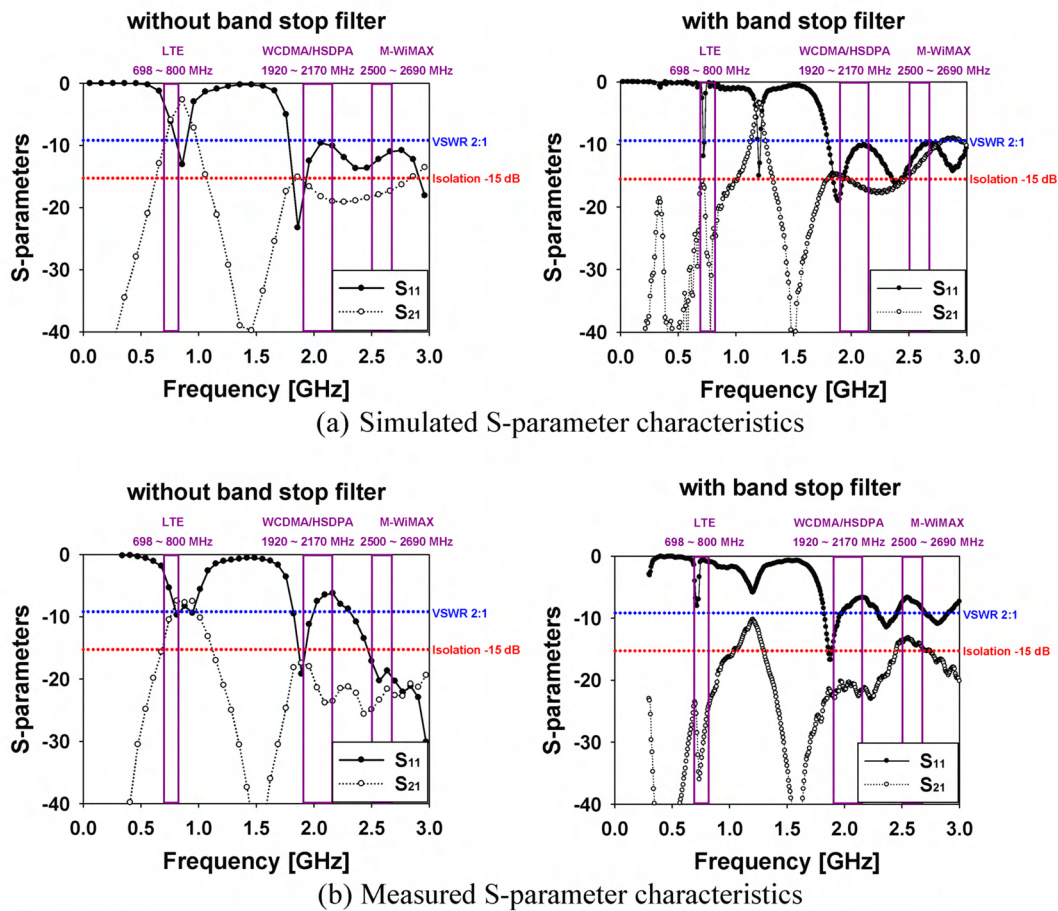
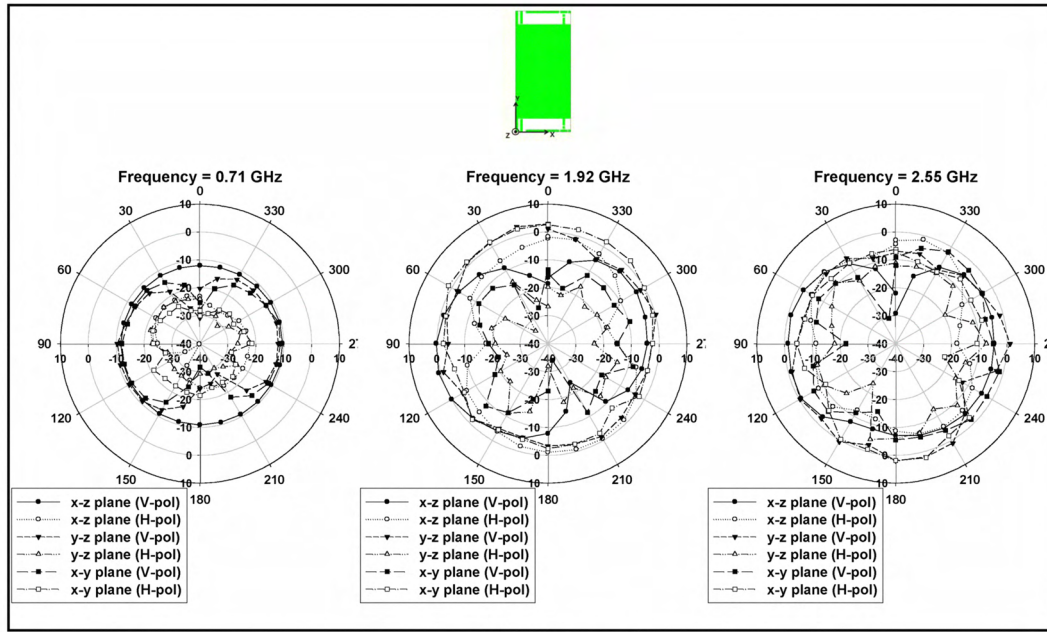
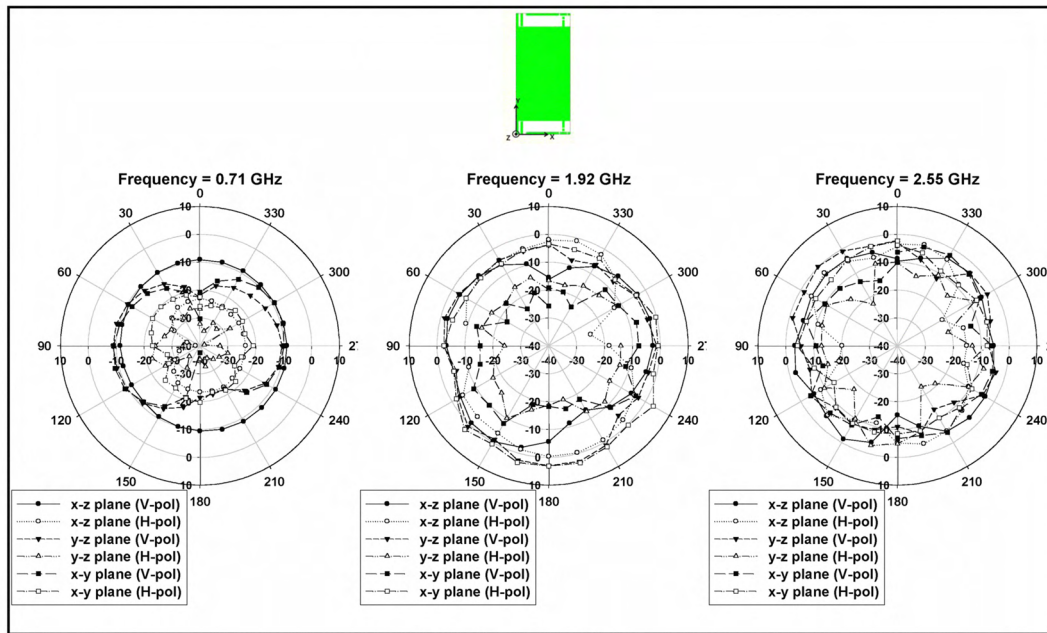


Figure 2. S-parameter characteristics without and with band stop filter



(a) Antenna #1



(b) Antenna #2

Figure 3. Measured radiation patterns of the proposed multiband MIMO antennas

Table 1. Simulated and measured antenna gains

Simulated Antenna Gains (dBi)	f=0.71 GHz	f=1.92 GHz	f=2.55 GHz
Antenna #1	-3.65	2.36	2.83
Antenna #2	-3.65	2.36	2.83
Measured Antenna Gains (dBi)	f=0.71 GHz	f=1.92 GHz	f=2.55 GHz
Antenna #1	-7.5	3.5	4.2
Antenna #2	-6.4	2.9	3.5