Wide-/Dual-Band Omnidirectional Dielectric Resonator Antenna with Filtering Function

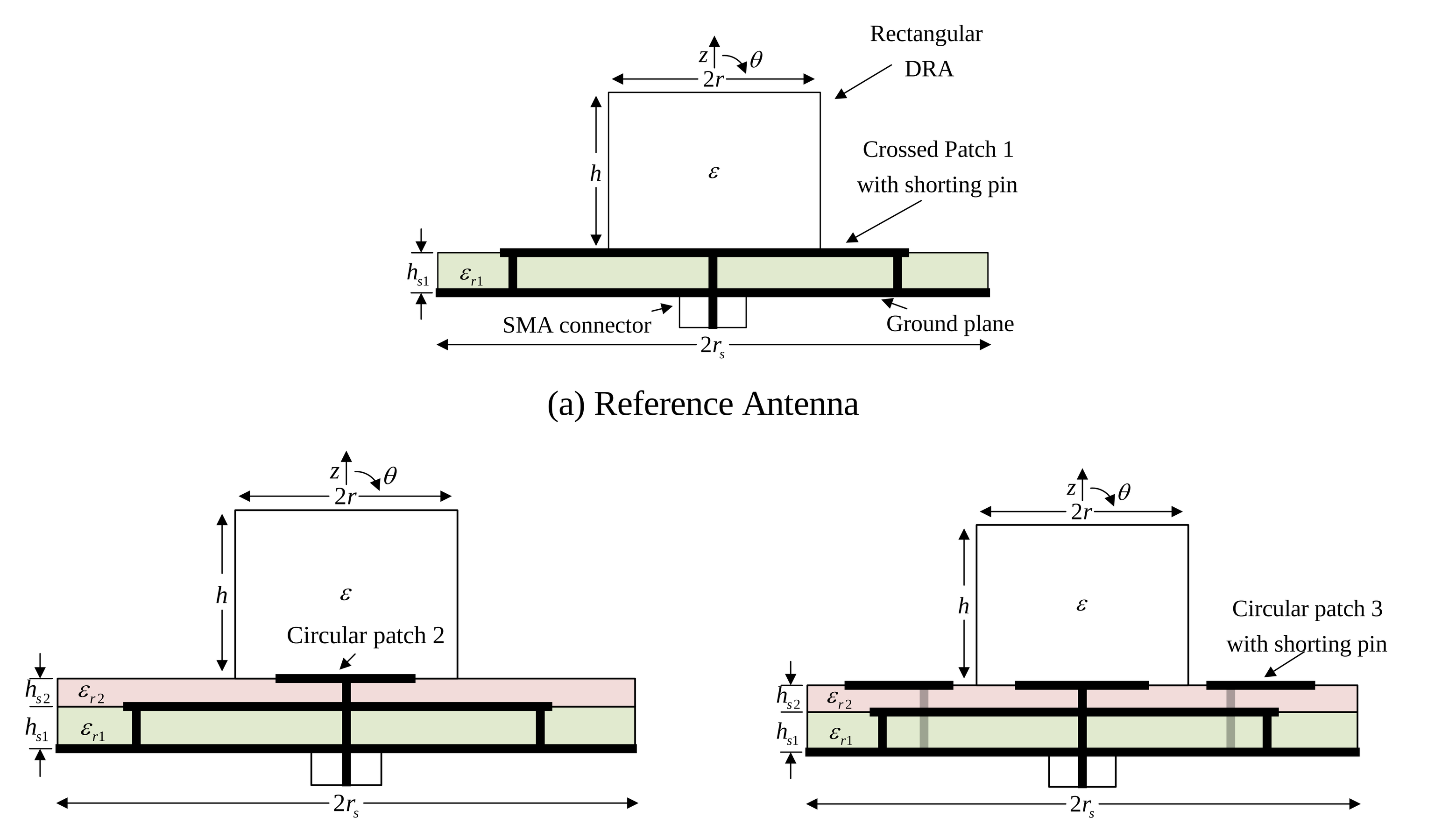
Hong-Cheng Li[1], Dong-Sheng La[1], Chao Zhang[1]

1 School of Computer and Communication Engineering, Northeastern University at Qinhuangdao

Introduction

Radio frequency (RF) transceiver system plays a huge role in wireless communication system. At the same time, filters and antennas are indispensable important devices in RF transceiver system. Therefore, many microwave scholars have been committed to the development and design of better performance, stable and reliable passive devices. In recent years, it has become a trend to combine filters and antennas to study filtering antennas. This fusion design technology can not only greatly reduce the size of RF equipment, but also reduce the insertion loss caused by the cascade of filters and antennas. Therefore, many high performance microstrip patch filtering antennas and slot filtering antennas are designed and fabricated. In recent years, the dielectric resonator antennas (DRA) have been widely studied by many scholars. Compared with the traditional microstrip patch antenna or slot antenna, the dielectric resonator antenna has the advantages such as easy excitation, almost no metal loss, and high design freedom.

This paper proposes wide-/dual-band omnidirectional filtering DRAs based on the fusion design method. The dielectric resonator, which locates at double layer substrate, is excited by a circular microstrip patch and doesn't need drill a hole in the dielectric resonator. With the microstrip patches located on upper- and lower-layer substrate, the bandwidth is extended and two RNs are generated. Finally, good filtering performance and omnidirectional radiation characteristic are realized.

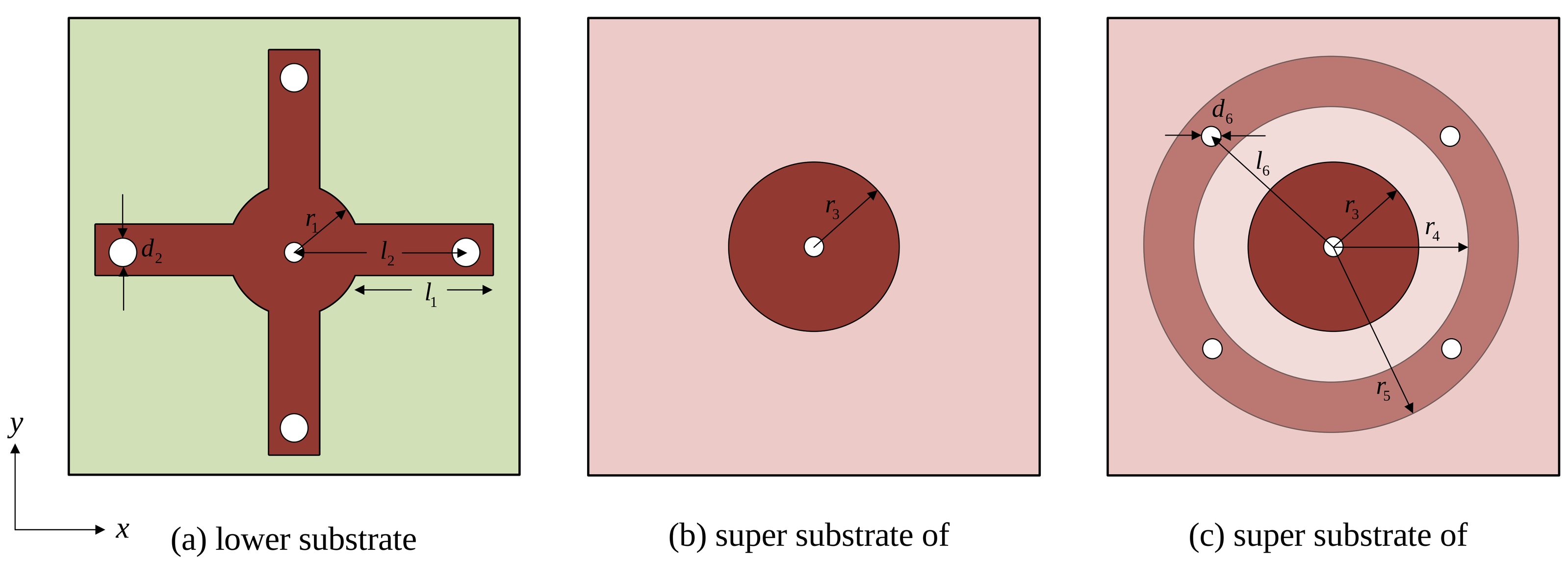


(a) Reference Antenna

(b) Proposed Antenna 1

(c) Proposed Antenna 2

Fig.1. Geometry of the reference and proposed antennas.



(a) lower substrate

(b) super substrate of the proposed DRA 1

(c) super substrate of the proposed DRA 2

Fig.2. Vertical view of the Proposed Antennas.

Antenna Configuration

The geometry of the proposed antennas and the reference antenna are shown in Fig.1 and Fig.2. As shown in Fig. 1(a), the rectangular DRA is excited by a planar microstrip crossed patch 1 with four shorting pins. The microstrip line structure of the proposed omnidirectional DRA 1 are shown in Fig. 2(a) and Fig. 2(b). Fig. 1(c) shows the proposed dual-band omnidirectional DRA 2. The microstrip line structure of DRA 2 are shown in Fig. 2(a) and Fig. 2(c). Compared with DRA 1, the DRA 2 has a circular microstrip patch 3 with four shorting pins. The reflection coefficients and realized gains of two DRAs are shown in Fig. 3. All the three antennas have been simulated by using the high frequency structure simulator.

Through above structure, the number of resonant modes has been increased, and the bandwidth of the antenna is extended. What's more, two RNs are obtained on the pass-band and are used to improve the filtering performance of the two pass-bands.

Measured Results

Fig. 3(a) and (b) are the simulated results of the reference and proposed antennas. The red dotted line is the simulated results of the reference DRA and the black solid line is the simulated results of the proposed DRA 1. Compared to the reference DRA, the bandwidth of DRA 1 is extended and a RN is obtained at the edge to improve the filtering response. The simulated pass-band bandwidth of the proposed DRA 1 is 42% (2.18~3.34 GHz). What's more, the simulated peak gain is 1.94 dBi, and the out-of-band suppression level of about 20 dB is realized. The blue dash-dotted line represents the simulated results of the proposed DRA 2. The circular microstrip patch 3 with four shorting pins, located on the top substrate, introduces a RN at 2.67 GHz. As shown in Fig. 3, the simulated pass-band bandwidths are 15.5% (2.08~2.43 GHz) and 12.5% (2.92~3.31GHz), the simulated peak gains are 1.15 and 0.6 dBi for the first and second bands and two RNs are generated at 2.67 and 3.84 GHz. The two RNs can improve the filtering performance and the suppression level.

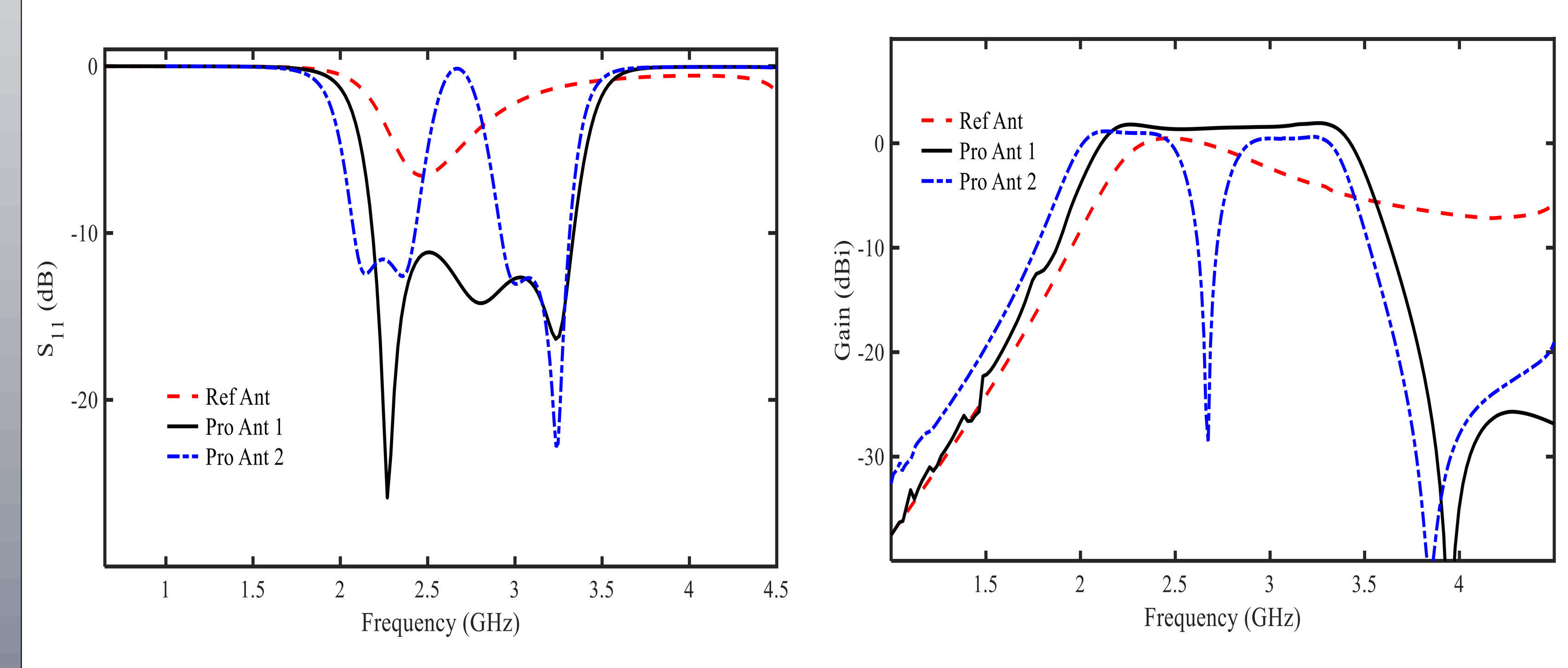


Fig.3. The simulated reflection coefficients and realized gains of the reference and proposed antennas.

Conclusions

The proposed wide-band DRA1 has a wide impedance bandwidth of 42% (2.18~3.34 GHz), a flat gain within the pass-band and the filtering function. The proposed dual-band DRA2 has the simulated impedance bandwidths of 15.5% (2.08~2.43 GHz) and 12.5% (2.92~3.31GHz).