2-Port Dual Band PIFA with Improved Isolation

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1. Introduction

Planar inverted-F antenna (PIFA) has long become one of the most widely used antenna elements in mobile handset and wireless terminal applications [1]. During the last decade, numerous designs of dual band and multiband PIFA configurations have been proposed and reported in the literature [1-3]. In recent years the compact multiband antennas have attracted much attention for the design of next-generation mobile handsets and smart phones. It is necessary to note that most of dual/multiband PIFA designs presented so far are utilizing single feed while operating at UMTS band (1920-2170 MHz), DCS band (1710-1880 MHz), GSM band (890-960 MHz), and GPS frequency (1575 MHz). Most of these wireless communication services use incompatible modulation standards and, therefore, require different RF receive/transmit circuitry which should be integrated into a modern mobile handset. If a multiband mobile phone antenna utilizes single RF feed, it is necessary to design a duplexer with multiband BP filters for incompatible wireless systems operation. It in turn increases the overall complexity and cost of a mobile handset. Therefore, there is a strong need to provide compact multiband antenna operating with different feeds so that to minimize the antenna ports mutual coupling without any BP filters. This paper presents an original design of 2-port dual band PIFA having low mutual coupling between RF ports and operating at GSM and UMTS frequencies. Both simulation and measured results are presented.

2. 2-Port Dual Band PIFA Design

The layout of the proposed PIFA is shown in Fig. 1. Planar PIFA is placed 8mm above the ground plane with a typical size of a handset PCB. Antenna consists of 2 elements, an L-shape low-band element for 890-960 MHz GSM band operation and straight high-band element for 1920-2170 MHz UMTS operation. PIFA is fed by 2 ports and their relative positions are indicated in Fig. 1. Because of system integration constraints the distance between antenna ports feeding two incompatible radios is required to be small so that improving the ports isolation becomes an additional challenge. Port #1 is used for lower-band GSM operation while Port #2 excites PIFA element for UMTS frequency band. The key feature of the proposed PIFA is the design of double short elements as indicated in Fig. 1. Short #1 is 2mm-wide strip placed at the corner of high-band PIFA element. Short #2 is formed by two orthogonal metal strips and placed at the spot connecting two PIFA elements. The geometry and mutual position of these two short circuits have been optimized to minimize the antenna ports mutual coupling. 2-port simulated S-parameters are presented in Fig. 2. At UMTS band the ports mutual coupling is -13 dB and at the low GSM band, where coupling is always more difficult to minimize, it is -10 dB. It should be noted that in the conventional design of 2-port PIFA the ports mutual coupling becomes as high as -4 dB. The proposed PIFA prototype has been made and its performance has been measured. Fig. 3 shows the antenna prototype where PIFA elements are printed underneath FR4 substrate to provide the rigidity of antenna layout. As can be seen, antenna ports utilize SMA connectors integrated with the coaxial cables. Measured S-parameters are presented in Fig. 4 and the results obtained confirm low mutual coupling between PIFA ports. An improved isolation is the result of short circuit design and its placement at the specific locations between antenna ports. Fig. 5 illustrates ports isolation in terms of current density distribution on antenna elements and ground plane. Strong currents are being shorted to the PIFA ground plane with very low current reaching the opposite port of PIFA.

3. Radiation Performance of Proposed PIFA

Calculated 3D radiation patterns at 950 MHz and 1.9 GHz are presented in Figs. 6 and 7, respectively. Top gain is 2.2 dBi at 950 MHz and 3.7 dBi at 1.9 GHz while the corresponding total antenna efficiency is 73% and 83%. Note that in 2-port antenna system the total antenna efficiency depends not only on the mismatch loss (S-11) but also on the ports isolation (S-21). So, high values of total efficiency are obtained as a result of low mutual coupling between PIFA ports. Radiation characteristics of the PIFA prototype shown in Fig. 3 have been measured in a SATIMO range. Total antenna efficiency has been recorded as 63% and 76% at low and high frequency bands, respectively. Measured radiation patterns are very similar to those depicted in Figs. 6 and 7.

4. Conclusions

An original design of 2-port dual band PIFA with improved port isolation has been presented. This antenna provides low port mutual coupling in both high and low frequency bands. The mechanism of PIFA port isolation is illustrated in terms of current densities on antenna elements and ground plane. It has been confirmed by both simulation and measurements that the proposed antenna gain and total efficiency satisfy the requirements for the dual-band performance of mobile handsets.

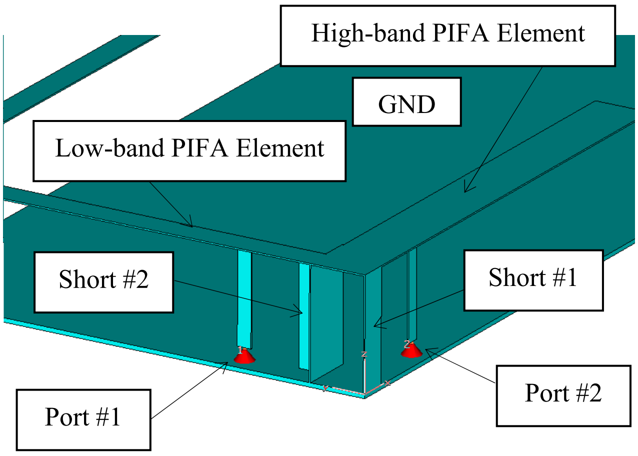

Figure 1: Layout of the 2-port dual-band PIFA

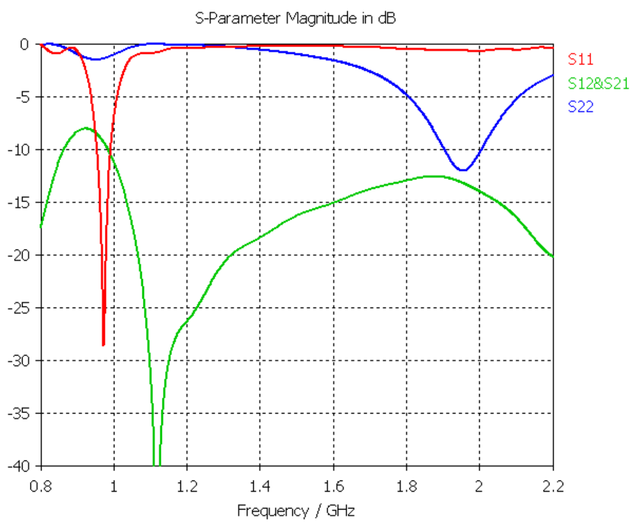

Figure 2: Calculated S-parameters of proposed 2-port PIFA

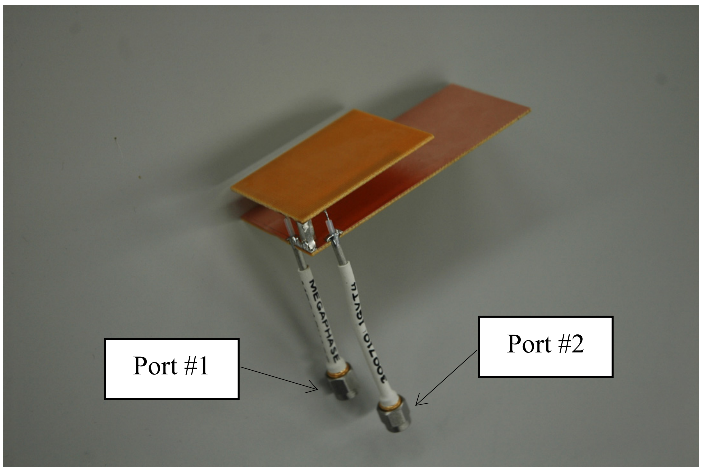

Figure 3: 2-port PIFA prototype

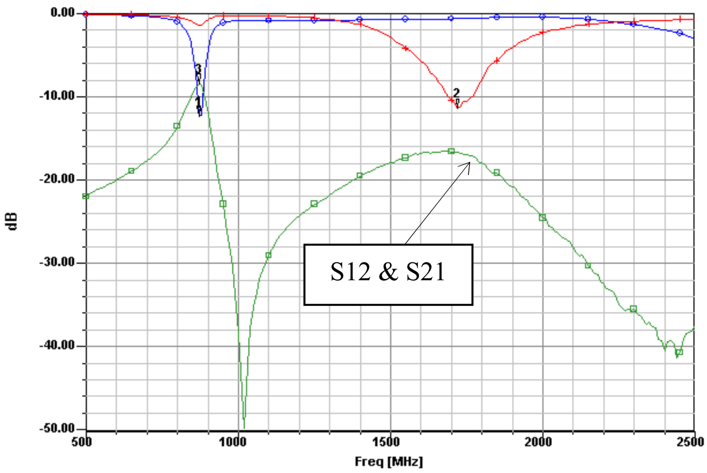

Figure 4: Measured S-parameters of 2-port PIFA prototype

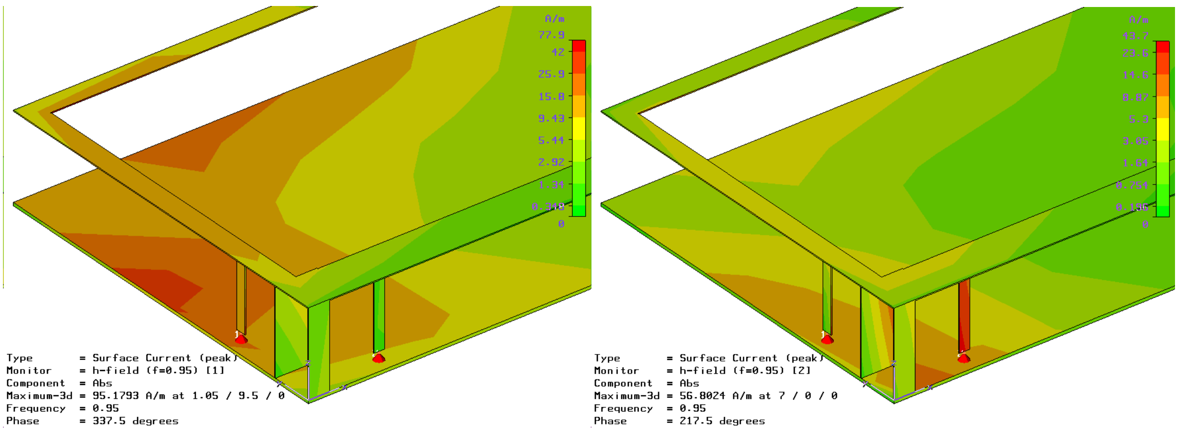

Figure 5: Current density at 950 MHz for Port #1 excitation, left, and Port #2 excitation, right

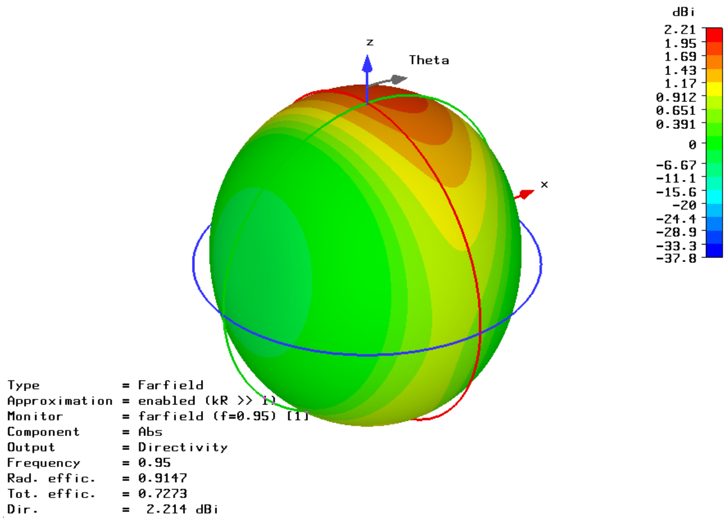

Figure 6: 3D directivity pattern at 950 MHz under port #1 excitation

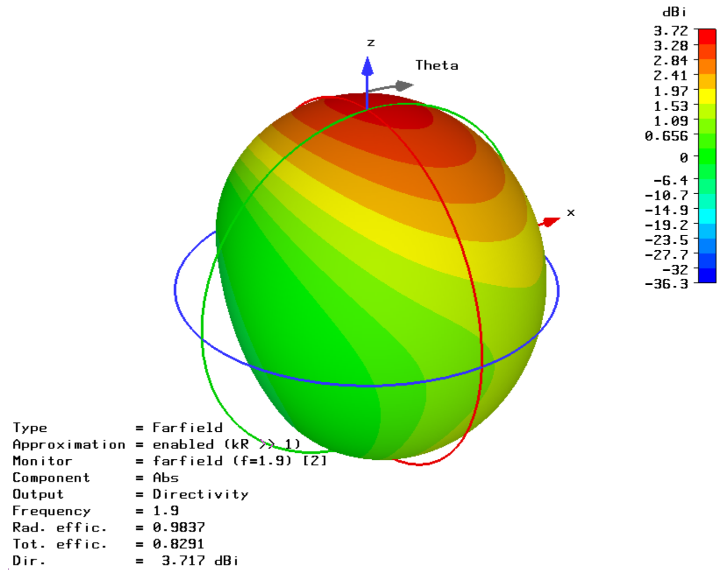

Figure 7: 3D directivity pattern at 1.9 GHz under port #2 excitation

References

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