Wideband Printed Monopole Antenna Stacked with a Shorted Square for Wireless Communications

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1. Introduction

In recent years, there have been some printed wideband monopole antenna designs studied and developed [1-3]. They are attractive because their operating bands usually have wide impedance bandwidths. However, there were very few wideband antennas that the impedance bandwidth can reach about 100% to cover multiple wireless communication systems.

In this paper, we propose a new design of the printed monopole antenna stacked with a shorted square for the wideband operation as shown in Fig. 1. By staking the suitable size of a parasitic shorted square on the driven monopole element, two close resonant modes can be excited. One resonant mode, contributed from the parasitic element, can be excited at the lower operation frequency and the other resonant mode driven by the monopole element can operate at the upper frequencies. Hence the operating frequencies of resonant modes can be controlled by both of them and the operating impedance bandwidth can be large enough to cover more multiple bands for wireless communications.

2. Antenna designs and experimental results

Figure 1 shows the geometry of the microstrip-line-fed printed monopole antenna with a shorted square for the wideband operation. By using the suitable size of this square parasitic element (21 × 21 mm^2) and the monopole driven element (19 × 3 mm^2), the wideband operation can be obtained with a good impedance matching. The driven element is printed on an inexpensive FR4 substrate of 1.6 mm in thickness and 4.4 in relative permittivity. The shorted square element of thickness 0.002 mm is stacked on the driven monopole and there is an air substrate of thickness 0.5 mm between them. In this antenna design, the 50-Ω microstrip feedline is used to feed the monopole patch, and is printed on the

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same substrate with the monopole patch. On the other side of this substrate, there is a ground plane of 60×31 mm^2 below the microstrip feedline.

Figure 2 shows the measured return loss of the proposed antenna. Due to the coupling of the printed monopole and the square elements, two resonant modes of similar printed monopole radiation characteristics can be controlled and excited closely. These two close resonant modes can then cause the enhancement of the impedance bandwidth of the proposed antenna. It is seen that the impedance bandwidth, defined by 10 dB return loss, provides an operating bandwidth of 3576 MHz (1850-5426 MHz) or about 98.3%, which covers the PCS (1850-1990 MHz), UMTS (1920-2170 MHz), WLAN (2400-2500 MHz) and HIPERLAN (5150-5350 MHz) of wireless communication bands. The measured radiation patterns at 1900 MHz of PCS band and 2050 MHz of UMTS band for both E- and H-planes are plotted in Fig. 3. Figure 4 shows the measured radiation patterns at the frequency $f =$ 2450 MHz of WLAN band and the frequency $f =$ 5200 MHz of HIPERLAN band. The measured radiation patterns of the frequencies at PCS/UMTS/WLAN/HIPERLAN bands show similar monopole-like radiation patterns. As for the peak antenna gain with the wideband operation for operating frequencies within the PCS/UMTS/WLAN/HIPERLAN bands, it is observed that the measured antenna gain levels are around 1.2, 2.5, 1.3, and 2 dBi, respectively. The measured results indicate small antenna gain variation.

3. Conclusions

A novel microstrip-line-fed printed monopole antenna stacked with a shorted square element for the wideband operation have been proposed and successfully implemented. In addition to the low-profile advantage, the proposed design is easy to be constructed and printed by an inexpensive substrate. As suitable size of driven and parasitic elements shown in Fig.1 are chosen, microstrip-line-fed printed monopole antenna can have a good impedance matching for the application to the PCS/UMTS/WLAN/HIPERLAN wireless communication systems. In this design, the wideband operation can provide with two close resonant modes that have monopole-like radiation patterns. It is seen that small antenna gain variation is obtained within each operating bands of wireless communication systems.

4. References

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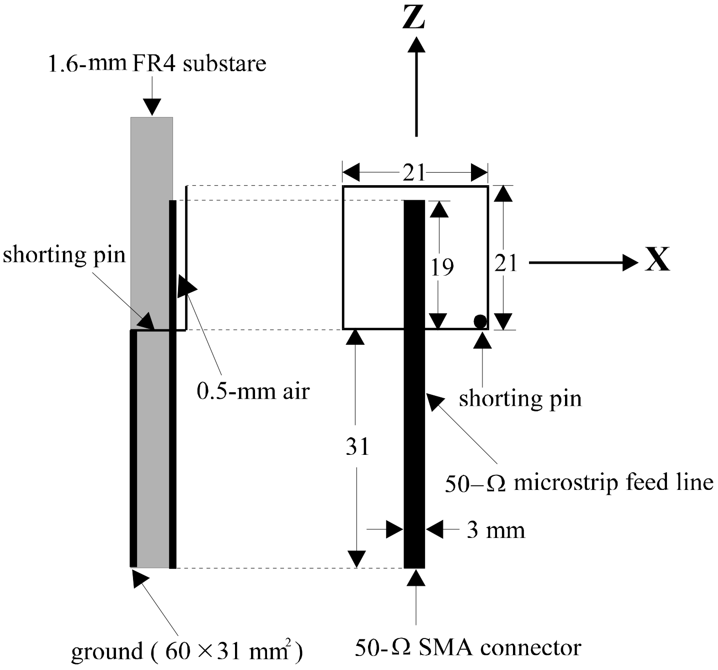

Fig. 1. Geometry and dimensions of wideband printed monopole antenna for wireless communication systems.

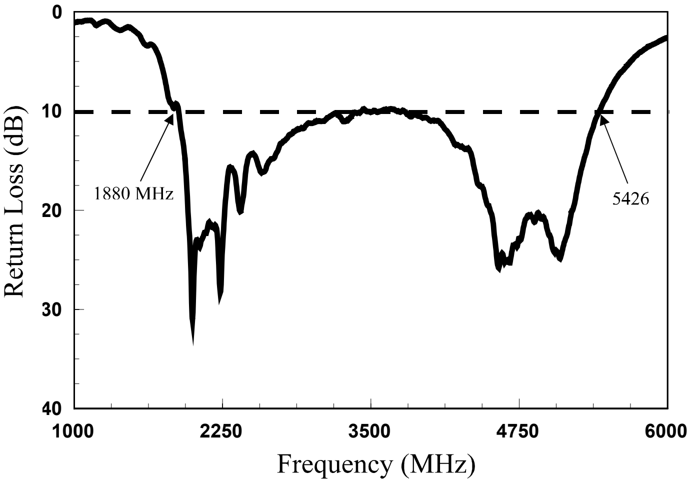

Fig. 3

Fig. 2. Measured return loss against frequency for the proposed antenna in Fig. 1.

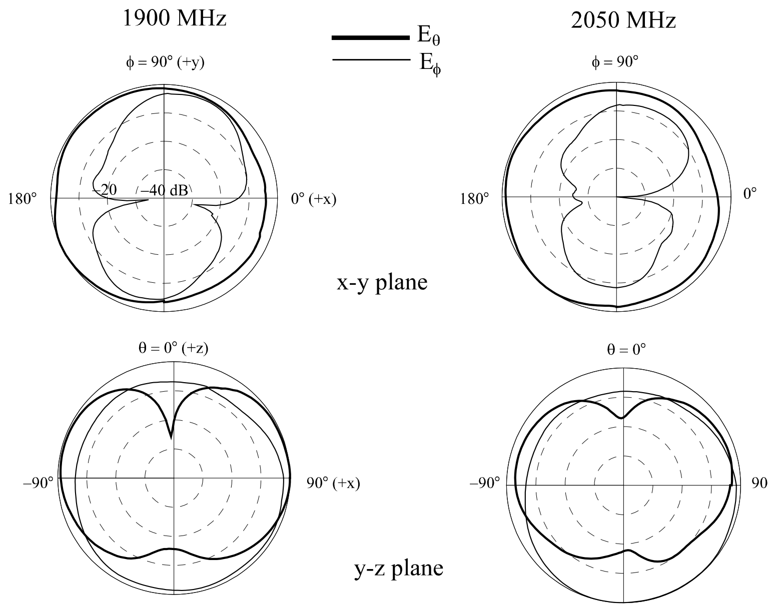

Fig. 3. Measured E-plane and H-plane radiation patterns at 1900 and 2050 MHz.

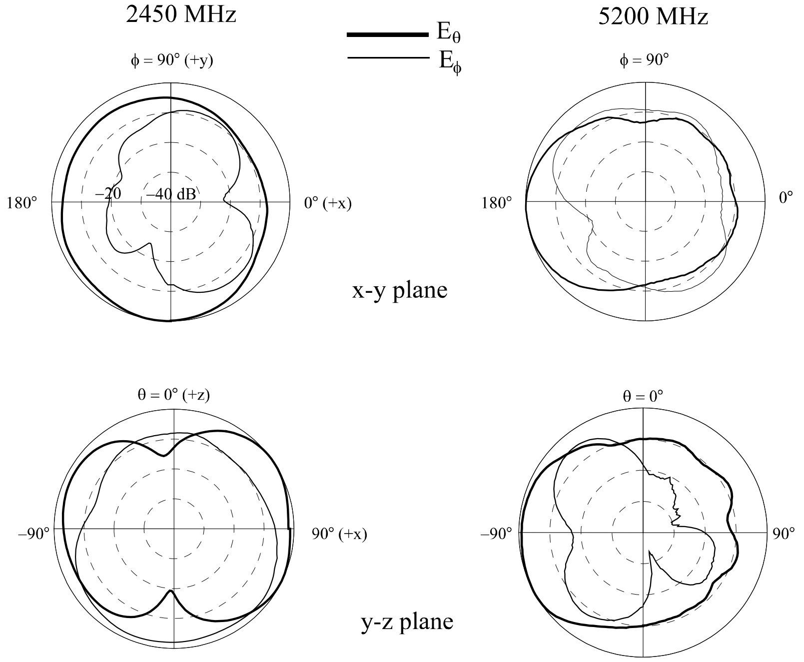

Fig. 4. Measured E-plane and H-plane radiation patterns at 2450 and 5200 MHz.