Multi-band Internal antenna for DVB-H and GSM services

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1. Introduction

The digital video broadcasting-handheld (DVB-H) service is a new standard for delivering live broadcasting television to handheld terminals and it utilizes UHF bands IV and V (470-862 MHz). However, since the upper limit of the DVB-H frequency band is within a measurable distance of the lower limit of the GSM 900 frequency band, the upper limit will probably be restricted to channel 49 (698 MHz) to relax requirement for a rejection filter [1]. To maintain the interoperability with commercial mobile service, the multi-band internal antenna is required. The wideband antennas for DVB-H service have been studied [2-3]. However, these antennas have larger size than commercial internal antennas. A multi-band antenna usually consists of a few radiators to obtain multiple resonant frequencies and each resonant frequency is tuned by adjusting the length of an individual radiator and the coupling between radiators [4-5]. However, it is difficult to independently tune the resonant frequency of an antenna because of the electromagnetic coupling between radiating elements forming an antenna. In this paper, a multi-band internal antenna for DVB-H and GSM services is proposed.

2. Antenna Design

Fig. 1 shows the proposed multi-band internal antenna structure. It consists of a tunable planar inverted-F radiator, a dual band printed monopole radiator and a rectangular ground plane (FR-4) of 90 mm × 40 mm × 1 mm.

Fig. 1 Overall geometry of the proposed antenna

Fig. 2 The detailed structure of radiator #2

The radiator #1 is tunable PIFA with a variable capacitor, which is placed at the edge of the radiator.
By adding the variable capacitor, the resonant frequency of the radiator can be tuned from 470 MHz to 740 MHz by adjusting the capacitance of the variable capacitor using DC bias. The dynamic range of DC bias voltage is from 0.3 V to 2.7 V due to the output voltage limit of handset battery. The capacitance of the loaded capacitor must be lower and should have wider variable range to provide the enough radiation gain and tunable range for DVB-H service.

The radiator #2 is a dual band monopole with a slit and a tuning stub as shown in Fig. 2. The lower frequency is fixed by the total length of the radiator #2, L_{tot}, and the higher frequency is adjusted by the length of the slit, L_{slit}. However, as L_{slit} is increased, L_{tot} is simultaneously increased; hence it is difficult that the required two resonant frequencies are obtained simultaneously. The tuning stub of length L_{stub} is added at the folded portion in order to independently adjust the two resonant frequencies. The designed antenna has small size of 40 mm × 10 mm × 6 mm.

3. Results

Figs. 3 show the return loss characteristics. The lowest resonant frequency for DVB-H service is controlled by a variable capacitor as shown in Fig. 3(a). The resonant frequency at DVB-H band can be swept from 472 MHz to 706 MHz by adjusting the capacitance of the variable capacitor by changing the DC bias voltage. The range of the DC bias voltage is from 0.3 V to 2.7 V because of the limited output voltage of the mobile set’s battery. The variable capacitance KDV240E [6] is used to sweep the resonant frequency. The highest resonant frequency for DCS 1800 band is fixed by the length of the slit, L_{slit} as shown in Fig. 3(b). When L_{slit} is shifted from 26 mm to 30 mm, the resonant frequency is moved from 1920 MHz to 1720 MHz. Fig. 3(c) shows that the second resonant frequency can be controlled by the length of an added stub, L_{stub}. The final designed antenna has L_{slit} = 28 mm and L_{stub} = 2 mm. Although the designed antenna has very narrow bandwidth at DCS 1800 service band, the three resonant frequencies of the antenna can be independently adjusted. Therefore, it is applicable to a mobile terminal for GSM and DVB-H services.
The measured gain characteristics of the designed antenna are shown in Fig. 4. Fig. 4(a) shows the tunable peak and average gain performance by DC bias controlling at the DVB-H band. The measured antenna gain satisfies the specified requirement. However, the maximum gains for the GSM 900 and DCS 1800 are lower than 0 dBi as shown in Fig. 4(b), gain enhancement needs to be studied further.

4. Conclusions

We proposed a multi-band internal antenna for the DVB-H and the GSM services. The proposed antenna consists of a tunable PIFA for the DVB-H service and a dual band folded monopole for the GSM 900 and the DCS 1800. The resonant frequencies of the designed antenna are independently adjusted. It can be used for a complex mobile set for a broadcasting service.

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References
