Compact Dipole Antenna for Terrestrial Digital Multimedia Broadcasting Service

Kwangwoo Ryu, Seunggil Jeon, Jeongpyo Kim, and Jaehoon Choi

ABSTRACT—A compact dipole antenna for the terrestrial digital multimedia broadcasting (TDMB) application is presented. The length of the antenna is about 0.06λ at the TDMB resonance frequency of 190 MHz. Miniaturization of the antenna is achieved by using meander structures and lumped elements. The proposed antenna has two resonance frequencies and covers the TDMB band from 174 MHz to 216 MHz in Korea. The antenna has good impedance bandwidth and radiation characteristics for the TDMB. The experimental results of the designed dipole antenna are presented and analyzed.

Keywords—Dipole antenna, TDMB, meander structure, lumped element.

I. Introduction

Rapid progress in TV broadcasting technology offers high quality broadcasting services for portable devices, such as the mobile phone, electronic notebook, and PDA. In particular, terrestrial digital multimedia broadcasting (TDMB) service was initiated for various mobile devices in Korea. TDMB can provide seamless high-quality audio, video, and data services. Since the wavelength at the center frequency (190 MHz) of band-III (174 MHz to 216 MHz) TDMB service [1]-[3] is 1.5 m, an ordinary dipole antenna is too long to use for portable devices.

In this letter, a compact dipole design for a TDMB antenna is proposed. The proposed antenna consists of a meandered pattern and lumped elements. By using a meandered pattern [4] and lumped elements, we are able to make the antenna compact in size with two adjacent resonance frequencies for the TDMB band. The parametric analysis for the antenna configuration is performed experimentally.

II. Antenna Design

The geometric configuration of the proposed antenna is shown in Fig. 1. It has a dipole structure and consists of two meandered patterns and lumped elements. The total volume of the antenna is 7 mm × 100 mm × 0.4 mm. Two meandered patterns are constructed on both sides of an FR4 substrate (ε_r =4.4) with a thickness of 0.4 mm and are connected through a via hole in a pad (P_V), as shown in Fig. 1(b). The lumped elements on the feeding part consist of a capacitor (C_S), a balun (MABA-007159-000000), and three inductors (L_P, L_1, and L_2), as shown in Fig. 1(c).

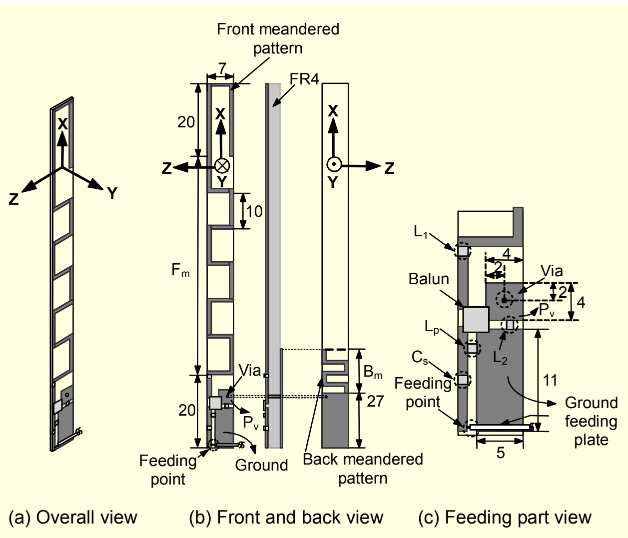

Fig. 1. Geometry of the proposed TDMB antenna.

Manuscript received Sept. 3, 2007; revised Nov. 29, 2007.

This work was supported by the IT R&D program of MIC/IITA [2007-S-001-01, Design of a compact and complex antenna for a mobile broadcasting service], Rep. of Korea.

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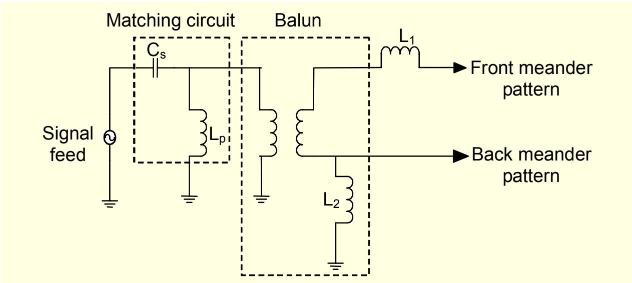

Fig. 2. Equivalent circuit of feeding part.

The equivalent circuit of the feeding part is shown in Fig. 2. The inductor (L_1) increases the electrical length of the front meandered pattern, and a balun divides the feed signal into two 50 Ω signal lines. As shown in Fig. 2, a capacitor (C_S) and an inductor (L_P) are used to improve the impedance characteristics [5]. The first resonance mode is caused by the front meandered pattern and inductance L_1, and the second resonance mode is caused by the back meandered pattern.

Figure 3 shows the return loss characteristic at each state. Figure 3(a) shows the return loss characteristic when the antenna has only a front meandered pattern and inductance L_1. The antenna generates the resonance mode at the 170 MHz. Figure 3(b) shows the return loss characteristic when the antenna has only a back meandered pattern. In this case, the resonance frequency is 230 MHz.

Figure 4 shows the measured return loss characteristics when the length of the front meandered (F_m) and back meandered (B_m) patterns is varied. Two resonance frequencies are controlled by the length of F_m and B_m. As shown in Fig. 4(a), the lower resonance frequency decreases when the length of F_m increases. The higher resonance frequency decreases as the length of B_m increases, as shown in Fig. 4(b).

Therefore, the higher resonance frequency is determined by the back meandered pattern (B_m). The lower resonance frequency is decided by front meandered pattern (F_m). The final design parameters of the proposed antenna are B_m=12 mm, F_m=60 mm, L_1=220 nH, L_2=68 nH, and C_S=390 pF.

III. Experimental Results

Figure 5 shows a photograph of the fabricated antenna. The total length of the antenna is 100 mm.

Figure 6 shows the measured return loss characteristic of the proposed antenna. The measured 10 dB return loss bandwidth is 42 MHz and ranges from 174 MHz to 216 MHz. The antenna provides sufficient bandwidth to cover the whole TDMB bandwidth by generating the two adjacent resonant frequencies within the required bandwidth.

Figures 7(a) to (f) show the measured radiation patterns at

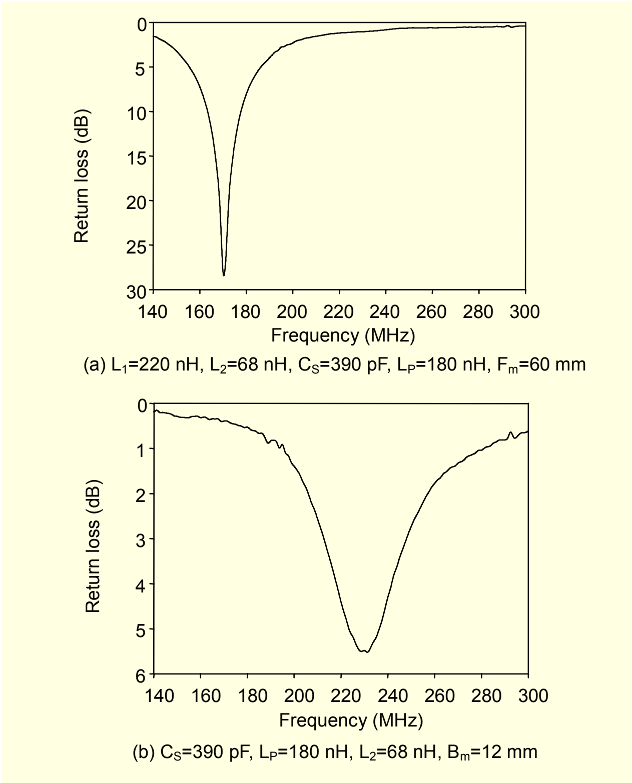

Fig. 3. Return loss characteristic at each state.

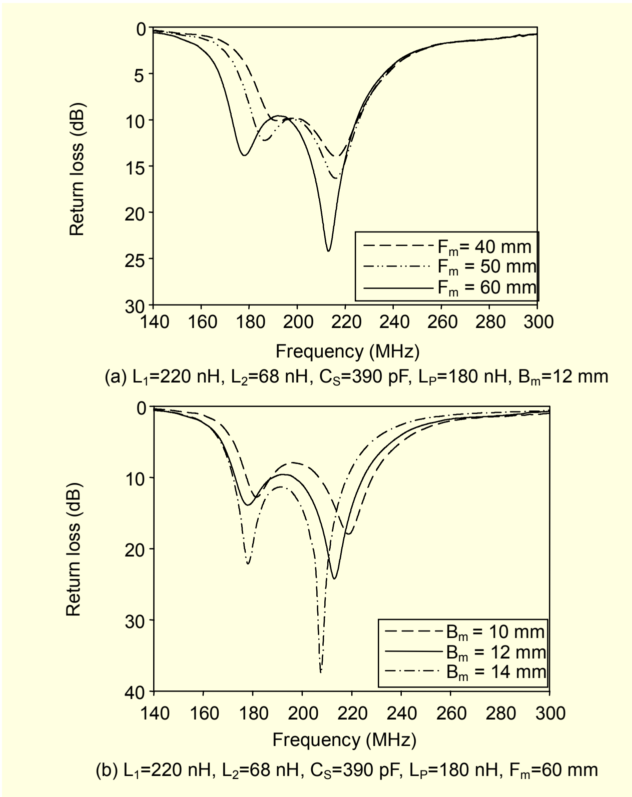

Fig. 4. Measured return losses for (a) front meander length variation and (b) back meander length variation.

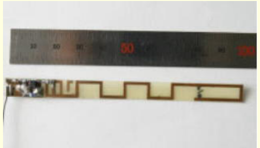

Fig. 5. Photograph of fabricated antenna.

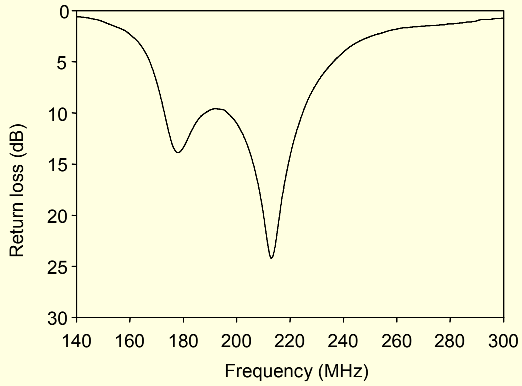

Fig. 6. Measured return losses.

174 MHz, 195 MHz, and 216 MHz, respectively. Nearly omni-directional patterns are observed for the TDMB band.

Figure 8 shows the measured peak antenna gain with respect to frequency. Although the length of the antenna is about 0.06λ at the center frequency of the TDMB band, the antenna gain is greater than -10 dBi over the whole band.

IV. Conclusion

A compact dipole antenna covering the TDMB band from 174 MHz to 216 MHz service in Korea has been proposed and experimentally analyzed. The proposed antenna generates two resonance frequencies to cover the TDMB band. Meandered structures and lumped elements are utilized to minimize the size, and a matching circuit is used to improve the impedance bandwidth. The proposed antenna has good impedance bandwidth and radiation patterns and shows great potential to be used for TDMB service applications.

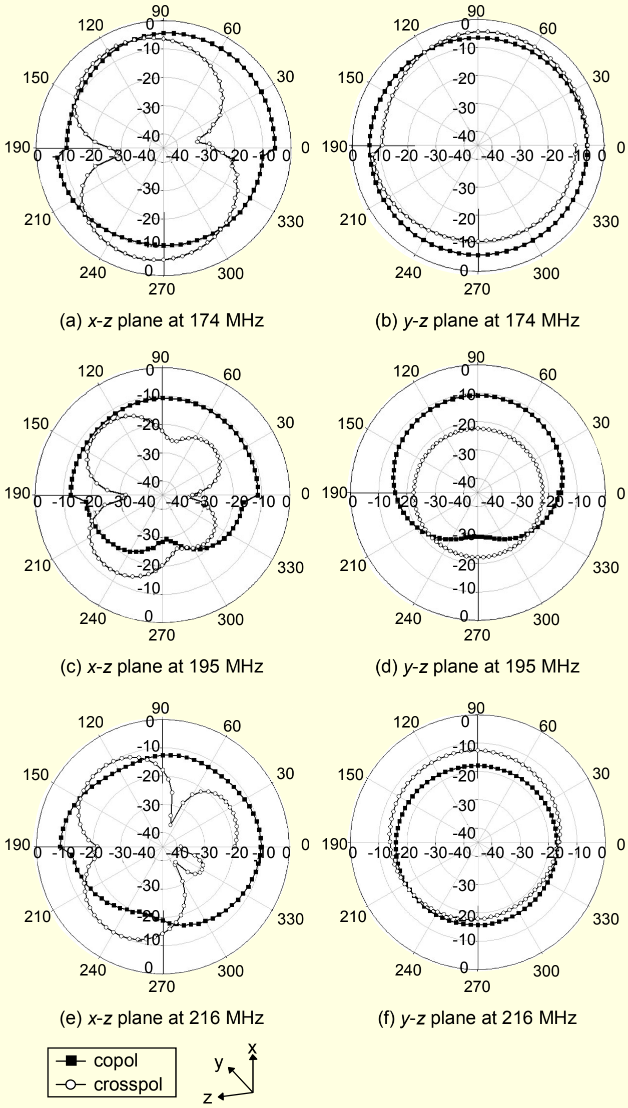

Fig. 7. Measured radiation pattern for TDMB band.

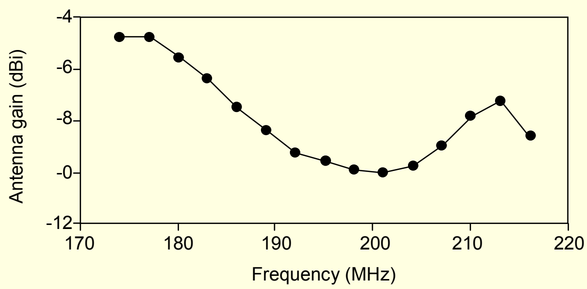

Fig. 8. Measured gains of the proposed antenna.

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