Compact TV Antenna Composed of Unbalanced Fed Ultra Low Profile Inverted L Antenna

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***Abstract*—The compact TV antenna composed of the unbalanced fed ultra low profile inverted L antenna is proposed. The antenna size is 40 mm by 244 mm by 32 mm. The return loss less than -10 dB is satisfied at the frequencies from 470 MHz to 713 MHz. The directivity is 2.83 dBi to 3.25 dBi.**

I. Introduction

Due to the development of wireless communication technology, low profile, wideband or multiband antennas are desired in recent years. An “ultra low profile dipole antenna”, which is a horizontal dipole antenna very closely located to a infinite conducting plane was proposed [1]-[2]. A half-wave dipole is excited at the offset points from its center. The reasonable impedance can be obtained even with a conducting plane in proximity to the dipole. The maximum gain of 8.4 dBi is obtained. The authors applied the unbalanced feed to the ultra low profile inverted L antenna on the rectangular conducting plane [3]. When the size of conducting plane is 0.245 λ (λ: wavelength) by 0.49 λ and the antenna height is $\lambda/30$, and the length of horizontal element is around $\lambda/4$, the input impedance of this antenna is matched to 50 Ω and its directivity becomes more than 4 dBi. The relative return loss bandwidth is 2.45 %. In this antenna, the inverted L element and the conducting plane are strongly coupled since the antenna height is very low. By controlling the mutual coupling among them, the return loss bandwidth is adjusted for the application. If the antenna height becomes narrow as $\lambda/43$, the return loss bandwidth becomes 0.23 %. This antenna is applied to the wireless power transmission system [4]. Two inverted L antennas are closely faced each other. When the distance of transmission and reception antennas is 14 mm at the design frequency of 1 GHz, the power transmission efficiency becomes more than 95 %.

In order to extend the return loss bandwidth of the unbalanced fed inverted L antenna, the parasitic elements are located above and below this narrow bandwidth antenna. As the reception antenna of the terrestrial television broadcasting in Japan, the return loss bandwidth less than -10 dB is satisfied at the whole broadcasting frequency band from 470 MHz to 710 MHz and the directivity of 5.44 dBi to 7.19 dBi is obtained in the case of antenna size of 170 mm by 325 mm by 29 mm [5]. For another application, the dual band antenna is realized by locating the parasitic wire above the inverted L antenna [6]. The inverted L antennas in [4] to [6] are basically narrow band antenna.

The return loss bandwidth of the unbalanced fed ultra low profile inverted L antenna can be extended by adjusting the size of its conducting plane for the purpose of reception antenna of the terrestrial television broadcasting in Japan. When the antenna size is 40 mm by 252 mm by 32 mm, the return loss less than -10 dB is satisfied at the frequencies from 463 MHz to 606 MHz, almost 60 % of the television frequency band in Japan. The directivity is 2.7 dBi to 3.4 dBi [7].

In this paper, in order to extend the return loss bandwidth of the antenna in the reference [7], the additional inverted L element is added between the fed element and the conducting plane. In the numerical analysis, the electromagnetic simulator WIPL-D based on the method of moment is used [8].

II. Analytical Model

Figure 1 shows the structure of proposed antenna. The inverted L antenna is composed of a semi rigid coaxial cable. The inner conductor of coaxial cable is extended from the end of the outer conductor. Therefore, this antenna is excited at the end of outer conductor. The characteristic impedance of coaxial cable is 75 Ω. The parasitic wire is located between the inverted L antenna and the ground plane. The parameters of antenna structure are as follows; $pxm = pxp$ = 20 mm, pym = 34 mm, pyp = 210 mm, L = 139 mm, $L1$ = 43 mm, h = 30 mm, $h2$ = 15 mm, $L2$ = 95 mm, d = 6 mm. The radii of outer conductor of coaxial cable and parasitic wire are 1.79 mm. The radius of inner conductor of coaxial cable is 0.255 mm.

III. Results and Discussion

Figure 2 shows the return loss characteristics of proposed antenna and the antenna in the reference [7]. The return loss is normalized by the characteristic impedance of 75 Ω. The antenna parameters are optimized to have widest return loss bandwidth. Figure 3 shows the directivity of these two antennas. By extending the return loss bandwidth, the directivity of the proposed antenna decreases. Figure 4 shows the current distribution of two antennas. At higher frequencies, the current is strongly excited on the parasitic wire.

IV. Conclusion

The small sized wideband antenna composed of the unbalanced fed ultra low profile inverted L antenna has been proposed for the terrestrial TV reception. The return loss bandwidth is extended by adjusting the length and width of its conducting plane and adding the parasitic wire. The antenna size is 40 mm by 244 mm by 32 mm. The return loss less than -10 dB is satisfied at the frequencies from 470 MHz to 713 MHz. The directivity is 2.83 dBi to 3.25 dBi.

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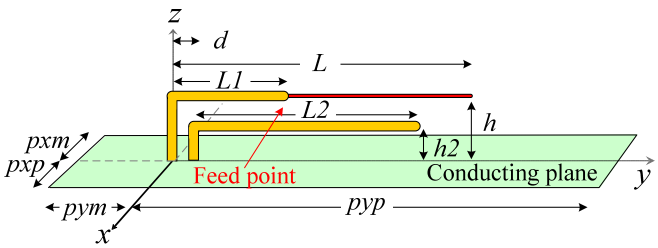


Fig. 1. Structure of proposed antenna.

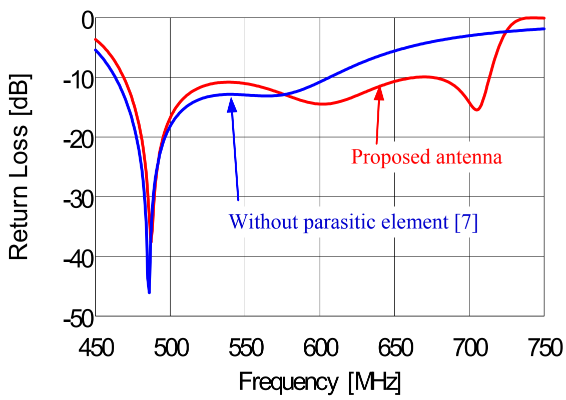


Fig. 2. Return loss characteristics of proposed antenna and antenna in [7].

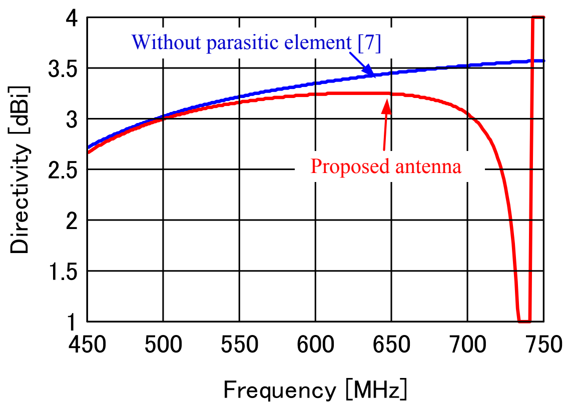
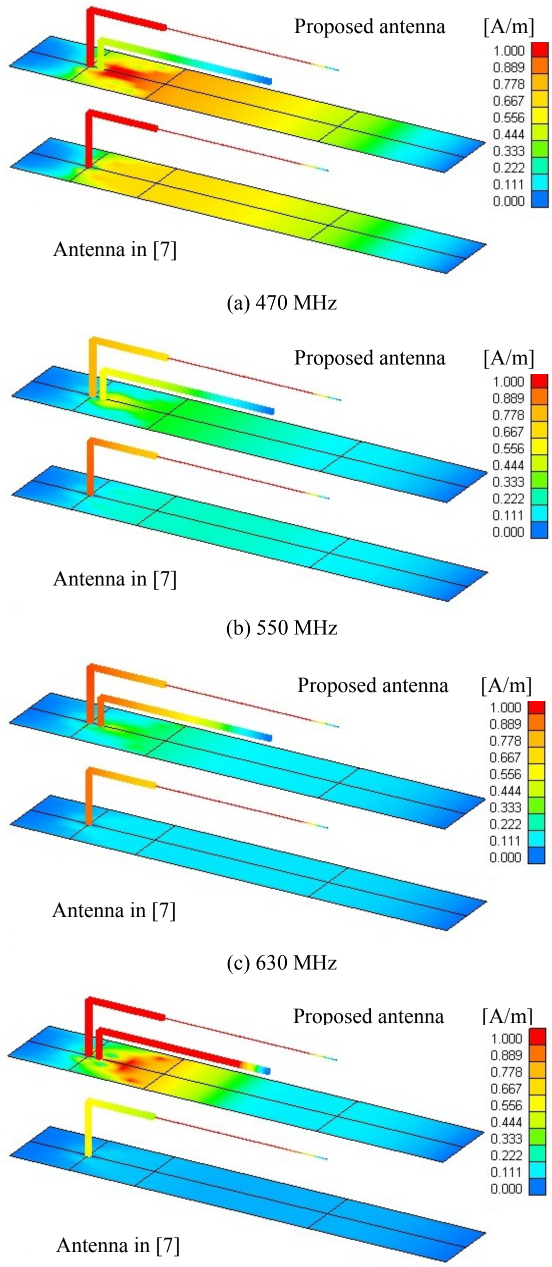


Fig. 3. Directivity of proposed antenna and antenna in [7].



(a) 470 MHz

(b) 550 MHz

(c) 630 MHz

(d) 710 MHz

Fig. 4. Current distribution of proposed antenna and antenna in [7].