Compact DVB-H Antenna with Dual-band Operation for PMP Applications

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1. Introduction

A digital video broadcasting-handheld (DVB-H) is a new standard for delivering broadcast television to mobile terminal, and it was officially endorsed by the Europe Union in 2008. In recent days, mobile TV for handheld device has become an important issue and especially DVB-H is planning to be serviced in Europe as well as many countries in the world. The DVB-H standard is designed to operate in UHF bands IV, V (470-862 MHz) and L band (1452-1492 MHz) [1]. The antenna size for DVB-H is too large to be assembled in mobile equipment because a quarter of a wavelength of the UHF band in vacuum is about 90-160mm. According to DVB-H implementation guidelines, an antenna gain of -10 dBi at 470 MHz to -7 dBi at 702 MHz is required [1].

Recently some various intennas for DVB-H have been developed including design of the novel DVB-H antenna for mobile handheld terminal [2], internal antenna with modified monopole type for DVB-H applications [3], and compact broadband planar antenna for DVB-H applications [4]. In [2], the DVB-H antenna as a coupled element is confined only to the folder type mobile devices. The proposed antenna in reference [3] is also difficult to apply compact devices, because the antenna has very restrictive relationship between radiator and ground as monopole type.

In this paper, we have presented a broadband planar inverted F-shape antenna (BPIFA) with matching circuit which can be easily embedded into side faces of the PMP and optimized for the DVB-H frequency bands of 470-862 MHz and 1452-1492 MHz. We used a planar inverted F-shaped radiator with wide arm to diversify the current paths. Also, we used a simple matching circuit which is composed of the lumped elements (an inductor and two capacitors) for broadband operations over the proposed DVB-H frequency band. The antenna was designed, fabricated, and measured in the case of PMP platform (i-station U43, Digital-Cube) with case (ε_r=3.2). It is possible to miniaturize since the antenna is compact. The radiation patterns of proposed antenna are omni-directional which is the same as conventional monopole antenna. The proposed antenna has wideband and satisfies UHF and L bands for DVB-H service.

2. Antenna design

Figure 1 shows the geometry of the proposed PIFA in a PMP flat-form. Figures 1(a) and 1(b) are the 3D view of the antenna and Figure 1(c) is the LC matching circuit for broadband UHF band. The permittivity of the mock-up's substrate is 3.2 and overall dimension of the antenna is 25.5×75.5×12 mm^3. In typical monopole antenna, a quarter of a wavelength of the UHF band in vacuum is about 90-160 mm, and a quarter of a wavelength of the L band in vacuum is about 50-52 mm. Because the radiator is located near ground plane, gap capacitance of between radiator and ground can be enable to reduce size of the proposed antenna which is much smaller than conventional monopole antenna.

The stepped slit on the radiator is also optimized to generate resonant path for L-band service. In Figure 1(b), the optimal parameters can be chosen as L_1=35.5 mm, L_2=50.5mm, W=12 mm, SL_1=12.5 mm, SL_2=8.5 mm, SW=15 mm, GL=35 mm, and GW=30 mm for DVB-H antenna. It is worth noting that three significant techniques are used to improve the performances of the proposed antenna. First, by varying shorting length of F-shape structure, impedance matching of the antenna can be improved. Especially SL_1 and SL_2 are optimized for best condition of DVB-H service. However, the structure of PIFA can not satisfies both impedance matching and wide UHF band. So secondly, by incorporating an internal matching circuit, which consists of two chip capacitors and a chip inductor, input impedance of the antenna is improved over a wide frequency range covering the desired UHF band. The preferred value of series inductor is 4 pF, series capacitor is 3 pF and shunt capacitor is 0.5 pF. Lastly, we can tune the desired frequency for DVB-H service and achieve good radiation efficiency by placing an interval of space from the edge of the ground, gap capacitance of between radiator and ground influences the electrical length of the antenna. To focus on the environment of the other mobile devices, the proposed antenna can be easily modified and satisfied with nearly same results as our study.

Figure 2 is the photograph of the fabricated antenna which is embedded in the PMP flat-form.

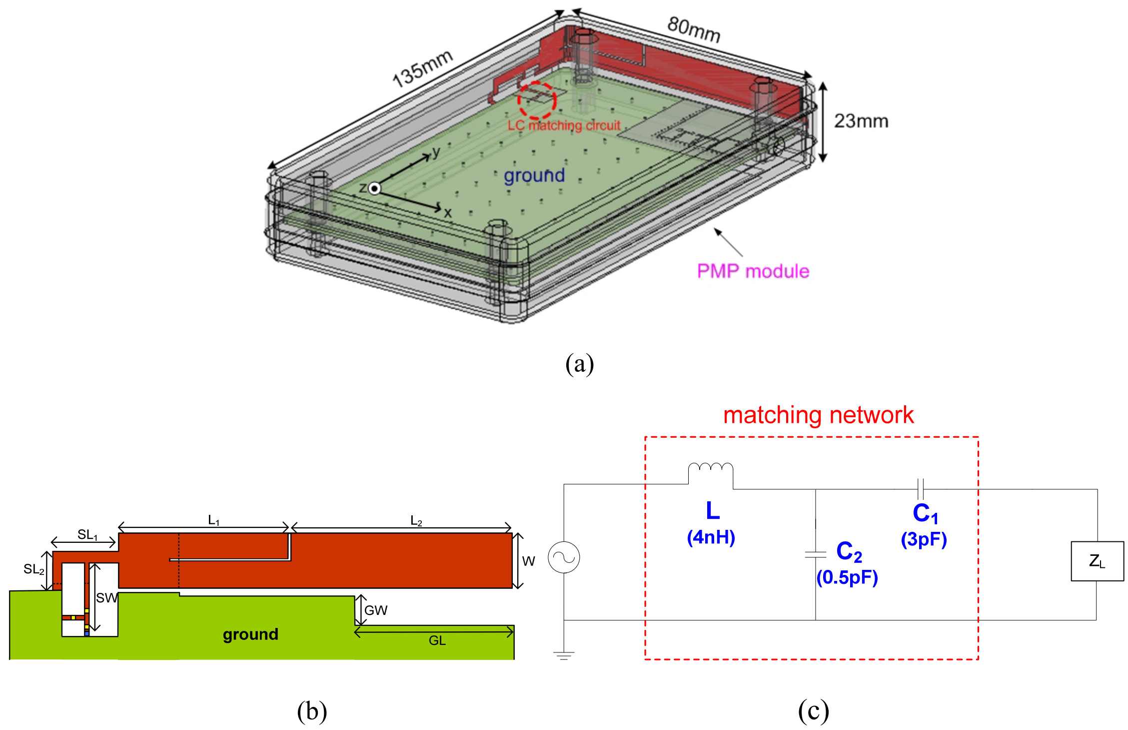

Figure 1: Geometry of the proposed broadband PIFA in a PMP flat-form
(a) 3D view, (b) Detail specification, (c) LC matching circuit

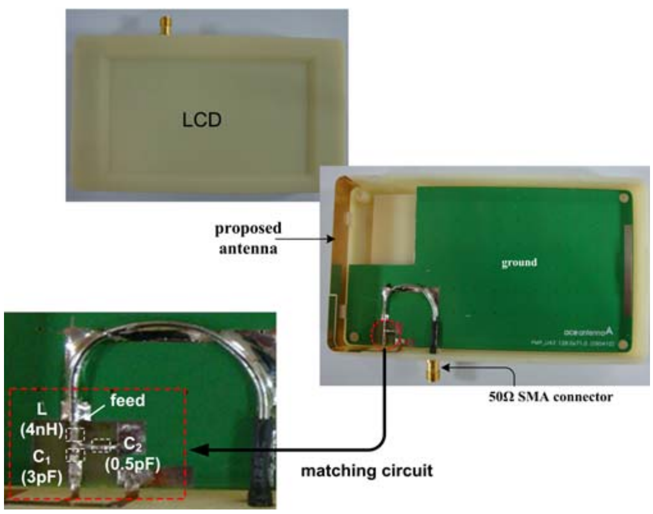

Figure 2: Photograph of the fabricated antenna

3. Results and Discussion

Figure 3 shows the simulated and measured results of S_{11} for the proposed antenna and input impedance of the antenna with matching circuit. A 50Ω coaxial feed is used to excite the fabricated antenna at the feeding point. Three resonant modes can be obviously found at frequencies in UHF and L band. The measured impedance bandwidths of fabricated antenna are about 420 MHz (490-910 MHz, 60% at center frequency), 60 MHz (1.42-1.48 GHz, 4%) in VSWR 3:1, 445 MHz (485-930 MHz, 63%) 100 MHz (1.40-1.50 GHz, 7%) in VSWR 4:1 and the proposed antenna is satisfied with the DVB-H service band.

Figure 4 shows the measured radiation patterns of the fabricated antenna in case of PMP's mock-up for 500, 600, 800, and 1450 MHz. The radiation patterns in the x-z and y-z plane are expected omni-directional and almost similar to the radiation pattern of monopole antenna. The measured peak gain, one of the most important fact for multimedia mobile handsets capable of DVB-H, varies from -0.22 to 3.45 dBi over the DVB-H band (500-900 MHz, 1400-1500 MHz) which easily meets the gain specification (-10 dBi to -7 dBi) of DVB-H system [1]. Recently, as mobile devices in many countries are smaller and smaller, to consider performance of the built-in antenna in case of the mobile device is more important and close to practical device.

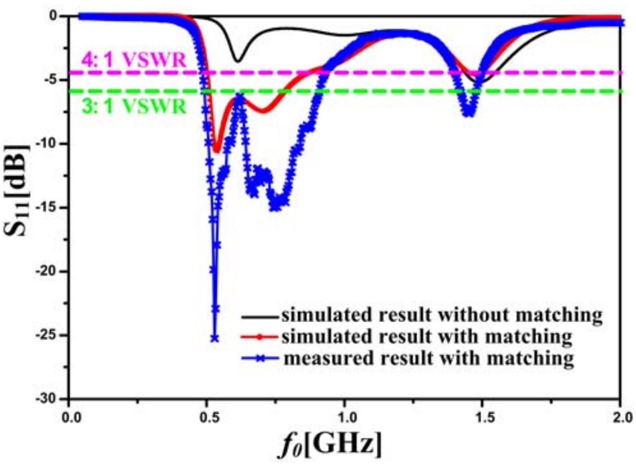

Figure 3: Comparisons of the return losses for three different cases

4. Conclusions

In this paper, a compact DVB-H antenna with dual-band operation for PMP applications has been proposed. The matching circuit is employed to improve the bandwidth of UHF band. The measured impedance bandwidth for VSWR<3 is about 420 MHz (490-910 MHz) and 60 MHz (1420-1480 MHz) which almost covers frequency allocations of the many countries. The structure of the proposed antenna is easily fabricated and modified in various mobile cases. The measured results meet the impedance bandwidth and gain requirements for DVB-H applications.

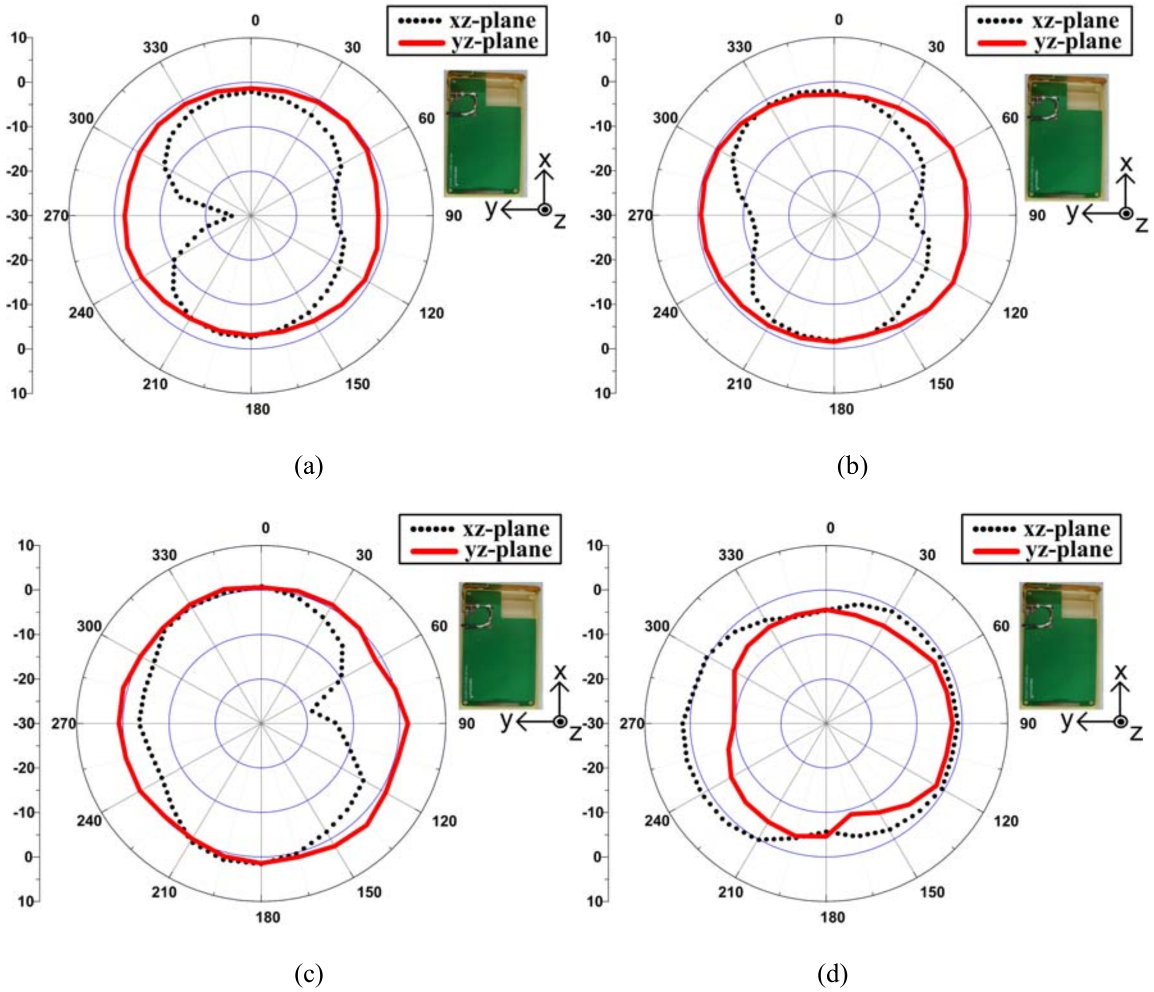

Figure 4: Measured radiation patterns at (a) 500, (b) 600, (c) 800, (d) 1450 MHz

References

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