Fabrication and Measurement of T-DMB/GPS/ Mobil Antenna for Vehicular Application

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1. INTRODUCTION

In the past, large external antennas were installed on automobiles. These were screw-shaped, helical-type winding-coil antennas. The disadvantage of these antennas is that they have an individual communication function. At present, shark antennas, which are placed on the rear part of automobiles, are largely being used as automobile antennas. The additional integrated design function of a T-DMB antenna and its radio reception may have an advantage, but they cost high and have limited reception, unlike external antennas. At present, as different multimedia equipment can now be integrated into one terminal, antennas are also being developed technically to provide a simple multimedia communication environment using drivers for multiple functions.

Especially in Korea, digital multimedia broadcasting (DMB) services are becoming popular. As the resonant length of the Terrestrial Digital Multimedia Broadcasting band (T-DMB, 174-214MHz) is much longer than that of the conventional antenna, it is very difficult to utilize a T-DMB antenna [1]. A GPS antenna for vehicle application is also proposed and designed to generate a circular polarized antenna for GPS and ETCS. Mobile bandwidths, such as Advanced Mobile Phone System (AMPS, 824-894MHz), Global System for Mobile Communication (GSM, 890-960MHz), Digital Communication System (DCS, 1710-1880MHz), Personal Communication System (PCS, 1850-1990MHz), and Universal Mobile Telecommunication System (UMTS, 1920-2170MHz) are necessary to communicate in vehicles. Hence, a multiband antenna for vehicle application is proposed. To meet the miniaturization and aesthetic requirements of a vehicle antenna, manufacturers are trying to come up with low profile and broadband antennas [2]. However, low profile, multiband, and integrated antenna for various services are needed.

In this document, we propose an integrated antenna which is suitable for mounting on a vehicle to access mobile, T-DMB, and GPS services. Details of the proposed antenna design and experimental results are described below.

2. ANTENNA DESIGN

Fig. 1 shows the configuration of the proposed T-DMB/GPS/mobile antenna. The cross section and front view of the proposed T-DMB/GPS/mobile antenna is shown in Fig. 1(a). The total size of the proposed antenna in the study is 1.0-mm thick with $215 \times 75 mm^2$ FR4 substrate, which is a reasonable size for practical vehicle application. The proposed patch antenna for vehicle application consists of three parts: the T-DMB antenna, GPS antenna, and mobile antenna. The T-DMB patch antenna is located at the right part of the proposed structure, the GPS patch antenna is located at the center, and the mobile patch antenna is located at the left part. Also, T-DMB and mobile patch antenna is set at the top layer, and the GPS patch antenna is at the bottom layer. In case of T-DMB and mobile antenna, ground plane at the opposite of the patch antenna is removed to achieve good radiation pattern. As for the GPS antenna, the ground plane of the opposite of the patch is not removed to enhance isolation between mobile and GPS. Also, coaxial feeding method is used by the GPS antenna and line feeding is used by T-DMB and mobile antenna.

To obtain the optimal parameters (lines, lengths, gaps) of the proposed T-DMB/GPS/mobile antenna, HFSS [3], which is a full-wave commercial EM software capable of simulating finite substrate and finite ground structure, was used to identify the ideal geometry for vehicle antenna. The dimensions of the mobile antenna are not display

3. MEASUREMENT

Based on the simulation results, the proposed T-DMB, GPS, and mobile patch antenna is created and tested using the Agilent Technologies E8362B Vector Network Analyzer, with far-field patterns and gain within a compact range, obtained from HCT Co. Ltd. and Korea Martin University. Figure 2(a) shows structure of the proposed antenna. Figure 2(b), (c), and (d) show the pattern of the T-DMB, GPS, and Mobile proposed antenna, respectively. Figure 3 shows the simulated and measured VSWR for the proposed antenna. The results show a satisfactory match between the antenna's measurement and the data from the simulation obtained from Ansoft HFSS. The cured trend is behaved well over the whole operating bands. Based on the 7.5 dB return loss bandwidth (VSWR 1:2.5), which is acceptable for each application, the impedance bandwidth of this T-DMB, GPS, and mobile antenna should be about 70 MHz (172~242MHz), 80 MHz (1550~1630MHz), and 330 MHz, 540MHz (740~1070 MHz, 1680~2200 MHz) respectively, covering the all T-DMB bandwidths (174~217MHz), all GPS bandwidths (1576.4~1574.4 MHz), and all existing mobile bandwidths (824~960MHz, 1710~2170MHz).

In particular, the bandwidth of the designed T-DMB patch antenna, is only 18MHz (192~210MHz), which does not cover the all T-DMB bandwidths. In figure 1(b), it is shown that the amount of inductance is not sufficient to match wider because the length of the strip line is very short and the capacitance between the fishbone increase.

The radiation patterns that have been measured per band are shown in Figure 3. Figure 3(a) shows the 2D measured radiation pattern for the proposed T-DMB patch antenna. Figure 3(b) and 3(c) show the 3D measured radiation pattern for the proposed GPS and mobile patch antenna, respectively. Good radiation patterns are observed, and the shape of radiation pattern is almost unchanging and uniform in each GPS frequency. Figure 3(c) shows the 3D radiation pattern at 824MHz, 1750MHz, and 2170MHz, respectively. Table 1 shows the measured gain of the proposed antenna for each operating frequency.

4. CONCLUSION

A T-DMB/GPS/mobile antenna was proposed for vehicle applications, and its prototype operated successfully. The experiment results showed that good impedance matching was achieved. This proposed T-DMB/GPS/mobile antenna had an impedance bandwidth (VSWR 1:2.5) of about 70 MHz (172~242MHz) or 33.82%, 80 MHz (1550~1630MHz) or 5.03%, and 330 MHz, 540MHz (740~1070 MHz, and 1680~2200 MHz) or 36.46% and 27.84%. The proposed antenna exhibited good radiation pattern characteristics and gain. The proposed antenna has an excellent potential for vehicle application.

REFERENCES

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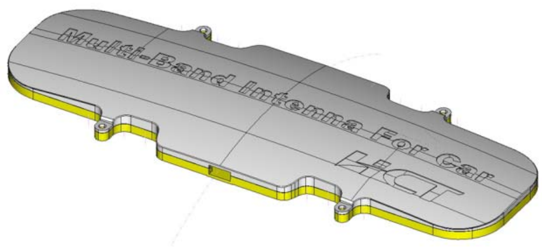
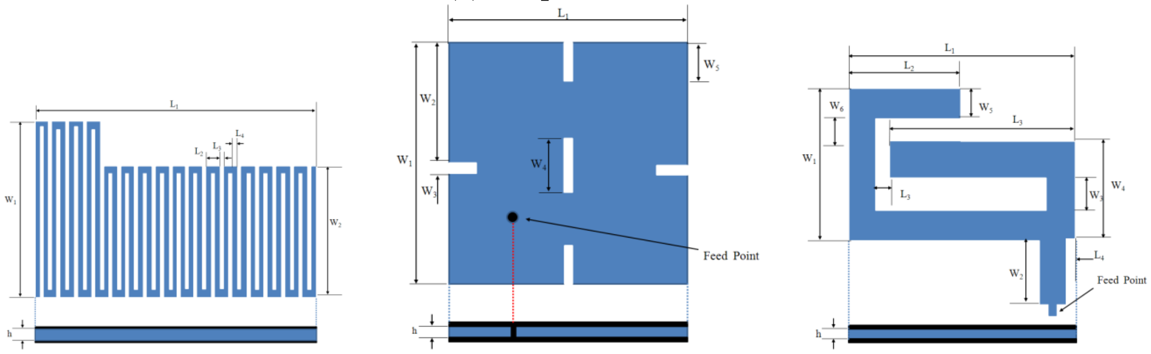
[3] Ansof High Frequency Structure Simulator (HFSS) Version 10.0, Ansoft Corporation, 2005.

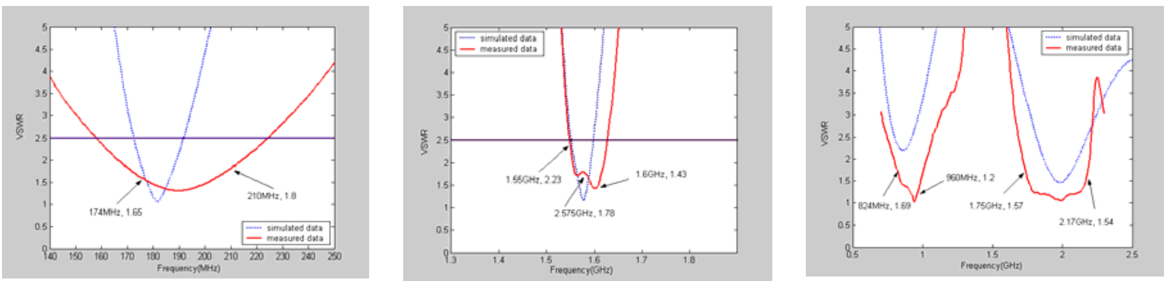


(a) Proposed structure



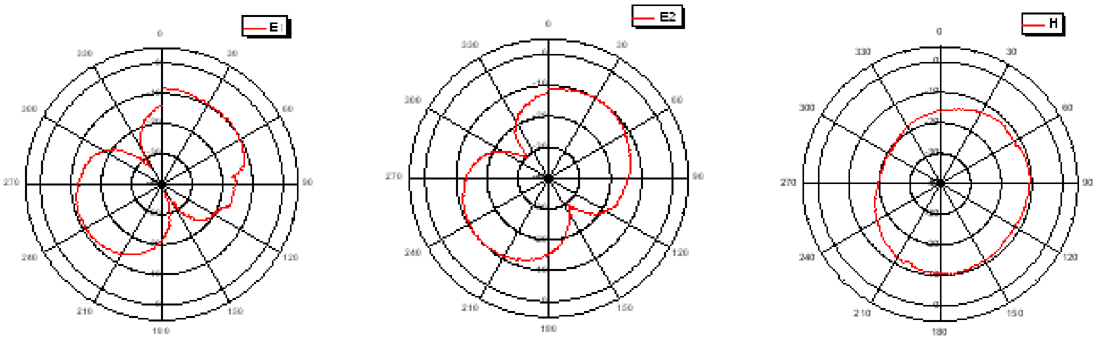
(b)T-DMB Model **(c) GPS Model** **(d Mobile Model**

Fig. 1. Configuration of the proposed antenna for vehicle application



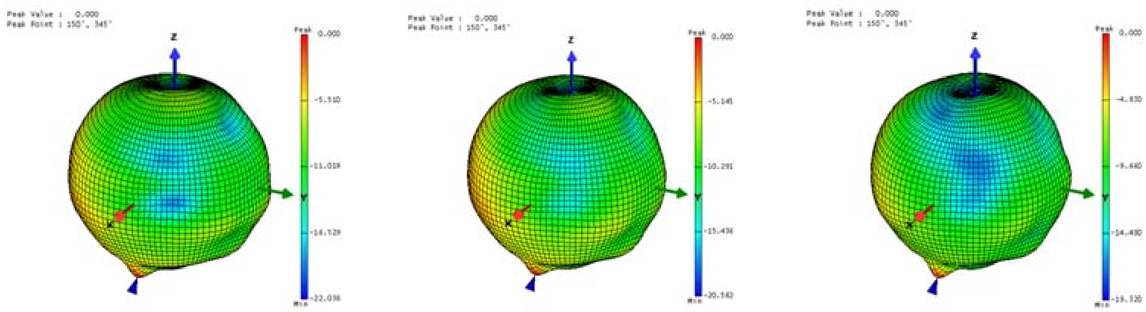
(a) T-DMB Model **(b) GPS Model** **(c) Mobile Model**

Fig. 2 Simulated and measured return loss vs. frequency for the proposed antenna



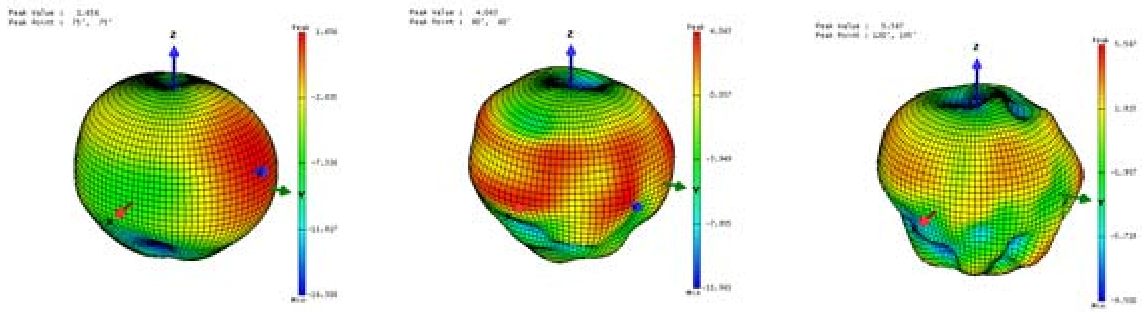
(a)x-z plane (b) y-z plane (c) x-y plane

Fig. 3 (a) Radiation patterns of the proposed compact antenna for T-DMB band(174MHz)



1560 MHz 1575 MHz 1590MHz

Fig. 3 (b) Radiation patterns of the proposed compact antenna for GPS band



824MHz 1745MHz 2170MHz

Fig. 3 (c) Radiation patterns of the proposed compact antenna for Mobile bands

Table 1. Measured proposed antenna gain for operating frequencies.

T-DMB band

Frequencies	Peak Gain
174	-8.36
184	-8.00
194	-8.78
210	-8.22

GPS band

Frequencies	Peak Gain
1574	-0.076
1575	0.009
1576	0.067

Mobile bands

Frequencies	Peak Gain
824	1.441
890	4.314
935	.34
960	4.306
1710	4.577
1840	5.43
1950	4.455
2170	5.298