Low Profile Multi Band Antenna for Underground

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Abstract

This paper presents a novel low profile multi-band antenna for the base station of various wireless communication systems in underground use. The proposed antenna can be operated from 0.5 GHz to 6 GHz. The electrical antenna height was 1 / 60 wave length at the lower edge frequency 0.5 GHz.

Keywords : Multi-bands Low profile Base station

1. Introduction

In recent years, various wireless communication systems are operating. For example, the frequency range of the terrestrial digital broadcasting is used from 0.5 to 0.7 GHz, the frequency of the mobile phone is about 2 GHz band and the frequency of the wireless LAN are about 2.4 GHz band and 5GHz band.

Numerous multi-band antennas have been developed in response to the recent demand for wireless communication systems, for instance, the antenna in [1] was for dual-band operation around 2.4 and 5 GHz, while the antenna in [2] was for multi-band operation ranging from 0.8 to 3 GHz. The radiation element in each of the antenna in [3],[4] stands upright above a conducting plane, while maintain the required frequency bandwidth of the VSWR. One challenge in the design of such base station antennas was the reduction of the antenna height above the ground plane. In general, if the antenna height is reduced, the bandwidth reduces.

This paper presents a novel low profile multi-band antenna for the wireless base station in underground use of wireless communication systems such as terrestrial digital broadcasting, mobile phone and wireless LAN. So, the proposed antenna must be operated from 0.5 GHz to 6 GHz.

2. Proposed antenna configuration

The proposed antenna 1 is composed of the asymmetric conducting T-shaped monopole and the rectangular conducting plane with small width as shown in Figure 1. The antenna height was 10 mm. So, the proposed antenna 1 with this size can be set up in the ceiling in the underground. This proposed antenna was fed by the coaxial cable and its characteristic impedance is 50 ohm. The theoretical analysis was performed using the simulation software Ansoft HFSS.

3. Simulated results

Figure 2 shows the simulated VSWR of the proposed antenna 1 as a parameter of X as shown in Figure 1. VSWR less than 2 was obtained the frequency range of 0.65 - 3 GHz at X=160 mm as shown green line. But, the band (0.5 -0.65GHz) of terrestrial digital broadcasting in Japan was not satisfied.

To satisfy this low band of the terrestrial digital broadcasting, the rectangular conducting plane was modified as shown in Figure 2. The antenna length was 442 mm and antenna width was 285 mm. By using this configuration, new resonance frequency at 0.5 GHz is occurred. Figure 4 shows the simulated VSWR of the proposed antenna 2 as shown in Figure 3. VSWR less than 2 was obtained from 0.5 to 0.65 GHz. And VSWR less than 2 was realized for WiMAX, wireless LAN and IMT-2000 bands.

To clarify the mechanism of the proposed antenna 2, the current distributions were simulated. Figure 5 shows the simulated current distributions of the asymmetric monopole antenna and the rectangular plane at 0.54 GHz, 3.0 GHz and 5.5 GHz. The red shows the strong current distribution and the blue shows the week current distribution. From Figure 5, the strong current was flows the rectangular plane and the near the feeding point.

Figure 6 shows the simulated radiation patterns at 0.54 GHz, 3.0 GHz and 5.5 GHz. The black line shows 0.54 GHz. The red line shows 3.0 GHz. The green line shows 5.5 GHz. In X-Y plane, the omni-directional radiation pattern was obtained at each frequency. In the X-Z plane and Y-Z plane, the conical beam was obtained. So, this radiation pattern was useful for underground shopping center. The gain was about 5 dBi.

4. Measured result

Figure 7 shows the fabricated proposed antenna 2. Figure 8 shows the simulated and measured VSWR. Both results were agreed very well. And VSWR less than 2.1 were obtained at 0.5 - 0.6 GHz , 0.8 - 1.0 GHz, 1.4 - 1.5 GHz, 1.7 - 2.2 GHz, 2.4 - 3 GHz, 3.4 - 3.6 GHz, and 5.1 -5.8 GHz for various wireless communication systems .

5. Conclusions

The very low profile and multiband base station antenna for underground was presented. The electrical antenna height at the lower edge frequency of the bandwidth was small 1 / 60 wave length. The proposed antenna was operated required multi-band from 0.5 GHz to 6 GHz for various wireless communication systems. The radiation pattern of the proposed antenna was similar to that of a monopole above a finite sized ground plane.

The proposed antenna can be used for the base station of various wireless communication systems such as terrestrial digital broadcasting, mobile phone and wireless LAN. And, the proposed antenna with this size can be set up on the ceiling in the underground.

References

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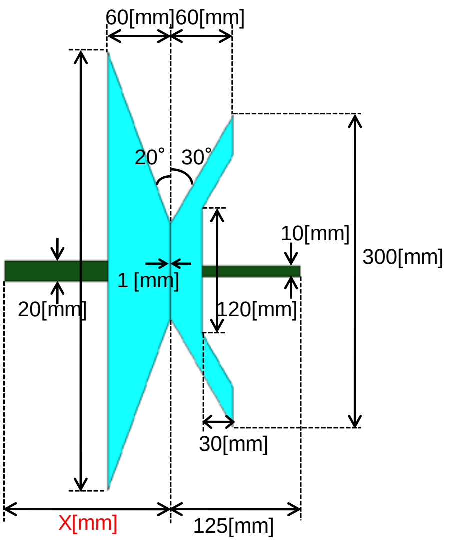


Figure 1: Proposed antenna 1.

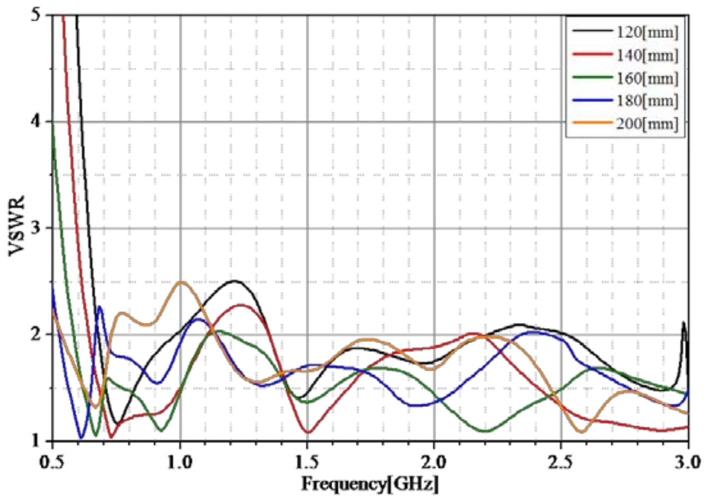


Figure 2 Simulated VSWR as a parameter of X.

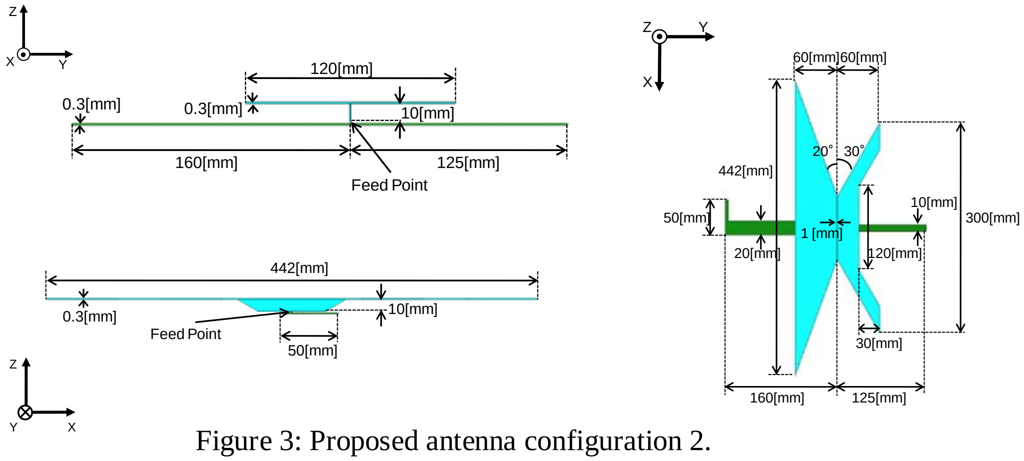


Figure 3: Proposed antenna configuration 2.

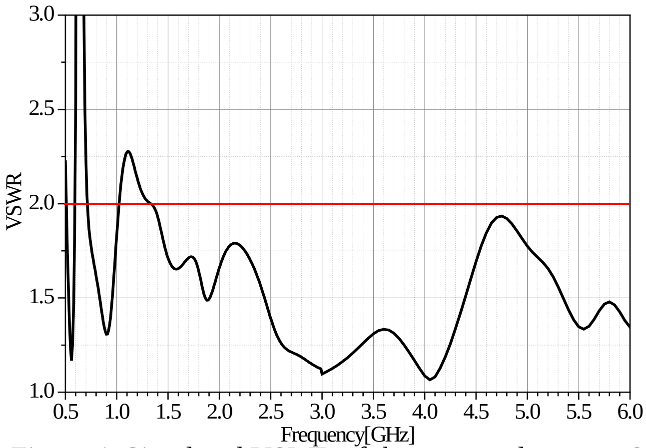
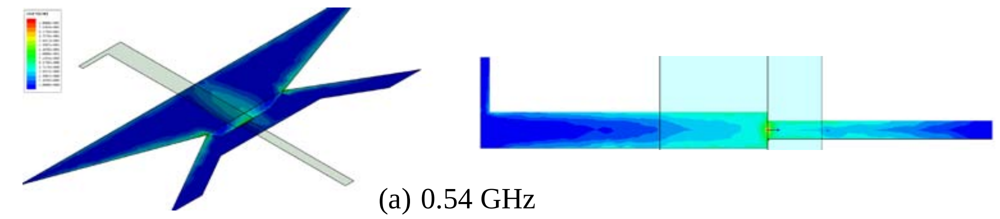
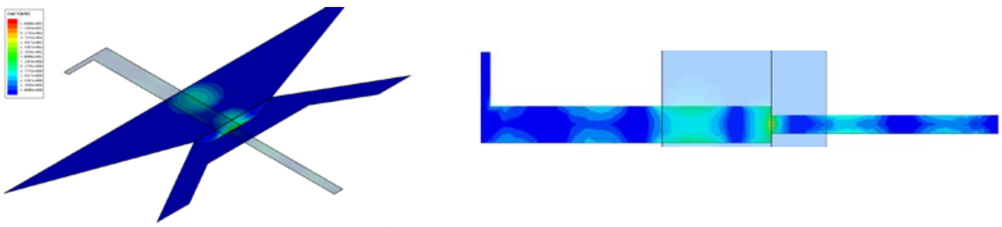


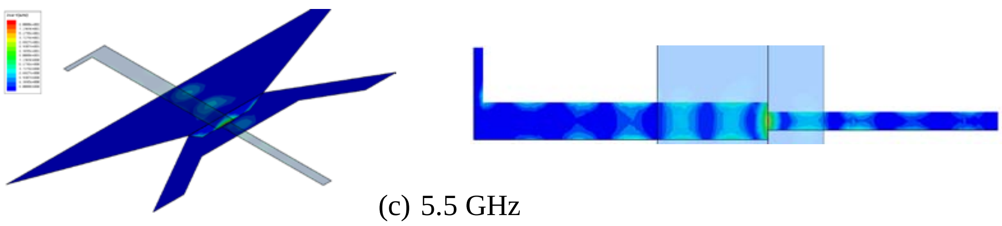
Figure 4: Simulated VSWR of the proposed antenna 2.



(a) 0.54 GHz

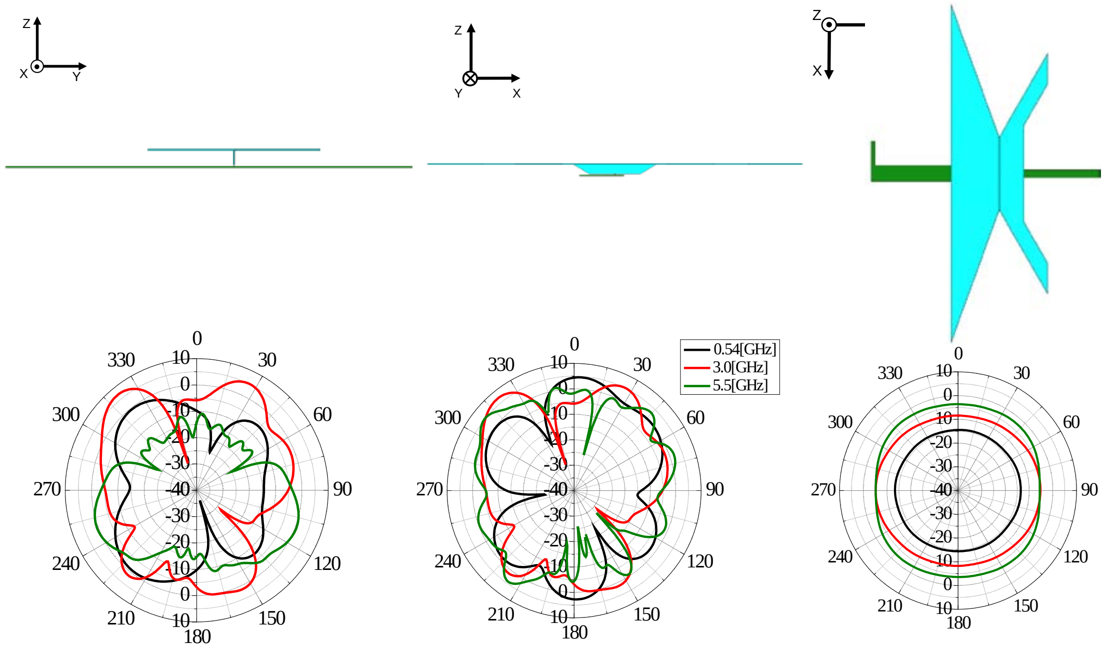


(b) 3.0 GHz



(c) 5.5 GHz

Figure 5: Simulated current distributions.



(a) Y-Z plane (b) X-Z plane (c) X-Y plane

Figure 6: Simulated radiation patterns of the proposed antenna 2.

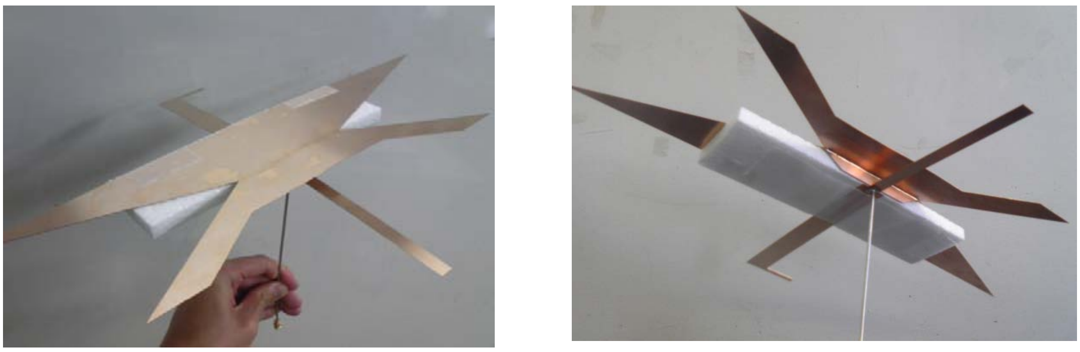


Figure 7: Fabricated the proposed antenna 2.

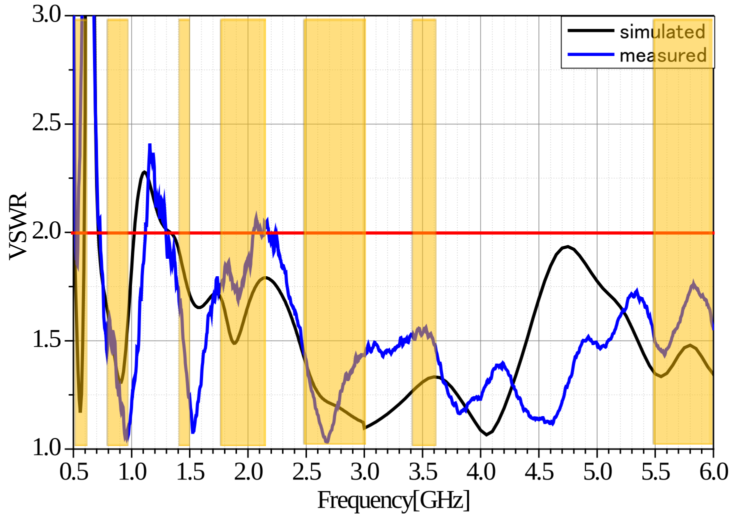


Figure 8: Simulated anted measured VSWR of the proposed antenna 2.