Impedance characteristics of an antenna apertured in metal housing wall of electronic equipment

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1. Introduction

In recent years, there are many cellular phones and laptop PCs using metal housing for strengthening and well-designing the housing.

When an antenna is embedded in a wireless equipment with a metal housing, typically, an aperture on the housing at a location close to the internally mounted antenna is provided so that the housing will not affect impedance characteristics and not hinder the radiowave radiation. The aperture itself then is usually covered with a non-conductive material such as a plastic resin.

However, it is difficult to ensure antenna characteristics over a wide frequency range by using this means. Especially in a UWB communication where a wide range of 3.1 GHz to 10.6 GHz is used, building an antenna for the UWB communication in a metal housing is a difficult task.

Now, if it is possible to use the housing itself as an antenna, influences on an antenna characteristics, caused when an antenna and a metal housing are close each other, will disappear. And it provides an effective solution for small mobile electronic equipment being densely packed as a high-density packaging since it eliminates the need to place an antenna inside the housing.

The authors have already proposed an antenna apertured with a half-semicircle and -trapezoid, formed in metal housing wall of a wireless equipment, and in case of equipment dimensions much larger compared with the UWB wavelength, we have confirmed to have the antenna characteristics enough for covering the UWB frequency band [1].

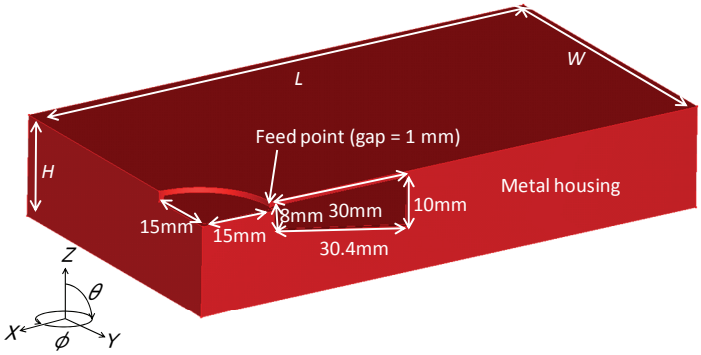
In this paper, the impedance, VSWR characteristics of the aperture antenna, formed in netbook-sized and cellular phone-sized metal housing walls of 240 mm x 190 mm x 20 mm and 110 mm x 60 mm x 20 mm, respectively, as practical cases, were investigated.

2. Antenna Configuration

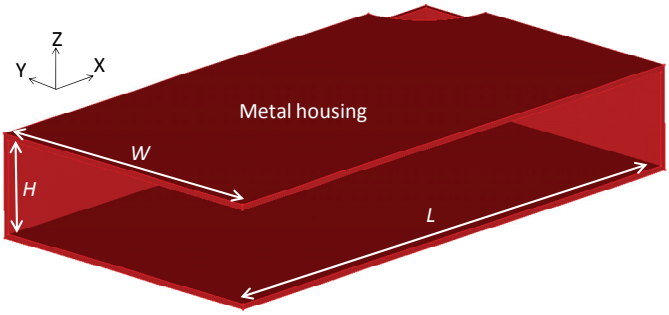
Fig. 1 shows the configurations of the aperture antenna in the metal housing wall. Fig. 1(a) shows a view from the aperture antenna side, and Fig. 1(b) shows a view from the backside (opposite side of aperture antenna). As shown in Fig. 1(a) and (b), an antenna apertured with a half-semicircle and -trapezoid formed at the corner of the metal housing wall of L x W x H. A feed point is located at the 1 mm gap between the arc of the half semicircle and the upper base of the half trapezoid as shown in Fig.1 (a).

3. Impedance Characteristics

Fig. 2, obtained from electromagnetic field analyses, shows input impedance characteristics of the antenna shown in Fig. 1 in the frequency range of 1 GHz to 12 GHz including UWB band. The impedance characteristics of the antenna in case of equipment dimensions much larger compared with the UWB wavelength is also shown in the Fig. 2. In the electromagnetic field analysis, Transmission Line Matrix (TLM) method (CST MICROSTRPES), was used.

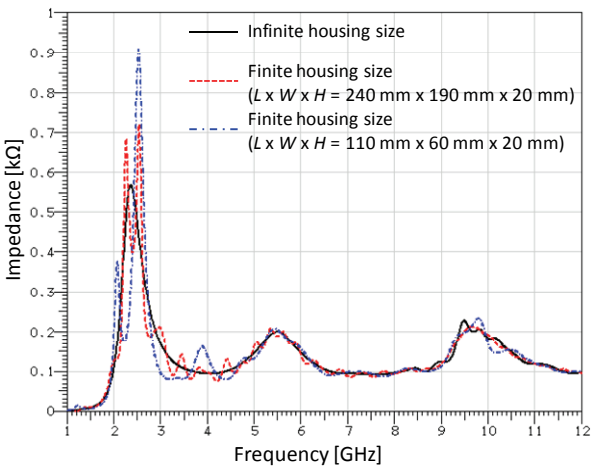


(a) View from aperture antenna side

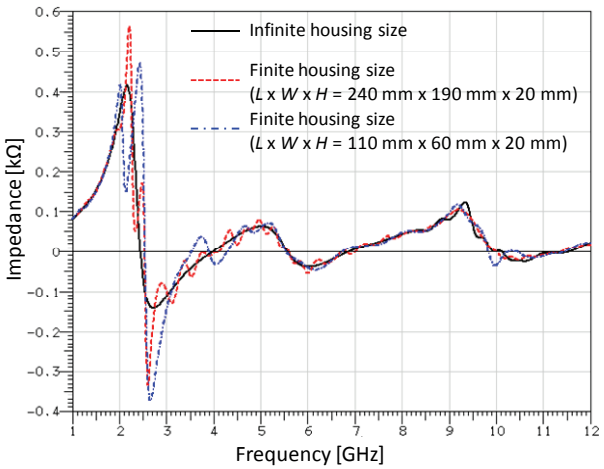


(b) View from the backside,
opposite side of aperture antenna

Fig.1 An antenna in metal housing wall



(a) Resistive component



(b) Reactive component

Fig.2 Input impedance characteristics

As shown in Fig. 2, impedance characteristics in the both case of employing netbook-sized and cellular phone-sized housing and infinitely large housing agreed well each other in a frequency range above 5 GHz. In a frequency range below 5 GHz, the impedance characteristics are slightly different from each other, but those show the same tendency.

Focused on the frequency range of 2.8 GHz to 12 GHz, the average values of the resistive and reactive components of the input impedance are about 150 ohm and about 0 ohm, respectively, and those show the constant impedance characteristics over a wide frequency range.

4. VSWR Characteristics

Fig. 3, obtained from electromagnetic field analyses, shows VSWR characteristics of the antenna shown in Fig. 1 in the frequency range of 1 GHz to 12 GHz including the UWB band. Based on results of the impedance characteristics in section 3, feeding source with an output impedance of 150 ohm was employed. The VSWR characteristics of the antenna in the case of equipment dimensions much larger compared with the UWB wavelength is also shown in the Fig. 3.

As shown in Fig. 3, the VSWR characteristics were below 2.8 for the entire frequency range of 3 GHz to 12 GHz including UWB band. Thus, the excellent VSWR characteristics over a wide frequency range are confirmed as much as a case of housing with infinite dimensions.

As observed in Fig. 3, the VSWR characteristics of the antennas with the housing of netbook-sized, cellular phone size and infinitely large size agree well in the frequency range above 3.5 GHz, and are slightly different in the lower frequency range below 3.5 GHz. This is due to a difference of the housing size. As shown in Fig. 2, the impedance characteristics, in the case employing netbook-sized and cellular phone-sized housing, at low frequency below 3 GHz, are deteriorated compared with the case employing infinitely large-sized housing.

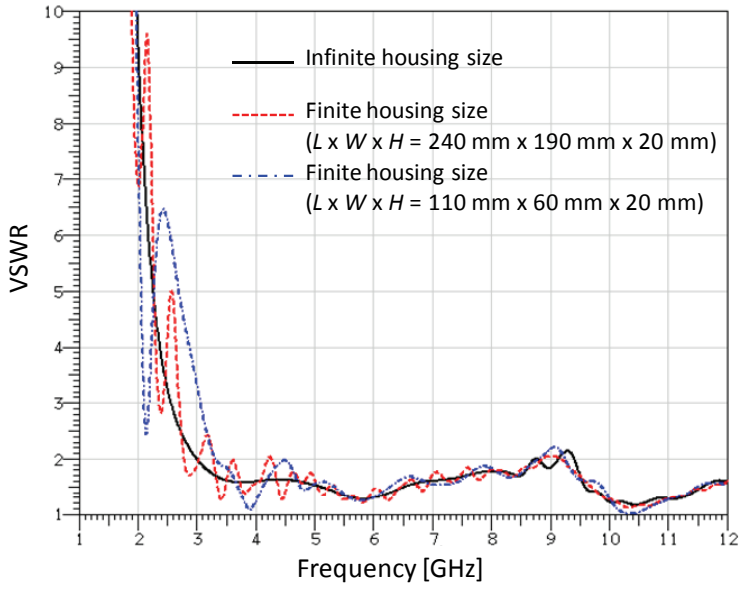


Fig. 3 VSWR characteristics

5. Conclusion

In this paper, we proposed an antenna apertured with a half-semicircle and -trapezoid, formed in netbook-sized and cellular phone-sized metal housing walls of 240 mm x 190 mm x 20 mm and 110 mm x 60 mm x 20 mm as practical sizes of wireless equipments.

The input impedance and VSWR characteristics of the proposed aperture antenna were investigated. As a result, it was found that the aperture antenna has constant impedance characteristics of about 150 ohm over a wide frequency range as much as a case of housing with infinite dimensions.

References

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