The Design of Small Size Chip Ceramic Dielectric Antenna for Bluetooth Application

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Abstract

This paper proposes a novel chip type ceramic dielectric antenna by using the advanced meander line technique that the radiation metals are formed on both the face of ceramic dielectric (8 x 4 x 1.5 mm, alumina) and two faces of substrate (1.0 mm thickness, FR-4). The performance of the antenna model has a good agreement between measured and computed results. In the results, it has a 10dB return-loss bandwidth(2.4-2.48 GHz) and 0.5 dBi measured radiation gain for Bluetooth application.

1. Introduction

In recent years, the wireless communication market has a lot of variations and it is difficult to predict the size of market precisely. There are also many kinds of radio frequency components in the market. One of those is the antenna that many researchers have tried to make with good performance. Antenna plays an important role in transforming electrical signal in communication system into electromagnetic wave. The sensitivity, impedance bandwidth, and radiation patterns of antenna are considered as very important design factors to make efficient communications. Besides those factors, the size or volume of antenna seems to be a valuable element in the antenna field.[1]-[4]

In this work, we proposed a novel chip ceramic dielectric antenna by using the advanced meander line technique that the radiation metals are formed on both the faces of ceramic dielectric (8 x 4 x 1.5 mm) and two faces of substrate(1.0 mm thickness, FR-4). The ceramic dielectric is made from alumina whose dielectric constant is 8.0.

2. A Novel Chip Type Ceramic Dielectric Antenna Design

Fig. 1 shows our proposed antenna model and metal patterns on each layer. We used CPW(Coplanar Waveguide) with ground plane to feed antenna and mounted the small ceramic chip on the top of substrate through reflow process(120 sec. at 220C.). This antenna is composed of three layers.(*layer_H, layer_M, layer_L*) The *layer_H* is formed on the top plane of ceramic chip and *layer_M* is done on the interface between the bottom of ceramic chip and the top plane of substrate. The *layer_L* is done on the bottom face of substrate. Each layer has its own metal pattern manufactured by using screen printer. These patterns are connected with via-hole through substrate and the assembled radiation pattern forms a modified meander line. From these figures, it is known that the metal pattern on *layer_M* connected to the ground plane is a part of this small antenna and is

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also used to attach the ceramic chip on the PCB. So this antenna has much smaller size than any other antenna in the same volume. Additionally, by trimming the end of metal pattern on *layer_L*, we can easily tune or shift the resonant frequency.

The size of substrate is 26(*Ls*) x 45(*Ws*) x 1(*t*) mm and the ceramic chip made of alumina(dielectric constant = 8.0) is 8.0(*L*) x 4.0(*W*) x 1.5(*h*) mm. *Lg* indicates the ground plane's length from the end of substrate connected with the coaxial cable to the end of CPW and is about 35 mm. The width of metal patterns on each layer is 1.0 mm(on *layer_H* and *layer_M*) and 0.7 mm(*on layer_L*).

3. The Measured Results

Fig. 2 shows our novel ceramic chip antenna's front and rear view. We designed this antenna using by commercial program based on the FEM method[5] and measured our antenna using by Agilent 8510C Network Analyzer. Fig. 3 shows the computed and measured return loss for our antenna. The solid line indicates measurements and dotted line does calculated results.

From Fig. 3, we know that the performance of antenna has a good agreement between measurements and computed results and this antenna is satisfied with the bandwidth of Bluetooth (2.4-2.4835 GHz) at VSWR<2.

Next, the computed and measured radiation patterns of our antenna are shown in Fig. 4. The solid line denotes measurements and dotted line does calculated results.

Although there are some differences between computed and measured results, the radiation patterns are nearly omni-directional and the maximum radiation gain is 0.5 dBi. Considering that the maximum gain of commercial antenna for Bluetooth has about 1.0 dBi, we can say that our antenna has good radiation gain. So this antenna can be used to Bluetooth application and other wireless communication. To advance this antenna, we need to miniature the size of ceramic chip and to consider the peripheral circuits located on the same substrate.

4. Conclusion

In this paper, we suggested a novel chip type ceramic dielectric antenna by using the advanced meander line technique that the radiation metals are formed on both the face of ceramic dielectric (8 x 4 x 1.5 mm, alumina) and two faces of substrate(1.0 mm, FR-4). The performance of the antenna model has a good agreement between measurements and computed results. It has a 10 dB return loss bandwidth(2.4 - 2.4835 GHz) and 0.5 dBi measured radiation gain for Bluetooth application.

Acknowledgement

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[5] HFSS, Ansoft Corp.

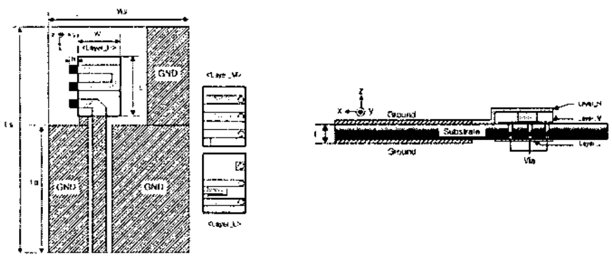


Fig. 1. Proposed antenna structure

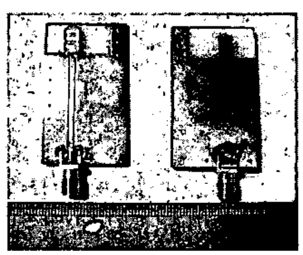


Fig. 2 Proposed ceramic chip antenna

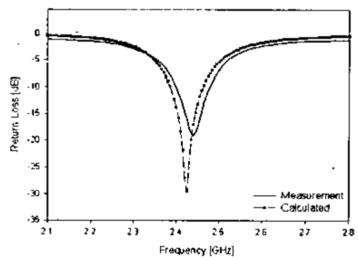
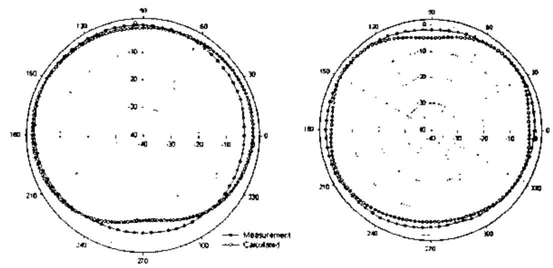


Fig. 3 The return loss of proposed ceramic antenna



(a) y-z plane

(b) x-z plane

Fig. 4 The radiation patterns for proposed ceramic antenna at 2.41 GHz