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Performance of Flat Type UWB Antenna Located near the Metal Plate

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1. Introduction

Recently W-PAN (wireless personal area network) system using UWB technique is considered. We focused the internal antenna for the personal computer or the audio-visual equipment in terms of W-PAN application. In this case, it is required the antenna should be flat in order to be installed easily and must perform good impedance matching when the antenna is located near the metal plate as a part of the equipment case.

As the wide band antenna, many kinds of antennas were published [1][2][3][4][5]. But these antennas were constructed 3-dimensional or were not confirmed to perform good impedance matching near the metal plate.

This time, we successfully developed the flat forming wide band antenna for W-PAN or UWB application, which performed good impedance matching near the metal plate.

2. Antenna Construction

The construction of the original antenna [6][7] made of the printed circuit board is shown in Fig.1. This antenna consists of the dual elliptical disk elements, which are large and small, and the inverted U-letter element. The large disk element has the elliptical hole whose size is approximately as same as the other small disk element. And the large and small disk elements are connected by through hole at the bottom of each disk. The trial antenna size is 58mm x 28mm and the printed circuit board size is 30mm x 75mm, whose thickness is 0.8mm. The material is Teflon and its dielectric constant is 2.6. The polarization of the antenna is mainly vertical.

3. Installed Antenna Condition

The installed antenna condition for the personal computer or other equipment is shown in Fig.2. The antenna is located in front of the metal case as the equipment, and the plastic cover plate is covered on the antenna. Generally, it is required the distance between the cover plate and the front metal plate of the case in Fig.2 is less than or equal 10mm. So the internal antenna must have good impedance matching performance under the above condition in the assumed UWB band from 3.1GHz to 4.9GHz. And we tried to optimize by experiment and simulation using Moment methods. First of all, we gave experimental evaluation for impedance matching to our flat UWB antenna [6][7] and got that it was improvable to adjust the hole size of the large disk element in Fig.1. Thereafter we investigated the best hole size by simulation and confirmed its performance by experiment. The final optimized sizes of the antenna and the installed construction are shown in Fig.1 and Fig.2.

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4. Performance

We made the one of the optimized antenna and measured its performances.
Fig.3 shows the measured return losses when the antenna is installed as Fig.2. The return losses are less than -8.3dB (VSWR<2.3) from 3.1GHz to 4.9GHz. Fig.4 shows the measured return losses when the antenna is in the free space. The return losses are less than -9.5dB (VSWR<2.0) from 2.4GHz to 5.25GHz. As a reason of result in Fig.4, this antenna type basically has the wider band performance in free space, for example 2.4GHz to 12GHz [6][7]. However the antenna in Fig.1 is re-sized and tuned so that the best matching performance is obtained under the condition in Fig.2. In other viewpoint, it is expected the antenna in Fig.1 to achieve the better return losses or the wider band width under the condition that the metal plate is separated more than 6.5mm from the antenna.

The radiation patterns in azimuth and elevation planes at 3.1GHz, 3.9GHz and 4.9GHz are shown from Fig.5 to Fig.10. In all azimuth patterns, the antenna has the beam peaks to the front direction. In elevation planes at 3.1GHz and 3.9GHz, the great back-lobes occurs by the influence of the metal case, but it is roughly confirmed that main beam radiates to the front direction.

Finally, the antenna performances are summarized in Table-1. The peak gain at 3.1GHz is 6.2dBi and more at other frequencies. The 3dB beam width in azimuth plane is more than or equal to 66.0 degrees.

5. Conclusion

We described the flat and wide band antenna for W-PAN or UWB application and its good performances under the condition that it is located at 6.5mm from the large metal plate. As the experimental results, VSWR is 2.3 or less from 3.1GHz to 4.9GHz. The radiation patterns are broad and have no null points in azimuth and elevation plane. The peak gain at 3.1GHz is 6.2dBi and more at other frequencies.

Therefore the flat type UWB antenna is very useful as the internal antenna in the equipment for W-PAN or UWB applications.

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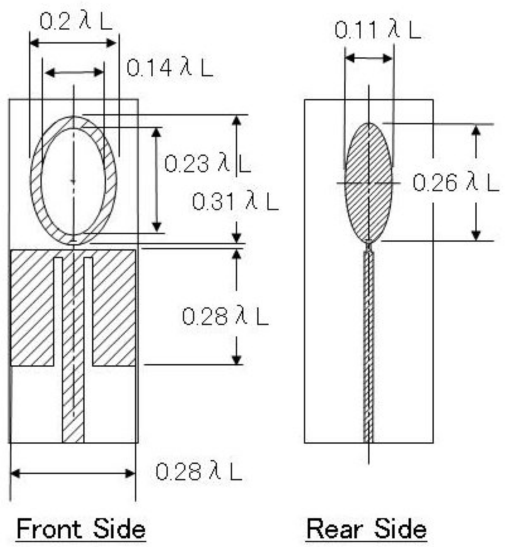

Fig.1 Construction

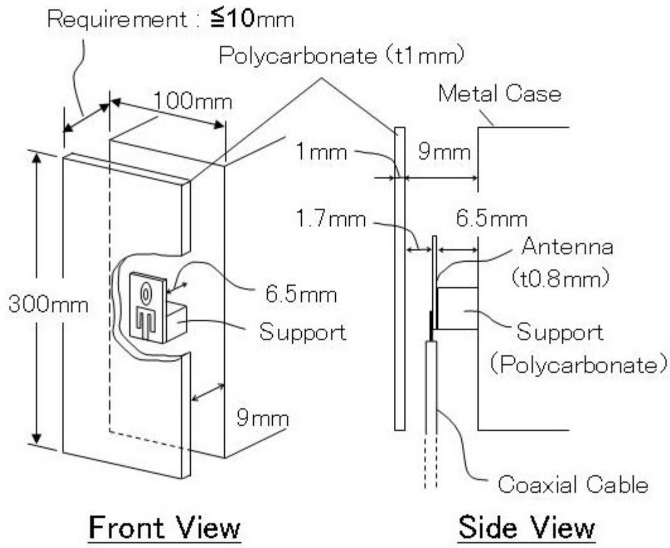

Fig.2 Installed Condition

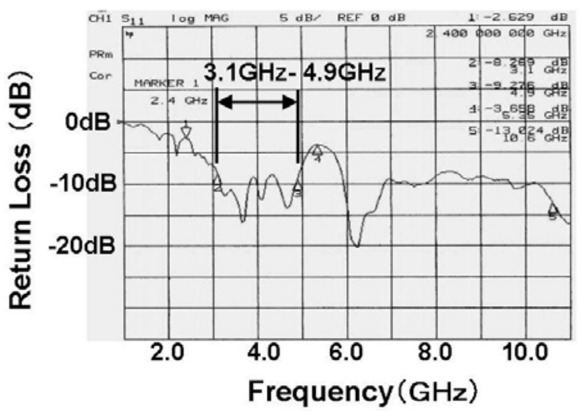

Fig.3 Return Loss near Metal Plate

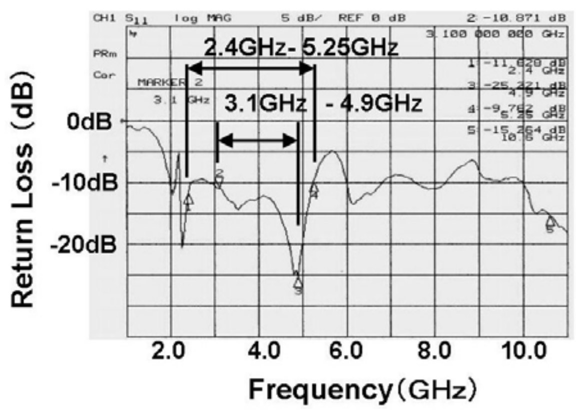

Fig.4 Return Loss in Free Space

Table 1 Antenna Performance

Item		Installed on Case	In Free Space
Frequency Band		3.1–4.9GHz	2.2–5.25GHz
VSWR		2.3	2.0
Peak Gain	3.1GHz	6.2dBi	–
	3.9GHz	6.5dBi	–
	4.9GHz	9.9dBi	–
3dB Beam Width in Azimuth	3.1GHz	76.0deg.	–
	3.9GHz	66.0deg.	–
	4.9GHz	76.0deg.	–
Polarization		V–pol	
Dimension (PCB size)	Height	58mm(75mm)	
	Width	28mm(30mm)	
	Thickness	0.8mm	

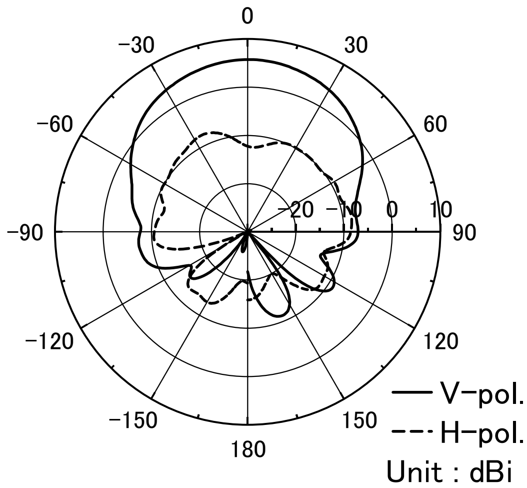

Fig.5 Azimuth Pattern at 3.1GHz

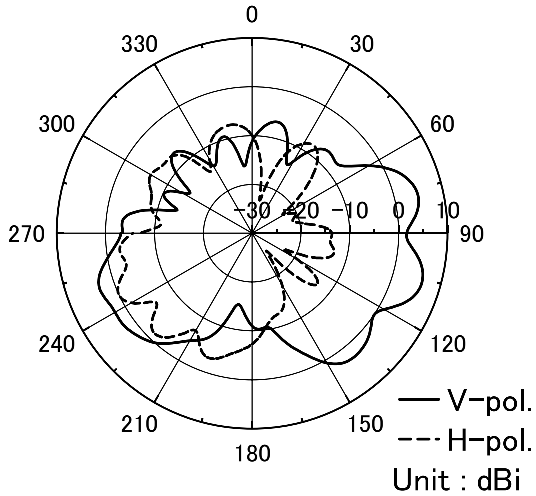

Fig.6 Elevation Pattern at 3.1GHz

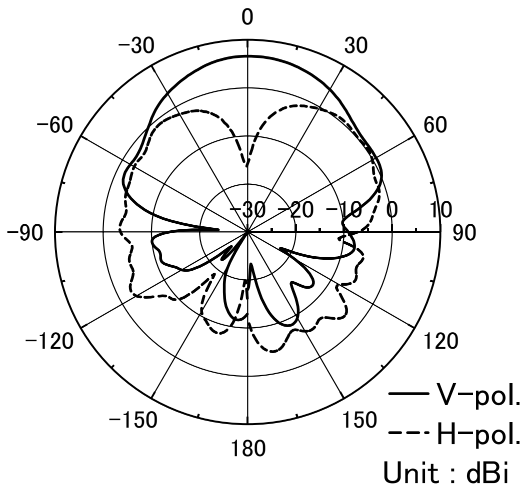

Fig.7 Azimuth Pattern at 3.9GHz

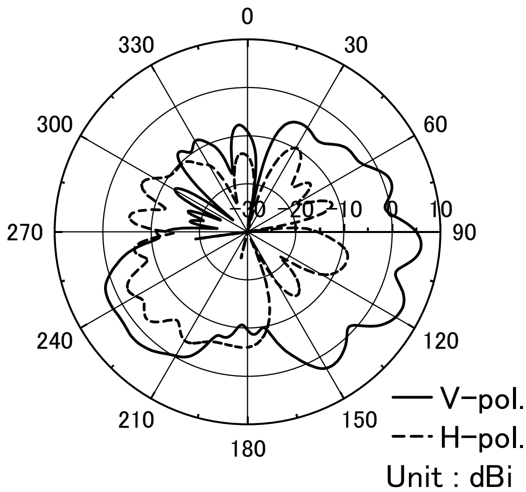

Fig.8 Elevation Pattern at 3.9GHz

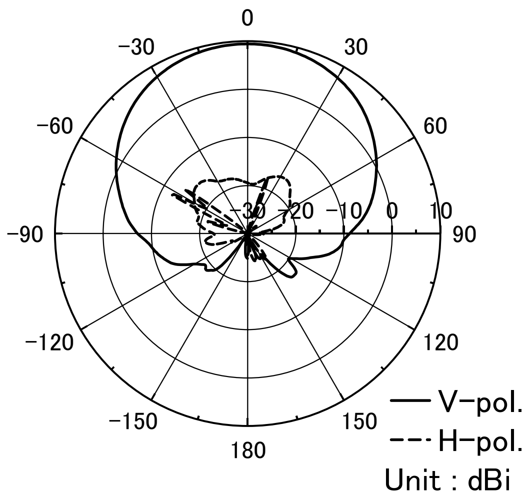

Fig.9 Azimuth Pattern at 4.9GHz

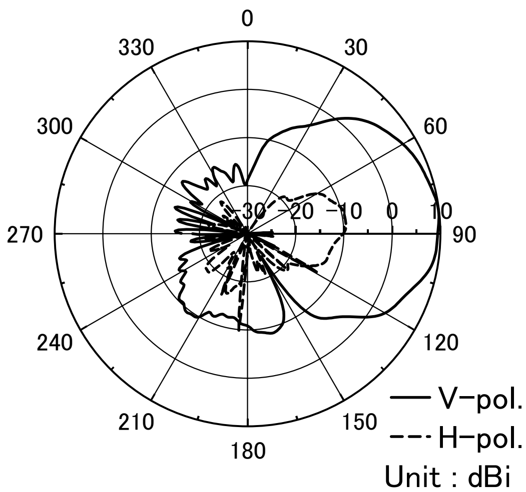

Fig.10 Elevation Pattern at 4.9GHz