Miniaturized High Gain Slot Dipole Array Antenna for X-band Application

Masahiro Koga, Kuniaki Yoshitomi, Haruichi Kanaya
Department of Electronics, Kyushu University, Fukuoka 819-0395, Japan

***Abstract* – A novel miniaturized high gain slot dipole array antenna for X-band radar application is proposed. This antenna has 2 emission elements to improve the antenna gain. A floating metal, which is not connected to antenna metal layer, is placed to the back of the antenna in order to achieve the one sided directional radiation. The RF signal is fed through the miniaturized coaxial connector to coplanar waveguide (CPW). The simulation and the measured results of the return losses, gains, and radiation patterns are shown in this paper. The maximum peak gain of this antenna has 7.09dBi at 10.8GHz and front to back ratio is about 15dB. The size of the antenna is 18mm x 6mm x 0.436mm. Proposed antenna realized a high gain and miniaturization.**

***Index Terms* —slot antenna, planar antenna, array antenna**

I. INTRODUCTION

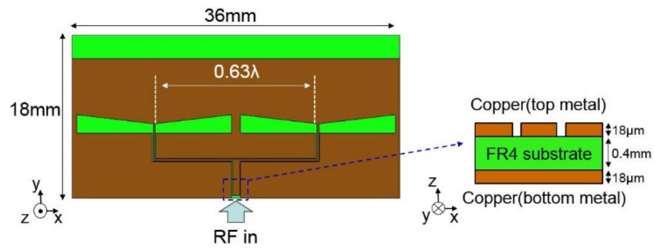
In recent years, radio wave is used in various fields such as telecommunication radar system. Especially, radars which used in X-band (8-12GHz) attract much attention because the radio wave of this band has a high resolution and straightness. In these systems, size reduction of the antenna is key issue because the device size is smaller and smaller. Furthermore, some of these devices are used as mobile communication and battery drive devices. In this reason, the built in antenna must achieve high gain as well as miniaturization.

A patch antenna is widely known as one of the high directional planar antennas and it has a high gain. However, the patch antenna requires large ground plate and thick substrate [1] [2]. Therefore, it is difficult to reduce the size of the antenna. Patch antennas also require microstrip line as a feed line, and it must be connected electrically between the top signal metal and bottom ground plate with connector [3]. Thus, design of the characteristic impedance of the microstrip line is another problem especially in the thin substrate. In this paper, one sided directional slot dipole array antenna with CPW feed line is proposed. In general, slot antenna consists of top metal with slot and dielectric substrate, and large ground plate is not necessary, because the layout of the antenna is completed on top metal. This characteristic enables us to mount connector on surface with CPW [4]. So, slot antenna is easy to miniaturize and to connect wireless devices. In addition, by attaching floating metal to the back of the antenna and optimizing the size of this floating metal, the antenna is able to realize one sided directivity [5] [6]. In this way, it is possible to improve antenna gain.

We designed 1 x 2 array slot dipole antenna by using the electro-magnetic field simulator (HFSS, Ansoft). The simulated and measured results of the proposed antenna are shown on this paper.

II. ANTENNA DESIGN

Fig. 1(a) shows the top view of the 1 x 2 array antenna layout and Fig. 1(b) shows the side view of the feeding point. FR4 substrate (ε_r = 4.1, tanδ =0.02) which has a 0.4mm thickness is used in this antenna and a top and bottom metal are 18um-thick metal (Cu). RF signal is fed to the antenna through CPW which has the width of signal line is 0.8mm and gap is 0.1mm. CPW is branched in order to supply the RF signal to 2 antenna elements at the same phase. The width of the branched signal CPW line is 0.2mm. This antenna is arrayed along X-axis. The distance between 2 antenna elements is 0.63λ.



(a)Top view (b)Side view

Figure 1. (a)Top and (b)side view of array antenna layout.

Fig. 2 shows the electric field simulation result of proposed antenna at 10.5GHz. Fig. 2(a) is top view and Fig. 2(b) is bottom view.

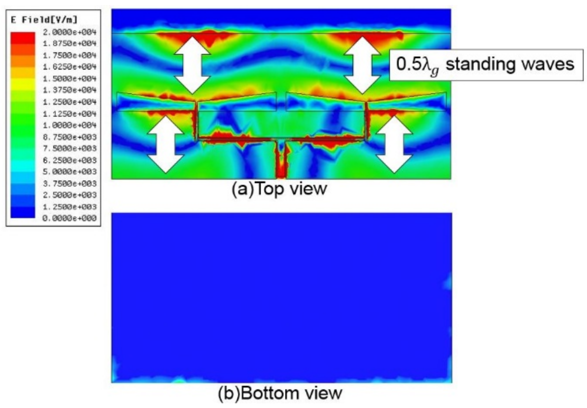


Figure 2. Top view (a) and bottom view (b) of the electric field of the 1 x 2 array antenna.

As shown in Fig. 2(a) we can see the 4 emission elements on this antenna because 4 standing waves appear on the surface. In contrast, there are no resonances on the bottom of this antenna. From Fig. 2, this antenna has an one sided directional radiation toward the top of the antenna.

III. ANTENNA FABRICATION AND MEASUREMENT RESULTS

Proposed slot dipole array antenna is fabricated on FR4 substrate with print board making equipment (MITS; FP-21T model 40). Fig. 3 shows the photograph of proposed antenna and close up of feeding point. RF signal is fed through the miniaturized coaxial connector to CPW. The total antenna size is 18mm x 36mm x 0.436mm.

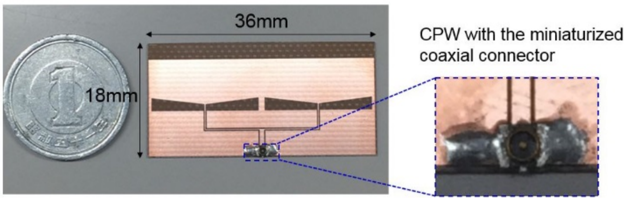


Figure 3. Photograph of proposed antenna.

Fig. 4 shows the measurement result of return loss compared with the simulation result of the proposed antenna. The -10dB bandwidth of measurement result is from 10.44GHz to 10.8GHz.

Fig. 5 shows the measurement result of the gain characteristics compared with the simulation result. The gain curve of the measured result is similar to that of the simulation. The peak gain of this antenna is 7.09dBi at 10.8GHz. There was a 1.3 dB difference of the peak gain between the measurement result and simulation result due to the loss of the cable or solder connecting part. However, this antenna has sufficient high gain by arraying 2 antenna elements.

Fig. 6 shows the measurement result of normalized radiation pattern at 10.5GHz compared with the simulation result. The measured result almost agrees with the simulation result. The beam of XZ plane is sharp characteristic because this antenna is arrayed along X-axis. Front to back ratio is about 15dB. Our proposed antenna realizes the one sided directional radiation and miniaturization.

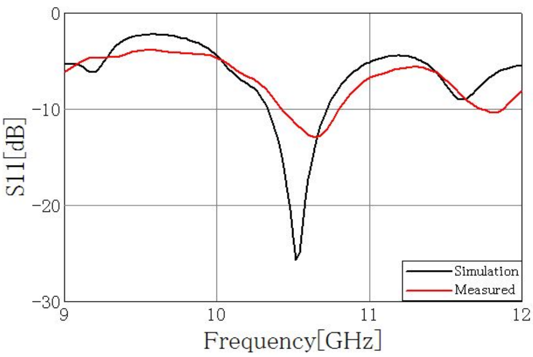


Figure 4. Measured and simulated return losses.

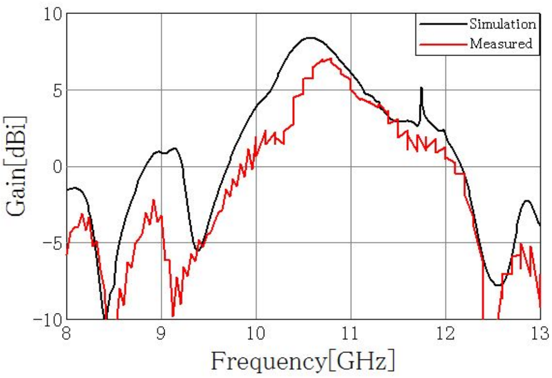


Figure 5. Measured and simulated antenna gains to the z-axis direction.

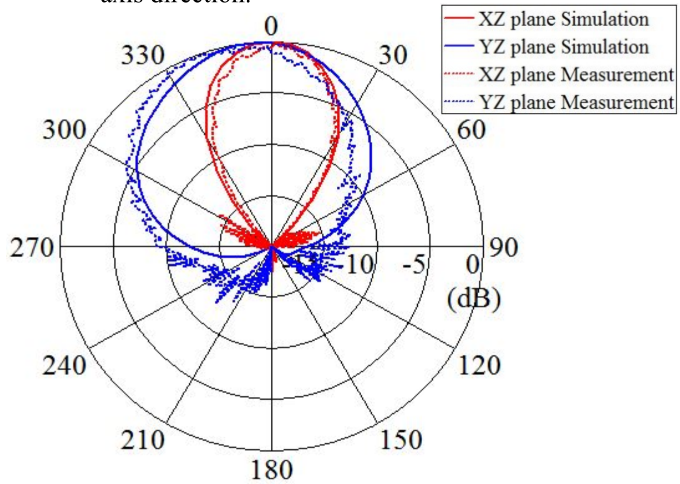


Figure 6. Measured and simulated radiation patterns.

IV. CONCLUSION

This paper presents the design of miniaturized high gain slot dipole array antenna. The proposed antenna has a high gain and size reduction at the same time.

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