2 × 2 Slot Dipole Array Antenna with CPW for 2.4GHz Band

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***Abstract* – This paper presents a novel design of a 2 × 2 slot dipole array antenna with the reflector fed by coplanar waveguide (CPW). The proposed antenna has four antenna elements and branched CPW structure to achieve a high antenna gain and a sharp beam. We fabricated and measured the array antenna with the reflector. The measured forward directional peak gain was 9.39dBi at 2.50GHz.**

***Index Terms* — Planar slot antenna, array antenna, 2.4GHz Band.**

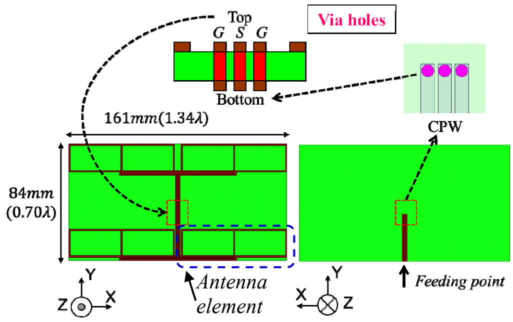
I. INTRODUCTION

Recently, explosive growth of wireless communication traffic has become one of the big problems because of the increasing wireless communication devices such as smart phones, tablets and mobile PCs. In order to achieve higher speed, longer distance and more capacity for wireless communication, a high gain antenna is required. There are a lot of researches about the high gain antennas for 2.4GHz band [1, 2]. However, the most of high gain antennas on printed circuit board (PCB) is patch antenna. In the case of a patch antenna, thicker dielectric substrate is required because the radiation is generated from the cross section of the patch antenna. In addition, larger ground metal layer compare with patch metal is also needed [1-4]. On the other hand, slot antennas can be designed only one layer because feed line is composed of coplanar wave guide (CPW), which has signal and ground metals on the same layer [5, 6].

In this paper, an array antenna by using four slot antenna elements and branched CPW is proposed and measured. The proposed antenna has the reflector in order to achieve a high antenna gain to forward (+z-axis) direction. We designed and simulated by electromagnetic field simulator (HFSS, Ansoft).

II. DESIGN OF ARRAY ANTENNA

Fig. 1 shows the layout of the top and bottom view of a 2 × 2 slot dipole array antenna. The proposed antenna is designed on a FR4 substrate (ε_r = 4.25, tanδ = 0.017) with 1.6mm thickness covered by top and bottom metal (Cu) layers. In order to obtain a high antenna gain to z-axis direction, the same RF power is injected to each antenna element with the same phase, and the spacing between each antenna element is half wavelength (0.50λ). However, in order to tune the phase, the spacing on x-axis direction is 0.69λ and on y-axis direction is 0.50λ in this antenna. RF signals are injected at the bottom CPW, and connected to the top CPW by via holes. The width of the signal line and the gap of the CPW are 1.0mm and 0.20mm, respectively.



(a)Top view (b) Bottom view

Fig. 1. Slot array antenna layout of top (a) and bottom view (b).

III. FABRICATION OF ARRAY ANTENNA

The slot dipole array antenna is fabricated by using the print board making equipment (MITS; FP-21T model 40). Fig. 2 shows the photograph of fabricated antenna with a reflector.

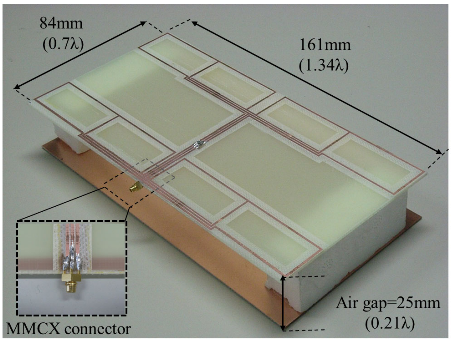


Fig. 2. Photograph of the fabricated 2 × 2 array antenna with the reflector.

RF signal is fed to CPW on the bottom metal by MMCX connector and the copper wire is filled in three via holes connecting between top and bottom CPW. The size of the reflector is the same length and width as the antenna substrate and thickness is 0.8mm. There is 25mm (0.21λ) air gap between the bottom metal and the reflector. The final antenna size including the reflector is 161mm (1.34λ) × 84mm (0.70λ) × 27.4mm.

IV. Measured and Simulated Results

S-parameter and antenna gain were measured by using a GP-IB controlled network analyzer (HP8722C, HP). Fig. 3 shows the simulated and measured results of S_{11}. The frequency characteristics of the measured S_{11} are similar to that of the simulation. However, the measured result of the resonant frequency is a little higher than that of the simulation because of the accuracy of the dielectric constant of the substrate. Bandwidth (S_{11} is less than -10dB) of the measured result is 210MHz from 2.35GHz to 2.56GHz. Fig. 4 shows the simulated and measured results of the antenna gain to +z-axis direction. The antenna peak gain is 9.39dBi at the central frequency (2.50GHz) and more than 8dBi antenna gain is obtained in 290MHz bandwidth from 2.30GHz to 2.59GHz owing to arraying antenna elements and putting the reflector under the antenna.

Fig. 5 shows the simulated radiation patterns of x-z and y-z plane. The beam become sharp because of arraying antenna elements and a front to back (F/B) ratio was 15.4dB. As shown in Fig. 5 side lobes are appearing in the radiation pattern of x-z plane, because the spacing between antennas in the x-axis direction is 0.69λ, which is not ideal antenna spacing (0.5λ).

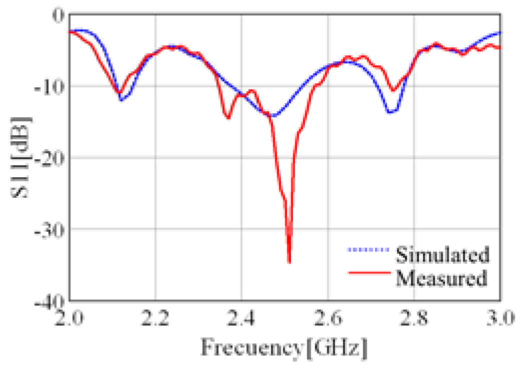


Fig. 3.Simulated and measured results of S-parameter.

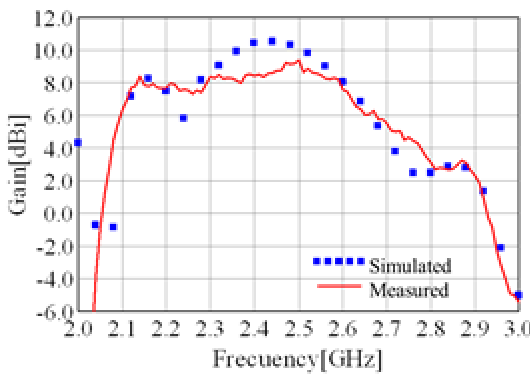


Fig. 4. Simulated and measured results of the +z-axis antenna gain.

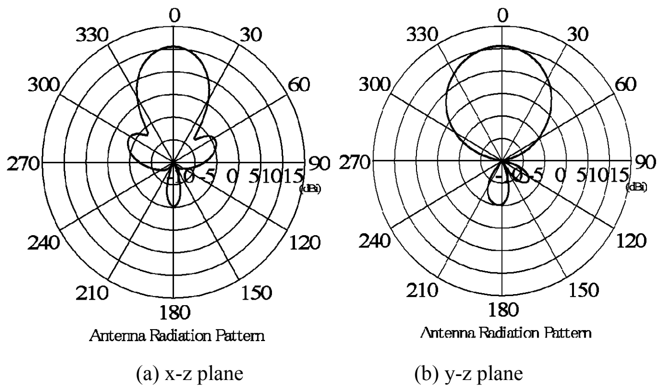


Fig. 5. Simulated radiation pattern results of the x-z (a) and y-z planes (b) at central frequency (2.44GHz).

V. Conclusion

This paper presents a 2 × 2 slot dipole array antenna on PCB with the reflector. By using branched CPW it is easy to inject the RF signal with the same power and the same phase. The size of the proposed antenna is 161mm × 84mm × 27.4mm. This antenna has 9.39dBi antenna gain and 15.4dB F/B ratio at 2.50GHz.

Acknowledgment

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