Bandwidth Improvement Through Slot Design on RLSA Performance

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***Abstract*-Radial Line Slot Array Antenna is a slot planar antenna. The slot has been arranged radially to create a concentration of wave into a single point. The body of this antenna normally a metal with hollow cavity and slots. However, recent development on RLSA has utilized the FR4 as a substrate material. The copper is attached to the substrate and the slot is not hollow as compare to the conventional approach. This research is studying the effect of slot with dielectric substrate to the Radial Line Slot Array Antenna (RLSA). From the measurement, it is found that the slot without substrate provide a better return loss as compare to slot with dielectric. It is also improve the bandwidth of the RLSA.**

I. Introduction

RLSA antenna for point to point microwave link based on 802.11a standard currently a popular candidate for this application due to its capability of carrying high speed signal [1]. RLSA prototypes has been designed and developed at the frequency range of 5725 – 5875 MHz by few researchers [2-4]. The classic design was using an air gap as a separator between radiation surface and ground plane [5]. Then, the polypropelene has been used as a slow wave element in the RLSA structure. This material normally give 2.3 dielectric value [6-7].

Recent development on RLSA has utilized FR4 board as a part of the antenna structure [7-11]. The copper is attached to the substrate and the slot is not hollow as compare to the conventional way. This research is studying the effect of slot with dielectric substrate to the Radial Line Slot Array Antenna (RLSA)

II. ANTENNA STRUCTURE

In this research, the FR4 board with air gap distance to the ground plane has been introduced as shown in Figure 1. The thickness of overall cavity is 9.6mm where the thickness of open air gap is 8mm. A 50Ω single coaxial probe coated with Teflon is used to feed the signal into the cavity. The aluminum plate is used as a platform to hold the antenna and also become a ground plane. The FR4 with 1.6mm thickness with 5.4 permittivity value is used as a first layer substrate to the radiating surface. Figure 2 shows the front view of the antenna.

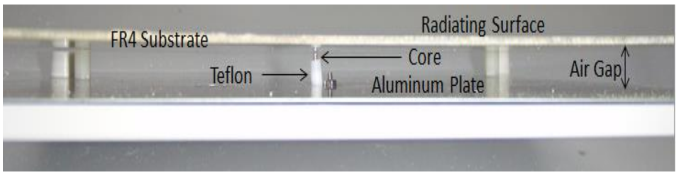

Figure 1: Fabricated open ended Air Gap RLSA Structure from side view

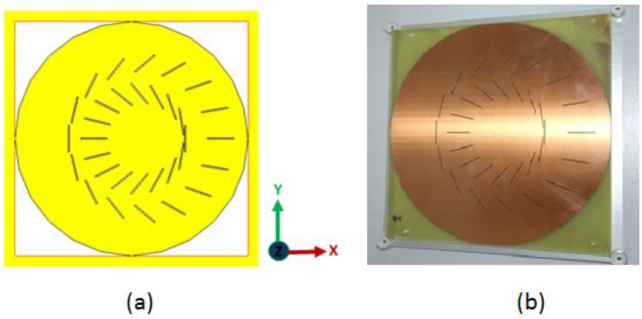

Figure 2: The slots arrangement on the surface of Air Gap RLSA (a) simulated, (b) fabricated

III. Antenna Development

The designed antenna has been developed as shown in Figure 1 and Figure 2(b). The slot has been constructed as shown in Figure 3 base on FR4 board. The arrow showed the wave movement to the air. However, the wave has to pass through the dielectric substrate that might provide the resistant value to the circuit.

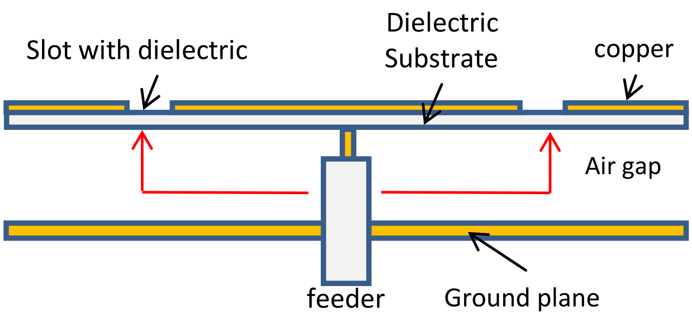

Figure 3: Slot antenna with dielectric substrate

Another approach to maximize the wave excitation to the air is to provide the hollow structure on the slot. The slot hole has been constructed as shown in Figure 4. It is expected that the wave will be fully excite to the air because the resistant element has been remove.

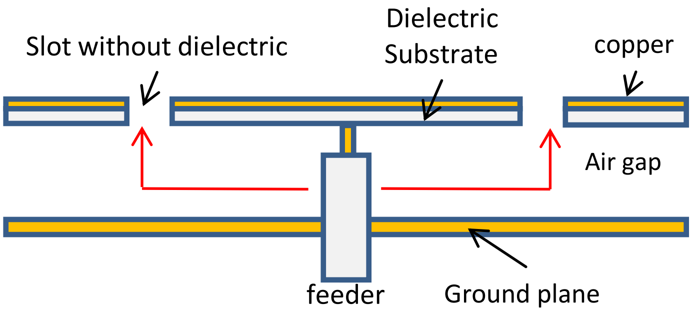

Figure 4: Slot antenna without dielectric substrate

The hollow slot has been constructed using DMF Milling Machine. The computerized machine has made the fabrication process become more easier. The FR4 board with hollow slot shown in Figure 5. A 2mm drill has been used to create the slots. The machine read the CATIA drawing file from it computer. The drawing originally drawed using CST softeware before converted to CATIA drawing file. Using this high end machine, an accurate slot dimention was succesfully constructed. The hollow slot board then installed into the antenna platform and become a complete antenna as shown in Figure 6.

Figure 5: Slot antenna without dielectric substrate fabricated using DMF Milling Machine

Figure 6: RLSA antenna with slot without dielectric substrate

IV. Result and Discussion

The concept of slot with and without dielectric was simulated using CST software. The simulated results show a smooth graph on slot with dielectric but not the slot without dielectric. The slot with dielectric performed better on reflection coefficient. The return loss of antenna slot with dielectric is from 5.3-6.9 GHz while the return loss antenna slot without dielectric are from 5.1-6.3GHz. The return loss at 5.8GHz antenna slot with dielectric is 16dB while antenna slot without dielectric is 12dB. However, the return loss on antenna slot without dielectric seems close to real environment. The researchers decided to proceed to fabrication and measured the real performance of the antenna.

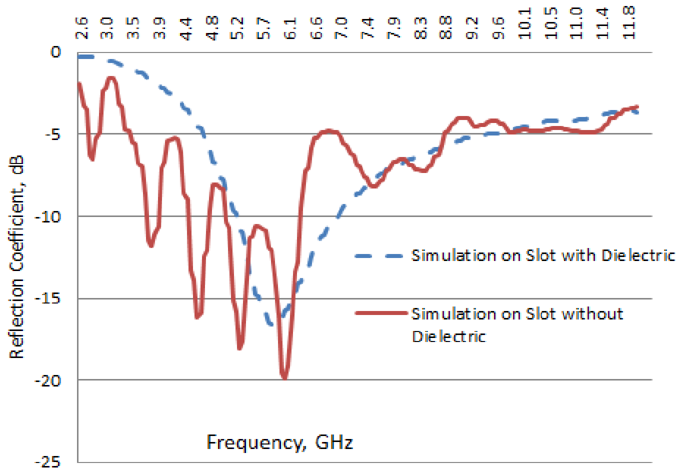

Figure 7: Simulated reflection coefficient of RLSA antenna slot with and without dielectric substrate

The fabricated antenna without slot has been measured it performances. A comparison on simulated and fabricated result for antenna slot without dielectric has been performed and presented in Figure 8. The fabricated results show a better performance. The return loss of the antenna is from 4.2-6.6 GHz. The 44% bandwidth recorded. It is 23% better than simulation. The return loss at 5.8 GHz for fabricated result is 24dB which is 12 dB better than simulated result.

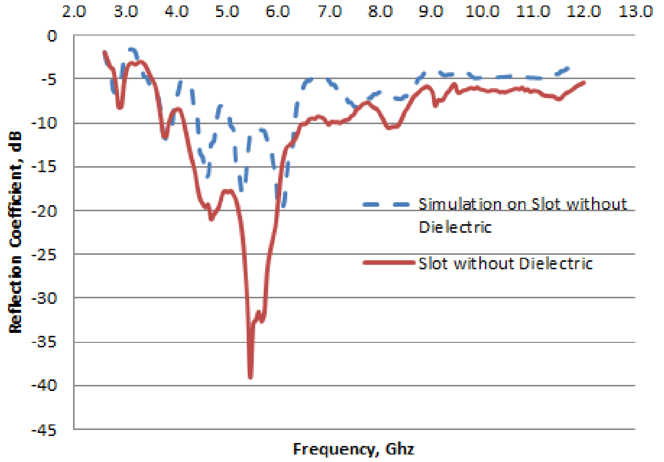

Figure 8: Simulated vs measured reflection coefficient of RLSA antenna slot without dielectric substrate

The antenna slot with and without dielectric are measured their performance and presented in Figure 9. The reflection coefficient result on antenna slot without dielectric demonstrate better performance as compare to antenna slot with dielectric.

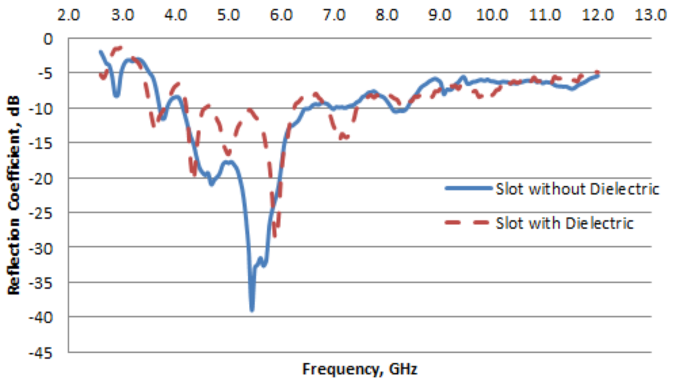

Figure 9: Measured reflection coefficient of fabricated RLSA antenna slot with and without dielectric substrate

Antenna slot without dielectric performed return loss from 4.2-6.6 GHz while antenna slot with dielectric performed from 4.2-6.2GHz. The 6% bandwidth improvement recorded for te antenna slot without dielectric. The return loss on that region show the antenna slot without dielectric is more dominant while antenna with dielectric demonstrated a few band notch and fluctuation. The return loss at 5.8 GHz for antenna without slot is 24dB which is only 2dB better than antenna slot with dielectric

The overall results are compressed on Table 1. It is show that the simulation performance show the antenna with dielectric slot perform better than antenna without dielectric slot. However, the measured performance show antenna without dielectric slot performed better.

Table 1: Comparison on simulated vs measured performances of RLSA antenna withy design slot with and without dielectric substrate

Design	Slot with Dielectric		Slot Without Dielectric	
Parameter Measured	Bandwidth	Return Loss at 5.8GHz	Bandwidth	Return Loss at 5.8GHz
Simulation	5.3-6.9 GHz, (26%)	16dB	5.1-6.3 GHz, (21%)	12dB
Measurement	4.2-6.2 GHz, (38%)	22dB	4.2-6.6 GHz, (44%)	24dB

V. CONCLUSION

It is show that the antenna without slot performed a better bandwidth and return loss. The return loss on the perform region also very dominant. The dielectric substrate has contributed a resistance element to the circuit. It has created resonant and band notch to the result. When this resistance element been removed from the circuit, it is show the wave has been smoothly travel through the slots. In overall, this research concluded that the slot design without dielectric has improve the bandwidth and return loss of the RLSA antenna.

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