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SLOTTED MICROSTRIP ANTENNA

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ABSTRACT

In this paper the effect of slots in the patch and ground plane have been presented. A rectangular slot has been incorporated on the rectangular patch and the results are analyzed. In another design rectangular slot has been incorporated on the ground plane. The results of conventional antenna, slotted patch antenna and slotted ground antennas are compared. The antennas have been designed for 2 to 4 GHz frequency range. The proposed analysis has been done on HFSS software.

Keywords: Modified Ground Plane; Slotted Ground Antenna; Slotted Antenna; Wideband Antenna.

I. INTRODUCTION

Micro-strip antenna has a number of useful properties, but one of the serious limitations of these antennas has been their narrow bandwidth characteristics [1] and [2]. The impedance bandwidth of a typical micro-strip patch antenna is less than 1% to several percent for thin substrate satisfying the criteria $h/\lambda 0 < 0.023$ for $\varepsilon r = 10$ to $h/\lambda 0 < 0.07$ for $\varepsilon r = 2.3$. This is in contrast to 15% to 50% bandwidth of commonly used antenna elements such as dipole, slots, and waveguide horns [3], [4] and [5]. Many techniques have been implemented for enhancement of the bandwidth to date.

II. SLOTTED PATCH ANTENNAS

When a rectangular slot is incorporated the rectangular patch acts like a parallel RLC circuit shown in Figure 2. The resonant frequency is determined by the L1C1 and L2C2. Impedance bandwidth of the patch varies inversely as quality factor (Q) of the patch antenna. Therefore the substrate parameter such as εr and thickness h can be varied to obtain different Q and ultimately the increase in impedance bandwidth.

$$BW = \frac{VSWR-1}{Q\sqrt{VSWR}} \quad \ldots 1$$

$$Q = \frac{\text{Energy stored}}{\text{Power lost}} \quad \ldots 2$$

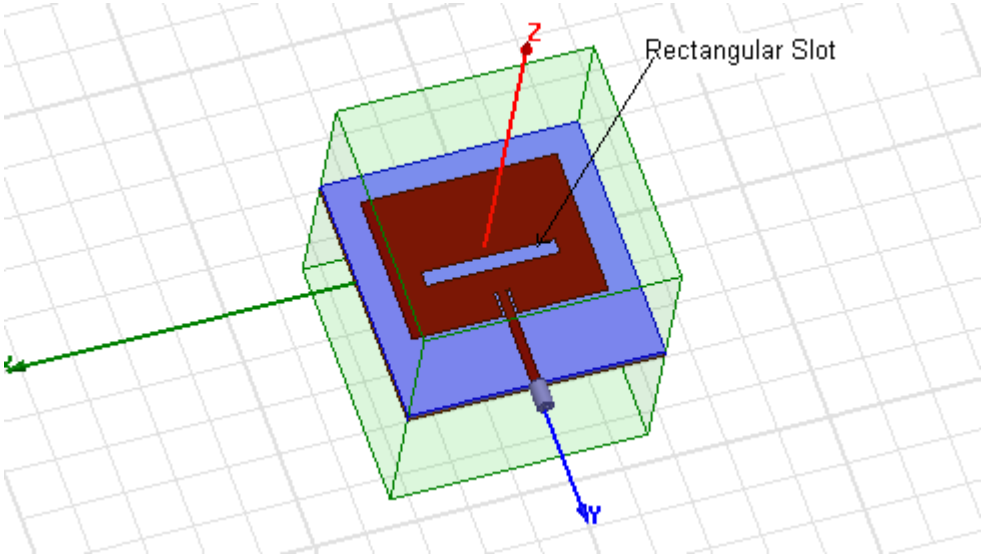

Figure.1: 3D view of slotted patch antenna in HFSS environment

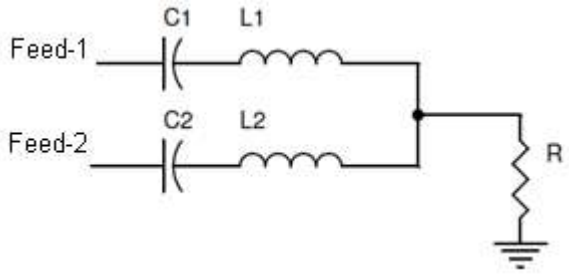

Figure.2: Equivalent Circuit of slotted patch antenna

$$Zin = j\frac{\left(\omega L1-\frac{1}{wC1}\right)\left(\omega L2-\frac{1}{\omega C2}\right)}{\omega(L1+L2)-\left(\frac{1}{\omega C1}+\frac{1}{\omega C2}\right)} \quad \ldots 3$$

The equivalent circuit represent the parallel resonate mode between two series resonate modes. If the two series resonate mode are too far apart the reactance of the antenna will be very high and reflection coefficient of the antenna will be unsatisfactory. If two resonant circuit is too near the parallel resonate mode will affect the overall frequency response.

Figure 3, Figure 4 and Figure 5 shows the comparative simulated results of conventional patch antenna (Section 3.2) and slotted rectangular patch antenna. A rectangular slot of length λ0/2 and width 2mm is incorporated on the conventional patch antenna. The location of slot is optimized to achieve the good impedance matching. From Figure 3 we can see that as rectangular slot has been incorporated the bandwidth of the antenna increases but the operation frequency shifted up to 3.5GHz. Since the operating frequency is inversely proportional to the dimension of antenna the size of antenna should reduce. So a rectangular slot approach gives wideband response but the size of antenna increases.

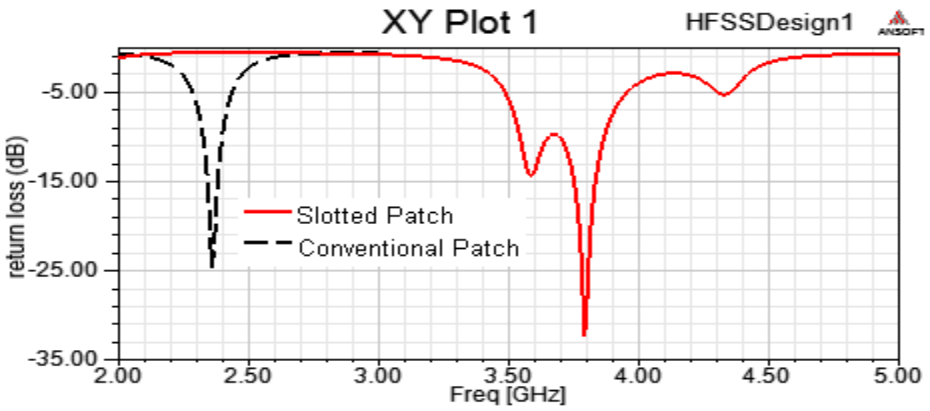

Figure. 3: Return loss of conventional patch and slotted patch antennas

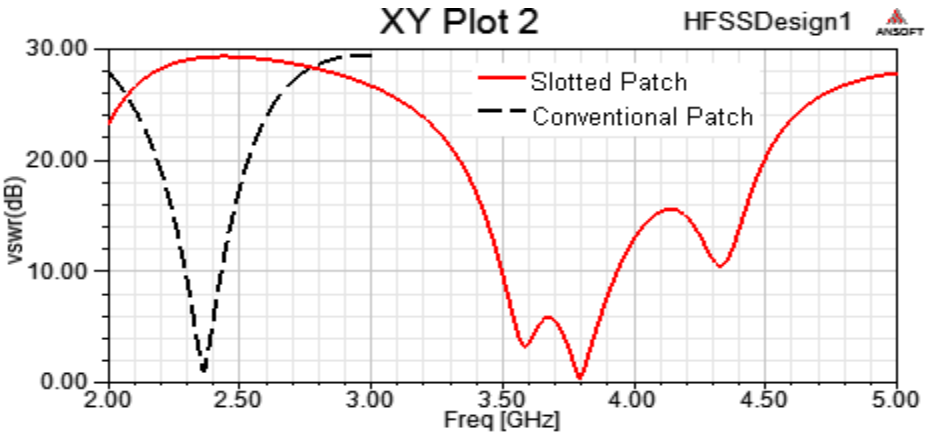

Figure. 4: VSWR of conventional patch and slotted patch antennas

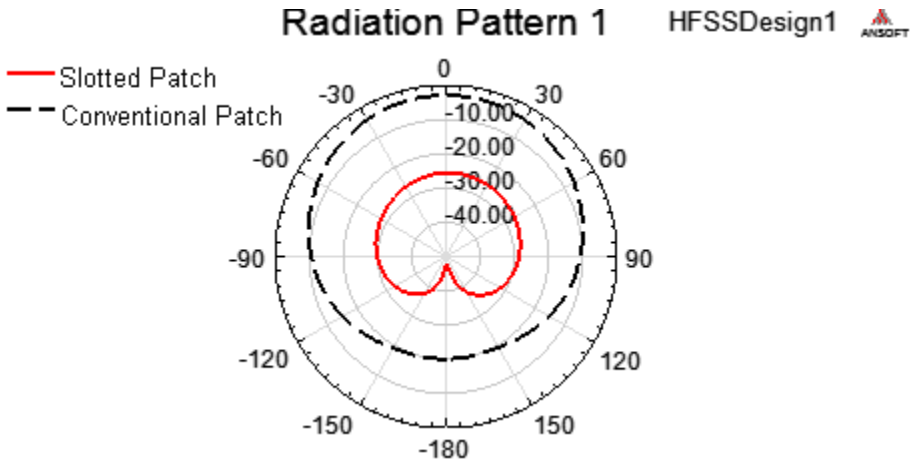

Figure.5: Radiation pattern of conventional patch and slotted patch antennas

III. SLOTTED GROUND ANTENNAS

The slotted ground plane antenna also acts as a parallel resonant circuit and having very less quality factor, results in wideband response. A rectangular slot is incorporated on the ground plane of conventional patch antenna. The length of the slot is λ0/2. The location of the slot is optimized to achieve the better results. The slotted ground plane antenna has same characteristics as of slotted patch antenna. Slotted ground plane antennas are more directive than the slotted patch antennas. Comparative results of conventional, slotted patch and slotted ground antennas are compared in Figure 7, Figure 8 and Figure 9. The dimensions of slot and x-y location of slot are same as of slotted patch antennas.

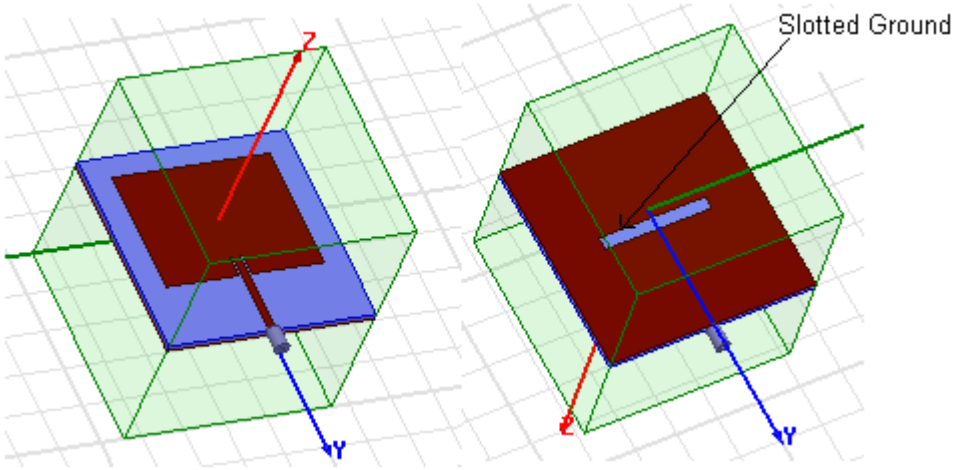

Figure.6 3D view of slotted ground antenna in HFSS environment

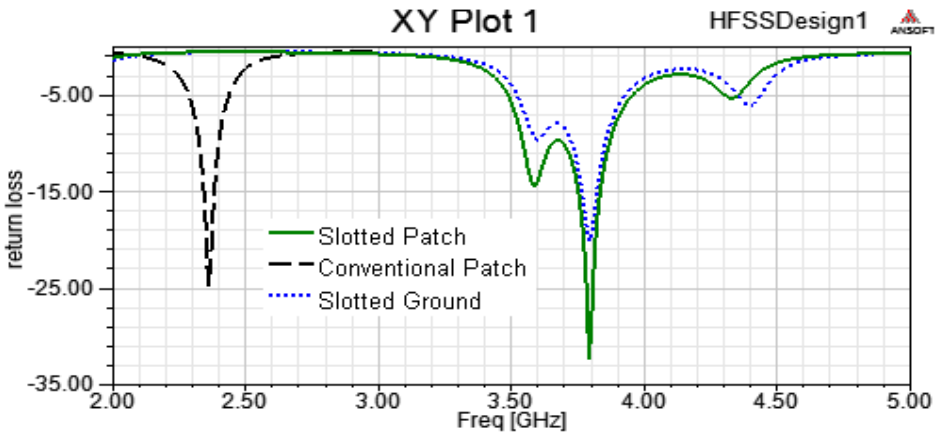

Figure.7 Return loss of conventional patch, slotted patch and slotted ground antennas

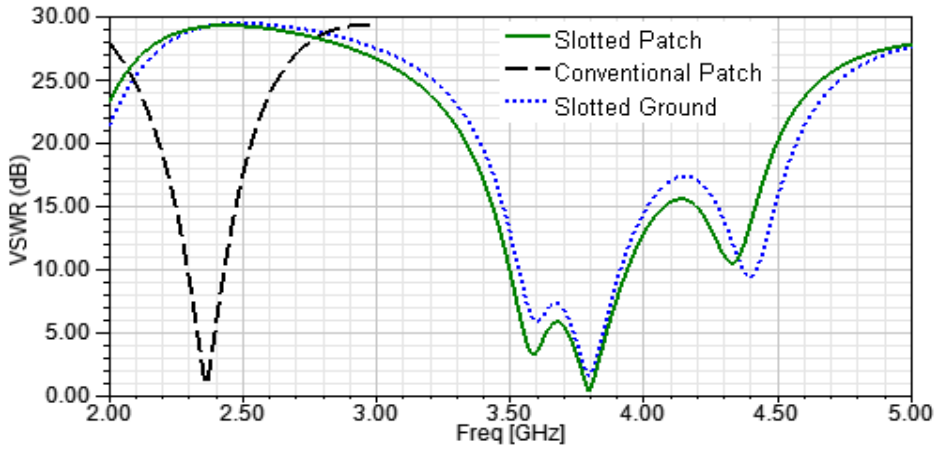

Figure.8: VSWR of conventional patch, slotted patch and slotted ground antennas

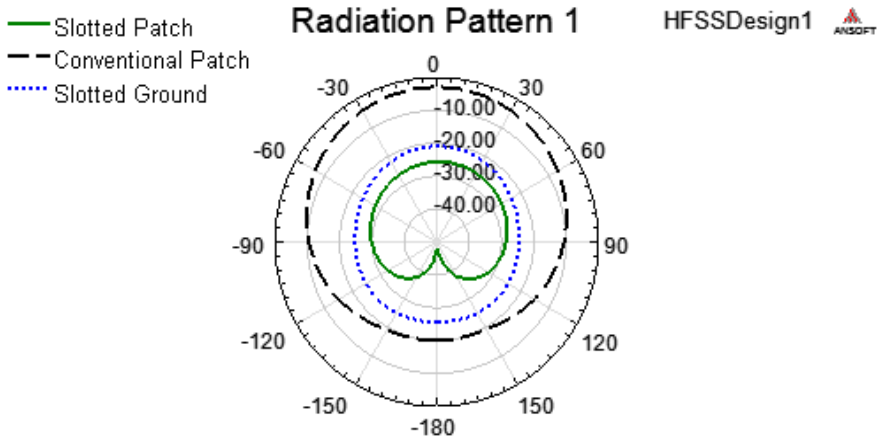

Figure.9: Radiation pattern of conventional patch, slotted patch and slotted ground antennas

Figure 7, Figure 8 and Figure 9 shows the comparative results of conventional patch antenna, slotted patch antenna and slotted ground antenna. In results we can see that both slotted patch and slotted ground antennas acts as a parallel resonate circuits and have wide band response. Slotted ground antenna exhibits the same characteristics as slotted patch antenna but the slotted ground is poor radiator than the slotted patch antenna. This can be observed in Figure 9.

IV. CONCLUSION

An experimental analysis of effect of slots on patch and ground is done. A conventional antenna acts as a series resonance circuit. When slots are incorporated the slotted antenna acts as a parallel resonance circuit. As the slots are incorporated on the patch and ground the bandwidth of the antenna improves and antenna exhibits wideband response but the operating frequencies range of the antenna changes. So by proposed experimental analysis desired frequency range wideband antenna can be designed.

V. REFERENCES

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