Optimum Return Loss of Right-Angle Triangular Slot Antenna

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Abstract: In this paper, we improve the matching impedance of antennas by inserting parasitic slots on the ground plane of right-angle triangular slot antennas. The designed antennas characteristics are analyzed by using Finite Different Time Domain (FDTD) method, the specific design frequency is 10 GHz and match impedance is 50 ohms. Simulation results show that the efficient of return loss and radiation patterns are improved and enhance. In this case, the right-angle triangular slot antennas with parasitic slots have matching impedance better than antennas without parasitic slots.

Keywords: microstrip, slot antenna, right-angle triangular slot, parasitic slot

1. INTRODUCTION

Microstrip antenna is widely used in microwave and wireless communications. Since these antennas are advantage of low profile, lightweight antennas, low fabrication cost, most suitable for wireless applications. Microstrip antennas can be dividing into three categories i.e. microstrip patch antennas, microstrip dipole antennas and microstrip slot antennas. Microstrip or printed antennas use planar transmission structures that are microstrip lines, slot lines and coplanar lines. Similarly, the microstrip slot antennas that have many shapes and configurations can fed with microstrip line, coplanar waveguide (CPW), slotline and coplanar strips (CPS).

In this paper of two right-angle triangular slot antennas comprise 2 slots cut in the ground plane fed by microstrip line. Energy propagation in the microstrip line excites the slots. The slots are either short circuit through the dielectric substrate to the microstrip conductor, or the strip conductor is terminated in an open circuit These right-angle triangular slot antennas are designed at 10 GHz and the transmission structure is microstrip line.

To describe the performance of an antenna, some parameters are necessary, Some of the parameters are interrelated and not all of them must be specified for complete description of the antenna performance. The parameters in characteristics of an antenna are return loss, input impedance, radiation patterns, VSWR and bandwidth. To achieve these parameters, FDTD method is introduced to solve the complicated problems in electromagnetic field theory. The FDTD method is capable of computing electromagnetic interactions for geometric problems that it is extremely difficult to analyze by other methods.

In the antenna design, it is important to focus on a signal returning from load. To avoid this unwanted effect, it is important to reduce the reflected signal as much as possible by process of matching. The parameter pertaining to matching is input impedance because it can produce the good matching impedance. One way to reduce the return loss is insert parasitic slots at some side or around the slot antennas. For more effect, the parasitic slots will be cut in the ground plane near the slot antennas at the base and perpendicular side of these antennas.

2. RIGHT-ANGLE TRIANGULAR SLOT ANTENNA

The structure of right-angle triangular slot antenna is shown in Fig.1. Two right-angle triangular slot antennas on the ground plane are fed by microstrip line at center between its. The microstrip line is designed to be 50 ohms and the substrate has the thickness h = 1.52 mm. with the dielectric constant ε_r = 2.17 at designed frequency 10 GHz.

The sizes of the right-angle triangular slot antenna are as follow:

Length of slot side A and B = 8.10 mm.
Length Lm = 5.85 mm.

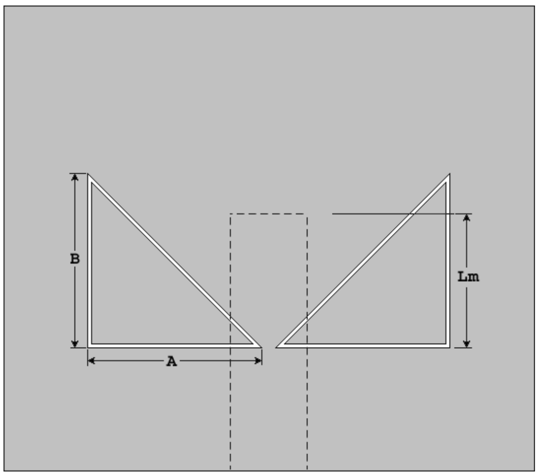

Fig. 1. The structure of Right-Angle Triangular Slot Antenna.

To adjust the distance between edge of microstrip line and the base of triangular slot antenna (Lm) will be high effect on match impedance. In this case, Lm will be 5.85 mm for matching impedance at resonance frequency about 10.09 GHz.

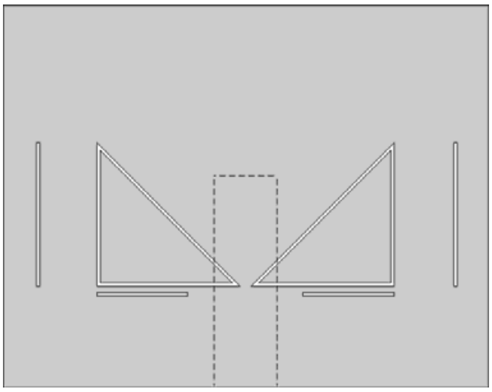

Fig. 2 The structure of right-angle triangular slot antenna with parasitic slots

3. PARASITIC SLOT

The parasitic usually refers to parasitic element of Yagi-Uda antenna so we refer to the principle of Yagi-Uda antenna. It uses parasitic elements around the feed element (antenna) for reflectors and directors to increasing gain and narrow bandwidth. For parasitic slot, it differ in type of element from strip to slot on the ground plane.

The parasitic slot as well as slot antenna, but it is unfed to directly connection from microstrip line. Only the slot antenna is directly feed, the field that will cause current flow to the parasitic slot.

In this paper, the parasitic slot for adding in the right-angle triangular slot antenna has an aspect in line shape and cut in the ground plane.

4. STRUCTURE AND SIMULATION RESULTS

4.1 Structure of Antenna with Parasitic Slots

The structure of right-angle triangular slot antennas with parasitic slots are shown in Fig. 2. The four parasitic slots have alignment near right-angle triangular slot antennas at the base and perpendicular sides. Its have 2 lengths, one is shorter length in horizontal (side A) and other longer length in vertical (B side) of triangular slot antennas.

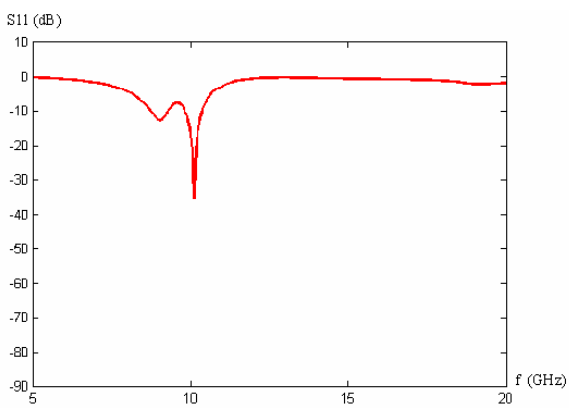

Fig. 3. The return loss of right-angle triangular slot antenna without parasitic slots.

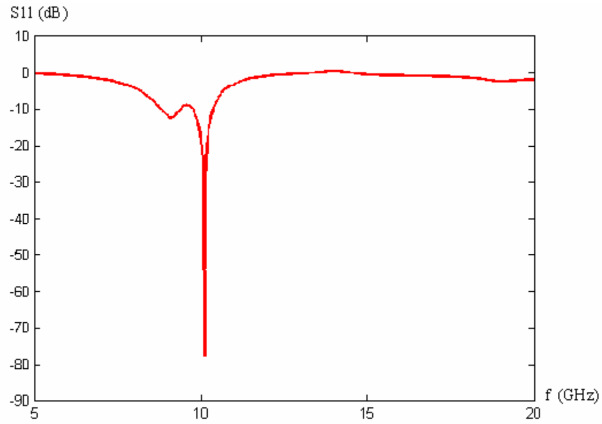

Fig. 4. The return loss of right-angle triangular slot antenna with parasitic slots.

4.2 Simulation Results

To simulation right-angle triangular slot antennas with and without parasitic slots by using FDTD analysis and design of microwave circuit and antenna software. This software is a full wave electromagnetic simulation code for general three-dimensional (3D) passive structures, particularly planar oriented microwave circuits and antennas that based on the FDTD algorithm. It can get the results such as input impedance, S parameter, radiation pattern, and VSWR. For these reasons, it can get the good results by simulation.

This simulation will design right-angle triangular slot antennas without parasitic slots to assign frequency. The designing can be done by adjust the size of right-angle triangular slot antenna and the length Lm for good matching impedance at desirable resonant frequency 10 GHz. The return loss (S11 parameter) of right-angle triangular slot antennas without parasitic slots are shown in Fig. 3, and the return loss of right-angle triangular slot antennas with parasitic slots are show in Fig. 4.

The comparison between the return loss of antennas without parasitic slots and the return loss of antennas with parasitic slots, the antennas with parasitic slots (S11 = -77.8312 dB) have the matching impedance better than the antennas without parasitic slots (S11 = -35.4068 dB).

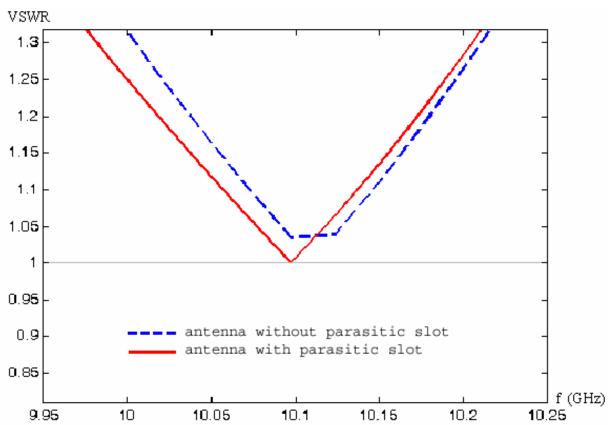

Fig. 5. VSWR of slot antennas

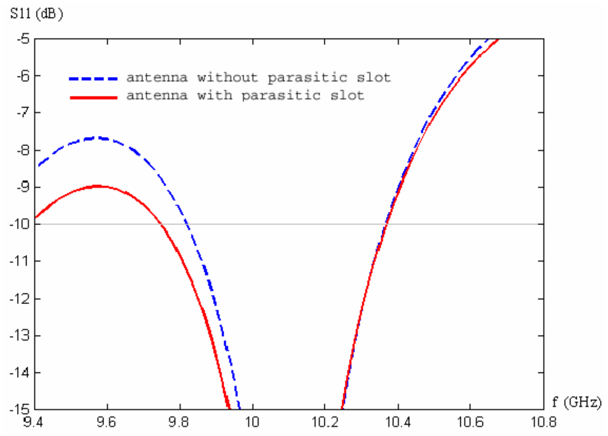

Fig. 6. Bandwidth of antennas.

VSWR is a characteristic for show performance of antenna that relates to return loss as show in Fig. 5.

From Fig. 5, VSWR of the antennas without parasitic slots is 1.0345 and VSWR of the antenna with parasitic slots is 1.007. The performance of the antennas with parasitic slots has better than the antenna without parasitic slot.

Table 1. Parameter of right-angle triangular slot antenna at resonance frequency about 10 GHz

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Case	S11 (dB)	Zin(ohm)		VSWR	Bandwidth (MHz)
		real	imag		
Antenna without parasitic slot	-35.40	50.89	1.46	1.0345	546.7
Antenna with parasitic slot	-77.83	49.99	-0.01	1.007	622.3

Fig. 6, show the bandwidth of right-angle triangular slot antenna. From comparison results of bandwidth of antennas, the bandwidth of antenna without parasitic slots is narrows than the bandwidth of antenna with parasitic slots.

The table 1 is showed the parameters of slot antenna without parasitic slots and antenna with parasitic slots.

Fig. 7 is shown the current density of right-angle triangular slot antenna with parasitic slots. The current density in slot antennas is high and can radiate wave because the slot antennas are directly feed by microstrip line, but the parasitic slots are excited by coupling from the slot antennas which have low currents and cannot radiate.

For radiation patterns of simulation results, the far-field patterns on xy-plane of right-angle triangular slot antenna without parasitic and with parasitic slots are shown in Fig. 8 and 9. Similarly, the far-field patterns on xz-plane on both case are shown in Fig. 10 and 11.

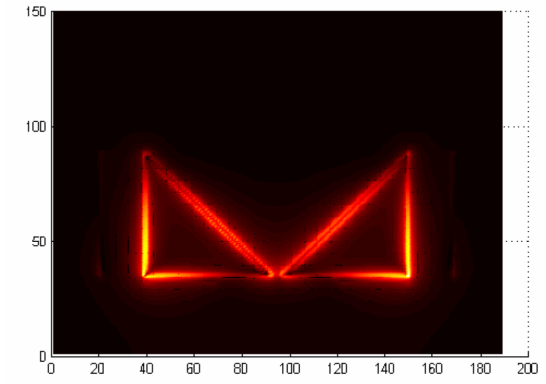

Fig. 7 Current Density of antenna with parasitic slots

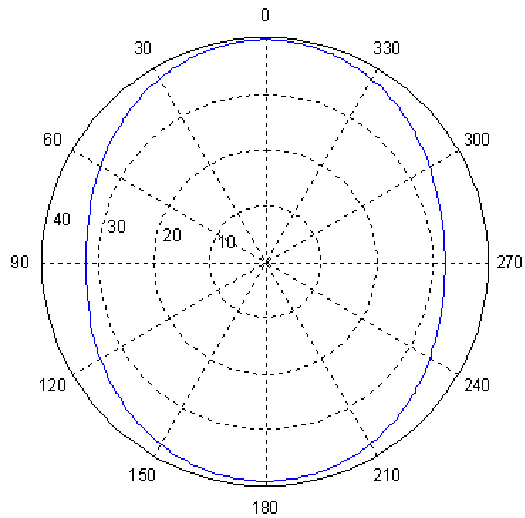

Fig. 8. The far-field radiation pattern on xy-plane of antenna without parasitic slots.

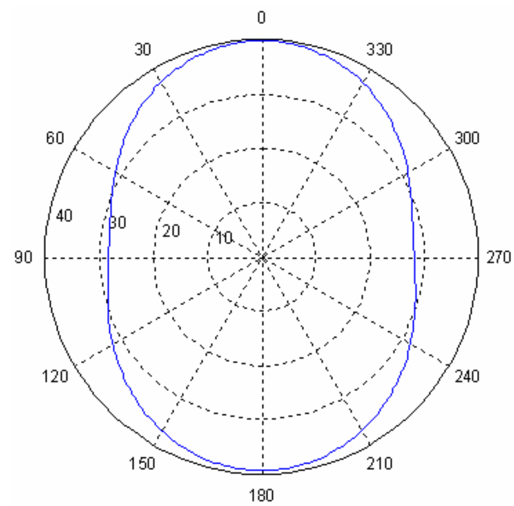

Fig. 9. The far-field radiation pattern on xy-plane of antennas with parasitic slots.

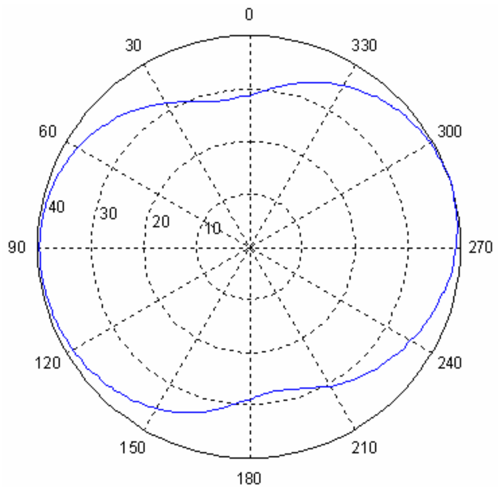

Fig. 10. The far-field radiation pattern on xz-plane of antenna without parasitic slots.

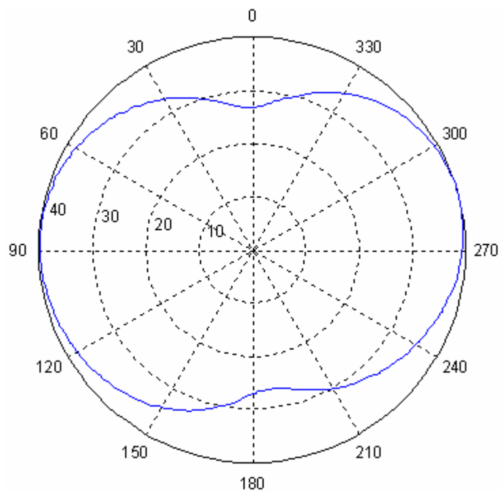

Fig. 11. The far-field radiation pattern on xz-plane of antenna with parasitic slots.

5. CONCLUSION

We have shown that return loss of right-angle triangular slot antennas are improved with optimum characteristics by insertion of parasitic slots in the ground plane near right angle of the slot antenna. The simulation results of S_{11} is –77.8312 dB which is sufficiently small. It is also shown that its matching impedance of triangular slot antenna with parasitic slots provided a better characteristics.

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