# Miniaturization of Cavity-Backed Crossed-Slot Antenna Using Folded Cavity

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***Abstract*—A technique for miniaturization of a cavity-backed crossed-slot antenna is presented. A conventional cavity-backed crossed-slot antenna is a square half guided-wavelength on a side. The proposed technique reduces the size of the cavity by folding each side. By folding the cavity, the guided length inside the cavity can be increased. The size of a cavity-backed crossed-slot antenna using proposed technique operating at 2.45 GHz is 26 mm x 26 mm. Compared to the conventional cavity-backed slot antenna, which has a size of 60 x 60 mm, more than 81.2 % size reduction is achieved with proposed technique.**

***Index Terms*—cavity-backed slot antenna; crossed-slot; miniaturization**

## I. Introduction

In many applications, antennas are backed by lossy high dielectric constant materials like a human body, the ground, etc. The resonance frequency and the antenna efficiency of antennas in these applications are severely affected by lossy highly dielectric constant materials.

A cavity-backed slot antenna has a cavity to eliminate the back-side radiation of the slot antenna. The cavity also can be used to reduce the effect of the back materials. It has high radiation efficiency compared to the dipole and slot antennas on the surface of a lossy medium. A cavity-backed slot antenna is a strong candidate for applications where lossy high dielectric materials are placed back of an antenna.

In [1], a cavity-backed crossed-slot antenna is proposed. It has a two crossed different length slots at the center surface of the cavity. It uses two orthogonal modes for circular polarization. The bandwidth of a cavity-backed crossed-slot antenna can have a dual-band or wide-band characteristic by controlling each slot length [2].

The one of the main drawbacks of a cavity-backed slot antenna is a size. A cavity-backed slot antenna has a quarter-guided wavelength cavity at the back side of the slot. A cavity is usually bent into the parallel direction with slot to lower the height of the antenna [3]. Therefore, the side length of a conventional cavity is a half guided wavelength, which is a serious limitation in some applications.

Various techniques are presented for miniaturization of a cavity-backed slot antenna. In [4], specific metallic patterns are included on the surface of the cavity for the miniaturization. The overall occupied volume of the modified cavity is reduced by more than 65% without affecting the high radiation. In [5], the miniaturization is achieved by meandering the passage from the bottom of the cavity to the slot aperture. This technique can reduce the dimensions of cavity-backed single slot antenna effectively.

In this paper, the technique for miniaturization of a cavity-backed crossed-slot antenna is presented. The proposed technique utilizes the cavity folded in all side. By folding the cavity, the effective width and length of the rectangular waveguide increase simultaneously. The size of a cavity-backed crossed-slot antenna with proposed technique is reduced more than 81.2% compared to that of a conventional cavity-backed crossed-slot antenna.

## II. Antenna Structure

The structure of the proposed folded cavity-backed crossed-slot antenna is illustrated in Fig. 1. The proposed structure is similar to that of a conventional cavity-backed crossed-slot antenna except a cavity structure. To support the half guided wavelength perpendicular to each crossed slots, the cavity is folded along all side. The center plate is inserted at the center of the cavity for folding structure. The center plate which divide the cavity into two series connected cavity, operates as a cavity wall.

There is a small gap between cavity and center plate along all side. The effective guided length of the folded cavity is about twice longer than that of a conventional cavity. The crossed-slots are placed on the top surface of the cavity. Because of the miniaturized cavity dimensions, H-shaped slots are used instead of the conventional straight line slot to increase the inductance of slot. The operating frequency of proposed antenna is set to 2.45 GHz. The horizontally placed slot is slightly longer than vertically placed slot for wide-band operation.

The proposed antenna is fed by coaxial cable. The center conductor is connected to the center plate and the outer conductor is connected to bottom of the cavity. The feeding position can be adjusted for the 50 ohm antenna impedance. The proposed antenna is simulated on the 1 mm height Duroid 5880 substrate.

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## III. SIMULATION RESULTS

For on body applications, the proposed antenna is simulated on the body surface, which have a homogeneous electric properties $\varepsilon_r = 35.15$, $\sigma = 1.16$ S/m. The distance from the body surface to the cavity bottom is fixed to 0.5 mm. The simulation is conducted using CST Microwave studio. The dimensions of proposed antenna on the 1 mm height substrate are 26 x 26 mm, which is 81.2% reduced size compared to that of a conventional cavity-backed crossed slot antenna.

The simulated antenna reflection coefficient and gain is plotted at Fig. 2. The simulated antenna showed 66 MHz -10dB bandwidth. Two resonances occurs at -10dB bandwidth because of different slot size.

Fig. 3 shows the simulated radiation pattern in y-z and x-z. The proposed antenna has a radiation pattern similar to that of a conventional cavity-backed slot antenna. In the boresight direction, the maximum radiation was measured in both cut-planes. Two orthogonally polarized waves are generated by each perpendicularly crossed slot. The vertically polarized wave which is generated by the horizontal slot is stronger than the horizontally polarized wave around the first resonance frequency because the horizontal slot is longer than the vertical slot. Similarly, the horizontally polarized wave is stronger than the vertically polarized wave at the second resonance.

The simulated antenna efficiency of proposed antenna at 2.45 GHz is 26.4 %, which is a considerable efficiency in low-profile on body BAN applications.

## IV. CONCLUSION

The miniaturization technique for a cavity-backed crossed-slot antenna is proposed. By inserting center plate in the cavity, guided length inside the cavity is increased in all directions. Using the proposed technique, the effective width and length of the rectangular waveguide increase simultaneously. Using proposed technique, 81.2 % size reduction is achieved compared to a conventional cavity-backed crossed-slot antenna.

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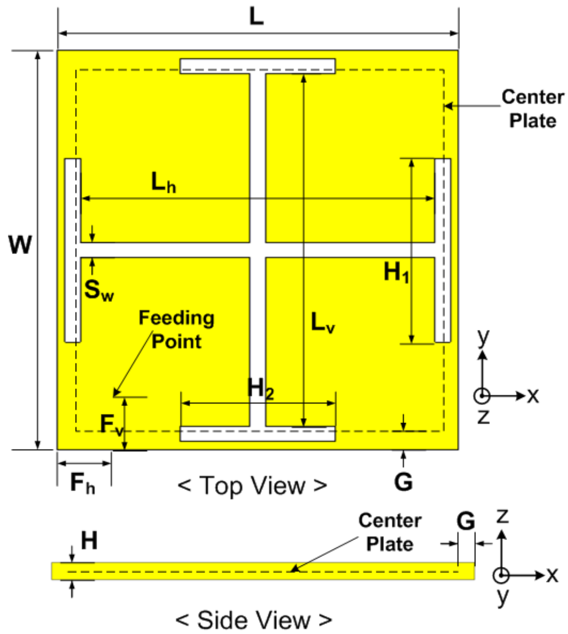



Figure 1. Geometry of the proposed folded cavity-backed crossed slot antenna(dimensions of the simulated antenna, W = 26, L = 26, $S_w = 1$, $L_h = 23$, $L_v = 23$, $F_h = 5$, $F_v = 5$ $H_1 = 8$, $H_2 = 6.6$, G = 1, H = 1, all in the unit of mm.)

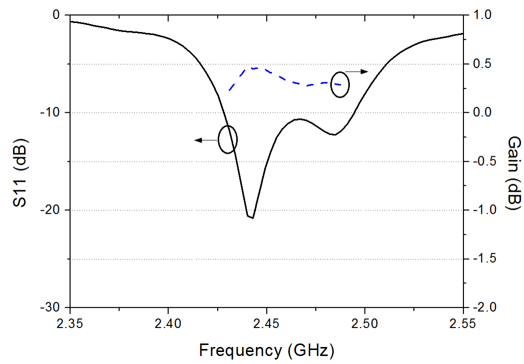
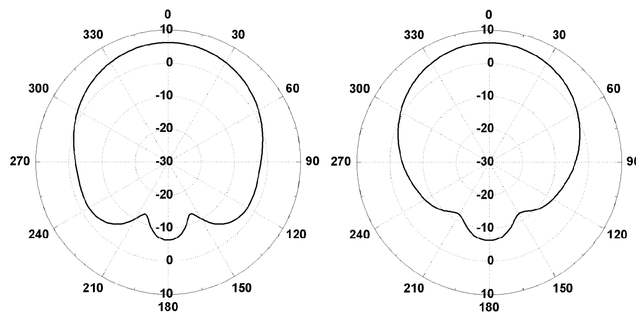



Figure 2. Simulated antenna reflection coefficient and gain.



(a) y-z plane (b) x-z plane

Figure 3. The simulated radiation pattern in y-z, x-z plane at 2.45 GHz.