A Review Paper on Cavity-Backed Slot Antenna

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***Abstract*— Low profile cavity backed slot antenna entirely realized by multilayer printed circuit board (PCB) structure has been efficiently working now a day. This paper presents a comparative study of various Cavity-Backed Slot Antenna. A brief review of various kind of cavity backed slot antenna based on their performance. Comparative result is shown in the table shown in the further section of this paper.**

***Index Terms*— Bandwidth, Cavity-Backed slot Antenna, hybrid modes, resonance, waveguide.**

I. INTRODUCTION

Now a day's development of wireless communication, low profile, light weight, lower cost antenna along with good radiation performance are in good demand now a days, particular in space applications like satellite communication, aircraft and radar in military communication systems. Slot antennas, for their attractive characteristics such as low profile, conformability to planar or curved surfaces, easy integration with planar circuits and better isolation from feed network, are very suitable for these applications and have been extensively studied by many researchers.

Dual frequency patch antennas can be generally divided into three classes [1]. The first class is comprised of a single radiating patch with single or multiple feeds based on two orthogonal modes. The second one is constructed with multiple radiating patches with either single or multiple feeds. The final one is constructed using a single radiating patch with a reactive load, where the reactive load can be realized by adding probes, stubs, notches, pins, capacitors, or slots. Recently, dual frequency slot antennas have been extensively studied for their attractive characteristics such as their conformability to planar or curved. Surfaces, easy integration with planar circuits and better isolation from the feeding networks.

In order to improve the radiation performance, a dual frequency slot antenna backed by a large metallic cavity has been analysed, and a cavity backed dual frequency patch antenna fabricated using surface micro-machining technology has already been designed. These cavity backed antennas exhibit good radiation performance; however, they are difficult to design and are expensive to fabricate due to their complicated structures.

Circularly polarized antennas are widely utilized to solve problems of polarization mismatch and multi-path interference in radar and communications. Low profile circularly polarized antennas have been investigated by numerous researchers.

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In order to reduce fabrication complexity and facilitate integration with planar circuits, the substrate integrated waveguide (SIW) technique is applied to cavity backed antenna designs. SIW has been widely employed in microwave components and circuits designs.

The use of slot antenna elements is a very attractive alternative for conformal applications. However, the nature of slot-element radiation is bidirectional and typically a reflector must be used in order to eliminate back radiation. The optimum distance between slot and reflector was found to be about one-quarter free-space wavelength [2]. But for antenna integration in arbitrarily curved surfaces it is desirable to use a thin substrate. The reflector should be placed very close to the slot's ground plane resulting in a typical stripline or tri-plate structure. Unfortunately, stripline configuration admits parallel-plate propagation and feeding the slot by a stripline typically excites the parallel-plate modes very efficiently. Reducing the reflector distance results in considerably increased parallel-plate mode excitation. Higher-order modes are avoided by choosing a thin substrate, whereas suppression of the fundamental transverse electromagnetic (TEM) mode starting at 0 Hz is extremely difficult for very thin substrates. One method to eliminate this mode is the use of twin slot configurations for phase cancellation, where arc-slot elements were proposed to suppress the TEM mode propagation in all radial directions [3].

An alternative and well-known approach for TEM mode suppression is the placement of shorting-pins around the slot, connecting the slot's ground plane with the back reflector. Thus, the electric field of the TEM mode is forced to zero by the shorting-pins. However, if the shorting-pins are close to the slot, the resonant and broadband behaviour of the slot is also strongly influenced. If the shorting-pins are too far from the slot, power leaks into the TEM mode and the antenna efficiency is bad. Consequently, the appropriate design of a unidirectional slot element with back reflector and shorting-pin suppression of the fundamental TEM mode is a very challenging task.

II. BASIC PRINCIPLE

The basic cavity-backed slot antenna is shown in Figure 1 (in a rectangular cube of size A*B*C). The walls are metallic type (electrically conducting), and the inside is hollow. a slot is cut out On one end , The cavity is typically excited by a probe antenna in the interior of the cavity, which is modelled as a monopole antenna. The monopole excited antenna is shown in green [4].

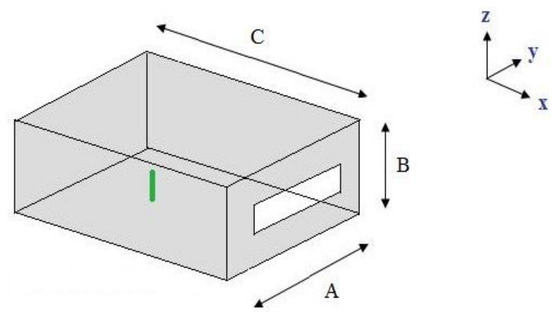

Fig 1: Cavity-Backed Slot Antenna

Let the height of the cavity C=36mm, the length be A=87mm and the height B=36mm. The monopole antenna height will be 29.5mm, therefore the monopole is a quarter-wavelength long at 2.55 GHz. Monopole antenna will be centred about the cavity in the y-axis, and 61.5mm behind the slot in the x-axis. The slot is 58mm long (in the y-direction) and 3 mm high (in the z-direction).
S11 is measured for this antenna (relative to a 50 Ohm source), and is plotted versus frequency in Figure 2.

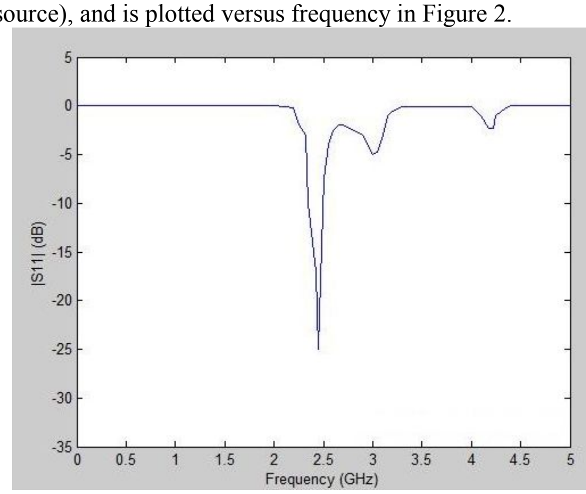

Fig 2: S11 Vs Frequency

The first resonance at about 2.45 GHz. For This cavity-backed slot antenna. The cavity backed slot antenna is roughly 0.474 wavelengths long at this frequency - which is roughly the length of a resonant dipole antenna. S11 drops to below -20 dB.This frequency shows that most of the power is radiated away. The bandwidth, measured (somewhat arbitrarily) as the frequency span that S11 is less than -6 dB is roughly from 2.35 GHz to 2.55 GHz, providing a fractional bandwidth of slightly over 8%.
The volume of the cavity typically influences the bandwidth - a larger volume often yields a higher bandwidth. The material within the cavity (so far I have assumed it was filled with air), can be changed with a dielectric medium. This decreases the resonant length of slot, permitted for a smaller antenna. the bandwidth and efficiency typically decrease with a dielectric cavity medium.
The radiation pattern at 2.45 GHz is now presented. The H-plane (xy-plane) is shown on the in Figure 3, and the E-plane (xz- plane) is shown in Figure 4.
The radiation pattern of the cavity backed slot antenna somewhat resembles that of a dipole antenna in the forward H-plane. The 3-dB beamwidth is about to 60 degrees in this plane. The radiation pattern is diminished in the rear H-plane, along with a significant back lobe about 6 dB down from the peak of the main beam. The pattern is fairly broad In the E-plane, along with a 3-dB beamwidht of about 120 degrees. This antenna's broad pattern makes them well suited for use in antenna arrays. The peak gain of a thin slot is usually around 2-3 dB.

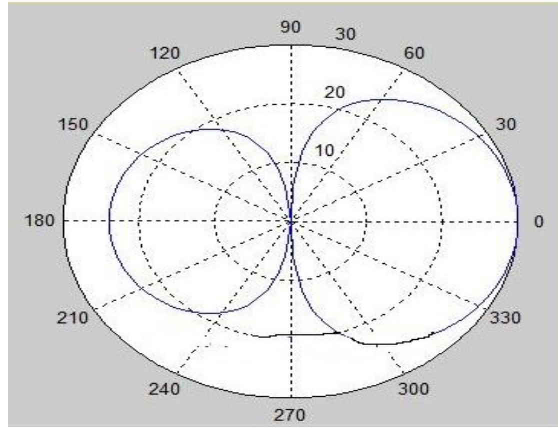

Fig 3: H-plane (xy plane). Angle measured off x-axis towards y-axis

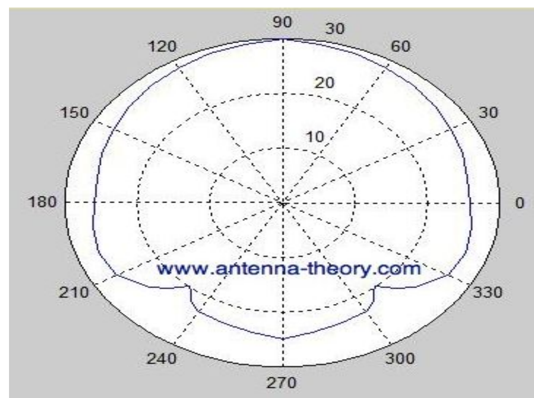

Fig 4: E-plane (xz-plane). Angle measured off z-axis (to x-axis)

If you are using *Word,* use either the Microsoft Equation Editor or the *Math Type* add-on (http://www.mathtype.com) for equations in your paper (Insert | Object | Create New | Microsoft Equation *or* Math Type Equation). "Float over text" should *not* be selected.

III. BACKGOUND AND LITERATURE SURVEY

Luo. G, et.al. in April-2012 proposed a Cavity backed Slot antenna based on Hybrid SIW Cavity modes. A bandwidth enhanced method of a low-profile substrate integrated waveguide (SIW) cavity-backed slot antenna is proposed. Bandwidth enhancement is achieved by simultaneously exciting two hybrid modes in the SIW-backed cavity and merging them within the required frequency range. The hybrid modes, whose dominant fields are located in different half parts of the SIW cavity, are two different combinations of the resonances [5].

Luo. G. et.al in 2008 proposed a novel design method of low profile cavity backed planar slot antenna. The whole antenna including backed cavity and feeding element is completely constructed at a single substrate by using substrate integrated waveguide technique and grounded coplanar waveguide. The proposed antenna keeps good radiation performance of conventional cavity backed antenna and has advantages of conventional planar antenna including low profile, light weight, easy design with low cost and convenient integration with planar circuit [3].

Paryani. R,et.al. in 2010 proposed a compact, dual-polarized, substrate-integrated cavity-backed slot antenna (SICBSA) that exhibits a bandwidth twice as large as other half-wavelength cross slot CBSAs by taking advantage of a tuneable second resonance. This is accomplished without an increase in the antenna's total volume. Furthermore, the wideband radiation characteristics are shown to be very consistent. This indicates that the antenna will maintain a high level of polarization purity over its operational range when used in a dual- or circular-polarized configuration [6].

Luo. G.et.al in 2009 proposed a Single fed low profile cavity backed crossed slot antennas for dual frequency dual linear polarization and circular polarization applications. By employing the substrate integrated waveguide (SIW) technique in the antenna fabrication, the low profile backed cavity model can be realized by using only a single layer of low cost printed circuit board (PCB) substrate. A single grounded coplanar waveguide (GCPW) is employed as the feeding element to excite the TE_{120} and TE_{210} modes in the SIW cavity. A crossed slot design is used as the radiating element in order to radiate the desired dual linearly or circularly polarized wave [2].

F. Giuppi with his colleagues in 2010 proposed a substrate integrated waveguide (SIW) cavity backed active slot antenna oscillator, the operation frequency of which can be tuned by means of a properly joint varactor. The cavity backed design allow overcoming potential problems such as heat dissipation and unwanted surface wave modes in large array design, and may give better phase noise (distortion) performance. The use of SIW technology allows a cost-effective fabrication process and simple implementation at millimetre-wave frequency range, for radar and communication applications [7].

Dong-Yeon Kim with these colleagues in 2011 proposed a circularly polarized antenna with a unified integration of matching feeding structure and SIW-typed cavity in a single layer and implemented. Particularly it is shown that the low loss characteristic of the feeding line and broadband impedance bandwidth of the proposed antenna have been accomplished by using an SIW structure compared to the conventional microstrip transmission line. In addition, in order to improve the refection coefficients remarkably, the asymmetric inductive diaphragm consisting of via arrays has been adopted as a control of input susceptance [8].

Yazid Yusuf in 2011 presents a novel synthesis technique to integrate high 3-D filters with highly efficient slot antennas is presented in this paper. This Method allows for compact integration of 3-D filters and antennas with very high antenna efficiency and significantly reduced form factor of integrated RF front ends. Prototype four-pole Chebyshev cavity filters integrated with slot antennas are demonstrated at -band using both coaxial and coplanar waveguide feeding [9].

Juan Carlos with these colleagues in 2009 proposed a new cavity-backed antenna compatible with planar technology. The original design consists of a slotted cavity fed by a microstrip line. This permits the design of the feeding line and the cavity on a single substrate, which is suitable with a standard printed circuit board (PCB) or low-temperature cofired ceramic (LTCC) design process. The idea is to append a specific slot patterns on the cavity back face such as meandered and edge slots [10].

Technique	Parameter	Publication	Year
Low Profile Cavity Backed Slot Antenna	90% Radiation Efficiency	IEEE	2012
Substrate Integrated Waveguide Cavity	1.7% bandwidth	IEEE	2008
Dual-Polarized, Substrate-Integrated	19% bandwidth	IEEE	2010
Low Profile Cavity Backed Crossed Slot Antennas	2.1% bandwidth	IEEE	2009
Tuneable SIW cavity backed active antenna	6% Bandwidth	Electronics Letter	2010
SIW Cavity-Backed Circular-Polarized Antennas	17.32% bandwidth	IEEE	2011
Low-Loss Integration of High-3-D Filters With Highly Efficient Antennas	6.0% bandwidth	IEEE	2011
Planar Substrate Integrated Waveguide Cavity-Backed Antenna	8.5dBi gain	IEEE	2009

CONCLUSION

In the above literature survey it is observe that by applying the different Technique of antenna design the Maximum bandwidth of the antenna is 19%. By applying the Technique of Slot cutting on the patch and ground plane and making hole using conical via we can improve the bandwidth of the antenna.

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