An Introduction of Aperture Coupled Microstrip Slot Antenna

ZARREEN AIJAZ* AND S.C.SHRIVASTAVA*
1Research Scholar, Dept of ECE, MANIT, Bhopal,India
2Professor, Dept of ECE, MANIT, Bhopal, India
1-Manit, Bhopal, India
2-Manit, Bhopal, India
Email: zarreen_aijaz@yahoo.co.in,.scs_manit@yahoo.com

Abstract:

A microstrip slot antenna is very small and lightweight still it has the problem of back radiation due to which power loss occurs and the SAR increases. To reduce the back lobe a technique introduces i.e. aperture coupled microstrip slot antenna which reduces the back lobe as well as increases the bandwidth of the antenna. Aperture coupled microstrip slot antenna couples the patch antenna with microstripline through an aperture.

Introduction:

At microwave and millimeter wave frequencies microstrip slot antenna (1) becomes very small & lightweight. In spite of these advantages, it has main disadvantage of back radiation; which limits its use in mobile communication. To minimize the back radiation a reflector plate behind the slot or a cavity (2-3) may be used. Reflector plate itself creates undesirable radiation. Using cavity behind the slot it excites higher order mode, which degrades the performance. Hence aperture coupling can solve back radiation problem. An aperture-coupled design is proposed for Microstrip slot antenna to improve its radiation pattern as well as bandwidth. It is based on coupling of an aperture between the patch antenna and Microstrip slot line. The slot shape also affects the radiation patterns by choosing the proper shape of the slot. We can improve the further radiation characteristic as well as bandwidth by choosing a suitable combination of the shape of feed and slot; it can be obtained optimum bandwidth with stable radiation pattern.

An aperture-coupled design is proposed for Microstrip slot antenna to improve its radiation pattern as well as bandwidth. It is based on coupling of an aperture between the patch antenna and Microstrip slot line.

The first aperture coupled microstrip antenna was introduced in 1985 by D M Pozar (4)

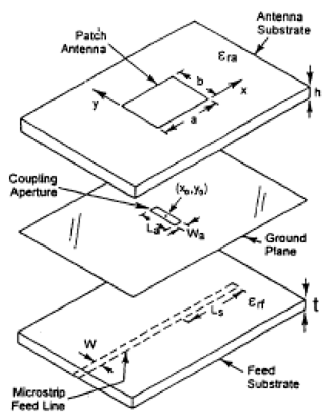

Figure1: Aperture coupled microstrip slot antenna

The geometry of an aperture coupled microstrip antenna is shown in Fig. 1. It consists of two substrates bonded together, with a ground plane in between (5). The radiating patch is printed on the top (antenna) substrate, while a microstrip feedline is printed on the bottom (feed) substrate. A small nonresonant aperture in the ground plane

couples the patch to the feed line. The bandwidth is essentially that of the patch antenna itself, and is not affected by the aperture coupling mechanism.
Front to back ratio 13 dB to 14 dB.

The slot shape affects the level of radiation:

The Slot length affects the coupling level and the back radiation level. The slot should be made no larger than is required for impedance matching. The ratio of slot length to width is typically 1/10.
For maximum coupling, the patch should be centered over the slot. The feed line is positioned at right angle to the center of the slot.

Since the patch is normally centered over the aperture, magnetic polarization of the slot is the dominant mechanism for coupling, which depends on the shape and size of the coupling aperture. Hence, it is desirable to use a shape that has maximum coupling for a given size. This allows the antenna to be impedance-matched with a smaller aperture. Smaller aperture areas result in lower back radiation levels, leading to less spurious radiation in the back region and improved efficiency [6].

By adding a slot at the end of the rectangular aperture (i.e., the ‘‘H’’-shaped aperture), the field becomes nearly uniform along the aperture and hence the coupling increases. Thus a dog bone shape or the H shape of the slot improves the F/B ratio.

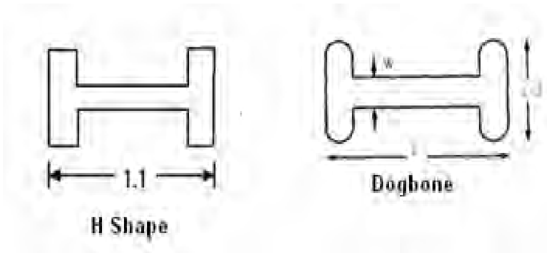

Figure2: H shape and the dog bone shape of slot

The feed line affects the level of radiation:
The purpose of the feed line is to carry energy from a connector to the actual antenna and so to launch guided waves only. An electrically thin substrate with large permittivity is therefore suitable. Another fact that influenced the selection of the feed substrate is the width of the feed line. The Tee shape feed line improves the F.B ratio [7].

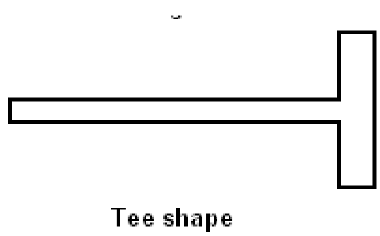

Figure 3: Tee shape feed line

Antenna Design:
For obtaining maximum bandwidth, the following item are required:
• Aperture coupled patch substrate.
• Low permittivity, high dielectric constant of the patch substrate.
• Thick patch substrate, thin feed substrate and resonant slot.

Substrate is chosen RT/Duroid 5880 for the patch antenna and RT/duroid 6006 for Microstrip feed line. For patch substrate thickness hp = $0.06\lambda_0$,The optimum design frequency is found by some iterations for different value of ratio (patch resonant frequency/ antenna resonant frequency) aspect ratio affects the band width of patch, it should be in the range from 0.75 to 0.875. Patch length determines the resonant frequency of the patch and patch width can be obtained with the help of aspects ratio.

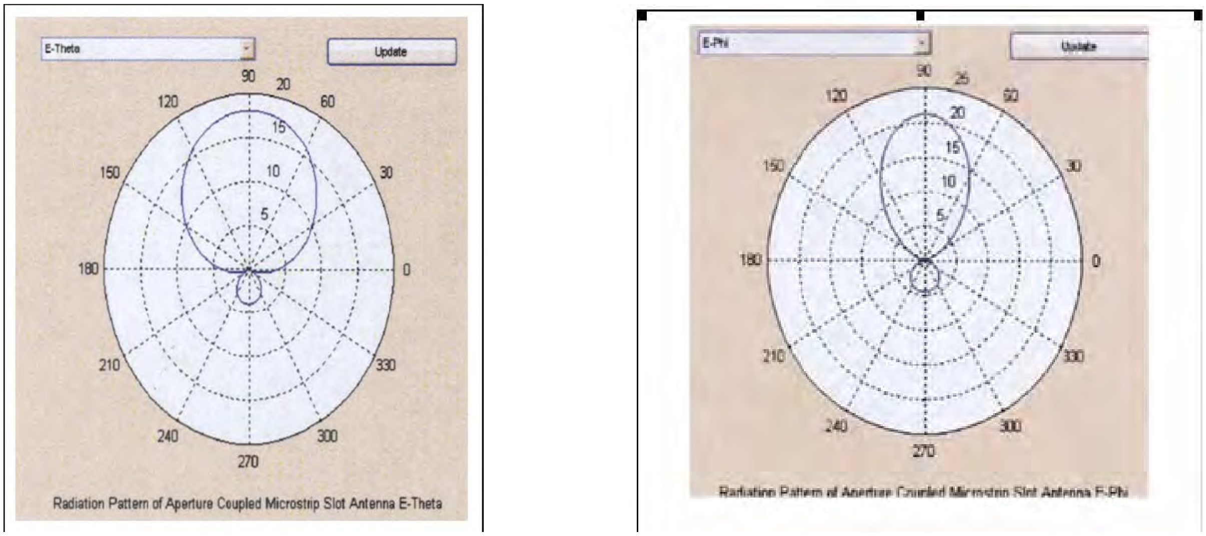

Figure4: Radiation patterns in E field and H field

Dimension of ground plane must be chosen enough large to replace entirely the infinite ground plane. To obtain maximum magnetic coupling the position of the patch is placed at the center of the antenna. Position of the slot is placed below the patch center. The feed line is position at the right angle to the center of slot. Slot length affects the coupling level and back radiation it should be in the range of 0.1 λ_0 to 0.2 λ_0.

Analysis:

This antenna can be analyzed by full wave moment method (8), which gives almost correct results, and it is easy to analyze discontinuities of the boundary conditions of the slot. By using Greens function, it can be solved.

Simulation:

To analyze the antenna performance, the simulation tool is used MATLAB .The simulated radiation patterns in both E field and H field planes are shown in plots.
The simulated patterns are at the ε_r =2.4 and the f_0=12GHz.

Conclusion:

By introducing a coupling of an aperture between the patch and the feed line, it can reduce the back lobe thus increases the F/B ratio.

References:

[1] Y. Yashimura, "A microstrip slot antenna," IEEE Trans. Antennas Propag., vol. AP-29, pp. 2-24, Jan. 1981.
[2] Q. Li, Z. Shen, and P. T. Teo, "Microstrip-fed cavitybacked slot antennas," Microwave Opt. Technol. Lett.,vol. 33, no. 4, pp. 229-233, May 2002.
[3] A. V. Sulima, "Cavity-backed slot antenna," in IEEE Antennas Propagation Soc. Int. Symp., vol. 4, 2003, pp. 22-27.
[4] D. M. POZAR,,"Microstrip Antenna Aperturecoupled To A Microstripline", IEEE Trans. ,vol. 21, January 17 1985.
[5] Broadband Microstrip antennas—Girish Kumar, K.P Ray.
[6] Qinjiang Rao, Tayeb A. Denidni," A New Aperture Coupled Microstrip Slot Antenna" IEEE Transactions on Antennas And Propagation, Vol. 53, No. 9, September 2005.

[7] Yong woong jang,"Wide band T-shaped microstrip fed twin-slot array antenna,"ETRI journal,volume 23,number1,march 2001.

[8] M. Pozar, "A reciprocity method of analysis for printed slot and slot coupled microstrip antennas", IEEE Trans. Antennas and Propagation, vol. AP-34, pp. 1439-1446, December 1986

.