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To Study the Slotted Rectangular Microstrip Antenna to Enhanced Bandwidth of Field Lobes

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Abstract— Analytical solution for the radiation fields of a microstrip antenna loaded with a generalized superstrate is proposed using the two slot model of microstrip antennas with the reciprocity theorem and the transmission line analogy. the proposed method is used to design and optimize. Rectangular microstrip antenna is developed on a single-layer electrically-thin substrate. By etching two straight slots close to and parallel with the non-radiating edges, the bandwidth of the rectangular microstrip antena is enhanced without affecting its radiation characteristics. The h-plane halfpower beamwidth 2.4degree and E-plane half power beamwidth 7.0degree achieved at 3.2GHz.

Keywords— Magnetic superstrate, two slot model, metamaterials, microstrip patch antennas

I. INTRODUCTION

The microstrip antenna is a good candidate for radar and communication systems due to its low profile and light weight as well as easy fabrication and low cost of production [1]. This type communication presents a complete and effective design procedure of a proposed microstrip antenna, printed on a single-layer substrate for applications. The superstrate layer over microstrip patch antenna (MPA) has been reported to allow for the enhancement of the antenna gain and radiation efficiency [2]–[8].

In this work, the substrate selected which has relative permittivity of 2.32 and a thickness of 0.175 mm. The reason for choosing electrically-thin substrate is that there are two problems associated with an electrically-thick substrate. One is related to high spurious radiation of feeding networks while the other is concerned with unwanted surface wave propagation. Both of them generally lead to reduced radiation efficiency and degraded radiation pattern [2]. The specified operating frequency band of the antenna under study is centered at 3.2 GHz with an absolute bandwidth of 1 GHz. Judging from the substrate thickness, this bandwidth specification is quite stringent and difficult to achieve for conventional microstrip patches [2]. A number of uniplanar bandwidth enhancement techniques have been reported in the literature [3]–[8]. First of all, impedance matching of microstrip patches has been improved by using different matching networks [3]–[5]. For example, a ring slot [4] or a U-shaped slot [5] is cut close to the feeding point of a microstrip patch on an electrically- thick substrate in order to tune out the parasitic inductance of the probe. In spite of the wide bandwidth achieved, this technique is not helpful in this case since this case is be designed on an electrically-thin substrate and directly fed by the microstrip line. Second, parasitic resonators have been located around the driven patch to create multiple resonances [6], [7]. However, this technique does not generate wideband radiation due to the frequency-dependent amplitude and phase distributions of coupled patches. The presence of coupled elements makes it difficult to place the feeding network on a single-layer substrate for different applications. Third case, multiple resonance can be created by loading a pair of right-angle slots on a microstrip patch [8]. The long-arm of the right-angle slots is parallel to the non-radiating edges with a length of over 90% of the patch length while the short-arm is etched close to the radiating edges with a length over 40% of the patch width. As a result, an additional mode is created near the fundamental mode and the impedance, bandwidth are effectively increased. However, the right-angle slots mainly the short-arms would perturb the current distribution at high frequencies such as 3.2GHz.

II. SRTRUCTURE OF MICROSTRIP ANTENNA

In the figure shown below the substrate selected which has relative permittivity of 2.32 and a thickness of 0.175 mm.

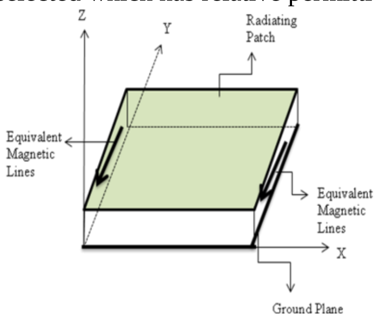

Figure1:Rectangular microstrip patch antenna

Here electrically-thin substrate is taken, slot is separated as 500micrometre and operating frequency is also taken as 3.2 GHz

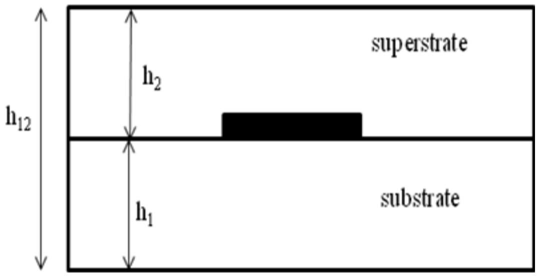

Figure2:cross sectional view of rectangular microstrip patch antenna

Due to open and extension ΔL, quantities Єr and W/h are replaced by Єr' and We/h12 respectively for Єr' [15],

$$\epsilon r' = \frac{2\epsilon r - 1 + A}{1 + A} \quad (1)$$

$$A = \left(1 + \frac{12h_{12}}{W}\right)^{-(1/2)} \quad (2)$$

III. Radiation Pattern Based on Two slot model

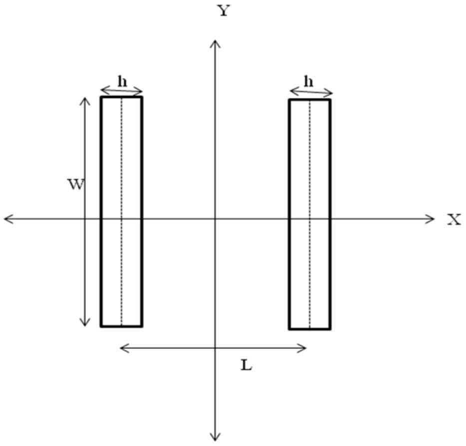

Figure3: Slot model of rectangular microstrip patch antenna

In this model the radiation patterns for TM_{10} mode are as two parallel slots of length 'W' width 'h' and spaced a distance 'L' the radiation for linearly polarized with electric field [11],

$$E_\theta = -jk0V0W\frac{e^{-jk_0 r}}{4\pi r}\cos\Phi F_1 F_2 \quad (3)$$

$$E_\Phi = jk0V0W\frac{e^{-jk_0 r}}{4\pi r}\cos\theta\sin\Phi F_1 F_2 \quad (4)$$

Where,

$$F_1 = \mathrm{sinc}\left(k_0 h\frac{\sin\theta\cos\Phi}{2}\right)\mathrm{sinc}\left(k_0 W\frac{\sin\theta\cos\Phi}{2}\right) \quad (5)$$

$$F_2 = 2\cos\left(k_0 L\frac{\sin\theta\cos\Phi}{2}\right) \quad (6)$$

For E-Plane

$$\Phi = 0^0$$

$$E_\theta = -jk0V0W\frac{e^{-jk_0 r}}{2\pi r}F_E \quad (7)$$

$$F_E = \mathrm{sinc}\left(k_0 h\frac{\sin\theta}{2}\right)\cos\left(k_0 L\frac{\sin\theta}{2}\right) \quad (8)$$

For H-Plane

$$\Phi = 90^0$$

$$E_\Phi = jk0V0W\frac{e^{-jk_0 r}}{4\pi r}F_H \quad (9)$$

$$F_H = \text{sinc}\left(k_0 W \frac{\sin\theta}{2}\right)\cos\theta \quad (10)$$

The half power beamwidth is defined [12],

For H-Plane

$$\theta_H = 2\sin^{-1}\left(\frac{1}{2+k_0 W}\right)^{(1/2)} \quad (11)$$

For E-Plane

$$\theta_E = 2\sin^{-1}\left(\frac{7.03}{3{k_0}^2L^2+k_0h^2}\right)^{(1/2)} \quad (12)$$

The figure shown in figure4 is the radiation pattern for H-plane at phi=0 degree. When theta is increases the field is increases but a certain level i.e. theta=0 degree after that it is decreases. So it is clear that at theta=0 degree the field strength is maximum and it is measure as 0.89dB.

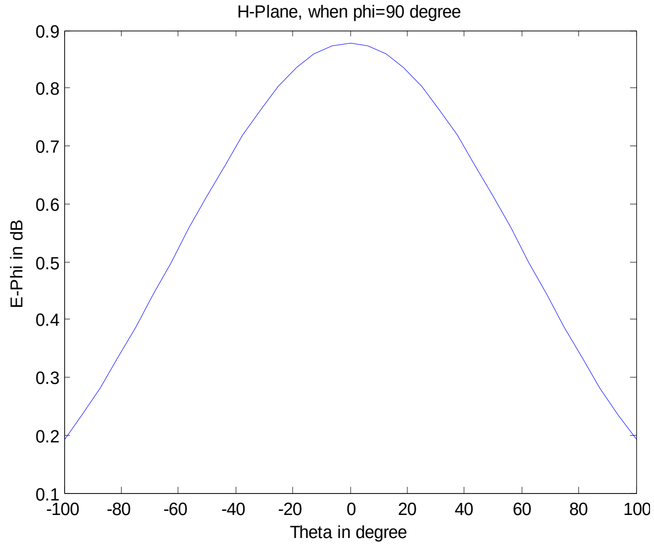

Figure4:Radiation pattern of H-Plane for rectangular microstrip patch antenna

The figure shown in figure5 is the radiation pattern for E-plane at phi=90 degree. When theta is increases the field is increases but a certain level i.e. theta=0 degree after that it is decreases. So it is clear that at theta=0 degree the field strength is maximum and it is measure as 0.425dB.

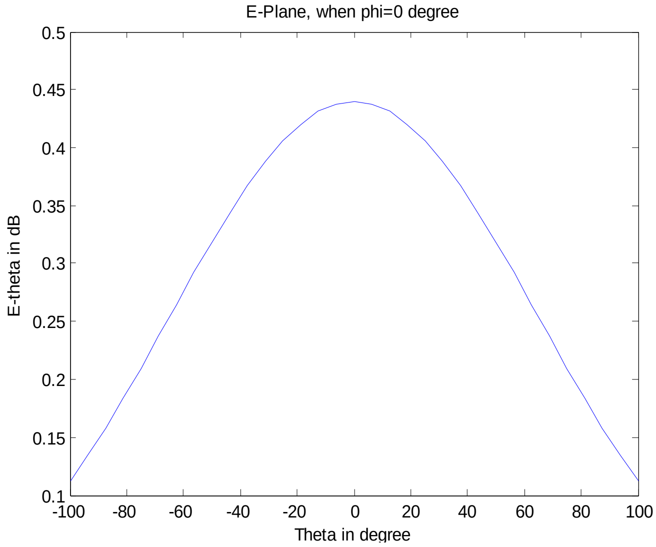

Figure5: Radiation pattern of E-Plane For rectangular microstrip patch antenna

The figure shown in figure6 is The E-plane half power beamwidth 7.2degree achieved at 3.2GHz when slot length increases then its beamwidth is going to decrease but not becomes zero and beyond a certain level again its beam width is increased for increasing the slot length and constant at 7.2degree.

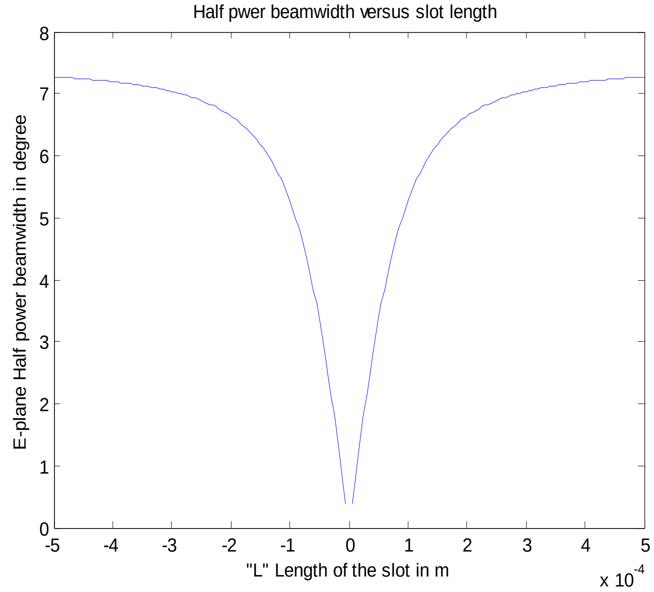

Figure6:For E-plane Beamwidth of side lobe radiation pattern with sloted distance

The figure shown in figure7 is The H-plane half power beamwidth 2.4degree achieved at 3.2GHz when slot length increases then its beamwidth is going to decrease with non linearly.

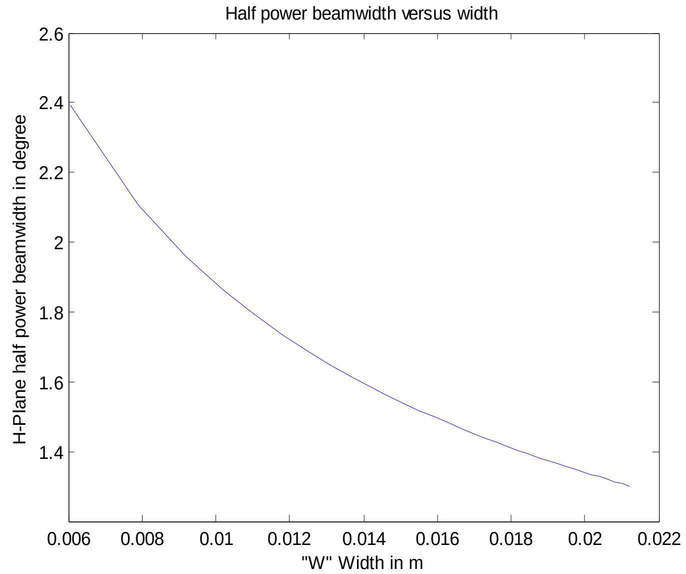

Figure7: For H-plane Beamwidth of side lobe radiation pattern with width of the patch

IV. CONCLUSION

It is concluded that the purposed structure of rectangular microstrip antenna developed on a single-layer substrate. By etching two straight slots close to and parallel with the non-radiating edges, the bandwidth of the rectangular microstrip antena enhanced during analytically without affecting its radiation characteristics. The h-plane halfpower beamwidth 2.4degree and E-plane half power beamwidth 7.0degree achieved at 3.2GHz.

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