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Computational Analysis of Return Loss for S-shape Microstrip Antenna

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I. Introduction

Microstrip antennas are being increasingly used for aerospace applications because of their low weight, low volume and conformal nature. The most commonly used microstrip antennas are rectangular and circular disc antennas. However, other microstrip antennas are also being considered, depending on the application [1].

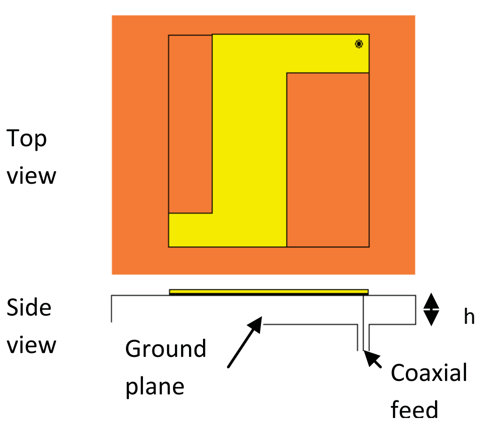

Fig.1 : Microstrip antenna configuration

In order to meet the requirement for mobile or personal communication systems, microstrip antennas with reduced size and broadband operation are of particular interest. Among various feeding mechanisms, the compact broadband microstrip antennas directly matched to a 50Ω coaxial line is also of importance, for its usefulness in integration with microwave integrated circuits. For this purpose, we present in this paper several related designs of microstrip antennas to broaden the operating bandwidth and reduce the overall size of the antenna. Here we discuss the S-shaped patch antenna. The S-shaped patch antenna reported here has a size about half that of the rectangular patch, with larger beamwidth but smaller bandwidth [2] shown in Fig.1.

II. Mathematical Analysis of S-Shape Antenna

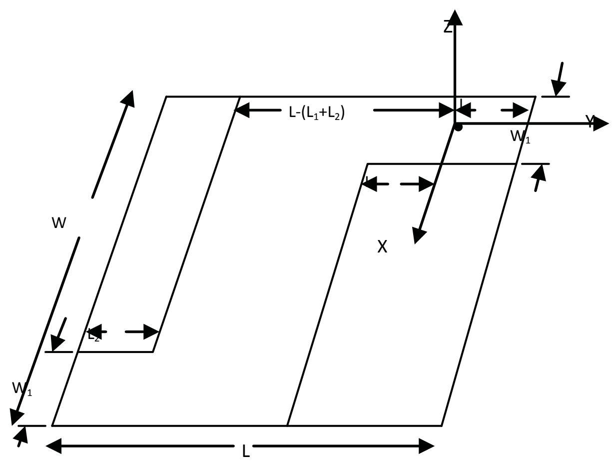

Fig. 2 : S-shape microstrip antenna with coaxil feed

Fig. 2. shows the geometry and co-ordinate system of the S-shape microstrip antenna. The width and length of the S-shape patch are W and L, respectively. The relative dielectric constant and the thickness of the substrate are ε_r and h, respectively. The antenna is excited at (x,y) by a coaxial feeder through the dielectric substrate. The electromagnetic fields in the x,y,z direction are denoted by (Ex , Ey, Ez) & (Hx, Hy, Hz) [3]. The electromagnetic fields within the cavity are divided into three regions by the boundaries through the feed point, as in Fig. 3. Moreover, as the antenna cavity is bounded on the side by the admittance wall, the electric field within the cavity is expanded in terms of the antenna parameters [5]. The electric field is expressed as

In region 1 (-W1/2 < X < +W1/2, -[L-(L1+L2)] < Y < L1, 0 < Z < h)

$$E_X = 0 \qquad (1)$$

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$$E_X = 0 \quad (1)$$

$$E_Y = E_0\cos\left(\frac{\pi}{[L_1 + (L - (L_1 + L_2))]}y'\right) \quad (2)$$

$$E_Z = 0 \quad (3)$$

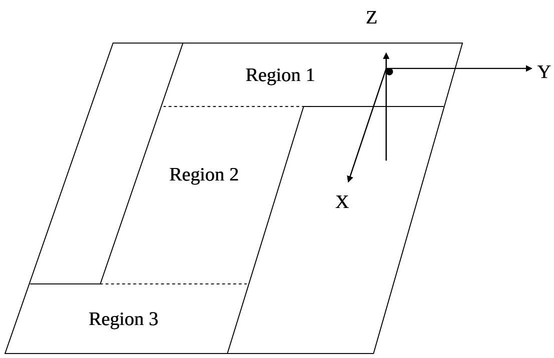

Fig. 3 : Geometry of S-shape antenna

In region 2 (W1/2 < X < [W1/2 + (W - 2W1)], -L3 < Y < (L3+{L-(L1+L2)}), 0 < Z < h]

$$E_X = EO\cos\left(\frac{\pi}{h}z'\right) \quad (4)$$

$$E_Y = 0 \quad (5)$$

$$E_Z = 0 \quad (6)$$

In region 3 ([W1/2 + (W-2W1) < X < W1/2 + (W-2W1) + W1], -L3 < Y < L3 + [L3-(L3 + L1)], 0 < Z < h)

$$E_X = 0 \quad (7)$$

$$E_Y = E_O\cos\left(\frac{\pi}{[L - L_3]}y'\right) \quad (8)$$

$$E_Z = 0 \quad (9)$$

And the magnetic field is expressed as

In region 1

$$H_X = H_O\cos\left(\frac{\pi}{[L - L_3]}y'\right) \quad (10)$$

$$H_Y = 0 \quad (11)$$

$$H_Z = 0 \quad (12)$$

Total electric field of S-shape antenna is presented by these equations which are expressed below [6]

$$E_X^{S-shape} = E_O\cos\left(\frac{\pi}{h}z'\right) \quad (13)$$

$$E_Y^{S-shape} = E_O\cos\left(\frac{\pi}{[L_1 + (L - (L_1 + L_2))]}y'\right) + E_O\cos\left(\frac{\pi}{[L - L_3]}y'\right) \quad (14)$$

$$E_Z^{S-shape} = 0 \quad (15)$$

and magnetic field is

$$H_X^{S-shape} = H_O\cos\left(\frac{\pi}{[L_1 + (L - (L_1 + L_2))]}y'\right) + H_O\cos\left(\frac{\pi}{[L - L_3]}y'\right) \quad (16)$$

$$H_Y^{S-shape} = 0 \quad (17)$$

$$H_Z^{S-shape} = 0 \quad (18)$$

III. Simulation Results and Discussion

As the design process goes the calculation of the parameters are done above and with the dimensions the S-shape patch antenna has been designed by the coaxial feeding techniques. Here, we take the coaxial feed technique in practice and the results are as shown below, A Matlab program has been compiled in order to produce the design and the responses for the S-shape microstrip patch antenna and its design. The table 1 below gives the possible parameters for the design of the microstrip patch antenna which will be used in the software for the results to examine. The width and the length of the patch have been rounded up to the close integer value.

Table 1 : Parameters used in software for the responses and simulations.

Parameter	Value
Dielectric constant of the substrate	4.2
Center Frequency	2.1GHz
Loss tangent	0.2

Width of the Patch	46.51mm
Length of the Patch	36.26mm
Height	1.6m
Zo	50Ω

The IE3D software has been compiled which gives us the following interface width (W) = 46.51mm length (L) = 36.26mm.

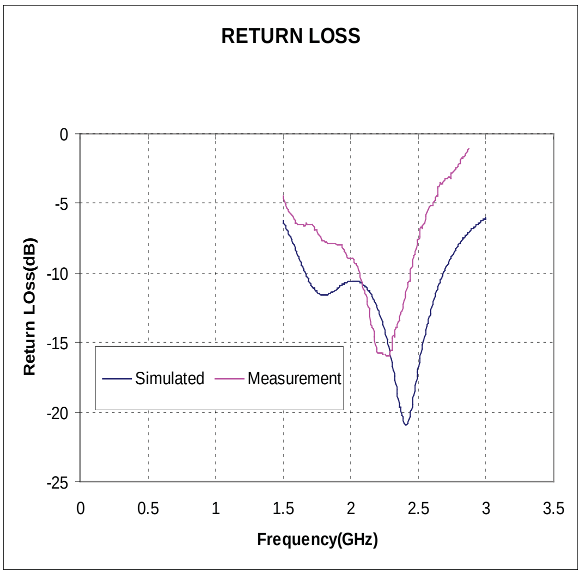

Fig.4 : Graph of the simulated & measured value

Graph of the simulated value & measured value are shown in the Fig.4. In these graph simulated and measured result are not closely matched. Simulated result is -23.34 dB at 2.4GHz resonating frequency [7] and measured result is -15.96db at 2.2GHz resonating frequency. At the operating frequency 2.1GHz the simulation result is -11.21db and the measured result is -10.73db. So that results presented that return loss are decreases without losses.

IV. Conclusion

The aim of this paper is to design a S-shape patch Microstrip antenna and to study the responses and electric and magnetic formulas are varies according to the boundry conditions. In this paper an antenna has been designed by the co-axial feeding technique. Having gone through the results it happened to be a bit difficult to decide the optimized design of the antenna, as there are different aspects that are involved in the design of patch antenna. It is good to see that the return loss has a negative value in all the cases which states that the losses are minimum during the transmission. In the design the Return Loss is -15.78dB in co-axial feed line technique for the simulated by the IE3D. But for the experimental design the Return Loss is -13.11dB in co-axial feed line.

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