WIDE BANDWIDTH TRIANGULAR PATCH ANTENNA FOR GSM APPLICATION

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Abstract - The narrow bandwidth of microstrip antenna is one of the important features that restrict its wide usage. This paper presents a bandwidth enhancement using slot geometry for the feed line matching is proposed and experimentally studied. The maximum bandwidth can be achieved by keeping the optimum distance between the two slots and by adjusting the length of the transmission feed line 50 Ohm. Return loss of -77.74 dB with VSWR 1.0026 for frequency at 940 MHz. The results show that the proposed antenna has the improved impedance bandwidth covering whole band.

Key words *- Triangular microstrip antenna, bandwidth, slot geometry, GSM.*

I. INTRODUCTION

Patch antenna possesses many advantages such as low profile, light weight, small volume and compatibility with microwave integrated circuit (MIC) and monolithic microwave integrated circuit (MMIC). However, the narrow bandwidth is the major obstacle in wide applications for the microstrip antenna. In general, the impedance bandwidth of the traditional microstrip antenna is only a few percent (2% - 5%) [1]. Therefore, it becomes very important to develop broadband technique to increase the bandwidth of the microstrip antenna.

There are several ways to overcome this problem such as use U-slotted patch [2] and use array technique [3], but [2] and [3] still use rectangular patch microstrip antenna. Although rectangular and circular geometries are most commonly used, other geometries having greater size reduction find wide applications in modern communication systems, where the prime concern is compactness. The triangular patch antenna configuration is chosen because it has the advantage of occupying less metalized area on substrate than other existing configurations.

In some applications which the increased bandwidth is needed, dual frequency patch antenna is one of the alternative solutions [4]. When modern communication system, such as satellite, radar and GSM requires operation at wide bandwidth. Wide bandwidth patch antennas may avoid the use of two different antennas. Recently, the most popular technique for obtaining wide bandwidth is by introducing a reactive loading to a single patch [5] [6] [7].

Mainly there are two feeding systems and can be categorized into two groups, direct coupling or probe feed and electromagnetic coupling. Microstrip line and coplanar waveguide are two types of transmission line and usually used as a feeding line for the electromagnetic coupling. The advantage of electromagnetic coupling is permits for improving bandwidth [8].

Using geometry and dimension from [7] this paper therefore proposed a design of triangular microstrip antenna using slot geometry for the feed line matching technique. Details of the proposed antenna design and the results of the VSWR and S parameter to enlarge the bandwidth performances are presented.

II. DESIGNING OF ANTENNA

The geometry of a single patch antenna using two slots with different height for wide bandwidth operation feed by microstrip feed line can be shown in Figure 1a and 1b. The patch antenna is constructed on two layers with the same dielectric substrate. On the first layer, the patch antenna is realized on FR 4 substrate and having a relative permittivity (ε_r) = 4.9, substrate of thickness (h) = 1.6 mm and the microstrip feed line is realized on the same layer.

Figure 1a, a is the dimension of the side length of the triangular patch antenna and given by

$$a = \frac{2c}{3f\sqrt{\epsilon_r}} \qquad (1)$$

a_1 is the left length of the triangular and the first slot, $a2$ is distance between the first slot and the second slot, $a3$ is the right length of the triangular and the second slot. Besides that, $x1$ and $y1$ are the length and width of the first slot, $x2$ and $y2$ are the length and the width of the second slot. Table 1a shows the parameters of a single patch antenna. Table 1b shows the parameters of microstrip feed line.

Table 1a: Parameters of a single patch antenna

Parameter	a	a1	a2	a3	x1	x2	y1	y2
Length (mm)	24	9	5	8	10	8	1	1

Table 1b: Parameters of micro strip feed line

Parameter	W1	L1	r
Length (mm)	2.8	12.5	18

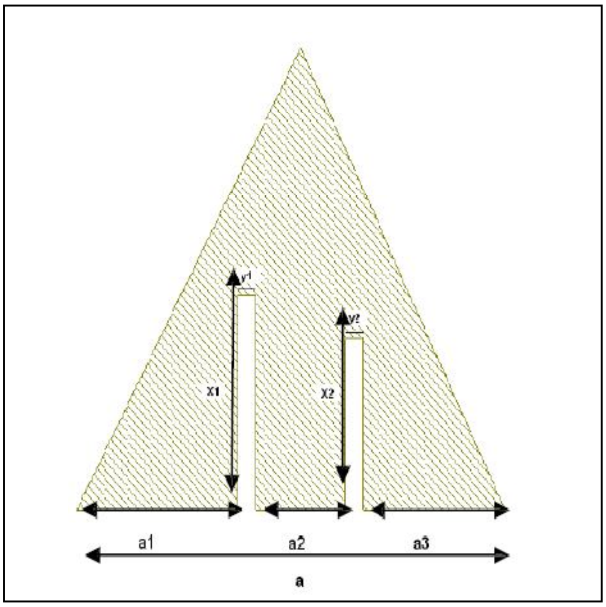

Fig. 1a : Geometry of a single patch antenna

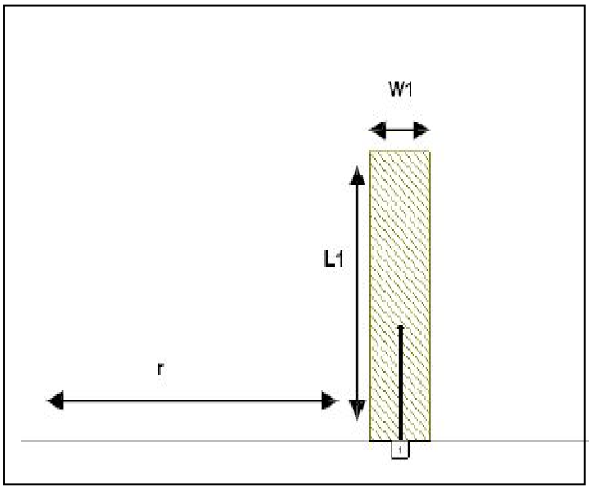

Fig. 1b : Geometry of microstrip feed line

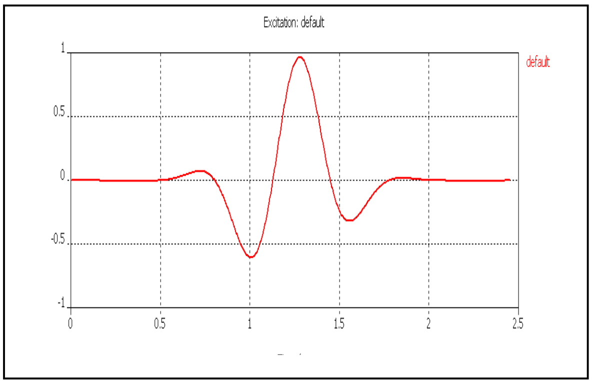

Fig. 1c : Waveform of feed line excitation signal

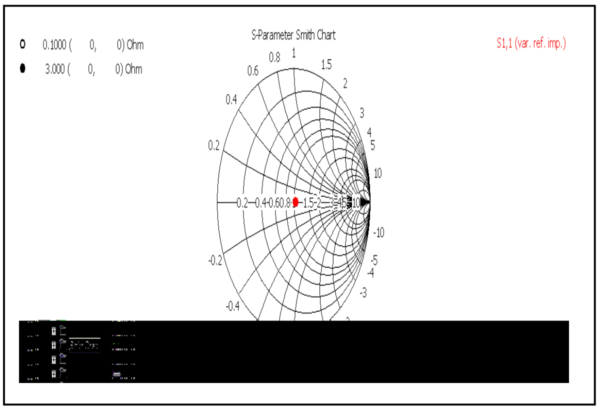

Fig. 1d : Smith Chart for the design

III. SIMULATION RESULTS

The results of the first condition of the proposed antenna are as follow, return loss of -77.74 dB with VSWR 1.0025 at frequency 940 MHz. The results shows that return loss and VSWR did not indicate the maximum value.

To achieve the maximum results, the distance between the patch adjusted and the length of the microstrip feed line

$$B = \frac{60\pi^2}{z_0 \sqrt{\epsilon_r}} \quad (2)$$

$$W = \frac{2h}{\pi}\left\{B - 1 - \ln(2B-1) + \frac{\varepsilon_r - 1}{2\varepsilon_r}\left[\ln(B-1) + 0{,}39 - \frac{0{,}61}{\varepsilon_r}\right]\right\} \quad (3)$$

From (2) and (3), the width of the three transmission feed line for the proposed antenna are as follow 0.5 mm, 1.5 mm and 3 mm respectively for 100 Ohm, 70.7 Ohm and 50 Ohm.

Figure 3 shows the geometry and the dimension of the proposed antenna.

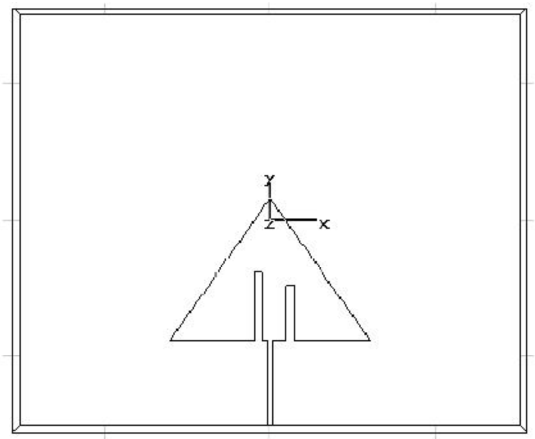

Fig. 2 : Geometry and dimension of the proposed antenna 50Ω needs to be controlled.

Table 2 shows the simulation results after controlling the length of the microstrip feed line 50 Ohm and Figure 3 and 4 shows the values of return loss and VSWR respectively. From below table, comparison shows that the best option is to have the return loss of -77.73dB at 942.83MHz frequency with VSWR of 1.0004.

Table 2 : Iteration of the width of the microstrip feed line 50 Ohm

Length of the microstrip feed line	Frequency of 940 MHz	
	Retrun Loss	VSWR
0.7150 mm	-77.78 dB	1.0040
0.3575 mm	-60.91 dB	1.0019
0.8938 mm	-73.6 dB	1.0003
0.53625	-73.08	1.0004
0.17875	-64.7	1.0012

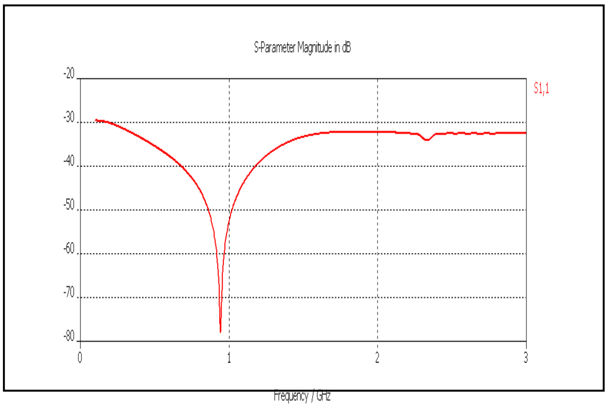

Fig. 3 : Return loss after adjusting the length of the microstrip feed line

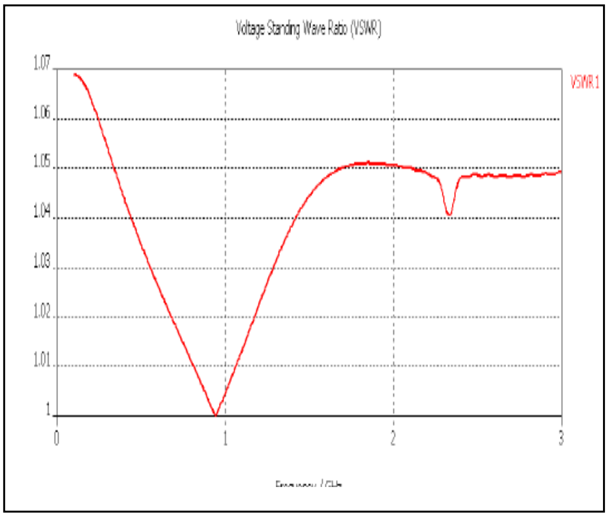

Fig. 4 : VSWR after adjusting the length of the microstrip

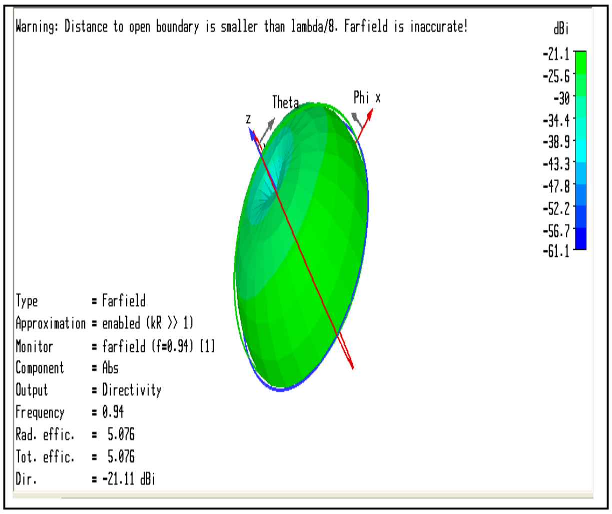

Fig. 5 : Radiation pattern of the design

IV. CONCLUSION

A novel configuration to increase bandwidth for microstrip antenna for GSM application has been experimentally studied. It is shown that the by using slot geometry required results can be easily obtained by varying the length of the microstrip feed line 50 Ohm and adjusting the distance between the two patch antennas. It is observed that return loss of -77.74 dB with VSWR 1.0025 can be achieved for frequency at 940 MHz and the impedance bandwidth (-40 dB) is about 51.91%. In addition, the gain of the proposed antenna is 14.06 dB .Therefore the proposed antenna is applicable as a new candidate for wide band antenna to enlarge the bandwidth for GSM application.

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