Study on Inclusion of Two Microstrip Square Open Loop Resonator to produce a Diplexer

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Abstract— **In this paper, a microstrip square open loop resonator as one of the design for band pass filter is proposed to develop the diplexer. A combination of two microstrip open loop resonator connected to T-junction will produce a diplexer. The microstrip square open loop resonator is operating at two frequencies, 1800 MHz and 2150 MHz. Comparisons between simulated and measured result shows a shifting in return loss, S_{11} and insertion loss, S_{21}. From the results, simulated result shows a better return loss and insertion loss.**

Keywords— ***microstrip, filter, resonator, diplexer, dual band, CST Microwave Studio.***

I. INTRODUCTION

One of the major challenges in our radio network is to reduce the usage of antenna for each telcos at the base station. It is due to the local authority issue as there is a public complaint on the too many antennas eg: RF antennas and transmission antenna; at the base station that can cause radiation issue. A microstrip dual band diplexer is the solution to the issue.

Diplexer is a device connecting two radios operating at different frequency bands to the same antenna which consists of a low pass, high pass or band pass filter connected to a single point of junction or T-junction [1]. The using of diplexer can reduce cost on the antenna system as shown in Fig. 1.

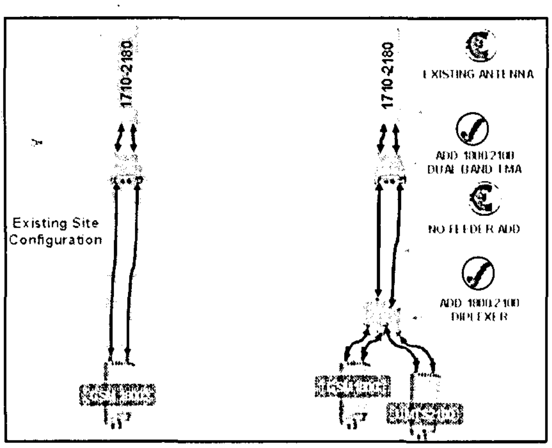

Fig. 1 Example of a diplexer configuration at the base station

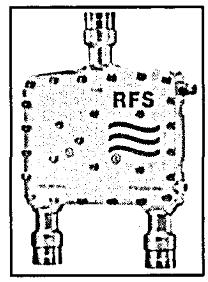

Fig. 2 Example of a diplexer

In this paper, a band pass filter is used in order to design a diplexer. The function of band pass filter is to pass signals of frequencies between lower and upper frequencies and block other transmission outside the band. Band pass filter employed in microwave and millimetre wave communication system to remove and suppress spurious signals from an undefined frequency or channel [2]. Microstrip band pass filter can be easily mounted on the dielectric substrate and can provide more flexibility design of the circuit layout [3].

II. ANTENNA DESIGN

The band pass filter illustrated in Fig. 3 shows a conventional square open loop resonator. Fig. 4 is the proposed square open loop resonator. The resonator is designed operating at 1800 MHz and 2150 MHz The resonator was fabricated on a FR4 with relative dielectic constant, $\varepsilon_r = 4.7$ and thickness, $h = 0.8$ mm and was designed by using CST Microwave Studio. The microstrip square open loop resonator can be implement either at the transmitter or receiver part.

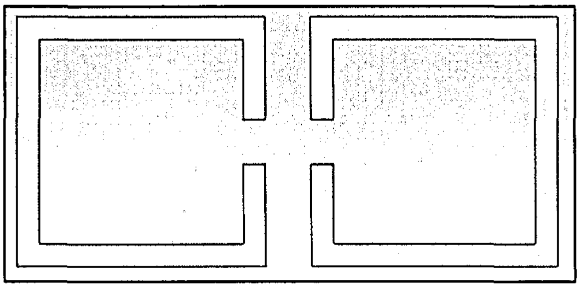

Fig. 3 Conventional Square Open Loop Resonator

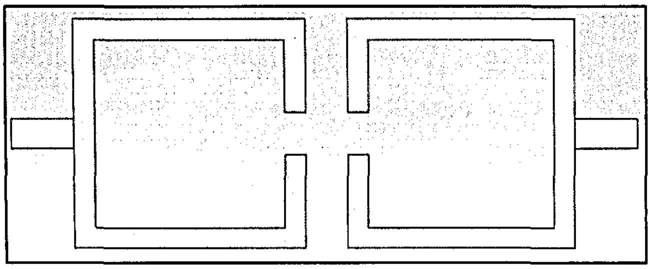

Fig. 4 Conventional Square Open Loop Resonator with symmetric feed

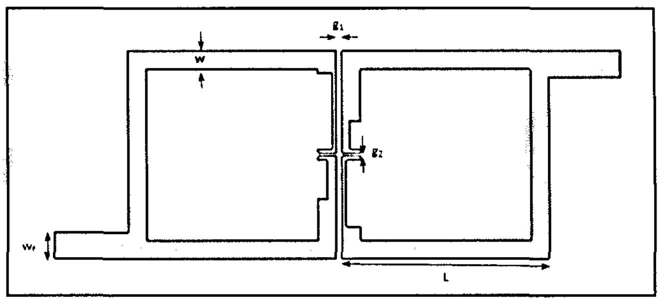

Fig. 5 Proposed resonator with asymmetric feed

The initial dimensional for the proposed resonator as following: w_f = 3 mm, w = 1 mm, L = 11 mm, g_1 = 1 mm, g_2 = 0.5 mm.

III. RESULTS

A. Simulation

The square open-loop resonator is designed by using CST Microwave Studio. Initial result for return loss, S_{11} and insertion loss, S_{21} are -8.0274 dB and -2.5687 dB respectively at 1800 MHz. As at 2150 MHz the values are S_{11} is -4.5535 dB and S_{21} is -3.7493 dB.

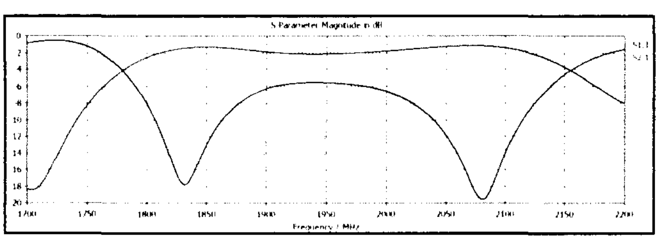

Fig. 6 Initial: Return loss, S_{11} and Insertion loss, S_{21}

After the optimization process, the values for return loss, S_{11} and insertion loss, S_{21} are -16.7578 dB and -1.18132 dB respectively at 1800 MHz and as at 2150 MHz, S_{11} is -17.3036 dB and S_{21} is -1.3018 dB.

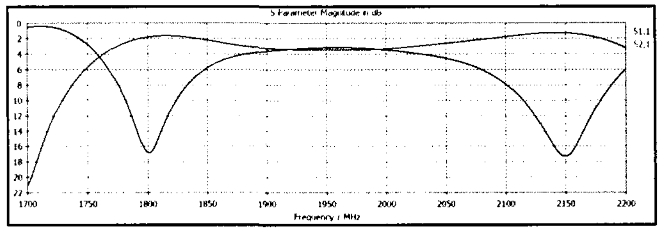

Fig. 7 Final: Return loss, S_{11} and Insertion loss, S_{21}

From the optimization, there are changes on the frequency and the values of return loss and insertion loss. The final simulation show that the return loss and insertion loss located at the desired frequency; 1800 Mhz and 2150 Mhz. By reducing gap, g_1, it effect the bandwidth of the filter. Besides, by optimizing the leg for both left and right patches with the step impedance, it effect the values of frequency, return loss and insertion loss.

B. Measurement

The final result in simulation has been fabricate using substrate, FR4. The return loss, S11 and insertion loss, S21 at 1800 MHz are -14.2442 dB and -1.4598 dB respectively. As at 2150 MHz, the values are -12.1195 dB and -1.0415 dB respectively.

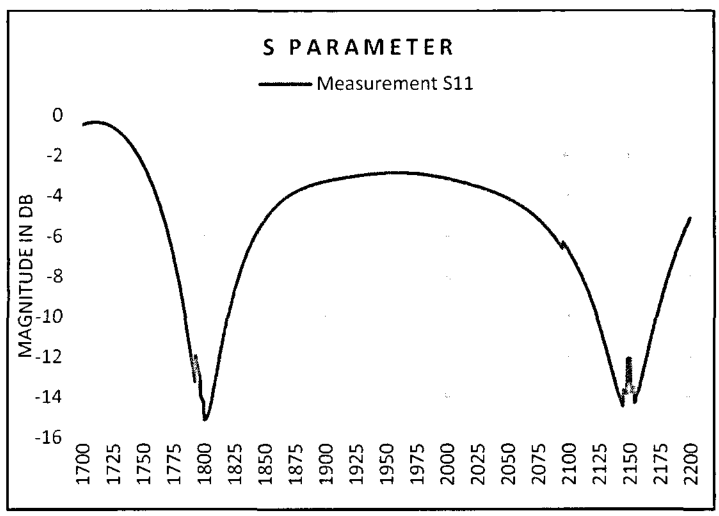

Fig. 8 Measured Return loss, S_{11}

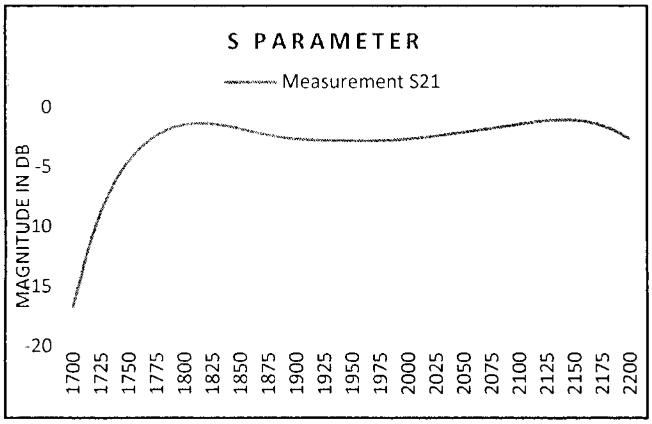

Fig. 9 Measured Return loss, S_{21}

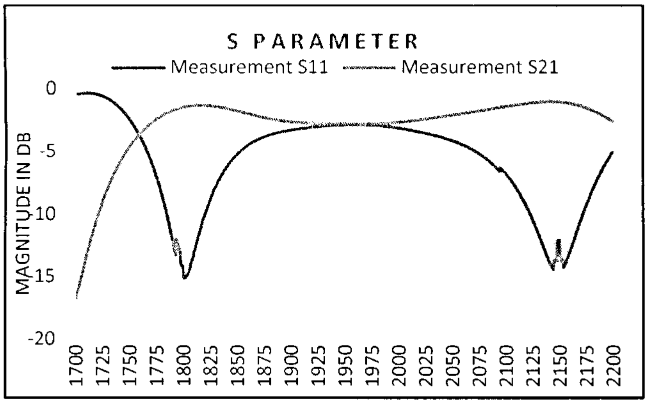

Fig. 10 Measured Return loss, S_{11} and Insertion loss, S_{21}

IV. DISCUSSIONS

From table 1, it shows that there is a small shifting for S_{11} and S_{21} around 10% to 20% between simulated and measured result. Referring to Fig. 4 and Fig. 5, there is an impact between symmetric and asymmetric feed. The impact is to 50 Ω line impedance.

TABLE I
SIMULATION AND MEASUREMENT RESULT

	1800 MHz		2150 MHz	
	S_{11}	S_{21}	S_{11}	S_{21}
Simulation	-16.7578	-1.18132	-17.3036	-1.3018
Measurement	-14.2442	-1.4598	-12.1195	-1.0415

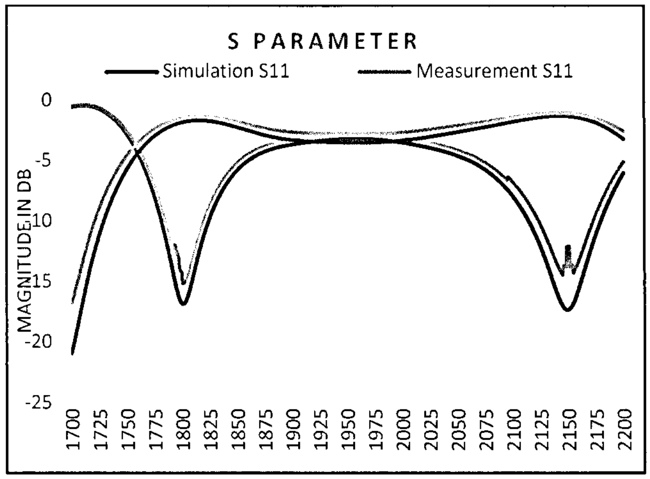

Fig. 11 Simulated and measured Return loss, S_{11} and Insertion loss, S_{21}

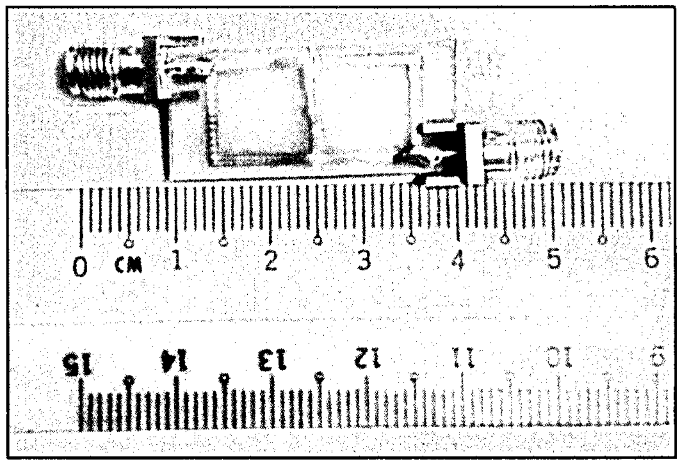

Fig. 12 Photograph of microstrip square open loop resonator

V. CONCLUSIONS AND FUTURE WORK

The resonator consist of two different patches where the gap between two patches effect the bandwidth and 50 Ω line impedance. From the result, it shown that simulated result much better than measured result. For simulated return loss, S11, is 17.65% better than measured return loss at 1800 MHz. The impact of S_{11} and S_{21} is depend on the gap, g_1, g_2, and also the two line between the patches. The preparation method of microstrip square open loop resonator also impact or effect the value of return loss and insertion loss.

An interesting future work that can be done is to produce a triplexer or quadplexer using microstrip square open loop resonator

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