Design and Analysis of T-shaped Resonator for oscillator application

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Abstract: **This paper presents, design and simulation of a T-shaped resonator. The resonance frequency of the resonator is 7.288 GHz with return loss 27.99 dB and insertion loss 5.502 dB. The T-shaped resonator structure has ease of frequent fabrication with accurate results. The proposed T-shaped resonator can be used for low phase noise oscillator design.**

Keywords: **Resonator, Resonant Frequency, Oscillator,**

I. INTRODUCTION

In the microwave regime the oscillator is mainly employed to produce continuous wave signal .It can then be treated as local oscillating signal generator for performing the frequency up conversion/down conversion in a wireless communication system or a radar system [2].Here in this paper we have simulated T-shaped resonator which can be used in the oscillation applications discussed above. To achieve a stable oscillation frequency and low phase noise performance, high- quality factor resonators, such as dielectric resonators , are usually adopted to develop microwave oscillators[1]. Although they are not easy to integrate with other planar circuits, and cannot be implemented in the process of integrated circuit (IC).

Multi resonator band pass filter with an elliptic response band filters can provide a higher-quality factor than that of the single resonator at the group-delay peak frequency. To achieve a good phase noise performance the overall network of the oscillator should have a high Qs value at the oscillation frequency [2]. Therfore resonator with a high quality factor Qr is usually employed to increase QS.

$$Q_r = \frac{\omega_0}{2}\left|\frac{d\phi(\omega)}{d\omega}\right|_{\omega=\omega_0} = \frac{\omega_0}{2}\tau_d \quad \ldots(1)$$

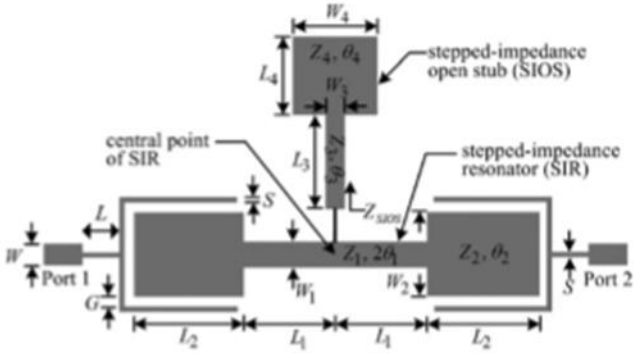

Figure 1: Structure of TSIR filter with dimensions

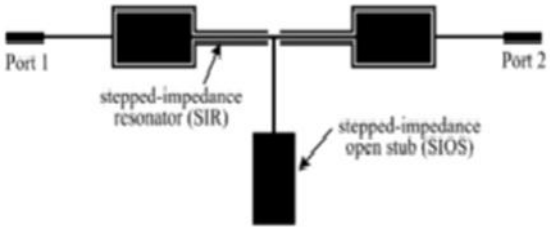

Figure 2: circuit scheme of T-shaped resonator

Where ω_0 is the oscillation frequency, ϕ (ω) is phase response of the oscillator and τd is group delay.Here,Qs spectrum based quality factor and is different from quality factor of resonator Qr.High quality resonator such as high permittivity dielectric resonator (DR) is used to achieve low phase noise[3].Although DR's are not practically possible to IC fabrication ,reason their bulky and non planar structure. To solve this problem, different types of planar microwave oscillators are substituted for DR's oscillators. Most of the previous studied have focussed on designing high Q planar-type single resonators including hair-pin resonators, active resonators, split ring resonator, spiral resonator and ring resonator. These resonators are placed as frequency stabilization element at the gate or base terminal of active devices. In spite of using trisection filter in or elliptic response filter in to

implement the filter based oscillator applications, still it is difficult to fabricate and has a large circuit size. In this paper we have simulated T-shaped resonator which can be used in oscillation applications. As compared to other filters, T-shaped resonator has smaller circuit size, which makes its implementation easy in the IC process. The proposed simulated T-shaped resonator has a resonance frequency at 7.288 GHz with return loss 27.99 dB and insertion loss 5.502 dB.

II. DESIGN OF T-SHAPED RESONATOR

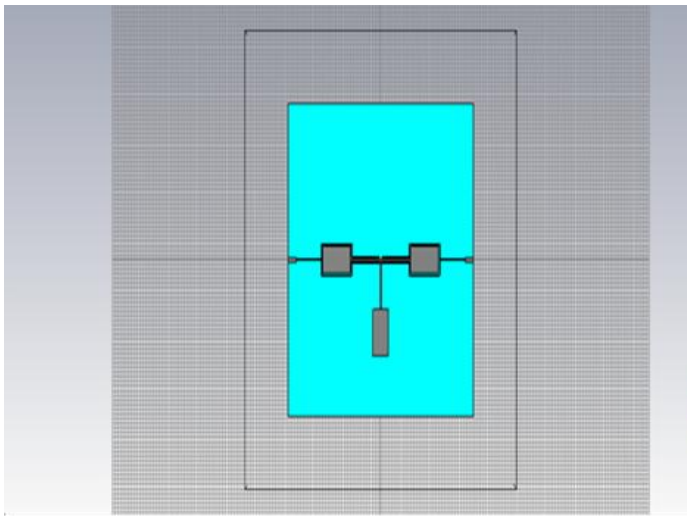

Figure 3 : Circuit structure of T-shaped resonator

The T-shaped resonator is designed to be operated at 7.288 GHz and simulated on a RO4003 substrate with a thickness of 0.508 mm, a dielectric constant of 3.38 . Referring to the dimension indications in Fig.2, the physical dimensions of the developed filter are W=1.1 mm, L=9 mm, W1=0.37 mm, L1=10.9 mm, W2=5.6 mm, L2=10 mm, W3=0.37 mm, L3=10.4 mm, W4=5.6 mm, L4=10 mm, S=0.3 mm and G=0.3 mm.

III. RESULT AND DISCUSSION

The resonance frequency of the resonator is 7.288 GHz with return loss 27.99 dB and insertion loss 5.502 dB and the quality factor is 51.702 . The R.L. is simply the amount of power that is lost to the load and does not return as a reflection. High R.L. is usually desired even though loss has negative connotations. R.L. is always in negative and more negative value of R.L. show the better result.

The I.L. about 0 dB (Ideal value), meaning that the entire signal is getting through. Insertion loss is calculated by the parameter S_{21} and S_{21} must always approaches to 0 value on y axis of figure 5 for better result. Bandwidth (BW) AND quality factor is having inverse relation.

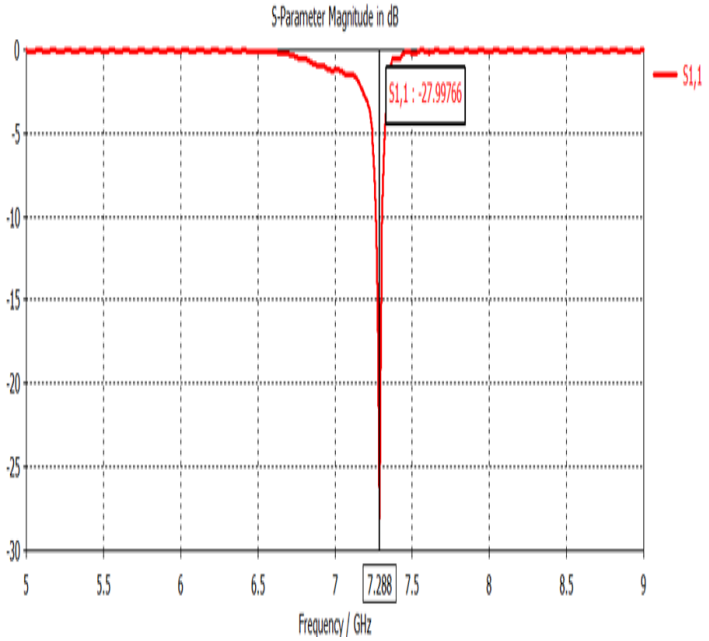

Figure 4: Simulated return loss

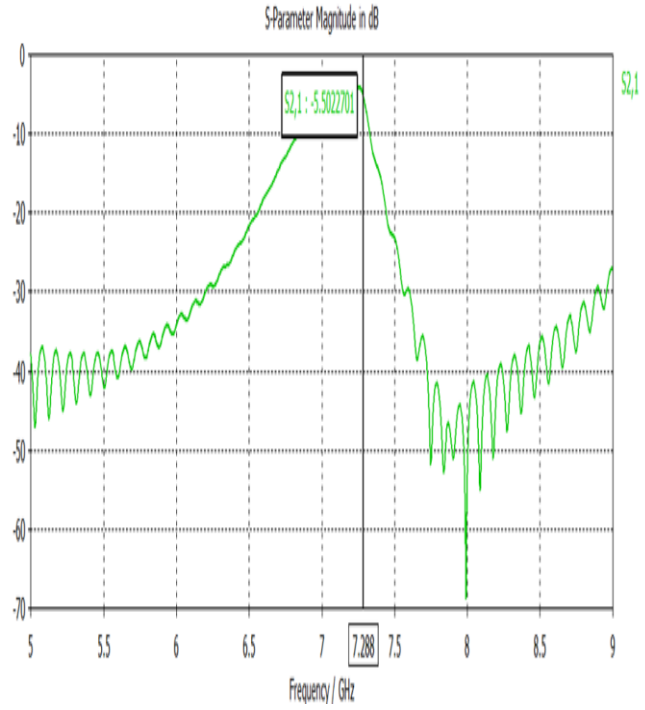

Figure 5: Simulated Insertion Loss

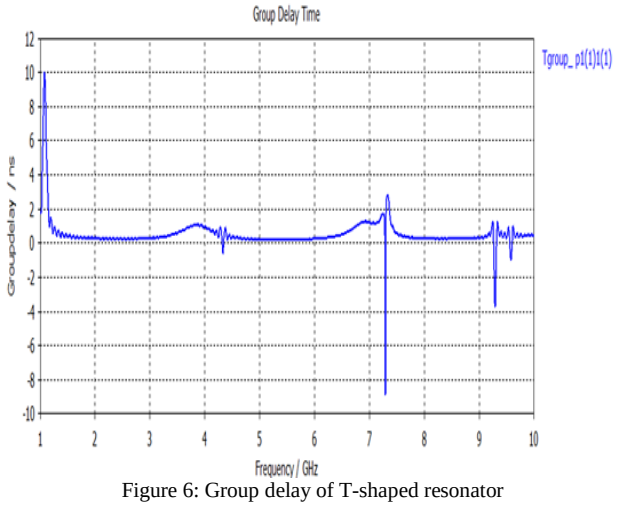

Figure 6: Group delay of T-shaped resonator

IV.CONCLUSION

The T-shaped resonator has been simulated .Its return loss is 27.99 dB and insertion loss is 5.502 dB.These are shown in figure 4 and figure 5.The Quality factor of the T-shaped resonator has also been calculated .Quality factor comes out to be 51.702.A high quality factor helps in reducing phase noise .The group delay of the T-shaped resonator has also been analysed .This is shown in figure 6.

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