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Compact-Size and High-Q Meanderline Resonator for ITS Application

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***Abstract*—A compact and high quality factor (Q_L) meanderline resonator for intelligent transport system (ITS) application on low dielectric substrate is presented. In order to get high Q_L and frequency responses, the resonator is connected directly to feeding line which is designed to operate at 5.8 GHz. The simulation result of the designed bandstop type resonator shows the Q_L value of 201. The dimension of the resonator is 1.85 x 1.59 mm^2.**

Keywords*— *Resonator, compact size; high quality factor; meander-F type;

I. INTRODUCTION

By the rapid growth of communication systems, intelligent transport system (ITS) service and local area network (LAN) are highly demanded in the recent years. High loaded quality factor (Q_L) plays a significant role in an ITS mobile communication system, there have been increasing researches on it with sharp-skirt, high selectivity characteristics, and small size for the resonator. For position detection in vehicle mobile communication, high-Q_L resonator is very important that decides the entire performance of the related devices. Since, the promising elements, the cavity and dielectric resonator have high-Q_L characteristic, the sizes of those resonators are very big [1]. Therefore, we can reduce the size of the resonator by using high dielectric (ε_r) substrate, but the cost is high [2].

In addition, a resonator is a system that displays necessary resonance frequency and it occurs in the form of standing waves owing to superposition of the traveling waves. The resonator is used to design high performance filters, oscillators, duplexers, mixers, and so on [3-4]. The characteristics of resonator can mainly determinate the required performance of filters and other resonator based components. There are many classical resonators include half- and one-wavelength uniform, ring, open-loop, and stepped-impedance ones (SIR)[5-6]. The design of the patch resonators requires complicated parameters tuning for achieving desired filtering performance. Most recently proposed stub-loaded resonators originated from the conventional stepped impedance transmission line ones.

Therefore, we designed the compact-size meanderline resonator with folded structure for ITS application which has bandstop characteristics. Due to close coupling effect, this structure is succeeded to achieve of high-Q_L which is very important in high performance resonators. In the next section, the analysis of the compact resonator, simulation results and conclusion will be discussed.

II. DESIGN ANALYSIS OF RESONATOR

Basically a hair-pin resonator is composed of $\lambda_g/2$ open-circuited line with folded structure. The input port and output port is terminated into 50 Ω [7]. However, in our design, we modified as shown in Figure 1 in which the meaderlines are folded in F-shaped to have very compact size. The spiral is meandered so that we can have high Q-factor. In the Fig. 1, Z_0 is the characteristic impedance of the single transmission line with input and output port and Z_1 is the characteristic impedance of the folded spiral meandered resonator section [8-9] obtained by the ABCD matrix, which expresses a transmission line and a capacitor [8-11].

The characteristic impedance of feeding line Z_0 is 50 Ω and the characteristic impedance of resonator Z_1 is 120 Ω. Also, the *w* and *s* are the width of microstrip line in the resonator and a gap between microstrip lines respectively. In the same way, l_1 and l_2 are lengths of the resonator. Then, the wavelength of a resonator is $\lambda_g/2$. In this characteristic, the proposed resonator is coupled to directly connection with feeding line. In this way, the meander-F type is built by folding to make the size small.

The equivalent circuit is shown in Fig. 2 in which RLC networks are arranged in parallel manner and these are connected to the main transmission line with input and output port. As shown in the Fig. 2, the L is inductance corresponding to the length of the resonator and the C is capacitance corresponding to the gap size in resonator. R is conductance in microstrip line. In the process of designing the compact and high-Q_L resonator, length, l is optimized to 1.85 mm and l1 is optimized to 1.59 mm and while width, w is set to 0.2 mm and the spiral structure is meandered so that it can be coupled much more than before, i. e. before meandering. Eventually, this pattern gives high-Q_L and good resonance performance.

The loaded quality factor can be found from the equivalent circuit shown in Fig. 2 as follows [6],

$$Q_L = \omega_o \frac{R \cdot 2Z_o}{R + 2Z_o} C \qquad (2)$$

The loaded quality factor corresponds to the 3 dB bandwidth of S_{11} given by

$$Q_L = \frac{\omega_o}{\Delta\omega}. \quad (3)$$

where ω_0 is the angular center frequency and $\Delta\omega$ is a half power bandwidth, i. e. the bandwidth over which the power vibration is greater than half the power at the resonance frequency, $\omega=2\pi f$.

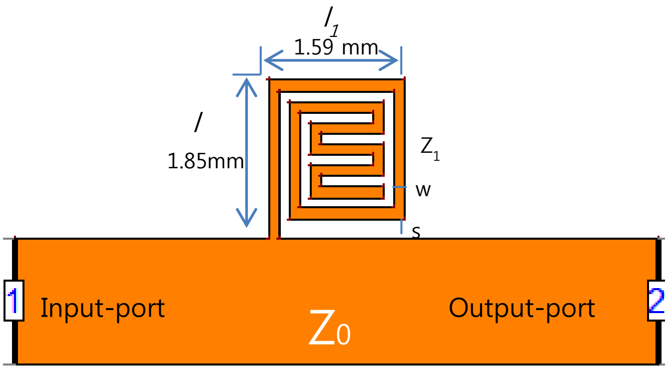

Fig. 1. Layout of the designed resonator

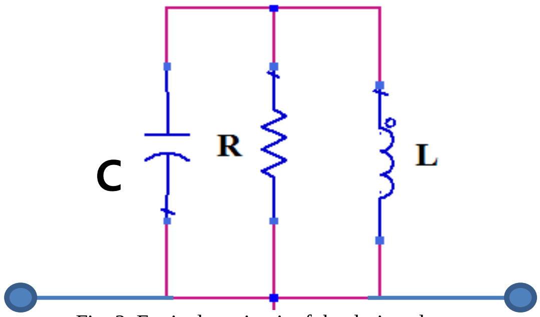

Fig. 2. Equivalent circuit of the designed resonator

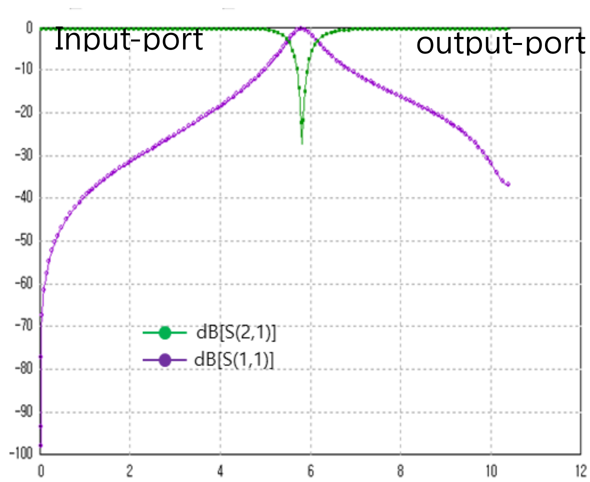

Fig. 3. Simulation result of the proposed resonator

III. SIMULATION RESULTS

The folded meander line resonator is simulated using IE3D simulator tool and we achieved high-Q_L of the designed resonator as 201 at the resonance frequency of 5.8 GHz as shown in Fig. 2. In the result, S-parameter responses are shown that includes transmission and reflection coefficients which are very essential in the resonator and these parameters determine the performance of the filter, oscillator, duplexer, etc. when they are implemented. And we can have good input reflection coefficient characteristics too. The entire size of the proposed resonator is 1.85 x 1.59 mm^2.

IV. CONCLUSION

A compact size with high-Q_L meanderline resonator with folded structure is suggested in this work. The resonator is connected to the main transmission line directly as the feeding line. The size was reduced due to folded structure and designed to the low dielectric material with dielectric constant of 0.54 and a thickness of 2.54 mm. The resonator is designed and simulated at 5.8 GHz for ITS application. The quality factor Q_L is found to be 201 in the simulation result. The size of the resonator is 1.85 X 1.59 mm^2. The further integration is possible using MMIC technology or IPD technology too due to its compact size.

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