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A Four Section Bandpass Filter with High Harmonics Suppression Performances at $2f_o$

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Abstract

This paper presents a design technique for 0.9 GHz bandpass filter by using four microstrip coupled lines. The first pair of parallel coupled lines is employed as a split resonator. While, the second pair is used as the coupled feed lines and improve the magnitude of frequency suppression in transition band. The compensation inductors are used simultaneously for input and output ports return loss tuning and 2 f_0 frequency suppression. To demonstrate the technique performance, simulated and measured results at 0.9 GHz of uncompensated and inductive-compensated circuits are compared. The measured results obtained from the proposed circuit exhibit more 55 dB spurious suppression than the uncompensated circuit at 2 f_0.

Keywords: Microstrip bandpass filter, split resonator, spurious suppression.

1. Introduction

A coupler bandpass filter has been widely used for circuits in microwave frequency e.g. directional connector, impedance merchant balance, bandpass filters, phasing circuit, resonator circuit, and wireless communication circuit system [1] because of coupler structure can be widely used as substate or base for electronic industries. It can easily connect to electronic equipments, IC, and other circuits. Moreover, it is a great design for ease of fabrication. There are many advantages and disadvantages that occur by nature of microstrip structure around the transmission lines. The phase velocity of the traveling wave mode and dual-mode transmission is not the same which causes significant impact on the performance of the device or circuit that is built from components that are connected in parallel lines. From previous researches, these limitations can be

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solved in several ways. The techniques to solve these problems are divided into two groups: 1) techniques using sparse and 2) techniques used for clustering [2]. Comparing the two techniques, group techniques [3-5], it is convenient to use because the equation is designed simply. The only disadvantage is the problem of hidden variables in the design phase of the cycle. It can be solved by careful design. This paper presents a new technique for the bandpass

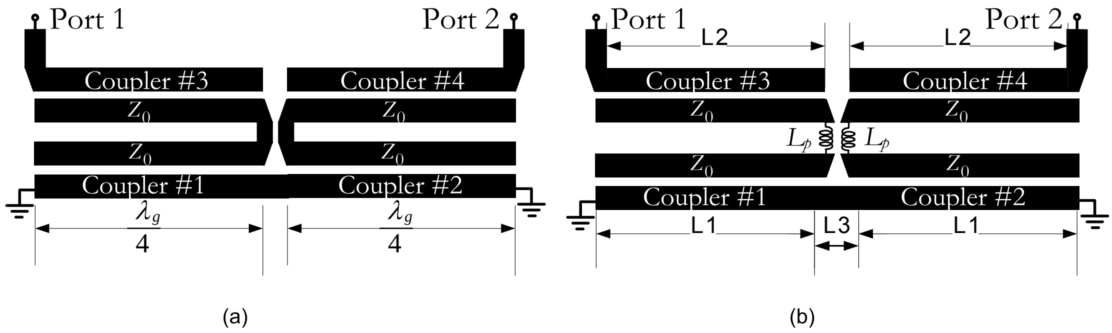


Fig.1. Structure of presented microstrip bandpass filter a) Normal type b) Microstrip bandpass filter connected to inductor to tune frequency

filter design in the 0.9 GHz frequency. The main structure of a transmission line connected to the two parallel lines connected to a separate circuit so the inductor is connected in parallel with the transmission line that serves as the interface signals. In order to improve the operation of the circuit to be able to suppress the harmonic frequency $2f_0$ devices as needed. The structure of the circuit is small. The design is very simple and has a frequency response at the frequency $2f_0$ is very high; it is likely to be used in communication systems and microwave frequencies in the future as well.

2. Open split ring resonator responses to bandpass filter

A bandpass filter resonator is able to analyze by transmission lines or circuits e.g. microstrip or coupled microstrip lines, opened and closed ring resonator. Frequency bandpass filter is synthesized from a section of transmission line connected in parallel. It is a basic research must be known [7] and simply. There is a problem of the asymmetry of the frequency response and the frequency response is spurious or harmonic frequency devices nearby. Particularly, the response of spurious frequency harmonic $2f_0$ reason on the transmission lines connected in parallel to the circuit so resonator would cause disadvantages such impact resonator a parallel transmission line to connect the components. Currently, research community of microstrip filter design has concentrated on the frequency bandpass filter using open or closed ring resonators because the ring resonator has many aspects such as the size and the synthesis flexibility. The circuit is based on the coupling or the energy in the form of the magnetic field and electric field, thus making the research both domestic and foreign researchers [6, 8]. Most of these studies have focused on improving the circuit performance by connecting the transmission line stub types. Most of these researches focus on inside and outside of the ring, or even a signal feed (feed line) to the circuit design and the wide frequency range. Sometimes the frequency band and the top (upper stop band) design may be overlooked problem of the internal structure of the circuit itself. In particular, the transmission line of microstrip connected parallel to the distance well as the behaviour of a transmission line connected in parallel to disguise itself up in those circuits. In this paper, the researchers have proposed a split resonator with a frequency response of bandpass, as shown in Fig. 2. The circuit is made of a grid connection which is broken. A quarter to a half wavelength in the crash and turned in the middle to separate the input and output ports.

Transmission line connecting the two parallel beams that are connected as shown in Fig. 1 will serve to connect the signal and increase the slope of the frequency response in the frequency transition. Inductor is connected to the frequency response at the frequency $2f_0$ configuration and allows the return loss of the circuit.

Induced by the design criteria used to force the separation of the transmission line connected in parallel microstrip is very close to the centre frequency of operation. This occurs when the coefficient of port 1 to port 3 signal is forced to a value close to zero or $S_{31}(f_0) \approx 0$. Under these conditions,

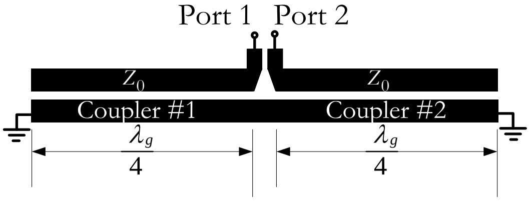


Fig.2. Main structure Split resonator to assign frequency operation of microstrip bandpass filter

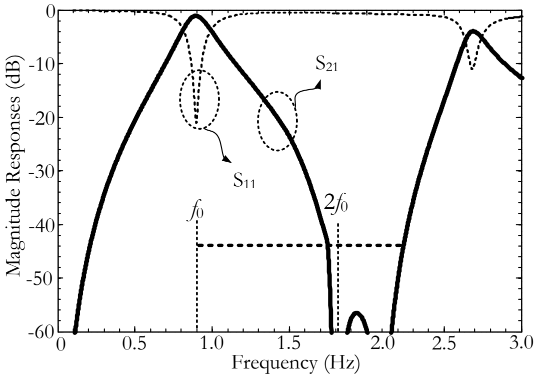


Fig.3. Frequency response of split resonator behaves as a microstrip bandpass filter

transmission lines connected in parallel to a component in the circuit resonator to reduce behaviour, and to create a spurious down very well [5] in the design resonator circuit and bandpass filter frequency on replacing the transmission lines connected in parallel with transmission lines connected in parallel connected inductor connected in parallel to the length of the transmission line will be reduced in size slightly.

3. Experimental design and results

This paper has been presented a 0.9 GHz bandpass filter resonator on FR4 printed circuit ($\varepsilon_r = 4.6$, h =1.6 mm. $\tan\delta = 0.02$). The structure of the filter frequency normal and grid connected in parallel to the inductor is shown in Fig. 1 a) and b), respectively, in this paper, a prototype of the circuit synthesis of the transmission line connecting a pair. Parallel model with the coefficient voltage (voltage coupling factor: k) 8.45 dB. The transmission lines are connected in parallel to the coefficient on the value of the wave impedance characteristics are odd and even modes. $Z_{0e} = 71.36$ and $Z_{0o} = 32.22$ Ohm. The printed circuit FR4 is constant, the electric Risk relative to wave mode dual mode and odd ratio $\varepsilon_{effe} = 3.605$, $\varepsilon_{effo} = 2.750$ of the variable power of these to determine the capacitance compensation equation (1) to compensate the inductance (L_p) is equal to 2.0 nH. When the inductor is necessary to reduce the length of angular grid connected in parallel to a decrease of the value in $\theta = 0.5\pi$ radians to tune the circuit operates at a frequency f_0 in this paper to reduce the length of angular grid connection. The remaining approximately parallel to $\theta = 0.47\pi$ radians. Parameters of transmission lines connected in parallel in both normal and connect the inductors are presented in Table 1, the result of the simulation of the circuit is simple and the presentation is shown in Fig. 4. The proposed circuit has the insertion loss S_{21} and S_{11} is the return loss at frequencies around 0.9 GHz. to 2.4 and less than 25 dB.

$$L_p = \frac{1}{2\pi f_o} \operatorname{Im}\left\{ \frac{-Z_{0e}\left(Z_{0o}^2 + Z_0^2\right)\sinh\theta_o + Z_{0o}\left(Z_{0e}^2 + Z_0^2\right)\sinh\theta_e - 2Z_0^2\Im}{Z_0\left(Z_{0e}\sinh\theta_o + Z_{0o}\sinh\theta_e\right) - 2Z_0^2\Im} \right\} \quad (1)$$

It is being able to press the response frequency spurious frequency $2f_0$ or the frequency 1.8 GHz. Which is greater than 60 dB. measured experimental prototype that creates the test. The research will be used power network analyzer (E5062 Vector Network Analyzer) of the calibration from 0.1 to 3.0 GHz. in the Force measurement experiment using Sonnet Lite™ for circuit design and simulation of circuit performance. The analysis and performance of circuits using Matlab (Student Edition) to display the measurement result of the circuit are both shown in Fig. 5, the circuit with the loss of interference and return loss at the frequency f_0 equal 2.9 and 16 dB., respectively, while the frequency response of the generator. Frequency equal to 1.8 GHz is about 55 dB with the simulation results. However, as noted by the measurement of the performance of the circuit. Impact of the internal circuit, which may be caused by patterned layout of the circuit is not complete and the cause of the frequency response in the range 1.1 to 1.7 GHz. In the future, if a careful design and layout of circuits that are more appropriate to measure the test results would be consistent with the simulation results. Circuit used in the experiment, both the normal and featuring the inductor in Fig. 6 a) and b).

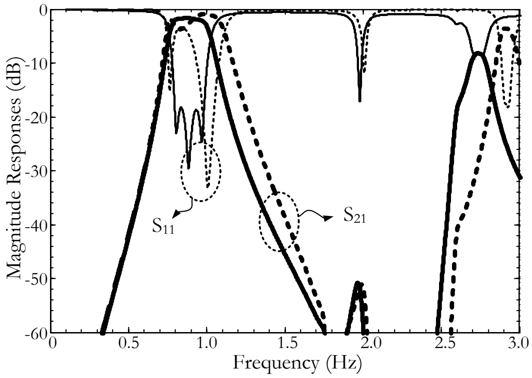


Fig.4. Simulated results of unconnected bandpass filter (··········) and connected to inductor (——)

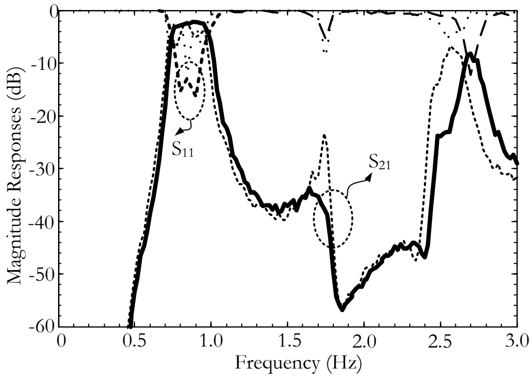
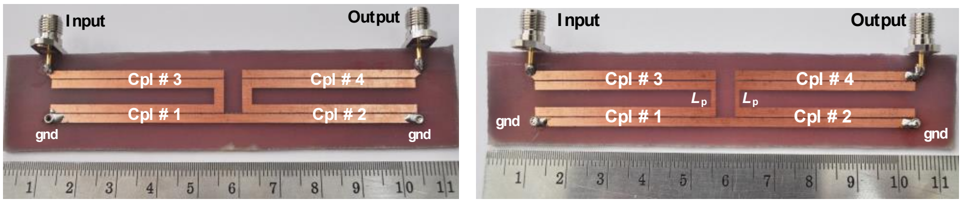


Fig.5. Experimental results of unconnected bandpass filter (··········) and connected to Inductor (——) using



(a) (b)

Fig.6. Printed circuit of bandpass filer (a) unconnected and (b) connected to inductor

4. Conclusion

A new 0.9 GHz bandpass filter that has been analyzed from coupled line resonator connected to ¼ split microstrip. The compensation inductors are used simultaneously for input and output ports return loss tuning and $2f_0$ frequency suppression more than 55 dB. However, the second pair is used as the coupled feed lines and improves the magnitude of frequency suppression in transition band. The measured results obtained from the proposed circuit exhibit more spurious suppression than the uncompensated circuit.

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Appendix A.

Table 1 Parameters

Techniques	Coupler's (θ,Z_0)	W,S,L (mm)
Coupler # 1,2	0.47π, 50	2.4, 0.2, 43.0
Coupler # 3,4	0.47π, 50	2.4, 0.2, 43.0
L3	Z_0 =50	W=2.4, L =5.0