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Implementation of Microstrip band pass filter using multimode resonators with CSRR embedded in the ground plane

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Abstract:

This paper witnessed the design of multimode resonator band pass filter with low insertion loss and the loss due to connectors at both input and output terminals. The design finds two cascaded MMR structure with two pair of CSRR, implemented at ground plane of the micro strip design to get five resonant frequencies which claims the required pass band. The frequencies we obtained here around the pass band are 3.4GHz, 4.2GHz, 5.2GHz, 6.5GHz and 7.5GHz. The substrate (Rogers RT/duroid 6010/6010LM (tm)) thickness is considered to be 0.787 mm with dielectric constant ε_r =2.2.The substrate and the conductor assume to be lossless to detect resonant peaks accurately. CSRR are implemented to achieve high band to band isolation with sharp transition characteristics. The benefit of incorporating the CSRR in this work is to get wide stop band with proper variation of dimensions.

Introduction

Microwave confine most of the modern wireless application. This include the frequencies roughly from 300 MHz to 300 GHz and the wave length has a variation about 1 m to 1 mm in general. We find application in radar, navigation, radio astronomy, satellite, medical instrumentation, sensing and many other. RF/microwave applications needs the design of filters which can separate or combine different frequencies based on the specific requirements. The advancement in technology could make the communication system faster, better and reliable. Microwave design is helpful in taking those challenges to provide such requirements. It is possible to develop components, where size, performance and cost can be sufficiently minimised. In other way the role of filter is quite significant as the electromagnetic spectrum is limited . So it is possible to make the signal available irrespective of whether it is RF/microwave, within assigned spectral limits. In this context we have many design techniques such as micro-electro-mechanic system (MEMS), microwave integrated circuit (MMIC), , micromachining, low-temperature co-fired ceramics (LTCC), high-temperature superconductor (HTS) and moreover multimode resonator. All these technique include either lumped element or distributed element circuits or it could be coaxial line, waveguide and micro strip. The current advancement in materials and fabrication technologies make the researcher to think in a wider prospect. Though these techniques are efficient but many time the performance can be further improved just by inculcating additional design for example in this article we added complementary split ring resonator[1-3] in the ground plane. This make the structure resonating at different frequency as 3.4GHz, 4.2GHz, 5.2GHz, 6.5GHz and 7.5GHz where S_{21} approaches to 0-dB.

Proposed Structure

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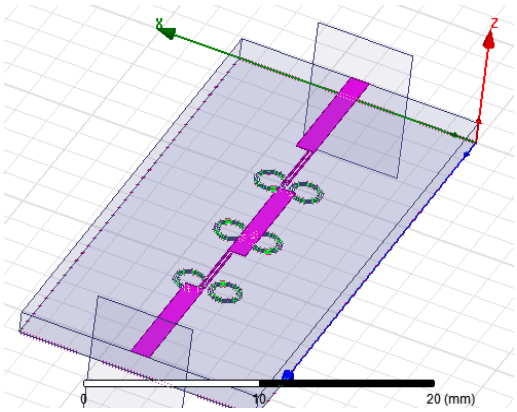
The entire design is developed on a Rogers RT/duroid 6010/6010LM (tm) substrate having thickness equals 0.787 mm with dielectric constant ε_r =2.2. It is composed of three piece of



rectangular MMR structure in parallel fashion which depicted in fig.1. In the ground plane three pairs of CSRR are embedded symmetrically in either side of signal line.

Figure 1 proposed structure of band pass filter loaded with CSRR in the ground plane

CSRR

Recently many design include SRR, CSRR along with base design, which brings betterment in performance like reduction of size, ultra wide band with band notch characteristics, gain enhancement in case of antenna design etc. Here we have considered three pairs of CSRR[4-7] which fetch notches which is reflecting in S_{21} parameter given in figure 2. This is just behaving like a negative indexed(permittivity and permeability) material and more appropriately it behaves like a medium. As per this design is concerned we are getting notches about frequency 3.4GHz, 4.2GHz, 5.2GHz, 6.5GHz and 7.5GHz where S_{21} approaching towards 0dB.

Results and Discussion

The proposed MMR based filter was designed and simulated through HFSS 13.0 which is a commercial EM simulator. Figure-2 explains about the frequency response plot in terms of S_{21} parameter. This structure is showing notches at 4.2GHz, 5.2GHz, 6.5GHz and 7.5GHz which is suitable for the upper WLAN band(5.15–5.85 GHz), 6.9 for RFID and satellite application. In addition to that we also estimated the group delay whose ideal value should be 1ns but we in this result got the value which lies within this margin. The group delay analysis output is reflected in figure3.

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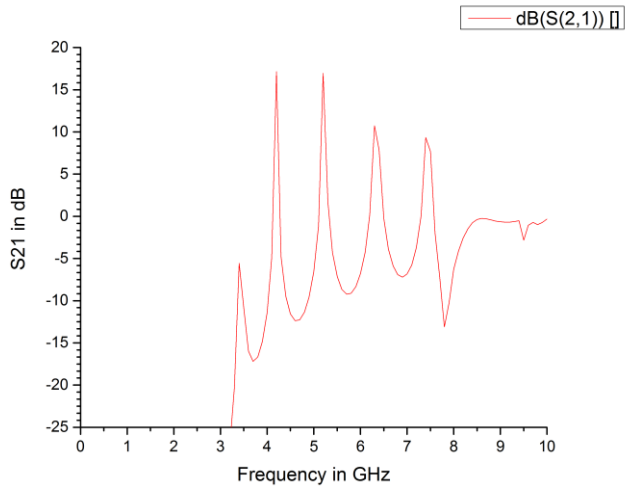

Figure 2 Performance of proposed filter in terms of S_{21} in dB

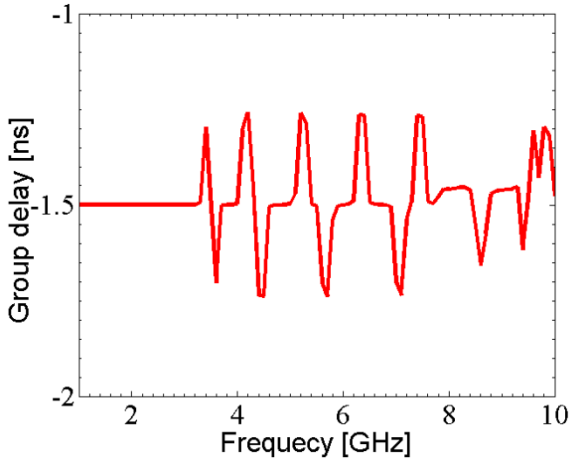

Figure 3 Group delay in ns

Conclusion

In conclusion and from the result analysis discussed above it can be said that the proposed design could be encased for wireless applications like WLAN, Satellite communication. The proposed designed is suitable for such applications.

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