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Design and Fabrication of Transmission line based Wideband band pass filter

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Abstract

A multi section wideband band pass filter with a centre frequency of 2.3 GHz and 3-dB bandwidth of approximately 618 MHz, is designed and fabricated. The design of the filter is based on transmission line section based circuit configuration. The salient features of this filter isthat it provides low insertion loss, sharp rejection along with simple approach and easy realization. The designed filter is simulated using Agilent® ADS tool and the experimental characteristics are found to be in close agreement with the simulation.

Keywords: Wideband band pass filter; transmission line techniques; ADS; micro strip line;RF filters.

1. Introduction

Recently, the demand for high performance RF band pass filter is gradually increasing. These filters need to satisfy the requirement of low insertion loss, sharp rejection and bandwidth. In general the required characteristics can be obtained by increasing the filter order. Alternate methods include cross coupling between the resonators and the usage of shunt-open stubs on the input and output feed lines.

The filter implementation at high frequencies is carried out using micro strip line, since lumped elements such as inductors and capacitors are lossy and generally available only for limited range of values. Further, the distances

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between filter components is not negligible at microwave frequencies. Richards's transformation is used to convert lumped elements to transmission line sections, while Kuroda's identities can be used to separate filter elements by using transmission line sections. Micro strip line is one of the most popular planar transmission lines which can be fabricated by photolithographic process. Further it can be easily integrated with other passive and active microwave devices [1]. Unlike strip line, where all fields are contained within a homogeneous dielectric region, micro strip has some of its field lines in the dielectric region between strip conductor and ground plane, and some fraction in the air region above the substrate. Signal Interference technique can provide good solution for designing wideband band pass filter [2]. This technique has also been used to design band stop & band pass filters [3,4]. Also this technique requires a smaller electrical line length for specified skirt selectivity. The filter design procedure adopted in this paper is based on signal interference technique with two sections cascaded to provide better performance. Based on the above approach, a wide band bandpass filter for 2.3GHz centre frequency, 27% bandwidth and 40 dB stop band attenuation is developed and its characteristics are obtained.

2. Filter Design

In many applications, rejection level of 40dB or more, is required, which may not be possible with single section. It may be achieved if one or more basic sections are cascaded. The basic section and multi section with open stub are shown in Fig.1(a)&(b) respectively. As indicated in Fig 1(a), Z_1 & Z_2 are the characteristic impedances and θ_1& θ_2 are the electrical lengths of the transmission line segments. The two lines are joined at both ends at the pass band centre frequency f_o. The input signal is divided into two components at one end and made to interfere at the other end with different phase and magnitudes, which is the concept of signal interference technique [5]. This technique is best suited for designing low insertion loss; sharp rejection and wide band pass filters.

If θ_1 and $\theta_2$are taken as θ_{10} and θ_{20} at f_o, then at any arbitrary frequency, f

$$\theta_i = \frac{f\theta_{i0}}{f_0}, i = 1,2 \quad (1)$$

For the basic filter section, the proposed electrical lengths are θ_{10}= 90º and θ_{20}= 270º and the corresponding Z_1 & Z_2 values are 25Ω and 50Ω respectively. The advantage of using low impedance values are decreased pass band insertion loss, increased selectivity, increased bandwidth and ease of fabrication. Also, filter 3-dB centre frequency depends on the chosen Z_1 & Z_2 values.

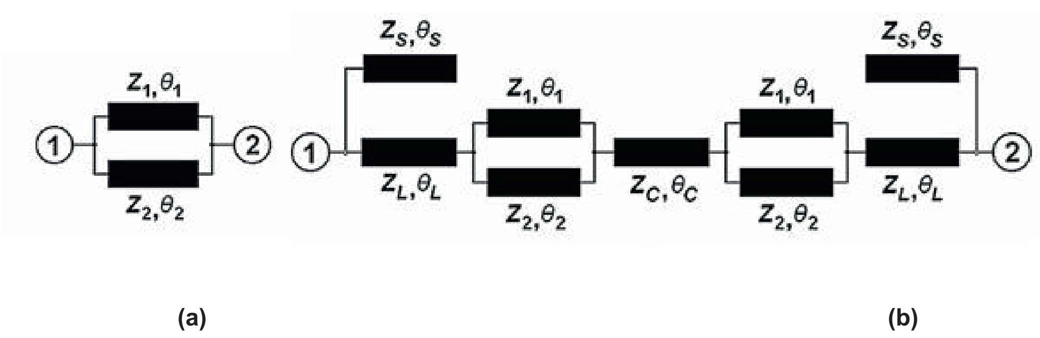

Fig 1. Configurations of (a) Basic filter section(b) Multi section with open stub [5]

Based on the lossless transmission-line model, the ABCD matrix of the basic configuration of Fig. 1a can be arrived as