Review on Micro Strip Low Pass Filter
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Abstract:
Micro-strip Filters are the essential part of the microwave system and play important role in many communication applications especially wireless and mobile communications. The paper focuses on filter fundamental long with different types of filter and its technology. Design of Filters, its analysis tools and its application has been discussed.

Keywords: Microstrip Filter, Low pass filter.

I. INTRODUCTION
Filters are networks that process signals in a frequency-dependent manner. The basic concept of a filter can be explained by examining the frequency dependent nature of the impedance of capacitors and inductors. Consider a voltage divider where the shunt leg is reactive impedance. As the frequency is changed, the value of the reactive impedance changes and the voltage divider is also changes.

This mechanism yields the frequency dependent change in the input/output transfer function that is defined as the frequency response. An ideal filter will have an amplitude response that is unity (or at a fixed gain) for the frequencies of interest (called the pass band) and zero everywhere (called the stop band). Frequency at which the response changes from passband to stopband is called cutoff frequency. In short Filters are frequency selective circuit which can select network output at a range of frequency or at particular frequency.

Today, most microwave filter designs are done with computer-aided design (CAD) packages, such as Advancing the Wireless Revolution, A soft Designer, etc based on the insertion loss method. In this work, the Butterworth lowpass filter design is taken into consideration. Functionally, filters can be grouped into four categories: low-pass filters (LPF), high-pass filters (HPF), bandpass filters (BPF), and band-stop filters (BSF). There are various sets of analytical functions that satisfy given filter specifications, but Butterworth, Chebyshev, Cauer, and Bessel functions, with their pros and cons, are the functions widely used in RF/microwave filter design. For example, Butterworth filters are maximally flat in the pass band, but their out-of-band attenuation slope are not good. Chebyshev filters have sharper attenuation slopes (as compared to Butterworth filters), but the payoff is the ripple inside the passband. Elliptic filters have the sharpest out-of-band attenuation, but they have undesired ripples both in and out of the pass band.

An analog filter is typically a single-input single output system. The input-output relationship is governed by the network function in the complex frequency domain. There are five ideal filter magnitude characteristics as
(a) Lowpass,
(b) Highpass,
(c) Bandpass
(d) Bandreject, and
(e) Allpass filters.

The Butterworth lowpass magnitude characteristic has the property that the response is flat. Because of this, all available degrees of freedom are utilized to make as many derivatives as possible zero at that point.

The Chebyshev low pass magnitude characteristics exhibit equal-ripple variation in the pass band and monotonic increase in attenuation outside the pass band. The performance of these characteristics is greatly improved over the Butterworth characteristics.

The elliptic-function filter characteristic has equal-ripple variation in both the pass band and the stop band. It offers further improvement in the magnitude characteristic for a given filter order.

II. LOW PASS FILTER
A low-pass filter is a filter that passes signals with a frequency lower than a certain cutoff frequency and attenuates signals with frequencies higher than the cutoff frequency. The amount of attenuation for each frequency depends on the filter design. The filter is sometimes called a high-cut filter. A general structure of the stepped-impedance low-pass microstrip filters, which cascaded structure of alternating high and low impedance transmission lines. These are much shorter than the associated guided wavelength, so as to act as semi lumped elements.

Low pass filters play an important role in wireless power transmission systems. Transmitted and received signals have to be filtered at a certain frequency with a specific bandwidth.
Basic design of microwave filters of type’s low-pass, band-pass and band-stop, operating at arbitrary frequency bands and between arbitrary resistive loads, are made from a prototype low-pass design through:

1) Some frequency transformer,
2) Element normalization and Simulation of these elements by means of sections of microwave transmission line,
3) Design of a prototype low-pass filter with the desired pass band characteristics,
4) Transformation of this prototype network to the required type (low-pass, high-pass, band-pass) filter with the specified center and band-edge frequencies.
5) Realization of the network in microwave form by using sections of microwave transmission lines.

Figure 2: Stepped-impedance low-pass filter formed from alternate high and low impedance sections of line.

The high impedance lines act as series inductors and the low-impedance lines act as shunt capacitors. Therefore, this filter structure is directly realizing the L-C ladder type of lowpass filter.

- \( Z_{OC} < Z_{C1} < Z_{OL} \), where \( Z_{OC} \) and \( Z_{OL} \) denote the characteristic impedances of the low and high impedance lines, respectively, and \( Z_{i} \) is the source impedance, which is usually 50 ohms for microstrip filters.

Electromagnetic equation [1] used for the design of LPF is

\[
\frac{W}{h} = \frac{8 \varepsilon^{A}}{\varepsilon^{2A} - 2} \tag{1}
\]

With

\[
A = \frac{Z_{C}}{60} \left[ \frac{\varepsilon_{r} + 1}{2} \right]^{0.5} + \frac{\varepsilon_{r} + 1}{\varepsilon_{r} + 1} \left[ 0.23 + \frac{0.11}{\varepsilon_{r}} \right] \tag{2}
\]

Where \( Z_C = Z_0 = 50 \Omega \) and \( \varepsilon_r \) (dielectric constant) = 4.4, \( W= \) width, \( h= \) height of dielectric which is taken as 1.6mm.

Effective dielectric constant of dielectric material given by equation (3) and (4)

For \( W/h \leq 1 \):

\[
\varepsilon_{re} = \frac{\varepsilon_{r} + 1}{2} + \frac{\varepsilon_{r} - 1}{2} \left( 1 + \frac{12 \frac{h}{w}}{1 + 12 \frac{h}{w}} \right)^{0.5} \tag{3}
\]

For \( W/h > 1 \):

\[
\varepsilon_{re} = \frac{\varepsilon_{r} + 1}{2} + \frac{\varepsilon_{r} - 1}{2} \left[ \left( 1 + \frac{12 \frac{h}{w}}{1 + 12 \frac{h}{w}} \right)^{-0.5} + 0.04 \left( 1 - \frac{w}{h} \right) \right] \tag{4}
\]

Whereas guided wavelength is given by equation (5)

\[
\lambda_g = \frac{300}{f(\text{GHz})\sqrt{\varepsilon_{re}}} \tag{5}
\]

\( \varepsilon_{re} \) = Effective dielectric constant , \( f=1.5 \text{ GHz} \)

Values of inductor and capacitor are given by

\[
C_i = \frac{1}{2 \pi \varepsilon_{re} \varepsilon_0 f_i^3} \tag{6}
\]

For \( i = 1, 2, 3, \ldots, 6 \).

Calculation of length of inductor and capacitor is done using formula

\[
l_{Li} = \frac{\lambda_g (f_i)}{2 \pi} \sin^{-1} \left( \frac{2 \pi Z_{OC} C_i}{\lambda_g} \right) \tag{7}
\]

\[
l_{Ci} = \frac{\lambda_g (f_i)}{2 \pi} \sin^{-1} \left( \frac{2 \pi Z_{OC} C_i}{\lambda_g} \right) \tag{8}
\]

III. LITERATURE REVIEW

- **June 2015, Hemant Kumar Gupta, et.al.** In this paper it has been designed a micro-strip low pass filter for L-band Application. Micro-strip Filter is designed from the methods of Step impedance low pass prototype filter, basic property of micro-strip filter like simulated design, return loss, amplitude frequency graph and smith chart discussed. Finally it is shown that -3dB return loss is shown at the frequency of 1.584GHz and this frequency come in the L-band so this filters showing a very sharp cutoff and used for different application of L-band (1-2GHz).

- **May 2014, Ahmad Aminu** In this paper, the design and optimization of Low pass Filter Using Maximally-Flat (Butterworth) Technique is proposed. The realization of seven order Low pass filter on Micro-strip transmission lines was carried out.
August 2013, K.Rajasekaran, et.al. This project describes a general design technique for micro strip low pass filters that are used to convey microwave frequency signals. The parasitic problems of X- band can be adjusted through impedance ratio K, which can enhance the performance of harmonic suppression. The ADS simulation tool is used to design an X-band stepped impedance low pass filter of range 8-12 GHz. This simulation results show that the filter works on 10GHz at the center frequency and achieves attenuation of 60dB, which effectively suppresses the parasitic bands. To attain the filter with these characteristics, Insertion Loss Method is performed. Compared to other filter types, this design works very well with excellent harmonic suppression performance.

March 2011, Dhirendra Kumar and Ashok De
Low impedance micro-strip lines are arranged such that they work as open stubs to increase the selectivity of the filter. Using the proposed technique about 57% size reduction has been realized with sharper roll off characteristics. An empirical expression is derived to determine the dimension of resonators. For cut-off frequency of 1.7 GHz the investigated method has been fabricated and tested.

2006, Mrinal Kanti Mandaland and Ajay Chakrabarty, Complementary split ring resonators are used to design compact, low insertion loss (IL), low pass filter with sharp cut-off. A prototype filter implementing area is 0.23 0.09, being the guided wavelength at 3-dB cut-off frequency (f) 1.887 GHz. Maximum IL is within 0.5 dB up to 1.717 GHz and 20-dB stop band extends up to 3.4

2006, Wen-Hua Tu and Kai Chang, This paper presents two micro-strip elliptic-function low-pass filters, one using distributed elements and one using a slotted ground structure. The one using distributed elements consists of a micro-strip line section in parallel with inter digital capacitor; the other one using a slotted ground structure consists of a low-impedance micro-strip line with a slotted ground structure cell under the center of the line. A transmission-line model and a full-wave simulation are used to calculate the inductance/capacitance values of the equivalent circuits. The design concept was validated through experiments showing good agreements with the full-wave simulated results.

January 2005, Zhewang MA, et.al. In this paper it has been designed a micro-strip low pass filter for L-band Application. Micro-strip Filter is designed from the methods of Step impedance low pass prototype filter, basic property of micro-strip filter like simulated design, return loss, amplitude frequency graph and smith chart discussed. Finally it is shown that -3dB return loss is shown at the frequency of 1.584GHz and this frequency come in the L-band so this filters showing a very sharp cutoff and used for different application of L-band (1-2GHz).

2005, Wen-HuaTu and Kai Chang, This letter presents a compact multi section sharp-rejection micro strip low-pass filter. Each section is consisted of a micro strip line section and an interdigital capacitor. The analysis for optimizing the attenuation poles by adjusting the finger number, and the width and length of the micro strip line section is presented. The cascaded four-section low-pass filter has a return loss of better than 17 dB and an insertion loss of less than 0.7 dB from dc to 1.6 GHz. The rejection is better than 20 dB from 2.1 to 7.5 GHz.

2003, Lung-Hwa Hsieh and Kai Chang, A compact elliptic-function low-pass filter using micro strip stepped-impedance hairpin resonators and their equivalent-circuit models are developed. The prototype filters are synthesized from the equivalent-circuit model using available element value tables. To optimize the performance of the filters, electromagnetic simulation is used to tune the dimensions of the prototype filters. The filter using multiple cascaded hairpin resonators provides a very sharp cutoff frequency response with low insertion loss. Furthermore, to increase the rejection-band bandwidth, additional attenuation poles are added in the filter. The filters are evaluated by experiment and simulation with good agreement. This simple equivalent-circuit model provides a useful method to design and understand this type of filters and other relative circuits.

2001, Chul-Soo Kim, et.al. A new defected ground structure (DGS) for the Micro strip line is proposed in this paper. The proposed DG Summit structure can provide the band gap characteristic in some frequency bands with only one or more unit lattices. The equivalent circuits for the proposed defected ground unit structure is derived by means of three-dimensional field analysis methods. The equivalent-circuit parameters are extracted by using a simple circuit analysis method. By employing the extracted parameter sand circuit analysis theory, the band gap effect for the provided defected ground unit structure can be explained. By using the derived and extracted equivalent circuit and parameter, the low-pass filters are designed and implemented. The experimental results show excellent agreements with theoretical results and the validity of the modeling method for the proposed defected ground unit structure.

IV. CONCLUCION
In the previous paper analysis that the designs of micro-strip low pass L-C filter using slotted ground structure has been investigated the measures shows the signal almost passes but does not reaches to the desired frequency and does not behaves as the ideal features of low pass filter. In the future work, slots in the ground structure produces so that the low power will consumption takes places and use the dielectric FR4 and make the circuit as an ideal and passes the most of the signal at the desires frequency and the graphical structure is maximally flat and the try to make the minimum insertion loss.
V. REFERENCES


