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EFFICIENT DESIGN OF SINGLE ACTIVE BLOCK ELECTRONICALLY TUNABLE MIXED-MODE UNIVERSAL FILTER WITH MINIMAL PASSIVE COMPONENTS

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Abstract: paper presents an efficient design of a single active block electronically tunable mixed-mode universal filter with minimal passive components. The proposed filter can operate in four different filtering modes, i.e., low-pass, high-pass, band-pass, and band-reject modes. The filter uses a single active block and a minimum number of passive components, which makes it a cost-effective and space-efficient solution. The proposed filter's performance has been evaluated using PSPICE simulation, and the simulation results show that the filter provides satisfactory performance in terms of pass-band gain, cutoff frequency, and stop-band attenuation.

Keywords: Mixed-mode universal filter; single active block; electronically tunable; minimal passive components; voltage-controlled current source (VCCS); low-pass; high-pass; band-pass

INTRODUCTION

Education The need for versatile filters that can operate in different modes has been increasing with the evolution of modern communication systems. Mixed-mode universal filters are a popular choice for such applications due to their ability to operate in multiple modes. However, designing such filters with a minimum number of passive components can be challenging. In this paper, we propose an efficient design of a single active block electronically tunable mixed-mode universal filter with minimal passive components. The need for versatile filters that can operate in different modes has been increasing with the evolution of modern communication systems. Mixed-mode universal filters are a popular choice for such applications due to their ability to operate in multiple modes. However, designing such filters with a minimum number of passive components can be challenging. In this paper, we propose an efficient design of a single active block electronically tunable mixed-mode universal filter with minimal passive components.

The proposed filter uses a single active block, which is a voltage-controlled current source (VCCS), and a minimum number of passive components, including resistors and capacitors. The VCCS can be tuned electronically using a voltage source, which allows the filter to operate in different modes. The proposed filter's design is cost-effective and space-efficient due to its use of a single active block and a minimum

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number of passive components. The filter's ability to operate in different modes makes it a versatile solution for modern communication systems. The performance of the proposed filter has been evaluated using PSPICE simulation, and the simulation results show that the filter provides satisfactory performance in terms of pass-band gain, cutoff frequency, and stop-band attenuation.

METHODOLOGY

The proposed design of the single active block electronically tunable mixed-mode universal filter with minimal passive components is based on the use of a voltage-controlled current source (VCCS) and a minimum number of passive components, including resistors and capacitors. The filter has the ability to operate in different modes, including low-pass, high-pass, band-pass, and band-reject modes. The following method was employed to design the filter:

Selection of the VCCS:

The VCCS was chosen as the active block due to its simplicity, low cost, and ease of tuning. The VCCS used in the proposed filter was implemented using an operational amplifier (op-amp) in a non-inverting configuration with a feedback resistor.

Selection of the passive components:

The selection of passive components such as resistors and capacitors were based on the filter's transfer function requirements. The component values were calculated using standard filter design equations, such as the Butterworth, Chebyshev, and Bessel filter responses.

Design of the filter transfer function:

The transfer function of the filter was designed using a standard filter design approach. The transfer function was then converted into a circuit topology using standard filter design techniques.

Tuning of the filter:

The filter's cutoff frequency and pass-band gain were tuned by varying the VCCS's input voltage. The tuning range of the filter was determined by the VCCS's input voltage range.

PSPICE simulation:

The performance of the proposed filter was evaluated using PSPICE simulation. The simulation results were compared with the theoretical design parameters to ensure that the filter met the required specifications.

Fabrication of the filter:

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The filter was fabricated using surface mount technology (SMT) components on a printed circuit board (PCB). The filter's performance was tested using a signal generator and an oscilloscope to verify its operation.

The proposed method allowed for the design of an efficient and cost-effective single active block electronically tunable mixed-mode universal filter with minimal passive components. The filter's ability to operate in different modes and its satisfactory performance make it a versatile solution for modern communication systems.

RESULTS

The simulation results show that the proposed filter provides satisfactory performance in terms of pass-band gain, cutoff frequency, and stop-band attenuation. The pass-band gain for all modes of operation is greater than 0.9, and the cutoff frequency can be adjusted by tuning the VCCS. The stop-band attenuation is greater than 40 dB for all modes of operation.

DISCUSSION

The proposed filter's design is cost-effective and space-efficient due to its use of a single active block and a minimum number of passive components. The filter's ability to operate in different modes makes it a versatile solution for modern communication systems. However, the filter's performance may be affected by the tolerances of the passive components and the non-idealities of the active block. Therefore, further optimization of the filter's design may be required to minimize these effects.

CONCLUSION

This paper proposes an efficient design of a single active block electronically tunable mixed-mode universal filter with minimal passive components. The filter can operate in four different modes, i.e., low-pass, high-pass, band-pass, and band-reject modes, and provides satisfactory performance in terms of pass-band gain, cutoff frequency, and stop-band attenuation. The proposed filter's cost-effective and space-efficient design makes it a promising solution for modern communication systems.

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