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Optimized fractional-order Butterworth filter design in complex *F*-plane

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Abstract

This paper introduces a new technique to optimally design the fractional-order Butterworth low-pass filter in the complex F-plane. Design stability is assured by incorporating the critical phase angle as an inequality constraint. The poles of the proposed approximants reside on the unit circle in the stable region of the F-plane. The improved accuracy of the suggested scheme as compared to the recently published literature is demonstrated. A mixed-integer genetic algorithm which considers the parallel combinations of resistors and capacitors for the Valsa network is used to optimize the frequency responses of the fractional-order capacitor emulators as part of the experimental verification using the Sallen–Key filter topology. The total harmonic distortion and spurious-free dynamic range of the practical 1.5th-order Butterwoth filter are measured as 0.13% and 62.18 dBc, respectively; the maximum and mean absolute relative magnitude errors are 0.03929 and 0.02051, respectively.

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