Title: Harmonic reduction of second order sallen and key lowpass filter and second order MFB lowpass filter through closed loop PID controlled method

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Abstract: Filters play a crucial role in various sectors, and active filters, in particular, find widespread applications. This research paper focuses on comparing the level of harmonics in two types of second-order Butterworth low-pass filters: the Voltage-Controlled Voltage Source (VCVS) Sallen and Key filter and the Multiple Feedback (MFB) filter, in both open-loop and closed-loop configurations. Harmonic reduction is a significant concern in filter design, and this study investigates the effectiveness of closed-loop techniques, including the Proportional-Integral-Derivative (PID) control, in minimizing Total Harmonic Distortion (%THD) in the output signal. The experimental results reveal that in the open-loop configuration, the VCVS low-pass filter exhibits an output THD of 5.35%, whereas the MFB low-pass filter shows an output THD of 5.33%. However, when utilized in the closed-loop method, both filters demonstrate remarkable reduction in %THD, with the VCVS filter achieving an output THD of 2.11% and the MFB filter reaching 2.33%. These findings underscore the efficacy of closed-loop PID controlled systems in enhancing harmonic suppression for both filter designs. This comparative analysis sheds light on the significant advantages of employing active filters with closed-loop configurations, and it establishes the potential of PID control in reducing harmonics in the output signal of second-order Butterworth low-pass filters. The insights gained from this research can aid engineers and practitioners in selecting appropriate filter designs for applications where harmonic distortion mitigation is paramount, such as noise signal filtering and square wave shaping.

Keywords: Voltage-Controlled Voltage Source (VCVS), Multiple Feedback (MFB) filter, Harmonic reduction, Total Harmonic Distortion (%THD), Closed-loop configuration, Proportional-Integral-Derivative (PID) control, Filter design, Harmonic suppression, Signal processing

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