ABSTRACT

Low Power High Efficiency Integrated Class-D Amplifier Circuits for Mobile Devices
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The consumer's demand for state-of-the-art multimedia devices such as smart phones and tablet computers has forced manufacturers to provide more system features to compete for a larger portion of the market share. The added features increase the power consumption and heat dissipation of integrated circuits, depleting the battery charge faster. Therefore, low-power high-efficiency circuits, such as the class-D audio amplifier, are needed to reduce heat dissipation and extend battery life in mobile devices. This dissertation focuses on new design techniques to create high performance class-D audio amplifiers that have low power consumption and occupy less space. The first part of this dissertation introduces the research motivation and fundamentals of audio amplification. The loudspeaker's operation and main audio performance metrics are examined to explain the limitations in the amplification process. Moreover, the operating principle and design procedure of the main class-D amplifier architectures are reviewed to provide the performance tradeoffs involved. The second part of this dissertation presents two new circuit designs to improve the audio performance, power consumption, and efficiency of standard class-D audio amplifiers. The first work proposes a feed-forward power-supply noise cancellation technique for single-ended class-D amplifier architectures to improve the power-supply rejection ratio across the entire audio frequency range. The design methodology, implementation, and tradeoffs of the proposed technique are clearly delineated to demonstrate its simplicity and effectiveness. The second work introduces a new class-D output stage design for piezoelectric speakers. The proposed design uses stacked-cascode thick-oxide CMOS transistors at the output stage that makes possible to handle high voltages in a low voltage standard CMOS technology. The design tradeoffs in efficiency, linearity, and electromagnetic interference are discussed. Finally, the open problems in audio amplification for mobile devices are discussed to delineate the possible future work to improve the performance of class-D amplifiers. For all the presented works, proof-of-concept prototypes are fabricated, and the measured results are used to verify the correct operation of the proposed solutions.