Abstract

This thesis pertains to the analysis and design of switching amplifiers with substantially improved specifications over the state-of-the-art for smartphones, including higher power-efficiency to address the short battery lifespan, lower noise, and wider bandwidth. The specific switching amplifiers are the Class D amplifier (CDA) for audio applications and the hybrid CDA for supply modulators for envelope tracking power amplifiers. For the former, we investigate and derive the mechanisms of the AC ground and their ensuing effects on Power-Supply-Rejection-Ratio and Power-Supply-Induced-Intermodulation. For the latter, we investigate the power mechanisms thereto and propose two architectures – the first with a novel delay-based hysteresis controller and Class AB amplifier, and the second with a novel dual-mode Sigma-Delta control and adaptive biasing Class AB amplifier. The proposed two architectures were monolithically realized. The mechanisms of the former and functionality of proposed architectures of the latter are verified experimentally, and the measurements depict improved specifications thereto.

Publication List

Journal Publications

1. **Huiqiao He**, Tong Ge, Linfei Guo and Joseph S. Chang, "3-state BTL Closed-loop PWM Class D Amplifiers", *Analog Integrated Circuits and Signal Processing*, Volume 88, Issue 2, pp 255-266.
2. **Huiqiao He**, Yang Kang, Tong Ge, Linfei Guo and Joseph S. Chang, "A 2.5W 40MHz-Bandwidth Hybrid Supply Modulator with 91% Peak Efficiency, 3V Output Swing and 4mV Output Ripple at 3.6V Supply", *IEEE Transactions on Power Electronics*, under revision.
3. **Huiqiao He**, Tong Ge, Yang Kang, Linfei Guo and Joseph S. Chang, "A 40MHz Dual-mode Sigma-Delta Control based Supply Modulator for Multi-standard Applications", *Journal of Solid-State Circuits*, in preparation.
4. Tong Ge, **Huiqiao He**, Linfei Guo and Joseph S. Chang, "A Direct Battery Hookup Filterless PWM Class D Amplifier with >100dB PSRR for 100Hz to 1kHz, 0.005% THD+N and 16μV noise", *IEEE Transactions on Power Electronics*, submitted.

Conference Publications

5. **Huiqiao He**, Tong Ge and Joseph S. Chang, "A Review on Supply Modulators for Envelope-Tracking Power Amplifiers", *IEEE International Symposium on Integrated Circuits (ISIC)*, 2016.
6. **Huiqiao He**, Yang Kang, Jia Yu, Linfei Guo, Tong Ge and Joseph S. Chang, "A Novel Low-Power High-Efficiency 3-State Filterless Bang-Bang Class D Amplifier", *IEEE International Conference on Electronics, Circuits, and Systems (ICECS)*, 2015.
7. **Huiqiao He**, Tong Ge, Linfei Guo and Joseph S. Chang, "An Investigation into the Effect of Carrier Generators on Power Supply Noise in PWM Class D Amplifiers", *IEEE Midwest Symposium on Circuit and Systems (MWSCAS)*, 2014.
8. Tong Ge, **Huiqiao He**, Jia Zhou, Yang Kang and Joseph S. Chang, "An Investigation of THD of a BTL Class D Amplifier", *IEEE International Symposium on Circuit and Systems (ISCAS)*, 2016.
9. Yu Jia, Ge Tong, **He Huiqiao** and Joseph S. Chang. "Substrate Thickness Effect on Transformer", *IEEE International Symposium on Integrated Circuits (ISIC)*, 2016.

10. Yang Kang, Tong Ge, **Huiqiao He**, and Joseph S. Chang, "A Review of Audio Class D Amplifiers", *IEEE International Symposium on Integrated Circuits (ISIC)*, 2016.

11. Tong Ge, Linfei Guo, **Huiqiao He**, Yang Kang, Jia Yu, Joseph S. Chang, "Envelope Tracking RF Power Amplifiers: Fundamentals, Design, Challenges, and Unique Opportunities Offered by LEES-SMART InGaAs-on-CMOS Process", *International Conference on Materials for Advanced Technologies (ICMAT)*, 2015.

12. Jia Zhou, Tong Ge, Linfei Guo, Eileen Pei Jian Ng, **Huiqiao He** and Joseph S. Chang, "A High Power Driver IC for Electroluminescent Panel: Design Challenges and Advantages of Using the Emerging LEES-SMART GaN-on-CMOS Process", *International Conference on Materials for Advanced Technologies (ICMAT)*, 2015

13. Tong Ge, Linfei Guo, Yang Kang, Jia Zhou, **Huiqiao He**, Pei Jian Eileen Ng, Eugene A. Fitzgerald and Joseph S. Chang ,"A Driver Circuit based on the emerging GaN-on-CMOS Process for the emerging Electroluminescent Panels", *IEEE Midwest Symposium on Circuit and Systems (MWSCAS)*, 2015.

14. Linfei Guo, Tong Ge, Yang Kang, **Huiqiao He** and Joseph S. Chang, "Analysis and design of PWM-in-PWM-out Class D Amplifiers", *IEEE Midwest Symposium on Circuit and Systems (MWSCAS)*, 2014.