Advances in Switching Power Conversion: Noise and EMI Reduction, On-Chip Power Grids, and Energy Harvesting

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Abstract: The recent expansion in the use of communication, navigation, and multimedia devices has fueled the demand for energy-efficient and low power implementations without compromising performance. A critical aspect of lowering the overall power consumption in these devices is the process of converting power from the battery to the various loads in the system. Although switching power conversion schemes are highly desired due to their high energy efficiency, their use in these devices is being limited by multiple factors, such as large switching noise and EMI, costly Bill of Material, and large weight and footprint. These factors force the use of alternative inefficient schemes, such as linear power converters, leading to much higher overall power consumption. This presentation will discuss various techniques that are being developed by the Power Management Research Lab (PMRL) at Iowa State University to overcome the aforementioned limitations in switching power converters. This includes switching mechanisms for eliminating spurious noise and reducing EMI, implementation techniques that utilize only on-chip passive components, and multi-frequency SIMO architectures with fully-integrated outputs. Energy-harvesting platforms to complement/charge batteries while producing regulated power supplies in portable devices will also be discussed.

Bio: Ayman Fayed received his B.Sc. in Electronics & Communications Engineering from Cairo University in 1998, and his M.Sc. and Ph.D. in Electrical & Computer Engineering from The Ohio State University in 2000 and 2004 respectively. From 2000 to 2009, he held several technical positions in the area of analog and mixed-signal design at Texas Instruments Inc., where he was a key contributor to many product lines for wire-line, wireless, and multi-media devices. From 2000 to 2005, he was with the Connectivity Solutions Dept. at TI, where he worked on the analog frontend design of high-speed wire-line transceivers such as USB 2.0, IEEE1394b, and HDMI. He also worked on the design of fully integrated switching/linear regulators and battery chargers for portable media players. From 2005 to 2009, he was a member of the technical staff with the wireless analog technology center at TI, where he worked on the design of several delta-sigma data converters for various wireless standards and the development of fully integrated power management solutions for mixed-signal SoCs with multi-RF cores in nanometer CMOS. Dr. Fayed joined the Dept. of Electrical & Computer Engineering at Iowa State University in 2009, where he held the Northrop Grumman Assistant Professorship and is currently an associate professor. He is the founder and director of the Power Management Research Lab (PMRL) and his current research interests include on-chip smart power grids for dynamic energy distribution in highly-integrated systems, low-noise wide-band power supply modulators for RF, high-frequency switching regulators with on-chip and on-package passives, energy harvesting for power-restricted & remotely-deployed systems, and power converter design in emerging technologies such as GaN. Dr. Fayed has many publications and patents in the field and has authored a book in the area of adaptive systems entitled “Adaptive Techniques for Mixed Signal System On Chip” (Springer 2006). He is a senior member of IEEE, an associate editor for IEEE TCAS-II, and serves in the technical program committee of RFIC, ISCAS, and the steering committee of MWSCAS. Dr. Fayed is a recipient of 2013 NSF CAREER Award.