Wireless Power Transfer: Energy Anytime and Anywhere

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Abstract
Imagine a world where energy is available everywhere and anytime through a virtual network with interconnectivity traversing applications from mobility to the Internet of Things (IoT). This seminar introduces some approaches towards the realization of the ubiquity of wireless power transfer (WPT). While WPT is emerging as the preeminent way to charge electric vehicles, there appears to be no unadulterated way to measure power transfer. Transfer-Power Measurement (TPM) employs non-contact sensing elements to measure magnetic field from WPT and to calculate the real power propagation through space. Individual losses from the transmitter and receiver may be disaggregated with low error even under misalignment using signal and data processing through a quadratic approximation of coupling coefficients. TPM is valuable for the evaluation and certification of wireless power transfer systems as well as to provide a method for metering, which incentivizes businesses and individuals to make choices that conserve energy and that advance technology via the provision of more information and the proper assignment of the loss recovery.

Bi-directional power transfer enables new paradigms in how users ubiquitously share and store energy. Increases in switching frequency helps miniaturize WPT, but bi-directional WPT at high-frequency (HF) – 3-30 MHz – and very-high-frequency (VHF) – 30-300 MHz – is challenging, especially with adjustable power and resilience to different loading and coupling conditions. We introduce 27.12 MHz bi-directional WPT using current-mode class D (CMCD) converters to help manage these challenges.

Scalability has been a persistent barrier to the intersection of WPT with the IoT. As densely connected networks of electronic devices require the ability to exchange power as freely as they can exchange information, existing approaches for multiple access often require cumbersome additional circuitry, complex feedback techniques, or dedicated slots in time, frequency, or space. These methods suffer from drawbacks and limit the scalability of WPT. We examine how code division multiple access (CDMA) enables scalability in WPT through the construction of a CDMA for WPT framework along with a simple-yet-effective coding scheme and a transceiver design.

Biography
Al-Thaddeus Avestruz received his SB in Physics, SM in EE and PhD in Electrical Engineering and Computer Science, all from the Massachusetts Institute of Technology. He is currently an Assistant Professor in Electrical Engineering and Computer Science and an affiliate of the Energy Institute at the University of Michigan at Ann Arbor. His research interests include the design, modeling, and control of high-performance power electronics and wireless power transfer for energy, mobility, medicine, and the IOT. He has complementary interests in circuits and systems for sensing, electromagnetic systems, feedback and controls, renewable energy, automotive, biomedical, consumer, and space applications. He has over a decade of industry and entrepreneurial experience and holds 8 U.S. patents, with several more pending.