BIOGRAPHICAL SKETCH

Benjamin Huey is a secure communication researcher and lead hardware design engineer in the Cyber and Information Security Research Group at the Oak Ridge National Laboratory. His work focuses on the design, development, and integration of custom RF and communications systems for a variety of commercial and government customers. His most recent design projects have been in the areas of microelectronics and embedded systems for harsh environments, compact software defined radios, and counter unmanned aerial vehicle systems. He has served as an antenna subject matter expert to the U.S. Army Test and Evaluation Command and as an electrical power distribution subject matter expert to the U.S. Missile Defense Agency.

Prior to coming to the Oak Ridge National Laboratory, Ben worked as an Instrumentation Engineer at the nation's largest public utility, the Tennessee Valley Authority. He oversaw the design and deployment of custom instrumentation, control, and RF systems and served as the lead hardware engineer for the communication and control components of the nuclear emergency public warning system. Ben has received industry training in nuclear emergency preparedness, power plant control, and utility system operations.

EDUCATION

University of Tennessee – Knoxville
BS Electrical Engineering, 2005

University of Tennessee – Knoxville
MS Electrical Engineering, 2008

Tennessee Tech University
PhD Engineering, expected December 2018

College of Engineering

TENNESSEE TECH

The Department of

Electrical & Computer Engineering

Announces the Dissertation Defense

of

Benjamin Huey

In Partial Fulfillment of the Requirements

For the degree of

Doctorate of Philosophy

Tuesday, October 2, 2018 at 1:00 p.m.

Held in

208 Brown Hall
115 West 10th Street
Cookeville, TN
Tennessee Tech University

FIELD OF STUDY

Wireless Communications and Electromagnetics

DISSERTATION TOPIC

Active Core Saturation Prevention in Ferromagnetic Core Loop Antennas

EXAMINING COMMITTEE

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ABSTRACT

Ferromagnetic core loop antennas with high permeability core materials are typically used in size constrained applications requiring the detection and reception of weak Very Low Frequency (VLF) and Extremely Low Frequency (ELF) signals. However, these antennas have two limitations that constrain their performance in real world applications. First, the high permeability materials are susceptible to saturation in the presence of strong magnetic fields such as those generated by power lines, in research laboratories, or through natural phenomena. Second, the demagnetizing field inside the antenna core limits its effective permeability and prevents receiving the full benefit of the core material's soft ferromagnetic properties.

Here, a system is presented that actively controls the magnetic flux in the core of the antenna by applying a control signal to an independent set of windings on the same core. This control signal is phase locked to the offending signal and the two signals destructively combine in the core. Also, methods of optimizing core geometry are explored in an attempt to improve antenna performance. In total, eleven experimental core shapes were simulated using finite element analysis electromagnetic simulation software.

The results show that it is possible to actively cancel the fundamental component of a strong interferer in the core of a high sensitivity ferromagnetic core loop antenna and prevent core saturation. This approach eliminates signal distortion caused by magnetic saturation that passive signal cancellation or signal processing in the receiver do not. Thus, high sensitivity ferromagnetic core antennas can be used in applications where they were previously thought unsuitable. Furthermore, simulation and testing of antenna core prototypes have shown that modifications to the geometry of the antenna core's ends can improve effective permeability and result in better antenna performance.