Clemson Vehicular Electronics Research

T. Hubing
Michelin Professor of Vehicle Electronic Systems Integration
Vehicular Electronics Laboratory Researchers

Faculty
   Todd Hubing  Michelin Professor

Graduate Students
   Xinbo He  Ph.D. Student - ECE
   Changyi Su  Ph.D. Student - ECE
   Hua Zeng  Ph.D. Student - ECE
   Ho-Cheol Kwak  Ph.D. Student - ECE
   Nan Maung  Ph.D. Student - ECE
   Li Niu  Ph.D. Student - AuE

Visiting Scholars
   Yanqiang Li  Shandong Academy of Sciences

Visiting Students
   Yi Sun  Beijing Jiao Tong University
Electronics Systems Research Focus Areas

- Electronics Integration for Reliability and Safety
- Vehicle Networks and Electronic Communications
- Power Distribution and Storage
Current Projects

- Maximum Emissions Calculator
- Ground Post Modeling
- Active Balancing of Power Inverters
- EM Modeling Resource
- Tire Pressure Monitoring
- Component Characterization for System Modeling
- Ultra-Capacitor Charging Circuit
- Electronic Component Failure Prediction
- Possible Causes of Sudden Unintended Acceleration
- LED Failure Analysis
Capacitor Research

- Clemson Advanced Capacitor Consortium

- Focusing on better methods for getting energy into and out of capacitors quickly and efficiently.

Patent Applications:


Active Balancing of Power Inverters

Imbalance arises from:

- **geometrical asymmetries** - unnecessary
- **unequal turn-on and turn-off times** – can compensate
- **unbalanced PWM control** – can use balanced method
- **unbalanced filtering** - unnecessary
- **switching device parasitics** – can compensate
- **imbalances in load impedance** – can compensate
Advanced Tire Pressure Monitoring

January 2010
Detecting IC and Power Inverter Failures Before They Occur

Onboard Circuitry

Monitoring
Real-time analysis
Warning

Component 1
Component 2
Component 3
Complex System
Component n

January 2010
Maximum Radiated Emission Calculator

Voltage-Driven Common-Mode EMI Calculator

The electric fields that couple directly to attached cables from a trace can induce common-mode currents on these cables resulting in radiated emissions. This source mechanism is referred to as voltage-driven, since the magnitude of the common-mode current is proportional to the signal voltage and independent of the signal current. For a given board geometry, a closed-form expression for the maximum emissions due to this coupling mechanism was developed in [1,2]. The number of cables attached to the board and the location of these cables does not affect the maximum emissions calculation.

Assumptions:
1. The board is not within a shielding enclosure. (There's a different calculator for this case.)
2. There is at least one cable attached to the board and the cable length is much greater than the board dimensions.

![Geometry Diagram]

Geometry:
- Board length (L):
  - inches
  - millimeters
- Board width (W):
  - inches
  - millimeters
- Trace length (L_t):
  - inches
- Trace height over the return plane (h_t):
  - inches
- Trace width (W_t):
  - inches
- Measurement distance (d):
  - meters

Voltage Source

- Digital Signal - Trapezoidal Waveform
  - Amplitude of the signal (V):
  - rise time (t_r):
  - fall time (t_f):
  - Duty Cycle:
  - Data Rate:

- Swept Frequency - Constant Voltage
  - Amplitude of the voltage signal (V):
  - Lower frequency (f_l):
  - Upper frequency (f_u):

References


Vehicle Electronic Component Characterization for Electromagnetic Modeling

- Develop models for all of the possible EM interactions between various system components and complex vehicular systems.

- Develop test procedures that will accurately characterize components in terms of their worst-possible EM interactions.

- Provide the research results and technical literature necessary to support changes in existing automotive and aerospace EMC test procedures.

Goal: Enable system-level performance modeling based on component-level tests.
Electromagnetic Modeling Resource

- Descriptions of modeling techniques
- Searchable list of commercial software
- Case studies
- Code-specific modeling advice

EM Modeling Information
- Electromagnetic Modeling Acronyms and Definitions
- What is the "best" EM Modeling technique?
  - Method of Moments (MoM)
  - Boundary Element Method (BEM)
  - Finite Element Method (FEM)
  - Finite Difference Frequency Domain (FDFD)
  - Partial Element Equivalent Circuit (PEEC)
  - Finite Integration Technique (FIT)
  - Asymptotic Methods (OTD/UTD/FD)
- Finite Difference Time Domain (FDTD)
- Transmission Line Matrix Method (TLM)
- Finite Element Time Domain (FETD)
- Finite Volume Time Domain (FVTD)
- Generalized Mitropoulos Technique (GMT)
- Time Domain Method of Moments (TDMoM)
- Hybrid Methods

Electromagnetic Simulation Tools
- Free Electromagnetic Modeling Codes
- Commercial Electromagnetic Modeling Codes

Upcoming Events
- IEEE Applied Electromagnetics Conference, Kolkata, India, December 14-16, 2009
- URSI-URSI National Radio Science Meeting, Boulder, CO, USA, Jan. 6-9, 2010
- Fourteenth Biennial IEEE Conference on Electromagnetic Field Computation (CEFC), Chicago, May 9-12, 2010
- 2010 IEEE International Symposium on Antennas and Propagation / URSI Radio Science Meeting, Toronto, Canada, July 11-17, 2010

More EM Modeling Information Sources
- Periodicals
- Books
- Mailing Lists
- Web Links

January 2010
Descriptions of automotive electronic systems, sensor, actuators.

Web Resources

Clemson Research