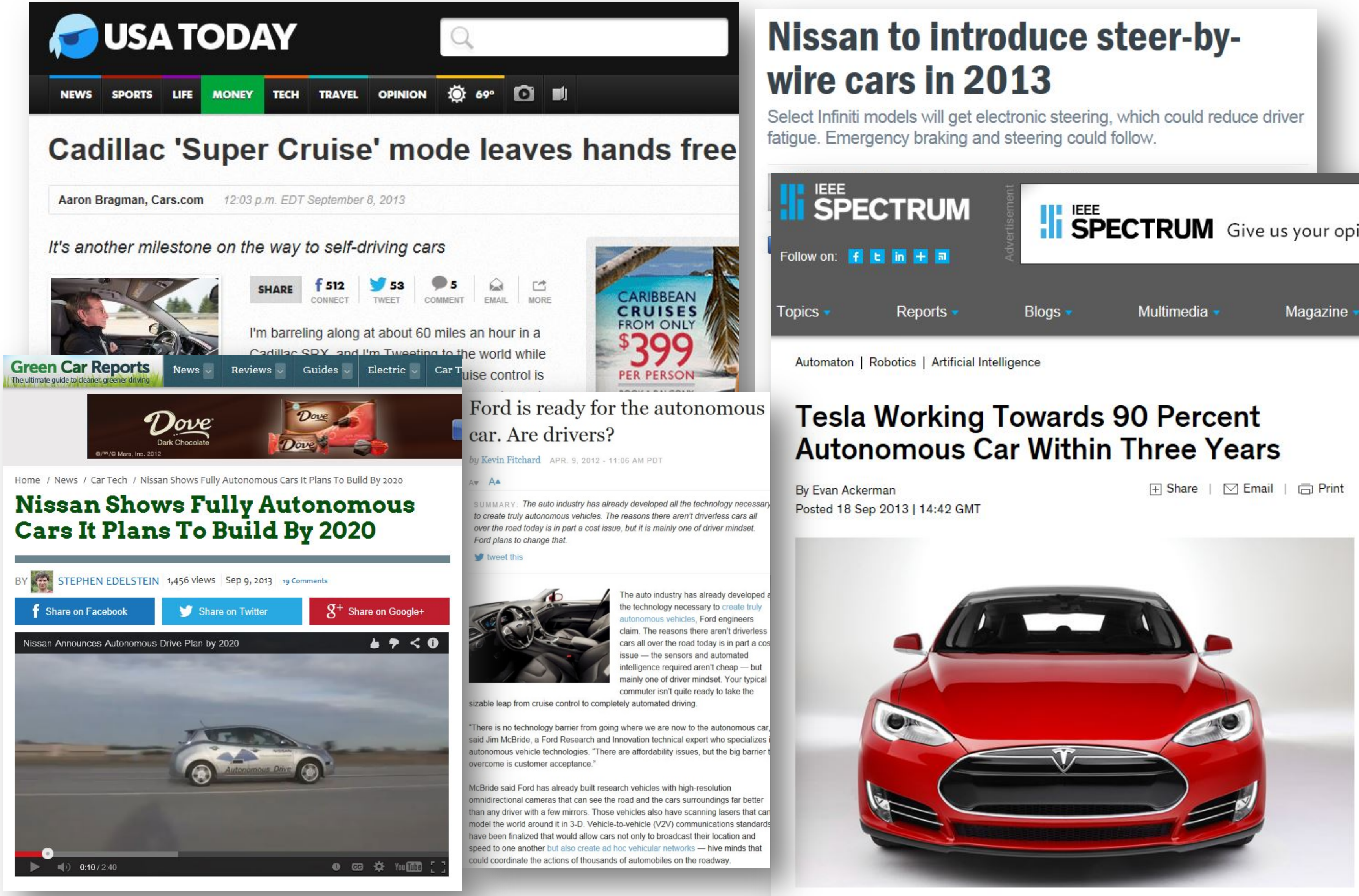
Vehicle Electronics

Vehicle Electronics – Strategic Drivers

- Exponential growth in automotive electronics as measured by:
  - Number of circuits
  - Number of components
  - Lines of software
  - Complexity
  - Data communications
  - Consumer demand
  - Safety-critical control
  - Safety-critical reliance
  - Development effort
  - Verification effort
- Moore’s Law: Doubling of complexity capability every 18 months.
  - 10 years from now: Factor of 100
  - 20 years from now: Factor of 10,000

Vehicle Electronics – Strategic Drivers



From a Recent IEEE Spectrum Article …

On autonomous cars:

It's unfortunate that while the technology for all of this is arguably mostly ready, society (socially and legally) just isn't yet. You can buy cars with adaptive cruise control and lane departure warnings, which could hypothetically let the car drive itself, at least under some specific circumstances. **And despite the fact that even a bad autonomous (or semi-autonomous) car would still save lives overall**, there's no legal infrastructure in place to make it possible for manufacturers to implement such technology without undue risk of being sued into oblivion the first time something goes wrong.

Quoted from: CMU's Autonomous Car Doesn't Look like a Robot, Even Ackerman, *IEEE Spectrum*, Sep. 9, 2013.

Vehicle Electronics – Strategic Drivers

The automotive industry does not (yet) fully appreciate the challenges associated with the reliable design of complex electronic systems.

McKinsey Global Institute - Disruptive technologies: Advances that will transform life, business, and the global economy.

~10-7/hr

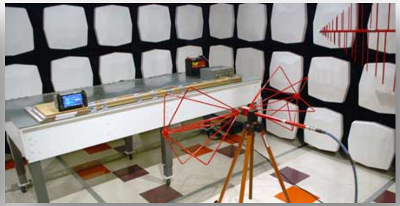
- Very unlikely to fail is not good enough.
  - 10^{-6}/hr probability of causing a fatal accident translates to thousands of fatal accidents in a popular vehicle model.
  - ISO 26262 target is 10^{-10}/hr.

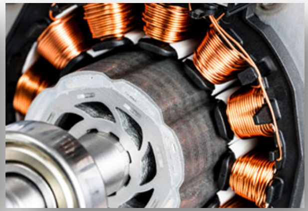
- Traditional design, modeling and verification procedures are failing to keep up.

Vehicle Electronics – Vision at CU-ICAR

Vision Statement

CU-ICAR will be the recognized leader in research leading to the safe, reliable design and integration of electronic systems in automobiles.





Key Areas of Research

- HMI and Human Factors
- Recognizing component and system failures before they are a safety issue
- Design of reliable components and systems
- Design and integration methodologies that guarantee performance
- Effective test procedures that validate designs

Vehicle Electronics Research at ICAR

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- Recognizing component and system failures before they are a safety issue
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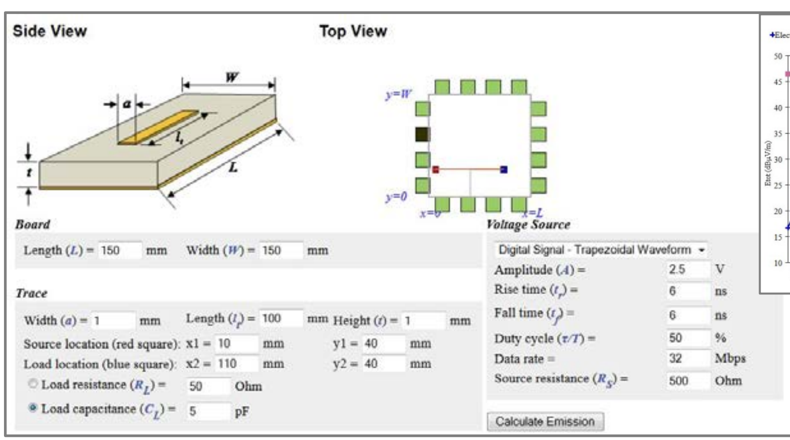
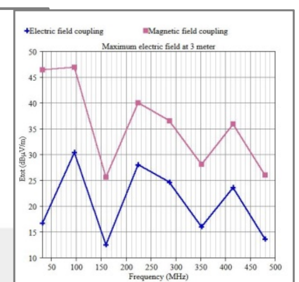
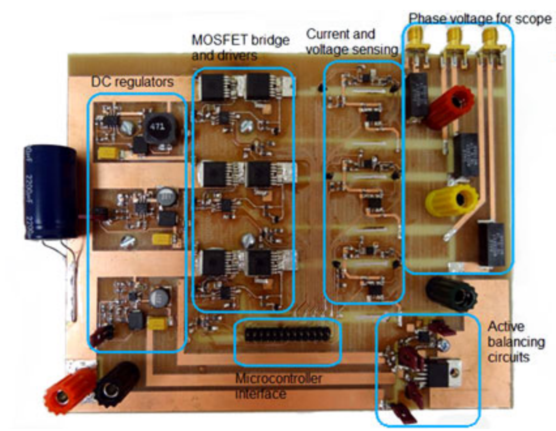
- Effective test procedures that validate designs
- Wireless charging of vehicles (emphasis on safety, reliability)
- Battery aging and characterization

Vehicle Electronics Research at ICAR

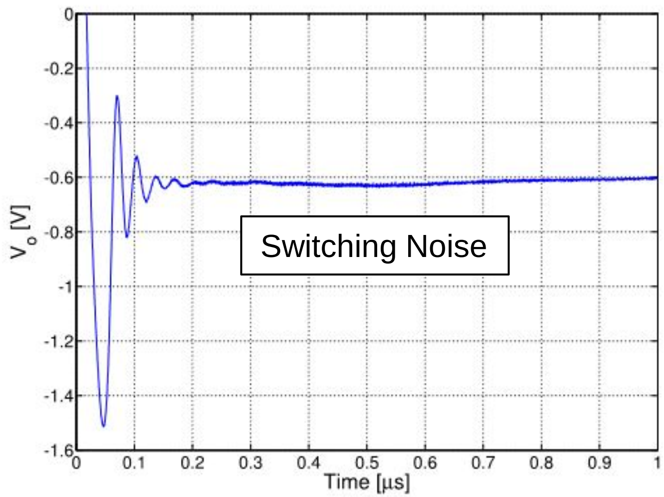
- Phase IV: Investigation of Design and Test Practice Related to Electronic Throttle and Braking Controls in Trucks and Automobiles
- Wireless Charging – ORNL
- Investigation of Capacitor Response to Electrical Transients
- Detecting MOSFET and IGBT Failures in Power Inverters
- Low-Noise Power Inverter Design
- Performance-Based Design for Ensuring Electromagnetic Compatibility

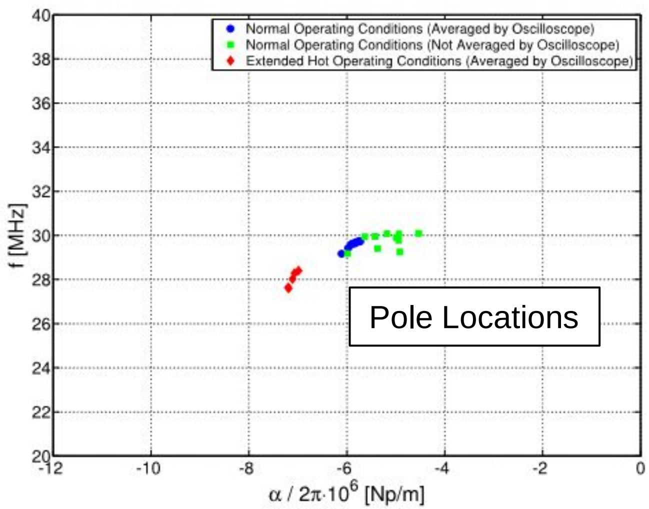


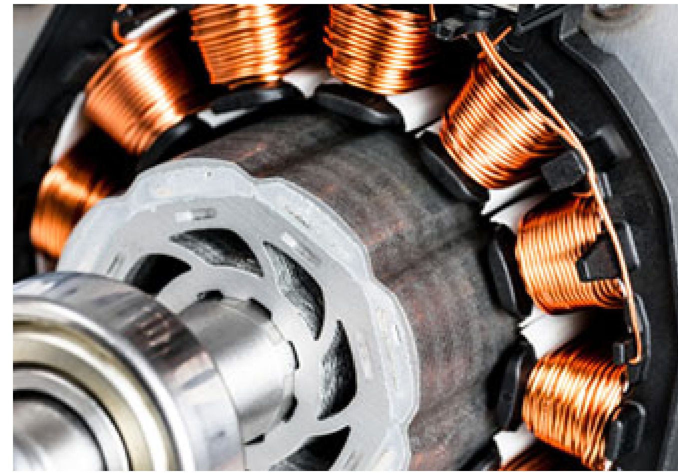




Using Unintentional Emissions to Anticipate MOSFET and IGBT Failures







Project Goal: Demonstrate that the unintentional electromagnetic emissions from power inverters and motor drivers can be monitored to anticipate electronic component failures before they occur.

CU-ICAR
CLEMSON UNIVERSITY INTERNATIONAL CENTER FOR AUTOMOTIVE RESEARCH

Performance-Based EMC Design of Electronic Systems

Designing Automotive Components for Guaranteed Compliance with Electromagnetic Compatibility Requirements

BY TODD HUBING

Automobiles typically have dozens of electronic systems operating interactively in a relatively compact space. These systems must operate reliably in a wide range of environments over extended periods of time. As a growing number of these systems play an ever expanding role in protecting the safety of a vehicle's occupants, there is an increasing need to ensure that the integrity of these systems will not be compromised by electromagnetic interference.

The traditional design, build and test approach to automotive EMC compliance will not be sufficient to ensure the safety or reliability of tomorrow's automobiles. A *Design for Guaranteed Compliance* approach promises to ensure that automotive components will meet all EMC requirements the first time they are tested, and that compatibility will not depend on the specific vehicle or system in which the components are installed. More work needs to be done before this concept reaches its full potential, but electronic system designers can already derive significant benefit by applying this approach to products currently under development.

1 In Compliance Month 2012 www.incompliancemag.com

In Compliance Magazine, May 2013.

COVER STORY

Model answer

With the mushrooming volume of electronics in vehicles making it harder than ever to test every possible electromagnetic compatibility scenario, research at Clemson University aims to reduce development times and improve results through the use of modeling

WORDS BY GRAHAM HEEPS

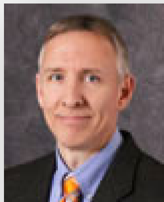
It may come as a surprise to learn that the advent of electric and hybrid-electric vehicles doesn't constitute the greatest challenge for the future of automotive electromagnetic compatibility (EMC) testing.

"Our ultimate goal is to reach the point where our models are good enough to tell us we won't have a problem in a given set of circumstances"

Automotive Testing Technology International, Nov. 2012.

Project Goal: Develop a method for designing electronic systems that are guaranteed to comply with their electromagnetic compatibility requirements.

CU-ICAR Personnel

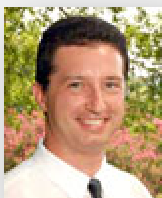


Todd Hubing

Electromagnetic Compatibility, EM Modeling, Fault Detection.

Joachim Taiber

Wireless Charging, Vehicle Communications



Pierluigi Pisu

Fault Diagnosis, Energy Management

David Smith

Human-Machine Interfaces, Automotive Software

Simona Onori

Integrated Powertrain Control and Optimization

Characterization, Aging and Modeling of Automotive Batteries

Main Campus Collaborators

Electrical Eng.

KC Wang

Wireless Networks, Ad Hoc Networks, V2I Communications

Keith Corzine

Power Electronics

Adam Hoover

Embedded Systems,
Driver Alertness Monitoring

Computer Science

Murali Sitaraman

RESOLVE (Fully Specified, Fully Verified) Software

Jason Hallstrom

Dependable Systems

John MacGregor

Dependable Systems

Labs