

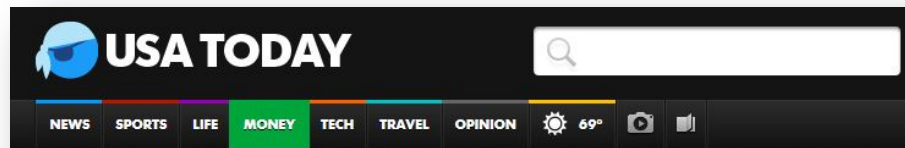


Vehicle Electronics

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



Cadillac 'Super Cruise' mode leaves hands free

Aaron Bragman, Cars.com 12:03 p.m. EDT September 8, 2013

It's another milestone on the way to self-driving cars



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I'm barreling along at about 60 miles an hour in a Cadillac SPY, and I'm Tweeting to the world while Super Cruise control is



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Nissan Shows Fully Autonomous Cars It Plans To Build By 2020

BY STEPHEN EDELSTEIN 1,456 views Sep 9, 2013 19 Comments

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Nissan Announces Autonomous Drive Plan by 2020



Ford is ready for the autonomous car. Are drivers?

by Kevin Fitchard APR. 9, 2012 - 11:06 AM PDT

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SUMMARY The auto industry has already developed all the technology necessary to create truly autonomous vehicles. The reasons there aren't driverless cars all over the road today is in part a cost issue, but it is mainly one of driver mindset. Ford plans to change that.



The auto industry has already developed all the technology necessary to create truly autonomous vehicles. Ford engineers claim. The reasons there aren't driverless cars all over the road today is in part a cost issue — the sensors and automated intelligence required aren't cheap — but mainly one of driver mindset. Your typical commuter isn't quite ready to take the

sizeable leap from cruise control to completely automated driving. "There is no technology barrier from going where we are now to the autonomous car," said Jim McBride, a Ford Research and Innovation technical expert who specializes in autonomous vehicle technologies. "There are affordability issues, but the big barrier to overcome is customer acceptance."

McBride said Ford has already built research vehicles with high-resolution omnidirectional cameras that can see the road and the cars surroundings far better than any driver with a few mirrors. Those vehicles also have scanning lasers that can model the world around it in 3-D. Vehicle-to-vehicle (V2V) communications standards have been finalized that would allow cars not only to broadcast their location and speed to one another but also create ad hoc vehicular networks — hive minds that could coordinate the actions of thousands of automobiles on the roadway.

Nissan to introduce steer-by-wire cars in 2013

Select Infiniti models will get electronic steering, which could reduce driver fatigue. Emergency braking and steering could follow.

IEEE SPECTRUM

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Tesla Working Towards 90 Percent Autonomous Car Within Three Years

By Evan Ackerman

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Posted 18 Sep 2013 | 14:42 GMT



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.



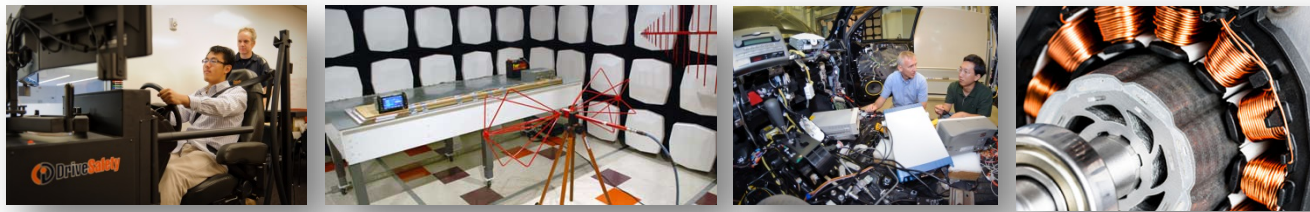
~10⁻⁷/hr

- 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

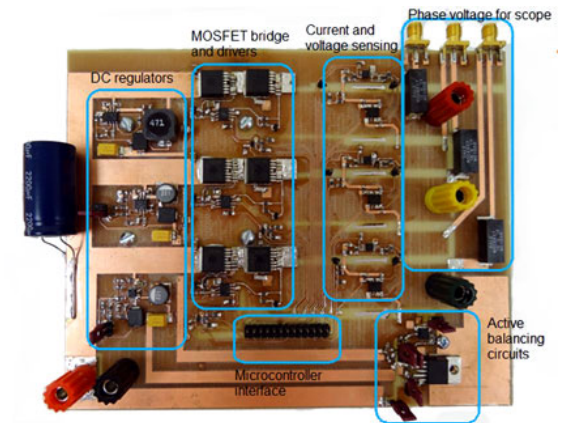
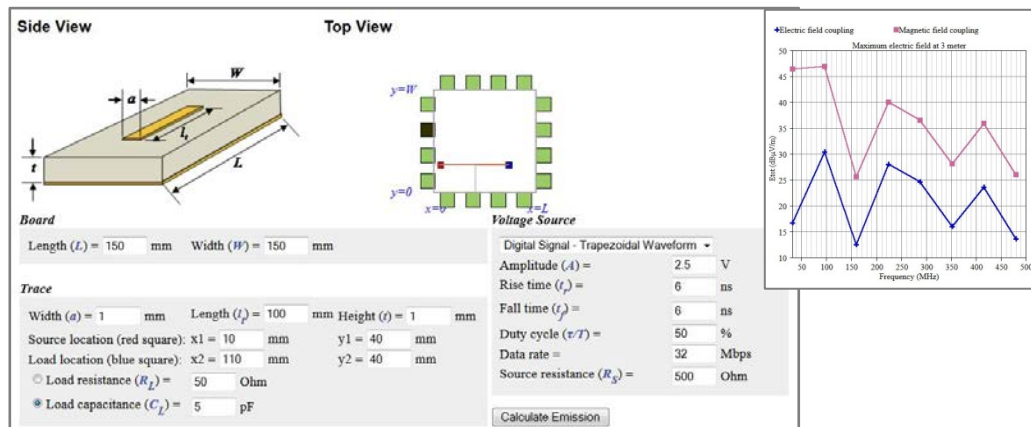
Vehicle Electronics Research at ICAR

- 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
- Wireless charging of vehicles (emphasis on safety, reliability)
- Battery aging and characterization

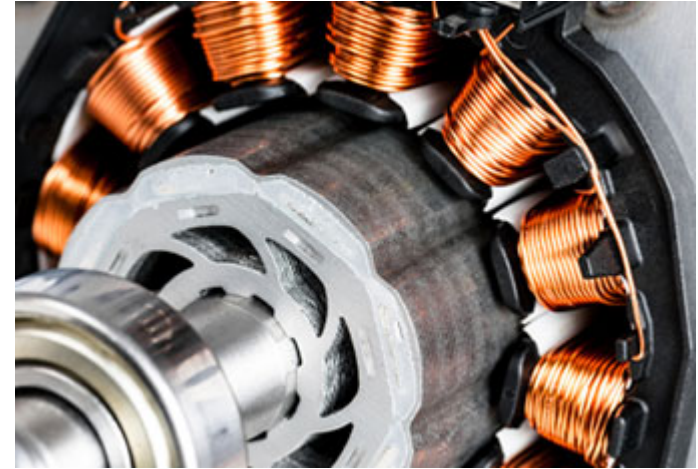
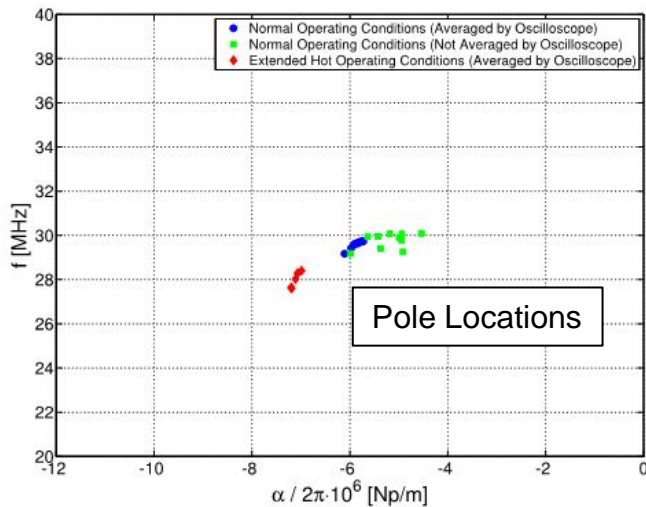
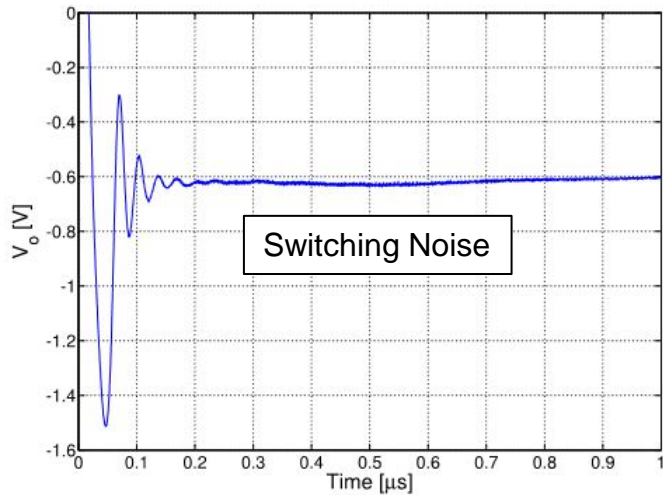
Vehicle Electronics – Research Projects

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.

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 benefits 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 HEERS

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. "Energy storage is a factor but not the biggest challenge,"

Hubing, Michelin chair and computer engineering at South Carolina. "Even without the amount of electronics going into an internal-combustion engine, as is our reliance on them, which wasn't the case before."

Hubing says that a new approach, Commercial Center for electromagnetic modeling, electromagnetic compatibility.

do more with modeling. We can't describe electromagnetic fields are going to be everywhere because we don't have enough detail on the source," explains Hubing. "Most of the EMC testing we do is on things like ECUs, which weren't designed to radiate anything, so the source of the radiated emissions is not

very well defined. There's no database that tells you how this ECU works as a radiation source. Without that specific information we can only do measurements, and use them to tell us what we need to know in our models. For the EMC modeling we want to take measurements that determine how this component is going to behave—what's going to come out of it, how it's going to react to things coming into it. We'll put some numbers into a database, and use those numbers in a vehicle model."

A focus of Clemson's research, which is being funded through the National Science Foundation Center for Electromagnetic Compatibility, is to be able to model the whole system. In order to do that, it has to have individual models for the components. Hubing says that a problem with current physical testing is that often, despite each component-level EMC test not flagging any issues, problems still arise at the system level. If a component test measured in a function test only of the component parameters but also of the cable attached and the structure in which the measurement is taken. There is no guarantee that when the component is put in a vehicle, the

situation will look anything like the way it was when the measurement was made.

"When it was developed, our component testing wasn't intended to be used in a system model, but that's the direction we need to go in," Hubing expands. "So we're looking at doing measurements on components that provide data that we can put into system-level models. We make a measurement of a complex component like an ECU, and then represent that in the system model with a well-defined set of parameters that we can plug in."

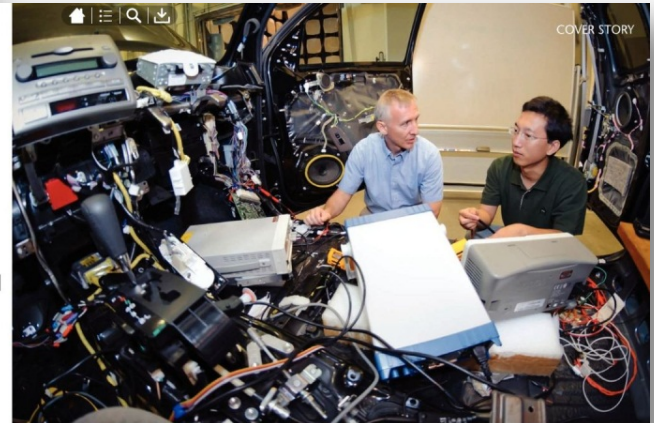
"At the system level, we run a model of the body of the vehicle, all the cables in it, and all the components attached to them. If we have good models for the components, then

at the system level we can evaluate what happens if we change the route of a cable, for example, or if we shield a cable, or we make a change in the mechanical structure of the vehicle. We don't want to change the component model each time we make a change to the system—we want to keep them independent. But of course, if the component changes then we'll probably have to take new measurements and make a new model for the new component."

He confirms that physical testing will still be required at the end of the process, but primarily as a validation of the model.

"The idea of the modeling is to help us understand the effects of these changes during the design process," Hubing

Photo: Professor Hubing (left) and PhD student Graham Heers (right) working on a car engine.



COVER STORY

Automotive Testing Technology International, Nov. 2012.



"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"

Todd Hubing, professor of electrical and computer engineering, Clemson University

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

