# Potential Electronic Causes of Unintended Acceleration

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# Summary of July 1 Presentation

- Current automotive design and integration strategies are not sustainable
- Electronic systems can fail in ways that cause unsafe vehicle behavior
- More testing is not the solution
- Design platforms/standards that facilitate modeling and validation of components and systems are needed
- Event data recorders that monitor safety critical electronic systems are needed

# Some Key Points

- Due largely to the electronics, today's cars are safer than ever before.
- Even for makes and models with the highest number of reported incidents, sudden acceleration incidents are reported about once in every 600 million miles driven.

# Topics 1 and 2

**How EMI could potentially cause unintended acceleration**

**How transient problems could cause sustained unexpected consequences**

# Forms of EMI

- Radiated Field Susceptibility
  - e.g. from nearby radio towers, wireless devices, digital electronics
- Crosstalk in Wiring Harnesses
  - e.g. from PWM controls, digital communications
- Electric Field Susceptibility
  - e.g. from overhead power lines, power inverters, motor/valve controls
- Magnetic Field Susceptibility
  - e.g. from magnets, motors, wires carrying large currents
- Power Dips
  - e.g. due to sudden current demand from devices sharing the same power source
- Transients / Surges
  - e.g. from electrostatic discharge, load dump, switching

# Example

http://www.youtube.com/watch?v=0HmP1HgV5to

# Systems Capable of Actuating Brakes/Throttle

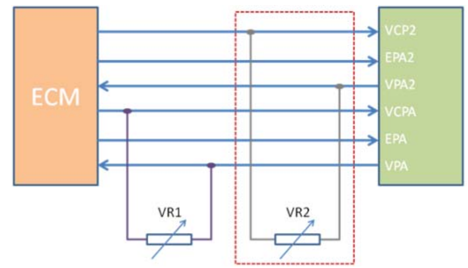
- Cruise Control
- Active Yaw Control
- Antilock Brakes
- Automatic Braking
- Automatic Parking
- Automatic Start/Stop
- Communication System
- Cabin Environment Controls
- Electronic Stability Control
- Electronic Throttle Control
- Engine Control
- Hill Hold Control
- Lane Departure Warning
- Regenerative Braking
- Transmission Control

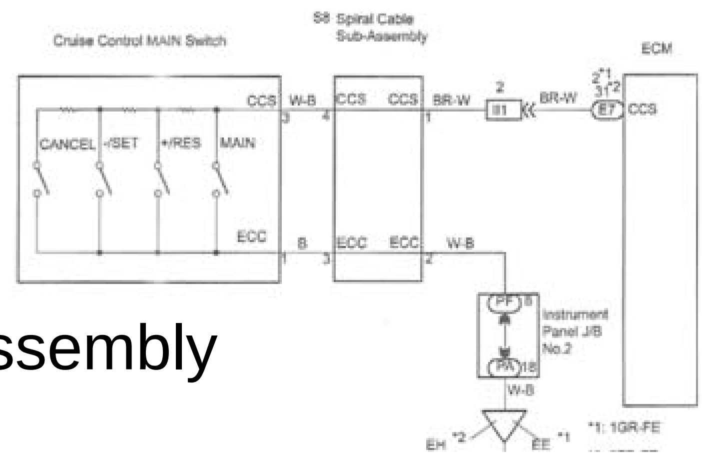
# Problems with Current Automotive Designs

- Safety critical reliance on analog sensor inputs whose accuracy cannot be validated.
- Safety critical reliance on undefined software whose performance cannot be modeled or validated.
- Safety critical reliance on individual hardware components (particularly microcontrollers).

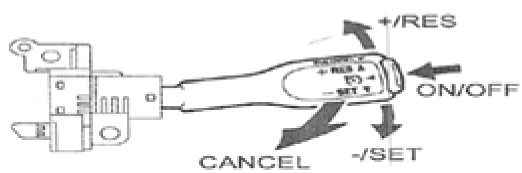
# Bad Sensor Input

- Accelerator position sensor
- Throttle position sensor
- Mass air flow sensor
- Air/Fuel ratio sensor
- Cruise control switch assembly




Cruise Control Main Switch
Connector Front View:




Standard Resistance

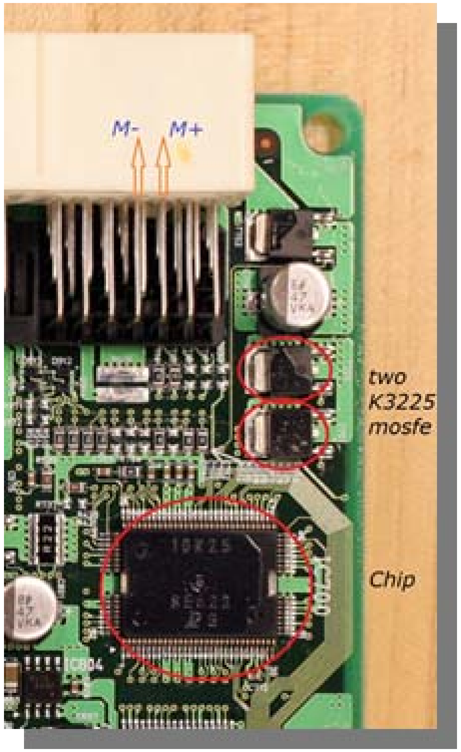
| Tester Connection | Switch Condition | Specified Condition |
|---|---|---|
| 1 - 3 | + / RES | 235 to 245 Ω |
| 1 - 3 | - / SET | 617 to 643 Ω |
| 1 - 3 | CANCEL | 1,509 to 1,571 Ω |
| 1 - 3 | Main Switch OFF | 10 kΩ or higher |
| 1 - 3 | Main Switch ON | Below 1 Ω |

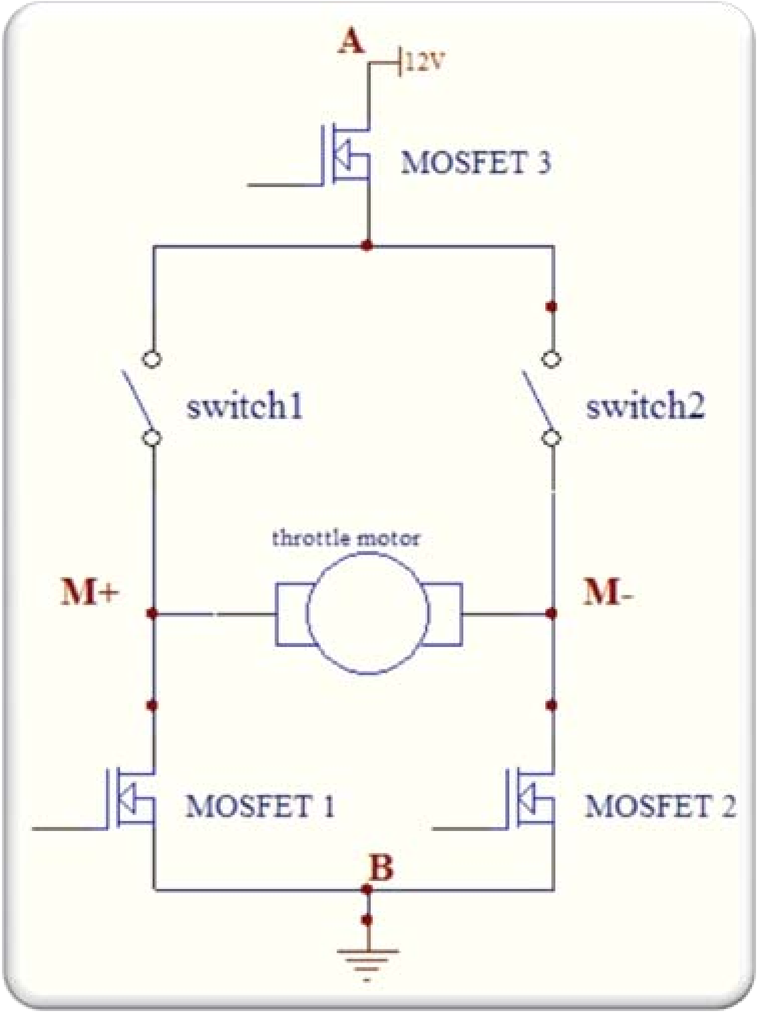
# Bad Software

- Cruise Control
- Active Yaw Control
- Automatic Parking
- Cabin Environment Controls
- Electronic Stability Control
- Electronic Throttle Control
- Engine Control
- Transmission Control

# Hardware Latch-up or Malfunction

- ECM main processor
- Throttle Motor Controller



# Topic 3

## Technical capabilities necessary to recognize and analyze EMI problems

# Technical Capabilities

- Unfortunately, many EMI problems leave no lasting evidence.
- An event data recorder could indicate the inputs and outputs associated with safety critical electronic systems allowing investigators to determine the system(s) that malfunctioned.
- EDR data coupled with environmental data could be used to postulate potential EMI problems. These could be investigated in a laboratory setting.

# Topic 4

## Analysis of the short and long term recommendations from the July 1 presentation

# Short-term Recommendations

- A software subroutine that cuts the throttle when the brake pedal is depressed would compensate for a large percentage of the possible failure mechanisms. A hardware solution (e.g. BMW's approach) should be even more reliable.
- The driver should have some way to override the engine control module (e.g. a key switch that physically removes the power to the ECM).
- Hardware redundancy and fault-tolerant software design would be relatively inexpensive and easy to implement if adopted by the entire automotive industry.

# Long-term Recommendations

- Must be able to model all system behavior including all hardware and software interactions.
- This requires design constraints and interface standards.
- Continuous refinement of these standards would be greatly facilitated by the installation of black boxes in automobiles.

# Topic 5

## How could the NHTSA database be improved?

# NHTSA Database

- Key word searching
- Description of the location (north or south) and the environment (weather, road condition)
- For many cases, no VIN provided. Thus making it difficult to track the information about the car. And in some cases, the total description is just one short sentence (e.g. “my car suddenly accelerated today…”)
- Contact information for the driver would be helpful.

# NHTSA Database

- I believe few people actually know about the database and many who are aware of it don't bother to provide input.
- Automatic uploading of data from dealers and auto-repair shops would probably improve the quality of the data.
- Providing diagnostic services and self-help information could encourage better reporting by drivers.
- Weather related information would be very helpful.

# Topic 6

## How automotive electronics will evolve and the implications for problems

# Current Situation

- Automotive industry is very competitive and secretive
- Driven by consumer demand, government regulations, costs, stockholder expectations, litigation.
- Want a new feature, add a new system. Complexity of safety critical hardware and software interactions growing exponentially.
- Driver error causes most accidents. More control being given to electronics.
- Electronics failures definitely to blame for some accidents, but it’s difficult to recognize or document these failures.

# Current Situation

- We can't design and build cars like commercial aircraft.
- We can't identify all possible failure mechanisms by testing.
- There is an unavoidable reliance on accident data to identify some safety problems.
- Many accidents caused by electronics malfunctions are difficult to distinguish from accidents caused by driver error.

# Expected Outcome

- As additional electronic controls are added to automobiles, the number of accidents due to driver error is expected to decrease while the number of accidents due to electronic malfunctions is expected to increase.

- As more attention is focused on problems related to the electronics, the automotive industry will take additional steps to prevent these malfunctions from affecting the safety of the vehicle.

# Enablers

- The industry as a whole would benefit greatly by increased standardization of electronic hardware and software.

  Not government mandated standards, but open standards developed by independent organizations

- The industry as a whole would benefit greatly by requiring the type of diagnostic data collection that would aid in identifying problems with electronics early on.

  i.e. event data recorders

# Final Thoughts

- Odds of being involved in an unintended acceleration accident are much lower than odds of being involved in other types of car accidents.

- Unintended automotive system behavior is a problem that will certainly get worse without a major change in automotive standards and design practices.

# Questions