Automotive EMC Requirements and Product Liability

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Automotive Electrical/ Electronics Subassemblies (ESA)

- Automotive Electrical Subassembly (ESA) means
  - an electrical and/or electronic device or set(s) of devices intended to be part of a vehicle,
  - together with any associated electrical connections and wiring, which performs one or more specialized functions.

Importance of Automotive ESA

- Today automobiles resemble ‘computers on wheels’ because of the increasing number of digital systems under the hood and inside the passenger cabin.
- The advancement in modern electronics technologies (especially in microelectronics) provides a feasible and cost-effective way of realizing the proliferating demands of the customers and the society on the functionality, dependability and environmental compatibility of a car.
  - e.g., driving comfort, handling, fuel efficiency, safety, minimal pollution.
  - Vehicle manufacturers continue to offer more sophisticated ESA addressing vehicle safety, telematics, and entertainment.
- The costs associated with these sophisticated systems are also rising.
  - Automotive ESA now account for 22 percent of a vehicle's cost and are projected to increase to up to 45 percent by year 2010.

EMI and its hazards

- Operation of electronic devices generates energies carried by electric, magnetic or electromagnetic fields.
- There is always such a possibility that an automotive ESA may accidentally receive or pick up this kind of energy generated by the other devices (either on-board or in the operation environment of the vehicle).
- This kind of energy then becomes disturbance signals to the ESA, and the ESA may react to the disturbances and consequently result in failure or degradation of performance.

Increasing Risks Due to EMI

Regulatory EMC Requirements

- EMC = Electromagnetic Compatibility
  - the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment
- EMC is not (necessarily) a Safety Issue
- EMC is an issue of public interest
  - because it concerns the relationship of a equipment with the other equipment in its near vicinity,
  - not the individual devices within the equipment system
- So EMC regulatory requirements exists (e.g. EMC Directive, etc.)
Intrinsic and Functional safety

- **Intrinsic safety:**
  - the possibility that injury or damage could occur due to electric shock, fire, mechanical instability, sharp edges, etc.

- **Functional safety:**
  - the hazards and risks depend upon the correct operation of devices/equipment

GAP Between Intrinsic Safety and EMC Regulatory Requirements

- Regulatory requirements are usually
  - The minimum technical requirements
  - Permitting a product to be put on the market

- There is a gap
  - between existing (intrinsic) safety and EMC regulations and standards
  - which do not correctly address the issue of electromagnetic interference (EMI) from the viewpoint of lifecycle safety (‘EMC for Functional Safety’).

EMC for Functional Safety

- EMC for Functional Safety addresses the gap between
  - intrinsic safety, and
  - electromagnetic compatibility (EMC) regulations

- Concerns/Focus more on immunity requirements

Functional Safety Concerns of Automobiles – Car Defects

- Any loss or perceptible degradation in function of automobile ESAs can result in Car Defects

- Car Defects can result in road accidents, and with personal injuries and property losses

- Some parties may, therefore, be liable to compensate or taking remedial actions for the losses

General Legal Liabilities

- **Administrative Law**
  - En SA, FCC Rules
  - National Highway Traffic Administration (NHTSA) regulations
  - EC Directives
  - e.g. EMC Directive, Automotive EMC Directive, R&TTE, etc.

- **Civil Law**
  - tort – injuries to persons or property
  - contract
  - antitrust, unfair competition etc.

- **Criminal Law**
  - intentional misconduct

Who is at Risk?

- Manufacturers, designers and distributors of products
  - direct and indirect
  - severally and jointly
**Administrative Liability**

- Policy - public interest protection
- Health safety and welfare of public is paramount
- Essential protection of limited public resources
- Typical violation is putting a non-compliant product on the market or into service

**Technical vs. administrative non-compliance**

- Technical non-compliance: Does not satisfy the specified limits or criteria
- Administrative non-compliance: Wrong product labeling
  - Missing information or errors in technical files or evidence

**Sanctions for rule violations**

- Generally broad spectrum of enforcement options, e.g.
  - Refuse to issue or withdraw Type-approval certifications
  - Fine
  - Order to recall

**Civil Liabilities**

- Relevant to products:
  - Negligence
    - Applies to designers, manufacturers, vendors, test labs
  - Strict liability
    - Everyone in chain of distribution can be liable
  - Warranty and Contract
    - Elements of proof are different
    - Fault required for negligence
    - Defective product required for strict liability
    - Warranty only covers products not services
    - Warranty and contract requires privity with plaintiff

**Civil Claims - Liability in motor vehicle defect**

- Product liability
- Controlled by the doctrine of strict liability.

**Basis of a product liability claim**

- The vehicle or one of its components had an "unreasonably dangerous" defect that injured you. The defect can come into existence either in the design of the vehicle, during manufacture, during handling or shipment (i.e. delivery from the manufacturer), or through a failure to warn consumers of a dangerous aspect of the vehicle.
- The defect caused an injury while the vehicle was being used in a way that it was intended to be used. For example, you may not be able to recover if a sports sedan were used to cross a stream.
- The vehicle had not been substantially changed from the condition in which it was originally sold. "Substantially" means in a way that affects how the vehicle performs.

**Rational**

- The most fundamental rationale for strict liability is to force producers to internalize the external costs they impose on society.

**Trends in Laws**

- Evolving notions of what is a "defective" product
  - Non-state-of-art EMC design
- Expanded concept of foreseeability of harm
  - Foreseeable misuse
- Expanded class of protected plaintiffs
  - Bystanders, 'good Samaritans' covered

**Sanction – Product Liability**

- Civil Claim
  - Punitive damages
    - Above and beyond damages to compensate a plaintiff for his or her injuries, and
    - Can range into the tens of millions of dollars in certain instances.
    - Intended to punish vehicle manufacturers and encourage them to fix inherent defects in vehicle designs that have resulted in injury.
  - Economic loss under contract and warranty

**Risk in potential losses suffered**

- High costs and time spending in
  - Law suits
  - Legal actions
  - Settlements
  - Punitive damages or compensations
  - Product recalls
  - Remedial works
Traditionally, vehicle manufacturers have engaged in what is known as a “cost-benefit” analysis when deciding whether to change a potentially defective vehicle design. In this process, the manufacturer will calculate the cost of implementing a design change (i.e., through vehicle recalls and repairs), and weigh that cost against the potential cost of litigation and settlement after the defect causes injuries. In USA, punitive damages are often awarded in order to add to the potential costs a manufacturer will face if it decides not to fix a design defect, thus shifting the cost-benefit analysis toward the elimination of defects.

Operational Environments of vehicles:
- The mobility of an automobile permits it to travel into many different electromagnetic situations, from remote rural locations to airports with high radar fields.
- Vehicles do not run in controlled environments.

Safety critical functions:
- The safety-critical nature of many of the functions now performed on the vehicles. These vital functions include engine management, braking control and airbag development.

Uncontrolled and self-contained electromagnetic environments:
- A vehicle is a self-contained system including generator, battery and operates at low voltage. The body and chassis connect to the vehicle battery, which is not a true ground reference for both the vehicle and systems.

EMC requirements for Automotive ESAs are dealing with Near-Field coupling phenomena rather than the far-field effects because:
- Within the enclosure of an automotive vehicle, the installation of different ESAs are in close vicinity.

Low power supply voltage of vehicle batteries (e.g., 12Vdc) gives high current carried by the electric wires which leads to high EMI levels.
- Hence automotive ESAs should be subject to much higher immunity test levels (e.g., over 100V/m).

Ultra-reliable systems with ultraquality control that are demanded by the automotive market and the society.
- Ultraquality is defined as a level of excellence so high that measuring it with confidence is close to impossible. Yet measurable or not, it must be achieved or the system will be judged a failure.
- Ultra-reliable ESA are usually demanded because of their potential to reduce the number and severity of road accidents.
Automotive EMC Standards

- National / International Regulations
  - EC's automotive EMC Directive

- National / International standards
  - EC: International ISO, CISPR
  - South America (US and Canada): SAE
  - Japan: JASO

- Usually basic standards
  - i.e. only test methods and set up are defined

- Automotive Manufacturers' (OEM) own internal standards:
  - GM, Ford, BMW, Toyota
  - With test methods, set up, categorization of products and corresponding test levels / performance criteria
  - MUCH MORE STRINGENT THAN REGULATORY REQUIREMENTS

International Automotive EMC Standards for Testing

<table>
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<th>Automotive Standard</th>
<th>Type</th>
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<td>ISO 7637</td>
<td>Transient immunity</td>
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<td>IEC 801-20</td>
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<td>CISPR-25</td>
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<td>2004/104/EC</td>
<td>Component Whole Vehicle</td>
<td>European Union</td>
<td>2004</td>
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Types of Automotive EMC Tests

- Radiated Emissions
  - ISO 11451: Frequency range: 30 MHz - 1 GHz, 2 dB across the frequency range (EC);
  - 150 KHz - 960 MHz, test level in 5 classes not continuous across the frequency range (CISPR);
  - Many OEM extend upper freq to 2-3 GHz

- Radiated Immunity
  - ISO 11452, 1 430, with limit levels (EC); 18 kHz - 18 MHz, multi-class of limit levels (ISO)

- Conducted Emissions
  - ISO 11452: Frequency range: 150 KHz - 108 MHz with 5 classes of limit levels (CISPR); 30 KHz - 120 MHz (BMW)

- Conducted Immunity
  - ISO 7637 Part 1: 12V power; Part 2 - 24V power; Part 3 - Signal/control lines;
  - Transient immunity: power line transient and signal/control line transients

- Immunity to Electrostatic Discharge (ESD)
  - Discharge level: +/- 2 KV - +/- 25 KV

Automotive EMC tests

- Vehicle level tests:
  - Carried by / for Vehicle manufacturers

- Component/ESA level tests:
  - Carried by / for both vehicle manufacturers and component/ESA manufacturers

Automotive EMC Test Laboratories

- A good automotive EMC test laboratory should have
  - good quality / management system and test capacity (human resources and environment)
  - Accreditation by appropriate accreditation bodies (e.g. A2LA)
  - Recognitions by the targeted vehicle manufacturers (OEMs)