Automotive Noise Consideration for IEEE 802.3dm

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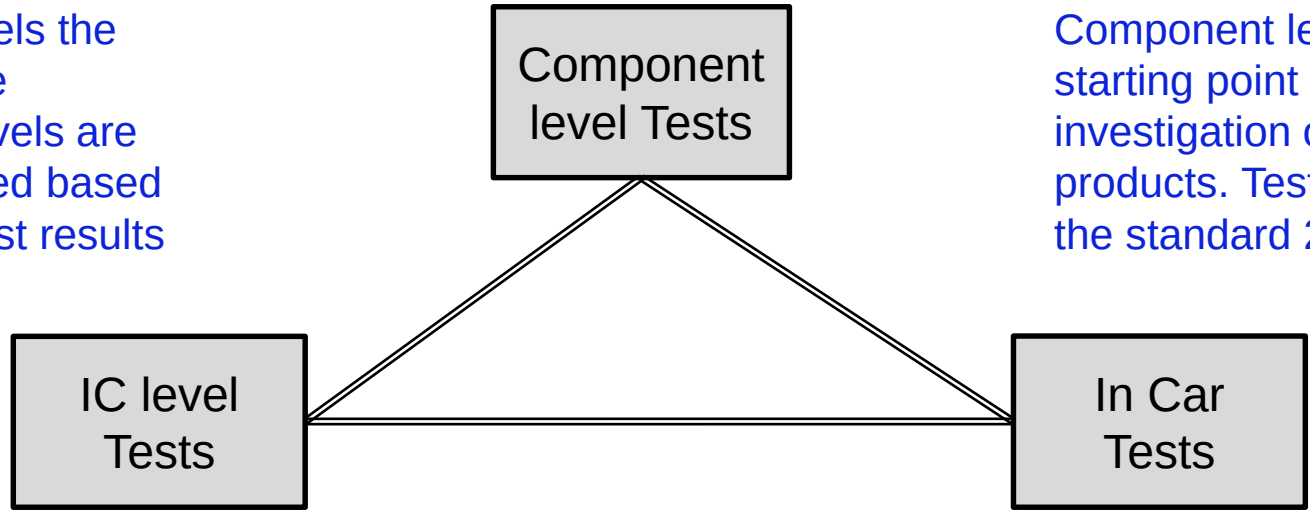
Automotive EMC Triangle

Predefined set up standards with a short cable (≤ 2m)
Conducted and Radiated Emission and Immunity

IC level testing models the noise coupling of the channel. The test levels are specified and updated based on ongoing in-car test results



Component level tests are often starting point for analysis and investigation of new standards and products. Testing with cables beyond the standard 2m is also possible.

Predefined board with no cable
Conducted Emission and Immunity (except for TEM cell)

Undefined set up with longer cables (≤15m)
Radiated Emission and Immunity

- Many car types, different regions and various applications
- Ever changing requirements of all test levels (even after 10 years!)
- Mostly tightening the requirement and occasionally relaxing them

Radiated Emission

- There are emission limits from just below 1MHz to over 3GHz. Higher frequencies up to 6GHz is recently considered for the newer high speed products.
- Emission is tested in all three formats of testing (In-car, Component level and IC-Level)
- In particular AM, FM, DAB and GPS bands emission limits are critical for any high speed automotive PHY design.
- Emission limits are as low as 4dBuV/m Average in GPS band!
- There are some regional variation in requirements based on local radio services.
- As the car industry evolves and higher speed data communications are deployed in the car, changes in requirements is inevitable.

Transient Noise Immunity

- Various types and models exist for transient noises in the car.
- Transients are mostly low frequency as compared to 802.3dm data rates.
- Transient noise level depends on the cable type, number of segments in the cable as well as board design. It also depends on the in-car cable bundling with power cords.
- ISO standard fast transient pulses may be modeled with a short 20MHz sinusoidal noise[1].
- Load variation generates transient noise if power over cable is used (Ldi/dt).
- ESD is a transient noise as well. Analysis and measurements of ESD effect on Coax and STP cables would be helpful.

1- See measurements and modeling of fast transient noises in Chini_Tazebay_3bp_01a_0114.pdf for UTP cabling and note that coaxial channel could be worse than UTP in lower frequency ranges depending on cabling and installation conditions.

Radiated Noise Immunity

- Radiated immunity is tested for three types of noises: CW, AM and Pulse. Typically up to 100V/m.
- Strongest RF Pulses simulate radar noise and are typically highest noise level tested, 300V/m and more.
- Tests are designed to model narrowband RF ingress noises up to at least 3GHz.
- Radiated noise immunity is tested both at component level and in-car.
- Practically the links installed on the car peripheral are subject to higher ingress noise and that is the case for camera applications.
- In addition to far-field radiated noise testing, there are near-field radiated noise tests that verify immunity to handheld wireless devices in the car.

Final Message

- The relative intensity of received noise in automotive applications varies significantly by many factors including the cable length, thermal and mechanical aging of cables, installation choices and board design.
- Transient noises are mostly in lower frequency band and are attenuated using a high pass receiver.
- Given all the known and unknown noise types and intensity, the 802.3dm project should allow for highest practical ingress noise for each target data rate while observing complexity and power limitations.
- It is not sufficient to optimize the link based on **AWGN noise** when dominant noise type is narrowband noise. While some CW noises may be rejected by a good receiver design, not all noise types can be rejected by the receiver and need to be considered in 802.3 spec development.