Detroit Automotive Center & EMC Test Lab

EMC Insights and Solutions

April 2022

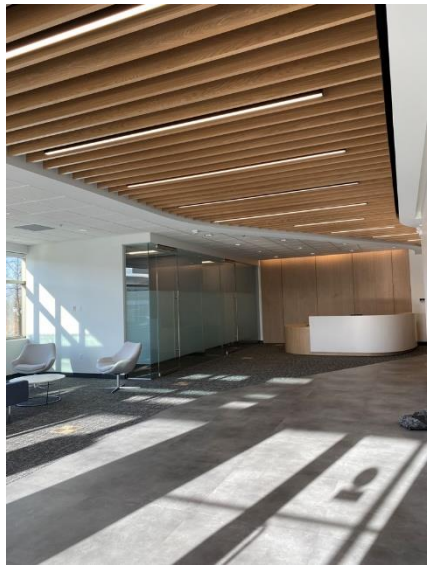
Presenter Intro: Barry Steltz

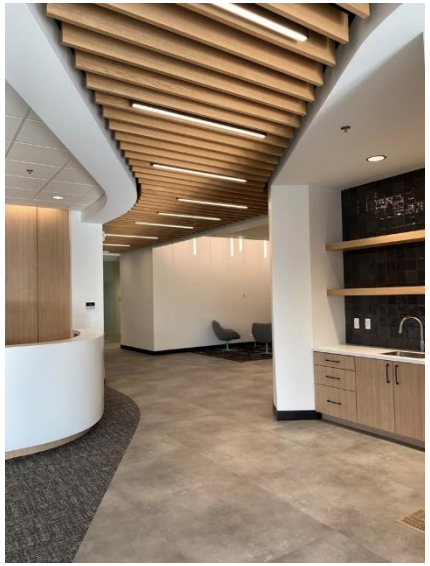
- Head of MPS EMC Lab in Detroit
- 20+ Years Experience in Automotive EMC Test and Design in Michigan
- 10+ Years Experience in Military & Commercial EMC Test & Design in Pennsylvania
- Designed, Built and Managed 4 Automotive EMC Labs
- Led the ISO 17025 Accreditation of 2 EMC Labs and Currently Working on the Third
- Additional Experience: Design and Quality Assurance Engineer
- Related Experience: 10 years Ford, 10 Years Hitachi, 3 years at MPS
- iNARTE Certified EMC Engineer
- BSEE and MBA Pennsylvania State University

Agenda

- Detroit Automotive Center
- EMC Testing Facilities
- Practical and Early Testing Showcases
- Open Q&A

MPS – Detroit Michigan

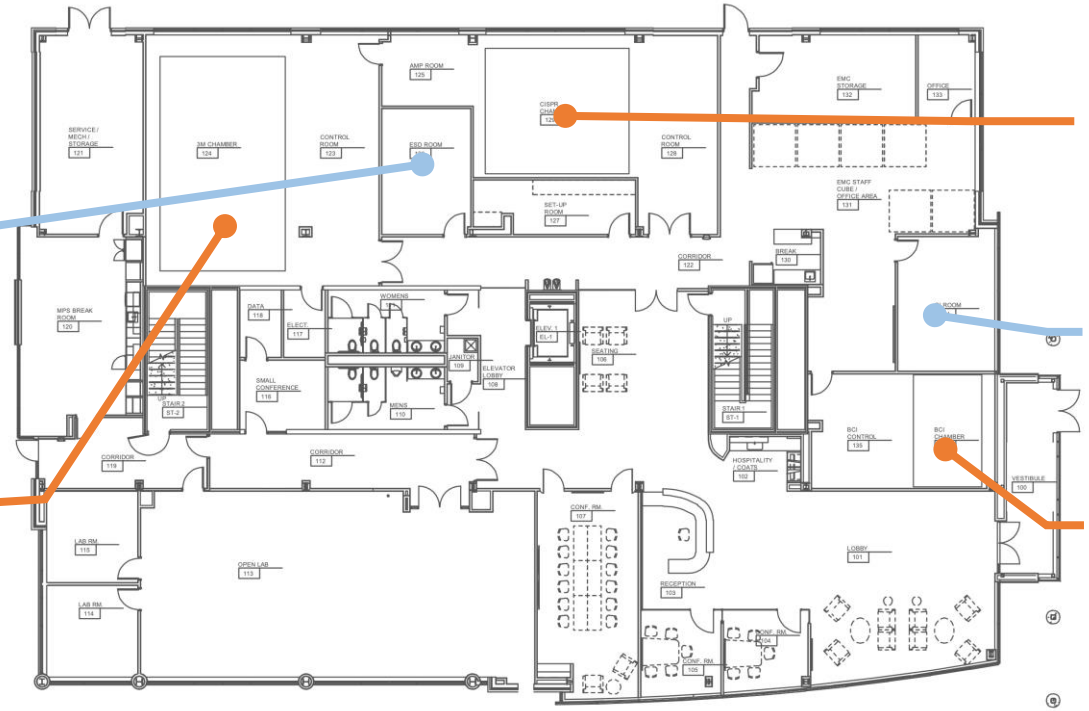




MPS Livonia

ESD Testing

3-Meter Chamber



CISPR Chamber

CI Testing

BCI Chamber

3 Meter Chamber

Automotive & Commercial

- ✓ Radiated Emissions (RE)
- ✓ Conducted Emissions (CE)

Commercial

- ✓ Radiated Immunity (RI)

Specifications

- ✓ CISPR25, CISPR32, ISO11452-9, IEC61000-4-3, FCC Part 15

CISPR Chamber

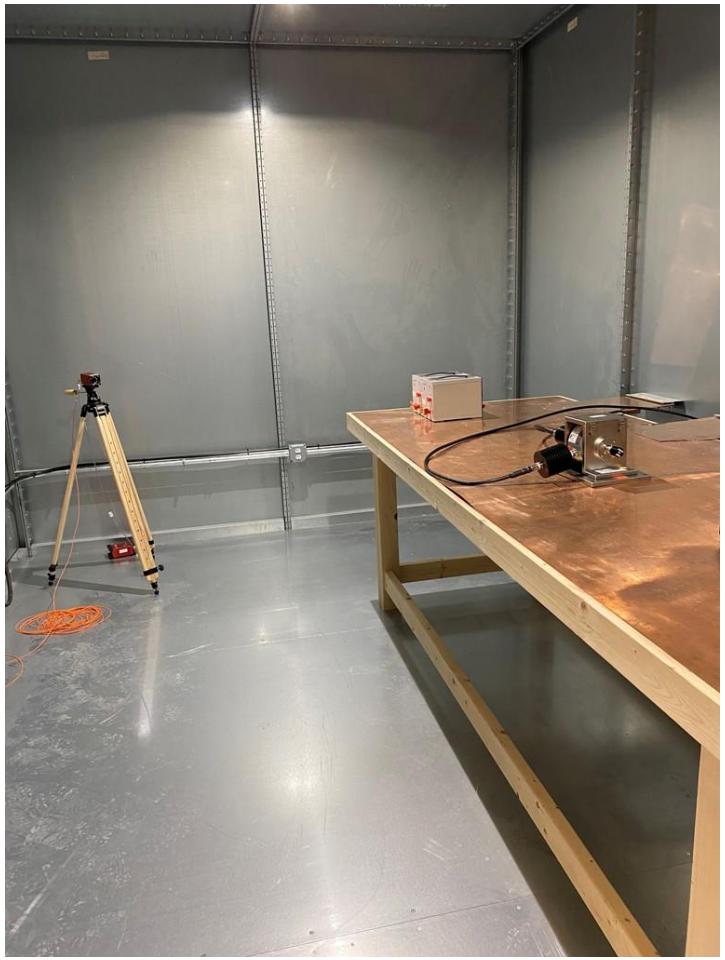
Automotive

- ✓ Radiated Emissions (RE)
- ✓ Conducted Emissions (CE)
- ✓ Radiated Immunity (RI)

Specifications

- ✓ CISPR25, ISO11452-9, ISO11452-2

BCI Chamber & Test Rack



Automotive & Commercial

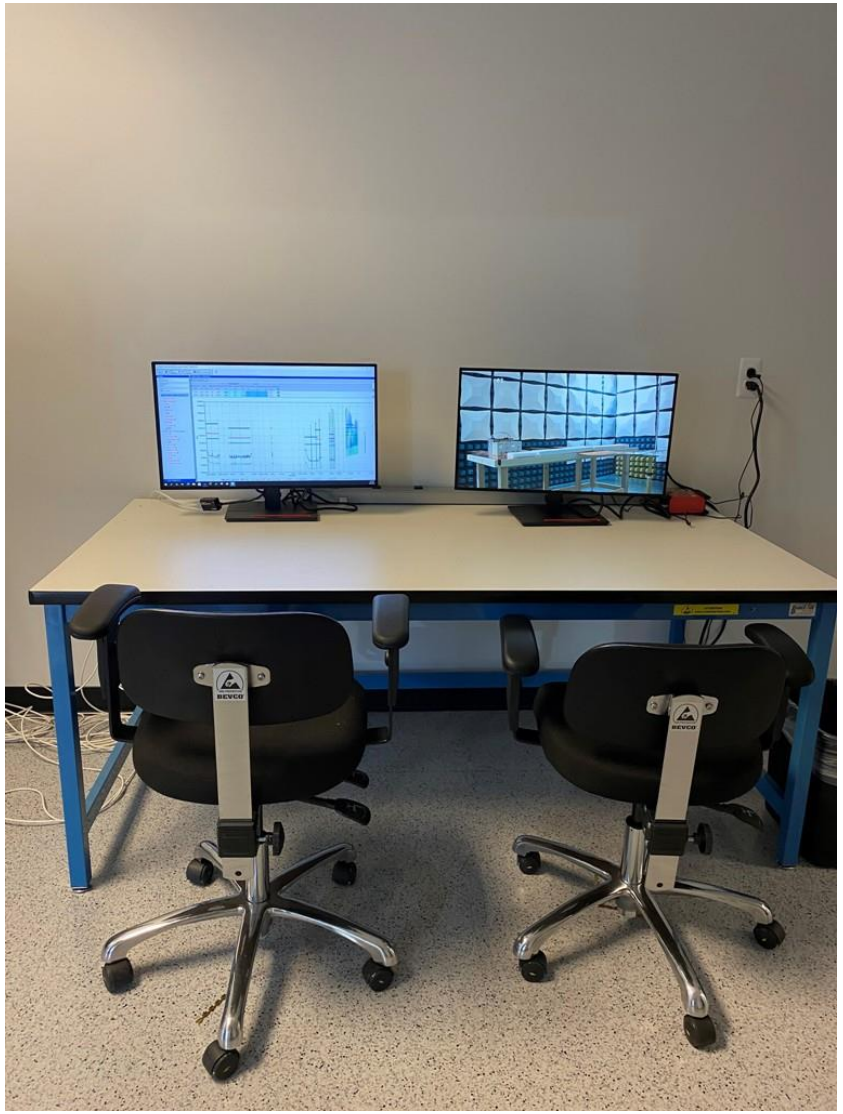
- ✓ Bulk Current Injection (BCI)
- ✓ Magnetic Immunity

Specifications

- ✓ ISO11452-8, ISO11452-4, IEC61000-4-6

Chamber Test Station (typ.)

Chamber Customer Monitoring Station (typ.)



CI Room

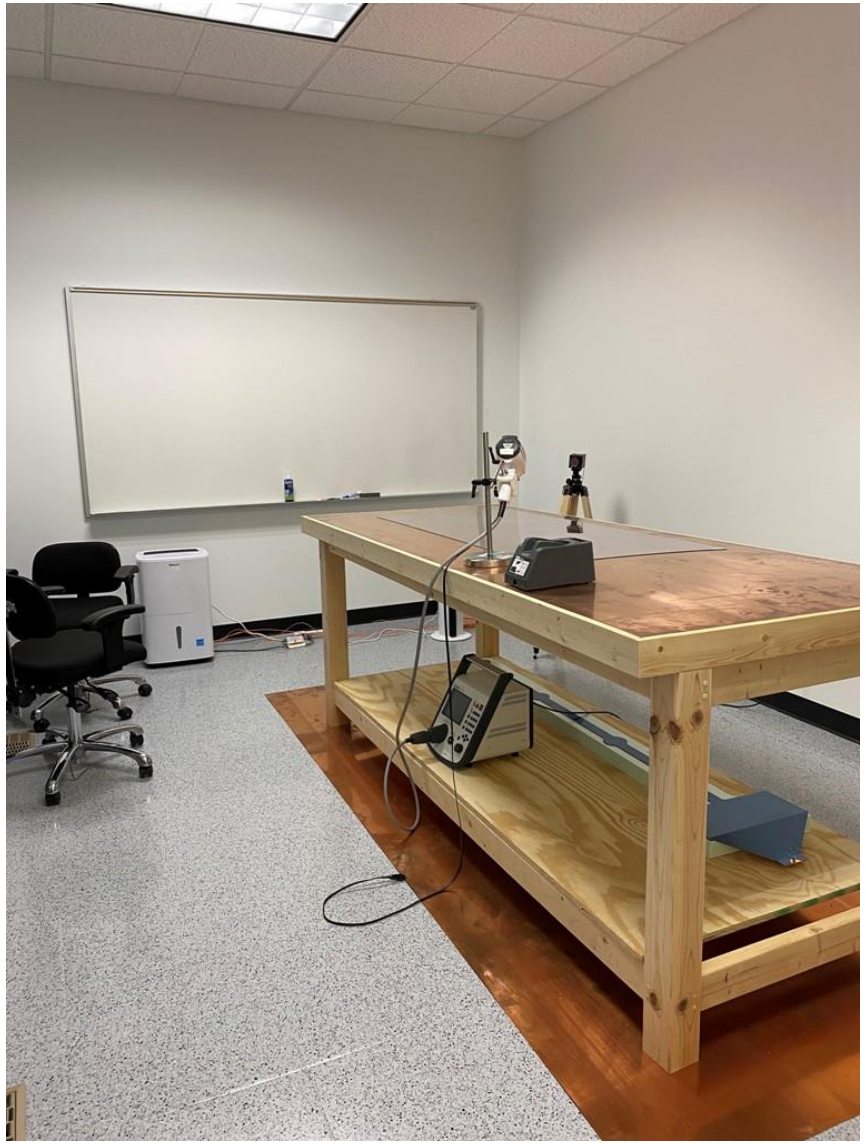
Automotive & Commercial

Conducted Immunity(CI)

Specifications

- ✓ ISO7637-2/3
- ✓ ISO 16750-4
- ✓ IEC 61000-4-4/5/11 VDI
- ✓ ANSI/IEEE C62.41

ESD Room



Automotive & Commercial

Electro Static Discharge(ESD)

Specifications

- ✓ ISO10605
- ✓ IEC61000-4-2

RI Magnetic

RI Near Field

Practical and Early Testing Showcases

Why is EMC important? – Functional point of view

Products need to work in a rough enviroment without emitting to much noise which can effect other products

Immunity

Products & Systems need to be robust enough to work at the rough environment of radio services, wireless services and disturbances.

Emmisions

The emitted noise & disturbances of products & systems need to be regulated.

Why is EMC important? – Economic point of view

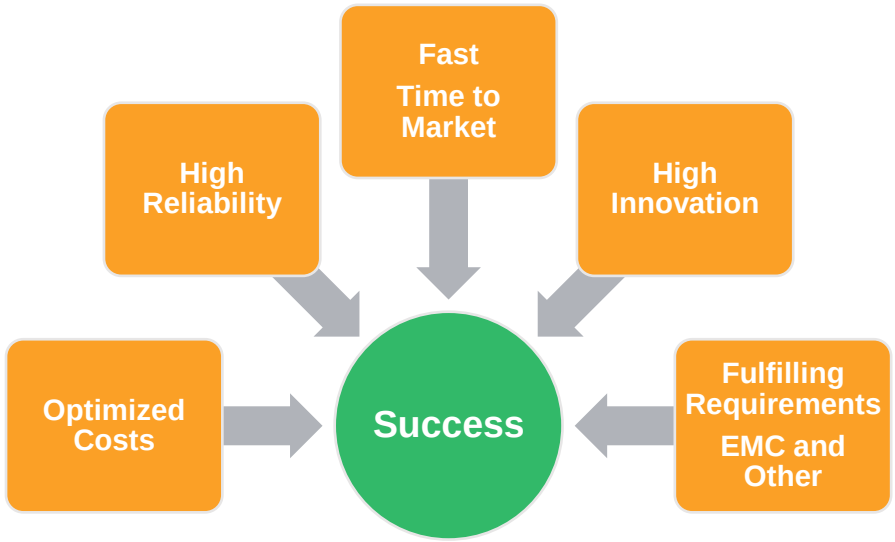
EMC results could effect the success of a product and the whole company.

To be successful in the long term, you have to be able to sell your products.

But you can only sell your products if you fulfil the EMC requirements.

Passing EMC is essential, if you would like to fullfil company goals and be successful.

A robust EMC development process shows the best possible compromise between…

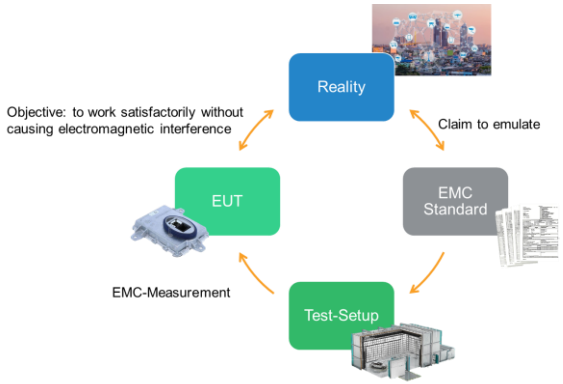


Practical and Early Testing

How Does EMC Become a Success Factor for Your Design Project?

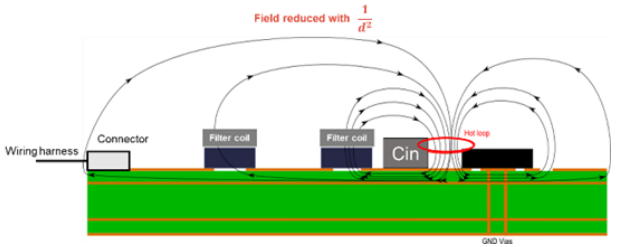
Understanding the Roots/Background of EMC and the defined Requirements

- Obtain the requirements for the product
- Define supplier requirements
- Define a test plan for the product and subassemblies



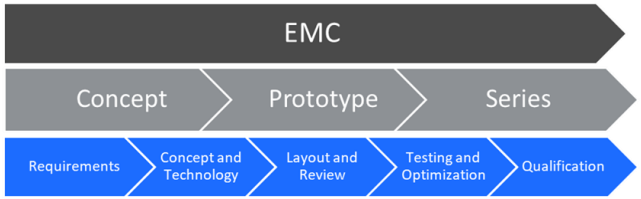
Consider EMC from the beginning of the Project

- Combine the mechanical and electrical concepts to determine the best overall concept
- **Conduct pre-tests by evaluating components to find the appropriate functional, thermal, and EMC viewpoints**



Clearly-structured EMC-development Process

- Conduct a hardware review and identify critical paths
- Leave room for additional filtering and modifications at the first layouts for investigations during a pre-test
- **Planning EMC tests during development (early state) and testing loops**



Practical and Early Testing

Conduct pre-tests by evaluating components to find the appropriate functional, thermal, and EMC viewpoints

- Discuss with your suppliers layout requirements, mandory components, options and different operational modes
  - Determine -How to set and choose the correct switching frequency
  - Possible other options which include(BST-Resistor, Spread Spectrum), Shielding,
  - Input filter (1-Stage / 2 Stage, Input-Caps…)

- Start testing with Evaluation-Boards and first prototypes to get a feeling and general understanding of the product/part.

Practical and Early Testing

Planning EMC tests during development (early state) and testing loops

- Leave room for additional filtering and modifications at the first layouts for investigations during a pre-test

- Get in touch with the Lab and define a test plan for the test-session
  - Talk about needed equipment and interfaces
  - Which power connectors are needed?
  - What should the wiring harness look like?

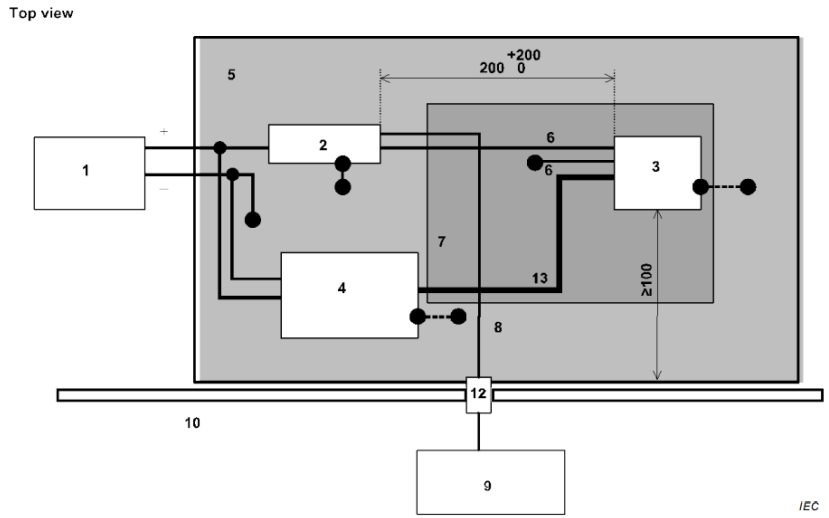
- Be realistic and plan testing loops to improve the product during the different testing states

Practical and Early Testing

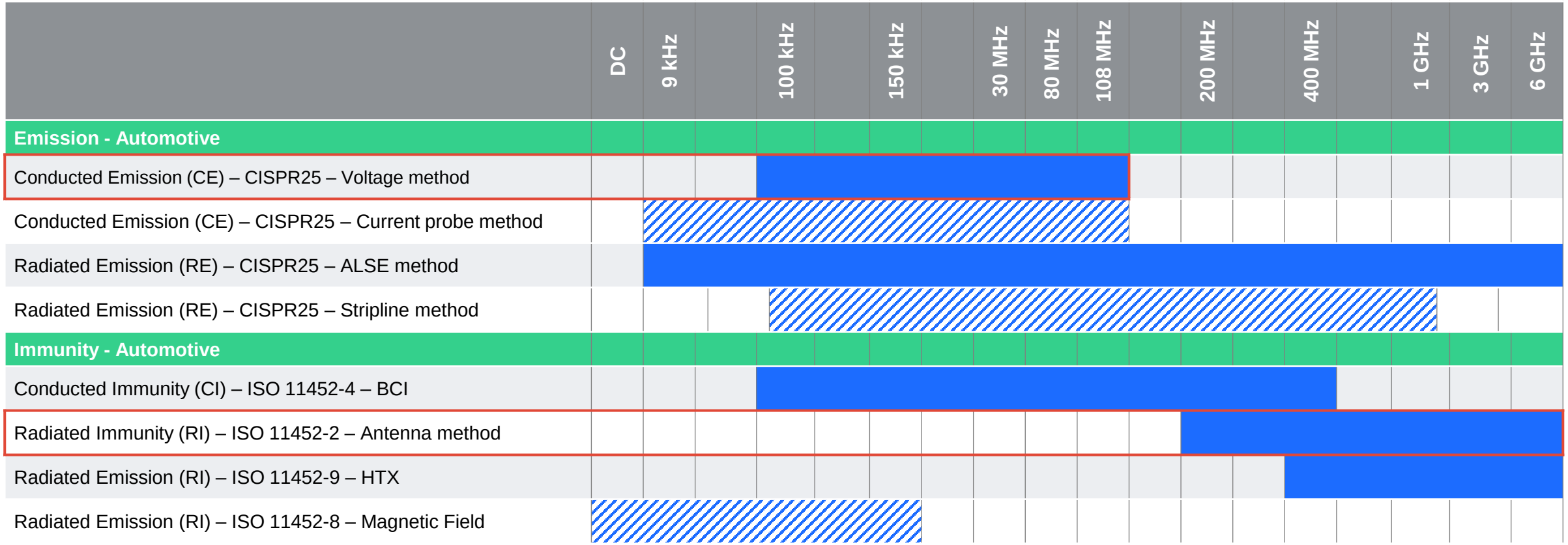
Planning EMC tests during development (early state) and testing loops

- Take (all) documents and spare parts with you to the Lab
  - Datasheets of the components used + Schematic + Layout
  - Reference Board from old measurements or previous internal measurements
  - Take spare PCBs and parts with you, as well as alternative components (different caps and inductors…)

- Prepare the test setup
  - Test Hardware and Software
  - Prepare all cables/harness and periphery
  - Make a list of all parts you need

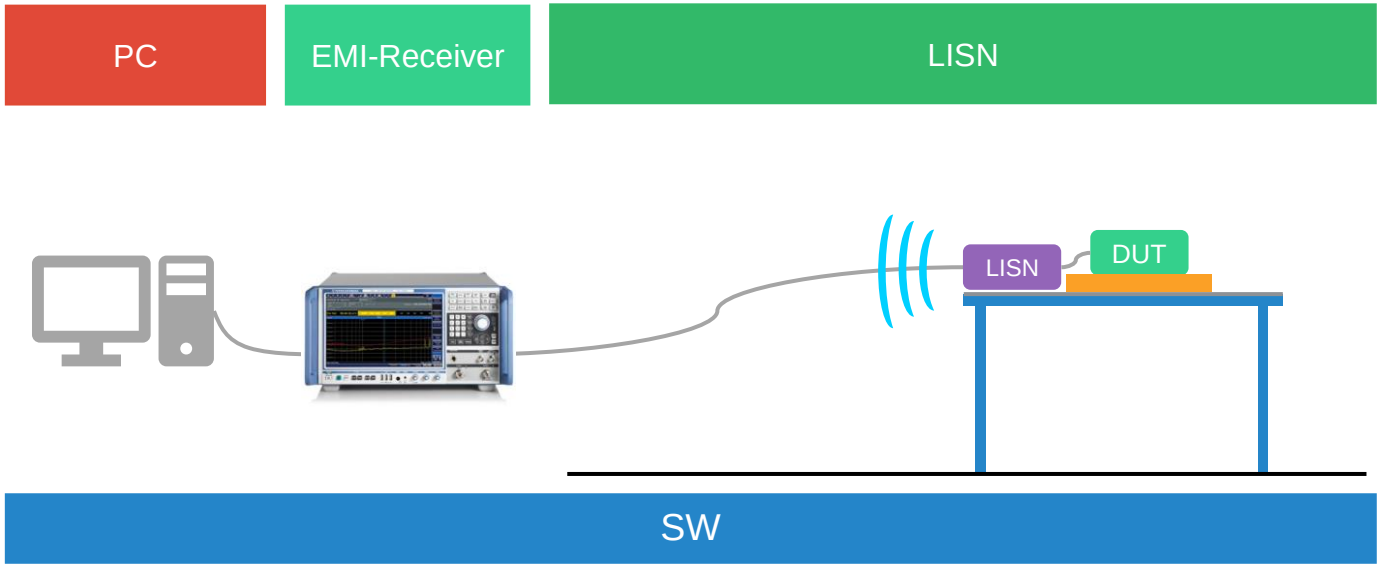


Overview – Test methods (Automotive)



Conducted Emission

You should be able to put the DUT at a functional status like in the real application with the worst case operation for Emission Testing.

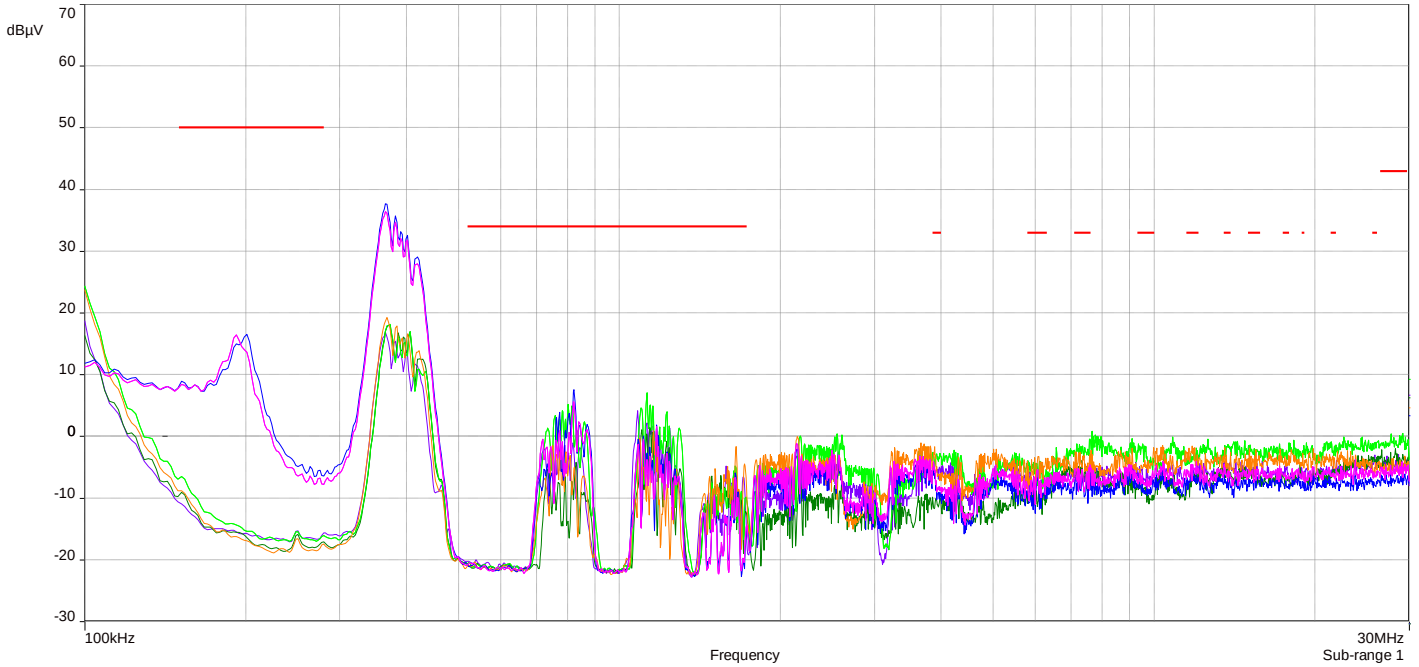


Conducted Emission measurements gives you a very good overview about your application in a short time.

- The measurement is quite fast
- The effort for the test setup is quite small.
- You can do the testing with a pre-compliance setup very good.

Conducted Emissions

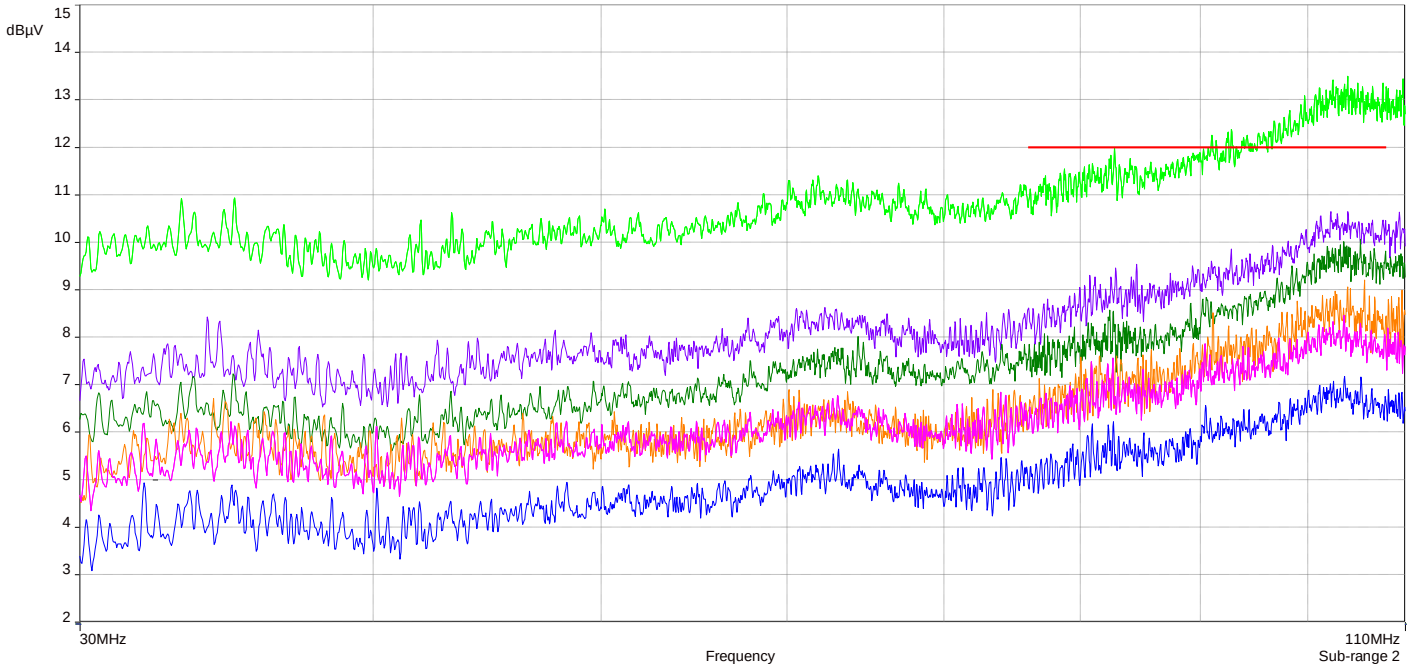
Conducted Emissions	0.15 kHz – 30 MHz	AVG-Detector	400kHz with Spread Spectrum



	Component	Component	Layout	Input-Filter	Layout	Result
Initial Setup	-	-				
Mod 1	Main-Coil turned by 180°					
Mod 2	Main-Coil turned by 180°	Main-Coil changed				
Mod 3	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces			
Mod 4	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces	modifyed Input-Filter		+18 dB
Mod 5	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces	modifyed Input-Filter	modifyed positions of Couts	0 dB

Conducted Emissions

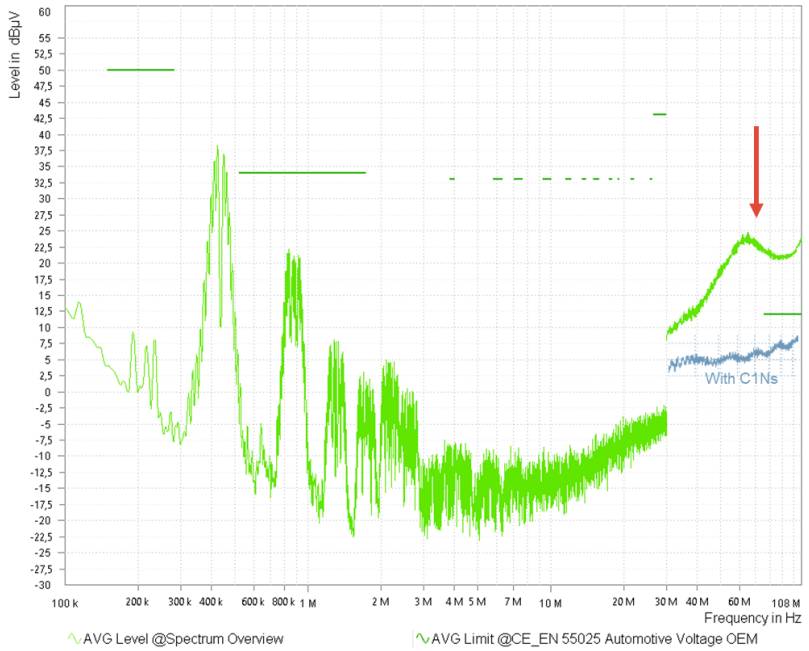
Conducted Emissions	30 MHz – 110 MHz	AVG-Detector	400kHz with Spread Spectrum

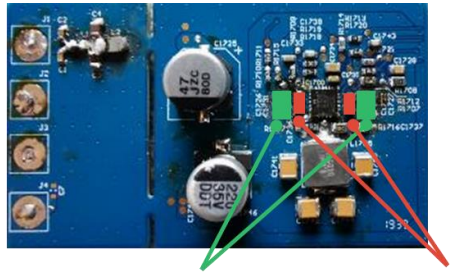


	Component	Component	Layout	Input-Filter	Layout	Result
Initial Setup	-	-				
Mod 1	Main-Coil turned by 180°					- 3 dB
Mod 2	Main-Coil turned by 180°	Main-Coil changed				- 0.5 dB
Mod 3	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces			-0.8 dB
Mod 4	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces	modifyed Input-Filter		-0.8 dB
Mod 5	Main-Coil turned by 180°	Main-Coil changed	Reduced SW-Loop and Vout-Traces	modifyed Input-Filter	modifyed positions of Couts	1.4 dB

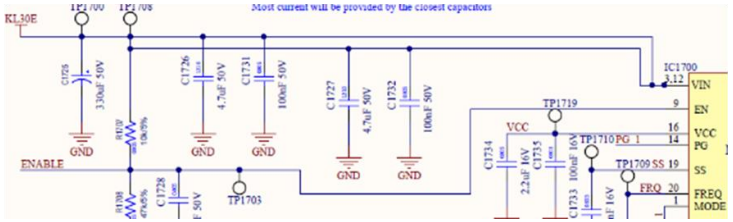
Conducted Emissions

Conducted Emissions	0.1 kHz – 110 MHz	AVG-Detector	400kHz with Spread Spectrum





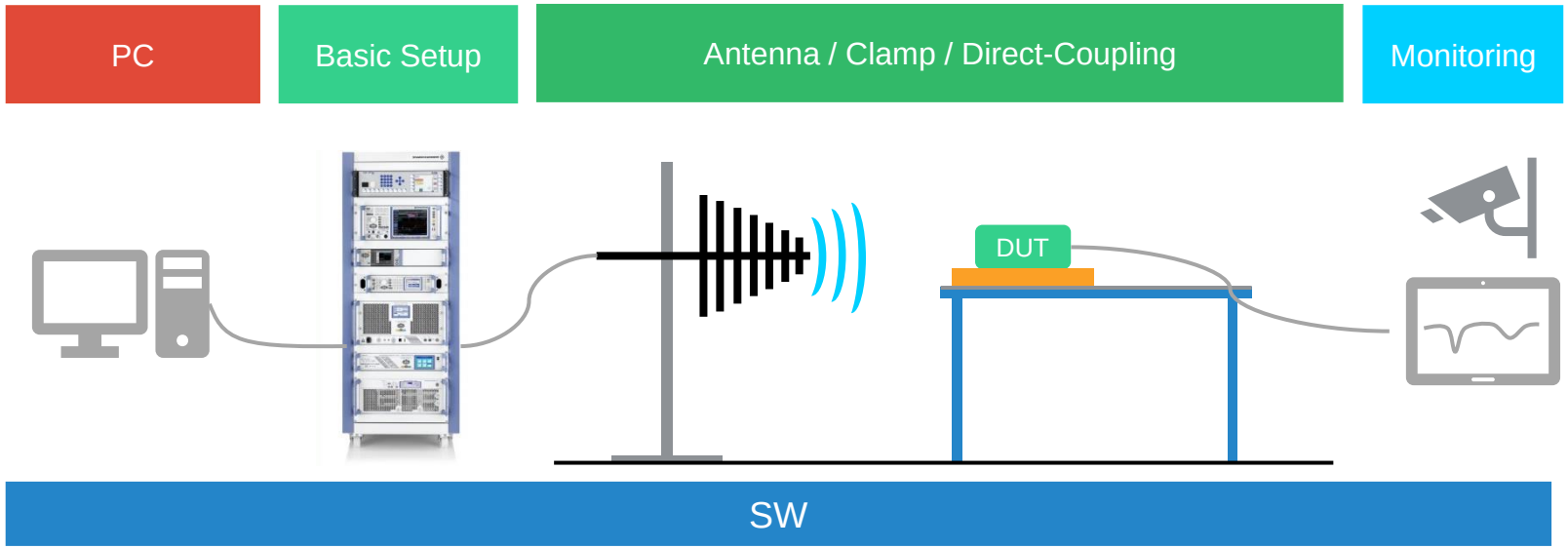
without C1726 + C1 727 and without C1731 + C1732



	Component	Component	Result
Initial Setup	Without CINs		
Mod 1		With CINs	- 15 dB

Radiated Immunity

You should be able to put the DUT at a functional status like in the real application and to monitor all relevant signals to understand the reaction on the disturbance if something happen.

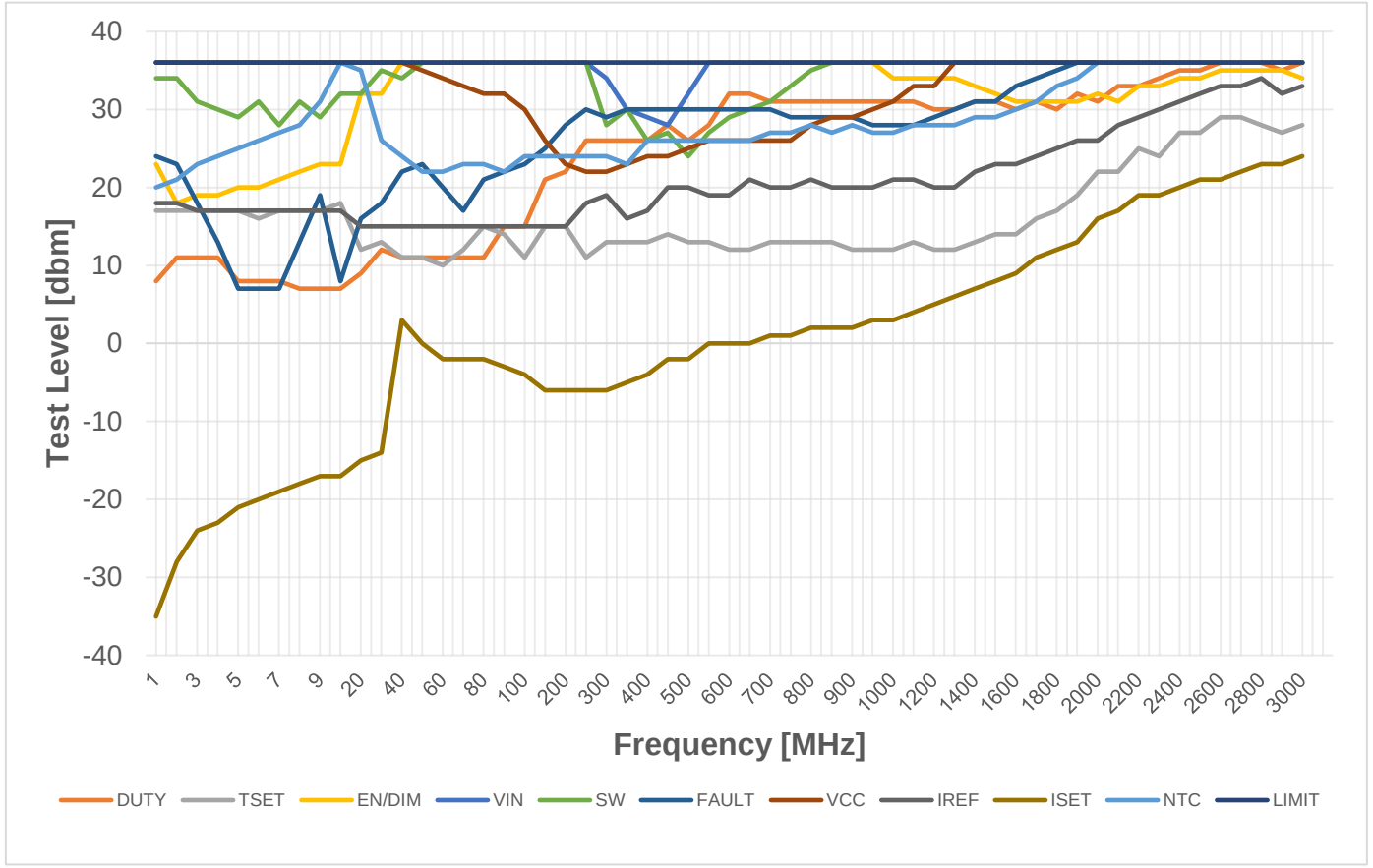


You want to test performance degradation in the presence of an electromagnetic disturbance. During the disturbance you have to monitor the DUT

- Optical via camera / Analog-Signals (Input-Voltage, Input-Current, Output-Voltage…) / Digital-Ports / Communication-Interfaces (LIN, CAN, Flexray…)

Immunity Behavior

Robustness against Disturbances



Some pins of a IC are sensitive per definition. Sensitive Pins needs to be routed carefully on the PCB. Traces could be act as an antenna.

Questions

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