Practical and Early Testing Showcases

Roots of EMI (Part 1)

November 2021

Why Is EMI Important? – Functional Point of View

Products need to work in rough environments without emitting too much noise, which can effect other products

The product/system needs to be robust enough to work in rough radio service, wireless service, and disturbance-heavy environments.

The emitted noise and disturbances of the product/system needs to be regulated.

Why Is EMI Important? – Economic Point of View

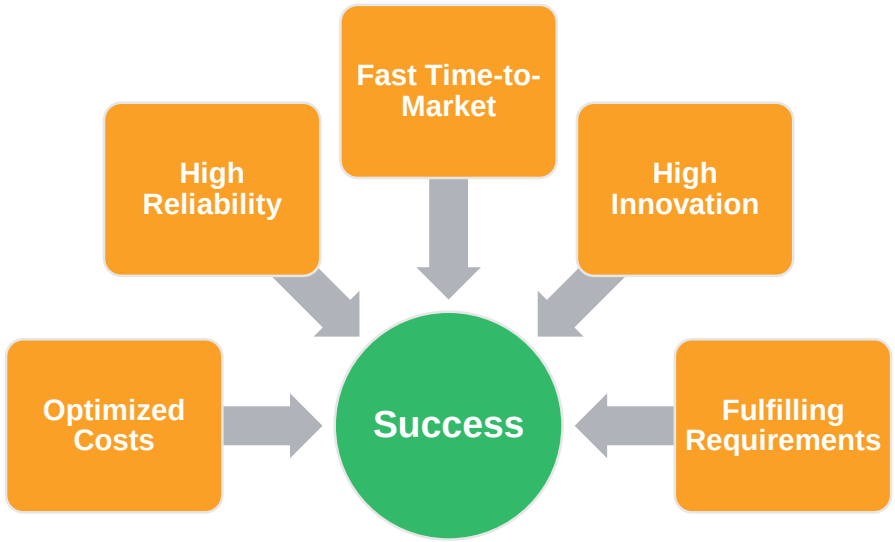
Poor EMI results could negatively affect the success of a product, and potentially the entire company.

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

But you can only sell your products if you fulfill the EMI requirements.

Addressing EMI is essential to fulfill company goals and to be successful.

A good EMI development process shows the best compromise between…

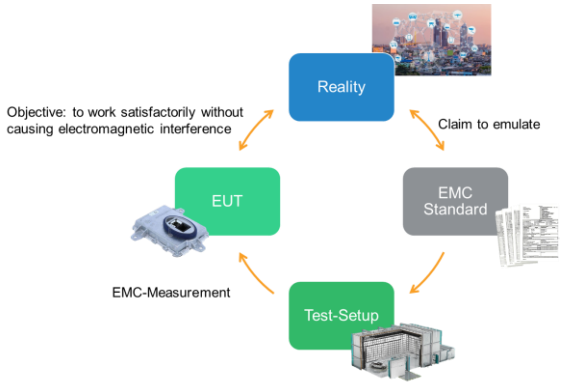


Practical and Early Testing

How does EMC become a success factor for your design project?

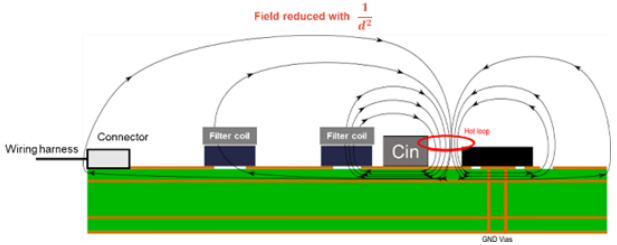
Understanding the Roots and Background of EMI and the Defined Requirements

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



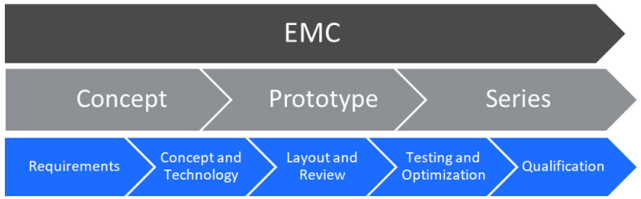
Thinking about EMI from the Beginning of the Project

- 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 EMI viewpoints**



Clearly Structured EMC Development Process

- Conduct a hardware review and identify critical paths
- Leave room for additional filtering and modifications to the first layout for investigation during pre-testing
- **Plan EMC tests during development (early stages) and testing loops**



Practical and Early Testing

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

- Talk with your suppliers about layout requirements, mandatory components, options, and different operation modes
  - How to set the switching frequency? How to choose the right switching frequency?
  - Which other options are possible (BST resistor, setting frequency spread spectrum, shieldings, input filter (1-stage/2-stage, input capacitors, etc.)
- Start testing with evaluation boards and prototypes first to get a feeling and general understanding of the product/part

Practical and Early Testing

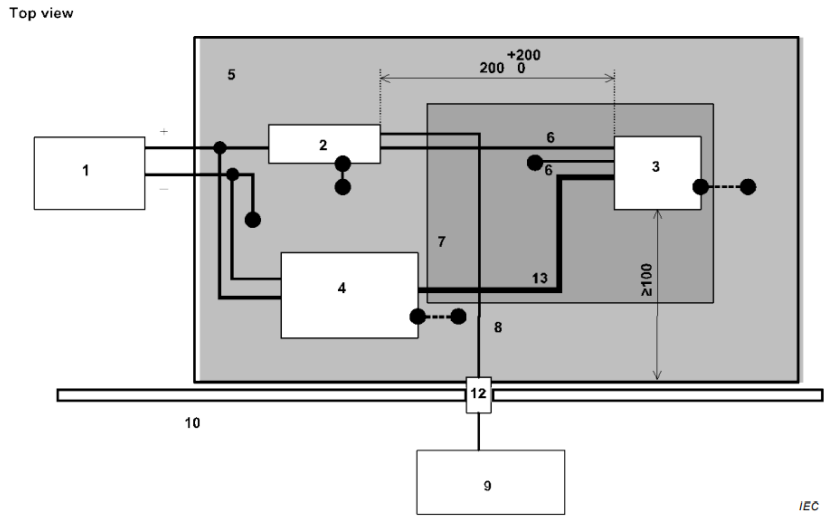
Plan EMC tests during development (early stages) and testing loops

- Leave room for additional filtering and modifications to the first layout for investigations during pre-testing
- Get in touch with the lab and define a test plan for the test session
  - Talk about required equipment and interfaces
  - Which power connectors are needed?
  - What should the wiring harness look like?
- Be realistic; plan testing loops to improve the product during the different testing stages

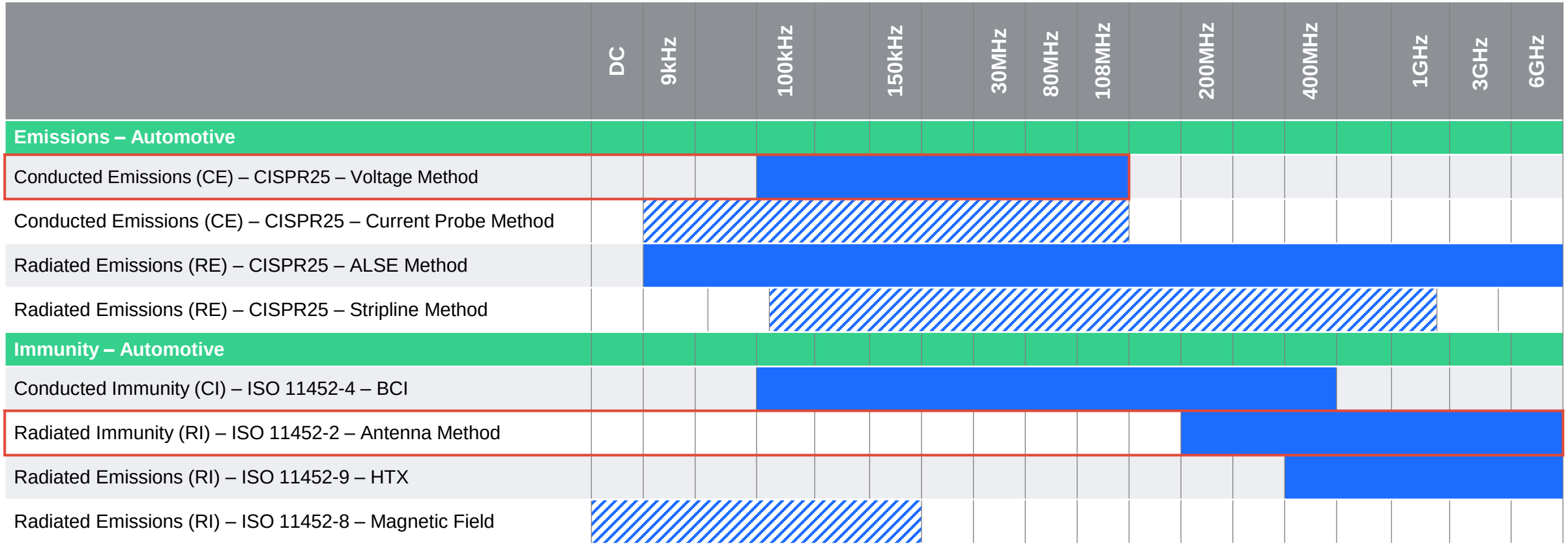
Practical and Early Testing

Plan EMC tests during development (early stages) and testing loops

- Take all documents and spare parts with you to the lab
  - Datasheets of the used components + schematic + layout
  - Reference board from old measurements and/or previous internal measurements
  - Take spare PCBs and parts with you, as well as alternative components (different capacitors and inductors, etc.)
- Prepare the test set-up
  - Test hardware and software
  - Prepare all cables/harness and periphery
  - Make a list of all parts you need

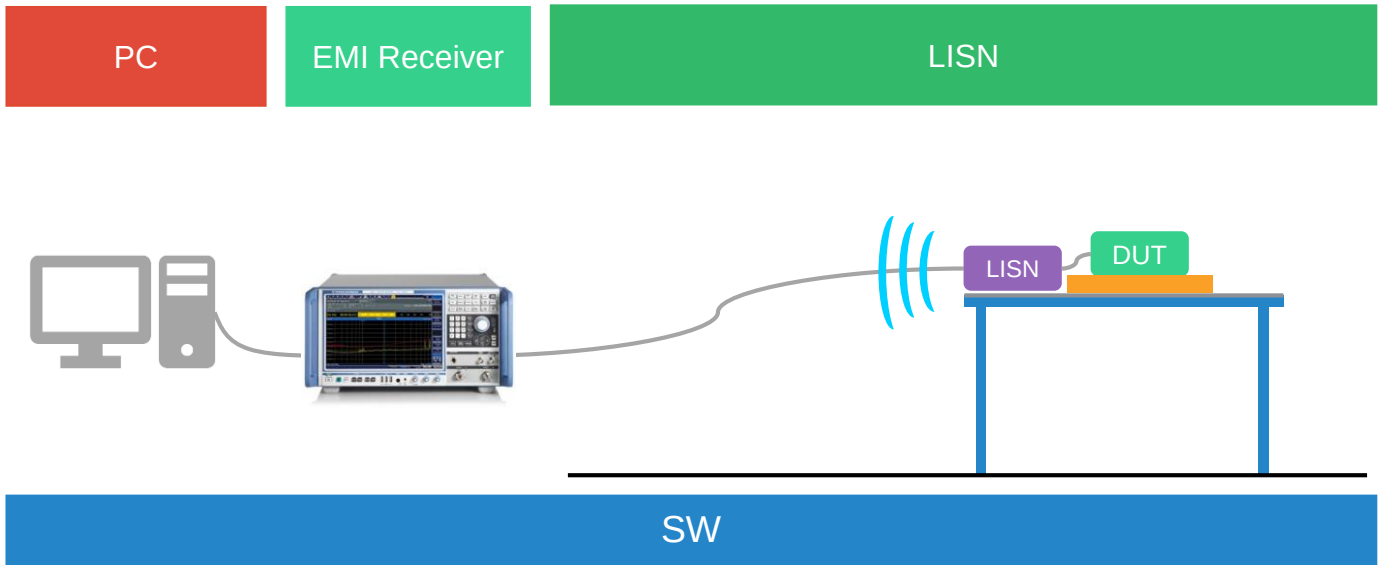


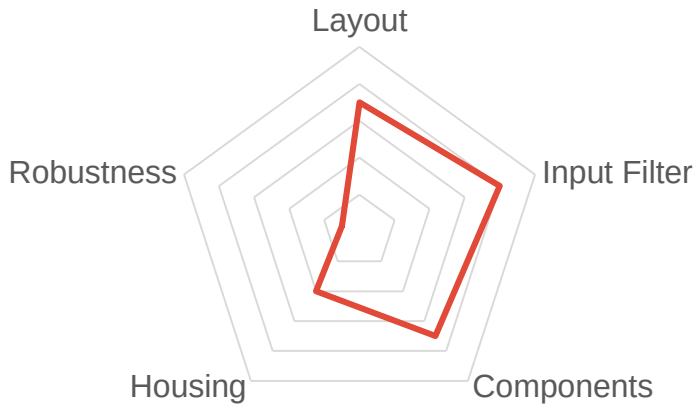
Overview – Test Methods (Automotive)



Conducted Emissions

You should be able to put the DUT in a functional status, like it would be in the real application, with the worst-case operation for emissions testing.



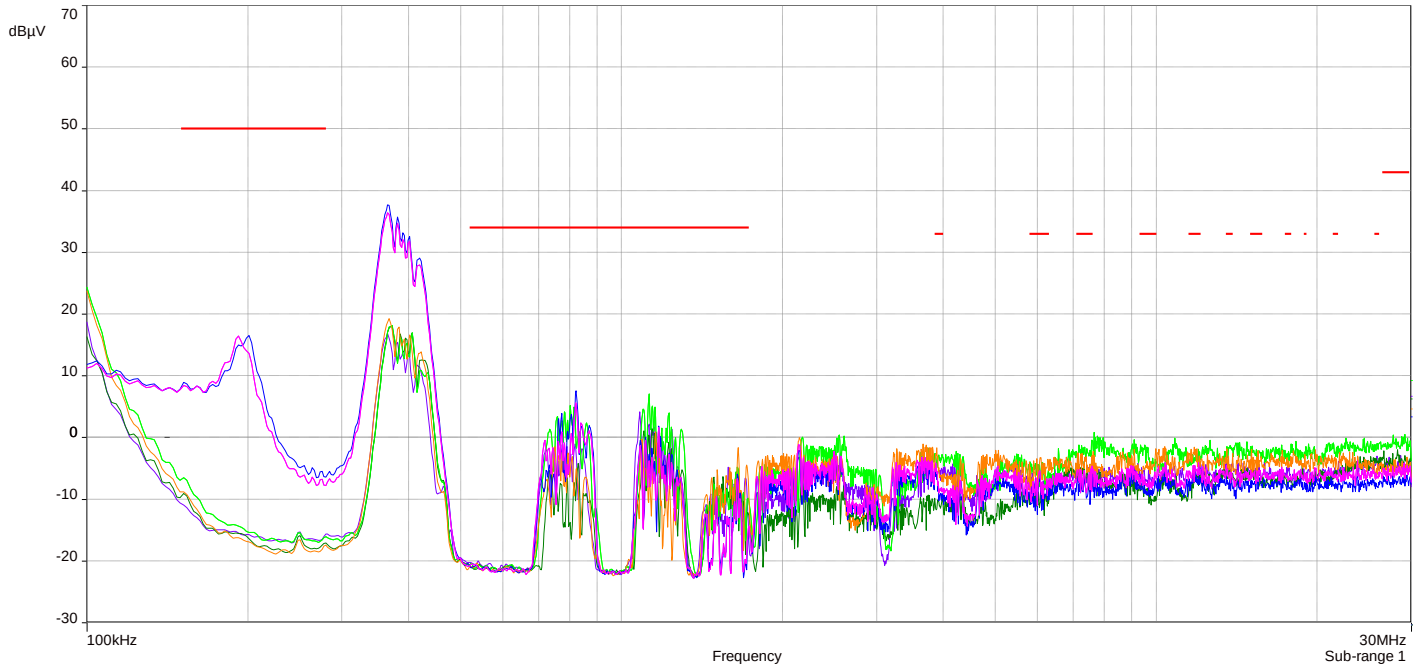


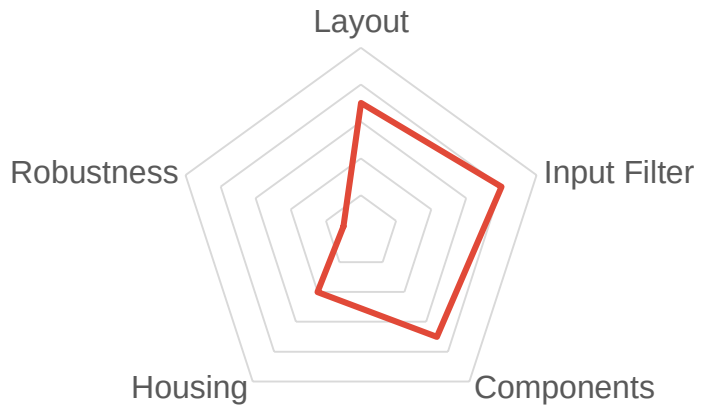
Conducted Emissions (CE) measurements gives you a very good overview about your application in a short time.

- The measurement is quite fast
- The effort for the test set-up is quite small
- Effective testing can be done with a pre-compliance set-up

Conducted Emissions

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

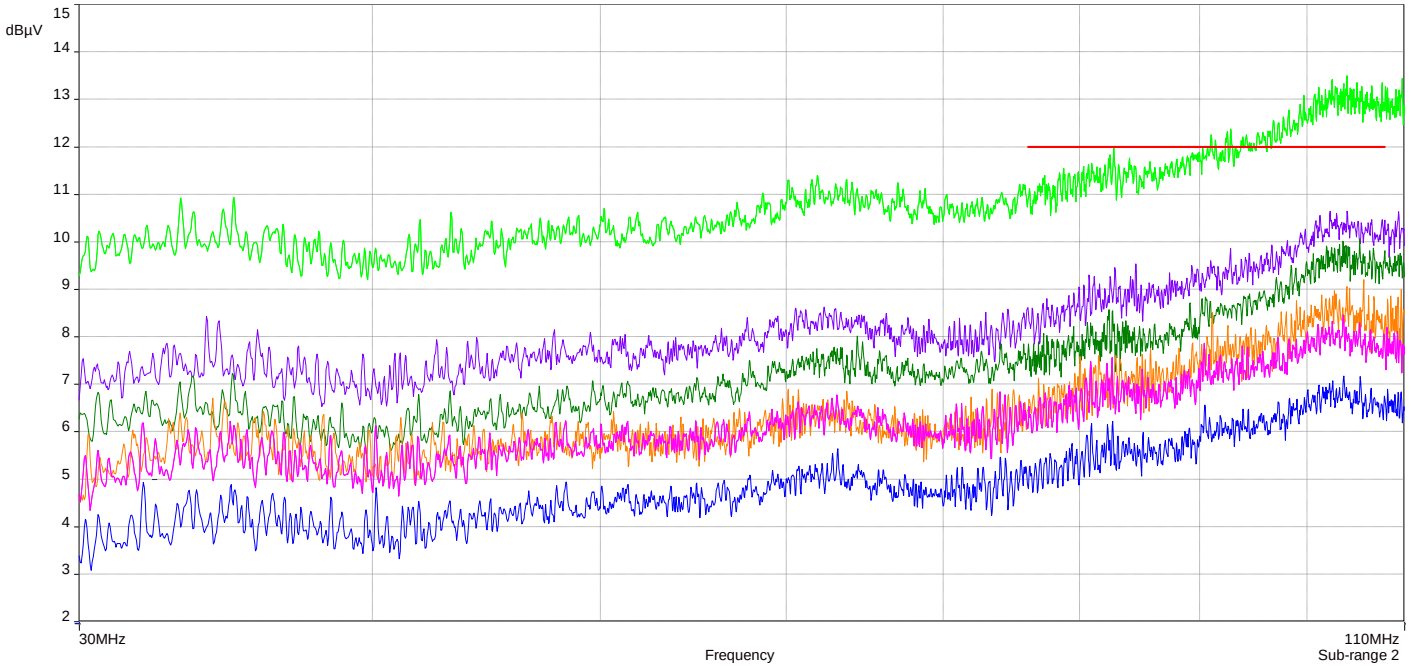


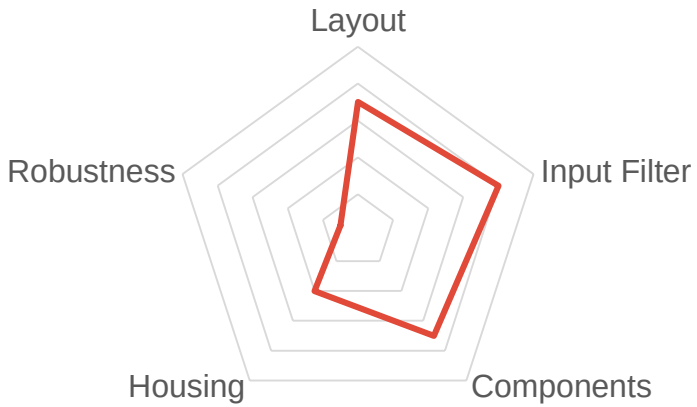


	Component	Component	Layout	Input Filter	Layout	Results
Initial Set-Up	-	-				
Mod 1	Main coil turned by 180°					
Mod 2	Main coil turned by 180°	Main coil changed				
Mod 3	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces			
Mod 4	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces	Modified input filter		+18dB
Mod 5	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces	Modified input filter	Modified positions of C_{OUT}	0dB

Conducted Emissions

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

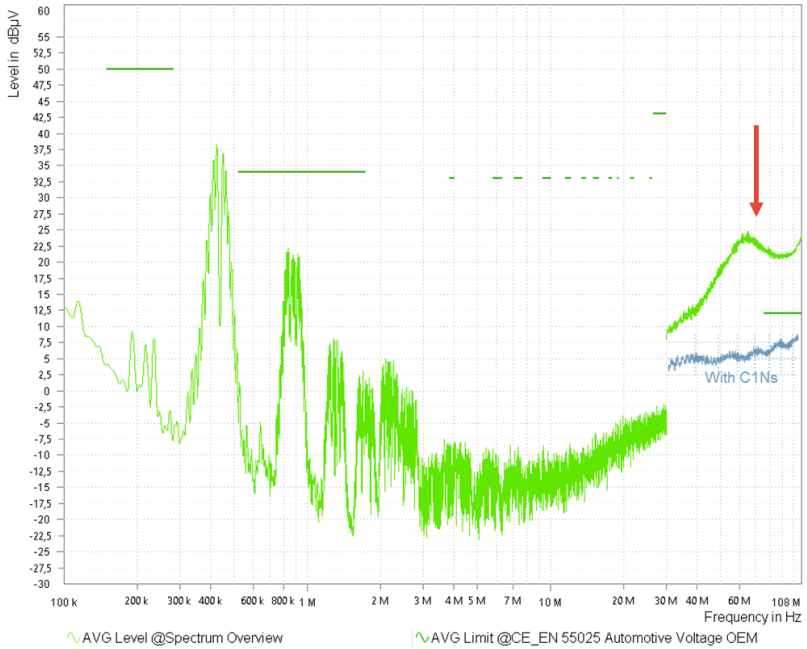


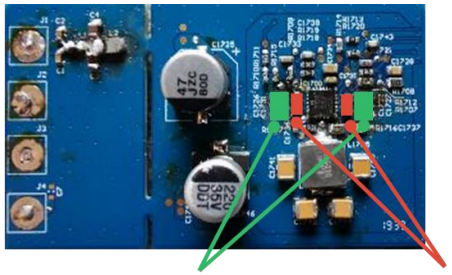


	Component	Component	Layout	Input Filter	Layout	Results
Initial Set-Up	-	-				
Mod 1	Main coil turned by 180°					-3dB
Mod 2	Main coil turned by 180°	Main coil changed				-0.5dB
Mod 3	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces			-0.8dB
Mod 4	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces	Modified input filter		-0.8dB
Mod 5	Main coil turned by 180°	Main coil changed	Reduced SW loop and V_{OUT} traces	Modified input filter	Modified positions of C_{OUT}	+1.4dB

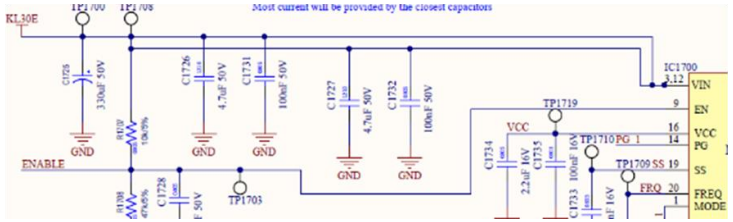
Conducted Emissions

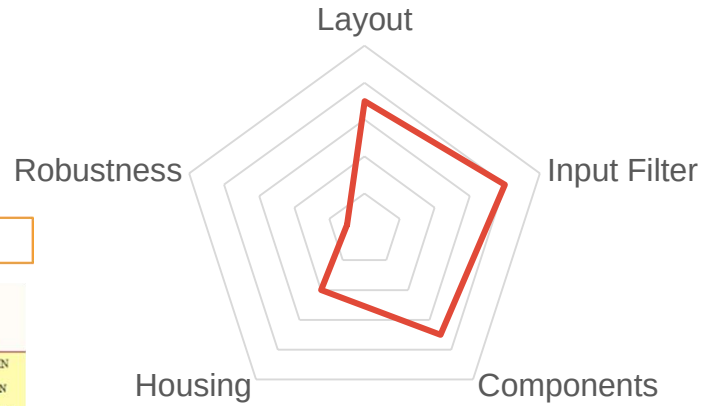
Conducted Emissions	0.1kHz to 110MHz	AVG Detector	400kHz with Spread Spectrum





without C1726 + C1 727 and without C1731 + C1732

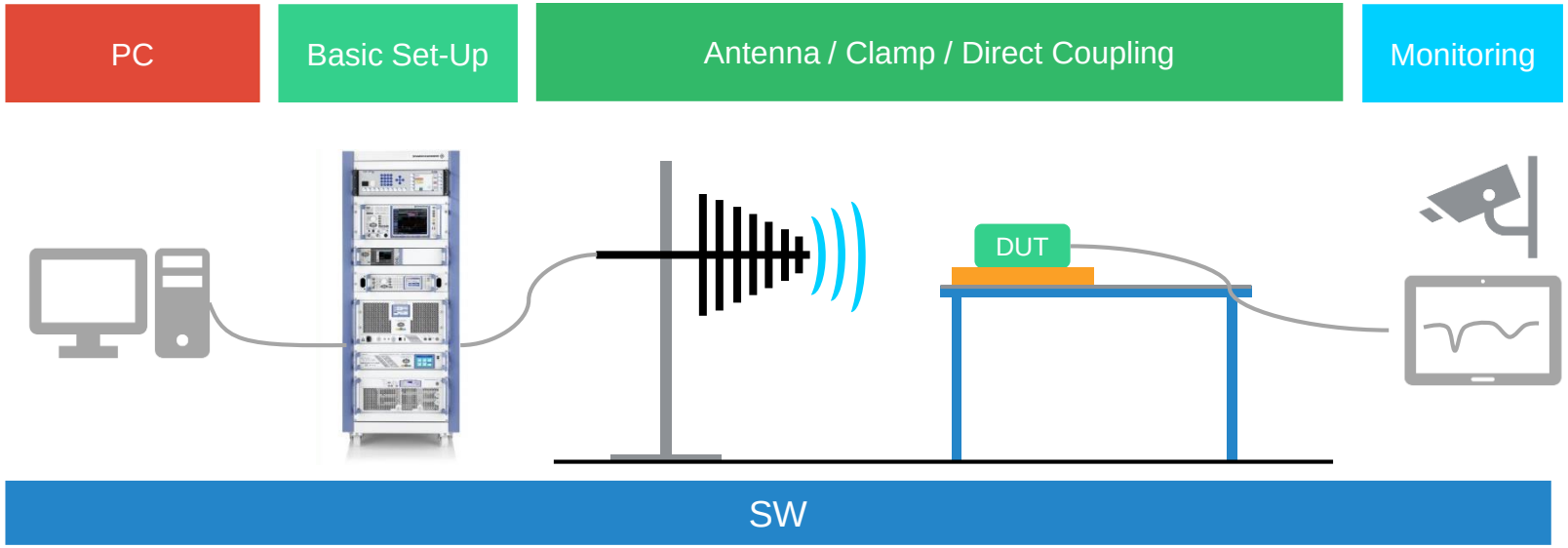


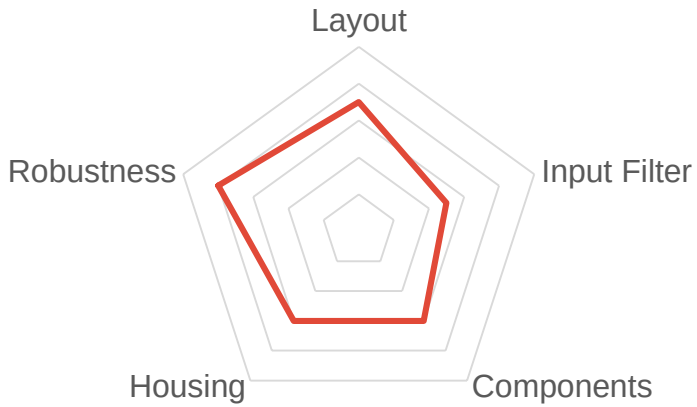


	Component	Component	Results
Initial Set-Up	Without C_{IN}s		
Mod 1		With C_{IN}s	- 15dB

Radiated Immunity

You should be able to put the DUT in a functional status, like it would be in the real application, and monitor all relevant signals to understand the effect on the disturbance if an unexpected event occurs.



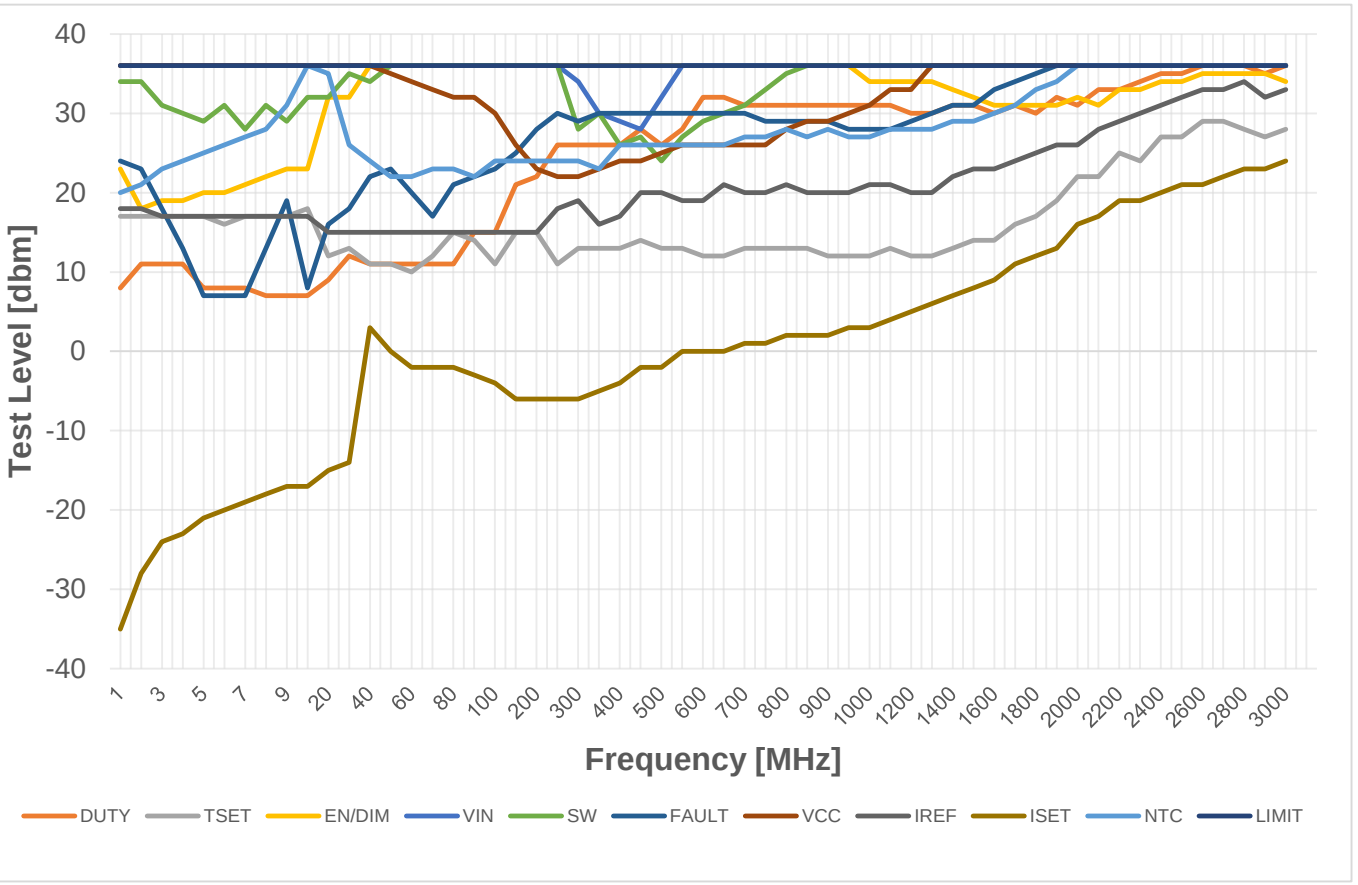


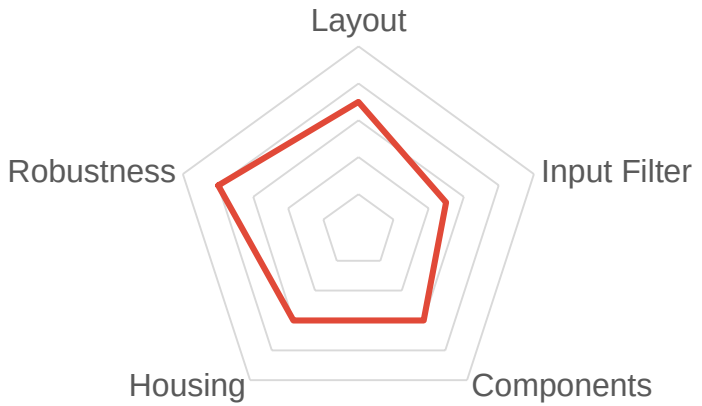
You want to test performance degradation in the presence of electromagnetic disturbance. During the disturbance, monitor the DUT:

- Optical via camera / analog signals (e.g. input voltage, input current, output voltage, etc.) / digital ports / communication interfaces (e.g. LIN, CAN, FlexRay, etc.)

Immunity Behavior

Robustness Against Disturbances





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

EMC Lab – Ettenheim, Germany

- Opened in June 2021
- Built from January 2020 to June 2021
- Office, meeting rooms, seminar rooms, and an EMC lab in 1,900sqm

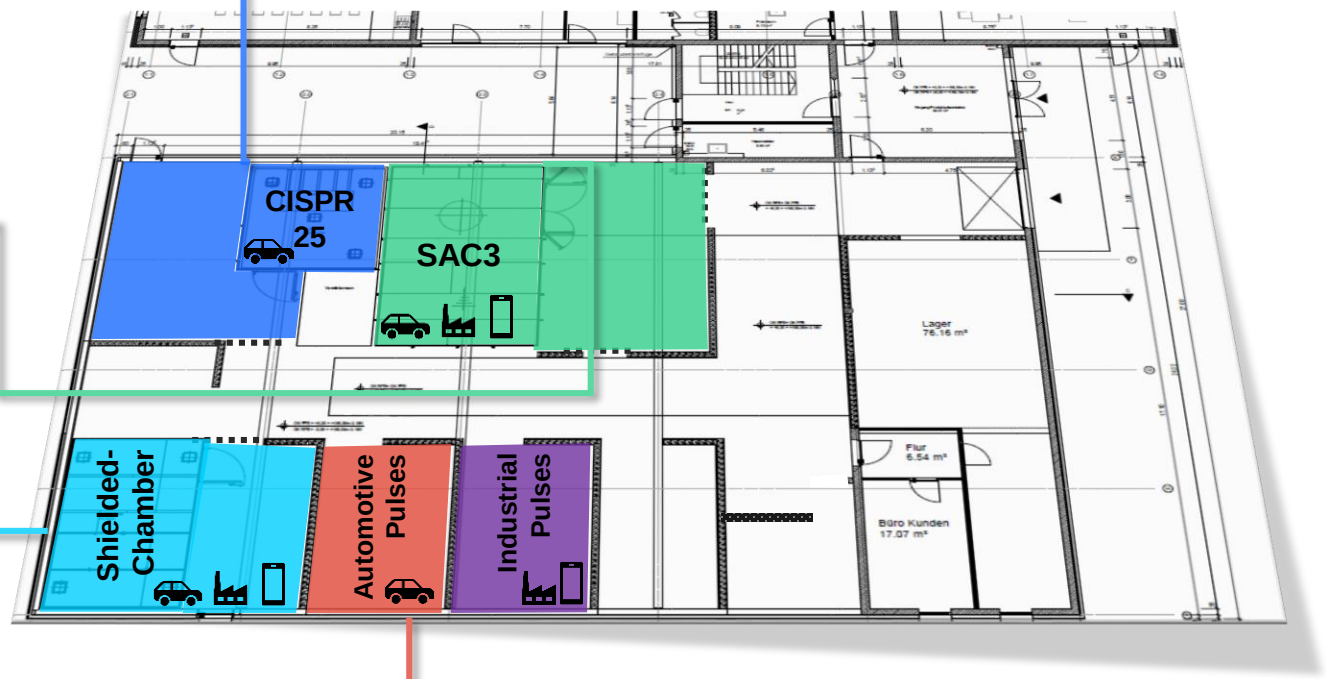
EMC Lab – Ettenheim, Germany

CISPR25 Chamber
For emissions and immunity testing of automotive electronics

SAC3 Chamber
For emissions and immunity testing of automotive, industrial, and consumer electronics

Shielded Chamber
For conducted emissions and immunity testing of automotive, industrial, and consumer applications

Pulse and Electrical Testing
Workplaces for electrical testing according to automotive and industrial standards



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