Demystifying EMC 2025

CHALLENGES FOR EMISSION MEASUREMENTS IN THE MODERN AUTOMOTIVE INDUSTRY

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Make ideas real

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AUTOMOTIVE TECHNOLOGIES

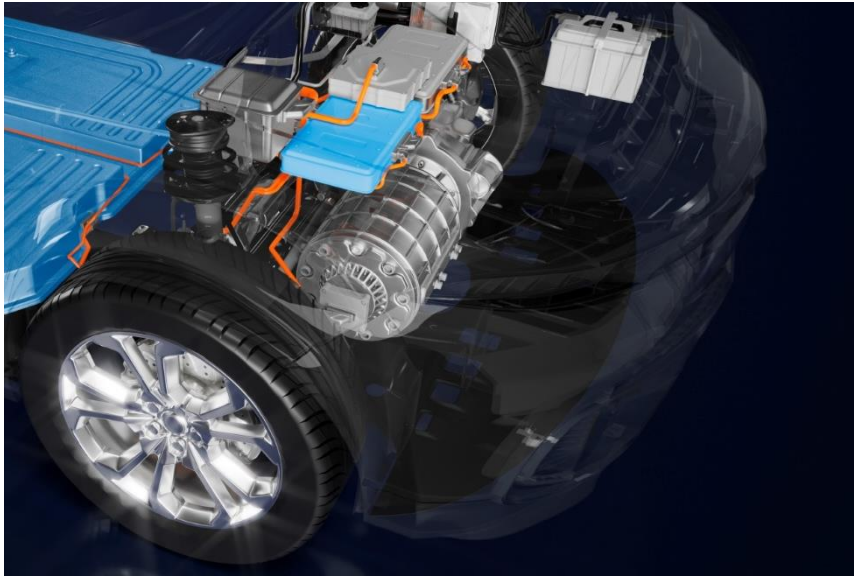
AUTOMOTIVE TECHNOLOGIES – E-MOBILITY

Every new Vehicle will have an electrified power train

- MHEV (Mild Hybrid Electric Vehicle / 48V)
- PHEV (Plugin Hybrid Electric Vehicle / ~400V)
- EV (Electric Vehicle / 800V;1500V)

EMI-Challenges :

- Fast switching of high-power density
  - High **broadband** emission
- Emissions are **not stable** and influenced by:
  - Voltage, power, torque, temperature
  - Different switching Modulations
  - Software power control algorithm (e.g.: FPGA)
- “Components” with the (half) size of a Vehicle
  - HV-Batteries, E-Axle…..

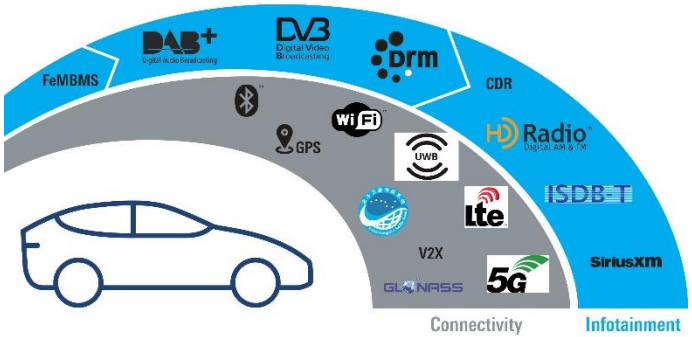


AUTOMOTIVE TECHNOLOGIES - CONNECTIVITY

- Vehicles becoming a “Driving Smartphone”
- Customers expect all Digital Services with good quality in their Vehicle
- Connectivity Quality should not be influenced by internal inference in the vehicle.

EMI-Challenges :

- **Increase** of relevant **Frequency Range** due to new technologies (WIFI7,5G, UWB….)
- **Increase** of **Test time** demand to check quality of all services in all relevant operating conditions.



AUTOMOTIVE TECHNOLOGIES – INFOTAINMENT

- "Driving Living Room" + "Software defined vehicle"
- Larger Screens with high resolution (4k/8k)
- DSP controlled HQ Audio systems
- Higher computing power
- Highspeed Bus (CAN-FD;100/1000 Base-T1 Eth)
- Increased power consumption

EMI-Challenges :

- **Higher** working **Frequency**
- **Software dependent Noise Source**
  - OS/DSP/FPGA/Firmware
  - Spread spectrum
- **Increase** of complexity / **operating conditions**

AUTOMOTIVE TECHNOLOGIES – COMFORT SYSTEMS

- Electrified heating and cooling systems
- Massive increase of actuators and sensor to move:
  - windows; sunroof; trunk; seats; mirrors, doors
- Heating of:
  - windows; seats, steering wheel, seat belt

EMI-Challenges :

- Mechanical components become electrical:
  - New component types must be EMC tested
- Lot of components can't operate stable, in worst case, over a long time.
  - Measurements must be carried out fast
- Challenging statistical interference source
  - e.g.: brush motor

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EMI TESTING

EMI TESTING - SHORTER DEVELOPMENT TIMES

- Demand for fast EMI (measure) Status
  - vehicle series / component samples
- Increase of fast EMI analysis capabilities
  - Identifying of (short) interference sources and their behavior over time (spectrogram)
- Use existing EMC resources more efficient (Chambers, Equipment, EMC Experts)
  - Higher automation in EMC processes (planning – measurement – analysis – reporting/status)

EMI TESTING - INCREASE OF COMPLEXITY

- Worst Case Analysis with all important EMI parameters
  - Voltage, power, torque, temperature, DUT orientation to Antenna
  - Longer measurement time need to cover all condition for worst case
- Increase of Operating conditions / configurations
  - DUT off (Noise), Standby, Operation Point 1,2,3……
- Software depended inference sources
  - EMI Testing for Software updates needed
- DUT operating not stable in general or over a longer time
  - e.g.: E-Axis (Dynamic Driving), Brush Motors, Seat Heating…..

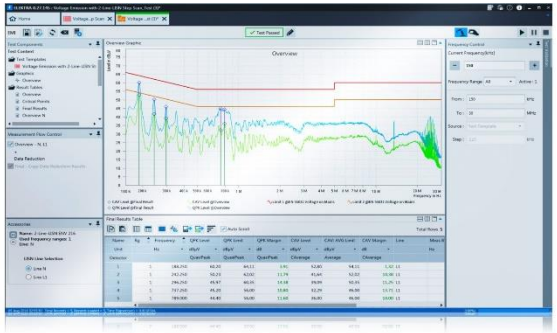
EMI CHALLENGES – POSSIBLE SOLUTION

Fast EMI Measurement

► Wideband FFT

Automation of Measurement

► EMC Test software



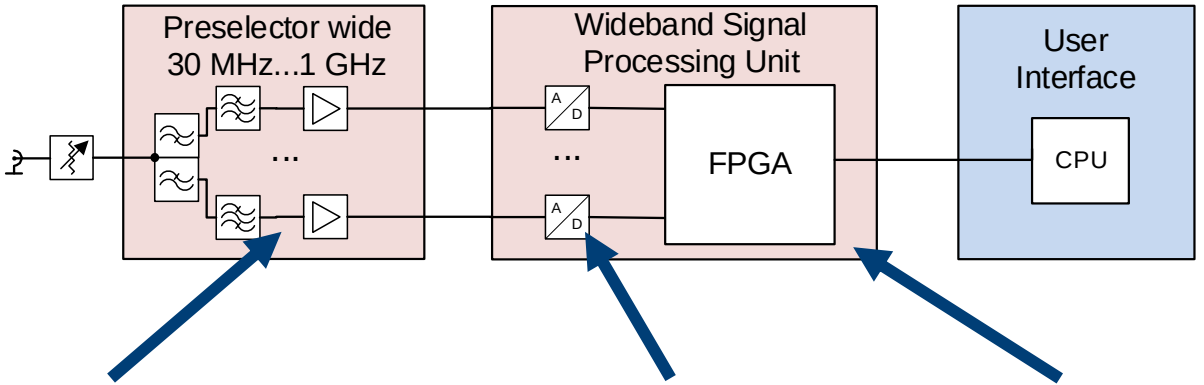
New Measurement Methods

► EMI in Reverberation Chambers

(under Development)

WIDEBAND EMI RECEIVER

970 MHz
FFT bandwidth
- 120 kHz RBW
- 30 MHz – 1 GHz (CISPR Band C&D)



Parallel signal paths cover **CISPR bands C and D**

All eight paths have their own preselection and preamplifier to achieve **maximum dynamic range**

Parallel A/D converters

Split signal path increases dynamic range for pulses

Massive computing power to calculate the spectrum in **real-time**

MEASUREMENT TIME COMPARISON ON COMPONENT LEVEL

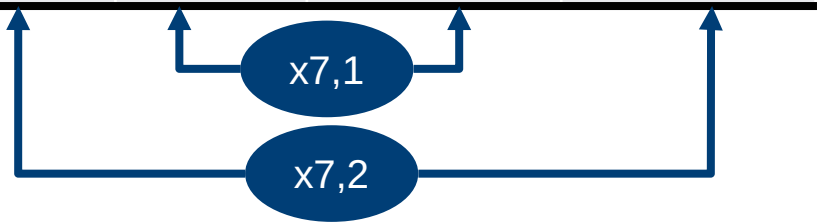
	R&S®ESW		R&S®ESW + B1000	
Measurement Time	1s	10s	10s	1s
Magnetic Field 60cm	~3s	~21s	~21s	~3s
Magnetic Field 12cm	~7s	~61s	~61s	~7s
Conducted AN	~17s	~89s	~55s	~10s
Conducted CP	~16s	~88s	~54s	~9s
Radiated Rod	~4s	~22s	~22s	~4s
Radiated BICON	~33s	~186s	~54s	~9s
Radiated LPDA	~94s	~553s	~54s	~9s
Radiated Horn	~416s	~2279s	~188s	~35s
Stripline	~129s	~750s	~87s	~15s

Reference is a component standard of a big OEM

TOTAL MEASUREMENT TIME OF AN EXAMPLE DUT

		R&S®ESW		R&S®ESW + B1000	
Measurement Time	Positions	1s	10s	10s	1s
Magnetic Field 60cm	3 (X,Y,Z)	~9s	~63s	~63s	~9s
Conducted AN	3 (KL15,30,31)	~51s	~267s	~165s	~30s
Conducted CP	2 (50+750mm)	~32s	~176s	~108s	~18s
Radiated	2 (Hor./Ver.)	~1090s	~6058s	~614s	~110s
Stripline	1	~129s	~750s	~87s	~15s
TOTAL		1311s	7314s	1037s	182s
TOTAL x 3		3933s (1,09h)	21942s (6,10h)	3111s (51,85min)	546s (9,1min)

The Total measurement time calculated with 3 Operating Conditions.
1. Noise Floor
2. DUT Standby
3. DUT Operating



SUMMARY – WIDEBAND RECEIVER

- Increase measurement speed.
  - Faster EMI Status
  - Faster Worst Case Analysis
  - Faster measure analysis (Task force)
- Increase measurement capacity with your existing resources (Chamber, EMC Experts)
- Accurate measurement and analysis of DUT with short operating time.

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Thank you for listening.

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