



Advanced EMC-Test Systems & Applications

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Today's Agenda

1

Current Automotive EMC Norms

Overview of EMC Norms for Vehicles and Components

2

Typical EMC Component Test System Setup

Basic Test System Structure and AVL EMC Load System Solutions

3

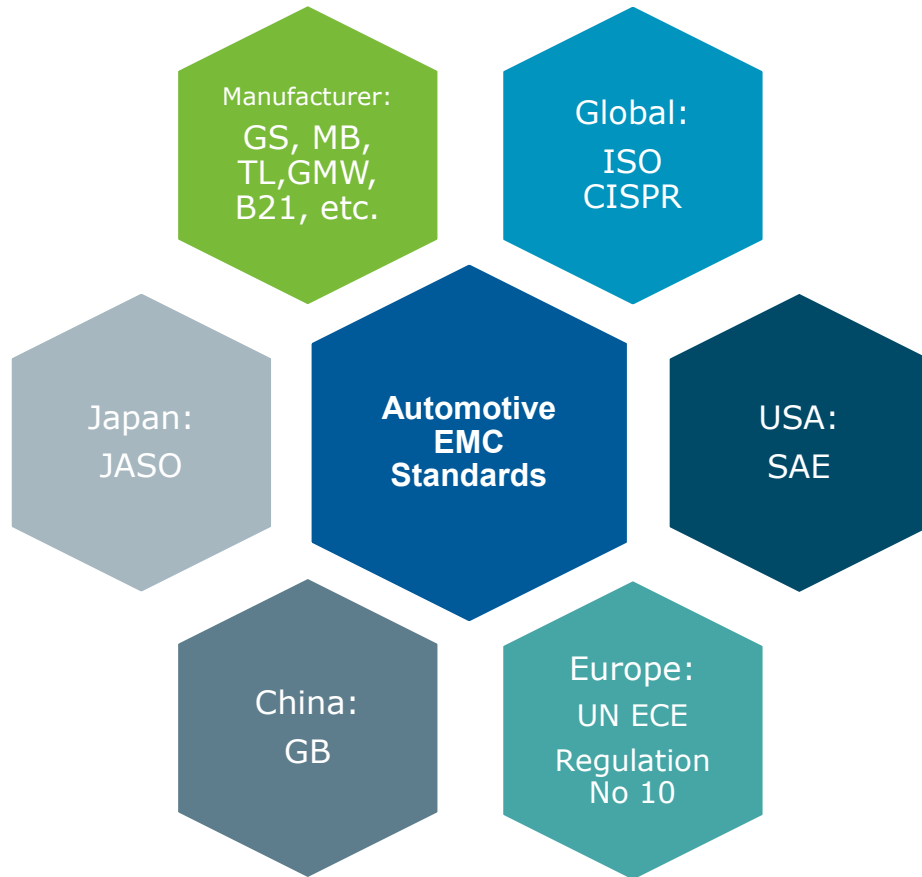
Advanced EMC Analysis Automation Interface

Data Synchronization and EMC Test Cycle Automation

4

Outlook on EMC Tools

Automotive EMC Standards



Operating behavior according to EMC Norms:

- **Radiated emissions CISPR 25**

The EUT shall be made to operate under **typical loading and other conditions as in the vehicle** such that the maximum emission state occurs.

- **Radiated immunity ISO 11452-2**

The DUT shall be made to operate under **typical loading and other conditions as in the vehicle**.

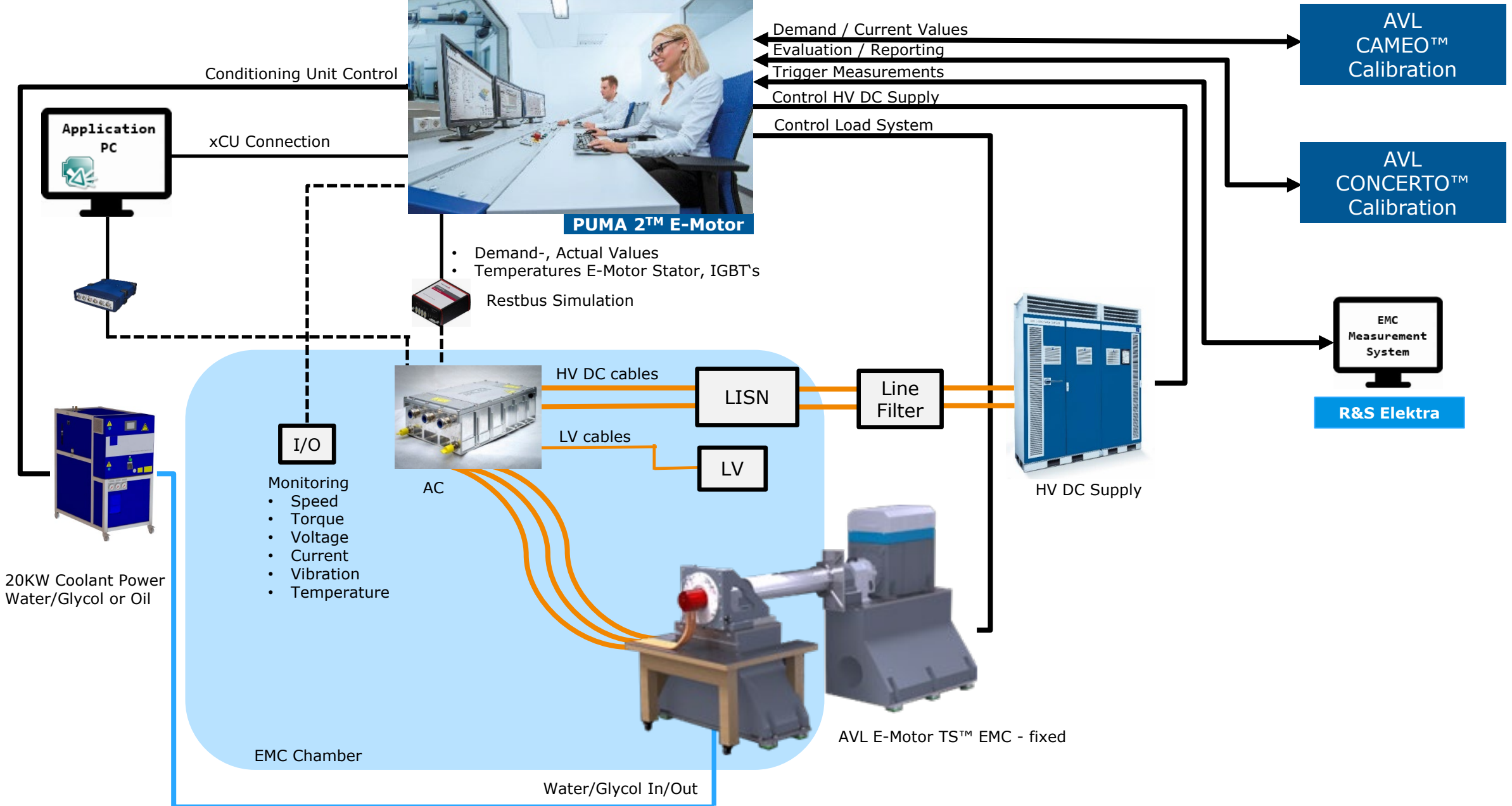
AVL approach:

EMC testing in early development stages from component level to vehicle, step by step.

Goal:

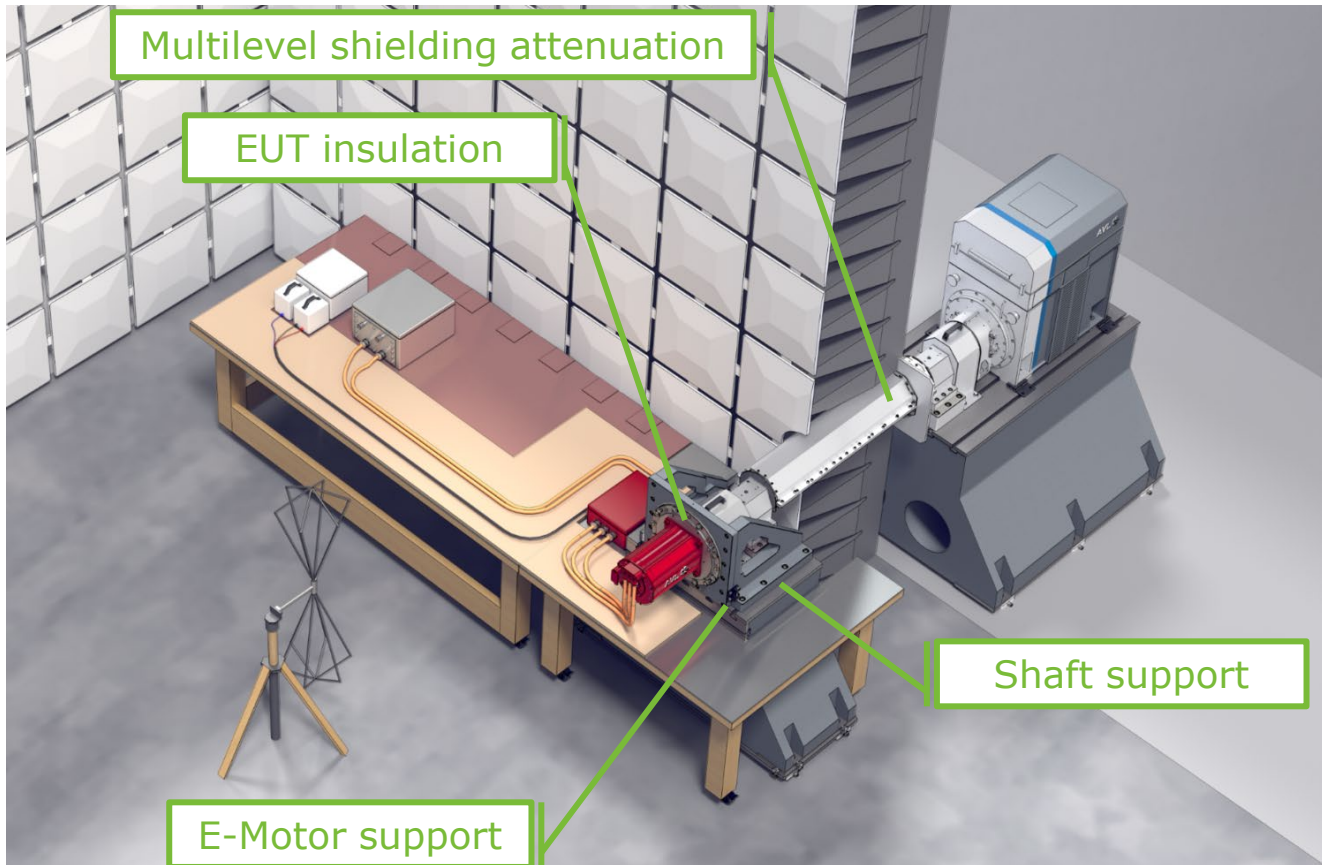
Avoid expensive redesigns in later stages.

AVL Test System Automation System



AVL E-Motor TS™ EMC - fixed

Setup according CISPR25



Setup of mechanic and EUT

- Dyno outside chamber
- Long shaft supported inside the chamber
- Shaft through wall
 - Multilevel shielding attenuation
 - Shielding with structure born noise damping
- E-Motor insulation
- Monitoring of EUT unbalances
- Distances of EUT, Cables and Antenna according to CISPR25

AVL E-Motor TS™ EMC - fixed

A wide range of dynamometers for high speed applications are available

Power: up to 700kW

Speed: up to 20000rpm (Up to 22000rpm on demand)

Torque: up to 4500Nm

Batterie Emulation: < 1200V, <1600A

Mounting: Flange/Foot available



AVL E-Motor TS™ EMC - mobile

Mobile testbed for EMC testing of high-voltage components

Full range high precision speed and torque control mobile in one System

Upgrade your existing EMC chamber with minimal effort on facility side

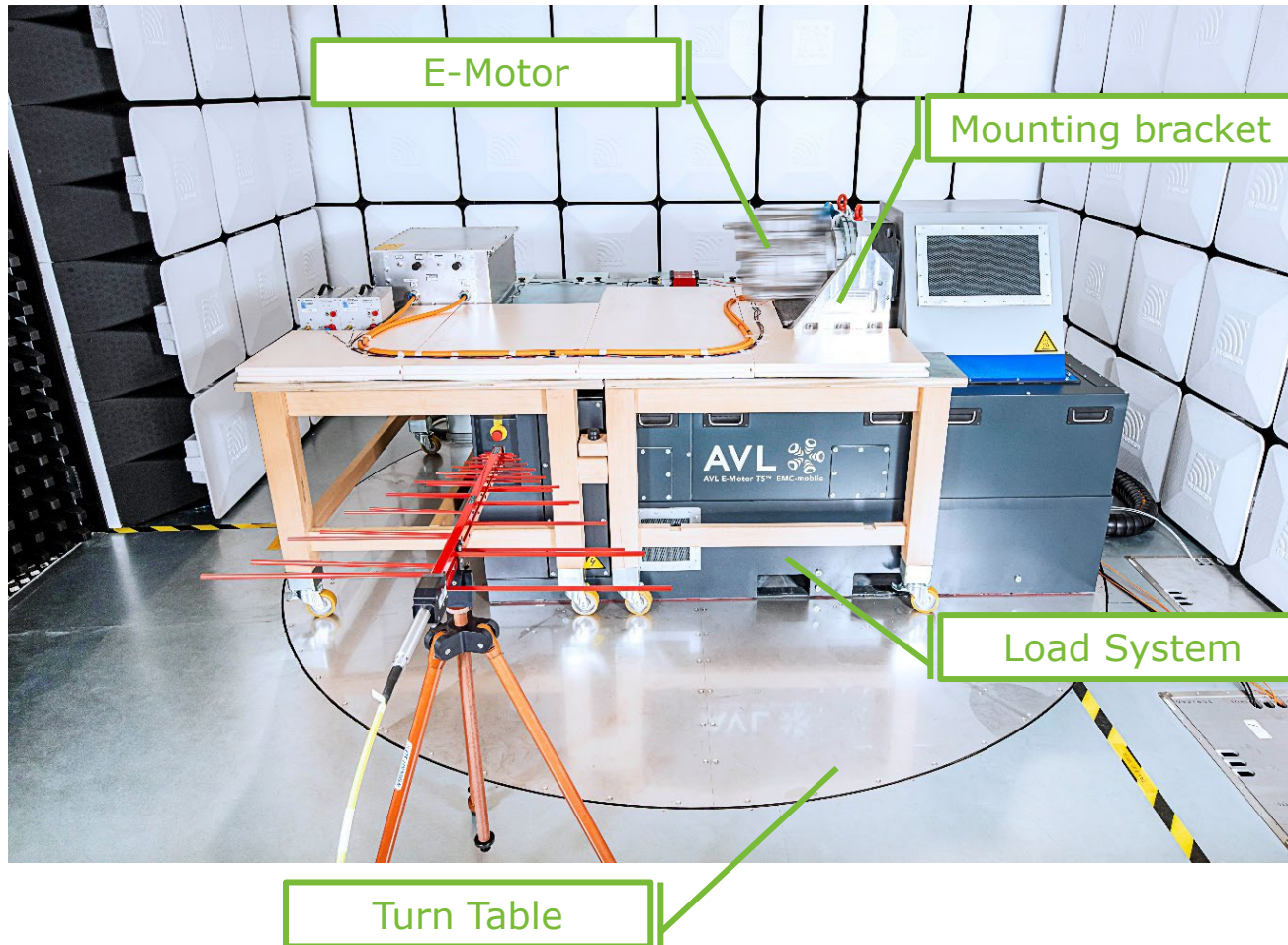
signed for time-efficient EMC testing of high-voltage components during entire development process

Supports latest EMC Standards



AVL E-Motor TS™ EMC - mobile

Setup according CISPR25



Setup

- Dyno inside the load system
- E-Motor mounted on top
- Measurements at different angles possible (turntable)

Dimensions, Weight and Scope of Supply

Basic Scope:

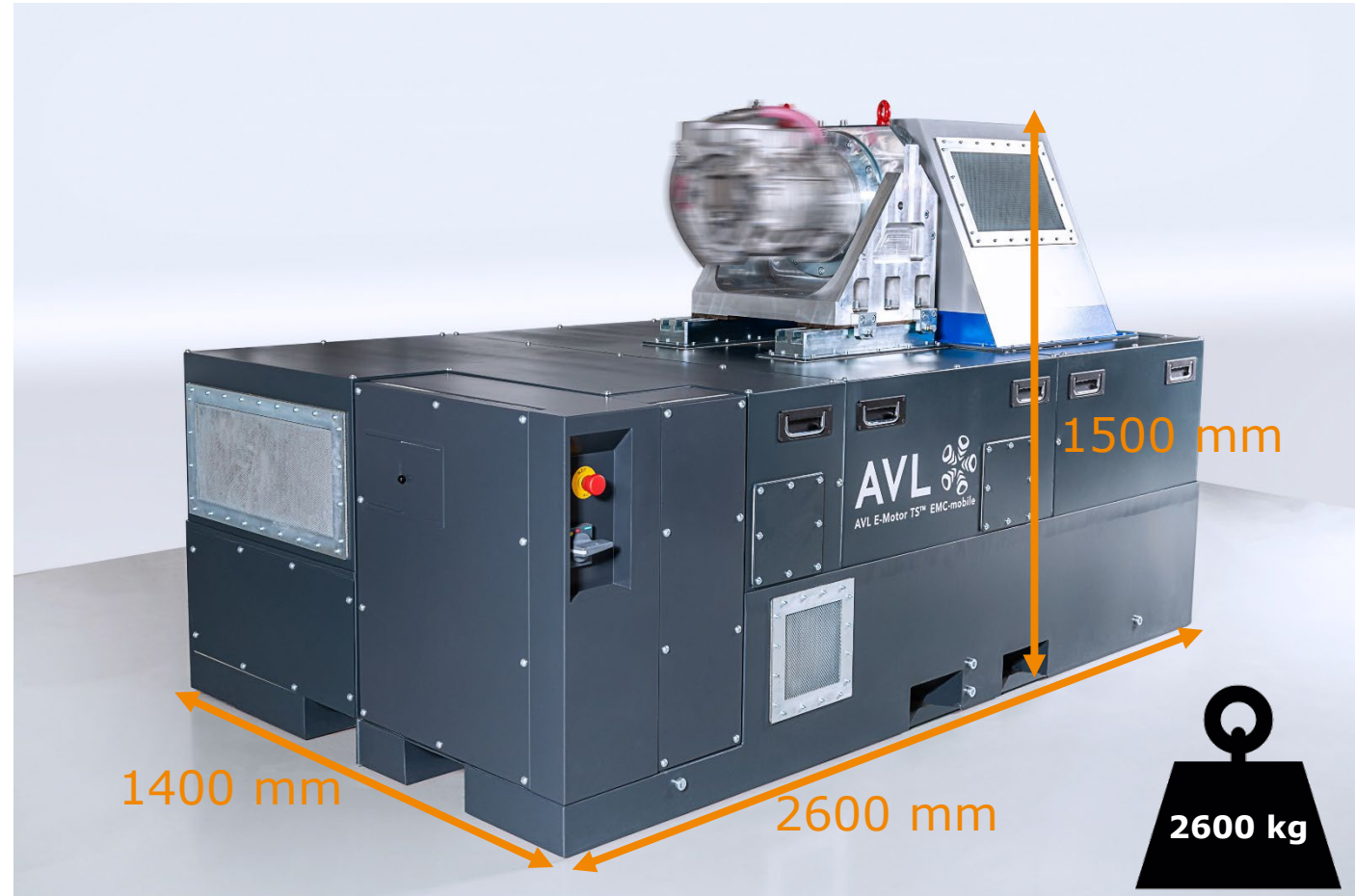
- AVL E-Motor EMC – mobile
- Power cables and plugs
- Communication cables

Options:

- EMC Table
- EUT Mounting Bracket
- EUT Adapter Plates
- UUT Shaft
- Shaft Burst Protection

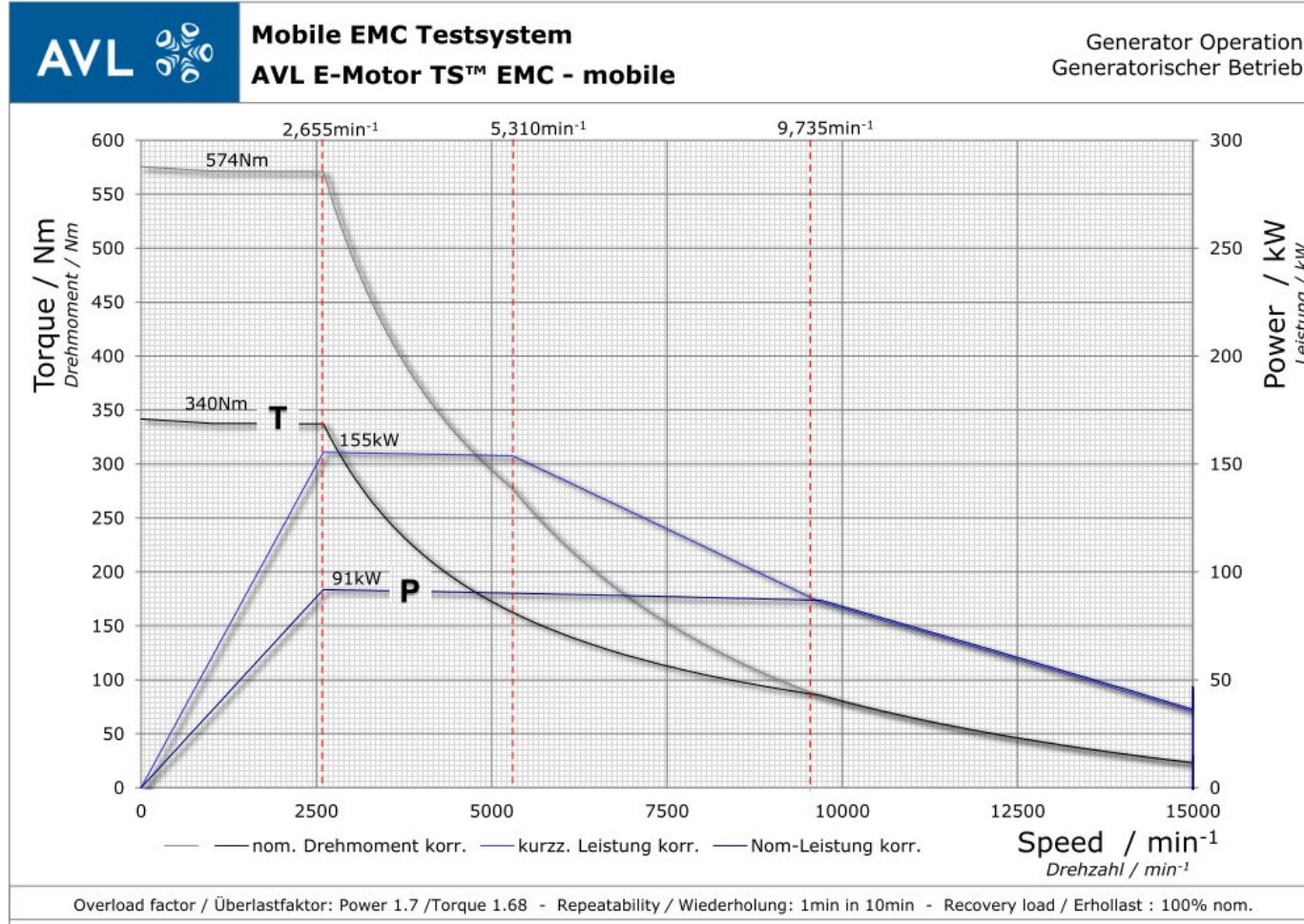
Automation Options:

- Standalone Trolley with AVL EMCON 6™
- Full Automation Integration with AVL PUMA 2™ & AVL EMC Tools



AVL E-Motor TS™ EMC – mobile

System Performance



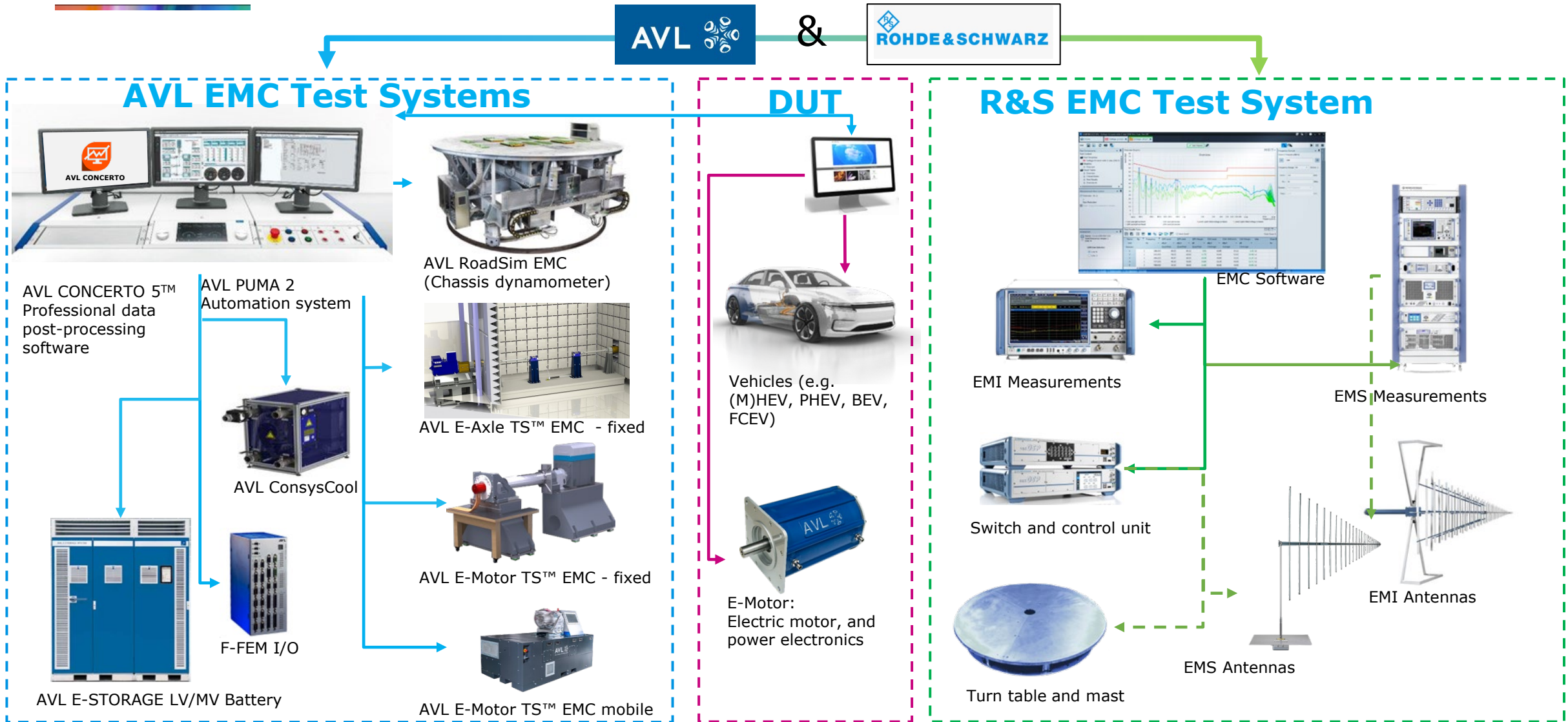
EMC PARAMETERS

- Radiated emissions** Frequency range 10 kHz to 18 GHz
- Ground noise** 6 dB less than the CISPR 12 broadband transient emissions. At least 6 dB better than class 5 according to CISPR 25.
- Immunity field** 400 V/m unmodulated, modulated (80 % AM 1 kHz) according to ISO 11452-2

SUPPORTED EMC STANDARDS

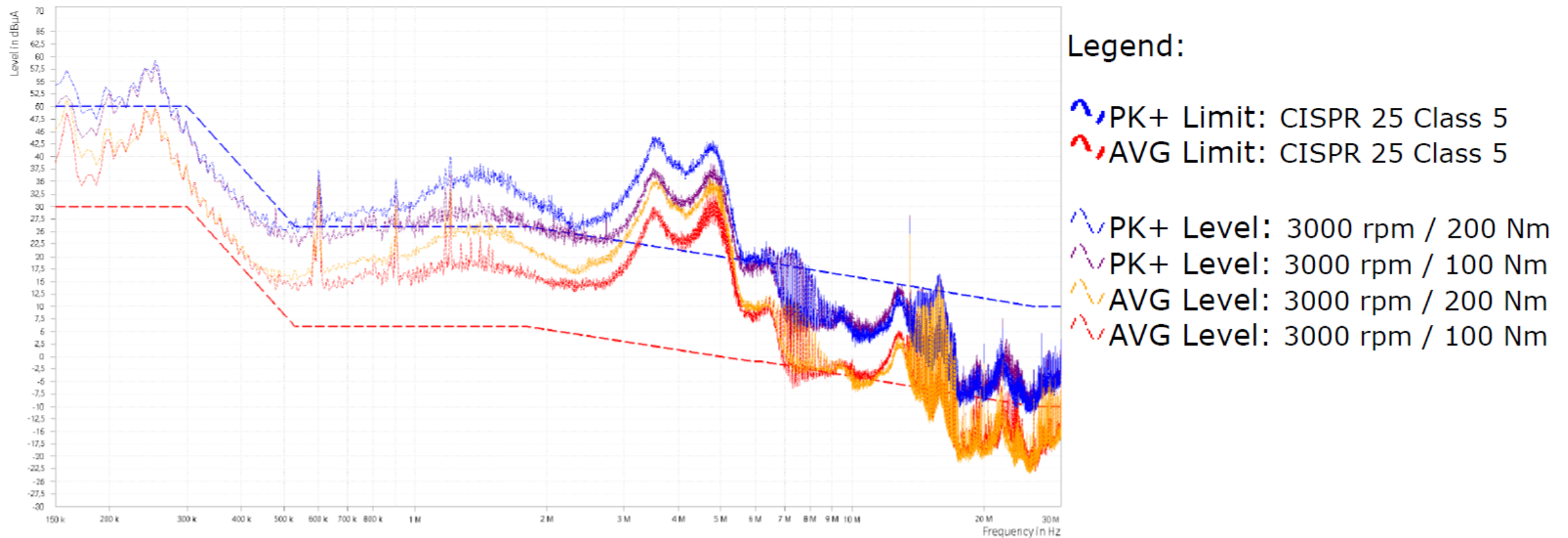
- Radiated Emission:**
- CISPR 25 fully compliant (6 dB better than class 5)
 - CISPR 12 in combination with a turntable compliant more than 6 dB
- Radiated Immunity:**
- ISO 11451-2 (vehicles and components)
 - SAE J551/11
 - ISO 11452-11 (applying higher EM fields)
 - 400 V/m with 80 % AM (1 kHz)

AVL – R&S / Advanced EMC Analysis



Motivation for Dynamic EMC Testing

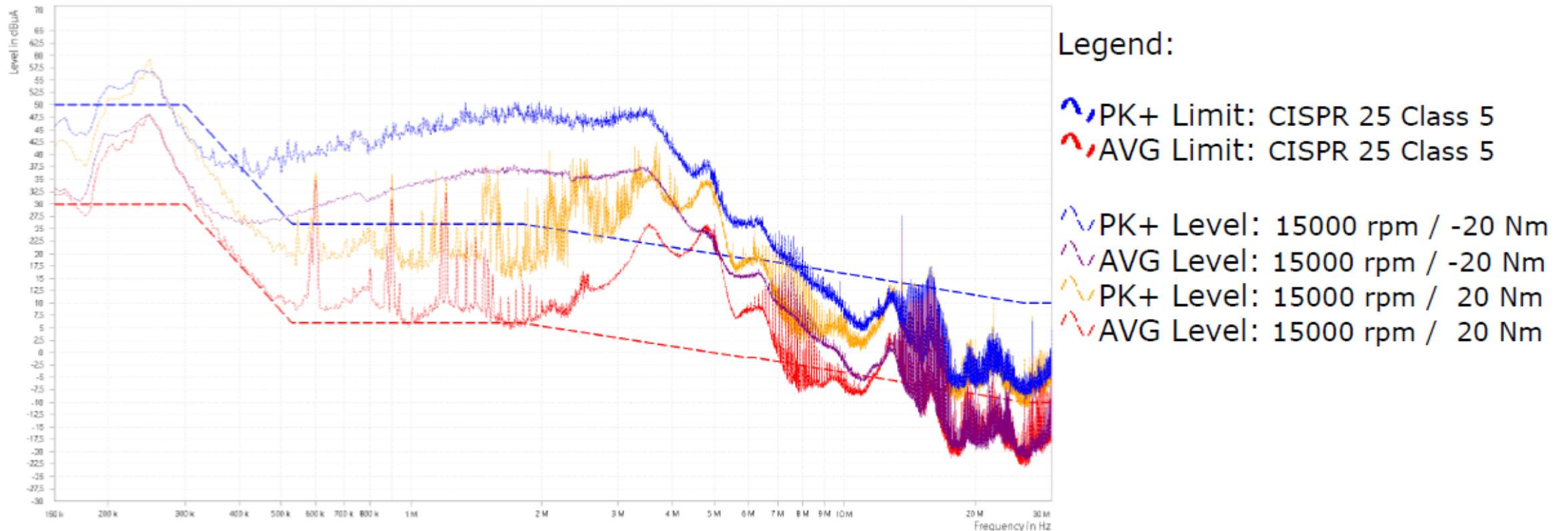
- Load change effect - current probe EMC measurement on HV line (low torque in violet, high torque in blue)
=> Higher broadband interference emissions with torque increase



Note: the measurements have been done in a pre-compliance environment, the background level interference emissions are higher than demanded by the standards

Motivation for Dynamic EMC Testing

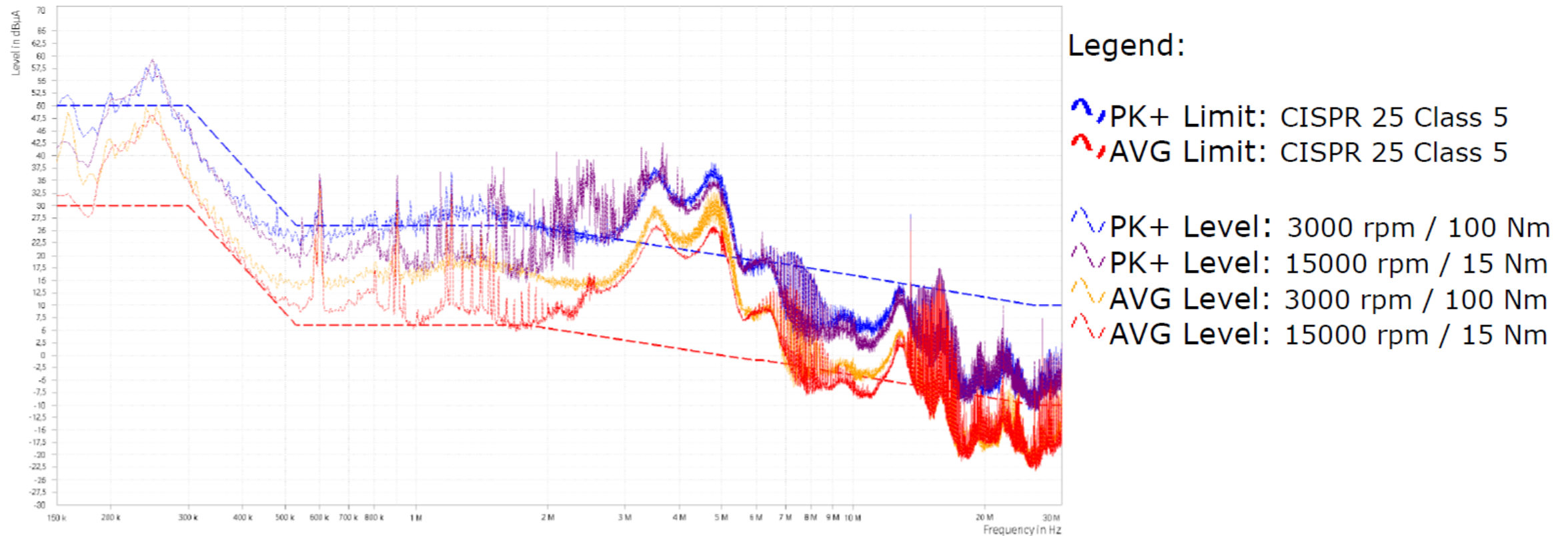
- Motor mode (acceleration in yellow) vs. Generator mode (braking in blue) - current probe EMC measurement on HV line
 - => Much higher broadband interference emissions in generator mode than in motoring mode



Note: the measurements have been done in a pre-compliance environment, the background level interference emissions are higher than demanded by the standards

Motivation for Dynamic EMC Testing

- Speed effect - current probe EMC measurement on HV line (low speed in blue, high speed in violet) => Higher discrete interference emission patterns at higher speed in specific frequency ranges



Note: the measurements have been done in a pre-compliance environment, the background level interference emissions are higher than demanded by the standards

Automotive Trend to Real Operating Behavior

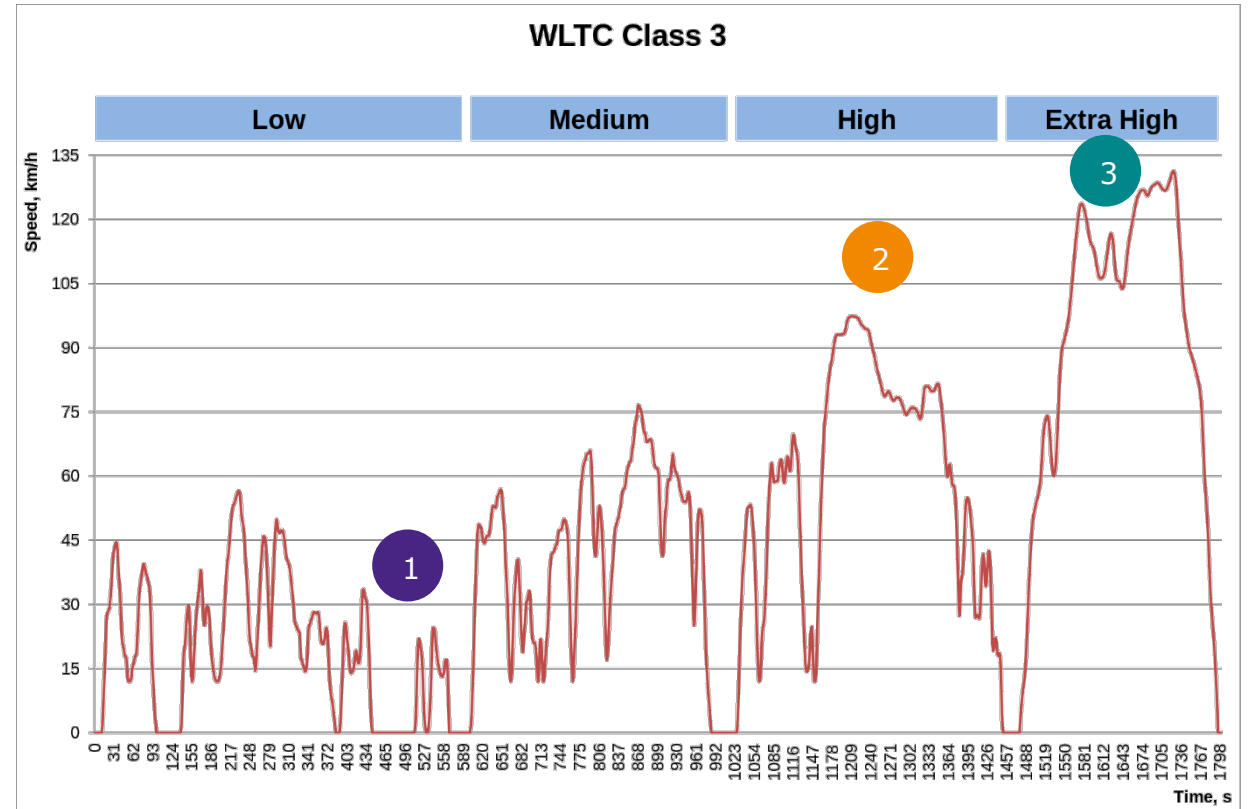
Operating Status:

- Speed
- Torque
- Voltage (Charge State)
- ...

Cable-type, connection impedance, cable length, shields, ...

Dynamic conditions (e.g. WLTP cycle)

- Acceleration
- Deceleration
- Regenerative braking

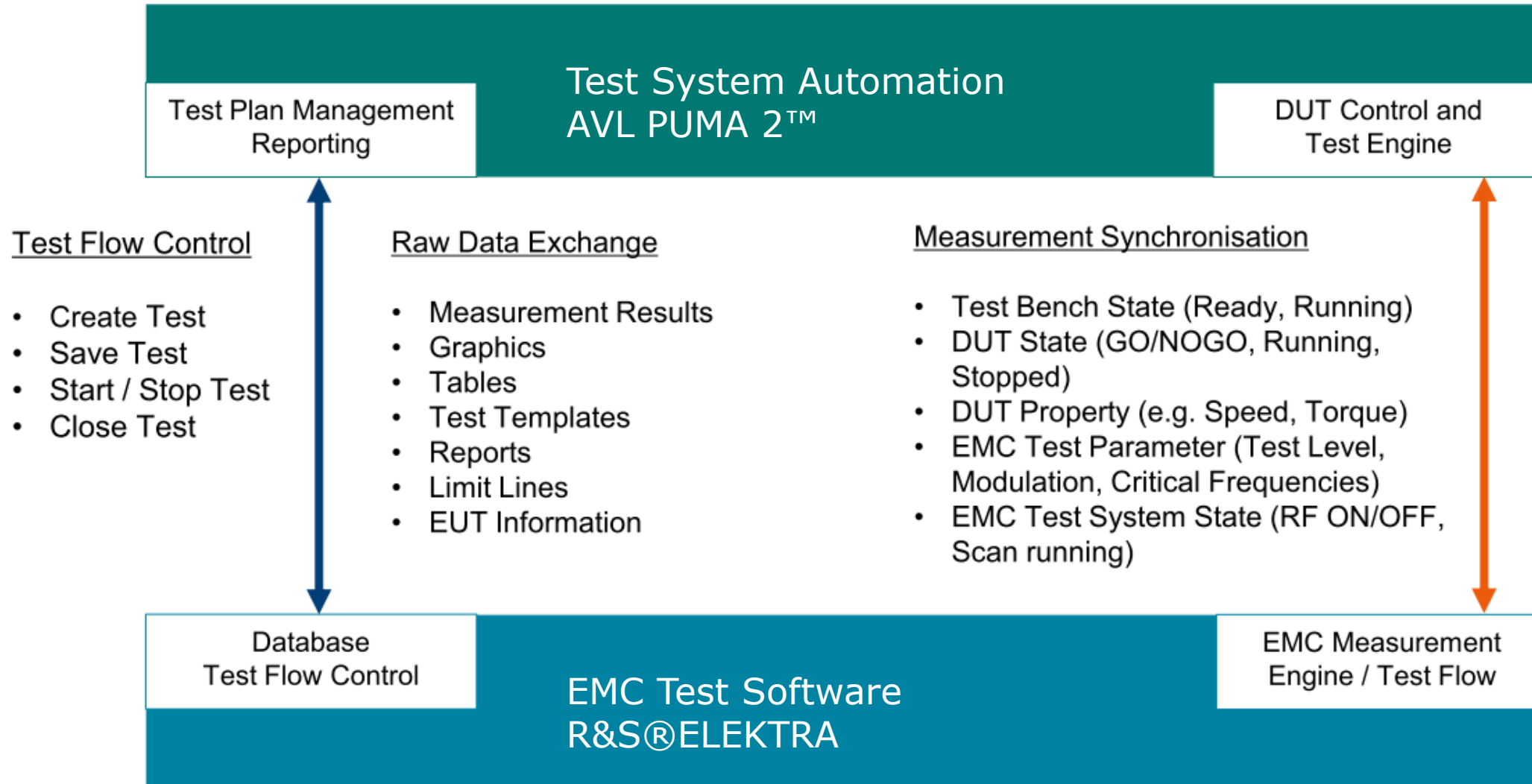


City

Country Road

Free Way

Test System Synchronization



AVL – R&S / Advanced EMC Analysis: Summary of Benefits

1

Wider and more realistic test coverage

EMC test under realistic driving conditions in which the dependencies of all variables are recognized at any time

2

Easy to operate

The EMC engineer can focus on his work and rely on fully automated & safe control and monitoring of testbed and DUT

Full automation instead of individual controls

3

Synchronized testbed and EMC automation with automated test run and post processing

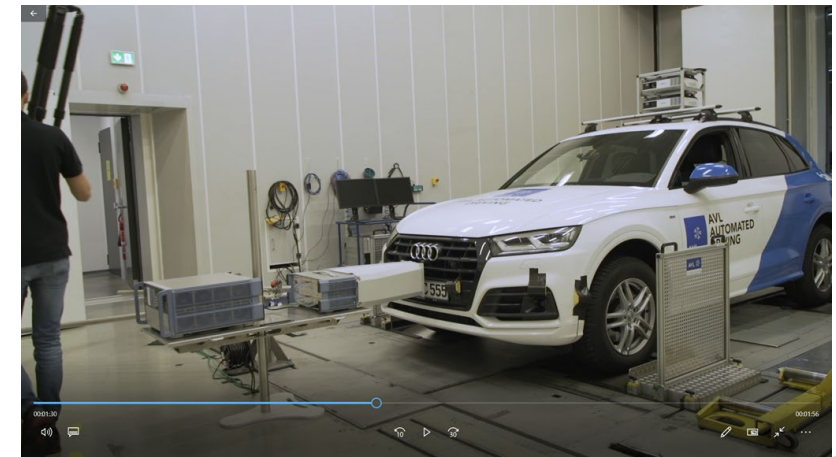
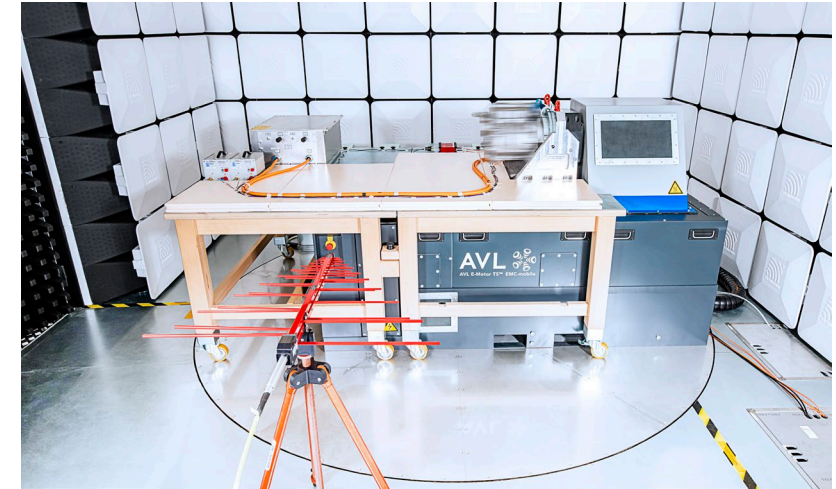
The equipment can be used for functional tests and EMC tests due high utilization rate

Risk minimization and identification of intolerances

4

Future Proof

Migration path to ADAS/AD functional testing by reuse of radar target simulator, roller test bench, PUMA



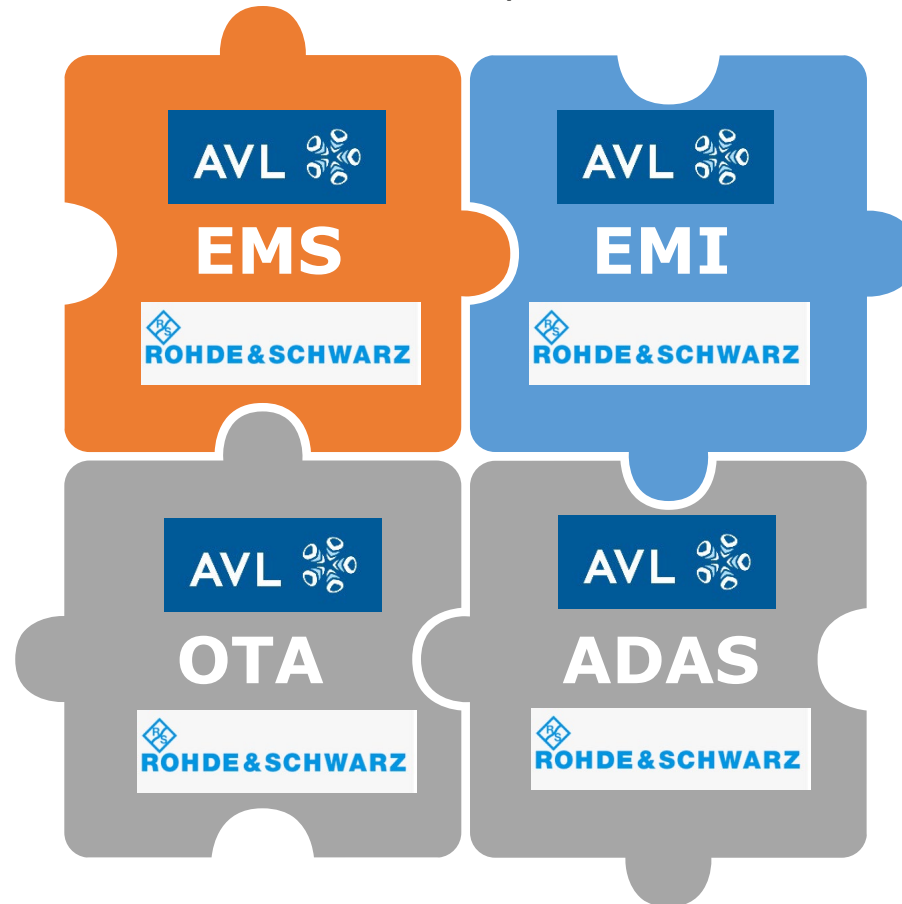
Outlook EMC Toolbox

AVL Scope



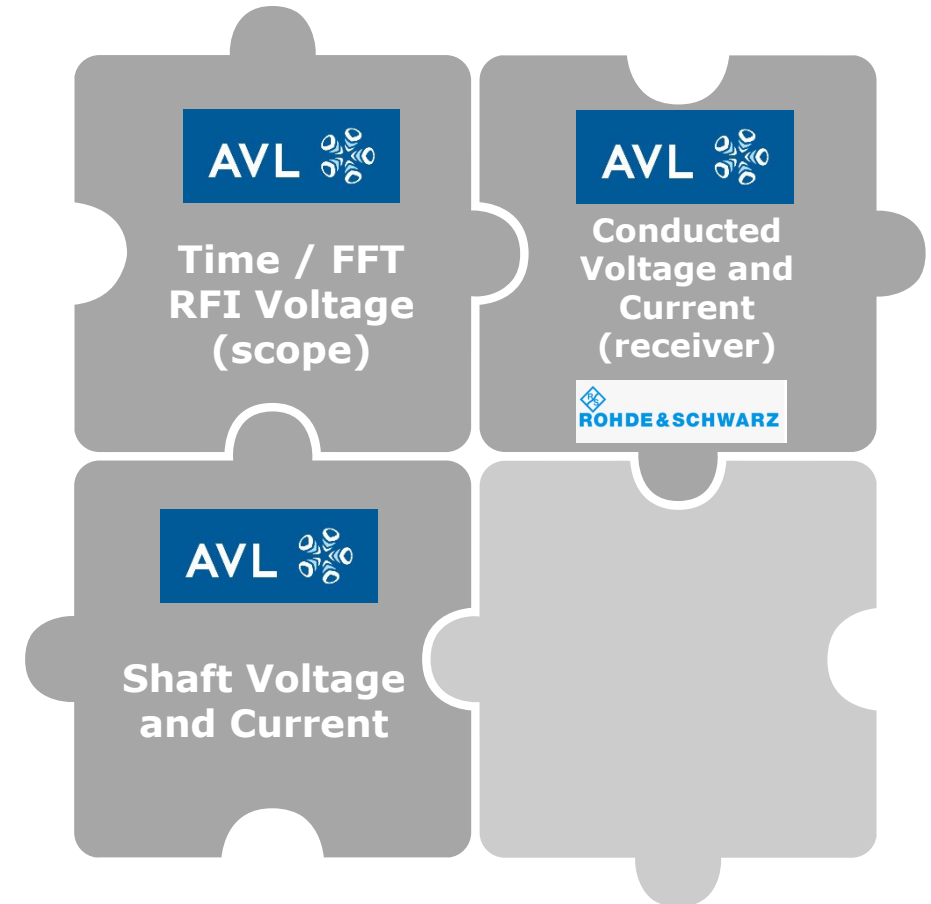
Full-compliance testing

EMC Test Systems



Pre-compliance testing

EMC and Performance Test Systems



Contact



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