



EMC EUROPE 2023

International Symposium and Exhibition on Electromagnetic Compatibility

Kraków, Poland, September 4 - 8, 2023

The biggest impressions from the conference

From the minds of

Lennart Hasselgren, Björn Bergqvist, Henrik Holst, Helin Zhou and Georgios

Mademlis



In short

Very nice town, well organized conference

Many attendants (15 swedes, 5 from Volvo), and large vehicle focus, >650 attendants, 210 papers presented (mixed quality observed), (14+4) rejected

2 presentations by Volvo, 4 Swedish oral contributions in total, 3 posters

Specific goodies found for more reading

Complete conference stored in “external info” folder. The number for the paper = same as in sub-folders

Workshops interesting for “espionage”

what is said – and what is not being said, get ideas for AE projects, evaluate VCC competence level

Getting to Krakow



After several delays and midnight taxi, we finally arrived

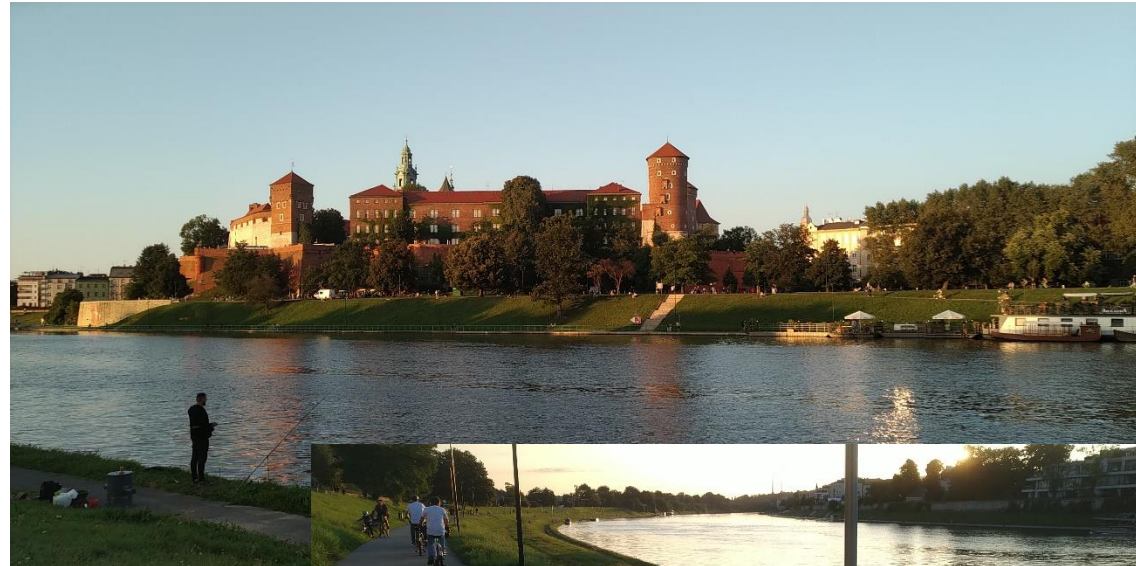
Krakov at a glance

*World cultural heritage, along
Wisla river*

Bike friendly old town

Trams ☺!

*Giant squares and > 100
churches*

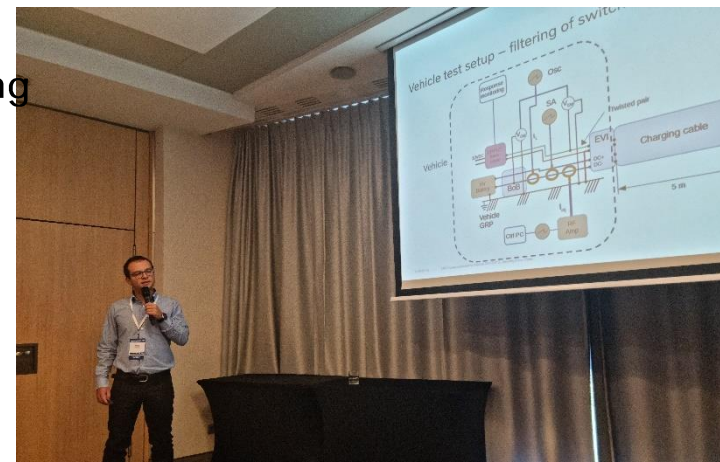


Volvo related papers/presentations

Time domain filter tuning for PLC protection

- Georgios M, Lennart H, Henrik H

OS-4B: Filtering



Emission from Wireless Power Transfer of electrical vehicles

- FOI (+ VCC)

WS-16B: Automotive EMC workshop



S-parameter modelling of el. machines

- Helin Zhou

What did we see?

Participating OEMS

- Volvo Car, Volvo Bus, Stellantis, Daimler, Toyota, etc

Suppliers:

- Siemens, Thyssen-Krupp, etc

Interesting research

- Active noise cancellation (use of notch filters, comb with ML)
- Machine learning
- New measurement techniques
 - In-situ measurements
 - MSC and emission

Missing items (that we did not find)

- Other OEMs work on drive shaft emission
- Ideas from other OEMS on how to handle AD and functional safety (e.g test 2 fail)

Total summary: *we are lacking* – in Sweden – a research structure for EMC (forskarskola) with a critical mass of PhD students as can be seen in other European countries

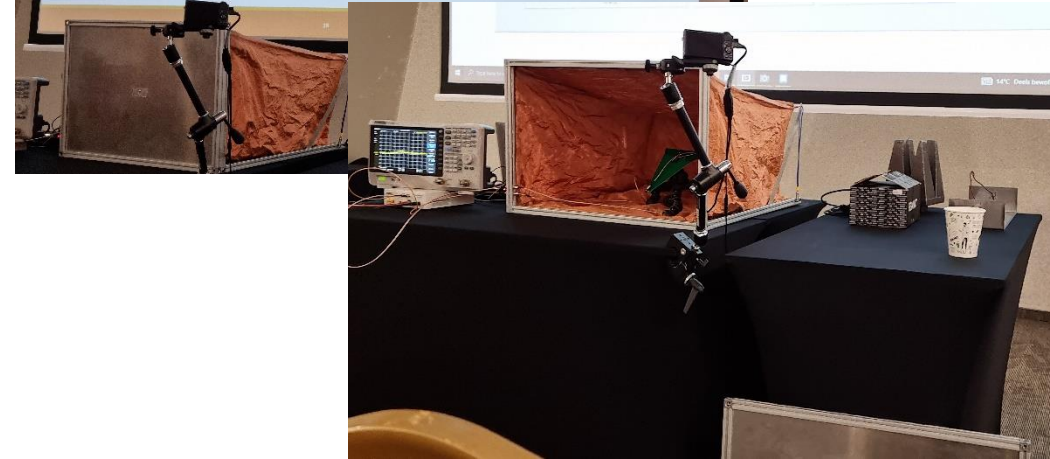
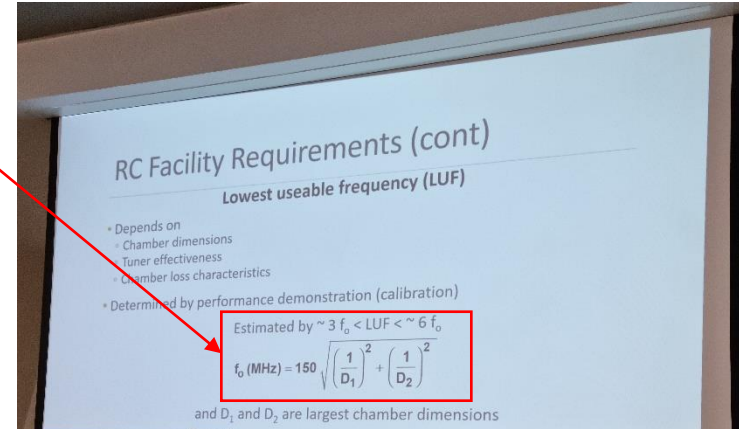
- Frank Leferink's group in University of Twente is a master example
- Other examples: KU Leuven, TU Graz (Austria), Ancona (Italy)
- Missing group (what has happened?): Univ. York

What did we see?

- Larger focus on modelling, testing and analysis of **power electronic components**
 - Workshops on SiC/GaN and standard Si inverters
 - Workshop on design rules for PCB:s
 - Multiple papers on modelling of PE components (modelling parasitic elements, power modules, etc.)
- **Automotive EMC** is one of the largest focus areas
- Wide-spread use of **machine learning** for
 - ✓ Designing individual components
 - ✓ Predicting emissions
 - ✓ Evaluating system design rules
 - ✗ Still problematic areas to be solved
 - ✗ Computational expensive
 - ✗ Needs lots of data

Workshop stirred chambers, MSC (WS-01A-D)

- Size of chamber affects the frequency that can be tested: the larger the chamber, the lower frequencies can be used
- It is easy to reproduce results in multiple test facilities, not sensitive to antenna positioning
- Injection antennas must not face each other and need to have a minimum distance from the walls to allow enough space for reflections
- Suitable for radiated immunity measurements, but also emission



Workshop Technology update on vehicle EMC (WS-06-A-B)

Abishek (Analog Devices): modern communication networks and PSDs

A lot of devices in cars – new functions

Example of interfaces:

- A2B Automotive Audio Bus
- E2B Ethernet to Edge Bus
- Acoustic noise cancellation systems
 - Audio sensors in bumpers

- Error sources - elevating noise
- UTP mixed cables upto 20 dB difference between cables
- CM choke leakage into termination resistors = unbalance current
- CM choke variation upto 10 dB between items (due to manufacturing)
- Powerline injection series inductors – routing optimization

Spread spectrum technique is very complex to achieve

- **Would rather be without it**

Workshop Technology update on vehicle EMC (WS-06-A-B)

Garth d'Àbreau (ETS Lindgren) what happens in testing business?

Standard overview

- CISPR 36 is coming (=chinese req on LF field emission)
- CISPR 12 v7 is cancelled and shall be restarted

Reverb (MSC):

- *Simultanouos testing* of multiple vehicles possible
- Fast stirring a challenge: DUT response time critical

Test chamber challenges

- Dynos need to handle EV modes, e.g. regen mode, maybe also dynamic mode profile
- EV charging inside chamber

Component test on propulsion system
many companies struggle with this:


- Test setups do not reflect the drive shaft emission effect
- Drive shaft mechanical load outside chamber – no alternatives are available

Keynote speaker: M Klingler, Stellantis vehicle EMC (page 3)

EMI challenges:






AD mode + functional safety

- Demonstrate Functional Safety
- new types of tests?



Autonomous Vehicles (2)

- Challenge #1: Guarantee EMC FS for very safety critical systems**
 - Develop technics and methodologies to demonstrate FS for EMC at specification and design phases (what is diversity for EMC immunity)?
 - Introduce validation tests at system level "on table"?
 - Increase the coverage of validation tests (e.g. complementary MSRC tests, Mode stirring in MSRC instead of tuning, etc)?
 - Extent current test methods to voluntarily apply simultaneous interferences on redundant items at system level "on table" and/or on vehicle (fault injection)?
- Challenge #2: Validate vehicle autonomous functions with sufficient robustness, ease and minimized cost**
 - Is it possible to develop and standardize a new test methodology that:
 - Is easy to be performed?
 - Is independent of the number of scenarios that must be tested and their exhaustivity?
 - Is independent of the complexity of a function?
 - Allows to limit the test durations or at least the duration won't be exponential?
 - Can be performed with the current EMC test facilities and instrumentation?
 - Avoiding the problem of not being able to carry on the tests in case of incoherencies in the stimulations of several sensors?

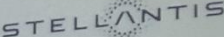






01796_23_00057 EMC Europe 2023, Kraków, Poland, 4th - 8th September 2023

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Keynote speaker: M Klingler, Stellantis vehicle EMC (page 4)


Conclusions




Conclusions And Perspectives

- **3 very challenging future evolutions**
 - Carbon neutrality: PHEV, EV, 48V, composite materials, ...
 - Connected world: connected vehicles, RF cybersecurity, ...
 - Autonomous vehicles and mobility
- **Increase of complexity**
 - More functions and more interaction between functions
 - More communication links to the outside world (RF communications, vehicle charging)
- **Increase in safety requirements**
 - Future autonomous vehicles with safety targets 10^{-9} to 10^{-11} failures per hour
- **Important challenges for EMC**
 - Amend international standards and internal specifications with new requirements and tests
 - Ensure an earlier and even more robust EMC design (justifications with expert tools, Machine Learning, simulation methodologies)
 - Develop new validation strategies (test methodology and facilities)
 - More connections with other domains (RF communication, safety, cybersecurity)

=> Further develop EMC skills and knowledge for design and validation



ISO 26262



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Active noise cancellation on inverter (OS-04A)

Stefan Haensel (Siemens)

Active noise cancellation by injection of counteracting signals

- Voltage sense current cancellation
- Capacitive injection in HV DC
- Gives smaller filters

Stability challenge

- High frequency – phase stability + computation speed
- Low frequency – phase stability + having enough energy storage

New approach

- RF mixed feedback
- LF sensor network loop

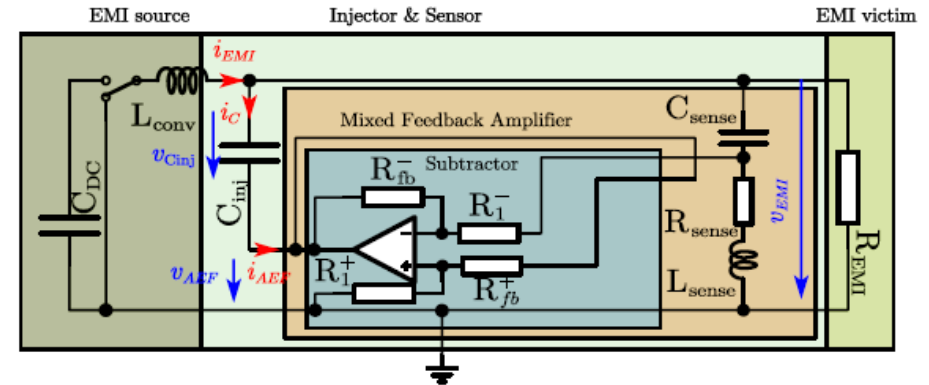


Fig. 5. Feedback voltage sense current injecting topology built up with an op-amp as a subtractor

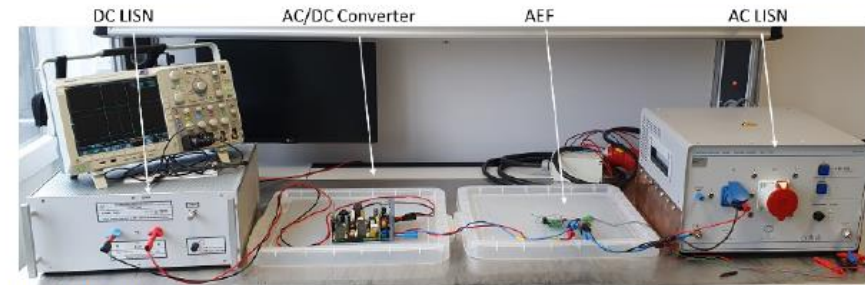


Fig. 11. Laboratory setup



RE from WPT of vehicles (OS-08B)

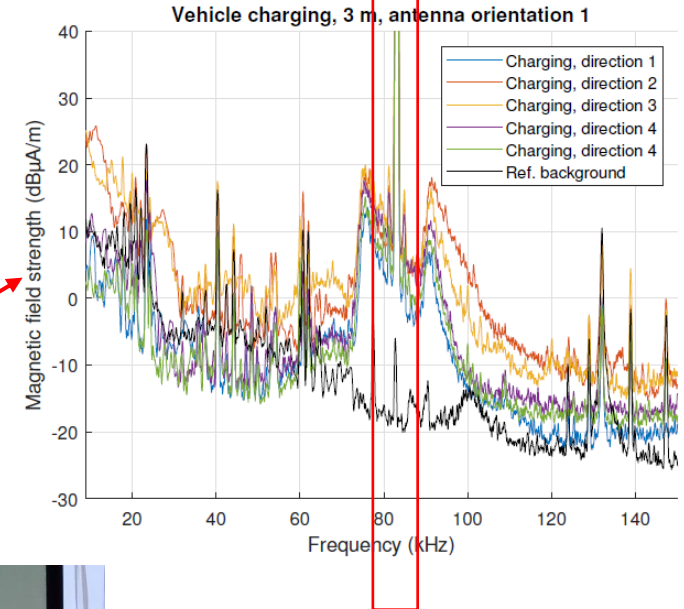
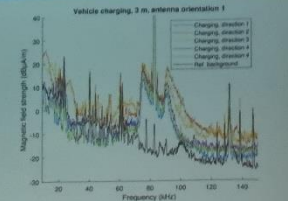
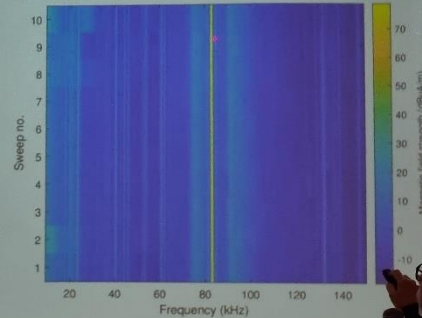
Kia Wiklundh (FOI)

WPT at 85 kHz

RE measurements outdoors, not in a chamber

Results: 9-150 kHz

- Spectrogram, (10 sweeps and a measurement time for each sub-band of 100 ms)
 - vehicle charging at 3 meter with antenna orientation 1 and direction 1
- Resonance frequency is transmitted continuously during the charging and consists of a sine signal



1) Instrument benchmark on conducted and radiated emission (SS-03A no 120)

2) Efficient in situ assessment of radiated emissions no 102

- 1) M Astarua (Catalunya, Spain)
- 2) Jordi Sole-Lloveras (EMC Barcelona)

There may be big advantages in using time domain technique combined with multi-port system for in-situ measurements

- Possible to identify and remove background noise in realtime
- Improvement of OATS (tent) measurement – *replacing ALSE*


emc BARCELONA Measuring Receiver Benchmark for Conducted and Radiated Emissions Testing in Space Applications EMC STD

Methodology

To compare the measurement results delivered by different measuring instruments during:


- CE verification
- CE testing
- RE testing

Frequency Swept Mode
FFT-based scan




R&S®ESW44 EMI Test Receiver
Image by Rohde & Schwarz

Direct Sampling
Instruments
Full-Time Domain
EMI measurements



PicoScope 5444D MSO
Image by Pico Technology



R&S®RTO6 oscilloscope
Image by Rohde & Schwarz

Measuring instrument	
Receiver 1, R_1	Picoscope 5444D + Software
Receiver 2, R_2	R&S RTO6 + Software
Receiver 3, R_3	R&S ESW44 (FFT scan mode)
Receiver 4, R_4	R&S ESW44 (Swept mode)

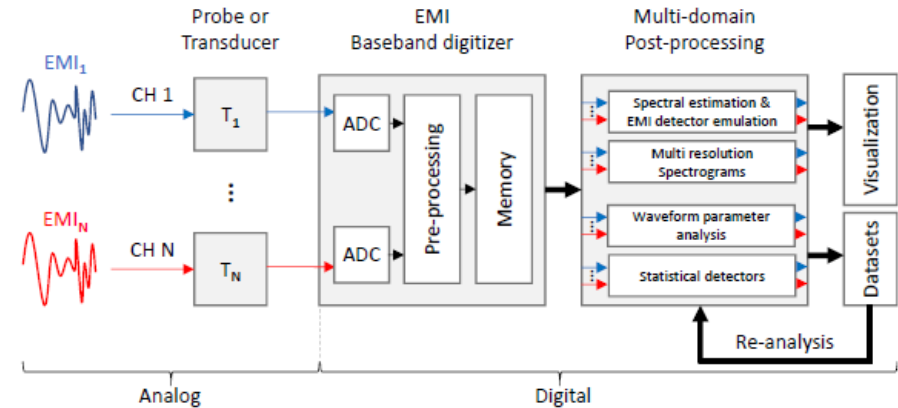


Fig. 2. Block diagram of the multi-channel time-domain EMI measurement system used during the experiments.