Monday, 5 September

Workshops

Date: Monday, 05/Sept/2022

9:00am - 10:40am	**WS-01A: Automotive EMC** Location: **G1** Chair: **Marco KLINGLER**	**WS-04A: You had me at "Reverb"…!** Location: **G2** Chair: **Vasiliki Gkatsi**	**WS-06A: Innovative Wireless Test Methodologies for 5G NR and mmWave Applications** Location: **G3** Chair: **Janet O'Neil**	**WS-07A: EMC aspects of electrification of the society** Location: **J1** Chair: **Urban Lundgren**	**WS-09: The art of filter design in EMC** Location: **J2** Chair: **Heinz Zenkner**	**WS-11: ANSI C63.25.3 EMC Test Site Validation in 18 to 40 GHz** Location: **R5** Chair: **Åsa Larsbo**	
10:40am - 11:10am	**F-01A: Coffe break** Location: **Exhibition Area**						
11:10am - 12:50pm	**WS-01B: Automotive EMC** Location: **G1** Chair: **Marco KLINGLER**	**WS-04B: You had me at "Reverb"…!** Location: **G2** Chair: **Vasiliki Gkatsi**	**WS-06B: Innovative Wireless Test Methodologies for 5G NR and mmWave Applications** Location: **G3** Chair: **Janet O'Neil**	**WS-07B: EMC aspects of electrification of the society** Location: **J1** Chair: **Urban Lundgren**	**WS-10A: Why are radiated emission/immunity EMC tests so tricky?** Location: **J2** Chair: **Diethard Hansen**	**WS-12: Development of a GB-Ethernet Interface under EMC Aspects** Location: **R5** Chair: **Heinz Zenkner**	**WS-14: Spread Spectrum Clocking (SSC) to overcome EMI issues** Location: **R6** Chair: **Bernd Deutschmann**
12:50pm - 2:00pm	**L-01: Lunch break** Location: **Restaurant Area**						
2:00pm - 3:40pm	**WS-02: Measurements on High Power Charging - Fast charging equipment for e-Cars** Location: **G1** Chair: **Werner Grommes**	**WS-04C: You had me at "Reverb"…!** Location: **G2** Chair: **Vasiliki Gkatsi**	**WS-06C: Innovative Wireless Test Methodologies for 5G NR and mmWave Applications** Location: **G3** Chair: **Janet O'Neil**	**WS-08A: LF EMC in power grid and transportation systems** Location: **J1** Chair: **Francinei L Vieira**	**WS-10B: Why are radiated emission/immunity EMC tests so tricky?** Location: **J2** Chair: **Diethard Hansen**	**WS-13A: EMC simulation workflow for Electrification Applications** Location: **R5** Chair: **Flavio Calvano**	**WS-15A: Risk-based EMC implementation with examples** Location: **R6** Chair: **Nandun Senevirathna**
3:40pm - 4:10pm	**F-01B: Coffe break** Location: **Exhibition Area**						
4:10pm - 5:50pm	**WS-03: EMC on humans** Location: **G1** Chair: **Jimmy Estenberg**	**WS-05: Device Measurements in Reverberation Chambers** Location: **G2** Chair: **Samar Hosseinzadegan**	**WS-06D: Innovative Wireless Test Methodologies for 5G NR and mmWave Applications** Location: **G3** Chair: **Janet O'Neil**	**WS-08B: LF EMC in power grid and transportation systems** Location: **J1** Chair: **Francinei L Vieira**	**WS-10C: Why are radiated emission/immunity EMC tests so tricky?** Location: **J2** Chair: **Diethard Hansen**	**WS-13B: EMC simulation workflow for Electrification Applications** Location: **R5** Chair: **Flavio Calvano**	**WS-15B: Risk-based EMC implementation with examples** Location: **R6** Chair: **Nandun Senevirathna**
6:00pm - 8:00pm	**ME-01: ISC Meeting** Location: **G1**		**ME-02: IEEE EMC-Society Sweden Chapter Meeting** Location: **G2**		**ME-03: IEEE EMC-Society Chapter Chairs Meeting** Location: **G3**		

Session

WS-01A + WS-01B: Automotive EMC

Time: *Location:* **G1**

Monday, 05/Sept/2022:

9:00am - 10:40am, 11:10am - 12:50pm

Session Chair: **Marco KLINGLER**

Session Abstract

Automotive electric / electronic systems are endlessly growing in complexity with a permanent constraint of a constant or reduced time-to-market. Therefore, there is a strong need to improve constantly the efficiency of the EMC related tasks throughout the entire development process, starting from the design phase until the full-vehicle validation phase.

This workshop intends to present an overview of the most recent industrial advances in the field of automotive EMC design, modeling and simulation as well as in the field of automotive standards, testing and measurements. The presentations in this workshop will cover EMC issues at system, subsystem, equipment and component levels. In particular, topics addressed by the speakers will include hybrid power-train systems EMC analysis, antenna implementation, equipment design, printed-circuit-board optimization, and electric/electronic component characterization.

Presentations / speakers (no given order at this stage):

1 - Methods For Reducing Resonances Of Vehicle Electrical Architectures Due To The Network Of Shielded Links And 0V Wires
Marco Klingler, Anass Samiri
Stellantis, France

2 - Methodology to Validate the Radiated Immunity of Very Complex Systems by a Succession of Simple Component Radiated Immunity Tests at System Level
Nadir Bedjiah(1)(2), Marco Klingler(1), Moncef kadi(2), Romain Rossi(2)
(1) Stellantis, France
(2) ESIGELEC, France

3 - How to measure the test level for ALSE vehicle testing
Dr. Martin Aidam
Mercedes-Benz, Germany

4 - All you need for an EMC inverter simulation
Andreas Barchanski(1), Jan Hansen(2), Michael Wendl(2)
(1) Dassault Système, Germany
(2) Robert Bosch GmbH, Germany

5 - Leveraging machine learning and design exploration to synthesize cable routing design rules
René Fiedler, Diana Mavrudieva
Altair, Germany

Session

WS-04A + WS-04B + WS-04C: You had me at “Reverb”…!

Time: *Location:* **G2**

Monday, 05/Sept/2022:

9:00am - 10:40am, 11:10am - 12:50pm

2:00pm - 3:40pm

Session Chair: **Vasiliki Gkatsi**

Session Abstract

This workshop will provide an introduction to recent applications of reverberation chambers (RCs). It is intended to provide EMC engineers who are interested in applying RCs to various measurement issues and the extension of RCs to solve a variety of EMC problems. The statistical methods used to evaluate the fields inside these chambers requires the collection of statistically independent samples. These samples can be generated by employing different stirring techniques such as mechanical mode stirring/tuning, spatial and frequency stirring. With the development of conductive fabric chambers and tents, another method of mechanical stirring is possible by movement of the fabric walls, or employing a fabric stirrer and is referred to in literature as a Vibrating Intrinsic Reverberation Chamber (VIRC).

This full-day workshop provides a brief overview of RC theory, followed by recent applications of RCs. The workshop material will be updated to reflect recent research results and implications. The format will be a conference presentation style (lecture) followed by a discussion moderated by the chairs. Furthermore, based on our successful RC workshop at EMC Europe 2013 in Brugge, a series of experiments aligned with the presentation topics will be demonstrated using a portable setup to clearly show the underlying principles of RCs and their applications in practice. The workshop attendees will have the opportunity to witness the presented theory in action, and even participate in performing some of the experiments themselves.

The workshop is designed for both academics and people from industry who will be involved in radiated emission or immunity testing of commercial or military systems using RCs, shielding effectiveness, or even communication channel. It will be valuable to personnel evaluating the use of RCs as a complement to or replacement for other types of radiated test facilities and for personnel who are trying to use statistical methods to characterize the electromagnetic environments.

Session

WS-06A + WS-06B + WS-06C + WS-06D: Innovative Wireless Test Methodologies for 5G NR and mmWave Applications

Time: *Location:* **G3**

Monday, 05/Sept/2022:

9:00am - 10:40am, 11:10am - 12:50pm

2:00pm - 3:40pm, 4:10pm - 5:50pm

Session Chair: **Janet O'Neil**

Session Abstract

As 5G begins to take center stage in the enterprise IOT and consumer markets, the wireless industry continues to develop the required test and measurement capabilities for the latest technologies to ensure that these products perform as intended. While considerable progress has been made, various industry organizations are still working on new test plans and test requirements that will be implemented throughout the industry. Although much of the low hanging fruit have been covered in test requirements to date, some of the toughest problems still remain to be solved. For example, current wireless networks are relying on much more integrated end-to-end (E2E) system architecture than ever before. The base stations (gNB) and the user equipment (UE) must understand how the RF environment is constantly changing around them and they must be able to make decisions in a fraction of a second in order to maintain connectivity with the network. All this must be done while maintaining the adequate bi-directional data throughput with the network.

The presentations in this tutorial will provide examples of the need for established industry metrics and test scenarios not only on the chip and module level, but for full scale implementation of a real life network in order to help designers to build fast and reliable networks for modern day requirements. Attendees at the tutorial will learn about solutions to address the challenges generated by the 5G New Radio and mmWave applications through system planning and innovative wireless performance verification testing methodologies. Hands-on demonstrations are planned to complement the lecture material.

The workshop will conclude with a panel discussion including all speakers.

Planned Speakers and Topics:

Characterization of oRAN Base Station Antenna Performance

James Young, ETS-Lindgren, Cedar Park, Texas, USA

Wireless Interference/Immunity: Product Quality as a Driver of Test Standards

Harry Skinner, Intel, Hillsboro, Oregon, USA

Use of Reverberation Chambers to Simplify EMC and RF Unwanted Emissions Measurements for 5G Base Stations

Ahmed Hussain, Ericsson AB, Kista, Sweden

On the Definition of Incident Power Density for 5G mmW Human Exposure Evaluation

Walid El Hajj, Intel, France

Hybrid Testing Techniques for Advanced Communications

Aric Sanders, National Institute of Standards and Technology, Boulder, Colorado, USA

Addressing the Increasing Wireless Requirements for Commercial Aircraft and Aerospace Applications

By Dennis Lewis, Boeing, Seattle, Washington, USA

Spurious Emissions up to 110 GHz in Reverberation Chambers

Lawrence Moore, Ericsson, Lund, Sweden

Definition of Far Field Measurement Distance for 5G mmWave Antenna Arrays: Application on N x M Patch Arrays

Juan-Antonio Del Real and Walid El Hajj, Intel, France

Recent Advances in C63.25.3: Qualifying Anechoic Chambers for Measurements of mmWave Devices

Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA

Potential of Edge Soldering in mmWave Antenna and EMC Design

Katerina Galitskaya, Radientum OY, Tampere, Finland

Session

WS-07A + WS-07B: EMC aspects of electrification of the society

Time: *Location:* **J1**

Monday, 05/Sept/2022:

9:00am - 10:40am, 11:10am - 12:50pm

Session Chair: **Urban Lundgren**

Session Abstract

Part 1:
”Results from on-site EMC emission measurements on PV-installations with variations in inverters, optimizers, solar panels and cable routing”
Presenter: Urban Lundgren
Affiliation: RISE, Research Institutes of Sweden

Abstract
Presentation of work in the project “Metoder för att detektera och förebygga elektromagnetiska störningar från solcellsinstallationer” funded by Swedish Energimyndigheten (Swedish Energy Agency). The project is aiming at giving recommendations on how to perform on-site measurements of radiated emissions from photovoltaic installations. Part of the work is also to try to verify recommendations for system installation such as DC cable routing, potential equalisation and the use of solar panel optimisers.

Part 2:
“Solar power – a View from the regulatory plane”
Presenter: Martin Gustafsson
Affiliation: Elsäkerhetsverket

Abstract
A summary of reported events of electromagnetic disturbance from photovoltaic installations and related products subject to complaints. Examples of real-world cases of disturbance in more detail. Also, the view on standardisation will be covered from a regulatory perspective.

Part 3:
”Power quality and EMC issues related to electric vehicle charging”
Presenter: Math H. J. Bollen
Affiliation: Luleå University of Technology, Skellefteå, Sweden

Abstract
With the quick increase of electrical vehicles (EV) and the desire to replace internal combustion engine vehicles, the electrical infrastructure for charging need to be adapted to driving patterns and charging characteristics of the EV:s. The hosting capacity for electric vehicles in a low-voltage distribution network can be analysed to estimate the impact on the power quality in the Swedish power grid. This presentation provides support for a discussion regarding the impacts of electromobility on the electrical system.

Session

WS-09: The art of filter design in EMC

Time: *Location:* **J2**

Monday, 05/Sept/2022:

9:00am - 10:40am

Session Chair: **Heinz Zenkner**

Session Abstract

The tutorial introduces the participant step by step to the design of filters, independent of the application, independent of complex mathematical calculations, but practice-oriented with concrete examples and pointing out important points to pay attention to during the design. Numerous examples with clearly comprehensible results are presented; filters with and without transient protection. A realistic estimation of the required insertion loss quickly shows that filters do not need 90 dB insertion loss, it also quickly shows that the specifications of filters determined in the 50 ohm system do not have much to do with practice. The tutorial shows ways to quickly and effectively develop the right filter and what needs to be considered. In addition, influencing variables such as the parasitic capacitance of inductances, the impedance of peripheral cables, ground conditions at the filter, current and voltage bias of inductors and capacitors are shown and explained in concrete examples.

Summary of the content:

What is an EMC filter, which parameters have to be considered, where is the difference to a "signal filter“?

Filter components (inductance, capacitor, voltage-limiting components).

Different filter topologies, what are the differences, which ones are to be used where.

Source and load impedance and some terms according to CISPR 17.

Comparison of source and load behaviour of Pi- and T-filters.

Practical design of a filter (T and Pi).

Filter characteristics and their differences in behaviour.

Comparison between real set-up, LTspice® simulation and RedExpert® simulation, explanation of differences.

Examples of different filters (concrete set-ups with circuit and measurement results):

- Different filters without transient protection
- Filters with transient protection
- Band stop filter for 6.78 MHZ (ISM band)
- Elliptical filter with use of the parasitic capacitance of the inductance as an advantage
- Filter system for decoupling source and load impedances
- Interface filter under real electromagnetic load conditions

Session

WS-11: ANSI C63.25.3 EMC Test Site Validation in 18 to 40 GHz

Time: *Location:* **R5**

Monday, 05/Sept/2022:

9:00am - 10:40am

Session Chair: **Åsa Larsbo**

Session Abstract

Today's methods in the USA's ANSI standards for test site validation stop at 18 GHz and in the past assumptions have been made that a test site which is validated below 18 GHz is also acceptable for measurements above 18 GHz. Given the proliferation of electronic devices operating at progressively higher frequencies, a suitable method for test site validation from 18 GHz to 40 GHz is needed.

Therefore, a new standard, ANSI C63.25.3 is being developed. Site validation methods for Open Area Test Sites (OATS) and Semi-Anechoic Chambers (SAC) with absorber on the ground plane as well as Fully Anechoic Rooms (FAR) are being explored using methods such as traditional s-VSWR, Time Domain s-VSWR, and Mode Filtered sVSWR, and Reverberation Chambers and Compact Antenna Test Ranges (CATR) are being examined to provide alternatives that address far field considerations.

Session

WS-10A + WS-10B: Why are radiated emission/immunity EMC tests so tricky?

Time: *Location:* **J2**

Monday, 05/Sept/2022:

11:10am - 12:50pm, 2:00pm - 3:40pm

Session Chair: **Diethard Hansen**

Session Abstract

Why is EMC getting ever more important? The vast proliferation of modern electronics in almost any area of product is accompanied, without effective mitigation, by unacceptable interference phenomena and lag of reliability. Regulations and technical standards try to control this. Here the radiated testing proves far more complex than conducted. Standards (STD) have inherent technical imperfections and are compromises in many ways. Understanding start with reviewing history background, physics and new game changing technologies like wireless 5G, medical devices and E-Mobility. In global markets international standards development (IEC/CISPR/ETSI/ISO/ SAE/ ANSI-IEEE) and harmonization eases trade. Focus: EU CE EMCD, RED, Automotive EMC. Testing acc. to STD is embedded in an overall product certification/qualification process. Therefore Product/Basic/Generic STD (limits) and the very important normative references (test methods) will be broadly technically analyzed. Product risk assessment/ EM-STDs get now more transparent.

Technical EMC Basics: EMC Units incl. dB, Constants in physics, frequency spectrum (to xx GHz), simple EM-radiators, near/far- field, basic test instrumentation, antennas, spectrum (FFT) and radiation efficiency of printed circuit boards and electronic components real world properties. We show typical cases for Pre/Compliance Testing Scenarios. Based on existing knowledge, clients improve their basic understanding of EMC testing and formal CE procedures.

Target Group
Parties benefiting from this specialized know-how are R&D/ QA/ corp. Standard-Compliance Department, Test Lab Organizations, Sales, Marketing, Legal Departments and Company Management up to CEO level. It does not stop here and incl. Investors and beyond. They certainly need to understand the risks involved in EM-Field related Product Compliance Testing. Seminar participants from management/sales/technical product R&D, QM or any other EMC concerned parties will greatly benefit. This is a specialized crash course with a safe 1-day guided Expert-Tour through one of the most challenging EMC areas ("el.-mag. fields"), a mine field!

We cover
EMC/Radio/Wireless/Automotive-EMC Testing per Norm and explain the background, for industry/government. We show winning EMC Testing strategies/CE compliance management. Real world cases "large/small Test Center" with planning from scratch to accreditation will be shown, fit for future.

Requirements
No special requirements. A general education background e.g., as technician /in engineering/physics or any similar level of expertise in electrical/electronic topics is beneficial.
Parties responsible for EMC management (company internal and/or external services) or those who even need to decide on setting-up their own ("EM Field") Test Facility/Test Center will surely enjoy details on planning, designing, specifying, quote evaluation, contracting, commissioning/accrediting.

Session

WS-12: Development of a GB-Ethernet Interface under EMC Aspects

Time: *Location:* **R5**

Monday, 05/Sept/2022:

11:10am - 12:50pm

Session Chair: **Heinz Zenkner**

Session Abstract

The workshop describes what is necessary for the EMC-compliant development of a GB Ethernet interface, between Phy and Ethernet connector. It goes into detail about the circuit technology, the components and the layout. Using a practical example, points such as adaptation of the symmetrical signal paths, protection against transient overvoltages, selection of suitable components, construction of the ground system, placement of the components on the PCB and layout design are demonstrated. The topic of EMC is taken into account comprehensively. Using real measurement results, the influences of cables, ground systems and system set-up on the immunity to interference of various disciplines as well as on interference emission are clearly illustrated.

Summary of the content:
 1 GB Ethernet front end design, overview
 Block diagram of a typical design
 Hardware design of a GB front end
 Schematic of the Ethernet interface
 Necessary key parameters of the components
 Some facts about signal integrity
 Layout considerations
 EMC requirements according to standards
 Measurement set-up for immunity and emission tests
 Aspects to consider for a proper set-up (cables, peripheral devices, power supply)
 Discussion of immunity tests and results
 Discussion of emission tests and results
 Discussion of emc behaviour of different shielding terminations
 Discussion of the emc behaviour of different Ethernet cable types
 Differences between integrated and discrete interface designs from the emc point of view
 Conclusions and summary

Session

WS-14: Spread Spectrum Clocking (SSC) to overcome EMI issues

Time: *Location:* **R6**

Monday, 05/Sept/2022:

11:10am - 12:50pm

Session Chair: **Bernd Deutschmann**

Session Abstract

A promising technique to improve the electromagnetic compatibility of electronic systems is based on spread spectrum clocking. Nowadays, this technique is widely used in modern electronic systems to reduce the electromagnetic emission by spreading the energy of a normally narrowband signal over a wider frequency range. Initially, such spread spectrum techniques were mainly used to make signal transmission systems more robust, avoid interference from RF signals, or to establish secure communications. Reducing the electromagnetic emission of an electronic system was less of a focus until the 1990s. Since then, many discussions have been held, e.g. on the question of legality under FCC regulations or the claim that spread spectrum is just a cheap trick to cheat an EMI receiver by actively shifting signals out of the receiver band while measuring at a certain frequency position.

In order to clear up these misunderstandings, this tutorial will provide a general overview of spread spectrum techniques, its history and applications, and an insight into the use of frequency modulation to reduce electromagnetic emission from electronic systems. Numerous practical examples of measurements of conducted electromagnetic emission from an electronic system are used to explain step-by-step how spread spectrum techniques actually work to reduce electromagnetic emissions. It is also shown how typical spread spectrum parameters such as frequency deviation, modulation frequency and modulation signal can be optimized accordingly to maximize emission reduction for the peak, average or quasi peak measurements in certain frequency ranges. In addition, the advantages and disadvantages of using spread spectrum techniques are explained and discussed.

Session

WS-02: Measurements on High Power Charging - Fast charging equipment for e-Cars

Time: *Location:* **G1**

Monday, 05/Sept/2022:

2:00pm - 3:40pm

Session Chair: **Werner Grommes**

Session Abstract

Measurements regarding electromagnetic interference fields on installed high power chargers are new, recent and challenging. In this tutorial, the general interference fields inverter driven charging devices are examined, as they are currently found in private and industrial use (solar panels and motor drives. High Power Chargers operate with pulsating DC voltages up to 800 V with charging currents up to 500 A. By the well-known formula for magnetics fields H = I x N becomes clear, that the high charging currents must also produce high magnetic fields. In addition to the fundamental wave, many harmonics are also generated by the pulsation, which are known to cause stronger interference phenomena. The focus of the measurements is on the limit values of electromagnetic fields with an effect on humans. Here, different limit values were defined for the general population, for workers and for implant carriers. However, these limits are frequency-dependent and depend on the duration of exposure.

Therefore, the assignment of the interference levels is always necessary with reference to the frequency. The following limit values and guidelines are normatively compared: - ICNIRP (international) - EMF Directive 2013/EU (Europe) - DGUV-Vorschrift 15 (Germany) - BMAS Forschungsbericht 451 (Herzschrittmacher) - DIN EN 45502-2-1 (active implants EMC immunity) Typical, known Effects of Electromagnetic Fields on Humans as well as on Implant Carriers:- - tingling, relaxation, muscle twitching, fatigue, restlessness, headache, chest pain, drowsiness - nausea, metallic taste, palpitations, phospene effect of the eyes, icrease in body temperatur What needs to be considered for the measurements:

- measurement technology used
- relevant directives on electromagnetic fields
- comparison of limits between ICNIRP, EMF-Directive and limits for pacemaker wearer
- measurements in time domain and frequency domain
- measurements related to the distance law: 0, 5, 10, 15 cm up to 50 cm
- the relevant area and measure point around the charging station, charging cable and charging plug

Measure method for detecting electrical and magnetic fields inside the e-Cars during driving: The strongest interference fields are generated during acceleration and deceleration. During constant travel the interference fields are low (as with high speed trains and railroads). The seats and the seats at buttock height and chest height are recommended as typical measuring points. The strongest fields are probably measured near the floor (inverter/harness). In addition to a small 3D field strength probe, an additional measurement with four mini 3D coils and a 4-channel oscilloscope is recommended.

The tutorial shows the theoretical basics as well as the field-tested measurement method in a practice-oriented manner.

Session

WS-08A + WS-08B: LF EMC in power grid and transportation systems

Time: *Location:* **J1**

Monday, 05/Sept/2022:

2:00pm - 3:40pm, 4:10pm - 5:50pm

Session Chair: **Francinei L Vieira**

Session Abstract

As the electrification of vehicles and trains increases, the power grid is also being modernized to supply different load types and to support different renewable energy sources through power converters. This interconnection leads to huge and complex systems, not only providing energy between the many sources and loads but also a potential path of electromagnetic interference (EMI) in the supraharmonic and RF conducted range (up to 30 MHz). A special focus is given to low frequencies (2-150 kHz) – a range lacking emission limits and analyses in the past. This tutorial session aims to provide a holistic overview of systems' design techniques, the electric/electronic component characterization, the electric performance metrics and state-of-the-art solutions for EMI/EMC issues in power transmission and distribution grids, railways, electrical vehicles and wind turbines. In particular, the speakers will address time-frequency methods, degradation of cable insulation, stray currents in railways, modelling of power converters, EMC in energy storage systems and EMC testing in wind turbines, electric vehicles, and power grids.

Presentation Title 1: EMC Testing: From wind turbines, over the power grid to electrical vehicles (EVs)
Speaker's Name: Sebastian Koj
Affiliation: Jade University of Applied Sciences, Germany

Presentation Title 2: Partial discharge location with time-reversal for the improvement of power transmission and distribution networks' reliability
Speaker's Name: Alistair Duffy (1) / Antonella Ragusa (1), (2)
Affiliation: (1) De Montfort University, United Kingdom
(2) The Institute of Marine Engineering of the Italian National Research Council (INM-CNR), Italy

Presentation Title 3: Supraharmonics from switched-mode power supplies in low-voltage grids
Speaker's Name: Leonardo Sandrolini (1) / Andrea Mariscotti (2)
Affiliation: (1) University of Bologna, Italy
(2) University of Genova, Italy

Presentation Title 4: Research of electromagnetic influence of traction supply systems on the railway automatics devices
Speaker's Name: Tetiana Serdiuk
Affiliation: Ukrainian State University of Science and Technologies, Ukraine

Presentation Title 5: Measurement and modelling of power inverter noise propagation on rolling stocks: practical examples
Speaker's Name: Umberto Paoletti
Affiliation: Hitachi, Ltd., Japan

Presentation Title 6: EMC challenges for energy storage systems
Speaker's Name: Bas ten Have
Affiliation: University of Twente, the Netherlands

Session

WS-13A + WS-13B: EMC simulation workflow for Electrification Applications

Time: *Location:* **R5**

Monday, 05/Sept/2022:

2:00pm - 3:40pm, 4:10pm - 5:50pm

Session Chair: **Flavio Calvano**

Session Abstract

In this tutorial we focus on the new EMC standard regulations for new hybrid and full electric vehicles which introduced the need to have a virtual modeling approach to reduce prototyping costs and time to market. We will present a simulation approach for IGBT/SiC power modules parasitics extraction, PCBs, busbar, cables, magnetic components for power conversion, common mode chokes and EMI filters, electrical motor, and, thanks to advanced circuit simulation, at system level, we will show how to reproduce EMC normative curves for power electronics components through real simulation examples. In addition, in this tutorial we will present different solutions to perform EMC simulations of full vehicle considering cable routing, antennas, control units, and other components according to most common standards as CISPR12, CISPR25 and ISO 11451.

What you will learn

• How to estimate the electromagnetic compatibility performance of a complex product, including the enclosures and cables, building a 3D virtual model which is matching measurements • How to model virtual models of common mode chokes and EMI filters

• How to extract power module parasitics power electronics printed circuit boards and study their effects on time domain signals, including the common mode noise in order to predict conducted emissions.

• Predict the dynamic breakdown of dielectrics when exposed to high electric fields.

Authors: Flavio Calvano, Giancarlo Guida, Ansys Italy, Marko Luukkainen and Bo Yang, Ansys Sweden

Session

WS-15A + WS-15B: Risk-based EMC implementation with examples

Time: *Location:* **R6**

Monday, 05/Sept/2022:

2:00pm - 3:40pm, 4:10pm - 5:50pm

Session Chair: **Nandun Senevirathna**

Session Abstract

The recent European Blue Guide [1] (regarding the implementation of EU product rules) has stipulated a risk-based approach (rather than the conventional, rule-based approach) mandatory for the EMC compliance of any new piece of electronic equipment with applicable EU Directives – including the LVD and the EMCD [2], [3].

Many manufacturers in the industry as well as the users of electronic systems may not be familiarized with this novel risk-based EMC approach to the full extent, as there is a lack of understanding and no clearly prescribed risk-assessment methodologies available yet. Particularly, the small and medium scale enterprises (SMEs), may need assistance to adapt to this major shift in approach.

In this workshop, we will present the EMC risk-based approach, emphasizing its contrast to the traditional rule-based EMC approach. We will focus on two examples of implementation of risk-based EMC approach in both military and medical contexts. The workshop will also address an example of systematic analysis of EMI Risks.

There is not only a need for formalization, but also for trained specialists having the capability to deal with the complexity of systems, and all the stakeholders (individuals and institutions) involved. We will introduce two large European networks, ETERNITY - European Training Network on Electromagnetic Risks in Medical Technology, and PETER - Pan-European Training, research and education network on Electromagnetic Risk management that are currently training 29 Early-Stage Researchers focusing on the development and implementation of risk-based EMC methodologies [4], [5].

• Risk-based EMC (military application example) – Frank Leferink
• Systematic Analysis of EMI Risks – Prof. Dr.-Ing. Frank Sabath
• EMC Risk-based Approach within Philips Medical Systems – Rob Kleihorst
• Presentation of the European Training Network PETER – Davy Pissoort
• Presentation of the European Training Network ETERNITY – Anne Roc'h

Hour 1:
• (20 minutes) – Risk-based EMC – Frank Leferink
• (Questions 10 min)
• (20 minutes) – Systematic Analysis of EMI Risks – Frank Sabath
• (Questions and discussions 10 min)

Hour 2
• (20 minutes) – Risk-based EMC Approach within Philips Medical Systems – Rob Kleihorst
• (Questions 10 min)
• Discussions on the last 3 ppts (30 min)

Hour 3
• (10 minutes) - Presentation of the European Training Network PETER (Pan-European Training Network on Electromagnetic Risks) – Davy Pissoort
• (Questions 5 min)
• (10 minutes) - Presentation of the European Training Network ETERNITY (European Training Network on Electromagnetic Risks in Medical Technology) – Anne Roc'h
• (Questions 5 min)

Session

WS-03: EMC on humans

Time:

Location: **G1**

Monday, 05/Sept/2022:

4:10pm - 5:50pm

Session Chair: **Jimmy Estenberg**

Session Abstract

High exposure to electromagnetic fields is known to have adverse health effects on humans. Heating and nerve stimulation are well established effects and we know that foetuses and people with active or passive medical implants are considered to be extra sensitive to exposure and are therefore subject to stricter recommendations and exposure guidelines. But we also meet arising questions regarding oxidative stress and other exposure related biological effects found in recent research.

Risk assessment in this area is based on two questions; “Which exposure will cause adverse effects in humans?” and “Which levels are we actually exposed to?”. The answers to these questions will guide us on how to perform a sound risk management: When do we need to limit exposure and how can it be done?

This workshop will deal with these questions and also give an overview of the guidelines from the International commission on non-ionizing radiation protection (ICNIRP), updated in 2020, as well as the European directive on the minimum health and safety requirements regarding the exposure of workers to the risks arising from electromagnetic fields. Another directive from the European Commission, relevant from this perspective, is the Radio equipment directive which states that radio equipment shall be constructed so as to ensure the protection of health and safety of persons and of domestic animals. What actions do we need to take to meet this requirement?

Session

WS-05: Device Measurements in Reverberation Chambers

Time: *Location:* **G2**

Monday, 05/Sept/2022:

4:10pm - 5:50pm

Session Chair: **Samar Hosseinzadegan**

Session Abstract

In this workshop we will cover various topics related to reverberation chamber test systems, including both theoretical and practical aspects. In this session, we will provide an overview of reverberation chambers and discuss their fundamentals and statistical properties. We will also compare this test facility with conventional anechoic chambers. In particular, we will focus on the practical aspects of reverberation chambers and discuss how measurements are performed and what parameters are measurable with this test facility. The workshop will conclude with a live demonstration of test measurements on-site or online, depending on the circumstances.

1. Basic Theory of Reverberation Chambers:
• Contrast to Anechoic Chamber Measurements
• Rich Isotropic Multipath (RIMP) Field
• Rayleigh and Exponential Distributions

2. Performing Reference Measurements:
• The significance of Gref (average chamber loss)
• Properties of the reference antenna
• Practical Do-s and Don't-s
• Handling of cable losses
• Tradeoffs in settings
- Number of samples, speed, sample correlation,frequency stirring, and etc.

3. Passive Measurements:
• Antenna Efficiency Measurements
- Reference antenna method
- Brief overview of the three-antenna method
• Diversity Gain Measurements
• Correlation measurements

4. Active Measurements:
• TRP measurements
• TIS measurements
• Throughput measurements

5. Directive Measurements:
• Technical solutions that enable LoS measurements
• Antenna Pattern measurements
• Throughput measurements
• EIRP
• EIS

Session

WS-10C: Why are radiated emission/immunity EMC tests so tricky?

Time: *Location:* **J2**

Monday, 05/Sept/2022:

4:10pm - 5:50pm

Session Chair: **Diethard Hansen**

Session Abstract

This WS builds on Part 1. Regulations/Tech-STD try to control EMI. Product Compliance assessment involves risks / measurement uncertainty. Here the radiated testing proves far more complex than conducted. Product-, Genericand Basic-Standards are partly tricky and have all inherent technical imperfections/compromises in many ways. We shine light into the jungle. Analysis of test reports? Radiated testing starts with understanding correct selection/use/limits of test antennas and their normative calibration. Additional devices are e.g., Field Sensors and TEM Cells plus typical test instruments, incl. Hard/Software. We discuss in detail basically all types/sizes of Test/Site Facilities for radiated Emission and Immunity and their normative ralidation (IEC/CISPR/ETSI/SAE/ANSI IEEE) for applications in EMC, Wireless and automotive EMC. Test Sites incl. OATS, ALSE, ALC, FAR, RVC. GTEMs start from DC to GHz, they can be used for time domain/ pulse testing.
Having assessed 400+ international test labs as tech-auditor (ISO EN 17025 accreditation) surely helps to sort things. Many Companies do “Conducted Tests” (R&D) inhouse and outsource “Field Testing”. When to use internal or external services is a technical as well as economic/management question. Sooner or later, depending on company size and market strategy, Lab Design (New EMC Test Center?): Planning, Quotation, Contract, Installation, Acceptance Test, Accreditation may become an issue. We present real world case studies.

Target Group
R&D, QM, QA, corp. Standard-Compliance Department, Test Lab Organizations, Sales, Marketing, Legal Departments and Company Management up to CEO level. It does not stop here and incl. Investors and beyond. They all certainly need to understand the risks involved in EM-Field related Product Compliance Testing. We demonstrate winning EMC Testing strategies/ CE compliance management. Real world cases "large/small Test Center" with planning from scratch to accreditation will be shown, fit for future.

Requirements
We recommend taking WS Part 1. Otherwise, no special requirements. A general education background e.g., as technician /in engineering/physics or any similar level of expertise in electrical/electronic topics is beneficial.