EMC EUROPE 2023

International Symposium and Exhibition on Electromagnetic Compatibility

CONFERENCE PROGRAMME

September 4 – 8, Kraków, Poland

Organizers

Wrocław University of Science and Technology

Honorary patronage of the President of UKE

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Welcome from ZbigniewJóskiewicz, Conference Chairman

Ladies and Gentlemen,

Dear Participants, Guests, Friends and Colleagues,

Welcome to the EMC Europe 2023 – the International Symposium and Exhibition on Electromagnetic Compatibility. For almost four decades, from 1972, Wroclaw University of Sciences and Technology (WUST) had organized 20 editions of Wroclaw International Symposia on EMC and since 2010, i.e. since the joining of the three largest European EMC conferences, the EMC Europe conference has been held three times in Poland. The previous two editions of EMC Europe were hosted in 2010 and 2016 in Wrocław. This year, we are honored to organize the next edition of this event in Krakow, the second-largest and one of the oldest and the most beautiful cities in Poland.

The city of Kraków (Cracow), situated on the Vistula River, dates back to the seventh century, was the official capital of Poland until 1596 and has traditionally been one of the leading centres of Polish academic, economic, cultural and artistic life. Cited as one of Europe's most beautiful cities, its Old Town with Wawel Royal Castle was declared a UNESCO World Heritage Site in 1978 making Kraków one of the world's first sites granted that status.

There are many universities in Krakow. The most famous and the oldest in Poland, the Jagieloński University, was founded in 1364. The world-famous astronomer Nicolaus Copernicus enrolled as a student at Jagiellonski University in 1491. Krakow is also home to one of the best technical universities in Poland, AGH University of Technology (its inauguration took place in 1919).

The city has many monuments, including the Wawel Royal Castle and a beautiful historic market. Due to the presence of thousands of students, it has a vibrant academic atmosphere. Krakow has many museums, galleries and other cultural institutions, and thus it is a very popular destination visited by tourists from all around the world. Among the historic buildings there are many atmospheric restaurants. I hope that in addition to participating in the conference, staying in Krakow will allow participants to enjoy all the historic city has to offer.

EMC Europe 2023 will last all week from Monday to Friday. The distinguishing feature of the conference organized in Wrocław was to highlight the subject of electromagnetic spectrum management and the impact of electromagnetic fields on living organisms. We continue this subject in a plenary presentation. Dr Aleksander Sołtysik will present the EU approach to the harmonious use of the electromagnetic spectrum, which is of particular importance in 5G ad 6G systems development. Prof. Jacek Starzyński and Prof. Elżbieta Trafny will discuss the influence of high-energy electromagnetic pulses on human cells. Dr Kamil Bechta will present approach used for EMF exposure compliance assessment of modern radio systems. The fourth plenary paper concerns the development of electromobility, which will be presented by Dr. Marco Klinger.

In addition to the plenary sessions, 165 scientific papers will be presented in 6 special sessions and 13 topic sessions, and 53 papers in 3 poster sessions. They were selected based on scientific merit from 251 submitted regular papers. A peer review process was performed by an Editorial Board of 92 international referees.

Also, a series of 24 workshops and 7 tutorials (called "EMC Marathon") devoted to various EMC issues are part of the conference organized on Monday and Friday. The Symposium will be accompanied by technical exhibition on EMC and RF/microwave measurements and instrumentation.

In addition to exchanging knowledge and experience in organized sessions and workshops, the conference is also a place where you can meet and discuss with colleagues during some meetings and social events. I am pleased to inform you that the Dinner Gala will take place in the former Salt Mine Wieliczka (Priceless Monument of World Material Culture, entered in 1978 on the First UNESCO World Heritage List). In addition, the participants will also be able to meet and interact at cocktail reception in the Old Tram Depot.

I would like to cordially thank the authors of papers, organisers of the invited sessions, workshops and tutorials for their contribution to the Conference program. Special thanks go to the International Steering Committee and a large group of reviewers for their support in evaluation of the submitted papers. I would also like to thank our sponsors and exhibitors for their contributions. Personally I would also thank my colleagues from the Local Organising Committee for their work dedicated for the Conference arrangements.

Thank you very much for your participation in the EMC Europe 2023 Conference. I hope the meeting will be valuable for all of you, and I wish you a pleasant stay in magic Krakow.

I am also looking forward to the subsequent EMC Europe conferences and I invite you to the next event - EMC Europe 2024, to be organized by our colleagues in Brudge (Belgium) next year.

Dr Zbigniew Joskiewicz
Chairman of the Local Organizing Committee.

Conference Information

Oral Sessions

Each paper assigned to the oral session is allowed for a 20 minutes presentation (including about 3-5 minutes for discussion). Detailed time schedule has been defined for each oral session in the programme.

Video projectors and computers (MS Power Point and Acrobat reader) are available for presentation in each conference room.

Authors must meet their session chairman in the room at least 15 minutes before the beginning of the session. Each speaker must give a short biography to the chairman and load the presentation in the computer, if did not submit it before to the organizers via on-line conference system as 2nd final submission. Only presentations provided on pendrives will be accepted for upload. The use of personal notebooks for presentation is not allowed.

Poster presentations

Each poster board will be marked with the poster ID-number, which can be found in the final conference programme as well. Authors are required to use only the board corresponding to their poster.

Poster presenters have to hang up their poster on the day of their presentation 15 minutes before the poster session. The authors will need to stay personally just during their poster session and to remove their posters from the boards after the poster session. Posters left on the boards after the poster sessions, will not be returned by the organisers.

Posters should be fixed to the poster board using materials (adhesive tapes or drawing pins) provided on site.

The display area dedicated for presenting a poster of A0 size has the following dimension: approx. 84.1 cm wide and 118.9 height).

Internet Access

Participants equipped with computers and other mobile equipment with wireless card 802.11b/g/n will be able to take advantage of the wireless LAN facility installed in the conference rooms, lobby and exhibition area, enabling them to connect to the Internet network. The dedicated wireless network for Symposium participant is **EMC2023** with password **emceurope**.

Mobile Conference assistant - Conference4Me

The Conference4Me smartphone application provides you with the most comfortable tool for browsing the complete programme of EMC Europe 2023 and planning your participation in this conference. Conference4Me application allows you to create your very own agenda on the fly directly from your phone or tablet. The Conference4Me application is available for free for Android, iOS, Windows Phone and Amazon Kindle Fire devices.

To download the mobile app, please visit http://conference4me.eu/download or search for "conference4me" in Google Play, App Store, respectively, or scan code presented below.

Venue

The EMC Europe 2023 symposium will take place in the Congress Centre of the Qubus Hotel**** Kraków (Poland) located close to the city center (1,5 km to the Old Market).

The opening ceremony as well as keynotes will be held in conference rooms B-E (B+C+D+E).

Oral sessions, workshops and tutorials will be held in conference rooms (A, B, C, D, E, G, H, I). Poster sessions will be held in room I.

Reception desk

For your convenience, the reception will be open on Sunday September 3, 2023 from 15:00 to 18:00, and every Conference day (September 4 - 8, 2023) from 8:00 to 17:40 or the end of the last session.

All items the participant is entitled to (i.e badge, lanyards, printed conference programme and ticket(s) for Cocktail and Gala Dinner) will be provided on site at the reception desk during check in.

Badges

All delegates will receive a badge and invitations for social events ordered during registration. For your convenience please wear your badge throughout the conference, even at the social events. The badge is multifunctional. It is also a pass for lunches and refreshments during breaks.

Transport in Kraków

Trams, buses, and taxis are at your disposal. A 20-minute tram and bus ticket costs 4,00 zloty. Tickets can be bought from vending machines situated nearby the tram and bus stops, around the city, once on board (payment by the credit/debit card). Please keep in mind that paper tickets need to be validated using special machines once on board, else you will be liable to pay a penalty fare.

The venue can be reached by public transport. The nearest bus and tram stop "Plac Bohaterów Getta" is located 250 meters away from the venue entrance.

You can use the website jakdojade.pl/krakow/trasa/?locale=en for travel planning, checking timetables, buying tickets and using other travel support services, available via the jakdojade.pl website and mobile applications.

Qubus Hotel from the Main Train Station can be reached by direct tram no 3, stop: "Plac Bohaterów Getta" and by train no SKA2, stop "Kraków Zabłocie"

From Main Square you can use tram no 3 and 24 from stop „Poczta Główna" to stop "Plac Bohaterów Getta".

Lunch

Lunch is served in the restaurant and lobby (see map at the end of programme). Admission ticket is badge so please bring it with you. The conference logo placed in selected boxes (corresponding to each conference day) at the bottom of the badge indicates the days when you are entitled to lunch. Vegetarian cours will be available. Enjoy your meal!

Symposium Cocktail   Wednesday, September 6th at 19:00

The Local Organizing Committee cordially invites to attend the Symposium Cocktail in the Old Tram Depot (Świętego Wawrzyńca 12, 31-060 Kraków). It's a unique opportunity to meet with your colleagues and exhibitors in an informal atmosphere.

Please take the invitation with you. Admission by invitation only. Ordered invitation is included in envelope received at the reception desk during check in.

During the Symposium Cocktail the Best Paper and Best Student Paper will be awarded as well as Travel grant will be granted.

Symposium Gala Dinner   Tuesday, September 5th at 20:00 (see bus departure)

The Local Organizing Committee cordially invites to attend the Symposium Gala Dinner in the former salt mine "Wieliczka".

Salt mine "Wieliczka" is located 14 km away from the conference venue (transportation will be provided), Symposium Gala Dinner will be served in the biggest chamber called Warszawa, 125 m under the ground.

Bus departure starts at 18:00 from the Congress Centre of the Qubus Hotel.

Please take the invitation with you. Admission by invitation only. Ordered invitation is included in envelope received at the reception desk during check in.

Accompanying Events

TEAM EMC @EMCEUROPE Bike Ride (Monday, September 04, 2023)

It is a city bike ride with a guide (English language) along the Vistula River and through the districts of Kazimierz and the Old Town,
The trip starts at 06:15 pm (Qubus Hotel Kraków) and ends at 09.00 pm at the bike rental company located in the Old Town. Bicycles will be available at the Qubus Hotel entrance for previously registered participants.
Cost - PLN 125 (the fee covers the cost of the guide and bike rental, payable on site on the day of the trip). The number of participants is limited!
Deadline for submission of applications: September 01, 2023
Applications should be sent to: miroslaw.zielenkiewicz@ieee.org

Kraków Old Town - a guided tour (Monday, September 04, 2023)

The tour starts at 06:00 pm and ends at 08.00 pm.
Participants registration via e-mail: krakowstoryteller@gmail.com
Cost: 50 PLN/person (payable on site on the day of the tour)
During a walk with a licensed tour guide you will see the most signifinact landmarks of the Old Town of the former royal capital of Poland - the medieval fortifications, the Main Square, the University quarter, the "Pope's Window", the oldest street in the city and the Wawel Hill, where the cathedral and the royal residence is. You will hear the buggle call and tons of stories that will make it easier to understand Polish history and the mentality of the Polish people. We will try to answer one very important question: what makes Kraków... Kraków?
The tour will be guided in English by Alicja Zioło, licensed tour guide in Krakow, with over 10 years experience in guiding foreigners.
We will be using the tour guide audio system. You can use the headphones provided by tour gude but it will be far more sanitary if you bring your own (minijack).

Jewish Kraków - a guided tour (Thursday, September 07, 2023)

The tour starts at 06:00 pm and ends at 08.00 pm.
Participants registration via e-mail: krakowstoryteller@gmail.com
Cost: 50 PLN/person (payable on site on the day of the tour)
The history of the Jewish community of Krakow is over 750 years long. The remains of the oldest Jewish district can still be found in the Old Town of Krakow. After the fire that destroyed a big part of the town in 1494, the Jews were forced to leave the Polish capital. Looking for a new place to live, they got to Kazimierz, a town nearby, on the other bank of the river. This is where they settled, this is where they created their new district that survived the centuries, even the most difficult one, 20th century. Today we can walk the same streets, visit the same buildings and this is the best setting for a discussion about the history of the Jewish community of Krakow – from Medieval times up to last week.

Individual guided tours

If you feel like walking an extra mile and exploring the wonders of Krakow? Please, contact krakowstoryteller@gmail.com. We can arrange private sightseeing in all local museums and historical sites.

Upcomming EMC Conferences:

EMC Europe Symposia:

2024 – Bruges, Belgium

2025 – Paris, France

IEEE EMC Symposia

2024 – Phoenix, Arizona, USA
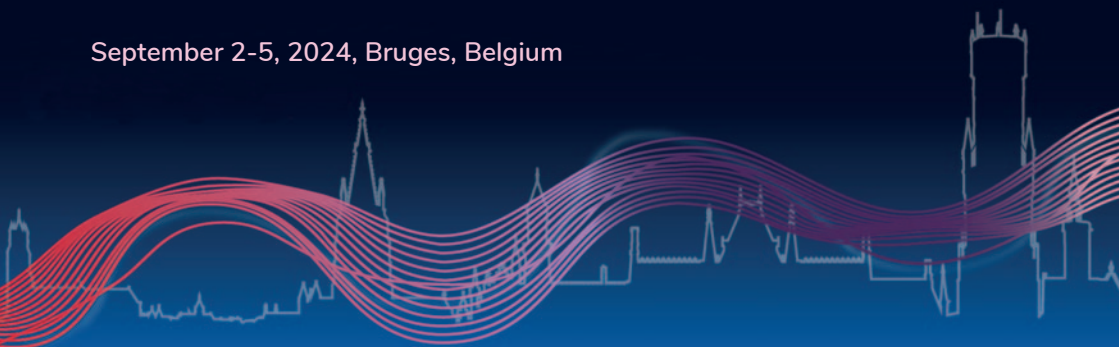
2025 – Raleigh, North Carolina, USA

AsiaPacific EMC

2024 – Okinawa, Japan

EMC EUROPE 2024

International Symposium and Exhibition on Electromagnetic Compatibility

September 2-5, 2024, Bruges, Belgium

CALL FOR PAPERS

SYMPOSIUM VENUE

In 2024, EMC Europe, the leading EMC Symposium in Europe, will be organized by the Mechatronics research group (M-Group) of KU Leuven Bruges Campus at the Bruges Meeting & Convention Centre (BMCC). Its outstanding location is within walking distance of numerous hotels and world-famous attractions, and it meets all requirements for a modern event like EMC Europe 2024. The BMCC is located approximately 1.5 km away from Bruges' Market Square, which is in the historic city center, often called the "Venice of the North".

IMPORTANT DEADLINES AND DATES

- Special Session Proposals: January 22, 2024
- Paper Submission Deadline: February 26, 2024
- Workshop & Tutorial Proposal Submission Deadline: March 25, 2024
- Notification of Paper Acceptance: April 29, 2024
- Reduced Registration Fee: May 31, 2024
- Final Paper Submission: May 31, 2024
- Exhibition Application: June 30, 2024
- EMC Europe 2024 Symposium: September 2-5, 2024

PAPER SUBMISSION

Authors are invited to submit original contributions on all EMC-related aspects within the technical areas listed above. Only full 2-column, 4 to 6 pages papers, prepared according to the IEEE rules for style using the template provided on the EMC Europe 2024 website, will be peer-reviewed and checked for plagiarism using the IEEE CrossCheck portal. Papers should be uploaded in PDF-format through the online conference system (**www.conftool.org/emceurope2024**) before **February 26, 2024**.

To submit the contribution, a new account has to be registered or an existing author's account has to be used. Final versions of accepted papers which will be presented at oral or poster sessions at EMC Europe 2024 will be submitted for publication in the IEEE Xplore® database. The Electronic IEEE Copyright Form needs to be signed for each paper and the appropriate copyright clearance code notice should be added on the bottom of the paper's first page. The Best Symposium Paper and Best Student paper will be selected by the International Steering Committee and awarded at the conference dinner.

CONTACT INFORMATION

- Symposium Website: **www.emceurope2024.org**
- Conference Venue: www.bmccbruges.com
- What's on in Bruges: www.visitbruges.be
- Conference Chair: Davy Pissoort (davy.pissoort@kuleuven.be)
- Technical Program Chair: Tim Claeys (tim.claeys@kuleuven.be)
- Exhibition & Sponsorship Chair: Marc Le Roy (marc.le.roy@comtest.eu)
- On-line Conference system: www.conftool.org/emceurope2024

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Keynotes

Dr. Aleksander Sołtysik

ALEKSANDER SOŁTYSIK is a Digital attaché for the telecommunication sector in the Permanent Representation of Poland to the European Union. He is responsible for matters regardin radio spectrum, gigabit infrastructrure, as well as artificial intelligence. He holds the position of the vice chair of the Radio Spectrum Policy Group – a high-level advisory group that assists the European Commission in the development of radio spectrum policy. He i salso a co- rapporteur of the RSPG Working Group on Peer Review and Member State cooperation on authorisations and awards, which is responsible for annual reports on the implementation of the art. 35 of the European Electronic Communications Code. He i salso respoonsible for radio spectrum policy issues both on a national and international level. Engagded in the International Telecommunication Union's and CEPT matters.

Radio spectrum policy in the European Union

ABSTRACT:

Connectivity and technological advance are cornerstones of economic recovery in the post pandemic scene. Efficient use of radio spectrum supporting EU policies while maximising societal value is the overarching target. Today we are equipped with several forward – looking regulations and policies such as European Electronic Communications Code, European Declaration on Digital Rights, Principles for the Digital Decade, and the Digital Decade Policy Programme 2030.

The scene is set for the ambitious goals that will be Europe's, huge leap in the digital transformation. With the first implementations of the 5G networks across European Union, work on the next generation began. Radio spectrum being a limited and scarce resource is a truly key enabler of fast and reliable connectivity.

We will take a look into decision making process in the European Union with regard to the radio spectrum, both current and planned regulations and present the scope of work of the authorities that adopt decisive documents and opinions in the scope of radio spectrum policy.

In this context we will bring closer the scope of the acivity of the Radio Spectrum Policy Group and its current and future Work Programme which is focusing on well known issues such as Peer Review Forum on the basis of the European Electronic Communications Code, World Radiocommunication Conferences or "Good Offices", but also new items such as 6G and Climate Change.

The presentation will put a spotlight on other various EU decision making group such as European Commission's Radio Spectrum Committee (RSC), Working Party on Telecommunications and Information Society (H.5) within the Council of European Union, and also those appriopriate for Europe as a whole, such as European Conference of Postal and Telecommunications Administrations (CEPT).

The aim is to deliver an overview of the complex decision – making process within the European Union in term of telecommunication and spectrum related issues and how and when interested stakeholders may influence the final outcome.

Dr. Marco Klingler

MARCO KLINGLER was born in Zurich, Switzerland, in 1963. He received his Engineer's degree in computer science from HEI, Lille (France) in 1989, his DEA (M.S.) degree in automatics / robotics and his Ph.D. in electronics in 1989 and 1992 respectively, both from the University of Lille. He then joined the French National Research Institute for Transport and Safety (INRETS) in Ville-neuve d'Ascq (France) as a researcher where he was in charge of the R&D activities in EMC of ground transportation systems. His main interests were electromagnetic interferences on PCBs, be-havior of electronic components in electromagnetic environments, coupling to wire structures, test methods, and test facilities. In 2002, he joined Groupe PSA (now Stellantis) in Velizy-Villacoublay (France) in the Development Division where he was successively in charge of the EMC design activities, the EMC / an-tenna simulation activities, and finally the EMC full vehicle valida-tion activities. In 2011, he moved to the Research Division where he is currently an EMC Expert and responsible of the EMC / an-tenna research activities. His current main interests include EMC modeling and simulation of automotive electric powertrains, EMC and functional safety of critical systems, EMC in advanced con-nectivity, and specific vehicle antennas.

Current and Future Technical Challenges in Automotive EMC

ABSTRACT:

For the first time in history, the automotive industry is facing simultaneously three major challenges which are carbon neutrality, advanced connectivity and autonomous vehicles.

Global warming and limited energy resources are leading to worldwide issues where ground transportation accounts for a big part of the global CO2 emissions. The automotive industry needs to develop more efficient powertrains based on new propulsion technologies releasing globally less CO2, become a part of the global solution of smart energy management, decrease the weight of new cars, and improve their recyclability. In a connected world were there are probably more mobile internet devices than people on earth, and where young generations are born and grow up in a daily life filled with internet applications and social network, the automotive industry needs to offer connected vehicles to keep in line with the yearning of many customers, to imagine what will be expected from tomorrow's cars, and to benefit from the simultaneous advent of Big Data to develop new business opportunities. Finally, more and more people are living in big cities and need to move around everyday, creating long and heavy traffic jams. Most developed countries are also aiming at zero death on roads. The automotive industry needs to develop smarter navigation systems to improve driving conditions, autonomous vehicles to make driving less stressful in harsh condition and technologies that will prevent casualties due to human mistakes.

This presentation will focus on the current and numerous technical challenges awaiting the automotive industry in the near future. In this context, the speaker will describe the most important topics which raise difficult and sometimes new EMC issues: battery electric vehicles (EVs) and full-hybrid electric vehicles (HEVs), EVs and HEVs in the situation of charging mode, the special case of wireless inductive charging of EVs and HEVs, composite materials, in-vehicle high data rate wire transmission links, wireless communication systems, safety-related Advanced Driver Assistance Systems (ADAS) and finally future autonomous vehicles.

Kamil Bechta

KAMIL BECHTA received the M.Sc. and Ph.D. degrees in wireless communications from the Electronics Faculty, Military University of Technology, Warsaw, Poland, in 2010 and 2021, respectively.

After graduation, he worked as a Research Assistant with the Military University of Technology, Warsaw, and he joined Nokia Siemens Networks in 2011 as a 3GPP RAN4 Standardization Specialist. Since 2015, he has been a 5G Senior Radio Research Engineer with Nokia Bell Labs, and since 2017 he has been responsible for RF EMF exposure assessment of radio modules for 5G systems with the Mobile Networks Department, Nokia, Wroclaw.

Since 2020 Dr. Bechta has been representing Nokia in Polish Committee for Standardization and participates in IEC TC 106 MT 3 Technical Committee for the RF EMF exposure assessment of base stations. He received Nokia Technology Center Wroclaw 2nd Award in 2020, The Foundation for the Development of Radiocommunication and Multimedia Technologies Distinguished Award in 2022 and Innovator of Mazovia - Innovative Scientist 1st Award in 2022. He is a co-author of more than 20 articles and 7 patent applications in the area of wireless communications.

Introduction to the actual maximum approach used for EMF exposure compliance assessment

ABSTRACT:

In the early implementation processes for base station compliance with the EMF exposure limits, the assessment of exposure levels was based on the rated maximum or configured maximum transmitted power. This approach did not consider neither the variability of the transmitted signal in time nor the variability of beam directions for base stations with massive MIMO, beamforming or beam steering capabilities. Recent modelling studies and field monitoring results have shown that the impact of averaging time specified in EMF exposure limits allows to implement power reduction factors on top of the maximum configured value in order to represent the actual exposure more accurately. Depends on the implemented beamformng algorithm, number of simultaneously transmitted beams and duration of a single downlink connection, the actual maximum transmitted power can be several dB lower than the configured maximum transmitted power. This is the basis for the implementation of the actual maximum approach that has been specified by International Electrotecnical Commission in the standard IEC 62232:2022.

The presentation introduces the background of the actual maximum approach, how it has been specified, how it can be validated and provide examples of implementation in the field.

Prof. Jacek Starzyński

JACEK STARZYŃSK received the M.Sc. and Ph.D. degrees in electrical engineering from the Warsaw University of Technology, Warsaw, Poland, in 1986 and 1996, respectively. He is currently a Professor with the Faculty of Electrical Engineering, Warsaw University of Technology, and with the Military University of Technology, Warsaw. His current research interests include FEM in electrical engineering (plasma simulation, open boundary problems, materials, and FEM codes), application of machine learning to automated diagnostics of electronic systems, optimal design in electromagnetics (hybrid methods and genetic algorithms), programming (open source), and bioelectromagnetism).

Prof. Elżbieta Tranfy

ELŻBIETA TRANFY is a biologist, working for years in molecular biology, microbiology and cellular biology. She is the Deputy Director for Scientific Affairs at the Biomedical Engineering Centre, at the Military University of Technology, Warsaw, Poland. Her recent scientific activity focuses on electromagnetic field interactions with healthy and cancer cells. She actively participated in the project "Methods and Means of Protection and Defence Against HPM Impulses" under the strategic programme of "New Weaponry and Defence Systems of Directed Energy" funded by the Polish National Centre for Research and Development.

Dr. Yahia Achours

Research on the Influence of High-Energy Electromagnetic Pulses on Human Cells

ABSTRACT: The effects of nanosecond electromagnetic pulses on human health are the subject of continuous research and ongoing discussion. The effects that have been studied and exploited show the possibility of significant effects on individual cells in the process of so-called electroporation, where an electromagnetic field is administered through devices that allow cells to be directly subjected to a field of high intensity and dose controlled at the level of a single cell. However, the mechanism that would allow the body as a whole to be affected in a comparable way has not been known. Such an impact could be relevant in an environment of increasing electromagnetic smog and could also apply to devices that produce simulated NEMPs for testing devices, for example. The authors aim to present research on the effects of electromagnetic pulses of very high instantaneous powers on single cells subjected to direct exposure and on groups of cells exposed to such pulses under conditions similar to whole-body exposures to NEMP pulses.

The lecture consists of two parts. First, we will present the simulator designs used in the authors' research. We will discuss typical NEM simulator generators based on classic but compact Marx-circuit generators, generating voltages of 1 MV and supplying strip lines in which groups of cells can be exposed to fields above 1 MV/m. We will show new designs of miniature high-voltage generators using solid-state switches, which makes it possible to precisely control the shape of the pulses, and therefore the dose, and apply the pulses in the form of controlled repetitions. The second part of the lecture is a discussion of the results. We will show how to assess and the results of evaluating the effects of different exposures on morphology, viability and free radical generation in cells. We will describe the behavior of human mesenchymal stem cells (hMSCs) exposed to a single electromagnetic pulse with an electric field magnitude greater than 1 MV/m and a pulse duration of approximately 120 ns generated from a classical 750 kV Marx generator, and the effect of repeatedly applied approximately 60 ns pulses on Leydig TM3 cells. A comparison of the results shows a significant effect of multiple pulses applied directly, but no effect of single pulses applied on a macro scale.

Best Paper Award Nominee

Paper ID	Title and authors	Session
112	**Broadband 3D Modeling and Simulation of DC-Biased SMT Ferrite Beads for EMI Filters** Christian Riener[1,2], Thomas Bauernfeind[2,1], Klaus Roppert[2,1], Samuel Kvasnicka[1,2], Bernhard Auinger[1], Manfred Kaltenbacher[2,1] [1]Silicon Austria Labs, TU-Graz SAL GEMC Lab, Austria; [2]Institute of Fundamentals and Theory in Electrical Engineering, Graz University of Technology, Austria	**OS-06A**
138	**In-Situ and Contactless Evaluation of Performance of Power Converter EMC Filter based on Near-Field Scan Measurement** Alexandre BOYER[1], Sébastien SERPAUD[2], Sonia BEN DHIA[1] [1]LAAS-CNRS, France; [2]IRT Saint-Exupéry institute, France	**OS-04A**
143	**Analysis Method for Magnetic Field Strength on On-Board Antenna due to Inverter Common-Mode Noise at Whole Train Level** Keisuke Fukumasu[1], Masayuki Nunokawa[2], Umberto Paoletti[1], Kiyoto Matsushima[1], Toshiaki Takami[2] [1]Hitachi, Ltd., Japan; [2]Central Japan Railway Company	**OS-10**
272	**Shielded Aircraft Windows to Protect Radio Altimeters in the Presence of Wireless Avionics Intra-Communication** Yuri Konter, Koen Blaauw, Jesper Lansink Rotgerink Royal NLR - Netherlands Aerospace Centre	**OS-01A**
286	**Monte Carlo Simulation of a Physical Random Unintentional Radiator as a Basis for Statistics in Fully Anechoic Room Measurements** Jörg Petzold, Mathias Magdowski, Ralf Vick Otto-von-Guericke University, Germany	**OS-06D**

Best Students Paper Award Nominee

Paper ID	Title and authors	Session
102	**Efficient In situ Assessment of Radiated Emissions using Time-Domain Measurements** Jordi Sole-Lloveras[1,2], Marco A. Azpurua[1,2], Marc Aragon Homar[1], Yasutoshi Yoshioka[3], Ferran Silva[2] [1]EMC Barcelona (EMC Electromagnetic BCN, S.L.); [2]Universitat Politècnica de Catalunya; [3]Fuji Electric Europe GmbH	**SS-03A**
276	**Evaluation of the Variability of the Maximum Expected Field Strengths in an MRI Room** Simon Rendon Velez[1,2], Ridvan Aba[2], Mark J. A. M. van Helvoort[1], Bärbel van den Berg[3], Robert Vogt-Ardatjew[2], Frank Leferink[2,4] [1]Philips Medical Systems; [2]University of Twente; [3]Medisch Spectrum Twente; [4]Thales	**SS-06C**
299	**A PCB Based High Resistance GHz Bandwidth Voltage Pick Up for Detecting Switching Voltage** Mehdi Gholizadeh[1,2], Sajjad Sadeghi[1], Amin Pak[1,2], Jan Hansen[1,2], David Pommerenke[1,2] [1]Graz University of Technology, Austria; [2]TU-Graz SAL GEMC Lab Austria	**OS-13**
302	**Performance Charaterisation of the Decoupling Capacitor Network using the Near-Field Measurement** Sebastien Serpaud[1], Alexandre Boyer[2], Sonia Ben Dhia[2], Fabio Coccetti[1] [1]IRT Saint Exupery, Toulouse, France; [2]Univ. de Toulouse, INSA, UPS, LAAS Toulouse, France	**OS-12B**
309	**Modified ESD Generator to Emulate Body Worn Equipment ESD and Human Skin ESD** Nikola Becanovic, Gabriel Fellner, Simon Buttinger, David Pommerenke Graz University of Technology, Austria	**OS-03**

Schedule at glance

	Monday, September 4, 2023	Tuesday, September 5, 2023	Wednesday, September 6, 2023	Thursday, September 7, 2023	Friday, September 8, 2023
09:00–10:20	WORKSHOPS & TUTORIALS	OPENING CEREMONY / PLENARY SESSION I (Keynote 1)	ORAL SESSIONS / MEETINGS	ORAL SESSIONS / MEETINGS	WORKSHOPS & TUTORIALS
10:30	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK
11:00–12:20	WORKSHOPS & TUTORIALS	PLENARY SESSION II (Keynotes 2, 3, 4)	ORAL SESSIONS	ORAL SESSIONS	WORKSHOPS & TUTORIALS
12:30–14:00	LUNCH	LUNCH / POSTER SESSION I / EXHIBITION / MEETINGS	LUNCH / POSTER SESSION II / EXHIBITION / MEETINGS	LUNCH / POSTER SESSION III / EXHIBITION / MEETINGS	LUNCH
14:30–16:00	WORKSHOPS & TUTORIALS	ORAL SESSIONS	ORAL SESSIONS	ORAL SESSIONS	WORKSHOPS & TUTORIALS
16:00	COFFEE BREAK		COFFEE BREAK	COFFEE BREAK	COFFEE BREAK
16:30		COFFEE BREAK			
16:50–17:50	WORKSHOPS & TUTORIALS		ORAL SESSIONS / MEETINGS	ORAL SESSIONS / MEETINGS	WORKSHOPS & TUTORIALS

Evening events:

TEAM EMC @EMCEUROPE BIKE RIDE (For registered participants only) (Exrta paid)

"KRAKÓW OLD TOWN" - A Guided Tour (For registered participants only) (Exrta paid)

BUS TRANSPORT TO THE BANQUET (Departure from the Qubus Hotel)

SYMPOSIUM GALA DINNER in former salt mine in Wieliczka (about 125 m under the ground) 20:00 - 23:00 (By invitation only)

SYMPOSIUM COCTAIL in Stara Zajednia (Old Tram Depot) by DeSilva 19:00 - 24:00 (By invitation only)

ISC DINNER 18:30 - 22:00 (By invitation only)

"JEWISH KRAKÓW" - A Guided Tour (For registered participants only) (Exrta paid)

Monday, 4th September 2023 – Workshops & Tutorials

Tutorials

TU-01A-B TUTORIAL	Time: 9:00 - 12:30

EMC Marathon - Tutorial: "Shielding : Emerging Challenges and Standards"

	Anne Roc'h, Eindhoven University of Technology, The Netherlands
Chaired by:	**Davy Pissoort**, KU Leuven, Belgium
	Pavithrakrishnan Radhakrishnan, KU Leuven, Belgium
Room	**I**

Speakers: Davy Pissoort, Anne Roc'h, Frank Leferink

Abstract: Shielding is particularly important in critical systems and environments, such as aerospace, defense, medical equipment, autonomous systems, and transportation. In these applications, even small disruptions caused by EMI can have significant consequences, including equipment failure, data loss, or safety hazards. Shielding helps to ensure the reliable operation of these systems and protects their operators and users from the harmful effects of EMI. In this two-part tutorial, we will provide a comprehensive overview of the principles of shielding and its various applications. We will also delve into the different techniques used for controlling EMI, including gasketing, planar materials, and other techniques, as well as their characterization methods, with illustrations and guidelines for best practice. Additionally, the tutorial will address the IEEE Shielding Standards Continuity Working Group related to these characterization and mitigation techniques, providing a detailed understanding of the current state of the art in shielding and its applications.

Novelty:

The proposed tutorial offers an opportunity for attendees to discover the latest advancements in shielding techniques over a broad frequency range. The event will also provide insight into emerging trends and cutting-edge developments, offering a unique learning experience for attendees seeking to expand their knowledge on shielding techniques.

Objectives

1. To provide a comprehensive overview of emerging challenges in shielding (Davy Pissoort, Anne Roc'h, Frank Leferink)

2. To make the audience aware of the Safe and Sustainable-by-design (SSbD) framework and how it impacts EM shielding design. The framework adopted by the European Commission as an official recommendation in December 2022. it is an integral part of the Circular Economy Action Plan under the European Green Deal. (Anne Roc'h)

3. To present the EU Doctoral Network PARASOL that focuses on the complete life cycle of electromagnetic shielding solutions for mobility using SSbD approach. (Anne Roc'h)

4. To present the TETRA - Shielding Revisited that focus on application of shielding techniques covering low and high frequency shielding characterisation, Board level shielding and absorbers. (Davy Pissoort)

5. To discuss any/all of the above with the audience.(Davy Pissoort, Anne

Roc'h, Frank Leferink)

<u>Primary Audience</u>

Practicing engineers and their managers play a crucial role in ensuring the reliability of critical systems through the implementation of effective shielding techniques. This includes gasketing, filtering, board level shielding, and other techniques to protect against EMI interference.

EMC engineers and managers, as well as EMC testing companies and other organizations interested in studying and understanding the physics behind the various standardized test methods used to characterize the SE of gaskets, board level shields, and planar materials. By attending, you will gain the knowledge and skills needed to effectively perform SE testing and ensure the reliability and safety of electronic systems.

<u>Secondary Audience</u>

While traditionally associated with the electronics industry, EM and EMI can impact a wide range of industries, including medical, nuclear, automotive, rail, aerospace, machinery, and processing industries, among others. As such, it is becoming increasingly important for engineers, companies, and other organizations to consider how to manage these risks.

Workshops

WS-01A-D	WORKSHOP	Time: 9:00 - 18:00

EMC MARATHON - WORKSHOP: "YOU HAD ME AT "REVERB…"!"

Chaired by:	**Vasso Gkatsi,** University of Twente, The Netherlands
	Robert Vogt-Ardatjew, University of Twente, The Netherlands
	Vignesh Rajamani, IEEE EMC-S, United States of America
Room	**A**

Speakers: Frank Leferink, Valter Mariani Primiani, Vignesh Rajamani, Mathias Magdowski, Vasso Gkatsi, Robert Vogt-Ardatjew, Andy Marvin & John Dawson

Abstract: Reverb? Reverb. Are you looking for reverbs? Wait. Okay, okay. Okay.

If this is where it has to happen, at the EMC Europe 2023 conference, this is where it has to happen, in this very workshop. We are not letting you go without learning about the well-known reverberation chambers, the statistical methods used to evaluate fields inside them, their theory and applications. How about that? This is our specialty. You know, we were good in the laboratories. But we came here, and we have prepared a workshop, but not alone. We have with us speakers from different areas of expertise regarding reverberation chambers, all from different institutes. And now, we just… are ready!

Today, our little workshop, our presentations, and our live demonstrations using a Vibrating Intrinsic Reverberation Chamber (VIRC) have a big day. A very, very big day. But so far, it is not complete, it isn't nearly close to being in the same vicinity as complete, because we have not shared it with you… yet. We cannot wait for you to witness the presented theory in action, and even participate in performing some of the experiments yourself. We live in an EMC world, a reverberating world, and we work with many people who specialize in this field…

We have them with us. We are just waiting for you!

WS-02

WORKSHOP

Time: 9:00 - 10:30

EMC MARATHON - WORKSHOP: LOW FREQUENCY SIGNAL INTEGRITY, WITH LIVE DEMONSTRATIONS

Chaired by:	**Lee Hill,** SILENT Solutions LLC & GmbH, Worcester Polytechnic Institute (WPI), University of Oxford, United States of America
Room	**B**

Speakers: Lee Hill

Abstract: Since most electrical engineers did not learn about low frequency signal integrity and grounding during their university studies, it can be challenging for them to achieve good low frequency signal integrity that is vital to the performance of closed-loop systems. Precision measurements and A/D conversion of temperature, flow, pressure, current, and voltage in modern energy conversion and motion control systems are simply not possible without excellent low frequency signal integrity.

During this presentation, using a signal generator, current and magnetic field probes, and an oscilloscope, Lee will model, demonstrate, and measure the emissions and immunity problems that can arise in low frequency circuits.

WS-03

WORKSHOP

Time: 11:00 - 12:30

EMC MARATHON - WORKSHOP: "ELECTROMAGNETIC PULSES"

Chaired by:	**Przemysław Stencel,** OBR CTM S.A., Poland
Room	**B**

Speakers: Przemysław Stencel, Marta Czarnowska, Grzegorz Gazda, Piotr Szymański

Abstract: The RS105 test method specified in MIL-STD-461F refers to the risk of radiated exposure to an Electromagnetic pulse (EMP) event. EMP could interfere with electronic systems located in the vicinity.

MIL-STD-461 RS105 refer to different variations of EMP. The main area of our activity is nuclear electromagnetic pulse (NEMP), which are magnetic fields caused by nuclear explosions.

NEMP test system mainly consists of a high voltage pulse generator connected to a transmission line. The system can be mounted indoor or outdoor. The following MIL-STD-461 RS105, the equipment under test (EUT) is exposed to an EMP. The system generates impulse which minimum amplitude of the field is 50 kV/m. The duration of the impulse is 23 ± 5 ns. The equipment under test is installed underneath the transmission line within the predetermined uniform field area. The generated electric and magnetic fields are monitored during testing. For proper standard testing, the equipment must be exposed to five pulses. The equipment cannot demonstrate of performance degradation or malfunction.

EMP susceptibility is increasingly measured in a number of industries and appli-cations. This research deals with safety-critical equipment and subsystems, in particular on military equipment. MIL-STD-461 applies to different variations of EMP. The RS105 test method specified in MIL-STD-461F applies to the risk of radiated exposure to an EMP event. EMP could interfere with electronic systems located in the vicinity.

MIL-STD-461 RS105 is applicable to equipment and subsystem enclosures which are exposed to the external electromagnetic environment. Testing is applicable to equipment installed in exposed environments on ships, submarines, vehicles and aircraft.

In this work, the examinations using NEMP (Nuclear Electromagnetic Pulse) test system. In particular, the aim of the research was to verify the ability of the equipment enclosure to withstand a transient electromagnetic field.

The RS105 limit requires that the equipment shall not degradation of performance malfunction, or deviation from specified indications above the equipment's specif-ic tolerances. The equipment must be exposed to five pulses.

The presented results of experimental show effects of electromagnetic pulse. We will present in detail counteract the negative effects of transient electromagnetic field.

WS-04A-B   WORKSHOP   Time: 14:30 - 18:00

EMC MARATHON - WORKSHOP: "RECENT ADVANCEMENTS IN HPEM, HEMP, AND IEMI PROTECTION – A GLOBAL PERSPECTIVE"

Chaired by: **Ilhem Toumi**, ETS-Lindgren, United States of America
Chaouki Kasmi, Technology Innovation Institute, United Arab Emirate

Room   **B**

Speakers: Carlos Romero, Chaouki Kasmi, Sergio Longoria, Erik Kampert, Joel Kellogg

Abstract: Despite the threats posed by High-Power Electromagnetic (HPEM), High-Altitude Electromagnetic Pulse (HEMP), and Intentional Electromagnetic Interference (IEMI), insufficient emphasis has been placed on the design development of HEMP/IEMI hardening solutions in order to mitigate the potential risk to "critical infrastructures". The focus on the resiliency of critical infrastructures is increasing globally with governments and industries placing more urgency on the need for protection from the effect of HPEM, HEMP, and IEMI. Even with the heightened emphasis on protecting critical infrastructures, industries continue to struggle to quantify the threat posed by HPEM, HEMP, and IEMI and to identify cost effective yet viable protection solutions.

Speakers in this workshop will address the challenges to those industries considered "critical infrastructure", such as utilities (power, water, gas) and services (data, financial, communication). The workshop includes an overview of filtering power and signals to harden facilities. The workshop also provides an international review by experts from industry and government, who will discuss their respective R&D activities and test methodologies. Attendees will receive a global summary of HPEM/HEMP/IEMI protection solutions currently being implemented in the United States, Europe, and the Middle East.

Programme:

14:30 – 16:00 **Protecting Critical Infrastructures from HPEM Threats: Practical Methods and Case Studies**
Dr. Carlos Romero, Senior Scientist, Armasuisse, Thun, Switzerland

Effects Detection Classifications and System Instrumentation
Chaouki Kasmi, Ph.D., Technology Innovation Institute, Abu Dhabi, United Arab Emirates

Protection with Power/Signal Filters for HPEM Applications Including the New MIL-STD-188-125-1A HEMP Requirement
Sergio Longoria, ETS-Lindgren, Cedar Park, TX, USA

16:30 – 18:00 **Tolerance Values and Confidence Level of HEMP System Tests**
Erik Kampert, Helmut-Schmidt-University, Germany

Electrical Grid HPEM/HEMP/IEMI Mitigation Strategies
Joel Kellogg, ETS-Lindgren, Cedar Park, TX, USA and Eric Easton, Ph.D., CenterPoint Energy, Houston, TX, USA

Panel Session

WS-05A-B WORKSHOP Time: 9:00 - 12:30

EMC MARATHON: "INNOVATIVE WIRELESS TEST METHODOLOGIES FOR 5G NEW RADIO AND mmWAVE APPLICATIONS"

Chaired by: **Janet O'Neil,** ETS-Lindgren, United States of America
Aurelian Bria, Ericsson, Sweden

Room **C**

Speakers: Lawrence Moore, Jonas Friden, Dennis Lewis, Benoit Derat, Jason Bommer

Abstract: As 5G continues 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. 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 workshop 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 workshop 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. Attendees will also appreciate learning about the art of RF and microwave power measurements to unlock the full potential of wireless technology.

Programme:

9:00 - 10:30 **Spurious Emissions Measurements Up to 220 GHz in a Reverberation Chamber**
Lawrence Moore, Ericsson AB, Kista, Sweden

Characterization and Measurement of Active Antenna System for NR 5G in Compact Antenna Test Range
Jari Vikstedt, ETS-Lindgren, Cedar Park, Texas, USA

Addressing the Increasing Wireless Requirements for Commercial Aircraft and Aerospace Applications
Dennis Lewis, Boeing, Seattle, Washington, USA

11:00 - 12:30 **Controlling the Trade-off Between OTA Measurement Accuracy, Range Length, and DUT Size: A Generalization of the Effective Far-field Distance**
Benoit Derat, Rohde & Schwarz, Munich, Germany

Antenna Simulation and the Dynamic Mission: A Case Study in Airborne Radar Altimeter and 5G Coexistence
Jason Bommer, Ansys, Seattle, Washington, USA

Panel Session with All Speakers

WS-06A-B   WORKSHOP

Time: 14:30 - 18:00

EMC MARATHON - WORKSHOP: "TECHNOLOGY UPDATE ON AUTOMOTIVE EMC DESIGN AND TEST METHODOLOGIES FOR MODERN CONNECTED AND ELECTRIC VEHICLES"

Chaired by:	**Janet O'Neil**, ETS-Lindgren, United States of America
	Zoltan Zempléni, Thyssenkrupp Automotiv, Hungary
Room	**C**

Speakers: Zhong Chen, Abhishek Ramanujan, Garth D'Abreu, Zoltan Zempléni, Mario Propst

Abstract: Due to its attractive characteristics of low emission, high-efficiency, and multi-energy features, Electric Vehicles (EVs) have become increasingly important in modern transportation as an effective way to address current environmental requirements and resource shortage problems. At the same time, beyond the typical EMC test requirements, modern vehicles will be even more state-of-the-art, relying increasingly on communication with other vehicles (V2V) and with infrastructure (V2I), imposing more advanced design and testing. These connected vehicles will also include multiple antennas of different types, covering a broad range of frequencies, protocols, and modulations. Workshop topics will address automotive component level to full vehicle design and test considerations.

In this workshop, industry experts will present an update on the EMC design and test challenges presented by modern electric and connected vehicles. Guidelines and successful solutions to these challenges will be shared. Attendees will learn about applicable standards and specifications as well as effective testing methods to validate performance of modern EV and connected vehicles.

Programme:

14:30 – 16:00   **Chamber Design Considerations for EMC and Antenna Pattern Measurements of Full Vehicles**
Mr. Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA

EMC Mitigation Techniques on Modern Communication Networks & DSPs in EVs
Dr. Abhishek Ramanujan, Analog Devices Inc., Limerick, Ireland

Effective Test Methods to Validate EMC Performance of Electric Vehicles
Mr. Garth D'Abreu, ETS-Lindgren, Cedar Park, Texas, USA

16:30 – 18:00   **A Lean Approach for Steer-By-Wire System EMC Testing: Optimal Component-Level Test Setup for Complex Steering Systems, including Two Separate DUTs**
Mr. Zoltan Zempléni, Thyssenkrupp Automotive, Budapest, Hungary

E-Vehicles: Implementation Options for E-Motor and E-Axle Test Systems
Mr. Mario Propst, AVL, Graz, Austria

Panel Session with Speakers

WS-08

WORKSHOP

Time: 11:00 - 12:30

EMC MARATHON: "EMC IN RAILWAYS"

Chaired by:	**Krzysztof Sieczkarek**, Lukasiewicz Research Network Poznan Institute of Technology / IEEE EMC-S Polish Chapter, Poland
Room	**D**

Speakers: Adam Maćkowiak, Tomasz Warzyński,Bartłomiej Nagórny, Michał Rokossowski, Radosław Szczepański, Krzysztof Sieczkarek, Krystian Woźniak

Abstract: The test set-up and the original software for automation of emissions measurement of trackside magnetic disturbances coming from rolling stock will be shown based on ERA/ERTMS/033281 requirements. System was made in the LabVIEW environment and dedicated for oscilloscope card and LF, HF rolling stock antennas with algorithm fully implementing normative requirements. Also, the practical examples RF measurements of Rolling stock - Train and complete vehicle according to EN 50121-3-1 will be presented.

In the second part of the workshop a unique test set-up for immunity testing of control systems to simulated passing trains will be shown. The immunity results for other phenomena will be presented as well.

Programme:

11:00 – 12:30 **Electromagnetic compatibility with train detection systems using track circuits - national and European requirements**
Radosław Waśkowicz, Adam Garczarek, Krystian Woźniak

Magnetic disturbances from rolling stock - acquisition and reproduction
Krzysztof Sieczkarek, Tomasz Warzyński, Bartłomiej Nagórny, Adam Maćkowiak

WS-09A-B   WORKSHOP   Time: 14:30 - 18:00

EMC MARATHON - WORKSHOP: "TEMPEST - COMPROMISING EMANATIONS, SIDE-CHANNEL ATTACKS"

Chaired by:	**Frank Leferink,** University of Twente, The Netherlands
	Yu-ichi Hayashi, Nara Institute of Science and Technology, Japan
Room	**D**

Speakers: Duncan van Meeteren, Yu-ichi Hayashi, Chaouki Kasmi, Islem Yahi, Hamad Al Yahyahee, Ali Yaqoob, Aysha Al Neyadi, Alexis Gandon, Frank Leferink

Abstract: TEMPEST is a codename referring to spying on information systems through leaking emanations like unintentional radio, or electrical signals, emission. TEMPEST covers both methods to spy upon others and how to shield equipment against such spying. The protection efforts for TEMPEST are also known as emission security (EMSEC). It is not limited to defense systems, or systems processing classified information; as our living society becomes more deeply entrenched with a wide variety of information devices that are processing private information, the need for protecting the emission of unwanted signals increases. Reported targets of information leakage include information on the screen of a monitor, keystroke information from tablets and smartphones, keystroke information from the keyboard, data being processed inside a CPU, and secret information inside devices that perform encryption processing. Among these threats, the threats mainly targeting cryptographic modules are called "side-channel attacks." These take into consideration leakage channels such as not only electromagnetic emission but also power consumption, sound, fan rotation speed, LED flickering, etc. In this workshop, we'll provide an overview of these threats and discuss current research activities related to them.

Programme:

14:30 **Increasing TEMPEST awareness**
Duncan van Meeteren (Thales Netherlands)

14:50 **Introduction to Emission Security, TEMPEST, Physical Layer Security, Side-Channel Attack**
Yu-ichi Hayashi (Nara University)

15:30 **Electromagnetic Threats to Cyber-physical systems: integrity of analogue/digital interfaces and sensors**
Chaouki Kasmi, Islem Yahi, Hamad Al Yahyahee, Ali Yaqoob, Aysha Al Neyadi, Alexis Gandon (Directed Energy Research Center, Technology Innovation Institute, UAE)

16:30 **Compromising Emanations and Artificial Intelligence for video signal denoising**
Chaouki Kasmi, Santiago Morales, David Martinez, Aysha Al Neyadi, and Juan Galvis (Directed Energy Research Center, Technology Innovation Institute, UAE)

17:00 **International TEMPEST regulations, and protection measures**
Frank Leferink (University of Twente & Thales, Netherlands)

17:20 **Discussion**

WS-10

WORKSHOP

Time: 9:00 - 10:30

EMC MARATHON - WORKSHOP: "RISK FROM ESD: CHARGING, OCCURRENCE RATE AND DISCHARGES"

Chaired by: **David Pommerenke**, Graz University of Technology, Austria

Room **E**

Speakers: David Pommeranke

Abstract: The workshop treats three aspects of ESD: The charging, voltages and occurrence rates and the physics of discharges.

The charging section of the workshop explains scenarios in which high voltages will be reached, such as walking on carpet in dry air, removal of garments and sitting up from chairs. Examples of measured distributions and voltages are shown. Goal is to raise awareness for these ESD risky situations and to explain the voltage levels that are to be expected and how humidity effects the voltages.

The occurrence rate section tries to answer how many ESDs are to be expected and what the voltage distribution might be. Also, it shows how the likelihood of ESD occurrences reduces with voltage. The section is based on historical data and data taken by the author of the workshop.

The third section focuses on discharges. Here, the reason for the variations of air discharge currents is explained and it is shown how the severity may vary with voltage, discharge type such as skin discharge and human metal discharge. Further human ESD is compared to discharges from body worn equipment.

WS-11

WORKSHOP

Time: 11:00 - 12:30

EMC Marathon - Workshop: "System Level ESD Design Based on the Simulation of TVS and IC Interactions"

Chaired by: **David Pommerenke**, Graz University of Technology, Austria

Room **E**

Speakers: David Pommeranke

Abstract: The workshop focuses on optimal I/O design. High speed I/O such as RF frontends, USB and CAN is the focus. It is shown how a well selected transient voltage suppressor diode can protect an I/O. A simulation based selection process is explained. It is needed as the interaction of TVS and I/O can often not be intuitively understood. The simulation based approach creates models for the TVS, the passive devices and the IC's ESD response. The combined model can simulate the ESD response and robustness levels.

Measurement methods, simulation models and examples of the interaction are shown. The needed effort and limits are discussed.

WS-12A-B WORKSHOP Time: 14:30 - 18:00

EMC MARATHON - WORKSHOP: "GAN/SIC - CONDUCTED EMISSIONS SIMULATION"

Chaired by: **Jan Hansen,** Graz University of Technology, Austria

Room **E**

Speakers: Jan Hansen, Mehdi Gholizadeh

Abstract: The workshop gives a structured guideline on how to build and run simulation models of power electronics with switching transistors, including SiC and GaN. The audience shall understand the goals and limits of different modeling approaches. Practical examples are shown. The workshop has the following contents:

Programme:

14:30 – 16:00
1) Introduction to the conducted emission of power electronic circuits
Typical circuit topologies, EMI sources and coupling paths
Conducted emission tests and their importance for EMI qualification of power electronics

2) The Challenges of modeling the EMI of power electronics
The modeling approaches and their goals
Modeling in Industry: Model shaping along the product development process

3) Passive and active component modeling
Passive assembly elements
Active assembly elements: transistors
EMI filter design by simulation

16:30 – 18:00
4) System Modeling at low (f < 30 MHz) frequencies
Circuit models and their properties, required subcomponent models
Accuracy and limits

5) System Modeling at high (f > 30 MHz) frequencies
Constructing and running 3D models
Assembly elements, subcomponent models
Accuracy and limits

6) Application of Machine Learning in EMC modeling
Machine Learning techniques
Examples of trained models
Multi-Objective Optimization and further applications

WS-13A-C   WORKSHOP   Time: 9:00 - 16:00

EMC MARATHON - WORKSHOP: "CONDUCTED AND RADIATED EMISSION ANALYSIS OF AN INVERTER"

Chaired by: **Andreas Barchanski,** Dassault Systems, Germany

Room   **H**

Speakers: Andreas Barchanski, René Fiedler

Abstract: Starting with a simplified SPICE model for conducted emission, we demonstrate the estimation of parasitic couplings using simulations of the real 3D inverter and their impact on the emission spectrum. In the next step a full 3D conducted emission simulation of the inverter-motor system will be presented. To understand how to best represent and model the various components, common- and differential mode according to CISPR are compared and practical recommendations are given for different purposes such as optimization of filter components or integrational aspects into e.g. an EV Vehicle. Later cabelling effects will be studied in detail to understand how the real cable and it´s routing effect both the conducted emission and/or may also cause problems with radiated emission.

Programme:

9:00 – 10:30   **Part 1: EMC Simulation: How to mimic the real world**
We start this Marathon by giving an overview on how we can solve real systems and duplicate measurements virtually on appropiate levels and what methods support us in this activity. This includes an overview on what principle types of models, such as a functional model, schematic model or full 3D model, are available with their respective benifit and limitation. Also how to translate a given complex system into a combination of those models for the different sub-systems.
This includes an overview of general tools and methods to perform e.g. wide sweeps rapidely and specialist tools for detailled analysis of e.g. PCBs, cables, SI or PI.

11:00 – 12:30   **Part 2: Conducted emissions analysis of an Inverter**
Starting with a simplified SPICE model for conducted emission, we demonstrate the estimation of parasitic couplings using simulations of the real 3D inverter and their impact on the emission spectrum. In the next step a full 3D conducted emission simulation of the inverter-motor system will be presented.
To understand how to best represent and model the various components, common- and differential mode according to CISPR are compared and practical recommendations are given for different purposes such as optimisation of filter components or integrational aspects into e.g. an EV Vehicle.

14:30 – 16:00   **Part 3: Radiated emissions from an Inverter - motor system**
This workshop details a radiated emissions analysis, focusing on effects related to the AC cables connecting the inverter to the motor. We start by giving a state of the overview of the different options of cable analysis and what we can do with it such as extraction of cable parameters, crosstalk or radiated emission. Then a functional inverter - motor model for conducted emission is refined with cables to study effects related to it´s length and routing. We end with an integrational scenario where we can see and compare the performance in it´s final position with other electrical components present.
Throughout this scenario we use relevant quantities according to CISPR and give practical recommendation to understand what type of complexity is necessary in the individual steps.

WS-14

WORKSHOP

Time: 16:30 - 18:00

EMC MARATHON - WORKSHOP: "FINDING ROOT CAUSES OF EMI/EMC PROBLEMS IN ELECTRONIC DESIGNS"

Chaired by:	**Tadeusz Asyngier**, Tektronix, Poland
Room	**H**

Speakers: Tadeusz Asyngier

Abstract: EMC/EMI compliance testing is required before releasing a product to the market to ensure there is no interference between operating devices. The tests are conducted against strict rules from the local regulators, in the certified labs equipped with highly specialized and expensive equipment. While EMC compliance testing takes place at very late stage of a product development, it's crucial to monitor EMC/EMI performance of the product during the whole design process to avoid costly and time-consuming fixing. Tektronix multi-domain analysis tools are specifically designed to address that need. During the workshop Tektronix will show EMI pre-compliance debugging of a sample embedded device with RSA (Real-Time Spectrum Analyzer) and MDO (Multi Domain Oscilloscope).

WS-15

WORKSHOP

Time: 14:30 - 16:00

EMC MARATHON - WORKSHOP: "IEC 61000-4-39 LFCP MAGNETIC FIELD AND OTHER PHENOMENA IN FREQUENCY BELOW 6GHZ"

Chaired by:	**Grzegorz Modrykamien**, EMC-FORTO Sp. z o.o., Poland
	Fridolin Heidler, University of the Federal Armed Forces Munich, Germany
Room	**I**

Speakers: Ralf Heinrich, Grzegorz Modrykamien

Abstract: Mobile communication is meanwhile an essential part of our daily life. Mobile phones are prominent examples for this development. Other examples are wireless networks, electronic article surveillance systems (EAS) or RFID.

The intensive use of mobile communication is significantly affecting the electromagnetic environment. Radiated disturbances can no longer be assumed being a far field from a remote source, they are rather a mixture of far fields and local exposure. The long existing standards for testing immunity against radiated RF fields, e.g. IEC 61000-4-3, do not necessarily cover the potential threats of local exposure. Local exposure is quite often characterized by higher filed strengths and local exposure effects of the EUT. These phenomena are specially covered in the IEC 61000-4-39, which defines the radiated immunity tests in close proximity to the EUT in the frequency range from 9 kHz to 6 GHz with special test methods depending on the frequency range and the expected radiated disturbances in the respective frequency ranges.

The workshop will provide an overview on the different test methods across the frequency range from 9 kHz to 6 GHz based on the normative requirements, practical examples as well as a life demo of the immunity tests.

WS-18

WORKSHOP

Time: 16:30 - 18:00

WS-18: EMC MARATHON: WORKSHOP: "UPDATE ON STANDARDS ANSI C63.4 AND ANSI C63.25 SERIES"

Chaired by: **Zhong Chen**, ETS-Lindgren, United States of America

Room **I**

Speakers: Zhong Chen, Nicholas Abbondante

Abstract: This workshop will share the activity currently underway in the American National Standards Committee (ANSC) C63® committee for the C63.4 and C63.25 series. Among the many updates, EMC Site Validation requirements are migrating from C63.4 to the C63.25 standards series: ANSC C63 - C63.25.1, C63.25.2, and C63.25.3. Topics covered include: (1) Review of the latest draft edition of ANSI C63.4:20xx and (2) Application of Time Domain (TD) SVSWR in C63.25.1 (1 GHz – 18 GHz) (3) Newly streamlined procedures for site validation measurements in C63.25.2 (30 MHz – 1 GHz) (4) Latest development for site validations using Cylindrical Mode Filtered SVSWR (CMF SVSWR) measurements for test site validation and antenna calibration (18 GHz – 40 GHz) to be included in C63.25.3. This workshop is designed to increase your understanding of the C63.4 standard and the expected changes in the next revision, and what to anticipate in the new C63.25 series on EMC site validation methods. The site validation test methodology above 18 GHz in C63.25.3 is under consideration for adoption by CISPR A.

For the C63.4 discussions, there will be an analyses and changes in the requirements for the above 1 GHz test method, use of the 2 dB rule, compliance files, test setup changes, and many other aspects. For the C63.25 discussion, application of time domain and mode filter methods for validating EMC test sites will be presented

Meetings

ME-01A-D	MEETING	Time: 09:00 - 18:00

EPM EMC-STD PROJECT MEETING

Chaired by: **Martin Hudlicka,** Czech metrology institute, Czech Republic

Room **G**

How Ansys tools can revolutionize your EMC design process?

Ansys offers many tools in its portfolio that can support virtual testing of individual components and complete systems for electromagnetic compatibility (EMC) aspects of engineering design. ANSYS advanced engineering software allows in particular addressing emission and immunity testing through near- and far-field distribution and perimeter analyses. Specialized tools dedicated to printed circuit board (PCB) simulation allow verification of individual components of designed devices. Among other things, they make it possible to verify shielding effectiveness and determine the EM field values generated by the circuit.

Ansys software also brings other benefits, such as:

1. **Time and cost savings:** with virtual testing, you can verify that your design meets EMC standards before you build the first prototype.
2. **Reduction of laboratory testing:** precise simulations reduce the number of real-world tests required.
3. **Optimization at the design stage:** early correction of detected problems
4. **Unlimited number of variants evaluation:** rapid testing against different standards and changing regulatory conditions.

For example, when designing a communications device, we can use Ansys tools to simulate and identify potential problems with exceeding the value of the EM field allowed by the standards. Then, by making corrections before the first prototype is created, we significantly reduce time to market delivery.

As an experienced Ansys partner, at Symkom we offer full support in using the tools offered by Ansys. Our Technical Department has the expertise and experience to perform accurate simulations for EMC issues. Meet us at the Symkom booth.

Tuesday, 5th September 2023 – 1st Symposium day

	Room A	Room B	Room C	Room D	Room E	Room I	Room G	Room H
Tuesday, September 5, 2023								
Room No. Capacity (persons)	120	100	100	90	90	50	25	30
09:00	**OPENING CEREMONY** *Chair: Dr Zbigniew Jóskiewicz*							
09:40	**PLENARY SESSION I** *Chairs: Jan Sroka, Zbigniew Jóskiewicz* **Keynote 1: "Radio spectrum policy in the European Union "** Aleksander Sołtysik (Counsellor in Permanent Representation of Poland to the EU, Radio Spectrum Policy Group member)							
10:00								
10:20	COFFEE BREAK							
10:50	**PLENARY SESSION II** *Chairs: Jan Sroka, Tadeusz Więckowski* **Keynote 2: "Current and Future Technical Challenges in Automotive EMC"** Marco Klingler (Stellantis, TECH / E&S / AEES / SCIC, EMC Expert)							
11:20	**Keynote 3: "Introduction to the actual maximum approach used for EMF exposure compliance assessment"** Kamil Bechta (R&D Manager/EMF Exposure Expert and IEC TC106 MT3 member, Nokia Wroclaw) and and Christophe Grangeat (Nokia EMF mitigation Lead and convenor of IEC TC106 MT3)"							
11:50	**Keynote 4: "Research on the Influence of High-Energy Electromagnetic Pulses on Human Cells "** Jacek Starzyński (Warsaw University of Technology, Poland), Elżbieta Tranfy (Military University of Technology, Warsaw, Poland) and Yahia Achours (Ecole Militaire Polytechnique, Algiers, Algeria)							
12:30	LUNCH					**PS-01: Poster Session I** *Chairs: Marek Michalak, Maciej Macko*	**ME-08: The IEEE EMC-S BeNeLux Chapter Meeting** Organized by Frank Leferink	
13:00							**ME-09: PARASOL project meeting** Organized by Anne Roc'h (closed meeting)	
13:30							**ME-10: PATTERN project meeting** Organized by Anne Roc'h (closed meeting)	**ME-02: IEEE EMC-Society Poland Chapter Meeting** Organized by Krzysztof Sieczkarek
14:00								
14:30								
14:50	**OS-01A: EMC in Aircraft and Space Applications** *Chair: Marc Pous*	**OS-02: Radio Techniques and Technology** *Chairs: Wiktor Sega, Zbigniew Joskiewicz*	**OS-03: Electrostatic Discharge** *Chairs: Jan Sroka, Ken Kawamata*	**OS-04A: Filtering I** *Chair: Philippe Besnier*	**SS-02 EMC Diagnostics of Complex Systems** *Chairs: Vladimir Mordachev, Eugene Sinkevich*			**ME-03: Open information meeting: "The current activities of CISPR SC/A and its Publication CISPR 16"** organized by Martin A. K. Wiles (CISPR SubCommittee A)
15:10								
15:30								
15:50								
16:20								
16:30 16:40	COFFEE BREAK							
17:00								
17:20								
17:40								

OPENING CEREMONY

Time: 9:00 - 9:50

Chaired by: **Zbigniew Joskiewicz**, Wroclaw University of Science and Technology, Poland

Room: **B-E**

Dr Zbigniew Joskiewicz, Chairman EMC Europe 2023
Prof Tadeusz Wieckowski, Honorary Chairman EMC Europe 2023
Dr Jacek Oko, President of Office of Electronic Communications
Prof. Ferran Silva, Chairman ISC EMC Europe
Dr Vignesh Rajamani, President of IEEE EMC-Society
Prof. Davy Pissoort, Chairman EMC Europe 2024

PLENARY SESSION I

Time: 9:50 - 10:20

Chaired by:
Jan Sroka, Warsaw University of Technology, Poland
Zbigniew Joskiewicz, Wroclaw University of Science and Technology, Poland

Room: **B-E**

9:40

KEYNOTE 1
Radio spectrum policy in the European Union
Aleksander Sołtysik

Ministry of Foreign Affairs Republic of Poland, Permanent Representation of Poland to the EU

Abstract:

Connectivity and technological advance are cornerstones of economic recovery in the post pandemic scene. Efficient use of radio spectrum supporting EU policies while maximising societal value is the overarching target. Today we are equipped with several forward – looking regulations and policies such as European Electronic Communications Code, European Declaration on Digital Rights, Principles for the Digital Decade, and the Digital Decade Policy Programme 2030.

The scene is set for the ambitious goals that will be Europe's, huge leap in the digital transformation. With the first implementations of the 5G networks across European Union, work on the next generation began. Radio spectrum being a limited and scarce resource is a truly key enabler of fast and reliable connectivity.

We will take a look into decision making process in the European Union with regard to the radio spectrum, both current and planned regulations and present the scope of work of the authorities that adopt decisive documents and opinions in the scope of radio spectrum policy.

In this context we will bring closer the scope of the acivity of the Radio Spectrum Policy Group and its current and future Work Programme which is focusing on well known issues such as Peer Review Forum on the basis of the European Electronic Communications Code, World Radiocommunication Conferences or "Good Offices", but also new items such as 6G and Climate Change.

The presentation will put a spotlight on other various EU decision making group such as European Commission's Radio Spectrum Committee (RSC), Working Party on Telecommunications and Information Society (H.5) within the Council of European Union, and also those apprioriate for Europe as a whole, such as European Conference of Postal and Telecommunications Administrations (CEPT).

The aim is to deliver an overview of the complex decision – making process

within the European Union in term of telecommunication and spectrum related issues and how and when interested stakeholders may influence the final outcome.

PLENARY SESSION II

Time: 10:50 - 12:30

Chaired by:	**Jan Sroka**, Warsaw University of Technology, Poland
	Zbigniew Joskiewicz, Wroclaw University of Science and Technology, Poland
Room:	**B-E**

KEYNOTE 2

10:50

Current and Future Technical Challenges in Automotive EMC

Marco Klingler

Stellantis, TECH / E&S / AEES / SCIC, EMC Expert

Abstract:

For the first time in history, the automotive industry is facing simultaneously three major challenges w hich are carbon neutrality, advanced connectivity and autonomous vehicles.

Global warming and limited energy resources are leading to worldwide issues where ground transportation accounts for a big part of the global CO_2 emissions. The automotive industry needs to develop more efficient powertrains based on new propulsion technologies releasing globally less CO_2, become a part of the global solution of smart energy management, decrease the weight of new cars, and improve their recyclability. In a connected world were there are probably more mobile internet devices than people on earth, and where young generations are born and grow up in a daily life filled with internet applications and social network, the automotive industry needs to offer connected vehicles to keep in line with the yearning of many customers, to imagine what will be expected from tomorrow's cars, and to benefit from the simultaneous advent of Big Data to develop new business opportunities. Finally, more and more people are living in big cities and need to move around everyday, creating long and heavy traffic jams. Most developed countries are also aiming at zero death on roads. The automotive industry needs to develop smarter navigation systems to improve driving conditions, autonomous vehicles to make driving less stressful in harsh condition and technologies that will prevent casualties due to human mistakes.

This presentation will focus on the current and numerous technical challenges awaiting the automotive industry in the near future. In this context, the speaker will describe the most important topics which raise difficult and sometimes new EMC issues: battery electric vehicles (EVs) and full-hybrid electric vehicles (HEVs), EVs and HEVs in the situation of charging mode, the special case of wireless inductive charging of EVs and HEVs, composite materials, in-vehicle high data rate wire transmission links, wireless communication systems, safety-related Advanced Driver Assistance Systems (ADAS) and finally future autonomous vehicles

KEYNOTE 3

11:20

Introduction to the actual maximum approach used for EMF exposure compliance assessmen

Kamil Bechta[1], Christophe Grangeat[2]

[1]Nokia Wroclaw, [2]Nokia EMF mitigation Lead and convenor of IEC TC106 MT3

Abstract:

In the early implementation processes for base station compliance with the EMF

exposure limits, the assessment of exposure levels was based on the rated maximum or configured maximum transmitted power. This approach did not consider neither the variability of the transmitted signal nor the variability of beam directions for base stations with massive MIMO, beamforming or beam steering capabilities. Recent modelling studies and field monitoring results have shown that the impact of averaging time specified in EMF exposure limits allows to implement power reduction factors on top of maximum configured value in order to represent the actual exposure more accurately. This is the basis for the implementation of actual maximum approach that has been specified in IEC 62232:2022.

The presentation will introduce the background of the actual maximum approach, how it has been specified, how it can be validated and provide examples of implementation in the field.

KEYNOTE 4

11:50 **Research on the Influence of High-Energy Electromagnetic Pulses on Human Cells**

Jacek Starzynski[1], Elzbieta Trafny[2], Yahia Achours[3]

[1]Warsaw University of Technology, Poland; [2]Military University of Technology, Warsaw, Poland; [3]Ecole Militaire Polytechnique, Bordj El-Bahri, Algiers, Algeria

Abstract:

The effects of nanosecond electromagnetic pulses on human health are the subject of continuous research and ongoing discussion. The effects that have been studied and exploited show the possibility of significant effects on individual cells in the process of so-called electroporation, where an electromagnetic field is administered through devices that allow cells to be directly subjected to a field of high intensity and dose controlled at the level of a single cell. However, the mechanism that would allow the body as a whole to be affected in a comparable way has not been known. Such an impact could be relevant in an environment of increasing electromagnetic smog (5G) and could also apply to devices that produce simulated NEMPs for testing devices, for example. The authors aim to present research on the effects of electromagnetic pulses of very high instantaneous powers on single cells subjected to direct exposure and on groups of cells exposed to such pulses under conditions similar to whole-body exposures to NEMP pulses.

The lecture consists of two parts. First, we will present the simulator designs used in the authors' research. We will discuss typical NEM simulator generators based on classic but compact Marx-circuit generators, generating voltages of the order of 1 MV and supplying strip lines in which groups of cells can be exposed to fields well above 1 MV/m. We will also show new designs of miniature high-voltage generators using solid-state switches, which makes it possible to precisely control the shape of the pulses, and therefore the dose, and apply the pulses in the form of controlled repetitions. The second part of the lecture is a discussion of the results. We will show how to assess and the results of evaluating the effects of different exposures on morphology, viability and free radical generation in cells. In particular, we will describe the behavior of human mesenchymal stem cells (hMSCs) exposed to a single electromagnetic pulse with an electric field magnitude greater than 1 MV/m and a pulse duration of approximately 120 ns generated from a classical 750 kV Marx generator, and the effect of repeatedly applied approximately 60 ns pulses on Leydig TM3 cells. A comparison of the results shows a significant effect of multiple pulses applied directly, but no effect of single pulses applied on a macro scale

Oral sessions

OS-01A ORAL SESSION Time: 14:30 - 16:30

EMC IN AIRCRAFT AND SPACE APPLICATIONS

Chaired by: **Marc Pous**, HE Space for ESA, The Netherlands

Room **A**

14:30 **Shielded Aircraft Windows to Protect Radio Altimeters in the Presence of Wireless Avionics Intra-Communication**
Yuri Konter, Koen Blaauw, Jesper Lansink Rotgerink
Royal NLR - Netherlands Aerospace Centre

14:50 **Comparison of the Damages Produced by Lightning Current Tests for Aircrafts with Unipolar and Oscillatory Waveform for Component A**
Felicitas Modlinger[1], Fridolin Heidler[2], Christian Karch[3]
[1]University of Federal Armed Forces Munich, Germany; [2]University of Federal Armed Forces Munich, Germany; [3]Airbus Defence and Space GmbH

15:10 **Feasibility Study of a Graphene-Loaded Composite for Improved EMI Performance of Satellite Cavities**
Alessandro Giordani[1], Emiliano Scione[1], Alice Nicole Casling[2], Giovanni Maria Mongini[1], Maria Sabrina Sarto[2]
[1]Thales Alenia Space Italia, Italy; [2]Sapienza University of Rome

15:30 **Power Line Communications for Avionics Systems: Robustness Against Electromagnetic Compatibility**
Jesper Lansink Rotgerink[1], Stephen Dominiak[2], Gerd Dietrich[3], Zdeněk Řezníček[4]
[1]Royal Netherlands Aerospace Centre, Netherlands, [2]plc-tec AG; [3]Hochschule Luzern; [4]Evektor, spol. s.r.o.

15:50 **Modelling and Simulation of the Mechanical Effects of a Lightning Discharge to Aircraft Carbon Fibre-Reinforced Polymer Structures**
João Pedro[1], Albertino Arteiro[1,2], Robert Honke[3], Christian Karch[4]
[1]INEGI, Universidade do Porto, Portugal; [2]DEMec, Faculdade de Engenharia - Universidade do Porto, Portugal; [3]University of Applied Sciences Hof, Germany; [4]Airbus Defence and Space GmbH, Germany

16:10 **Impact of Emission Noise and Electromagnetic Shielding on Mobile Communication Systems in Unmanned Aerial Vehicles**
Ryota Sakai, Koh Watanabe, Sosuke Ashida, Hiraku Uehara, Satoshi Tanaka, Makoto Nagata
Kobe University, Japan

OS-02 — ORAL SESSION — Time: 14:30 - 16:30

RADIO TECHNIQUES AND TECHNOLOGY

Chaired by: **Wiktor Sega,** Office of Electronic Communications, Poland
Zbigniew Joskiewicz, Wroclaw University of Science and Technology, Poland

Room **B**

14:30 **Protection distance for HF communication based on emission standards**
Sara Linder, Kia Wiklundh, Karina Fors, Peter Holm
FOI, Sweden

14:50 **Modulation Frequency Effects on the Spread-Spectrum Clocking**
Jurica Kundrata, Adrijan Barić
University of Zagreb Faculty of Electrical Engineering and Computing, Croatia

15:10 **Novel Narrowband Interference Model to Analyze the Electromagnetic Resilience of OFDM Systems**
Brian Leeman, Tim Claeys, Sofie Pollin, Hans Hallez, Davy Pissoort
KU Leuven, Belgium

15:30 **Electromagnetic Susceptibility of a Connected System Against Intentional Electromagnetic Interferences Assessment**
Antoine Duguet[1,2], Tristan Dubois[1], Geneviève Duchamp[1], David Hardy[2], Franck Salvador[2]
[1]Univ. Bordeaux, CNRS, Bordeaux INP, IMS UMR 5218,F-33400, Talence, France; [2]Thales SIX GTS France SAS, France

15:50 **Deploying a Continuous Wave Electromagnetic Disturbance Removal Algorithm on an OFDM System**
Aleksandr Ovechkin, Brian Leeman, Dries Vanoost, Tim Claeys, Guy Vandenbosch, Davy Pissoort
KU Leuven, Belgium

16:10 **Frequency hopping signals tracking and sorting algorithm for military radio networks**
Annamaria Sârbu[1], Mirela Șorecău[2], Emil Șorecău[2], Paul Bechet[1]
[1]Nicolae Balcescu Land Forces Academy Sibiu, Romania, Romania; [2]Technical University Cluj Napoca

OS-03

ORAL SESSION

Time: 14:30 - 16:30

ELECTROSTATIC DISCHARGE

Chaired by: **Jan Sroka,** Warsaw University of Technology, Poland

Ken Kawamata, Tohoku Gakuin University, Japan

Room **C**

14:30 **Automatic Creation of TVS SPICE Models for ESD System Level Simulations**
Lukas Pertoll, Amin Pak, David Pommerenke
Graz University of Technology, Austria

14:50 **Modified ESD Generator to Emulate Body Worn Equipment ESD and Human Skin ESD**
Nikola Becanovic, Gabriel Fellner, Simon Buttinger, David Pommerenke
Graz University of Technology, Austria

15:10 **An Acoustic Method to Measure the Length of an ESD Spark**
Leonie Wiesel, Carina Krieger, David Pommerenke
Graz University of Technology, Austria

15:30 **The distribution of discharge amplitudes of randomly colliding charged spheres**
Abraham Jörg Reithofer, Maoxing Zhang, Jan Carsten Hansen, David Johannes Pommerenke
Graz University of Technology, Austria

15:50 **Influence of Return Current Cable Arrangement on Ringing Damped Oscillations in Contact Discharge Calibration Waveform from ESD Generator**
Yukihiro Tozawa[1], Takeshi Ishida[1], Jiaqing Wang[2], Osamu Fujiwara[1,2]
[1]Noise Laboratory Co.,Ltd.; [2]Nagoya Institute of Technology

16:10 **Detection and Localization of CDM like ESD using a novel Sensor derived from Leaky-Coax**
Gabriel Fellner[1], Amin Pak[1,2], David Pommerenke[1,2]
[1]Graz University of Technology; [2]SAL Graz EMC lab

OS-04   ORAL SESSION   Time: 14:30 - 16:30

FILTERING I

Chaired by: **Philippe Besnier,** CNRS - UMR 6164 - IETR, France

Room   **D**

14:30   **In-Situ and Contactless Evaluation of Performance of Power Converter EMC Filter based on Near-Field Scan Measurement**
Alexandre Boyer[1], Sébastien Serpaud[2], Sonia Ben Dhia[1]
[1]LAAS-CNRS, France; [2]IRT Saint-Exupéry institute, France

14:50   **Machine-Learning-Based Parameterization of Adaptive Notch Filters for CM Noise Reduction in Motor Inverters**
Carina Austermann, Tobias Dörlemann, Stephan Frei
TU Dortmund University, Germany

15:10   **FPGA Based Motor Inverter Control for Strictly Synchronous Digital Active EMI Cancellation**
Maximilian Lemke, Tobias Dörlemann, Stephan Frei
TU Dortmund University, Germany

15:30   **Modeling and Stability Analysis of Voltage Sense Current Cancellation Active EMI Filter**
Stefan Haensel[1], Janina Teller[2], Stephan Frei[3]
[1]Siemens AG, Germany; [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; [3]Technische Universität Dortmund, Germany

15:50   **Prevention of Sensor Disturbances caused by IEMI**
Arne Pahl, Kai-Uwe Rathjen, Stefan Dickmann
Helmut Schmidt University, Germany

16:10   **Analysis of Multi-Filter EMI Mitigation for Weight and Volume Optimization**
Leonardo Malburg[1], Niek Moonen[1], Frank Leferink[1,2]
[1]University of Twente, The Netherlands; [2]Thales Nederland B.V., The Netherlands

SS-02   SPECIAL SESSION   Time: 14:30 - 16:30

EMC DIAGNOSTICS OF COMPLEX SYSTEMS

Chaired by:	**Vladimir Mordachev,** Belarusian State University of Informatics and Radioelectronics, Belarus
	Eugene Sinkevich, Belarusian State University of Informatics and Radioelectronics (BSUIR), Belarus
Room	**E**

14:30   **Influence of Base Stations Radiation Patterns on the Level of the Outdoor Electromagnetic Background Created by Mobile (Cellular) Communications**
Vladimir Mordachev, Dzmitry Tsyanenka
Belarusian State University of Informatics and Radioelectronics, Belarus

14:50   **Problem of Electromagnetic Compatibility between 4G/5G Mobile Communications and Railway Signaling/Telecommunication Equipment**
Aliaksandr Svistunou, Vladimir Mordachev, Eugene Sinkevich
EMC R&D laboratory, Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus

15:10   **Adjacent channel co-existence study between 5G NR and Wi-Fi in the 6 GHz band for indoor scenario**
Alexander Pastukh[1], Valery Tikhvinskiy[2], Evgeny Devyatkin[1], Eugene Sinkevich[3]
[1]Institute of Radio and Information System (IRIS), Vienna, Austria; [2]International Information Technology University (IITU), Almaty, Kazakhstan; [3]Belarusian State University of Informatics and Radioelectronics (BSUIR), Minsk, Belarus

15:30   **Influence of the Radiating UE Distribution Irregularity in Building Internal Space on the Level of Indoor Electromagnetic Background**
Vladimir Mordachev
Belarusian State University of Informatics and Radioelectronics, Belarus

15:50   **Technique for Evaluating the Contribution of Protective Means to Shielding Effectiveness of Heterogeneous Wall**
Dzmitry Tsyanenka[1], Eugene Sinkevich[1], Yauheni Arlou[1], Ivan Shakinko[1], Xie Ma[2], Wen-Qing Guo[2]
[1]Belarusian State University of Informatics and Radioelectronics (BSUIR), Belarus; [2]China Electronics Technology Cyber Security Co., Ltd., Chengdu, Taiyuan, China

16:10   **Analysis of EMC between Equipment of Wireless Systems and Medical NB IoT Devices**
Aliaksandr Svistunou[1], Vladimir Mordachev[1], Eugene Sinkevich[1], Ming Ye[2], Arthur Dubovik[1]
[1]EMC R&D Laboratory, Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus; [2]R&D engineering Lab, Huawei Technologies Sweden AB, Stockholm, Sweden

Posters

PS-01	POSTER SESSION	Time: 12:30 - 14:30

POSTER SESSION 1

Chaired by:	**Marek Michalak,** Wroclaw University of Science and Technology, Poland
	Maciej Macko, Wroclaw University of Science and Technology, Poland
Room	**I** (1st floor)

P1 (1)   **EMI Radiated Emission Prediction of Full Bridge Inverter**
O Hyun Gwon, Jin Kuk Hong, Heon Soo Choi, Nam Kyu Kim, Yong Gi Kim, Wook Dong Cho
LS Electric, Korea, Republic of South Korea

P 1 (2)   **A Novel Spread Spectrum on Average Time-Based For Serial Interface**
Min-woo Kim, Jiwon Kim, Kyung-hwan Moon, Jung-Bong Lee, Won-Ju Shin
samsung display, Korea, Republic of South Korea

P 1 (3)   **Securing Temperature Measurements: An Assessment of Sensors' Vulnerability to IEMI**
Louis Cesbron Lavau[1], Michael Suhrke[1], Peter Knott[2,3]
[1]Fraunhofer INT, Germany; [2]Fraunhofer FHR, Germany; [3]RWTH Aachen, Germany

P 1 (4)   **Observations of radiated and conducted emissions from an Electric Plane charging station**
Manav Giri, Babak Sadeghi, Sarah Rönnberg, Jonny Johansson, Jonas Ekman
Luleå Univeristy of Technology, Sweden

P 1 (5)   **Radiated Noise Measurement from Multiple LED Lights Using Reverberation Chamber**
Ifong Wu, Sadaaki Shiota, Yasushi Matsumoto, Kaoru Gotoh
National Institute of Information and Communications Technology, Japan

P 1 (6)   **Thermal Simulation and Optimization of a Common-Mode Filter for a SiC Inverter**
Maurizio Tranchero[1], Paolo Santero[1], Georg von Pfingsten[2], Mika Nuotio[2]
[1]Ideas & Motion, Italy; [2]Rheinmetall AG

P 1 (7)   **Signal Integrity Design of PCB Transmission Paths using a Decision Tree Approach**
Emre Ecik[1], John Werner[1], Julian Withöft[1], Ralf Brüning[2], Jürgen Götze[1]
[1]TU Dortmund University, Germany; [2]Zuken GmbH, Germany

P 1 (8)   **Circuit Prediction Model of Electric Field Emission of a Vehicle-mounted Three-phase DC/AC Inverter**
Junping He, Tao Yang, Weixin Wang
Harbin Institute of Technology, Shenzhen, People's Republic of China

P 1 (9)   **Improving the performance of characteristic recognition for unknown antennas with limited data**
Dong-hyun Oh[1], Gilles Yowel MASSALA MBOYI[1], Sung-Jun Yang[2], Jung-Hoon Han[1]
[1]Jeju national university, Korea, Republic of (South Korea); [2]Seoul national university of Science and Technology, Korea, Republic of (South Korea)

P 1 (10)   **Estimating the Optimal Polynomial Order for the Vector Fitting Algorithm**
Max Rosenthal, Ralf Vick

Otto von Guericke University Magdeburg, Germany

P 1 (11) **Intersystem-Interference Consequences in Ultra-Dense Scenarios for 6G**
Kia Wiklundh, Peter Stenumgaard
FOI, Sweden

P 1 (12) **Setting of Protection Distance and Exclusion Distance and Effect on Emission Limits**
Yasushi Matsumoto, Kaoru Gotoh, Yukio Yamanaka
National Institute of Information and Communications Technology, Japan

P 1 (13) **Randomizing Plane-Wave Incidence for Rayleigh Field Synthesis in Reverberation Chambers**
Valerio De Santis[1], Antonio Faraone[2], Giorgi Bit-Babik[2]
[1]University of L'Aquila, Italy; [2]Motorola Solutions Inc., Fort Lauderdale, Florida, USA

P 1 (14) **Computational Electromagnetics of Reverberation Chambers and an Open Coaxial Return Rig**
Alexander Schoisl[1], Markus Rothenhaeusler[1], Martin Schwarz[2]
[1]Airbus Defence and Space GmbH; [2]Wehrtechnische Dienststelle für Informationstechnologie und Elektronik

P 1 (15) **Comparison between segregation and filtering using a black-box inverter model**
Pierre-Louis Bourlon[1,2], Arnaud Breard[2], Christian Vollaire[2], Marc Meyer[3]
[1]Airbus Helicopters, France; [2]Univ Lyon, Ecole Centrale de Lyon, INSA Lyon, Université Claude Bernard Lyon 1, CNRS, Ampère, UMR5005 Ecully, France; [3]Airbus Helicopters, Germany

P 1 (16) **Investigation on radiated emissions of electric aircraft at airports**
Jiexiong Yan, Jonny Johansson, Jonas Ekman, Andreas Nilsson, Åke Wisten
Luleå University of Technology, Sweden

P 1 (17) **A forensic detection system for intentional electromagnetic interference (IEMI) attempts**
Thorsten Ragnar Pusch, Christian Adami, Sven Ruge, Michael Suhrke
Fraunhofer INT, Germany

P 1 (18) **Non-uniform Transmission Lines for Studying the Transient Behavior of a Grounding Systems**
Bachir Nekhoul, Ahmed Boutadjine
University of Jijel, Algeria

Meetings

ME-02   MEETING   Time: 13:30 - 14:30

IEEE EMC-SOCIETY POLAND CHAPTER MEETING

Chaired by: **Krzysztof Sieczkarek,** Lukasiewicz Research Network Đ Poznan Institute of Technology / IEEE EMC-S Polish Chapter, Poland

Room   **H**

ME-03   MEETING   Time: 14:30 - 16:30

OPEN INFORMATION MEETING: THE CURRENT ACTIVITIES OF CISPR SC/A AND ITS PUBLICATION CISPR 16

Chaired by: **Martin Wiles,** Albatross Projects, Germany

Room   **H**

ME-08   MEETING   Time: 12:30 - 13:00

THE IEEE EMC-S BENELUX CHAPTER MEETING

Chaired by: **Frank Leferink,** University of Twente, The Netherlands

Room   **G**

ME-09   MEETING   Time: 13:00 - 13:30

PARASOL PROJECT MEETING

Chaired by: **Anne Roc'h,** Eindhoven University of Technology, The Netherlands

Room   **G**

ME-10   MEETING   Time: 13:30 - 14:15

PATTERN PROJECT MEETING

Chaired by: **Anne Roc'h,** Eindhoven University of Technology, The Netherlands
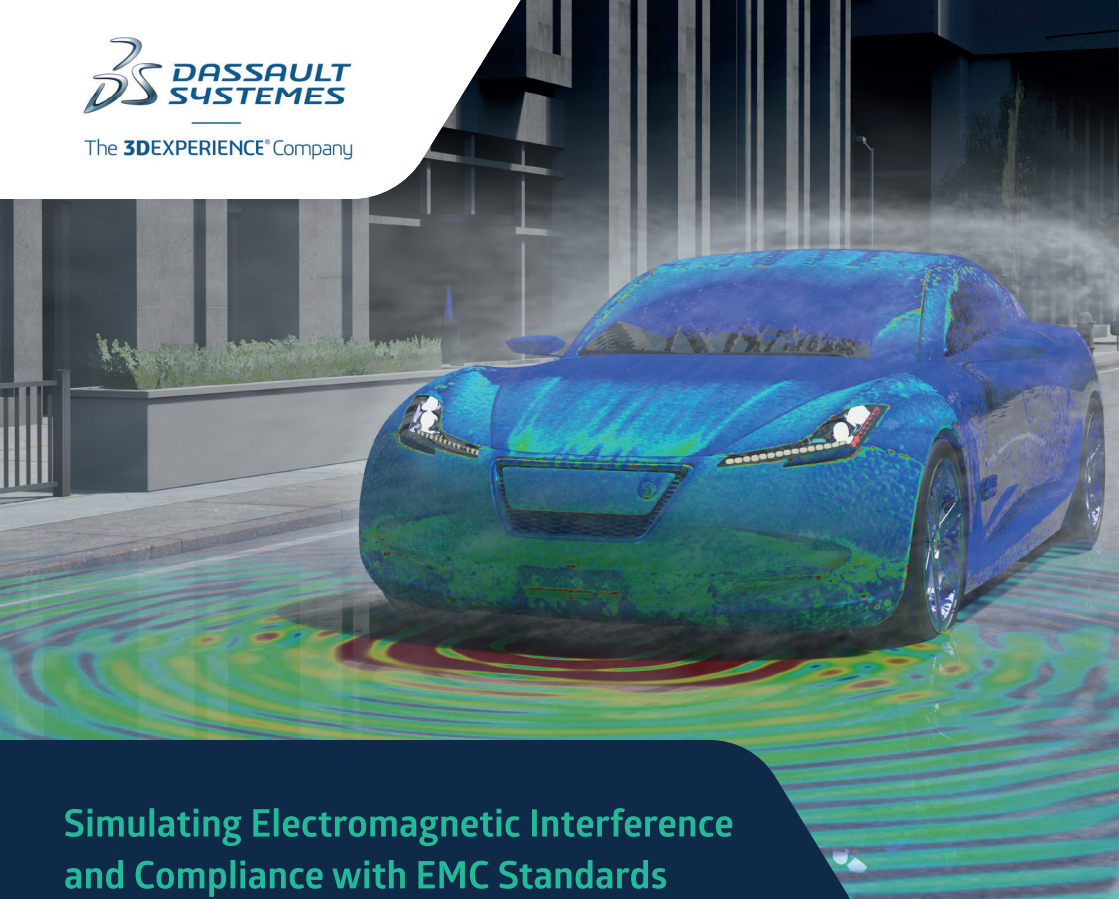
Room   **G**

Social events

Symposium Gala Dinner

Time: 20:00 - 23:00

former salt mine "Wieliczka"

Bus transpotation starts at 18:00, next to hotel enterance

For details see page 8.

Simulating Electromagnetic Interference and Compliance with EMC Standards

Workshop:
"Conducted and radiated emission analysis of an Inverter"
Authors/presenters: Andreas Barchanski, René Fiedler
Monday: 9:00 – 16:00, Room H
Friday: 9:00 – 16:00, Room H

Presentation:
"A Macromodeling Approach for EMC Simulations of Power Electronics Systems"
Authors/presenters: Andreas Barchanski, Michelangelo Bandinu
Wednesday: 9:00 – 09:20, Room E

Booth location:
Room T, Booth: T3, T4

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Wednesday, 6th September 2023 – 2nd Symposium day

Room No. Capacity (persons)	Room A 120	Room B 100	Room C 100	Room D 90	Room E 90	Room I 50	Room G 25	Room H 30
	Wednesday, September 6, 2023							
09:00 09:20 09:40 10:00	**OS-01-B** EMC in Aircraft and Space Applications *Chairs: Heyno Garbe, Frank Sabath*	**SS-01A** Physical Layer Security and Hardware Supply Chain Security: EM tricks keep your information and devices safe *Chairs: Frank Leferink, Yu-ichi Hayash*	**SS-03A** In-situ Electromagnetic Emissions Measurements: Challenges and Solutions for Assessing Atypical Equipment	**OS-04B:** Filtering II *Chair: Valter Mariani Primiani*	**OS-09:** Power Electronics *Chair: Stefan Dickmann*		Demonstrator presentation and Nokia's labs virtual tour	**ME-11:** Open information meeting: "New AECTP 500: what has changed?" organized by Hywell Sollis (NATO E3 Action team)
10:20	COFFEE BREAK							
10:50 11:10 11:30 11:50	**OS-05A:** Reverberation Chambers I *Chair: Andy Marvin*	**OS-01B** Physical Layer Security and Hardware Supply Chain Security: EM tricks keep your information and devices safe *Chairs: Frank Leferink, Yu-ichi Hayash*	**SS-03B** In-situ Electromagnetic Emissions Measurements: Challenges and Solutions for Assessing Atypical Equipment *Chair: Marco A. Azpurua*	**OS-08A:** EMC in Automotive I *Chair: Marco Klingler*	**OS-10:** EMC in railway *Chair: Volodymyr Havryliuk*		Demonstrator presentation and Nokia's labs virtual tour	
12:10 12:20 12:30 13:00 13:30 14:00	LUNCH					**PS-02:** Poster Session II *Chair: Monika Szafranska*	Demonstrator presentation and Nokia's labs virtual tour	**ME-04:** "IEEE EMC-Society Chapter Representatives Meeting + IEEE Senior Member Elevation Event" Organized by Krzysztof Sieczkarek
14:30 14:50 15:10 15:30	**OS-05B:** Reverberation Chambers II *Chair: Ramiro Serra*	**OS-07A:** Shielding I *Chair: Mauro Feliziani*	**OS-08B:** EMC in Automotive II *Chair: Stephan Frei*	**OS11:** Immunity *Chair: Francesca Maradei*			Demonstrator presentation and Nokia's labs virtual tour	
15:50	COFFEE BREAK							
16:20 16:30 16:40 17:00 17:20 17:40	**OS-6A:** Computational Electromagnetics and Modeling I *Chair: David Thomas*	**OS-07B:** Shielding II *Chair: Jan Luiken ter Haseborg*	**OS-08C:** EMC in Automotive III *Chair: Bernd Deutschmann*	**OS-12A:** Measurement Techniques and Instruments I *Chair: Ferran Silva*		**ME-05:** "IEEE Women in EMC" organized by EMC-S WIE Session Chair: Mariya Antyufeyeva, EMC-S WIE representative (16:00-18:00)	Demonstrator presentation and Nokia's labs virtual tour	

Oral sessions

OS-01B	ORAL SESSION	Time: 9:00 - 10:20

EMC IN AIRCRAFT AND SPACE APPLICATIONS

Chaired by: **Heyno Garbe,** Leibniz Universitaet Hannover, Germany
                Frank Sabath, WIS, Germany

Room   **A**

9:00   **Magnetic cleanliness on NanoMagSat, a CubeSats' constellation science mission**
Carlos Javier Arranz[1], Valentina Marchese[2], Marc Pous[3], Jean-Michel Léger[4], María Vallmitjana[5], Thomas Jager[4]
[1]Akkodis for European Space Agency; [2]Telespazio Belgium for European Space Agency; [3]HE Space for European Space Agency; [4]CEA-Leti; [5]Open Cosmos

9:20   **Hints and ideas on customising the EMC engineering approach for CubeSat projects**
Dongsheng Zhao[1], Marc Pous[2]
[1]RHEA System for European Space Agency; [2]HE Space for European Space Agency

9:40   **A Study on Application of Bulk Current Injection Method as an EMC Test Method for ESD-Induced Conducted Suseptibility on Spacecraft**
Toru Kasai[1], Toshio Onigata[2]
[1]Japan Aerospace Exploration Agency, Japan; [2]e-OHTAMA, LTD.

10:00   **Conducted Emissions Verification Setup Improvement for Space Applications**
Marc Pous[1], Marco A. Azpúrua[3,4], Dongsheng Zhao[2], Ferran Silva[4]
[1]HE Space for European Space Agency; [2]RHEA System for European Space Agency; [3]EMC Barcelona (EMC Electromagnetic BCN, S.L.); [4]Universitat Politècnica de Catalunya

OS-04B ORAL SESSION Time: 9:00 - 10:20

FILTERING II

Chaired by: **Valter Mariani Primiani,** Università Politecnica delle Marche, Italy

Room **D**

9:00 **Analysis of Cancellation Path Estimation Errors in Narrow-band Adaptive Digital Active EMI Filters**
Tobias Dörlemann, Stephan Frei
On-board Systems lab, TU Dortmund University, Germany

9:20 **High frequency measurement and simulation of electromagnetic interference filters**
Bálnt Pintér[1,2], Arnold Bingler[1,2], Márk Csörnyei[2]
[1]Budapest University of Technology and Economics, Department of Broadband Infocommunications and Electromagnetic Theory, Hungary; [2]Robert Bosch Kft., Powertrain Solutions - Power Electronics

9:40 **New Time-Domain Tuning of RF Filter for Evaluating Immunity of Vehicle DC Charging Communication**
Georgios Mademlis, Lennart Hasselgren, Henrik Holst
Volvo Cars Corporation, Sweden

10:00 **Utilization of the Return Conductor for Cancellation of CM Currents for a PMSM Inverter Drive**
Patrick Damian Koch[1], Leonardo Correa Malburg[1], Niek Moonen[1], Frank Leferink[1,2]
[1]University of Twente, Enschede, The Netherlands; [2]Thales, Hengelo, The Netherlands

OS-09

ORAL SESSION

Time: 9:00 - 10:20

FILTERING II

Chaired by: **Stefan Dickmann,** Helmut Schmidt University, Germany

Room **E**

9:00 **A Macromodeling Approach for EMC Simulations of Power Electronics Systems**
Andreas Barchanski[1], Michelangelo Bandinu[2]
[1]Dassault Systems, Germany; [2]Dassault Systems, Italy

9:20 **Analysis of Common-mode Voltage during Switching of Individual IGBTs in Three-phase Inverter**
Makoto Fujimura[1], Tohlu Matsushima[1], Yuki Fukumoto[1], Kohei Takada[2], Koji Kobayashi[2]
[1]Kyushu Institute of Technology, Japan; [2]Sanden Corporation, Japan

9:40 **PEEC-based Wideband Micro-Model of Inductive Components for Power Electronics Applications**
Diana Eremyan[1,2], Anna Gheonjian[1,2], Davit Imnadze[1,2], Konstantin Parshutkin[1,2], Roman Jobava[1,2]
[1]EMCoS LLC, Georgia; [2]Tbilisi State University

10:00 **Narrowband Frequency Domain Optimized Gate Driving Signals for Power Transistors of DC/DC Converters**
Caroline Krause, Stephan Frei
TU Dortmund University, Germany

Special sessions

SS-01A	SPECIAL SESSION	Time: 9:00 - 10:20

PHYSICAL LAYER SECURITY AND HARDWARE SUPPLY CHAIN SECURITY: EM TRICKS KEEP YOUR INFORMATION AND DEVICES SAFE

Chaired by:	**Frank Leferink,** University of Twente, The Netherlands
	Yu-ichi Hayashi, Nara Institute of Science and Technology, Japan
Room	**B**

9:00   **Introduction to Physical Layer Security and Hardware Supply Chain Security: EM Tricks to Keep Your Information and Devices Safe**
Yuichi Hayashi[1], Frank Leferink[2], Makoto Nagata[3]
[1]Nara Institute of Science and Technology, Japan; [2]University of Twente and Thales Netherlands; [3]Kobe University

9:20   **An Introduction to TEMPEST (Classified), using ChatGPT**
Frank Leferink[1,2]
[1]University of Twente, The Netherlands; [2]Thales Netherlands, The Netherlands

9:40   **TEMPEST Demo for Increasing Awareness**
Ryan Groot[1,2], Duncan van Meeteren[1], Frank Leferink[1,2]
[1]Thales Netherlands, The Netherlands; [2]University of Twente, The Netherlands

10:00   **Evaluation of Impact of Differential Transfer Efficiency of EM Leakage on Screen Reconstruction against High-Resolution Displays**
Taiki Kitazawa, Yuichi Hayashi
Nara Institute of Science and Technology, Japan

SS-03A

SPECIAL SESSION

Time: 9:00 - 10:20

IN-SITU ELECTROMAGNETIC EMISSIONS MEASUREMENTS: CHALLENGES AND SOLUTIONS FOR ASSESSING ATYPICAL EQUIPMENT

Chaired by:

Serdar Büyük, The Scientific and Technological Research Council of Türkiye (TUBITAK)), Turkiye

Marco A. Azpurua, EMC Electromagnetic BCN, S.L., Spain

Room **C**

9:00 **Measuring Receiver Benchmark for Conducted and Radiated Emissions Testing in Space Applications**
Marco A. Azpurua[1,2], Marc Pous[3], Jordi Sole-Lloveras[1], Dongsheng Zhao[4], Ferran Silva[2]
[1]EMC Barcelona (EMC Electromagnetic BCN, S.L.); [2]Universitat Politècnica de Catalunya; [3]HE Space for European Space Agency; [4]RHEA System for European Space Agency

9:20 **Efficient In situ Assessment of Radiated Emissions using Time-Domain Measurements**
Jordi Sole-Lloveras[1], Marco A. Azpurua[1,2], Marc Aragon Homar[1], Yasutoshi Yoshioka[3], Ferran Silva[2]
[1]EMC Barcelona (EMC Electromagnetic BCN, S.L.); [2]Universitat Politècnica de Catalunya; [3]Fuji Electric Europe GmbH

9:40 **Improvement in Low Frequency Emission Test Method by Live Impedance Measurement**
Soydan Cakir[1], Osman Sen[1], Serdar Buyuk[1], Marco A. Azpurua[2], Engin Ozdemir[3]
[1]TUBITAK UME, Kocaeli, Turkey; [2]EMC Barcelona (EMC Electromagnetic BCN, S.L.), Spain; [3]Kocaeli University (KOU), Kocaeli, Turkey

10:00 **Metrological Characterization of EMI Receivers**
Martin Hudlička[1], Marco A. Azpúrua[2], Marcin Wojciechowski[3]
[1]Czech metrology institute, Czech Republic; [2]EMC Barcelona, Spain; [3]Central Office of Measures (GUM), Poland

OS-05A

ORAL SESSION

Time: 10:50 - 12:10

REVERBERATION CHAMBERS I

Chaired by:	**Andy Marvin,** University of York, United Kingdom
Room	**A**

10:50 **Short pulse testing of a reference test setup in a reverberation chamber of two different time constants**
Alan Aliyali, Mattias Elfsberg, Tomas Hurtig, Pablo Vallejos, Frans Nyberg
FOI (Swedish Defence Research Agency), Sweden

11:10 **A Multivariate Approach for the Effective Sample Size of Frequency Stirring**
Ramiro Serra[1], Carlo Carobbi[2]
[1]Eindhoven University of Technology, Netherlands, The; [2]University of Florence, Italy

11:30 **Rician K Factor Tuning for 5G Channel Emulation in Different Typologies of Reverberation Chambers**
Alfredo De Leo[1], Ramiro Serra[2], Paola Russo[1], Valter Mariani Primiani[1]
[1]Universita Politecnica Marche, Italy; [2]Eindhoven University of Technology

11:50 **Statistical Inference of Electric Fields in Lossy Reverberating Environments Subject to High Intensity Radiated Field and Direct Current Injection**
Jan Ückerseifer, Shuchen Xu, Frank Gronwald
University of Siegen, Germany

OS-08A

ORAL SESSION

Time: 10:50 - 12:10

EMC IN AUTOMOTIVE I

Chaired by:	**Marco Klingler,** Stellantis, France
Room	**D**

10:50   **A first simplified approach to estimate the probability of an induced voltage on a component in a vehicle**
Baptiste Hamard[1,2], Marco Klingler[1], Tristan Dubois[2], Geneviève Duchamp[2]
[1]Centre Technique de Velizy Velizy-Villacoublay, France; [2]Univ. Bordeaux, CNRS, Bordeaux INP, IMS, UMR 5218, F-33400 Talence, France

11:10   **Agreement Quantification of a Numerical EMC Computer Model and Test Infrastructure for the HV Power Train Emissions for an Electric Vehicle**
Thomas Stöhr1,2, Guido Albert Rasek2, Nagapoornima Sreenivasa Murthy3
[1]Friedrich-Alexander-Universität Erlangen, Germany; [2]Valeo eAutomotive Germany GmbH; [3]Technische Universität Chemnitz

11:30   **Impact of Dual-Tone Interference on an Automotive Smart Power High-Side Switch using Direct Power Injection**
Daniel Kircher, Fabio Rosenmayr, Bernd Deutschmann
Institute of Electronics, Graz University of Technology, Austria

11:50   **Investigation of Real Dynamic Automotive Electromagnetic Environment Measurements**
Vasso Gkatsi[1], Robert Vogt-Ardatjew[1], Frank Leferink[1,2]
[1]University of Twente, The Netherlands; [2]Thales Nederland, The Netherlands

OS-10   ORAL SESSION   Time: 10:50 - 12:10

EMC IN RAILWAY

Chaired by: **Volodymyr Havryliuk**, Ukrainian State University of Science and Technologyies, Ukraine

Room   **E**

10:50   **Features of Electromagnetic Compatibility in Railway Transport**

Oksana Gololobova[1], Tetiana Serdiuk[1], Serhii Buriak[1], Kseniia Serdiuk[1], Oleh Voznyak[2], Svitlana Serdiuk[3], Viktor Skalko[1]

[1]Ukrainian State University of Science and Technologies, Ukraine; [2]Lviv Polytechnic National University, Lviv, Ukraine, [3]Oles Honchar Dnipro National University, Dnipro, Ukraine

11:10   **Evaluation of Electromagnetic Compatibility of Electric City Transport with the Automatics Systems**

Tetiana Serdiuk[1], Syarfa Zahirah Binti Sapuan[2], Kseniia Serdiuk[1], Dwi Mandaris[3], Anatolii Radkevych[1], Maksym Serchenko[1]

[1]Ukrainian State University of Science and Technologies, Ukraine; [2]Universiti Tun Hussein Onn, Malaysia; [3]National Research and Innovation Agency, South Tangerang, Indonesia

11:30   **Analysis Method for Magnetic Field Strength on On-Board Antenna due to Inverter Common-Mode Noise at Whole Train Level**

Keisuke Fukumasu[1], Masayuki Nunokawa[2], Umberto Paoletti[1], Kiyoto Matsushima[1], Toshiaki Takami[2]

[1]Hitachi, Ltd., Japan; [2]Central Japan Railway Company

11:50   **Designing a Sequence of Transient EM Signals in Order to Test Railway Wireless Communications Face to EM Interferences Produced by the Catenary-Pantograph Contact**

Artur Nogueira de São José[1], Nathan Chopinet[1], Virginie Deniau[1], Eric Simon[2]

[1]COSYS-LEOST, Univ Gustave Eiffel, IFSTTAR, Univ Lille; [2]Univ. Lille, CNRS, USR 3380—IRCICA—Institut de Recherche sur les Composants Logiciels et Matériels pour l'Information et la Communication Avancée

Special sessions

SS-01B	SPECIAL SESSION	Time: 10:50 - 12:10

PHYSICAL LAYER SECURITY AND HARDWARE SUPPLY CHAIN SECURITY: EM TRICKS KEEP YOUR INFORMATION AND DEVICES SAFE

Chaired by:
Frank Leferink, University of Twente, The Netherlands

Yu-ichi Hayashi, Nara Institute of Science and Technology, Japan

Room **B**

10:50 **Intrusion Detection and Shielding Measurements using Signals of Opportunity**
Ridvan Aba[1], Robert Vogt-Ardatjew[1], Frank Leferink[1,2]
[1]University of Twente, Netherlands, The; [2]Thales, Nederland B.V.

11:10 **Counter-TEMPEST: Information Spoofing based on the EM-leakage Signature of TMDS system**
Euibum Lee, Dong-hoon Choi, Taesik Nam, Jong-gwan Yook
Yonsei University, Korea, Republic of (South Korea)

11:30 **Prediction Accuracy Improvement of Side-channel Information Leakage by Using EM-Circuit Co-simulation of PDN with Filters**
Masaki Himuro, Kengo Iokibe, Yoshitaka Toyota
Okayama University, Japan

11:50 **Hardware Supply Chain Security and EM Tricks**
Makoto Nagata[1], Naofumi Homma[2], Yuichi Hayashi[3]
[1]Kobe University, Japan; [2]Tohoku University, Japan; [3]NAIST, Japan

SS-03B SPECIAL SESSION Time: 10:50 - 12:10

IN-SITU ELECTROMAGNETIC EMISSIONS MEASUREMENTS: CHALLENGES AND SOLUTIONS FOR ASSESSING ATYPICAL EQUIPMENT

Chaired by:	**Marco A. Azpurua**, EMC Electromagnetic BCN, S.L., Spain
Room	**C**

10:50   **Variability of Conducted Emissions of EV Chargers due to Mutual Effects on a DC Grid**
Sahil Bhagat[1], Andrea Mariscotti[1], Mattia Simonazzi[2], Leonardo Sandrolini[2]
[1]University of Genova, Italy; [2]University of Bologna, Italy

11:10   **Experimental Evaluation Result of Preliminary Measurement for In-Situ Test Method in CISPR 37**
Kimihiro Tajima[1], Nobuyuki Mitsuzuka[2], Masashi Takabe[1], Eichi Kobayashi[1], Toshiaki Ono[1]
[1]NTT Advanced Technology Corporation, Japan; [2]Matsudo laboratory Telecom Engineering Center, Japan

11:30   **Implementation of Trakside Measuring Method of Low-Frequency Magnetic Fields coming from Passing Rolling Stock for Assurance Reliability of Axle Counters**
Krzysztof Sieczkarek, Bartlomiej Nagorny, Adam Mackowiak, Tomasz Warzynski, Michal Rokossowski, Radoslaw Szczepanski
Lukasiewicz Research Network - Poznan Institute of Technology

11:50   **Radiated Electromagnetic Emissions from Photovoltaic Systems – Measurement Results from Inverter and Modules**
Désirée Kroner[1,2], Urban Lundgren[3]
[1]Dalarna University, Sweden; [2]Luleå University of Technology, Sweden; [3]RISE Research Institutes of Sweden, Sweden

Oral sessions

OS-05B	ORAL SESSION	Time:	14:30 - 15:50

REVERBERATION CHAMBERS II

Chaired by: **Ramiro Serra,** Eindhoven University of Technology, Netherland

Room **A**

14:30 **Effect of Environment of Dual Vibrating Intrinsic Reverberation Chamber on Dynamic Range for Shielding Effectiveness Measurements**
Hans Schipper[1], Frank Leferink[1,2]
[1]Thales Nederland B.V., The Netherlands, [2]University of Twente, The Netherlands

14:50 **Measurement of the Radiation Pattern of a Horn Antenna in a Vibrating Intrinsic Reverberation Chamber**
Youssef Rammal[1], Guillaume Andrieu[1], Nicolas Ticaud[2], Nicolas Roger[3], Alexandre Laisné[4], Philippe Pouliguen[5]
[1]xlim, France; [2]Cisteme, France; [3]Jacques Dubois, France; [4]DGA Techniques a´eronautiques, France; [5]DGA / AID, France

15:10 **Direct Current Mode Stirred –Susceptibility Testing Results of a small EUT and Comparison to RC and SAC Results**
Markus Rothenhaeusler[1], Andreas Ruhfass[1], Steffen Schneider[1], Alexander Schoisl[1], Martin Schwarz[2]
[1]Airbus Defence and Space GE, Germany; [2]Wehrtechnische Dienststelle für Informationstechnologie und Elektronik, Germany

15:30 **A Comparative Study of the Signal to Noise Ratio of Received Signals in a Reverberation Chamber and an Anechoic Chamber**
Andy Marvin[1], Simon Bale[1], Ian Flintoft[2]
[1]University of York, United Kingdom; [2]SNC-Lavalin/Atkins, United Kingdom

OS-07A

ORAL SESSION

Time: 14:30 - 15:50

SHIELDING I

Chaired by: **Mauro Feliziani**, Università degli Studi dell'Aquila, Italy

Room **B**

14:30 **Electromagnetic shielding properties of impact damaged carbon and hybrid carbon and glass fibre reinforced polymer composites**
Ewa Ewelina Mikinka[1], Thomas Whittaker[2], Piotr Synaszko[3], William Whittow[2], Krzysztof Dragan[3]
[1]Aeronautical and Automotive Engineering Department, Loughborough University, United Kingdom; [2]Wolfson School of Mechanical, Electrical and Manufacturing Engineering, Loughborough University, United Kingdom; [3]Air Force Institute of Technology, Warsaw, Poland

14:50 **Characterization of Low Frequency Electric and Magnetic Shielding Effectiveness of Board-Level Shields using the Stripline Method**
Pavithrakrishnan Radhakrishnan, Tim Claeys, Johan Catrysse, Davy Pissoort
KU Leuven, Belgium

15:10 **A Method to Determine the Permittivity of Anisotropic Thin Sheet Absorber Materials**
Sajjad Sadeghi, Seyed Mostafa Mousavi, David Pommerenke
TU Graz, Austria

15:30 **Measurement and Simulation Methodology for Characterizing the Shielding Effectiveness of Coating Materials for Optical Sensors**
Dominik Kreindl[1,2], Bernhard Weiss[1], Christian Stockreiter[1], Thomas Bauernfeind[2], Manfred Kaltenbacher[2], Martin Faccinelli[1]
[1]ams OSRAM Group; [2]Institute of Fundamentals and Theory in Electrical Engineering, Graz University of Technology

OS-08B

ORAL SESSION

Time: 14:30 - 15:50

EMC IN AUTOMOTIVE II

Chaired by:	**Stephan Frei,** TU Dortmund University, Germany
Room	**C**

14:30 **Prediction of automotive radiated emission using machine learning**
Hiroshi Suenaga[1], Makoto Nagata[2]
[1]Panasonic Industry Co., Ltd.; [2]Kobe University

14:50 **Emission from Wireless Power Transfer of Electrical Vehicles**
Sofia Bergström, Sara Linder, Kia Wiklundh, Eric Corrigan
FOI, Sweden

15:10 **Correlation of Electromagnetic Interference in Inverter and Radio Disturbance on Assessment of Component and Battery Electric Vehicle**
Ryota Morimoto, Katsumasa Aoki, Daisuke Funahashi
Toyota Motor Corporation

15:30 **Passive Cell Balancing Impact On Injection Levels During Direct Power injection on Battery Cell Controller**
Badr Guendouz[1,2], Kamel Abouda[1], Alexandre Boyer[2], Sonia Ben Dhia[3], Matthieu Aribaud[1]
[1]NXP Semiconductors, France; [2]LAAS-CNRS,Univ. de Toulouse, INSA, UPS; [3]Univ. de Toulouse, INSA, UPS

OS-11

ORAL SESSION   Time: 14:30 - 15:50

IMMUNITY

Chaired by: **Francesca Maradei,** Sapienza University of Rome, Italy

Room   **D+E**

14:30   **Characterizing the Electromagnetic Immunity of Operational Amplifiers based on EMIRR and DPI**
Bernd Deutschmann, Gunter Winkler
Graz University of Technology, Austria

14:50   **A Two Stage Miller OpAmp with Low Voltage Cascode Current Source with High EMI Immunity**
Shivdeep[1], Sahil Sharma[1], Subrahmanyam Boyapati[2], Devarshi Mrinal Das[1]
[1]Indian Institute of Technology Ropar, India; [2]Carinthia University of Applied Sciences, Carinthia, Austria

15:10   **Modal Analysis of Bulk Current Injection Tests Involving Multiwire Harnesses**
Xinglong Wu[1], Nicola Toscani[2], Domenico Spina[3], Dries Vande Ginste[3], Flavia Grassi[1]
[1]DEIB, Politecnico di Milano, Milan, Italy; [2]DMEC, Politecnico di Milano, Milan, Italy; [3]IDLab, Ghent University-imec, Ghent, Belgium

15:30   **Comparative Analysis of EM Susceptibility of Shielded Objects Based on Susceptibility Pattern**
Anna Grytsko, Piotr Słobodzian
Wrocław University of Science and Technology, Poland

OS-06A   ORAL SESSION   Time: 16:20 - 17:40

COMPUTATIONAL ELECTROMAGNETICS AND MODELING I

Chaired by: **David Thomas,** The University of Nottingham, United Kingdom

Room   **A**

16:20 **Influence of Complex Magnetic Permeability on 3-D Simulation of MnZn Common-Mode Chokes**

Rafael Suárez[1,2], María Tijero[1], Roberto Moreno[1], Aitor Arriola[1], Jose Manuel González[2]

[1]Ikerlan Technology Research Centre, Basque Research and Technology Alliance (BRTA), Spain; [2]University of Basque Country (UPV/EHU)

16:40 **Broadband 3D Modeling and Simulation of DC-Biased SMT Ferrite Beads for EMI Filters**

Christian Riener[1,2], Thomas Bauernfeind[2,1], Klaus Roppert[2,1], Samuel Kvasnicka[1,2], Bernhard Auinger[1], Manfred Kaltenbacher[2,1]

[1]Silicon Austria Labs, TU-Graz SAL GEMC Lab, Austria; [2]Institute of Fundamentals and Theory in Electrical Engineering, Graz University of Technology, Austria

17:00 **Reducing Parasitic Capacitances of Ring-Core Inductors**

Pablo Ruiz-Morales[1], Alvaro Ojeda-Rodriguez[1], Joaquin Bernal-Mendez[2], Maria Angeles Martin-Prats[3]

[1]University of Seville, Spain; [2]Dpt. Applied Physics III, University of Seville, Spain; [3]Dpt. Electronics Engineering, University of Seville, Spain

17:20 **On the Difficulties to Determine the Intrinsic Material Parameters for MnZn Ferrites**

Richard Bernd Fischbacher[1,2], Seyedmostafa Mousavi[1], Christian Manfred Riener[1,2], Sajjad Sadeghi[1], Mojtaba Fallahpour[3], Wolfgang Bösch[1], David Pommerenke[1,2]

[1]Graz University of Technology, Austria; [2]Silicon Austria Labs; [3]Apple Inc.

OS-07B

ORAL SESSION

Time: 16:20 – 17:40

SHIELDING II

Chaired by:	**Jan Luiken ter Haseborg**, Technische Universität Hamburg, Germany
Room	**B**

16:20 **An Experimental Study of the Effects of Internal Loading on the Measured Shielding Effectiveness of Printed Circuit Board Shields**
Andy Marvin, John Dawson
University of York, United Kingdom

16:40 **Effective Inductances of Periodic Perforated Metal Plates for Predicting Microwave Shielding Effectiveness**
Alessandro D'Aloia, Marcello D'Amore, Maria Sabrina Sarto
Sapienza University of Rome, Italy

17:00 **Frequency Dependent Attenuation of Metal Joint Configurations**
Rob Bijman[1], Hans Schipper[1], Patrick Deschenes[1], Frank Leferink[1,2]
[1]Thales Nederland BV; [2]University of Twente

17:20 **Optimization of the Magnetic Shielding Selection for NFC Systems**
Victor Solera[1], Antonio Alcarria[2], Pedro A. Martinez[1], Jorge Victoria[2], Roberto Herraiz[3], Jose Torres[3]
[1]Catedra EMC Würth Elektronik University of Valencia, Spain; [2]Würth Elektronik; [3]University of Valencia

OS-08C

ORAL SESSION

Time: 16:20 - 17:40

EMC IN AUTOMOTIVE III

Chaired by:	**Bernd Deutschmann,** Graz University of Technology, Austria
Room	**C**

16:20   **EMC Study of Automotive Wire Harness Configurations in a GTEM Cell**
Unai Aizpurua, Erik Kampert, Stefan Dickmann
Helmut-Schmidt-University/University of the German Federal Armed Forces Hamburg, Germany

16:40   **Common Mode Loop Impedance Analysis for Wire System in the Vehicle using PEEC Solution**
Irina Oganezova[1], Anna Gheonjian[1], Badri Khvitia[1], Roman Jobava[1], Xavier Bunlon[2]
[1]EMCoS, Georgia; [2]Technocentre RENAULT, France

17:00   **Influences of Ground Connection and Cable Length on the EMC behavior of Electric Vehicles during Conductive Charging Operations**
Inti Runa Supa Stölben[1], Michael Beltle[1], Stefan Tenbohlen[1], Roland Eidher[2], Konstantin Spanos[2], Volker Rischmüller[2]
[1]University of Stuttgart, Germany; [2]Robert Bosch GmbH, Germany

17:20   **A study on the characteristics of signal transmission in the electronic brake system for autonomous driving**
Jungrae Ha, Minho Kim, Sangwoo Kim, Sangwon Yun, Kawnseek Kim, Yeongsik Kim
Mando, Korea, Republic of (South Korea)

OS-12A   ORAL SESSION   Time: 16:20 - 17:40

MEASUREMENT TECHNIQUES AND INSTRUMENTS I

Chaired by:	**Ferran Silva**, UPC, Spain
Room	**D+E**

16:20 **Control equipment in the unique EMC environment of High Current Testing Laboratory, case study**
Jolanta Sadura[1], Adam Jóśko[1], Maciej Owsiński[2], Jan Sroka[1], Przemysław Sul[1]
[1]Warsaw University of Technology, Poland; [2]Institute of Power Engineering, Poland

16:40 **Progressive Expansion Sampling of Quasi-Static Magnetic Fields for EMI Noise Detection and Equivalent Source Modeling**
Norbert Seliger[1], Georg Faltlhauser[2]
[1]Technical University of Applied Sciences Rosenheim, Germany; [2]Stercom Power Solutions GmbH

17:00 **Comprehensive Evaluation of Novel Light-QP and Statistical-QP Methods for Supraharmonic Disturbances from EV Chargers**
Alexander Gallarreta[1], Jon González-Ramos[1], Igor Fernández[1], David de la Vega[1], Itziar Angulo[2], Amaia Arrinda[1]
[1]University of the Basque Country (UPV/EHU), Dpt. of Communications Engineering, Spain; [2]University of the Basque Country (UPV/EHU), Dpt. of Applied Mathematics, Spain

17:20 **Simple Energy-Based Method for Estimating the Equivalent Circuit Parameters of Electrolytic Capacitors**
Leonardo Sandrolini[1], Mattia Simonazzi[1], Andrea Mariscotti[2], Gaetano Pasini[1]
[1]University of Bologna, Italy; [2]University of Genoa, Italy

Posters

PS-02	POSTER SESSION	Time: 12:10 - 14:30

POSTER SESSION 2

Chaired by: **Monika Szafranska**, Wroclaw University of Science and Technology, Poland

Room **I**

P2 (1) **Numerical Analysis of the Variability of the Shielding Effectiveness of Gaskets Characterized by the MIL DTL 83528G method**
Pavithrakrishnan Radhakrishnan, Tim Claeys, Johan Catrysse, Davy Pissoort
KU Leuven, Belgium

P2 (2) **Optimization of sensing and injecting units for a common-mode active EMI filter**
Sebastien Serpaud[1], Davin Guedon[2], Richard Perraud[3], Madalina Pascaru[3], Tobias Dorlemann[4], Stephan Frei[4]
[1]IRT Saint Exupery, Toulouse, France; [2]Airbus Central Research and Technology, Issy les Moulineaux, France; [3]Airbus Central Research and Technology, Toulouse, France; [4]Electrical Department TU Dortmund Dortmund, Germany

P2 (3) **Quasi-electrostatic shielding of dissipative cylindrical shells**
Dick W. Harberts[1], Mark J. A. M. van Helvoort[2]
[1]ASML, Netherlands, The; [2]Philips, The Netherlands

P2 (4) **Application of Entire Domain Hyper Basis Functions Approach to Solution of EMC Problems**
Faik G. Bogdanov, Irina Chochia, Roman Jobava
EMCoS LLC, Georgia

P2 (5) **Characterization of High Voltage EMC filters for Electric Vehicles charging applications**
Antonio Camarda[1], Mirco Balbarani[4], Flavio Calvano[1], Stefano Righi[2,3], Luca Dossi[2], Alessandro Tacchini[2,3]
[1]Ansys Italy srl, Italy; [2]Metasystem Italy; [3]Modena and Reggio Emilia University; [4]Motor Power Company

P2 (6) **Common-mode Current converted from PLC signal in Three-phase Distribution Network with Circuit Breaker**
Ryouya Enoki, Toshiyuki Wakisaka, Tohlu Matsushima, Yuki Fukumoto
Kyushu Institute of Technology, Japan

P2 (7) **Magnetic-Metallic board-level shielding hybrid solution evaluation**
Antonio Alcarria[1,2], Adrian Suarez[2], Jorge Victoria[1,2], Pedro A. Martinez[2], Andrea Amaro[2], Jose Torres[2]
[1]Würth Elektronik, Spain; [2]Catedra EMC WE-UV, University of Valencia

P2 (8) **Analysis and Modelling of a Ring Core Inductor under Saturation Effect**
Alvaro Ojeda-Rodriguez[1], Gabriel Cano-Gomez[2], Joaquin Bernal-Mendez[2]
[1]University of Seville, Spain; [2]Department of Applied Physics III, University of Seville, Spain

P2 (9) **Harmonic Stability of Grid-connected Voltage Source Converters Considering Parameter Sensitivity**
Duc-Thanh Do
Hanoi University of Mining and Geology, Germany

P2 (10) **Measurement and Simulation of the Shielding Effectiveness of Planar Material with Apertures using a ASTM D4935 TEM Cell**
Michaela Gruber, Michael Beltle, Stefan Tenbohlen
University of Stuttgart, Germany

P2 (11) **Correspondence of Frequency Dispersion of Primary Parameters of Shielded-Printed Circuit Board to Shielding Effectiveness of Near Magnetic Field**
Taiki Yamagiwa[1], Takanobu Tsuyama[1], Yoshiki Kayano[1], Yoshio Kami[1], Fengchao Xiao[1], Hiroshi Inoue[2]
[1]The University of Electro-Communications, Japan; [2]Akita University, Japan

P2 (12) **On the Measurement of Far Field Intensities Generated by Cables Shielded with Composites Showing Electromagnetic Losses**
Martin Pospisilik, Stanislav Kovar, Marie Nedvedova
Tomas Bata University in Zlín, Czech Republic

P2 (13) **Traveling Wave Method Calibration for Spatial Resolution of Field Probe System**
Yuntao Jin, Chen Jiao, Fei Dai
Beihang University, China, People's Republic of China

P2 (14) **Measurement of Radiation Patterns for Ultra-Broadband Folded Long-Hexagon Antenna**
Shinobu Ishigami[1], Keita Kobayashi[1], Ken Kawamata[1], Katsushige Harima[2], Shingo Inori[3]
[1]Tohoku Gakuin University, Japan; [2]National Institute of Information and Communications Technology, Japan; [3]Elena Electric Co.Ltd., Japan

P2 (15) **Dynamic Propagation Channel Evaluation with Software Defined Radio Architectures**
Anne Vaske[1], Robert Geise[2], Henriette Reineke[1]
[1]TU Braunschweig; [2]HTWK Leipzig, Germany

P2 (16) **Impact of Semi-Anechoic Chambers on Magnetic Field Measurements for Frequencies up to 30 MHz**
Michael Kleinen[1], Sebastian Jeschke[1], Marcel Olbrich[1], Jörg Bärenfänger[1], Jan Christopher Reiß[2]
[1]EMC Test NRW GmbH, Germany; [2]Hochschule Bochum, Bochum University of Applied Sciences, Bochum

P2 (17) **Harmonic Distortion Reference Structure for Contact Induced Harmonics**
Leonhard Petzel[1], Rui Mi[1], David Pommerenke[1], Steffen Holland[2]
[1]TU Graz, Austria; [2]Nexperia Germany GmbH

P2 (18) **Critical aspects of the uncertainty budget in the shielding effectiveness measurements**
Karolina Małecka[1], Robert Olczyk[1], Jan Sroka[1], Grzegorz Urbaniak[2]
[1]Warsaw University of Technology, Poland; [2]Poznan University of Technology

Meetings

ME-11	MEETING	Time: 9:00 - 10:20

OPEN INFORMATION MEETING: "NEW AECTP 500: WHAT HAS CHANGED?"

Chaired by: **Hywel Sollis,** UK MoD, United Kingdom

Room **H**

ME-04	MEETING	Time: 13:00 - 14:30

IEEE EMC-SOCIETY CHAPTER REPRESENTATIVES MEETING + IEEE SENIOR MEMBER ELEVATION EVENT

Chaired by:

Krzysztof Sieczkarek, Lukasiewicz Research Network Đ Poznan Institute of Technology / IEEE EMC-S Polish Chapter, Poland

Vignesh Rajamani, Exponent, United States of America

Janet O'Neil, ETS-Lindgren, United States of America

Room **H**

ME-05	MEETING	Time: 16:00 - 18:00

WOMEN IN EMC

Chaired by: **Mariya Antyufeyeva**, V. N. Karazin Kharkiv National University, Kharkiv, Ukraine and Newcastle University, Newcastle, UK., United Kingdom

Room **I**

Social events

Symposium coctail

Time: 19:00 – 24:00

Old Tram Depot

For details see page 5.

ROHDE & SCHWARZ

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- Vector Network Analyzers (VNA)

- Automotive Radar Testing

- RF and microwave power meters

- RF broadband amplifiers

- Power supplies and source measure units

- Service, calibrations, training and technical support

Thursday, 7th September 2023 – 3rd Symposium day

Room No.	Room A	Room B	Room C	Room D-E	Room I	Room G	Room H
Thursday, September 7, 2023							
Capacity (persons)	120	100	100	180	50	25	30
09:00 / 09:20 / 09:40 / 10:00	**OS-06B: Computational Electromagnetics and Modeling II** *Chair: Piotr Slobodzian*	**SS-04A Electromagnetic interference measurement and modeling for low-frequency electronic and power systems and the possible mitigation techniques** *Chairs: Amr Ibrahim Madi, Cathrine E.S. Feloups*	**SS-06A Risk-based EMC** *Chairs: Davy Pissoort, Anne Roc'h, Sebastian Mauricio Salas Laurens*	**OS-12B: Measurement Techniques and Instruments II** *Chair: Heyno Garbe*		Demonstrator presentation and Nokia's labs virtual tour	
10:20	COFFEE BREAK						
10:50 / 11:10 / 11:30 / 11:50	**OS-06C: Computational Electromagnetics and Modeling III** *Chair: Mohamed Ramdani*	**SS-04B Electromagnetic interference measurement and modeling for low-frequency electronic and power systems and the possible mitigation techniques** *Chairs: Amr Ibrahim Madi, Cathrine E.S. Feloups*	**SS-06B Risk-based EMC** *Chairs: Davy Pissoort, Anne Roc'h, Miriam Gonzalez*	**OS-12C: Measurement Techniques and Instruments III** *Chair: Jan Carlsson*		Demonstrator presentation and Nokia's labs virtual tour	
12:10 / 12:20 / 12:30 / 13:00 / 13:30 / 14:00	LUNCH				**PS-03: Poster Session III** *Chairs: Jaroslaw Janiszewski, Damian Kaliszuk*	Demonstrator presentation and Nokia's labs virtual tour	**ME-12: "GREEN project meeting"** organized by Tetiana Serdiuk **ME-06: "NEPIT project kick-off meeting"** organized by Frank Leferink (closed meeting)
14:30 / 14:50 / 15:10 / 15:30	**OS-06D: Computational Electromagnetics and Modeling IV** *Chair: Piotr Slobodzian*	**OS-13: EMC on the PCB and IC Levels** *Chair: Jan Hansen*	**SS-06C Risk-based EMC** *Chairs: Anne Roc'h, Tiago Nunes*	**OS-12D: Measurement Techniques and Instruments IV** *Chairs: Piotr Gajewski, Rafal Namiotko*		Demonstrator presentation and Nokia's labs virtual tour	**ME-07A: "EMC Europe - International Steering Committee meeting"** Organized by Ferran Silva (closed meeting)
15:50	COFFEE BREAK						
16:20 / 16:30 / 16:40 / 17:00 / 17:20 / 17:40	**OS-06E: Computational Electromagnetics and Modeling V** *Chair: David Pommerenke*	**SS-05 Evaluation of RF environment focused on the outdoor workers' exposure** *Chairs: Sachiko Yamaguchi-Sekino, Victoria Ramos*	**SS-06D Risk-based EMC** *Chairs: Anne Roc'h, Asif Ali*	**OS-12E: Measurement Techniques and Instruments V** *Chairs: Marek Michalak, Tomasz Dróżdż*		Demonstrator presentation and Nokia's labs virtual tour	**ME-07B: "EMC Europe - International Steering Committee meeting"** Organized by Ferran Silva (closed meeting)

Oral sessions

OS-06B	ORAL SESSION	Time: 9:00 - 10:20

COMPUTATIONAL ELECTROMAGNETICS AND MODELING II

Chaired by: **Piotr Slobodzian,** Wroclaw University of Science and Technology, Poland

Room **A**

9:00 **Python-LTSpice Framework for Multi-Objective EMC Filter Optimization**
Herbert Hackl[1], Martin Stoiber[1], Bernhard Auinger[1], Thomas Zengerle[2], Franz Königseder[3], Jan Hansen[4]
[1]Silicon Austria Labs GmbH; [2]Tridonic GmbH & Co KG; [3]MAGNA Powertrain GmbH & Co KG; [4]Graz University of Technology, Institute of Electronics

9:20 **A Time Domain Model of Reconfigurable Intelligent Surfaces through the Fast Inversion of the Laplace Transform**
Fabrizio Loreto[1], Giuseppe Pettanice[2], Roberto Valentini[2], Piergiuseppe Di Marco[2], Daniele Romano[1], Martin Stumpf[3], Fortunato Santucci[2], Giulio Antonini[1]
[1]Department of Industrial and Information Engineering and Economics, University of L'Aquila, Italy; [2]Department of Information Engineering Computer Sciences and Mathematics, University of L'Aquila, Italy; [3]Lerch Group of EM Research, Dept. Radio Electronics, Brno University of Technology, Czech Republic

9:40 **Analysis of aircraft shieldings for lightning indirect effects by a novel S-FDTD**
Miguel Ruiz Cabello[1], Enrique Pascual-Gil[2], Guadalupe Gutierrez Gutierrez[2], Hirahi Galindo Perez[2], Luis Diaz Angulo[1], Alberto Gascon Bravo[1], Alberto Prados Perez[1], Salvador Gonzalez Garcia[1]
[1]University of Granada, Spain; [2]Airbus, Spain

10:00 **An Efficient Neural Network Learning Algorithm for Printed Spiral Coil (PSC) Impedance Prediction**
Joojoong Kim, Eakhwan Song
Kwanwoon University, Korea, Republic of (South Korea)

OS-12B   ORAL SESSION   Time: 9:00 - 10:20

MEASUREMENT TECHNIQUES AND INSTRUMENTS II

Chaired by: **Heyno Garbe,** Leibniz Universitaet Hannover, Germany

Room   **D+E**

9:00   **Performance Charaterisation of the Decoupling Capacitor Network using the Near-Field Measurement**
Sebastien Serpaud[1], Alexandre Boyer[2], Sonia Ben Dhia[2], Fabio Coccetti[1]
[1]IRT Saint Exupery, Toulouse, France; [2]Univ. de Toulouse, INSA, UPS, LAAS Toulouse, France

9:20   **Configurable Resonant and Broadband Magnetic Near-Field Probe**
Amin Pak[1], Lucas Speckbacher[2], Mehdi Gholizadeh[1], David Pommerenke[1]
[1]Institute of Electronics, Graz University of Technology. Silicon Austria Labs, TU-Graz SAL GEMC Lab, Austria; [2]Chair of Electronic Design Automation, Technical University of Munich, Munich, Germany

9:40   **Single-probe Near-field Phase Retrieval using On-The-Fly Scan and Hilbert Transform**
Cheng Yang, Christian Adam, Sebastian Goetschel
Hamburg University of Technology, Germany

10:00   **Measurement of Impulsive Electromagnetic Field Caused by ESD Using A Folded Long-Hexagon Antenna and It's Transient Characteristics**
Ken Kawamata[1], Shinobu Ishigami[1], Osamu Fujiwara[2]
[1]Tohoku Gakuin University, Japan; [2]Nagoya Institute of Technology, Japan

Special sessions

SS-04A	SPECIAL SESSION	Time: 9:00 - 10:20

ELECTROMAGNETIC INTERFERENCE MEASUREMENT AND MODELING FOR LOW-FREQUENCY ELECTRONIC AND POWER SYSTEMS AND THE POSSIBLE MITIGATION TECHNIQUES

Chaired by:	**Amr Ibrahim Madi,** University of Zielona Gora, Poland
	Cathrine E.S. Feloups, University of Twente, The Netherlands
Room	**B**

9:00 **Investigating the CM Noise Generated by Different Configurations of Multiple Forward Converters**
Cathrine E.S. Feloups[1], Hafte H. Adhena[2], Niek Moonen[1], David Thomas[2], Frank Leferink[1,3]
[1]University of Twente, Enschede, The Netherlands; [2]University of Nottingham, Nottingham, United Kingdom; [3]Thales Netherlands, 7554 RR, Hengelo, The Netherlands

9:20 **Risk of EMI due to Necessary Modification in a Remote Microgrid in Indonesia**
Ilman Sulaeman Islahuzzaman[1], Alexander Matthee[1], Hafsah Halidah[2], Kholid Akhmad[2], Niek Moonen[1], Jelena Popovic[3], Frank Leferink[3]
[1]University of Twente; [2]National Research and Innovation Agency of Indonesia; [3]Thales Nederland B.V.

9:40 **EMI Conducted Emission on Synchronization Conditions for FPGA-Based Multidrives Network**
Douglas Nascimento[1,2], Robert Smolenski[1], Piotr Lezynski[1], Michał Przybylski[1], Niek Moonen[2]
[1]University of Zielona Góra, Poland; [2]University of Twente, Netherlands

10:00 **An Assessment of Multilevel Converters Submodules EMI Emissions Considering Three Configurations Including Parasitic Parameters**
Amr Ibrahim Madi[1,2], Waseem Elsayed[1,2], Ahmed Hebala[3], Michal Przybylski[1], Piotr Lezynski[1], Robert Smolenski[1]
[1]University of Zielona Gora, Poland; [2]University of Twente, Netherlands; [3]Arab Academy for Science, Technology and Maritime

SS-06A · SPECIAL SESSION · Time: 9:00 - 10:20

RISK-BASED EMC

Chaired by:	**Davy Pissoort,** KU Leuven, Belgium
	Anne Roc'h, Eindhoven University of Technology, The Netherlands
	Sebastian Mauricio Salas Laurens, Eindhoven University of Technology, The Netherlands
Room	**C**

9:00   **Electromagnetic Hazard Analysis Technique based on System-Theoretic Process Analysis**
Miriam Gonzalez-Atienza[1], Dries Vanoost[1], Rob Kleihorst[2], Davy Pissoort[1]
[1]ESAT-WaveCoRe, M-Group. KU Leuven Bruges Campus. Bruges, Belgium; [2]Philips Medical Systems. Best, The Netherlands

9:20   **Application of a Testing-to-Failure Approach to the Susceptibility Assessment of Electronic Systems**
Xinting Xue, Tim Claeys, Davy Pissoort
KU Leuven, ESAT-WaveCore, M-Group, Bruges, Belgium

9:40   **Stage-by-stage evaluation of a biomedical system regarding its electromagnetic susceptibility**
Tiago Nunes[1], Marcos Quílez[2], Mireya Fernández-Chimeno[2], Ferran Silva[2], Hugo Plácido da Silva[1]
[1]PLUX Wireless Biosignals, Lisbon, Portugal; [2]Universitat Politècnica de Catalunya, Barcelona, Spain

10:00   **Investigation of the Mechanisms behind EMI Issues caused by Ready-Made Connecting Devices in Electronic Systems**
Zhao CHEN, Tim Claeys, Johan Catrysse, Davy Pissoort
ESAT-WaveCoRe, M-Group, KU Leuven Bruges Campus, Belgium

OS-06C

ORAL SESSION

Time: 10:50 - 12:10

COMPUTATIONAL ELECTROMAGNETICS AND MODELING III

Chaired by: **Mohamed Ramdani,** ESEO, France

Room **A**

10:50 **Modeling a GaN Transistor and its Impact on Conducted Emission up to 300 MHz**
Mehdi Gholizadeh[1,2], Ko Odreitz[1], Christian Riener[1,2], Amin Pak[1,2], David Pommerenke[1,2], Jan Hansen[1,2]
[1]Graz University of Technology, Austria; [2]TU-Graz SAL GEMC Lab Austria

11:10 **Physics-based and Behavioural Models for the Dynamic Response of a TVS Diode**
Renaud Gillon
SYDELITY b.v., Belgium

11:30 **AI-Based SI-Compliant PCB Design Support for DDR Technology Enhanced by Transfer Learning**
Julian Withöft[1], Werner John[2], Emre Ecik[1], Jürgen Götze[1]
[1]Information Processing Lab/TU Dortmund; [2]PYRAMIDE2525/TU Dortmund

11:50 **Simulation of Resonances in Power Electronic Circuits for EMC Prediction**
Simon Podendorf, Kai-Uwe Rathjen, Norman Landskron, Soenke Brandt, Klaus F. Hoffmann, Stefan Dickmann
Helmut Schmidt University, Germany

OS-12C
ORAL SESSION

Time: 10:50 - 12:10

MEASUREMENT TECHNIQUES AND INSTRUMENTS III

Chaired by:	**Jan Carlsson,** Provinn, Sweden
Room	**D+E**

10:50   **Validation procedures for EMC Test Sites in the frequency range 1 to 18 GHz in view of extension to the frequency range 18 to 40 GHz**
Sven Battermann[1], Jochen Riedelsheimer[2], Markus Metzger[3], Friedrich-Wilhelm Trautnitz[4]
[1]FH Bielefeld - University of Applied Sciences, Germany; [2]Albatross Projects GmbH, Germany; [3]CONFORMITAS GmbH & Co. KG, Germany; [4]IEEE Senior Member

11:10   **Generalized Cylindrical Mode Filtered Site VSWR for Above 18 GHz EMC Site Evaluation Using Compressed Sensing**
Zhong Chen, Yibo Wang
ETS-Lindgren, United States of America

11:30   **Lessons from Proficiency Testing in EMC**
Emrah Tas, Frederic Pythoud
Federal Institute of Metrology METAS, Switzerland

11:50   **Improved System for Measuring Contact Induced Harmonics**
Rui Mi[1], Leonhard Petzel[1], Sam Bai[1], Seyedmostafa Mousavi[2], Lijuan Qu[3], Yiqiang Zhang[3], David Johannes Pommerenke[1]
[1]Graz University of Technology, Austria; [2]Missouri University of Science and Technology, USA; [3]vivo Communication Technology Co. Ltd.,China

Special sessions

SS-04B	SPECIAL SESSION	Time: 10:50 - 12:10

ELECTROMAGNETIC INTERFERENCE MEASUREMENT AND MODELING FOR LOW-FREQUENCY ELECTRONIC AND POWER SYSTEMS AND THE POSSIBLE MITIGATION TECHNIQUES

Chaired by: **Amr Ibrahim Madi,** University of Zielona Gora, Poland
Cathrine E.S. Feloups, University of Twente, The Netherlands

Room **B**

10:50 **Electromagnetic Interference Modelling and Validation Methods in Electrified Railways**
Iqra Aitbar, Sviatoslav Voskresenskyi, Erjon Ballukja, David Thomas, Steve Greedy
University of Nottingham, United Kingdom

11:10 **Unexpected Common Mode Choke Saturation**
Daria Nemashkalo[1], Patrick Koch[1], Niek Moonen[1], Frank Leferink[1,2]
[1]University of Twente, Netherlands, The; [2]Thales Nederland, B.V., Hengelo, the Netherlands

11:30 **Comparison of the Current Harmonic Pollution of Asynchronous Motor Drives With Field Oriented Control and Direct Torque Control**
Iurie Nuca, Dusan Kostic, Petre-Marian Nicolae, Ileana-Diana Nicolae
Universitatea Craiova, Romania

11:50 **Educational Demo's for Showing the Influence of (im)proper Installation and Grounding of Filters**
Rodica Botnarevscaia[1], Ivan Struzhko[1], Ben Puylaert[1], Tetiana Serdiuk[2], Frank Leferink[1,3]
[1]University of Twente, Enschede, The Netherlands; [2]Ukrainian State University of Science and Technologies, Dnipro, Ukraine; [3]Thales Netherlands, Hengelo, The Netherlands

SS-06B   SPECIAL SESSION   Time: 10:50 - 12:10

RISK-BASED EMC

Chaired by:
Davy Pissoort, KU Leuven, Belgium
Anne Roc'h, Eindhoven University of Technology, The Netherlands
Miriam Gonzalez, KU Leuven, Belgium

Room   **C**

10:50	**Analysis of the Effect of Deviated Modulating Signal Characteristics on the Susceptibility of a Small Medical Device** Geon George Bastian[1], Tiago Pinto Nunes[2], Marcos Quílez[3], Mireya Fernández-Chimeno[3], Ferran Silva[3] [1]IDNEO; [2]PLUX Biosignals S.A; [3]Universitat Politecnica de Catalunya
11:10	**"Fifty Shades of Grey and More": Medical Use of Systems of Systems, Trends, Challenges and, Implications to EMC** Nandun Senevirathna[1,2], Rob Kleihorst[1], Sander Bronckers[2], Anne Roc'h[2] [1]Philips Medical Systems Nederland B.V.,Best, The Netherlands, [2]Eindhoven University of Technology ,Eindhoven, The Netherlands
11:30	**Risky Play: A Risk-based Case Study for Common Mode Current Assessment of a Medical Plasma Device** Marc Kopf, Anne Roc'h Eindhoven University of Technology, The Netherlands
11:50	**Reduction of EMC Power Amplifier Intermodulation by Using Digital Signal Predistortion** Nathalia Alves Rocha Batista, Marcos Quílez Figuerola, Ferran Silva Martinez Universitat Politècnica de Catalunya, Spain

Oral sessions

OS-06D	ORAL SESSION	Time: 14:30 - 15:50

COMPUTATIONAL ELECTROMAGNETICS AND MODELING IV

Chaired by: **Piotr Slobodzian,** Wroclaw University of Science and Technology, Poland

Room **A**

14:30 **Monte Carlo Simulation of a Physical Random Unintentional Radiator as a Basis for Statistics in Fully Anechoic Room Measurements**
Jörg Petzold, Mathias Magdowski, Ralf Vick
Otto-von-Guericke University, Germany

14:50 **Model-Order Reduction of the Full-Wave Method of Moments System by a Static-Mode Extraction**
Hannes Schreiber, Marco Leone
Otto von Guericke University Magdeburg, Germany

15:10 **PEEC Solution of EM-Circuit Problems for Combined Metalic and Dielectric Structures Based on the Augmented Integral Equations**
Giorgi Chigovani[1], Alexander Demurov[1], Diana Eremyan[1,2], Davit Imnadze[1,2], Anna Gheon-jian[1,2], Roman Jobava[1,2]
[1]EMCoS LLC, Georgia; [2]Tbilisi State University

15:30 **FDTD Full Wave Simulations of Reconfigurable Intelligent Surfaces**
Emanuel Colella[1,2], Luca Bastianelli[1,2], Valter Mariani Primiani[1,2], Franco Moglie[1,2]
[1]Università Politecnica delle Marche; [2]Consorzio Nazionale Interuniversitario delle Teleco-municazioni (CNIT)

OS-13   ORAL SESSION   Time: 14:30 - 15:50

EMC ON THE PCB AND IC LEVELS

Chaired by:	**Jan Hansen,** Graz University of Technology, Austria
Room	**B**

14:30   **A PCB Based High Resistance GHz Bandwidth Voltage Pick Up for Detecting Switching Voltage**
Mehdi Gholizadeh[1,2], Sajjad Sadeghi[1], Amin Pak[1,2], Jan Hansen[1,2], David Pommerenke[1,2]
[1]Graz University of Technology, Austria; [2]TU-Graz SAL GEMC Lab Austria

14:50   **Smart Input Space Sampling Combined with Kriging-Partial Least Square Regression for EMC Risk Analysis at PCB Level with Many Variables**
Alexandre Plot[1,2], Philippe Besnier[2], Benoit Goral[1]
[1]THALES SIX GTS, France, France; [2]Univ Rennes, INSA Rennes, CNRS, IETR - UMR 6164

15:10   **Interference-induced Electromagnetic Emission in Functioning Operating States of Integrated Circuits**
Nikolaus Czepl, Daniel Kircher, Bernd Deutschmann
Graz University of Technology, Austria

15:30   **Impact of Supply Voltage and Operating Point in IC PDN Modeling**
Ko Odreitz[1], Christoph Maier[2], Felix Minichmair[1], Bernd Deutschmann[1,2]
[1]Institute of Electronics, Graz University of Technology, Graz, Austria; [2]Institute of Microwave and Photonic Engineering, Graz University of Technology, Graz, Austria

OS-12D ORAL SESSION Time: 14:30 - 15:50

MEASUREMENT TECHNIQUES AND INSTRUMENTS IV

Chaired by:
Piotr Gajewski, National Institute of Telecommunications, Poland

Rafal Namiotko, Osrodek Badawczo-Rozrojowy Centrum Techniki Morskiej JSC, Poland

Room **D+E**

14:30 **Bus Electrocardiogram: Vulnerability of SoC-FPGA Internal AXI Bus to Electromagnetic Side-Channel Analysis**
May Myat Thu, Maria Méndez Real, Maxime Pelcat, Philippe Besnier
Univ Rennes, INSA Rennes, Nantes Université, CNRS, IETR-UMR 6164, F-35000 Rennes

14:50 **Radiofrequency Measuring Receiver with Spectrum Analyzer Function as a Tool for Noise Measurement of Semiconductor Structures**
Marcin Stanisław Wojciechowski
Central Office of Measures (GUM), Poland

15:10 **Clustering Technique for Broadband Electromagnetic Noise Source Separation**
Umberto Paoletti
HITACHI, Japan

15:30 **Limited Effectiveness of Balancing a Coaxial Feeder with a Balun for Radio Frequencies**
Ikuko Mori[1], Andrzej E Sowa[2]
[1]National Institute of Technology, Suzuka College, Japan; [2]Wroclaw University of Science and Technology

Special sessions

SS-06C	SPECIAL SESSION	Time: 14:30 - 15:50

RISK-BASED EMC

Chaired by:	**Anne Roc'h,** Eindhoven University of Technology, The Netherlands
	Tiago Nunes, PLUX Wireless Biosignals, Portugal
Room	**C**

14:30 **One Framework to Rule Them All? Framework for Testing Different Sampling Methods for Characterizing the EM Fields in a Scenario**
Sebastian Mauricio Salas Laurens, Anne Roc'h
Eindhoven University of Technology, The Netherlands

14:50 **Challenges in Risk-based EMC for MRI Systems**
Simon Rendon Velez[1,2], Mark J. A. M. van Helvoort[1], Robert Vogt-Ardatjew[2], Bärbel van den Berg[3], Frank Leferink[2,4]
[1]Philips Medical Systems; [2]University of Twente; [3]Medisch Spectrum Twente; 4Thales

15:10 **Evaluation of the Variability of the Maximum Expected Field Strengths in an MRI Room**
Simon Rendon Velez[1,2], Ridvan Aba[2], Mark J. A. M. van Helvoort[1], Bärbel van den Berg[3], Robert Vogt-Ardatjew[2], Frank Leferink[2,4]
[1]Philips Medical Systems; [2]University of Twente; 3Medisch Spectrum Twente; 4Thales

15:30 **Definition And Characterization Of An Electromagnetic Operational Domain Model**
Mohammad Tishehzan, Mark Nicholson, John F. Dawson
University of York, United Kingdom

Oral sessions

OS-06E ORAL SESSION Time: 16:20 - 17:40

COMPUTATIONAL ELECTROMAGNETICS AND MODELING V

Chaired by: **David Pommerenke,** Graz University of Technology, Austria

Room **A**

16:20 **Influence of the Frequency Dependence of Electrical Ground Parameters and Different Formulations for the Ground Correction Terms on Field-Induced Currents and Voltages on Overhead Lines**
Rafael Alipio, Naiara Duarte
Swiss Federal Institute of Technology (EPFL), Switzerland

16:40 **Circuit Modeling of Fast Ethernet Signal for EMC and SI Analysis**
Ludovica Illiano, Xiaokang Liu, Xinglong Wu, Flavia Grassi, Sergio Amedeo Pignari
Politecnico di Milano, Italy

17:00 **Coupling Path to Attached Cables in an Arbitrary Flyback Converter**
Daniel Lyngby Commerou[1], Kasper Mayntz Paasch[1], Morten Sørensen[2], Seungtaek Jeong[3], Chulsoon Hwang[3]
[1]University of Southern Denmark, Denmark; [2]Force Technology; [3]Missuri University of Science and Technology

17:20 **SAE J2954 WPT System Radiated Emission Model**
Tommaso Campi[1], Silvano Cruciani[2], Francesca Maradei[3], Mauro Feliziani[1]
[1]University of L'Aquila, Italy; [2]Tor Vergata University of Rome, Rome, Italy; [3]Sapienza University of Rome, Rome, Italy

OS-12E ORAL SESSION Time: 16:20 - 17:40

MEASUREMENT TECHNIQUES AND INSTRUMENTS V

Chaired by: **Marek Michalak,** Wroclaw University of Science and Technology, Poland

Tomasz Dróżdż, University of Agriculture in Krakow, Poland

Room **D+E**

16:20 **A Feed-Forward Gain Control for Improving the Dynamic Range of the Receiver's ADC in EMC Measurements**
Dimitrios Kalodikis, Christian Spindelberger, Holger Arthaber

Institute of Electrodynamics, Microwave and Circuit Engineering, TU Wien, Austria

16:40 **SNR Improvement for Heart Rate Estimation Using mmWave 79 GHz FMCW MIMO Radar**
Gilles Yowel Massala Mboyi[1], Dong-Hyun Oh[1], Jung-Hoon Han[1], Hyung-ju Kim[2], Byung-Jang Jeong[2]
[1]Jeju National University, Korea, Republic of South Korea,
[2]Radio Research Division ETRI, Daejeon, Republic of South Korea

17:00 **Influence of nonlinear circuit components on the creation of intermodulation**
Martin Kurka, Jan Weber, Holger Hirsch
University of Duisburg-Essen, Germany

17:20 **An Investigation of Lithium-ion Battery Induced Near Field Electromagnetic Interference in Wearable Audio Devices**
Xiaolong Yue, Min Zhang
Xiaomi Inc, China, People's Republic of

Special sessions

SS-05	SPECIAL SESSION	Time: 16:20 - 17:40

EVALUATION OF RF ENVIRONMENT FOCUSED ON THE OUTDOOR WORKERS' EXPOSURE

Chaired by:	**Sachiko Yamaguchi-Sekino,** National Institute of Information Technology, Japan
	Victoria Ramos, Instituto de Salud Carlos III, Spain
Room	**B**

16:20   **Effects of Feedback Report with Objectively Measured Radio-Frequency Electromagnetic Fields (RF-EMF) Levels on Recipient's Subjective RF-EMF Exposure Levels**
Sachiko Yamaguchi-Sekino, Miwa Ikuyo, Kazuhisa Kamegai, Masao Taki, Teruo Onishi, Soichi Watanabe
National Institute of Information Technology, Japan

16:40   **Survey of RF Electromagnetic Field Exposure in a Public Health Research Environment**
Victoria Ramos[1], Samuel Suarez[2], Pablo Marina-Boillos[1], Victor M. Febles[2], Luis Rabassa[2], José A. Hernandez[2]
[1]Instituto de Salud Carlos III; [2]Hospital Universitario de Canarias, La Laguna, Spain

17:00   **The characteristic of radiofrequency electromagnetic exposures during the outdoor activity of workers in the harbor versus downtown**
Jolanta Karpowicz, Krzysztof Gryz, Patryk Zradziński
Central Institute for Labour Protection-National Research Institute (CIOP-PIB), Poland

17:20   **Contribution from 4G/5G networks into the electromagnetic environment in the railway stations in Warszawa**
Krzysztof Gryz, Jolanta Karpowicz, Patryk Zradziński
Central Institute for Labour Protection - National Research Institute, Poland

SS-06D   SPECIAL SESSION   Time: 16:20 - 17:40

RISK-BASED EMC

Chaired by:	**Anne Roc'h,** Eindhoven University of Technology, The Netherlands
	Asif Ali, UPC, Spain
Room	**C**

16:20 **Susceptible Frequency Range Definition for Robust Immunity Tests**
Ivan Struzhko[1], Robert Vogt-Ardatjew[1], Frank Leferink[1,2]
[1]University of Twente, The Netherlands, [2]Thales Nederland, The Netherlands

16:40 **Wide-band Characterization of Multi-Layer Coding Techniques to Achieve Electromagnetic Resilient Communication Networks**
Mohammad Kameli, Tim Claeys, Davy Pissoort
KU Leuven, Bruges Campus

17:00 **Assessment of the Effect of a Test Setup on the Input Impedance Measurement of Cables**
Mohammad Khorramizadeh[1], Maxime Payen[2], Sander Bronckers[1], Anne Roc'h[1]
[1]Technische Universiteit Eindhoven, The Netherlands; [2]ENAC Toulouse, France

Posters

PS-03	POSTER SESSION	Time: 12:10 - 14:30

POSTER SESSION 3

Chaired by:	**Jaroslaw Janiszewski**, Wroclaw University of Science and Technology, Poland
	Damian Kaliszuk, Wroclaw University of Science and Technology, Poland
Room	**I**

P3 (1)   **Extracting High Speed Refresh Current for DDR5 Module based on Network Parameter Theory**

Wonseok Hong[1], Kwangho Kim[1], Jaeyoung Shin[2], Rakjoo Sung[1], Woosin Choi[1], Young-Chul Cho[1], Jung-Hwan Choi[1], Hyungjong Ko[1]
[1]Samsung electronics, Korea, Republic of (South Korea); [2]Sungkyunkwan University, Korea, Republic of (South Korea)

P3 (2)   **High Temperature Accelerated Ageing Influence on the Conducted Immunity Modelling of the Commonly Used Voltage Regulator ICs**

Jaber AL Rashid[1], Mohsen Koohestani[2,3], Laurent Saintis[1], Mihaela Barreau[1]
[1]LARIS SFR MATHSTIC, Universit´e d'Angers, Angers F−49000, France; [2]Ecole Sup´erieure d' ´ Electronique de l'Ouest (ESEO), Angers 49107, France; [3]Institute of Electronics and Telecommunications of Rennes (IETR), Rennes 35042, France

P3 (3)   **Investigation of the Interference Effects from Different Time Domain Signals on WLAN**

Henrik Brech, Heyno Garbe
Leibniz University Hannover, Germany

P3 (4)   **SMPS Design Criteria for Meeting Radiated Emission Limits**

Steffen Schulze[1], Saad Al-Hamid[2], Moustafa Raya[2]
[1]Würth Elektronik eiSos GmbH, Waldenburg, Germany; [2]Otto von Guericke University, Magdeburg, Germany

P3 (5)   **Characteristics of 3D Printed SIW Filter Incorporated with Artificial Dielectric Material**

Achmad Munir[1], Muhammad Farhan Maulana[1], Dwi Andi Nurmantris[2], Zulfi Zulfi[2]
[1]Institut Teknologi Bandung, Indonesia; [2]Telkom University, Indonesia

P3 (6)   **Investigation of Guard Trace Utilization for EM Coupling Reduction Between Closely-Spaced Microstrip Patch Antennas**

Zulfi Zulfi[1,2], Joko Suryana[1], Levy Olivia Nur[2], Achmad Munir[1]
[1]Institut Teknologi Bandung, Indonesia; [2]Telkom University, Indonesia

P3 (7)   **Discussion of the height scan introduced in CISPR 32 for measuring emissions above 1 GHz**

Sven Battermann[1], Kurt Hemmerlein[2], Manfred Stecher[3]
[1]FH Bielefeld - University of Applied Sciences, Germany; [2]Federal network agency (BNetzA); [3]IEEE life member

P3 (8)   **Virtual Triaxial Setup Modeling for Numerical Determination of Transfer Impedance of Shielded Cables**

Iskander Badzagua[1], Ilona Danelyan[1], Kakhaber Odisharia[1], Anna Gheonjian[1,2], Roman Jobava[1,2]
[1]EMCoS LLC, Georgia; [2]Tbilisi State University

P3 (9)   **Usage of Ansys in Electrostatic Discharge (ESD) Simulations for Automo-**

tive Devices
Pawel Rochninski[1], Karol Zimolag[2]
[1]Aptiv, Poland; [2]Ansys, USA

P3 (10) **New Evaluation Concept for Electromagnetic Interference of HVDC Cables to neighboring Buried Pipelines**
Mohammad Nazemi[1], Robert Dommerque[1], Sven Daniel[2]
[1]Amprion GmbH, Germany; [2]GRIDSIDE Energy Consult GmbH, Germany

P3 (11) **Mitigating Common-Mode Noise in the Totem Pole Bridgeless PFC Using Balance Boost Technique**
Minh-Hoang Nguyen
University of Tours, GREMAN UMR 7347, Tours 37200, France

P3 (12) **Investigation of the influence of standard test instruments on the production of radio frequency mixed products in EMC context**
Jan Weber, Holger Hirsch, Martin Kurka, Max Weber
University of Duisburg-Essen, Germany

P3 (13) **Mapping the Interdependence of Parasitic Capacitances in Isolated Phase-Shifted Full-Bridge DC/DC Converter**
Róbert Orvai[1], Márk Csörnyei[2]
[1]Óbuda University, Hungary; [2]Robert Bosch Kft., Hungary

P3 (14) **Predictive sensitivity analysis of motor's windings HF impedances**
Arthur Piat[1,2], Sami Hlioui[2,3], Pierre-Etienne Lévy[2], François Costa[2,4]
[1]IRT Saint exupery, France; [2]Université Paris-Saclay, ENS Paris-Saclay , CNRS, SATIE, France; [3]CY Cergy Paris University; [4]Université Paris Est Créteil

P3 (15) **Choice of STFT and WT Parameters for Monitoring of EMI in Track Circuits**
Volodymyr Havryliuk
Ukrainian State University of Science and Technologies, Ukraine

P3 (16) **SPICE-Based Model Validation for 1200V AcepackTM Drive Traction Power Module**
Andrea Cusumano, Debora Crimi, Alessandra Manzitto, Gaetano Bazzano, Alessandra Raffa, Ludovica Longo
STMicroelectronics, Italy

P3 (17) **Comparison Results of the Conducted and Radiated Measurements of a Radio Device Performed under Temperature Extreme Conditions**
Adam Jan Jeżak, Robert Borowiec
Wroclaw University of Science and Technology, Poland

Meetings

ME-12	MEETING	Time:	12:30 - 13:00

GREEN PROJECT MEETING

Chaired by:	**Frank Leferink**, University of Twente, The Netherlands
	Tetiana Serdiuk, Ukrainian State University of Science and Technologies, Ukraine
Room	**H**

ME-06	MEETING	Time:	13:00 - 14:30

NEPIT PROJECT KICK-OFF MEETING

Chaired by:	**Frank Leferink**, University of Twente, The Netherlands
Room	**H**

ME-07A	MEETING	Time:	14:30 - 15:50

"EMC EUROPE - INTERNATIONAL STEERING COMMITTEE MEETING" - PART 1

Chaired by:	**Ferran Silva,** UPC, Spain
	Ramiro Serra, Eindhoven University of Technology, The Netherlands
Room	**H**

ME-07B	MEETING	Time:	16:20 - 17:40

"EMC EUROPE - INTERNATIONAL STEERING COMMITTEE MEETING" - PART 2

Chaired by:	**Ferran Silva,** UPC, Spain
	Ramiro Serra, Eindhoven University of Technology, The Netherlands
Room	**H**

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Friday, 8th September 2023 – Workshops and Tutorials

Friday, September 8, 2023								
Room A	Room B	Room C	Room D	Room E	Room G	Room H	Room I
120	100	100	90	90	25	30	50

Room No.
Capacity (persons)

Time	Room A	Room B	Room C	Room D	Room E	Room G	Room H	Room I
09:00–10:00	**WS-16A: EMC MARATHON - Workshop: "Automotive EMC"** - Part 1 by Marco Klingler (Stellantis) & Xinglong Wu (Politecnico di Milano)	**TU-02A: EMC MARATHON -Tutorial: "Why are radiated Emission/Immunity EMC-Tests so tricky?"** - Part 1a by Diethard Hansen (EURO EMC SERVICE)	**WS-17A: EMC MARATHON - Workshop: "How to solve EMC immunity problems in practice – An experimental workshop"** - Part 1 by Sven König (Langer EMV-Technik)	**WS-19: EMC MARATHON - Workshop: "Near Field Scanning Techniques"** by David Pommerenke (Graz University of Technology)	**TU-06: EMC MARATHON - Tutorial: "Requirements for Protection Against Surges and Lightning Discharges of Photovoltaic Power Plants"** by Miroslaw Zielenkiewicz (RST sp. z o.o.)		**WS-22A: EMC MARATHON - Workshop: "Conducted and radiated emission analysis of an Inverter"** - Part 1 by Dassault Systèmes (WS-13 replay) Advance registration required	**TU-05A: EMC MARATHON -Tutorial: "EMC of Electrification with Ansys"** - part 1 Dr. Flavio Calvano (ANSYS Italy)
10:30	COFFEE BREAK							
11:00–12:00	**WS-16B: EMC MARATHON - Workshop: "Automotive EMC"** - Part 2 by Marco Klingler (Stellantis) & Xinglong Wu (Politecnico di Milano)	**TU-02B: EMC MARATHON -Tutorial: "Why are radiated Emission/Immunity EMC-Tests so tricky?"** - Part 1b by Diethard Hansen (EURO EMC SERVICE)	**WS-17B: EMC MARATHON - Workshop: "How to solve EMC immunity problems in practice – An experimental workshop"** - Part 2 by Sven König (Langer EMV-Technik)	**WS-20: EMC MARATHON - Workshop: "Design Issues and Considerations when Planning a Shielded Chamber"** by Paul Duxbury (MVG Industries UK Ltd)	**TU-07: EMC MARATHON - Tutorial: "Electromagnetic Compatibility of Mountain Ropeways in a Lightning Environment"** by Miroslaw Zielenkiewicz (RST sp. z o.o.)	**WS-24: EMC MARATHON - Workshop: „Robust & Resilient PNT - Vulnerabilities of GNSS Signals to RF Jamming and Spoofing"** by Peter Wollmann (Spirent Communications)	**WS-22B: EMC MARATHON - Workshop: "Conducted and radiated emission analysis of an Inverter"** - Part 2 by Dassault Systèmes (WS-13 replay) Advance registration required	**TU-05B: EMC MARATHON -Tutorial: "EMC of Electrification with Ansys"** - part 2 Dr. Flavio Calvano (ANSYS Italy)
12:30–14:00	LUNCH							
14:30–15:40	**WS-16C: EMC MARATHON - Workshop: "Automotive EMC"** - Part 3 by Marco Klingler (Stellantis) & Xinglong Wu (Politecnico di Milano)	**TU-02C: EMC MARATHON -Tutorial: "Why are radiated Emission/Immunity EMC-Tests so tricky?"** - Part 2a by Diethard Hansen (EURO EMC SERVICE)	**TU-03A: EMC MARATHON - Tutorial: "Hennel.jl: Plasma modeling using Particle-in-Cell and Monte Carlo Collisions"** - Part 1 by Jan Sroka (Warsaw University of Technology)	**TU-04: EMC MARATHON -Tutorial: "Spread Spectrum Techniques to Reduce Electromagnetic Emission"** by Bernd Deutschmann (Graz University of Technology)	**WS-21: EMC MARATHON - Workshop: "Practical use of near-field scanning to troubleshoot electromagnetic interference of devices"** - by Zenon Furgala (Tespol) & Adam Linkowski (Pendulum-Instruments)	**WS-25: EMC MARATHON - Workshop: „Next Generation Controlled Reception Pattern Antenna (CRPA) Testing"** by Peter Wollmann (Spirent Communications)	**WS-22C: EMC MARATHON - Workshop: "EMC Simulations of an Inverter"** - Part 3 by Dassault Systèmes (WS-13 replay) Advance registration required	**WS-23: EMC MARATHON - Workshop: "How to route signals on PCB? High-frequency content in digital and analog signals. SI and EMC for hardware designers (layout PCB)"** by Tomasz Utkowski
16:00	COFFEE BREAK							
16:30–18:00	**WS-16D: EMC MARATHON - Workshop: "Automotive EMC"** - Part 4 by Marco Klingler (Stellantis) & Xinglong Wu (Politecnico di Milano)	**TU-02A: EMC MARATHON -Tutorial: "Why are radiated Emission/Immunity EMC-Tests so tricky?"** - Part 2b by Diethard Hansen (EURO EMC SERVICE)	**WS-03B: EMC MARATHON - Tutorial: "Hennel.jl: Plasma modeling using Particle-in-Cell and Monte Carlo Collisions"** - Part 2 by Jan Sroka (Warsaw University of Technology)					

Tutorials

TU-02A-D	TUTORIAL	Time: 9:00 - 18:00

EMC MARATHON - TUTORIAL: "WHY ARE RADIATED EMISSION/IMMUNITY EMC-TESTS SO TRICKY?"

Chaired by:	**Diethard Hansen**, Euro EMC Service (EES) Dr. Hansen Consulting, Switzerland
Room	**B**

Speakers: Diethard E. A. Hansen

Abstract: This interconnected (Part A,B -basics,C-D-advanced) WS is based on, and vastly expanded from, the two previous successful EMV-Mesago WSs on Basics and Advanced: Understanding EMC/Radio/Automotive Standards-EM-Field related Testing - Norm update. The new WS covers basically all international relevant developments (technical/ scientific), predominantly within the last dynamic 10 years, with game changing technologies.

For more details please see on website conference agenda section session abstract

Structure/Content of Part 1-- **Basics**:

1. Why EMC? Physics and important EMC Background Info
2. Defining Scope and Exclusions (EMF, HPM, Military)
3. Risks (Compromises / Deficiencies in Standard!)
4. Regulations/Standards Basics

   - Driving Regulatory Product Compliance Forces (CE-Marking):
     - o EU Blue-Guide 2016, EMC-D2014/30/EU, Radio Equipment-D
     - o 2014/53/EU (latest Guide Dec.-19- 2018)
     - o automotive UNECR Regulation R10, Nov 2019 Rev.6 (e.g., Marking, Vehicle, ESA)
   - Product/Generic/Basic Standards
   - Normative References in Standards (Basic Standards => Test Methods)
   - EM-Field Test Scenarios (1/3/5/10/30m)
5. EMC Basics

Structure/Content of Part 2 --**Advanced**:

1. EMC Antenna Calibration
2. Characteristics of additional Auxiliary Testing Devices (TEM Devices, EM-Field Sensors)
3. Radiated Emission Test Sites/Facilities, Validation
4. Radiated Immunity Test Sites/Facilities, Validation
5. Testing in accredited/non accredited Labs (EN 17025- (2017) Quality, MU, Pass/Fail)
6. Using internal or external (EMC) Services
7. Lab Design (New EMC Test Center?): Planning, Quotation, Contract, Installation, Acceptance Test, Accreditation

TU-05A-B   TUTORIAL   Time: 9:00 - 12:30

EMC MARATHON - TUTORIAL: "EMC OF ELECTRIFICATION WITH ANSYS"

Chaired by:	**Flavio Calvano**, Ansys Italy, Italy
Room	**I** (1st floor)

Speakers: Flavio Calvano, Antonio Camarda, Karol Zimolag, Marek Szymczak, Mateusz Będkowski

Abstract: The world of power electronics is transitioning from silicon to wide-bandgap semi-conductors such as silicon carbide (SiC) due to their superior performance in automotive and industrial applications. SiC enable smaller, faster, and more efficient design, but produce high level electromagnetic interference (EMI) which generates conducted and radiated emissions. The noise on the battery and motor cables or busbars can radiate and disturb the control units and antenna placed on the vehicle, in addition internal couplings can be dangerous for functional behavior of the complete EPowertrain system. This tutorial presents a complete simulation approach, formulated to be optimal in terms of accuracy and speed for each inverter main component. The virtual simulation approach is proposed at the design stage of each component, and at system level in the final validation and homologation to save time for EMI testing; the Common Mode Chokes (CMC) and EMI filters design is helping EMC engineers to get lower emissions.

TU-06   TUTORIAL   Time: 9:00 - 10:30

EMC MARATHON - TUTORIAL: "REQUIREMENTS FOR PROTECTION AGAINST SURGES AND LIGHTNING DISCHARGES OF PHOTOVOLTAIC POWER PLANTS"

Chaired by: **Mirosław Zielenkiewicz**, RST sp z o.o., Poland

Room **E**

Speakers: Mirosław Zielenkiewicz

Abstract: It is becoming more and more common to use the energy generated by photovoltaic power plants to power facilities equipped with microprocessor electronic systems. Therefore, there are new threats to ensuring the proper level of electromagnetic compatibility of this type of power supply systems. The obvious necessity to locate photovoltaic panels in spaces that are not shielded from atmospheric influences is associated with the special need to ensure an appropriate level of electromagnetic compatibility of PV power plants in a lightning environment (in the technical literature you can find data that 32% of damage to PV panels is caused by atmospheric discharges). Due to the specificity of the lightning impact, it is of particular importance not only for the proper and uninterrupted operation of such powered systems, but also for preventive fire protection of the entire facility where the photovoltaic power plant is located.

Requirements relating to the protection of PV power plants against lightning electromagnetic disturbances vary depending on the size of the area they occupy and their location. Due to the obvious fact that a PV installation mounted on a building must be located on the external planes of its roof or side elevations, it is necessary to determine each time whether its protection against direct lightning discharges is needed in a given case. On the other hand, PV power plants located in open areas usually occupy a large area and hence the risk of a direct lightning discharge in their territory increases. At the same time, the risk of indirect electromagnetic impact of the lightning channel current on the electrical circuits of such power plants also increases.

Uncontrolled penetration of part of the lightning discharge energy into the PV installation may result not only in extensive damage the surface of the PV modules as a result of the direct impact of the lightning discharge and the electronics of the inverters, also as a result of the influence of induced overvoltages of lightning origin, but it can also lead to dangerous sparking causing a fire. This may be the result of flashovers of a part of the lightning current flowing from the lightning down conductor system to the earth electrode to improperly separated (isolated) elements of the PV installation. The risk of fire also applies to a situation in which lightning current penetrates the PV modules and PV system circuits through cabling or equipment housing, causing secondary local overheating of internal electrical or electronic components.

With today's knowledge, a properly designed and constructed lightning protection device (LPS) allows to achieve a very high level of certainty of safe operation of the PV installations protected by it, even in the event of a direct lightning discharge.

This tutorial discusses issues related to:
- lightning hazard of PV power plants installed on building structures and isolated power plants located on the ground surface,
- assessment of the lightning hazard, dimensioning of protection zones and selection of lightning and surge protection measures at the initial stage of PV installation design work and their coordination with the building construction design and the power supply installation design,
- the need to consider the influence of direct lightning discharges and the indirect impact of nearby discharges.

TU-07   TUTORIAL   Time: 11:00 - 12:30

EMC MARATHON - TUTORIAL: "ELECTROMAGNETIC COMPATIBILITY OF MOUNTAIN ROPEWAYS IN A LIGHTNING ENVIRONMENT"

Chaired by: **Mirosław Zielenkiewicz**, RST sp z o.o., Poland

Room   **E**

Speakers: Mirosław Zielenkiewicz

Abstract: The purpose of this tutorial is to present the method of assessing the lightning hazard of mountain cableways and the selection of protective measures based on the results of this assessment in relation to station buildings, an overhead passenger transport line and people (passengers and tourists in the vicinity of station buildings). The cableway is treated as an extensive building structure, therefore the guidelines contained in the series of lightning protection standards IEC/EN 62305 are the appropriate tool for analyzing the resistance of such objects.

The subject of detailed considerations are the risks resulting from the impact of direct and nearby lightning on mountain cableways for all existing installations: both the supporting structure of the overhead cableway and each of the stations (lower, upper and intermediate - if any). They have a direct impact on the overvoltage and lightning hazard of the cableway. It is necessary to disclose all possible ways of overvoltage penetration into these facilities and to carry out an analysis of the compliance of the currently existing protection measures with the requirements of current standards and regulations regarding the electromagnetic compatibility of cableway equipment and systems in the presence of nearby lightning discharges and the resistance of the structure of the railway transport line and its station buildings to direct lightning discharges.

On the example of an existing overhead circular monocable railway facility, the results of a practical assessment of the effectiveness of locally applied lightning and surge protection measures and the degree of their actual adaptation to the requirements of current EMC and lightning protection standards will also be presented. Existing threats revealed during this assessment will be demonstrated, both in relation to the safety of people and in relation to the systems of technical devices.

TU-03A-B   TUTORIAL

Time: 14:30 - 18:00

EMC Marathon - Tutorial: "Hennel.jl: Plasma modeling using Particle-in-Cell and Monte Carlo Collisions

Chaired by: **Jan Sroka**, Warsaw University of Technology, Poland

Room **C**

Speakers: Bartosz Chaber, Wiktor Łodyga

Abstract: We present our software package for solving electromagnetic problems involving interaction between plasma and electromagnetic field. This tutorial covers four problems: two-stream instability, Klystron cavity, the first Townsend coefficient calculation, and radio frequency discharge in Helium gas. The Particle-in-Cell and Monte Carlo Collisions algorithms are used for the problem solutions. The chemical reactions of the particle interaction utilize available data from real-life measurements. The modeling and computations are done using Hennel.jl – an original novel tool for automatic solver code generation written in Julia programming language. The presentations cover all the steps of the problem-solving process: the problem definition (description of available domains, geometries, boundary conditions, excitations, and more), the solver code generation (description of generation process, problem discretization, performance implications, discussion on advantage of custom generated code for specific problem) and computing the solution using the generated solver. Hennel.jl is a tool allowing people with knowledge about modeling physical phenomena to get the optimized, fast solver tailored to their particular problem without needing advanced programming skills and knowledge. The presentations also cover the topic of parallelization and GPU (CUDA) deployment of Particle-in-Cell and Monte Carlo Collisions implementations.

TU-04   TUTORIAL   Time: 14:30 - 16:00

EMC MARATHON - TUTORIAL: "SPREAD SPECTRUM TECHNIQUES TO REDUCE ELECTROMAGNETIC EMISSION"

Chaired by:	**Bernd Deutschmann**, Graz University of Technology, Austria
Room	**D**

Speakers: Bernd Deutschmann

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.

Workshops

WS-16A-D WORKSHOP	Time: 9:00 - 18:00

EMC Marathon - Workshop: "Automotive EMC"

Chaired by:	**Marco Klingler**, Stellantis, France
	Xinglong Wu, Politecnico di Milano, Italy
Room	**A**

Speakers: Marco Klingler, Xinglong Wu, Jan Hansen, Andreas Barchanski, Helin Zhou, Alessandra Manzitto, Alexander Demurov, Oussama Sassi, Tommaso Campi, Martin Aidam, Abhishek Ramanujan, Umberto Paoletti

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 and academic 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, sub-system, equipment, and component levels. In particular, topics addressed by the speakers will include hybrid power-train systems EMC analysis, antenna implementation, equipment design, advanced testing techniques, printed-circuit-board optimization, and electric/electronic component characterization.

Programme:

9:00   **On The Use of Machine Learning for Quantitative and Qualitative Applications in EMC Design**
Marco Klingler, Enzo Morais
Stellantis, France

9:30   **Using Machine-Learned Models for EMC Optimization**
Jan Hansen
Graz University of Technology, Austria

10:00   **Concurrent Shielding Effectiveness and Thermal Simulations**
Andreas Barchanski, Marcel Plonka, Richard Sjiariel
Dassault Systems, Germany

11:00   **A new Electromagnetic modeling approach for SiC based traction inverters power modules**
Andrea Cusumano[1], Debora Crimi[1], Alessandra Manzitto[1], Ludovica Longo[1], Flavio Calvano[2]
[1]STMicroelectronics, Italy; [2]Ansys, Italy

11:30   **Compliance of automotive WPT systems with EMC, EMF and CIED standards**
Tommaso Campi[1], S. Cruciani[2], F. Maradei[3], M. Feliziani[1]
[1]University of L'Aquila, L'Aquila, Italy, [2]Tor Vergata University of Rome, Rome, Italy, [3]Sapienza University of Rome, Rome, Italy

12:00   **CISPR36. Measurement or Simulation?**
Martin Aidam

Mercedes-Benz, Germany

14:30 **S-parameter measurements of electric machines and their application in EMC simulations**
Helin Zhou, David Håkansson, Shefeen Maliyakkal, Mattias Ingvarson
Volvo Car Corporation, Sweden

15:00 **Modeling of HV Components for Electrical Vehicles Based on CISPR-25 Conducted Emission Test**
Alexander Demurov[1,2], Anna Gheonjian[1,2], Badri Khvitia[1,2], Zviadi Kutchadze[1,2], Irina Oganezova[1,2], Roman Jobava[1,2]
[1]EMCoS, Georgia; [2]Tbilisi State University, Georgia

15:30 **Validation of the Fast calculation approach based on the Bio-savart law to calculate the radiated magnetic field from a cable above a ground plane**
Oussama Sassi
Volkswagen AG, Germany

16:30 **Test methods for the immunity evaluation of automotive electronics using near-field probes**
Xinglong Wu[1], Flavia Grassi[1], Giordano Spadacini[1], Sergio Pignari[1], Umberto Paoletti[2], Isao Hoda[2]
[1]Politecnico di Milano, Italy; [2]Hitachi, Japan

17:00 **Comprehending the variables and nuances in the Automotive Indirect ESD Testing method using Field Coupling Plane through 3D EM simulations**
Abhishek Ramanujan[1], Patrick DeRoy[1], David Johns[2]
[1]Analog Devices, Inc., [2]Dassault Simulia 3DS

17:30 **A set of time domain measurement techniques for broadband EM noise source identification**
Umberto Paoletti
HITACHI, Japan

WS-17A-B

WORKSHOP

Time: 9:00 - 12:30

EMC MARATHON - WORKSHOP: "HOW TO SOLVE EMC IMMUNITY PROBLEMS IN PRACTICE – AN EXPERIMENTAL WORKSHOP"

Chaired by:	**Sven König**, Langer EMV-Technik GmbH, Germany
Room	**C**

Speakers: Sven König

Abstract: Workshop structure:

- o EMC-Compliance test – Fail!
- o What to do when EMC requirements are not met
- o Disturbance influence in the electronics – Fundamentals of the physical mechanisms
- o Fault analysis in practice
- o Localization of the faults with near-fields
- o Modification of the weak spots
- o Peculiarities of ESD tests

In recent years, the interference immunity requirements in the development of devices and components have continued to increase. This is especially true when modern highly integrated ICs are used. The causes lie in the increasing integration density and smaller structure width of ICs, the higher processing speeds / clock frequencies and the rapidly increasing complexity of electronic products. In combination with very high-frequency interference processes such as an ESD discharge, electronics can react very sensitively.

If there is an immunity problem, an in-depth analysis of the entire electronics is often necessary. Increasingly large and complex projects, often with several nested electronic components (modular structure), make it more difficult to solve an EMC problem and take significantly more time. In addition, several serious immunity problems can coexist in these devices. These can overlap and are therefore even more difficult to localize. Modifications to individual components or a redesign of the entire electronics do not always lead to a significant improvement in the problem.

In the course of this workshop, various effects and consequences of interference immunity tests, such as burst, ESD and conducted as well as radiated HF coupling, will be demonstrated using a sample assembly. The module consists of a standard ARM Cortex-M microcontroller with various interfaces (SPI, UART, ...) and an expansion board. Furthermore, topics related to housing connection, connections between assemblies, interface design and layout recommendations are discussed using the practical example.

The EMC analysis of the electronics and the subsequent modification or redesign does not necessarily lead to the desired result. Often, despite these reworks, no improvements in the EMC tests come into effect. There is a widespread opinion that serious EMC problems can be solved with an improved layout of the electronics. In many situations, however, several new layout versions do not bring sufficient success. Effective EMC measures can be, for example, design changes, which result in changes to expensive tools that have already been developed. The larger and more complex the projects become and the more electronic components are interconnected, the more difficult and lengthy the EMC solution be-

comes.

What are the causes?

The basis for the successful implementation of an innovation is the engineering approach in the development process. This requires theoretical and practical development tools. The basic coherences for EMC development are often missing or experience from other projects is referred to, which does not always make sense ("... we always do it that way."). There is little information about the behavior of relevant components, such as connectors and ICs, during an EMC test. As a result, no dimensioning process is possible as part of an EMC development. These components are designed into developments without suspecting the catastrophes they will trigger during the EMC test of the first device.

Focus:

- o Basics of interference immunity
- o Analysis of the various test methods and how they affect the electronics
- o Disturbances and their generated fields
- o Layout and design guidelines

Then the methodical procedure for the EMC problem analysis is explained and solution strategies are shown. This includes:

- o Procedure for locating the problem areas on the electronics
- o Avoiding sources of error when setting up the test
- o Hints on interference suppression measures
- o Insights into avoiding problems during development

WS-19

WORKSHOP

Time: 9:00 - 10:30

EMC MARATHON - WORKSHOP: "NEAR FIELD SCANNING TECHNIQUES"

Chaired by: **David Pommerenke,** Graz University of Technology, Austria

Room **D**

Speakers: David Pommeranke

Abstract: The workshop introduces near field scanning techniques for both immunity and emissions and critically analyzes their abilities and limitations. The following techniques will be discussed:

- o Near Field Scanning:
- o Settings such as probes, time needed, resolution, sensitivity, scanning strategies

Data processing of near field data such as A vs. B, synchronized scanning, near to far field transformation

Emission Source Microscopy (ESM), this is a method similar to near field scanning, but it ONLY shows the radiating sources and suppresses the none radiating near field:

- o Mathematical base of ESM
- o Phase measurement in scanning
- o Ability and Limit of ESM
- o Processing such as masking, radiation pattern
- o Related holographic methods

RF susceptibility scanning, here a local probe injects an RF signal locally and the system response is observed. This is useful for finding the root cause of RF Immunity failures.

- o Implementation
- o Ability and Limits

ESD susceptibility scanning, here, locally pulsed signals having < 500ps risetime are injected mostly via field coupling and the system response is observed. This is for the root cause analysis of ESD induced soft failures in electronic system.

- o Implementation
- o Ability and Limits

Finally, the workshop will discuss aspects in which scanning can and should be improved.

WS-20

WORKSHOP

Time: 11:00 - 12:30

EMC MARATHON - WORKSHOP: "DESIGN ISSUES AND CONSIDERATIONS WHEN PLANNING A SHIELDED CHAMBER"

Chaired by: **Paul Duxbury**, MVG Industries UK Ltd, United Kingdom

Room **D**

Speakers: Paul Duxbury

Abstract: When you are looking to install a shielded chamber, there are several aspects which you need to take into account, depending on what the chamber will be used for, and the size of the chamber. During this presentation we will review some of these, and provide some guidance on the areas which you, as the user of the chamber, need to consider when starting to plan the installation of a new chamber. We will also consider areas which we, as the chamber supplier, can assist with, and provide design input on for you. While focusing on larger EMC chambers, this presentation will also be relevant for smaller chambers, shielded rooms or anechoic chambers, and whether for EMC, antenna, RF or microwave applications.

WS-21

WORKSHOP

Time: 14:30 - 16:00

EMC MARATHON - WORKSHOP: "PRACTICAL USE OF NEAR-FIELD SCANNING TO TROUBLESHOOT ELECTROMAGNETIC INTERFERENCE OF DEVICES"

Chaired by:	**Adam Linkowski**, Pendulum-Instruments, Poland
	Zenon Furgała, Tespol, Polan
Room	**E**

Speakers: Adam Linkowski, Zenon Furgała

Abstract: Topics covered at the workshop:

1. EMC - Measurements methods
2. Graph – possibilities of modification vs. costs
3. Simple rules
4. Practical measurements – live
5. Practical examples of our measurements
6. Case study
7. Information about equipment used for the measurements.
8. Summary
9. Questions & Answers

WS-22A-C   WORKSHOP   Time: 9:00 - 16:00

EMC MARATHON - WORKSHOP: "CONDUCTED AND RADIATED EMISSION ANALYSIS OF AN INVERTER"

Chaired by: **Andreas Barchanski**, Dassault Systems, Germany

Room **H**

Speakers:

Abstract: Starting with a simplified SPICE model for conducted emission, we demonstrate the estimation of parasitic couplings using simulations of the real 3D inverter and their impact on the emission spectrum. In the next step a full 3D conducted emission simulation of the inverter-motor system will be presented. To understand how to best represent and model the various components, common- and differential mode according to CISPR are compared and practical recommendations are given for different purposes such as optimization of filter components or integrational aspects into e.g. an EV Vehicle. Later cabelling effects will be studied in detail to understand how the real cable and it´s routing effect both the conducted emission and/or may also cause problems with radiated emission.

It is the second edition of the workshop WS-13, which was scheduled on Monday, September 4, 2023.

Programme:

9:00 Part 1: EMC Simulation: How to mimic the real world
We start this Marathon by giving an overview on how we can solve real systems and duplicate measurements virtually on appropiate levels and what methods support us in this activity. This includes an overview on what principle types of models, such as a functional model, schematic model or full 3D model, are available with their respective benifit and limitation. Also how to translate a given complex system into a combination of those models for the different sub-systems.
This includes an overview of general tools and methods to perform e.g. wide sweeps rapidely and specialist tools for detailed analysis of e.g. PCBs, cables, SI or PI.

11:00 Part 2: Conducted emissions analysis of an Inverter
Starting with a simplified SPICE model for conducted emission, we demonstrate the estimation of parasitic couplings using simulations of the real 3D inverter and their impact on the emission spectrum. In the next step a full 3D conducted emission simulation of the inverter-motor system will be presented.
To understand how to best represent and model the various components, common- and differential mode according to CISPR are compared and practical recommendations are given for different purposes such as optimisation of filter components or integrational aspects into e.g. an EV Vehicle.

14:30 Part 3: Radiated emissions from an Inverter - motor system
This workshop details a radiated emissions analysis, focusing on effects related to the AC cables connecting the inverter to the motor. We start by giving a state of the overview of the different options of cable analysis and what we can do with it such as extraction of cable parameters, crosstalk or radiated emission. Then a functional inverter - motor model for conducted emission is refined with cables to study effects related to it´s length and routing. We end with an integrational scenario where we can see and compare the performance in it´s final position with other electrical components present.
Throughout this scenario we use relevant quantities according to CISPR and give practical recommendation to understand what type of complexity is necessary in the individual steps.

WS-23   WORKSHOP   Time: 14:30 - 16:00

EMC MARATHON - WORKSHOP: "HOW TO ROUTE SIGNALS ON PCB? HIGH-FREQUENCY CONTENT IN DIGITAL AND ANALOG SIGNALS. SI AND EMC FOR HARDWARE DESIGNERS (LAYOUT PCB)"

Chaired by: **Tomasz Utkowski**, EMC For Business

Room   **I**

Speakers: Tomasz Utkowski

Abstract: The most essential thing in PCB design for high freq. Signals.

Understand how the current flow in PCB – AC/DC/HF

Knows Analog and Digital Signals spectrum

In the Frequency and time domain issues

What is Impedance, Coupling, Decoupling

How Grounding, Slot, Via, Power plane affects signals.

Crosstalks and emission problems. Signal integrity.

Workshop with use of a spectrum analyzer and a scope with exemplar PCBs. Different structures and layouts on PCBs will be measured.

WS-24   WORKSHOP

EMC MARATHON - WORKSHOP: "ROBUST & RESILIENT PNT - VULNERABILITIES OF GNSS SIGNALS TO RF JAMMING AND SPOOFING"

Chaired by:	**Peter Wollmann**, Spirent Communications, Germany
Room	**G**

Speakers: Andrew Hart, Peter Wollmann

Abstract: As more and more systems come to rely on accurate positioning, the threat of GNSS to jamming and spoofing is growing significantly. Understanding how jamming and spoofing affects systems and the methodologies available to help mitigate that threat is extremely important for developers of safety- and mission-critical systems.

WS-25 WORKSHOP

Time: 14:30 - 16:00

EMC MARATHON - WORKSHOP: "NEXT GENERATION CONTROLLED RECEPTION PATTERN ANTENNA (CRPA) TESTING"

Chaired by: **Peter Wollmann**, Spirent Communications, Germany

Room **G**

Speakers: Ricardo Verdeguer Moreno, Graeme Hooper, Peter Wollmann

Abstract: RF interference and spoofing are growing threats to safety and liability-critical PNT systems, which can be partially mitigated through the use of adaptive antenna technologies.

The increasing use of adaptive antennas for commercial and military use will see a growing number of models being developed in the coming years for different industry markets. But testing CRPA antennas presents unique and sometimes very complex challenges.

The work shop describes the principles of an CRPA antenna and explains different test methods and challenges to help developers, integrators and buyers of adaptive antenna-based systems to address those challenges, with a comprehensive suite of solutions and services.

Exhibition

Exhibition booths are presented in room I, J, G and T (tent). From 9:00 to 17:00 on September 5 – 7, 2023 you are invited to attend the exhibiting companies.

Exhibitor List

Exhibitor	*Booth no*
Advanced Test Equipment Corp	T22
AM Technologies Sp. z o.o. Sp. k.	T13
Amber Precision Instruments	T11
Ametek CTS	I3
Ansys / Symkom Sp. z o.o.	T7
AP-FLYER Sp. z o.o.	T25 & T26
ASTAT Sp. z o.o	J11 – J15
Centrum Techniki Morskiej S.A.	J17
Cergen GmbH	T5
Changzhou Pioneer Electronic Co.,Ltd	J9
Dacpol Sp. z o.o./ Langer EMV - Technik	T9 & T10
Dassault Systems / Tespol Sp. z o. o.	T3 & T4
Dovitech GmbH	J4
EMC-FORTO	I1
EMCoS LLC	T14 & T15
ETS-Lindgren	I4 & I5
Eurotempest BV	J5 & J6
Frankonia EMC Test-Systems GmbH	J7
Freicomp GmbH	J3
Haefely AG	T23
HYMAG'IN	J20
IEEE EMC Society	T24
Kemet Electronics GmbH	T18 & T19
Kitagawa GmbH	J16
Lumiloop GmbH	J18
Łukasiewicz – Poznań Institute of Technology Microwave Vision Group (MVG)	T12
Narda Safety Test Solutions S.R.L.	J8
NOKIA	J1 & J2
	Room G

Oak-Mitsui Technologies	J21
Pendulum Instruments Sp. z o. o.	T21
Rohde & Schwarz	T16-17, T20
Solar	I6
Shieldex Statex Produktions - und Vertriebs	T8
GmbH Tektronix	T27 & T28
Teseq	I2
Tianjin Deviser Electronics Instrument Co.,	
Ltd. Wave-Test Sp. z o.o.	T1 & T2
Würth Elektronik	J19
	T6

Exhibitor Information

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Microwave Vision Group (MVG)
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www.mvg-world.com

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Wave-Test Sp. z o.o.
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http://www.wave-test.pl/

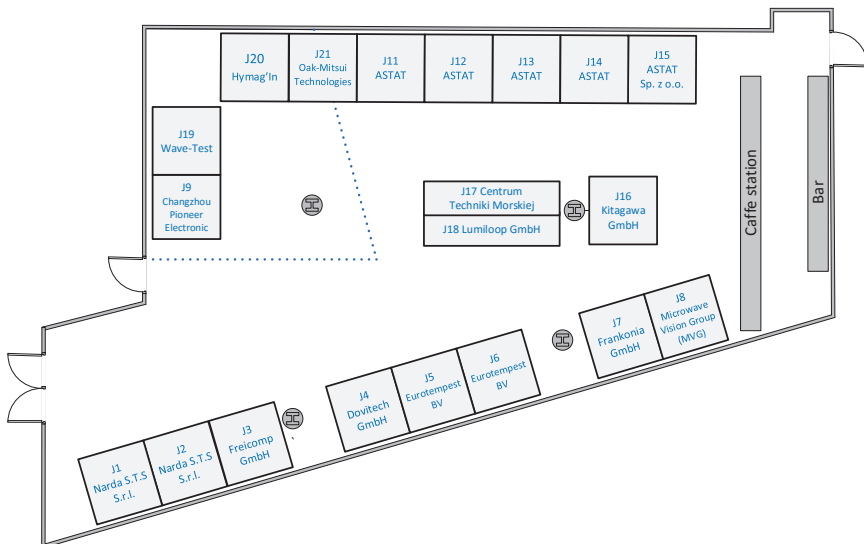Würth Elektronik
eiSos-poland@we-online.com
www.we-online.com

Venue plans and Technical exhibition plans
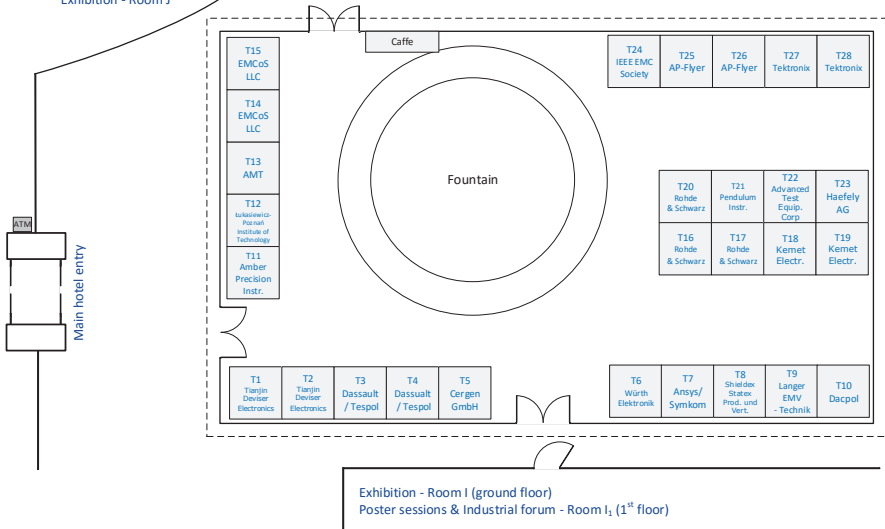
EMC Europe 2023 Kraków

Exhibition Plan
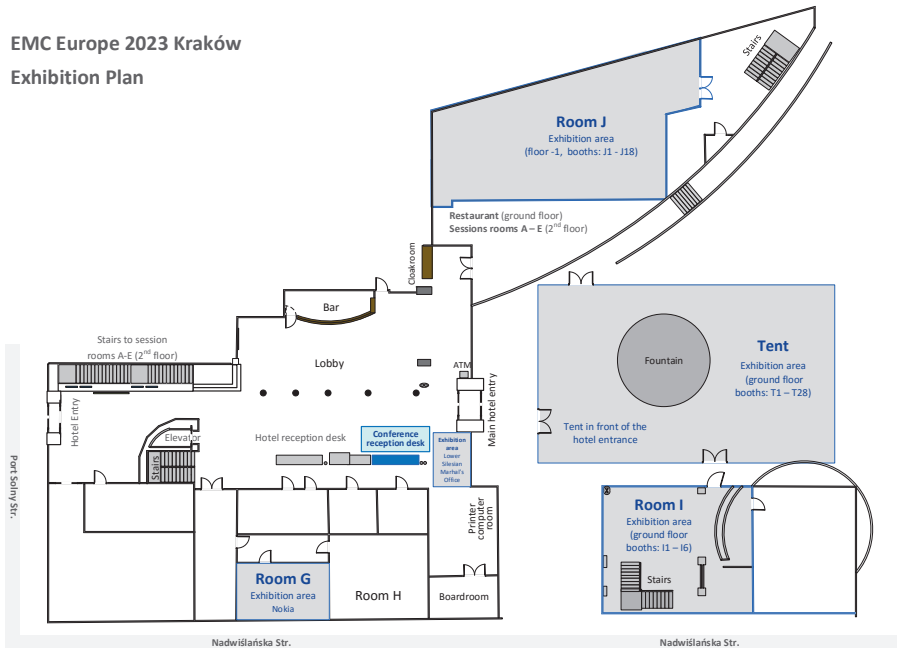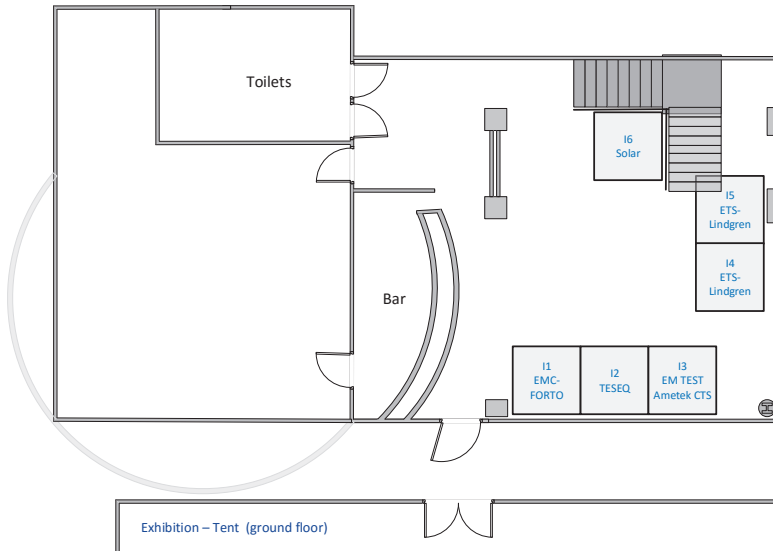

Room J (Jazz room, floor -1, booths J1 – J21)

Room T (ground floor, booths: T1 – T28)

Conference rooms A - E
Restaurant
Exhibition - Room J

ATM

Main hotel entry

Caffe

Fountain

Booth	Name
T15	EMCoS LLC
T14	EMCoS LLC
T13	AMT
T12	Łukasiewicz-Poznań Institute of Technology
T11	Amber Precision Instr.

T24	T25	T26	T27	T28
IEEE EMC Society	AP-Flyer	AP-Flyer	Tektronix	Tektronix

T20	T21	T22	T23
Rohde & Schwarz	Pendulum Instr.	Advanced Test Equip. Corp	Haefely AG
T16 Rohde & Schwarz	T17 Rohde & Schwarz	T18 Kemet Electr.	T19 Kemet Electr.

T1	T2	T3	T4	T5
Tianjin Deviser Electronics	Tianjin Deviser Electronics	Dassault / Tespol	Dassualt / Tespol	Cergen GmbH

T6	T7	T8	T9	T10
Würth Elektronik	Ansys/ Symkom	Shieldex Statex Prod. und Vert.	Langer EMV - Technik	Dacpol

Exhibition - Room I (ground floor)
Poster sessions & Industrial forum - Room I₁ (1st floor)

Room I (Club room, ground floor, booths: I1 – I6)

Toilets

Bar

I6 Solar

I5 ETS-Lindgren

I4 ETS-Lindgren

I1	I2	I3
EMC-FORTO	TESEQ	EM TEST Ametek CTS

Exhibition – Tent (ground floor)

Blueferrite.com

Experience
Blue Magic!

Contact:

We have a worldwide presence

The Blueferrite Nanocrystalline Cores can be bought through our ever-expanding distributor and Sales Network.

We can deliver to any country in the world and specialized distributors are based in Germany, United States, Sweden, Denmark, Finland, India and Italy. In case the country of your choice is not listed, please contact the team in Germany.

Please visit blueferrite.com/contact for more details

The Blueferrite Cores are easy to Install

EASY TO INSTALL

Installation Example – Solar Application

Blueferrite Cores for Common Mode Noise absorption

Blueferrite Cores for Differential Mode Noise absorption

Solar Panels

DC

Inverter

AC

Grid

Correct Installation

Incorrect Installation
GND and shielding should Not go through cores.

Notes

Notes

Notes

Notes

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