CONFERENCE PROGRAM

HYBRID CONFERENCE

APEMC

APEMC2021
BALI-INDONESIA

Asia Pacific International Symposium on Electromagnetic Compatibility

APEMC 2021

27 - 30 September 2021

Organized by :

BRIN · UNIVERSITY OF TWENTE. · BSN BADAN STANDARDISASI NASIONAL

Technical co-sponsor :

EMC SOCIETY · IEEE · EMC EUROPE

2021 Asia-Pacific International Symposium on Electromagnetic Compatibility
(APEMC 2021)
September 27th – 30th , 2021
in Bali, Indonesia

ORGANIZED BY

BRIN LIPI BPPT ITS UNIVERSITY OF TWENTE.

TECHNICAL CO-SPONSORS

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LOC CHAIRMAN'S MESSAGE

Welcome from the Chairman of Local Organizing Committee APEMC 2021

Dear Participants, Honourable Guests,

This year, Indonesia is a host for the such prestigious event, the 2021 Asia Pacific International Symposium on Electromagnetic Compatibility 2021 (APEMC 2021).
This symposium initially will be organized fully on-site in Bali, Indonesia on May 2021. Unfortunately, there is covid-19 outbreaks spreading all over the world. Then it has been shifted to September 2021.
It's been 1.5 year since the first covid-19 plague, however this pandemic has no end yet, at least until this month when the APEMC 2021 is organized. So then sadly, I have to decide the conference runs by hybrid method to accommodate more than 90% participant who are not be able to attend onsite.
By the time this program book is created, the restriction for foreigner still applied by Indonesian government and the impact is foreign participant has to be present online. We apologize for these circumstances which are out of our control. However, the conference has to go on. Although most of us couldn't meet in-person but hopefully, this not forbid us to have a nice conference, discuss, share experience and broader collaboration.

It is a great honor and pleasure for me to welcome all of you in our beloved beautiful island of Indonesia, 'BALI ISLAND', although virtually.
I also would like to highly gratitude and appreciate to all LoC members, Technical Program Committee (TPC) members, participants, and sponsors who have supported this symposium.
Last but not least, I truly hope in the near future, Bali can be one of the options to host this event again, so we could serve all of you to enjoy the culture and nature of Bali.

Bali, 27 September 2021

With warmest regards,
LoC Chair of APEMC 2021,

Dwi Mandaris Ph.D

TPC CHAIR GENERAL REPORT

Prof. dr. ir. Frank B. J. Leferink
IEEE Fellow Frank Leferink has been with THALES in the Netherlands since 1984, where he is responsible for the EMC activities for the development of new radar systems and naval platforms. He is also manager of the Network of Excellence for EMC of the THALES group.
THALES is sponsoring his part-time, full-research, professor position at the University of Twente, where Frank is holding the Chair for EMC. Twenty-two PhD researchers, two assistant-professors and several master students are currently active in the EMC group.
Frank is member of the Board of Directors of the IEEE EMC Society and associate editor of the IEEE Transactions on EMC and the new IEEE Letters on EMC Practice and Applications.

Dear authors, attendees, organisers, sponsors,

On behalf of the Technical Program Committee, I am delighted and privileged to welcome you to the Asia-Pacific EMC conference.
The 2021 APEMC conference attracted 203 papers and 20 workshops/tutorials. From the 203 papers, 151 will be published in the final program, which means an acceptance ratio of around 74%. Most of the papers will be introduced remotely via pre-recorded videopresentations. The highest number of authors, 430, is from Asia-Pacific, while 232 authors are from Europe, 21 authors are from the United States, 9 Middle-East and Africa while 2 authors are from South-America. The countries which generated the highest number of papers is China, followed by Japan, Taiwan, the Netherlands, Indonesa, Singapore, Poland and Germany.
I would like to thank the Technical Program Committee members for their commitment in finding good reviewers and make sure the review process is fair, but correct, and on-time. Furthermore, I would like to thank the reviewers for reading the papers, grading them, and give useful advice to the authors for improving the paper. TC02, EMC Measurements and EM Environment, attracted again the highest number of papers, followed by TC-08, Smart Grid and Low Frequency EMC. Special Session organisers Yuichi Hayashi & William Radasky received the highest number of papers for their session ‘Hardware security issue due to EM passive/active attacks on devices complying EMC standards’.
Due to the Covid-19 pandemic most of us cannot attend the conference in person, and I sincerely hope we will be able to meet eachother in person very soon.

Frank Leferink

WELCOME SPEECH

APEMC 2021 GENERAL CHAIR

Prof. Er-Ping Li

Li ERPING holds the appointment of Qiushi and Changjiang Chair Professor in Zhejiang University, China, Founding Dean for Zhejiang University- University of Illinois at Urbana-Champaign Institute (ZJU-UIUC Institute), Fellow of IEEE. He also holds the Founding Technical Director for a Startup Company where focuses on the development of 5G-Com system shielding technologies and products. Prof Li research interests include 5G communication antenna system EMI , chip level packaging and metasurface for advanced 5G Com and AI-IC electromagnetic integration. He is pioneering in 5G-Com IC and system shielding, holds number of patents in 5G com, many of his 5G research results have been implemented and commercialized.

Prof Li worked in UK and Singapore A*STAR Institute of High Performance Computing as a Principal Scientist, Department Director and Senior Director of A-STAR-IHPC, adjunct Professor at Singapore Nanyang Technological University. He authored or co-authored over 400 papers published in the referred international journals, authored two books published at John-Wiley Press (2012) and Cambridge University Press (2014). Dr Li is a Fellow of IEEE (2007), and a Fellow of MIT Electromagnetics Academy, USA. He received numerous international awards including the IEEE EMC Technical Achievement Award in 2006, IEEE EMC Richard Stoddard Award in 2015, and IEEE EMC Laurence Cumming Award in 2021. He is the Founding Chair for APEMC, served as General Chair and Technical Program Chair for more than 20 prestigious international conferences and delivered over 100 invited talks and plenary speeches at various international conferences and forums.

OPENING SPEECH

Chairman of National Research and Innovation Agency (BRIN), Republic of Indonesia
Dr. Ir. Laksana Tri Handoko, M.Sc

Laksana Tri Handoko

I'm just an ordinary scientist who is driven by scientific curiosity and unlimited passion to make invention in any topics of research conducted with my small groups.

My philosophy on science:
The main task of a scientist is NOT to develop a great science, but to generate invention in a scientific way, no matter how small or great it is. I do believe an invention would contribute to the human life although no one can mention (nor even knows) when, where and how it would be. The greatness of our work should NOT be the main purpose, since that is justified by anyone else, the domain of public audience and in some sense the matter of time. Secondly, I always let my wild mind to explore new possibilities across the fields as long as there is a possibility to discover new invention within my ability in an appropriate time frame.

Therefore, I put a lot of efforts to educate and supervise my students and group-mates through my research. Much more than the researches itself, I am proud very much of them, and wish all of them to be great scientists in the future ! That is the least claim I can make, and the only proof that I might already contribute little to my people.

Contact

Badan Riset dan Inovasi Nasional/
National Research and Innovation Agency
BJ Habibie Building, Jl. MH Thamrin No. 8,
Central Jakarta 10340

lthandoko@brin.go.id

Education

Bachelor – Physics	Master – Physics Program: Elementary Particle Theory	Doctor – Physics Program: Elementary Particle Theory
熊本大学 Kumamoto University	HIROSHIMA UNIVERSITY	HIROSHIMA UNIVERSITY

Bureaucratic Experience

- 2021 – present — Chairman of National Research and Innovation Agency
- 2018 - May 2021 — Chairman of Indonesian Institute of Sciences (LIPI)
- 2014 - 2018 — Deputy of Engineering Science, LIPI
- 2012 - 2014 — Head of Informatics Research Center, LIPI
- 2002 - 2012 — Head of Group for Theoretic Physics and Computational, Physics Research Center, LIPI

Academic Experience

- 2002 – present — **Lecturer** at the Department of Physics, **University of Indonesia**
- 2002 - 2004 — **Lecturer** at the Department of Physics, **Bogor Agricultural Institute**
- 2003 — Visiting researcher at **Yonsei University, Seoul**
- 2002 - present — **Researcher** at Physics Research Center, **LIPI**
- 2000 - 2000 — **Humboldt Fellow** at **DESY Theory Group, Hamburg**
- 1999 - 1999 — **Researcher** at **ICTP HEP Group, Trieste**
- 1998 - — **Researcher** at **ICTP HEP Group, Trieste**
- 1997 — **Researcher** at the **Theory Group of KEK, Tsukuba**

Professional Organization

- Theoretical Physics Group of Indonesia (GFTI)
- Indonesian Physical Society (HFI)
- Indonesian Computational Society (MKI)
- Indonesia Researcher Association (HIMPENINDO)
- American Physical Society (APS)
- Institute of Electrical and Electronics Engineers – Senior Member (IEEE)
- Japan Physical Society (JPS)
- Japan Theoretical Particle Physicist Group

Scientific Award

- Senior Fellow IEEE 2017
- Simons ICTP Associate Fellow (2014 – 2019 period) 2013
- PII Adhidarma Profesi Award 2010
- Penemuan Baru yang Bermanfaat Bagi Negara (New inventions that are beneficial to the country) 2010
- The 400 most highly cited papers of All Time in High Energy Physics 2010
- Anugerah Kekayaan Intelektual Luar Biasa (Ilmu Pengetahuan) {Outstanding Intellectual Property Award (Science)} 2009
- 101 Inovasi paling Prospektif (101 Most Prospective Innovations) 2009
- Satyalancana Wira Karya for Science 2009
- Achmad Bakrie Award for Science Field 2008
- Asia Pacific ICT Award (e-Gov & Services) 2006
- Habibie Award for Basic Sciences 2004
- Asia Pacific ICT Award (Research & Development) 2004
- Asia Pacific ICT Award (Education & Training) 2003
- Peneliti Muda Indonesia Bidang Ilmu Dasar (Young Indonesian Researcher in Basic Science) 2002
- Humboldt Fellow 1999

Copyright

- Integrated System Software for Modular Network Robots
  Copyright No: 045239 (October 24, 2008)
- Data Integration with Focused Web Harvesting Algorithm
  Copyright No: 045143 (May 6, 2008)
- Integrated ISSN System and Integrated Barcode Generation
  Copyright No: 045144 (May 6, 2008)
- Online Employee Admission System
  Copyright No: 036749 (June 9, 2008)
- OPI LIPI: Scientific Professional Organization Online Management System
  Copyright No: B 268482 (March 1, 2006)
- SciBlog: Scientific Collaboration Online Management System
  Copyright No: B 268483 (March 1, 2006)
- Scientific Portal: Integrated Online Portal System of Science
  Copyright No: B 268484 (March 1, 2006)
- Online Journal: Scientific Journal Publication in Online Management System
  Copyright No: B 268486 (March 1, 2006)
- Public Cluster: Web-based Open Parallel Engine
  Copyright No: B 268487 (March 1, 2006)

Publication

More than 70 scientific publications in various journals andinternational scientific meetings. (can be seen on *http://lt.handoko.id*)

Patent

- Connection System to Multi Grid with Open Cluster
  Regular Patent No: P00200800720
  (November 10, 2008)
- Modular Network Robot System
  Regular Patent No: P00200800752
  (November 26, 2008)
- Automatic Electronic Control of Water Level in the Reservoir Tub
  Simple Patent No: S00200800210
  (November 10, 2008)

Scientific Activities

- **1998 – 2006:**
  Together with his research group at DESY Hamburg and ICTP Trieste, they had conducted a theoretical phenomenological study of the existence of the hypothetical Higgs particle which is currently being proven to exist at the Large Hadron Collider (LHC), a global collaborative particle accelerator facility at CERN Switzerland.
- **2005 – present:**
  Together with his research group at GFTK LIPI, they had conducted a theoretical study for modeling the dynamics of elementary biological elements (DNA and protein) based on interactions between elements such as the theory of elementary particles. Modeling with this method is a pioneer in the biophysics community.
- **2002 – present:**
  Together with the computing research group at GFTK LIPI, they had conducted studies and technological development on computing and distributed data. The application of distributed computing technology innovation has been applied in the form of Public Clusters, while the innovation of distributed data and data mining are applied in various forms of application as written in the social contribution below. The various innovations of robots have been recognized in the form of several patents and copyrights. In addition, together with the theoretical research group at Physics (in the University of Indonesia and Bogor Agricultural Institute), they continued their research in the field of particle physics theory. In this topic he became a pioneer for particle interaction modeling for the Grand Unified Theory (GUT) based on the symmetry of the SU(6) group.

Educational activities

- Members of the third group of topics above consist of civitas and students from various institutions, such as: TISDA BPPT, PPIN BATAN, Fasilkom UI, PTDT LAPAN, Physics UI, Engineering Physics ITB, Physics ITB, Physics LIPI, Telkoma LIPI, Physics IPB, STT Telkom, Physics UNJ, Physics UNNESA.
  Number of students who are still involved / have been generated since 2002 until now:
  - Doctoral degree: 7 person
  - Master degree: 13 person
  - Bachelor degree: 26 person

Related activities

- Scientific Steering Board, Indonesian Science Fund (March 2016 – present)
  Advisory/Organizing Committee at various international and national scientific meetings, such as: ICSSST, APS, ISDT, ICANSE, AMNRE, WNP, WTP, WCS, CTPNP, etc.
- Assessors/judges in various research funds and international/national scientific competitions, such as: *Hibah Pasca DIKTI, Hibah Bersaing DIKTI, Hibah Pekerti DIKTI, BSNP, Riset Unggulan UI, Riset Unggulan IPB, Riset Klaster UI,* LKIR, PIRN, NYIA, ISEF, Pimnas, ISEF, IPhO, APhO, ISPO, OSN-PTI, IOAA, and IJSO.
- Editor/assessor in various international/national journals: Physics Letter B, IJCTE, Physics Journal, JTCS.

Social Activities

- Pioneer and initiator of the formation of the theoretical physics community (Indonesian Theoretical Physicist Group) and computational science (Indonesian Computational Society). As a form of real activity, he is also initiating the scientific meetings and theoretical journals in both communities with a consortium model between various higher education and research institutions.
- Pioneer and initiator of various good governance systems based on information technology using the above innovations, especially for various aspects of scientific activities. One of famous example is the Online CPNS Admission System, which is the first system and the only one system who adopt a fully online system that continues until present since 2005.
- Pioneer and initiator of various scientific information systems that innovative solutions to infrastructure problems in Indonesia as well as a form of application technology of computing and distributed data. Some examples include ISSN Online, Online Journal, E-Book LIPI, Indonesian Scientific Index, ARCHIVES and several other. He also active as a developer of various open source software original: openNR (open networked-robot), openISI (open topical data integration), openPC (Public Cluster toolkit).

OPENING SPEECH

ISC Chairman of APEMC

Mark Mifsud

Mark Mifsud is currently a Principle EMC Specialist, providing, advice, training and leadership for the EMC Capability at Boeing Defence Australia. Mark obtained his Bachelors Degree in Electrical Engineering from RMIT University in Melbourne, Australia in 1989.

While studying for his degree he obtained a scholarship and employment from Australia's Department of Defence. After a short period designing control systems for generators, Mark transferred to the EMC section where he eventually became the Laboratory Manager in 1998. In 1996 he was posted the UK where he worked at TUV Product Services and the Motor Industry and Research Association.

In 2001 Mark was appointed Manager of Australia's largest EMC test Facility at EMC Technologies in Melbourne, a position he held for 10 years. In 2012 Mark joined Nova Defence Systems as a Senior EMC Consultant and Capability Lead.

Mark joined Boeing in 2020 in his current role. Mark is the Institute of Engineers Australia EMC Society's National Chairman and is the local chapter chair for the IEEE EMC Society. Mark is the current chair of the APEMC International Steering Committee and is an associate member of Engineers Australia's Electrical College Board and Information Technology and Electronic Engineering College Board. He is a technical assessor of laboratories for the National Association of Testing Authorities and is a registered professional engineer. Mark is a senior member of the IEEE and is a chartered fellow of Institute of Engineers Australia.

Mark is known for expertise in Military testing and consulting on large infrastructure projects such the Square Kilometre Radio Telescope Array Project. He has consulted on a diverse range of projects both commercial and defence. Mark is also an authority on electromagnetic radiation hazards to personnel, fuels and ordnance.

KEYNOTE SPEECH

The President of the IEEE EMC Society

Prof. AliStair Duffy

Alistair Duffy is the current President of the IEEE EMC Society, and has previously served the Society in a variety of roles, including as VP Conferences, Chair of the Standards Development Committee and Distinguished Lecturer. Within the IEEE he also serves on the Technical Activities Board's Finance Committee, Committee on Standards, and the Conference Application Review Committee. Alistair is Professor of Electromagnetics at De Montfort University, UK, and a Guest Professor at Harbin Institute of Technology, China. He has authored over 300 papers, supervised more than 20 PhDs and edited more than 10 books. He received the BEng(Hons) and MEng degrees from University College Cardiff in 1988 and 1989, his PhD from the University of Nottingham in 1993 and his DSc from Cardiff University in 2019. He also holds an MBA. His main research themes centre on electromagnetic measurement and simulation techniques, with a particular focus on validation. Alistair is a Fellow of the IEEE.

GUEST SPEECH

Ir. Reza Septiawan, Ph.D

Reza is a senior engineer in EMC laboratory of Center for Electronics Technology in BRIN (National Research and Innovation Institution of Indonesia). Together with his EMC team, they perform EM compliance testing for electronic products as required by Indonesian Ministry of Information and Communication. In addition, he is also doing research and development related to the integrity of CNS (communication navigation surveillance) signals in the existence of various electromagnetic field in its environment, such as pre-compliance and development testing of:

- Marine electronics (Auto Identification System/AIS, Ocean Bottom Unit/OBU for buoy and Cable Based Tsunami sensors, and InaTEWS CBT)
- Civil Aviation electronics (Automatic Dependent Surveillance – Broadcast/ADS-B, Advanced – Surface Movement Guidance & Control System/ASMGCS, airborne radome
- GNSS integrity and EM potential interference sources

Abstract:
The increase use of many IoTs (internet of things devices) and autonomous vehicles requires reliable signal integrity for their communication navigation and surveillance (CNS) electronics systems. A decrease signal integrity may increase the safety and security risk of both electronic devices and people in the surrounding of these devices. Signal integrity is depending on many CNS parameters such as the signal gains of both transmitters and receivers, transmission media types, the earth contours of their locations, type of buildings or trees, and the intentional/unintentional interference sources mainly in the form of Electromagnetic (EM) fields. This last parameter regarding EM potential interference sources may result in a significant degradation of signal integrity. The EM potential interference sources are originating from inside the device itself (such as wiring design, power sources) and from outside the device (such as transmission towers, other electronic devices, scintillation of ionosphere). A brief overview of these EM potential interference sources, activities in BRIN's (formerly BPPT) EMC Laboratory for both compliance and precompliance/development testing, and an overview of Indonesian EMC laboratories will be presented.

TABLE OF CONTENTS

I. APEMC HISTORY AT GLANCE

The Asia-Pacific International Symposium on Electromagnetic Compatibility (APEMC) was founded in May 2008. After the great success of EMC Zurich held in Singapore in 2006, board discussion commenced and as a result, APEMC was established. APEMC aims to share advances in all aspects of research conducted into EMC and respond to the latest requirements by networking with the international EMC community. Past APEMC conferences:

- 2006: Singapore
- 2008: Singapore
- 2009: Kyoto Japan (no APEMC)
- 2010: Bejing, China
- 2011: Jeju Island, S.Korea
- 2012: Singapore
- 2013: Melbourne, Australia
- 2014: Tokyo, Japan (no APEMC)
- 2015: Taipei, Taiwan
- 2016: Shenzhen, China
- 2017: Seoul, S.Korea
- 2018: Singapore, combined with the International IEEE EMC
- 2019: Sapporo, Japan (joint with APEMC)
- 2020: Sydney, Australia (cancel, covid-19 pandemic)
- 2021: Bali, Indonesia (Hybrid conference)

II. APEMC IN BALI

II.1 VENUE AND LOCATION

II.1.1 VENUE

MERUSAKA
NUSA DUA

Figure 1 Beautiful Location of APEMC 2021 Venue

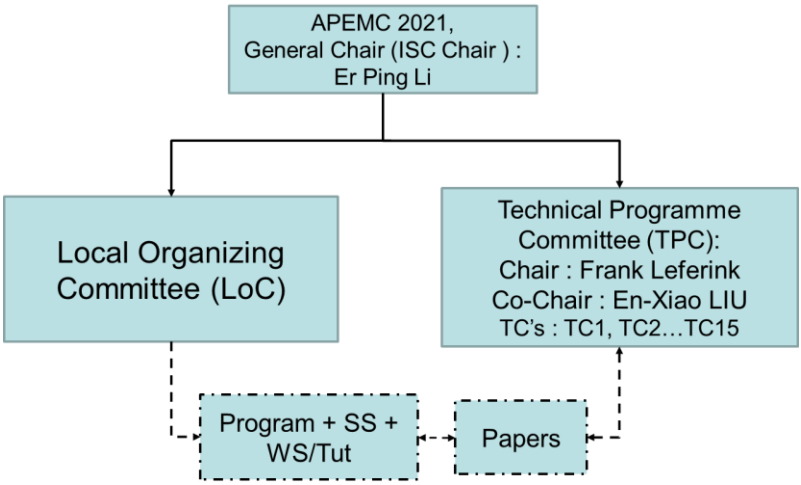
Merusaka Nusa Dua (formerly Inaya Putri Hotel and Convention Center), Nusa Dua Bali, Indonesia
Address
Kawasan Wisata Nusa Dua Lot S-3, Benoa, Kuta Selatan, Benoa, Kuta Sel., Kabupaten Badung, Bali 80363, Indonesia
Phone +62 361 2002900

II.1.2 LOCATION

Map https://goo.gl/maps/N91aZnYqGmSG1hhdA

Figure 2 Venue Location in the heart of Bali Island Indonesia

III. COMMITTEE



III.1 LOCAL ORGANIZING COMMITTEE (LOC)

Chair	Dwi Mandaris	National Research and Innovation Agency, Indonesia
Secretary	Yoppy	National Research and Innovation Agency, Indonesia
Treasury	Sugiyanti	National Research and Innovation Agency, Indonesia
Publicity and Social Media	Hutomo Wahyu Nugroho Muhammad Wibisono	National Research and Innovation Agency, Indonesia Bandung Institute of Technology, Indonesia / University of Twente, the Netherlands
Website	Muhhamad Imam Sudrajat Akbar Aryanto	National Research and Innovation Agency, Indonesia / University of Twente, the Netherlands National Agency for Standardization, Indonesia
IT	Kusetiawan Delly	National Research and Innovation Agency, Indonesia National Research and Innovation Agency, Indonesia

	Nurul Hasikin	National Research and Innovation Agency, Indonesia
	Merry Marsita	National Research and Innovation Agency, Indonesia
Sponsors and Exhibition	Hadi Sanjaya	TUV Rheiland, Thailand
	Tyas Ari Wijanarko	National Research and Innovation Agency, Indonesia
Social Event	Asep Rahmat Hidayat	National Research and Innovation Agency, Indonesia
Program & Paper	Deny Hamdani	Bandung Institute of Technology (ITB), Indonesia
	Achmad Munir	Bandung Institute of Technology (ITB), Indonesia
	Reza Septiawan	National Research and Innovation Agency, Indonesia
	Gamantyo Hendrantoro	Sepuluh November Institute of Technology (ITS), Indonesia
	Eko Setiadji	Sepuluh November Institute of Technology (ITS), Indonesia
	Hardiles	National Agency for Standardization, Indonesia
	Eko Rufianto	National Research and Innovation Agency, Indonesia

III.2 TECHNICAL PROGRAME COMMITTEE

Chair: Prof. Dr. Ir. Frank Leferink

Co-Chair: Dr. EnXiao Liu

Technical Committee (TC)	TC Chairs
TC-1 EMC Management, Standards and Regulations	Deny Hamdani (Indonesia)
TC-2 EMC Measurements and EM Environment	Wen-Yan Yin (China)
TC-3 Lightning	Yoshihiro Baba (Japan)
TC-4 High Power Electromagnetics	William Radasky (United States)
TC-5 System-Level EMC and Protection	Richard Xian-Ke GAO (Singapore)
TC-6 Transportation EMC, Automotive/Railway/Ship EMC	Sergio Pignari (Italy)
TC-7 Aerospace EMC	See Kye Yak (South Korea)
TC-8 Smart Grid and Low Frequency EMC	W. H. Siew (United Kingdom)
TC-9 IC and Semiconductor EMC	Bernd Deutschmann (Austria)
TC-10 Signal Integrity and Power Integrity	Er-Ping Li (China)
TC-11 Computational Electromagnetics and Multiphysics Modeling	Lijun Jiang (Hongkong)
TC-12 Bio-Medical Electromagnetics & Wearable Devices EMC	Jianqing Wang (Japan)
TC-13 Wireless Communication EMC	Gamantyo Hendrantoro (Indonesia)
TC-14 Nanotechnology and New Materials	SungTek Kahng (South Korea)
TC-15 EMC in Emerging Countries	Ahmad Munir (Indonesia)

III.3 INTERNATIONAL STEERING COMMITTEE (ISC)

Chair : Mark Mifsud (Australia)

Member : Er-Ping Li (China)
Liju Jiang (Hong Kong)
Joungho Kim (South Korea)
En-Xiao Liu (Singapore)
Osami Wada (Japan)
Tzong-Lin Wu (Taiwan)

IV. PAPERS

Author Distribution by Countries in APEMC 2021. There are 151 papers accepted from 203 papers submitted.

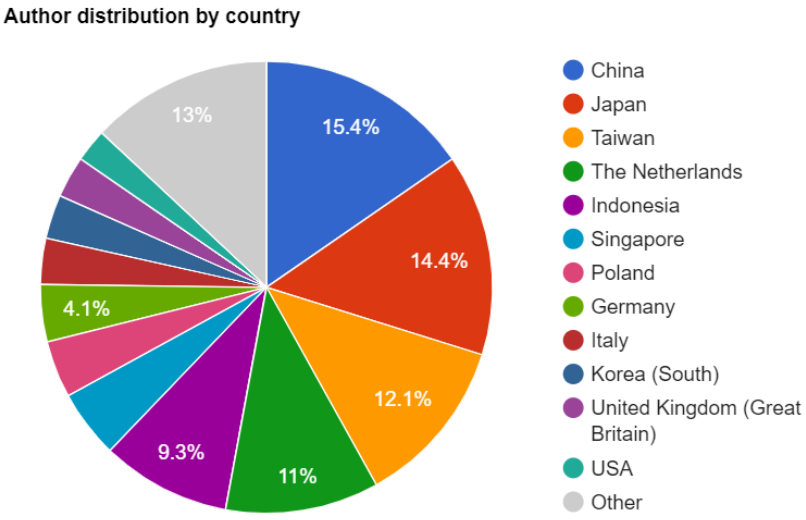


Figure 3 Distribution of accepted papers in APEMC 2021

V. TECHNICAL AREA

Focus Event will be an important part of the APEMC 2021 International Symposium to highlight important topics or emerging new technical fields that are gaining importance in EMC. Papers of EMC related technical area or EMC hot topics are:

- EMC Management, Standards and Regulations
- EMC Measurements and EM Environment
- Lightning
- High Power Electromagnetics
- System-Level EMC and Protection
- Transportation EMC, Automotive/Railway/Ship EMC
- Aerospace EMC
- Smart Grid and Low-Frequency EMC
- IC and Semiconductor EMC
- Signal Integrity and Power Integrity
- Computational Electromagnetics and Multiphysics Modeling
- Bio-Medical Electromagnetics & Wearable Device EMC
- Wireless Communication EMC
- Nanotechnology and New Materials
- EMC in Emerging Countries

VI. UPCOMING EMC SYMPOSIA

VI.1 EMC EUROPE 2022

EMC Europe, the leading EMC Symposium in Europe, will be held at The Swedish Exhibition & Congress Centre in Gothenburg, Sweden, in September 5-8, 2022. We wish to invite and encourage all those working in the area of electromagnetic compatibility to participate in this prestigious event.

Regular Paper Submission Deadline:	February 16, 2022
Workshop Paper Submission Deadline:	March 16, 2022
Notice of Acceptance:	April 16, 2022
Final Regular Paper Submission:	May 15, 2022
Final Workshop Paper Submission:	June 17, 2022

VI.2 IEEE EMC+SIPI 2022

The IEEE EMC Society EMC+SIPI conference will be held in Spokane (WA), August 1-5, 2022.

Important dates:

Special Sessions deadline, acceptance before January 1	:	December 15, 2021
Traditional and Special Session Paper Submission Deadline	:	January 10, 2022
Notification of Acceptance/Rejection for Traditional and Special Session Papers, first Round	:	February 21, 2022
Abstract-Reviewed Paper and Workshop, Tutorial, and Experiments & Demonstrations Proposals Submission Deadline	:	March 7, 2022
Revised Traditional and Special Session Paper Submission Deadline	:	March 21, 2022
Notification of Acceptance/Rejection for Workshops, Tutorials, Experiments & Demonstrations	:	April 15, 2022
Notification of Acceptance/Rejection for Traditional, Abstract-Reviewed and Special Session Papers, Final	:	May 2, 2022
Final Paper, Workshop and Tutorial Submission Deadline	:	May 16, 2022

VI.3 APEMC 2022

The 13th Asia-Pacific International Symposium on Electromagnetic Compatibility & Technical Exhibition (APEMC 2022) will be co-located with and held during the 2022 Beijing EMC Week, Beijing, China, from 08 to 11 May 2022.

The Symposium will continue the APEMC spirit to engage and address the world-wide EMC community with a primary focus on the Asia-Pacific region. The 2022 APEMC will serve as a bridge and provide a broad exchange platform for both academia and industry. The symposium will recognize innovations and technology leaderships through Best Symposium Paper Awards, the Best Student Paper Awards, and other reputable recognitions. The scope of the symposium will encompass the entire spectrum of electromagnetic compatibility, electromagnetic environment, signal integrity as well as featured EMC in emerging technologies.

Improtant dates:

Proposals for special/focused sessions, industrial forums, workshops and tutorial. (Deadline)	:	December 05, 2021
Preliminary Paper Submission. (Deadline)	:	December 20, 2021
Three (3)-page Preliminary Paper Submissions (3-page papers presented at the conference will be included in the IEEE Digital Xplore with EI indexing)		
One (1)-page Abstract Submission to be published in conference proceedings but NOT in IEEE Xplore; No final paper submissions are required		
Notification of Acceptance	:	February 15, 2022
Final Paper Submission. (Deadline)	:	March 05, 2021

VII. AWARDS

APEMC2021 recognizes the innovative and high-quality paper submission through the following prestigious awards:

BEST SYMPOSIUM PAPER AWARD

To honor the authors of papers judged to be of high-novelty, quality of results and excellent presentation.

The best-paper-finalists

Paper Number and Paper ID	Title, Authors and Affiliation
1570706785 – 27	**Radiated Noise Dominancy Analysis by Extended Double Pulse Test and Power Device Optimization for Inverter Use** Toshiya Tadakuma; SeongHong SH Lim; Koichi Nishi; Michael Rogers; Motonobu Joko; Masahito Shoyama *Mitsubishi Electric Corporation, Japan, Singapore, USA*
1570717301 – 43	**Fast Discrete Diagnostics of EMC of Complex Co-Located Radio Systems by Using Worst-Case Models of Electromagnetic Spurious Couplings** Mordachev Vladimir; Eugene Sinkevich; Dzmitry Tsyanenka; Yauheni Arlou *Belarusian State University of Informatics and Radioelectronics, Belarus*
1570727061 – 121	**A Study for Low Calculation Cost Side-Channel Resistance Prediction Based on Transfer Impedance of Leakage Path** Kengo Iokibe; Yoshitaka Toyota; Masaki Himuro *Okayama University, Japan*
1570730755 - 166	**Measurement of In-Circuit Common-Mode Impedance at the AC Input of a Motor Drive System** Zhenyu Zhao; Fei Fan; Arjuna Weerasinghe; Pengfei Tu; Kye Yak See *Nanyang Technological University, Singapore*
1570730827 – 188	**Optimization Methods for Common Mode Cancellation in Phase Shifted Inverter Operation** Jonas Bertelmann; Michael Beltle; Stefan Tenbohlen *University of Stuttgart, Germany*

BEST STUDENT PAPER AWARD

To honor a full-time student who is the first author of an outstanding paper of works in the EMC field. Papers co-authored by a student and his or her advisor are eligible, provided the student is the principle author and also the presenter.

The best-student-paper-finalists

Paper Number and Paper ID	Title, Authors and Affiliation
1570719764 – 49	**The Influence of Spread-Spectrum Modulation on the G3-PLC Performance** Waseem Elsayed; Hermes Loschi; Muhammad Ammar Wibisono; Niek Moonen; Piotr Lezynski; Robert Smolenski *University of Zielona Gora, Poland; University of Twente, the Netherlands*
1570720439 – 51	**EMI Mitigation Technique for Warship Power Distribution Systems in the Frequency Range Below 150 kHz** Muhammad Imam Sudrajat; Niek Moonen; Hans Bergsma; Frank Leferink *Univerisity of Twente, the Netherlands; THALES, the Netherlands; Indonesian Institute of Sciences (LIPI), Indonesia*
1570724406 – 58	**Impact of a Speed-Controlled Water Pump on Power Line Communication of Smart Energy Meters** Muhammad Ammar Wibisono; Bas ten Have; Waseem Elsayed; Niek Moonen; Deny Hamdani; Frank Leferink *Univerisity of Twente, the Netherlands; University of Zielona Gora, Poland; Bandung Institute of Technology (ITB), Indonesia*
1570727432 – 126	**Sensitivity Analysis of Parasitics in Power Electronic Circuit Through Sobol' Indices** Karol Niewiadomski; Angel Eduardo Pena-Quintal; David Thomas; Sharmila Sumsurooah *University of Nottingham, U.K*
1570730807 – 172	**In-Circuit Differential-Mode Impedance Extraction at the AC Input of a Motor Drive System** Arjuna Weerasinghe; Zhenyu Zhao; Fei Fan; Pengfei Tu; Kye Yak See *Nanyang Technological University, Singapore*

VIII. SCHEDULE AT GLANCE

<table>
<tr><th>Time</th><th>MONDAY
Sept 27th , 2021</th><th>TUESDAY
Sept 28th , 2021</th><th>WEDNESDAY
Sept 29th , 2021</th><th>THURSDAY
Sept 30th , 2021</th></tr>
<tr><td>8.00</td><td rowspan="3">Wokshops/
Tutorials</td><td colspan="3">Registration</td></tr>
<tr><td>8.30</td><td rowspan="4">Opening
Ceremony and
Plenary Sesion</td><td rowspan="2">Oral
Sessions</td><td rowspan="2">Oral Sessions</td></tr>
<tr><td>9.30</td></tr>
<tr><td>10.00</td><td rowspan="4">Workshops/
Tutorials</td><td rowspan="2">Break</td><td rowspan="2">Break</td></tr>
<tr><td>10.10</td></tr>
<tr><td>10.20</td><td rowspan="2">Oral
Sessions</td><td rowspan="2">Oral Sessions</td></tr>
<tr><td>11.00</td></tr>
<tr><td>12.00</td><td>Lunch</td><td>Lunch</td><td>ISC Virtual
Meeting</td><td>Lunch</td></tr>
<tr><td>13.00</td><td rowspan="3">Workshops/
Tutorials</td><td rowspan="3">Oral Sessions</td><td rowspan="2">Oral
Sessions</td><td rowspan="2">Oral Sessions</td></tr>
<tr><td>14.00</td></tr>
<tr><td>14.40</td><td>Break</td><td>Break</td><td rowspan="3">Oral
Sessions</td><td rowspan="3">Oral Sessions</td></tr>
<tr><td>15.00</td><td>Break</td><td>Break</td></tr>
<tr><td>15.10</td><td rowspan="8">Workshops/
Tutorials</td><td rowspan="5">Oral Sessions</td></tr>
<tr><td>15.30</td></tr>
<tr><td>16.00</td></tr>
<tr><td>16.30</td></tr>
<tr><td>16.40</td></tr>
<tr><td>17.00</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>17.10</td></tr>
<tr><td>17.30</td><td></td></tr>
<tr><td>18.00</td><td rowspan="4">Welcome
Reception</td><td rowspan="3"></td><td>`Best Paper Awad
Ceremony</td></tr>
<tr><td>18.30</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>19.00</td></tr>
<tr><td>19.10</td><td rowspan="3"></td></tr>
<tr><td>19.30</td></tr>
<tr><td>20.00</td><td></td><td></td></tr>
<tr><td>21.00</td><td></td><td></td><td></td><td></td></tr>
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IX. PROGRAMS SCHEDULES

MONDAY, 27 SEPTEMBER 2021

Time : Indonesian Central Time (GMT+8 Time Zone)

ROOM / TIME	Room 1	Room 2	Room 3
08:00-10:00	**Tutorial 1 (T1)** Global EMC Standards Update for Commercial, Automotive, and Aerospace/Government Applications Chair : **Zhong Chen,** **ETS Lindgren**		**Tutorial 4 (T4)** IEEE Electromagnetic Compatibility Transactions Chair : **John Norgard** **Perry Wilson**
10:00-12:00	**Tutorial 2 (T2)** Connected Vehicles: The Future of the Modern Automotive Industry Chair : **Garth D'Abaeu,** **ETS Lindgren**		
12:00-13:00	**Lunch**		
13:00-15:00	**Tutorial 3 (T3)** Improving integrated circuit reliability by combining tests to ionizing radiation and electromagnetic compatibility Chair : **Fabian Vargas** **Bernd Deutschmann** **Sonia Ben Dhia**	**Tutorial 5 (T5)** Power Quality and EMC in Transportation and Renewable Energy Systems Chair : **Muhammad Alamsyah** **Venkatkumar** **Muneeswaran**	**Workshop 1 (W1)** Risk Based EMC initiatives in Europe Chair : **Anne Roc'h** **Frank Leferink** **Davy Pissoort** **Keith Armstrong**
15:00-15:10	**Break**		
15:10-17:10	**Workshop 2 (W2)** Empower a billion lives Chair : **Frank Leferink** **Jelena Popovic** **Deny Hamdani** **Flavia Grassi**	**Workshop 3 (W3)** Conducted EMI problems with modern static electrical energy meters Chair : **Cees Keyer** **Tom Hartman** **Bas ten Have**	**Workshop 6 (W6)** Comparing Emission Measurements performed by a Spectrum Analyzer with EMC Functions vs. Pre and Full Compliant Receivers Chair : **Michele Zingarelli**
17:10-19:10		**Workshop 4 (W4)** The Impact of Electro Mobility on Automotive EMC Standards and Measurements Chair : **Jens Medler** **Sam Chew**	**Sponsor Exhibition** Organizer(s): **Narda Safety Test Solutions Srl** SUBSIDIARY OF L3HARRIS TECHNOLOGIES, INC.

Tutorials

T1	Tutorial 1	Time : 10.00 – 12.00
Global EMC Standards Update for Commercial, Automotive, and Aerospace/Government Applications		
Chaired by :	Janet O'Neil	Room : Room 1

Speakers : Zhong Chen, ETS-Lindgren
Garth D'Abreu, ETS-Lindgren

Abstract :
This tutorial will provide updates on the industry EMC standards most commonly used for commercial, automotive, and aerospace/military applications. Speakers will share information about the state of the art in test site validation, automotive performance verification, and use of EMC measurement equipment required by many current international standards. Specific requirements and nuances that can challenge even the most experienced EMC practitioner will be discussed. This tutorial strives to provide the latest developments in CISPR 16, ANSI C63®, Automotive, and Military standards, as well as "behind the scenes" discussions associated with proposed changes to future editions.
Speakers include global experts who are actively involved in using, writing, and maintaining the standards in which the commercial, automotive, and aerospace/ MIL-STD EMC measurement requirements are specified. For example, for the automotive standards, reviews will include the current revisions of the main international automotive component and full vehicle standards, including CISPR 12, CISPR 25, ISO 11451-2, ISO 11452-2, and ECE Reg. 10.6. For the ANSI standards, discussions will include C63.25.1 and C63.25.2 for site validation techniques and requirements for above and below 1 GHz testing. An update on the latest developments proposed for the next edition of C63.4 will be provided. Attendees can expect to increase their understanding of both the background of the latest equirements for usage of EMC measurement equipment and test environments as well as learn novel approaches to test site validation of anechoic chambers.

Agenda :

Update of Site Validation Measurements in the ANSI C63 Standards (C63.25.1 and C63.25.2) and Proposed Changes to C63.4
Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA

Automotive International EMC Standards Update
Garth D'Abreu, ETS-Lindgren, Cedar Park, Texas, USA

T2	Tutorial 2	Time : 10.00 – 12.00
Connected Vehicles: The Future of the Modern Automotive Industry		
Chaired by :	Janet O'Neil	Room : Room 1

Speakers : Garth D'Abreu, ETS-Lindgren
Zhong Chen, ETS-Lindgren

Abstract :
The phrase "connected vehicles" is a hot topic these days, but what does this mean and why is it important? "Connected vehicles" refers to communication between vehicles (vehicle-to-vehicle V2V), between vehicles and the surrounding communication infrastructure (vehicle-to-infrastructure V2I), vehicle-to-cloud (V2C) and cellular vehicle-to-everything (C-V2X). The developing Advanced Driver Assistance Systems (ADAS) rely on this communication network for increasing levels of vehicle autonomy. Current ADAS features including adaptive cruise control, autonomous emergency breaking, lane departure warning systems, and blind spot warning, to name a few, rely solely on the on board sensors. On board systems are currently included in the scope of module-based EMC tests. Over the Air (OTA) communication for connected vehicles, however, necessitates additional measurements now required to verify wireless performance of the systems. To satisfy the requirements of high network reliability, high data throughput and low latency, there are potential solutions with Dedicated Short Range Communications (DSRC), 4G and 5G based cellular networks. Today's drivers expect safety features to operate flawlessly. In the future, with autonomous vehicles and no driver, it is critical that connected vehicles operate seamlessly, with no margin for error
Speakers in this tutorial will address the challenges connected vehicle technology presents on performance and verification test methods. Novel solutions to these challenges will be provided. Topics related to automotive test and measurement include a primer on basic computer simulation. This will demonstrate how simulation tools can be applied early to achieve compliance, using automotive EMC standards as a guide. Full vehicle measurement techniques and guidelines will be reviewed to evaluate the performance of connected vehicles.
The tutorial will conclude with a discussion on the EMC test environment for conducting these automotive measurements, with a focus on the important contribution of dynamometers and e-motors to simulating real-world applications.

Agenda :

Implementing Vehicle Level Measurements for Advanced Driver Assistance Systems
Garth D'Abreu, ETS-Lindgren, Cedar Park, Texas, USA

Chamber Design Considerations for EMC and Antenna Pattern Measurements of Full Vehicles
Zhong Chen, ETS-Lindgren, Cedar Park, Texas, USA

T3	Tutorial 3	Time : 13.00 – 15.00
Improving integrated circuit reliability by combining tests to ionizing radiation and electromagnetic compatibility		
Chaired by :	Fabian Vargas Bernd Deutschmann Sonia Ben Dhia	Room : Room 1

Speakers :

Fabian Vargas, Catholic University – PUCRS
Bernd Deutschmann, Graz University of Technology
Sonia Ben Dhia, Université de Toulouse, LAAS-CNRS

Abstract :
Technology scaling, which made electronics accessible and affordable for almost everyone on the globe, has advanced IC and electronics since sixties. Nevertheless, it is well recognized that such scaling has introduced new (and major) reliability challenges to the semiconductor industry. This tutorial addresses the background mechanisms impacting reliability of very deep submicron (VDSM) integrated circuits (Ics). In more detail, topics such as the basics about electromagnetic compatibility (EMC) and ionizing radiation, the mechanisms by which they affect Ics, the current standards and laboratory test infrastructure for EMC, total-ionizing dose (TID) and single-event effects (SEEs) on Ics are presented and their combined effects on the reliability of modern ICs are discussed. Moreover, the way reliability failure mechanisms for (ionizing and non-ionizing) radiation are modeled and how they are impacting IC aging and lifetime will be covered. Recent results from laboratory experimental measurements are described. Classic design solutions to counteract with TID, SEEs, aging and EMC in VDSM ICs as well as the recent achievements on the development of on-chip sensors to monitor EM conducted noise on IC power supply lines are introduced. A YouTube video is presented to illustrate the effectiveness of such on-chip sensors to detect aging. Finally, Spice simulations are used to demonstrate the

combined effect of ionizing radiation with power supply noise on SRAM cells followed by the presentation of some measures to counteract with it..

T4	Tutorial 4	Time : 10.00 – 12.00
IEEE Electromagnetic Compatibility Transactions		
Chaired by :	John Norgard Perry Wilson	Room : Room 1

Speakers :
Prof. John Norgard - NASA/JSC
Dr. Perry Wilson - NIST

Abstract :
This EMCT Tutorial is intended for everyone interested in publishing a paper in the EMCT, especially for the first time. This Tutorial is on the IEEE Electromagnetic Compatibility Transactions (EMCT).

Agenda :
Publishing a Paper in the EMCT
Writing a Good EMCT Paper: My Perspective

T5	Tutorial 5	Time : 13.00 – 15.00
Power Quality and EMC in Transportation and Renewable Energy Systems		
Chaired by :	Muhammad Alamsyah Venkatkumar Muneeswaran	Room : Room 2

Speakers :
Dr.-Ing. Sebastian Koj, IAV GmbH
Prof. Dave Thomas, University of Nottingham
Prof. Petre-Marian Nicolae, University of Craiova
Prof. Robert Smoleński, University of Zielóna Gora

Abstract :
The rapid increasing of renewable energy sources around the world and its EMC problems are something that can not be separated. Both Low-Frequency conducted and radiated emission research have been conducted due to the problem caused by it. Therefore, there is a strong need to analyze the Renewable Energy Systems in Low-Frequency area in order to comply with the EMC standards. In this Tutorial, the related problems will be presented focusing on conducted interference topic, aiming to get better perspective of understanding the EMC issue in power converters in Renewable Energy systems also covering Aerospace applications, and Automotive vehicle sector.

Agenda :

Renewable Energy and Automotive EMC – Testing, Standards and Regulations
Dr.-Ing. Sebastian Koj – Development Engineer EMC and Antenna at IAV GmbH

Methodologies or The Simulation of Conducted Emissions of DC-DC Converters For Future Aerospace Applications
Prof. Dave Thomas – Head of George Green Institute for Electromagnetic Research at University of Nottingham

Some problems concerning Power Quality and EMC in Energy Systems Including Renewables
Prof. Petre-Marian Nicolae – Professor at University of Craiova, Prof. Ileana-Diana Nicolae -Professor at University of Craiova

Aggregated Conducted Interference Generated by Power Electronic Interfaces in Photovoltaic Power Plant
Prof. Robert Smoleński – Professor at University of Zielóna Gora

Workshop

W1	Workshop 1	Time : 13.00 – 15.00
Risk Based EMC initiatives in Europe		
Chaired by :	Anne Roc'h Frank Leferink Davy Pissoort Keith Armstrong	Room : Room 2

Speakers :
Dr. Anne Roc'h, Eindhoven University of Technology
Prof.dr. Frank Leferink, University of Twente - THALES
Prof.dr. Davy Pissoort, Katholieke Universiteit Leuven
Keith Armstrong, Cherry Clough Consultants

Abstract :
The recent European Blue Guide (which is about the implementation of EU product rules) made an EMI risk-based approach (rather than a conventional, rule-based approach) mandatory for any new piece of electronic equipment. Meanwhile, the specific regulations for medical equipment (MDR ‾ Medical Devices Regulations and IEC 60601-1-2), which also refer to a risk-based approach became mandatory in 2021.
The problem is that many companies in the technology industry as well as the users of electronic systems are struggling with this EMI risk-based approach

as there is a lack of understanding and no clearly prescribed risk-assessment methodology in place. Small and medium-sized enterprises (SMEs) are often not able to cope with such a major shift in approach.
In this workshop we will present the EMC Risk-based approach, in contrast with the tradition Rule-based one. We will discuss the recent IEEE 1848 which provides a set of practical methods for helping to manage the levels of risks due to electromagnetic (EM) disturbances throughout the lifecycles of electronic equipment.
This new risk-based methodology requires not only a formalization, but trained specialists to address the complexity of system, and all the individuals and institutions involved. We will introduce you to the two large European Networks (PETER and ETERNITY) which are currently training 29 Early Stage Researchers into the development and implementation of the risk-based methodology.

Agenda :

Risk based EMC
Frank Leferink

Techniques and Measures for Managing the Functional Safety and Other Risks that can be caused by EMI (IEEE 1848)
Keith Armstrong

Presentation of the European Training Network PETER
Davy Pissoort

Presentation of the European Training Network ETERNITY
Anne Roc'h

W2	Workshop 2	Time : 15.10 – 17.10
Empower a billion lives		
Chaired by :	Frank Leferink Jelena Popovic Deny Hamdani Flavia Grassi	Room : Room 2

Speakers :

Prof.dr. Frank Leferink, University of Twente - THALES
Dr. Jelena Popovic, University of Twente – Klimop Energy, Vice-Chair TC12 IEEE PELS
Dr. Deny Hamdani, ITB Bandung
Dr. Flavia Grassi, Polito di Milano – Chair TC7 IEEE EMCS

Abstract :

IEEE PELS launched IEEE Empower a Billion Lives (EBL-I) in 2018 as a recurring global competition for teams to develop and demonstrate scalable solutions to energy access. Over 450 teams from 70 countries responded. Five regional competitions (China, India, Africa, Europe and US) and field demonstrations in Rwanda, Uganda, Malaysia, Nepal, Madagascar, India, Tanzania, China, Nigeria, Cambodia, Singapore, Kenya & Ivory Coast with a global final in Baltimore in Oct 2019.
Solutions presented by the teams included microgrids, nanogrids, solar home systems, improved business models, and appliances. Over $500,000 was provide in awards and team support, including a $100,000 Grand Prize to team SoULS from IIT Bombay. Other global winners include Xpower, Reeddi, Entrepreneurs du Monde and Okra, SolarWorx and Havenhill Synergy. EMC, and especially power quality is strongly relating to renewable energy generation, as the majority of equipment is using fast-switching semiconductors to connect the generated energy to the micro-or nano-grid, or use fast switching semiconductors to consume energy. By default, any micro- or nano-grid has low inertia like in conventional grids, and this low intertie is the cause of dips, surges and outages.
Building on the success of EBL-I, Empower a Billion Lives – II, global competition to be held from August 2021 to October 2022. Please visit www.empowerabillionlives.org for further information on joining the EBL community and/or to participate as a team.

Agenda :
In this workshop we will present the concept of EBL, we will discuss with key stakeholders and to build global partnerships, to explore ways in which IEEE can help energy access, and to build a community to support EBL-II.

W3	Workshop 3	Time : 15.10 – 17.10
Conducted EMI problems with modern static electrical energy meters		
Chaired by :	Cees Keyer Tom Hartman Bas ten Have	Room : Room 2

Speakers :
Cees Keyer, University of Twente
Tom Hartman, University of Twente
Bas ten Have, University of Twente

Abstract :
More often consumers are complaining about the energy bill after the conventional electromechanical meter has been replaced by an electronic, or static, energy meter. Active infeed converters for photo-voltaic systems are a

known source for interference to static meters. To investigate the root cause, experiments on static meters have been performed in a controlled lab environment. Interference cases are found due to dimmed lighting equipment of light emitting diode and compact fluorescent lighting technology, and a speed controlled water pump. Maximum experimental errors of 2675% are found. The drawn currents have a high rising slope, small pulse duration and high crest factor. Static energy meters that use a Rogowski coil to measure the current contribute to the highest misreadings, followed by the current transformer principle, and when using a shunt resistor or Hall effect sensor lower energy readings are reported.

Agenda :

Conducted EMI on static energy meters from modern household appliances

Static energy meters running backwards

Measurement survey of current waveforms occurring in on-site situations

Discussion panel

W4	Workshop 4	Time : 17.10 – 19.10
The Impact of Electro Mobility on Automotive EMC Standards and Measurements		
Chaired by :	Jens Medler Sam Chew	Room : Room 3

Speakers :

Jens Medler, Rohde & Schwarz GmbH
Zhang Xu, China Automotive Technology and Research Center Co. Ltd
Sam Chew, Rohde & Schwarz ASIA
Jacky Li, Rohde & Schwarz ASIA

Abstract :

This workshop will provide key updates to the global Automotive EMC Standards and will review proposed changes to address the rapidly developing electro mobility. Participants will learn what is new in these standards, what to expect in the new revisions, what to anticipate in future standards based on automotive technology trends, and how this may influence their current EMC test and measurement activity.

Agenda :

Current and Future Changes to the CISPR Automotive EMI Standards and the applicability of FFT-based measuring receivers for compliance measurements
Jens Medler, CISPR A & D Expert, Rohde & Schwarz, Munich, Germany

EMC Safety in ADAS and Autonomous Driving - Challenges and possible solutions
Zhang Xu, ISO/TC22/SC32/WG3 Expert, IEC/CISPRD Expert, UNECE/TF EMC Expert, China Automotive Technology and Research Center Co. Ltd., Tianjin, China

The challenges of electromagnetic environment scenarios testing for connected cars
Sam Chew, Technical Sales for EMC Projects, Rohde & Schwarz ASIA, Singapore

Monitoring and assessing performance of automotive systems during EMS testing
Jacky Li, Senior system engineer for EMC & OTA projects, Rohde & Schwarz ASIA, Singapore

W6	Workshop 6	Time : 15.10 – 17.10
Comparing Emission Measurements performed by a Spectrum Analyzer with EMC Functions vs. Pre and Full Compliant Receivers		
Chaired by :	Michele Zingarelli	Room : Room 3

Speakers : Dr.Eng. Michele Zingarelli, Narda Safety Test Solutions

Abstract :
A comparison between measurements performed with 1 Spectrum Analyzer, 1 PreCompliant Receiver and 1 Full-Compliant Receiver will be showed, using a Reference CISPR 16-1-1 Pulse Repetition Frequency Generator and a sample EUT, in order to bring the evidence on how much an Emission Test could be affected by a simple Spectrum Analyzer or a Pre-Compliant EMI Receiver, versus a CISPR 16-1-1 Certified Full-Compliant EMI Receiver.

Agenda :
A short theoretical introduction will be given for highlighting the requirements from the Standard and resuming the various CISPR Defined Detectors and their responses to the pulses defined as references for the validation of an EMI Measuring Equipment. Then practical measurements will be performed using these three different equipment on a selected EUT.

TUESDAY, 28 SEPTEMBER 2021
Time : Indonesian Central Time (GMT+8 Time Zone)

ROOM / TIME	Room 1	Room 2	Room 3
08:30-12:00	***PLENARY SESSION***		
12:00-13:00	**Lunch**		
13:00-15:00	**[SS-06] SCENT: EMC in Smart Cities via Power Electronics** Organizer(s): Muhammad Imam Sudrajat Session Chairs: Prof. David W.P Thomas & Prof. Robert Smolenski	**[SS-01] ESD and Transients** Organizer(s): Takahiro Yoshida Session Chairs: Takahiro Yoshida	**[SS-03] EMC Diagnostics of Complex Systems** Organizer(s): Vladimir Mordachev & Eugene Sinkevich Session Chairs: Vladimir Mordachev & Eugene Sinkevich
15:00-15:10	**Break**		
15:10-17:30	**[SS-05] ETOPIA: Microgrids and Low Frequency EMC** Organizer(s): Arun Dilip Khilnani Session Chairs: Prof. Flavia Grassi & Prof. Petre-Marian Nicolae	**[SS-02] : Hardware security issue due to EM passive/active attacks on devices complying EMC standards** Organizer(s): Yuichi Hayashi & William Radasky Session Chairs: Yuichi Hayashi & William Radasky **TC-01 EMC Management, Standards and Regulations** Session Chairs: Dr. Ing. Deny Hamdani, M.Sc	**[SS-07] The Emerging Near-field/Far-field EMC Measurement and Modeling Technologies for Complex Electromagnetic Problems** Organizer(s): Richard Xian-Ke Gao & Xing-Chang Wei Session Chairs: Richard Xian-Ke Gao & Xing-Chang Wei

PLENARY SESSION & PARALLEL SESSION ORAL PRESENTATION
DAY 2 (Tuesday, 28 September 2021)
Time : Indonesian Central Time (GMT+8 Time Zone)

Time	*Sessions*	*Room*
	PLENARY SESSION	***PLENARY ROOM***
08:30-08.40	***General Report:*** LoC Chair: Dwi Mandaris, Ph.D TPC Chair: Prof. dr. Ir. Frank Leferink	
08:40-09:00	***Welcome Talk:*** APEMC General Chair: Prof. Er-Ping Li	
09:00-09:30	***Opening Talk:*** Chairman of National Research and Innovation Agency (BRIN), Indonesia: Dr. Laksana Tri Handoko, M.Sc	
09:30-10:00	***Opening Talk:*** Chairman of International Steering Committee (ISC) APEMC: Mark Mifsud	
10:00-11:00	***Keynote Speaker:*** Director of IEEE EMC Society: Prof. Alistair Duffy	
11:00-11:50	***Guest Speaker:*** Researcher from National Research and Innovation Agency (BRIN) Indonesia: Ir. Reza Septiawan, Ph.D	
11:50-11:55	Information from the Chair of APEMC 2022: Dr. Dong-Lin SU	
11:55-12:00	Information from the Chair of EMC Europe 2022: Prof. Jan Carlsson	
12:00-13:00	***Lunch***	
13:00-15:00	**[SS-06] SCENT: EMC in Smart Cities via Power Electronics** Organizer(s): Muhammad Imam Sudrajat Session Chairs: Prof. David W.P Thomas & Prof. Robert Smolenski	***Room 1***
	An Approach in Modelling and Simulation of Crosstalk Effect in Cables Ventatkumar Muneeswaran *University of Nottingham, U.K*	
	Electromagnetic Disturbance Characteristics and Influence Factors of PETT Oscillation in High-Voltage IGBT Devices Jiayu Fan; Jinqiang Zhang; Feng He; Xuebao Li; Zhibin Zhao; Xiang Cui *North China Electric Power University, China; Global Energy Interconnection Research Institude Co. Ltd, China*	
	The Influence of Spread-Spectrum Modulation on the G3-PLC Performance Waseem Elsayed; Hermes Loschi; Muhammad Ammar Wibisono; Niek Moonen; Piotr Lezynski; Robert Smolenski	

	University of Zielona Gora, Poland; University of Twente, the Netherlands	
	EMI Mitigation Technique for Warship Power Distribution Systems in the Frequency Range Below 150 kHz Muhammad Imam Sudrajat; Niek Moonen; Hans Bergsma; Frank Leferink *Univerisity of Twente, the Netherlands; THALES, the Netherlands; Indonesian Institute of Sciences (LIPI), Indonesia*	
	Impact of a Speed-Controlled Water Pump on Power Line Communication of Smart Energy Meters Muhammad Ammar Wibisono; Bas ten Have; Waseem Elsayed; Niek Moonen; Deny Hamdani; Frank Leferink *Univerisity of Twente, the Netherlands; University of Zielona Gora, Poland; Bandung Institute of Technology (ITB), Indonesia*	
	Radiated and Conducted EMI by RF Fields at Hospital Environment J. Ramos Evangelista; Hermes Loschi; Eduardo Tavares Costa; Robert Smolenski; Niek Moonen; Robert Vogt-Ardatjew *UNICAMP & ANATEL, Brazil; University of Zielona Gora, Poland; University of Campinas, Brazil; University of Twente, The Netherlands*	
13:00-15:00	**[SS-01] ESD and Transients** Organizer(s): Takahiro Yoshida Session Chairs: Takahiro Yoshida **Development of Immunity Test Method for Long-Duration Induced Noise on a Wearable Devices by Electrostatic Discharge** Musashi Tanaka; Takahiro Yoshida *Tokyo University of Science, Japan* **Distance Characteristics of Transient Magnetic Field Caused by ESD in Sphere-Gap** Kento Kato; Ken Kawamata; Shinobu Ishigami; Osamu Fujiwara *Tohoku Gakuin University, Japan: Nagoya Institute of Technology, Japan* **Development and Evaluation of Ultra-Wideband Antenna for Measurement of Transient Electromagnetic Fields** Shinobu Ishigami; Toshi-ya Ishizaki; Keita Kobayashi; Ken Kawamata; Katsushige Harima; Shingo Inori	***Room 2***

	Tohoku Gakuin University, Japan: Nagoya Institute of Technology, Japan; Elena Electronics Co. Ltd., Japan; National Institute of Information and Communications Technology, Japan **Observation of Peeling Discharge Phenomenon by Ultra-High Sensitivity Ultraviolet Camera** Takayoshi Ohtsu; Takami Hasegawa; Ryuji Osawa *National Institute of Technology, Numazu College, Japan; Bluevision Ltd., Japan; SEIKOH GIKEN Co., Ltd., Japan*	
	[SS-02] : Hardware security issue due to EM passive/active attacks on devices complying EMC standards Organizer(s): Yuichi Hayashi & William Radasky Session Chairs: Yuichi Hayashi & William Radasky **Board-Level Hardware Trojan Detection Using Sensing Function of On-Board ICs in IT Devices** Masahiro Kinugawa; Yuichi Hayashi *The University of Fukuchiyama, Japan: Nara Institute of Science and Technology, Japan* **An Analysis of Video Signal Using Double-Endedmode in Perspective of EMI** Dong-Hoon Choi; TaeSik Nam; Eui Bum Lee; Jong-Gwan Yook *Yonsei University, South Korea*	
13:00-15:00	**[SS-03] EMC Diagnostics of Complex Systems** Organizer(s): Vladimir Mordachev & Eugene Sinkevich Session Chairs: Vladimir Mordachev & Eugene Sinkevich **Electromagnetic Background Generated by Mobile (Cellular) Communications** Mordachev Vladimir *Belarusian State University of Informatics and Radioelectronics, Belarus* **UWB EMP Susceptibility Testing of General-Purpose Electronic, Radio Communication, and Industrial Equipment** Dzmitry Tsyanenka; Mordachev Vladimir; Eugene Sinkevich; Alexey Galenko; Xie Ma; Wen-Qing Guo *Belarusian State University of Informatics and Radioelectronics & Belarusian State University, Belarus; China Electronics Technology Cyber Security Co., Ltd., China; China Electronics Technology Cyber Security Co., Ltd., China*	***Room 3***

	Fast Discrete Diagnostics of EMC of Complex Co-Located Radio Systems by Using Worst-Case Models of Electromagnetic Spurious Couplings Mordachev Vladimir; Eugene Sinkevich; Dzmitry Tsyanenka; Yauheni Arlou *Belarusian State University of Informatics and Radioelectronics, Belarus* **Research on Optimum Scheme of GPS Receiving Sensitivity with Holographic Interference** Jiandong Guo; Shuai Hou; Dengyu Zhang; Yue Zhang *China Automotive Test Center(Tianjijn) Co., Ltd, China; CATARC Automotive Test Center(Tianjin) Co., Ltd., China; CATARC, China* **Experimental Studies of Electromagnetic Compatibility Between 5G Network Transmitters and Receivers Operating in Earth Exploration-Satellite Service and Space Research Service in the 27 GHz Band** Valery Tikhvinskiy; Victor Koval; Pavel Korchagin; Altay Aitmagambetov *Radio Research & Development Institute (NIIR) & Bauman Moscow State Technical University (BMSTU), Russia; GEYSER-TELECOM, Ltd, Russia; PInternational Information Technologies University, Kazakhstan*	
	Common-Mode Noise Analysis and Suppression of a GaN-Based LCLC Resonant Converter for Ion Propulsion Power Supply Minghai Dong; Hui Li; Shan Yin; Zhenyu Zhao; Yingzhe Wu *University of Electronic Science and Technology of China, China; Nanyang Technological University, Singapore*	
15:00-15:10	**Break**	
15:10-17.30	**[SS-05] ETOPIA: Microgrids and Low Frequency EMC** Organizer(s): Arun Dilip Khilnani Session Chairs: Prof. Flavia Grassi & Prof. Petre-Marian Nicolae	***Room 1***
	Efficient Time-Domain Multi-Channel Measurements Using a Multi-Axis Antenna for Frequency Range Below 30 MHz Denys Pokotilov; Robert Vogt-Ardatjew; Frank Leferink *University of Twente, the Netherlands*	

	EMI Levels Associated with MMC Capacitors Voltage Balancing Techniques Amr Madi; Niek Moonen; Robert Smolenski; Douglas Aguiar do Nascimento; Piotr Lezynski; Frank Leferink *University of Zielona Gora, Poland; University of Twente, The Netherlands*	
	A Simulation for Parameters Extraction of Double-Layer Shielded Power Cable Using FEA Douglas Aguiar do Nascimento; Robert Smolenski; Hermes Loschi; Amr Madi; Muhammad Septian Alamsyah; Francinei L Vieira *University of Zielona Gora, Poland; University of Twente, The Netherlands; Leibniz University Hannover, Germany*	
	The Influence of the Number of Frequencies and the Frequency Repetitions Rates in Spread Spectrum Sigma-Delta Modulated DC-DC Converters Angel Eduardo Pena-Quintal; Karol Niewiadomski; Steve Greedy; Mark Sumner; David Thomas *University of Nottingham & George Green Laboratory for Electromagnetic Research, United Kingdom (Great Britain)*	
	Limitations in Applying the Existing LISN Topologies for Low Frequency Conducted Emission Measurements and Possible Solution Lu Wan; Arun Dilip Khilnani; Abduselam Hamid; Flavia Grassi; Giordano Spadacini; Sergio A Pignari; Mark Sumner; David Thomas *Politecnico di Milano, Italy; University of Nottingham, U.K*	
	Effects of Random Modulation on Powerline Communication System Abduselam Hamid; Lu Wan; Waseem Elsayed; Flavia Grassi; Paolo S. Crovetti; Giordano Spadacini; Sergio A Pignari *Politecnico di Milano, Italy; University of Zielona Gora, Poland; University of Twente, The Netherlands; Politecnico di Torino, Italy*	
	About the Distorting Regime Induced by an Electronic Induction Heating System Adrian Hurezeanu; Iurie Nuca; Ileana-Diana Nicolae; Lucian-Cristian Scarlatescu; Petre Marian Nicolae *University of Craiova, Romania*	
15:10-17:30	**[SS-02] : Hardware security issue due to EM passive/active attacks on devices complying EMC standards** Organizer(s): Yuichi Hayashi & William Radasky Session Chairs: Yuichi Hayashi & William Radasky	***Room 2***

	A Scheme to Improve SNR of Received EMI Signal from Information Display Device Eui Bum Lee, Dong-Hoon Choi, TaeSik Nam and Jong-Gwan Yook *Yonsei University, South Korea*	
	Investigation of the Effect of Temperature on Fault Injection Using Intentional Electromagnetic Interference Daisuke Fujimoto; Yuichi Hayashi *Nara Institute of Science and Technology, Japan*	
	A Study for Low Calculation Cost Side-Channel Resistance Prediction Based on Transfer Impedance of Leakage Path Kengo Iokibe; Yoshitaka Toyota; Masaki Himuro *Okayama University, Japan*	
	Analysis of Electromagnetic Information Leakage from Overdesigned Power Delivery Network of Cryptographic Devices Youngwoo Kim; Shinpei Wada; Daisuke Fujimoto; Yuichi Hayashi *Nara Institute of Science and Technology, Japan*	
	A Fundamental Evaluation of EM Information Leakage Induced by IEMI for a Device with Differential Signaling Shugo Kaji; Daisuke Fujimoto; Youngwoo Kim; Yuichi Hayashi *Nara Institute of Science and Technology, Japan*	
	A Study on Output Bit Tampering of True Random Number Generators Using Time-Varying EM Waves Saki Osuka; Daisuke Fujimoto; Arthur Beckers; Benedikt Gierlichs; Ingrid Verbauwhede; Yuichi Hayashi *Nara Institute of Science and Technology, Japan; KU Leuven, Belgium; ESAT/COSIC*	
	TC-01 EMC Management, Standards and Regulations Session Chairs: Dr. Ing. Deny Hamdani, M.Sc **EMC Regulation in Infrastructure Assurance (IAS) Telkom Indonesia** Kiswanto Kiswanto; Eddy Yuniarto *PT. Telekomunikasi Indonesia*	
15:10-17:30	**[SS-07] The Emerging Near-field/Far-field EMC Measurement and Modeling Technologies for Complex Electromagnetic Problems** Organizer(s): Richard Xian-Ke Gao & Xing-Chang Wei Session Chairs: Richard Xian-Ke Gao & Xing-Chang Wei	***Room 3***

	Research on Calibration Method of Horizontal Loop Magnetic Near-Field Probe Peng-Cheng Huang; Quan Huang *School of Electronics and Information South China University of Technology, Guangzhou; China Electronic Product Reliability and Environmental Testing Research Institute, Guangzhou, China*	
	Exploring the Effectiveness of Thin Microwave Absorber Applied in Parallel-Plate Waveguide Da Yi; Ming-Chun Tang; Xing-Chang Wei *Chongqing University, China; Zhejiang University, China*	
	Reactive Near-Field to 3-Meter Field Transformation Based on Artificial Neural Networks Zhi Yang; Jun-Jian Ju; Xing-Chang Wei; Guoping Zou *Zhejiang University, China; State Grid Zhejiang Electric Power Research Institute, China*	
	A Miniaturized Tri-Band Frequency Selective Surface for 5G Electromagnetic Shielding Jinghan Zhang; Liping Yan; Richard Xian-Ke Gao; Xiang Zhao *Sichuan University, China; A*STAR Institute of High Performance Computing, Singapore*	
	A Field Iterative Method for Efficient Source Reconstruction Based on Magnitude-Only and Single-Plane Near-Field Scanning Zou Jian; Xinxin Tian; Wenxiao Fang; Ruo He Yao *School of Electronics and Information South China University of Technology, China; Guangdong University of Technology, China; CEPREI Laboratory, China*	
	A Novel Waveguide Test Kit for Convenient Material Characterization Si-Ping Gao; Yong-xin Guo *National University of Singapore, Singapore*	
	Equivalent Radiation Source Reconstruction Based on Artificial Neural Network for Electromagnetic Interference Prediction Zhe Gao; Xiaochun LI; Junfa Mao *Shanghai Jiao Tong University, China*	

WEDNESDAY, 29 SEPTEMBER 2021
Time : Indonesian Central Time (GMT+8 Time Zone)

ROOM / TIME	Room 1	Room 2	Room 3
08:30-10:10	**TC-05 System Level EMC and Protection** Session Chairs: Dr. Richard Xian-Ke GAO, Prof. Xing-Chang Wei	**TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Er-Ping Li, Dr. En Xiao	**[SS-04] Power Electronics EMC Related to Motor Drive Systems** Organizer(s): Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao Session Chairs: Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao
10:10-10:20	**Break**		
10:20-12:00	**TC-03 Lightning** Session Chairs: Prof. Yoshihiro Baba, Prof. Vladimir Rakoy	**TC-09 IC and Semiconductor** **TC-10 Signal Integrity and Power Intensity** Session Chairs: Ding-Bing Lin, Prof. Wen Cheng Lai	**[SS-04] Power Electronics EMC Related to Motor Drive Systems** Organizer(s): Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao **TC-06 Transportation EMC, Automotive/Railway/Ship EMC** Session Chairs: Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao
12:00-13:00	**Lunch / ISC APEMC Virtual Lunch Meeting**		
13:00-14:40	**[SS-06] SCENT: EMC in Smart Cities via Power Electronics** Organizer(s): Muhammad Imam Sudrajat Session Chairs: Prof. David W.P Thomas & Prof. Robert Smolenski	**TC-04 High Power Electromagnetics** **TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Dr. William Radasky, Prof. Alistair Duffy	**TC-06 Transportation EMC, Automotive/Railway/Ship EMC** **TC-07 Aerospace EMC** Session Chairs: Prof. Sergio Pignari, Dr. Niek Moonen
14:40-15:00	**Break**		
15:00-17:00 (Room 1) **15:00-16:40 (Room 2&3)**	**TC-05 System Level EMC and Protection** Session Chairs: Dr. Richard Xian-Ke GAO & Prof. Xing-Chang Wei	**TC-09 IC and Semiconductor EMC** **TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Bernd Deutschmann	**TC-11 Computational Electromagnetics and Multiphysics Modeling** **TC-05 System Level EMC and Protection** Session Chairs: Prof. Paolo Manfredi, Prof. dr. ir. Frank Leferink

PARALEL SESSION ORAL PRESENTATION
DAY 3 (Wednesday, 29 September 2021)

Time	*Sessions*	*Room*
08:30-10:10	**TC-05 System Level EMC and Protection** Session Chairs: Dr. Richard Xian-Ke GAO, Prof. Xing-Chang Wei	*Room 1*
	Electromagnetic Interference (EMI) Cyber Attack Protective Measures in Modular Data Center (MDC) Shahriar Saadat *University of Washington, USA*	
	A Magnetic Field Cancelling System Design for Mitigating Extremely Low Frequency Magnetic Field in a High Tech Fab Hung-Yi Lin; Yu-Lin Song; Luh-Maan Chang *National Taiwan University, Taiwan; Asia University, Taiwan*	
	Modeling of Common Mode Current in Automotive Inverters Based on Norton Equivalent Circuits Jia Li *Yoshida-cho Totsuka-ku & Hitachi Ltd, Japan*	
	A Polarization-Insensitive Resistor-Free Ultrathin Absorber for Curved-Surface Objects Chien-Ju Chen; Chen-Ying Hsieh; Cheng-Nan Chiu; Yuan-Fu Ku; Ming-Kun Hsieh *Yuan Ze University, Taiwan; Taiwan Testing and Certification Center, Taiwan; Bureau of Standards, Metrology and Inspection (BSMI), Taiwan*	
	Stochastic Analysis of Braided-Shielded TWP/Twinax Cables with Random Nonuniform Shield Parameters Oussama Gassab; Jingxiao Li; Fang He; Qiwei Zhan; Wen-Yan Yin *Zhejiang University, China; Zhejiang Zhaolong Interconnect Technology Co., Ltd., China*	
08:30-10:10	**TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Er-Ping Li, Dr. En Xiao	*Room 2*
	Broadband Characteristic Impedance Extraction for Planar Transmission Lines on Lossy Substrates Chien-Chang Huang *Yuan Ze University, Taiwan*	
	Asymmetric Dual Bend Skew Compensation Technique for Reducing Differential to Common Mode Conversion Jianquan Lou; Juhi Garg; Alpesh Bhobe; Joel Goergen *CISCO, China; Cisco Systems India, India; CISCO, USA; Cisco Systems, Inc, USA*	

	Accurate Multi-Port De-Embedding of Crosstalk-Affected Fixtures for High Speed Devices Simone Scafati; Francesco de Paulis; Mike Resso; Tim Wang-Lee *University of L'Aquila, Italy; Keysight Technologies, USA*	
	Analysis of Ground Void Patterns for Differential Microstrip Impedance Matching on Surface Mount Pads Kuan-Ting Wu; Hank Lin; Bin-Chyi Tseng; Jackson Yen *ASUSTeK Computer Inc., Taiwan*	
	How the Type of Glass Fiber Cloth Affects Insertion Loss Jerry Syue; Huishan Tsai; Leo Guan; Ranger. Hsu; Doxon Wu *ITEQ Corporation, Taiwan*	
08:30-10:10	**[SS-04] Power Electronics EMC Related to Motor Drive Systems** Organizer(s): Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao Session Chairs: Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao	***Room 3***
	High-Frequency Modeling of Permanent Magnet Synchronous Motor Considering Internal Imbalances Yuandong Guo; Muqi Ouyang; Zhifel Xu; Hongseok Kim; Jun Fan; Junesang Lee; Jungrae Ha; Minho Kim; Sangwon Yun *Missouri University of Science and Technology, USA; Missouri University of Science and Technology & Electromagnetic Compatibility Laboratory (EMC), USA; Mando, South Korea*	
	Behavioural Modelling of Common-Mode Chokes with Frequency-Dependent Permeability Core Shaojun Huang; Kye Yak See; Fei Fan; R Simanjorang; Firman Sasongko *Nanyang Technological University, Singapore; Advanced Technology Centre, Rolls-Royce Singapore Pte. Ltd, Singapore; Rolls-Royce Electrical, Rolls-Royce Singapore Pte. Ltd, Singapore*	
	Impact of Motor Stator Winding Faults on Common-Mode Current Fei Fan; Zhenyu Zhao; Pengfei Tu; Jie Huamin; Kye Yak See *Nanyang Technological University, Singapore*	

	Measurement of In-Circuit Common-Mode Impedance at the AC Input of a Motor Drive System Zhenyu Zhao; Fei Fan; Arjuna Weerasinghe; Pengfei Tu; Kye Yak See *Nanyang Technological University, Singapore*	
10:10-10:20	**Break**	
10:20-12:00	**TC-03 Lightning** Session Chairs: Prof. Yoshihiro Baba, Prof. Vladimir Rakoy	***Room 1***
	Discussion on Lightning Indirect Effects Test of DO160 Yin Fang *Suzhou Three-ctest Electronic Co., Ltd., China*	
	Model for Surge Generator Transient Analysis and Immunity Improvement Investigation on Power Grid System Han-Nien Lin; Tzu-Hao Ho; Yu-Lin Tsai; Jie-Kuan Li; Wan-Yu Syu; Yueh-Hsun Lee; Yu-Ming Wei; Liang-Yang Lin; Jun Sheng Lao *Feng-Chia University, Taiwan; Bureau of Standards, Metrology & Inspection, Taiwan; Linkuo Lab. of Taiwan Testing and Certification Center, Taiwan*	
	Analysis of Lightning Environment of Radio Base Stations in Shenzhen Based on Lightning Locating System Li Wei; Yuanlong Liu *ZTE Corporation, China*	
	Lightning Strike EMP Effect on Local Grids Alexander Matthee; Peter William Futter; Robert Vogt-Ardatjew; Frank Leferink *University of Twente, The Netherlands; MiX Telematics, South Africa*	
	Comparison of LEMPs Computed Using Different Lightning Models Nao Kato; Yoshihiro Baba; Thang H. Tran; Vladimir Rakov *Doshisha University, Japan; National Institute of Technology, Tsuruoka College, Japan; University of Florida, USA*	
10:20-12:00	**TC-09 IC and Semiconductor** **TC-10 Signal Integrity and Power Intensity** Session Chairs: Prof. Ding-Bing Lin, Prof. Wen Cheng Lai **Integrated ADC and Low Noise PLL with Low-Dropout Regulator for Transformer Coupler Quadrature Hybrid Wireless Charging** Wen Cheng Lai *National Taiwan University of Science and Technology, Taiwan*	***Room 2***

	Technique of Measuring Injection Locking of VCO Yin-Cheng Chang; Ta-Yeh Lin; Chaoping Hsieh; Mao-Hsu Yen; Yih-Hsia Lin; Yan-Wei Yu; Yuan-Fu Ku; Che-Wei Chang; Shuohung Hsu; Da-Chiang Chang *Taiwan Semiconductor Research Institute, National Applied Research Laboratories, Taiwan; National Taiwan Ocean University, Taiwan; Ming Chuan University, Taiwan; Taiwan Testing and Certification Center, Taiwan; Bureau of Standards, Metrology and Inspection, Taiwan; National Tsinghua University, Taiwan; Chip Implementation Center, National Applied Research Laboratories, Taiwan* **Effect of Feed Forward Equalization on EMI-Related Common Mode Noise in 56-Gbps PAM-4 Optical Transmitter** Rehan Azmat; Patrick Yue *Hong Kong University of Science and Technology, Hong Kong* **A Broadband Common-Mode Filter by Using Dual Band Transmission Zero** Cheng-Yi Zhuang; Tjahjo Adiprabowo; Ding-Bing Lin; Yen-Hao Chen; You-Hao Zheng; Bo-Hung Tsai; Aloysius Adya Pramudita *National Taiwan University of Science and Technology; Inventec Corporation, Taiwan; Telkom University, Indonesia* **Comparison Among Types of CSRR DGS RCMF** Tjahjo Adiprabowo; Ding-Bing Lin; Cheng-Yi Zhuang; Aloysius Adya Pramudita *National Taiwan University of Science and Technology, Taiwan; Telkom University, Indonesia*	
10:20-12:00	**[SS-04] Power Electronics EMC Related to Motor Drive Systems** Organizer(s): Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao **TC-06 Transportation EMC, Automotive/Railway/Ship EMC** Session Chairs: Kye Yak See, Eng Kee Chua, Fei Fan & Zhenyu Zhao **In-Circuit Differential-Mode Impedance Extraction at the AC Input of a Motor Drive System** Arjuna Weerasinghe; Zhenyu Zhao; Fei Fan; Pengfei Tu; Kye Yak See *Nanyang Technological University, Singapore*	***Room 3***

	Noise Suppression Using a New Mode Conversion Method on an Asymmetric Boost Converter Retsu Sugawara *Mitsubishi Electric Corporation, Japan* **Research of Interference in the Operational Current of DC Motors of Railway Switch Points** Tetiana Serdiuk *Dnipro National University of Railway Transport named after Academician V. Lazaryan, Ukraine* **Model of Propagation of Traction Current Harmonics from Trains to a Track Circuit Receiver** Volodymyr Havryliuk *Dnipro National University of Railway Transport named after Academician V. Lazaryan, Ukraine*	
12:00-13:00	**Lunch**	
13:00-14:40	**[SS-06] SCENT: EMC in Smart Cities via Power Electronics** Organizer(s): Muhammad Imam Sudrajat Session Chairs: Prof. David W.P Thomas & Prof. Robert Smolenski	***Room 1***
	Why Not(ch) Daria Nemashkalo; Niek Moonen; Frank Leferink *University of Twente, the Netherlands*	
	Characteristic of Conducted EMI in Compact Fluorescent Lamps Application Assessment Based on CISPR-11 Choon Long Lok; Muhammad Ammar Wibisono; Niek Moonen; Robert Smolenski *University of Zielona Gora, Poland; University of Twente, the Netherlands; Institut Teknologi Bandung, Indonesia*	
	Sensitivity Analysis of Parasitics in Power Electronic Circuit Through Sobol' Indices Karol Niewiadomski; Angel Eduardo Pena-Quintal; David Thomas; Sharmila Sumsurooah *University of Nottingham, U.K*	
	Low-Frequency Envelope of DC/DC Converters Due Differences in the Control Hardware Features Waseem Elsayed; Hermes Loschi; Amr Madi; Niek Moonen; Robert Smolenski; Frank Leferink *University of Zielona Gora, Poland; University of Twente, the Netherlands*	
13:00-14:40	**TC-04 High Power Electromagnetics** **TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Dr. William Radasky, Prof. Alistair Duffy	***Room 2***

	Evaluation of Overvoltages Transmitted in High Power Transformer Windings at Lightning During the Design Stage Petre Marian Nicolae; Marian-Stefan Nicolae; Maria-Cristina Nitu *University of Craiova, Romania; Research Institute ICMET, Romania* **Time Reversal for Partial Discharge Localization on Power Lines with Different Termination Impedances** Antonella Ragusa; Hugh Sasse; Alistair Duffy *De Montfort University, United Kingdom (Great Britain)*	
	A Study of Conduction Noise Suppression Control for Two-Motor Drive Systems Shota Hanioka; Masahiro Iezawa; Satoshi Ogasawara *Mitsubishi Electric Corporation, Japan; Hokkaido University, Japan* **Current Emissions Generated by Dimmed Lighting Equipment of Different Technologies** Bas ten Have; Niek Moonen; Frank Leferink *University of Twente, the Netherlands* **The Effects of Falling and Rising Edge Dimming on Static Energy Meter Errors** Tom Hartman; Roelof Grootjans; Niek Moonen; Frank Leferink *University of Twente, the Netherlands*	
13:00-14:40	**TC-06 Transportation EMC, Automotive/Railway/Ship EMC** **TC-07 Aerospace EMC** Session Chairs: Prof. Sergio Pignari, Dr. Niek Moonen **Optimization Methods for Common Mode Cancellation in Phase Shifted Inverter Operation** Jonas Bertelmann; Michael Beltle; Stefan Tenbohlen *University of Stuttgart, Germany*	***Room 3***
	Application of the CRLH-Based Antenna to Improve Aerospace EMI Daichi Hirahara *Japan Aerospace Exploration Agency, Japan*	

	Electromagnetic Scattering Reduction for Conical Objects Jian-Wei Guan; Cheng-Nan Chiu; Chien-Ju Chen; Yu-Chou Chuang; Yuan-Fu Ku; Ming-Kun Hsieh *Yuan Ze University, Taiwan; Taiwan Testing and Certification Center, Taiwan; Bureau of Standards, Metrology and Inspection (BSMI), Taiwan* **Measurements of Undesired Radio Waves Nearby a Compact Drone** Koh Watanabe; Mai Aoi; Misaki Komatsu; Satoshi Tanaka; Makoto Nagata *Kobe University, Japan* **The Impact of Flight Profiles Towards EMC on All-Electric Aircraft** Leonardo C Malburg; Frank Leferink; Niek Moonen *University of Twente, the Netherlands*	
14:40-15:00	**Break**	
15:00-17:00	**TC-05 System Level EMC and Protection** Session Chairs: Dr. Richard Xian-Ke GAO, Prof. Xing-Chang Wie	***Room 1***
	Loop-To-Loop Close-Range EM Signal Transfer Through a Conducting Thin Sheet - an Analytical Study Based on the Cagniard-DeHoop Technique Martin Štumpf; Petr Kadlec; Tomas Dolezal *Brno University of Technology, Czech Republic*	
	Reconstructing the Material Properties of a Scalar Metasurface - A Stochastic Optimization Approach Petr Kadlec; Martin Štumpf; Tomas Dolezal *Brno University of Technology, Czech Republic*	
	Shielding Effectiveness of Volume Materials Monika Ewelina Szafranska; Zbigniew Jóskiewicz; Jarosław Janukiewicz *Wroclaw University of Science and Technology, Poland*	
	Transmission Line Model of Field-To-Wire Coupling with Transmission Line Cables from near and Far Field Sources Jingxiao Li; Oussama Gassab; Fang He; Zhizhen Su; Jie Liao; Qiwei Zhan; Wen-Yan Yin *Zhejiang University, China; Zhejiang Zhaolong Interconnect Technology Co., Ltd., China*	
	A SPICE Model for a Field-Coupled Conductor Based on the Scattered Voltage Formulation Moustafa Raya; Sergey V. Tkachenko; Ralf Vick *Otto-von-Guericke University, Magdeburg, Germany*	

	Transmission Line Model of Field-To-Wire Coupling with Transmission Line Cables from near and Far Field Sources Jingxiao Li; Oussama Gassab; Fang He; Zhizhen Su; Jie Liao; Qiwei Zhan; Wen-Yan Yin *Zhejiang University, China; Zhejiang Zhaolong Interconnect Technology Co., Ltd., China*	
15:00-16:40	**TC-09 IC and Semiconductor EMC** **TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Bernd Deutschmann **A Generalisable Component-Level ESD Failure Characterisation for TLP Measurements** Patrick Schrey *Graz University of Technology & Institute of Electronics, Austria* **IC-Package Optimization for Conducted EME Performance: Impact of Discrete Decoupling Capacitors and Parasitic Inductive Effects** Aurora Sanna; Giovanni Graziosi *STMicroelectronics, Italy* **Influence of Layout Parasitics on EMI Improved Folded Cascode Amplifier Input Stages Using Filtering and Linearisation Methods** Dominik Zupan; Nikolaus Czepl; Bernd Deutschmann *Graz University of Technology, Austria* **A Broadband, High Common-Mode Rejection Ratio Instrumentation Amplifier** Marcel J. van der Horst *Amsterdam University of Applied Sciences, The Netherlands* **3D Full-Wave Simulation of Stub Length Effect of Vias in High Speed PCB Design** Eric Steenbergen; Niek Moonen; Frank Leferink *University of Twente, the Netherlands*	***Room 2***
15:00-16:40	**TC-11 Computational Electromagnetics and Multiphysics Modeling** **TC-05 System Level EMC and Protection** Session Chairs: Prof. Paolo Manfredi, Prof. dr. ir. Frank Leferink	***Room 3***

	Compressed Stochastic Macromodeling of Electrical Systems via Rational Polynomial Chaos and Principal Component Analysis Paolo Manfredi; Stefano Grivet-Talocia *Politecnico di Torino, Italy* **Improved Unscented Kalman Filter Algorithm Adapted to the State Under Non-Common View** Runjia Su *Harbin Engineering University, China*	
	System Identification of a Branched 50 Ohm Network by Transient Excitation Felix Burghardt; Nico Feige; Heyno Garbe *Leibniz Universität Hannover, Germany* **Prediction of Radiated Emission with Transmission Line Model for CISPR 25** Sayantan Dhar; Kaushik Patra; Shynu Nair; Lohith Kumar; Shibu Krishnan; Bibhu Prasad Nayak *Robert Bosch Engineering & Business Solutions, India* **Board Level Shielding Effectiveness Measurements Using the Dual VIRC** Vasiliki Gkatsi; Robert Vogt-Ardatjew; Hans Schipper; Frank Leferink *University of Twente, the Netherlands; THALES, the Netherlands*	

THURSDAY, 30 SEPTEMBER 2021
Time : Indonesian Central Time (GMT+8 Time Zone)

ROOM TIME	Room 1	Room 2	Room 3
08:30-09:50 (Room 1) **08:30-10:10 (Room 2&3)**	**TC-04 High Power Electromagnetics** Session Chairs: Dr. Eng. Achmad Munir	**TC-02 EMC Measurements and EM Environment** Session Chairs: Prof. Wen-Yan Yin	**TC-11 Computational Electromagnetics and Multiphysics Modeling** **TC-12 Bio-Medical Electromagnetics & Wearable Devices EMC** Session Chairs: Prof. Lijun Jiang, Prof. Jianging Wang
10:10-10:20	**Break**		
10:20-12:00	**TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Er-Ping Li	**TC-02 EMC Measurements and EM Environment** Session Chairs: Prof. Wen-Yan Yin, Prof. Jianfei Wu	**TC-11 Computational Electromagnetics and Multiphysics Modeling** Session Chairs: Prof. Lijun Jiang, Prof. Gamantyo Hendrantoro
12:00-13:00	**Lunch**		
13:00-14:40	**TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Prof. W. H. Siew	**TC-02 EMC Measurements and EM Environment** Session Chairs: Dr. Ken Kawamata, Mr. Tomas Hurtig	**TC-11 Computational Electromagnetics and Multiphysics Modeling** Session Chairs: Prof. Lijun Jiang, Prof. Jianging Wang
14:40-15:00	**Break**		
15:00-17:00	**TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Prof. W. H. Siew, Prof. Fransesca Maradei	**TC-02 EMC Measurements and EM Environment** Session Chairs: Prof. Wen-Yan Yin, Prof. Osami Wada, Dr. Eng. Achmad Munir	**TC-13 Wireless Communication EMC** Session Chairs: Prof. Gamantyo Hendrantoro
18:00-18:30	**Best Student Paper Awards** **Given by : TPC Chair and TPC Co-Chair**		

PARALEL SESSION ORAL PRESENTATION
DAY 4 (Thursday, 30 September 2021)

Time	*Sessions*	*Room*
08:30-09:50	**TC-04 High Power Electromagnetics** Session Chairs: Dr. Eng. Achmad Munir **Simulation Model for Evaluation of IEMI Threat on Electrical Substation** Fei Fan; Kye Yak See *Nanyang Technological University, Singapore* **High Frequency Power Combiner of Two Magnetrons Based on the E-Plane Y-Structure Waveguide** Saowalak Siribunkun *Suranaree University of Technology, Thailand* **Simulation and Experimental Study on Electromagnetic Heating for Heavy Oil Stimulation** Gerry Sasanti Nirmala; John Hery Tuah Ramadhan; Astrie Kusuma Dewi; Doddy Abdassah; Taufan Marhaendrajana; Achmad Munir *Bandung Institute of Technology; Polytechnic of Energy And Mineral, Indonesia* **Switching Noise Analysis for Conducted Electromagnetic Interference from of Power Electronic Module** Han-Nien Lin; Tzu-Hao Ho; Po-Ning Ko; Yu-Lin Tsai; Huei-Chun Hsiao; Yen-Ting Lin; Sung-Mao Wu; Liang-Yang Lin; Jun Sheng Lao *Feng-Chia University, Taiwan; National Kaohsiung University, Taiwan; Bureau of Standards, Metrology & Inspection, Taiwan; Linkuo Lab. of Taiwan Testing and Certification Center, Taiwan*	***Room 1***
	TC-02 EMC Measurements and EM Environment Session Chairs: Prof. Wen-Yan Yin **Portable, Shielded, Repeatable and Adjustable Cable Shielding Effectiveness Tester** Francis L Bongo *Lexmark Research and Development, Corp., Philippines* **Radiated Noise Dominancy Analysis by Extended Double Pulse Test and Power Device Optimization for Inverter Use** Toshiya Tadakuma; SeongHong SH Lim; Koichi Nishi; Michael Rogers; Motonobu Joko; Masahito Shoyama	

08:30-10:10	*Kyushu University, Japan; Mitsubishi Electric Asia Pte Ltd, Singapore; Mitsubishi Electric Corporation, Japan; Mitsubishi Electric US, USA*	***Room 2***
	Research on Vehicle AC Charging EMC Test Method for Isolating the Influence of Charging Equipment Kaiyi Sun; Yue Zhang; Chen Guo; Jiandong Guo *China Automotive Test Center(Tianjijn) Co., Ltd, China; CATARC, China; CATARC Automotive Test Center (Tianjin) Co., Ltd., China*	
	A New Measurement Method for Electromagnetic Parameters of Flexible Materials in Low Frequency Band Mingjie Sheng; Zhongyuan Zhou; Yixing Gu; Qi Zhou; Yang Xiao; Feng Tian *Southeast University, China*	
	Design and Evaluation of Long Hexagonal Folded Antenna Toshi-ya Ishizaki; Keita Kobayashi; Shinobu Ishigami; Ken Kawamata; Katsushige Harima; Shingo Inori *Graduate School of Engineering, Japan; Tohoku Gakuin University, Japan; National Institute of Information and Communications Technology, Japan; Elena Electronics Co. Ltd., Japan*	
08:30-10:10	**TC-11 Computational Electromagnetics and Multiphysics Modeling** **TC-12 Bio-Medical Electromagnetics & Wearable Devices EMC** Session Chairs: Prof. Lijun Jiang, Prof. Jianging Wang	***Room 3***
	EM Performance of Segmented Diverter Strips Used in Lightning Protection of Wind Turbine Blades Yijie Zheng; Ana Vukovic; Phillip Sewell; Allen Hall *University of Nottingham, United Kingdom (Great Britain); Weather Guard Lightning Tech, USA*	
	Effect of Cable-Bend on CISPR25 CE Current Method Bibhu Prasad Nayak *Simyog Technology Pvt. Ltd, India*	
	Time-Frequency Analysis in EEG for the Treatment of Major Depressive Disorder Using rTMS Mehran Nikravan; Mahdi Masoudi Moqaddam; Elias Ebrahimzadeh	

	Shiraz University, Iran; Ahvaz Jondishapour University of Medical Science, Iran; University of Tehran, Iran & University of Calgary, Canada **EMF Characteristic Inside the Infant Incubator Compartment** Wuwus Ardiatna; Siddiq Wahyu Hidayat; Hutomo Wahyu Nugroho; Ihsan Supono; Irawan Sukma; Dwi Mandaris *Research Center for Testing Technology, Indonesian Institute of Sciences, Indonesia* **Design and Development of Biosensor Microstrip Antenna at 2.45 GHz** Yusnita Rahayu; Meilita Kurniati; Inesti Qodriyah *Universitas Riau, Riau, Indonesia*	
10:10-10:20	**Break**	
10:20-12:00	**TC-10 Signal Integrity and Power Integrity** Session Chairs: Prof. Er-Ping Li **Characterization of Polygonal Planar Loop Probe for Near-Field Measurement Application** Haryo Dwi Prananto; Priyo Wibowo; Tyas Ari Wahyu Wijanarko; Wuwus Ardiatna; Harry Arjadi; Achmad Munir *Research Center for Testing Technology, Indonesian Institute of Sciences, Indonesia; Bandung Institute of Technology, Indonesia* **[SS-02] Hardware security issue due to EM passive/active attacks on devices complying EMC standards** Organizer(s): Yuichi Hayashi & William Radasky **TC-14 Nanotechnology and New Materials** Session Chairs: Yuichi Hayashi & William Radasky **Study on Measurement Resolution of Side-Channel Waveform in Correlation Power Analysis** Hideaki Sone; Kohei Utsumi; Yuichi Hayashi; Takaaki Mizuki *Tohoku University, Japan; Nara Institute of Science and Technology, Japan* **Fundamental Study on Evaluating Immunity of RO-Based TRNGs Against Frequency Injection Attack** Riki Hashimoto; Daisuke Fujimoto; Yuichi Hayashi *Nara Institute of Science and Technology, Japan*	***Room 1***

	Shielding Effectiveness of Conductive CFRP with Copper-Plated Fibre Jin Ann Toh; Neelakantam Venkatarayalu; Viet Phuong Bui; Warintorn Thitsartarn *University of Glasgow Singapore, Singapore; 10 Dover Drive & Singapore Institute of Technology, Singapore; Institute of High Performance Computing, Singapore; A *STAR Singapore, Singapore* **Design of Millimeter-Wave Patch Array by Using TSV-Based III-V IPD Technology** Ta-Yeh Lin; Shuw-Guann Lin; Yin-Cheng Chang; Chaoping Hsieh; Mao-Hsu Yen; Yih-Hsia Lin; Yan-Wei Yu; Yuan-Fu Ku; Che-Wei Chang; Da-Chiang Chang *Taiwan Semiconductor Research Institute, National Applied Research Laboratories, Taiwan; National Taiwan Ocean University, Taiwan; Ming Chuan University, Taiwan; Taiwan Testing and Certification Center, Taiwan; Bureau of Standards, Metrology and Inspection, Taiwan; Chip Implementation Center, National Applied Research Laboratories, Taiwan*	
10:20-12:00	**TC-02 EMC Measurements and EM Environment** Session Chairs: Prof. Wen-Yan Yin, Prof. Jianfei Wu	***Room 2***
	Research on an Optimized Recording Method of Actual Electromagnetic Environment Signal Yue Zhang; Shuai Hou *CATARC, China*	
	Detection and Correction of Scanning Attitude of EMF Meter Using Machine Learning Ken Sato; Takumi Miura; Yoshitsugu Kamimura *National Institute of Technology, Hachinohe College, Japan; Utsunomiya University, Japan*	
	Verification of Using 150-Ohm Δ-AN Specified in Clause 4.7 of CISPR 16-1-2 for Measuring Conducted Emissions on AC Mains Power Ports Nozomi Miyake; Motoki Yoshida; Hidenori Muramatsu *NEC Coroporation, Japan; Panasonic Corporation, Japan; VCCI Council, Japan*	
	Correlation Between Measured Wideband Ratio-Frequency Electromagnetic Radiation and the Area of Buildings Xinwei Song; Ruofan Li; Yuntao Yue; Shanshan Wan *Beijing University of Civil Engineering and Architecture, China*	
	An Optimized Test Method Based on IC-Stripline TEM Cell	

	Chen Ledong; Jianfei Wu; Hongli Zhang; Yifei Zheng; Wu Jianyu *National University of Defense Technology, China; Tianjin Institute of Advanced Technology, China; National University of Defense Technical, China; KunPeng Company, China*	
10:20-12:00	**TC-11 Computational Electromagnetics and Multiphysics Modeling** Session Chairs: Prof. Lijun Jiang, Prof. Gamantyo Hendrantoro	***Room 3***
	Performance Analysis of PLA-Based EMI Shield Material for MALE UAV Application Agus Wahyudi; Nurul Muzayadah; Abdurrasyid Ruhiyat; Imas Setyadewi; Encung Sumarna; Astrie Kusuma Dewi; Gerry Sasanti Nirmala; John Hery Tuah Ramadhan; Achmad Munir *National Institute of Aeronautics and Space, Indonesia; Polytechnic of Energy And Mineral, Indonesia; Bandung Institute of Technology, Indonesia*	
	Study of Radiated Emission from an Automotive Touchscreen System - A Simulation Driven Approach Anant Devi; Ihor Musijchuk; Bibhu Prasad Nayak *Simyog Technology Pvt Ltd, India; Infineon Technologies AG, Ukraine*	
	Stochastic Transmission Line Analysis via Least Squares Polynomial Chaos Regression Weiwei Chen; Xiang Zhao; Liping Yan; Fan Rong *Sichuan University, China*	
	Bandwidth Enhancement of Wideband Sensor Using Triangle-To-Oval Patch Geometric Change for EMC Measurement Agus D. Prasetyo; Achmad Munir *Bandung Institute of Technology (ITB), Indonesia*	
12:00-13:00	**Lunch**	
13:00-14:40	**TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Prof. W. H. Siew	***Room 1***
	Parasitics Analysis in the Power and Gate Driver Loops and Impact on the Ringing of SiC MOSFETs Desmon Petrus Simatupang; Ilman Sulaeman; Niek Moonen; Jelena Popovic; Frank Leferink *University of Twente, The Netherlands; Klimop Energy, the Netherlands*	

	Source and Load Impedance Mismatch Analysis of a Power Line Filter in Microgrid Application Ilman Sulaeman; Desmon Petrus Simatupang; Niek Moonen; Jelena Popovic; Frank Leferink *University of Twente, The Netherlands; Klimop Energy, the Netherlands*	
	Susceptibility of Power Line Communication (PLC) Channel to DS, AM and Jamming Intentional Electromagnetic Interferences Arash Nateghi, MEng; Martin Schaarschmidt; Sven Fisahn *Leibniz Universität Hannover, Germany; Wehrwissenschaftliches Institut für Schutztechnologien - ABC-Schutz (WIS), Germany*	
	Super High Resolution Time-Frequency Analysis of Switching Noise Which Emitted on Power Line Fumihiko Ishiyama; Masato Maruyama *NTT, Japan*	
	An Approach to Predict Conducted Noise from DC/DC Converter Considering Switching Fluctuation Shuqi Zhang; Kengo Iokibe; Yoshitaka Toyota *Okayama University, Japan*	
13:00-14:40	**TC-02 EMC Measurements and EM Environment** Session Chairs: Dr. Ken Kawamata, Mr. Tomas Hurtig	***Room 2***
	Experimental Observations of the Minimum Dwell Time for Radiated Immunity Tests in a Vibrating Intrinsic Reverberation Chamber Danilo Izzo; Robert Vogt-Ardatjew; Frank Leferink *University of Twente, the Netherlands*	
	Improved Field Uniformity over Metallic Table in Military Radiated Susceptibility Testing by Adjusting Lengths of Antenna Elements and Test Table Soydan Cakir; Osman Sen; Bahadir Tektaş; Mesut Ozturk; Aykut Ayaydin *TUBITAK UME, Turkey*	
	Analysis of Metamaterial Walls Reverberation Chamber by Using Modal Expansion Theory Jeudy Kean; Nathalie Raveu; Hamza Kaouach; Kosorl Thourn; Sokchenda Sreng *Toulouse INP, France; Laplace - Université de Toulouse - UPS INPT CNRS, France; Université Férérale Toulouse Midi-Pyrénées, France; Institute of Technology of Cambodia, Cambodia*	
	Proposal of Radiated Disturbances Measurements Above 30 MHz for Large-Scale Electric Equipment Tatsuru Itsukaichi; Shinobu Ishigami; Ken Kawamata; Yasutoshi Yoshioka	

	Tohoku Gakuin University, Japan; Fuji Electric Europe GmbH, Germany	
	Influence of Mean and Peak Power on HPEM Susceptibility Tests of a Reference Test Setup Hanna Sundberg; Mattias Elfsberg; Tomas Hurtig; Sten Nyholm *Swedish Defence Research Agency - FOI, Sweden*	
13:00-14:40	**TC-11 Computational Electromagnetics and Multiphysics Modeling** Session Chairs: Prof. Lijun Jiang, Prof. Jianging Wang **Study on Shielding Effectiveness Based on the Modeling of a Shielded Enclosure** Petre Marian Nicolae; Ileana-Diana Nicolae; Livia-Andreea Dina; Marian-Stefan Nicolae *University of Craiova, Romania* **Extraction of Single Cell Impedance from Battery Pack Measurement by Simulation-Based Multiport De-Embedding** Herbert Hackl; Martin Ibel; Bernhard Auinger *Silicon Austria Labs GmbH, Austria* **SPICE-Based Lumped Circuit Model of Shielded Multiconductor Cables** Moustafa Raya; Mathias Magdowski; Ralf Vick *Otto-von-Guericke University, Magdeburg, Germany* **The Analytical Method for Pulse EMI Analysis in Shielded Cables** Maksim M. Tomilin *Moscow Aviation Institute, Russia*	***Room 3***
	Numerical Study of Facial Nerve Stimulation After Cochlear Implant Surgery Junaid Sadrach; Ursula van Rienen *University of Rostock, Germany*	
14:40-15:00	**Break**	
15:00-17:00	**TC-08 Smart Grid and Low Frequency EMC** Session Chairs: Prof. W. H. Siew, Prof. Fransesca Maradei	***Room 1***
	Measurement of LiFePO4 Battery Modal Impedances Under Different Conditions Enrico Mazzola; Alessandro Amaducci; Edoardo Franchi Bononi; Valentino Antonio Montanaro *Schaffner EMV AG, Switzerland; Automoive Industry, Germany*	

	Active Transient EMI Stabilization Boy Ihsan; Alexander Matthee; Frank Leferink; Tri Desmana Rachmilda; Deny Hamdani *Institut Teknologi Bandung, Indonesia; University of Twente, The Netherlands*	
	Comparative Analysis of Conducted Emission of Off-Grid PV Inverter Using Different DC-LISNs Yudhistira Yudhistira; Dwi Mandaris; Yoppy Yoppy; Deny Hamdani; Tri Desmana Rachmilda; Ferdaus Ario Nurman *Indonesian Institute of Sciences, Indonesia; School of Informatics and Electrical Engineering, Bandung Institute of Technology, Indonesia; PT. LEN Industri (Persero), Indonesia*	
	Magnetic Field Emission of Automotive Inductive Charging Systems in the 9 kHz - 30 MHz Range Manuel Haug; Michael Beltle; Stefan Tenbohlen *Institute of Power Transmission and High Voltage Technology, Germany; Universität Stuttgart, Germany*	
	Identification of Harmonic Current at Off-Grid PV Inverters Connected to the Load Yudhistira Yudhistira; Prayoga Bakti; Tyas Ari Wahyu Wijanarko; Dwi Mandaris *Indonesian Institute of Sciences (LIPI), Indonesia*	
	Dynamic Wireless Power Transfer in Urban Area: EMI on Traffic Signal Cables Silvano Cruciani; Tommaso Campi; Francescaromana Maradei; Mauro Feliziani *Sapienza University of Rome, Italy; University of L'Aquila, Italy*	
15:00-17:00	**TC-02 EMC Measurements and EM Environment** Session Chairs: Prof. Osami Wada, Dr. Eng. Achmad Munir	***Room 2***
	Quantitative Interlaboratory Comparison of Radiated Immunity Test for On-Board Equipment Takanori Uno; Koji Maeda; Hironori Okamoto; Mitsuo Kaiyama; Osami Wada *DENSO EMC Engineering Service Corporation & DENSO Corporation, Japan; Aisin Corporation, Japan; Kansai Electronic Industry Development Center, Japan; Bureau Veritas Japan Co., Ltd., Japan; Kyoto University & Graduate School of Engineering, Japan*	
	Development of a TEM Cell with 2 m in Height Yixing Gu; Zhongyuan Zhou; Yunfen Chang *Southeast University, China; Research Institute of Chemical Defence, China*	
	Development of Wideband Discone Antenna for Medical Devices Interference Haryo Dwi Prananto; Achmad Munir	

	Indonesian Institute of Sciences (LIPI), Indonesia; Bandung Institute of Technology (ITB), Indonesia	
	Studying the Probability of EMI Through Time-Variance Behavior of Environment on Medical Devices Mumpy Das; Robert Vogt-Ardatjew; Bärbel van den Berg; Frank Leferink *University of Twente, The Netherlands; Medisch Spectrum Twente, The Netherlands*	
	Investigating the EMC Performance of a Matrix Converter and Measures to Improve It Nancy Omollo; Robert Vogt-Ardatjew; Frank Leferink; Jan-Kees van der Ven *University of Twente, The Netherlands; RH Marine NL, The Netherlands*	
	Influence of a MST Probe on the Measured Field Compared to a Classical Dipole Probe Andrzej Sowa; Robert Vogt-Ardatjew; Ikuko Mori Wroclaw University of Technology, Poland; University of Twente, The Netherlands; National Institute of Technology, Japan	
15:00-17:00	**TC-13 Wireless Communication EMC** Session Chairs: Prof. Gamantyo Hendrantoro	***Room 3***
	A Draft of New Japanese Guidelines for Hospital Building Construction to Insure the Safe Introduction of Wireless Communication Systems Eisuke Hanada; Tetsuo Endo; Hiroyuki Sakakibara; Takehiro Tsuruta; Yoshiya Muraki; Hidenao Atarashi; Manabu Kawabe *Saga University, Japan; Taisei Corporation, Japan; Kandenko Co., ltd., Japan; Takenaka Corporation, Japan; Seisa University, Japan; University of Tokyo Hospital, Japan; Saitama Medical University, Japan*	
	Summary of EMC Test Standards for Wireless Power Transfer Systems of Electric Vehicles Li Jiang *CATARC, China*	
	FPGA-Based Design and Implementation of High-Speed Spatial Adaptive Processing Zhongpu Cui; Yongcai Liu; Yaxing Li; Meng Jin; Wang YaChen *Naval University of Engineering, China*	
	Channel Discrepancies Adaptive Modulation Recognition Using Domain Adversarial Training Yaxing Li; Hao Wu; Ying Kang; Yu Guo; Zhongpu Cui; JinLing Xing; Qing Wang; Meng Jin *Naval University of Engineering, China*	

	A Circularly Polarized Planar Antenna Having High Gain and Shielding Effectiveness Yi Chen Deng; Cheng-Nan Chiu; Yu-Chou Chuang; Yuan-Fu Ku; Ming-Kun Hsieh *Yuan Ze University, Taiwan; Taiwan Testing and Certification Center, Taiwan; Bureau of Standards, Metrology and Inspection (BSMI), Taiwan*	
	Characteristic Investigation of Dome-Shaped Patch Antenna as Wearable EMI Sensor Edwar Edwar; Sri Ayu Amalia; Heroe Wijanto; Agus D. Prasetyo; Muhammad Dzaky Ivansyah; Achmad Munir *Telkom University, Indonesia; Institut Teknologi Bandung, Indonesia*	

X. PAPER ABSTRACT

[SS-01] ESD and Transients

Development of Immunity Test Method for LongDuration Induced Noise on a Wearable Devices by Electrostatic Discharge
Musashi Tanaka, Takahiro Yoshida
Tokyo University of Science, Japan

In practical applications of wearable devices, there is a situation where the human body and devices are charged to high voltage, and their potential rapidly drops when electrostatic discharge (ESD) from the human body to a surrounding object occurs. In our previous study, we measured ESD stress induced on a portable oscilloscope held by a charged human when ESD occurs from the fingertip of the human to a surrounding object. We found that the duration of the induced noise on the wearable device is very long (ten to hundred microsecond order) when the input circuit of the wearable device exhibited high impedance. The noise could cause wearable devices malfunction due to its long duration. However, an immunity test on the long-duration noise is difficult because a charged human body is required for measuring the long-duration induced noise. In this study, we developed immunity test methods for long- duration induced noise. The methods do not require the human body. Method A uses an ESD gun and high-voltage relay and Method B uses a high- voltage DC power supply and high-voltage relay to simulate the charging of the human body and ESD from the charged human body. We confirmed that the proposed immunity test methods are effective.

Distance Characteristics of Transient Magnetic Field Caused by ESD in Sphere-Gap
Kento Kato[1], Ken Kawamata[1], Shinobu Ishigami[1], and Osamu Fujiwara[2]

[1] Graduate School of Engineering, Tohoku Gakuin University, 1-13-1, Chuo, Tagajo, Miyagi, 985-8537 Japan
[2] Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya, Aichi, 466-8555 Japan

The electromagnetic noise of the ESD (electrostatic discharge) events shows impulsive transients and becomes a source of wide-band electromagnetic noise. To discuss the EM radiation mechanism due to ESD, transient magnetic field was measured to consider the distance characteristics of peak value of transient magnetic field. It was confirmed that the transient magnetic field attenuated according to 1/d^2 of the distance d in the vicinity of the discharge point and attenuated according to 1/d in a far distance.

Development and evaluation of ultra-wideband antenna for measurement of transient electromagnetic fields

Shinobu Ishigami [1], Toshi-ya Ishizaki[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 Electronics Co. Ltd., Japan

In this paper, we introduce a new type of microwave broadband antenna developed for measuring transient electromagnetic fields from an electrostatic discharge (ESD) event and show the measurement results of its complex antenna factor.

Observation of Peeling discharge phenomenon by ultra-high sensitivity ultraviolet camera

Takayoshi Ohtsu[1], Takami Hasegawa[2], Ryuji Osawa[3]
[1]National Institute of Technology, Numazu College, Japan
[2]Bluevision Ltd., Japan
[3]SEIKOH GIKEN Co., Ltd., Japan

Observation of low energy discharge phenomena is important in identifying the cause and confirming the effect of the countermeasure technology as the electrostatic resistance of the electronic equipment decreases. As the low energy discharge, the discharge phenomenon due to peeling charge occurs in various processes such as the transfer of adhesive tape, protective film, and glass substrate for liquid crystal panel, so detailed elucidation of not only the charge phenomenon but the discharge phenomenon is desired. In this study, we observed the electrostatic discharge phenomenon using an ultra-high sensitivity ultraviolet camera and an optical electric field sensor. In this paper, it reports about the peeling speed dependence of the micro gap discharge by the peeling charge of an adhesive tape with or without ground.

[SS-02] : Hardware security issue due to EM passive/active attacks on devices complying EMC standards

Board-Level Hardware Trojan Detection Using Sensing Function of On-Board ICs in IT Devices

Masahiro Kinugawa[1], Yuichi Hayashi[2]
[1]The University of Fukuchiyama, Japan
[2]Nara Institute of Science and Technology, Japan

Board-level hardware trojan (HT) threats differ from IC-level HT continue even after the information technology (IT) device has shipped. Therefore, the authenticity of the IT devices requires lifetime monitoring of their circuit. This study investigates the monitoring method using a microcontroller with a touch sensing function on the circuit boards of IT devices. We showed that it is possible to detect electrical characteristics that change with the insertion of HT using only the touch sensor in the microcontroller.

An Analysis of Video Signal Using Double-Endedmode in Perspective of EMI

Dong-Hoon Choi, TaeSik Nam, Eui Bum Lee, Jong-Gwan Yook
Yonsei University, Republic of Korea

High Definition Multimedia Interface(HDMI), the representative output device of computers, generally leaks unintended electromagnetic waves. However, not all frequency components of the digital signal are leaked out in a befitting state for reconstruction image. In this study, frequency components of video signals and frequency bands suitable for reconstruction image information are analyzed.

A Scheme to Improve SNR of Received EMI Signal from Information Display Device

Eui Bum Lee, Dong-Hoon Choi, TaeSik Nam, Jong-Gwan Yook
Yonsei University, Rep. of Korea

This paper analyzes the characteristics of the display signal for an information display device and proposes a synchronization algorithm using its periodicity. The synchronization is the most important to enhance the signal-to-noise ratio (SNR), and it requires two kinds of phase information. One is the phase of the frame, and the other is the phase of the carrier frequency. Hence, this paper describes a methodology to estimate the phase terms, and the result conducted measurement data is verified.

Investigation of the Effect of Temperature on Fault Injection Using Intentional Electromagnetic Interference

Daisuke Fujimoto, Yuichi Hayashi
Nara Institute of Science and Technology, Japan

In this paper, we investigate the temperature dependence of the efficiency of fault injection on cryptographic circuits using IEMI(Intentional electromagnetic interference). The attacks that use IEMI to generate clock glitches and faults in cryptographic circuits have been proposed. The fault timing, which determines the analyzability, depends on the width of the clock glitch. The width of the clock glitch induced by IEMI is determined by the shape of the clock signal. On the other hand, if the propagation delay of the internal combinational logic

circuit is changed, the occurrence of faults may change even if the width of the clock glitch is the same. In this paper, we construct a measurement system that can simultaneously measure both the generated clock glitch and the propagation delay of the internal combinational logic circuit, and confirm the change in the efficiency of fault injection with temperature.

A Study for Low Calculation Cost Side-Channel Resistance Prediction Based on Transfer Impedance of Leakage Path
Kengo Iokibe, Yoshitaka Toyota, Masaki Himuro
Okayama University, Japan

We investigated the possibility of low-cost prediction of side-channel attack vulnerability without the need to observe a large number of leakage traces for application to the side-channel attack countermeasure design for cryptographic devices. Assuming an on-board power analysis attack against AES, we applied a decoupling capacitor as a countermeasure against SCA on the printed circuit board. The leakage strength after the countermeasure was predicted from the change in the transfer impedance of the leakage path due to the addition of the capacitor. As a result, the prediction agreed with the measured leakage strength with high accuracy. This result suggests that the countermeasure effect can be predicted quantitatively without observing the leakage traces by focusing on the change in the transfer impedance before and after countermeasure implementation.

Analysis of Electromagnetic Information Leakage from Overdesigned Power Delivery Network of Cryptographic Devices
Youngwoo Kim, Shinpei Wada, Daisuke Fujimoto, Yuichi Hayashi
Nara Institute of Science and Technology, Japan

In this paper, an analysis of electromagnetic (EM) information leakage from an overdesigned power delivery network (PDN) of cryptographic devices is presented. In the target hierarchical PDN, sufficient decoupling capacitors are mounted in both on-chip and printed circuit board (PCB) PDNs which maintained the hierarchical PDN impedance below a target impedance from 1 MHz to 10 GHz. Correlation electromagnetic analysis (CEMA) and secret key extraction are conducted based on measured electric and magnetic field radiations from various locations in the hierarchical PDN such as above chip, PCB PDN, and decoupling capacitors. For the first time, it is verified that a cryptographic device complying with the target impedance specification with a sufficient impedance margin can leak full-byte secret key information via EM field radiation. Based on the analysis result, the PDN design methodology for the cryptographic device is presented.

A Fundamental Evaluation of EM Information Leakage Induced by IEMI for a Device with Differential Signaling
Shugo Kaji, Daisuke Fujimoto, Youngwoo Kim, Yuichi Hayashi
Nara Institute of Science and Technology, Japan

The threat of electromagnetic (EM) information leakage induced by intentional electromagnetic interference (IEMI) for the single-ended signal has been reported. In the threat, the intensity of the leaked EM waves can be controlled by the intensity of the induced disturbance waves. If the EM information leakage method can be applied to other signaling schemes, more devices would be threatened, and countermeasures against the threat need to be taken. This paper shows that the threat of EM information leakage induced by IEMI exists in other signaling schemes, using the universal serial bus (USB) 2.0 devices, one of the differential signaling standards. Specifically, we demonstrate that the IC's output impedance changes according to the IC's output states cause fluctuation in the amplitude of the reflected waves using a USB keyboard as an evaluation target. As a result, we confirm that the differential signal is leaked by demodulating the amplitude of the reflected waves.

A Study on Output Bit Tampering of True Random Number Generators Using Time-Varying EM Waves

Saki Osuka [1,2], Daisuke Fujimoto[1], Arthur Beckers[2], Benedikt Gierlichs[2] Ingrid Verbauwhede[2] and Yuichi Hayashi[1]
[1] Nara Institute of Science and Technology, 8916-5 Takayama-cho, Ikoma, Nara 630-0192, Japan
[2] ESAT/COSIC, KU Leuven, Kasteelpark 10, B-3001 Heverlee, Belgium

True random number generators (TRNGs) based on ring oscillators are employed in many devices because they can be constructed with logic gates only. If the randomness is degraded by the attack, it may affect the security of the cryptographic protocol. As a physical attack against TRNG, several attack methods that reduce its randomness have been proposed. On the other hand, TRNG is recommended to implement an online health test to guarantee the quality of random numbers, and if this module exists, conventional attacks would be difficult. In this paper, we have shown the possibility of tampering with a part of the random number sequence by controlling the electromagnetic waves applied to the TERO-based TRNG. Specifically, disturbance waves are applied to TRNG to change the power supply voltage of the device. By modulating the amplitude of the disturbance wave, some of the random number bits are tampered with.

Study on Measurement Resolution of Side-Channel Waveform in Correlation Power Analysis

Hideaki Sone[1], Kohei Utsumi[1], Yuichi Hayashi[2], Takaaki Mizuki[1]
[1]Tohoku University, Japan
[2]Nara Institute of Science and Technology, Japan

Effect of measurement resolution of waveform in correlation power analysis is studied. Extracting efficiency of secret key does not increase in high-resolution conditions, and possible effects of the limit are other noise resources and variation of transfer function in the chip and module.

Fundamental Study on Evaluating Immunity of RO-Based TRNGs Against Frequency Injection Attack
Riki Hashimoto, Daisuke Fujimoto, and Yuichi Hayashi
Nara Institute of Science and Technology, 8916-5 Takayama-cho, Ikoma, Nara 630-0192, Japan

In this study, a system which comprehensively evaluates the immunity of ring-oscillator-based true random number generators (RO-based TRNGs) against frequency injection is developed. With the system, we investigated the frequency range of disturbance waves required to suppress frequency injection attacks.

[SS-03] EMC Diagnostics of Complex Systems

Electromagnetic Background Generated by Mobile (Cellular) Communications
Mordachev Vladimir
Belarusian State University of Informatics and Radioelectronics, Belarus

A practical technique for the worst-case evaluation of levels of electromagnetic background generated by cellular communication systems is proposed. It is based on the analysis of the average electromagnetic loading on area created by base and mobile subscriber's stations, and on the prediction of the area traffic capacity created by wireless information services supported by cellular communications. Such evaluations are very important for supporting the intersystem EMC, electromagnetic safety and ecological compatibility of 4G/5G/6G systems.

UWB EMP Susceptibility Testing of General-Purpose Electronic, Radio Communication, and Industrial Equipment
Dzmitry Tsyanenka[1], Mordachev Vladimir[1], Eugene Sinkevich[1], Alexey Galenko[1], Xie Ma[2], Wen-Qing Guo[2]
[1]Belarusian State University of Informatics and Radioelectronics, Belarus
[2]China Electronics Technology Cyber Security Co., Ltd., China

Technique and results of testing of general-purpose electronic, radio communication and industrial equipment for susceptibility to powerful ultra-wideband electromagnetic (EM) pulses is presented. An example of the implementation of the developed technique is given using equipment that provides exposure in form of series of electromagnetic pulses with an amplitude of up to 50 kV/m, a duration of 220-250 ps, and a rise time of 120-150 ps. A pulse repetition rate is from 100 Hz to 1 kHz and duration of pulse train is from 0.1 to 300 s. The test results confirm the significant effect of EM pulses impact on the performance of the set of tested radioelectronic products of general-purpose for pulse amplitudes of 1...50 kV/m.

Fast Discrete Diagnostics of EMC of Complex Co-Located Radio Systems by Using Worst-Case Models of Electromagnetic Spurious Couplings
Eugene Sinkevich, Mordachev Vladimir, Dzmitry Tsyanenka, Yauheni Arlou

Belarusian State University of Informatics and Radioelectronics, Belarus

A technique of high computational efficiency for EMC diagnostics of complex co-located set of radio systems is presented. The technique is based on the following: the use of worst-case models of electromagnetic spurious couplings between antennas (in order to eliminate the second-type errors in detection of dangerous couplings), iterative refinement of these models for the potentially dangerous couplings in the process of solving an EMC problem, and the extra efficient discrete technique for nonlinear behavior simulation of radio receiver operation in complex electromagnetic environment.

Research on Optimum Scheme of GPS Receiving Sensitivity with Holographic Interference

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This paper is mainly aimed at the vehicle GPS system being interfered after the vehicle is powered on, and the signal strength does not meet the design requirements. According to the scientific elimination method, we find that the holographic image is the main source of electromagnetic disturbance, and the mechanism of disturbance is analyzed and studied. Finally, considering the key elements of the vehicle, an engineering optimization scheme is introduced to make the GPS receiver meet the design requirements.

Experimental Studies of Electromagnetic Compatibility Between 5G Network Transmitters and Receivers Operating in Earth Exploration-Satellite Service and Space Research Service in the 27 GHz Band

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Lower part of the 27 GHz band is one of the most attractive for deployment of 5G networks. 3GPP identified two frequency bands n257 and n258 for the use of various frequency bands within the 27 GHz range with Time Division Duplex (TDD) frequency arrangements [1,2]. However, the use of these bands needs provision of electromagnetic compatibility (EMC) between 5G networks and incumbent systems operating in the frequency band 25.5- 27 GHz in Earth exploration-satellite service (EESS) and space research service (SRC) via space-to-Earth links on a primary basis as stated in Article 5 (Frequency allocations) of the Radio Regulations [3], as well as in the European Table of Frequency Allocations [4]. Experimental studies on estimation of interference from 5G network transmitters to EESS and SRS earth station receivers in the 27 GHz band performed by authors of the paper enable determination of actual protection criteria for incumbent services. Organizational and technical measure are proposed to resolve the EMC issue and ensure required

protection from 5G network interference on the basis of necessary coordination zones around receiving earth stations in EESS and SRS.

SS-04] Power Electronics EMC Related to Motor Drive Systems

Common-Mode Noise Analysis and Suppression of a GaN-Based LCLC Resonant Converter for Ion Propulsion Power Supply

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This work analyzes the CM noise of a GaN-based LCLC resonant converter in an IPPS and proposes a method to suppress the noise. It confirms that the GaN-based converter can cause severe CM noise, especially at high frequencies. In the full paper submission, details of analysis and suppression of the CM noise, as well as the experimental validation, will be elaborated.

High-Frequency Modeling of Permanent Magnet Synchronous Motor Considering Internal Imbalances

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In this paper, an accurate high-frequency modeling methodology for a permanent magnet synchronous motor (PMSM) in a vehicular electrical braking system is presented, which is suitable for analyzing various electromagnetic interference problems caused by a motor drive system. The proposed modeling approach is established according to the vector fitting technique and based on the S-parameter measurements of the PMSM. The equivalent circuit model of the PMSM converted from a measured S-parameter matrix can better describe the impedance characteristics of the three-phase PMSM under study compared to the existing equivalent circuit models because the imbalances inside the motor are taken into account in the proposed modeling process. The proposed PMSM model exhibits high accuracy in the range from 100 kHz to 120 MHz in comparison with the common-mode and differential-mode characteristics of the PMSM, which are measured using the conventional setups.

Behavioural Modelling of Common-Mode Chokes with Frequency-Dependent Permeability Core

Shaojun Huang[1], Kye Yak See[1], Fei Fan[1], R Simanjorang[2], Firman Sasongko[2]

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Based on the measured impedance frequency response, this paper proposes a behavioral model of any common-mode choke (CMC) with magnetic core that exhibits frequency-dependent permeability. The model consists of several cascaded RLC parallel circuit blocks that resembles the actual measured impedance response in the frequency range of interest. The iterative algorithm to construct these RLC circuit blocks is described and the behavioral models of two commercially available CMCs are verified experimentally.

Impact of Motor Stator Winding Faults on Common-Mode Current
Fei Fan, Zhenyu Zhao, Pengfei Tu, Huamin Jie, Kye Yak See
Nanyang Technological University, Singapore

This paper investigates the influence of different motor stator failures on the common-mode (CM) current. The stator winding failures will affect the motor's CM impedance, and also increase the unbalance of the differential-mode (DM) noise path. The experimental results show that the former will increase the CM current induced by the CM noise source, while the latter will cause the DM current induced by the DM noise source to be converted into the CM current.

Measurement of In-Circuit Common-Mode Impedance at the AC Input of a Motor Drive System
Zhenyu Zhao, Fei Fan, Arjuna Weerasinghe, Pengfei Tu, and Kye Yak See
Nanyang Technological University, Singapore

The in-circuit common-mode (CM) impedance at the AC input of a motor drive system (MDS) provides valuable inputs for evaluating and estimating the CM electromagnetic interference (EMI) noise generated by the switching of power semiconductor devices in the MDS. This paper introduces a single-probe setup (SPS) with frequency-domain measurement to extract the in-circuit CM impedance of a MDS under its different operating modes. The SPS has the merits of non-contact measurement and simple structure.

In-Circuit Differential-Mode Impedance Extraction at the AC Input of a Motor Drive System
Arjuna Weerasinghe, Zhenyu Zhao, Fei Fan, Pengfei Tu, and Kye Yak See
Nanyang Technological University, Singapore

The in-circuit differential-mode (DM) impedance at the AC input of a motor drive system (MDS) serves as a key parameter to evaluate and estimate the DM electromagnetic interference (EMI) noise caused by the switching of power semiconductor devices in the MDS. This paper discusses a single-probe setup (SPS) with frequency-domain measurement to extract the in-circuit DM impedance of an MDS under its different operating modes. The advantages of the SPS are its non-contact measurement and simple structure.

[SS-05] ETOPIA: Microgrids and Low Frequency EMC

Efficient Time-Domain Multi-Channel Measurements Using a Multi-Axis Antenna for Frequency Range Below 30 MHz

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Radiated electromagnetic interference measurements were traditionally done in the frequency domain. A super-heterodyne EMI test receiver is then analyzing each frequency individually during a sweep across the spectrum. Despite the high accuracy, the time needed for the measurements sometimes reaches several days due to the small bandwidth and thus long dwell time, especially in the low-frequency range below 30 MHz. Modern time-domain EMI analyzers already created major reductions in measurement time. Some standards require measuring with several magnetic loop antenna orientations with respect to the equipment under test. Instead of the expensive single-channel time-domain analyzers, cost-efficient multichannel digitizers are proposed to perform measurements using several magnetic loop antenna positions and polarizations simultaneously.

EMI Levels Associated with MMC Capacitors Voltage Balancing Techniques

Amr Madi [1,2], Niek Moonen[2], Robert Smolenski[1], Douglas Aguiar do Nascimento [1,2], Piotr Lezynski[1], Frank Leferink[2]
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Multilevel Modular Converters (MMC) are popular type for lowering the Electromagnetic interference (EMI) emissions in high voltage and medium voltage applications. Next to the inherent reduction of EMI associated with MMC much can be gained by tuning its own components and operating algorithms. This paper present a study on the relation between the emission levels and the submodule (SM) capacitors voltage balancing techniques. Level Shifted Pulse Width Modulation (LSPWM) with sensor-less balancing algorithm and Phase Shifted Pulse Width Modulation (PSPWM) are investigated in this paper.

A Simulation for Parameters Extraction of Double-Layer Shielded Power Cable Using FEA

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This paper addresses a preliminary research on numerical simulation method of an shielded and low voltage cable for electric vehicle powertrain using Finite Element Analysis

(FEA) and Simulation Program with Integrated Circuit Emphasis (SPICE) as software tools. Simulating this fast method through FEA for only one transmission line cell (1 cm cable length), it was obtained the transmission lines parameters and the magnetic flux density of the cable. Then, its length is extended to 100 cells (1-meter) by using transmission lines theory and the frequency response of the cable was gathered as an evaluation of the current method implemented in SPICE. Thus, those analyses can provide a faster and better overview concerning the prediction of electromagnetic behavior in order to avoid EMC (Electromagnetic Compatibility) compliance issues in the early-stage development of the vehicle.

The Influence of the Number of Frequencies and the Frequency Repetitions Rates in Spread Spectrum Sigma-Delta Modulated DC-DC Converters

Angel Pena-Quintal, Karol Niewiadomski, Steve Greedy, Mark Sumner, David Thomas
University of Nottingham, United Kingdom

This paper explores the impact of using a Spread Spectrum modulation technique based on a Sigma-Delta modulator for a DC-DC SiC-based power converter. A simple block is proposed for the PWM to generate square pulses close to 20 kHz with a controlled ramp profile. Then, different frequencies and repetition rates are used to systematically evaluate their influence of carrier related emissions. The comparison of results is carried out by measuring the peak of the switching harmonic and the average value over CISPR band A (9-150 kHz). The measurements are taken at the input voltage of the converter.

Limitations in Applying the Existing LISN Topologies for Low Frequency Conducted Emission Measurements and Possible Solution

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The use of power electronic converters to interface renewable sources and intelligent loads to electricity distribution systems is increasing at a rapid rate as they bring flexibility and control to the system. However, they also bring an increased level of conducted emissions (CE) to the system due to their switching behaviour - usually at a few tens of kilohertz. The increased emissions are seen particularly in the low-frequency range (2-150 kHz) and it may possibly impair the operation of information and communication technology (ICT) equipment connected to the same system. It is therefore essential to assure accurate measurement of low frequency emissions from a particular piece of equipment, to ensure it meets standards for electromagnetic compatibility (EMC). According to EMC standards, CE are usually measured by using a Line Impedance Stabilization Network (LISN). However, the standard LISN bandwidth does not fully cover this low-frequency range (2-150 kHz), resulting in inaccurate measurement and poor repeatability. This paper examines this issue, by investigating the limitations in using the CISPR 16-1-2 LISN topology for CE measurement at low frequency in a grid-tied inverter system, and by proposing a possible solution, which requires adding extra components to the LISN circuit.

Effects of Random Modulation on Power Line Communication System
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In this paper the impact of Random Pulse Width Modulation (RPWM) on the powerline communication (PLC) system is investigated. The PLC system is implemented in SIMULINK to measure load voltages in smart grid application. Results shows that even if the deployment of RPWM techniques may lead to an appreciable reduction/spreading of harmonic peaks, it may also lead to an increase of the bit error rate on the PLC system. This possible detrimental effect is investigated in this work, by considering a PLC system for advanced meter reading implemented in a PV-panel link.

About the Distorting Regime Induced by an Electronic Induction Heating System
Adrian Hurezeanu, Iurie Nuca, Ileana-Diana Nicolae, Lucian-Cristian Scarlatescu, Petre Marian Nicolae
University of Craiova, Romania

The paper deals with the operational principles, schematic diagrams and implementation of an Electronic Induction Heating System Prototype. The main technical characteristics are: supplying voltage 3x400Vac / 50Hz; rated power: around 10 kW; absorbed current - around 11 A; working frequency: 9.75kHz; IGBT transistors, with PWM control by using current zero crossing; Digital control with DSP; 2 operational modes: power saving and normal. Data relative to 3-phase currents and voltages were acquired from the heating system terminals and analyzed with original software packages relying on Fast Fourier Transform and Discrete Wavelet Transform. A good convergence of results was obtained and it was proved that the current total harmonic distortions (higher for the PS mode) were found to have unacceptably high values by comparing to standards for power quality and electromagnetic compatibility (with a large spectrum of harmonics). The protective measures for the supplying network are necessary to improve power quality and electromagnetic interferences.

[SS-06] SCENT: EMC in Smart Cities via Power Electronics

An Approach in Modelling and Simulation of Crosstalk Effect in Cables
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University of Nottingham, United Kingdom

The paper reports on modelling of coupling between two coaxial cables in both time and frequency domain using both simulation and experimental measurements. The simulation

exploits the SPICE and SACAMOS software to develop a model for the cable transfer impedance. The results compare the experimental and simulation approaches and also help evaluate how the presence of the ground affects the coupling between two coaxial cables.

Electromagnetic Disturbance Characteristics and Influence Factors of PETT Oscillation in Highvoltage IGBT devices

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Plasma extraction transit time (PETT) oscillation occurs when high-voltage device turn-off, whose frequency can reach hundreds of MHz in the experiment. High-frequency oscillation cause electromagnetic interference (EMI) problems and may exceed relevant IEC limits. The relationship between characteristics of PETT oscillation and commutation conditions of insulated gate bipolar transistor (IGBT) devices are systematically studied by experiment. The dependency of oscillation peak on reverse voltage, forward current, and the temperature is presented in this paper. It is shown that the characteristics of PETT oscillation vary greatly with the operation conditions of IGBT devices. Based on the experiment results in this paper, the test for IGBT is suggested to take reverse voltage, forward current, and temperature into consideration.

The Influence of Spread-Spectrum Modulation on the G3-PLC Performance

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The smart grid is a fertile ground for conducted Electromagnetic Interference (EMI) between the power and the communication circuits. This paper shows the detrimental effect of spreading the switching spectrum (Spread-Spectrum modulation) on the performance of G3-PLC, which is counterintuitive to be a mitigation technique. An experimental setup is built to emulate an in-situ coupling situation between both circuits. Finally, tests are performed with different operating scenarios, and the results are discussed in the Electromagnetic Compatibility (EMC) framework.

EMI Mitigation Technique for Warship Power Distribution Systems in the Frequency Range Below 150 kHz

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Electromagnetic compatibility should be considered when integrating a commercial off the shelf device into an islanded power distribution system like a warship. To stabilize the supply to critical loads, ships and warships often use commercial off the shelf (COTS) uninterruptible power supplies (UPS). On the other hand, the switching mechanism of the COTS-based UPS generates electromagnetic interference, especially in the frequency range 2 kHz to 150 kHz which is the frequency range that is not covered by generic standards. This study presents an electromagnetic interference mitigation technique for ship power distribution systems, especially in the frequency range of 2 kHz to 150 kHz using the combination of a line reactor and an EMI filter. The experimental results demonstrated the effectiveness of the proposed technique to reduce the electromagnetic interference in this frequency range.

Impact of a Speed-Controlled Water Pump on Power Line Communication of Smart Energy Meters

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Conducted electromagnetic interference cases are increasing due to the rapid increase of energy-efficient electrical equipment in smart grids. For example, static energy meter readings are interfered due to non-linear pulsed currents drawn by dimmed lighting technology and a speed-controlled water pump. A communication interface can be added to the static energy meter to form a smart meter, for example using power line communication which works in the CENELEC-A band. This paper shows that the interference from a water pump does not only interfere with the readings of static energy meters but also affects the power line communication of a smart meter. It is shown that the interfered and lost frames during communication are affected by the average impedance of the speed-controlled water pump.

Radiated and Conducted EMI by RF Fields at Hospital Environment

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Nowadays, hospital environments are among the most complex environments to establish electromagnetic compatibility. The newest health technologies associated with medical electrical equipment and their possible electromagnetic interference are being extensively

investigated. However, the electricity supply system infrastructure remains present in hospital environments and might be responsible for the conducted electromagnetic interference through coupling with radio frequency fields, e.g. broadcasting station. Therefore, aiming to understand the electromagnetic environment, this paper presents the methodology used and the electromagnetic interference measurements in one hospital environment in São Paulo, Brazil. The results show that although all equipment in surgery room has been tested for electromagnetic compatibility, the risk still exists. Highlighting how important the comprehension and analysis of the electromagnetic environment is as a first step towards implementing specific solutions to mitigate the medium and high risk cases.

Why Not(ch)?

Daria Nemashkalo[1], Niek Moonen[1], Frank Leferink [1,2]
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The paper presents an alternative EMI filtering solution. Drawbacks of low-frequency differential mode filters are discussed and a solution for mitigation given disadvantages is proposed. A need for the filter optimization based on a dominant mode of interference and terminating impedances has been addressed, as well as a novel optimization parameter - the applicable frequency band of the filter. Applying a broadband filter to a narrowband interference proved to be a redundantly costly solution with respect to weight, volume, and finances. On the contrary, the proposed narrowband notch filter, while providing comparable to a conventional low-pass filter attenuation, has significantly smaller weight and volume.

Characteristic of Conducted EMI in Compact Fluorescent Lamps Application Assessment based on CISPR-11

Choon Long Lok[1], Muhammad Ammar Wibisono[2], Niek Moonen[2], Robert Smolenski[1], Piotr Lezynski[1]
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This paper presents the assessment of aggregated conducted emission resulted from dynamic interaction of multiple frequency sources in grid in the frequency range of 9 kHz to 150 kHz. The study involves multiple Compact Fluorescent Lamps (CFL) connected in a typical indoor lighting configuration. Based on the current standardized Intermediate Frequency Bandwidth (IFBW) laid out in CISPR-11 (Band A), the aggregation by dynamic interaction of highly volatile interference signals generated by these lamps is inadequate to represent the peak total emission. This paper discusses this specific issue accompanying measurements of conducted Electromagnetic Interference (EMI) in this particular multi-converter system. Our measurement results confirm the phenomenon with simple mathematical theorem and simulation illustrations.

Sensitivity Analysis of Parasitics in Power Electronic Circuit through Sobol' Indices

Karol Niewiadomski, Angel Eduardo Pena-Quintal, David Thomas, Sharmila Sumsurooah

University of Nottingham, United Kingdom

This paper provides a sensitivity analysis of the conducted emissions from a power converter by the means of Sobol' indices. The sensitivity measures are computed by utilizing sparse Polynomial Chaos expansions, thanks to which the number of simulations is smaller than that required by standard Polynomial Chaos methods and far smaller than in Monte Carlo approaches. The method developed in the paper quantifies the impact of parasitic elements, modeled as 18 independent random variables, on the common and differential mode voltage in the frequency range between 150 kHz and 30 MHz and consequently identifies the key influential parameters amongst all the parasitic parameters. The advantage of the approach is that it significantly reduces the complexity of the further analysis needed to reducing conducted emissions in a power electronic circuit.

Low-Frequency Envelope of DC/DC Converters due Differences in the Control Hardware Features

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The consciousness on the importance of smart grids is increasing exponentially. In conjunction with concerns about electromagnetic compatibility (EMC). In particular, a peculiar phenomenon has been gaining notoriety, i.e., the low-frequency envelope provided by the frequency beat. Produced from the aggregation of harmonics generated by multiple Power electronic converters. The low-frequency envelope becomes worrisome as the variations in the amplitude of electromagnetic interference (EMI) in the time domain, can influence the performance of the EMI detectors, e.g., average detector (AV). Therefore, this paper addresses the low-frequency envelope provided by the frequency beat, using two DC/DC converters controlled by two different controllers: FPGA-7854R and Atmega328P. The practical setup and EMI measurements are discussed in the EMC framework.

[SS-07] The Emerging Near-field/Far-field EMC Measurement and Modeling Technologies for Complex Electromagnetic Problems

Research on Calibration Method of Horizontal Loop Magnetic Near-field Probe

Pengcheng Huang, Quan Huang, Zhijian Chen, Yuchen Wang, Weiheng Shao, Kaiwei Wang, Wenxiao Fang, Yan Gao, Chen Sun, Guoguang Lu, Yun Huang

Internationally, electromagnetic near-field probe is an important tool to solve the EMC problem of integrated circuits. However, the IEC61967 standard only specifies the

calibration method of vertical loop magnetic near-field probe (measuring horizontal magnetic field). This paper proposes a calibration method of horizontal-loop magnetic near-field probe based on micro-strip line TEM field based on the in-depth study of IEC61967 related to probe calibration method. In order to verify this method, a horizontal loop magnetic near-field probe is fabricated based on LTCC, and a micro-strip line with impedance of 50 Ω is designed by using PCB process, and the verification test of the proposed calibration method is carried out. The simulation and experimental results show that the calibration method proposed in this paper can realize the calibration of the horizontal loop magnetic near-field probe, which can make up for the deficiency of the calibration method of the horizontal loop magnetic near-field probe in IEC61967 standard, and has important applicable value.

Exploring the Effectiveness of Thin Microwave Absorber Applied in Parallel-Plate Waveguide

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This work explores the effectiveness of the conventional thin microwave absorber (MA) applied in the parallel-plate waveguide (PPWG). The simulation results reveal that, the MA designed for absorbing the normally incident wave in the free space also suits the PPWG application when the thickness of the PPWG $t \leq 0.25\ \lambda_0$. A segment of the MA with $0.5\ \lambda_0$ length could bring ~10 dB electromagnetic interference (EMI) suppression in the PPWG with $t \sim 0.25\ \lambda_0$, at the designed working frequency of the MA. While in the thin PPWG ($t < 0.25\ \lambda_0$), the MA exhibits larger EMI suppression magnitude and bandwidth. Based on these discoveries, the MA design difficulties for the practical engineering scenes, such as multi-layered printed circuit boards and high-speed circuits' packages, are discussed to provide a valuable reference.

Reactive Near-Field to 3-Meter Field Transformation Based on Artificial Neural Networks

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In this paper, a reactive near-field to 3-meter field transform method based on artificial neural networks (ANN) is proposed. The input of ANN is a vector composed of radiated electric or magnetic fields in the near-field region of the unknown radiator, and the output is the value of 3-meter field in the far-field region. We verified the effectiveness of the proposed method by the simulation data, where the randomly distributed dipoles are taken as the unknown radiator. The trained ANN model can directly predict the 3-meter field by the scanned near-field of dipoles. Compared with other near-field to far-field transform methods, the major benefit of the proposed method is its robust and efficiency.

A Miniaturized Tri-band Frequency Selective Surface for 5G Electromagnetic Shielding

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A novel tri-stopband frequency selective surface (FSS) for 5G electromagnetic shielding applications is proposed in this paper. The difficulty and uncertainty of tri-band FSS design is greatly reduced by using the double-layered complementary pattern structure. The proposed FSS resonating at 2.61 GHz, 3.5 GHz and 4.88 GHz provides at least 15 dB shielding effectiveness for the three commercial bands of Sub-6 GHz communication in China. The miniaturized symmetric unit cell with a dimension of only 0.051λ manifests an angular stability of up to 600 and polarization insensitivity.

A Field Iterative Method for Efficient Source Reconstruction Based on Magnitude-Only and Single-Plane Near-Field Scanning

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Radio-frequency interference (RFI) problems in modern electronic product become complex which result in the increasing number of scanning points. Conventional near-field phaseless source reconstruction methods such as double planes iteration method and single plane iteration method will spend a lot of time in both scanning and calculating. To save the calculating time and scanning time, a alternately iterative method is proposed for source reconstruction based on magnitude-only and single-plane near field scanning. Firstly, the single-plane scanning data is divided into two groups as group A and B according to the components, i.e. the electric field group and the magnetic field group for the four components, or Hx group and Hy group for two components. Then, the processed A and B phaseless data groups are used iteratively in the back-and-forth transformations to get the equivalent dipole elements. Compared with conventional method regard the scanning data into a whole matrix, the proposed method can save 90% calculating time, especially the time in singular value decomposition (SVD) before the iteration. A numerical simulation and a measurement example is verified the effectiveness of the proposed method, which show a comprise between accuracy and efficiency.

A Novel Waveguide Test Kit for Convenient Material Characterization

Si-Ping Gao, Yong-xin Guo
National University of Singapore, Singapore

Conventional material characterization often requires delicate and expensive test fixtures. The transmission method based on waveguides is widely used because it is able to characterize material over wider frequency band than the cavity method and provide better accuracy than coaxial fixtures. In this abstract, we present a novel waveguide-based test

kit for characterizing the constitutive constants of materials. It is free of waveguide calibration; only a coaxial calibration is required to move the measurement plane to the ends of VNA cables, making the characterization process easy to implement. Moreover, the proposed test kit enables material characterization 1) with unknown sample positions, 2) free of VNA drift (suitable for temperature measurement), and 3) without owning expensive waveguide calibration kit.

Equivalent Radiation Source Reconstruction Based on Artificial Neural Network for Electromagnetic Interference Prediction
Zhe Gao, Xiaochun LI, Junfa Mao
Shanghai Jiao Tong University, China

In this paper, a source reconstruction algorithm based on artificial neural network (ANN) is proposed. Equivalent dipole array is used for the source reconstruction, which parameters are extracted by ANN. The dipole array includes z direction electric dipole, x direction and y direction magnetic dipoles. In conventional source reconstruction, a linear equation is used to fit the nonlinear relationship between dipoles and fields, which has some errors. In contrast, ANN is suitable to model complex and nonlinear circuit characteristics with its powerful self-learning ability. The input of ANN is the Green's function of dipoles, and the expected output is the electromagnetic field data obtained by near-field scanning. A patch antenna is used as an example to validate the accuracy of the method.

TC-01 EMC Management, Standards and Regulations

EMC Regulation in Infrastructure Assurance (IAS) Telkom Indonesia
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Electromagnetic compatibility (EMC) can be considered as the ability of the electromagnetic apparatus to function satisfactorily without interfering the others or being interfered by the others. Nowadays, Indonesian government have a big concern about the conformity of electromagnetic products to corresponding EMC standards. The EMC conformity becomes the main part of quality assurance and safety of products in Telkom Indonesia. This paper presents the EMC conformity of products in Telkom Indonesia from regulation and technical point of view. We conducted survey on the quo-vadis of EMC regulation in the country by communicating with some Quality Assurance laboratory. At the same time, we investigated the EMC conformity of some telecommunication products to find their quality by conducting EMC testing on them including radiated and conducted emission test. From our investigation it is realized that some product was not yet comply compare to the newest standard of EMC, especially CISPR 32. Conformity of EMC is mandatory in Telkom Indonesia's standard. Therefore EMC conformity is mandatory for products manufactured or imported for deployment in Telkom's operation. The biggest concern is about health issue from radio transmission coming from its radiated interference, hence most part of Telkom's

apparatus was used radio frequency. Moreover, EMC testing showed that the products under testing are mostly conforming to EMC standards.

TC-02 EMC Measurements and EM Environment

Portable, Shielded, Repeatable and Adjustable Cable Shielding Effectiveness Tester
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Improperly constructed shielded cables can cause high electromagnetic emissions due to common-mode currents. Device manufacturers perform cable shielding effectiveness tests to shielded cables to qualify them by measuring the amount of common-mode current that arises in the cable shield. This paper shows a project that implements a new test setup for cable shielding effectiveness testing. It has a shielding enclosure, and can accommodate different cable types and lengths. It also provides consistent routing for the cable under test that helps establish a reliable pass/fail limit and repeatable test results. The current probe is also low cost since it is self-made.

Radiated Noise Dominancy Analysis by Extended Double Pulse Test and Power Device Optimization for Inverter Use
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Conventionally power device characteristics were measured by a double pulse test on half bridge circuit and radiated noise was estimated by analyzing results of switching speed. This conventional method is indirectly effective to consider common and differential mode noise in final products since noise is formed by a combination of impedance on route and higher harmonics by source of signal. However, directly measurable methods for radiated noise from power devices before being assembled into final products are expected to shorten power device development periods for the sake of establishing both of low radiated noise and low losses during conduction and switching. Hence, this paper proposes an extended double pulse test and describes that radiated noise can be also measured at the same time of measuring switching characteristics. Additionally, dominant timing can be separated, whether turn on or turn off with conduction current dependency, after analysis of directly detected radiated noise signal on a conventional half bridge. Using this method, both loss and radiation noise of the switching device can be measured simultaneously and further optimization on IGBT / CSTBT chip structures can be established in short period of time.

Research on Vehicle AC Charging EMC Test Method for Isolating the Influence of Charging Equipment

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For the AC charging electromagnetic compatibility (EMC) test of electric vehicles, the test setup of charging equipment is not specified in the standard. In actual operation, the charging equipment and the vehicle are generally placed in the test environment, accuracy and consistency of the test results are easily affected by the charging device. In view of the above problems, a vehicle AC charging simulation method is proposed to ensure the effective isolation of the charging device and reduce the impact of the charging equipment on the test results. The test proves that this method can effectively solve the shortcomings in the existing automotive AC charging EMC test technology, and provides a reasonable test idea for obtaining the performance of the vehicle during charging.

A New Measurement Method for Electromagnetic Parameters of Flexible Materials in Low Frequency Band

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In this paper, a new measurement method for electromagnetic parameters of flexible materials based on air coaxial line in low frequency band is proposed. First a material with known electromagnetic parameters and smooth surface is selected as the substrate, the flexible material is attached to the substrate and loaded into the air coaxial line together. Then calibration kits open and short are connected to the terminal of the air coaxial line respectively, and the single-port reflection coefficient of the device is measured by vector network analyzer (VNA). Finally, the electromagnetic parameters of the flexible material are deduced based on the impedance of the specimens section in air coaxial line. Experimental results show that the method proposed in this paper is effective and reliable.

Design and Evaluation of Long Hexagonal Folded Antenna

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The folded rhombic antenna as a broadband antenna for using electromagnetic interference (EMI) measurements and radiofrequency (RF) immunity tests was studied. In this paper, the characteristics of antenna in which the antenna element is changed to a long hexagonal shape are proposed to improve an antenna gain.

Research on an Optimized Recording Method of Actual Electromagnetic Environment Signal
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Recording of the actual electromagnetic environment signal is a prerequisite for testing the vehicle performance in the electromagnetic environment in the chamber. Based on the research of the existing electromagnetic environment recording scheme, the influence of the coupling current of the RF cable shielding layer on the test results is analyzed, and an electromagnetic environment signal recording method on the basis of the optical fiber link system is proposed. It is verified that this method can effectively reduce the influence of the shielding current of RF cable and improve the accuracy of the test results.

Detection and Correction of Scanning Attitude of EMF Meter Using Machine Learning
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For measuring EMF distribution, it is very important to track the field sensors. In this paper, we examined the method of detecting the position and scanning direction of the field meter using machine learning. As a result, we were able to detect the orientation of the measuring device by learning images taken at five different angles.

Verification of Using 150-Ohm Δ-AN Specified in Clause 4.7 of CISPR 16-1-2 for Measuring Conducted Emissions on AC Mains Power Ports
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Δ-AN specified in CISPR 16-1-2 can be used to measure conducted emissions on AC mains power ports according to CISPR 32. In this paper, to confirm the effect on use of Δ-AN, conducted emissions on AC mains power port were measured using each of V-AMN and Δ-AN. The measurement results show that conducted emissions on AC mains power port using Δ-AN is maximum of 16.9 dB higher than using V-AMN, and Δ-AN cannot use to measure conducted emissions on AC mains power port according to CISPR 32.

Correlation Between Measured Wideband Ratio-Frequency Electromagnetic Radiation and the Area of Buildings
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In order to estimate electromagnetic radiation (EMR) levels from geographical data, the correlation between wideband ratio-frequency electric field strength and the area of surrounding buildings is investigated in this paper. EMR measurements were conducted at

60 locations on various roads in Beijing, and the area of buildings up to a distance of 600 m from each measurement location were extracted from the map. Correlation coefficients are derived as a function of the distance. It is shown that the EMR level has a positive correlation with the area of surrounding buildings, and the correlation is maximal at distances up to 400-500 m from the measurement location. Furthermore, the regression line between the EMR level and the building area is calculated. The result shows that the EMR level could be estimated from the area of buildings within 500 m, and buildings in the annulus 400-500 m have a dominant influence on the level.

An Optimized Test Method Based on IC-Stripline TEM Cell

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The purpose of integrated circuit (IC) electromagnetic radiation measurement is to measure the conducted or radiated emission level generated by the device under test (DUT). Many standards provide detailed requirements for testing, such as IEC 61967-2 and IEC 61967-8. Test equipment based on these standards usually reserves a square test window. The traditional test scheme is to design the electromagnetic compatibility (EMC) test board as a square that matches the test window. This undoubtedly limits the test angle to a selected four. Designing the EMC test board to be circular, and installing a square to circular metal partition on the test window can effectively solve this limitation, and test the radiation of the DUT at any angle. The test results show that the maximum radiation emission of some typical frequencies appears at other test angles.

Experimental Observations of the Minimum Dwell Time for Radiated Immunity Tests in a Vibrating Intrinsic Reverberation Chamber

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Reverberation environments permit creating a statistically homogenous and isotropic electromagnetic field for testing electronic devices. Vibrating intrinsic reverberation chambers are one of the possible reverberation environments where successive, independent samples of the electromagnetic field values are generated through the vibrations of the flexible walls. In this paper, we investigate the test time (the dwell time) necessary for creating dataset of independent field sample values with homogenous statistics in a 1.5 m x 1.2 m x 1.0 m vibrating cavity. In particular, we present the results of an experimental study conducted at frequencies close the lowest usable frequency. We have compared empirical to simulated datasets showing that a prediction, based only on a theoretical approach, of the minimum dwell time could lead to large errors when non-idealities in the stirring process appear.

Improved Field Uniformity over Metallic Table in Military Radiated Susceptibility Testing by Adjusting Lengths of Antenna Elements and Test Table

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The MIL-STD461G RS103 test is one of the essential radiated susceptibility tests for military equipment. Unlike the pre-calibration method of commercial radiated susceptibility tests such as IEC61000-4-3, the RS103 test requires the placement of an electrical field sensor close to the application region of the Equipment Under Test (EUT) and also requires active-leveling of the field based on the feedback from the sensor without use of a pre-calibrated field, which is called close-loop testing. In most cases, the position of the sensor is not certain in the standard and every laboratory uses their own selection for probe positions which should be close to the application region. In this research, we firstly showed that the metallic test table used in the test significantly affects the field uniformity & level achievement over the table. This problem commonly arises in the range of 30 MHz - 100 MHz in the horizontal polarisation and almost impedes proper testing due to very high power requirements & poor field uniformity particularly when a high test level such as 200 V/m is targeted. Moreover, this issue also considerably reduces the reproducibility of test results and consistency between laboratories with its probe-position-dependence. This paper firstly sets out the issue that results from the metallic test table and thereafter proposes a solution to the issue by means of the adjustment of radiating elements' lengths of the transmitting antenna and changing the dimensions of the test table, which alleviates the issue and forms a more comfortable test environment over the metallic test table.

Analysis of Metamaterial Walls Reverberation Chamber by Using Modal Expansion Theory

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This paper deals with the modal expansion theory to characterize reverberation chamber with anisotropic walls. Adding anisotropic walls, such as metamaterial, allows to reduce the Lowest Usable Frequency (LUF). A methodology is proposed to choose the required metamaterials to reduce this LUF. By changing only two parallel walls, the LUF is almost reduced by 3 times compared to the classical reverberant chamber LUF.

Proposal of Radiated Disturbances Measurements Above 30 MHz for Large-Scale Electric Equipment

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This paper proposes a measurement method of radiated disturbances above 30 MHz for large-scale electric equipment. The proposed method applies 3m distance measurements instead of conventional 10m distance measurements. Results of experimental measurements shows that frequency characteristics of electric field strength measured with the proposed method are identical with those measured with conventional method. Difference between the measured conversion factor of electric field strength from 10 m to 3m and the theoretical factor is within 3 dB. Those results shows the validity of the proposed measurement method.

Influence of Mean and Peak Power on HPEM Susceptibility Tests of a Reference Test Setup

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Susceptibility tests with varying test parameters have been performed in a reverberation chamber of a reference test setup consisting of a Raspberry Pi single board computer and peripherals. The tests are a part of an international collaboration for comparative susceptibility tests of a common test setup with different test methods and in different laboratories. The results of seven test series in the frequency interval 1 - 2 GHz of high power electromagnetic radiation with different pulse lengths and pulse repetition frequencies are reported on here. A new error class has been identified and added to the previously defined error classes of the comparative studies. It is found that unlike the capability of the required mean power to cause an error, the required peak power of the radiation is roughly unaffected by increasing the pulse length and pulse repetition frequency.

Quantitative Interlaboratory Comparison of Radiated Immunity Test for On-Board Equipment

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With respect to the radiated immunity standard for on-board equipment (ISO 11452-2), a new draft assessment method for evaluation of the validity of measuring sites and correlation among test sites is proposed. This method consists of the long wire antenna method described in CISPR 25 and the reference field calibration. Regarding the proposed method, round-robin measurement was performed at 20 sites. It became clear that in order to assure high ILC, characteristics of field-radiating antennas should be the same, and strong resonance characteristics originated in the measurement system appear as part of the stress level applied on the DUT.

Development of a TEM Cell with 2 m in Height

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In this paper, a transverse electromagnetic (TEM) cell with a height of 2 m is designed and developed through theoretical calculation and electromagnetic simulation. Simulation results show that the voltage standing wave ratio (VSWR) of the TEM cell is below 1.04, since then the simulation model was used as the basis for TEM cell manufacturing, test shows that the VSWR of the finished TEM cell is below 1.08, similar to the simulation results and meeting the design requirements.

Development of Wideband Discone Antenna for Medical Devices Interference

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Medical equipment that uses IoT has the potential to experience electromagnetic interference, which can interfere with the performance of the device. It is necessary to map the source of the interference so that it can mitigate the interference that occurs. Discone antenna is a measuring instrument that has suitable criteria as an interference measuring tool. Therefore, the discone antenna was designing and developing on frequency range of 700 - 6 GHz and using copper sheets as a material. Discone Antena has good characteristic of S11 in frequency wireless medical devices. The radiation pattern of this design showed omnidirectional in cross-polarization.

Studying the Probability of EMI Through Time-Variance Behavior of Environment on Medical Devices

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Various studies have been conducted to monitor the electromagnetic (EM) environment of the hospital, where an emitter is mounted near medical devices. They placed their antenna in a specific area to test the maximum amplitude of power obtained by the antenna as well as explore the environment without identifying the time-variance behavior. The main goal of this paper is to observe the time-variance behavior of the emitters over the course of a 24-hour period when a receiving antenna is installed in a room and the effect they have on the EM environment. It will provide the probability of EMI from the perspective of the emitters, which will help to use it further for the risk-based EMC approach. In this paper, the discussion about the different types of time-variance behavior is done with examples, statistically explained the results.

Investigating the EMC Performance of a Matrix Converter and Measures to Improve It

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Electromagnetic interference caused by nonlinear loads can significantly affect electronic equipment in a system, especially those that operate on low amplitude control signals. Matrix converters is an example of such nonlinear load. This paper investigates through measurements, the EMC behavior, radiated and conducted emissions by a matrix converter, compares this performance to conventional converters, and defines mitigation measures employed to improve the EMC performance and reduce any risk of interference. These mitigation measures follows a risk based approach and can thus be designed according to the given electromagnetic environment in question, on board ships.

Influence of a MST Probe on the Measured Field Compared to a Classical Dipole Probe

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Modulated Scatterer Technique, especially its version using optically modulated scatterers occurred a very effective tool for near field mapping. The field strength is measured by means of a scattering probe placed at the analyzed point in space. This probe is modulated. Most often, modulation is introduced by alternating shorting and opening the terminals of the probe dipole. However, load modulation of the probe radiating element alters, at the same time, its radiation pattern. This paper analyzes the effect of the presence of a load modulated probe on the result of an electromagnetic field measurement at the probe location. The results obtained for the MST probe were compared with the results for an isolated classical receiving probe, loaded with a resistance of 50ohm, with physical dimensions identical to those of the scattering probe.

TC-03 Lighting

Discussion on Lightning Indirect Effects Test of DO160

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With regard to some possible insufficiencies/shortcomings of RTCA DO-160 and considering the scenarios of aircraft stroke by lightning directly, this paper discusses the main electromagnetic coupling mechanisms between the exterior and interior, analyses and explains the lightning indirect effect, induced voltage or current and their transient waveform onto interfaces/cables of airborne equipment inside metal or CFC aircraft. Finally suggestions are given for supplementing or improving DO-160 Section 22 and other related lightning indirect test Specifications.

Model for Surge Generator Transient Analysis and Immunity Improvement Investigation on Power Grid System

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The micro-grid power system is a world-wide trend for green energy demanding as part of smart-grid, and the most popular solar-cell inverter is possible suffering the surge transient disturbance from connected power system. This study investigates the electromagnetic model establishment for surge transient immunity protection analysis with ANSYS simulation tool. We first verify the simulated output of surge generator meets the waveform requirement for IEC61000-4-5[1], and then investigate the possible scheme for circuit protection with proper TVS devices and placement location. We also try to investigate the possible intruding surge monitoring mechanism by analyzing the spectrum characteristics via coupling device for power system alarm implementation.

Analysis of Lightning Environment of Radio Base Stations in Shenzhen Based on Lightning Locating System

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In recent years, a large number of radio base stations and antenna towers have been built in Shenzhen. The height of antenna tower is usually tens of meters, which may increase the probability of lightning strike. The lightning environment of radio base stations has been analyzed by the data accumulated by the lightning location system of Guangdong-Hongkong-Macao. The results show that the lightning occurrence probability in the surrounding domain cannot be increased by signal tower. The lightning parameter is basically the same in inner domain (177 m radius) and outer domain (177-250 m radius). The lightning parameter in the domain around radio base stations which were analyzed is also basically the same as those in Shenzhen.

Lightning Strike EMP Effect on Local Grids

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Electric fields generated by lightning strikes are analysed and compared with effects of a high altitude nuclear weapon detonation electromagnetic pulse scenarios. The decay in amplitude of electric fields generated by a intermediate level lightning strike is calculated over distance and further analysed in a full real world simulation of a severe lightning strike event within close proximity of a isolated residential grid. Factors influencing the immunity of the grid to electromagnetic pulses are simulated and discussed as well as induced voltages on conductors.

Comparison of LEMPs Computed Using Different Lightning Models

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Vertical electric fields (including skywaves) produced by lightning return strokes at distances ranging from 100 to 958 km have been computed using the finite-difference time-domain (FDTD) method in the 2-D spherical coordinate system. The return stroke is represented by the original transmission-line (TL) model (with no current decay with height and abrupt current termination at the channel top), the modified TL model with linear current decay with height (MTLL model), the modified TL model with exponential current decay with height (MTLE model), or the Hertzian dipole (HD) model. All the TL-type models include propagation delay, while in the HD model current changes with time, but does so simultaneously in all channel sections; that is, without any propagation delay. The HD model predicts considerably higher fields than the TL-type models, if the same channel length (7 km) is employed. The HD model with an unrealistically small channel length of 0.7 km yields electric field peaks similar to those produced by the TL-type models with a 7-km channel. Ground waves and skywaves computed using the HD model have faster rise and decay times (shorter pulse widths) than those computed using the TL-type models. Electric fields produced by a longer-risetime current are less attenuated due to propagation over lossy ground when a TL-type model is used, while they are more attenuated if the HD model is employed. The opposite trends are related to the fact that the radiation field peak is proportional to the product of the current and propagation speed for the TL-type models, while for the HD model it is proportional to the product of the time derivative of current and channel length. In the TL model, abrupt termination of significant current at the channel top results in the so-called mirror image (abrupt radiation field polarity change). This artefact does not occur in the framework of the MTLL model (since the current is required to vanish at the channel top) and is negligible in the MTLE model with lambda = 2 km and H = 7 km, where lambda is the current decay height constant.

TC-04 High Power Electromagnetics

Evaluation of Overvoltages Transmitted in High Power Transformer Windings at Lightning During the Design Stage

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This paper presents a calculation method for voltage transmitted between the windings of the transformer while it is being subjected to the lightning impulse; it describes the reasoning and analytical relations for the predetermination of the transmitted voltage. The modeling of the phenomenon of transmitting voltage between the transformer windings was

realized by using MATLAB, in order to make the calculation more efficient and to illustrate the corresponding waveforms of the transmitted voltage determined by calculation. The study was conducted on a 54/73 MVA, TTUS-ONAN, 110/15/6.6 kV transformer, and the results achieved by calculation have been validated through experimental tests.

Time Reversal for Partial Discharge Localization on Power Lines with Different Termination Impedances

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This paper describes a new method for the on-line location of partial discharges (PDs) in power transmission and distribution networks based on Electromagnetic Time Reversal (EMTR) theory and on the Transmission Line Matrix (TLM) method in order to describe the time reversed propagation. In particular, the paper shows the effectiveness of the method in localizing the PD source when the impedances at the terminations of the line are unknown and describes the procedure to be followed in this case. The analysis is performed in simulation, and a model of the PD signal propagation that is able to reproduce the distortion phenomenon that affect the PD signal propagation on power lines and thus the accuracy of the on-line PD location methods is also described.

Simulation Model for Evaluation of IEMI Threat on Electrical Substation

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Intentional Electromagnetic Interference (IEMI) with sufficiently high power is capable of disrupting the control instruments of the switchgear in a substation, which may lead to unexpected tripping of the switchgear of a critical power grid. To evaluate the IEMI threat of the control instruments in a substation, a numerical model based on an actual 22kV substation is developed. With the model, the transfer function between the IEMI source excitation and the resultant field strength can be established so that the risk of an IEMI threat can be evaluated quantitatively.

High Frequency Power Combiner of Two Magnetrons Based on the E-Plane Y-Structure Waveguide

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In this article, we propose to combine the powers of two magnetron. By combining the power of a microwave, two continuous magnetron waves are used as the source of the s-band waves. We use square waveguides (WR340) the Y-structure to achieve industrial high power at 2.45 GHz. To combine the power of a 1 kW magnetron and use it to adjust the phase difference of the two magnetrons. With low loss for using two magnets in the process, insertion loss is less than 0.5dB, reflection loss is less than -28dB at 2.45GHz frequency.

Simulation and Experimental Study on Electromagnetic Heating for Heavy Oil Stimulation

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Simulation and laboratory experimentation are carried out as a part of study on electromagnetic heating for heavy oil stimulation. In prior investigation, it has been shown that the microwave heating was effective for reducing viscosity of heavy oil, so this method has been promising the implementation for real oil well in the future. The simulation using COMSOL Multiphysics shows that the use of frequency is less effective with a very short heating penetration through the sample. While more conductive samples used in the laboratory experimentation indicates further heating penetration. Through the on-off pattern of heating process, it is found that the heat transfer mechanism occurs based on the radiation and conduction. Both of these heat transfer mechanisms could work simultaneously to increase the temperature of sample up to 76,8 ºC from the initial temperature of 24 ºC.

TC-05 System-Level EMC and Protection

Electromagnetic Interference (EMI) Cyber Attack Protective Measures in Modular Data Center (MDC)

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Both physical and cyber security designs are vital for Data Centers. As part of this design applying an adequate physical security measure to prevent a possible cyber-attack is essential. Electro-magnetic field interference (EMI) induced by power equipment can produce detrimental effects, including security breach through eavesdropping, which is a major threat to confidentiality, integrity and availability of information. This security design measure sometimes holds a lower hierarchy when planning a data center. This paper talks about the next-generation methodological approaches to protect data stored within the Modular Data Center against EMI affect and discuss their pros and cons.

A Magnetic Field Cancelling System Design for Mitigating Extremely Low Frequency Magnetic Field in a High Tech Fab

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A magnetic field cancelling system (MFCS) integrated the active magnetic cancelling system (AMCS) and the passive magnetic cancelling system (PMCS) is addressed in this paper. For the design of the AMCS, an embedded system with the square Helmholtz coil

structure is realized. In order to achieve the fast response of the AMCS against the extremely low frequency magnetic field (ELFM) change, a real-time operating system was implemented. For the design of the PMCS, permalloy material with multi-layer structure and different hole patterns are used. The experiments are conducted to validate the proposed approach in this paper.

Modeling of Common Mode Current in Automotive Inverters Based on Norton Equivalent Circuits

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Automotive inverters are required to comply with high voltage conducted emission (HVCE) tests as regulated in the international electromagnetic compatibility (EMC) standard CISPR25. One of the HVCE tests is to evaluate the common mode (CM) current on the HV cables due to the switching transients. A filter is usually employed to suppress the CM current and for filter development, an effective simulation methodology is beneficial. However, how to model the noise sources in an accurate but time efficient way remains challenging, especially for ordinary EMC engineers. In this paper, a two terminal Norton equivalent circuit is derived to predict the CM current in an automotive inverter motor drive system based on a standard CISPR25 measurement. The prediction accuracy is validated experimentally to be < 5 dB up to 50 MHz and within 10 dB up to 108 MHz. The approach is chosen and applied due to its easy implementation and high accuracy, which makes it a promising tool in practical filter development for EMC engineers.

A Polarization-Insensitive Resistor-Free Ultrathin Absorber for Curved-Surface Objects

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A novel resistor-free ultrathin absorber is proposed in this study. The absorber is polarization insensitive and especially suitable for coating on curved-surface objects. An absorber prototype is demonstrated for X-band applications. It is shown to highly reduce the radar cross-section (RCS) of a metal cylinder without unfavorable polarization conversion.

Stochastic Analysis of Braided-Shielded TWP/Twinax Cables with Random Nonuniform Shield Parameters

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A generalized model for a nonuniform braided-shielded twisted wire pair (TWP) is formulated to investigate the effect of the nonuniformities of the braided shield on its shielding effectiveness performance. Since the apertures of the braided shield are exposed to shape deformation and also their location on the shield is irregular, they are considered to be random variables rather than deterministic values. Therefore, the effect of nonuniformities of the braided shield on the induced common-mode (CM) and differential-mode (DM) currents of braided-shielded TWP and twinax cables are investigated by using the Monte Carlo method, where the probability density functions of the CM and DM currents are also generated. It is shown that TWP has a great advantage as compared to the untwisted one in reducing the interference due to the nonuniformities of the braided-shield structure.

Loop-To-Loop Close-Range EM Signal Transfer Through a Conducting Thin Sheet - an Analytical Study Based on the Cagniard-DeHoop Technique
Martin Štumpf, Petr Kadlec, Tomas Dolezal
Brno University of Technology, Czech Republic

A dedicated version of the Cagniard-DeHoop technique is applied to analyze the close-range electromagnetic (EM) field signal transfer between two small loop antennas through a highly-contrasting, thin conducting sheet. It is demonstrated that the solution methodology leads to useful asymptotic closed-form expressions describing the signal transfer in terms of Kirchhoffcircuit elements. Illustrative numerical examples that validate the results are presented.

Reconstructing the Material Properties of a Scalar Metasurface - A Stochastic Optimization Approach
Petr Kadlec, Martin Štumpf, Tomas Dolezal
Brno University of Technology, Czech Republic

The problem of material characterization of a scalar metasurface is solved in the paper. The proposed method benefits from the combination of a stochastic optimization method and a fast analytical time-domain approach to compute electromagnetic fields in the vicinity of the thin sheet. The convergence of five state-of-the-art evolutionary optimization algorithms on the material characterization problem is compared here. The influence of problem parameters on the convergence of the characterization method is discussed.

Shielding Effectiveness of Volume Materials
Monika Ewelina Szafranska, Zbigniew Jóskiewicz, Jarosław Janukiewicz
Wroclaw University of Science and Technology, Poland

This paper presents some results of shielding effectiveness measurements of volume materials, which are large, heavy and not easy to manipulate. A concept of measuring of the shielding effectiveness of prefabricated building materials as well as possible approaches to testing and evaluation results are presented. Some basic information

regarding theory of shielding effectiveness and their implementation were presented in this paper too.

Transmission Line Model of Field-to-Wire Coupling with Transmission Line Cables From Near and Far Field Sources

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In this paper, a transmission line model is established to describe the electromagnetic wave coupling with transmission line cables from far and near fields. The far-field is described by a plane wave, whereas the near field is considered to be generated by a dipole antenna. Consequently, the affecting electric field due to the plane waves and electric dipole antenna are formulated analytically. In addition, a general expression for the current and voltage at both ends of the transmission line are presented. The model is used to fast calculate the induced common mode and differential mode currents at the cable terminals when the cable is exposed to electromagnetic interference from far and near fields. The results of the proposed analytical model are compared with those of commercial software FEKO, and good agreements are obtained.

A SPICE Model for a Field-Coupled Conductor Based on the Scattered Voltage Formulation

Moustafa Raya, Sergey V. Tkachenko, Ralf Vick
Otto-von-Guericke University, Magdeburg, Germany

This paper presents a network model of a field-coupled single conductor over a perfectly conducting ground plane. The model was developed from the scattered voltage formulation for field coupling on transmission lines and can be implemented directly in SPICE programs. With this model, a field coupling test can be carried out in which the voltage response of an incident plane wave can be calculated. The model can be used in the time and frequency domain. The validation was carried out by comparing the results with those of field simulations.

System Identification of a Branched 50 Ohm Network by Transient Excitation

Felix Burghardt, Nico Feige, Heyno Garbe
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The transmission of a single conductor or filter can be determined analytically as well as with a measuring device such as the Vector Network Analyzer (VNA). Even small networks that cannot be calculated analytically can be determined with a network analyzer. The use of a network analyzer is not advisable in complex networks where the ports to be considered are spatially far apart. The measuring cables used for this would have to be very long, which increases the attenuation in the high-frequency range. This paper introduces a method for

performing system identification on a branched 50 Ohm network using a signal generator and an oscilloscope. For this purpose, the network is stimulated with a transient signal and the system response is recorded. The transfer function can then be determined from this system response.

Prediction of Radiated Emission with Transmission Line Model for CISPR 25
Sayantan Dhar, Kaushik Patra, Shynu Nair, Lohith Kumar, Shibu Krishnan, Bibhu Prasad Nayak
Robert Bosch Engineering & Business Solutions, India

Modern automotive ECUs are composed of multitude of microprocessors and other high speed circuits. High speed signals to/from the ECUs for data/control pass through long connecting cable harnesses and generate radiated disturbances on all onboard and off-board electronics. CISPR 25 is standard to control this emission level. However, enforcement of this standard at the post prototype measurement step leads to difficulties in case of failure. Emission is often due to the cable bundle's Common-Mode (CM) current which can be measured easily with current clamps or computed using electromagnetic solvers. In this work, a transmission line based analytical approach is proposed for estimation of Radiated Emission (RE) from an equivalent single cable model emulating the same common mode behavior of a cable bundle. Emission is calculated using the spatial current on the line which in turn are dependent on the terminal impedances. The proposed method is validated with full wave 3D simulation as well as practical measurement. Results show good agreement with a substantially reduced computing resource requirement allowing a quick estimation of the radiated fields.

Board Level Shielding Effectiveness Measurements Using the Dual VIRC
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This paper presents shielding effectiveness measurements of board level shielding materials using the dual vibrating intrinsic reverberation chamber. Various sized board level shielding materials mounted on specifically designed printed circuit boards are examined in order to evaluate the shielding performance in each case. Experiments presented in this paper aim to investigate the effect of appropriate mounting of the test samples before performing a shielding effectiveness measurement, as well as to compare the shielding mechanisms of these kinds of materials. Additionally, based on the obtained measurement data, a discussion on the definition of shielding effectiveness and the effect of the aperture on the coupling of the two cavities of the dual VIRC is briefly conducted.

TC-06 Transportation EMC, Automotive/Railway/Ship EMC

Noise Suppression Using a New Mode Conversion Method on an Asymmetric Boost Converter

Retsu Sugawara
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An asymmetric circuit causes impedance imbalance, leading to mode conversion. Especially, in the case of a power conversion circuit, a reactor is usually on one side of the positive and negative electrodes. Therefore, a power conversion circuit with a reactor causes mode conversion in most cases. If we try to reduce noise generated by mode conversion with a noise filter, we should add some components, or will need a larger noise filter. We can solve this problem by impedance balancing to suppress mode conversion. However, we need to understand the mechanism of the mode conversion of an asymmetric power conversion circuit with a reactor to balance the impedance. In this paper, we clarify the mechanism of the mode conversion of an asymmetric power conversion circuit with a reactor, and suggest a new method to suppress the mode conversion with a simple change of the circuit .

Research of Interference in the Operational Current of DC Motors of Railway Switch Points

Tetiana Serdiuk
Dnipro National University of Railway Transport named after Academician V. Lazaryan, Ukraine

This paper deals with the research of interference in the curve of current of DC motors railway switch points and the diagnostics of using harmonic analysis of it during the operation. The current spectral composition of the DC motor with series excitation was evaluated experimentally and theoretically. The influence of DC motors interferences on the adjacent railway automatics devices was investigated.

Model of Propagation of Traction Current Harmonics from Trains to a Track Circuit Receiver

Volodymyr Havryliuk
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The problem considered in the work is related to ensuring the electromagnetic compatibility of new types of rolling stock with track circuits. The article presents a mathematical model for propagation of traction current harmonics in asymmetric rail line from multiple rolling stock units to a track circuit receiver. To simulate the distribution of return traction current harmonics in longitudinally inhomogeneous and asymmetric rail lines, a large number of parameters are required that characterize a specific design of a traction network and track circuits, which makes the task difficult for practical implementation. The mathematical model proposed in this work can be conditionally divided into three parts. In the first part, the distribution of the total traction current harmonic in both rails from all rolling stock units located in a feeder zone is determined without considering rails asymmetry. In the second, the distribution of traction current harmonics in rails, considering their electrical asymmetry, is determined for the problem track section. And in the third part, the propagation of the

traction current harmonics from the rails to the track circuit receiver is investigated. The adequacy of the developed model was verified by comparing the results of calculations and measurements.

Optimization Methods for Common Mode Cancellation in Phase Shifted Inverter Operation
Jonas Bertelmann, Michael Beltle, Stefan Tenbohlen
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Synchronized switching of two opposing semiconductors in a six-phase inverter setup can reduce the common mode spectrum. In a first prototypical setup, attenuations of up to 40 dB can be achieved up to the frequency range of the medium wave (500 kHz - 2 MHz). For an improved cancellation of the disturbances, a synchronization of switching edges is suggested in this contribution. Two methods are investigated, one in the time domain and the other in the frequency domain. Additionally, cancellation performance improvements with the help of skipped switching processes while zero crossing are introduced and evaluated.

TC-07 Aerospace EMC

Application of the CRLH-Based Antenna to Improve Aerospace EMI
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Japan Aerospace Exploration Agency, Japan

Electromagnetic interference from each antenna poses a serious problem regarding the integration of satellite missions. This paper proposes a CRLH-based dipole antenna of VHF to reduce aerospace EMI at the L-band. Improving EMI is tuned by the LC network, and the VHF antenna with a length of 0.22 λ is designed using negative resonances.

Electromagnetic Scattering Reduction for Conical Objects
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In this paper, the skills for reducing the electromagnetic scattering from an extended conical object are suggested and investigated. The skills include both the geometric optimization of the cone shape and the absorptive coating. The cone angle is the dominant factor for the optimization. However, the absorptive coating is needed for further reduction in scattering. By using both skills, the reduction of scattering in terms of radar cross-section (RCS) is shown to be remarkable.

Measurements of Undesired Radio Waves Nearby a Compact Drone
Koh Watanabe, Mai Aoi, Misaki Komatsu, Satoshi Tanaka, Makoto Nagata
Kobe University, Japan

Unmanned aerial vehicles (UAVs) have been penetrated into various markets. The control through cellular communication channels becomes of significant importance to ensure safely flying above densely populated areas. UAVs may suffer from electromagnetic interference (EMI) problems where their airframe is densely packed in a compact chassis with multiple electronic modules for power, control, and wireless communications. This paper describes the experiments on undesired radio waves (UR) within a compact (hobby or home) drone and the potentiality of EMI among the control and wireless modules once integrated in the same chassis. The UR waves were measured in a frequency range from 0.5 to 6 GHz, with a folded long-hexagon antenna at 200 mm away from the drone in an anechoic box. It was observed that the drone emanated the UR waves up to -150.6 dBm/Hz in 800 MHz band. The influence on 5G based wireless communication performance was evaluated with a wireless communication system level simulator, showing the degradation by at most 15 dB in the minimum sensitivity if a receiver module exists in the same aircraft.

The Impact of Flight Profiles Towards EMC on All-Electric Aircraft
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All-electric aircraft (AEA) currently experiences an increase in industrial and research initiatives. The implementation of such technology in commercial activities is imminent, however, entirely dependent on technological advancements yet to be achieved. Dealing with a full electric powertrain presents several challenges, amongst which ensuring electromagnetic compatibility (EMC) is one of the most important topics. Therefore, different permanent magnet synchronous motor operational speeds were evaluated in a simulation to determine their impact on generated electromagnetic interference (EMI). Thus, different emission levels originating from the implemented speeds will impact the mitigation design strategy, leading to the development of proper solutions.

TC-08 Smart Grid and Low Frequency EMC

A Study of Conduction Noise Suppression Control for Two-Motor Drive Systems
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This paper introduces a pulse-width modulation (PWM) method for a two-motor drive system that reduces the propagation of conduction noise to the power supply. This two-motor drive system consists of two motors with each of the two inverters connected to a common DC bus. The proposed method suppresses the common mode voltage ideally to zero by shifting the rise and fall times of the output voltage of each inverter. Our

experimental results show that the rise and fall times of the output voltage can be synchronized even when the two inverters are driven at different amplitudes and frequencies. We further confirmed that the proposed method suppresses the propagation of conduction noise to the power supply.

Current Emissions Generated by Dimmed Lighting Equipment of Different Technologies

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The use of energy efficient equipment in household situations is increasing. Because of the non-linear and time-invariant behavior of such equipment, conducted electromagnetic interference problems arise. For instance, dimmed light equipment and a speed controlled water pump resulted in interference of static energy meters in previous studies. And the large crest factor, short pulse duration, and fast rising slope of the drawn current were correlated with the interference. Next to this, no strict regulations apply for the emission of dimmers that control the intensity or speed of a load. Therefore, this paper researches the current emissions of dimmed lighting equipment. By providing situations that are representative to be used in low-voltage networks. This includes different lighting technologies and different dimming principles, i.e. rising and falling edge dimming. It was found that falling edge dimming resulted in the lowest conducted emissions.

The Effects of Falling and Rising Edge Dimming on Static Energy Meter Errors

Tom Hartman, Roelof Grootjans, Niek Moonen, Frank Leferink
University of Twente, the Netherlands

For a better understanding on what is causing static energy meter misreadings different current waveforms with falling and rising edges have been compared. Falling edge dimming showed higher static energy meter deviations due to the larger rate of change in the current, |dI/dt|, compared to the rising edge dimming. The difference in |dI/dt| is due to the asymmetry inherent in the semiconductors used. No specific difference in static energy meter deviation was found due to the polarity of the dI/dt. Faling edges in the first quarter of the sine wave resulted in an overestimation of the consumed power just as rising edges in the second quarter. Rising edges in the first quarter and falling edges in the second however showed an underestimation of the consumed power. The underestimation seems to compensate the overestimation when using complementary waveforms.

Switching Noise Analysis for Conducted Electromagnetic Interference from of Power Electronic Module

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Power semiconductor devices, especially for the ac-dc adaptors, have been widely used and developed toward higher power density with smaller size in recent years due to ICT and consumer electronics demand. The ability to pack more power into smaller spaces and use it more efficiently - is key to improving electronic devices, strengthening digital operations, upgrading our using experiences and more. The power module for ac-dc adaptors is developing toward high power density and size reduction for portable convenience. Since the conversion efficiency and size of the traditional linear power-supply is not suitable for high-speed digital electronic product applications [1], the switching-mode power supply technology thus becomes the main stream for the applications. To achieve the goal of size reduction and conversion efficiency improvement, the MOSFET switching frequency of power module will need to increase and inevitably bring into design problem. Under the fast switching operation of power module, there will exist large ripples and switching noises causing electromagnetic interference issue [2]. The power electronics industry now faces the deign challenge to meet the compliance of electromagnetic compatibility regulations while keeping power density increase, size reduction and cost effectivity. We thus analyze the conducted EMI root cause of high efficiency and compact size ac-dc adaptor, and further investigate the mitigation methods on noise filtering and PCB layout in this publication.

Parasitics Analysis in the Power and Gate Driver Loops and Impact on the Ringing of SiC MOSFETs

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This paper analyzes the behavior of transient switching silicon carbide devices influenced by the parasitics of printed circuit board and the component itself. The parasitics in power and gate driver loops are described and investigated. Double pulse test simulations for silicon carbide devices are conducted in this report and verified through the circuit simulation. The parasitics in the printed circuit board are added based on the real experience printed circuit board design and the parasitics in silicon carbide devices are added based on the manufacturer modeling. The parasitic inductances in the simulation are varied +/- 30% to understand the effect of the parasitics. The drain and source parasitic inductances and the gate parasitic resistance are simulated separately to understand the individual effect on the ringing of silicon carbide devices. The ringing impact on the reliability of devices is also analyzed in this paper.

Source and Load Impedance Mismatch Analysis of a Power Line Filter in Microgrid Application

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Operation of microgrids requires intensive monitoring and control between components through a communication network. A harsh signal environment in a microgrid might disrupt the communication and lead to component failures. Filters are required to protect the critical equipment and ensure seamless communication while filters could also influence communication signals. This paper analyzes the filter effectiveness in microgrid applications, which is illustrated by a mismatch between source and load impedances. The observed filter includes components' parasitics and imperfect inductor coupling as its nonideal characteristics. Due to the converter's switching frequency, a mismatch between source and load impedances, and unintentional inductance in the ground wire, reduced attenuation could be expected for a filter that is implemented in a microgrid.

Susceptibility of Power Line Communication (PLC) Channel to DS, AM and Jamming Intentional Electromagnetic Interferences

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The use of power lines as a communication channel for transferring data between communication devices for power systems in smart grid communication systems is growing rapidly. This paper describes three different types of methods for radiating and conducting Intentional Electromagnetic Interference, IEMI, signals: Amplitude Modulated, Damped Sinusoidal and Sweep Frequency Jamming Signals. The severity of all three types of IEMI signals on a power line communication channel using a single phase of a three-phase, low-voltage power distribution board is compared. The method for measuring interference is then explained and the influence of radiated and conducted interferences on data transmission is assessed. After discussing the IEEE 1901 power line communication channel's vulnerability to IEMI, this article explains the need for a systematic risk-based approach, in coalition with the rules-based perspective, to mitigate its impact.

Super High Resolution Time-Frequency Analysis of Switching Noise Which Emitted on Power Line

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We are investigating the characteristics of electromagnetic noise which switching power supplies emit on power line. In our previous work, we found the relationship between the intensity of electromagnetic noise and the degree of deterioration of a switching power supply. However, the result was only for a single switching power supply, and the generality of the result is not confirmed. Therefore we measured and analyzed the electromagnetic noise of various electric appliances to find the variation of switching noise, in advance to the confirmation. All of their time-frequency characteristics were different from the one which measured in our previous work.

An Approach to Predict Conducted Noise from DC/DC Converter Considering Switching Fluctuation

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The switching fluctuation known as jitter exists in the DC/DC converter's clock signal, which makes conducted noise to be time-variant. Oscilloscope averaging mode in the measurement for model identification based on black-box equivalent circuit model removes part of high-frequency noise. Thus, prediction accuracy is affected by switching fluctuation. The first topic of this paper is to remove the effect of switching fluctuation and improve noise prediction accuracy by the noise signal decomposition method. We propose a method to decompose measured time-domain noise signal into ripple noise, turn-on, and turn-off spike noise to prevent the accuracy degradation of the parameter identification. The predicted noise is closed to the peak value. The result shows an error with the measurement is within 3 dB up to 200 MHz by using the waveform decomposition method as the power density of the predicted signal is spread by switching fluctuation. The second topic is to predict the noise spectrum with switching fluctuation existed. The result shows good accuracy comparing with measurement.

Measurement of $LiFePO_4$ Battery Modal Impedances Under Different Conditions

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One of the key aspects when designing an EMI filter for automotive applications is the knowledge of the system's impedances given by different components, such as drive inverters and batteries. The goal of this work is to characterize from an EMC point of view, i.e., measuring the common mode and differential mode impedances, a 48 V Li-ion battery. The measurements are performed exploiting an impedance analyzer and a coupling device that allows the measurement of the battery in different configurations. The investigation shows the modal impedances as a function of the state of charge, loading condition, and metal enclosure structure.

Active Transient EMI Stabilization

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Inrush currents, as well as other transient switching electromagnetic interference events are a major cause for concern, especially so on isolated grids with limited capacity. This paper investigates via simulations a concept for a weak grid supportive device which supplies higher order currents and high-power short time duration disturbances. The device suggests improved power quality as well as overall local current stabilization.

Comparative Analysis of Conducted Emission of Off-Grid PV Inverter Using Different DC-LISNs

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The comparison and analysis of conducted emission measurements on the off-grid photovoltaic (PV) inverter on the direct current (DC) side using two DC Line Impedance Stabilization Network (DC-LISN) models has been successfully carried out. The DC-LISN originating from the manufacturer was used as the first model while the self-developed model using more affordable materials was used as the second model. The impedance and isolation characteristic values of each DC-LISN are compared based on CISPR 16-1-2:2014. The results of impedance and isolation of each DC-LISN were within the tolerance range allowed by the standard. Furthermore, the measurement setup in the IEC 62920:2017 standard was applied to measure the conducted emission on the DC side of the PV inverter various in no-load mode. The highest level of noise was obtained with the 500 W inverter, both when using the first and second DC-LISN models. In addition, the difference of the maximum peak noise value of about 6 dB between the first and second DC-LISN models were due to the inductance value, 5 µH for the first DC-LISN and 50 µH for the second DC-LISN. The discrepancy of the peak noise profile at high frequency that occurs in all inverters were due to differences in the characteristics of DC-LISN components. However, the entire peak noise profile of the second DC-LISN model is utterly similar to the first model interprets that the low-cost, self-developed DC-LISN could be used as an alternative to conduct the conducted emission measurement of PV inverters.

Magnetic Field Emission of Automotive Inductive Charging Systems in the 9 kHz - 30 MHz Range

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Wireless-Power-Transfer (WPT) systems for electric vehicles (EV) are subject to international standardization. Therefore, electric & magnetic field emission limits have to be defined for these systems. In this paper the setup of a WPT test bench for EMC measurements is presented, according to proposals of Society of Automotive Engineers (SAE). The relevant interference CM & DM current paths are analyzed and the systems near field magnetic emission in the frequency range from 9 kHz to 30 MHz are presented.

Identification of Harmonic Current at Off-Grid PV Inverters Connected to the Load

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The phenomenon of harmonic current arising from an inverter connected to the load in an off-grid photovoltaic (PV) system has been identified. The pure sine wave (PSW) and modified sine wave (MSW) inverters were used in this study and were connected to the load of incandescent and LED lamps. The Power Analyzer was used to obtain the output voltage of each inverter and the current harmonic values in the inverter and load lines. The highest percentage value of harmonic current is 72.51% for the PSW inverter connected to the LED lamp and 49.92% for the MSW inverter connected to the LED Lamp. Further research is needed regarding the filtering method to reduce the harmonic current so that the PSW and MSW inverter could be used properly in the off-grid PV system.

Dynamic Wireless Power Transfer in Urban Area: EMI on Traffic Signal Cables

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This study deals with a preliminary analysis of the electromagnetic interference (EMI) produced by a dynamic wireless power transfer (DWPT) system on an underground traffic signal cable. The considered DWPT is composed by an electrified lane with short-track pads architecture. The induced effects in a multiconductor underground cable are calculated by the theory of field-excited multiconductor transmission line (MTL) where the distributed sources are derived from the electromagnetic field generated by the DWPT coils operating at 85 kHz and transferring a power of 10 kW. The obtained preliminary results, validated by comparison with other methods, show that the induced current on a traffic signal cable is small for higher odd harmonics, while it is negligible for even harmonics. Thus, only the first harmonic could produce EMI.

TC-09 IC and Semiconductor EMC

Integrated ADC and Low Noise PLL with Low-Dropout Regulator for Transformer Coupler Quadrature Hybrid Wireless Charging

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The proposed integrated wireless power coupler consists of successive-approximation analog to digital converter (SAR ADC), phase locked loop (PLL), wide bandgap voltage reference (WBGR) and low-dropout regulator (LDO). The integrated wireless power coupler uses transformer-based quadrature hybrid are fully utilized to final tune the layout dimension and insertion loss as the resonator for wireless power coupler. The proposed design is successfully implemented at the performance of 10-bits ADC Code with neural network (NN). The experimental results are in good agreement with the measured wireless power transfer efficiencies (PTEs) and show that by changing the buck switching regulator output can be effectively achieved in low-dropout regulator.

Technique of Measuring Injection Locking of VCO

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The IC stripline method is utilized for characterizing the injection locking effect of voltage-controlled oscillator (VCO). An IC stripline with the operation bandwidth of 2.5 GHz is realized and the test setup is built. A 1.5 GHz VCO is used to demonstrate the experiment. The result depicts the occurrence of locking effect under certain radiated emission level at each single frequency and shows the effectiveness of the proposed technique for measuring injection locking of VCO.

Effect of Feed Forward Equalization on EMI-Related Common Mode Noise in 56-Gbps PAM-4 Optical Transmitter

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Electromagnetic interference (EMI) signals, which radiate in the environment and cause the malfunction of electronic devices in proximity, are generated due to the common mode (CM) noise in differential circuits. This CM noise is produced because of the imbalance in the charging and discharging paths of the driver and equalizer circuits in the transmitter. However, the effects of the equalizer on CM noise have not been examined. This paper systematically investigates the effect of different feed forward equalizer (FFE) configurations on EMI-related CM noise in a 56-Gbps four-level pulse-amplitude modulation (PAM-4) optical transmitter, aiming to provide an optimized configuration with low CM noise and power consumption, while providing high compensation. The simulation results show that an asymmetric equalizer significantly improves the compensation performance. However, the offset in differential pair of output stage should be minimized to decrease the CM noise generated from the FFE.

A Generalisable Component-Level ESD Failure Characterisation for TLP Measurements

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Designing an electronic system to be robust against electrostatic discharges remains challenging. Components have to be characterised with respect to system-relevant soft-failures in addition to the commonly investigated hard-failures. A method to provide this

information is proposed in this paper. The method is based on transmission line pulsing measurements with freely definable failure detection and processing routines, and is able to simultaneously check several failure criteria. This allows to adapt the measurements depending on the requirements of a random component and its surrounding system.

IC-Package Optimization for Conducted EME Performance: Impact of Discrete Decoupling Capacitors and Parasitic Inductive Effects
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In the evaluation of conducted emissions from digital integrated circuits, the package must be considered as fundamental contributor. The impact of small package design details becomes more significant with the increasing application frequencies, but the growing flexibility in terms of packaging technologies offers some powerful instruments to properly address the final performances. Goal of this paper is to analyze the impact on conducted emissions of two important package parameters: parasitic inductance and integrated decoupling capacitors. The trade-off between conducted emissions optimization and dynamic IR-drop reduction is also taken into account. All the presented results are obtained by system-level simulations considering die, package and board.

Influence of Layout Parasitics on EMI Improved Folded Cascode Amplifier Input Stages Using Filtering and Linearisation Methods
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This paper investigates the electromagnetic interference (EMI) behaviour of EMI improved integrated folded cascode amplifier input stages. In this context three EMI improved differential input pair structures, using concepts of filtering and linearisation, are compared in terms of their susceptibility. Special attention is paid to the differences in the behavior of the structures at the design stage and the layout stage, where layout-specific parasitics that can affect circuit performance are also considered. Comparisons on the investigated structures are made in terms of EMI induced offset voltage, electromagnetic interference rejection ratio (EMIRR), layout considerations, differential and common mode gain, gain-bandwidth product (GBWP), stability, power consumption, area requirement (estimation vs. implementation) etc.

TC-10 Signal Integrity and Power Integrity

Broadband Characteristic Impedance Extraction for Planar Transmission Lines on Lossy Substrates
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The analytical expressions and measurement results for extracting the broadband characteristic impedances of planar transmission lines (TLs) on lossy substrates were presented, with aids of the multiline thru-reflect-line (MTRL) calibration with a series resistor. Based on the constant resistance assumption of the series resistor, the TL unit length capacitance/ conductance can be acquired; thereby the characteristic impedance can be determined with the obtained propagation constant after calibration. The shown method was examined by coplanar waveguide in CMOS 0.18 μm technology from 1 GHz to 110 GHz.

Asymmetric Dual Bend Skew Compensation Technique for Reducing Differential to Common Mode Conversion

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Asymmetric dual bend skew compensation scheme is proposed in this paper, to reduce differential mode to common mode conversion in a system, thereby improving EMI performance of the system, at no additional cost and without reducing the SI performance. Three types of asymmetric dual bends are presented, and their EMI and SI performance is simulated in comparison with current skew compensation technique and an ideal layout. The results show that these Asymmetric dual bends can provide ~ 10dB improvement in Scd21 for frequencies till 20GHz for stripline routing and ~ 5dB for frequencies till 15GHz for microstrip routing.

Accurate Multi-Port De-Embedding of Crosstalk-Affected Fixtures for High Speed Devices

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The paper investigates how much the crosstalk within the fixtures for multi-port device measurements affect the de-embedded results. Usually such type of fixtures are designed to minimize the crosstalk among the lines or the differential pairs, thus the de-embedded can be performed by applying iteratively the well-known 4-port de-embedding process based on the S-to-T and T-to-S parameter conversion. However such process ignores the crosstalk among the lines within the fixtures; in the case that the coupling is not negligible or it is ignored, especially for devices working at very high frequency (tens of GHz), the simple 4-port de-embedding leads to errors in the extraction DUT S-parameters. The multi-port de-embedding algorithm reviewed in this paper, instead, is able to take this coupling into account, independently on the amount of crosstalk within the fixtures. The de-embedding based on multi-port S-to-T parameters conversion (and vice-versa) always provides perfectly de-embedded DUT parameters, as highlighted by a realistic exampled based on a multipin connector for PAM4-based 112 Gbps applications.

Analysis of Ground Void Patterns for Differential Microstrip Impedance Matching on Surface Mount Pads

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The mounting pads of surface mount device introduce transmission line discontinuities and cause signal integrity degradation. To compensate for the excess parasitic capacitance, ground void may be utilized on the ground plane underneath the pads. In this paper, conventional patterns of plane cutout are presented and analyzed using a 3-D full wave solver. In addition, new void patterns with circular outline are proposed and investigated. From the simulation results, for a pair of 85-Ohm differential traces with 0201 package-sized components in series, suitable design of ground void can be determined, and can effectively control the trace impedance.

How the Type of Glass Fiber Cloth Affects Insertion Loss

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As the frequency of high-speed signal increases dramatically, accurate PCB trace modeling become more important. From the Dk and Df accuracy of the material itself to the roughness setting of the copper foil, it needs to be studied in depth to meet the actual situation above 16G+Hz. In this study, we discussed in depth the influence of resin and fiberglass cloth on Dk and Df, and used simulation tool to modify the parameters to make the simulation results more in line with the real measurement. In addition, the research results are used to optimize the stackup of high-speed products to have the advantages of reducing board thickness, reducing crosstalk, and improving loss performance.

A Broadband Common-Mode Filter by Using Dual Band Transmission Zero

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A broadband common-mode filter composed of three layers of a printed circuit board (PCB) with 5.2 mm x 17.6 mm area is proposed. Multiple transmission zeros can be created by a T-type resonator on the second PCB layer with a differential pair on the first PCB layer. The broadband common-mode noise suppression can be achieved by positioning transmission zeros appropriately. ANSYS HFSS is used to verify the design of proposed filter and the simulation result shows the common-mode noise is suppressed over 10 dB from 2 GHz to 10.5 GHz with 136% fractional bandwidth. The differential signal keeps good integrity in the frequency range from DC to 12 GHz.

Comparison Among Types of CSRR DGS RCMF

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Four types of CSRR DGS RCMF (Complementary Split Ring Resonator Defected Ground Structure Reflective Common-Mode Filter) simulations are presented. Their equivalent circuits are also presented. Their performance results are also shown and analyzed. ANSYS HFSS is used to verify these performances. The dimension of the proposed filters is 11.0 mm x 11.0 mm. The best result is achieved by D_CSRR DGS RCMF with the resonance frequency of the transmission zero at 2.44 GHz, the transmission zero depth is -26.0 dB, the -5 dB bandwidth is 1.8 GHz, and the -10 dB bandwidth is 500 MHz.

A Broadband, High Common-Mode Rejection Ratio Instrumentation Amplifier
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An operational amplifier based instrumentation amplifier (IA) with a common-mode rejection ratio (CMRR) independent of resistance tolerances is presented in this paper. The CMRR is determined by the operational amplifier characteristics. The IA shows a high CMRR up to 100~kHz. Moreover, since the presented IA operates in the current domain, no large internal voltage swings occur, making it an interesting choice for low-voltage applications in situations where common-mode disturbances may affect the signal processing.

3D Full-Wave Simulation of Stub Length Effect of Vias in High Speed PCB Design
Eric Steenbergen, Niek Moonen, Frank Leferink
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Together with the increase in data rates for electronics, the signal rise and fall times have shortened similarly. Throughout this paper, there is focused on signal integrity problems in high-speed PCB design as a result of impedance mismatches caused by fabrication tolerances and via stubs present in PCB transmission lines. These problems are modeled within the 3D EM simulation environment in CST Studio. There is shown that the insertion loss of the signal is affected by the resonance frequency of the via stub and impedance mismatches throughout the transmission lines. Although, promising shielding techniques have been proposed to combat these effects on signal integrity with significant improvement of the bandwidth as a result.

Characterization of Polygonal Planar Loop Probe for Near-Field Measurement Application
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Every electronic equipment can emit electromagnetic interference and interfere with other electronic components and equipment. To find out how much emi is generated due to

electronic device components, near field measurements are needed. The planar loop probe is a near field measurement tool. In this study, a polygonal planar loop was designed for near field applications. Various planar loop probes with a different number of sides are triangle, rectangular, hexagon, octagon, pentagon and circle. The polygonal probes were characterized and compared and then looking for the best sensitivity. The triangular polygonal planar probe has the best sensitivity. The sensitivity of the triangular probe was compared with the result of S_{11}. The comparison show the sensitivity is reversely proportional from S_{11}. After that the sensitivity and S_{11} compared to simulation.

TC-11 Computational Electromagnetics and Multiphysics Modeling

Compressed Stochastic Macromodeling of Electrical Systems via Rational Polynomial Chaos and Principal Component Analysis
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This paper introduces a compression strategy to speed-up the calculation of frequency-domain stochastic models based on rational polynomial chaos expansions. Principal component analysis is used to remove redundancy in the data, thus leading to a considerable reduction in the number of model coefficients to estimate. Compared to the state-of-the-art techniques, the proposed solution turns out to be a good trade-off between accuracy and processing efficiency. As a validation, the method is applied to the uncertainty quantification of the scattering responses of a nine-port distributed network.

Improved Unscented Kalman Filter Algorithm Adapted to the State Under Non-Common View
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In the actual tracking environment, when multi-station tracks motion targets, due to the limitation of the observation range, there may be a situation where one or some observation stations cannot detect the radiation source signal. This paper proposes an improved passive filter tracking algorithm that improves positioning and tracking performance under non-common view condition. First, we establish an observation and tracking model in a non-common view environment; we then use joint TDOA(Time Differences of Arrival) and AOA(Angle of Arrival) localization algorithm to estimate the location of the observation and tracking model in a non-common view environment, and finally we use the improved adaptive state UKF(Unscented Kalman Filter) algorithm to make prediction updates. The simulation results show that the proposed algorithm in this paper can effectively improve the target tracking effect under non-common view condition, effectively delay the decline in tracking accuracy when the target cannot be located, and make full use of the previous estimation results.

EM Performance of Segmented Diverter Strips Used in Lightning Protection of Wind Turbine Blades

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Segmented diverter strips are increasingly becoming used for the lightning protection of wind turbine blades. This paper investigates the electromagnetic properties of a range of segmented diverter designs that differ in terms of size, shape and the separation gap between the metallic segments. Furthermore, the performance of segmented diverters positioned on two different materials namely fiberglass epoxy and carbon fiber, are also compared.

Effect of Cable-Bend on CISPR25 CE Current Method

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Conducted Emissions (CE) contributes to a significant percentage of compliance failures in the verification stage of electronic hardware. In this work, the effect of cable-bend on the CE results is studied. The cable bend at the LISN-end can affect the common mode impedance due to the change in the mutual coupling between the cables. A full-system hybrid-solver capability is implemented based on the observations. The cable bend effect is demonstrated using the simulation setup comprising of LISN, cable harness and DUT. The effect is further validated using measurements.

Performance Analysis of PLA-Based EMI Shield Material for MALE UAV Application

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This paper presents the performance analysis of electromagnetics interference (EMI) shield material made of polylactid-acid (PLA) for medium-altitude long-endurance (MALE) unmanned aerial vehicle (UAV) application. The analysis is performed to investigate the effect of varied thickness, dielectric constant, and dielectric loss to the characteristics of proposed PLA-based EMI shield material. Scattering parameter of the analysis system is established using a scale model of cylindrical casing and spherical cover. The models are applied to observe the characteristics of EMI shield material tested in two different shapes. In general, it is shown that the two shapes of analysis system model give the different value of transmission coefficient (S_{21}) less than 0.8dB for the same variation of PLA-based EMI shield material parameter.

Study of Radiated Emission from an Automotive Touchscreen System – A Simulation Driven Approach

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Capacitive touchscreens offer an intuitive and robust interface that increase product reliability by eliminating mechanical parts. However, such systems contribute to Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) issues, such as Radiated Emissions (RE). In this paper, a simulation-based approach is presented to predict RE performance of a capacitive touchscreen system (TSG6XL) in a CISPR 25 environment. The simulation results are correlated with measurement. The simulation setup is then used to study the effect of transmitter excitation characteristics like slew rate, spread spectrum and position with respect to antenna. The emission contribution from PCB, cable and screen is also studied. Such a simulation driven approach therefore may be adopted for optimization of such systems in Design for EMC.

Stochastic Transmission Line Analysis via Least Squares Polynomial Chaos Regression

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Least squares polynomial chaos regression (LSPCR), a non-intrusive method, is introduced to solve stochastic transmission line (TL) problems. As an example, a wire over ground is analyzed comparing with the Monte Carlo (MC) simulation and the stochastic Galerkin (SG) method. It is shown that the LSPCR results (N=3) for the mean and the standard deviation of the terminal voltage are closer to the statistical results of the MC simulation ($N=10^5$) than the SG counterparts are. Moreover, the LSPCR is slightly faster than the SG method.

Study on Shielding Effectiveness Based on the Modeling of a Shielded Enclosure

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The paper deals with the shielding effectiveness for electric field in an anechoic chamber. A brief description of the anechoic chamber geometric model related to walls is provided. Previous experiments proved that most of the shielding effectiveness problems appeared at joints (doors, supplying panels, ventilation panels, cables etc). Therefore, this study is focused on the shielding effectiveness for the studied anechoic chamber door and one of the ventilation panels. The simulation addressing the shielding effectiveness was accomplished with the specialized software - CST Studio Suite®. Data obtained through numeric simulations are compared to experimental data obtained for an identical anechoic chamber. The experimental data are close to that provided by simulations, proving that the model built for simulation is correct and the materials selected for shielding have good shielding properties.

Extraction of Single Cell Impedance from Battery Pack Measurement by Simulation-Based Multiport De-Embedding
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Battery cell modeling is becoming increasingly important for EMC simulation, because batteries are a fundamental part of many modern electric networks, such as electric vehicle powertrains or powerline communication systems. The battery's impedance and reaction on transient events can have a dominant impact on electromagnetic distortions and susceptibility of the overall network to electromagnetic interference. Simulation models which depict the interior of a battery pack are usually composed of models of the individual cells, whereas the cell impedance data is obtained by measurement on single cells. However, when individual cells are not accessible, the single cell impedance needs to be extracted from measurement of the complete pack. This work describes a solution to this problem by combining numerical multiport de-embedding with measured pack impedance and 3D simulation of the pack assembly. For validation of the approach, cell impedances obtained by pack measurement and subsequent de-embedding are compared to single cell measurement results for frequencies from 9 kHz to 1 GHz. The demonstration is conducted with a commercial PP3 9V battery made of six closely packed LR61 alkaline cells.

SPICE-Based Lumped Circuit Model of Shielded Multiconductor Cables
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This paper presents a lumped circuit model for a multiconductor coaxial cable with braided shielding placed over a ground plane. A field immunity test can be simulated with this model, in which the voltage response of an incident plane wave can be calculated. The bidirectional coupling between the inner and the outer system is taken into account, which allows the calculation of the emissions in the outer system. The cable is divided into segments at first. In a later step, equivalent circuit diagrams are created for each segment and connected together to represent the entire cable. The model can be used in the time and frequency domain. The validation was carried out by comparing the results of the developed model with those of field simulations.

The Analytical Method for Pulse EMI Analysis in Shielded Cables
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This paper describes computational procedure for currents and voltages calculation on shields and inner wires of cables generated from pulse EMI. The procedure based on approximation of frequency responses of transfer impedance and admittance.

TC-12 Bio-Medical Electromagnetics & Wearable Devices EMC

Time-Frequency Analysis in EEG for the Treatment of Major Depressive Disorder Using rTMS

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Transcranial Magnetic Stimulation (TMS) is defined as a non-invasive technique of brain stimulation conducted for both diagnostic and therapeutic purposes. TMS can effectively excite the brain neurons and increase the brain plasticity which comes particularly useful in psychiatric and neurological fields. This research has looked into different electroencephalograph (EEG) frequency bands: alpha (8-13 Hz), beta (15-30 Hz), gamma (30-100 Hz), theta (4-7 Hz) and delta (0.5-4 Hz) before and after using a novel TMS device, which is designed to create a high current pulse generator on the transducer. We have demonstrated the overall design process of our TMS device as well as the effects of the new Major Depression Disorder (MDD) protocol in 5 days in each week and a total of 3 weeks on 31 cases including normal people and patients with different levels of depression severity differentiated based on the Beck depression inventory and by processing the EEG signals and time-frequency analysis. We then go on to compare the participants' depression severity before, after and 2 months after finishing the last treatment session using the proposed TMS. Absolute Power (AP), Band Powers (BP), Theta and Beta Bands Entropies (BA), which were extracted from the EEG, as well as nonlinear methods are used as features for the classification of changes in patient and normal cases after applying the new TMS. Finally, to evaluate the outcome of the treatment procedures, in which the proposed TMS has been implemented, we used different classifiers such as Support Vector Machine (SVM) and Artificial Neural Network (ANN). Accordingly, we can go beyond the Beck score and clinically classify the EEG signal into two classes of depression and normal. The results showed significant changes in left prefrontal cortex of brain activities in medication-resistance patients after 3 weeks of applying the proposed TMS. Also, the electrophysiological changes are shown to be evident in patients with major depression.

EMF Characteristic Inside the Infant Incubator Compartment

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Infant incubator is one of MEEs (Medical electrical equipment) that is largely used to preserve preterm and sick babies from postnatal stressors. However, their motors produce high electromagnetic fields (EMFs) which could affect the incubator as well as its occupants. In this paper, it has been done the EMF measurement to study and to quantify the level of EMF by mapping the magnetic field distribution inside the compartment of infant incubator. Measurement method was conducted on three layers from the mattress by magnetic near field probe and Spectrum Analyzers. The result showed that by $p<0.005$, the EMF is not significantly different from layer 1, layer 2, and layer 3. The averages values of the EMF are 0.53 µT, 0.98 µT, and 0.97 µT, at first, second and third layer on every stage of heater level.

This EMF is far below the standard level for magnetic field ERLs for exposure of limbs, and head and torso at 0 Hz to 5MHz by the IEEE and ICNRP.

Design and Development of Biosensor Microstrip Antenna at 2.45 GHz
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Biosensors antenna can be applied to the human body such as for health monitoring, diagnosis, and treatment. This research proposes a microstrip antenna that is applied for biosensing applications. The proposed antenna operates in the Industrial Scientific Medicine (ISM) band (2.4-2.5 GHz). In this study, the antenna is designed using the proximity coupled feeding technique. The proposed antenna is designed using CST Software. The antenna was fabricated and measured using the Pocket Vector Network Analyzer (VNA) device. The antenna substrate material used is Roger 3010 with a thickness of 1.28 mm. The results of the proposed antenna simulation show that the operating frequency is 2.46 GHz, return loss is -19.76 dB, and bandwidth is 401.2 MHz. Meanwhile, the results of the fabricated antenna measurements show the operating frequency at 2.5 GHz with a return loss of -21.55 dB. Based on the comparison graph between the simulation results and the measurement results, it can be concluded that the fabricated antenna has experienced an increasing shift frequency compared to the simulation results.

Numerical Study of Facial Nerve Stimulation After Cochlear Implant Surgery
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Cochlear implants (CI) have been widely used because it has been proven to help severe to profound hearing problem. Although cochlear implants have been successfully helping patients with hearing loss, some problems remain to occur these days as side effects of cochlear implantation. After the implantation, one of the unpleasant feelings experienced by patients is facial nerve stimulation (FNS) with intra cochlear electrical stimulation. FNS is the presence of any facial movement at or below the maximum comfortable loudness level (the so-called C-level) on one or more electrodes. Previous research suggested that triphasic pulse is better compared to biphasic pulse at reducing FNS. In this research, 3D geometry modeling of the facial nerve and potential field measurements for biphasic and triphasic pulse with different signal waveforms is conducted. This study aims to compare several types of triphasic signal forms to determine which type of signal is the best to reduce FNS. From the various maximum potentials generated, it can be concluded that the best triphasic pulse waveform is the symmetrical waveform, which produces the lowest maximum potential.

TC-13 Wireless Communication EMC

A Draft of New Japanese Guidelines for Hospital Building Construction to Insure the Safe Introduction of Wireless Communication Systems

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The introduction of information and communication technology in hospitals is rapidly expanding, with wireless communication systems integral to their smooth functioning. However, there are many problems, such as signals that do not cover the required area or the inability to make a required connection. In medical wireless telemetry systems, the lack of a signal can be life-threatening if alerts about abnormalities in a patient's vital signs do not reach the staff. Many hospitals have problems with the reflection of radio waves from walls and floors, lack of consideration for the placement of metal fixtures, or not having appropriate space for cable routing. Reasons for these problems include the hospital construction process in which the planning of the installation of information and communication equipment is not done until after the building framework is completed and that information on the materials of walls, floors and doors is not shared with the information and communication equipment managers. To counter these problems, the Architectural Institute of Japan Steering Committee on Electromagnetic Environment organized a subcommittee to examine how building planners can better take into account the use of radio waves in hospitals. Our first target was to set guidelines for wireless medical telemetry systems. Herein, we show our draft of these guidelines.

Summary of EMC Test Standards for Wireless Power Transfer Systems of Electric Vehicles

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As an important part of the new automobile four modernizations, wireless power transfer (WPT) system solves a series of problems of the conductive charging way, and its application is better for the accelerating development of electric vehicles (EVs). At the same time, the electromagnetic safety problem of WPT system is also gradually become one of the focus of public attention. However, due to the imperfection of relevant standards and regulations, the wireless charging system of electric vehicles is currently in the state of prototype and demonstration operation. The standardized wireless charging system will play a positive role in promoting the large-scale electrification of the wireless charging system of electric vehicles. This paper focuses on the research of EMC of the wireless charging system of electric vehicles. Firstly, based on the structure of the wireless charging system, the possible EMC problems are introduced. Furthermore, the existing EMC standards of wireless charging at home and abroad are compared and analyzed, and the

test layout is introduced. Relevant content will provide guidance for enterprises in the development and testing of wireless charging systems.

FPGA-Based Design and Implementation of High-Speed Spatial Adaptive Processing
Zhongpu Cui, Yongcai Liu, Yaxing Li, Meng Jin, Wang YaChen
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In this paper, a high-speed FPGA implementation of complex spatial adaptive processing system based on Xilinx System Generator is presented to suppress interference for wireless radios. By adopting Complex Delayed Least Mean Square (CDLMS) structure, 200 million-samples-per-second (Msps) throughput rate can be achieved with a 16-bits input/output data, which enables a wideband interference suppression. Furthermore, the orders of the proposed system can be expanded easily without performance decrement of system delay and throughput rate, and the adaptive step factors can be modified if needed. The experimental results show that it can realize 30dB interference suppression of 10MHz BPSK signal within 10000 iterations (i.e. 50us when clock frequency is 200MHz). Compared with Direct Matrix inversion (DMI), the proposed scheme can achieve almost the same interference suppression capacity at the cost of less calculation complexity, and enables a real-time implementation.

Channel Discrepancies Adaptive Modulation Recognition Using Domain Adversarial Training
Yaxing Li, Hao Wu, Ying Kang, Yu Guo, Zhongpu Cui, JinLing Xing, Qing Wang, Meng Jin
Naval University of Engineering, China

In this paper, we introduce a channel discrepancies adaptive automatic modulation recognition (AMR) method, which employs the domain adversarial training (DAT) to tackle the issue of wireless channel mismatch between training and testing conditions. The channel mismatch is a critical problem for deep learning (DL) based AMR systems. In realistic scenarios, the channel environment mismatch commonly happens and a large mismatch may seriously degrade the recognition accuracy of signals. The introduced channel discrepancies adaptive AMR method consists of a 1-dimensional convolutional neural network (1-D CNN) based recognition model and a domain discriminator model. The DAT encourages the 1-D CNN to extract channel invariant features and increase the robustness of the AMR system to new channel environment. We evaluate the proposed method and competition approaches on the popular RadioML2016.04c and RadioML2016.10a dataset. Experimental results shows that the introduced channel discrepancies adaptive AMR system produce notable better recognition performance than that of the methods without domain adaptation for the channel discrepancies of training and testing datasets.

A Circularly Polarized Planar Antenna Having High Gain and Shielding Effectiveness
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A high-gain circularly-polarized planar antenna is proposed for satellite communications. It consists of a linearly-polarized patch antenna and an asymmetric frequency selective shield newly developed. The antenna is designed to operate in the C-band and has high gains more than 10 dBic across the operation band. For creating the admirable features, the frequency-selective shield should be asymmetric and partially transmissible in the band. In addition, the shield should provide high shielding effectiveness to stop electromagnetic interference (EMI).

Characteristic Investigation of Dome-Shaped Patch Antenna as Wearable EMI Sensor

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Microstrip antenna is a popular planar antenna which is used in wide applications, including for wearable EMI sensor. It has small form factor and can be made from unique shapes. This paper presents an investigation of a dome-shape patch antenna for EMI wireless sensor purpose. It has two main structures which are the dome structure and the lower part structure. Several simulations have done to verify this antenna design performance such as its return loss, gain, and radiation pattern. It shows that the dome size contributes to the antenna frequency center while the lower part affects the return loss and bandwidth of the antenna.

Bandwidth Enhancement of Wideband Sensor Using Triangle-To-Oval Patch Geometric Change for EMC Measurement

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This paper deals with the bandwidth enhancement of ultra-wideband (UWB) planar monopole antenna proposed as an electromagnetic sensor for electromagnetic compatibility (EMC) measurement. The patch of monopole antenna on the sensor takes initially a geometry of inverted isosceles triangle. This geometry is then changed over into an oval, called as triangle-to-oval patch geometric change, by utilizing the relationship between the isosceles triangle and the ellipse to enhance the bandwidth characteristic. In a series of optimization processes, the degree of curvature and optimum configuration are investigated. The investigation results show that the sensor with an oval patch has better performance on the reflection coefficient. A good agreement on the bandwidth response is achieved between simulation and measurement in the frequency range of 3.06 GHz to 19.51 GHz. Furthermore, the sensor has an average measured gain of 3.23 dBi with the maximum gain of 6.57 dBi at the frequency of 19 GHz.

TC-14 Nanotechnology and New Materials

Shielding Effectiveness of Conductive CFRP with Copper-Plated Fibre

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Use of conductive fillers in CFRP is a common method to increase their electrical conductivity. Additionally using copper-plated fibre as inclusions is known to increase electrical conductivity even further. Investigations on the shielding effectiveness (SE) of CFRPs made with a) conventional resin, b)conductive fillers in resin and c) copper-plated fibre in conductive resin is carried out. SE is measurement using two different procedures viz., a) free-space measurement and b) shielded box enclosure measurement. A dependence on the number of ply and hence on the thickness of the CFRP is observed in the comparison of the SE performance of the different samples. The thickness of CFRP plays a significant role even while using copper-plated fibre, indicating absorption loss to be a major contribution in achieving higher SE in CFRPs.

Design of Millimeter-Wave Patch Array by Using TSV-Based III-V IPD Technology

Ta-Yeh Lin[1], Shuw-Guann Lin[1], Yin-Cheng Chang[1], Chaoping Hsieh[1], Mao-Hsu Yen[2], Yih-Hsia Lin[3], Yan-Wei Yu[2],
Yuan-Fu Ku[4], Che-Wei Chang[5], and Da-Chiang Chang[1]
[1]Taiwan Semiconductor Research Institute, National Applied Research Laboratories, Hsinchu, Taiwan
[2]Department of Computer Science and Engineering, National Taiwan Ocean University, Keelung, Taiwan
[3]Department of Electronic Engineering, Ming Chuan University, Taipei, Taiwan
[4]Taiwan Testing and Certification Center, Taoyuan, Taiwan
[5]Bureau of Standards, Metrology and Inspection, M.O.E.A, Taipei, Taiwan

A 4 × 4 TSV-based III-V integrated passive device (IPD) millimeter-wave (mmW) patch antenna array is proposed in this paper. The antenna efficiency reaches 83% by using backside grounded metal technology in IPD. The insertion loss of 1-to-4 power divider is only 0.6 dB. Meanwhile, the measured return loss is highly consistent with the simulated data from 50 GHz to 100 GHz through TRL calibration technology. Compared with PCB array, IPD array system achieves a size reduction of 61 %. The proposed 4 × 4 patch array shows an array gain of 12.1 dBi with a small form factor of 6 mm × 6 mm × 0.1 mm.

XI. IMPORTANT INFORMATION

XI.1 EMBASSIES

https://imigrasingurahrai.kemenkumham.go.id/web/

XI.2 LOCAL POLICE

https://www.balitourismboard.org/police-stations.html

XI.3 HOSPITALS

INDONESIA COVID-19 INFORMATION
To stop the chain spread of COVID-19 and give health protection to all citizen, the Indonesian government has distributed Covid-19 vaccine to all provinces in Indonesia and establish a large scale social distancing policy. Free vaccine provision has started on 13 January 2021 and will continue to be carried out massively throughout the population.
External links for more information:
-The Ministry of Law and Human Rights RI: Information on immigration regulations during the Covid-19 pandemic
-Indonesia Travel: Advisory on COVID-19, Garuda-Indonesia: Information about operational policy due to the impact covid-19 outbreak Bali.com: Bali Corona update

Bali Med Hospital
Jl. Mahendradatta no 57X
Denpasar
Tel: (+62-361) 484748
Fax: (+62-361) 484748

BIMC Hospitals
Jl. Bypass Ngurah Rai No. 100X
Kuta 80361
Tel: (+62-361) 761 263 - Fax: (+62-361) 764 345
Kawasan BTDC Blok D
Nusa Dua 80363
Tel: (+62-361) 3000 911
E-mail: info@bimcbali.com
website: www.bimcbali.com

BROS Hospital
Jl. Tantular No.6
Renon, Denpasar - Bali Indonesia
Tel: +62 361 247499

Kasih Ibu Hospital
Jl. Teuku Umar 120 Denpasar
Tel: (+62 361) 223 036
Fax: (+62 361) 268 690

Prima Medika Hospital
Jl. P Serangan 9x, Denpasar
Tel: (+62 361) 236225

Sanglah Public Hospital
Jl. Kesehatan Selatan 1
Sanglah Denpasar
Tel: (+62 361) 227 911 - 15 / (+62 361) 232 603 (VIP rooms) / (+62 361) 247 250/5 (Super VIP rooms)
Fax: (+62 361) 226 363

Siloam Hospital
Jl Sunset Road No. 818
Kuta, Badung
Tel: (+62-361) 779900 - Fax: (+62-361) 779933
E-mail: Info.bali@siloamhospitals.com

Surya Husada Hospital
Jl. P. Serangan 1
Denpasar
Tel: (+62-361) 233787 or 235041
Fax: (+62 361) 231177

Medical Clinics
There are three medical clinics that cater almost exclusively to foreigners in Bali. Both are western owned and operated, and are well located for access from Kuta, Nusa Dua and Sanur.

Clinic contact details:
BIMC Hospitals
Jl. Bypass Ngurah Rai No. 100X
Kuta 80361
Tel: (+62-361) 761 263 - Fax: (+62-361) 764 345
Kawasan BTDC Blok D
Nusa Dua 80363
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E-mail: info@bimcbali.com

website: www.bimcbali.com

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Tel: (+62-361) 710 505
Fax: (+62-361)710 515
E-mail: baliassistoperation@internationalsos.com
website: www.sos-bali.com

XI.4 TRANSPORTATION

https://www.balitourismboard.org/bali_local-transport.html

XI.5 ACCOMMODATION

https://www.balitourismboard.org/bali_hotels.html

XI.6 APEMC 2021 SECRETARIATE

1. Website: apemc2021.org
2. Email: info@apemc2021.org
3. Call: Yoppy (+62) 85646708051; Dwi (+62) 81291990029

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H 15:30 Indonesian Central Time| 150 min

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CALL for PAPERS

The 13th Asia-Pacific International Symposium on Electromagnetic Compatibility & Technical Exhibition

The **13th Asia-Pacific International Symposium on Electromagnetic Compatibility & Technical Exhibition** (**APEMC 2022**) will be held during the **2022 Beijing EMC Week** (www.emcconf.org), in Beijing, China, from May 8 to 11, 2022.

The Symposium will continue the APEMC spirit to engage and address the world-wide EMC community with primary focus on the Asia-Pacific region. The 2022 APEMC will serve as a bridge and provide a broad exchange platform for both academia and industry. The symposium will celebrate innovations and technology leaderships through Best Symposium Paper Awards, Best Student Paper Awards, and other reputable recognitions. The scope of the symposium will encompass the entire spectrum of electromagnetic compatibility, electromagnetic environment, signal integrity as well as featured EMC in emerging technologies.

We warmly invite all prospective authors to submit original papers with latest research results. We also welcome proposals for focused sessions, industrial forums, workshops and tutorials.

Important Dates

- **Proposals for special/focused sessions, industrial forums, workshops and tutorials (Deadline)** — **Dec. 05, 2021**
- **Preliminary Paper Submission Deadline** — **Dec. 20, 2021**
  - ***Three (3)-page*** Preliminary Paper Submissions
    (3-page papers presented at the conference will be included in the IEEE Digital Xplore with EI indexing)
    OR
  - ***One (1)-page*** Abstract Submission
    (to be published in conference proceedings but NOT in IEEE Xplore; No final paper submissions are required)
- **Notification of Acceptance** — **Feb. 15, 2022**
- **Final Paper Submission Deadline** — **Mar. 05, 2022**

All submissions must be electronic. Details can be found in the symposium website: www.apemc.org

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Conference Web
www.apemc.org www.emcconf.org

Contact
e: apemc@apemc.org


EMC EUROPE 2022
GOTHENBURG, SWEDEN
Call for Papers
EMC Europe 2022
International Symposium on Electromagnetic Compatibility
September 5-8, 2022, Gothenburg, Sweden
The Symposium
EMC Europe, the leading EMC Symposium in Europe, will be held at The Swedish Exhibition & Congress Centre in Gothenburg, Sweden, September 5-8, 2022. We are pleased to invite and encourage all those working in the field of electromagnetic compatibility to participate in this prestigious event.
EMC research and conferences in Europe have a long tradition. The series of independent EMC Symposia based in Wroclaw, Zurich and Rome running every second year, has now merged into EMC Europe which is organised annually in a European city to provide an international forum for the exchange of technical information on EMC.
EMC Europe 2022, Gothenburg, will consist of four days oral and poster presentations, workshops, tutorials, special sessions and an exhibition. The organisers aim at making this a technical rewarding conference and your stay in Gothenburg a very pleasant one.
Technical Scope
Authors are invited to submit original contributions on all EMC-related aspects in the technical areas listed in the following. Only full 2-column papers 4-6 pages in length, in IEEE format, will be considered by the deadlines. The paper should clearly explain the originality and the relevance to EMC, and should be uploaded in PDF-format through the symposium web-site (www.emceurope2022.org) where detailed guidelines and paper templates can be found.
All submitted papers will be evaluated by a peer review process and accepted papers presented as either poster or orally will be submitted for publication in IEEE Xplore. In addition, workshops, tutorials and other special sessions will be organised to provide up-to-date practical help to those new to the subject or requiring an update, as well as to address in-depth topical subjects.
www.emceurope2022.org

Technical Areas

- EM Environment, Lightning, Intentional EMI & EMP, High Power Electromagnetics, ESD
- Transmission Lines, Cables, Crosstalk, Coupling
- Shielding, Gasketing & Filtering, Grounding
- Measurement & Instrumentation, Emission, and Immunity, Chambers & Cells, Antennas
- Advanced Materials, Nanotechnology, NEMS & MEMS, Smart Sensors
- Computational Electromagnetics, Model Validation
- Semiconductors, PCB, Electronic Packaging & Integration, Power & Signal Integrity
- Power Systems, Power Quality, Power, Electronics, Smart Grids
- Wired & Wireless Communications, UWB, Power Line Communications, Spectrum Management
- Automotive, Railway Systems, Naval Systems, Aircraft & Space Systems
- Human exposure to EM fields, Biological, Effects, Medical Devices & Hospital Equipment
- Standards and Regulations, EMC Management, EMC Education
- EMC in Security and Safety Applications
- EMC in Industrial Environments
- EMC in Military Applications
- Any other relevant topic

Exhibition

In parallel with the conference a technical exhibition of software, hardware, equipment, materials, services and literature will be organised. This will be an excellent opportunity for companies to present their latest development to a world-wide audience of researchers and engineers. Companies, institutions, research centres and universities are all encouraged to register for the exhibition. Sponsorship opportunities are also available, please visit the EMC Europe 2022 web-site (www.emceurope2022.org) for details.

www.emceurope2022.org

The Venue

Welcome to a city where professionalism, quality and pleasure goes without saying. Gothenburg is truly a world class meeting and events city, easily accessible from around the world. Located on the beautiful west coast of Sweden, Gothenburg is a buzzing city well-experienced in hosting major international meetings. Meeting venues, hotels, restaurants, shops and entertainment are all located within convenient walking distance. Scandinavia's largest city centred, allunder one-roof convention centre is located here and worldrenowned brands, cutting-edge industries and universities also call Gothenburg home.

The city's spectacular surroundings, closeness to the sea and the stunning archipelago guarantee a whole new meeting experience, far from the traditional big city meetings. Gothenburg is the only city in Scandinavia with all-inclusive congress facilities in the city centre. Restaurants, hotels, entertainment, parks, theatres and shops are conveniently located within walking distance. A convenience greatly appreciated by organisers and delegates alike as there is only a limited need for transfers. In terms of comfort and technological facilities, the Swedish Exhibition & Congress Centre is one of the leading centres in Europe. Every year, over one million visitors use the facilities for around 30 trade fairs and hundreds of conferences and congresses, large and small. The opportunities to combine largescale congresses with exhibitions, posters, seminars, lectures and smaller conferences are practically endless thanks to the versatile interiors. Attached to the congress centre is also the in-house Gothia Towers hotel which is the largest hotel in Scandinavia.

For more information: www.svenskamassan.se/en/

Important Dates

Paper Submission	February 16, 2022
Proposals for Workshops, Tutorials and Special Sessions	March 16, 2022
Notification of Acceptance	April 16, 2022
Final Paper Submission	May 15, 2022

www.emceurope2022.org

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Contacts & Information

Symposium web-site: www.emceurope2022.org
Conference Venue: www.svenskamassan.se/en/

What's on in Gothenburg: www.goteborg.com

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