# EMC EUROPE-24: INTERNATIONAL PROBLEMS OF ELECTROMAGNETIC COMPATIBILITY:

Valery Tikhvinskiy 1, 2

<sup>1</sup> Institute of Radio and Information Systems (IRIS), Vienna, Austria;
<sup>2</sup> International Information Technologies University (IITU), Almaty 050000, Kazakhstan vtniir@mail.ru

## ABSTRACT

The article reviews the latest scientific achievements in the field of electromagnetic compatibility, presented at the international regional symposium on electromagnetic compatibility "EMC Europe 24" by the leading EMC research organizations, European, Asian, African and South American universities, as well as the largest companies, microelectronics manufacturers, automotive and aviation companies. The symposium "EMC Europe" is the leading international regional symposium on electromagnetic compatibility and continues a long tradition of regular international symposiums on EMC, organized in Europe. The symposium considered the following issues: EMC of 5G, 6G networks and the Internet of Things (IoT); standards and regulations, EMC management, EMC education; risk-based EMC, electromagnetic immunity; EMC in safety and security applications, in industrial environments and in military applications; Electromagnetic environment, lightning protection, intentional EMF and EMP, high-power electromagnetic interference, electrostatic discharges; wired and wireless communications, UWB, power line communications, spectrum management; automotive, rail, naval, aviation and space systems. The article presents the results of studies on the assessment of the EMC impact of Wi-Fi device transmitters (RLAN networks) on 5G radio receivers, the application of models developed for assessing the shielding properties of a wide range of products made of composite materials, the study of the characteristics and development of nonlinearity models of radio frequency amplifiers (RFAs) of the FR1 range of 5G networks for their subsequent application in solving EMC problems of radio equipment for mobile (cellular) communications in complex EMC created in the 4G/5G frequency bands, etc.

**KEYWORDS:** *electromagnetic compatibility, EMC Europe-24, frequency range, 5G networks* 

DOI: 10.36724/2664-066X-2024-10-5-42-46

Received: 15.09.2024 Accepted: 10.10.2024

 Citation:
 Valery
 Tikhvinskiy,
 "EMC
 Europe-24:

 International
 Problems
 of
 Electromagnetic

 Compatibility"
 Synchroinfo
 Journal
 2024, vol. 10, no. 5, pp. 42-46

Licensee IRIS, Vienna, Austria.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Copyright: © 2024 by the authors.

## Introduction

From September 2 to 5, 2024, the second significant international regional symposium on electromagnetic compatibility "EMC Europe-24" was held in Bruges (western Belgium) at the VMCC Congress and Assembly Center, the other - the Asia-Pacific symposium AREMS-24 was held at the end of May 2024 in Naha on Okinawa Island (Japan). The symposium "EMC Europe-24" brought together more than 700 participants from more than 50 countries, representing leading EMC research organizations, European, Asian, African and South American universities, as well as major companies, microelectronics manufacturers, automotive and aviation companies.

The EMC Europe Symposium is the leading international regional symposium on electromagnetic compatibility and continues a long tradition of regular international EMC symposia organised in Europe: at the Wroclaw University of Technology since 1972 (20 annual symposia) and at the Zurich University of Technology (also 20 annual symposia since 1973), as well as other European symposia that were organised in Rome (since 1994) and later in Bruges, Sorrento, Eindhoven, Barcelona and Hamburg. Each of these three EMC symposia was held every two years. Since 2010, these scientific forums have been united into EMC Europe – the International Symposium and Exhibition on Electromagnetic Compatibility.

EMC Europe is now organized annually in a European city with an EMC research center to provide an international forum for leading scientists and experts to exchange technical information on EMC. Joint EMC Europe symposia have been organized in Wroclaw (2010, 2016), York (2011), Rome (2012, 2020), Bruges (2013), Gothenburg (2014, 2022), Dresden (2015), Angers (2017), Amsterdam (2018), Barcelona (2019) and Glasgow (2021 – virtual) – these symposia have become joint symposia of the IEEE International Symposium on EMC and EMC Europe.

The 15 sessions of the EMC Europe 24 Symposium covered the following topics: EMC of 5G, 6G and the Internet of Things (IoT); Standards and Rules, EMC Management, EMC Education; Risk-based EMC, Electromagnetic Immunity; EMC in Safety and Security Applications; EMC in Industrial and Enterprise Environments; EMC in Military Applications; Electromagnetic Environment, Lightning Protection, Intentional EMI/EMF, High Power Interference, Electrostatic Discharge; Wired and Wireless Communications, UWB, Power Line Communications, Spectrum Management; Automotive, Rail, Naval, Aviation and Space Systems.

### Electromagnetic compatibility issues

The plenary session of the EMC Europe 24 Symposium featured papers on the electromagnetic compatibility scientific research programmes within the work framework of the European Research Agency (REA) and Phillips on ensuring EMC of medical devices when they are used in modern medicine.

First report by REA specialists presented the possibilities of cooperation between scientists within the framework of international doctoral research programs as a form of combining efforts for scientists and specialists from different countries in solving EMC problems in the form of temporary creative associations with centralized funding at the international level with a total volume of 606 million euros over the next three years.



The main target funding of the program is 417 million euros, which is aimed at financing the research of postgraduate students studying EMC problems at the university level and combining their efforts in a single network structure of researchers of EMC prospects. In addition to the effectiveness of research, the program pays great attention to innovation and patenting of the obtained results. The second report was devoted to EMC management issues based on the functional safety risks in medical devices design. Due to the fact that electromagnetic environments are becoming less predictable, passing EMC tests based on current standards does not mean that the medical device will be safe and effective in the intended environment of use. To reduce the risks of medical devices functional safety, a combination of solving electromagnetic compatibility and functional safety issues during the design is proposed to achieve a comprehensive solution for the safety of medical devices.

Traditionally, for more than 10 years, one of EMC Europe important sections was a session organized by scientists from the EMC Research Laboratory of the Belarusian State University of Informatics and Radioelectronics (NIL EMC BSUIR, https://emc.bsuir.by/), dedicated to comprehensive diagnostics of EMC of complex systems and headed by BSUIR professor V.I. Mordachev.

Several interesting reports were made at the session. For example, the report of professor V.I. Mordachev was devoted to the development of a technology for analyzing the statistical characteristics of the electromagnetic environment (EME) near the earth's surface, created by emissions from mega-constellations of low-orbit communication satellites such as Starlink, OneWeb, etc. [1-8]. Presented a method for predicting the average intensity of the electromagnetic background (EMF) generated by these satellites, based on the statistical theory of EMF developed by the author and linking the average EMF levels with the number of satellites in the group, the parameters of their radiation on the main and side lobes, orbital altitudes and limitations on the elevation angle of ground equipment servicing.

The calculation results showed that the expected EMF levels of the microwave range generated by mega-constellations of low-orbit communication satellites are safe, since they are many orders of magnitude lower than the accepted maximum permissible level of radio frequency EMF for the population, but at the same time they are many orders of magnitude higher than the levels of EMF of natural origin, which significantly changes the physical characteristics of the habitat and requires serious attention and analysis [9-11].



During the session, the Deputy Head of the Research Laboratory of EMC BSUIR Sinkevich E.V. made reports on behalf of the international cooperation of scientists. His first report was devoted to the results of experimental studies of the characteristics and development of nonlinearity models of radio frequency amplifiers of the FR1 range of 5G networks for purpose of their subsequent application in solving problems for radio equipment – mobile (cellular) communications EMC in complex EMO created in the 4G/5G frequency bands [12-17]. The amplifier characteristics were measured using the original dual-frequency probing technology in n7 range (2500-2570 / 2620-2690 MHz), which is allocated in the Republic of Belarus for 4G mobile communication systems, and n78 frequency range (3300-3800 MHz) of 5G mobile communication systems. Based on the results of measuring dual-frequency characteristics of amplifiers, their single-signal amplitude characteristics, as well as dual-signal amplitude characteristics and values of the dynamic range for intermodulation 3rd, 5th, 7th and 9th orders in first harmonic zone, polynomial models of 27th-37th orders were synthesized, adequately describing the studied amplifiers transfer characteristics both in low nonlinearity region and in the saturation region.

The synthesized models cover a wide dynamic range of input effects while simultaneously analyzing nonlinear effects of all types, including intermodulation, blocking and crosstalk. Using the original technology of discrete nonlinear EMC analysis. This technology is invariant to EMO complexity for a polynomial models fixed order of the RF amplifier transfer characteristics, obtained models provide high efficiency of nonlinear processes quantitative analysis and radio interference.

And in arising in 4G/5G equipment and networks for any practically achievable number of input unwanted signals distributed in a dynamic range of up to 200 dB.

An interesting report was presented by E.V. Sinkevich. He considered models developed application for assessing the shielding properties of a wide range for composite materials products made: silicone and rubber conductive gaskets, conductive adhesives and paints, absorber panels. The models allow calculating the shielding efficiency of gaskets and analyzing absorbers based on their geometric parameters and general information about the internal composite material structure.

An analytical model of composite materials conductivity with conductive fillers, based on the percolation theory, has high computational efficiency and is applicable in a wide frequency range. It is used to describe the shielding properties of conductive silicone, rubber, conductive materials based on foamed polyurethane, as well as to assess the reflectivity and shielding properties of absorber panels.

An empirical model for assessing gaskets shielding efficiency made of composite materials is based on representing the gasket as an equivalent wire mesh. This model can be used in designing electromagnetic protection of the system in cases where information on the internal structure of the composite gasket is missing. The developed models validity was confirmed by comparison with experiments results in frequency range from 800 MHz to 16 GHz.

In this session of the EMC Europe-24 symposium, a member of the Synchroinfo Journal editorial board, professor, Doctor of Economics V. O. Tikhvinsky took part with a report from a team of scientists. The results of theoretical studies were presented on assessing the EMC impact of Wi-Fi device transmitters (RLAN networks) on 5G radio receivers (UE subscriber devices and gNB base stations) in the range of 6425-7125 MHz in dense urban areas.

The report noted that at WRC-23 (Dubai, UAE), the frequency bands 6425-7125 MHz in Region 1, in some countries in Region 2 and 7025-7125 MHz in Region 3 were identified for use by Administrations wishing to implement the terrestrial component of International Mobile Telecommunications (IMT), including IMT-2020/5G. Some Administrations plan to simultaneously implement 5G and Wi-Fi networks on common frequency channels, as well as RLANs in this upper half of the 6 GHz frequency range.

Calculations have shown that in dense urban areas in the frequency range 6425-7125 MHz, 5G gNB base station transmitters at ranges greater than 50 m from Wi-Fi located inside buildings do not affect LBT devices designed to prohibit Wi-Fi operation in conditions of unintentional interference in the operating channel. Based on the results of the probabilistic EMC assessment (SEAMCAT 5.5.0) obtained by the authors, the levels of throughput reduction of UE subscriber devices and gNB base stations were estimated under the group impact of 50, 100 and 200 Wi-Fi transmitting devices on them and a conclusion was made about the impossibility of joint operation without frequency spacing, which was reported at the symposium "EMC Europe-24".

## Conclusion

The EMC Europe 2024 Symposium aims to be a dynamic platform where leading experts, researchers and practitioners come together to share their latest findings, hold lively discussions and establish collaborations that will drive the field of electromagnetic compatibility forward. With a carefully curated programme including keynote speeches, technical sessions, workshops and tutorials, EMC Europe aim to explore the frontiers of EMC, covering a wide range of topics such as measurement techniques, computational electrodynamics, electromagnetic risk management and more.

The next stage of holding international regional symposia on EMC in 2025 will include holding the symposia AREMS-25 in May on Taiwan Island (China) and "EMC Europe-25" in Paris (France).

#### REFERENCES

- A.P. Buslaev, D.A. Kuchelev, M.V. Yashina, "Dynamic systems and mathematical models of information traffic," *T-Comm.* 2018. Vol. 12. No. 3. Pp. 22-38.
- [2] S.V. Kozlov, A.N. Kubankov, "Process foundations of integration and comprehensive development of information, control, robotic, telecommunication systems," *High-Tech in Earth Space Research*. 2020. Vol. 12. No. 1. Pp. 23-31.
- [3] V.A. Dokuchaev, V.V. Maklachkova, V.Yu. Statev, "Classification of personal data security threats in information systems," *T-Comm.* 2020. Vol. 14. No. 1. Pp. 56-60.
- [4] A.N. Burenin, K.E. Legkov, "Security issues of infocommunication systems and special-purpose networks: main threats, methods and means of ensuring comprehensive network security," *High-Tech in Earth Space Research*. 2015. Vol. 7. No. 3. Pp. 46-61.
- [5] R.I. Zakharchenko, I.D. Korolev, "Methodology for assessing the sustainability of critical information infrastructure facilities operating in cyberspace," *High-Tech in Earth Space Research*. 2018. Vol. 10. No. 2. Pp. 52-61.
- [6] D.S. Chirov, E.M. Lobov, "Selection of a signal-code design for a command-telemetry radio communication line with medium- and long-range unmanned aerial vehicles," *T-Comm.* 2017. Vol. 11. No. 10. Pp. 21-28.
- [7] O.G. Chertova, D.S. Chirov, "Construction of a backbone communication network based on small-sized unmanned aerial vehicles in the absence of ground infrastructure," *High-Tech in Earth Space Research*. 2019. Vol. 11. No. 3. Pp. 60-71.
- [8] A.N. Burenin, K.E. Legkov, V.V. Orkin, "Algorithm for adaptive control of information systems under conditions of mass disturbances," *High-Tech in Earth Space Research*. 2017. Vol. 9. No. 6. Pp. 90-95.
- I.V. Bogachkov, "Detection of strained sections in optical fibers based on the Brillouin reflectometry method," *T-Comm.* 2016. Vol. 10. No. 12. Pp. 85-91.
- [10] D.S. Chirov, E.O. Lobova, "Wideband hf signals dispersion distortion compensator based on digital filter banks. Theory and approbation," *T-Comm.* 2020. Vol. 14. No. 4. Pp. 57-65.
- [11] A.S. Kryukovsky, D.S. Lukin, D.V. Rastyagaev, Yu.I. Skvortsova, "Numerical modeling of the propagation of spatio-temporal frequency-modulated radio waves in an anisotropic medium," *T-Comm.* 2015. Vol. 9. No. 9. Pp. 40-47.
- [12] S.S. Dymkova, "Identifying and implementing successful scientific projects, in the framework of 'IEEE technology and engineering management society' events," 2020 International Conference on Engineering Management of Communication and Technology, EMCTECH 2020. Proceedings. New York, 2020. Pp. 9261533.
- [13] O. Varlamov, "Research of influence of DRM broadcast transmitter nonlinearities onto the output signal parameters," *T-Comm.* 2014. Vol. 8. No. 2. Pp. 59-60.
- [14] V. Tikhvinskiy, E. Deviatkin, A. Aitmagambetov, A. Kulakaeva, "Provision of IoT services for Co-Located 4G/5G networks utilization with dynamic frequency sharing," 2020 International Conference on Engineering Management of Communication and Technology, EMCTECH 2020: Proceedings, Vienna, October 20-22, 2020. P. 9261526. DOI 10.1109/EMCTECH49634.2020.9261526.
- [15] A. Pastukh, V. Tikhvinskiy, Š.S. Dymkova, O.V. Varlamov, "Challenges of using the I-band and s-band for direct-to-cellular satellite 5G-6G NTN systems," *Technologies*. 2023. Vol. 11. No. 4. Pp. 110.
  [16] Pastukh A., Deviatkin E., Tikhvinskiy V., Kulakaeva A., "Compatibility studies between 5G IoT networks and fixed service in the
- [16] Pastukh A., Deviatkin E., Tikhvinskiy V., Kulakaeva A., "Compatibility studies between 5G IoT networks and fixed service in the 6425-7125 MHz band, "2021 International Conference on Engineering Management of Communication and Technology, EMCTECH 2021 – Proceedings. 2021. DOI: 10.1109/EMCTECH53459.2021.9619176.
- [17] A. Pastukh, V. Tikhvinskiy, E. Devyatkin, A. Kulakayeva, "Sharing studies between 5G IoT networks and fixed service in the 6425-7125 MHz band with Monte Carlo simulation analysis", *Sensors*. 2022. Vol. 22. No. 4. DOI: 10.3390/s22041587.