Digital Object Identifier 10.1109/OJAP.2026.3693038

Guest Editorial: Introduction to the Special Section on Near-Field Antenna Systems for Communications and Sensing

THE increasing demand for wireless systems that can operate effectively in the near field of radiating devices represents a significant shift in research approaches for antenna engineers. In near-field scenarios, traditional far-field approximations often fail to yield accurate results. This necessitates a specialized approach to develop channel modeling and efficient radiating devices designed for near-field applications. Such methodologies are essential for advancing the next generation of antennas that can meet the stringent requirements of near-field environments in various applications, including near-field communications, imaging, and sensing. This special section explores innovative techniques for the analysis, design, and modeling of antennas and propagating channels that are specifically tailored for near-field sensing and next-generation communication systems.

The special section starts with a series of articles analyzing the communication channels between radiating devices and apertures in the near field to maximize power transfer and data rates. Lewis et al. [A1] proposed a design framework based on multimodal network theory to maximize power coupling between two arbitrary aperture antennas. The channel coupling between the apertures is modeled using a multimodal two-port impedance matrix. The concept of simultaneous conjugate matching is applied to derive the termination impedance matrices that achieve a simultaneous Hermitian impedance match at both aperture ports. An eigenvalue problem is solved to derive optimal modal current excitation vectors on the transmit aperture, thereby defining independent eigenchannels between the transmit and receive apertures.

A systematic analysis is proposed in [A2] to analyze near-field links using non-diffractive Bessel beams. Compact launchers based on a resonant cavity and a partially open radial waveguide are considered for the link. Ray-optics interpretations and leaky-wave analysis are used to provide qualitative and quantitative design rules for selecting the size and type of emitting and receiving devices. In particular, it is shown that the link efficiency increases dramatically when different sizes and types of radiating devices are selected for a given link.

Plug et al. [A3] presented a design methodology for high-capacity line-of-sight communication arrays in the radiative near-field region. The study demonstrates that using radiating devices with an equivalent aperture current distribution characterized by a prolate spheroidal wave function in amplitude and a quadratic phase focusing term, yields noise-limited independent data streams. This approach achieves a maximal average signal-to-noise interference ratio across a specified communication range. The findings are validated through a wireless link utilizing 2×2 arrays operating at 270 GHz, paired with $6\lambda_0$-diameter leaky-wave lenses.

Ozturk et al. [A4] presented a systematic over-the-air characterization methodology for short-range, high-data-rate millimeter-wave in-band full-duplex communication channels. The work investigates how antenna radiation characteristics and relative positioning influence the channel response. An automated measurement setup is developed to characterize those short-range channels using two types of antennas: endfire mode Yagui-Uda antennas and broadside mode Tightly Coupled Dipole Array antennas operating within the 57-64 GHz band. Extensive measurements are reported as channel heatmaps and include analyses of transmission levels, RMS delay spread, and self-interference, providing insights for antenna selection in short-range millimeter-wave in-band full-duplex communication links.

Smart Electromagnetic Skins are introduced in [A5] to enhance millimeter-wave communication in realistic indoor environments and mitigate static near-field blind spots. The work presents the design and implementation of two metasurface-based antennas: a high-gain directive antenna emulating a base station and a metasurface to extend coverage. The Smart Electromagnetic Skin is designed using a synthesis process that accounts for practical implementation constraints, including a cost-efficient single-layer patch topology with limited phased range and the actual field distribution produced by the base station. The concept is experimentally validated through radiated-field measurements and an end-to-end communication link using a complete RF chain and software-defined radio devices, demonstrating reliable near-field millimeter-wave communications and effective blind-spot mitigation.

The work [A6] presented a method for synthesizing focused and curved electromagnetic beams in the near-field region for microwave and millimeter-wave applications. The approach is based on ray-caustic theory, in which the

© 2026 The Authors. This work is licensed under a Creative Commons Attribution 4.0 License.
For more information, see https://creativecommons.org/licenses/by/4.0/

desired beam trajectory is defined by a target caustic curve that enables spatial control of the field distribution along arbitrarily shaped paths. Compared with conventional techniques that rely on non-diffractive beams, the method offers greater flexibility in beam shaping and near-field confinement. The concept is validated through analytical modeling, full-wave simulations, and a prototype based on a slot array.

A wearable ultra-wideband antenna intended for wireless power transmission applications is presented in [A7]. The antenna operates at 3.11 GHz and achieves a realized gain of 6.35 dBi with a fractional bandwidth of 69.93%. Its performance is evaluated both in free space and on a human skeletal muscle tissue phantom to assess realistic on-body operation. Near-field transmission measurements show a maximum power transfer efficiency of 66.3% at a transfer distance of 0.3λ. In addition, specific absorption rate analysis confirms that the proposed design satisfies safety requirements, demonstrating its suitability for wearable wireless power transfer systems.

Carnicero et al. [A8] presented the design, fabrication, and experimental validation of a near-field magnetic RFID system for the detection of ultraminiature chipless tags operating in the UHF band. The proposed system comprises four subwavelength chipless tags based on LC resonators with octagonal loop antennas and floating capacitors, together with a frequency-reconfigurable segmented loop reader antenna operating between 1.14 and 1.50 GHz. To determine the maximum detection distance, a backend detection approach based on the Frequency Sweep Envelope method is applied to the phase derivative of both the reflection coefficient and the input impedance measured at the reader. The results show that using the derivative of the input impedance phase enhances sensitivity to the small perturbations introduced by the tags, enabling improved detection performance.

Finally, [A9] investigates the use of one-dimensional bi-directionally fed frequency-scanning leaky-wave antennas for proximity sensing applications. By exciting a microstrip leaky-wave antenna from two opposite ports, a frequency-dependent near-field focused radiation pattern is generated, enabling frequency-diverse sensing in the Fresnel region of the antenna. A half-width microstrip leaky-wave antenna with a length of 350 mm is designed to operate around the 5.5 GHz band, and its capability to synthesize near-field focusing patterns over the 5.18–5.72 GHz range is demonstrated both theoretically and experimentally. The work further shows the feasibility of sensing objects within a 50×50 cm region surrounding the antenna aperture.

The guest editors would like to express their sincere gratitude to all authors for their outstanding contributions and to the many anonymous reviewers for their valuable feedback. We also appreciate the continuous support from the OJAP staff and the Editor-in-Chief. We hope you enjoy reading this special section and that it inspires further innovation in near-field antenna systems for communications and sensing.

MANUEL ARREBOLA, *Lead Guest Editor*
Universidad Politécnica de Madrid
28040 Madrid, Spain
e-mail: manuel.arrebola@upm.es

SÉRGIO MATOS, *Guest Editor*
ISCTE–Instituto Universitário de Lisboa (ISCTE-IUL)
1649-026 Lisbon, Portugal
e-mail: Sergio.Matos@iscte-iul.pt

ÁLVARO F. VAQUERO, *Guest Editor*
Departamento de Ingeniería Eléctrica Electrónica, de Comunicaciones y de Sistemas
Universidad de Oviedo
33203 Gijón, Spain
e-mail: fernandezvalvaro@uniovi.es

MAURO ETTORRE, *Guest Editor*
Department of Electrical and Computer Engineering
Michigan State University
East Lansing, MI 48824 USA
e-mail: ettorre@msu.edu

APPENDIX: RELATED ARTICLES

[A1] C. K. Lewis, F. Alsolamy, and A. Grbic, "Maximum coupling channels between multimodal aperture antennas with simultaneous Hermitian matching," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1033–1049, Jun. 2026, doi: 10.1109/OJAP.2025.3627890.

[A2] L. D. Biondo, E. Negri, M. Ettorre, A. Galli, P. Burghignoli, and W. Fuscaldo, "Efficient wireless near-field links between Bessel-beam launchers," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1050–1061, Jun. 2026, doi: 10.1109/OJAP.2025.3558890.

[A3] N. B. Plug, J. Tan, S. Bosma, G. Carluccio, A. Neto, and N. Llombart, "Optimal current distributions for antenna arrays in radiative near-field communication links," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1062–1077, Jun. 2026, doi: 10.1109/OJAP.2025.3573016.

[A4] Y. Ozturk, N. K. Nahar, and K. Sertel, "Characterization of short-range mmW in-band full-duplex channels with a focus on antenna characteristics," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1078–1090, Jun. 2026, doi: 10.1109/OJAP.2025.3637086.

[A5] Á. F. Vaquero, S. M. Feito, Á. Pendás-Recondo, M. R. Pino, and M. Arrebola, "Smart electromagnetic skin for near-field mmWave communications: Design, system implementation, and end-to-end link evaluation," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1091–1103, Jun. 2026, doi: 10.1109/OJAP.2025.3637377.

[A6] F. Anfuso, A. U. Khan, G. Sorbello, and S. C. Pavone, "On the radiation of curved beams in the near-field by distributed caustics for NLOS applications," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1104–1116, Jun. 2026, doi: 10.1109/OJAP.2025.3626778.

[A7] K. Kakaraparty and I. Mahbub, "High-gain, compact UWB antenna for wireless power transfer based wearable applications," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1117–1128, Jun. 2026, doi: 10.1109/OJAP.2024.3520069.

[A8] A. F. Carnicero, F. F. Hartmann, G. A. Ramírez, L. G. Villanueva, and A. K. Skrivervik, "Ultraminiature RFID chipless tag detection through magnetic near-field," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1129–1142, Jun. 2026, doi: 10.1109/OJAP.2025.3625418.

[A9] G. I. Muñoz, À. D. Alonso, J. A. López-Pastor, A. Gil-Martínez, A. Algaba-Brazález, and J. L. Gómez-Tornero, "Near-field focusing with bi-directionally fed frequency-scanned antennas for proximity sensing," *IEEE Open J. Antennas Propag.*, vol. 7, no. 3, pp. 1143–1530, Jun. 2026, doi: 10.1109/OJAP.2025.3592129.



MANUEL ARREBOLA (Senior Member, IEEE) received the M.Sc. degree in telecommunication engineering from the University of Málaga, Málaga, Spain, in 2002, and the Ph.D. degree from the Universidad Politécnica de Madrid (UPM), Madrid, Spain, in 2008.

From 2003 to 2007, he was a Research Assistant with the Department of Electromagnetism and Circuit Theory, UPM. From 2007 to 2024, he was with the Department of Electrical Engineering, University of Oviedo, Gijón, Spain, where he became an Associate Professor. In 2024, he joined the Department of Signals, Systems and Radiocommunications, UPM, where he is a Full Professor with the Applied Electromagnetics Group. He was a Visiting Researcher with the Department of Microwave Techniques, Universität Ulm, Ulm, Germany, in 2005; and European Space Research and Technology Center, European Space Agency, Noordwijk, The Netherlands, in 2009. He has been a Visiting Professor with several institutions, such as the Edward S. Rogers Sr. Department of Electrical and Computer Engineering, University of Toronto, Toronto, ON, Canada, in 2018; the Institute of Sensors, Signals and Systems, Heriot-Watt University, Edinburgh, U.K., in 2019; and the Antennas and Propagation Group, Instituto de Telecomunicações, Lisbon, Portugal, in 2023. He has authored and co-authored more than 250 peer-reviewed journals and conference papers. His current research interests include the application of innovative manufacturing techniques in mm and sub-mm-wave antenna design and the development of efficient analysis, design, and optimization techniques of spatial fed arrays, including reflect arrays and transmit arrays, and periodic structures for near and far-field applications.

Dr. Arrebola was a co-recipient of the 2007 Sergei A. Schelkunoff Transactions Prize Paper Award from the IEEE Antennas and Propagation Society. He has also received the 2008 Outstanding Ph.D. Thesis Award from UPM and the 2009 National Award for the Best Ph.D. Thesis on Telecommunication Networks. Since 2024, he has been appointed as a Regional Delegate of European Association on Antennas and Propagation (EurAAP). Since 2022, he has been an Associate Editor of IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION.



SÉRGIO MATOS (Senior Member, IEEE) received the Licenciado, M.Sc., and Ph.D. degrees in electrical and computer engineering from the Instituto Superior Técnico (IST), University of Lisbon, Lisbon, Portugal, in 2004, 2005, and 2010, respectively. He is currently a Senior Researcher with the Instituto de Telecomunicações (IT), Lisbon. He is also an Associate Professor with Habilitation at the Departamento de Ciências e Tecnologias da Informação, Instituto Universitário de Lisboa (ISCTE-IUL). He is the co-author of more than 150 technical papers in international journals (33) and conference proceedings (119). He has several high-impact contributions in the area of satellite communications at Ka-band in the context of national and international projects. His main research interests include the design of millimeter-wave antennas for satellite and 5G and 6G applications. He is a member of the European Conference on Antennas and Propagation (EuCAP) Steering Committee. He is also the Chair of the Scientific Committee B (fields and waves, electromagnetic theory and applications) of Portuguese International Union of Radio Science (URSI) Committee and a Consultant of European Association on Antennas and Propagation.



ÁLVARO F. VAQUERO (Member, IEEE) received the B.Sc., M.Sc., and Ph.D. degrees in telecommunication engineering from the Universidad de Oviedo (UO), Gijón, Spain, in 2015, 2017, and 2021, respectively.

From 2016 to 2021, he was a Research Assistant with the Signal Theory and Communications Group, UO. He was a Visiting Researcher with the Antennas and Propagation Group, Instituto de Telecomunicações, Lisbon, Portugal, in 2017, 2021, and 2023. In December 2021, he joined the Department of Signals, Systems, and Radiocommunications, Universidad Politécnica de Madrid, Spain, as a Post-Doctoral Researcher, before returning to UO in 2022. He has been an Assistant Professor with the Signal Theory and Communications Area, UO, since September 2025. He has authored more than 60 peer-reviewed journal articles and conference papers. His research interests include efficient techniques for the analysis and optimization of spatially fed arrays, the design of reconfigurable intelligent surfaces, and additive manufacturing antennas at mm-Wave frequencies.

Dr. Vaquero was a recipient of a Postdoctoral Fellowship financed by Spanish Government in 2023 and the IEEE Antennas and Propagation Society Fellowship in 2023. He has also received the 2022 Outstanding Ph.D. Thesis Award from UO and the 2021 National Award for the Best Ph.D. Thesis on Telecommunication Engineering for 5G Innovation for Sustainable Connectivity.



MAURO ETTORRE (Fellow, IEEE) received the Laurea degree (summa cum laude) in electrical engineering and the Ph.D. degree in electromagnetics from the University of Siena, Italy, in 2004 and 2008, respectively.

Part of his Ph.D. work was developed at The Netherlands Organization for Applied Scientific Research (TNO), The Hague, The Netherlands, where he later worked as an Antenna Researcher. From 2008 to 2010, he was a Post-Doctoral Fellow at IETR, University of Rennes 1, France. In 2010 and 2016, he was a Visiting Scholar with the Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA. From 2014 to 2020, he co-led the multi-beam antenna activity for satellite applications in the joint laboratory between IETR and Thales Alenia Space, Toulouse, France. From 2016 to 2021, he led the BEam Antennas up to Mm and Sub-mm waves (BEAMS) Team, IETR. Since 2023, he has been a Professor with Michigan State University, East Lansing, USA. Previously, he was a Research Scientist at the Centre National de la Recherche Scientifique (CNRS), IETR Laboratory, France. His research interests include the analysis and design of quasi-optical systems, periodic structures, wideband arrays, millimeter-wave antennas, non-diffractive radiation, and localized waves.

Dr. Ettorre was a member of French National Committee for Scientific Research, CNRS, France, from 2016 to 2021. Since 2021 and 2024, he has been a member of the technical committee MTT-29 Microwave Aerospace Systems and AP-S TC-2 Arrays Antenna Arrays and Systems, respectively. Since 2023, he has also been a member of the Board of Directors of EurAAP. His research activities have been recognized with several prizes, including the Innovation Award at the 2018 ESA Antenna Workshop in The Netherlands; the Best Paper Award in Electromagnetics and Antenna Theory at the 2018 European Conference on Antennas and Propagation (EuCAP), London, U.K.; the Best Antennas Paper Award at EuCAP 2021, Düsseldorf, Germany; and the Best Paper Award at the 2023 International Workshop on Antenna Technology (iWAT), Aalborg, Denmark. From 2017 to 2019 and from 2023 to 2025, he served on the selection committees for the Best Paper Awards in IEEE TRANSACTIONS ON TERAHERTZ SCIENCE AND TECHNOLOGY and IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, respectively. From 2017 to 2023, he served as an Associate Editor for IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. Since 2023, he has been serving as a Track Editor for IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. He currently serves as the Editor-in-Chief for *IEEE Antennas and Propagation Magazine*. In 2020 and 2021, he was appointed as an European Association on Antennas and Propagation (EurAAP) Ambassador. He is the 2024 IEEE MTT-S and AP-S Inter-Society Distinguished Lecturer.