

## Guest Editorial

Special Issue: *Millimetre Wave System, Circuit and Antenna Integration Challenges for Broadband Everywhere*

Spectrum crowding in microwaves and bandwidth hungry applications is a problem, resulting in the need to use higher frequencies. Millimetre waves have the potential to provide the new capabilities that are required for emerging applications, such as 5G and satellite communications, and carry the promise of making broadband available everywhere. Antennas and circuits are vital in achieving this goal and innovative designs can help to alleviate power needs. Furthermore, these components need to be integrated with other subsystems. The transfer of microwave techniques to millimetre technologies is not straightforward as losses become very important and gain specifications are higher.

This Special Issue aims to address the above topics with contributions from leading researchers around the world. The issue comprises of five papers which showcase a range of interesting technologies in millimetre-wave frequencies.

### Switchable Bandpass Front-Ends

The paper “A CMOS/IPD Switchable Bandpass Front-End for 28/39-GHz Fifth-Generation Applications” by Wang and Cho presents a reconfigurable front-end component that is of importance to 5G generation mobile communications where many bands are expected to be available [*Ka* band (28/39 GHz), *V* band (60 GHz), *E* band (73/83 GHz), and *W* band (94 GHz)]. Two Bandpass Filters and a SPDT switch for the 28-GHz and 39-GHz bands are fabricated using 18  $\mu\text{m}$  CMOS along with Integrated Passive Device technology.

### Propagation Models

Path loss models are the core part of wireless propagation channel models and system design. The paper “Path Loss Models with Distance Dependent Weighted Fitting and Estimation of Censored Path Loss Data” by Karttunen *et al.* introduces an improved fitting process. It offers better accuracy at the distances of interest and takes into account thresholding in the measurement procedure. Examples on 28 GHz channels are presented.

### Multi-Beam Antennas

“Multi-beam Antennas for Global Satellite Coverage: Theory and Design” by Kaifas *et al.* is concerned with the High-Throughput Satellite communications that promise capacities in the order of 100 Gbit/s. Multibeam antennas, able to generate multiple narrowly focused spot beams with frequency and polarization reuse can be implemented as Direct Radiating sparse arrays. The authors present an efficient deterministic synthesis procedure to achieve global coverage.

### Scanning mm-wave lenses design

The paper “Effects of Antireflective Coatings on Scanning Performance of Mm-Wave Lenses” by Sonmez and Tocan study a 77GHz extended hemispherical lens antenna for automotive radar. The antenna is made of alumina and is coated with different types of antireflection layers. The authors investigate in detail the beam scanning due to coatings geometry.

### OAM for millimeter wave links

In the paper “Planar millimetre-wave antenna simultaneously producing four orbital angular momentum modes and associated multi-element receiver array” by Vourch *et al.* focuses on the additional capacity gained by encoding information using orbital angular momentum (OAM) modes. OAM research, traditionally in the optical regime, has attracted interest for millimetre-wave frequencies. The authors present a flat plate antenna achieving four OAM modes with a 2.4 GHz impedance bandwidth that can be utilized by short-range 60 GHz communications links.

All of the papers selected for this Special Issue show a variety of activities in millimetre waves from the antenna and propagation community which is bound to continue with greater intensity in the near future.

We hope our readers will find this collection of works an interesting and stimulating snapshot of a technology that is sure to continue to grow in application and development over the coming years.

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### Guest Editor Biographies



Christos Kalialakis was awarded his Ph.D. Degree in Electronic and Electrical Engineering from the University of Birmingham, UK in 1999. He received a B.Sc. in Physics and MSc in Telecommunications in 1993 and 1995 both from the Aristotle University of Thessaloniki, Greece. He has industry experience in UK as an antenna designer and then in Greece and USA as an RF Hardware Engineer. From the end of 2002, he was with the National Regulatory Authority of Greece for ICT as an Expert on Wireless Communications. Dr Kalialakis joined CTTC, Spain in 2015 as a Senior Researcher.



Apostolos Georgiadis received his Ph.D. degree in Electrical Engineering from the University of Massachusetts, Amherst, in 2002. He is Associate Professor at Heriot-Watt University, UK. He is Editor-in-Chief of Cambridge Wireless Power Transfer Journal. He is a Distinguished Lecturer of IEEE Council on RFID. He is Member of IEEE Technical Committee MTT-24 on RFID technologies and MTT-26 on wireless energy transfer and conversion. He is also Vice Chair of URSI Commission D Electronics and Photonics. His research interests include energy harvesting and wireless power transmission, RFID technology, active antennas and phased array antennas, inkjet and 3D printed electronics, millimeter wave systems.



Maurizio Bozzi received his Ph.D. degree in Electronics and Computer Science from the University of Pavia, Italy, in 2000. In 2002 he joined the University of Pavia, where he is currently an Associate Professor. He is also a Guest Professor of Tianjin University, China. He is the 2016 Secretary of the IEEE MTT-S and a member of the General Assembly of the EuMA. His main research interests concern the computational electromagnetics, the substrate integrated waveguide technology, and novel materials and fabrication technologies for microwave circuits (paper, textile, 3D printing). He authored 90+ journal papers and co-authored the book Microstrip Lines and Slotlines (Artech House, 2013).



Dr Ben Allen is a visiting Fellow with the Communications Research Group at the University of Oxford. His research interests include wireless systems, antennas, propagation, waveform design and energy harvesting. He is a fellow of the IET, senior member of the IEEE, fellow of the Higher Education Academy, Erskine Fellow Canterbury University, New Zealand, and associate editor of the *IET Microwaves, Antennas, and Propagation* journal. He has published over 150 papers, 3 books and filed 3 patents.

He is formally Professor of Computer Science and founder and head of the Centre for Wireless Research at the University of Bedfordshire. He has led several pioneering projects in the area of millimeter wave communications.



Dr Anil Shukla (FIET) obtained his degree from the University of Nottingham and his PhD from the University of Leicester. He is a QinetiQ Fellow in “Intelligently using the radio spectrum” with over 25 years’ experience of radio systems, RF technologies, signal propagation and spectrum regulation. His propagation experience ranges from medium wave to mm-waves and his current research interests lie in; “Operating RF systems in difficult environments”, “Cognitive radios” and “Physical layer security”. He works across industry and academia.

He chairs the UK “Defence Manufacturers’ Spectrum Forum”, is an honorary research fellow at the University of Birmingham, where he supervises PhD students, and provides industrial support to a number of other UK Universities