

# IJWMT Special issue on “Filters and multiplexers for satellite communications systems”

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## Guest Editorial

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This special issue is focused on the latest practical developments of microwave filters and multiplexers for satellite communication systems, where they are key elements in the high-frequency front-end for both on-board payloads and Earth stations, giving support to a large number of advanced services. Outstanding examples of these satellite-based applications are the very high-throughput satellites (VHTS) currently under development, the global navigation system GALILEO (sponsored by the European Union, with technical management by the European Space Agency, ESA), as well as meteorological missions such as METOP and the Earth observation program COPERNICUS. In addition, the upcoming small satellite fleets in low Earth orbit (LEO) being currently developed will also use filters and multiplexers to provide internet over satellites (IoS) and sky support to the next 5 and 6 G mobile communication systems, as a complement to large geostationary platforms offering advanced telecommunication services.

To deal successfully with the demands of emerging applications, services and next generations of satellites, new filtering structures are currently being developed. For instance, more compact devices handling higher power levels in L-band for the next generation of GALILEO satellites are needed. Lighter passive components in more classical (planar and waveguide) technologies will also be needed at S-, C-, and X-bands for future remote sensing missions. Compact lightweight filters with integration capabilities will be essential for telecommunication satellites, in order to support the development of payloads based on active array antennas with increased modularity and re-configurability at Ku, Ka-band (and above). Advanced solutions for passive devices in the Ku- and Ka-band (using low-cost and fast-fabrication techniques) will be required by mega-constellation satellites, whereas reconfiguration capabilities and increasing operational bandwidths are needed by up-coming large Ka-band satellites. The potential use of higher frequency bands, such as the Q- and V-bands (37.5–75 GHz), and even the W-band between 75 and 110 GHz, is also envisaged for the next generation of satellite-based applications to avoid growing congestion at the Ku- and Ka-band frequencies.

All of the related technical challenges will have to be addressed by the novel passive components under development including, in particular, filters and multiplexers. Advanced solutions in different technologies, such as waveguides and planar circuits, as well as their hybrid integration using substrate integrated waveguides (SIW), will be needed for a wide range of frequency bands. In this context, therefore, this special issue collects 15 papers, all from well-known experts from both academia and industry, actively involved in the space sector, including also the results of a number of research projects recently funded by ESA.

Two of the papers are focused on novel solutions for L-band high-power filters in coaxial technology, where the first one details a low-pass filter with an ultra-wide high-suppression stopband. The second article demonstrates a compact bandpass filtering structure, based on stepped impedance resonators, providing also a high multipactor breakdown threshold. A third paper is also included, showing the main results of an ESA-funded project on dielectric-loaded filters for L-band satellite diplexers. To also cover developments in S- and C-bands, two additional papers propose the use of additive manufacturing techniques with bandpass filters based on coaxial resonators (strongly loaded with metal posts), and a transversal topology for implementing multiplexers with filters based on acoustic resonators.

Planar and hybrid (SIW) technologies are also considered in four additional papers. In the first, novel microstrip implementations of tuneable lossy filters (with a wide bandwidth tuning range) for intermediate frequency converters are discussed. Another contribution describes diplexers with multi-band channel responses to be used in L-band receivers for mobile satellite communication systems. The third contribution reviews the recent advances of SIW filters with more selective frequency responses. The integration of planar and SIW technologies for implementing small ground-segment user terminals in Ku- and Ka-bands is discussed in the fourth article.

There more papers are included where novel developments in waveguide technology are described. A reconfigurable Ku-band diplexer based on a hybrid coupler topology, using tuneable filters implemented with circular resonators and dielectric inserts, is proposed. Two more

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contributions are related to higher frequency applications using rectangular cavities. One paper presents a novel folded multilayer topology for channel filters at Q- and V-band for input multiplexers. The other deals with practical realization aspects (related to manufacturing processes) of cross-coupled W-band waveguide filters.

This special issue is finally concluded with three additional papers, focused on advanced theoretical and practical topics. One of them presents a general synthesis method to be used in the design of recently developed filters with dispersive coupling elements. A second article reviews the use of space mapping techniques for the systematic design and tuning of microwave filters. The last paper shows a modular platform for the rapid prototyping (and evaluation) of waveguide filters with advanced topologies.

As guest editors, we would like to sincerely thank all the authors who have accepted our invitation to submit papers describing their recent works. We also sincerely appreciate all their efforts to produce very valuable contributions, and to follow all the comments and suggestions from both the reviewers and the editorial board. Our most sincere acknowledgment goes also to all the reviewers, who have devoted their time and expertise to the careful revision of the received contributions. Last but not least, we appreciate the continuous guidance, advice and enthusiastic support of the editor-in-chief (Professor Francisco Medina). Finally, we also want to recognize the contribution of the previous editor-in-chief (Professor Almudena Suárez) for having promoted this special issue and for inviting us to contribute to the initiative.

Our very last thought as guest editors goes to the intended target of this special issue, namely, all of the students and professional colleagues who will read the contributions we have collected! We wish you a nice and fruitful reading, with the hope that our efforts will be useful in advancing your professional and research activity.



**Vicente E. Boria** was born in Valencia, Spain, on 18 May 1970. He received his “Ingeniero de Telecomunicación” degree and the “Doctor Ingeniero de Telecomunicación” degree from the Universidad Politécnica de Valencia, Valencia, Spain, in 1993 and 1997, respectively. In 1993 he joined the “Departamento de Comunicaciones,” Universidad Politécnica de Valencia, where he is full professor since 2003.

In 1995 and 1996, he was holding a Spanish Trainee position with the European Space Research and Technology Centre, European Space Agency (ESTEC-ESA), Noordwijk, The Netherlands, where he was involved in the area of EM analysis and design of passive waveguide devices. He has authored or co-authored 15 chapters in technical textbooks, 200 papers in refereed international technical journals, and over 250 papers in international conference proceedings. His current research interests are focused on the analysis and automated design of passive components (in particular filters and multiplexers) in several technologies, as well as on the simulation and measurement of power effects in high-frequency devices and systems.

Dr. Boria is a member of the European Microwave Association (EuMA), and he has been the chair of the 48th European Microwave Conference held in Madrid, Spain. Since 2018 he is a fellow of IEEE, where he has been member of MTT and AP societies since 1992. He acts as a regular reviewer of the most relevant IEEE and IET technical journals on his areas of interest, and also he has been associate editor of *IEEE Microwave and Wireless Components Letters* (2013–2018) and *IET Electronics Letters* (2015–2018). Currently, he is subject editor (Microwaves) of *IET Electronics Letters*, and editorial board member of *International Journal of RF and Microwave Computer-Aided Engineering*. He is also a member of the Technical Committees of the IEEE-MTT International Microwave Symposium and the European Microwave Conference.



**Jaione Galdeano** was born in Pamplona, Spain, in 1983. She obtained an M.Sc. in telecommunication engineering from the Public University of Navarre (UPNA) in 2007. From 2007 until 2013, she was with Ryma Espacio, Madrid, Spain (now SENER Aerospacial) where she was involved in the development of passive hardware, filters and multiplexers for space applications. Since 2013, she has been with the

European Space Agency (ESA), Noordwijk, The Netherlands, where she is responsible for research and development activities and provides support to ESA space missions in relation to RF passive equipment. Among her research interests are the synthesis and design of microwave filters and multiplexers, design and modeling of acoustic wave filters for space applications, and RF breakdown in space microwave components.



**Marco Guglielmi** was born in Rome, Italy, on 17 December 1954. He received the degree “Laurea in Ingegneria Elettronica” in 1979 from the University of Rome “La Sapienza,” Rome, Italy, where in 1980 he also attended the “Scuola di Specializzazione in Elettromagnetismo Applicato.” In 1981 he was awarded a Fulbright Scholarship in Rome, Italy, and an HISP (Halsey International Scholarship Programme) from the University

of Bridgeport, Connecticut, USA, where in 1982 he obtained an MS in electrical engineering. In 1986 he was awarded a Ph.D. in electrophysics from the Polytechnic University, Brooklyn, New York, USA. From 1984 to 1986 he was academic associate at Polytechnic University, and from 1986 to 1988 he was assistant professor in the same institution. From 1988 to 1989 he was assistant professor at the New Jersey Institute of Technology, Newark, New Jersey, USA. In 1989 he joined the European Space Agency as a senior microwave engineer in the RF System Division of the European Space Research and Technology Centre (ESTEC), Noordwijk, The Netherlands, where he was in charge of the development of microwave filters and electromagnetic simulation tools. In 2001 he was appointed head of the Technology Strategy Section of ESTEC where he contributed to the development of management processes and tools for the formulation of a European strategy for Space Technology Research and Development. In 2014 Dr. Guglielmi retired from the European Space Agency and is currently holding the position of invited senior researcher at the Polytechnic University of Valencia, Valencia, Spain. Dr. Guglielmi has been elevated to the grade of fellow of the IEEE in January 2013 “For contributions to multimode equivalent networks and microwave filter design.” In January 2020, Dr. Guglielmi achieved the status of life fellow.