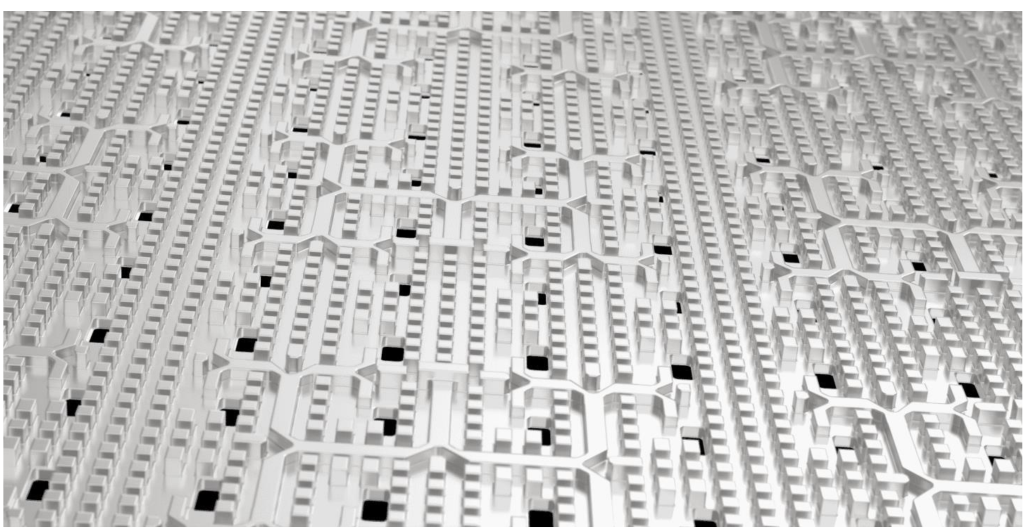
Gap waveguide Technology for mmWave Antennas and RF System Integration

Abstract

There is an emergent need for a higher data rate for upcoming wireless applications. Given the data rate, capacity, and quality of service (QoS) requirements, this can only be possible if the vast unlicensed bandwidth available at mmWave frequencies can be utilized and all the technical hurdles at mmWave frequencies (above 30 GHz) are solved cost-effectively. Regarding bandwidth worldwide and flexible transmission rules, 60GHz is a boon from a system perspective. However, RF designers have faced enormous challenges in simulation, design, integration, physical realization, packaging, and testing of the complete systems. The technical challenge is more complex than today's 2.4GHz or 5GHz Wi-Fi systems. The gap waveguide technology can potentially be used as a low-loss mmWave technology and a potential candidate for THz. The main advantages of the gap waveguide structure are: Gap waveguide is a waveguide where EM wave can be guided and controlled even in an oversized parallel-plate structure. The waveguide can be realized without any metal contact requirement between the conducting surfaces' layers. Thus, allowing cheap manufacturing of low-loss guiding structures and related components at mmWave frequency bands compared to the conventional waveguide components. The relaxed mechanical requirements pave the way for low or moderate precision machining and lower fabrication time requirements and may even make possible the usage of some low-cost fabrication techniques, such as injection molding and hot plastic embossing. The short course will overview the gap waveguide technology, focusing on mmWave high-efficiency antennas and the integration of RF electronics with the proposed antennas.

Graphical abstract



Recommended prerequisites

Basic Electromagnetic Field Theory, Basic Microwave Engineering, Introductory to Antennas and its terminology, one of the full-wave commercial software.

Learning objectives

The participants will be able to know the following:

• Basic working principle of gap waveguide technology, loss evaluation, and design procedure from cell to the line.
• Realization of the unphysical perfect magnetic conductor (PMC) surface as an artificial magnetic conductor (AMC) for a specified bandwidth using periodic structures.
• Design principles for gap waveguide components such as power dividers, hybrid couplers, filters, and antennas.
• Design low-loss wideband transitions between non-standard gap waveguide and standard guiding structures for component testing and integration techniques for gap waveguide components.

Solutions to connections of conventional waveguides at mmWave bands.

Course outline

This short course will focus on the following topics:

- An overview of the gap waveguide technology and comparison with other mmWave technologies
- Parallel-plate stopband design with different types of periodic structures
- High gain, high-efficiency antenna designs based on gap waveguide technology at different mmWave frequency ranges.
- Analog beamforming network.
- RF subsystem design, such as diplexer filters, packaging of RF electronics. This will give an opportunity to the future antenna specialists to work and know about this newly devolved technology.
- High efficiency active phased array antennas based on gap waveguide technology.
- Dual CP antenna for automotive polarimetric radar .

Instructor 1 – biography

Ashraf Uz Zaman was born in Chittagong, Bangladesh. He received the M.Sc. and Ph.D. degrees from the Chalmers University of Technology, Gothenburg, Sweden, in 2007 and 2013, respectively. He is currently an Associate Professor with the Communication and Antenna Systems Division, Chalmers University of Technology. His current research interests include high gain millimeter-wave planar antennas, gap waveguide technology, frequency-selective surfaces, microwave passive components, RF packaging techniques and low-loss integration of MMICs with the antennas. He is also serving as an Associate editor for IEEE Transactions on Antennas and Propagation.

Instructor 2 – biography

Ahmed A. Kishk is a Professor and Canada Research Chair at Concordia University. He is a distinguish lecturer for the Antennas and Propagation Society (2013-2015). He is an AP AdCom member (2013-2015).

His research interest includes the areas of Dielectric resonator antennas, microstrip antennas, small antennas, microwave sensors, RFID antennas, Multi-function antennas, microwave circuits, EBG, artificial magnetic conductors, and phased array antennas. He has published over 240-refereed Journal articles and 380 conference papers. He is a coauthor of four books and several book chapters and editor of three books. He offered several short courses in international conferences.

Kishk received the 1995 and 2006 outstanding paper awards for papers published in the *Applied Computational Electromagnetic Society Journal*. He received the 1997 Outstanding Engineering Educator Award from Memphis section of the IEEE. He received the Outstanding Engineering Faculty Member of the Year on 1998 and 2009, Faculty research award for outstanding performance in research on 2001 and 2005. He received the Award of Distinguished Technical Communication for the entry of IEEE Antennas and Propagation Magazine, 2001. He received the Microwave Theory and Techniques Society **Microwave Prize** 2004. He received *2013 Chen-To Tai Distinguished Educator Award* of the IEEE Antennas and Propagation Society.

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