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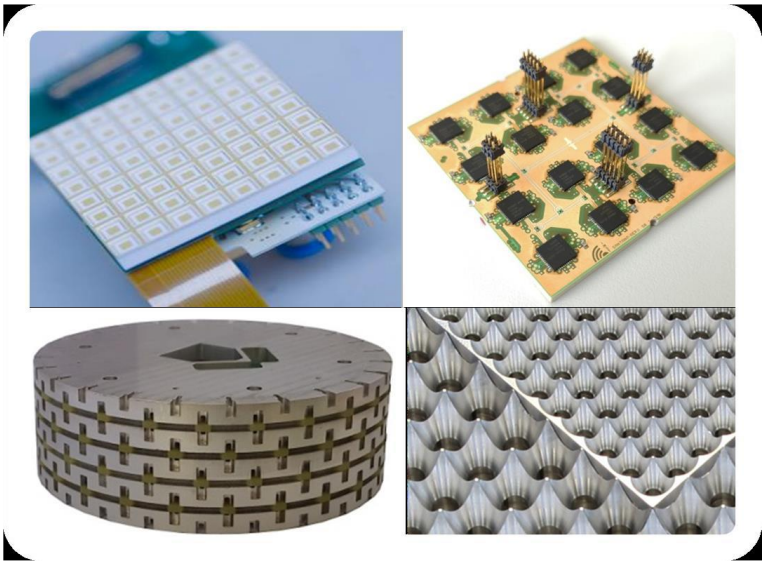
On the Design, Simulation and Realization of Phased Array Antennas

Abstract

Phased arrays provide scanned beams or multiple beams that are commonly used for radar, communications systems and space applications. This course begins with an introduction of the fundamentals of phased antennas array making emphasis on main concepts as array factor, coupling, gain/directivity and problems such as grating lobes, beam squint and scan blindness. The course is supported by hands-on experience, using design tools to introduce the basic design process in antenna arrays. Finally, examples of real active array antenna systems are shown, and important design trade-offs will be shown. Different array architectures, topologies and thermal concepts will be discussed.

Graphical abstract



Recommended prerequisites

This is a short course that provides an overview of phased array antenna principles and technology, with emphasis on analysis, design, implementation, and verification. The course is intended both for those who have a basic understanding of antenna arrays and for engineers and scientists who already work with antenna arrays and wish to improve their knowledge.

Learning objectives

Upon completion of this short course program, participants will:

- Know phased array fundamentals and understand common terminology
- Learn the basic concepts, application and operating principles of phased array antenna
- Learn the essential design process of a phased-array
- Describe the key technical trade-offs in phased array antenna system design

Course outline

The short course is organized into three sections covering the following sub-topics.

1. **Fundamentals on Phased Antenna Array**. This part introduces the principles of array and phased array antennas. Basic terms will be provided for understanding key points and issues in antenna array design. Effects of array factor, coupling gain/directivity are analyzed in relation with array side-lobes, beam squinting, and scan blindness.

2. **Phased Array design and simulati**ons. This part will provide participants with basic guidelines for the analysis and design of phased antenna arrays via EM modeling software. The key parameters introduced in the first part of the course will be revisited and applied in practical examples. The focus will be on the use of simulation tools to optimize different antenna arrays taking into account the real dimension of the array, feeding network and all mechanical parts.

3. **Practical Examples**. Finally, the course is filled with practical examples of real array antenna systems. Different antenna arrays are shown, in which beam steering is obtained using both phase shifters and true-time-delay devices. Various array architectures, topologies and thermal concepts will be discussed, as well as important trade-offs such as system cost-performance. Array performances will be shown comparing measurements and simulations. The hardware for some of the systems presented will be also shown in the course..

Instructor 1 – biography

Matthias Geissler was born in Tauberbischofsheim, Germany. He received the M. Sc. Degree in Electrical engineering from the University of Karlsruhe and the Ph.D. degree from the University of Duisburg.In 1995 he joined IMST GmbH in Kamp-Lintfort, Germany and worked in the development of planar antennas and of antennas for mobile applications. In parallel he was active in research focussing on fundamental limitations and exact characterisation of small antennas. In 2003 he became Head of the Department of Antennas & EM Modelling at IMST GmbH. His department deals with the development and characterisation of antennas and arrays as well as with the development of EM modelling tools. Dr. Geissler is honorary professor at the Ruhr-University Bochum and teaches regularly on antennadesign and measurements. He is member of IEEE, VDE-ITG and of EurAAP.

Instructor 2 – biography

Simona Bruni received the Laurea degree in telecommunication engineering and the Ph.D. degree in electromagnetics from the University of Siena, Siena, Italy, in 2002 and 2006, respectively. Her Ph.D. degree was financed and hosted by the Defense, Security and Safety Institute of the Netherlands Organization for Applied Scientific Research (TNO), The Hague, The Netherlands. She worked as a Researcher with the Defense, Security and Safety Institute of the Netherlands Organization for Applied Scientific Research (TNO). From 2007 to 2013, she worked as an Research and Development Antenna Engineer with the Calearo Advanced Technology (CAT) Department, Calearo SPA, Vicenza, Italy. Since 2013, she has been with the Antennas and EM Modeling Group, IMST GmbH, Kamp-Lintfort, Germany, where she works as a Research and Development Antenna Engineer with the Antenna Front-Ends Team. Her research interests include the design of integrated antennas, high-frequency antenna arrays, and front-end design for communications and automotive applications.

Instructor 3 – biography

Marta Arias Campo received the M.Sc. degree in telecommunications engineering from the Universidad Politécnica de Madrid, Madrid, Spain, in 2009, and the Ph.D. degree from the Delft University of Technology, Delft, The Netherlands, in 2021. Her Ph.D. study was carried out in the framework of collaboration between the Terahertz Sensing Group, Delft University of Technology, and the Department of Antennas and EM Modeling, IMST GmbH, Kamp-Lintfort, Germany. In 2009, she joined the Antennas and EM Modeling Department, IMST GmbH, where she currently works as a Research and Development Antenna Engineer at the Antenna Front-End Team, with the main focus on the design of active planar antenna arrays and dielectric lens antennas. From 2016 to 2020, she worked as a Researcher at the Terahertz Sensing Group, Delft University of Technology. Her research interests include the analysis and design of lens antennas and quasi-optical structures for highspeed wireless communications and radar applications.

Key bibliography

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