SC 10 Advanced impedance matching and impedance analysis for antenna applications

Course Lecturer Dr. Jussi Rahola

Course Description

The main topics of the course are:

1) impedance matching using the theory of power waves,
2) estimating the obtainable antenna bandwidth using the concept of bandwidth potential and
3) estimating the worst-case isolation in multiantenna systems using the concept of electromagnetic isolation.

The theory of power waves greatly simplifies the analysis of matching circuits where complex termination impedances are used. Contrary to the generally used travelling wave theory, the power wave theory is directly describing the propagation of power in microwave networks with complex termination impedances. Using the same S parameter analysis, both the impedance matching and efficiency of a matching circuit can be analyzed. In part 2, the obtainable bandwidth of an antenna through a matching circuit is estimated using the concept of bandwidth potential. Contrary to the Q value analysis, the bandwidth potential gives meaningful results also then wideband resonances or multiple resonances are present. This concept can be used to select best antenna candidates in an early design stage. In part 3, it is shown how the effect of impedance matching can be removed in isolation analysis using the concept of electromagnetic isolation. This concept can be used for example to analyze the effect of metamaterials to antenna isolation, as it removes the effect of the changing input impedances of the antennas.

The course is targeted for antenna and RF engineers and researchers who study new antenna concepts or need to use matching circuits in their work. It reviews the definitions of the reflection coefficient, S and Z parameters (also in the multiport case) and the Smith chart so that the course can be used as theory refresher for all antenna engineers. It is also explaining the theory of power waves, which makes the understanding of impedance matching to complex generator impedances easier. The course will present some novel views on matching circuit design. For example it will be demonstrated that the goal of matching circuit design using realistic component models it not to obtain the best possible impedance match, which may seem paradoxical at first. Overall, the course will cover the theory and practical aspects of matching circuit design and impedance analysis and it offers new information to both beginners and more senior antenna and RF experts.

Biography

Jussi Rahola obtained the M.Sc. (Tech.) and D.Sc. (Tech.) degrees in applied mathematics from Aalto University (former Helsinki University of Technology) in 1990, and 1996, respectively. The topic of his dissertation was the solution of large dense systems of linear equations of electromagnetics using iterative solvers and the fast multipole method. From 1989 to 1999 he was working as an application specialist and a development manager in CSC - IT Center for Science Ltd, Finland. During 1997-1998 he also worked in CERFACS, Toulouse, France as a post-doctoral researcher in the field of computational electromagnetics. From 2000 to 2009 he

worked in Nokia Research Center and Nokia Devices R&D as a senior research engineer, research manager and principal scientist in the field of antenna research. In 2009 he founded Optenni Ltd and is working as its managing director. He has over 30 publications in international journals and conference proceedings. His research interests include antennas, circuit simulation, computational electromagnetics and numerical mathematics.