Design of multiport feeding networks for antennas of ultrawideband systems

Abstract

The dissertation presents very actual problem related to designing multi-port feeding networks of ultra-wideband antenna systems for a modern radio-communication systems operating in the frequency band according to the ETSI standard. The scope of the carried out research is mainly connected with the following fields of electronics: radioelectronics, signal theory, circuit theory, antenna theory, electromagnetic field theory, and computer-aided design as well as optimization of electronic circuits and antennas. The work is based on a full comprehensive approach to the synthesis, analysis and design of multiport feeding networks for UWB radiators, starting from time and frequency analysis of UWB signals, through the development of appropriate antenna structures and its feeding networks till the analysis of radiation, transmission and reception of UWB signals. The use of a comprehensive approach to the synthesis, analysis and design of UWB antennas feeding systems is novel proposal presented in the dissertation.

The aim of the work was to develop new methods of analysis, synthesis and optimization of selected structures for ultra-wideband multiport feeding networks allowing effective data transmission in wireless communication systems considering time and frequency domain.

The thesis of the work was that the developed structures of selected ultrawideband UWB feeding networks and methods of their analysis, synthesis and optimization, using a mathematical model taking into account new scattering matrix normalization, allow for a significant increase in data transmission efficiency in wireless communication systems considering time and frequency domain.

The implementation of the work objective performed out on three levels: theoretical, simulation and experimental. A mathematical model based on a standard and new scattering matrix of multiport antenna feeding networks, using eigenvectors and eigenvalues of the matrix, for an analysis of parameters describing power distribution of UWB systems was used. The time and frequency analysis of characteristics of UWB signals was carried out, including modulated signals, in accordance with the requirements launched in Europe. Software for calculation and visualization of time and frequency characteristics of feeding network components and antenna arrays was developed. Additionally computer-aided design of UWB feeding network, single antennas and antenna arrays and their equivalents circuit were performed. Synthesis and optimization of UWB radiator circuits were carried out, including matching circuits and uncoupling networks. Selected ultra-wideband multiport feeding networks based on hybrid rings and additionally integrated structures with UWB radiators on a common substrate were fabricated and tested experimentally. Obtained results of the measured characteristics show convergence with the results obtained during computer simulations

The developed methods and procedures as well as described results of their application confirm the validity of the thesis.

The results of work has been presented in 20 publications by the author - articles and presentations at domestic and international conferences.