Abstract

Multi-port networks finds its use in wireless communication, radar and power-delivery system. In RF, microwave and mm-wave frequency range some of the commonly used multi-port networks are two-port filter and impedance matching network (IMN), three-port power-divider (PD), four-port rat-race and branch-line coupler (RRC & BLC) etc. These networks finds application in the design of antenna feed network, high frequency amplifier input and output matching, design of power combiners and dividers, balanced mixers and amplifiers, image rejection mixers, modulators, demodulators etc. The IMNs are finding increasing usefulness in the modern day applications like RFID, impedance compensation network for energy harvesting etc. Conventionally these network are designed using symmetrical transmission line or its equivalent network, while in recent years design emphasis has been laid upon using asymmetric elementary building blocks to have enhanced figure-of-merit.

This thesis is about synthesizing a multiport network with or without plane of symmetry. A conceptually correct synthesis approach of conventional equal power division rat-race and branch-line coupler using asymmetric-two-port network have been proposed exploiting the symmetry property of the asymmetric network. The synthesis equations are laid down in forms of two theorems. A generalized multi-port network synthesis algorithm has been proposed based on a novel philosophy of port-decomposition technique. This algorithm can be applied to any type of multi-port networks like the symmetric or asymmetric, perfectly matched or unmatched, lossy or lossless etc. Concept of true transmission phase and it's usefulness has also been introduced. Four theorems pertaining to multi-port network synthesis have been postulated. The theorems provides the conditions for realization of generalized rat-race and branch-line couplers, a five-port network using such two-port building blocks and a coupled-line based arbitrary phase difference coupler. The two-port lossless ABCD parameters of a matching circuit with desired transmission phase has been derived and its importance has been discussed, which matches an arbitrary complex load to

different complex source impedance, thus providing maximum power transfer.

Keywords: arbitrary phase coupler, asymmetric two-port network, branch-line coupler, coupled lines, directed graph, five-port network, impedance matching, multiport network, network synthesis, phase shifter, port decomposition, power combiners and dividers, power-wave, rat-race coupler, transmission phase, unequal power division.