A Conformal Micro-strip Rotman Lens design using Particle Swarm Optimization (PSO)

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Beam forming networks (BFNs) render the appropriate feeding information for array antennas. One of the most famous architecture for a microwave BFN is the Rotman lens (W. Rotman, R.F. Turner, "Wide-angle microwave lens for line source applications", 1963), which had been widely used to feed linear array antennas due to their inherent broad bandwidth. A limitation of Rotman lens, however, is that it is based on the assumption of radiating elements lying on a straight line.

In this paper, we develop a new design of Rotman Lens to feed conformal array antennas; i.e. an array of radiating elements that conform to some prescribed shape, such as the surface of an airplane's wing, body of a missile or a high-speed train. This paper proposes a new design technique of Rotman Lens based on Particle Swarm Optimization (PSO). For the purposes of this paper, a Rotman lens with four input ports feeding an 8-element conformal array will be demonstrated. The operating frequency is 10 GHz. The array uses rectangular patch antennas to conform on an arc with a specific radius.

Two tasks are considered in order to design the lens. The first task is to use the PSO to determine the 4 different sets of phase information corresponding to 4 input ports of the lens. The second task is to use the phase information obtained in the first task as an objective function for PSO to optimize the beam port contour, inner receiving beam contour and the delay lines. Physical properties such as the overall lens dimensions, total weight and smoothness of the beam contours as well as the scan performance are compared with the same 4-input, 8-output conventional Rotman Lens to see the robustness of the new design technique.