Investigation of Broad- and Multi-Band Expansion by Multiline Coupling for Half-Wave Microstrip Arrays

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Arrays of microstrip parallel coupled half-wave resonators have been used extensively as broad- and multi-band radiators. Despite being widely cited, design guidelines for these antennas are scarce beyond general tables for log-periodic design, and the behavior of these radiating structures is not thoroughly explained in the available literature. Generally, lines of different lengths can be added to an array to add additional resonant frequencies, but it is often unclear how many lines can be added with acceptable impedance matching and power transfer. Additionally, the optimal width of each line and spacing between lines is unknown apart from computationally intensive optimization techniques. Part of the difficulty in analyzing this structure comes from the lack of a theoretical transmission line model for multiline coupling. Though two coupled microstrip lines have been characterized in terms of an even and odd mode characteristic impedance, an analytical or empirical multiline capacitance matrix remains undeveloped. Moreover, as more resonators are added to the array, a higher number of modal current distributions must be considered in order to explain system performance.

The authors have investigated multiline coupling models and will briefly present their findings and apply them to the analysis of well cited multiline resonators. Improved models of multiline coupling will be used to predict antenna performance over a practical range of line spacing, line widths, and number of radiating elements. Theoretical analysis will be compared against results calculated in full-wave solvers, with the goal of understanding how to couple power most efficiently to every resonator in the radiating structure. This investigation will culminate in the development of an improved set of synthesis guidelines for microstrip coupled half-wave resonators that can be extended to the analysis of similar structures in stripline, slotline, and coplanar waveguide.