Design of Planar Microstrip Array in Ku Band for Analog-Digital Beamforming

S. Farzaneh*[(1)], J. J. Laurin[(2)]
(1) CCI Products, Ottawa, Canada
(2) PolyGrames Research Center, Ecole Polytechnique de Montreal, Montreal, Canada

For some radar applications it is desired to design a phased array with fixed shaped beam in the elevation plane and scanning capability in the azimuth plane using digital beamforming. Depending on the azimuth scan range, the element spacing is limited by the grating lobe condition. When other design requirements such as narrow beamwidth, low beam squint, low elevation side lobe level (SLL), and high radiation efficiency are desired, the design of the antenna array and passive beamforming network becomes challenging. Microstrip technology is a desired option due to the compact size and low cost. To meet size requirements and avoid undesired radiation, the antenna array and the passive feed network need to be on different layers, with a thick substrate for antenna array and a thin substrate for feed network. In addition, when low beam squint is required, corporate feed is the optimum option but it takes a large space for a large array.

In a corporate feed network the feed network ends at the center of the array in the elevation plane. To interface different passive arrays which are in parallel, it is possible to extend the center lines of the array to the edge of the array. However, this reduces the maximum number of elements in the elevation plane due to corporate feed structure. In addition, this increases losses in the feed network. Another method is to use surface mount (SMT) connectors at the center of the elevation plane. However, SMT connectors do not match well to the antenna array in Ku band due to the capacitance between the center conductor soldering pad and the reference ground plane. This becomes more stringent as the feed network substrate becomes thinner because of capacitance increase.

In this paper the interfacing of a planar two-layer microstrip antenna array intended for analog-digital beamforming is addressed. Each column of the planar antenna array is an 8-element array which is fed by passive feed network which makes a fixed shaped beam with -20 dB SLL in the elevation plane. The output of each passive array is interfaced to an external circuitry where digital beamforming is implemented. SMT connectors are used on each passive beamforming network column. The matching of these connectors with antenna array is improved by cutting out a disk with proper radius in the middle ground plane. A hole with proper radius in the top substrate improves SLL and radiation efficiency. A 4x8 and a 32x8 array are designed, fabricated, and tested to verify the presented approach. Details of the prototypes and measurement results will be shown during the presentation.