All Metal Heat Sink Dual Linear Polarized Phased Array Antenna for X-Band Communication Applications

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A new 2x4 dual linear polarized phased array antenna (PAA), with 16 innovatively designed metallic radiators, each working as heat sink as well, is proposed for X-band communication applications. Each single radiator is approximately half wavelength (λ/2) in height corresponding to 9.5 GHz, and fed by a stripline through a intuitively shaped balun. Two shaped radiators are placed at right angles within a metal cavity of square cross-section and overall dimension of nearly λ/2 × λ/2 corresponding to 9.5 GHz. This constitutes the proposed dual linear polarized radiating elements as a unit cell. A multi-layered printed circuit board (PCB) is used to accommodate stripline feed for two radiators and surface waves generated due to thick substrate is supressed by using a number of vias, placed underneath each metal cavity. The single radiating element is designed to provide wideband performance with respect to S_{11} of 10dB between 8.5-10.5 GHz and good radiation pattern is observed over the entire bandwidth. With the motivation of 3D metal printing, the electrical conductivity of the material used for designing the radiators is chosen as 600000 S/m.

Inter-element spacing between unit cells is λ/2 corresponding to 9.5 GHz. The metal walls of the adjacent cells are connected in such a way that the whole antenna aperture appears as a continuous structure, which in turn helps in 3D printing as well as better heat sinking. To achieve good co-to-cross-polarization separation in radiation patterns, adjacent unit cells are mirrored. The array offers peak realized gain at broadside angle from 11-14 dBi over the bandwidth and the minimum co-cross separation is better than 20dB. Expected beam steering angle is ±45°. The thermal analysis of the antenna aperture will be done considering the maximum heat generated by the RFICs.

Anokiwave RFIC (AWS0105) will be employed for the beamforming network (BFN) which will be directly integrated with the phased array antenna aperture. Anokiwave RFIC has features such as 8.5-10.55 GHz operation for dual polarization, and provides 20 dB gain and +13 dBm output power during transmit mode and 9 dB gain and +6 dBm IIP3 during receive mode. The RFIC supports single beam transmit, single beam receive and all requisite beam steering controls for 6 bit phase and gain control are included. The fabricated phased array antenna with the integrated BFN will be tested for its impedance matching and radiation patterns in the Antenna and Microwave lab (AML) at San Diego State University. The infrared (IR) camera will be used to validate the thermal analysis.