Compact High Gain High Efficiency Co-Planar Si-Based DRA Antenna for Millimeter Wave Application

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We present an integrated dielectric resonator antenna (DRA) in a Si-based technology platform for 77 GHz millimeter wave applications. The recent developments in millimeter-wave communications have many challenges from design, fabrication to measurement. The designs usually suffer from high losses and difficulty of circuit integration. Millimeter wave (mmW) antenna can be implemented using different available technologies such as SIW, LTCC, SIIG, and SI-based technology platform. On-chip antennas for 60, 77GHz applications have been reported, however they suffer poor performance with radiation efficiency less than 54% and gain below 3.6 dB. Dielectric resonator antennas (DRA) were intensively developed at low frequencies. Scaling up the frequency to mmW frequencies faces many challenges in the fabrication and appropriate material selection for both RF performance and fabrication technology compatibility. We propose a novel, high gain, high efficiency DRA using Si-based technology platform where all components are fabricated using microfabrication technique at the same time. The technology platform uses high resistivity Si wafers (conductivity = 0.01 s/m). The DRA is excited using co-planar waveguide feed (CPW). Effects of various antenna parameters such as dimensions of the feeder, and the dielectric resonator, thickness of the substrate, and the dielectric resonator on the radiation performance of the antenna are investigated and optimized. The rectangular and half ring DRA antenna gains of 4.72 dB gain with 98% radiation efficiency.