Reconfigurable Intra-chip Antenna for Future Wireless Communications

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In this work, we propose a reconfigurable intra-chip antenna system using liquid-crystal to provide dynamic control of the wireless link gain that can be used in future wireless intra-chip interconnects with applications to multicore architectures and system-on-chips (SoCs). Prior to this design, we used vertical quarter-wavelength monopoles at 60 GHz on a ground plane surrounded by a specially-designed dielectric property distribution. This additional degree of freedom in design, enabled by 3D printing technology was used to tailor antenna radiation patterns, which led to enhancement of signal in the desired direction and reduction in undesired spatial crosstalk. However, the earlier design was not capable of providing dynamic control (reconfigurability) across the wireless links. Hence, in this work, we propose to incorporate liquid crystal in the structure surrounding the monopole antennas to achieve the reconfigurable intra-chip wireless communication.

To demonstrate the idea, we design an ANSYS HFSS model with four quarter-wavelength monopoles (1-mm long; 0.25-mm diameter) on top of the ground plane (20×20 mm^2). The monopoles are surrounded by 20×20 unit cells each having their individual dielectric constants. The dielectric constants can be any value from 2.4 to 3.2 with a 0.05 increment. Each unit cell has a $1 \times 1 \times 1.25$ mm^3 with a small metallic patch on top for biasing purpose. The patch size is 0.8×0.8 mm^2. These small patches allow individual voltage potentials to be applied to control the local dielectric constant. By adjusting the voltage potential across each unit cell, their dielectric constant can be tuned and hence, transmission in desired direction can be achieved while simultaneously avoiding the path that can cause crosstalk. Simulation results show that the proposed design is a promising option for achieving reconfigurability in wireless intra-chip communication.