A Novel Inductorless Low-Powered Quadrature Phase Generator for High-Frequency Communications

Xue Ru Zhou

Abstract

Today, the advancement of millimeter-wave (mm-wave) communications research and new sensing capabilities encourages us to find and develop impactful applications such as real-time patient monitoring or 5G mm-wave communications in the subway. However, these promising high-level ideas are not feasible without continuous efforts to optimize the underlying circuits of the devices that make up these high-speed networks. Many solutions for high-frequency integrated circuits exist but still face problems in dealing with reducing silicon area and power consumption while balancing tradeoffs with bandwidth and gain. This thesis looks at the specific task of optimizing these parameters for a 65 nm integrated quadrature phase generator circuit in the context of a radio frequency receiver operating at bands centered at 7 GHz and 60 GHz.

We review the motivation behind quadrature signals for image rejection in receivers and the workings of conventional designs such as hybrid couplers and RC-CR networks. With this foundation, we extended the usage of conventional inductorless designs to higher frequencies and conceptualized and simulated a novel inductorless and low-powered quadrature phase generator topology. Simulated results show that this topology drastically reduces power consumption compared to baseline tests of a conventional design. Specifically, the proposed design consumes a total power of 0.749mW and 6.955mW for 7 GHz and 60 GHz, respectively, in comparison to the baseline test, which consumes 6.516mW and 19.088mW. This is, however, at the cost of other parameters, such as bandwidth (within $\pm 5^\circ$ error) for improvement in power consumption. Future work in layout and system integration is required to learn more about its overall design size and image rejection capability.