Designing a CMOS Digitally-Controllable Oscillator

MAD VLSI FA23 Final Project Proposal by Alex Butler & Max Stopyra

Overview:

For this course's final project, our team has chosen to create a Digitally-Controlled Oscillator (DCO). This project will incorporate significant digital and analog mixed-signal components and serve as a great platform for us to dive deeper into the tuning and characterization of the system. DCOs are useful as they can be used for many different applications including, outputting clock signals, modulating signals for software-defined radios, audio synthesis, and can generate multiple RF signals.

Digital Block:

At the time of proposal, we plan on implementing a simple ring oscillator composed of not gates “chasing their tail” first to generate a simple digital square wave signal which is fed into a series of shift registers to “divide” the signal into lower frequencies. These frequencies are all available as digital outputs.

Analog Block:

For the analog portion of our chip, we plan on utilizing and tailoring our DAC design from MP4 to be used alongside our DCO. We would like to design this so that it can work with the wide range of functionality at which our DCO will be able to operate. The DAC will primarily serve as a current source to bias the comparator. This comparator will be in the loop of our DCO to “set and lock” into a specific output frequency corresponding to the input digital codeword.

Resources

Barusu, Madhusudhana Reddy & Jose, P.P. & Babu, P.L. & Logeshwaran, V.. (2015). CMOS based digital controlled oscillators (DCO) - A review. International Journal of Applied Engineering Research. 10. 18626-18630. https://www.researchgate.net/publication/283751064_CMOS_based_digital_controlled_oscillators_DCO_-_A_review

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Y. Ho, Y. -S. Yang and C. Su, "A 0.2–0.6 V ring oscillator design using bootstrap technique," *IEEE Asian Solid-State Circuits Conference 2011*, Jeju, Korea (South), 2011, pp. 333-336, doi: 10.1109/ASSCC.2011.6123581.