ECE 444 – Design Project
Temperature Stabilized Ring Oscillator using a
Band–gap Reference Voltage Source

January 20, 2021

Introduction: The output frequency of a CMOS ring oscillator is strongly dependent on both the operating temperature and the supply voltage. The frequency increases with increasing supply voltage, and increases with decreasing temperature.

Part A. Design a ring oscillator, using the 65nm CMOS process, that has a nominal oscillation frequency of 3 GHz at a temperature of $27°$C and supply voltage of ~ 1 V. Simulate the oscillation frequency as a function of temperature ($0°$ to $100°$ C) and supply voltage (0.8 - 1.4 V). Determine the required supply voltage as a function of temperature needed to stabilize the oscillation frequency at 3 GHz as the temperature is varied between $0°$ and $100°$ C

Part B. Design a band–gap reference circuit, using the 350nm process, to generate the ring oscillator supply voltage as a function of temperature determined in Part A. The operational amplifier used in the band-gap reference circuit should be biased using a boot-strapped bias circuit. The band–gap reference circuit should compensation the ring oscillator so that the oscillation frequency remains close to 3 GHz as the temperature is varied between $0°$ and $100°$ C, and the supply voltage to the band–gap reference circuit is varied between 3.1 and 3.5 V.

A preliminary report describing the results from Part A will be due mid-semester. A final project report describing the design for Part B will be due during final's week.

Designs with minimal variation in the output frequency as a function of the supply voltage and temperature will be considered superior.

Specification:

1. Nominal oscillation frequency: 3 GHz

2. Input voltage: 3.1 – 3.5 V (single rail)

3. Temperature: $0°$ to $100°$C

4. Variation in output frequency: minimal