Design of CMOS Variable Gain Amplifier

Group Members
Lun Ying Wai (03217850)
Wu Kwan Cheung (03216430)

Project Supervisor
Dr. Howard Cam Luong
Strength of Signals in communication systems varies during transmission as well as processing. A Variable gain amplifier (VGA) is required to maintain the signals amplitude and output power which maximizes the system performance.

In this project, a VGA was designed to have the following specifications:

- Low Supply Voltage (±0.9V)
- Wide Bandwidth ($f_{3dB} > 300$MHz)
- Variable Gain Range (0 – 46.5dB) with 1.5dB step
- 5-bit Linear-in-dB Gain Control
Schematic and Layout

Whole Schematic

Layout of Amplifier 1

Layout of Amplifier 2
Parameters | Specification | Pre-Simulation
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Output Load capacitance | 100f | 100f
Supply Voltage (V_s) | +/-0.9V | +/-0.9V
Gain Range | 0 ~ 50dB | 0 ~ 46.5dB for 1.5dB Step
3dB Bandwidth at room temperature | ≥300MHz | 300MHz
Input Voltage for maximum performance | +/-0.5uV ~ +/-3mV | +/-80nV (SNR_voltage~100dB) ~ +/- 20mV
Max Output Voltage Swing | +/-1V | +/-20mV (min gain), +/-1V (max gain)
Gain Control Method | 5-bit digital control | 5-bit digital control
Power Consumption | <400mW | 80mW
Input Referred Noise | < 1n V/(Hz)^1/2 | < 767.5p V/(Hz)^1/2

Therefore, with different input signal amplitude, the output signal amplitude can be maintained constant by changing the gain of amplifier.