وَمَا أُوتِيتُمْ مِنَ الْعِلْمِ إِلَّا قَلِيلًا

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Analog IC Design
Design Challenge
Digitally Controlled Variable Gain Amplifier (VGA)

Intended Learning Objectives

In this design challenge you will:
- Learn how to select a proper circuit topology.
- Learn how to design an analog circuit on your own.
- Learn how to implement a digitally controlled analog circuit.
- Learn how variations affect the circuit.

Design Specs

It is required to design a digitally controlled variable gain amplifier with the following specifications.

Technology	0.18um
Supply voltage	1.8V
Variations (Corners)	For passive elements used inside your design: Assume caps vary +/- 10% Assume resistors vary +/- 20%
Reference signal	Use a single 50uA ideal reference current source in your testbench.
Output type	Single ended
External load	500 fF
Feedback type	Resistive (use 100kΩ unit element resistors ONLY)
DC Input impedance	Infinite
Digital control	Single bit signal (D0)
Closed loop gain	D0 = 0: 6 dB D0 = 1: 12 dB
OTA phase margin	> 50°
OTA open loop gain	> 66 dB
OTA unity gain frequency	> 150 MHz
Output swing	> 1 V pk-to-pk

Input signal DC level	**1.2 V**
Power consumption	**Minimize**

Notes

- You can design the OTA using ADT or any other method.
- If you cannot report your open-loop OTA specs due to systematic mismatch, use any simulation tricks to close the loop in DC.

Deliverables

- OTA selection and design strategy.
- Schematic with device sizing.
- Simulations showing open-loop OTA specs (gain, UGF, PM) satisfied across all required corners.
- Simulations showing the amplifier closed loop specs (Closed loop gain, DC LG, UGF, and PM) at the two different gain settings and across all required corners. Compare to open loop specs and comment.
- Closed loop transient simulations at the nominal settings showing the output swing at the two different gain settings.

Acknowledgements