

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	65nm
Supply voltage	2V
Reference current seed	Use a single 20uA ideal reference current source.
Output type	Single ended
External load	500 fF
Feedback type	Capacitive (use 500fF unit capacitors ONLY)
Digital control	Single bit signal (D0)
Closed loop gain	D0 = 0: 6 dB D0 = 1: 12 dB
LG PM (worst case)	> 60°
DC LG	> 54 dB
Closed loop BW	> 10 MHz
Output swing	> 1.6 V pk-to-pk
Power consumption	Minimize

Deliverables

- Part 1 (6 pts)
 - From the closed loop specs, calculate the OTA open loop specs.
 - OTA topology selection and design steps (use ADT cockpit **or** the Sizing Assistant).
 - Justify your assumptions.
 - Justify the chosen bias points and bias currents if you use the cockpit.
 - Schematics with device sizing.
 - Schematics with DC OP and node voltages annotated.
 - Closed loop stb analysis results showing the amplifier closed loop specs (Closed loop gain and BW, DC LG, and PM) at the two different gain settings
 - Note: The PM is measured from the stb analysis (LG), not from the CL response!
 - Closed loop transient simulation results with sinusoidal input (1 MHz) at the nominal corner showing the maximum output swing at the two different gain settings.
- Part 2 (4 pts)
 - Use the THD function in the calculator to calculate the output distortion.
 - Replace the analog lib passives with PDK passives.
 - Report the simulation results across corners
 - SS and 100 °C
 - FF and -40 °C

Acknowledgements

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