Transistor-Level EKV Design Methodologies

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Outline

- Introduction
- Design spaces and constraints
- Design strategy
- Design charts
- Conclusion

Analog Design is Complex

- What is the design space?
- Where are its boundaries?
- Where am I in the design space?
- What is the best parameter to adjust?
- How far should it be changed?
- What is the best tradeoff?

Design Equations

$$\frac{g_m = \frac{1}{nU_T} \cdot \frac{I_D}{\frac{1}{2} + \sqrt{\frac{1}{4} + i_f}}}{g_{ds} = \frac{1}{U_a} \cdot \frac{I_D}{L}} = \frac{g_m}{g_{ds}} = \frac{U_a}{nU_T} \cdot \frac{L}{\frac{1}{2} + \sqrt{\frac{1}{4} + i_f}}$$

$$f_t = \frac{1}{2\pi C_{ox}} \cdot \frac{g_m}{WL}$$

$$V_{DSat} = 4U_T \left(1 + \frac{\sqrt{i_f}}{2}\right)$$

Design Comfort

- Same design parameters for all equations
- Orthogonal design space
- Fixed design space boundaries
- Direct FOM & indicators:
  - Current consumption
  - Area
  - Operation mode (i_f)
- 3 degrees of freedom, but…
- No 3D graphs!

Conclusion

- Same orthogonal design space used in all equations
- Fixed design space boundaries
- Chart tools for design process:
  - 2D representation of 3D design space
  - Intuitive design space exploration
- Normalized design variables
- Methodology applicable even with complex equations (e.g. real g_{ds})

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