Analog Design Tool based on the ACM model

Carlos Galup-Montoro
Márcio Cherem Schneider
Cátia dos Reis Machado

carlos@eel.ufsc.br, marcio@eel.ufsc.br, catia@eel.ufsc.br

University of Santa Catarina
http://www.ufsc.br/

Integrated Circuits Laboratory
http://eel.ufsc.br/ldc/
INTRODUCTION

MOSVIEW:

- Graphical tool for transistor-level analog design
- Based on the ACM model
- Current version: common-source amplifier with four sets of input specs
- Allows biasing and sizing the MOS transistor for a given set of specs.
- Families of curves of constant performance (ft, Vdssat, current,) define a region in the gain vs. L plot denominated design space.
THE DRAIN CURRENT OF MOSFETS

Output characteristic of a long-channel NMOS transistor for constant $V_S$ and $V_G$

\[ I_D = I_F - I_R = I(V_G, V_S) - I(V_G, V_D) \quad (1a) \]
\[ I_{F(R)} = I_S \cdot i_{f(r)} \quad (1b) \]
\[ I_S = \mu C_{ox} n \phi_l^2 \frac{W}{2L} \quad (1c) \]

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THE COMMON-SOURCE AMPLIFIER

A. Voltage gain and bandwidth

\[ A_{vo} = \frac{g_m}{g_{ds}} = \frac{g_m}{I_D} V_E L \]

\[ g_m = 2\pi GB C_L \]

B. Design space
MOSVIEW

A. Graphical tool for transistor-level design

Technological Parameters:
- $L_{min} = 1 \mu m$
- $V_t = 0.5 \text{ V}$
- $VE = 5 \text{V}/\mu \text{m}$

Specifications:
- $g_m = 157 \mu \text{A/V}$,
- $f_{T_{min}} = 100 \text{MHz}$,
- $f_{T_{max}} = 1000 \text{MHz}$,
- $A_{V0} = 100$

- $C’_{ox} = 2fF/\mu \text{m}^2$
- $\mu 0 = 500 \text{cm}^2/\text{V}s$
- $\phi t = 25.9 \text{ mV}$
B. Design example

Analog Design Tool based on the ACM model

### Calculated parameters for Amplifier I

<table>
<thead>
<tr>
<th>Spec</th>
<th>Marker</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>L [um]</td>
<td></td>
<td>2.85</td>
<td>1.15</td>
<td>1.25</td>
<td>8.25</td>
<td>2.50</td>
</tr>
<tr>
<td>$A_{vo}$</td>
<td></td>
<td>197</td>
<td>121</td>
<td>77</td>
<td>113</td>
<td>28</td>
</tr>
<tr>
<td>$I_d$</td>
<td></td>
<td>10.7</td>
<td>2.75</td>
<td>14</td>
<td>430</td>
<td>550</td>
</tr>
<tr>
<td>W [um]</td>
<td></td>
<td>72</td>
<td>76</td>
<td>27</td>
<td>26</td>
<td>7.5</td>
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<tr>
<td>WL [um²]</td>
<td></td>
<td>205.2</td>
<td>87.4</td>
<td>33.7</td>
<td>214.5</td>
<td>18.7</td>
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<tr>
<td>$f_T$ [MHz]</td>
<td></td>
<td>120</td>
<td>280</td>
<td>730</td>
<td>115</td>
<td>1330</td>
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<tr>
<td>$V_{DSsat}$ [mV]</td>
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<td>165</td>
<td>130</td>
<td>180</td>
<td>620</td>
<td>690</td>
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<tr>
<td>$g_m/I_d$ [1/V]</td>
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<td>13.9</td>
<td>20.8</td>
<td>12.4</td>
<td>2.74</td>
<td>2.25</td>
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<tr>
<td>$I_d$ [µA]</td>
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<td>11.3</td>
<td>7.53</td>
<td>12.7</td>
<td>57.3</td>
<td>69.7</td>
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<tr>
<td>$S_{th}$ [A²/Hz]</td>
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<td>7.49E-24</td>
<td>5.59E-24</td>
<td>8.94E-24</td>
<td>3.34E-23</td>
<td>3.02E-23</td>
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<tr>
<td>FC [MHz]</td>
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<td>9.69E-2</td>
<td>1.66E-1</td>
<td>5.32E-1</td>
<td>9.16E-2</td>
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<tr>
<td>SDyn [mV]</td>
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<td>0.58</td>
<td>0.76</td>
<td>1.36</td>
<td>0.56</td>
<td>1.82</td>
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