Reference Voltage’s Generator for an 5v, 2v p-p differential Pipelined 8-bit ADC

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Outline

• Introduction to Reference voltages
  – Accuracy needed
• Topologies under consideration
  – Major differences
• Selection of OpAmp
  – Desired characteristics of the OpAmp
• Current mirror circuits
• Issues to be resolved
• Conclusions
Introduction

• Reference Generator
  – Number of reference’s needed - “5”
    • $+V_{\text{ref}}$ “3.25v”
    • $+V_{\text{ref}/4}$ “2.50v”
    • $V_{\text{C.M}}$ “2.25v”
    • $-V_{\text{ref}/4}$ “2.00v”
    • $-V_{\text{ref}}$ “1.25v”

• Accuracy needed for $+V_{\text{ref}}, -V_{\text{ref}}$ 0.1%
• Accuracy needed for $+V_{\text{ref}/4}, -V_{\text{ref}/4}$ 6.0mv
Accuracy

• Accuracy of the voltages generated play an important role in determining the overall accuracy of the ADC.

• Error in reference voltages generated would directly result in generation of wrong digital codes.

• Care needed while generating and maintaining the reference voltages across various legs.
Topology A
Topology B
Desired OpAmp Characteristics

• High gain

• High unity gain frequency (bandwidth)

• Low settling time

• Good Phase margin
OpAmp Selection

- Telescopic Cascode Amplifier
- Folded Cascode Amplifier
- Current mirror Amplifier
Telescopic Cascode OpAmp

• It has high gain.

• High Bandwidth.

• Limited output swing, not of real concern since we have a 5v supply voltage.

• But the problem is………………
Folded cascode and Current mirror OpAmp

• Unity gain frequency
  – For a folded cascode opamp:
    \[ W_t = \frac{gm_1}{cl} \]
  – For a Current mirror opamp:
    \[ W_t = k \frac{gm_1}{cl} \]

• Settling time (t) – the relation which holds good is
  – To settle within a error percent “E”
    \[ t > \left( \frac{A_0}{\omega t} \right) \ln(1/E) \]
    where \( A_0 \) is the closed loop gain
## Overshoot and Settling time

<table>
<thead>
<tr>
<th>Phase Margin</th>
<th>% Overshoot For step I/P</th>
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</thead>
<tbody>
<tr>
<td>55°</td>
<td>13.3%</td>
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<tr>
<td>60°</td>
<td>8.7%</td>
</tr>
<tr>
<td>65°</td>
<td>4.7%</td>
</tr>
<tr>
<td>70°</td>
<td>1.4%</td>
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<tr>
<td>75°</td>
<td>0.008%</td>
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</table>
Current Mirror ckt s

• As we are working on a 5v power supply, I have the liberty of stacking cascode devices (increase output impedance) to get the desired accuracy while I mirror the current.
Issues to be resolved

- Will I generate all the reference voltages at one place and transfer the currents to all the stages.
- As I have to generate a whole range of voltages from $+V_{ref}$ to $-V_{ref}$
  - Could I use the same OpAmp as the buffer OpAmp for all the stages.
  - If I do use a single OpAmp and then will I be able to have a good OpAmp with wide input and output common mode range.
Conclusions

• Basic reference generation topologies are presented.
• Importance of reference voltages as applied to the accuracy of the ADC is mentioned.
• OpAmp selection justification with some major characteristics.
• Ready to get started on simulations.