Interference

• Only $V_{in}$ and $V_o$ are "signals of interest"

• In practice, on a chip (or PCB), many signals are present:

$$V_o = a_{in}V_{in} + \sum_i a_i V_i$$

• Solutions:
  – Ensure that $a_i$ small!
  – Eliminate $V_i$ (?)
Typical Interferers
Fully Differential versus Single Ended
Differential versus Common-Mode
CMRR and PSRR
Conversion: Balun

- Use for simulation only
- Realizable transformers inadequate for implementation at mixed-signal frequencies
Loop-Gain Simulation

\[ \Delta + \sum C_{s1} \quad C_{f1} \quad C_{L1} \]

\[ v_{id} \quad v_{ic} \quad v_{xc} \quad v_{xd} \quad v_{oc} \quad v_{od} \]

\[ C_{s2} \quad C_{f2} \quad C_{L2} \]
Interference Comparison

Single Ended

Differential
Advanced Analog Integrated Circuits

Differential Pair

Bernhard E. Boser
University of California, Berkeley
boser@eecs.berkeley.edu

Copyright © 2016 by Bernhard Boser
Differential Pair

Differential Half Circuit

Common-Mode Half Circuit
Tail Current Source

versus
Tail Current Source

Note: mismatch in differential pair
Simulation Result

![Graph showing CMRR vs Frequency](image)
Advanced Analog Integrated Circuits

Common-Mode Feedback

Bernhard E. Boser
University of California, Berkeley
bolser@eecs.berkeley.edu

Copyright © 2016 by Bernhard Boser
Output Common-Mode Voltage
Common Mode Feedback (CMFB)
Adjust $V_{oc}$
$V_{cm}$ Sense
Continuous Time CMFB

Advanced Analog Integrated Circuits

Switched Capacitor CMFB

Bernhard E. Boser
University of California, Berkeley
bos@eeecs.berkeley.edu

Copyright © 2016 by Bernhard Boser
SC Common-Mode Feedback

\[ I_{c/2} \]

\[ I_{d/2} \]

\[ I_{o/2} \]

\[ V_{ip} \]

\[ V_x \]

\[ M = 2 \]

\[ M = 1 \]

\[ M_1 \]

\[ M_3 \]

\[ C_{cmfb} \]

\[ V_{ocm0} \]

\[ V_B \]

\[ \phi_2 \]

\[ \phi_1 \]
Continuous SC CMFB

SC CMFB in 2-Stage Opamps
CMFB Loop Gain

CMFB half circuit
Setting the Loop Gain
Noise in Differential Circuits
Noise from Tail Current Source