Differential Circuits

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Single-Ended vs. Differential Ended

• Single-ended signals
  – Referenced to a fixed potential (usually ground)

• Differential signals
  – Measured between two nodes that have equal and opposite signal excursions about a fixed potential
  – The two nodes [must] have equal impedances to that fixed potential
  – The fixed potential is called the “common-mode” (CM) level
  – Generally, a signal is defined as the difference between V1 and V2
    • \( V_1 - V_2 = \Delta V = V_{id} \)
Advantages of Differential Circuits

• **Common-Mode Rejection**
  – Rejects “environmental” noise (noise produced by the environment or other circuits)
  – This noise will be “common” to both signals and will eventually be subtracted out

• **Power-Supply Rejection**
  – Reduces the noise contributed by noisy power supplies

• **Increases/doubles the maximum achievable voltage swings**

• **Increased Linearity**
  – Removes even-order harmonics in fully differential systems

• **Typically simpler to bias**
Costs of Differential Circuits

• Increased area
  – In reality, the benefits far outweigh this minor detail
  – Single-ended circuits may consume more area to achieve the same performance

• Twice the power consumption
  – (Similar concepts as above)