Basics of Analog Multiplexers 3

TIPL 2603

TI Precision Labs – Op Amps

Created by Abhijeet Godbole, Art Kay

Presented by Peggy Liska

Analog Multiplexer Parameters Summary

- Part 1: Understanding Performance parameters of Multiplexer

  1) Bandwidth
  - How MUX bandwidth is defined
  - Factors affecting MUX bandwidth

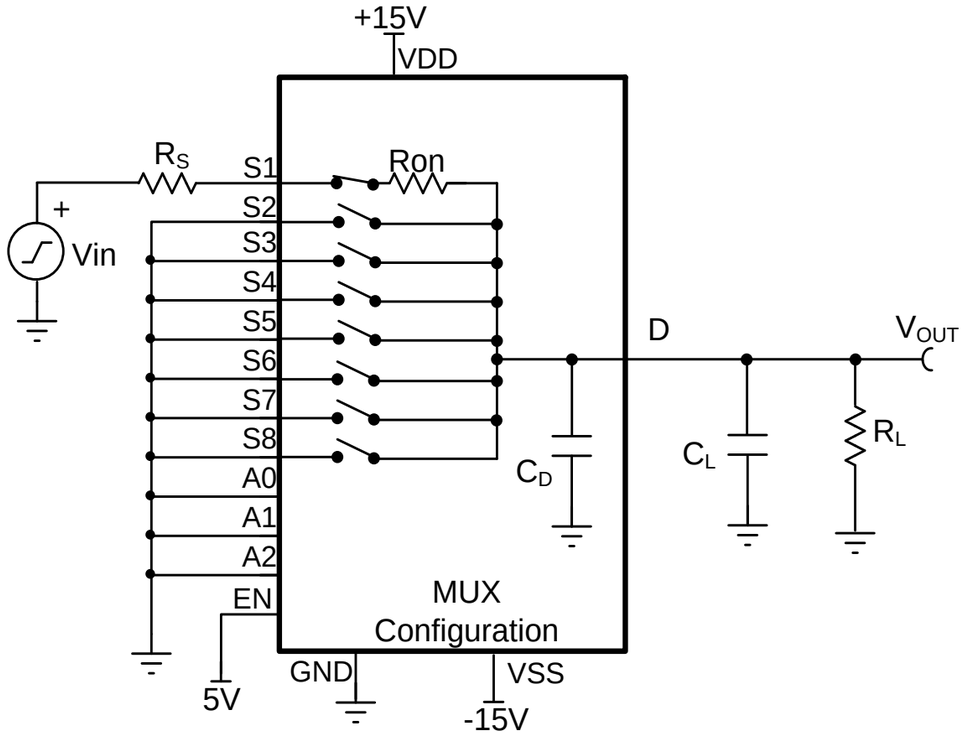
  2) Channel to Channel Crosstalk
  - Understanding Channel to Channel Crosstalk
  - Factors affecting Crosstalk

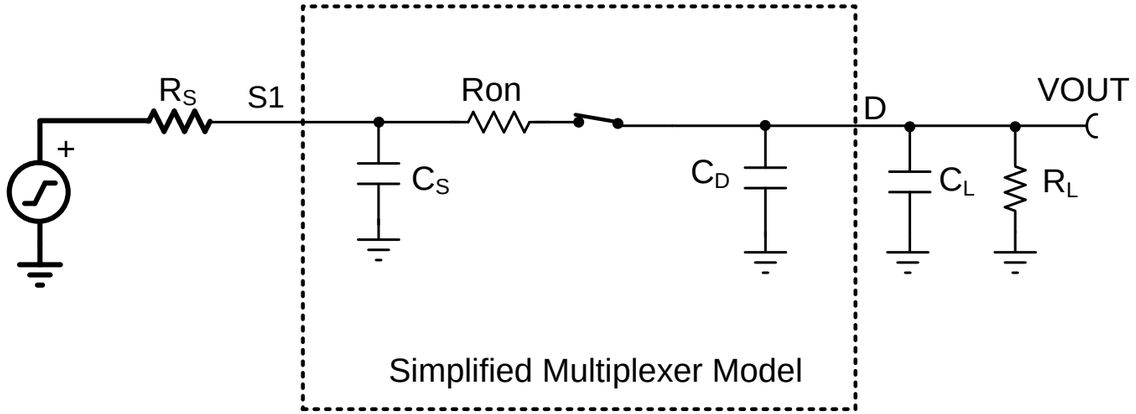
  3) OFF Isolation
  - Understanding OFF Isolation of MUX
  - Factors affecting OFF Isolation

  4) THD+Noise
  - Understanding THD+Noise parameter

- Goals:
  - 1. To understand performance parameters of multiplexers
  - 2. Understand their importance while designing data acquisition system

Bandwidth





Bandwidth : The frequency at which the output is attenuated by 3 dB from the pass band (dc) response.

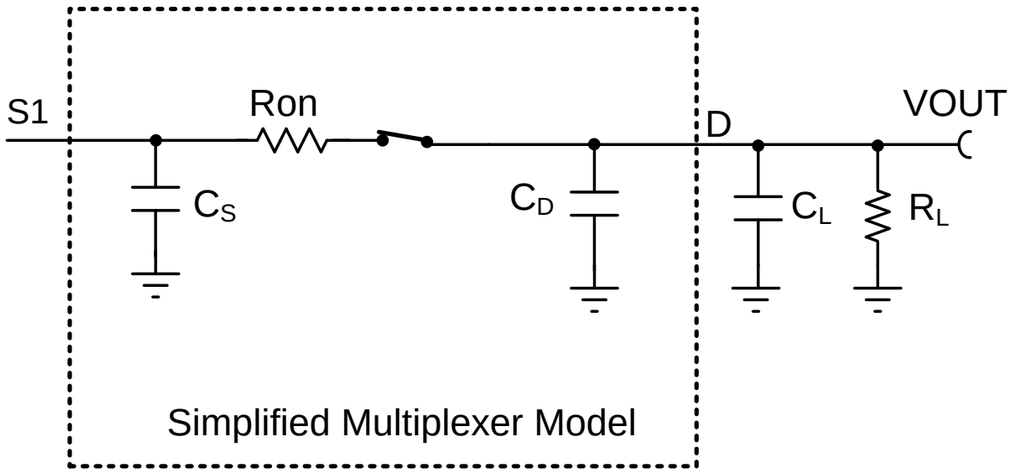
Transfer function

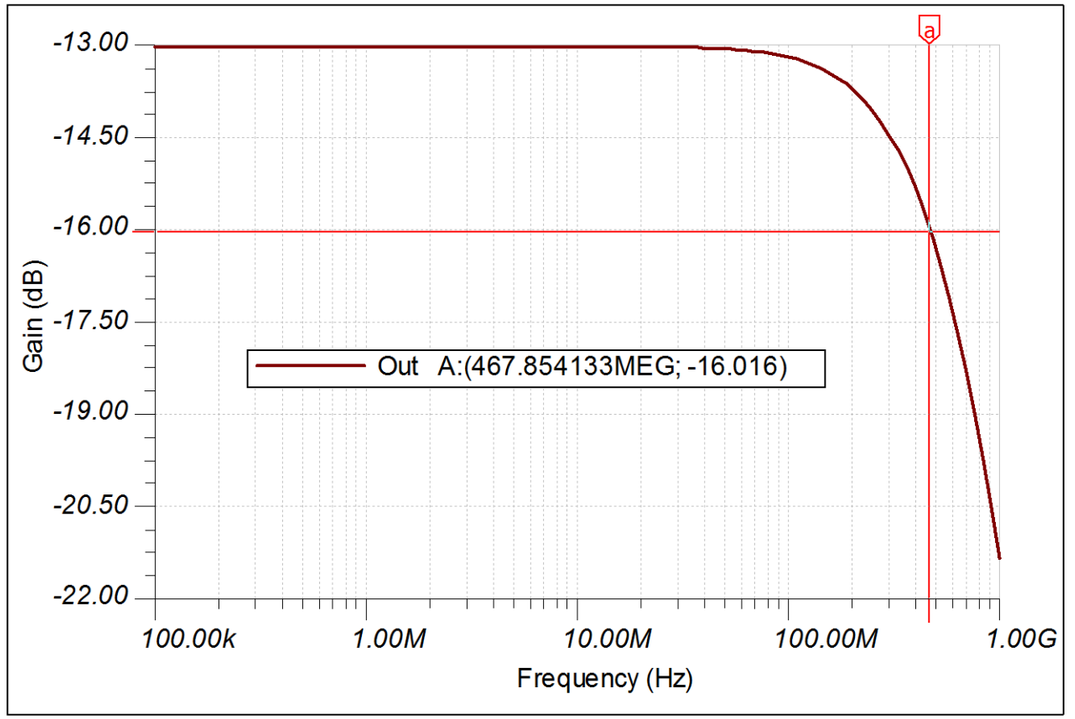
$$\frac{V_{OUT}}{V_{in}} = \left(\frac{R_L}{R_L + R_{on}}\right)\left(\frac{1}{\left(\frac{f}{f_c}\right) + 1}\right)$$

3 dB Cut OFF Frequency:

$$f_c = \frac{(R_L + R_{on})}{2 \cdot \pi \cdot (R_L \cdot R_{on}) \cdot (C_D + C_L)}$$

Bandwidth





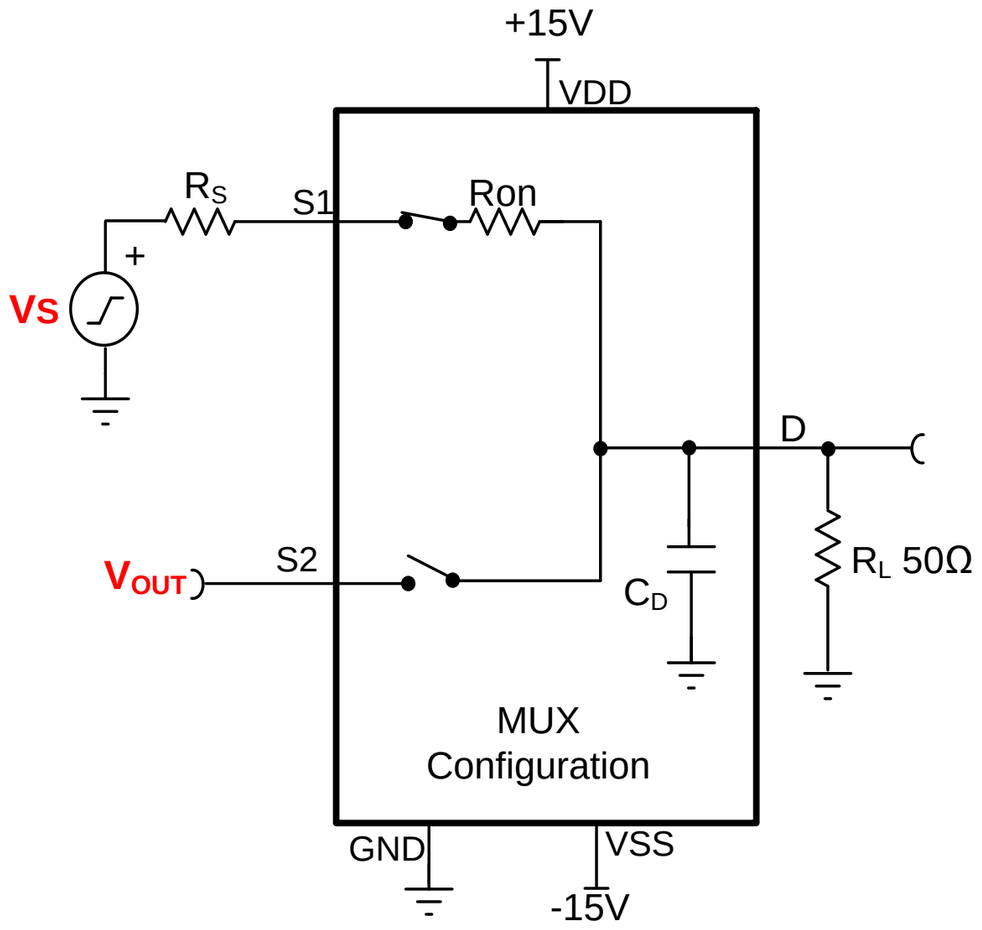
3 dB Cut OFF Frequency:

$$f_c = \frac{(R_L + R_{on})}{2 \cdot \pi \cdot (R_L \cdot R_{on}) \cdot (C_D + C_L)}$$

R_L >> R_{ON} Cutoff Frequency

$$f_c = \frac{1}{2 \cdot \pi \cdot (R_{on}) \cdot (C_D + C_L)}$$

Channel to Channel Crosstalk



Crosstalk: voltage feed through to the source pin of an off-channel from a known signal is applied to the source pin of an on-channel

Channel to Channel Crosstalk (dB)

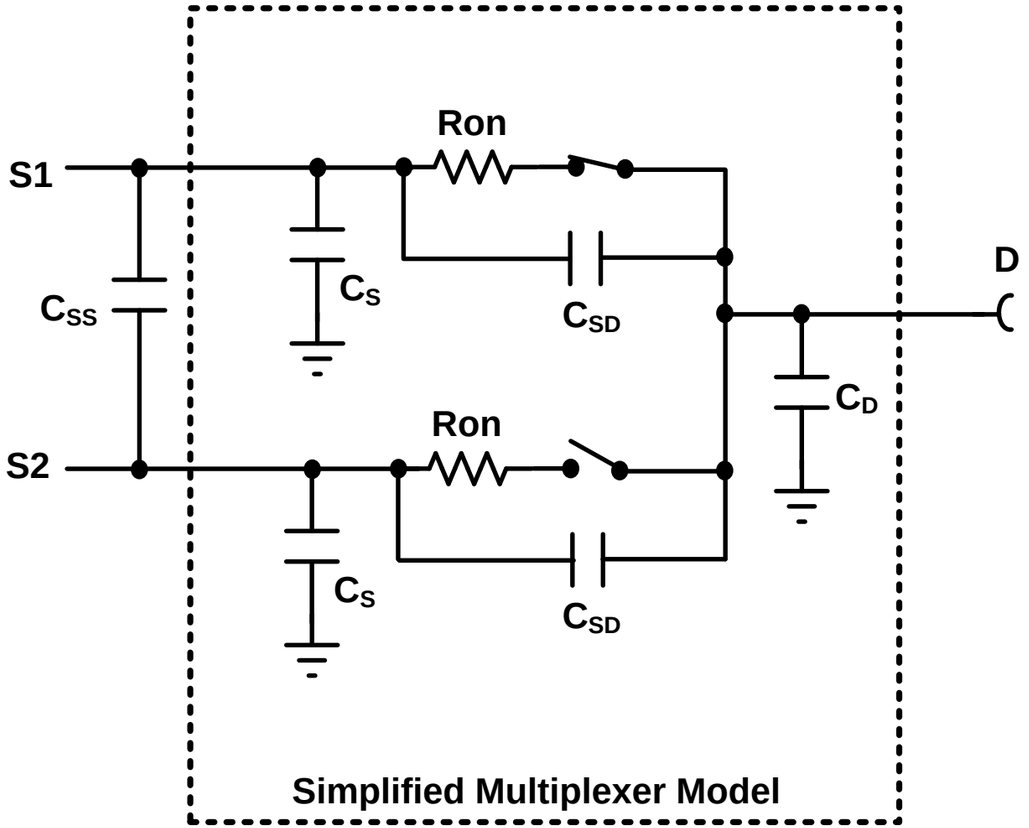
$$= 20 * \log\left(\frac{V_{OUT}}{V_S}\right)$$

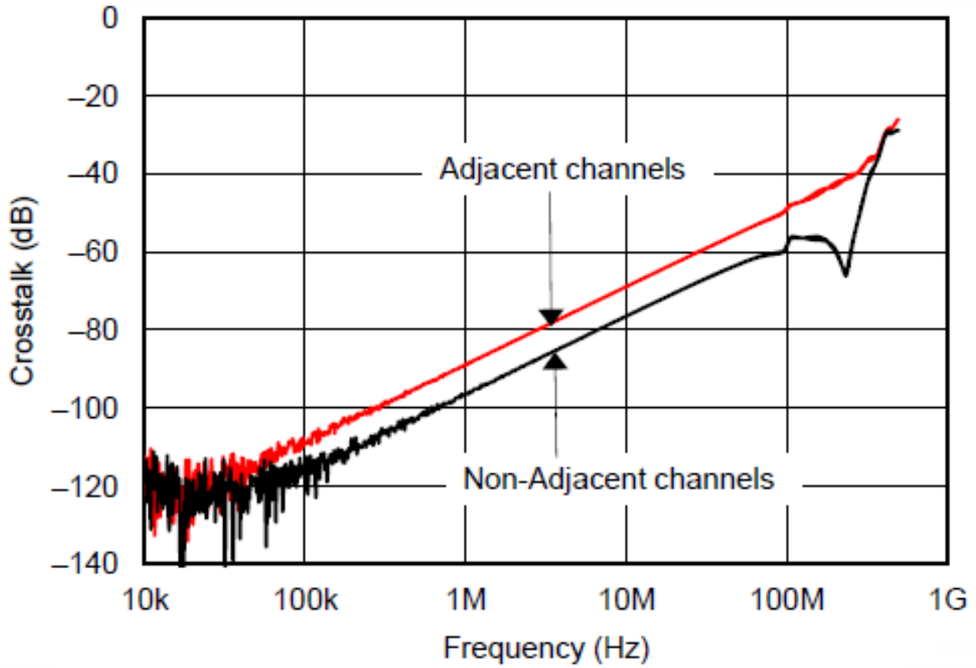
Where

Vs : Voltage applied to source pin of on channel

V_{OUT}: Voltage measured at source pin of off channel

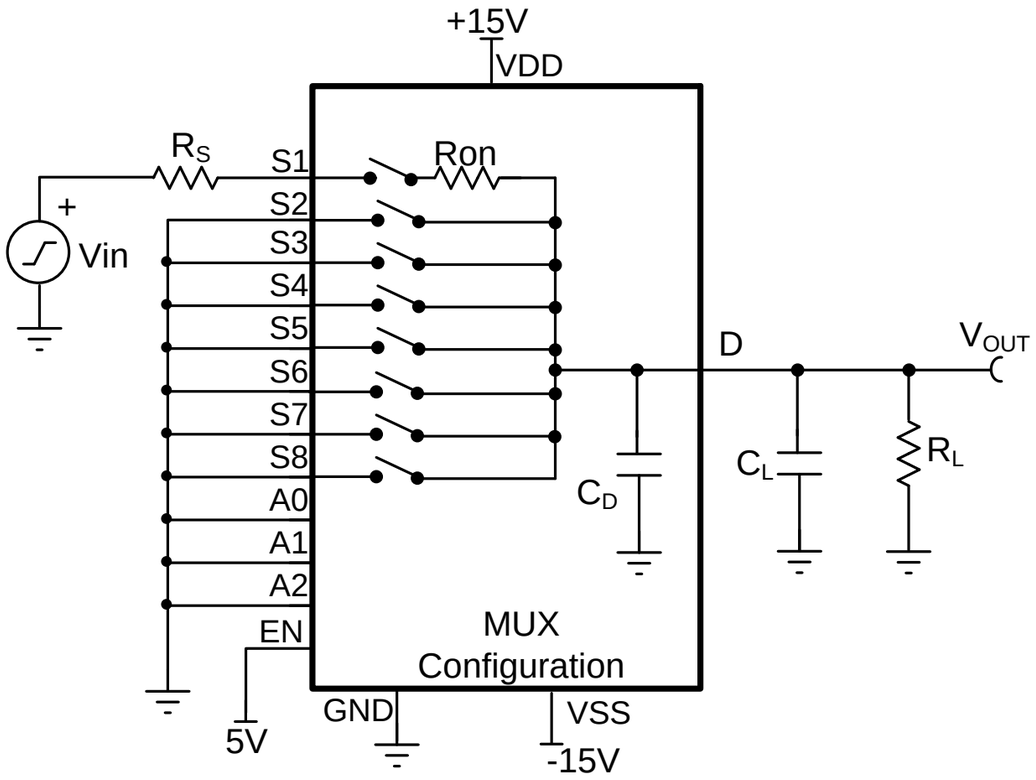
Channel to Channel Crosstalk





MUX36S08 Channel to Channel Crosstalk vs. Frequency

OFF Isolation



OFF Isolation: voltage at output pin of an multiplexer when a known signal is applied at the source pin of an OFF-channel

OFF Isolation (dB)

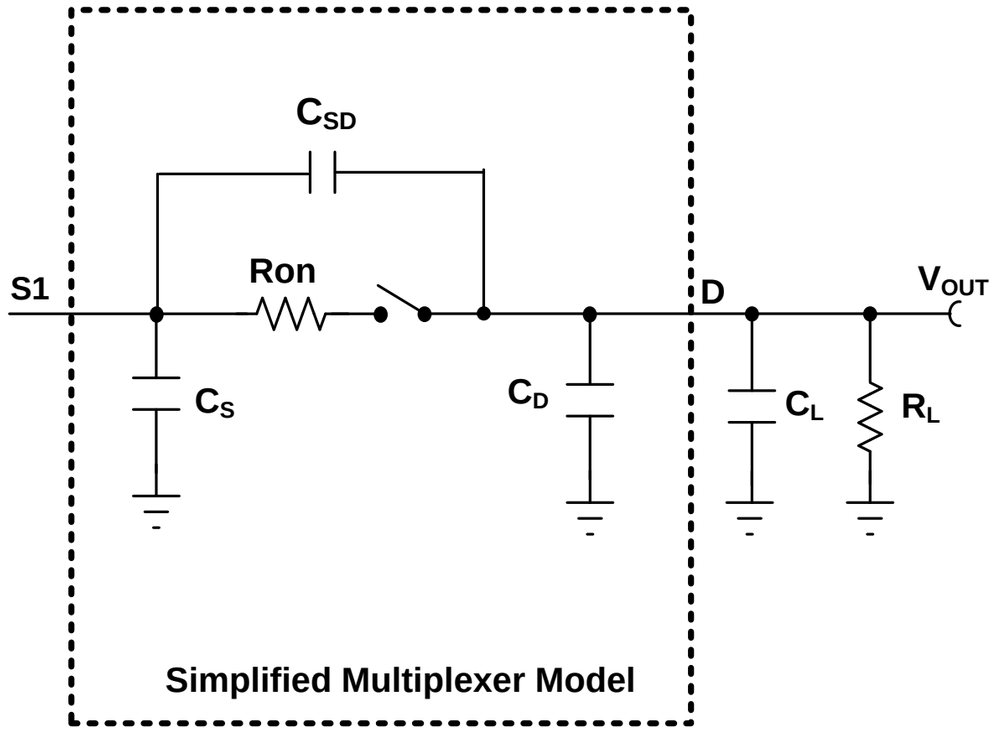
$$= 20 * log\left(\frac{V_{OUT}}{V_{in}}\right)$$

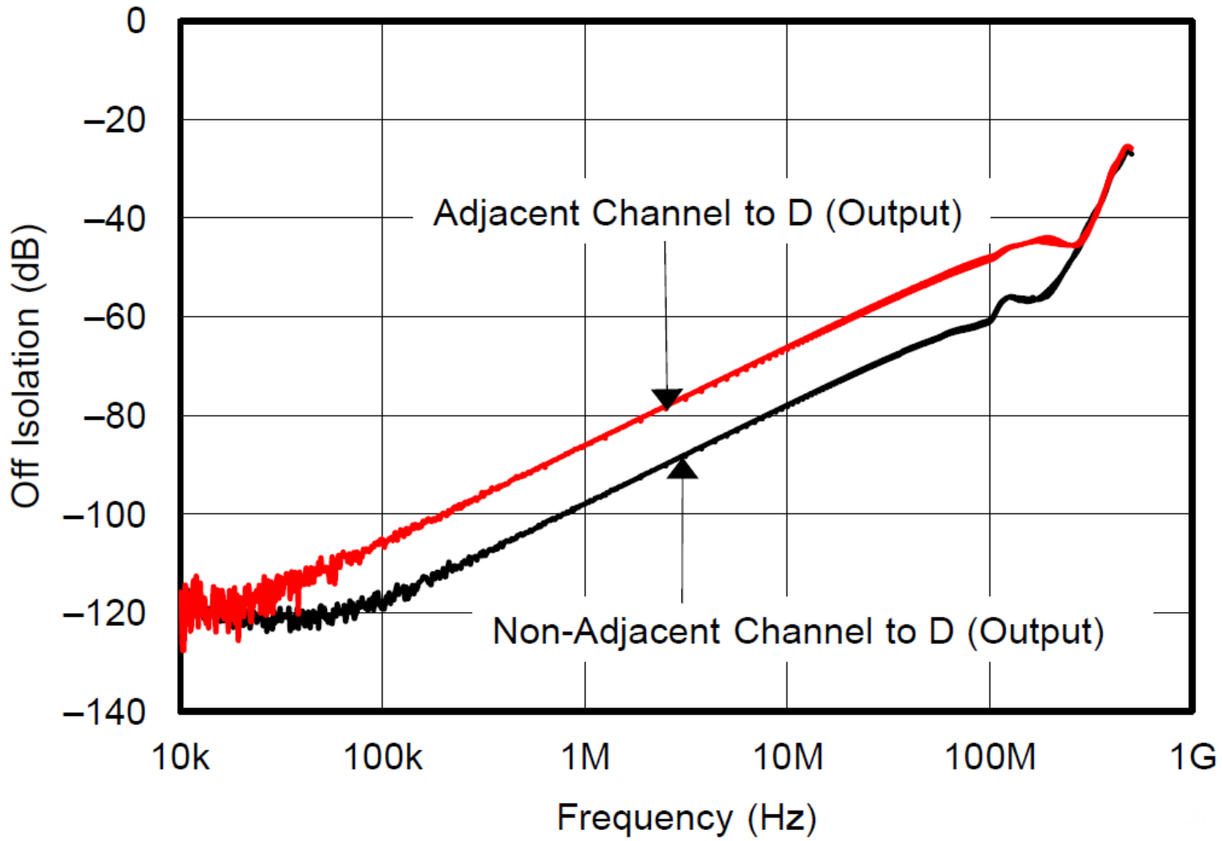
Where

Vin : Voltage applied at source pin of off channel

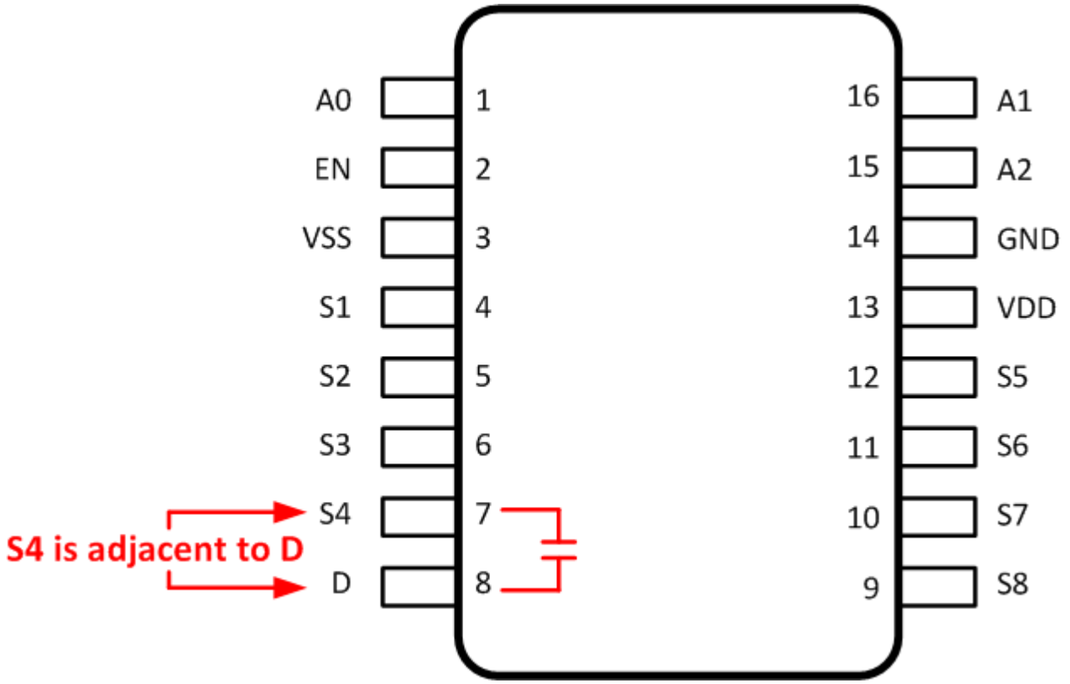
V_{OUT}: Voltage measured at source pin of off channel

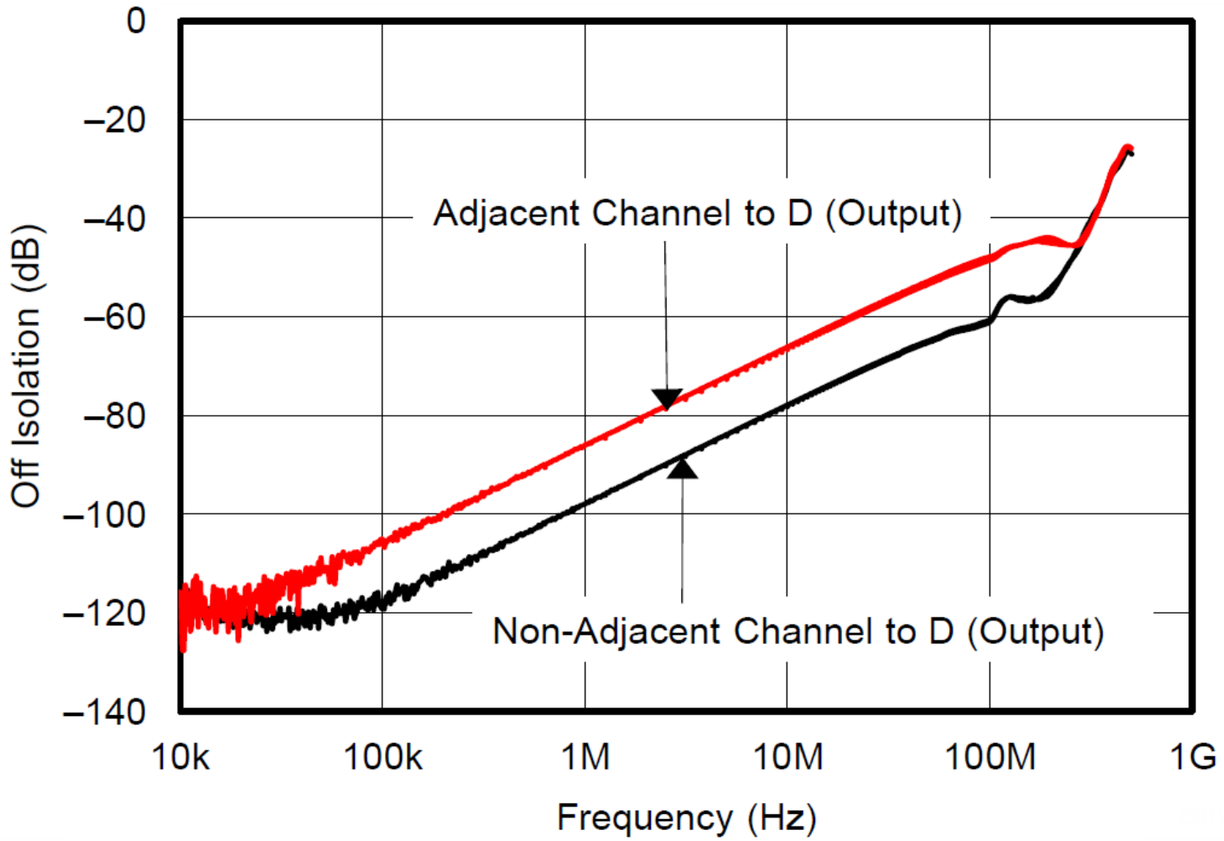
OFF Isolation



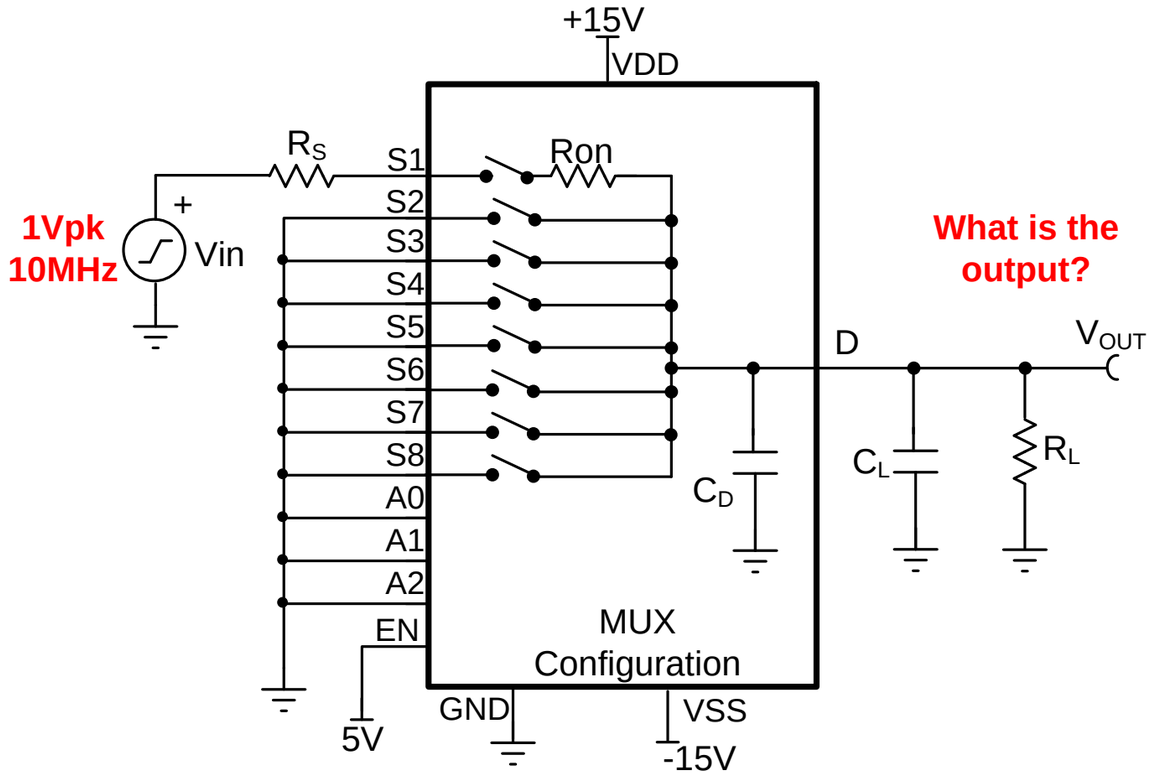


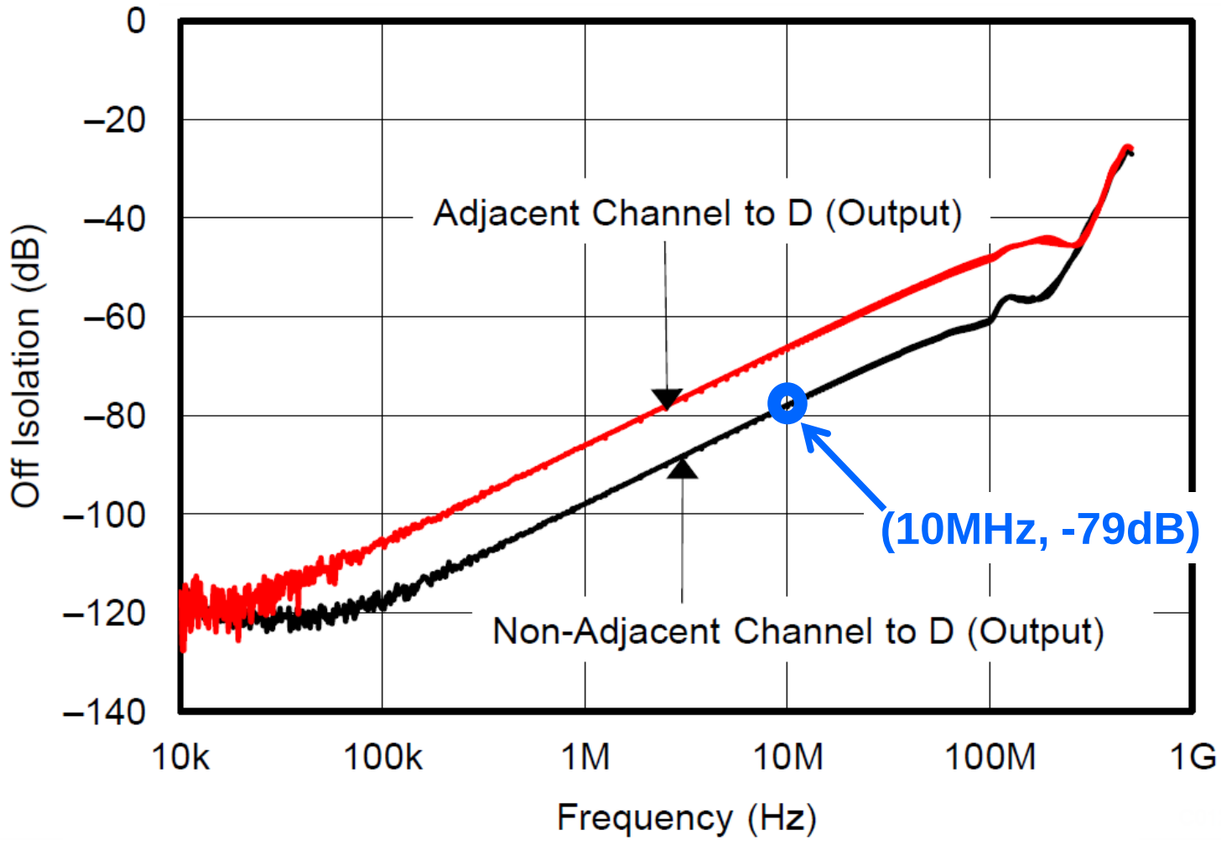
Off Isolation: Adjacent Channels





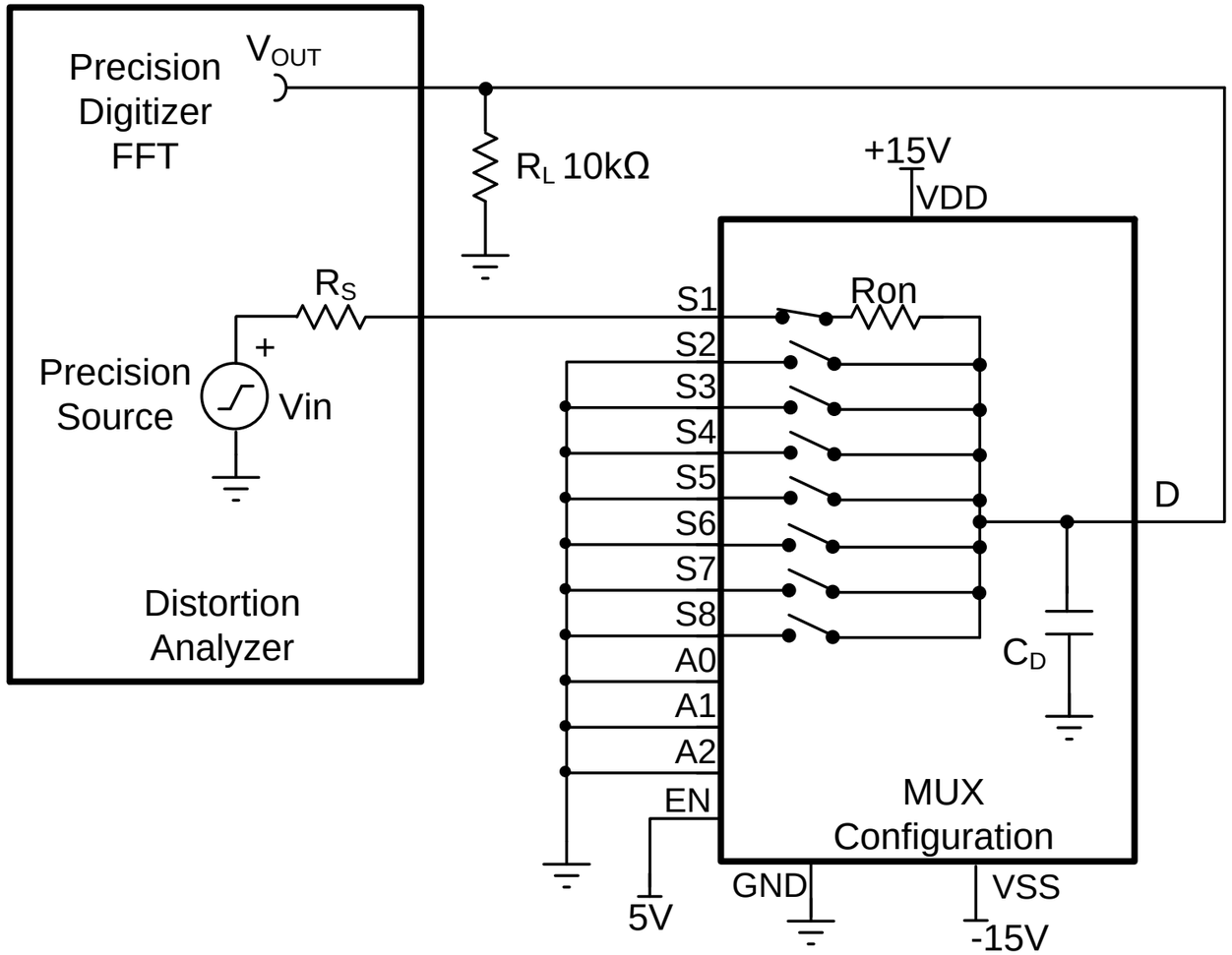
Off Isolation: Example Calculation

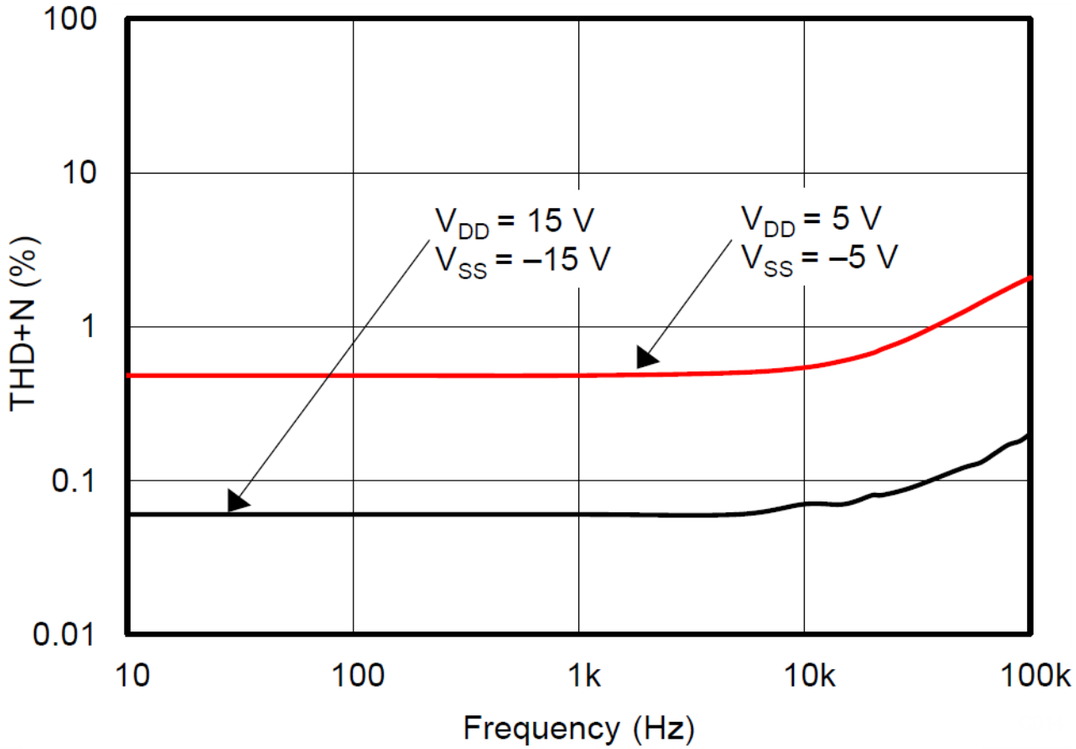




$$V_{OUT} = 1Vpk \cdot 10^{\left(-\frac{79dB}{20}\right)} = 112\mu Vpk$$

Total Harmonic Distortion + Noise: THD+N

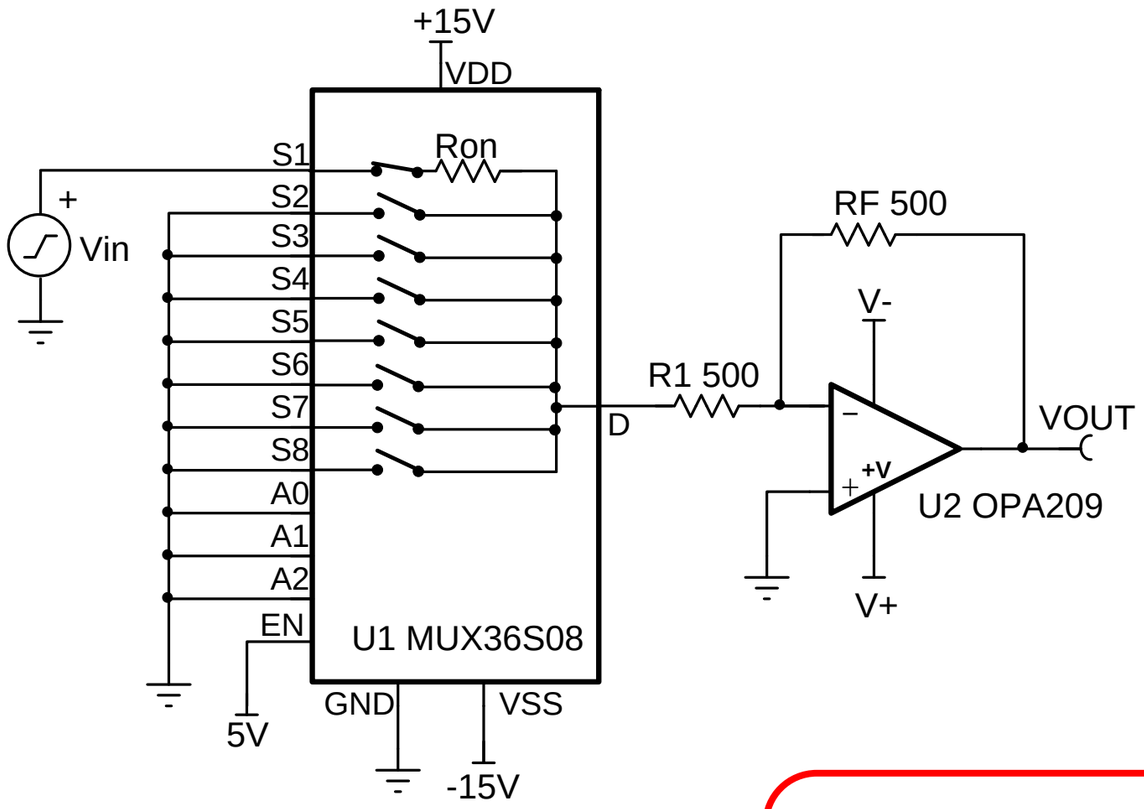




Total Harmonic Distortion + Noise

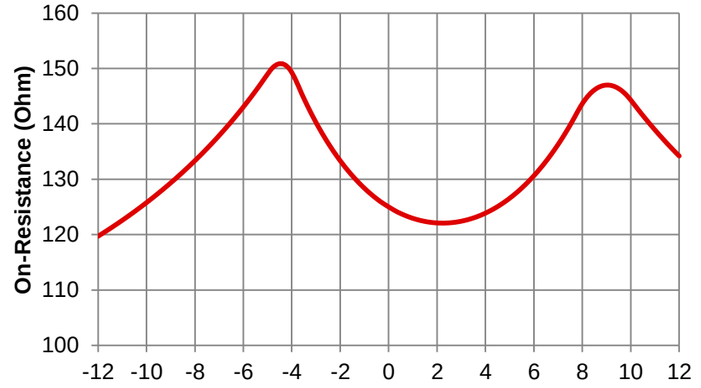
$$(\boldsymbol{THD+N})(\%) = \mathbf{100}\left(\sqrt{\frac{\sum_{i=2}^{\infty}\left(V_i^{\,2}\right)+V_n^{\,2}}{V_f^{\,2}}}\right)$$

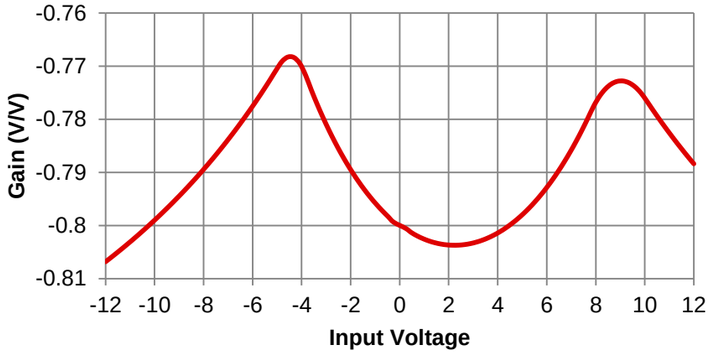
THD+Noise

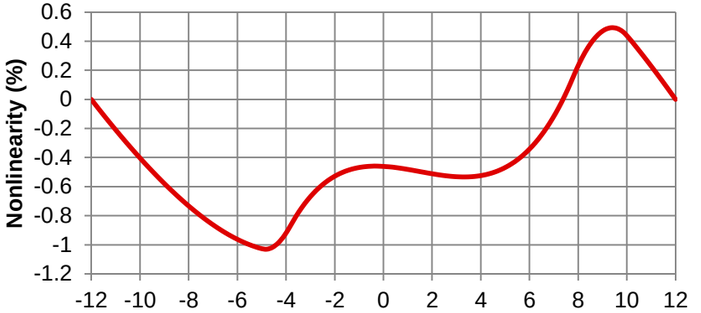


Effective Gain with MUX R_{ON} is:

$$AG = -RF/(R1 + R_{ON})$$







Thanks for your time!
Please try the quiz.