Key Formulas

Resolution: $V_{FS} / (2^N - 1)$

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MSB Weighting: $2^{-1} V_{FS}$

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MSB Weighting: $2^{-1} V_{FS}$

LSB weighting: $2^{-N} V_{FS}$

Maximum output: $(1 - 2^{-N}) V_{FS}$

OSR : $f_S / 2f_m$

key Formulas

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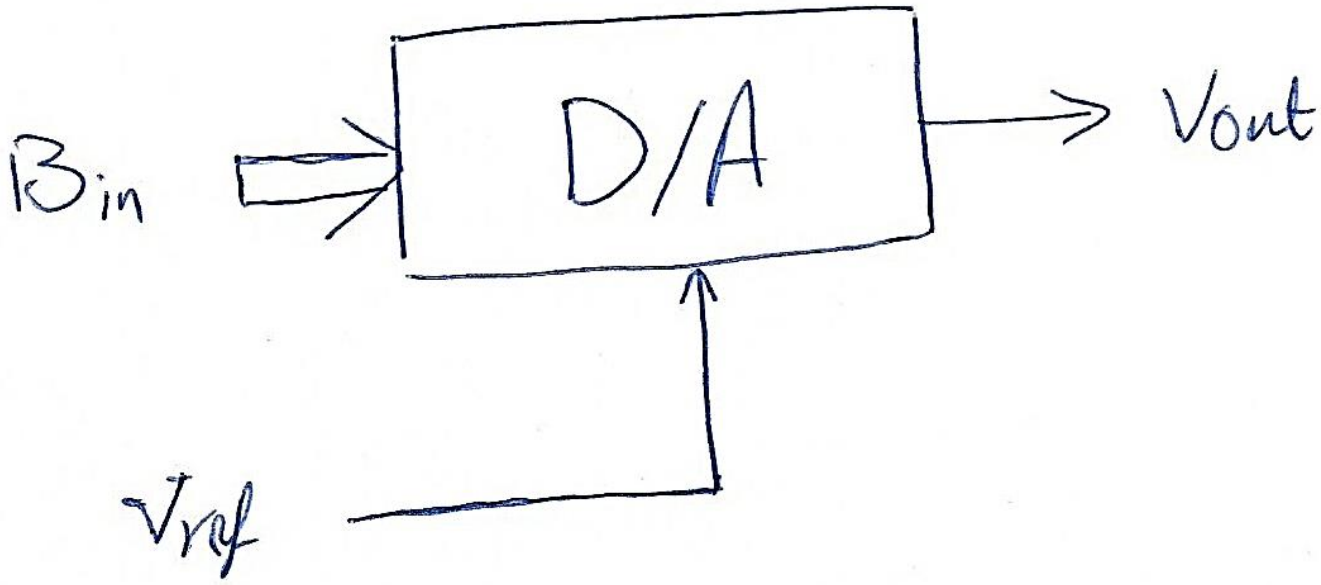
2 x OSR $\longrightarrow$ +3 dB

key Formulas



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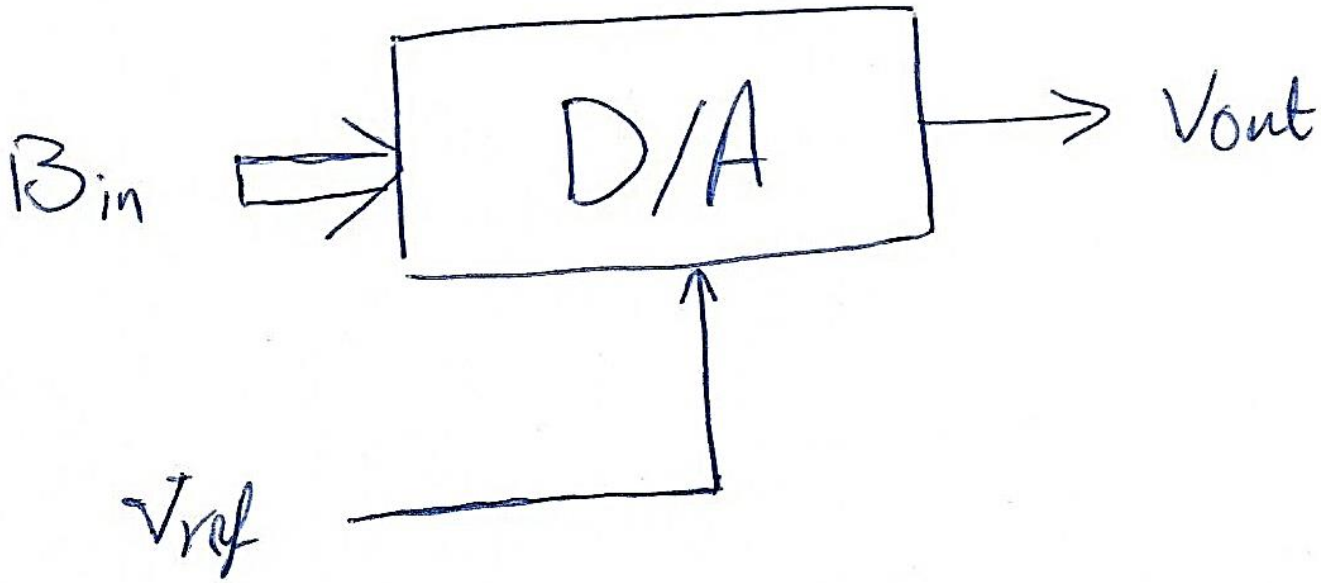

$$V_{out} = V_{ref}\left(b_1 2^{-1} + b_2 2^{-2} + b_3 2^{-3} \cdots b_N 2^{-N}\right)$$

Exercise

An 8-bit D/A converter has $V_{ref} = 5$ V. What is the output voltage when $B_{in} = 10110100$? Also, find V_{LSB}.

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$V_{out} = V_{ref} \cdot B_{in} = 3.516\ V$

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$V_{LSB} = V_{ref} \cdot 2^{-N} = \frac{5}{256} = 19.5\ mV$

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$$= 49.92 \text{ dB}$$

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$$SQNR_{new} = SQNR_{old} + 3\text{dB} =$$

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What if I add 3 extra bit too:

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What if I add 3 extra bit too:

$$SQNR = SQNR_{old} + 3 \times 6 =$$

$$52.92 + 18 = 70,92 \text{ dB}$$

Exercise 1

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if V_{in} is sin wave and

$V_{pp} = V_{ref}$ ((Full Scale)) :

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$V_{pp} = V_{ref}$ (Full Scale):

$$SQNR = (6.02N + 1.76 + 20\log\sqrt{OSR})$$

if $V_{pp} < V_{ref}$:

$$SQNR = (SQNR)_{old} - 20\log\left(\frac{V_{ref}}{V_{pp}}\right)$$

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Full Scale Sine wave:

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if $V_{pp} = 1/3\, V_{ref}$

$$SQNR = 6.02N + 1.76 - 20\log 3 = 64.5\,dB$$

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Full Scale Sine wave:

$$SQNR = 6.02N + 1.76 = 74\,dB$$

if $V_{pp} = \frac{1}{3} V_{ref}$ ($V_{ref}/V_{pp} \downarrow 3$)

$$SQNR = 6.02N + 1.76 - 20\log 3 = 64.5\,dB$$

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Now $SQNR = 0 \Rightarrow V_{PP} = ?$

detailed:

$$SQNR = 6.02N + 1.76 - 20\log\left(\frac{V_{ref}}{V_{PP}}\right)$$

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$$\Rightarrow 74\,dB = 20\log\left(\frac{V_{rms}}{V_{pp}}\right)$$

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Now $SQNR = 0 \Rightarrow V_{pp} = ?$

detailed:

$$SQNR = \underbrace{6.02N + 1.76}_{74} - 20\log\left(\frac{V_{rms}}{V_{pp}}\right)$$

$$\Rightarrow 74\,dB = 20\log\left(\frac{V_{rms}}{V_{pp}}\right)$$

$$\Rightarrow V_{pp\,input} = 0.6\ mV$$