Solutions

Examination in Integrated A/D and D/A Converters, ETI220

14.00-19.00, Thursday, Dec. 16, 2010

I. Basic questions about A/D converters

a) The spectral leakage is due to non-coherent sampling. Use coherent sampling to avoid it.

b) See lecture 1 and chapter 1.4 in the textbook.

c) SFDR may be relevant in the context of radio communications, where huge interfering signals coexist with tiny desired signals.

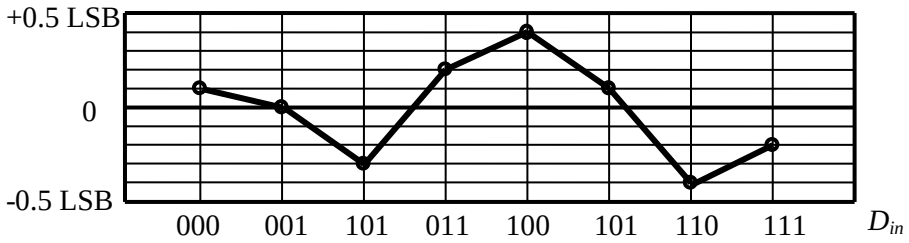
d) See lecture 5 and chapter 5.5 in the textbook.

II. Specific questions about converters

a) See lecture 4 and chapter 4.8 in the textbook.

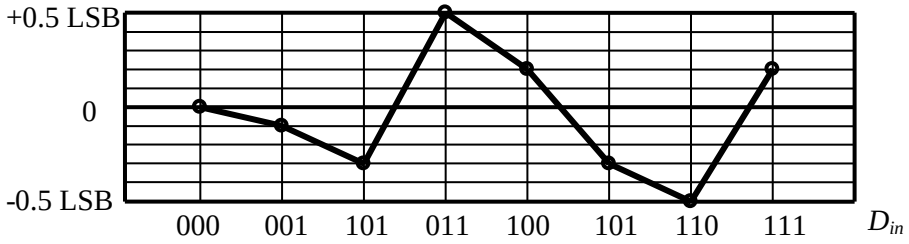
b) Assume e.g. an 8-bit DAC. Assume all resistor ideal, except the MSB resistor, with value 2R(1+dr). Code 10000000 results in $I_{out,1} = I_{ref} \cdot 1/(2+dr)$, while code 01111111 results in $I_{out,2} = I_{ref} \cdot (1+dr)/(2+dr)\cdot(1-2^{-7})$. If $dr > 2^{-7} = 0.0078$, monotonicity is lost.

c)



INL of a 3-bit D/A converter

Draw the DNL curve based on above INL curve.



DNL of a 3-bit D/A converter

d) See lecture 3 and chapter 3.3.3 in the textbook.

e) The noise floor is at -120dB, which means that with 4096 bins from DC to Nyquist the noise floor power is $-120+10\cdot\log10(4096) \cong -84$dB. Thus, the SNR is 81dB, and the ENOB is $(81-1.76)/6.02 \cong 13.1$.

f) STF and NTF are:

$$X - Y\left[\left(\frac{z^{-1}}{1-z^{-1}}\right)^2 + 2\left(\frac{z^{-1}}{1-z^{-1}}\right)\right] + X + \varepsilon = Y$$

$$Y = X + \left(1-z^{-1}\right)^2 \varepsilon = STF \cdot X + NTF \cdot \varepsilon$$

Concerning the popularity of Delta-Sigma converters, see lecture 6 and chapter 6.1-2 in the textbook.

g) See lecture 3 and chapter 3.4.4 in the textbook.