Exercise 4: AD Converters

Purpose of the lecture is to get familiar with:

- Typical A/D converter specifications
- DNL and INL calculations;

Exercise 1: INL and DNL calculations

Figure 1 shows ideal and real 3-bit A/D converter. Fulfill the Table 1 and calculate DNL, RMS(DNL), INL and its maximum value.

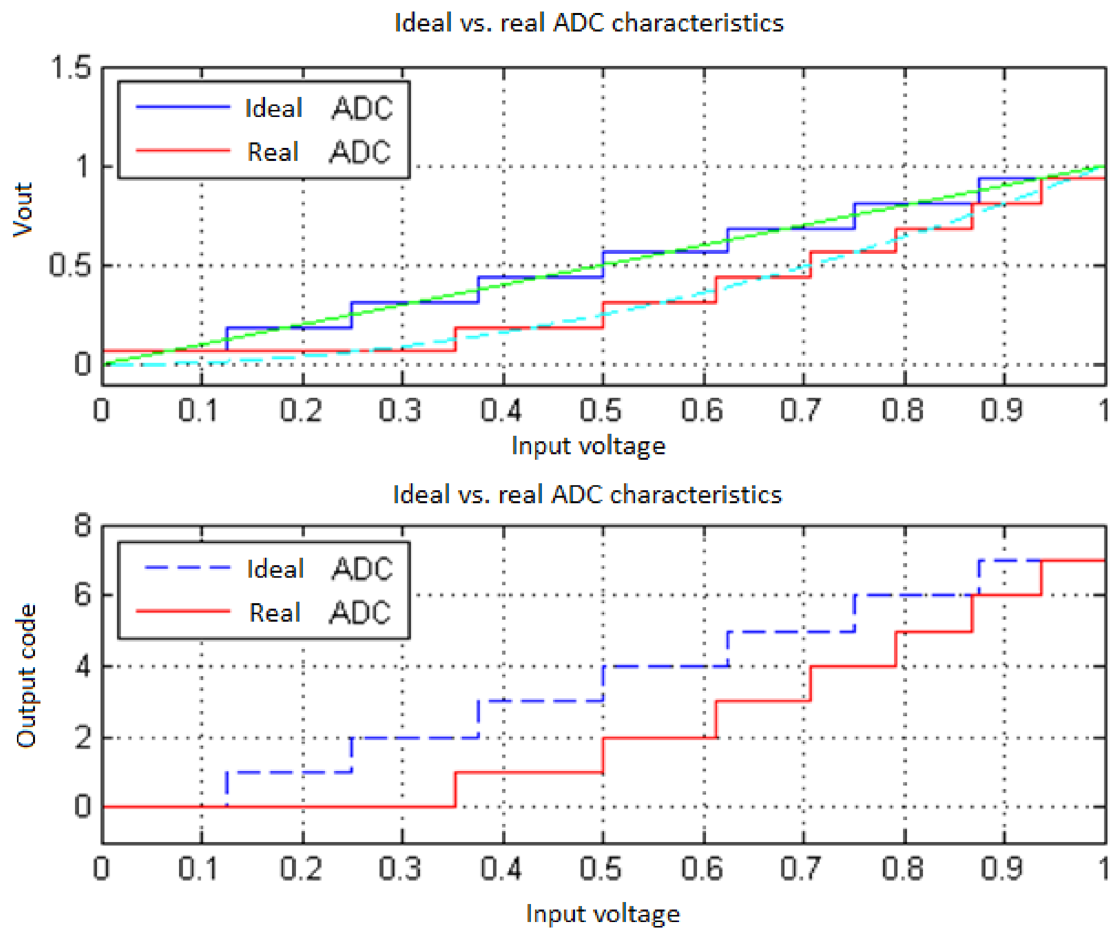

Figure 1: Comparison between ideal and real ADC.

Table 1: Ideal and real ADC specifications

n	Transition point (ideal)	Code(ideal)	Transition point (real)	Code (real)	DNL(n)	INL(n)
0	0.000	0	0.0000		0	0
1	0.125	1	0.3535			
2	0.250	2	0.5000			
3	0.375	3	0.6125			
4	0.500	4	0.7070			
5	0.625	5	0.7905			
6	0.750	6	0.8660			
7	0.875	7	0.9355			

$$\Delta_r(k) = X(k) - X(k-1)$$

$$DNL(k) = \frac{\Delta_r(k) - \Delta}{\Delta}$$

$$DNL_{rms} = \sqrt{\frac{1}{2^N - 1}\sum_{1}^{2^N - 1}\left[DNL(k)\right]^2}$$

DNL_{rms}=

$$INL(k) = (1+G)\sum_{i=1}^{k} DNL(i)$$

INL_{max}=

Exercise 2: Real A/D - INL and DNL calculation

Prepare .m file where you realize model of real/ideal 3-bit A/D converter (Fig. 2) using prepared function adc_MES.m available on the e.fe.uni-lj.si. Input signal should be linear ramp function from 0 to 1 consisting of 2^16 samples. Plot histogram where "x" axis represents output code and "y" frequency of its repetitions. Determine transition points of real and ideal A/D and calculate DNL, INL, RMS(DNL) in INL_{max}.

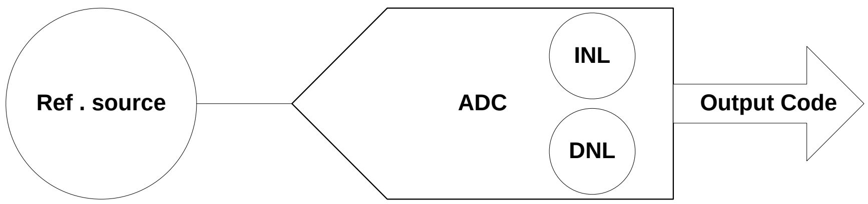

Figure 2: ADC example

Table 2: Ideal and real ADC specification

n	Transition point (ideal)	Code (ideal)	Transition point (real)	Code (real)	DNL(n)	INL(n)
0					0	0
1						
2						
3						
4						
5						
6						
7						

DNL_{rms}=

INL_{max}=