# Exercise 7: DA Converters

Purpose of the lecture is to get familiar with:

- D/A converter based on current sources;
- INL and spectrum of output voltage;
- Output voltage spectrum comparison of differential and non-differential D/A converter based on current sources.

**Exercise 1: Model of D/A converter realized with current sources**

Prepare .m file where you model D/A converter realized with unit current sources (Figure 1). Calculate and plot INL for 12-bit D/A converter. Load resistance $R_L$ should be 25 Ω, while switch serial resistance Ron and parallel current source Ru is equal Ron=100 Ω in Ru=200 M Ω (Figure 2, Figure 3). Firstly plot output voltage versus linearly increased code (n=0:2^B-1) Then calculate and plot spectrum of output voltage with input signal xsin=(2^B-1)*(0.5*sin(2*pi*500/length(n).*n)+0.5). Check the influence of the differential and non-differential D/A on the output spectrum.

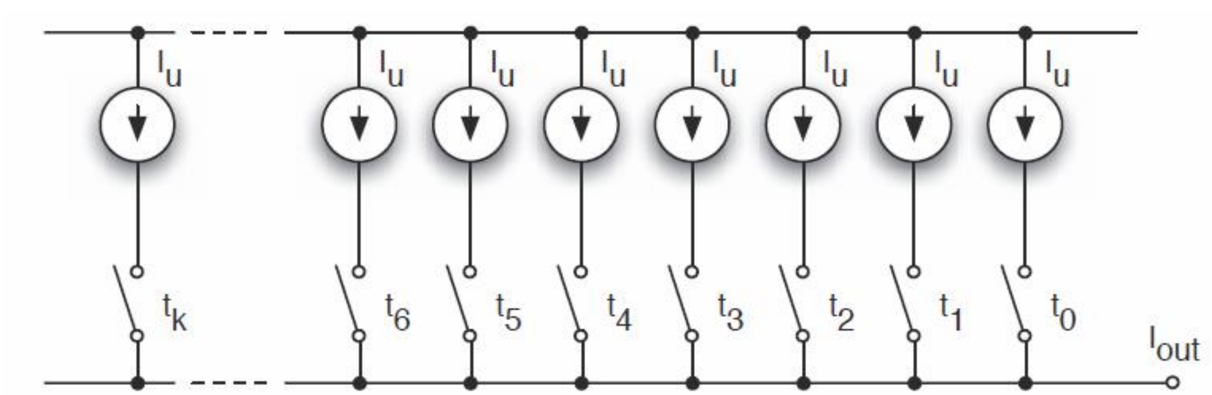


**Figure 1: D/A converter realized with current sources.**

$$I_{out} = I_u \cdot B = I_u \left(2^0 \cdot b_0 + 2^1 \cdot b_1 + 2^2 \cdot b_2 + ... + 2^k \cdot b_k + ... + 2^{(N-1)} \cdot b_{N-1}\right)$$

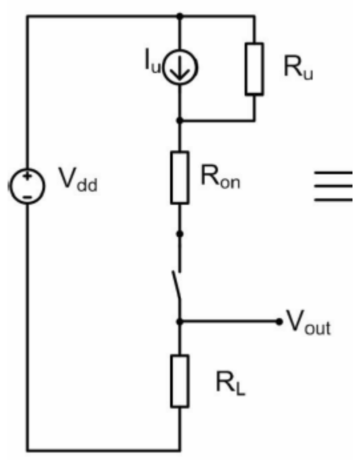

Figure 2: Current source model.

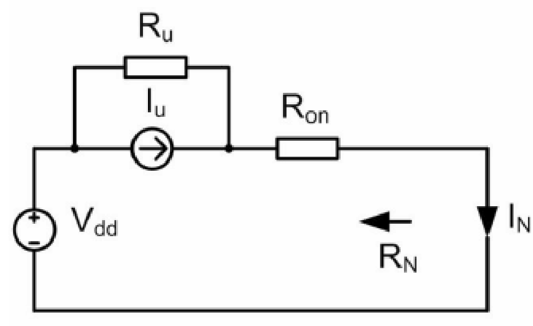

Figure 3: Current source model.

$$I_N = \frac{V_{dd}}{R_u + R_{on}} + I_u = \frac{V_{dd} + I_u R_N}{R_N}$$

$$R_N = R_u + R_{on}$$

$$I_N = \frac{V_{dd}}{R_u + R_{on}} + I_u =$$

$$R_{N,k} = \frac{R_N}{k};\ I_{N,k} = k \cdot I_N$$

$$V_{out} = k \cdot I_N \frac{R_L \cdot (R_N / k)}{R_L + (R_N / k)} = I_N R_L \frac{k}{1 + \alpha k}; \quad \alpha = \frac{R_L}{R_N}$$