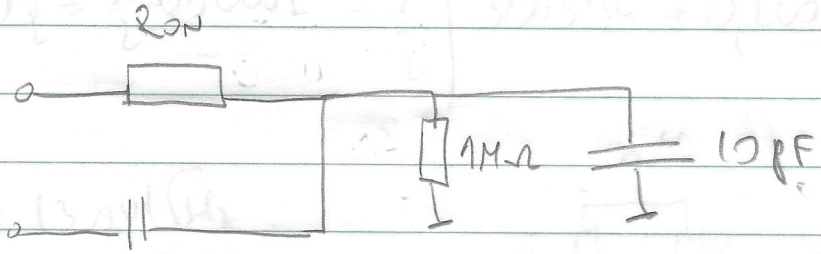
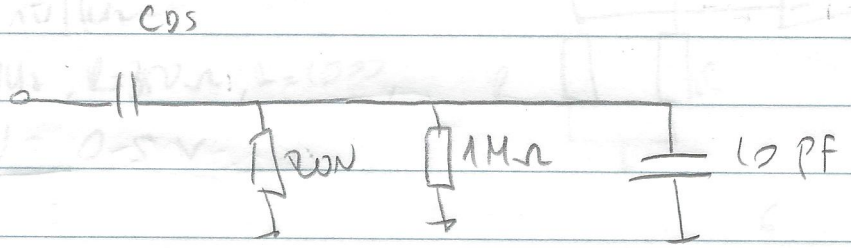
MEDZISPIT 22.4.2015 EI

① N=16 1MΩ||10pF

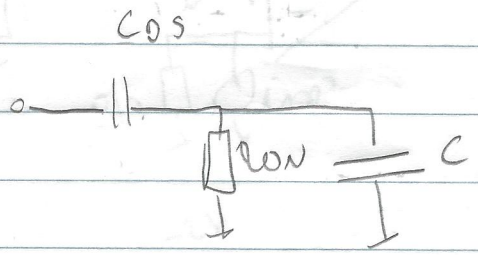
a) $R_{ON} = 1\,\Omega$

stat. preslušavanie $< \frac{1}{2}$ LSB, $f = 10\,MHz$

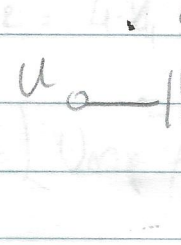




$1\,\Omega \,||\, 1M\Omega \approx 1\,\Omega$



$$Z = \frac{R_{ON}\cdot\frac{1}{j\omega C}}{R_{ON}+\frac{1}{j\omega C}} = \frac{R_{ON}}{1+j\omega C R_{ON}}$$



$$\frac{U_{iz}}{U} = \frac{\frac{R_{ON}}{1+j\omega C R_{ON}}}{\frac{R_{ON}\cdot j\omega C_{DS}+1+j\omega C R_{ON}}{(1+j\omega C R_{ON})\,j\omega C_{DS}}} = \frac{j\cdot R_{ON}\cdot\omega\cdot C_{DS}}{1+j\omega R_{ON}(C+C_{DS})} \approx 1$$

$$U\cdot R_{ON}\cdot\omega\cdot C_{DS} < \frac{LSB}{2}$$

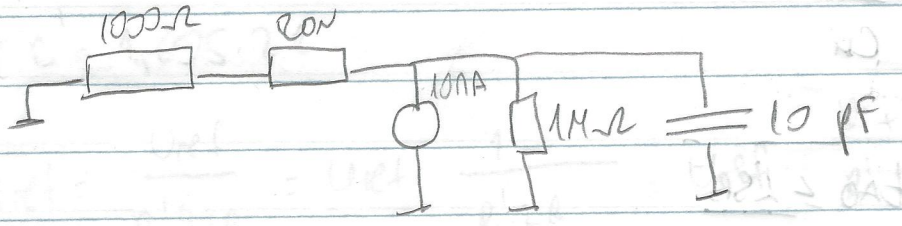
3) $U \cdot R_{ON} \cdot 2 \cdot \pi \cdot f \cdot C_{DS} \leq \frac{U}{2 \cdot 2^N}$

$$C_{DS} \leq \frac{1}{2 \cdot 2^N \cdot R_{ON} \cdot 2 \cdot \pi \cdot f}$$

$$C_{DS} \leq \frac{1}{2 \cdot 2^{16} \cdot 1 \cdot 2 \cdot \pi \cdot 10.10^6}$$

$$C_{DS} \leq 1{,}2143.10^{-13}\ F$$

b)



$R_{uk} = (1000 + R_{ON}) \| 1\,M\Omega = 999{,}999\ \Omega$

$U = 10nA \cdot R_{uk} = 10.10^{-9} \cdot 999{,}999 \approx 10.10^{-6}\ V$

2) $U = 5V,\ N = 12,\ f_{uz} = 350\ kHz,\ t_{AD} = 650ns,\ f_{sig} = 50\ kHz$

a) taper = 35 ns kompenzira se

b) $\frac{du}{dt} \cdot taper \leq \frac{LSB}{2}$

$u(t) = U_{max} \cdot \sin(2\pi f t)$

$\frac{du(t)}{dt} = U_{max} \cdot 2\pi \cdot f \cdot \underbrace{\cos(2\pi f t)}_{1 \text{ za max}}$

$U_{max} \cdot 2\pi \cdot f \cdot taper \leq \frac{U_{FS}}{2 \cdot 2^N}$

$$\frac{U_{FS}}{2} \cdot 2\pi \cdot f \cdot t_{aper} \leq \frac{U_{FS}}{2 \cdot 2^N}$$

$$f \leq \frac{1}{2 \cdot 2^N \cdot \pi \cdot t_{aper}}$$

$$f \leq \frac{1}{2 \cdot 2^{12} \cdot \pi \cdot 0{,}5 \cdot 10^{-6}}$$

$$f \leq 77{,}7 \text{ kHz}$$

c) $$\frac{du}{dt} = \frac{I}{C_H}$$

$$\frac{du}{dt} \cdot t_{AD} \leq \frac{LSB}{2}$$

$$\frac{I}{C_H} \cdot t_{AD} \leq \frac{U_{FS}}{2 \cdot 2^N}$$

$$\frac{I}{C_H} \leq \frac{U_{FS}}{2 \cdot 2^N \cdot t_{AD}}$$

$$\frac{I}{C_H} \leq \frac{5}{2 \cdot 2^{12} \cdot 650 \cdot 10^{-9}}$$

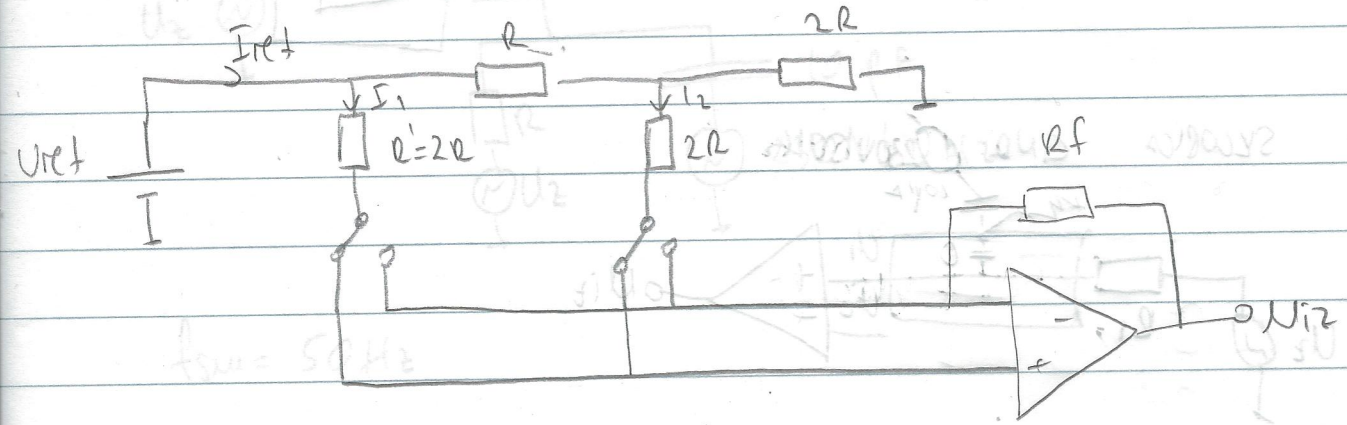
$$\frac{I}{C_H} \leq 939 \text{ V/s}$$

d) $$\frac{1}{f} = t_{AD} + t_{acv} + t_{aper} = 650 \cdot 10^{-9} + 2 \cdot 10^{-6} + 0{,}5 \cdot 10^{-6}$$

$$f = 377{,}3 \text{ kHz}$$

③ $n=2$ bita, $U_{ref} = -4\,V$

kvant. korak $q = \frac{|U_{ref}|}{2^n} = \frac{4}{2^2} = 1\,V$



$R' = 1{,}005 \cdot 2R$

$$I_{ref} = \frac{U_{ref}}{R' \| 2R} = U_{ref} \cdot \frac{1}{\frac{R' \cdot 2R}{R' + 2R}} = U_{ref} \cdot \frac{R' + 2R}{R' \cdot 2R}$$

$$I_{ref} = U_{ref} \frac{1{,}005 \cdot 2R + 2R}{1{,}005 \cdot 2R \cdot 2R} = U_{ref} \cdot \frac{2{,}005}{1{,}005 \cdot 2R} = 0{,}9975 \cdot \frac{U_{ref}}{R}$$

$$U_{iz} = -U_{ref} \cdot 0{,}9975 \left[a_1 \cdot \frac{1}{2} + a_2 \cdot \frac{1}{4} \right]$$

00: $U_{iz} = 0\,V$

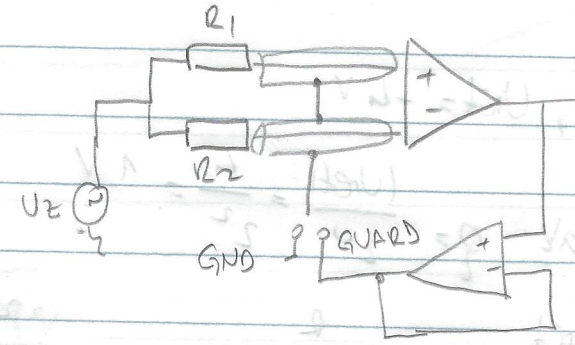
01: $U_{iz} = 4 \cdot 0{,}9975 \cdot \left[0 + \frac{1}{4} \right] = 0{,}9975\,V$

10: $U_{iz} = 4 \cdot 0{,}9975 \cdot \left[\frac{1}{2} + 0 \right] = 1{,}995\,V$

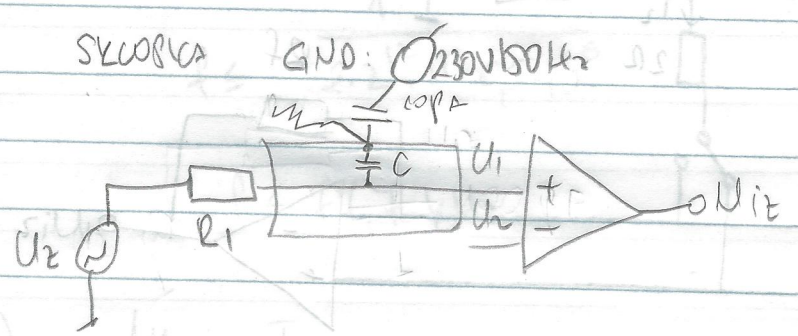
11: $U_{iz} = 4 \cdot 0{,}9975 \left[\frac{1}{2} + \frac{1}{4} \right] = 2{,}9925\,V$

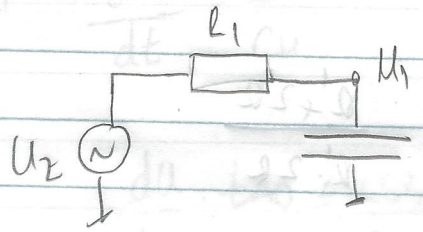
$DNL = 1\,V - 0{,}99 = 0{,}01\,V$

④ $R_1 = 9\,k\Omega$, $R_2 = 10\,k\Omega$



a) SKICA GND: 230V 50Hz





$f_{sw} = f_i = 1\,kHz$

$$\frac{U_1}{U_z} = \frac{\frac{1}{jwC}}{R_1 + \frac{1}{jwC}} = \frac{1}{1 + jwCR_1}$$

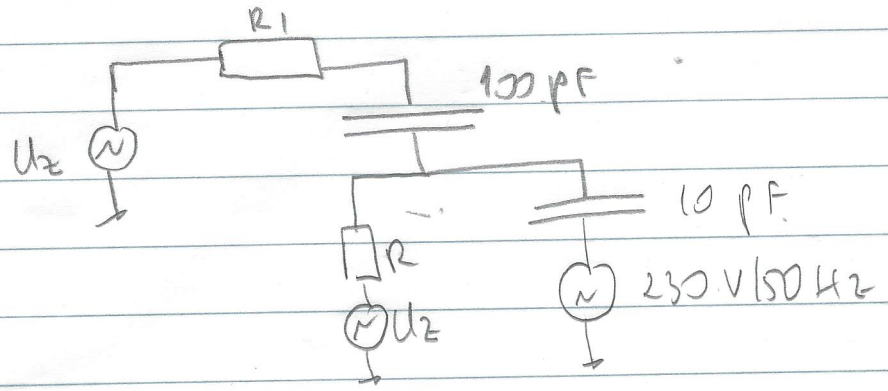
Vrijedi i za U_2:

$$U_{iz} = A_0 U_0 = A_0 (U_1 - U_2) = A_0 U_z \left[\frac{1}{1 + jwCR_1} - \frac{1}{1 + jwCR_2} \right]$$

$$= 100 \cdot 1 \left[\frac{1}{1 + j \cdot 2\pi \cdot 1 \cdot 10^3 \cdot 9 \cdot 10^3 \cdot 10 \cdot 10^{-9}} - \frac{1}{1 + j \cdot 2\pi \cdot 1 \cdot 10^3 \cdot 10 \cdot 10^3 \cdot 10 \cdot 10^{-9}} \right]$$

$U_{iz} = 0,0628\,V$

b) SKUPKA GUARD



$f_{SM} = 50\,Hz$