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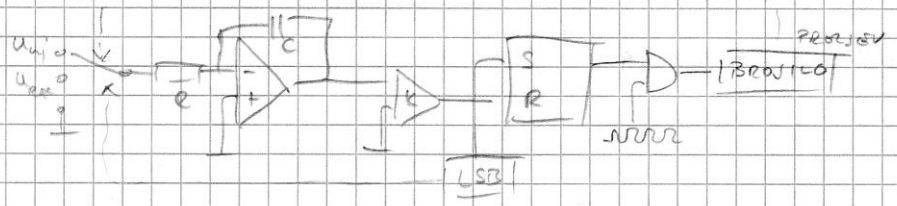
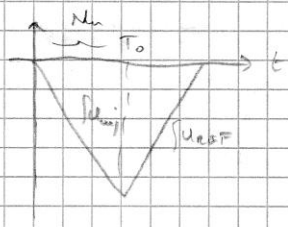
ELEKTRONIČKA INSTRUMENTACIJA

DOMAĆA ZADAĆA 2

1. $f_{osc} = 1\,MHz$ $U_{ref} = 5V$ $N_0 = 10^4$ $U_{ulj} = 3.6V$ $U_{šum} = 180\,mV$

$f_{šum} = 12.5\,Hz$



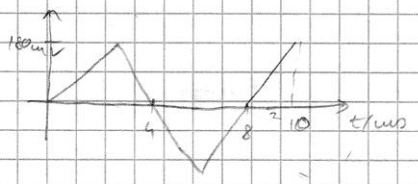


Bez smetnje: $\frac{N_0}{f_{osc}} \cdot U_{ulj} = U_{REF} \cdot \frac{N_m}{f_{osc}}$

$N_m = N_0 \frac{U_{ulj}}{U_{REF}} = 7200$ impula

$T_0 = \frac{N_0}{f_0} = 10\,ms$

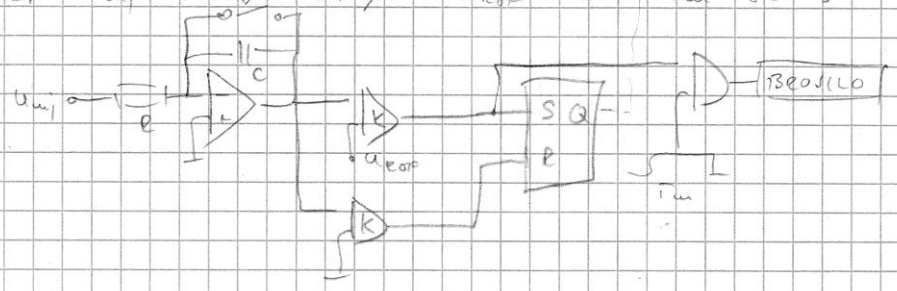
$T_{šum} = 8\,ms$

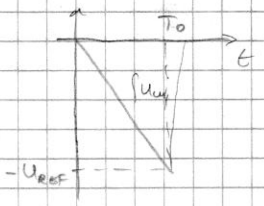


$U_{šum,pp} = \frac{180\,mV \cdot 2\,ms}{T_0 \cdot 2} + 3.6V = 3.618\,V$

smetnja: $N_{šum} = 7236$

2. $U_{ulj} = 4V$ $\Delta T = 240\,\mu s$ $U_{REF} = -2V$ $T_{uz} = 50\,ms$





$$T_0 = \tau \cdot \frac{U_{ref}}{U_{mj}} = 120 \mu s$$

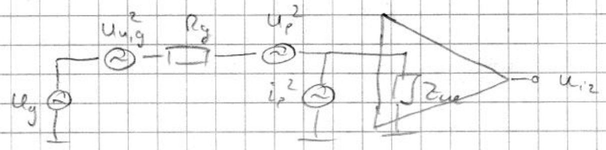
$$N = \frac{T_{int}}{T_0} = 416.67 \approx 416 \text{ impulsa}$$

$$p = \frac{416.67 - 416}{416} = 0.16\,\%$$

$$T_0' = T_0 \cdot \left(1 + \frac{0.16}{100}\right) = 120.1923 \mu s$$

Smetnje frekvencije 20Hz ne utječe na mjerenje jer je period smetnje višekratnik perioda ADP-a, dok smetnja od 30Hz utječe na mjerenje.

3.



$$u_p^2 = 4 \cdot 10^{-16}\ V^2/Hz$$

$$i_p^2 = 10^{-22}\ A^2/Hz$$

$$U_{N,g}^2 = 4kR_gT = 3.3 \cdot 10^{-17}\ V^2/Hz$$

$$R_g = \sqrt{\frac{u_p^2}{i_p^2}} = 2000\,\Omega$$

sustav prvog reda

$$U_{N,uk}^2 = A_0^2 \cdot \left(\frac{Z_{ul}}{Z_{ul}+R_g}\right)^2 \cdot \frac{\pi}{2} f_g \cdot \left(U_{N,g}^2 + u_p^2 + R_g^2 i_p^2\right)$$

$$= 2.65 \cdot 10^{-7}\ V^2$$

$$U_{N,ef} = 514.8\ \mu V_{ef}$$

$$F = \frac{U_{N,g}^2 + u_p^2 + R_g^2 i_p^2}{\frac{\pi}{2} U_{N,g}^2} = 16$$

4. $u_0 = 4 \cdot 10^{-16} V^2/Hz$ $i_0 = 10^{-22} A^2/Hz$ $A_0 = 10$

$$f_g = \frac{1}{2\pi R_2 C_2} = 24868 Hz$$

$$U_{ei,iz}^2 = \frac{\pi}{2} f_g \cdot A_0^2 \cdot 4kR_1T$$

$$U_{R2,iz}^2 = 6.47 \cdot 10^{-10} V^2$$

$$U_{R2,iz}^2 = 6.47 \cdot 10^{-11} V^2$$

$$U_{p,uc}^2 = \frac{\pi}{2} f_g \cdot \left(1+\frac{R_2}{R_1}\right)^2 \left(U_p^2 + (R_1 \| R_2)^2 i_p^2 \right) = 4.09 \cdot 10^{-8} V^2$$

$$U_{N,iz}^2 = \Sigma u^2 = 4.16 \cdot 10^{-8} V^2$$

$$U_{iz,N} = 204.1 \mu V_{ef}$$

$$q = \frac{U_{ADC}}{2^n} = 244 \mu V$$

$$2^n \cdot q > 6 \cdot U_{iz,N}$$

$$n > \log_2 \frac{6 \cdot U_{iz,N}}{q} = 7.33$$

$\Rightarrow$ $n = 3$ bity

$$\omega = \frac{2\pi}{T}$$

5. $U_{sr} = 0.5V$ $U_0 = 3V$

$$U_{sr} = \frac{1}{T}\int_0^T u_{REF}\, u(t)\, dt = \frac{1}{T}\left(-\int_0^{T/2} U_0 \sin(\omega t + \varphi) + \int_{T/2}^{T} U_0 \sin(\omega t + \varphi) \right)$$

$$= \frac{1}{T} \cdot \frac{U_0}{\omega} \left(\cos\left(\frac{T}{2} + \varphi\right) - \cos\varphi - \cos(\varphi + 2\pi) + \cos\left(\frac{T}{2} + \varphi\right) \right)$$

$$= \frac{2U_0}{T} \cos\varphi$$

$$\varphi = 74.82°$$

$$Z = R + \frac{1}{j\omega C} = R - j\frac{1}{\omega C}$$

$$\angle Z = \operatorname{arctg} \frac{1}{\omega RC} = 74.82°$$

$$\frac{1}{\omega C} = 3.6857\, R \quad (1)$$

$$|Z| = \sqrt{R^2 + \frac{1}{\omega^2 C^2}} = \frac{U_0}{I} = 60\,\Omega$$

$$R = 15.71\,\Omega$$

$$C = 2.7484\,\mu F$$