Elektronski fakultet u Nišu
Katedra za Elektroniku
Šifra: OEE5O03, OEU5A05, OEE7O02

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RF Elektronika

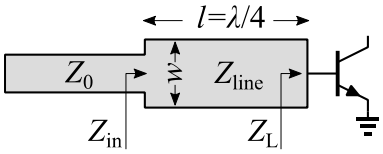
1. Tranzistor koji radi na frekvenciji, f=3GHz, ima ulaznu impedansu, Z_L=50Ω. Za prilagođenje sa vodom karakteristične impedanse, Z_0=75Ω, upotrebljena je λ/4 transformator (Slika 1). Odrediti:

a) karakterističnu impedansu, Z_{line},

b) širinu, w, i

c) dužinu, l, λ/4 transformatora.

Debljina dielektrika je d=2mm, a njegova realtivna dielektrična konstanta i magnetna permabilnost su ε_r=4.2 i μ_r=1. Poznato je, c=3·10^8 m/s, ε_0=8.84·10^{-12} F/m, μ_0=4π·10^{-7} H/m.



Slika1

a) **40%**

$$\beta = \frac{2\pi}{\lambda}, l = \frac{\lambda}{4} \Rightarrow \beta l = \frac{\pi}{2}$$

$$Z_{in} = Z_0 = Z_{line}\frac{Z_L + jZ_{line}\tan(\beta l)}{Z_{line} + jZ_L\tan(\beta l)} = \frac{Z_{line}^2}{Z_L} \Rightarrow Z_{lin} = \sqrt{Z_0 Z_L} = 61.24\Omega$$

b) **40%**

$$Z_f = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 376.82\Omega$$

$$Z_{line} \approx \sqrt{\frac{L'}{C'}} = \sqrt{\frac{\mu_r\mu_0\frac{d}{w}}{\varepsilon_r\varepsilon_0\frac{w}{d}}} = Z_f\sqrt{\frac{\mu_r}{\varepsilon_r}}\cdot\frac{d}{w} \Rightarrow w = d\cdot\frac{Z_f}{Z_{lin}}\cdot\sqrt{\frac{\mu_r}{\varepsilon_r}} = 6.005mm$$

c) **20%**

$$v_p = \frac{c}{\sqrt{\varepsilon_r\mu_r}}, \lambda = \frac{v_p}{f} = 48.795mm \Rightarrow l = \frac{\lambda}{4} = \frac{1}{4}\cdot\frac{v_p}{f} = 12.20mm$$

Predmetni nastavnik

2. Na slici 2 prikazan je pojačavač klase C sa MOS-FET tranzistorom. Zavisnost struje drejan od napona gejt-sors je data izrazom, $I_d=I_{dss}(U_{gs}-V_T)^2$, gde je $I_{dss}=0.5A/V^2$ i $V_T=1V$. Odrediti:

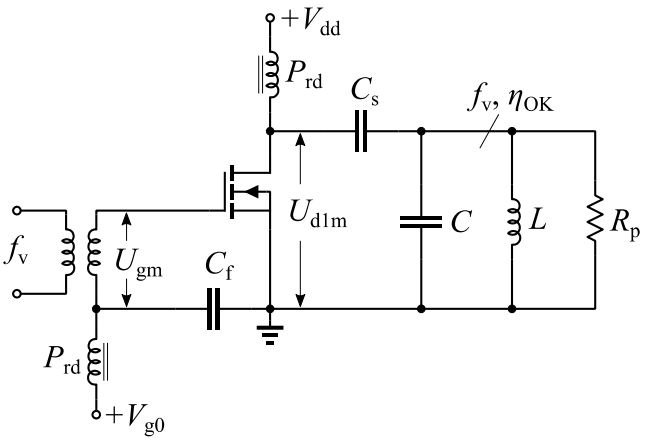
a) amplitudu prvog harmonika struje drejna,

b) korisnu snagu P_{Rp} na potrošaču R_p i

c) frekvenciju izlaznog signala, f_v, ako je širina propusnog ospega B=5MHz.

Poznato je: V_{g0}=0.5V, U_{gm}=1.5V, R_p=50Ω, η_{OK}=80%, L=200nH i

$\alpha_1(50°)=0.3388$, $\alpha_1(60°)=0.391$, $\alpha_1(70°)=0.4356$



Slika 2

a) **40%**

$$e_g = u_g + V_{go} \Rightarrow U_{gmax} = e_{gmax} = U_{gm} + V_{g0} = 4V$$

$$J_{dm} = I_{dm} = I_{dss}\left(U_{gmax} - V_T\right)^2 = 500.00mA$$

$$e_g(\theta_d) = U_{gm}\cos(\theta_d) + V_{g0} = V_T \Rightarrow \theta_d = \operatorname{acos}\left(\frac{V_T - V_{g0}}{U_{gm}}\right) = 70.529° \approx 70°$$

$$J_{d1m} = \alpha_1(\theta_d)J_{dm} = 217.8mA$$

b) **40%**

$$R_d = R_{d0}||R_p$$

$$\eta_{OK} = \frac{P_{R_p}}{P_{uk}} = \frac{\frac{1}{2}\frac{U_{d1m}^2}{R_p}}{\frac{1}{2}\frac{U_{d1m}^2}{R_d}} = \frac{R_{d0}}{R_{d0}+R_p} \Rightarrow R_{d0} = R_p\frac{\eta_{OK}}{1-\eta_{OK}} = 200\Omega$$

$$R_d = R_{d0}||R_p = 40\Omega, U_{d1m} = J_{d1m}R_d = 8.712V \Rightarrow P_{R_p} = \frac{1}{2}\frac{U_{d1m}^2}{R_p} = 758.989mW$$

b) **20%**

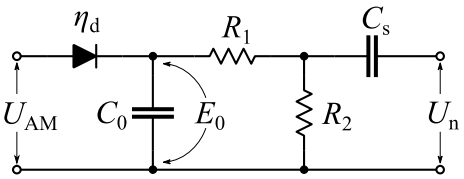
$$Q = \frac{R_d}{2\pi f_v L}, B = \frac{f_v}{Q} \Rightarrow f_v = \sqrt{\frac{R_d B}{2\pi L}} = 12.616MHz$$

3. Za AM detektor sa slike 3. Odrediti:

a) ulaznu otpornost, R_{ul},

b) detektovani jednosmerni napon, E_0 i

c) amplitudu detektovanog NF napon, U_n, ako je stepen amplitudske modulacije m = 45%.



Slika 3

Poznato je:

U_{AM} = 2V, η_d = 0.85, R_1 = 1kΩ i R_2 = 3kΩ.

a) $R_{ul} \approx \frac{R_1+R_2}{2} = 2k\Omega$ 20%

b) $\eta_d = \frac{E_o}{U_{AM}} \Rightarrow E_o = \eta_d U_{AM} = 1.7V$ 20%

c)

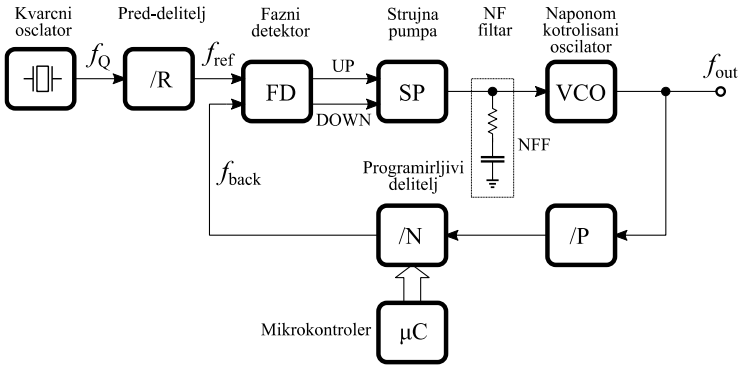
$U_{C_o,max} = U_{AM}(1+m) = 1.1V, U_{C_o,min} = U_{AM}(1-m) = 2.9V$ 20%

$U_{C_o,pp} = U_{C_0,max} - U_{C_0 min} = 1.8V$ 20%

$U_{C_0} = \frac{U_{C_o,pp}}{2} = 0.9V, U_n' = \eta_d U_{C_o} = 0.765V, U_n = \frac{R_2}{R_1+R_2} U_n' = 573.75mV$ 20%

4. PLL sintetizator sa slike 4 sastoji se od:

- kvarcnog oscilatora, f_Q = 1MHz,
- pred-delitelja, R = 800,
- preskalera, P = 400, i
- programirljivog delitelja (N_{min} – N_{max}) = (1400 – 2600).



Slika 4

Odrediti:

a) korak (rezoluciju) u sintezi frekvencije, Δf, i

b) opseg frekvencija (f_{0min} – f_{0max}) u kome PLL sintetiše frekvencije.

a)

$\Delta f_0 = f_q \frac{P}{R} = 500kHz$ 50%

b)

$f_{0,min} = N_{min}\Delta f_0 = 700MHz$ 25%

$f_{0,max} = N_{max}\Delta f_0 = 1300MHz$ 25%