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

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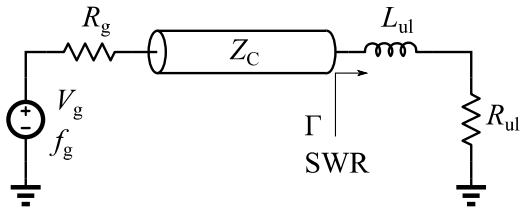
RF Elektronika

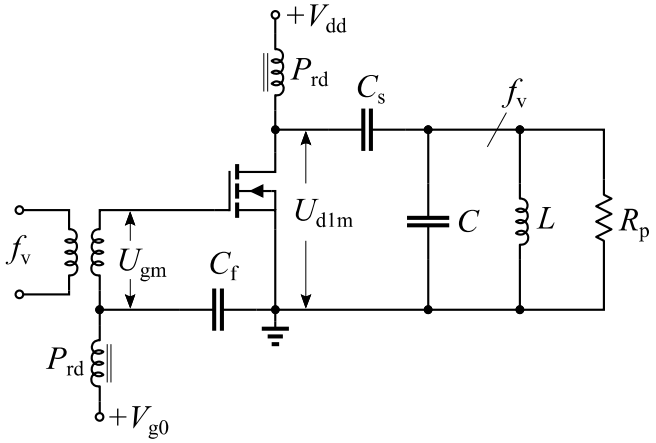
1. Na slici 1 generator unutrašnje otpornosti $R_g = 50\Omega$, preko koaksijalnog kabla karakteristične impedanse $Z_C = 50\Omega$, napaja uređaj signalom frekvencije $f_g = 5GHz$. Ulaznu impedansu uređaja čine redna veza ulazne otpornost, $R_{ul} = 25\Omega$, i induktivnosti, $L_{ul} = 5nH$. Na ulazu uređaja naći:
a) koeficijent refleksije Γ i
b) koeficijent stojećeg talasa, SWR.



Slika1

a)
$$X_{ul} = \omega_g L_{ul} = 2\pi f_g L_{ul} = 157.08\,\Omega,\ Z_{ul} = R_{ul} + jX_{ul} = 25 + j\,157.08\,\Omega\ 25\%$$
$$\Gamma = \frac{Z_{ul} - Z_C}{Z_{ul} + Z_C} = 0.752 + j\,0.518 = 0.914\,e^{j34.57^\circ},\ |\Gamma| = 0.914\ 25\%$$
b)
$$SWR = \frac{1+|\Gamma|}{1-|\Gamma|} = 22.194\ 50\%$$

2. Na slici 2 je prikazan pojačavač klase C sa MOSFET tranzistorom. Zavisnost struje drejna od napona gejt-sors data je izrazom, $I_d = I_{dss}(U_{gs} - V_T)^2$, gde je $I_{dss} = 0.5A/V^2$, a napon praga $V_T = 0.5V$. Odrediti:
a) napon polarizacije gejta V_{g0}, tako da pri visokofrekventnom pobudnom signalu napona amplitude $U_{gm} = 1V$ ugao protoka struje drejna bude $\theta_d = 50°$ i
b) korisnu sangu P_k na potrošaču $R_p = 75\Omega$.
Poznato je: $\alpha_1(50°) = 0.3388$.



Slika 2

a)
$$e_g(\theta) = V_{g0} + U_{gm}\cos(\theta) \Rightarrow e_g(\theta_d) = V_T,\ V_{g0} = V_T - U_{gm}\cos(\theta_d) = 0.353\,V\ 50\%$$
b)
$$@\,\omega = \omega_v,\ R_{d0} \to \infty\,\Omega \Rightarrow R_d = R_{d0} \parallel R_p = R_p = 75\,\Omega$$
$$J_d = I_{dss}(V_{gs} - V_T)^2 = I_{dss}(e_g(\theta) - V_T)^2 \Rightarrow J_{d,max} = I_{dss}(e_g(0°) - V_T)^2$$
$$J_{d,max} = I_{dss}(V_{g0} + U_{gm} - V_T)^2 = 363.674\,mA\ 20\%$$
$$J_{d1,max} = \alpha_1(\theta_d) J_{d,max} = 133.032\,mA\ 20\%$$
$$P_k = \frac{1}{2} J_{d1,max}^2 R_d = 663.657\,mW\ 10\%$$

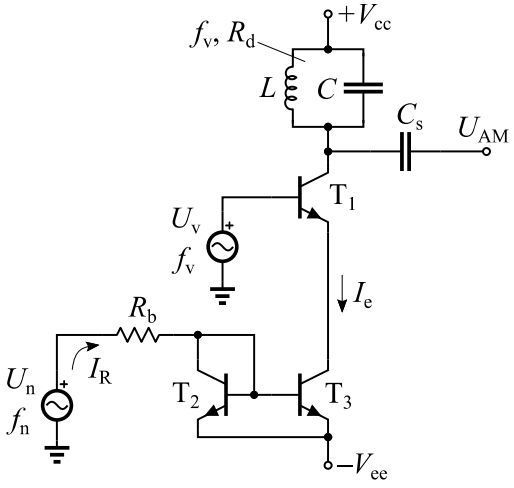
Predmetni nastavnik

3. Na slici 3 je prikazan AM modulator.
Odrediti:

a) amplitudu izlaznog napona U_{AM} u odsustvu modulacionog signala ($u_n = 0$V) ako je amplituda nosioca $U_v = 15$mV a dinamička otpornost oscilatornog kola $R_d = 10$kΩ.

b) stepn amplitudske modulacije m ako je amplituda modulacionog napona $U_n = 0.5$V.

Poznato je: $R_b = 10$kΩ, $U_{be} = 0.7$V,
$V_{cc} = V_{ee} = 5$V i $V_T = 26$mV.



Slika 3

$$I_R = \frac{(u_n - V_{be} + V_{ee})}{R_b} = \frac{(V_{ee} - V_{be})}{R_b}\left(1 + \frac{U_n}{V_{ee} - V_{be}}\cos(\omega_n t)\right)$$

$$I_R = I_{R0}\left(1 + m \cdot \cos(\omega_n t)\right), I_{R0} = \frac{(V_{ee} - V_{be})}{R_b}, m = \frac{U_n}{V_{ee} - V_{be}}$$

$$\beta \gg 1 \Rightarrow I_R \approx I_{c3} = I_{e1} \approx I_{c1} \Rightarrow g_{m1} = \frac{I_{c1}}{V_T} \approx \frac{I_R}{V_T}$$

$$u_{AM}(m) = g_{m1} u_v R_d \approx I_R R_d \frac{U_v}{V_T}\cos(\omega_v t) = I_{R0} R_d \frac{U_v}{V_T}\left(1 + m \cdot \cos(\omega_n t)\right)\cos(\omega_v t)$$

$$U_{AM} = u_{AM}(0) = I_{R0} R_d \frac{U_v}{V_T}$$

a)

$$I_{R0} = \frac{(V_{ee} - V_{be})}{R_b} = 430\,\mu A\ 25\,\%$$

$$U_{AM} = I_{R0} R_d \frac{U_v}{V_T} = 2.481\,V\ 25\,\%$$

b)

$$m = \frac{U_n}{V_{ee} - V_{be}} = 0.116\,(11.6\,\%)\ 50\,\%$$

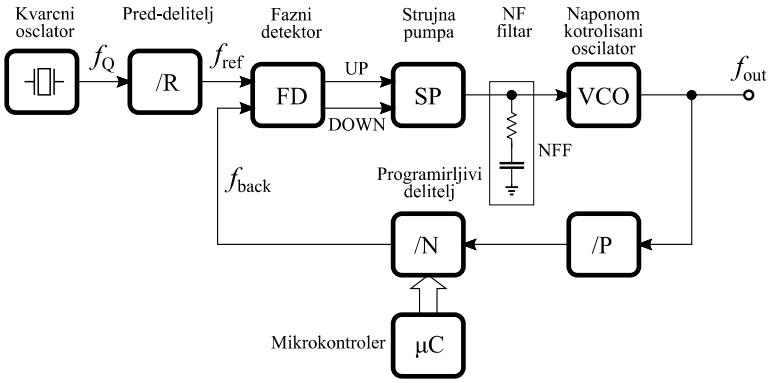
4. PLL sintetizator sa slike 4 sastoji se od:

- kvarcnog oscilatora, f_Q = 4MHz,
- pred-delitelja, R = 200,
- preskalera, P = 80, i
- programirljivog delitelja ($N_{min} – N_{max}$) = (500 – 1500).

Odrediti:

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

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



Slika 4

a)

$$\Delta f_0 = f_q \frac{P}{R} = 1.6\,MHz\,50\,\%$$

b)

$$f_{0,min} = N_{min}\,\Delta f_0 = 800\,MHz\,25\,\%$$

$$f_{0,max} = N_{max}\,\Delta f_0 = 2.4\,GHz\,25\,\%$$