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1. $Z_S=(50-j100)\Omega$, $P_S=1W$, $l=\frac{3}{8}\lambda$, $Z_0=50\Omega$

(1) 若欲單向传输，则有 $Z_L=Z_0=50\Omega$

此时有：$\frac{P_{S.max}-P_L}{P_{S.max}}=\left\|\frac{Z_L-Z_S^*}{Z_L+Z_S}\right\|^2$

$\Rightarrow P_L=P_{S.max}\left(1-\left\|\frac{Z_L-Z_S^*}{Z_L+Z_S}\right\|^2\right)=0.5W$

(2) 若欲最大功率传输匹配，则应有：

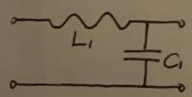
$Z_{in}=Z_S^*=Z_0\cdot\frac{Z_L+jZ_0\tan\frac{3}{4}\pi}{Z_0+jZ_L\tan\frac{3}{4}\pi}=Z_0\frac{Z_L-jZ_0}{Z_0-jZ_L}$

由此解得：$Z_L=(50-j100)\Omega$

此时负载获得功率：$P_L=P_{S.max}=1W$

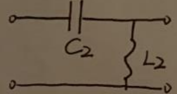
2. 設計 $R_S=50\Omega$, $R_L=1k\Omega$ 时的 L 型低、高通匹配网络

① 低通网络



$$\begin{cases} L_1=\frac{R_S}{\omega_m}\sqrt{\frac{R_L}{R_S}-1}=0.35\mu H \\ C_1=\frac{1}{\omega_m R_L}\sqrt{\frac{R_L}{R_S}-1}=6.94pF \end{cases}$$

② 高通网络

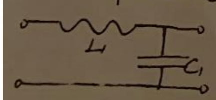


$$\begin{cases} C_2=\frac{1}{\omega_m R_S}/\sqrt{\frac{R_L}{R_S}-1}=7.30pF \\ L_2=\frac{R_L}{\omega_m}/\sqrt{\frac{R_L}{R_S}-1}=0.37\mu H \end{cases}$$

好像差得不多

3. 宽带匹配网络实现：$R_S=10\Omega$, $R_L=1k\Omega$

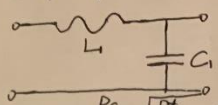
(1) 一节L型低通



$$\begin{cases} L_1=1.584\mu H \\ C_1=158.4pF \end{cases}$$

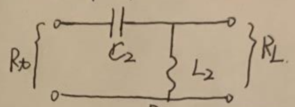
(2) 低通 $\Longleftrightarrow$ 高通级联，$f_m=10MHz$

① 第一节低通，$10\Omega\Rightarrow100\Omega$



$$\begin{cases} L_1=\frac{R_S}{\omega_m}\sqrt{\frac{R_L}{R_S}-1}=4.77\times10^{-7}H=0.48\mu H \\ C_1=\frac{1}{\omega_m R_L}\sqrt{\frac{R_L}{R_S}-1}=4.77\times10^{-10}F=477.5pF \end{cases}$$

② 第二节高通：$100\Omega\Rightarrow1k\Omega$



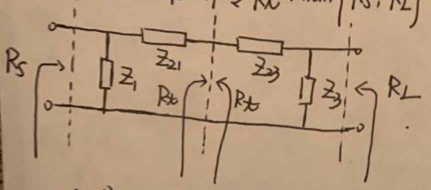
$$\begin{cases} L_2=\frac{R_L}{\omega_m}/\sqrt{\frac{R_L}{R_{中}}-1}=5.31\mu H \\ C_2=\frac{1}{\omega_m R_{中}}/\sqrt{\frac{R_L}{R_{中}}-1}=53.1pF \end{cases}$$

4. π型低通LC：

$R_S=10\Omega$, $R_L=1k\Omega$, $\omega_m=2\pi\times 10M$ rad/s

$BW_{3dB}=100kHz$

拆分π型网络，并令 $R_t<\min\{R_S,R_L\}$

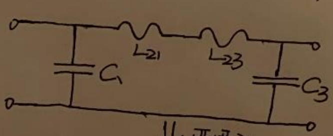


易得：

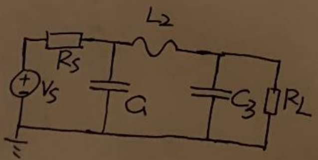
$$\begin{cases} Z_{21}=\sqrt{R_SR_t\left(\frac{R_t}{R_S}-1\right)}=j\sqrt{R_SR_t\left(1-\frac{R_t}{R_S}\right)}=j\omega_mL_{21} \\ Z_1=\sqrt{R_SR_t/\left(\frac{R_t}{R_S}-1\right)}=\frac{1}{j}\sqrt{R_SR_t/\left(1-\frac{R_t}{R_S}\right)}=\frac{1}{j\omega_mC_1} \end{cases}$$

$$\begin{cases} Z_{23}=\sqrt{R_tR_L\left(\frac{R_t}{R_L}-1\right)}=j\sqrt{R_tR_L\left(1-\frac{R_t}{R_L}\right)}=j\omega_mL_{23} \\ Z_3=\sqrt{R_tR_L/\left(\frac{R_t}{R_L}-1\right)}=\frac{1}{j}\sqrt{R_tR_L/\left(1-\frac{R_t}{R_L}\right)}=\frac{1}{j\omega_mC_3} \end{cases}$$

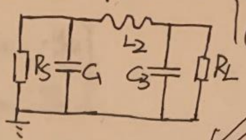
于是有
$$\begin{cases} L_{21}=\frac{1}{\omega_m}\sqrt{R_SR_t\left(1-\frac{R_t}{R_S}\right)} \\ C_1=\frac{1}{\omega_m}\sqrt{\left(1-\frac{R_t}{R_S}\right)/R_SR_t} \\ L_{23}=\frac{1}{\omega_m}\sqrt{R_tR_L\left(1-\frac{R_t}{R_L}\right)} \\ C_3=\frac{1}{\omega_m}\sqrt{\left(1-\frac{R_t}{R_L}\right)/R_tR_L} \end{cases}$$



$\Downarrow$ 匹配



下面考查串并联转换：$\begin{cases} Q_1=\omega_mC_1R_S \\ Q_2=\omega_mC_3R_L \end{cases}$

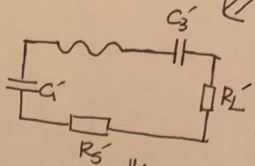


$R_S'=\frac{R_S}{1+Q_1^2}$

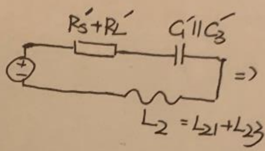
$C_1'=(1+Q_1^{-2})C_1$

$R_L'=\frac{R_L}{1+Q_2^2}$

$C_3'=(1+Q_2^{-2})C_3$



$\Downarrow$



$\Rightarrow$
$$\begin{cases} Q=\dfrac{\sqrt{\dfrac{L_{21}+L_{23}}{C_1'\|C_3'}}}{R_S'+R_L'} \\ \text{仿真} \\ BW=? \end{cases}$$

5、已知Y参量的双端共轭匹配：

由 $y = \begin{bmatrix} y_{11}, & y_{12} \\ y_{21}, & y_{22} \end{bmatrix}$，立刻有 $z = \dfrac{1}{y_{11}y_{22}-y_{12}y_{21}} \begin{bmatrix} y_{22}, & -y_{12} \\ -y_{21}, & y_{11} \end{bmatrix}$

$$Z_{01} = \sqrt{Z_{in_1,o} \cdot Z_{in_1,s}} = \sqrt{\frac{y_{22}}{y_{11}} \cdot \frac{1}{y_{11}y_{22} - y_{21}y_{12}}}$$

$$Z_{02} = \sqrt{Z_{in_1,o} \cdot Z_{in_1,s}} = \sqrt{\frac{y_{11}}{y_{22}} \cdot \frac{1}{y_{11}y_{22} - y_{21}y_{12}}}$$

由 y、z 参量可得 ABCD 参量：

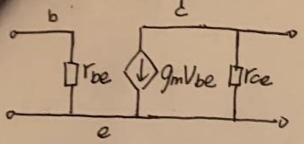
$$ABCD = \begin{bmatrix} -\dfrac{y_{22}}{y_{21}}, & -\dfrac{1}{y_{21}} \\ -\dfrac{y_{11}y_{22}-y_{12}y_{21}}{y_{21}}, & -\dfrac{y_{11}}{y_{21}} \end{bmatrix}$$

$$k = \frac{Re(A^*D + B^*C)}{\| AD - BC \|} = \frac{Re\left(\dfrac{y_{22}}{y_{21}} \cdot \left(\dfrac{y_{11}}{y_{21}}\right)^* + \left(\dfrac{1}{y_{21}}\right)^* \dfrac{y_{11}y_{22}-y_{12}y_{21}}{y_{21}}\right)}{\left\| \dfrac{y_{11}y_{22}}{y_{21}^2} - \dfrac{y_{11}y_{22}-y_{12}y_{21}}{y_{21}^2} \right\|}$$

$$= \frac{Re\left(\dfrac{1}{y_{21}^2}\left(y_{11}^*y_{22} + y_{11}y_{22} - y_{12}y_{21}\right)\right)}{\left\| \dfrac{y_{12}}{y_{21}} \right\|}$$

$$MAG = \frac{1}{\left\| \dfrac{y_{12}}{y_{21}} \right\|} \left(\frac{Re\left(\dfrac{1}{y_{21}^2}(y_{11}^*y_{22} + y_{11}y_{22} - y_{12}y_{21})\right)}{\left\| \dfrac{y_{12}}{y_{21}} \right\|} - \sqrt{\frac{Re^2\left[\dfrac{1}{y_{21}^2}(y_{11}^*y_{22} + y_{11}y_{22} - y_{12}y_{21})\right]}{\left\| \dfrac{y_{12}}{y_{21}} \right\|^2} - 1} \right)$$

∴ BJT晶体管小信号：



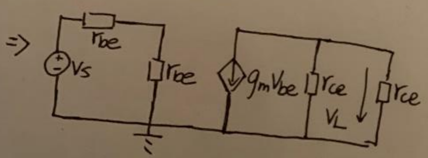
首先立刻得其y参量：

$$y=\begin{bmatrix}\frac{1}{r_{be}} & 0\\ g_m & \frac{1}{r_{ce}}\end{bmatrix}$$

由T5结论立刻得到双端特征阻抗：

$$\begin{cases}Z_{01}=\sqrt{\dfrac{r_{be}}{r_{ce}}\cdot\dfrac{1}{\frac{1}{r_{be}r_{ce}}-g_m\cdot 0}}=r_{be}\\[2ex] Z_{02}=\sqrt{\dfrac{r_{ce}}{r_{be}}\cdot\dfrac{1}{\frac{1}{r_{be}r_{ce}}-g_m\cdot 0}}=r_{ce}.\end{cases}$$

$\Rightarrow$



故有：$V_L=\frac{1}{2}g_m V_s\cdot\frac{1}{2}r_{ce}=\frac{1}{4}g_m r_{ce}V_s$

$$P_L=\frac{V_L^2}{r_{ce}}=\frac{1}{16}g_m^2 r_{ce}V_s^2$$

$$G_p=\frac{P_L}{\frac{1}{4}\frac{V_s^2}{r_{be}}}=\boxed{\frac{1}{4}g_m^2 r_{ce}r_{be}}.$$