
廣東工業大學
Guangdong University of Technology
广东工业大学
通信电路与系统
信息工程学院
李志忠


廣東工業大學
Guangdong University of Technology
广东工业大学
第五章 正弦波振荡器
信息工程学院
李志忠

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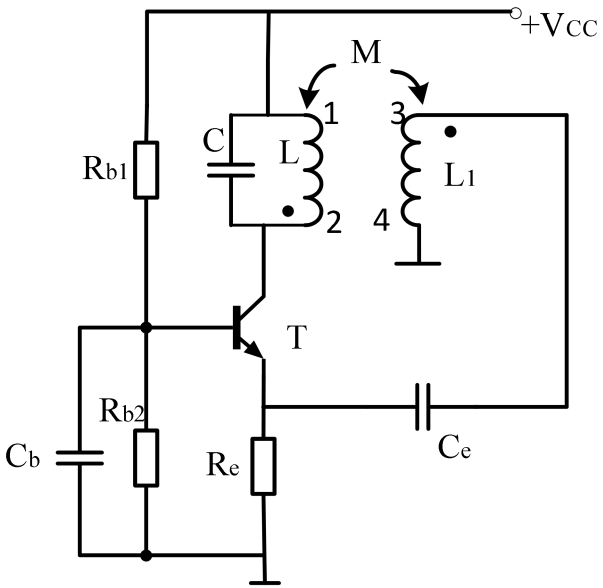
5.2 反馈型LC振荡电路

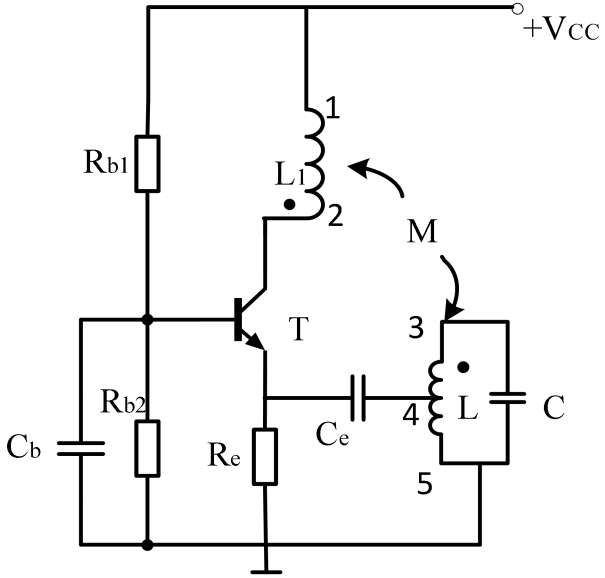
一、互感耦合振荡电路

1. 反馈振荡器的组成



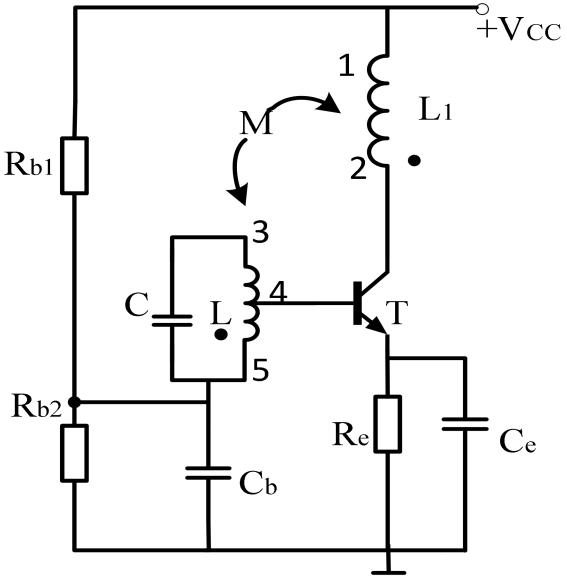
（a）集电极调谐

调集



（b）发射极极调谐

调射



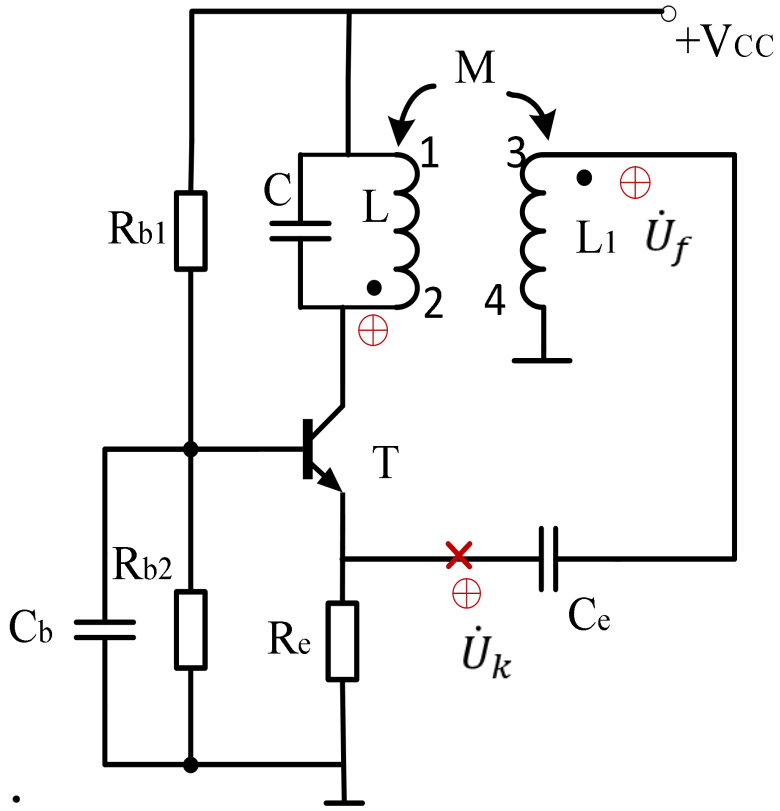
（c）基极调谐

调基

互感耦合式振荡器是利用电感之间的耦合来实现正反馈的。
同名端的位置决定了能否实现正反馈。

5.2 反馈型LC振荡电路

2. 调集振荡器



① 分析电路形式

一找组成，二查静态、动态

② 判断振荡条件

相位条件：采用瞬时极性法。

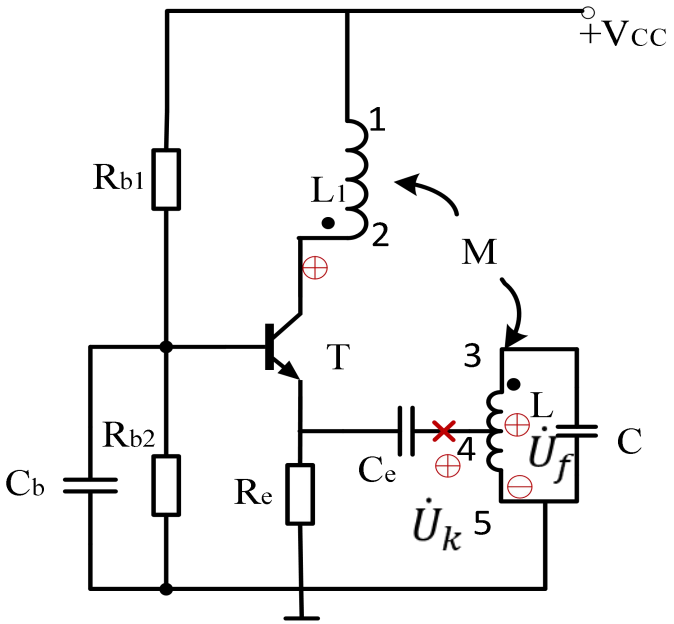
$\dot{U}_k \oplus \rightarrow \dot{U}_c \oplus \rightarrow$ 由同名端可知3端为 $\oplus \rightarrow \dot{U}_f \oplus$

③ 估算振荡频率

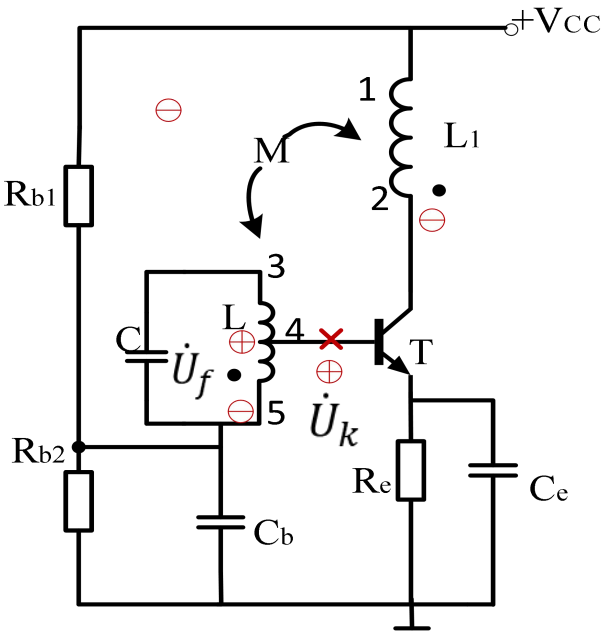
由选频回路决定。 $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

5.2 反馈型LC振荡电路

3.调射振荡器



发射极调谐



基极调谐

$\dot{U}_f$取自L_{45},加在发射极，共基组态

$\dot{U}_k \oplus \rightarrow \dot{U}_c \oplus \rightarrow$ 4端 $\oplus \rightarrow \dot{U}_f \oplus$

$\dot{U}_f$取自L_{45},加在基极，共射组态

$\dot{U}_k \oplus \rightarrow \dot{U}_c \oplus \rightarrow$ 4端 $\oplus \rightarrow \dot{U}_f \oplus$

注意：反馈元件的一个端交流接地

5.2 反馈型LC振荡电路

二、三端式振荡器的相位平衡条件

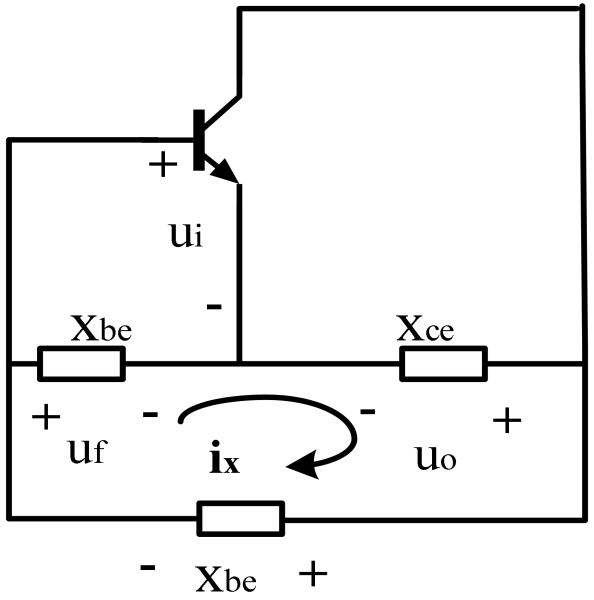
$$\varphi_{\Sigma}=2n\pi \qquad n=0,1,2\ldots$$

$$F=\frac{U_f}{U_0}=\frac{i_x X_{be}}{-i_x X_{be}}=-\frac{X_{be}}{X_{ce}}$$

正反馈 $\dot{U}_i \xrightarrow{\ominus} \dot{U}_0 \xrightarrow{\ominus} \dot{U}_f$

$$\therefore \frac{X_{be}}{X_{ce}}\geq 0$$

X_{be}、X_{ce}为同性电抗元件



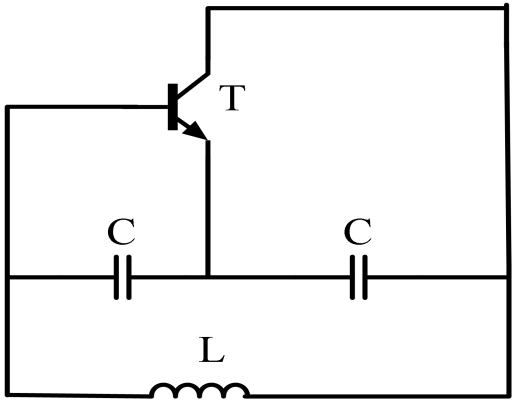
X_{be}、X_{ce}、X_{bc} 均为电抗元件

射同基反

$$\omega=\omega_0 \qquad \Sigma X=X_{be}+X_{ce}+X_{bc}=0$$

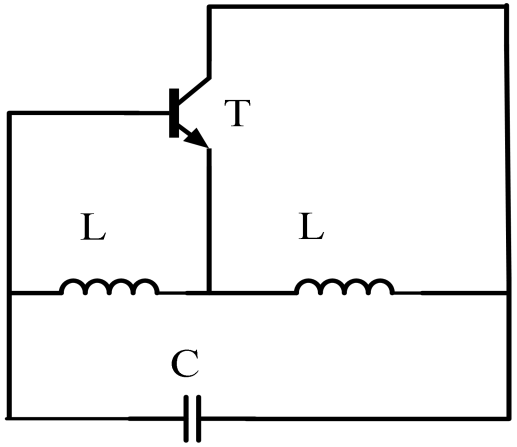
$$X_{bc}=-(X_{be}+X_{ce})$$ X_{be}与X_{ce}、X_{bc} 异性

5.2 反馈型LC振荡电路



$X_{bc}:L;X_{be}、X_{ce}:C$

电容反馈三点式



$X_{bc}:C;X_{be}、X_{ce}:L$

电感反馈三点式

源同栅反 同相端相同，反向端相反

5.2 反馈型LC振荡电路

例

B反：L, L_1并C_1为C

$$\omega > \omega_{01} = \frac{1}{\sqrt{L_1 C_1}}$$

E同：L_1并C_1为C

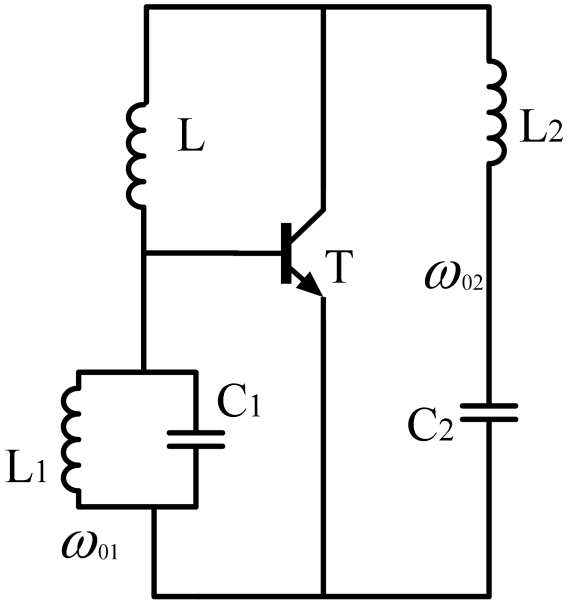
L_2并C_2为C

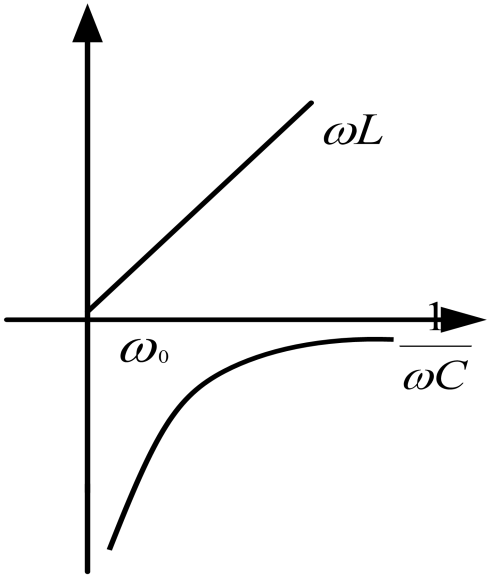
$$\omega < \omega_{02} = \frac{1}{\sqrt{L_2 C_2}}$$

$$\therefore \omega_{01} < \omega < \omega_{02}$$

$$\frac{1}{\sqrt{L_1 C_1}} < \omega < \frac{1}{\sqrt{L_2 C_2}}$$

$$L_1 C_1 > L_2 C_2$$



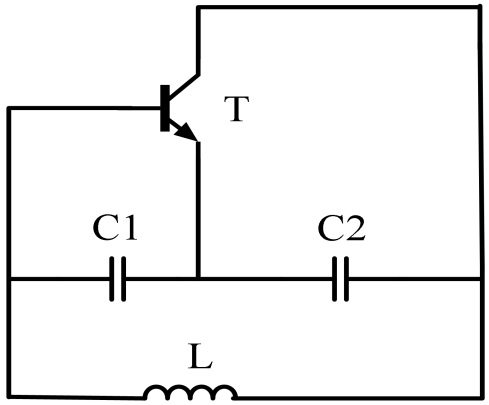


5.2 反馈型LC振荡电路

三、三端式振荡器主要参数的计算

1. 谐振频率计算

$\omega = \omega_0$ 谐振



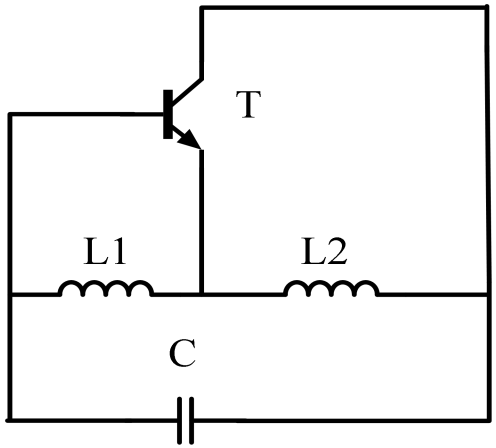
$$\frac{1}{j\omega_0 C_1} + \frac{1}{j\omega_0 C_2} + j\omega_0 L = 0$$

$$j\left(-\frac{1}{\omega_0 C_1} - \frac{1}{\omega_0 C_2} + \omega_0 L\right) = 0$$

$$\omega_0 L = \frac{1}{\omega_0 C_1} + \frac{1}{\omega_0 C_2} \qquad \omega_0^{\,2} = \frac{1}{L}\left(\frac{1}{C_1} + \frac{1}{C_2}\right) = \frac{1}{LC} \qquad \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\omega_g = \omega_0 = \frac{1}{\sqrt{LC_\Sigma}} \qquad C_\Sigma = C_1 // C_2$$

$$\omega_g = \omega_0 = \frac{1}{\sqrt{LC_\Sigma}} = \frac{1}{\sqrt{C\left(L_1 + L_2\right)}}$$

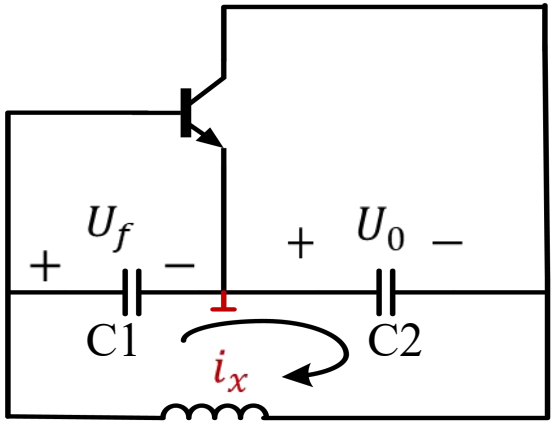


5.2 反馈型LC振荡电路

2. 反馈系数的计算

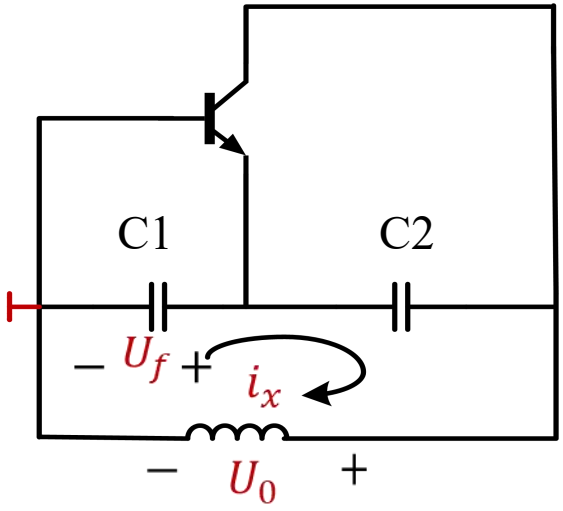
（1）电容三端式

CE: $$F=\frac{U_f}{U_0}=\frac{C_2}{C_1}$$



CB: $$F=\frac{U_f}{U_0}=\frac{i_x\dfrac{1}{j\omega_0 C_1}}{i_x j\omega_0 L}=\frac{C}{C_1}$$

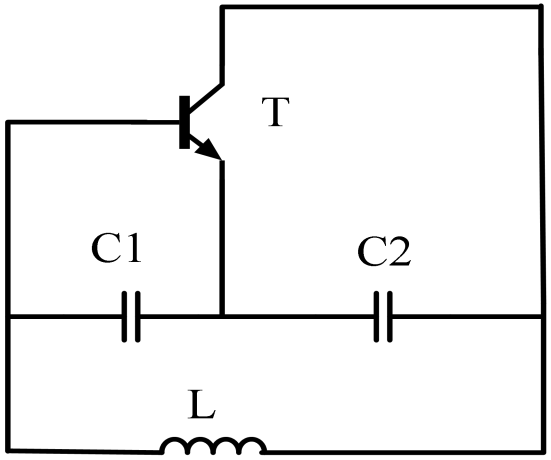
$$=\frac{C_1C_2}{C_1\left(C_1+C_2\right)}=\frac{C_2}{C_1+C_2}$$



5.2 反馈型LC振荡电路

$$\omega_g = \omega_0 = \frac{1}{\sqrt{L(C_1 // C_2)}}$$

CE: $F = \frac{C_2}{C_1}$　　CB: $F = \frac{C_2}{C_1 + C_2}$



高频时考虑　$C_{b'c} \downarrow C_{b'e}\ C_{ce}$

$$C_1' = C_1 + C_{b'e} \qquad C_2' = C_2 + C_{ce}$$

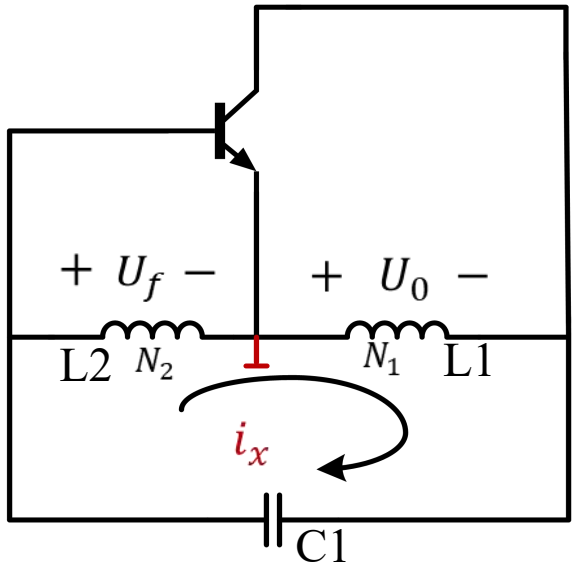
优点：适合高频，可工作于Microwave
频率稳定度高；波形较好

缺点：起振较难

5.2 反馈型LC振荡电路

(2) 电感三点式

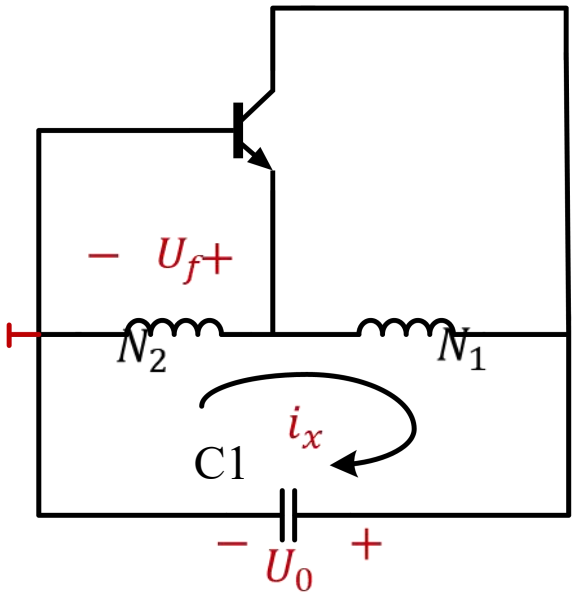
$$\omega_g = \omega_0 = \frac{1}{\sqrt{C(L_1 + L_2)}}$$



CE: $$F_{ce} = \frac{U_f}{U_0} = \frac{L_2}{L_1} = \frac{N_2}{N_1}$$

考虑互感 $$F_{ce} = \frac{L_2 + M}{L_1 + M}$$

CB: $$F_{cb} = \frac{U_f}{U_0} = \frac{L_2}{L_1 + L_2} = \frac{N_2}{N_1 + N_2}$$



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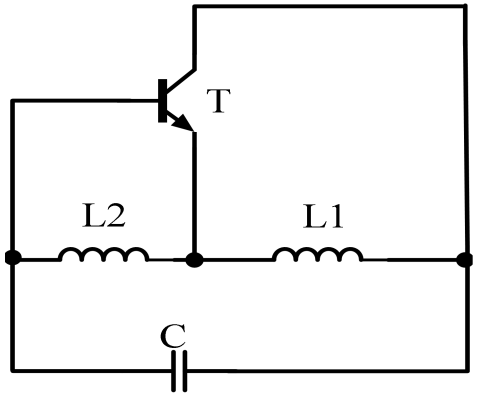
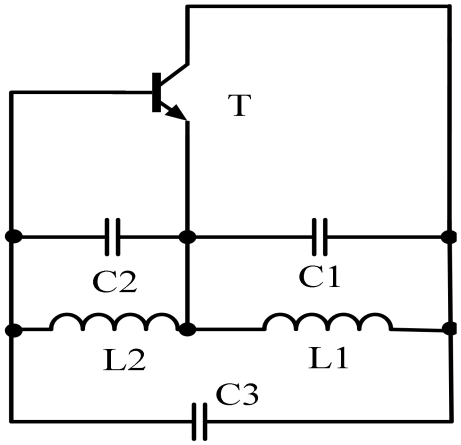
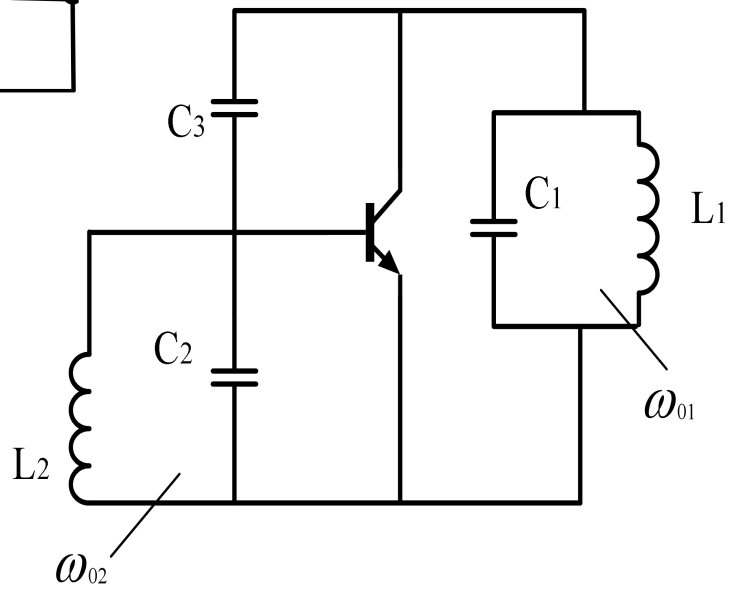




高频时考虑 $C_{b'c} \downarrow C_{b'e}\ C_{ce}$

$$L_1' = L_1 // C_{ce}$$

$$L_2' = L_2 // C_{b'e}$$



优点： 易起振

$$\omega < \min(\omega_{01}, \omega_{02})$$

缺点：不适于高频；频率稳定度较差； 波形较差