串联谐振特点

1）谐振时的阻抗

$$Z = R + \mathrm{j}(\omega_0 L - 1/\omega_0 C) = R = Z_{\min}$$

阻抗角 $\varphi_z = 0$

$$\omega_0 L = 1/\omega_0 C = \rho = \sqrt{L/C}\Big|_{\omega_0 = 1/\sqrt{LC}}$$

***RLC*串联电路的特性阻抗**

***RLC*电路串联谐振时，阻抗最小，等于电阻值，阻抗角为零。**

串联谐振特点

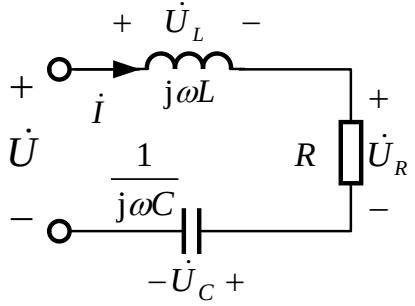
2）谐振时的电流

$$\dot{I}_0 = \frac{\dot{U}}{Z} = \frac{U\angle\varphi_u}{Z_{\min}} = \frac{U\angle 0^\circ}{R} = I_{\max}$$

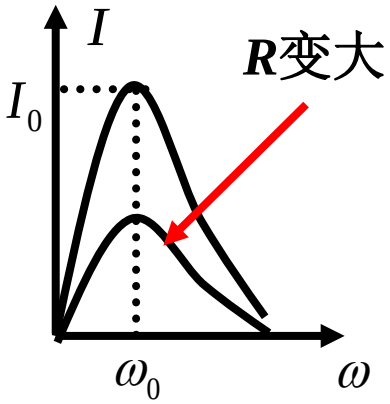
当端口电压一定时，谐振端口电流最大，其值只与电阻值有关，与电感、电容值不直接相关。

串联谐振特点

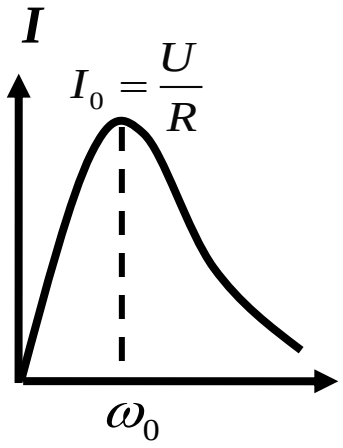
电路参数对谐振曲线的影响

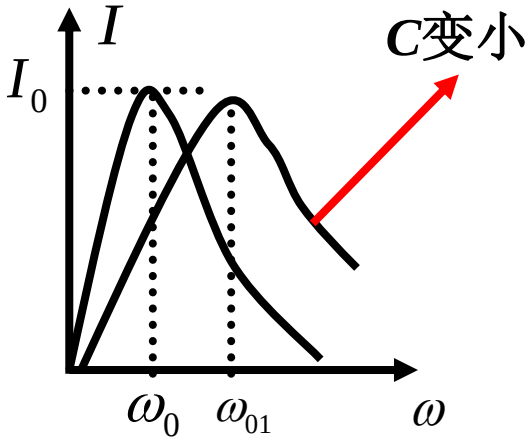


(a) ***R*变大**



(b) ***L*或*C* 变小**





(a) ω_0不变，I_0变小。

(b) I_0不变，ω_0变大。

串联谐振特点

3) 谐振时R、L、C各元件上的电压

$$\dot{U}_R = R\dot{I}_0 = R\frac{\dot{U}}{R} = \dot{U}$$

RLC串联电路的品质因数

$$\dot{U}_L = \mathrm{j}\omega_0 L\dot{I}_0 = \mathrm{j}\omega_0 L\frac{\dot{U}}{R} = \mathrm{j}\frac{\rho}{R}\dot{U} = \mathrm{j}Q\dot{U}$$

$$\dot{U}_C = \frac{1}{\mathrm{j}\omega_0 C}\dot{I}_0 = -\mathrm{j}\frac{1}{\omega_0 C}\frac{\dot{U}}{R} = -\mathrm{j}\frac{\rho}{R}\dot{U} = -\mathrm{j}Q\dot{U}$$

$$\dot{U}_X = \dot{U}_L + \dot{U}_C = 0$$

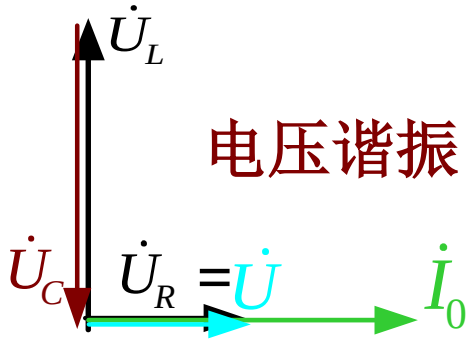
可见LC串联谐振部分相当于短路

注 $U_X = 0$ 但$U_L \neq 0, U_C \neq 0$ $U_L = U_C = QU$

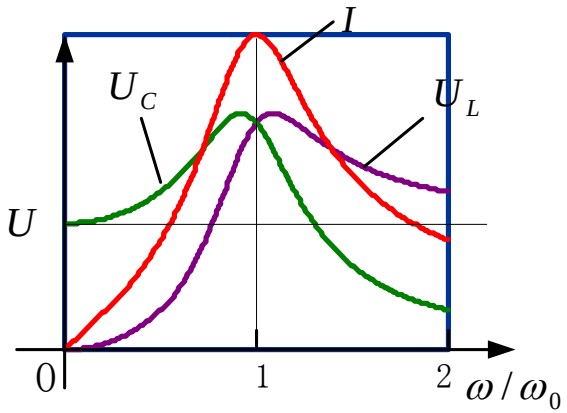
$Q >> 1 \rightarrow U_L(U_C) >> U$ 使电气设备受损害，应避免

串联谐振特点

4）相量图及频率特性曲线



*RLC*串联谐振相量图



*RLC*串联频率特性曲线

5）谐振时端口吸收的有功功率和无功功率

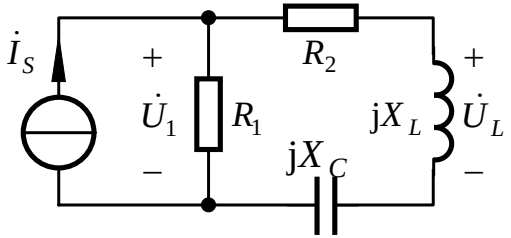
$$P = UI\cos\varphi_Z = UI = RI^2 = P_R$$

$$Q = UI\sin\varphi_Z = 0$$

电场能量和磁场能量互相转换

串联谐振-例题

例2 设图示电路处于谐振状态，其中 $I_S=1\text{A}$ ，$R_1=|X_C|=100\Omega$ $U_1=50\text{V}$，求电压U_L和电阻 R_2 。



解：处于谐振状态，电感电容串联相当于短路，则有

$$R_1//R_2=\frac{R_1R_2}{R_1+R_2}=\frac{U_1}{I_S}=50\Omega$$

解得 $R_2=100\Omega$

电路处于谐振状态 ，则 $X_L=|X_C|=100\Omega$

得 $U_L=\frac{1}{2}I_SX_L=50\text{V}$