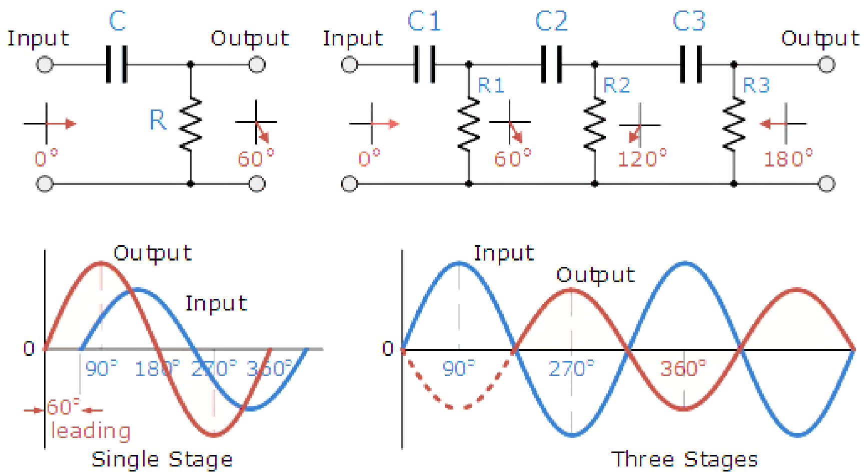
INTRONIC

Oscilador



L-C

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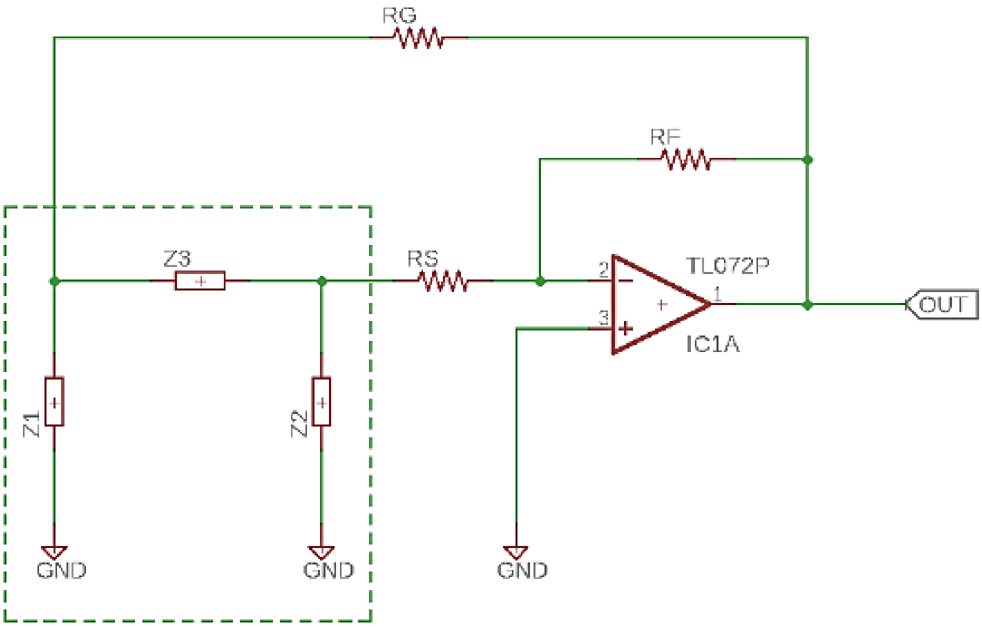


$$V_o = \frac{Z_P}{(Z_P + R_G)} \frac{Z_1}{(Z_1 + Z_3)} V_i \quad [1]$$

Donde Z_P es el paralelo entre Z_2 y $(Z_1 + Z_3)$, entonces:

$$Z_P = \frac{Z_2\,(Z_1 + Z_3)}{Z_1 + Z_2 + Z_3} \quad [2]$$

Reemplazando [2] en [1]:

$$\frac{V_o}{V_i} = \frac{\dfrac{Z_2\,(Z_1 + Z_3)}{Z_1 + Z_2 + Z_3}}{\dfrac{Z_2\,(Z_1 + Z_3)}{Z_1 + Z_2 + Z_3} + R_G} \frac{Z_1}{(Z_1 + Z_3)} \Rightarrow$$

$$\frac{V_o}{V_i} = \frac{\dfrac{Z_2\,(Z_1 + Z_3)}{Z_1 + Z_2 + Z_3}}{\dfrac{Z_2\,(Z_1 + Z_3) + R_G\,(Z_1 + Z_2 + Z_3)}{Z_1 + Z_2 + Z_3}} \frac{Z_1}{(Z_1 + Z_3)} \Rightarrow$$

$$\frac{V_o}{V_i} = \frac{Z_2\,(Z_1 + Z_3)}{(Z_1 + Z_2 + Z_3)}\,\frac{(Z_1 + Z_2 + Z_3)}{[Z_2\,(Z_1 + Z_3) + R_G\,(Z_1 + Z_2 + Z_3)]}\,\frac{Z_1}{(Z_1 + Z_3)} \Longrightarrow$$

$$\frac{V_o}{V_i} = \frac{Z_2\,(Z_1 + Z_3)}{Z_2\,(Z_1 + Z_3) + R_G\,(Z_1 + Z_2 + Z_3)}\,\frac{Z_1}{(Z_1 + Z_3)} \Longrightarrow$$

$$\boxed{\frac{V_o}{V_i} = \frac{Z_1\,Z_2}{Z_2\,(Z_1 + Z_3) + R_G\,(Z_1 + Z_2 + Z_3)} \quad [3]}$$

Las impedancias Z_1, Z_2 y Z_3 son reactancias puras (inductores o capacitores) de la forma: $j\,x_n$. Reemplazando en [3], resulta:

$$\frac{V_o}{V_i} = \frac{j\,x_1\,j\,x_2}{j\,x_2\,(j\,x_1 + j\,x_3) + R_G\,(j\,x_1 + j\,x_2 + j\,x_3)} \Longrightarrow$$

$$\frac{V_o}{V_i} = \frac{-x_1\,x_2}{-x_2\,(x_1 + x_3) + j\,R_G\,(x_1 + x_2 + x_3)} \Longrightarrow$$

$$R_G\,(x_1 + x_2 + x_3) = 0 \quad \Longrightarrow$$

$$\boxed{x_3 = -(x_1 + x_2) \quad [4]}$$

Análisis de atenuación

$$\frac{V_o}{V_i} = \frac{-x_1\,x_2}{-x_2\,(x_1 + x_3) + j\,R_G\,(x_1 + x_2 + x_3)}$$

Reemplazamos por [4] en la ecuación anterior:

$$\frac{V_o}{V_i} = \frac{-x_1\, x_2}{-x_2\left(x_1 - (x_1 + x_2)\right) + j\, \underbrace{R_G\left(x_1 + x_2 - (x_1 + x_2)\right)}_{=0}}$$

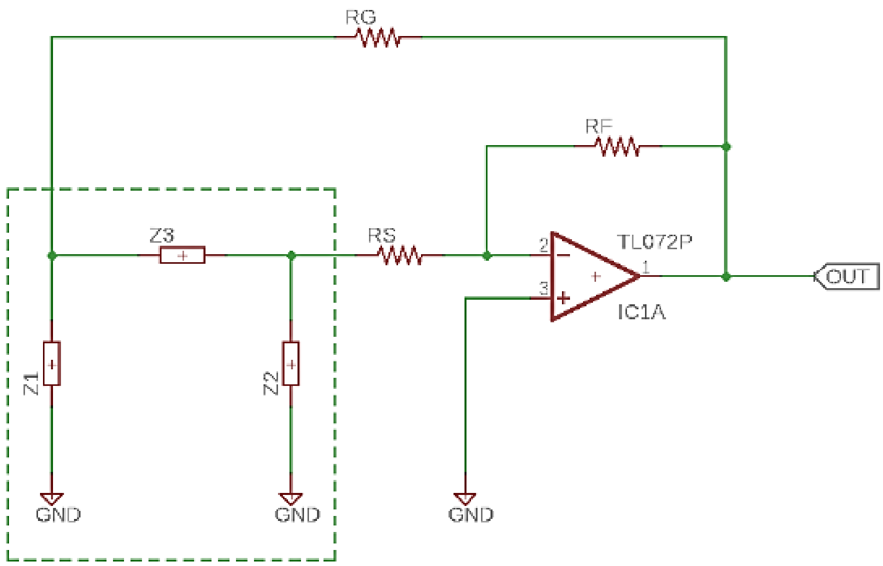
$$\frac{V_o}{V_i} = \frac{-x_1\, x_2}{-x_2\,(x_1 - x_1 - x_2)}$$

$$\frac{V_o}{V_i} = \frac{x_1\, x_2}{x_2\,(-x_2)} = -\frac{x_1}{x_2}$$

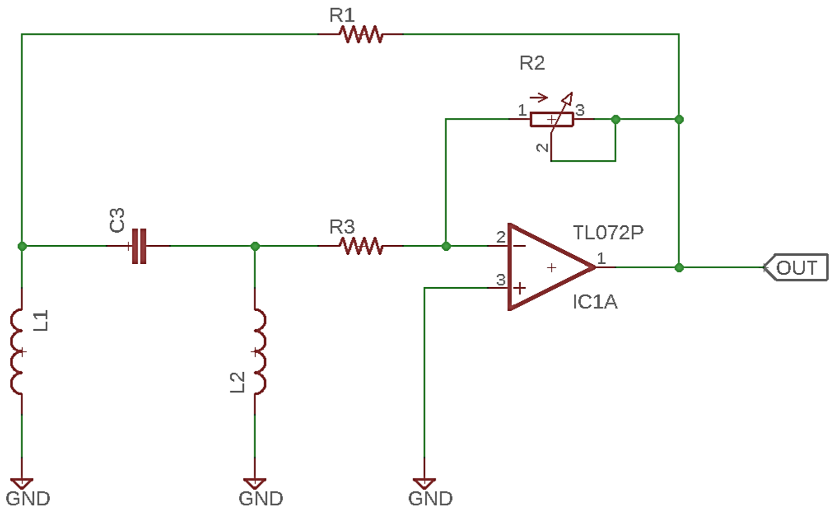
Pero de [4] sabemos que: $x_2 = -x_1 - x_3 = -(x_1 + x_3)$

$$\boxed{\frac{V_o}{V_i} = -\frac{x_1}{-(x_1 + x_3)} = \frac{x_1}{x_1 + x_3} \quad [5]}$$

Reactancia	Oscilador
L_1, L_2, C_3	Hartley
C_1, C_2, L_3	Colpitts



Oscilador de Hartley (noviembre 30, 1888 – mayo 1, 1970)



$$X_{L_1} = j\,\omega\,L_1$$

$$X_{L_2} = j\,\omega\,L_2$$

$$X_{C_3} = \frac{1}{j\,\omega\,C_3} = \frac{-j}{\omega\,C_3}$$

Reemplazo en [4] para hallar la frecuencia en la cual se cumple dicha igualdad:

$$x_3 = -(x_1 + x_2)$$

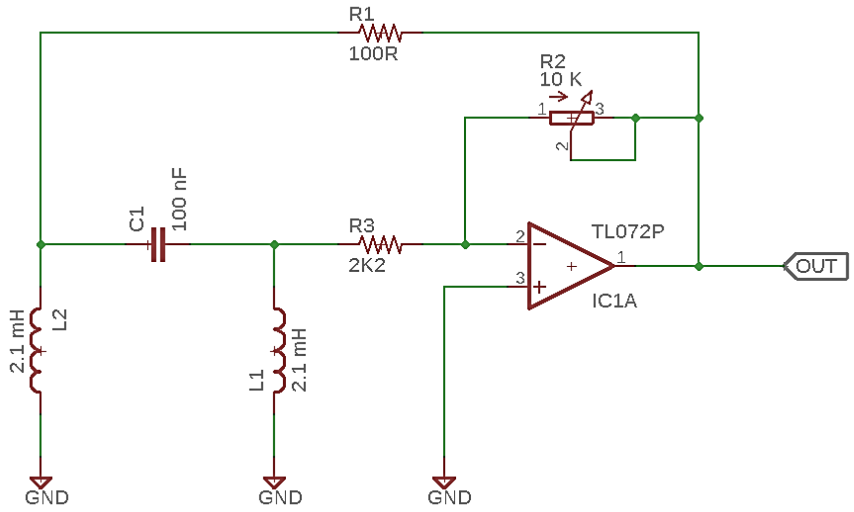
$$\frac{-j}{\omega\,C_3} = -j\,(\omega\,L_1 + \omega\,L_2) \quad \Longrightarrow$$

$$\frac{1}{\omega\,C_3} = \omega\,\underbrace{(L_1 + L_2)}_{L_{eq}} \quad \Longrightarrow$$

$$\omega^2 = \frac{1}{L_{eq}\,C_3} \quad \therefore$$

$$\boxed{f = \frac{1}{2\,\pi\,\sqrt{L_{eq}\,C_3}}}$$

Ejemplo de cálculo



$$f = \frac{1}{2\,\pi\,\sqrt{L_{eq}\,C_3}} = \frac{1}{2\,\pi\,\sqrt{(2{,}1 + 2{,}1)\,10^{-3}\,HY\,100\,10^{-9}\,F}} = 7765{,}9\,Hz$$

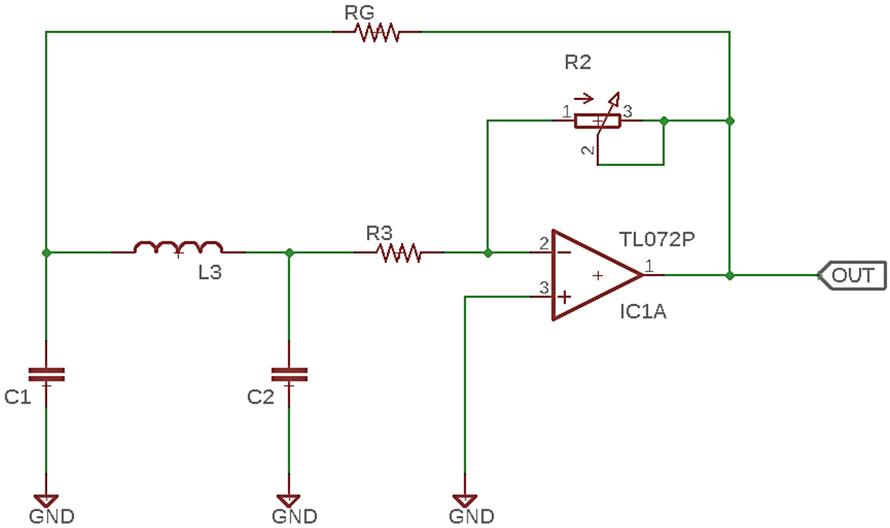
$$x_{L_1} = x_{L_2} = \omega\,L = 2\,\pi\,f\,L = 2\,\pi\,7765{,}9\,Hz\,2{,}1\,10^{-3}\,Hy = 102{,}46\,\Omega$$

$$x_{C_3} = \frac{1}{\omega\,C_3} = \frac{1}{2\,\pi\,f\,C_3} = \frac{1}{2\,\pi\,7765{,}9\,Hz\,100\,10^{-9}\,F} = 204{,}93\,\Omega$$

$$\frac{V_o}{V_i} = \frac{x_1}{x_1 + x_3} = \frac{102{,}46\,\Omega}{102{,}46\,\Omega + 204{,}93\,\Omega} = 0{,}3\hat{3} \cong \frac{1}{3}$$

La ganancia necesaria será: $G \cong 3$

Oscilador de Colpitts (Enero 19, 1872 – Marzo 6, 1949)



$$X_{C_1} = \frac{1}{j\,\omega\,C_1} = \frac{-j}{\omega\,C_1}$$

$$X_{C_2} = \frac{1}{j\,\omega\,C_2} = \frac{-j}{\omega\,C_2}$$

$$X_{L_3} = j\,\omega\,L_3$$

Reemplazo en [4]:

$$x_3 = -(x_1 + x_2)$$

$$j\,\omega\,L_3 = -\left(\frac{-j}{\omega\,C_1} + \frac{-j}{\omega\,C_2}\right) \quad \Rightarrow$$

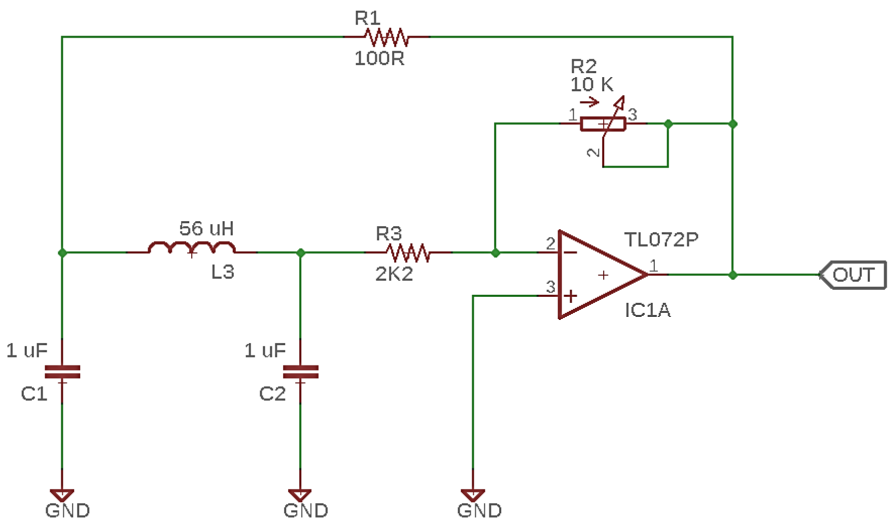
$$j\,\omega\,L_3 = \frac{j}{\omega}\left(\frac{1}{C_1} + \frac{1}{C_2}\right) \quad \Rightarrow$$

$$\omega^2\,L_3 = \underbrace{\frac{C_1 + C_2}{C_1\,C_2}}_{\frac{1}{C_{eq}}} \quad \Rightarrow$$

$$\omega = \sqrt{\frac{1}{L_3\, C_{eq}}} \Longrightarrow$$

$$\boxed{f = \frac{1}{2\,\pi\,\sqrt{L_3\, C_{eq}}}}$$

Ejemplo de cálculo



$$C_{eq} = \frac{C_1\, C_2}{C_1 + C_2} = \frac{1\;10^{-6}\;F\;1\;10^{-6}\;F}{1\;10^{-6}\;F + 1\;10^{-6}\;F} = 0{,}5\;10^{-6}\;F$$

$$f = \frac{1}{2\,\pi\,\sqrt{L_3\, C_{eq}}} = \frac{1}{2\,\pi\,\sqrt{56\;10^{-6}\;Hy\;0{,}5\;10^{-6}\;F}} = 30077{,}45\;Hz$$

$$X_{C_1} = X_{C_2} = \frac{1}{2\,\pi\,f\,C_1} = \frac{1}{2\,\pi\;30077{,}45\;Hz\;1\;10^{-6}\;F} = 5{,}29\;\Omega$$

$$X_{L_3} = \omega\,L = 2\,\pi\,f\,L = 2\,\pi\;30077{,}45\;Hz\;56\;10^{-6}\;Hy = 10{,}58\;\Omega$$

$$\frac{V_o}{V_i} = \frac{x_1}{x_1 + x_3} = \frac{5{,}29\;\Omega}{5{,}29\;\Omega + 10{,}58\;\Omega} = 0{,}3\hat{3}$$

La ganancia necesaria será: $G \cong 3$