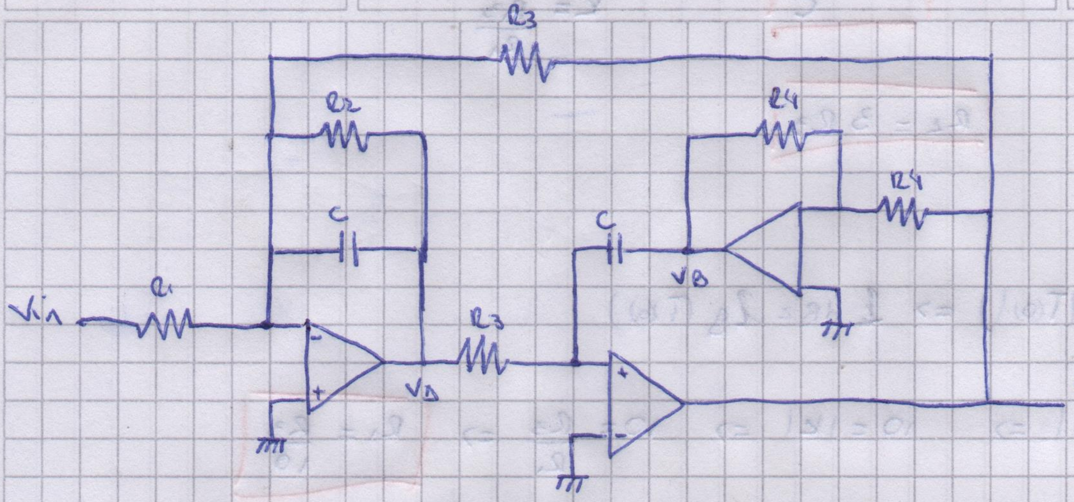
HOJA N°

FECHA



$$-V_{in}G_1 - V_A(sC+G_2) - V_0 G_3 = 0$$

$$-V_A G_3 - V_B sC = 0 \qquad V_A = \frac{-V_B sC}{G_3} \qquad V_A = \frac{V_0 sC}{G_3}$$

$$-V_0 G_4 - V_B G_4 = 0$$

$$V_B = -V_0$$

$$-V_{in}G_1 = \frac{V_0 sC(sC+G_2)}{G_3} + V_0 G_3$$

$$-V_{in}G_1 = V_0\left(\frac{sC(sC+G_2) + G_3^2}{G_3}\right)$$

$$\frac{V_0}{V_{in}} = -\frac{G_1 G_3}{s^2C^2 + sCG_2 + G_3^2}$$

$$\frac{V_0}{V_{in}} = \frac{\frac{G_1G_3}{C^2}}{s^2 + s\frac{G_2}{C} + \left(\frac{G_3}{C}\right)^2} = \frac{K\,\omega_0^2}{s^2 + \frac{\omega_0}{Q} + \omega_0^2}$$

$$\boxed{\omega_0 = \frac{G_3}{C}} \qquad \frac{\omega_0}{Q} = \frac{G_2}{C}$$

$$\boxed{Q = \frac{G_3}{G_2}} \qquad \boxed{K = \frac{G_1}{G_3}}$$

NOTA

$\omega_0 = \frac{1}{C R_3} = 1$ $\boxed{R_3 = \frac{1}{C}}$ $K = \frac{R_3}{R_1}$

$Q = \frac{R_2}{R_3} = 3$ $\boxed{R_2 = 3 R_3}$

$20^{dB} = 20 \lg(|T(0)|) \Rightarrow 1\,dB = \lg(|T(0)|)$

$10^1 = |T(0)| \Rightarrow 10 = |K| \Rightarrow 10 = \frac{R_3}{R_1} \Rightarrow \boxed{R_1 = \frac{R_3}{10}}$

$$\frac{V_o}{V_{in}} = \frac{\frac{R_3}{R_1}\left(\frac{1}{R_3 C}\right)^2}{S^2 + S\frac{1}{R_2 C} + \left(\frac{1}{R_3 C}\right)^2}$$

Normalización en Impedancia $\boxed{Z_R = R_2}$

$$\frac{V_o}{V_{in}} = \frac{\frac{R_3'}{R_1'}\left(\frac{1}{R_3' C'}\right)^2}{S^2 + S\frac{1}{C'} + \left(\frac{1}{R_3' C'}\right)^2}$$

$\boxed{\frac{R_2}{Z_R} = 1}$ $\boxed{R_3' = \frac{R_3}{Z_R}}$ $\boxed{R_1' = \frac{R_1}{Z_R}}$

$\boxed{C' = C Z_R}$

Normalización en Frecuencia $\boxed{\Omega_N = \frac{1}{R_3' C'}}$

$$\frac{V_o}{V_{in}} = \frac{\frac{R_3'}{R_1'} \quad 1}{S^2 + S\frac{1}{C''} + 1}$$

$\boxed{C'' = C' \Omega_N = \frac{1}{R_3'}}$

SENSIBILIDAD

$$S_C^{\omega_0} = \frac{C}{\omega_0}\frac{\partial \omega_0}{\partial C} \Rightarrow \frac{\partial \omega_0}{\partial C} = \frac{-R_3}{(C R_3)^2}$$

$$\boxed{\omega_0 = \frac{1}{R_3 C}}$$

$$\boxed{S_C^{\omega_0}} = \frac{C}{\omega_0}\left[\frac{-R_3}{(C R_3)^2}\right] = \frac{-C R_3}{\cancel{\omega_0}} \cdot \omega_0^{\cancel{2}} = -R_3 C \cdot \omega_0 = \boxed{-1}$$

$$S_{R_2}^{Q} = \frac{R_2}{Q}\frac{\partial Q}{\partial R_2} \Rightarrow \frac{\partial Q}{\partial R_2} = \frac{1}{R_3}$$

$$\boxed{Q = \frac{R_2}{R_3}}$$

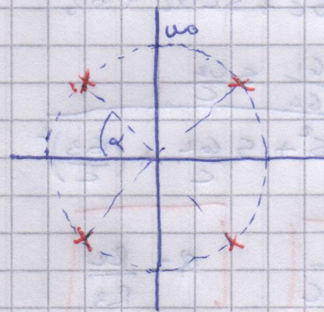
$$\boxed{S_{R_2}^{Q}} = \frac{R_2}{Q} \cdot \frac{1}{R_3} = \boxed{1}$$

$$S_{R_3}^{Q} = \frac{R_3}{Q}\frac{\partial Q}{\partial R_3} \Rightarrow \frac{\partial Q}{\partial R_3} = -\frac{R_2}{R_3^2}$$

$$\boxed{S_{R_3}^{Q}} = \frac{\cancel{R_3}}{\cancel{Q}} \cdot \left(-\frac{R_2}{R_3^{\cancel{2}}}\right) = -\frac{Q}{Q} = \boxed{-1}$$

Transferencia de Butterworth

Para que sea una transferencia de Butterworth sus singularidades tienen que estar X espaciada una de otra con el mismo angulo de separacion una de otra en una circunferencia de radio ω_0



$$\alpha = \frac{\pi}{4}$$

$$Q = \frac{1}{2\cos\alpha}$$

$$Q = \frac{1}{2\cos(\frac{\pi}{4})} = \frac{1}{\sqrt{2}} \qquad \omega_0 = 1$$

$$T(s) = \frac{K\,\omega_0^2}{s^2 + s\frac{\omega_0}{Q} + \omega_0^2}$$

$$T(s) = \frac{K\,1}{s^2 + s\sqrt{2} + 1}$$

$$\omega_0 = \frac{1}{C R_3} = 1 \qquad \boxed{R_3 = \frac{1}{C}}$$

$$Q = \frac{1}{\sqrt{2}} = \frac{R_2}{R_3} \qquad \boxed{R_2 = \frac{R_3}{\sqrt{2}}}$$

$$\boxed{R_1 = \frac{R_3}{10}}$$

Para diseñar un filtro posa bando tengo que tomar a la salida del <u>opam V1</u>

$$-V_{in}G_1 - V_A(SC+G_2) - V_o G_3 = 0$$

$$-V_A G_3 - V_B SC = 0 \quad \Rightarrow \quad V_B = -\frac{V_A G_3}{SC}$$

$$-V_o G_4 - V_B G_4 = 0 \qquad V_B = -V_o$$

$$V_o = \frac{V_A G_3}{SC}$$

$$-V_{in}G_1 - V_A(SC+G_2) - \frac{V_A G_3^2}{SC} = 0$$

$$-V_{in}G_1 = V_A\left(SC + G_2 + \frac{G_3^2}{SC}\right)$$

$$-V_{in}G_1 = V_A\left(\frac{S^2C^2 + SCG_2 + G_3^2}{SC}\right)$$

$$\frac{V_A}{V_{in}} = \frac{-SG_1C}{S^2C^2 + SCG_2 + G_3^2}$$

$$\frac{V_A}{V_{in}} = -\frac{\frac{G_1}{G_2}\,S\frac{G_2}{C}}{S^2 + S\frac{G_2}{C} + \left(\frac{G_3}{C}\right)^2}$$

$$\boxed{\omega_0 = \frac{1}{R_3C}} \qquad \boxed{Q = \frac{R_2}{R_3}}$$

$$\boxed{K = \frac{R_2}{R_1}}$$