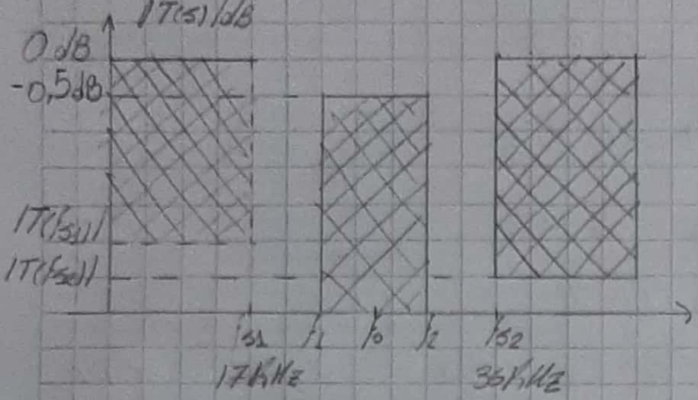
TS4 bis²



- $\omega_0 = 2\pi\, 22\, KHz$
- $Q = 5$
- chebyshev
- $\alpha_{MAX} = 0,5\, dB$

$|T(f_{S1})| = -16\, dB$

$|T(f_{S2})| = -24$

$\Omega_\omega = 2\pi\, 22\, KHz \Rightarrow \omega_0 = 1$

$\omega_{S1} = \frac{17}{22} = 0,773$ y $\omega_{S2} = \frac{36}{22} = 1,636$

$Q = \frac{\omega_0}{BW} \Rightarrow BW = \frac{\omega_0}{Q} = \frac{1}{5} = 0,2$

$\varepsilon^2 = 10^{\frac{\alpha_{MAX}}{10}} - 1 = \boxed{0,122}$

Nucleo de transformación

$K(s) = Q\,\frac{s^2 - 1}{s}$

$$\begin{cases} \Omega_{S1} = Q\,\frac{\omega_{S1}^2 - 1}{\omega_{S1}} = -2,6 \\ \Omega_{S2} = Q\,\frac{\omega_{S2} - 1}{\omega_{S2}} = 5,124 \end{cases}$$

Se busca un orden tal que cumpla la minima atenuación pedida con la mínima ω_S

$\alpha_{MIN} = 10 \log\left[1 + \varepsilon^2 \cosh^2(n \cosh^{-1} \omega_S)\right]$

ω_{S1}		ω_{S2}	
$n=2$	13 dB	$n=2$	25,1 dB
$n=3$	26,8 dB	$n=3$	45,23 dB

Con $\boxed{n = 3}$ cumple las 2 restricciones de At mínima

Escaneado con CamScanner

Plantilla pasabanda normalizada

para averiguar ω_1 y ω_2

$$\Omega_1 = Q\,\frac{\omega_1^2 - 1}{\omega_1} = -1 \Rightarrow Q(\omega_1^2 - 1) = -\omega_1$$

$$\omega_1^2 + \frac{\omega_1}{Q} - 1 = 0 \rightarrow 0{,}905 \quad ; \quad -1{,}105$$

$$\omega_2^2 - \frac{\omega_2}{Q} - 1 = 0 \rightarrow -0{,}905 \quad ; \quad 1{,}105$$

$\Rightarrow$

ω_0	ω_1	ω_2	ω_{s1}	ω_{s2}	α_{MAX}	α_{MIN}
1	0,903	1,107	0,773	1,636	0,5	-24 dB

Prototipo pasabanda

Filtro pasabajo chebyshev

$n = 3 \quad \omega_s = 2{,}6 \quad \omega_p = 1 \quad \alpha_{MAX} = 0{,}5\ dB$

$\varepsilon^2 = 0{,}122$

$$|T_{C_3}|^2 = \frac{1}{1 + \varepsilon^2 C_{3(\omega)}^2}$$

↳ Python $|T_{C_{3\,LP}}(\omega)| = \frac{0{,}626}{s + 0{,}626} \cdot \frac{1{,}143}{s^2 + s\frac{1{,}069}{1{,}706} + 1{,}069^2}$

Aplico núcleo de Transformación

$$K(s) = Q\,\frac{(s^2 - 1)}{s}$$

↳ Python

$$|T_{C_{3\,BP}}(s)| = \frac{s \cdot 1{,}207\,\frac{1}{7{,}981}}{s^2 + s\frac{1}{7{,}981} + 1^2} \cdot \frac{s \cdot 2{,}045\,\frac{0{,}903}{16{,}05}}{s^2 + s\frac{0{,}903}{16{,}05} + 0{,}903^2} \cdot \frac{s \cdot 4{,}768 \cdot \frac{1{,}107}{16{,}05}}{s^2 + s\frac{1{,}107}{16{,}05} + 1{,}107^2}$$

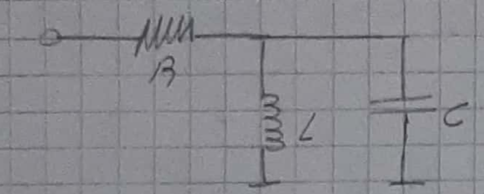
NOTA

Escaneado con CamScanner

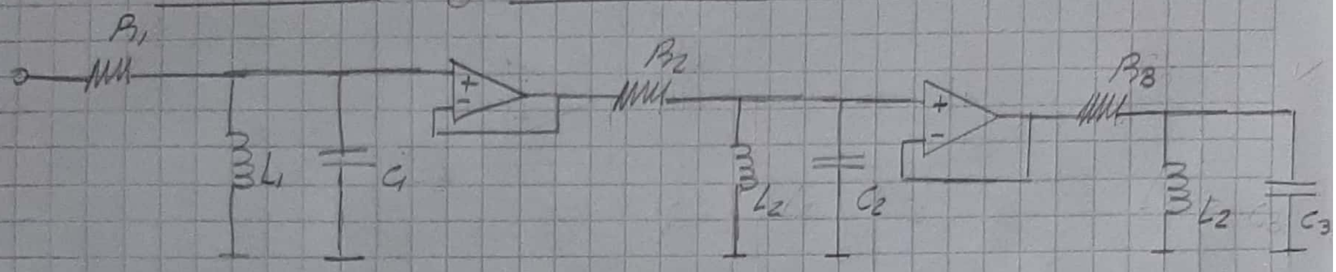
HOJA Nº 2

FECHA

Circuito Pasabanda Pasivo



$$H(s) = \frac{s\frac{1}{CR}}{s^2 + s\frac{1}{CR} + \frac{1}{LC}}$$



$$|T_{C3_{BP}}(s)| = |T_{SOS_1}(\omega)| \cdot |T_{SOS_2}(\omega)| \cdot |T_{SOS_3}(\omega)|$$

Como los circuitos pasivos no amplifican $\Rightarrow$ se hacen todos los filtros de 0dB

$$SOS_1 : T(s) = \frac{s\frac{1}{7{,}981}}{s^2 + s\frac{1}{7{,}981} + 1^2}$$

$$\begin{cases} \frac{1}{L_1 C_1} = 1 \\ \frac{1}{R_1 C_1} = \frac{1}{7{,}981} \end{cases}$$

Propongo $C_1 = 1 \Rightarrow L_1 = 1$

y $R_1 = Q = 7{,}981$

$$SOS_2 : T(s) = \frac{s \cdot \frac{0{,}903}{16{,}05}}{s^2 + s\frac{0{,}903}{16{,}05} + 0{,}903^2}$$

$$\begin{cases} \frac{1}{L_2 C_2} = 0{,}903^2 \\ \frac{0{,}903}{16{,}05} = \frac{1}{R_2 C_2} \end{cases}$$

Propongo $C_2 = 1 \Rightarrow L_2 = \frac{1}{0{,}903^2} = 1{,}226$

$\Rightarrow R_2 = \frac{16{,}05}{0{,}903} = 17{,}774$

$$SOS_3 : T(s) \quad \frac{s \cdot \frac{1{,}107}{16{,}05}}{s^2 + s\frac{1{,}107}{16{,}05} + 1{,}107^2}$$

$$\begin{cases} \frac{1}{L_3 C_3} = 1{,}107^2 \\ \frac{1{,}107}{16{,}05} = \frac{1}{R_3 C_3} \end{cases}$$

Propongo $C_3 = 1 \Rightarrow L_3 = \frac{1}{1{,}107^2} = 0{,}816$

$\Rightarrow R_3 = \frac{16{,}05}{1{,}107} = 14{,}499$

NOTA $|4{:}15 \rightarrow |20{:}34$

+6h

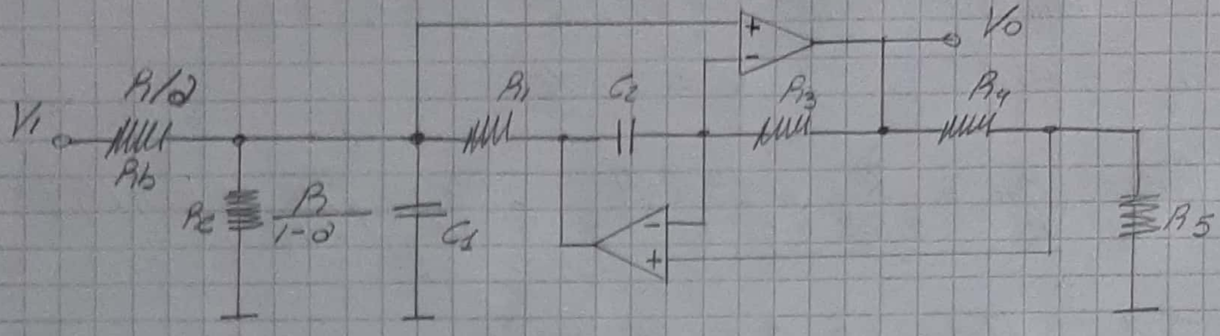
Escaneado con CamScanner

HOJA Nº 3

FECHA

GIC pasabandas

Página 183 del Schaumann Cap 4.



$$T(s) = \frac{V_0}{V_1} = \frac{s\alpha\left(1+\frac{G_5}{G_4}\right)\frac{G_1}{C_1}}{s^2 + s\frac{G_1}{C_1} + \frac{G_1 G_3 G_5}{C_1 C_2 G_4}}$$

Se propone

$C_1 = C_2$ y $R_1 = R_3 = R_4 = R_5$

$$H = \alpha\left(1+\frac{G_5}{G_4}\right)$$

H puede ser mayor a 2 si $R_4 > R_5$ pero esto provocará errores en w_0 y Q ∴ se fija $R_4 = R_5$

x lo que $H_{MAX} = 2$ cuando $\alpha = 1$

$$\Rightarrow T(s) = \frac{s\, 2\alpha \frac{1}{RC}}{s^2 + s\frac{1}{RC} + \frac{1}{(R_1 C)^2}}$$

$$\begin{cases} Q = \frac{R}{R_1} \\ H = 2\alpha \\ w_0 = \frac{1}{R_1 C} \end{cases}$$

$$|T_{C3\,BP}(\omega)| = |T_{SOS_1}| \cdot |T_{SOS_2}| \cdot |T_{SOS_3}|$$

NOTA

Escaneado con CamScanner

$$SOS\,1: \quad |T_{SOS_1}| = \frac{s\,.\,1{,}207\,\frac{1}{7{,}981}}{s^2 + s\,\frac{1}{7{,}981} + 1^2} = \frac{s\,2a\,\frac{w_o}{Q}}{s^2 + s\,\frac{w_o}{Q} + w_o^2}$$

$$\begin{cases} w_o = \dfrac{1}{R_{11} C_1} = 1 \\ Q = \dfrac{R_{a1}}{R_{11}} = 7{,}981 \\ 2a_1 = 1{,}207 \end{cases}$$

Propongo $C_1 = 1 \Rightarrow R_{11} = 1$

$\Rightarrow R_{a1} = Q = 7{,}981$

$Q = 0{,}604$

$$R_{b1} = \frac{R_{a1}}{a_1} = \frac{Q}{0{,}604} = 13{,}214 \qquad R_{c1} = \frac{R_{a1}}{1 - a_1} = 20{,}154$$

$$SOS\,2: \quad |T_{SOS_2}| = \frac{s\,2{,}045\,\frac{0{,}903}{16{,}05}}{s^2 + s\,\frac{0{,}903}{16{,}05} + 0{,}903^2}$$

$$\begin{cases} w_o = \dfrac{1}{R_{12} C_2} = 0{,}903 \\ Q = \dfrac{R_{a2}}{R_{12}} = 16{,}05 \\ 2a_2 \approx 2 \rightarrow a_2 = 1 \end{cases}$$

Propongo $C_2 = 1$

$$R_{1_2} = \frac{1}{0{,}903} = 1{,}107$$

$$R_{a2} = Q\,.\,R_{12} = 17{,}767$$

$$R_{b2} = 17{,}767 \quad \text{y} \quad R_{c2} \rightarrow \infty$$

$$SOS\,3: \quad |T_{SOS_3}| = \frac{s.\,4{,}768.\,\frac{1{,}107}{16{,}05}}{s^2 + s\,\frac{1{,}107}{16{,}05} + 1{,}107^2}$$

En este caso $H > 2$ $\therefore$ como el GIC solo puede amplificar 2 veces como máximo, se agregará una etapa amplificadora.

$\Rightarrow$ se propone $2a_3 = 1 \Rightarrow a_3 = 1/2$

$$\begin{cases} w_o = \dfrac{1}{R_{13}.\,C_3} = 1{,}107 \\ Q = \dfrac{R_{a3}}{R_{13}} = 16{,}05 \end{cases}$$

se propone $C_3 = 1$

$$\Rightarrow R_{13} = \frac{1}{1{,}107} = 0{,}903$$

$$R_{a3} = Q\,.\,R_{13} = 14{,}493$$

$$R_{b2} = \frac{R_{a3}}{a_3} = 28{,}986 \qquad R_{c2} = \frac{R_{a3}}{1 - a_3} = 28{,}986$$

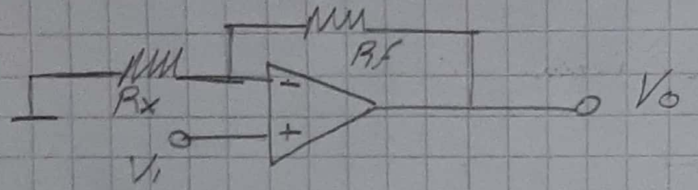
NOTA

Escaneado con CamScanner

HOJA Nº 4

FECHA

Amplificador no inversor de 4,768



$$\frac{V_o}{V_1} = 1 + \frac{RF}{Rx} = 4,768$$

Propongo $Rx = 1 \Rightarrow RF = 3,768.$

Escaneado con CamScanner