Ej. 7)

$f_{ci} = 1600\ KHZ$

$f_{cs} = 2500\ KHZ$

RIPPLE MAXIMO 3dB

MP.

GANANCIA MAXIMA EN LA BANDA DE PASO: 10 dB

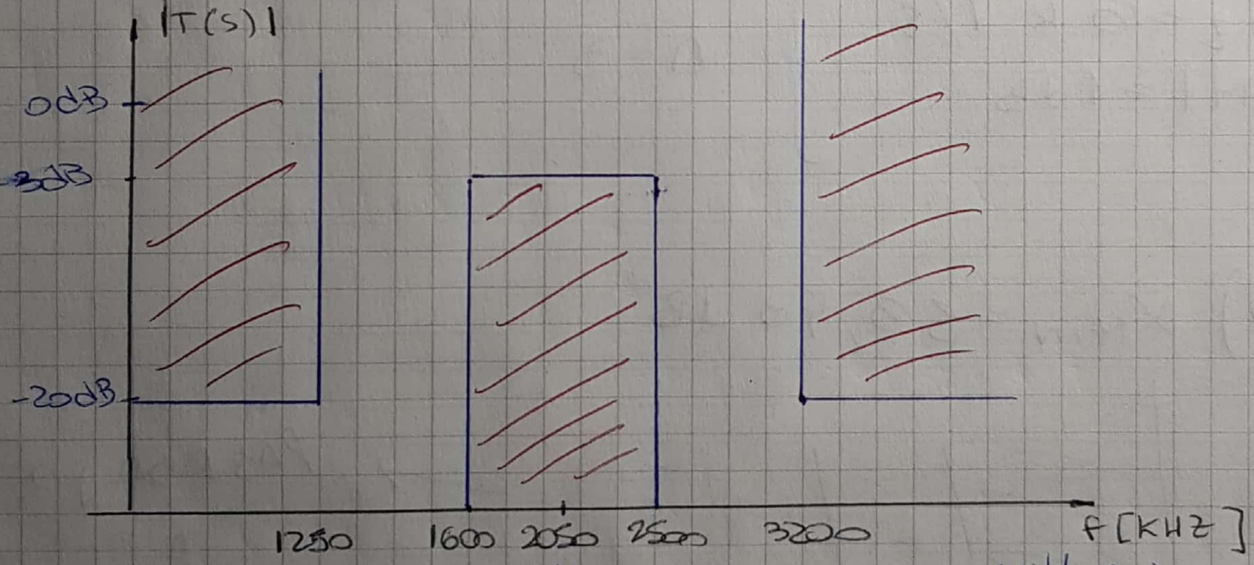
Att_{MIN}: 20 dB ⟶ 1250 KHZ y 3200 KHZ

a) $T(s)_n$

b) P y Z

c) GRAFICAR TRANSF. MODULO y FASE

d) SINTETIZAR C/ ACKERBERG-MOSBERG



(MP)

$\alpha_{MAX} = 3dB$

$\alpha_{MIN} = 20dB$

$\xi^2 = 10^{\left(\frac{att_{MAX}}{10}\right)} - 1 = 0,99 \cong 1$

$n =$

$w_{ci_n} =$ ~~...~~ $0,8$

$w_{cs_n} =$ ~~...~~ $1,25$

$w_{s_n} =$ ~~0,609~~ $0,625$

$w_{s2_n} =$ ~~1,56~~ $1,6$

$K(s) = Q \cdot \frac{s^2+1}{s}$

$W_{on} \to 1$ $\quad \to Q = \frac{W_{o_n}}{BW}$

$BW = W_{cs} - W_{ci}$

$Q = 2,273$

$\Omega_s = 2,16$ } TRASLADADAS A PASABAJO
$\Omega_p = 1$

$n = 3 \longrightarrow Att = 20,16\ dB$

ITERAR

$$\alpha_{MIN} = 10 \log_{10}\left(1 + \xi^2 \Omega_s^{2n}\right)$$

MODELO PASABAJOS

$$\frac{1}{1-\xi^2 s^6} = \frac{1}{as^3+bs^2+cs+d} \cdot \frac{1}{-as^3+bs^2-cs+d}$$

$+\xi^2 = +a^2 \Rightarrow a = \xi$

$d^2 = 1 \longrightarrow d = 1$

$n = 4$
$0 = b^2 \mp ac - ac \Rightarrow +2ac = b^2$

$n = 2$
$c^2 = 2bd$
$c^2 = 2b \longrightarrow c = \sqrt{2b}$

$2\xi c = b^2 \rightarrow 2\xi\sqrt{2b} = b^2$
$4\xi^2 2\cancel{b} = b^{\cancel{4}\,3}$

$$\boxed{2\xi^{2/3} = b}$$

$c = \sqrt{2b} = \sqrt{4\xi^{2/3}}$
$= 2\xi^{2/6} = \boxed{2\xi^{1/3} = c}$

$$\frac{1}{\xi s^3 + 2\xi^{2/3}s^2 + 2\xi^{1/3}s + 1} = T(s)$$

$P_1 = \cancel{\text{ }} s + 1$

$P_2 = s - (-0{,}5 + j0{,}866)$

$P_3 = s - (-0{,}5 - j0{,}866)$

$$T(s) = \frac{1}{s+1} \quad \frac{1}{s^2 + s + 1}$$

DESNORMALIZO $\quad s = \dfrac{\$}{\xi^{-1/3}}$

$$T(s) = \frac{1}{\dfrac{\$}{\underbrace{\xi^{-1/3}}_{\to 1}} + 1} \quad \frac{1}{\dfrac{\$^2}{\underbrace{\xi^{-2/3}}_{\to 1}} + \dfrac{\$}{\underbrace{\xi^{-1/3}}_{\to 1}} + 1}$$

$$= \frac{1}{s+1} \quad \frac{1}{s^2 + s + 1}$$

NUCLEO: $Q\dfrac{(s^2+1)}{s}$

$$T(s)_{Bp} = \frac{1}{\dfrac{Q(s^2+1)}{s} + 1} \quad \frac{1}{\dfrac{Q^2(s^2+1)^2}{s^2} + \dfrac{Q(s^2+1)}{s} + 1} =$$

$$= \frac{s}{Qs^2 + s + Q} \quad \frac{s^2}{Q^2s^4 + 2Q^2s^2 + Q^2 + Qs^3 + Qs + s^2}$$

$$= \frac{s/Q}{s^2 + \dfrac{s}{Q} + 1} \quad \frac{s^2/Q^2}{s^4 + \dfrac{s^3}{Q} + \underbrace{3s^2}_{2+\frac{1}{Q^2}} + \dfrac{s}{Q} + 1}$$

$\downarrow$ $-0{,}225 \pm 0{,}974$

Polos $\rightarrow$ $-0{,}162 \pm j1{,}595$

$-0{,}063 \pm j0{,}62$

$$= \frac{s/Q}{s^2 + \dfrac{s}{Q} + 1} \quad \frac{s/Q}{s^2 + s0{,}324 + 2{,}57} \quad \frac{s/Q}{s^2 + s0{,}126 + 0{,}383}$$

NOTA

Polos:

$$p_{1,2} = -0{,}134 \pm j1{,}207$$

$$p_{3,4} = -0{,}225 \pm 0{,}974$$

$$p_{5,6} = -0{,}09 \pm j\,0{,}818$$

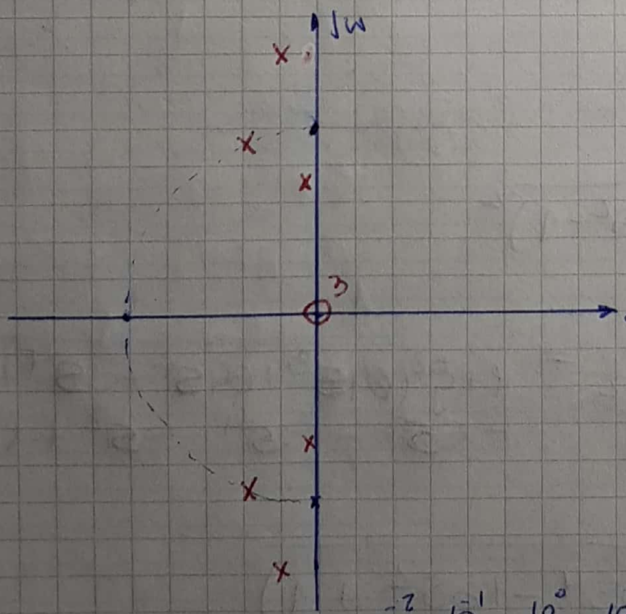
$$z = (0)^3$$

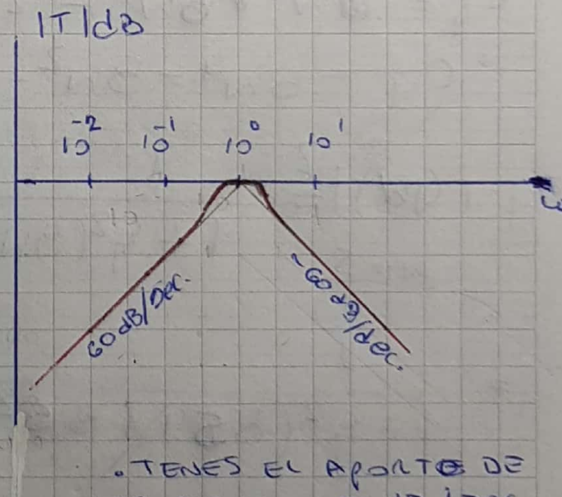
SOS 1 · SOS 2 ·

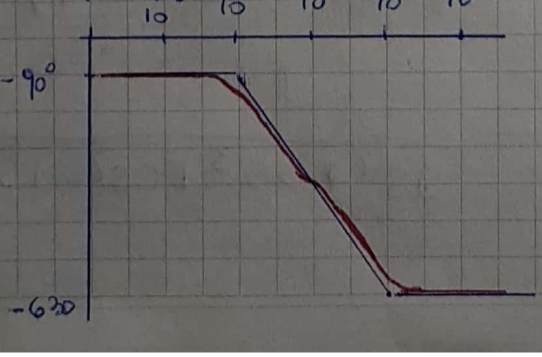
$$\overbrace{\frac{S/Q}{s^2+\frac{s}{Q}+1}} \cdot \frac{0{,}268 \cdot S \left(\frac{1}{Q \cdot 0{,}268}\right)}{s^2+0{,}268s+1{,}475} \cdot \frac{0{,}18\, S \left(\frac{1}{Q \cdot 0{,}18}\right)}{s^2+0{,}18+0{,}677}$$

$\frac{\omega_{o2}}{Q2}$ · K2 · $\frac{\omega_{o3}}{Q3}$ · K_3

$\omega_{o1} = 1$	$\omega_{o2} = 1{,}21$	$\omega_{o3} = 0{,}822$
$Q_1 = Q$	$Q_2 = 4{,}53$	$Q_3 = 4{,}56$
$K_1 = 1$	$K_2 = 1{,}68$	$K_3 = 2{,}5$



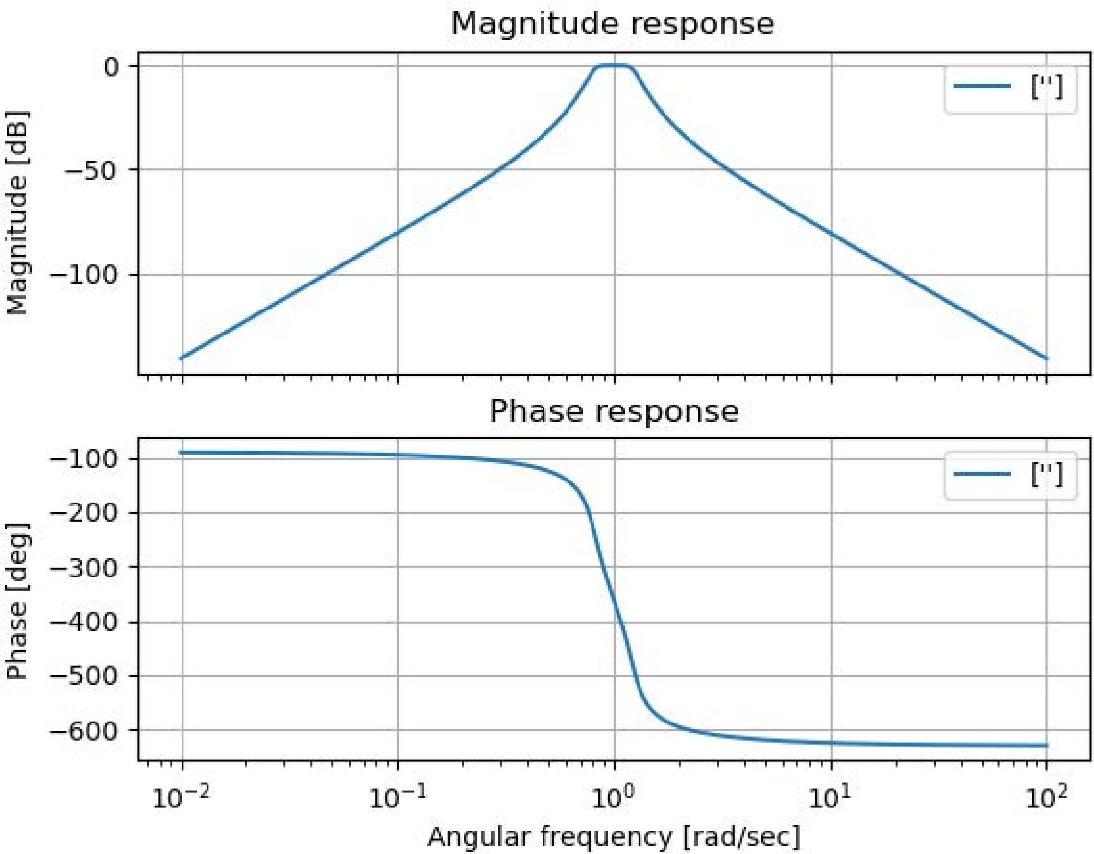


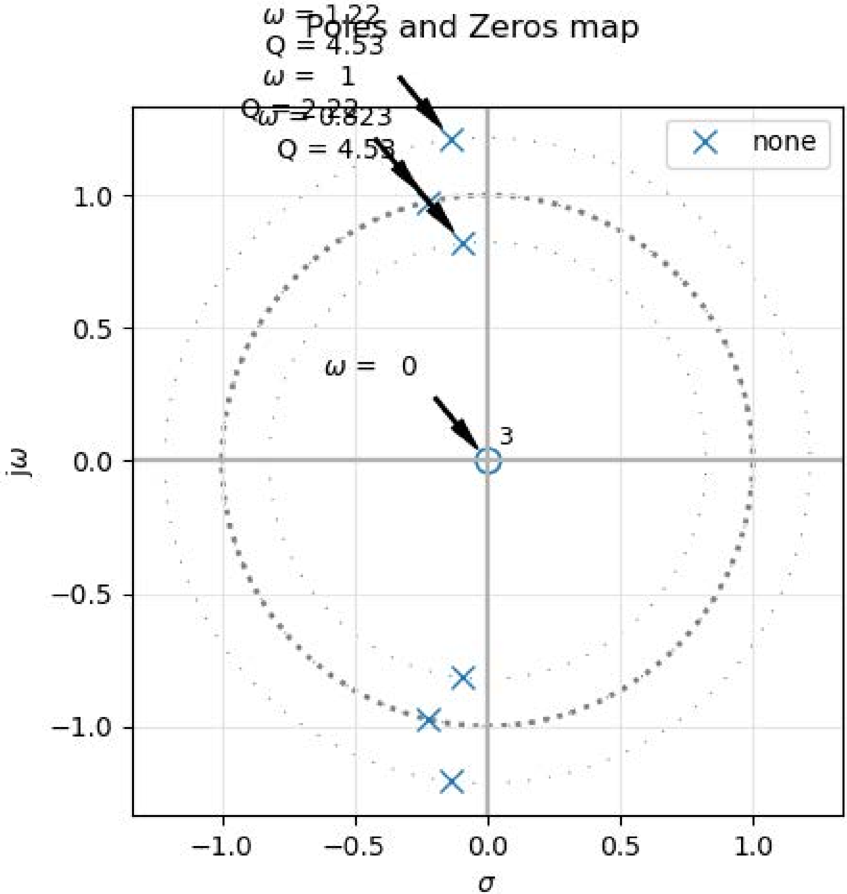


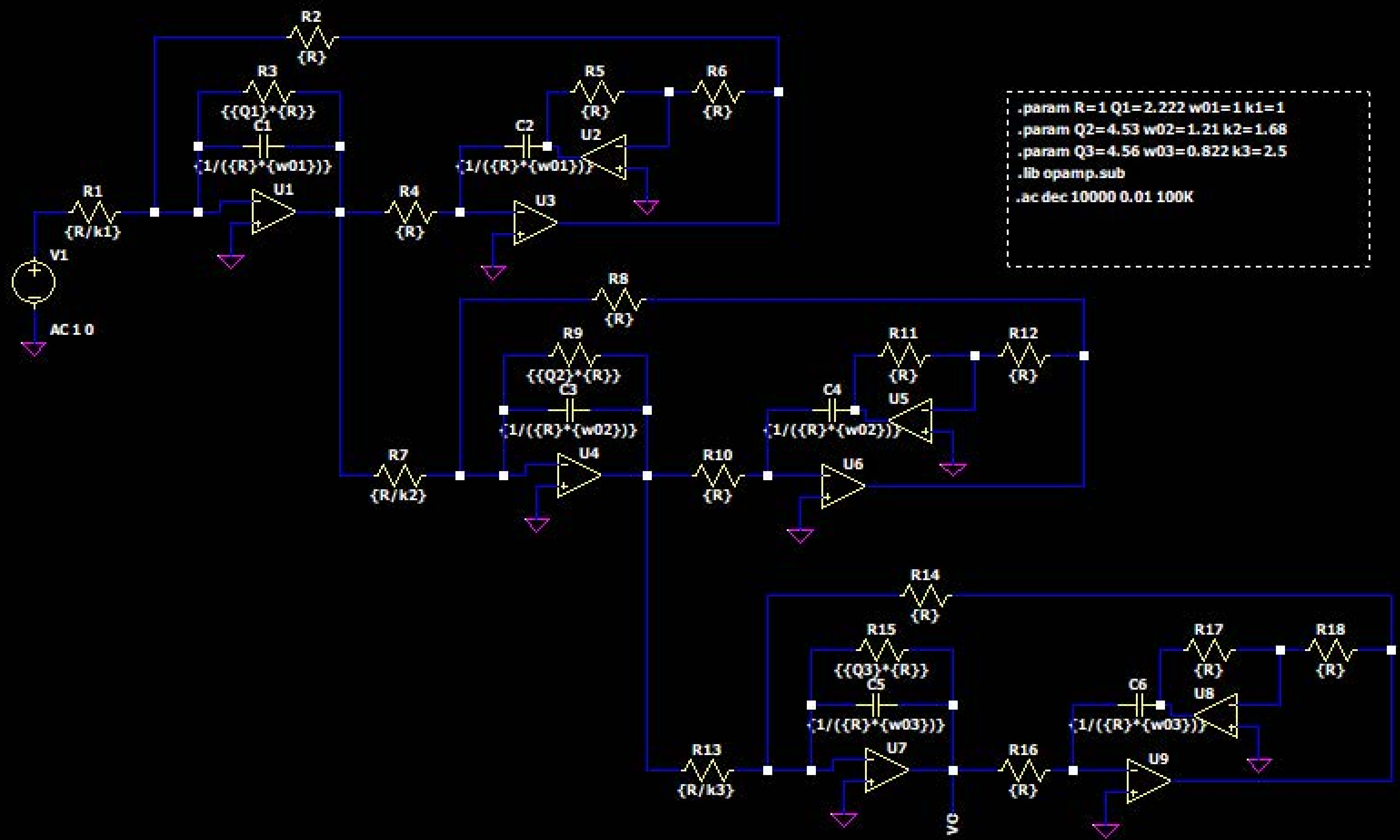
• TENES EL APORTE DE LOS CEROS → 60dB/dec QUE SE VERAN COMPENSADOS CON LOS CEROS, LOS CUALES TERMINARAN APORTANDO -60dB/dec

$z^3 \rightarrow 270°$
$-90°$

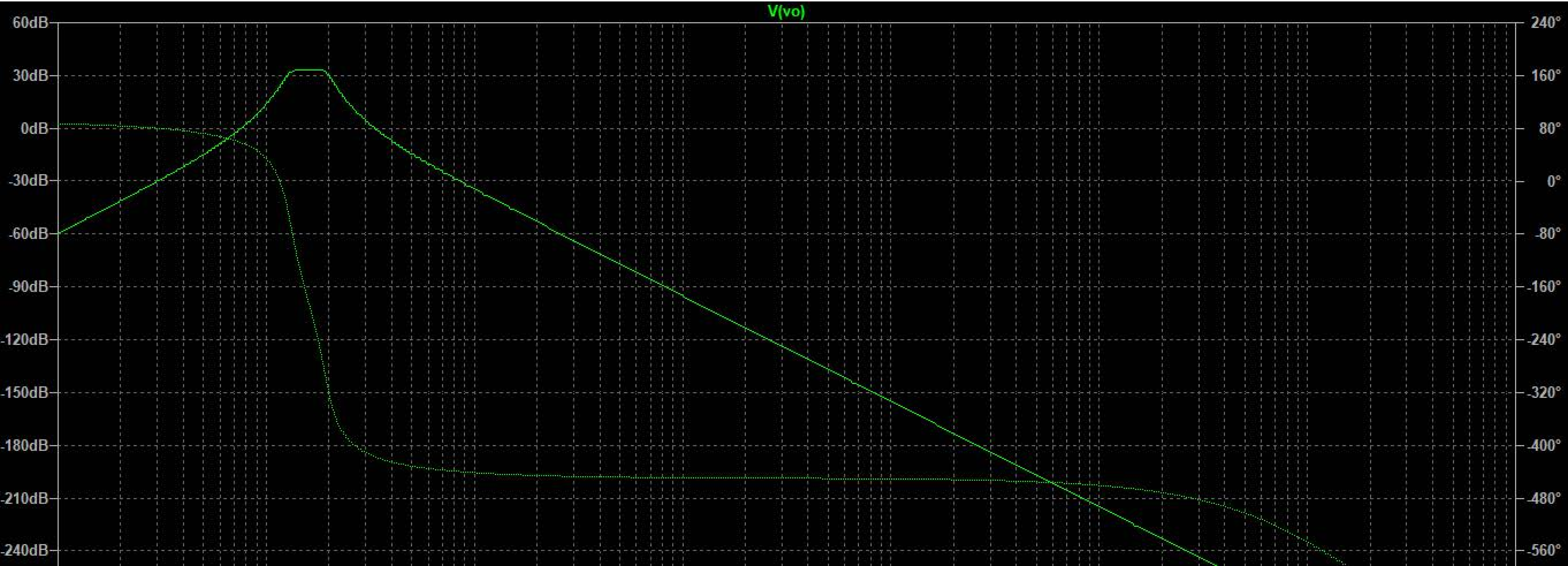
$p^2 \rightarrow 3 \cdot -180°$
$-540°$


Magnitude response
0
−50
−100
Magnitude [dB]
['']
Phase response
−100
−200
−300
−400
−500
−600
Phase [deg]
['']
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Angular frequency [rad/sec]

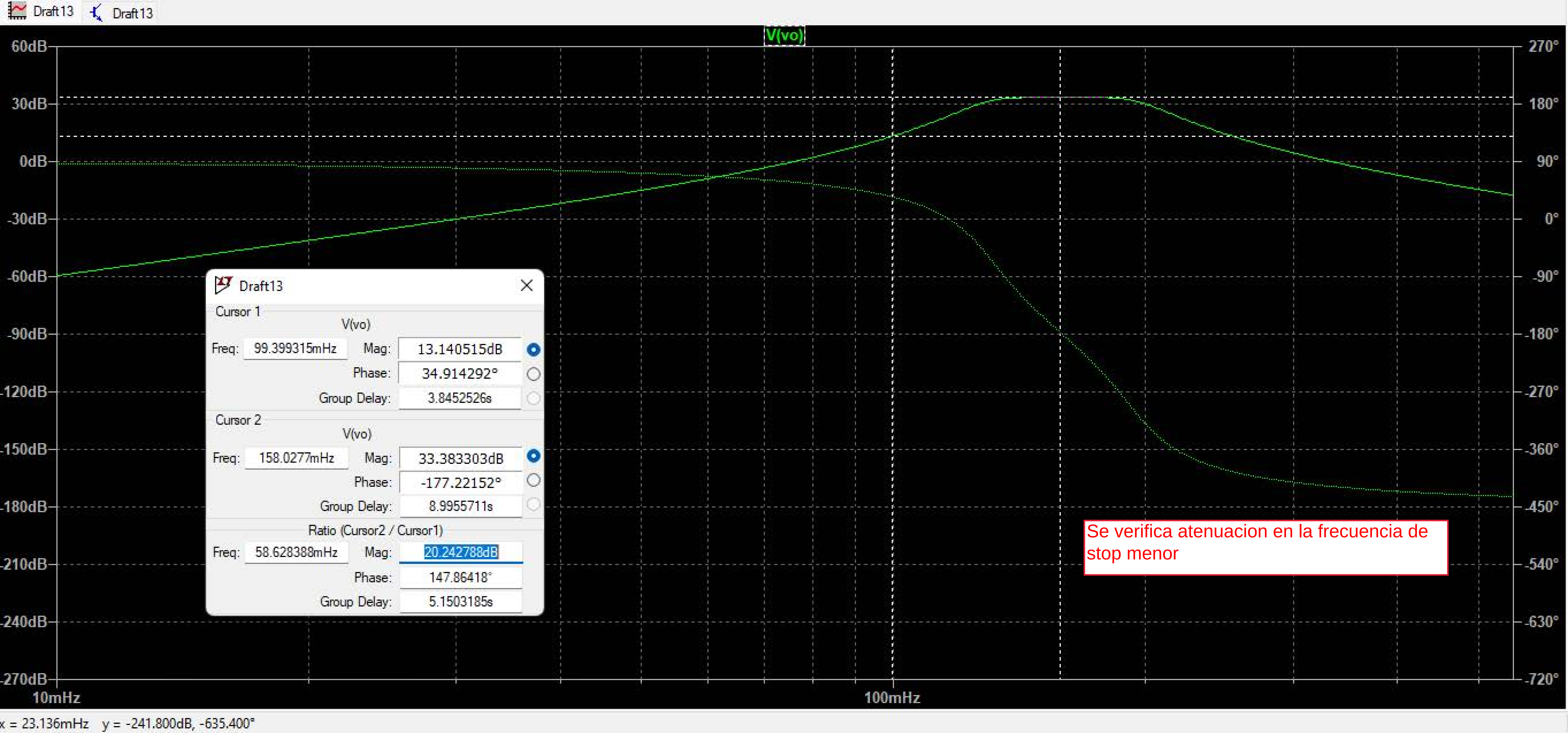

Poles and Zeros map
ω = 1.22
Q = 4.53
ω = 1
Q = 2.22
ω = 0.823
Q = 4.53
ω = 0
3
none
jω
σ
1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0



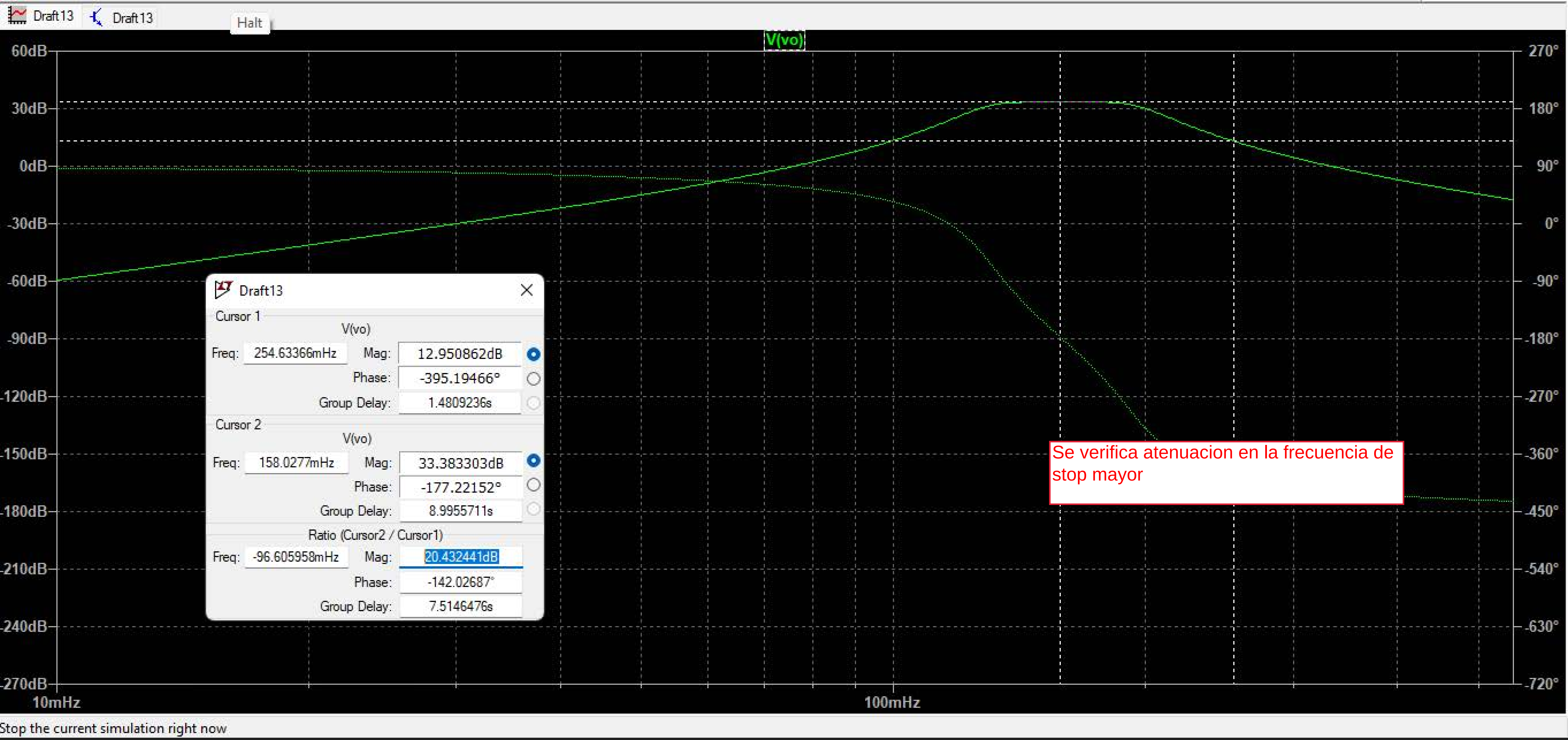
R1
{R/k1}
V1
AC 1 0
R2
{R}
R3
{{Q1}*{R}}
C1
{1/({R}*{w01})}
U1
R4
{R}
C2
{1/({R}*{w01})}
R5
{R}
R6
{R}
U2
U3
R7
{R/k2}
R8
{R}
R9
{{Q2}*{R}}
C3
{1/({R}*{w02})}
U4
R10
{R}
C4
{1/({R}*{w02})}
R11
{R}
R12
{R}
U5
U6
R13
{R/k3}
R14
{R}
R15
{{Q3}*{R}}
C5
{1/({R}*{w03})}
U7
R16
{R}
C6
{1/({R}*{w03})}
R17
{R}
R18
{R}
U8
U9
VO
.param R=1 Q1=2.222 w01=1 k1=1
.param Q2=4.53 w02=1.21 k2=1.68
.param Q3=4.56 w03=0.822 k3=2.5
.lib opamp.sub
.ac dec 10000 0.01 100K

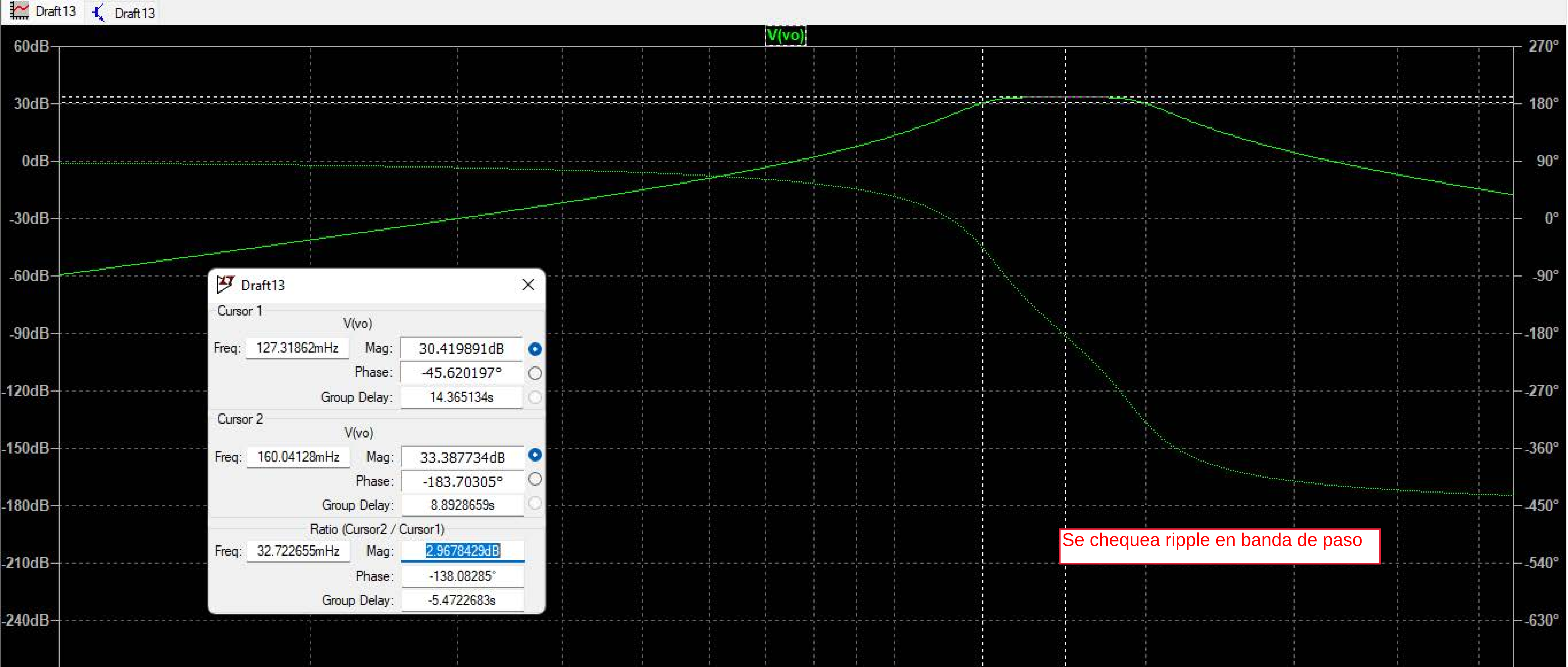


V(vo)
60dB
30dB
0dB
-30dB
-60dB
-90dB
-120dB
-150dB
-180dB
-210dB
-240dB
240°
160°
80°
0°
-80°
-160°
-240°
-320°
-400°
-480°
-560°



Draft13
Draft13
V(vo)
60dB
30dB
0dB
-30dB
-60dB
-90dB
-120dB
-150dB
-180dB
-210dB
-240dB
-270dB
270°
180°
90°
0°
-90°
-180°
-270°
-360°
-450°
-540°
-630°
-720°
10mHz
100mHz
Cursor 1
V(vo)
Freq: 99.399315mHz
Mag: 13.140515dB
Phase: 34.914292°
Group Delay: 3.8452526s
Cursor 2
V(vo)
Freq: 158.0277mHz
Mag: 33.383303dB
Phase: -177.22152°
Group Delay: 8.9955711s
Ratio (Cursor2 / Cursor1)
Freq: 58.628388mHz
Mag: 20.242788dB
Phase: 147.86418°
Group Delay: 5.1503185s
Se verifica atenuacion en la frecuencia de stop menor
x = 23.136mHz y = -241.800dB, -635.400°


Draft13
Draft13
Halt
V(vo)
60dB
30dB
0dB
-30dB
-60dB
-90dB
-120dB
-150dB
-180dB
-210dB
-240dB
-270dB
270°
180°
90°
0°
-90°
-180°
-270°
-360°
-450°
-540°
-630°
-720°
10mHz
100mHz
Draft13
Cursor 1
V(vo)
Freq: 254.63366mHz
Mag: 12.950862dB
Phase: -395.19466°
Group Delay: 1.4809236s
Cursor 2
V(vo)
Freq: 158.0277mHz
Mag: 33.383303dB
Phase: -177.22152°
Group Delay: 8.9955711s
Ratio (Cursor2 / Cursor1)
Freq: -96.605958mHz
Mag: 20.432441dB
Phase: -142.02687°
Group Delay: 7.5146476s
Se verifica atenuacion en la frecuencia de stop mayor
Stop the current simulation right now



Draft13
Draft13
V(vo)
60dB
30dB
0dB
-30dB
-60dB
-90dB
-120dB
-150dB
-180dB
-210dB
-240dB
270°
180°
90°
0°
-90°
-180°
-270°
-360°
-450°
-540°
-630°
Draft13
Cursor 1
V(vo)
Freq: 127.31862mHz
Mag: 30.419891dB
Phase: -45.620197°
Group Delay: 14.365134s
Cursor 2
V(vo)
Freq: 160.04128mHz
Mag: 33.387734dB
Phase: -183.70305°
Group Delay: 8.8928659s
Ratio (Cursor2 / Cursor1)
Freq: 32.722655mHz
Mag: 2.9678429dB
Phase: -138.08285°
Group Delay: -5.4722683s
Se chequea ripple en banda de paso