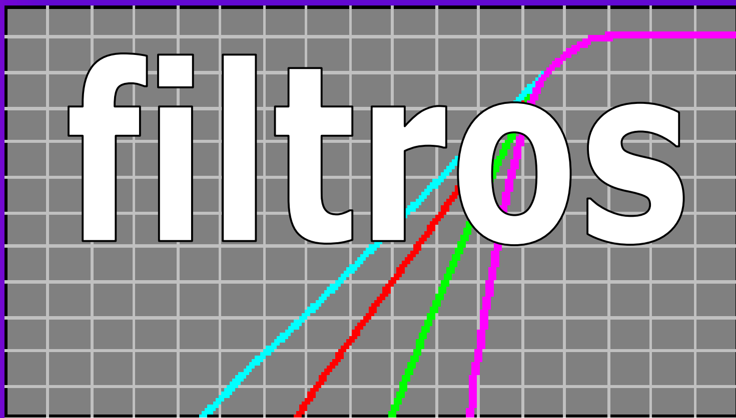
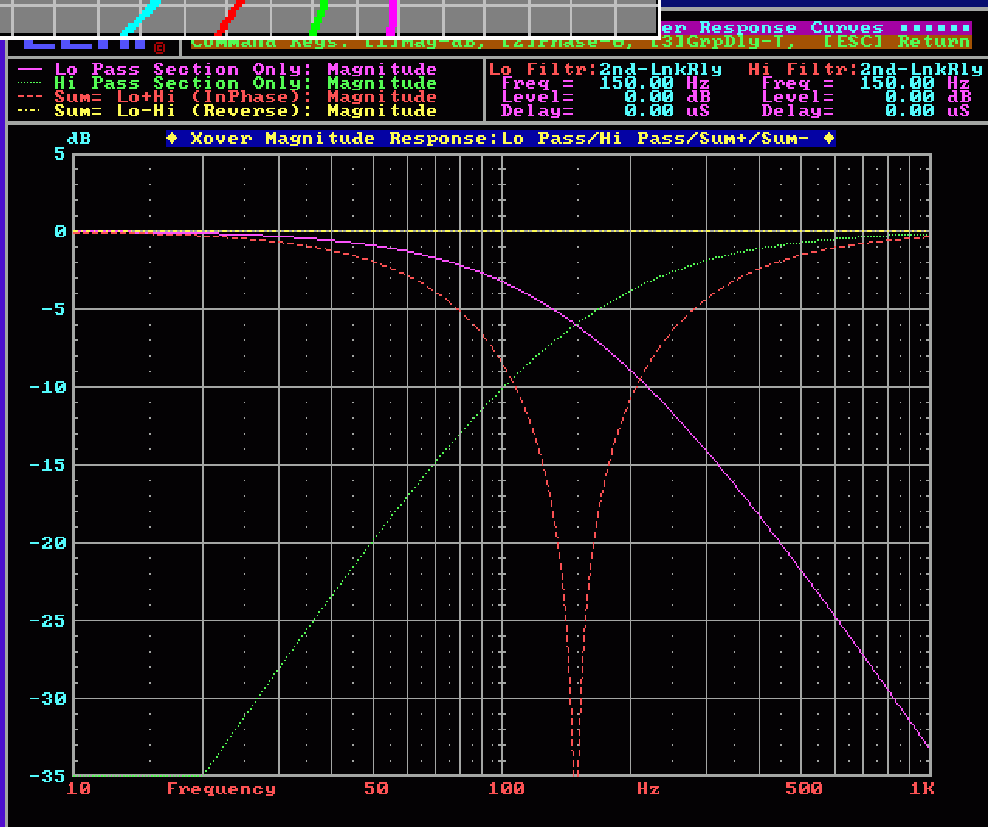
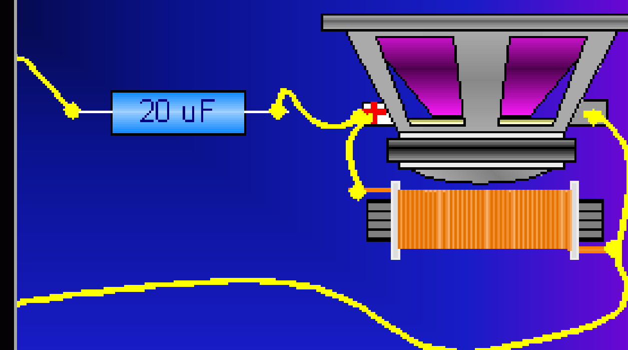
filtros de cruce





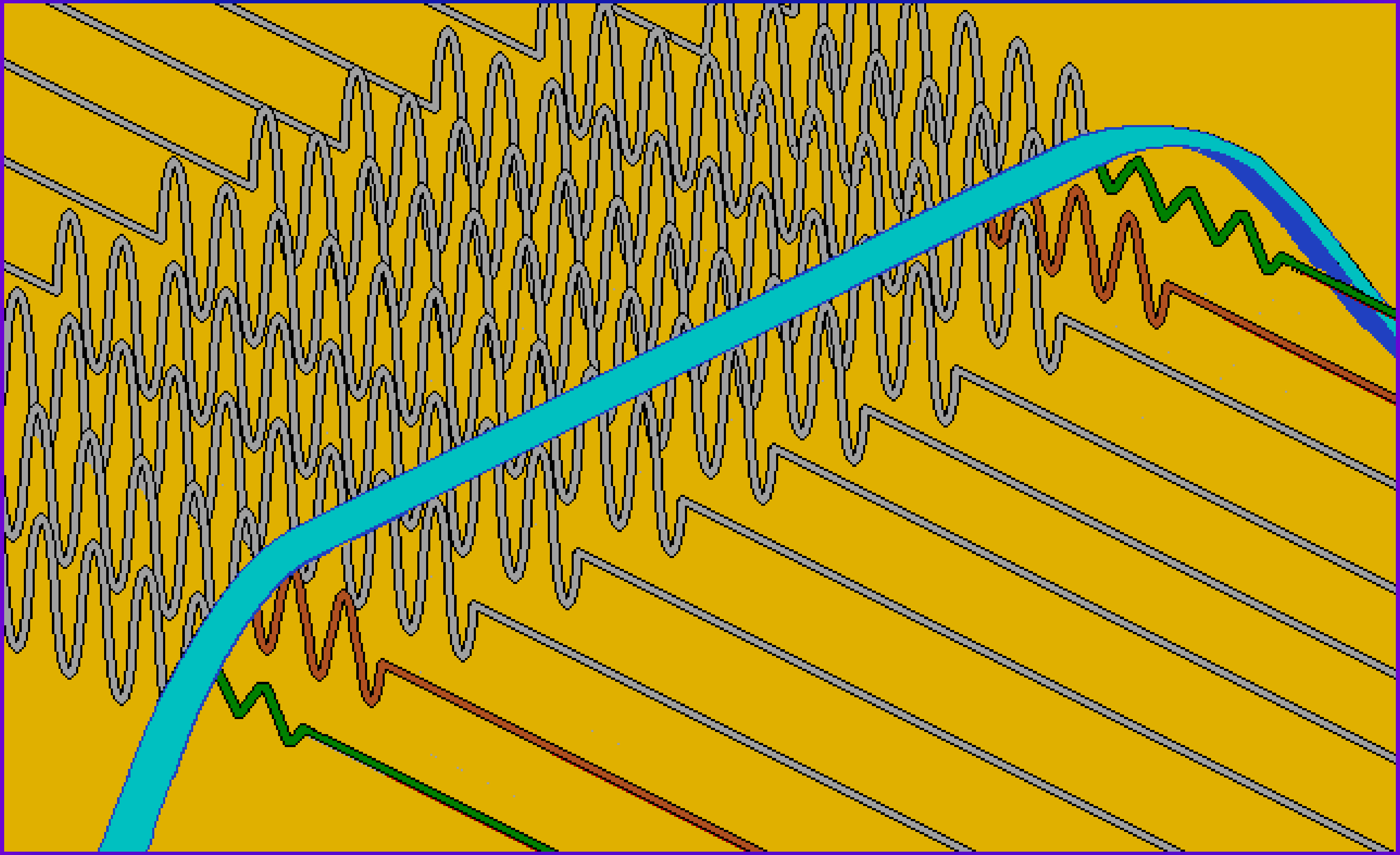


Xullo Xermade

¿cal é a función do filtro?

Distribuir o sinal según as frecuencias

¿qué fan os filtros:

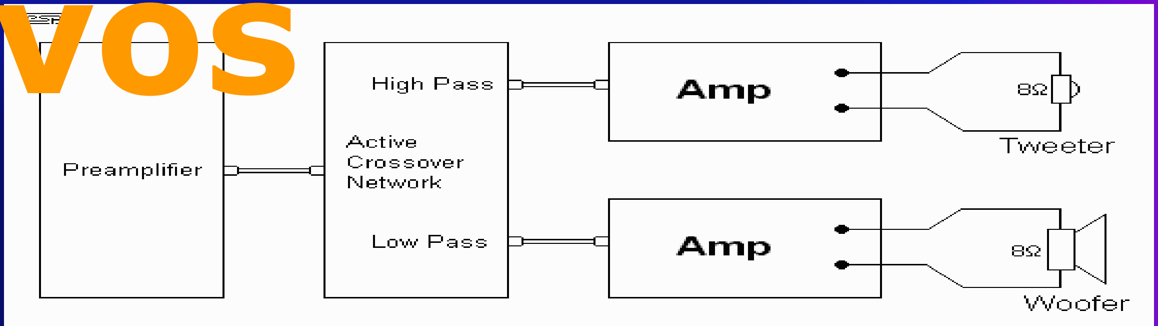


características dun filtro?

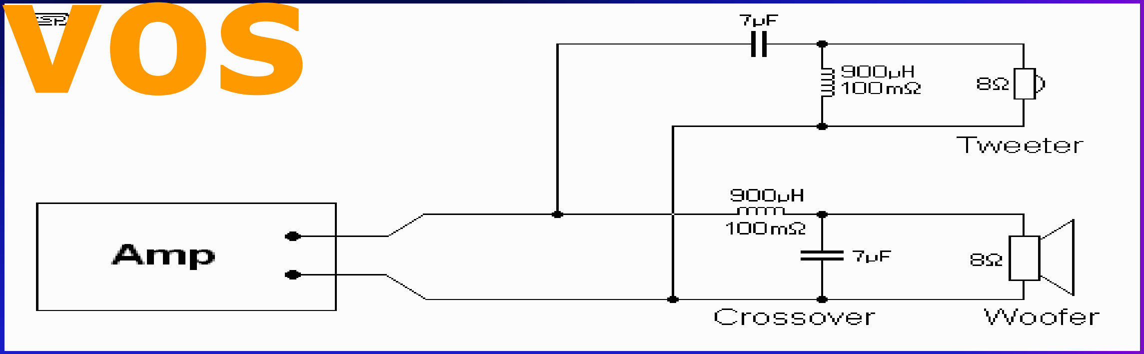
* Nº de vias
* Frecuencia de corte
* Impedancia de carga
* Atenuación da célula
* Fase da saida

familias de filtros:

* activos



* pasivos



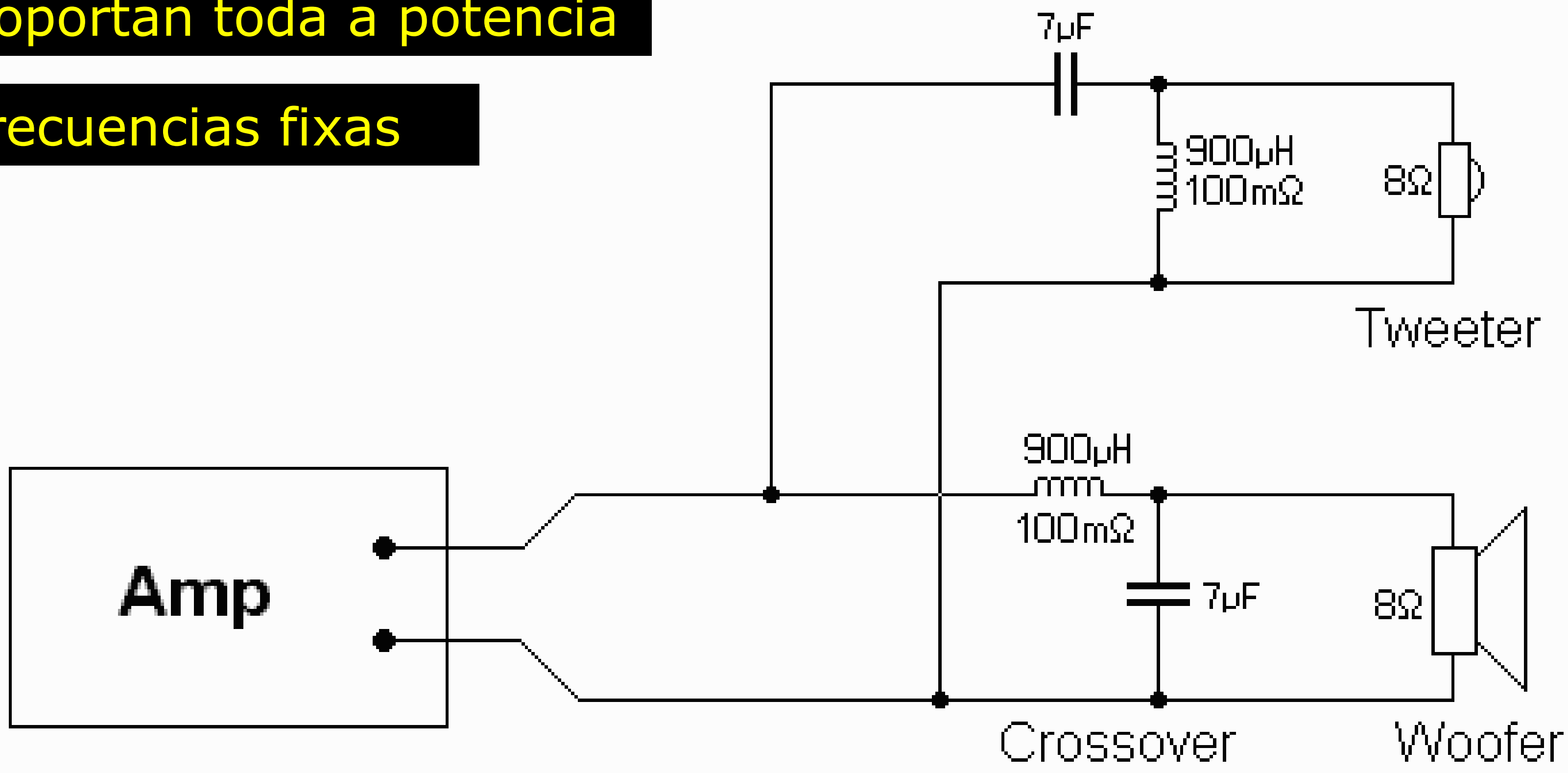
filtros pasivos:

utilizan compoñentes pasivos

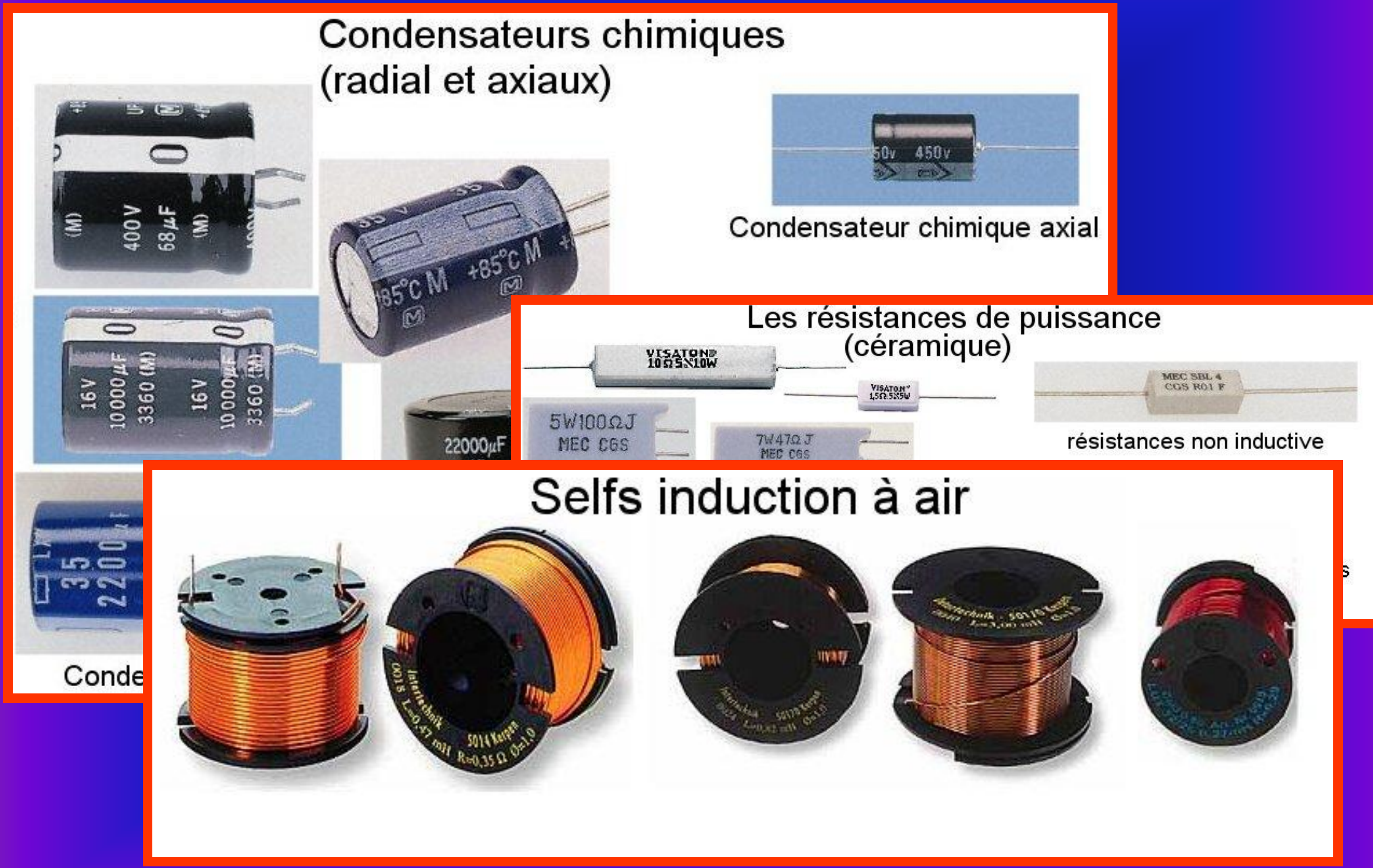
non amplifican

soportan toda a potencia

frecuencias fixas

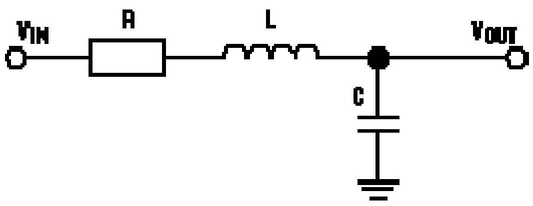


compoñentes pasivos:



Ventaxas e inconvintes, pasivos:

- Filtros pasivos
  - No usan amplificadores
    - Bajo ruido
    - No ganancia y mala adaptación de impedancias
  - Fácil diseñar e implementar para 1 o 2 polos (sólo RC)
    - Poca pendiente: la frecuencia a filtrar debe estar lejos de la banda de paso
    - No adecuados para baja frecuencia porque R y C ↑↑
  - Difícil diseñar e implementar para varios polos y RLC
    - Se acercan a los ideales pero los componentes (L) son grandes y caros
    - Requieren ajustes en producción



$$H(s) = \frac{\omega_c^2}{s^2 + s\omega_c / Q + \omega_c^2}$$ donde

$$\omega_c^2 = \frac{1}{LC} \qquad Q = \frac{\omega_c L}{R}$$

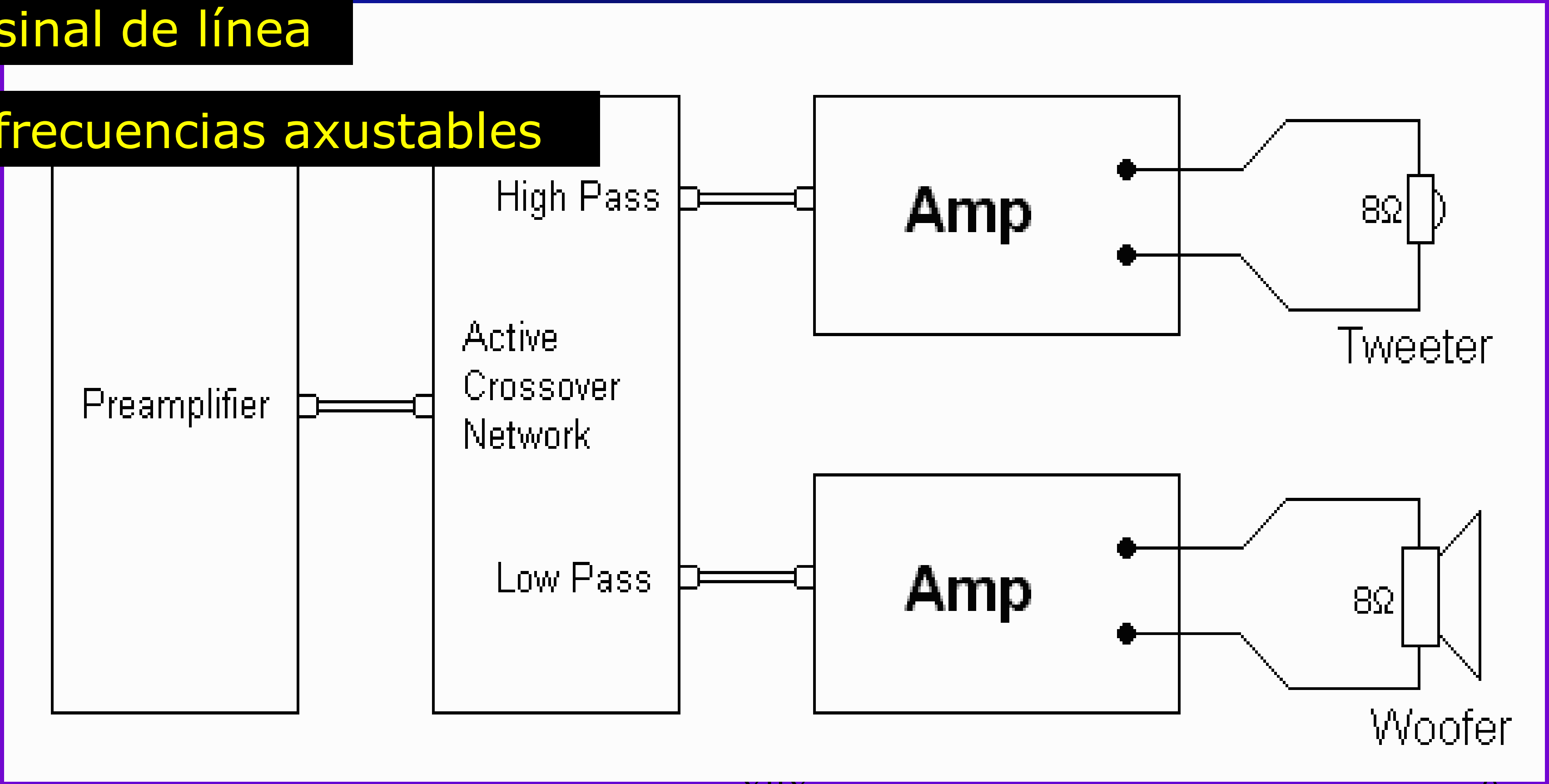
filtros activos:

utilizan compoñentes activos

pendentes axustables

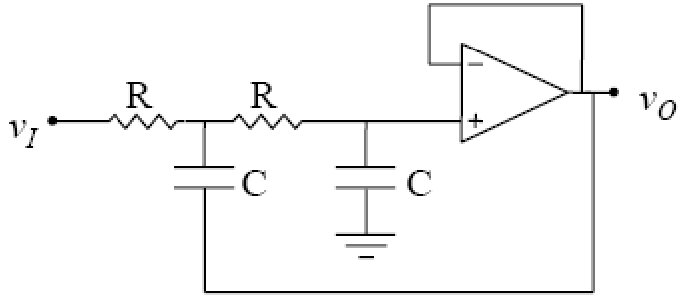
sinal de línea

frecuencias axustables



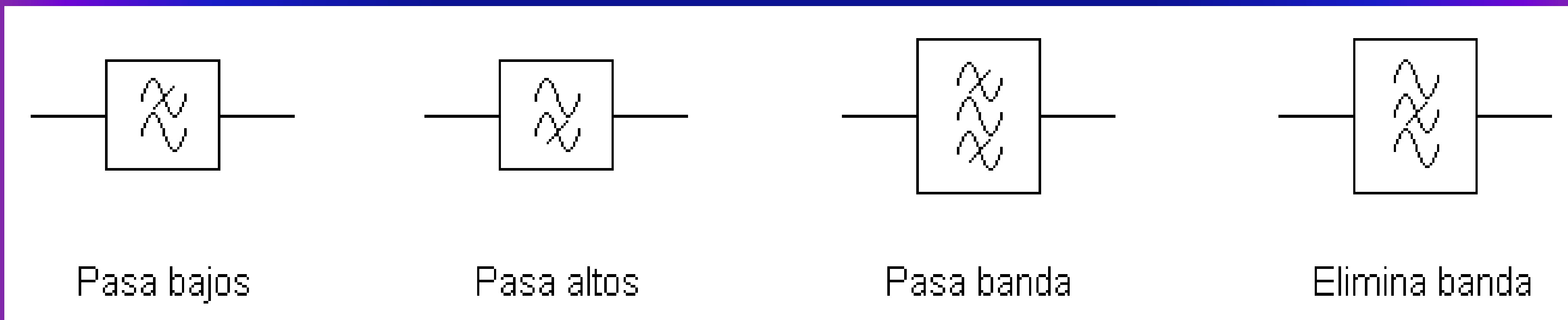
Ventaxas e inconvintes, activos:

- Filtros activos
  - Usan amplificadores y RC, no L
    - Tienen ganancia y buena adaptación de impedancias
    - Más ruido que los pasivos
  - Fácil diseñar e implementar varios polos (etapas de 2 polos en cascada)
    - Se consigue pendiente elevada
  - Limitación en alta frecuencia por el AO



$$H(s) = \frac{1}{R^2C^2s^2 + 2RCs + 1}$$

Simboloxía:



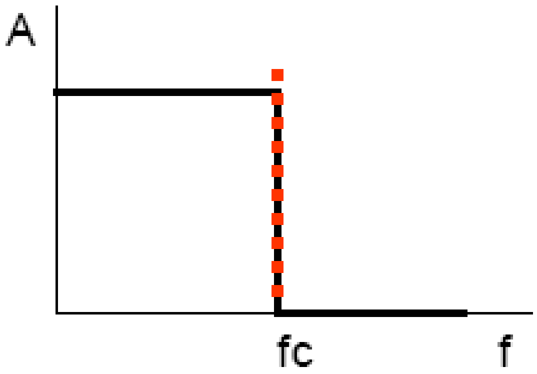
Low **P**ass

High **P**ass

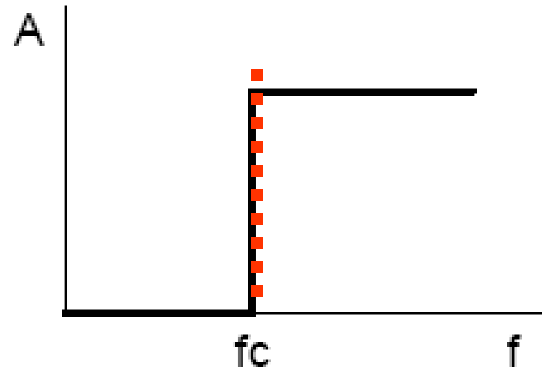
Band **P**ass

Band **R**eject

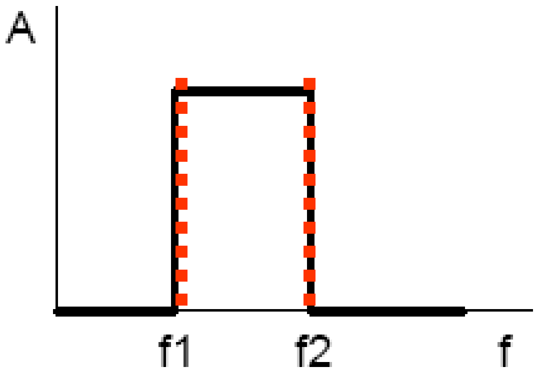
Frecuencia de corte:



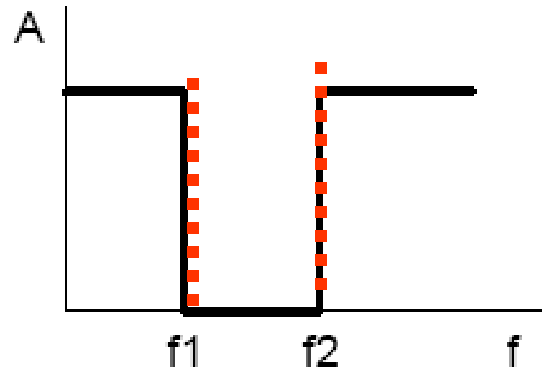
Filtro **PASO BAJO** (LP)



Filtro **PASO ALTO** (HP)

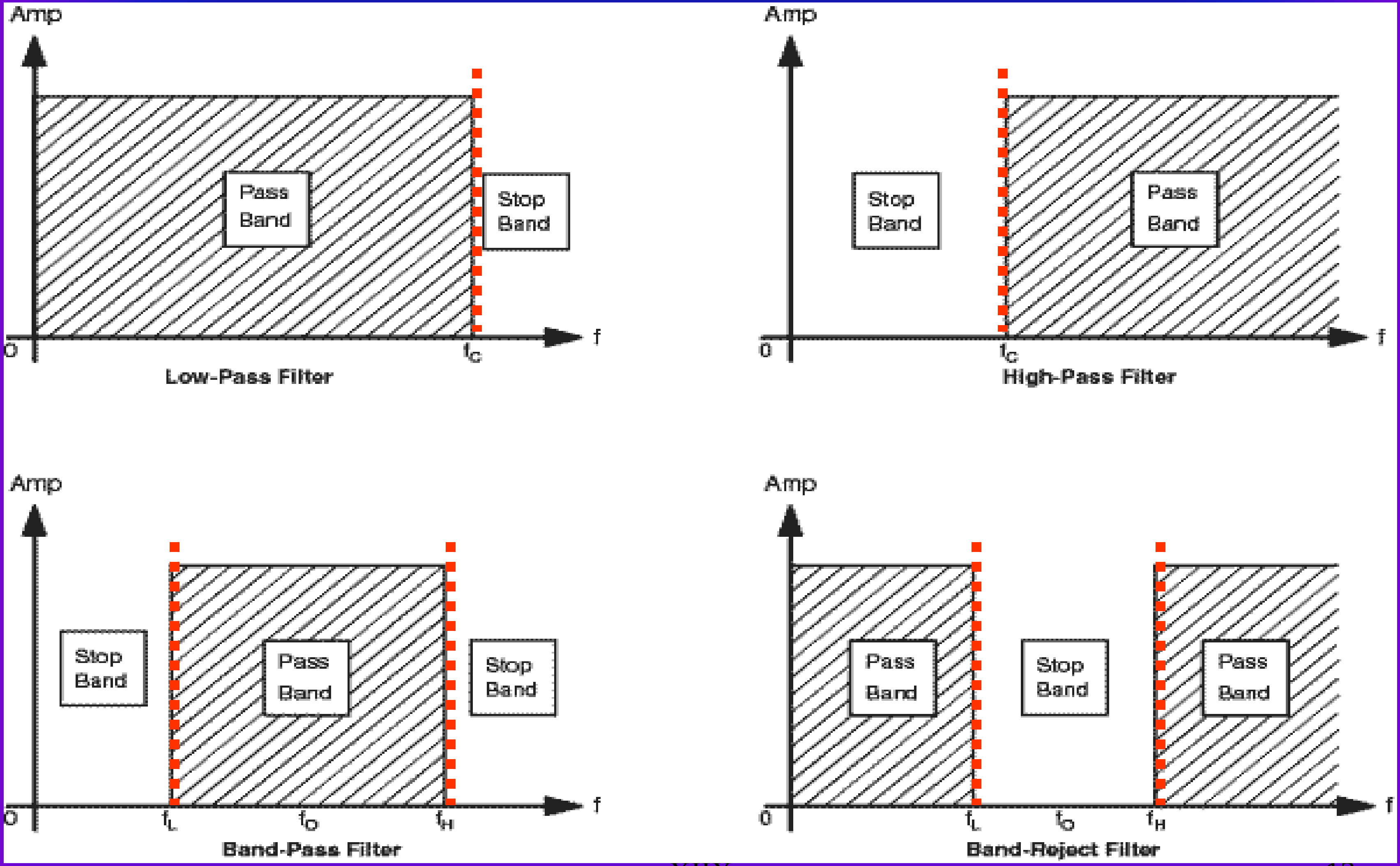


Filtro **PASO BANDA** (BP)

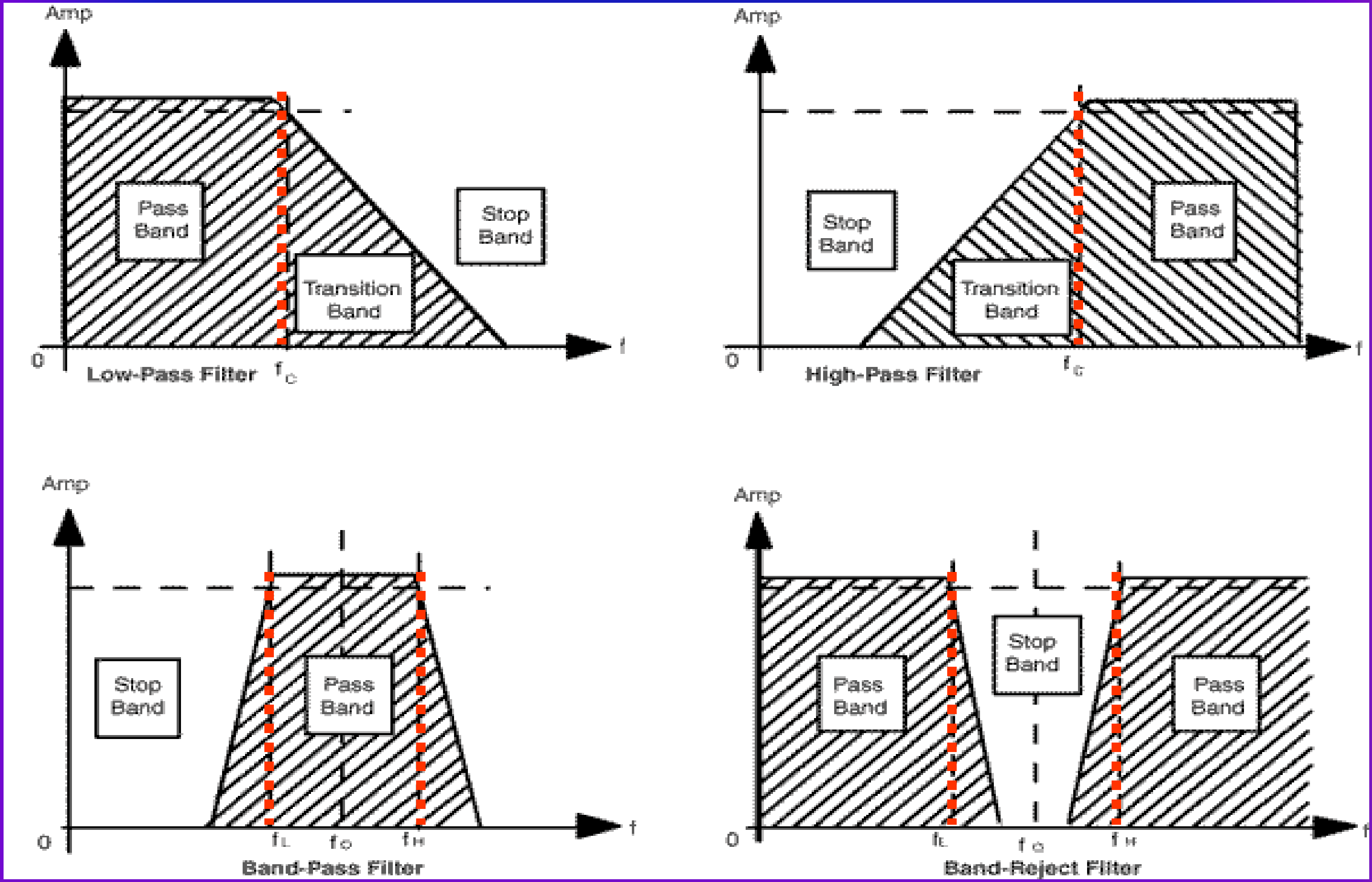


Filtro **BANDA ATENUADA**

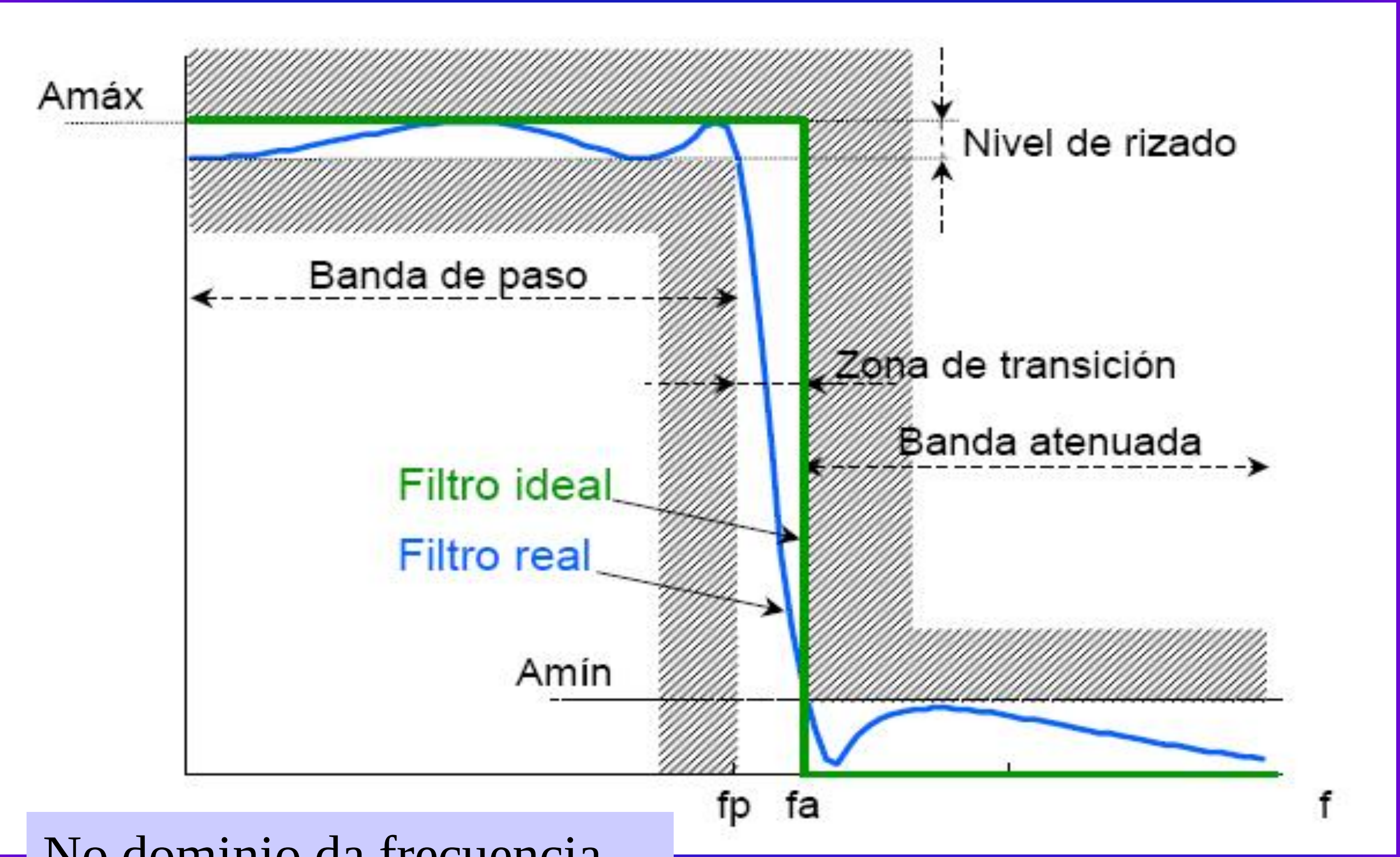
filtro ideal:



banda de transición:

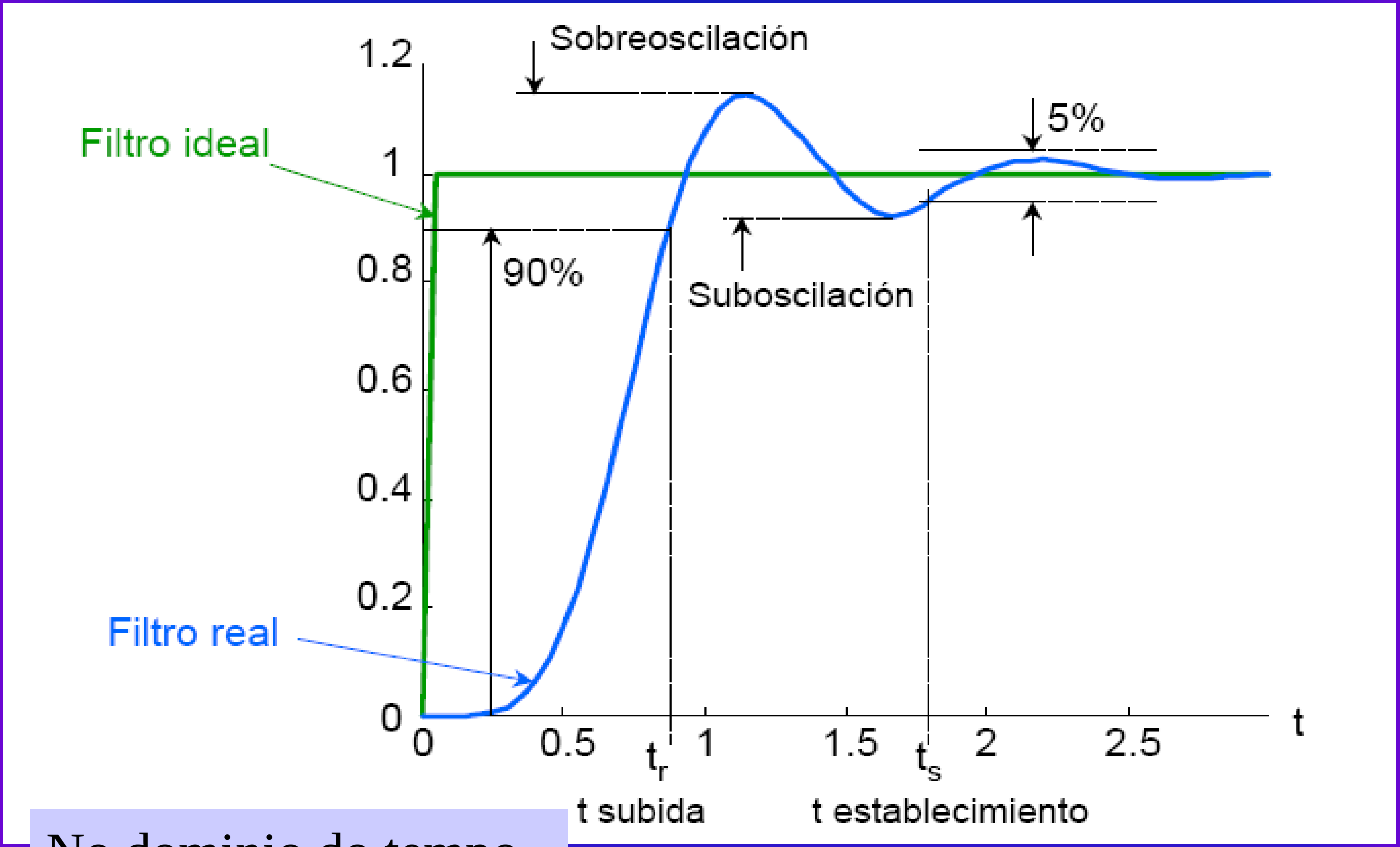


curva real (1):



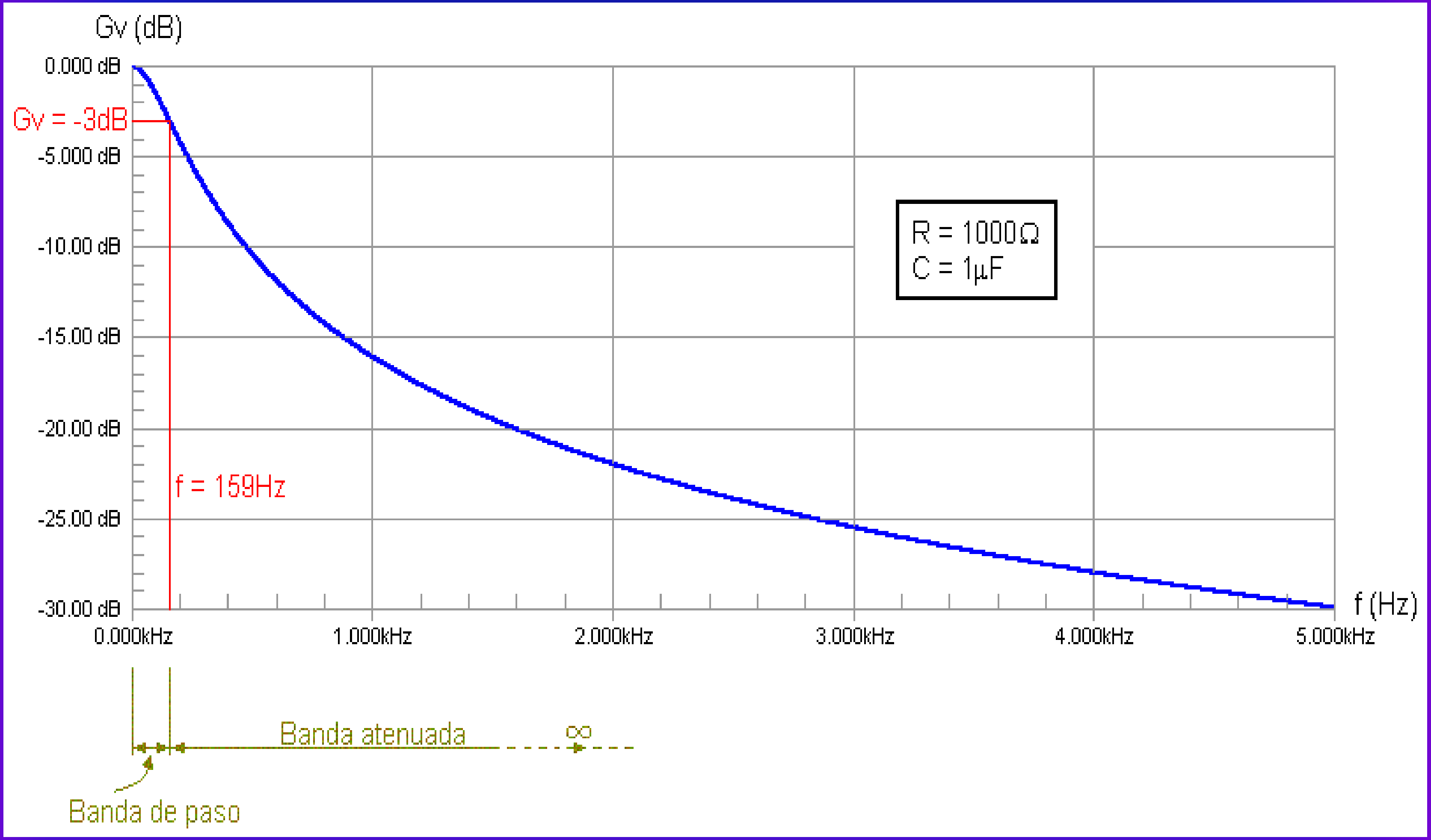
No dominio da frecuencia

curva real (2):

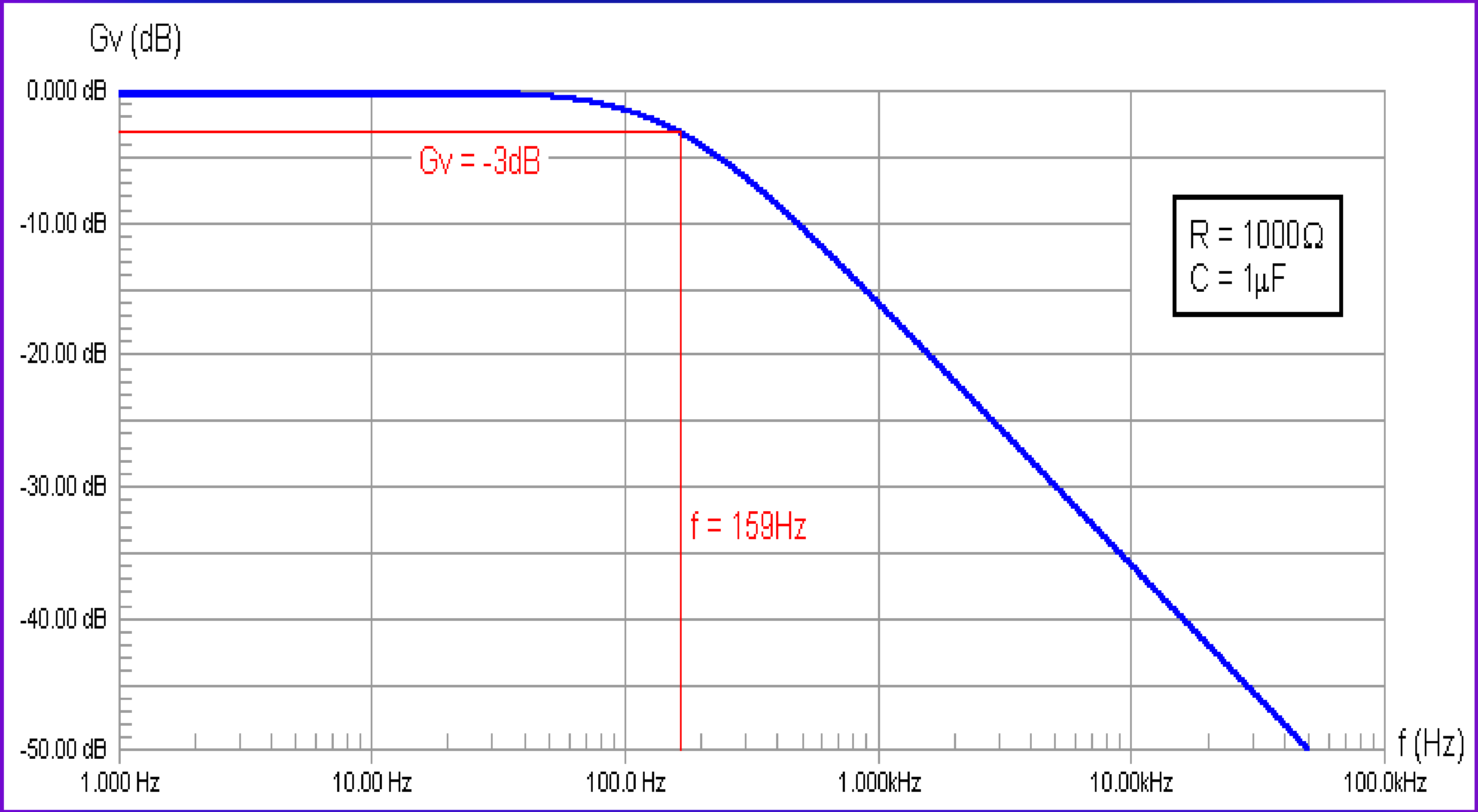


No dominio do tempo

Banda de paso (1):

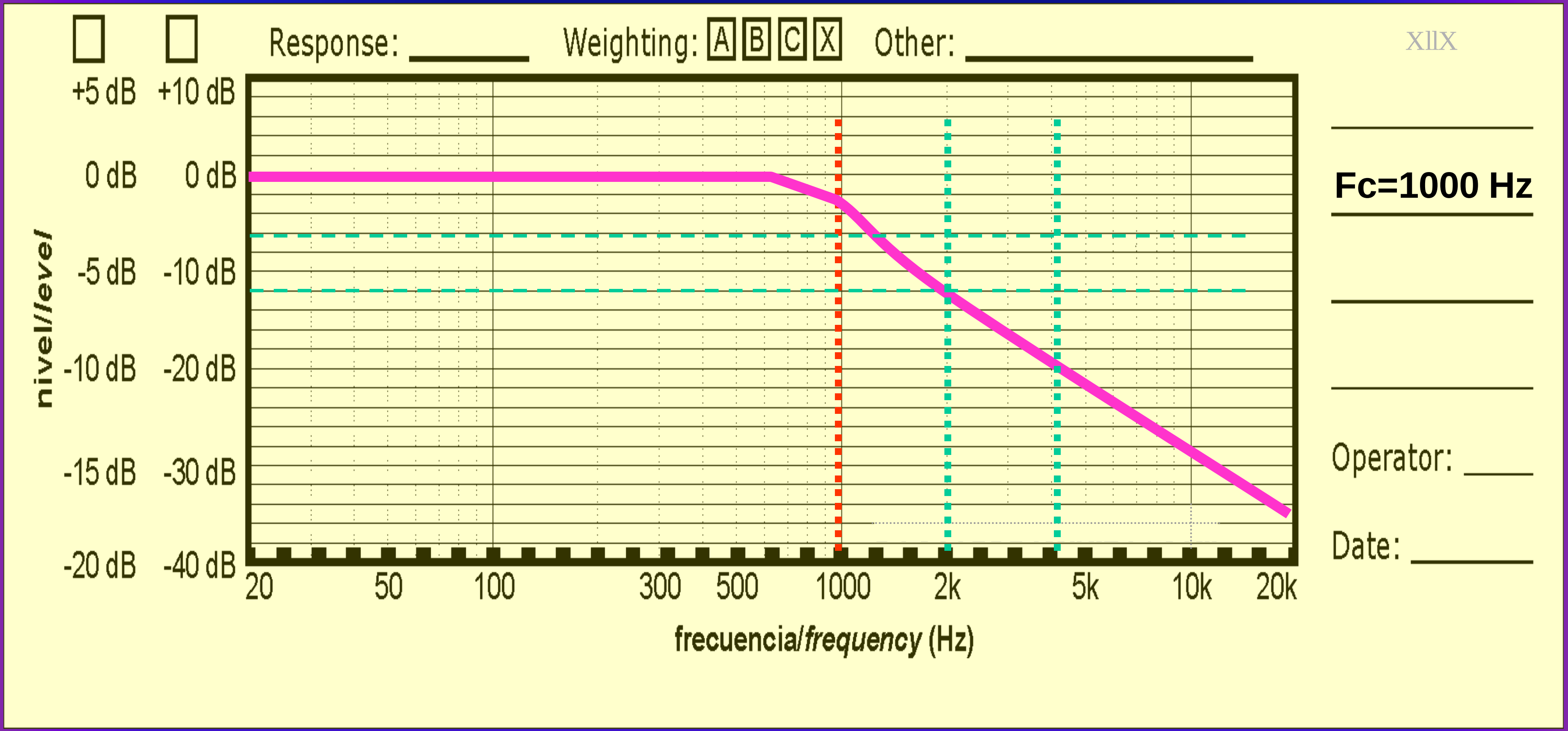


Banda de paso (2):



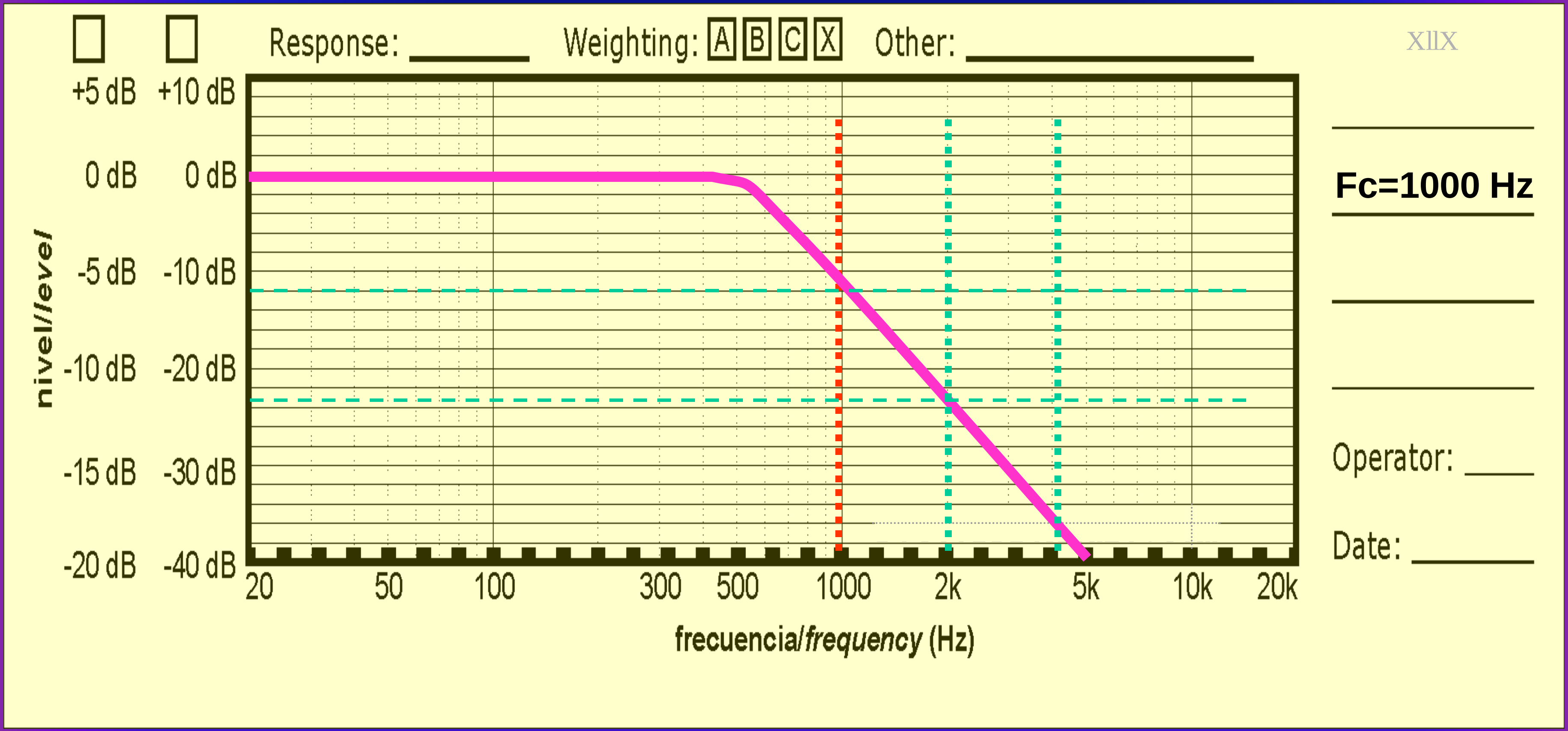
clases de ordenes:

1º orden: -6 dB/octava



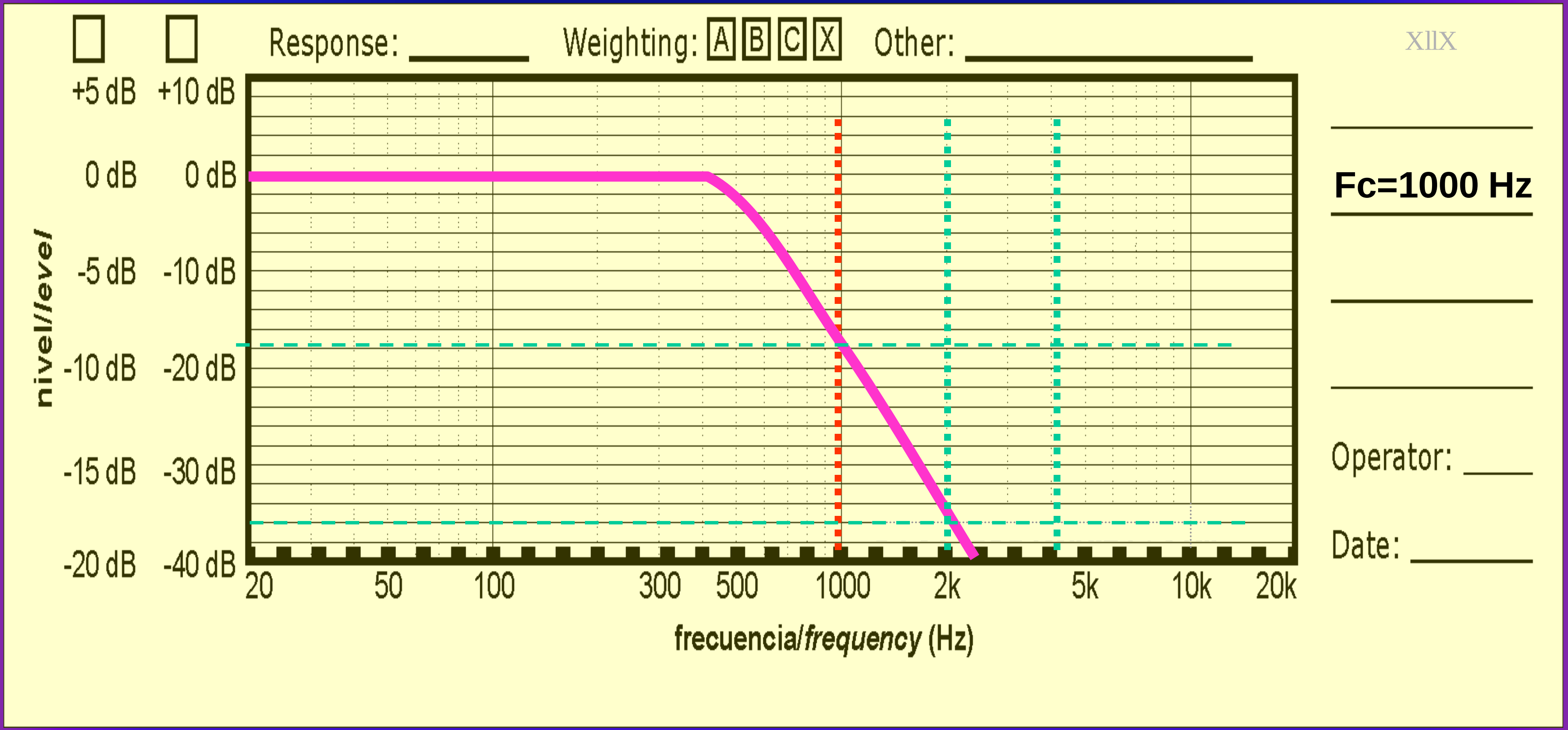
clases de ordenes:

2º orden: -12 dB/octava



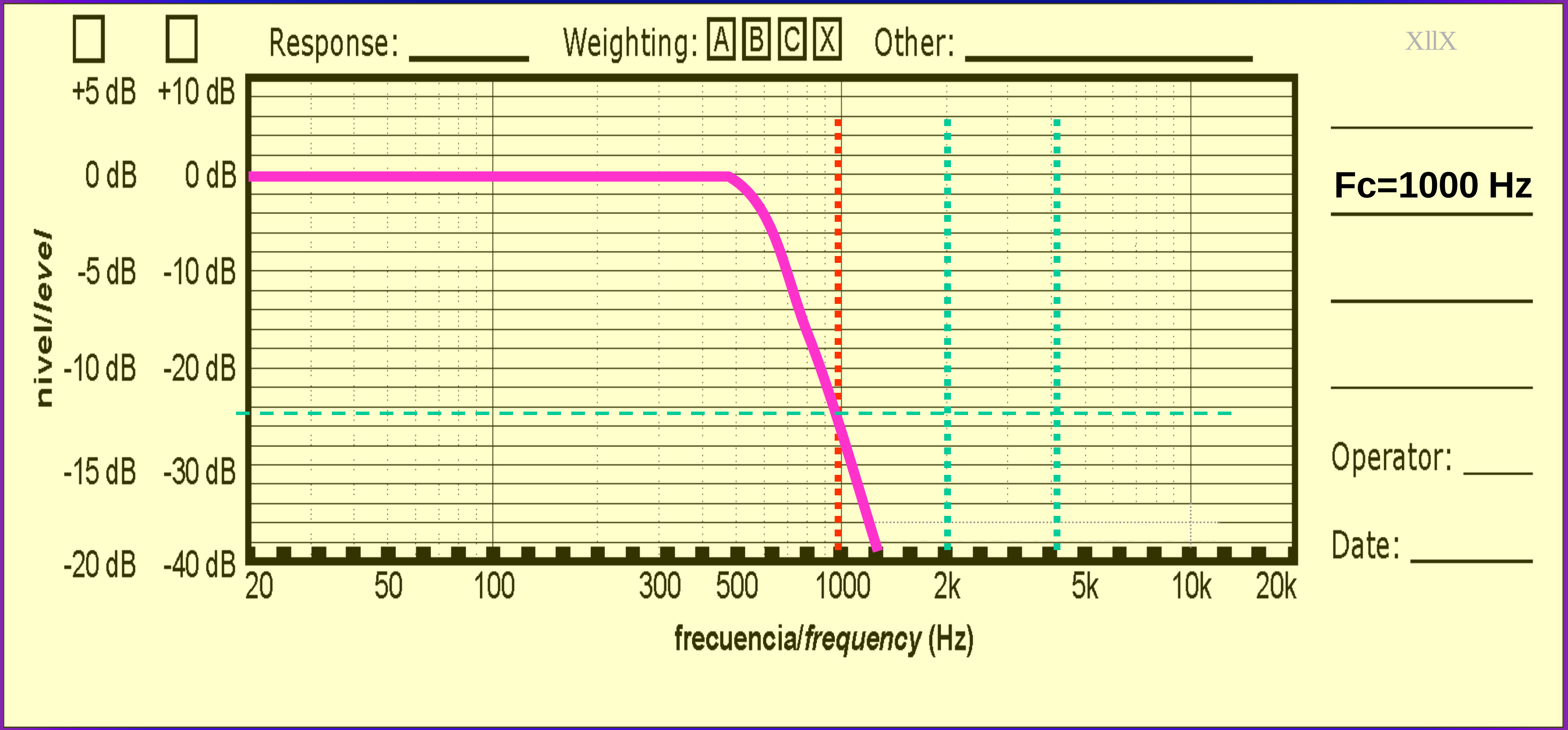
clases de ordenes:

3º orden: -18 dB/octava

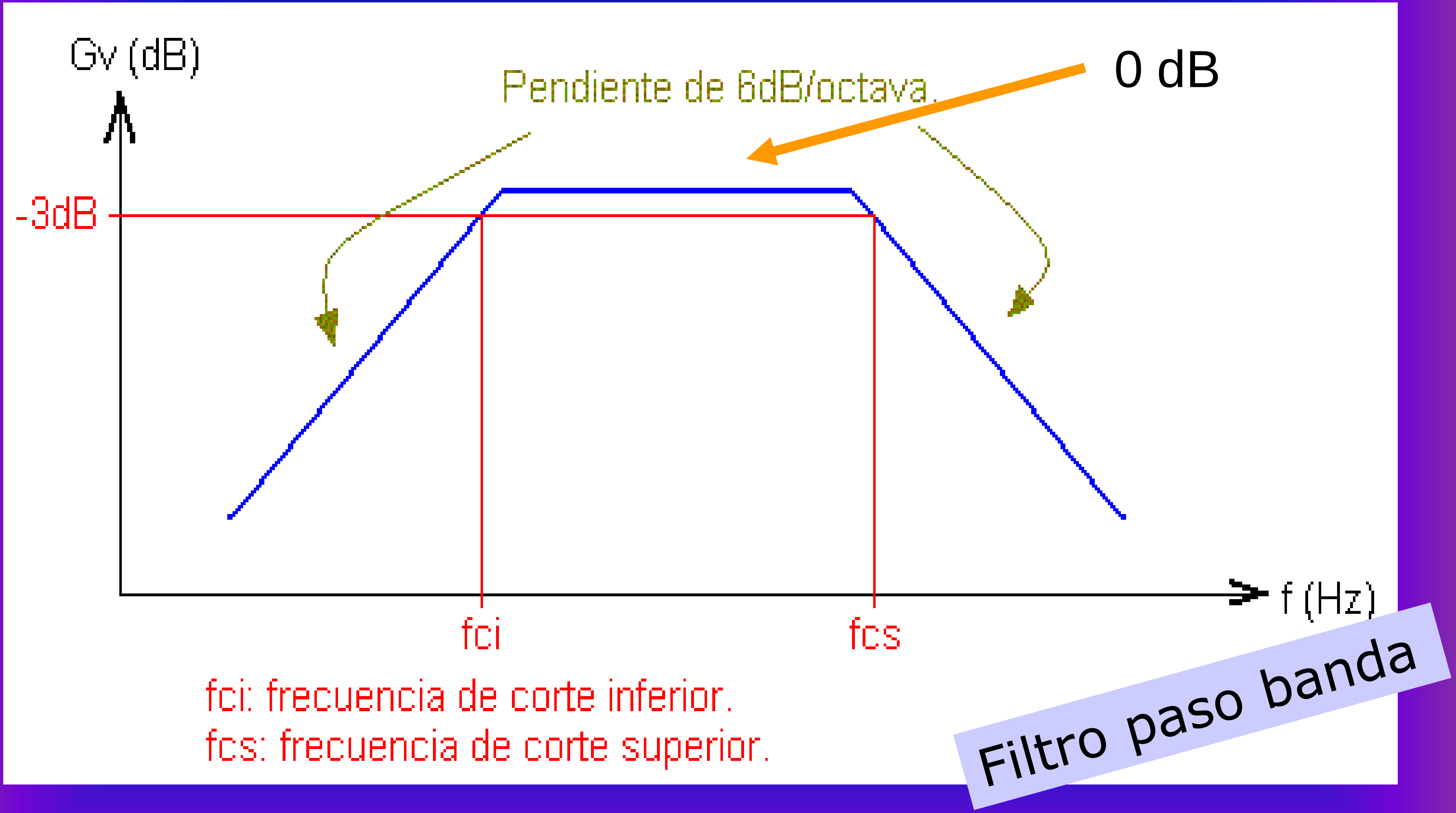


clases de ordenes:

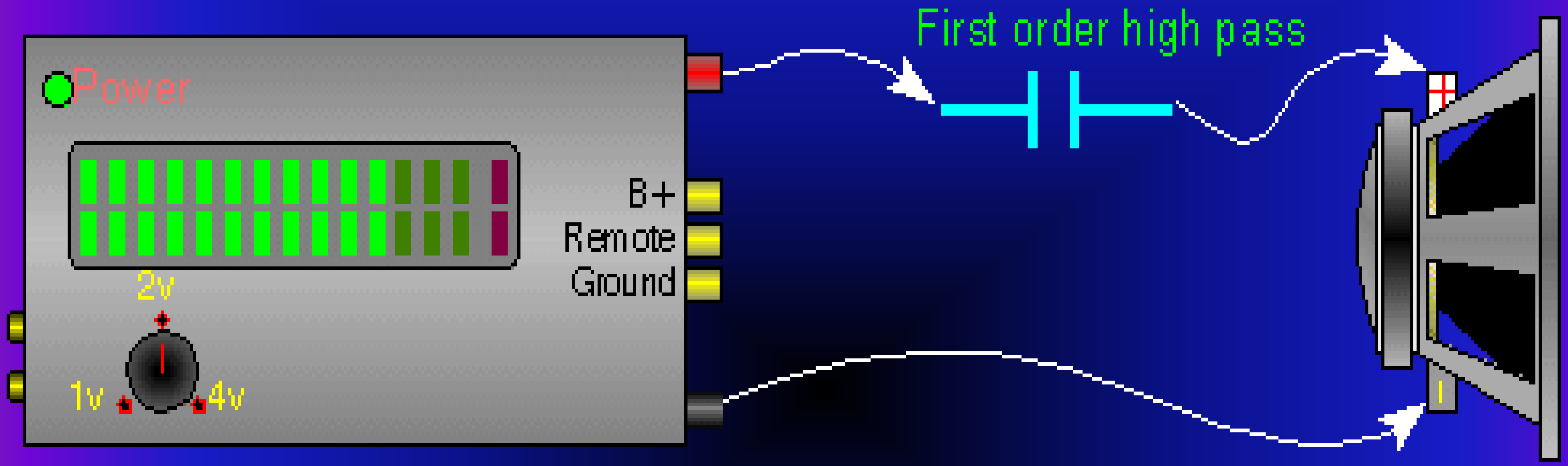
4º orden: -24 dB/octava

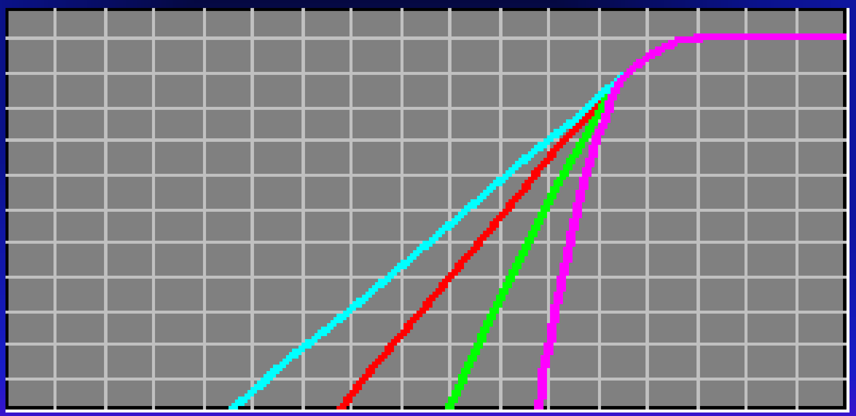


orden:

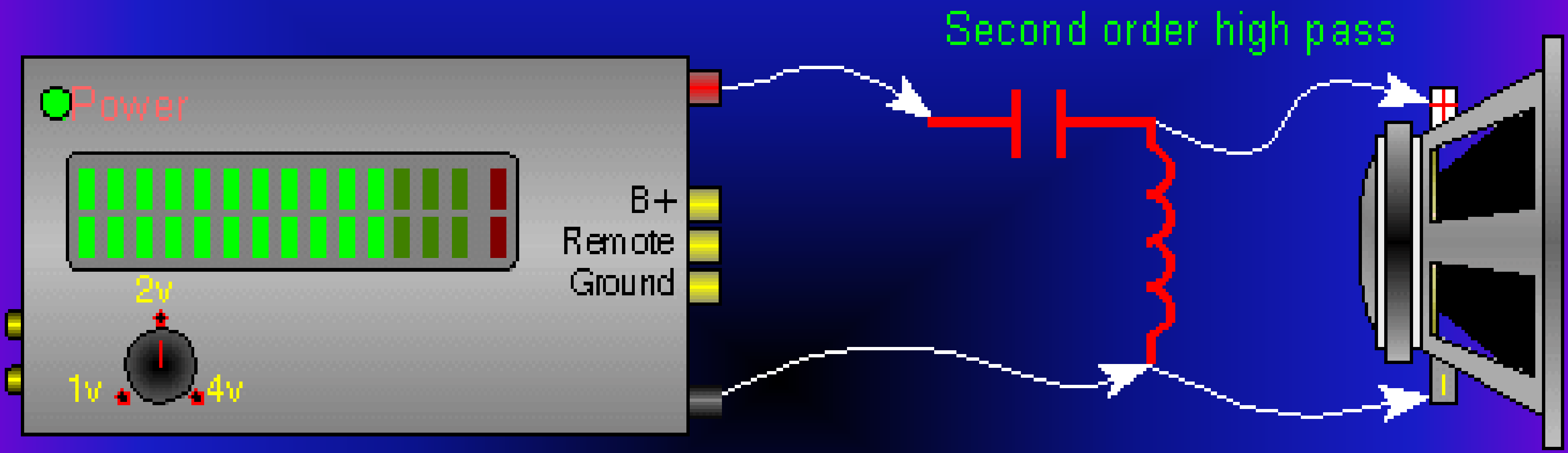

Gv (dB)
Pendiente de 6dB/octava.
0 dB
-3dB
f (Hz)
fci
fcs
fci: frecuencia de corte inferior.
fcs: frecuencia de corte superior.
Filtro paso banda

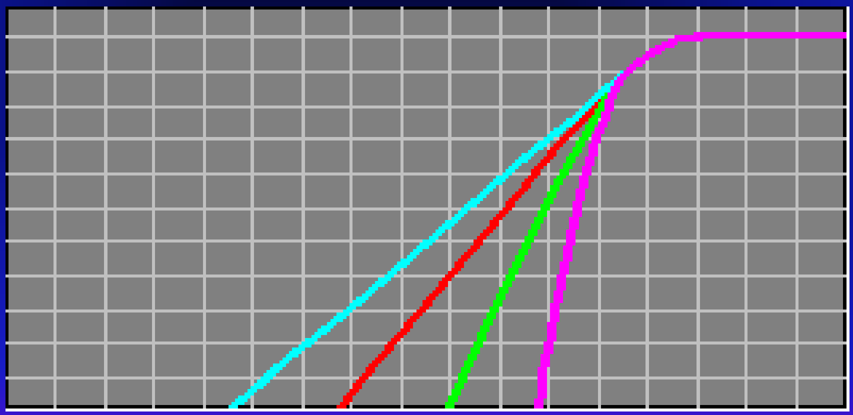
1º orden – paso alto:



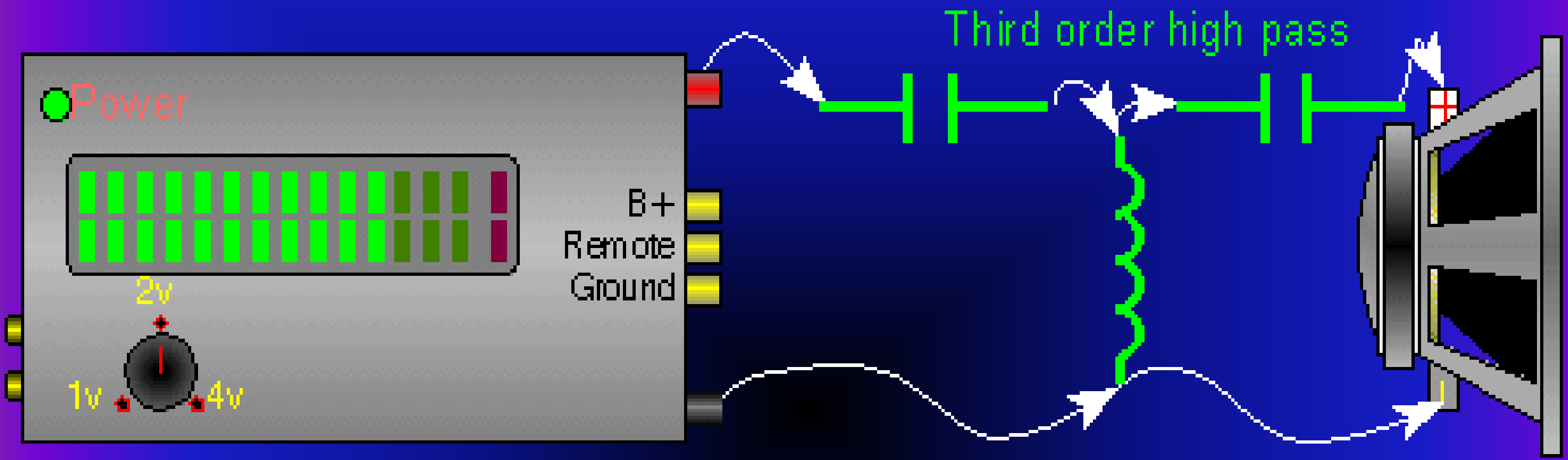


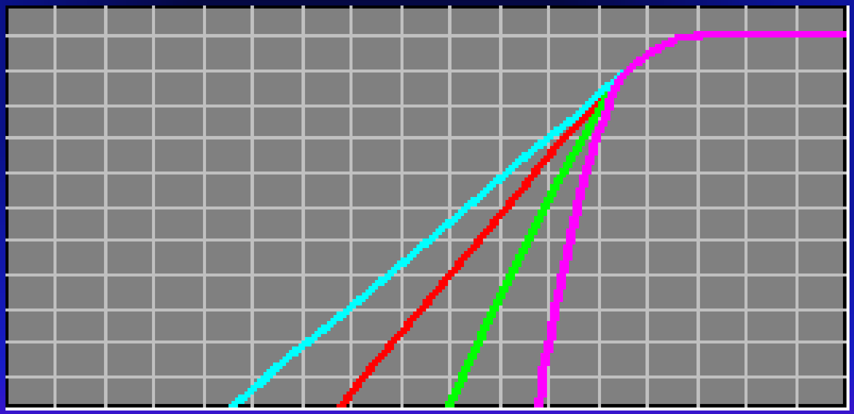
2º orden – paso alto:



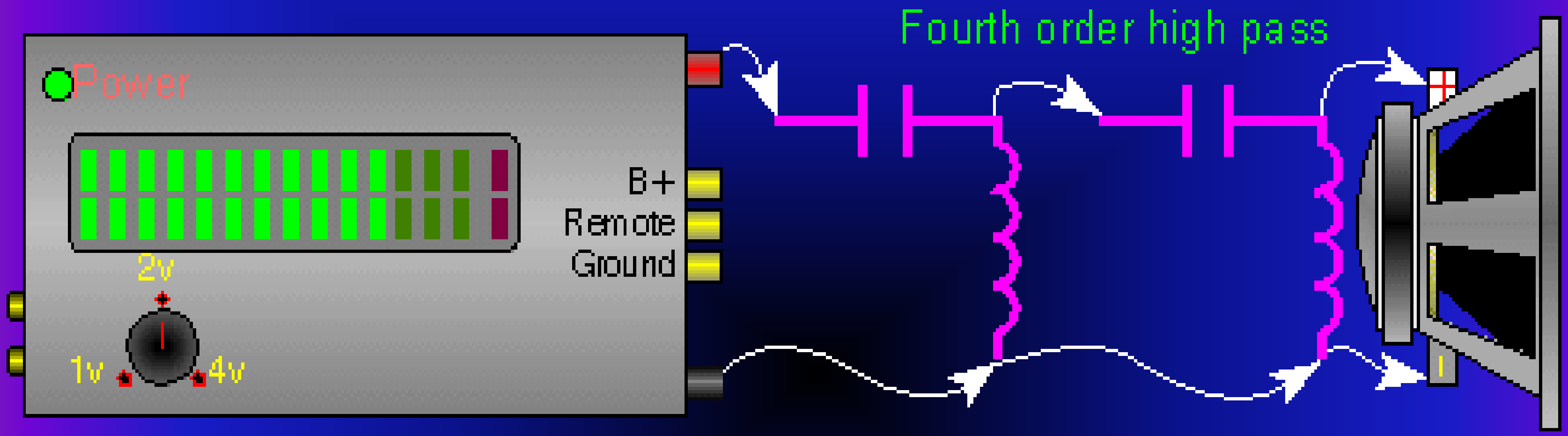


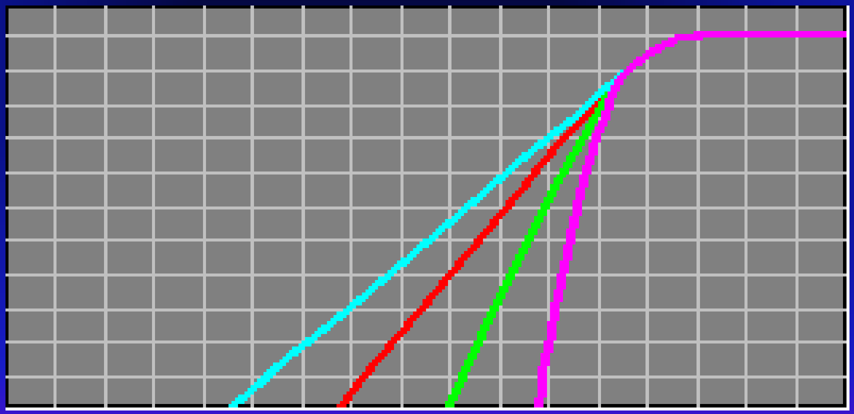
3º orden – paso alto:



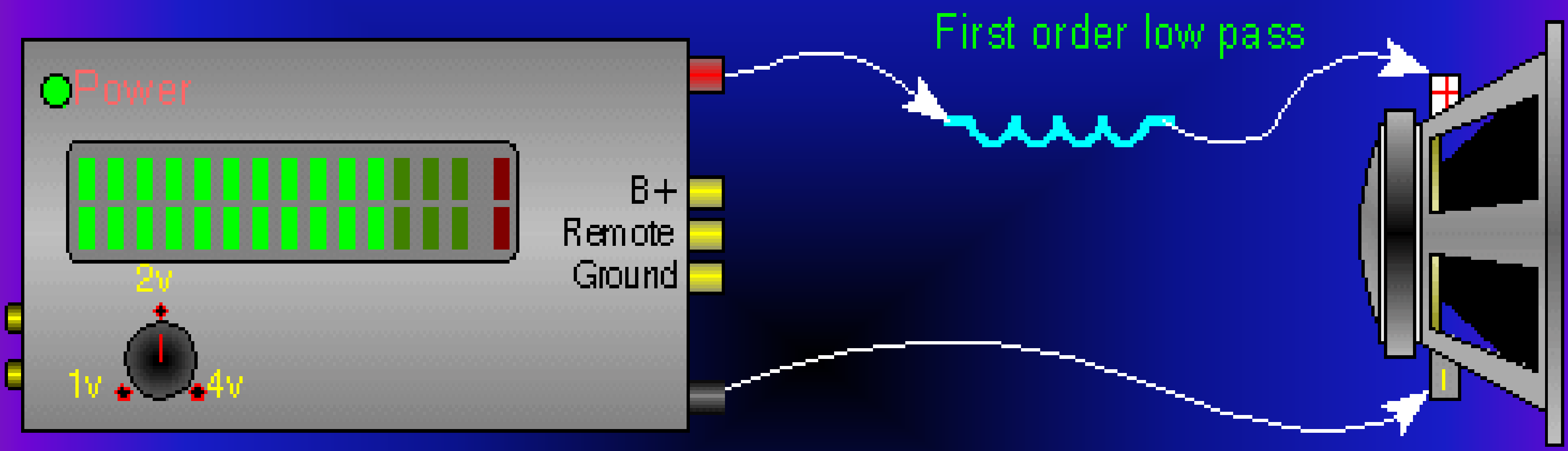


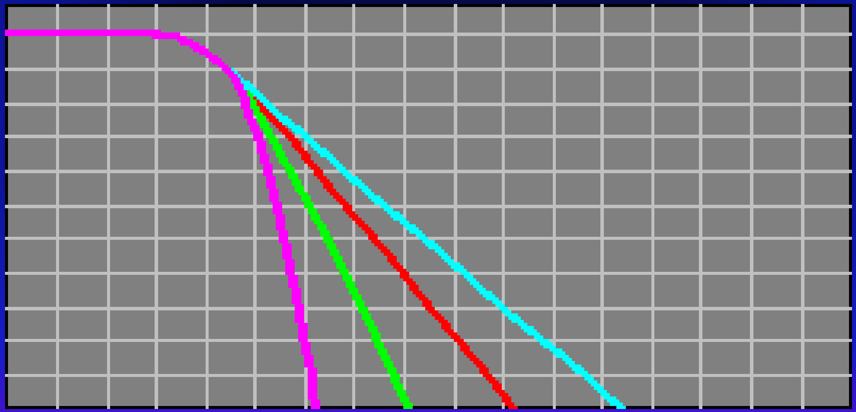
4º orden – paso alto:



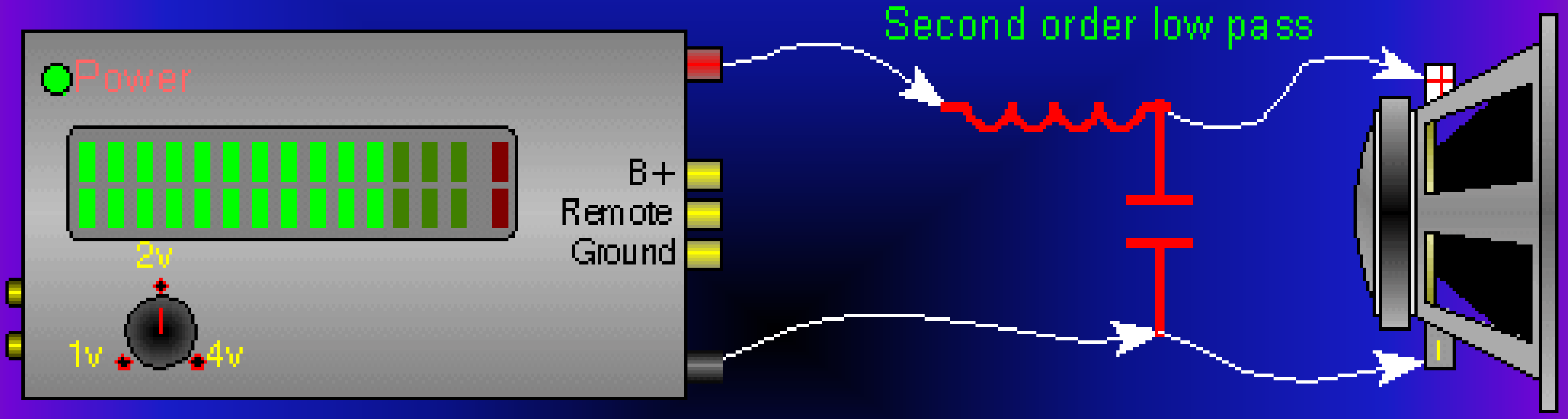


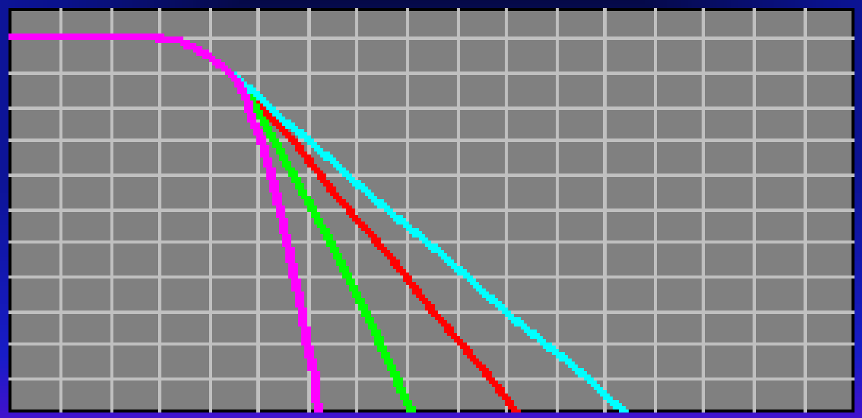
1º orden – paso baixo:



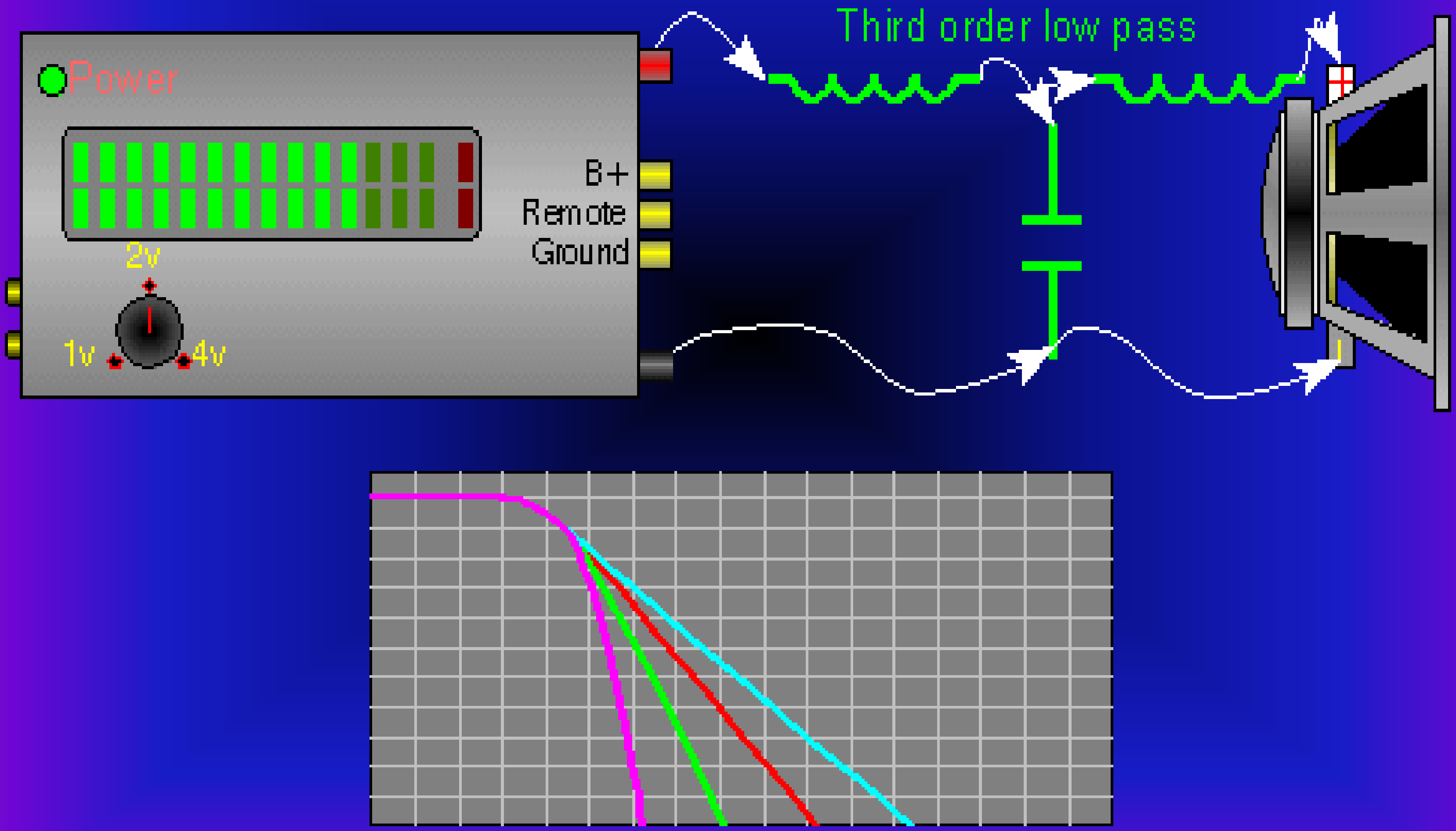


2º orden – paso baixo:

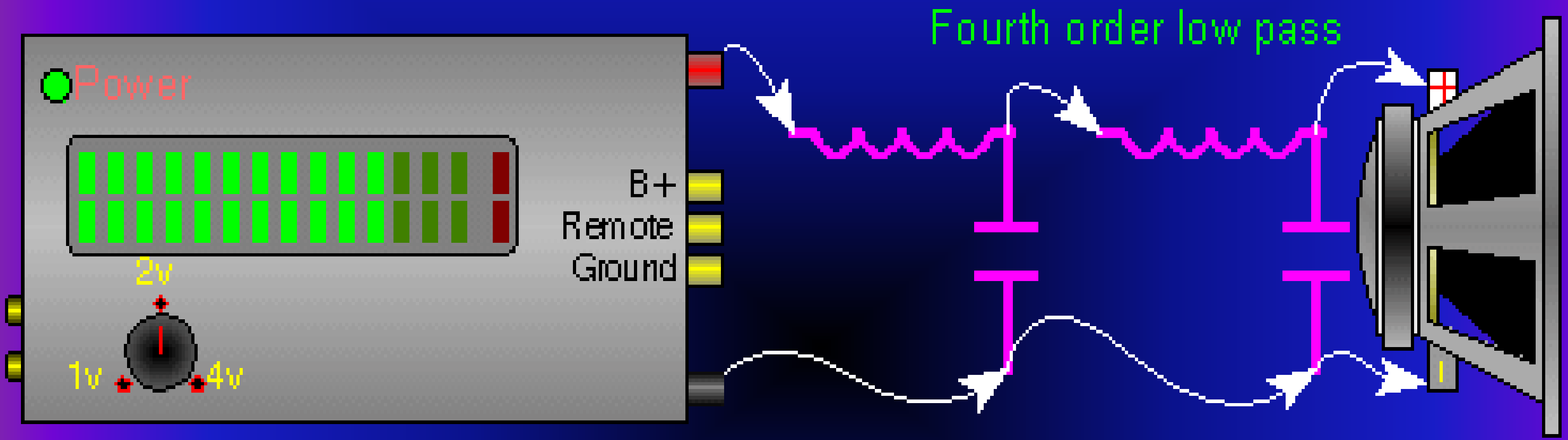


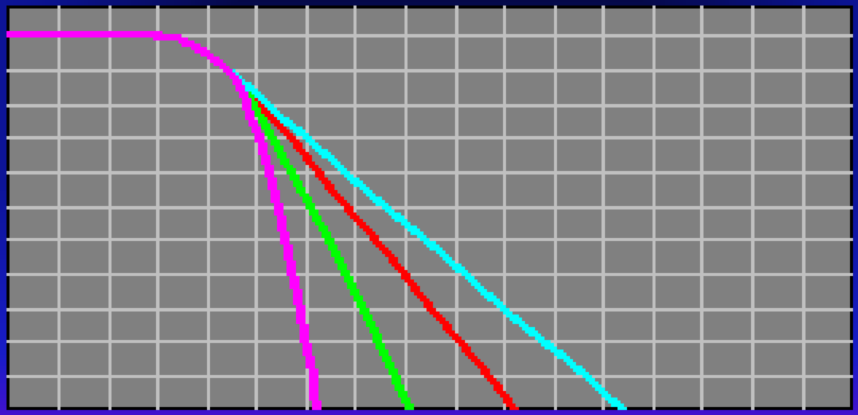


3º orden – paso baixo:



4º orden – paso baixo:





tipos de filtros:

- Según función de transferencia:
  - Butterworth
  - Bessel
  - Chebyshev
  - Cauer
- Según tecnología:
  - Pasivos
  - Activos
  - Capacidades conmutadas
  - Digitales

- Según tipo de implementación:
  - VCVS
  - Variables de estado
  - Frecuencia eliminada

Características según os tipos:

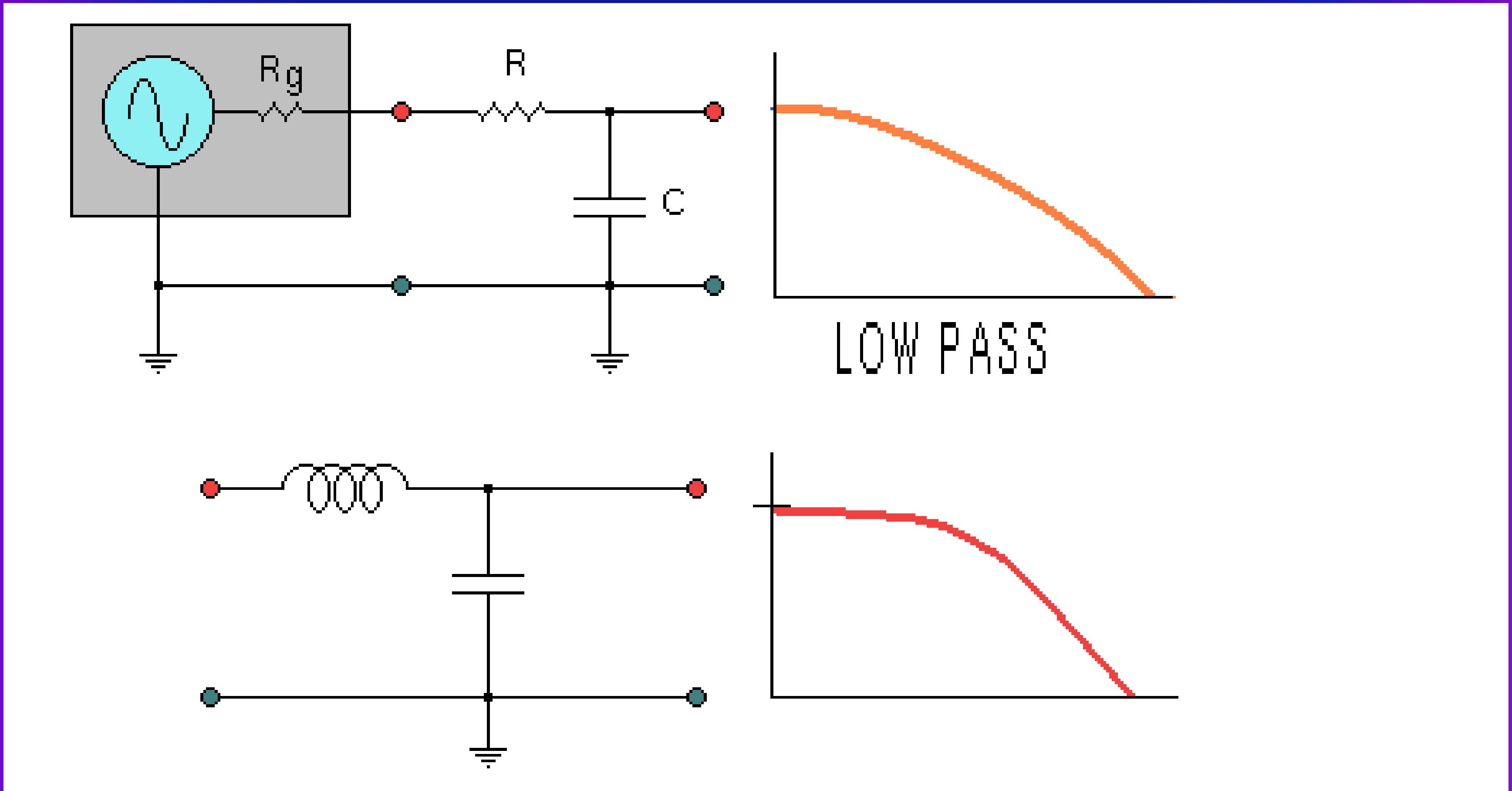
- No es posible realizar filtros ideales
  - Se han desarrollado aproximaciones matemáticas
  - Cada tipo de filtro es una aproximación que optimiza un aspecto parcial

- Filtro de Butterworth
  - **Ganancia lo más plana posible** en la banda de paso a expensas de un corte poco abrupto.
  - Pendiente de transición mediocre.
  - Respuesta transitoria satisfactoria.

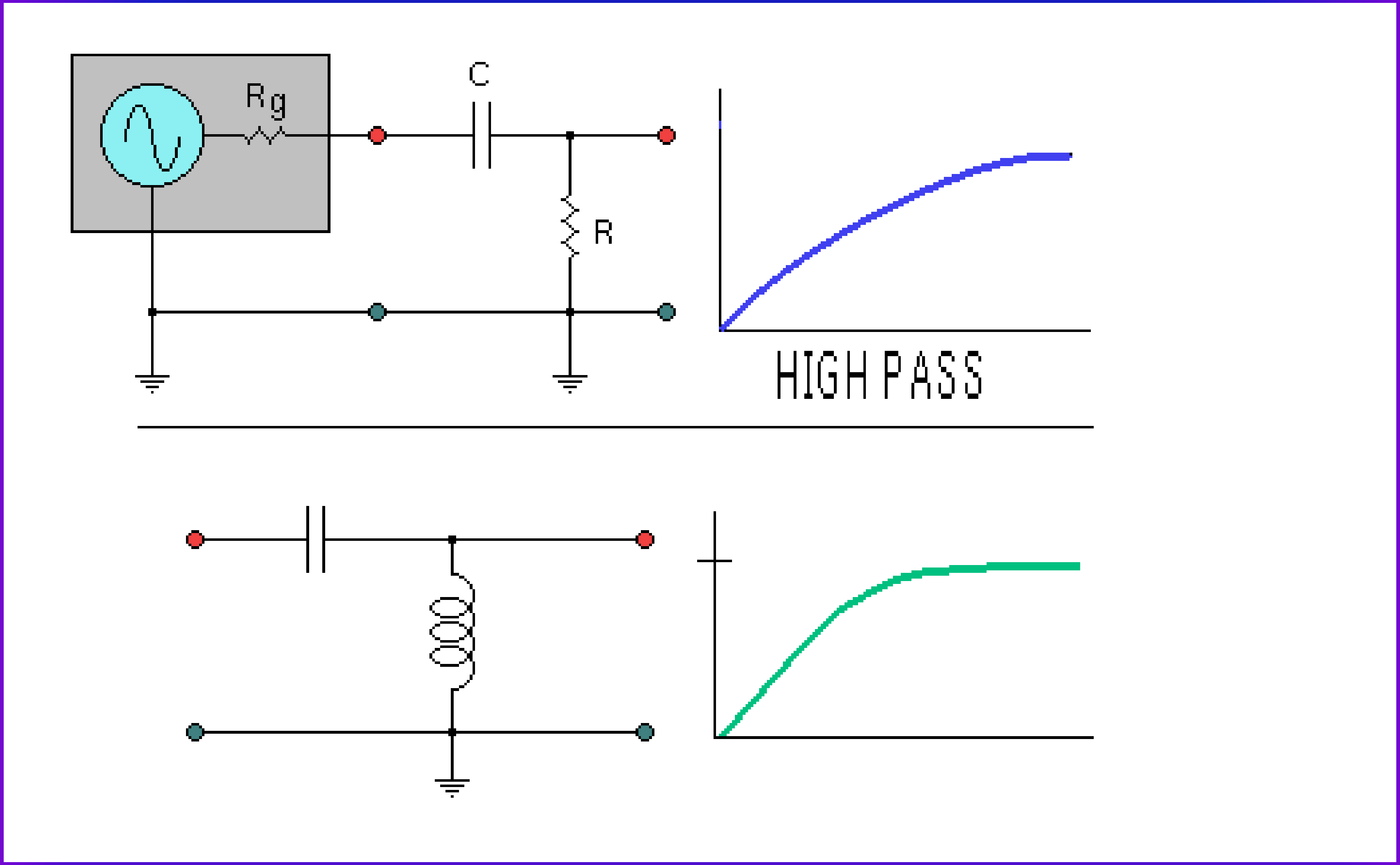
Características según os tipos:

- Filtro de Chebyshev
  - **Corte más abrupto** a expensas de rizado en la banda de paso.
  - Pendiente de transición más alta (cerca de *fp*)
  - Respuesta transitoria peor que Butterworth.
- Filtro de Bessel
  - **Mínima deformación de la señal**:
    - Desfase lineal con la frecuencia ⇔ tiempo de propagación constante.
  - Pendiente de transición peor que Butterworth.
- Filtro de Cauer o elíptico
  - **Corte muy abrupto** con rizado en la banda de paso y en la atenuada.
  - Respuesta transitoria peor que Chebyshev.
  - Adecuados para la eliminación de una frecuencia concreta.

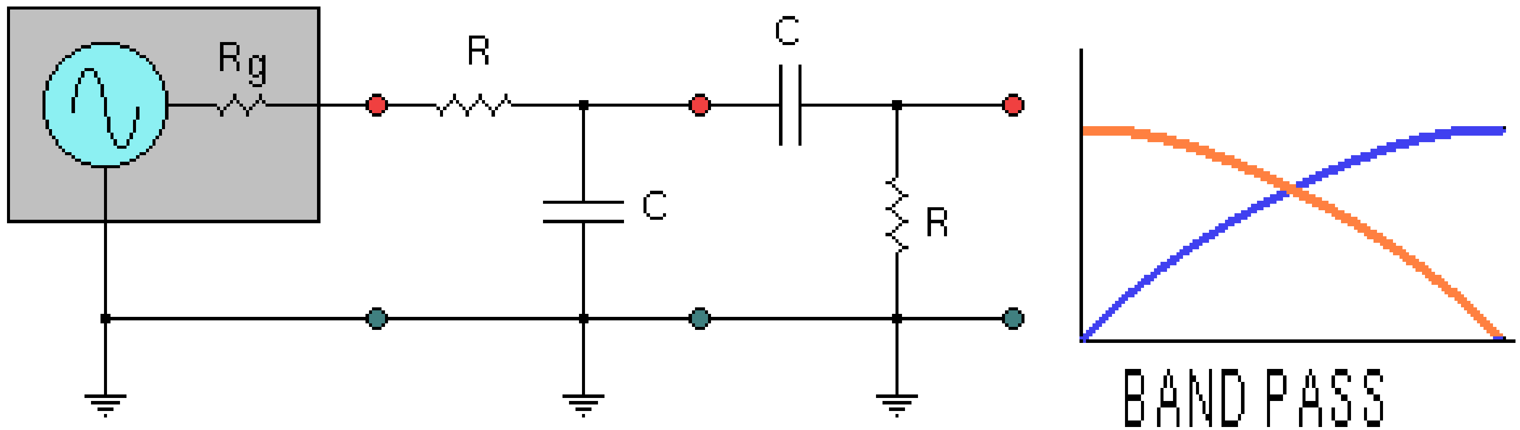
paso baixo R vs L:

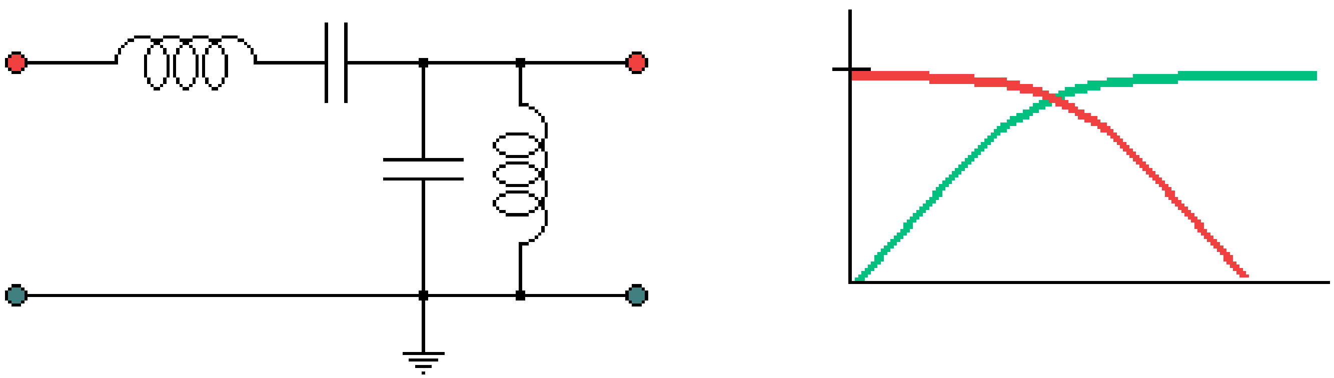


paso alto R vs L:

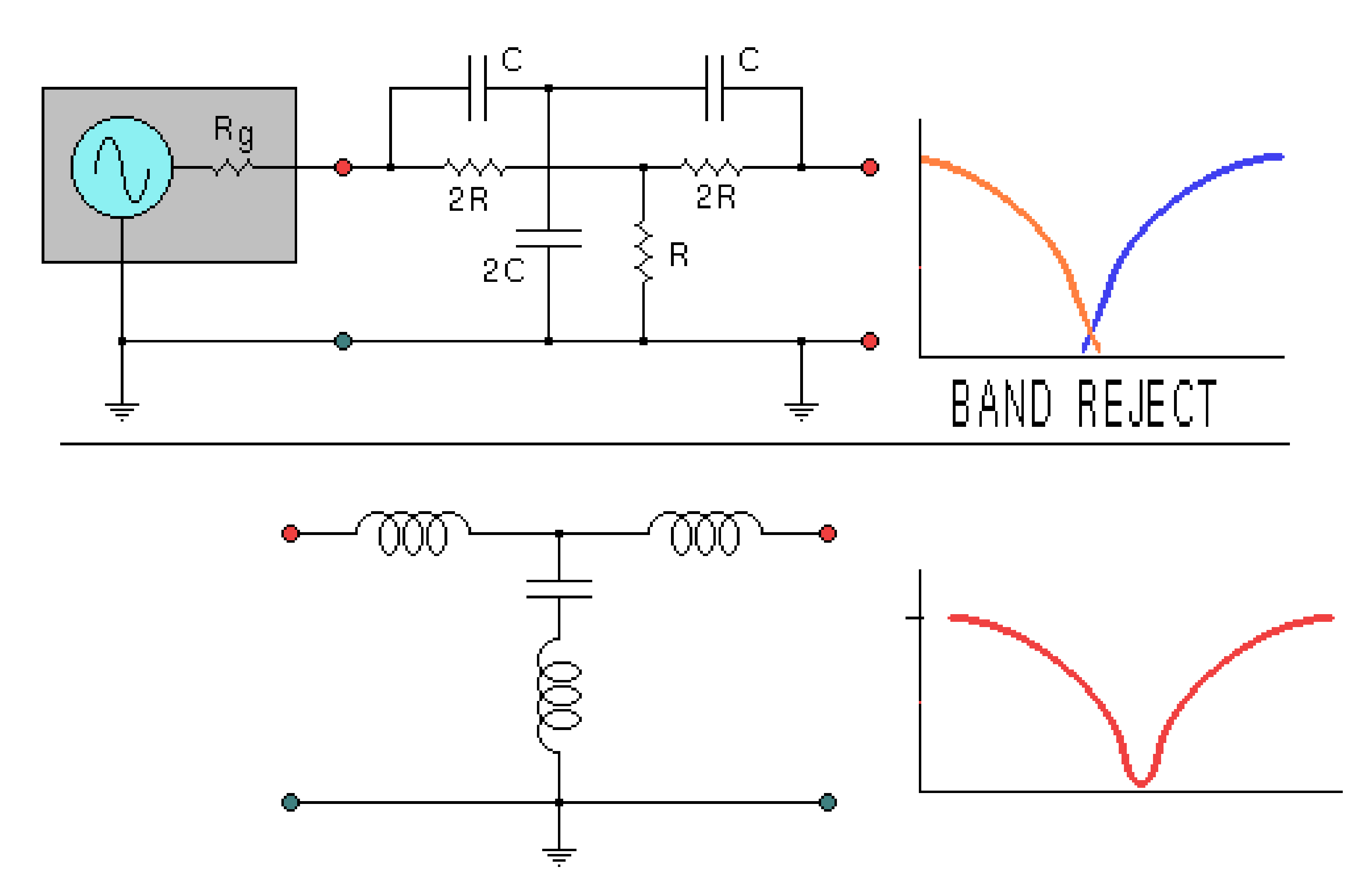


paso banda R vs L:

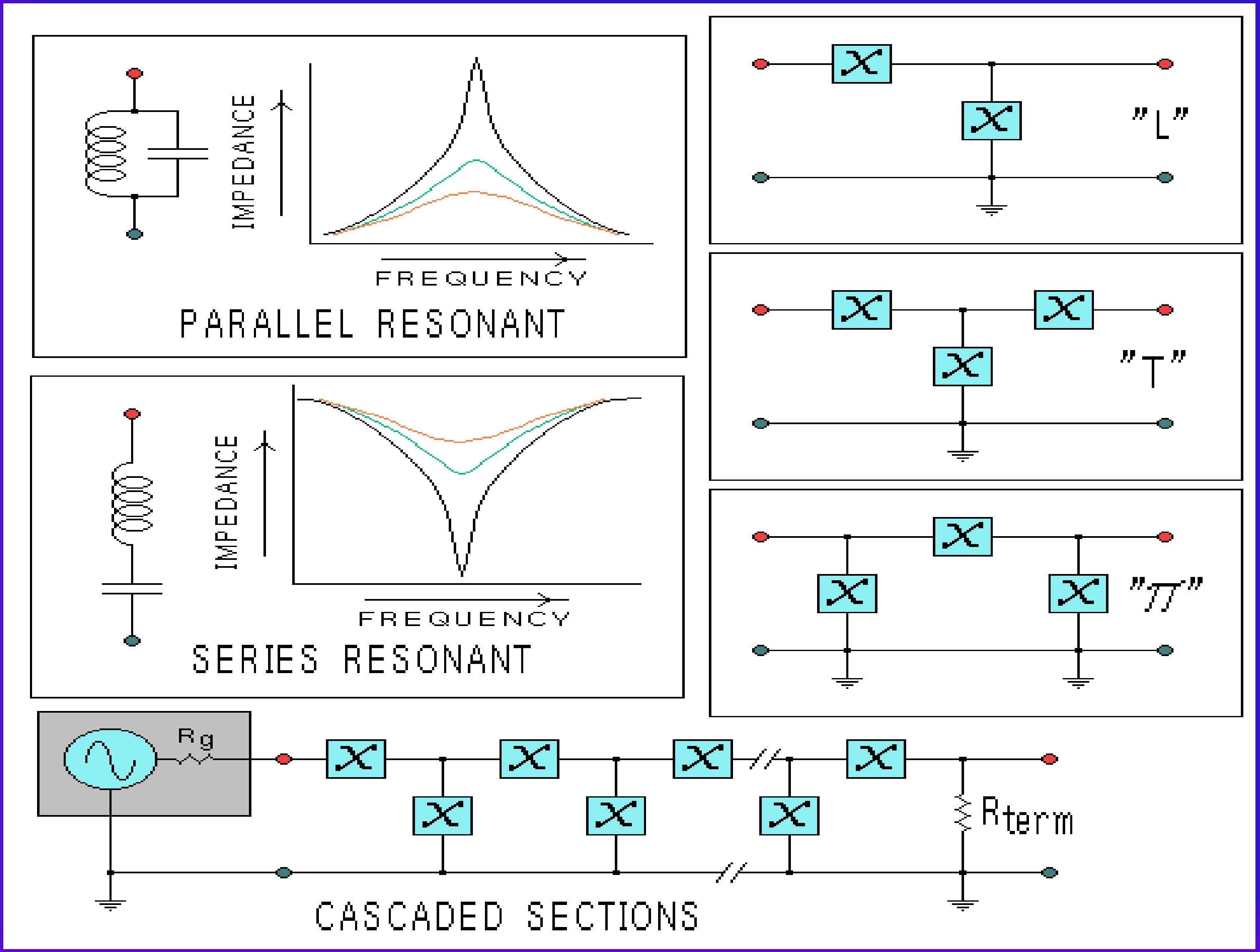




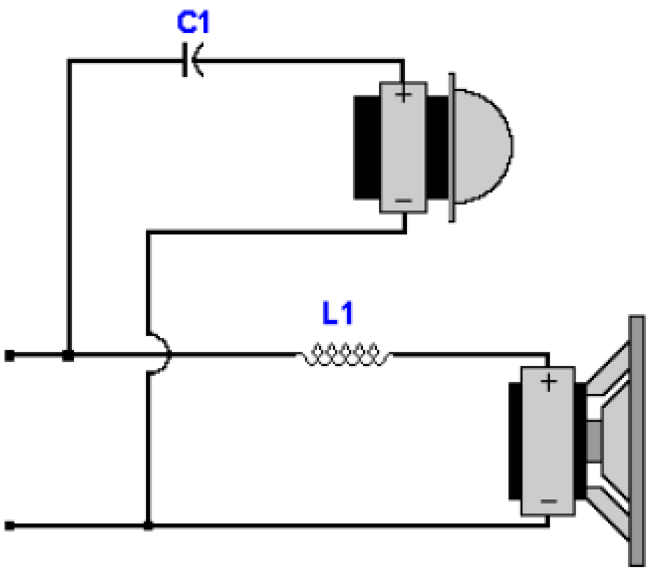
banda atenuada R vs L:



Filtros “L” “T” e “ π”:

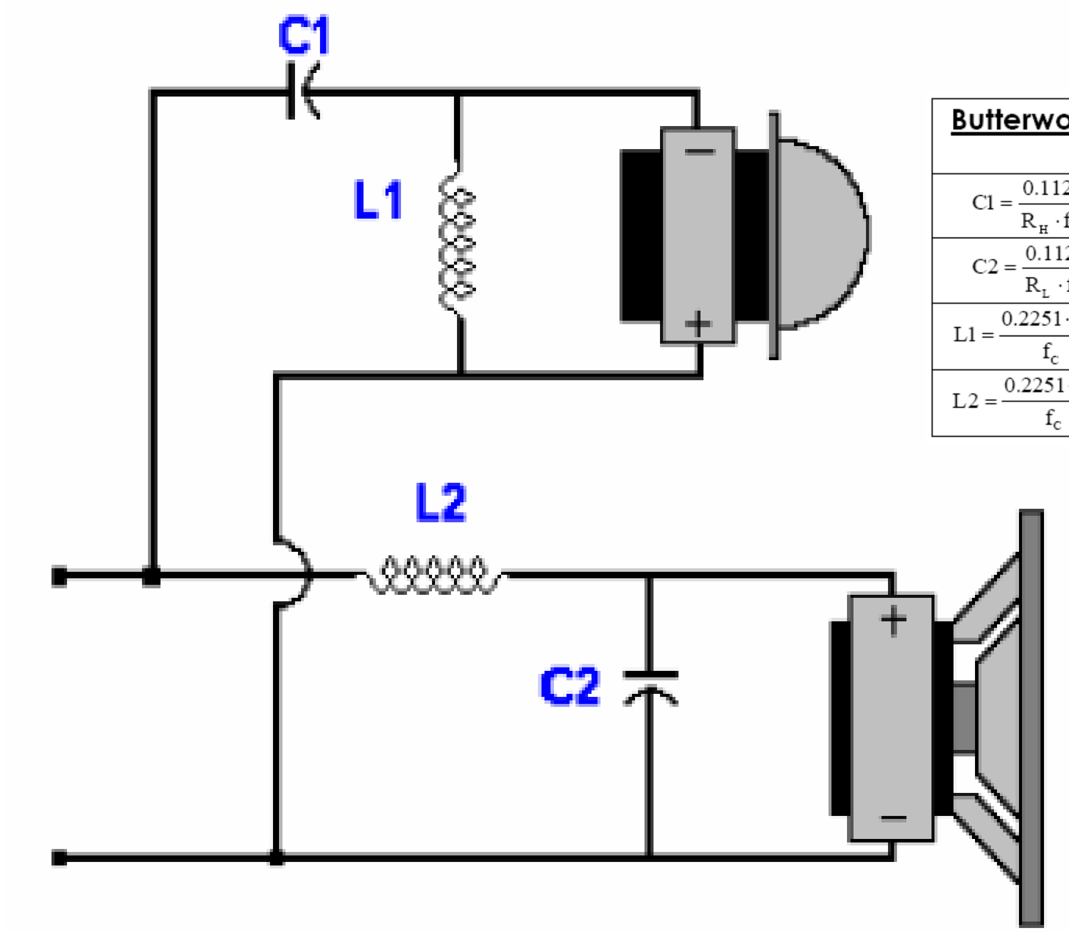


CROSSOVERS DE 1° ORDEN



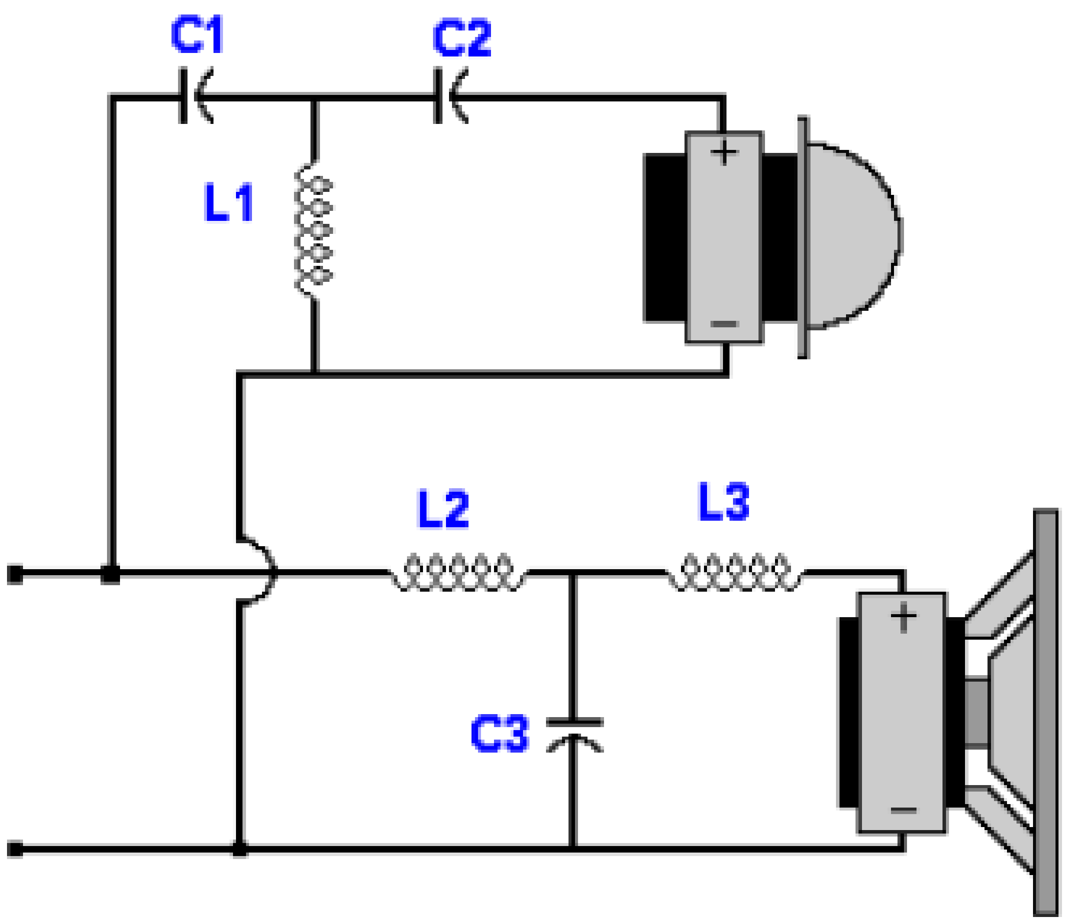
Butterworth
$C1 = \frac{0.159}{R_H \cdot f_C}$
$L1 = \frac{R_L}{6.28 \cdot f_C}$

CROSSOVER DE 2° ORDEN



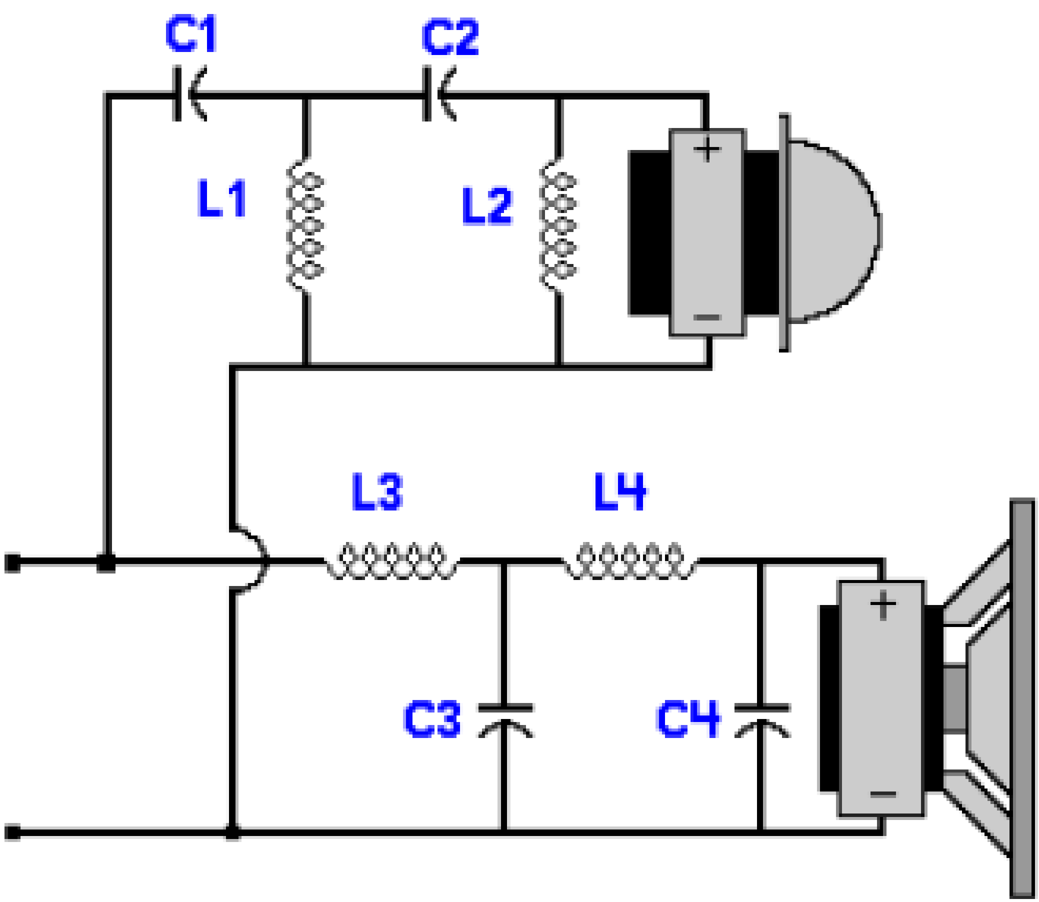
Butterworth	Linkwitz-Riley	Bessel	Chebyshev
$C1 = \frac{0.1125}{R_H \cdot f_c}$	$C1 = \frac{0.0796}{R_H \cdot f_c}$	$C1 = \frac{0.0912}{R_H \cdot f_c}$	$C1 = \frac{0.1592}{R_H \cdot f_c}$
$C2 = \frac{0.1125}{R_L \cdot f_c}$	$C2 = \frac{0.0796}{R_L \cdot f_c}$	$C2 = \frac{0.0912}{R_L \cdot f_c}$	$C2 = \frac{0.1592}{R_L \cdot f_c}$
$L1 = \frac{0.2251 \cdot R_H}{f_c}$	$L1 = \frac{0.3183 \cdot R_H}{f_c}$	$L1 = \frac{0.2756 \cdot R_H}{f_c}$	$L1 = \frac{0.1592 \cdot R_H}{f_c}$
$L2 = \frac{0.2251 \cdot R_L}{f_c}$	$L2 = \frac{0.3183 \cdot R_L}{f_c}$	$L2 = \frac{0.2756 \cdot R_L}{f_c}$	$L2 = \frac{0.1592 \cdot R_L}{f_c}$

CROSSOVER DE 3° ORDEN



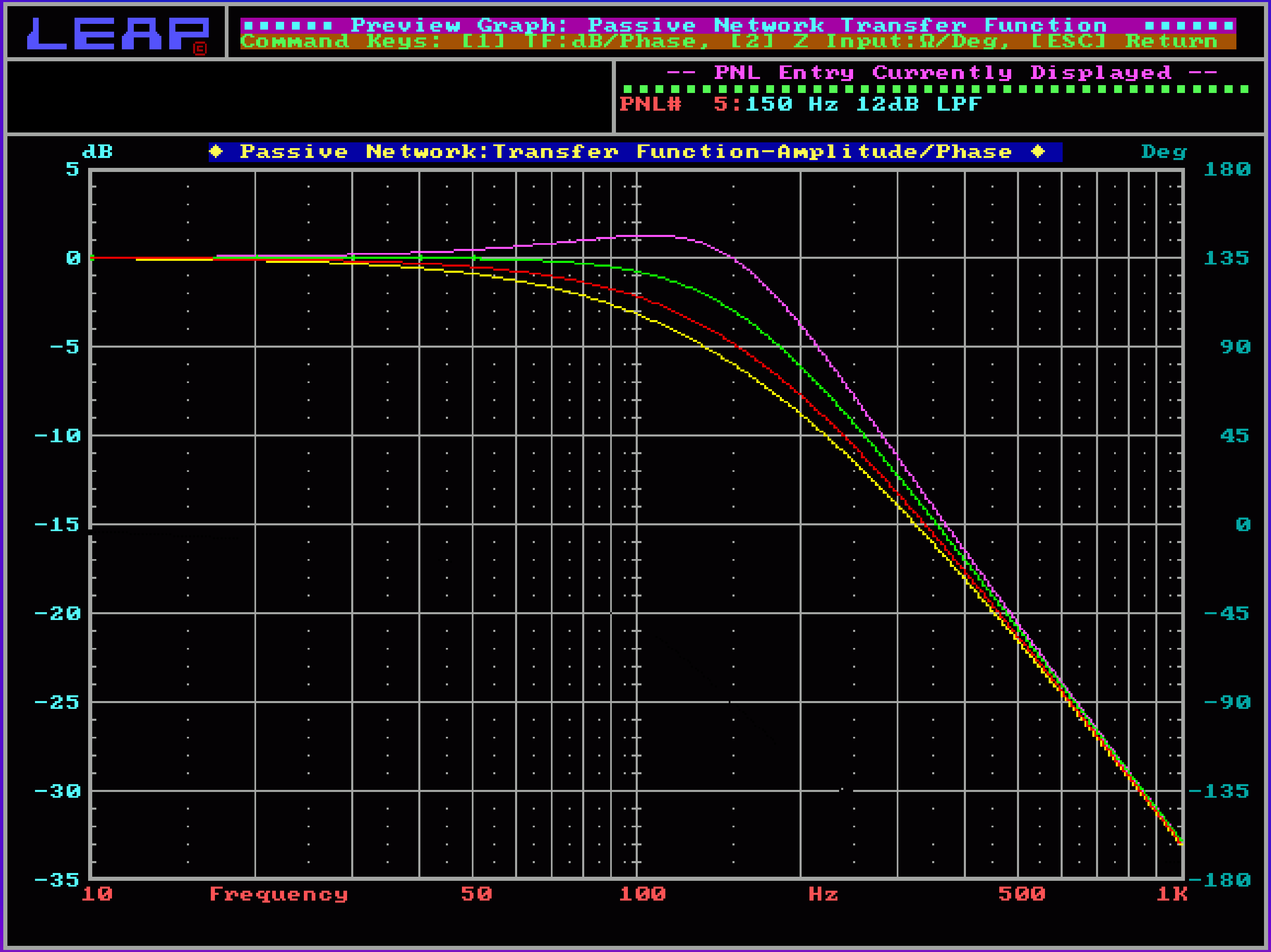
Butterworth
$C1 = \frac{0.1061}{R_H \cdot f_C}$
$C2 = \frac{0.3183}{R_H \cdot f_C}$
$C3 = \frac{0.2122}{R_L \cdot f_C}$
$L1 = \frac{0.1194 \cdot R_H}{f_C}$
$L2 = \frac{0.2387 \cdot R_L}{f_C}$
$L3 = \frac{0.0796 \cdot R_L}{f_C}$

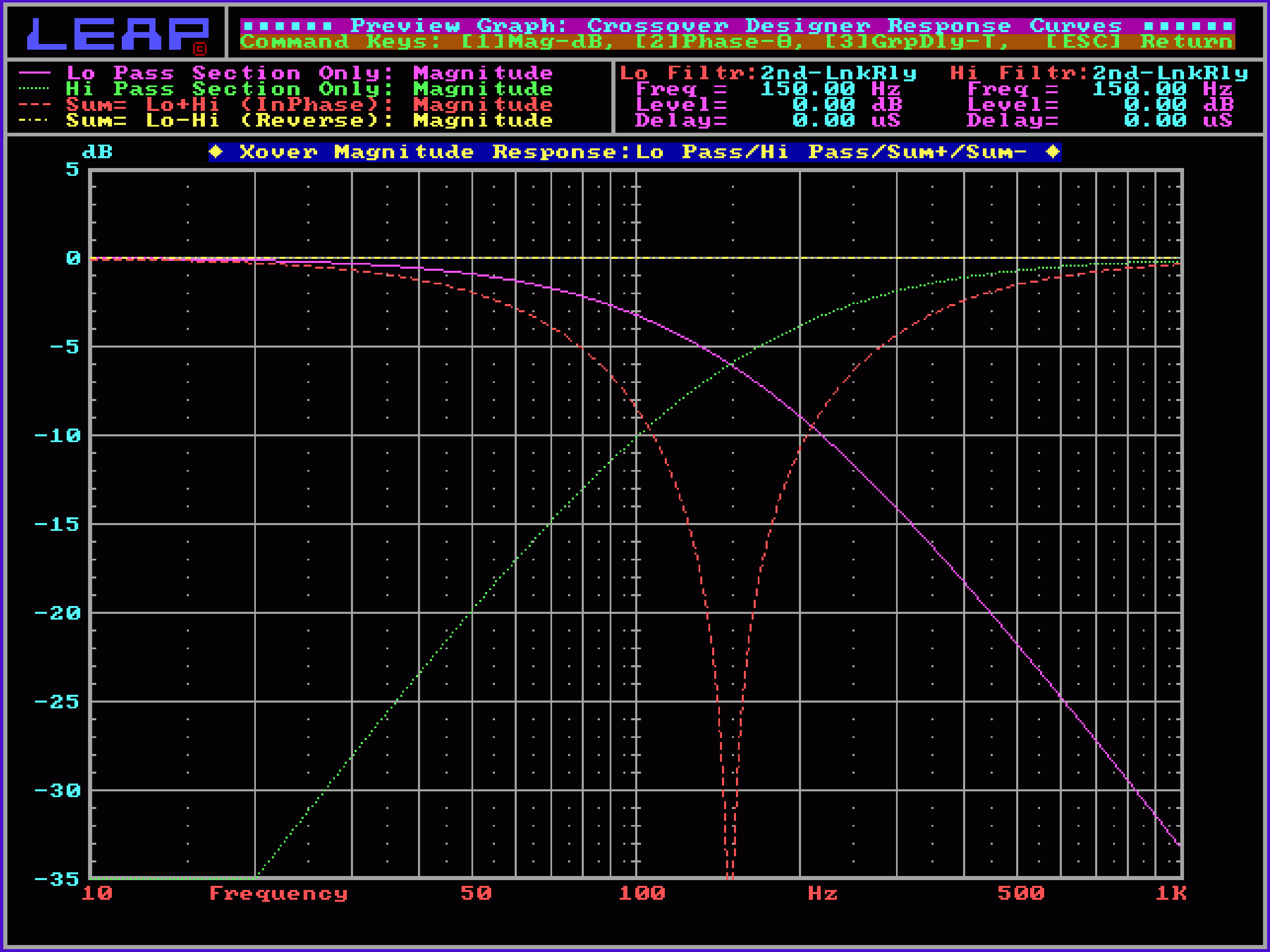
CROSSOVER DE 4° ORDEN

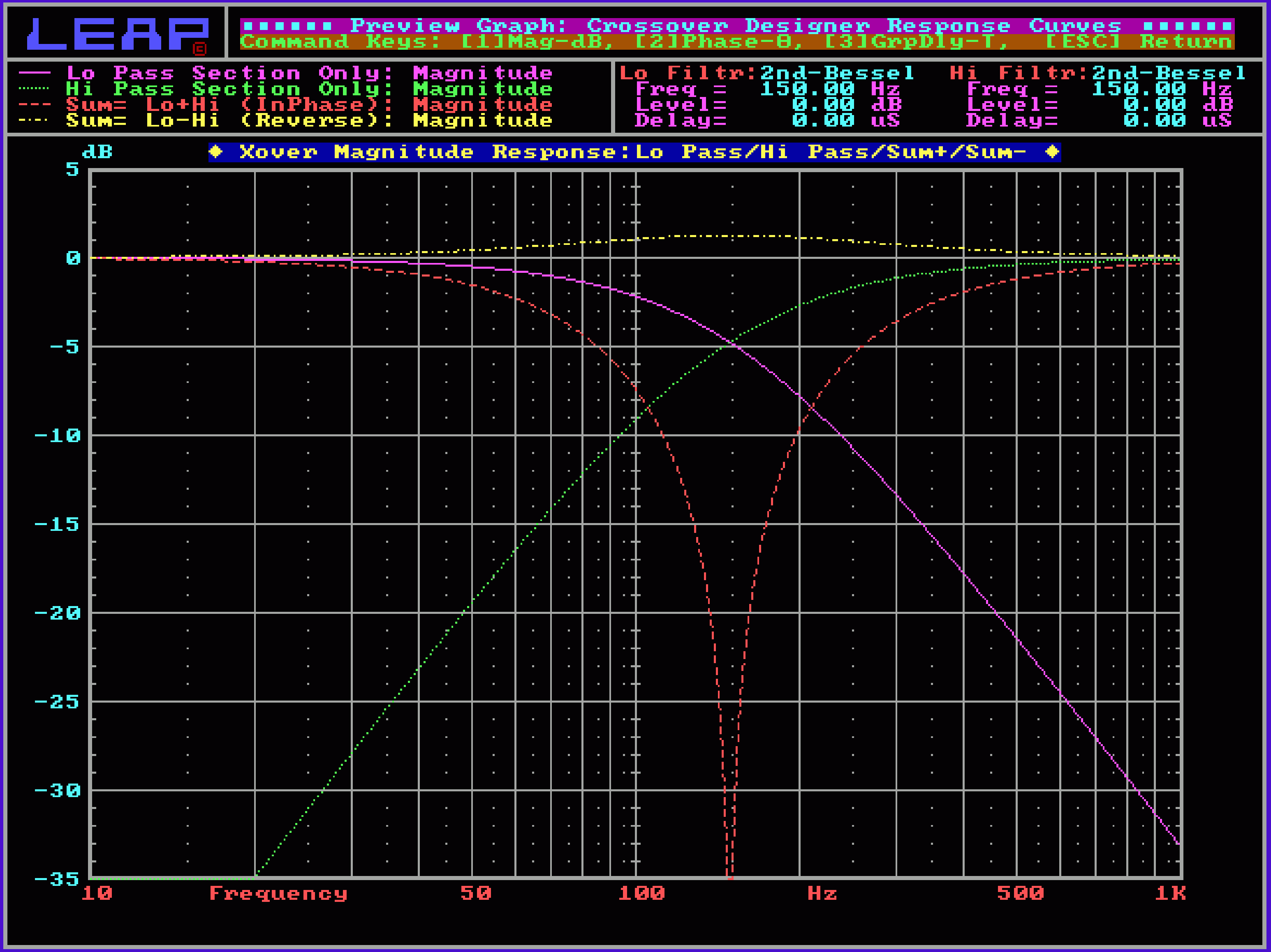


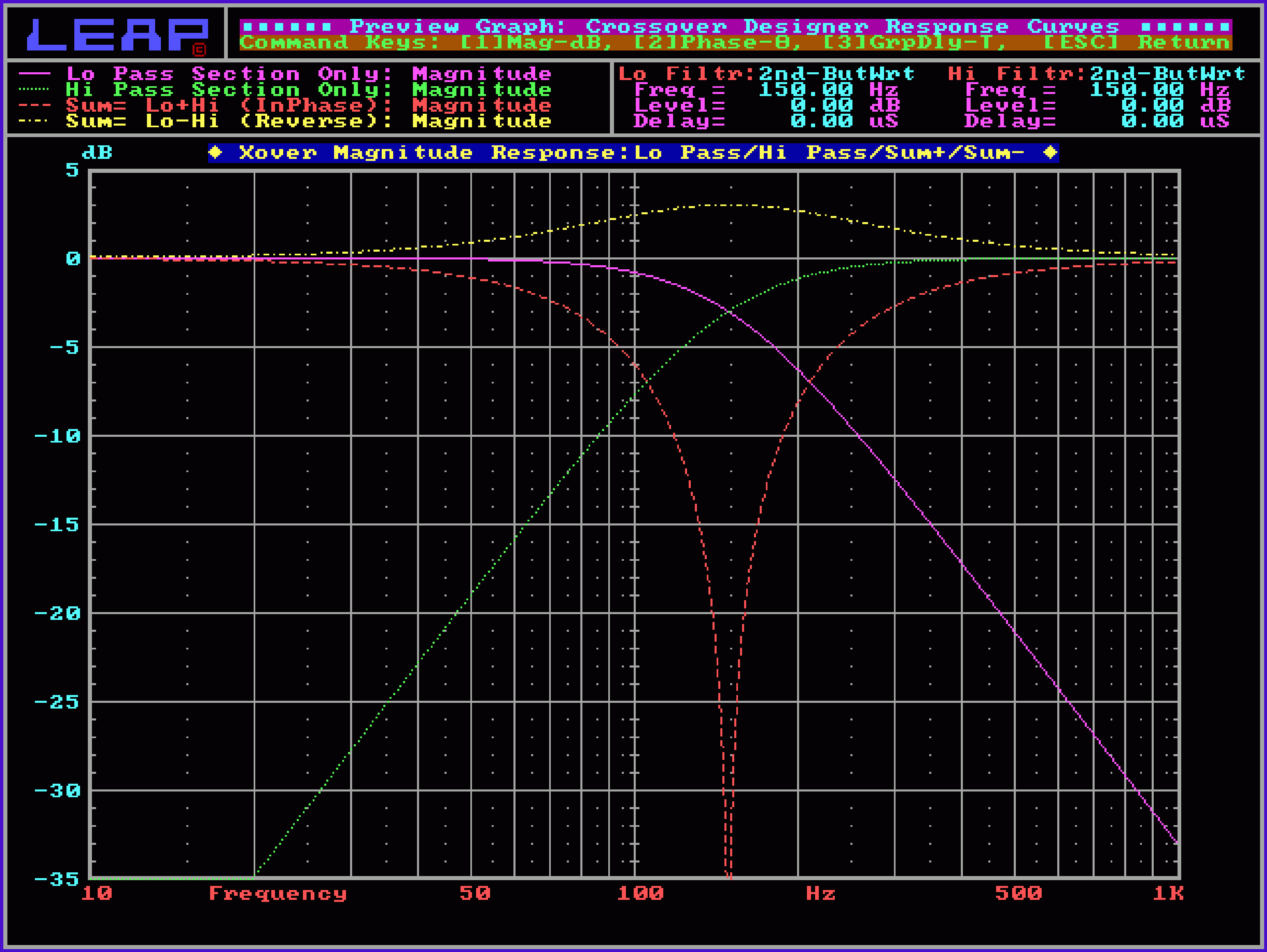
Butterworth	Linkwitz-Riley	Bessel
$C1=\frac{0.1040}{R_H \cdot f_C}$	$C1=\frac{0.0844}{R_H \cdot f_C}$	$C1=\frac{0.0702}{R_H \cdot f_C}$
$C2=\frac{0.1470}{R_H \cdot f_C}$	$C2=\frac{0.1688}{R_H \cdot f_C}$	$C2=\frac{0.0719}{R_H \cdot f_C}$
$C3=\frac{0.2509}{R_L \cdot f_C}$	$C3=\frac{0.2533}{R_L \cdot f_C}$	$C3=\frac{0.2336}{R_L \cdot f_C}$
$C4=\frac{0.0609}{R_L \cdot f_C}$	$C4=\frac{0.0563}{R_L \cdot f_C}$	$C4=\frac{0.0504}{R_L \cdot f_C}$
$L1=\frac{0.1009 \cdot R_H}{f_C}$	$L1=\frac{0.1000 \cdot R_H}{f_C}$	$L1=\frac{0.0862 \cdot R_H}{f_C}$
$L2=\frac{0.4159 \cdot R_H}{f_C}$	$L2=\frac{0.4501 \cdot R_H}{f_C}$	$L2=\frac{0.4983 \cdot R_H}{f_C}$
$L3=\frac{0.2437 \cdot R_L}{f_C}$	$L3=\frac{0.3000 \cdot R_L}{f_C}$	$L3=\frac{0.3583 \cdot R_L}{f_C}$
$L4=\frac{0.1723 \cdot R_L}{f_C}$	$L4=\frac{0.1500 \cdot R_L}{f_C}$	$L4=\frac{0.1463 \cdot R_L}{f_C}$

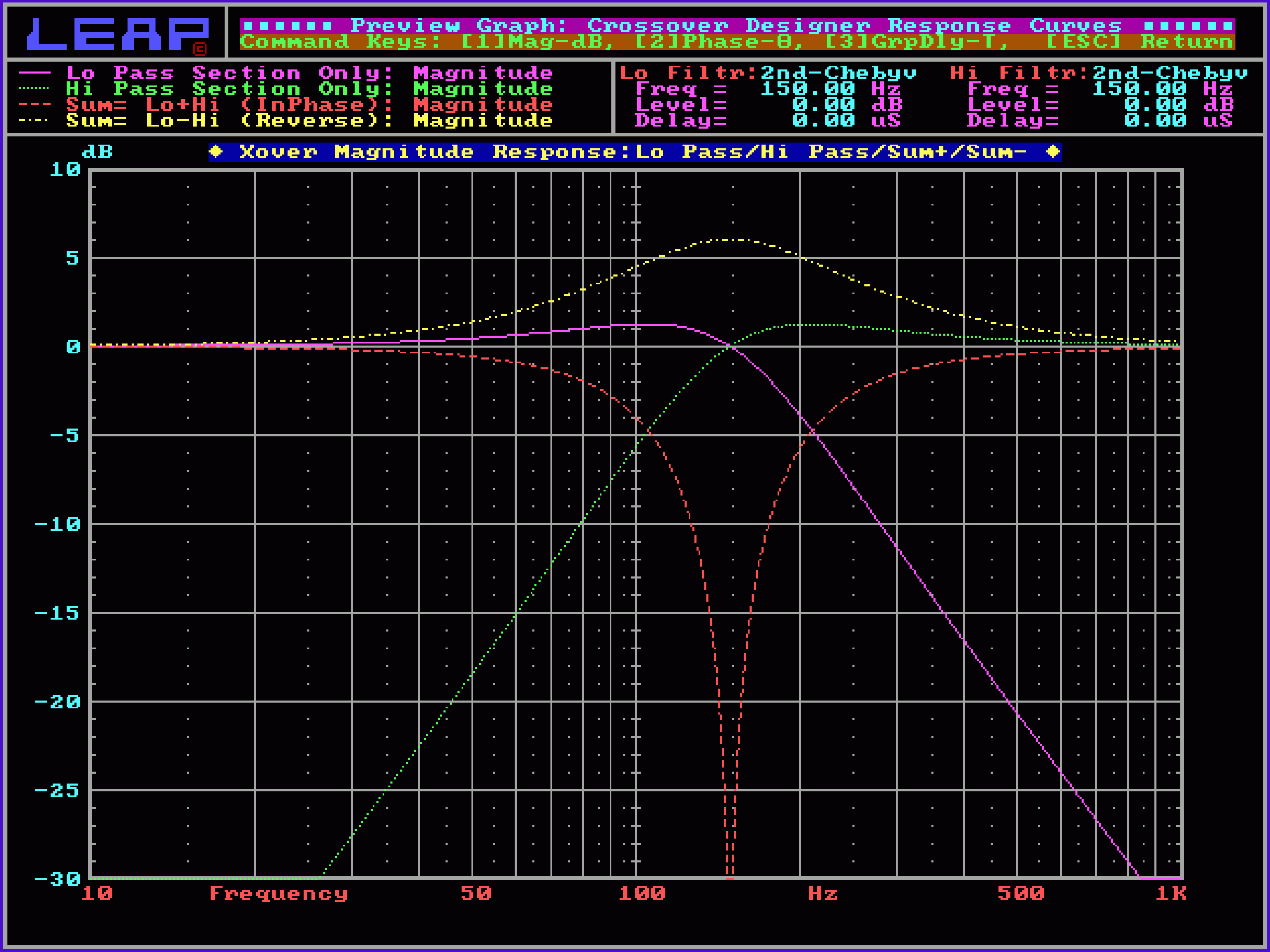
Chebychev: Q = 1
Butterworth: Q = .707
Bessel: Q = .58
Linkwitz-Riley: Q = .49




LEAP
Preview Graph: Crossover Designer Response Curves
Command Keys: [1]Mag-dB, [2]Phase-θ, [3]GrpDly-T, [ESC] Return
Lo Pass Section Only: Magnitude
Hi Pass Section Only: Magnitude
Sum= Lo+Hi (InPhase): Magnitude
Sum= Lo-Hi (Reverse): Magnitude
Lo Filtr:2nd-LnkRly
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
Hi Filtr:2nd-LnkRly
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
dB
Xover Magnitude Response:Lo Pass/Hi Pass/Sum+/Sum-
5
0
-5
-10
-15
-20
-25
-30
-35
10
Frequency
50
100
Hz
500
1K


LEAP
Preview Graph: Crossover Designer Response Curves
Command Keys: [1]Mag-dB, [2]Phase-θ, [3]GrpDly-T, [ESC] Return
Lo Pass Section Only: Magnitude
Hi Pass Section Only: Magnitude
Sum= Lo+Hi (InPhase): Magnitude
Sum= Lo-Hi (Reverse): Magnitude
Lo Filtr:2nd-Bessel
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
Hi Filtr:2nd-Bessel
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
Xover Magnitude Response:Lo Pass/Hi Pass/Sum+/Sum-
dB
5
0
-5
-10
-15
-20
-25
-30
-35
10
Frequency
50
100
Hz
500
1K


LEAP
Preview Graph: Crossover Designer Response Curves
Command Keys: [1]Mag-dB, [2]Phase-θ, [3]GrpDly-T, [ESC] Return
Lo Pass Section Only: Magnitude
Hi Pass Section Only: Magnitude
Sum= Lo+Hi (InPhase): Magnitude
Sum= Lo-Hi (Reverse): Magnitude
Lo Filtr:2nd-ButWrt
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
Hi Filtr:2nd-ButWrt
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
dB
Xover Magnitude Response:Lo Pass/Hi Pass/Sum+/Sum-
5
0
-5
-10
-15
-20
-25
-30
-35
10
Frequency
50
100
Hz
500
1K


LEAP
Preview Graph: Crossover Designer Response Curves
Command Keys: [1]Mag-dB, [2]Phase-θ, [3]GrpDly-T, [ESC] Return
Lo Pass Section Only: Magnitude
Hi Pass Section Only: Magnitude
Sum= Lo+Hi (InPhase): Magnitude
Sum= Lo-Hi (Reverse): Magnitude
Lo Filtr:2nd-Chebyv
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
Hi Filtr:2nd-Chebyv
Freq = 150.00 Hz
Level= 0.00 dB
Delay= 0.00 uS
dB
Xover Magnitude Response:Lo Pass/Hi Pass/Sum+/Sum-
10
5
0
-5
-10
-15
-20
-25
-30
10
Frequency
50
100
Hz
500
1K

Tipo 2 vías

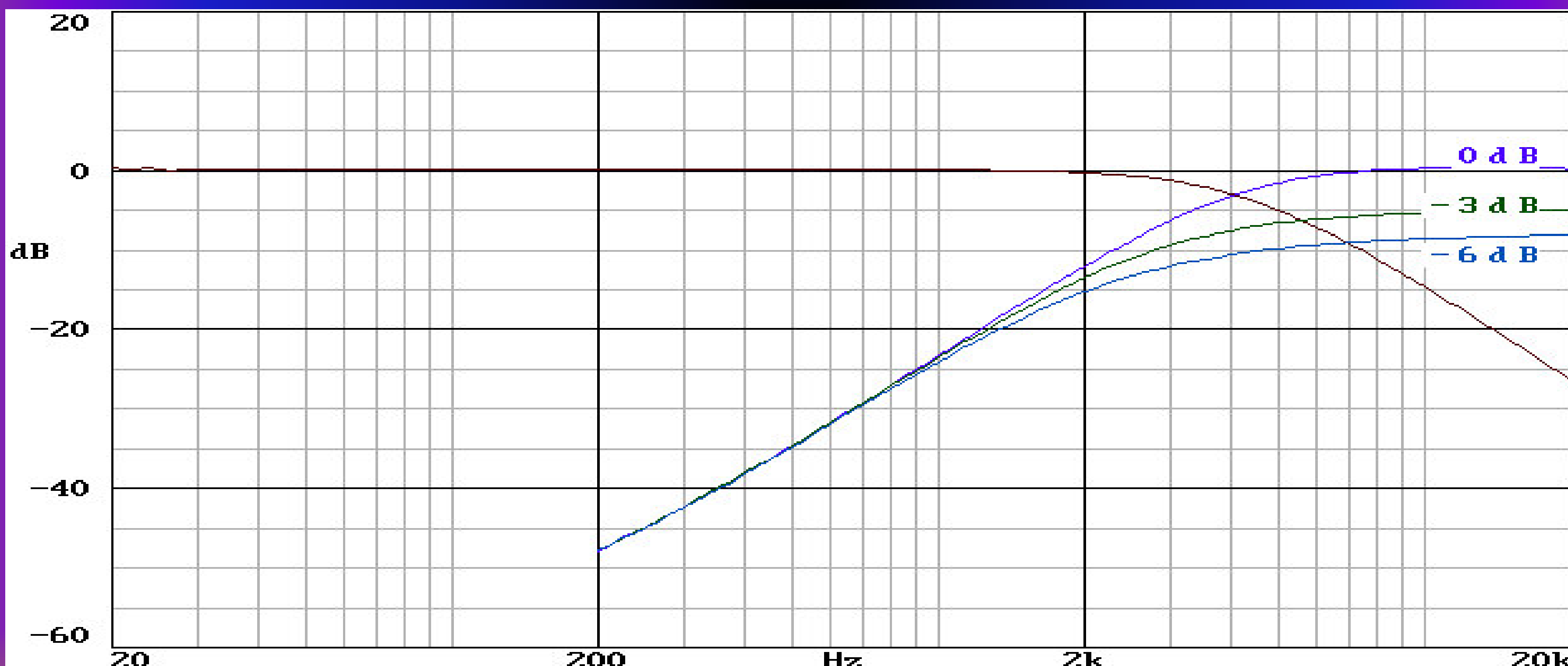
Frecuencia de cruce 4 kHz

Potencia admisible 150 w RMS

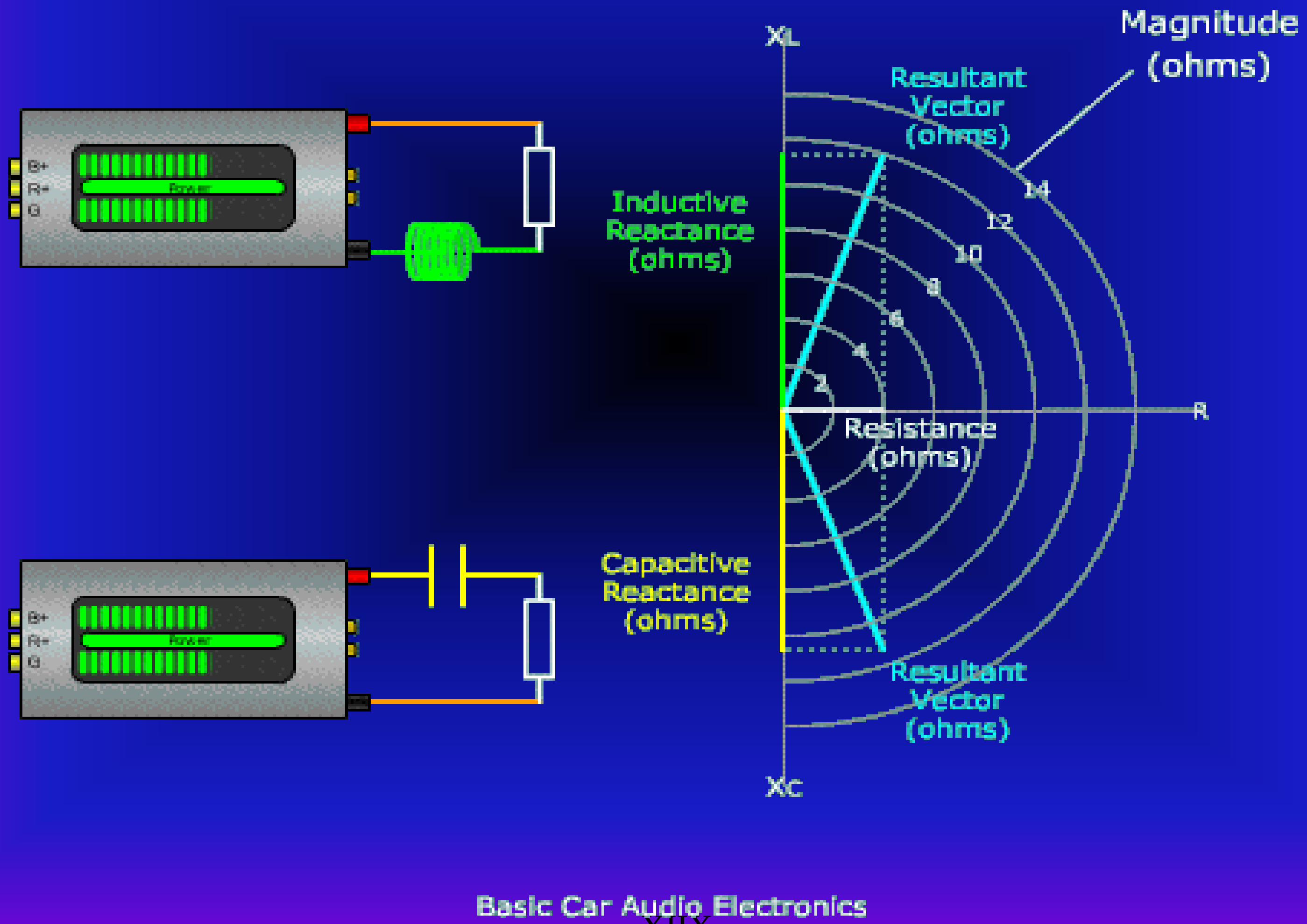
Impedancia de carga 4 ohmios.

Pendiente de atenuación 12 dB/oct.

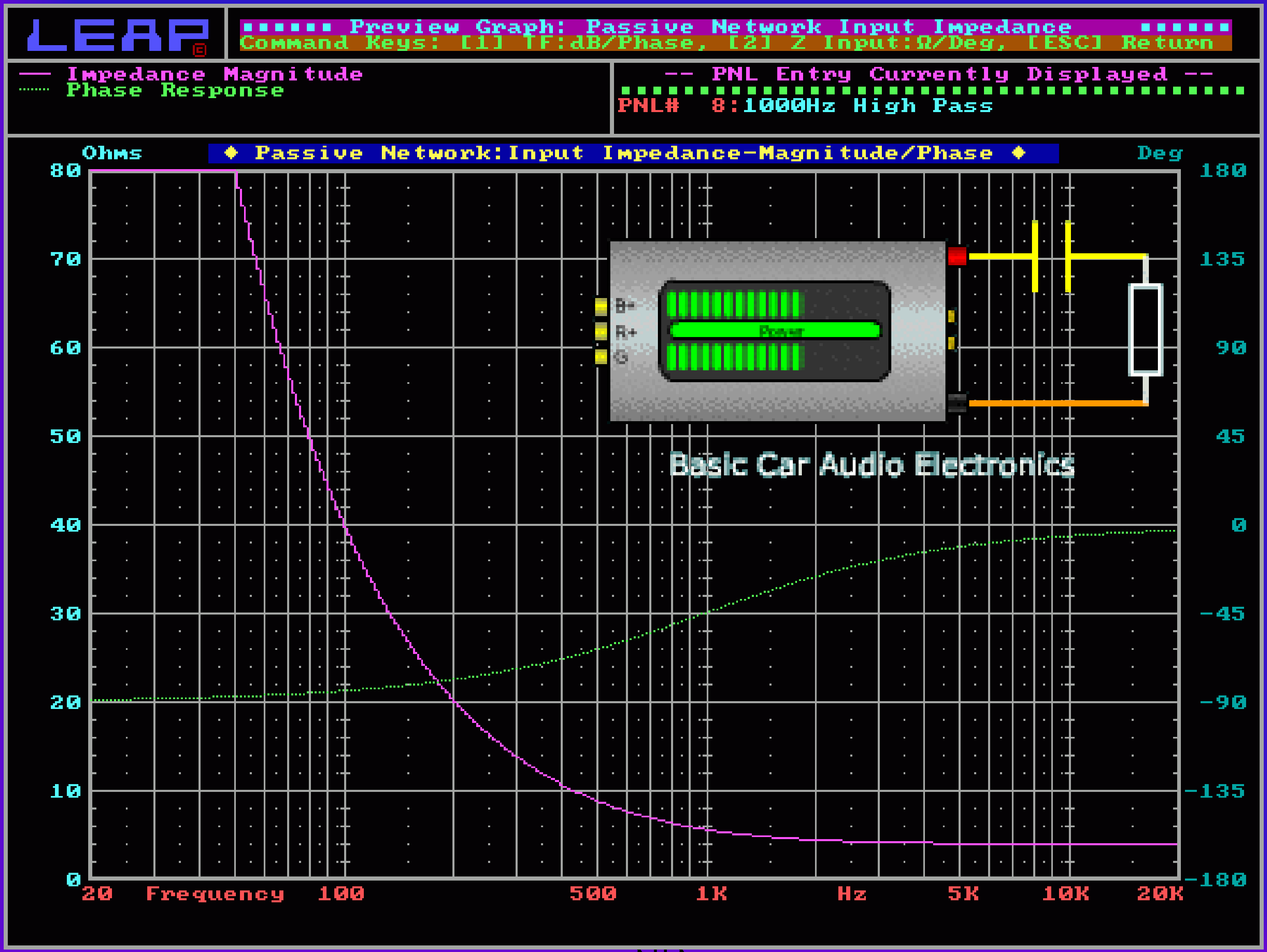
Atenuación de agudos 0, -3, -6 dB

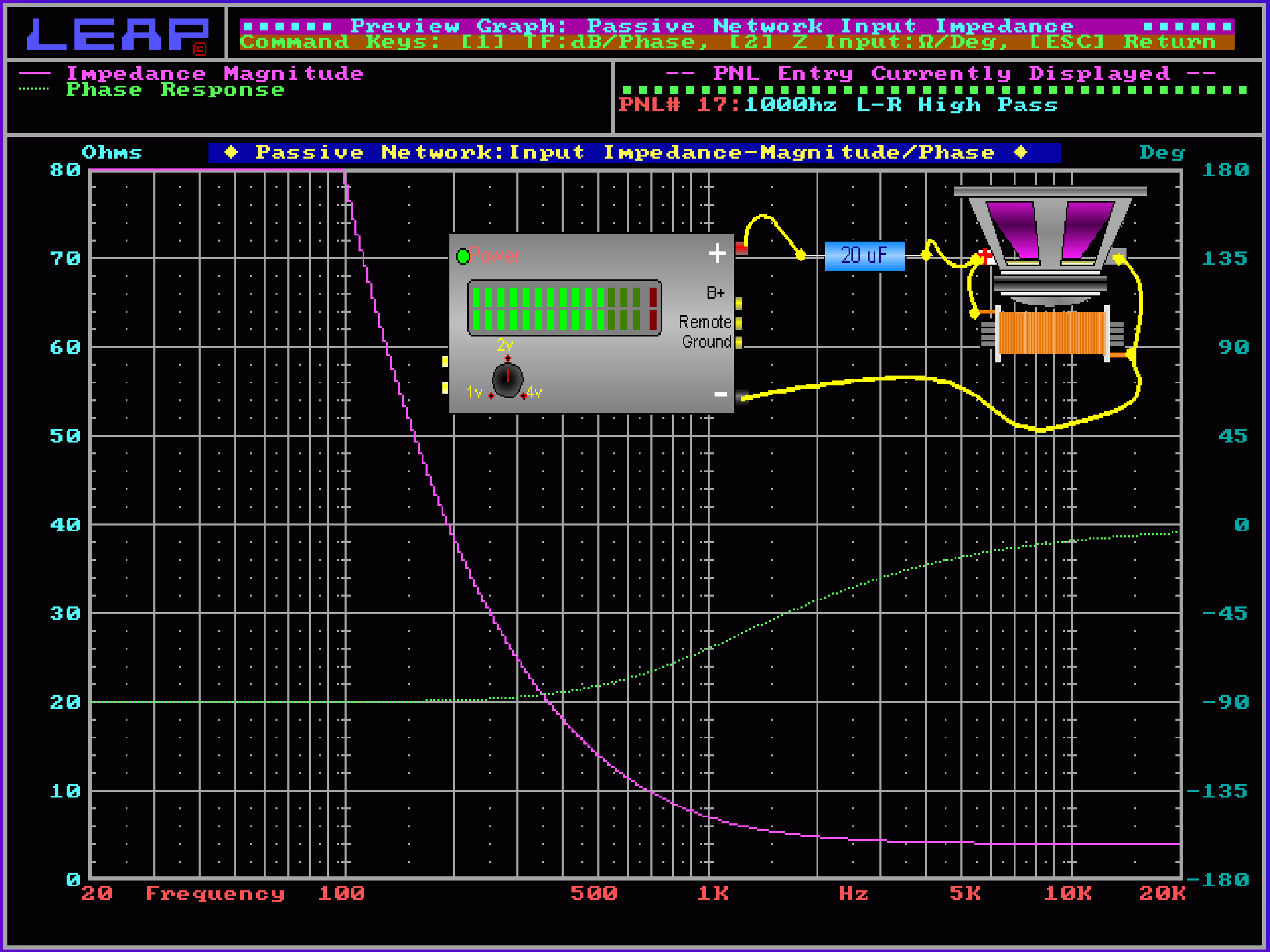


desfase:

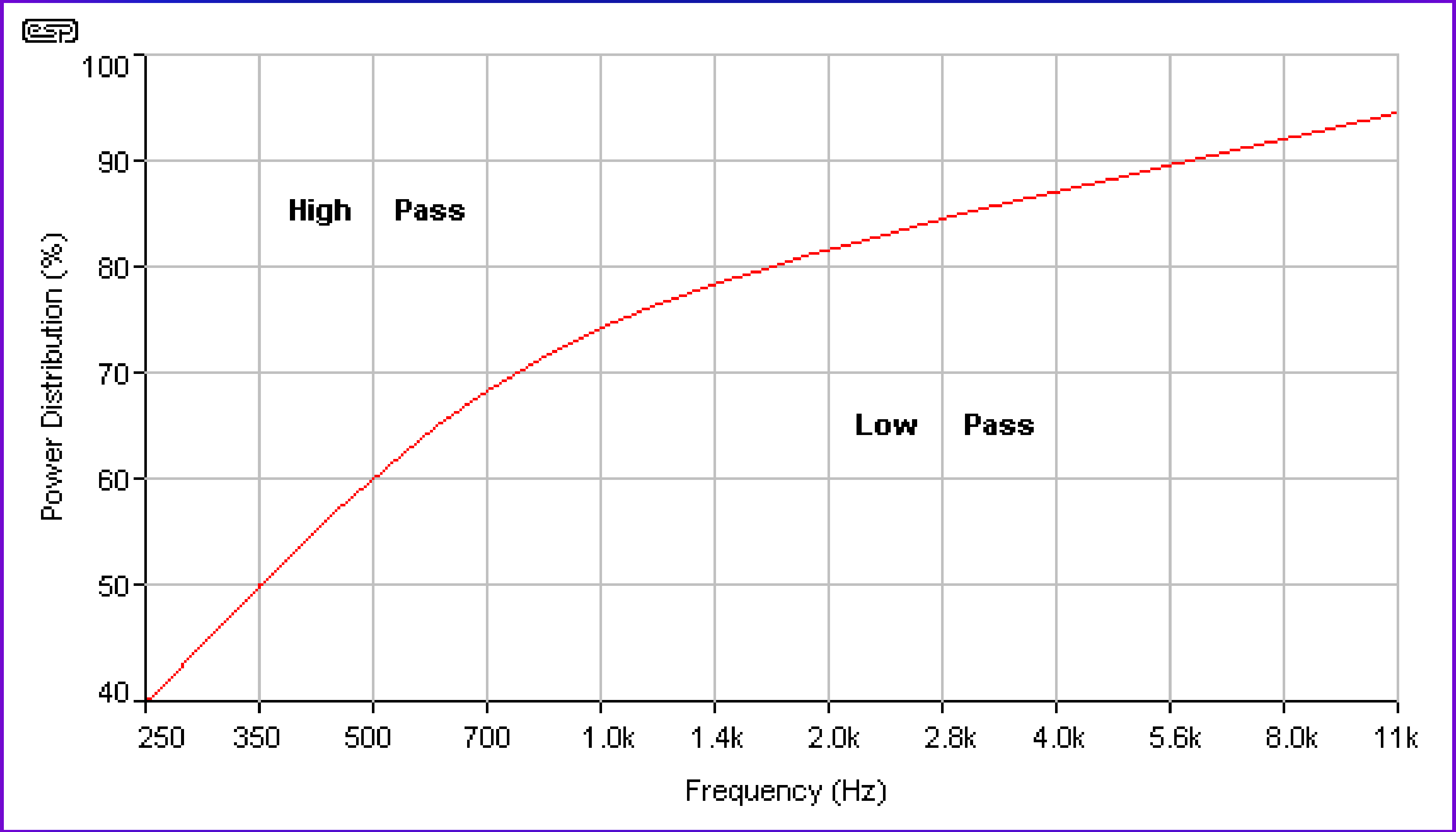


B+
R+
G
Power
B+
R+
G
Power
Inductive
Reactance
(ohms)
Capacitive
Reactance
(ohms)
XL
Resultant
Vector
(ohms)
Magnitude
(ohms)
14
12
10
8
6
4
2
R
Resistance
(ohms)
Resultant
Vector
(ohms)
XC
Basic Car Audio Electronics


LEAP
Preview Graph: Passive Network Input Impedance
Command Keys: [1] TF:dB/Phase, [2] Z Input:Ω/Deg, [ESC] Return
Impedance Magnitude
Phase Response
-- PNL Entry Currently Displayed --
PNL# 8:1000Hz High Pass
Ohms
Passive Network:Input Impedance-Magnitude/Phase
Deg
80
70
60
50
40
30
20
10
0
180
135
90
45
0
-45
-90
-135
-180
20
Frequency
100
500
1K
Hz
5K
10K
20K
Basic Car Audio Electronics


LEAP
Preview Graph: Passive Network Input Impedance
Command Keys: [1] TF:dB/Phase, [2] Z Input:Ω/Deg, [ESC] Return
Impedance Magnitude
Phase Response
-- PNL Entry Currently Displayed --
PNL# 17:1000hz L-R High Pass
Ohms
Passive Network:Input Impedance-Magnitude/Phase
Deg
80
70
60
50
40
30
20
10
0
180
135
90
45
0
-45
-90
-135
-180
20
Frequency
100
500
1K
Hz
5K
10K
20K
Power
B+
Remote
Ground
2v
1v
4v
20 uF

curva de potencia:




CARPOWER
by MONACOR


CARPOWER
by MONACOR
2-WAY CROSSOVER NETWORK
12dB/Oct.
W+ W– T+ T– IN– IN+


CARPOWER
by MONACOR
3-WAY CROSSOVER NETWORK
12dB/Oct.
INPUT
WOOFER
MIDRANGE
TWEETER