Filters

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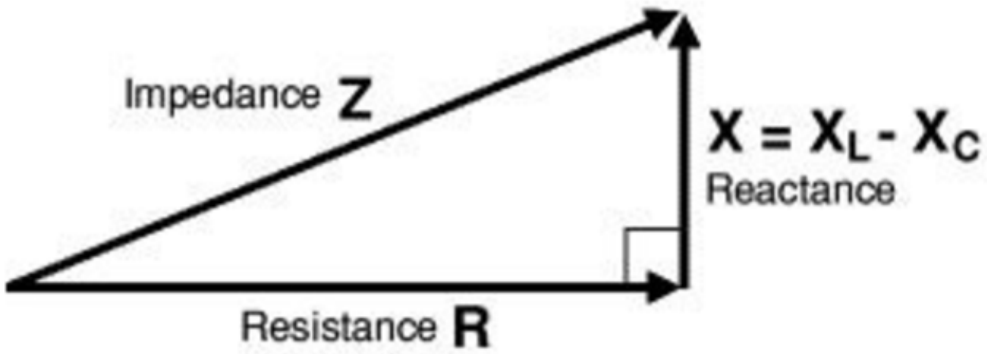
電容有電抗作用，阻止低頻訊號通過

[電阻、電抗]

$Z = \text{sqrt}(R^2 + X^2)$

阻抗＝ Impedance(Z)
電阻＝ Resistance(R)
電抗＝ Reactance(X)　（　$X = X_L - X_C$



$$\text{Impedance, } Z = \sqrt{R^2 + X^2}$$

- **電容抗（capacitive reactance），Xc**

$$Xc = \frac{1}{2\pi fC}$$ where: Xc = reactance in ohms (Ω), f = frequency in hertz (Hz), C = capacitance in farads (F)

Xc 在低頻時變大，高頻時變小。在穩定直流（DC）頻率為零時，Xc 無限大（完全抵抗），因此，**電容器交流（AC）通行，直流（DC）阻隔。**

例如：一個 1μF 的電容，信號 50 Hz 時電抗為 3.2 kΩ，可是當頻率提高至 10 kHz 時電抗則僅有 16Ω。

電感抗（inductive reactance），X_L

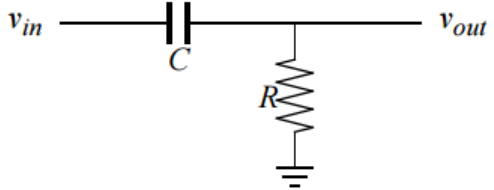
$$X_L = 2\pi fL$$ where: X_L = reactance in ohms (Ω), f = frequency in hertz (Hz), L = inductance in henrys (H)

X_L 在低頻時變小，高頻時變大。在穩定直流（DC）頻率為零時，X_L 為零（無抵抗），因此，**電感器直流（DC）通行，交流（AC）阻隔。**

例如：一個 1 mH 的電感，信號 50 Hz 時電抗為 0.3Ω，可是當頻率提高至 10 kHz 時電抗則為 63Ω。

Filter Circuits

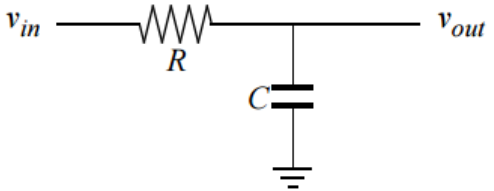
- Passive filters with a single resistor and capacitor are called one-pole filters.
- The high-pass filter selects frequencies above a breakpoint frequen



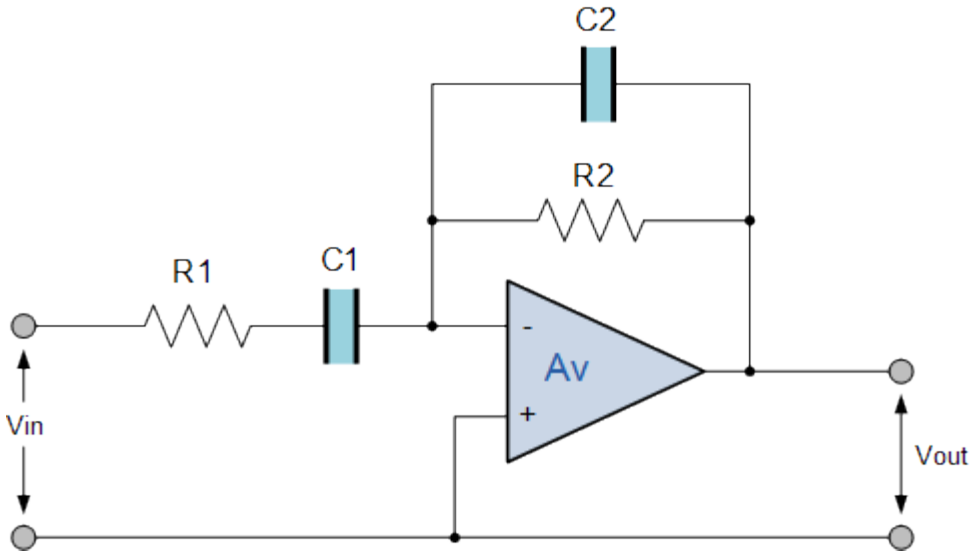
ω =1/RC

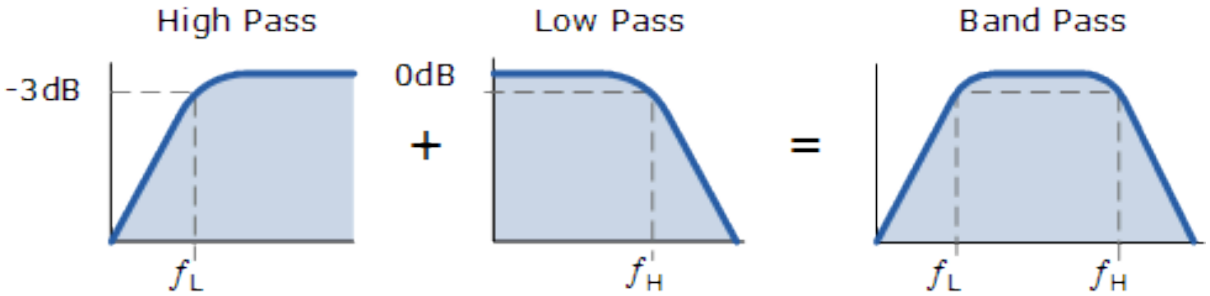
ω =1/RC

- The low uencies below a breakpoint frequer



Bandpass filter





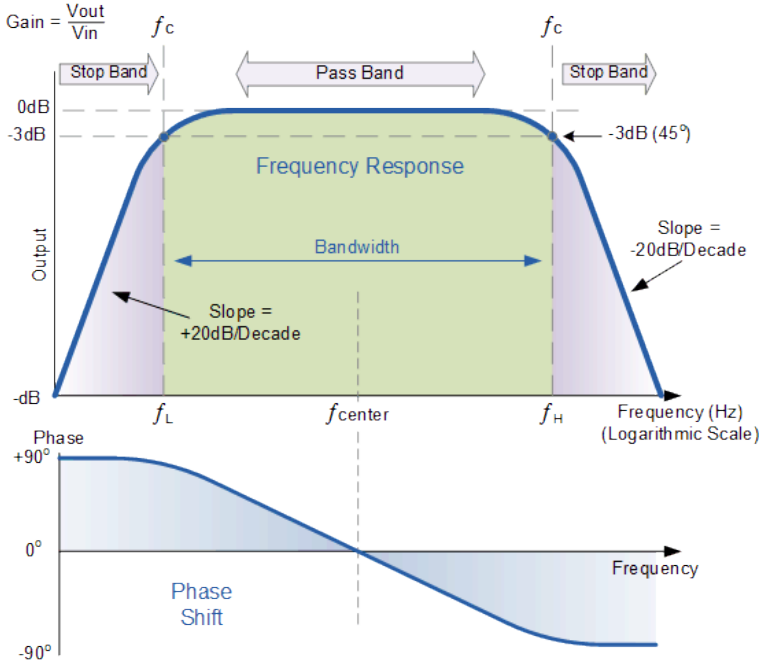
Bandpass filter

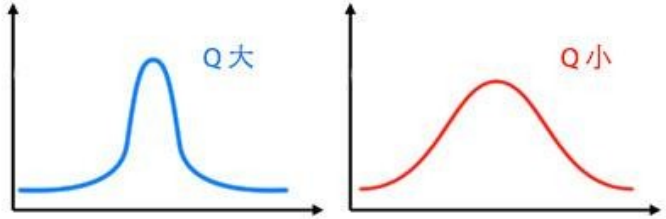
- **Frequency**
  - f_r is the resonant or Center Frequency
  - f_L is the lower -3dB cut-off frequency point
  - f_H is the upper -3db cut-off frequency point
- **Quality Factor**
- **Gain**

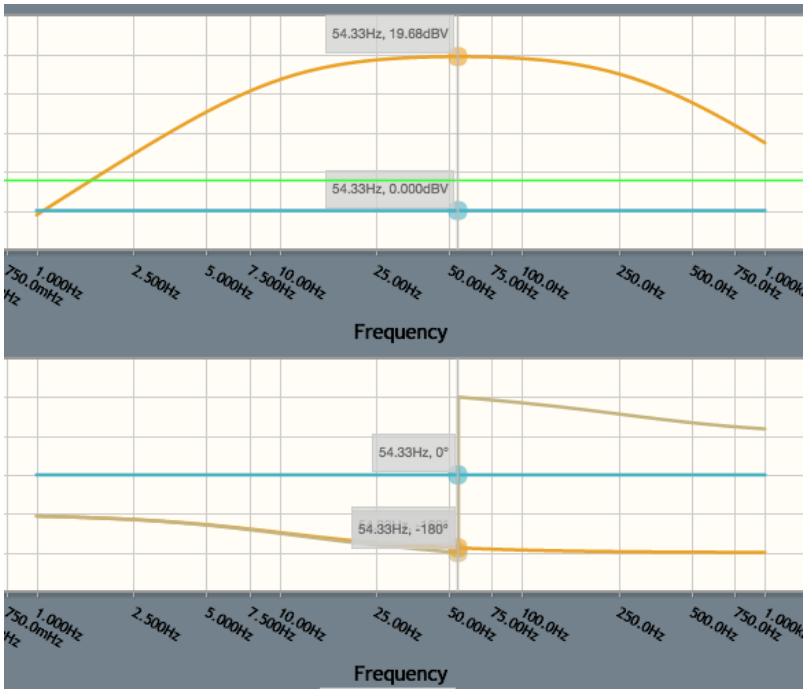
$$f_r = \sqrt{f_L \times f_H}$$

$$Q = \frac{\text{Resonant Frequency}}{\text{Bandwidth}}$$

$$Voltage\ Gain = -\frac{R_2}{R_1},\quad fc_1 = \frac{1}{2\pi R_1 C_1},\quad fc_2 = \frac{1}{2\pi R_2 C_2}$$

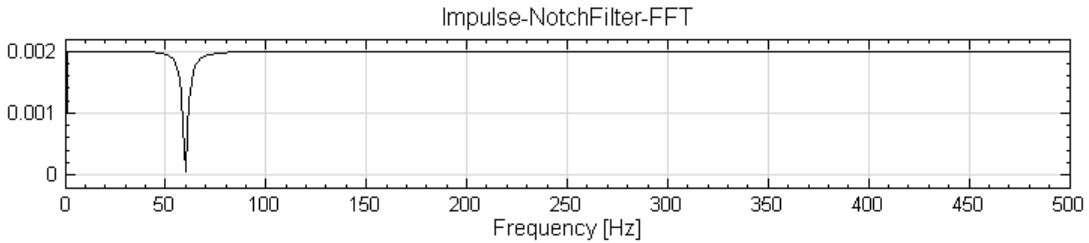





54.33Hz, 19.68dBV
54.33Hz, 0.000dBV
750.0mHz
1.000Hz
2.500Hz
5.000Hz
7.500Hz
10.00Hz
25.00Hz
50.00Hz
75.00Hz
100.0Hz
250.0Hz
500.0Hz
750.0Hz
1.000k
Frequency
54.33Hz, 0°
54.33Hz, -180°
750.0mHz
1.000Hz
2.500Hz
5.000Hz
7.500Hz
10.00Hz
25.00Hz
50.00Hz
75.00Hz
100.0Hz
250.0Hz
500.0Hz
750.0Hz
1.000k
Frequency

Notch Filter

- Commonly referred to as band-stop or band-rejection filters.
- Notch Filter 的主要濾除某一特定頻率
- 若假設濾波器設計為濾除為 60 Hz 的訊號，其 Frequency Response Function 如下圖。



Twin T notch filter

- A notch filter can be built with combining two 2-pole passive filters. One is low pass, and one is high pass.