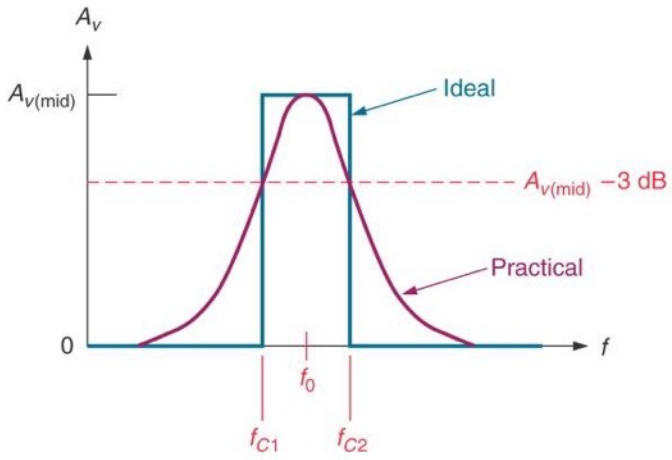
Frekvensfilter

Kap. 23

Filtre kan inndeles i mange grupper – vi skal se på noen av de mest brukte. Noen navn beskriver teknologien bak filteret – andre navn beskriver frekvensområdet hvor filteret arbeider :

1 a. Aktive filtre
1 b. Passive filtre
2 a. Bredbåndfilter
2 b. Smalbånd filter (tuned filter)
3 a. Lavpass filter
3 b. Høypass filter
4. Bånd- stopp – eller Notch filter

Tuned filter - smalbåndfilter



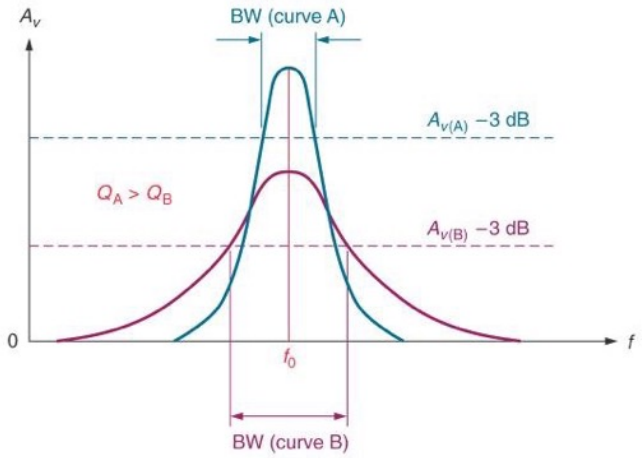
Frekvensfilter

Q-verdi

Q - verdien bestemmer båndbredden til filteret. Høy Q-verdi = smal båndbredde

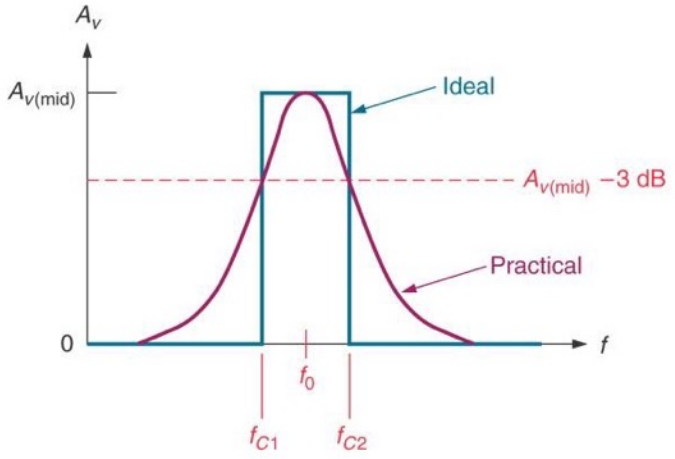
(Q = Quality factor)

$$Q = \frac{f_o}{\mathrm{BW}}$$

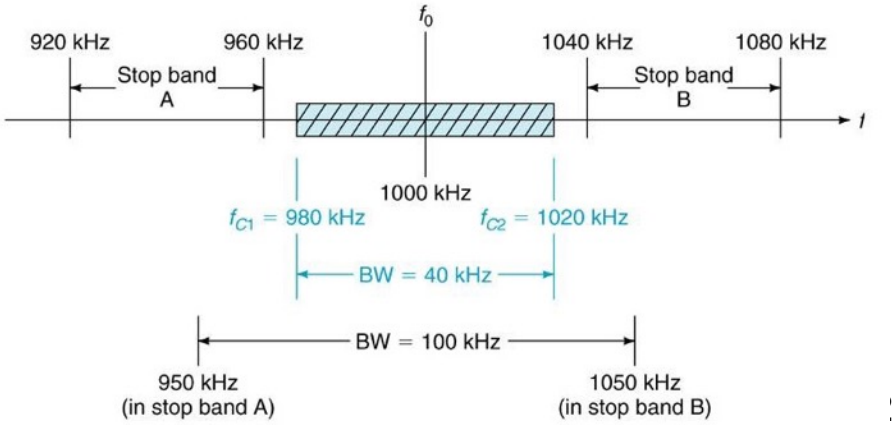


Geometrisk senterfrekvens f_0

$$f_0 = \sqrt{f_{C1} f_{C2}}$$



Frekvenskravet til filteret må være klart definert



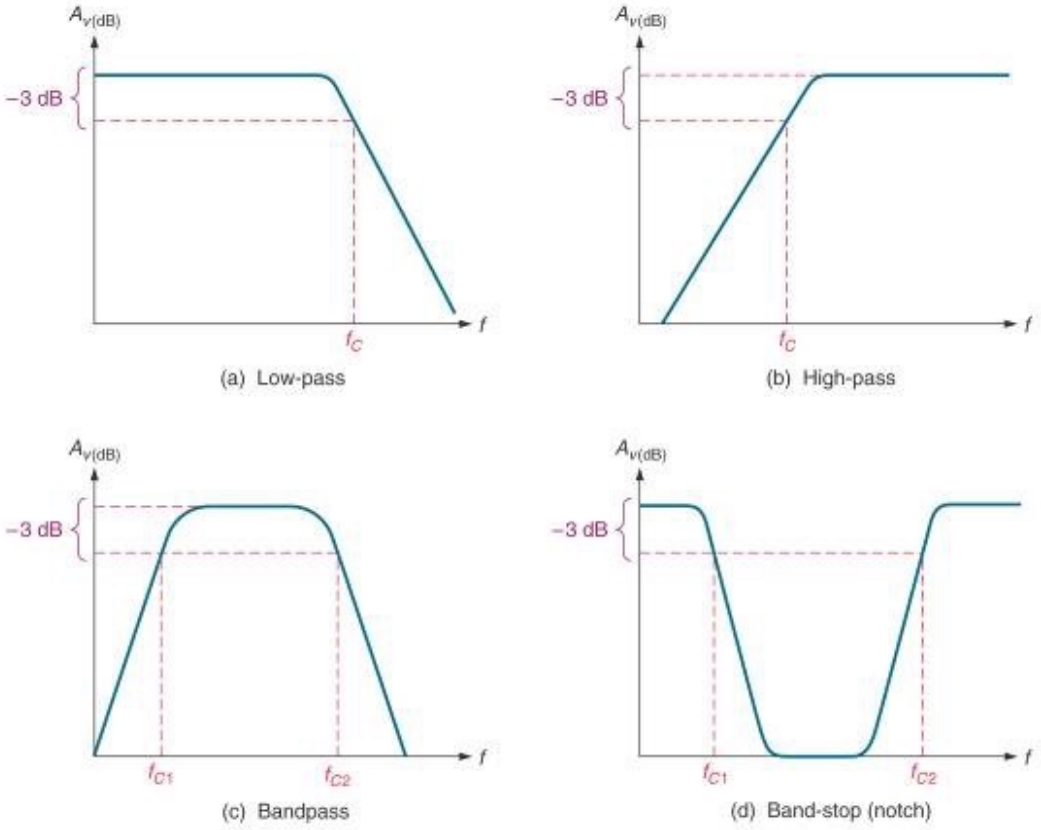
Frekvensfilter

Filter terminologi

Litt filterterminologi :

Aktivt filter er en filterkrets hvor operasjonsforsterkere inngår.

Vi har fire (4) hovedtyper av filtere :



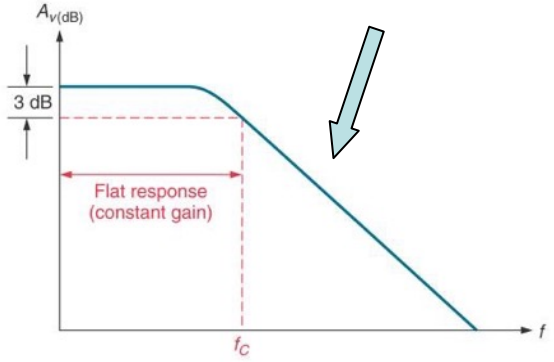
Frekvensfilter

Filter terminologi

- Mer filter- terminologi - poler og orden
  - **Pol**
    - En RC- krets
    - Eksempel: Filter med en pol: - filtret inneholder en RC- krets
  - **Orden**
    - Brukes for å beskrive antall poler
    - Eksempel: første ordens filter: inneholder en pol
  - **Flere poler –** steilere "Roll-off"-flanke

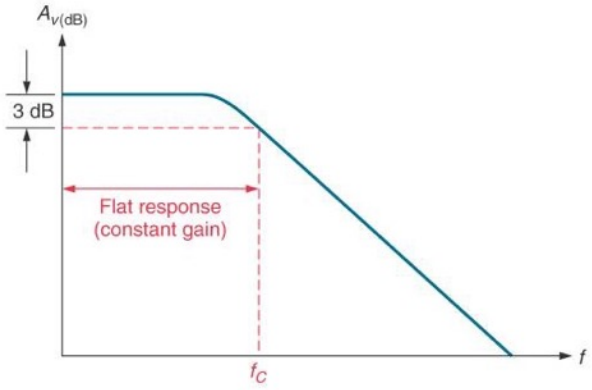
Butterworth Første ordens filter. Flanken faller med 20 dB/dekade – 6 dB pr. oktav

Filter Type	***Antall poler***	***Total Gain Roll-Off***
First-order	1	20 dB/decade
Second-order	2	40 dB/decade
Third-order	3	60 dB/decade



Frekvensfilter

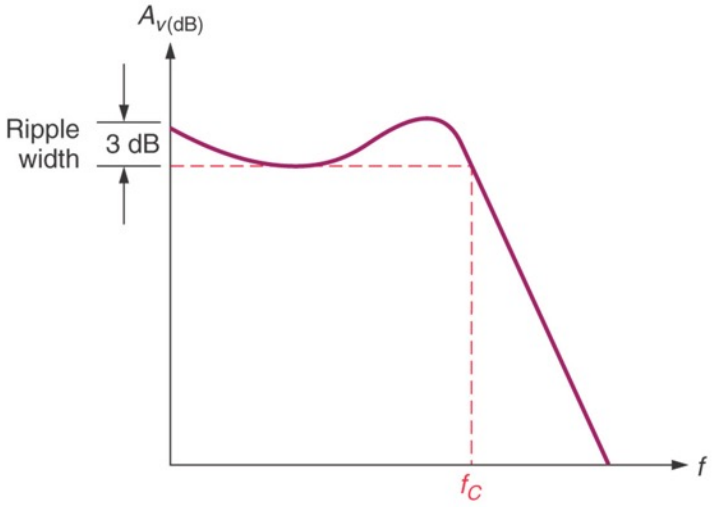
Ulike filter typer



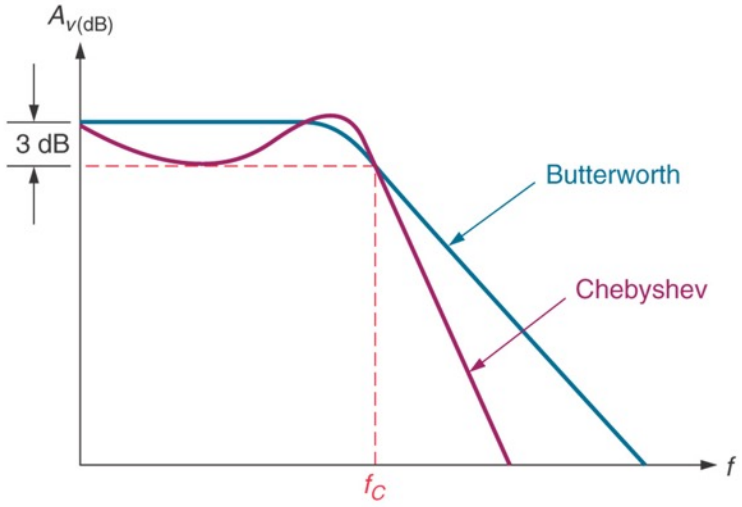
Butterworth, Chebyshev, og Bessel Filter

- Butterworth (maximally flat or flat-flat) – har en relativt flat respons over pass-båndet
- Butterworth – det mest bruket av aktive filtre

Chebyshev – Har brattere “roll-off rate”



(a) A Chebyshev response curve

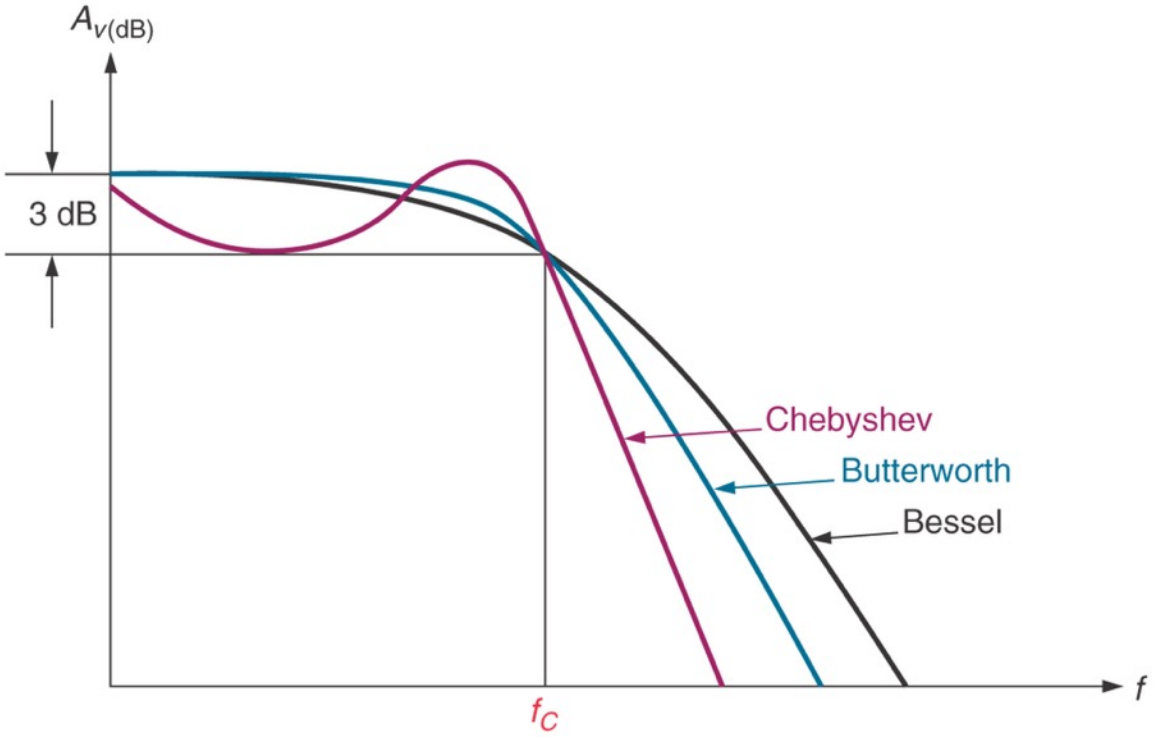


(b) Response curves for comparable Chebyshev and Butterworth filters

Frekvensfilter

Ulike filter typer

- Butterworth, Chebyshev, og Bessel Filters
- - Chebyshev - brattest “roll-off rate” - men har “rippel” i pass-båndet
  - Bessel – filter som gir konstant faseskift over hele pass-båndet
  - Butterworth – filter med maksimalt flat respons

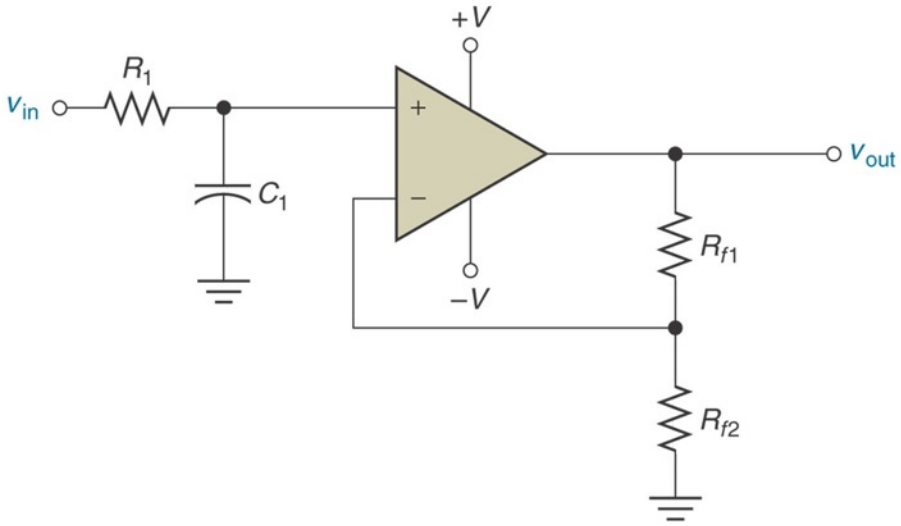


Frekvensfilter

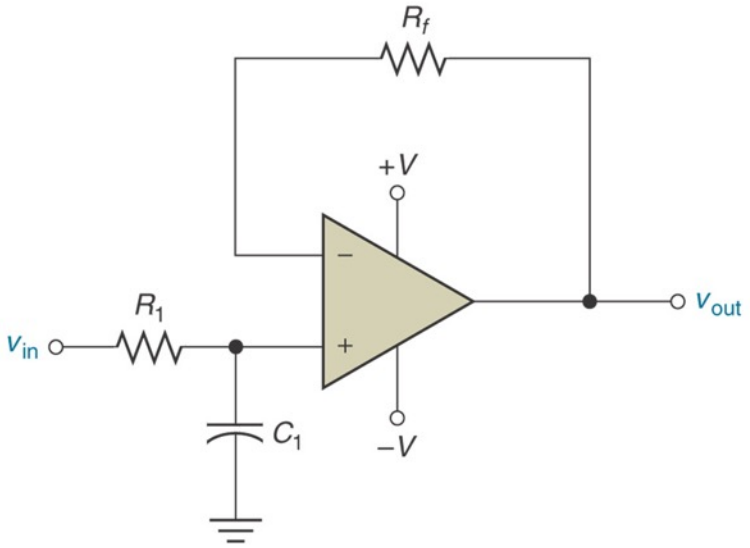
Butterworth

En pol – Lavpass filter – med eller uten forsterkning – type Butterworth

$$f_C = \frac{1}{2\pi RC}$$



(a) Variable-gain circuit



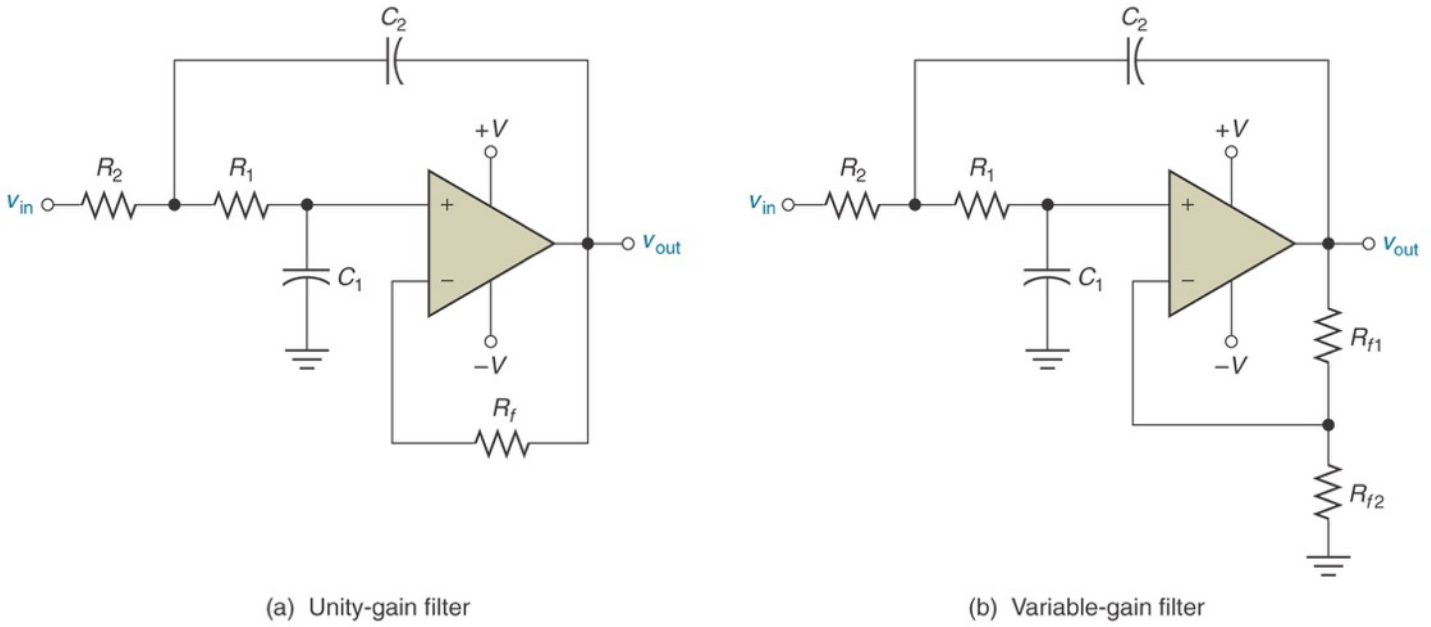
(b) Unity-gain circuit

Frekvensfilter

Butterworth

Butterworth lavpass filter med 2 poler – faller med - *40dB/dekade*

$$f_C = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

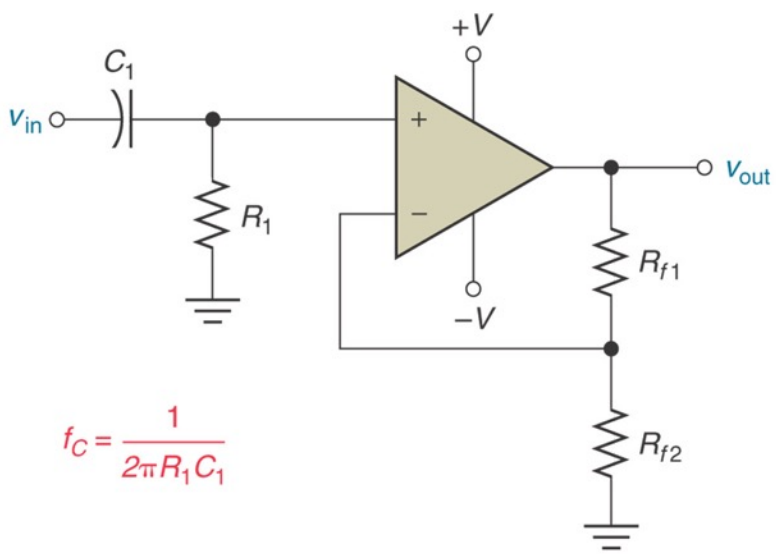


(a) Unity-gain filter

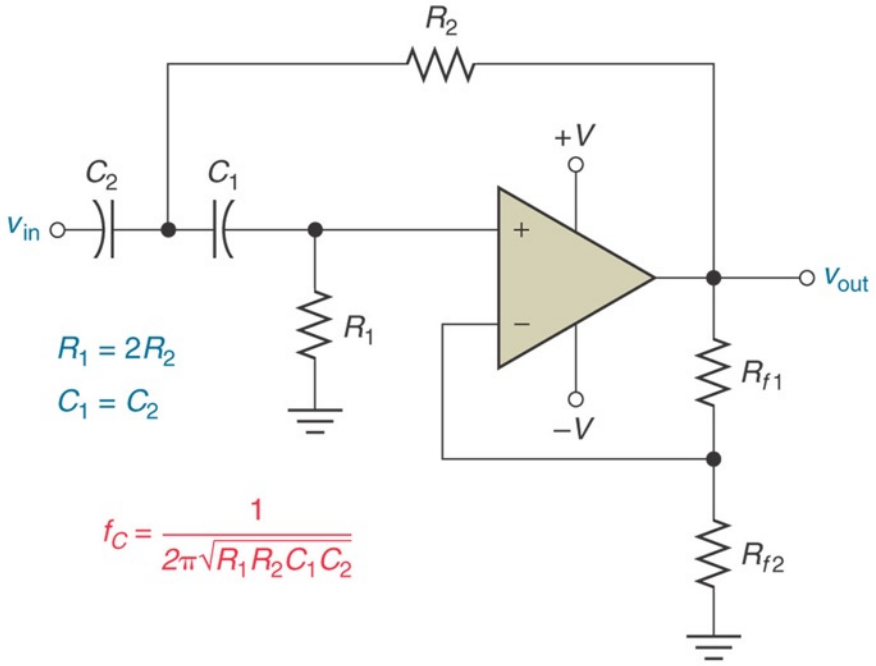
(b) Variable-gain filter

Frekvensfilter

Høypass filter – en og to poler - ***Butterworth***



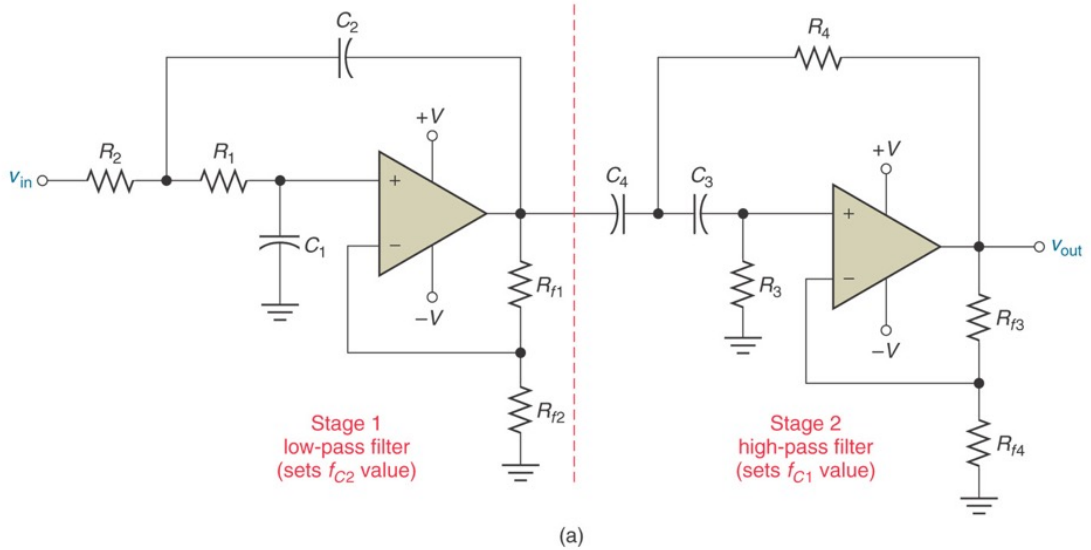
(a) One-pole



(b) Two-pole

Frekvensfilter

To trinns Båndpass- og Notch-filter – kaskadekopling av filtre
Først lavpass- så følger høypassfilter

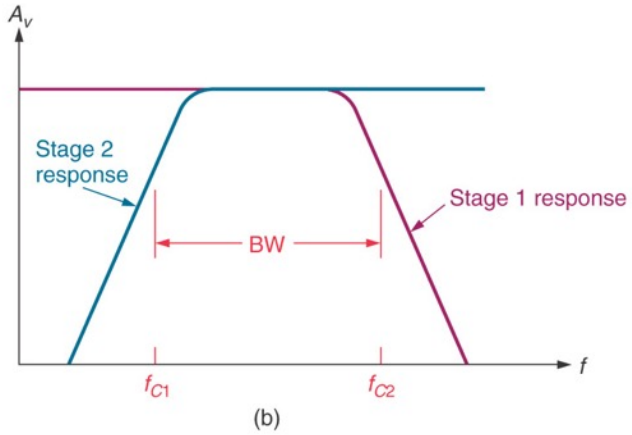


(a)

$$BW = f_{C2} - f_{C1}$$

$$f_0 = \sqrt{f_{C1} f_{C2}}$$

$$Q = \frac{f_0}{BW}$$



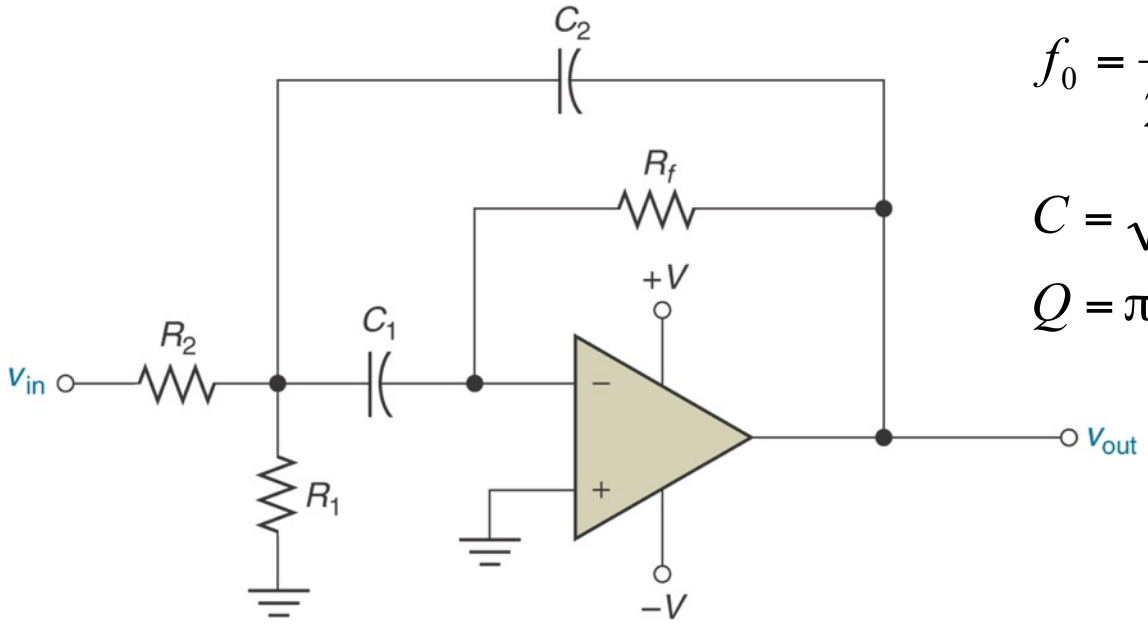
(b)

Frekvensfilter

Multiple- Feedback Båndpassfilter

Multiple- Feedback Båndpassfilter

- 2 feedback- nettverk, - et kapasitivt og et resistivt nettverk
- Krever færre komponenter enn et 2-trinns filter



$$f_0 = \frac{1}{2\pi\sqrt{(R_1 \| R_2) R_f C_1 C_2}}$$

$$C = \sqrt{C_1 C_2}$$

$$Q = \pi f_0 R_f C$$

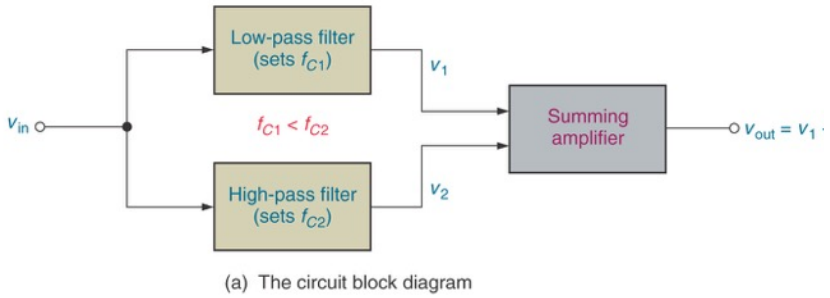
$$A_{CL} = \frac{R_f}{2R_{in}}$$

Rin = kretsens serie inngangsmotstand

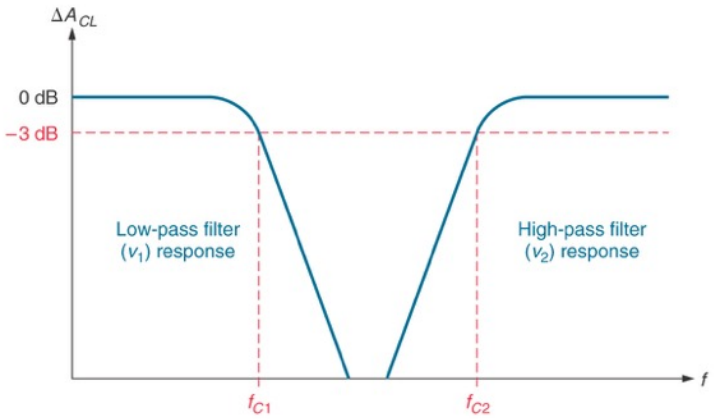
Frekvensfilter

Notch Filter

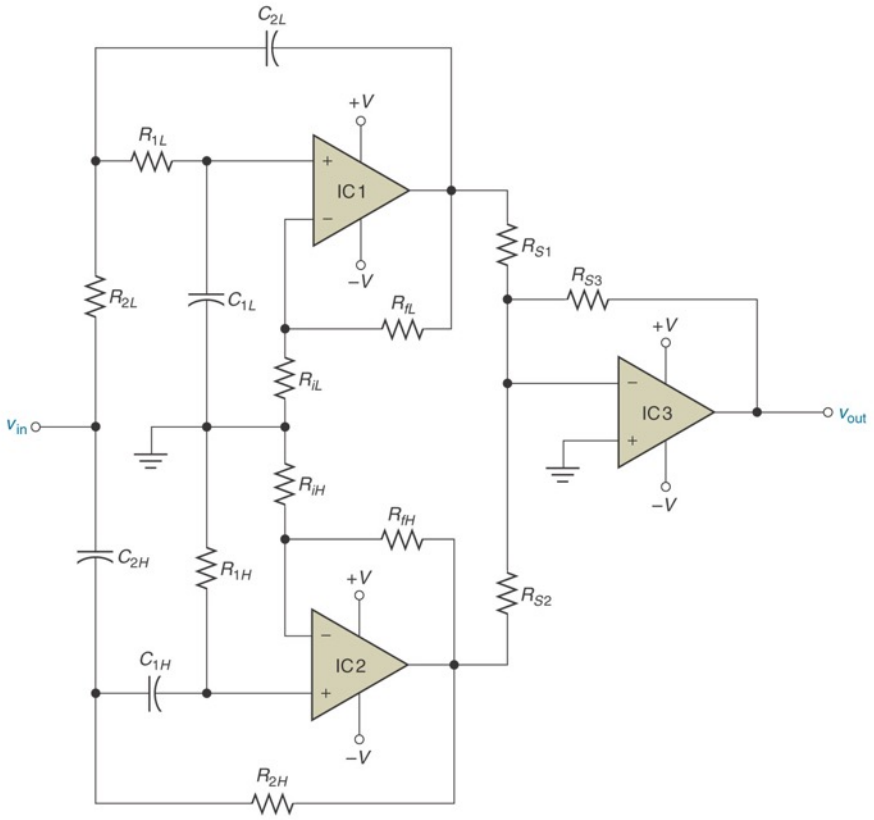
Notch Filter – skal blokkere alle frekvenser som faller innenfor båndbredden



(a) The circuit block diagram



(b) The circuit frequency response characteristics

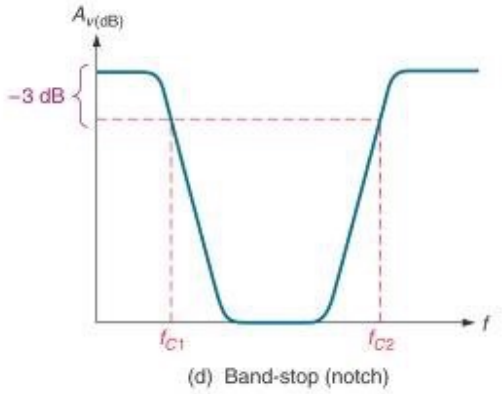


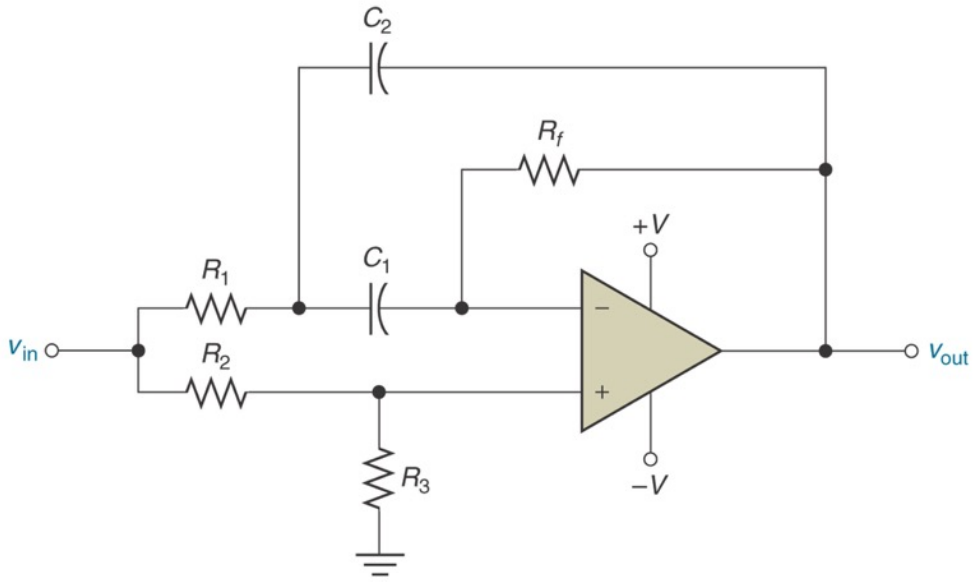
Frekvensfilter

Notch Filter

Notch Filter – skal blokkere alle frekvenser som faller innenfor båndbredden
Her realisert som et multippel feedback-filter

$$f_0 = \frac{1}{2\pi\sqrt{R_1 R_f C_1 C_2}}$$

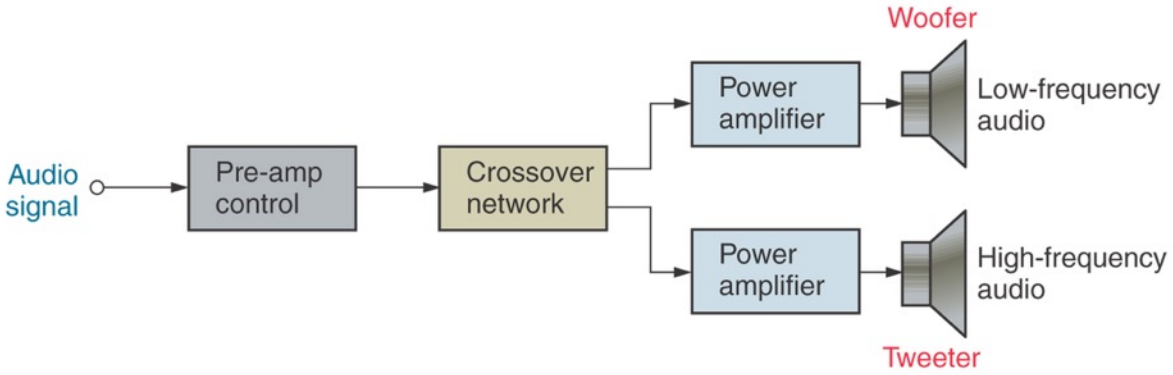


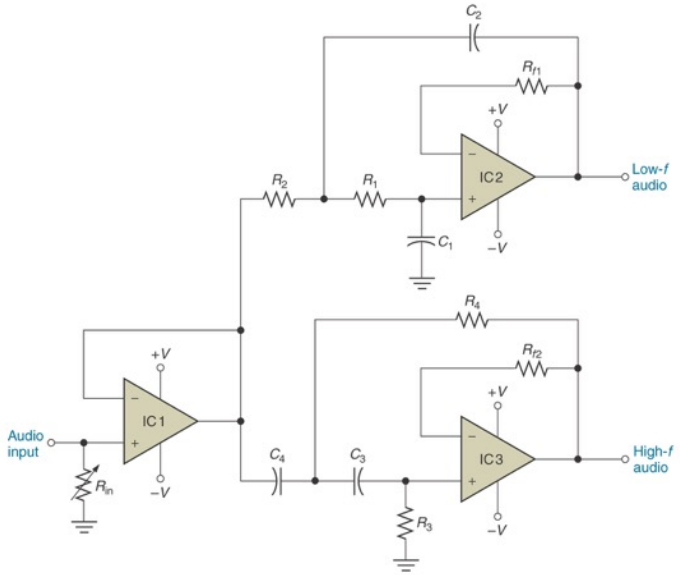


Frekvensfilter

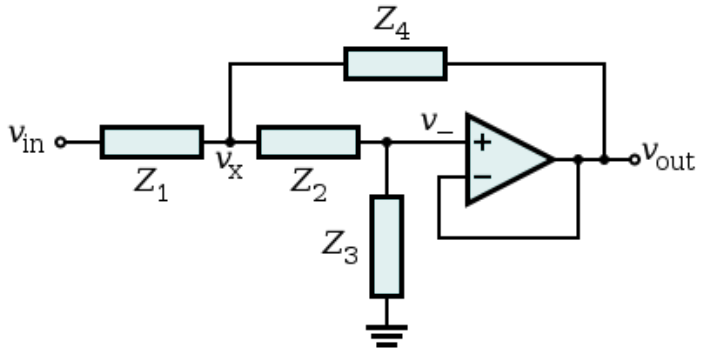
Aktive filtre

Aktive filtre – noen anvendelser - delefilter for høyttalere



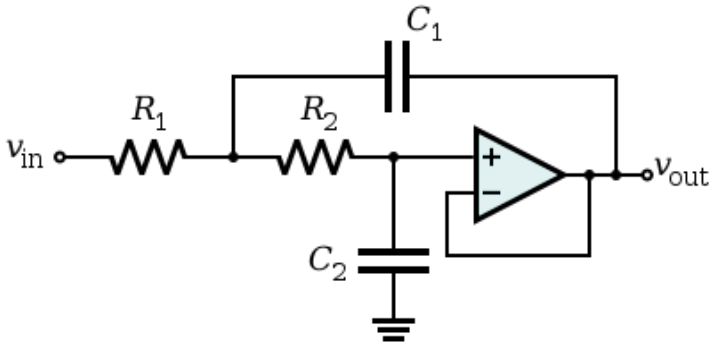


Frekvensfilter

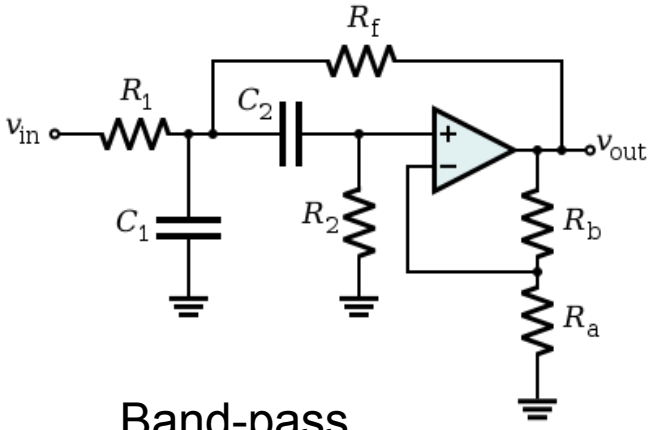


Sallen-Key filter

[Analog Devices filter design applet](#)
[Online Calculation Tool for Sallen–Key Low-pass/High-pass Filters](#)



Low-pass



Band-pass

Texas Instruments Active Filter Design Application - Filter pro