OKAWA Electric Design

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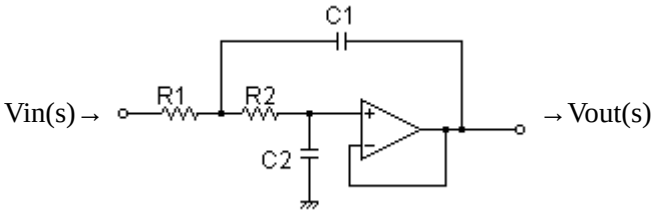
disclaimer blog

Sallen-Key Low-pass Filter Design Tool

This page is a web application that design a Sallen-Key low-pass filter. Use this utility to simulate the Transfer Function for filters at a given frequency, damping ratio ζ, Q or values of R and C. The response of the filter is displayed on graphs, showing Bode diagram, Nyquist diagram, Impulse response and Step response.

Sample calculation

Calculate the transfer function for Sallen-Key low-pass filter with R and C values



Transfer function:

$$\frac{Vout(s)}{Vin(s)} = \frac{\frac{1}{R1C1R2C2}}{s^2 + s\left(\frac{1}{R2C1} + \frac{1}{R1C1}\right) + \frac{1}{R1C1R2C2}}$$

R1= Ω C1= F

Calculate the R and C values for the Sallen-Key filter at a given frequency and Q factor

R2= Ω C2= F

p:pico, n:nano, u:micro, k:kilo, M:mega

Frequency analysis

- [x] Bode diagram
  - (•) Phase ( ) Group delay
- [x] Nyquist diagram
- [x] Pole, zero
- [x] Phase margin
- [x] Oscillation analysis

Upper and lower frequency limits:

f1= - f2= [Hz]

(frequency limits are optional)

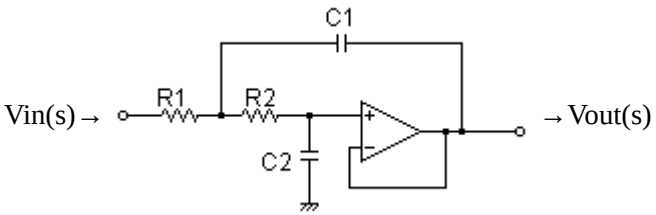
Transient analysis

- [x] Step response
- [ ] Impulse response
- [x] Overshoot
- [x] Final value of the step response

Simulation time:

0 - [sec] (optional)

Calculate



Cut-off frequency:

$$fc = \frac{1}{2\pi\sqrt{R1C1R2C2}}$$

Transfer function:

$$\frac{Vout(s)}{Vin(s)} = \frac{(2\pi f_c)^2}{s^2 + 2\zeta(2\pi f_c)s + (2\pi f_c)^2}$$

$$Q = \frac{1}{2\zeta}$$

Ge

f_c= Hz

Q factor | Damping ratio ζ

Quality factor Q = 0.707

Damping ratio ζ = 1

C1 = F C2 = F

C1, C2 is optional. But when setting these capacitances, C1 and C2 of both are needed to give following the equation

$(C2/C1) \leq \zeta^2$

$(C1/C2) \geq 4Q^2$

Select Capacitor Sequence: E6

Select Resistor Sequence: E24

Frequency analysis

☑ Bode diagram
◉ Phase ○ Group delay
☑ Nyquist diagram
☑ Pole, zero
☑ Phase margin
☑ Oscillation analysis

Upper and lower frequency limits:
f1= - f2= [Hz]
(frequency limits are optional)

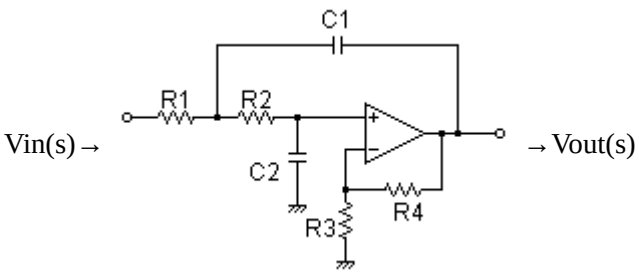
Transient analysis

☑ Step response
☐ Impulse response
☑ Overshoot
☑ Final value of the step response

Simulation time:
0 - [sec] (optional)

Calculate

Calculate the transfer function for Sallen-Key low-pass filter with R and C values



Transfer function:
Transfer function

R1= Ω C1= F

R2= Ω C2= F

R3= Ω

R4= Ω

p:pico, n:nano, u:micro, k:kilo, M:mega

Frequency analysis

- [x] Bode diagram
  - (•) Phase ( ) Group delay
- [x] Nyquist diagram
- [x] Pole, zero
- [x] Phase margin
- [x] Oscillation analysis

Upper and lower frequency limits:

f1= - f2= [Hz]

(frequency limits are optional)

Transient analysis

- [x] Step response
- [ ] Impulse response
- [x] Overshoot

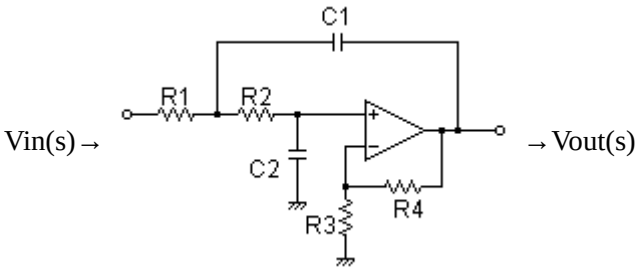
☑ Final value of the step response

Simulation time:

0 - [sec] (optional)

Calculate

Calculate the R and C values for the Sallen-Key filter at a given frequency and Q factor



Cut-off frequency:

$$fc = \frac{1}{2\pi\sqrt{R1C1R2C2}}$$

Transfer function:

$$\frac{Vout(s)}{Vin(s)} = \frac{G(2\pi f_c)^2}{s^2 + 2\zeta(2\pi f_c)s + (2\pi f_c)^2}$$

$$Q = \frac{1}{2\zeta}$$

$$G = \frac{R3+R4}{R3}$$

f_c= Hz

G= 1.59 at f=0Hz (G>1)

Q factor | Damping ratio ζ

○ Quality factor Q = 0.707

◉ Damping ratio ζ = 1

C1 = F C2 = F

C1, C2 is optional. But when setting these capacitances, C1 and C2 of both are needed to give following the equation

$G-1 < C2/C1 \leq \zeta^2+G-1$

Select Capacitor Sequence: E6

Select Resistor Sequence: E24

Frequency analysis

- [x] Bode diagram
  - (•) Phase ( ) Group delay
- [x] Nyquist diagram
- [x] Pole, zero
- [x] Phase margin
- [x] Oscillation analysis

Upper and lower frequency limits:

f1= - f2= [Hz]

(frequency limits are optional)

Transient analysis

- [x] Step response
- [ ] Impulse response
- [x] Overshoot
- [x] Final value of the step response

Simulation time:

0 - [sec] (optional)

Calculate

Filter tools

RC LPF
RC HPF
LR LPF
LR HPF
RLC LPF
RLC HPF
RLC BPF
RLC BEF
Sallen-Key LPF
Sallen-Key HPF
3rd order SallenKeyLPF
3rd order SallenKeyHPF
Multiple feedback LPF
Multiple feedback HPF
Multiple feedback BPF
3rd order Multiple feedback LPF
3rd order Multiple feedback HPF
TwinT notch
CR-2nd order Active filter LPF,HPF,BPF

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