Sallen–Key Low-Pass Filter: Cutoff Frequency and Q

Natural (cutoff) frequency, quality factor and gain of a Sallen–Key second-order active low-pass filter from its resistors, capacitors and amplifier gain.

Method: Sallen–Key second-order active filter

Input parameters

Unit system: SI

Parameter	Value	Unit
Input resistor R_1	10.000	kΩ
Second resistor R_2	10.000	kΩ
Feedback capacitor C_1 (to output)	22.000	nF
Capacitor C_2 (to ground)	10.000	nF
Amplifier gain (1 for a follower)	1.0000	

Calculated results

Parameter	Value	Unit
Natural frequency	1,073.0	Hz
Quality factor	0.74162	
Pass-band gain (dB)	0	
Peak gain above the pass band (dB; 0 if Q ≤ 0.707)	0.036041	

Notes for this case

• H(s) = K $\omega_0^2/(s^2 + (\omega_0/Q)s + \omega_0^2)$ with $\omega_0 = 1/\sqrt{(R_1R_2C_1C_2)}$ and $Q = \sqrt{(R_1R_2C_1C_2)}/[C_2(R_1 + R_2) + R_1C_1(1 - K)]$. Q = 0.707 is Butterworth (maximally flat); with K = 1 choose $C_1 = 2C_2$ and equal resistors.

Formula and method

$$f_0 = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}, \quad Q = \frac{\sqrt{R_1 R_2 C_1 C_2}}{C_2(R_1 + R_2) + R_1 C_1 (1 - K)}$$

Variables

R_1	Input resistor R_1	Ω
R_2	Second resistor R_2	Ω
C_1	Feedback capacitor C_1 (to output)	F
C_2	Capacitor C_2 (to ground)	F
K	Amplifier gain (1 for a follower)	-
f_0	Natural frequency	1/s
Q	Quality factor	-
K_{dB}	Pass-band gain (dB)	-
G_{peak}	Peak gain above the pass band (dB; 0 if Q ≤ 0.707)	-

Method and standards

Second-order active filter analysis.

Assumptions and limits

- Ideal op-amp, unloaded output.

References

Sallen–Key second-order active filter

Report details

Report reference	FCC-J248-J6T2 (the same inputs always give the same reference)
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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/electronics/sallen-key-low-pass

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Reopens the calculator with the inputs of this report.