RC Low-Pass Filter: Cut-Off, Time Constant and Attenuation

Cut-off frequency and time constant of a first-order RC low-pass filter, with its attenuation and phase lag at a chosen frequency.

Method: First-order RC low-pass filter (circuit theory definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Resistance	10,000	Ω
Capacitance	1.0000	µF
Signal or noise frequency	50.000	Hz

Calculated results

Parameter	Value	Unit
Cut-off frequency (−3 dB)	15.915	Hz
Time constant	0.010000	s
Gain at f	0.30331	
Attenuation at f (dB)	10.362	
Phase lag at f	72.343	°

Notes for this case

• A first-order filter attenuates 20 dB per decade above cut-off. Every filter adds lag: keep the time constant well below the control loop's dead time.

Formula and method

$$f_c = \frac{1}{2\pi RC}, \quad |G| = \frac{1}{\sqrt{1+(f/f_c)^2}}, \quad \phi = \arctan\frac{f}{f_c}$$

Variables

R	Resistance	Ω
C	Capacitance	F
f	Signal or noise frequency	1/s
f_c	Cut-off frequency (−3 dB)	1/s
$\mathcal{T}$	Time constant	s
	G	$
A	Attenuation at f (dB)	-
ϕ	Phase lag at f	rad

Method and standards

First-order response.

Assumptions and limits

- Unloaded first-order RC.

References

• First-order RC low-pass filter (circuit theory definitions)

Report details

Report reference	FCC-7876-KD8Q (the same inputs always give the same reference)
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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/signals-calibration/rc-filter-cutoff

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.