Inductive and Capacitive Reactance, Impedance and Resonance

Inductive and capacitive reactance at a frequency, impedance, current and phase angle of a series RLC circuit, its resonant frequency, Q factor and bandwidth.

Method: AC circuit theory (phasors)

Input parameters

Unit system: SI

Parameter	Value	Unit
Supply frequency	50.000	Hz
Resistance	10.000	Ω
Inductance Above zero: a series RLC circuit. For a resistor and capacitor alone use the RC time constant calculator.	100.00	mH
Capacitance	100.00	µF
Supply voltage (rms)	230.00	V

Calculated results

Parameter	Value	Unit
Inductive reactance 2πfL	31.416	Ω
Capacitive reactance 1 / (2πfC)	31.831	Ω
Net reactance X_L − X_C	-0.41506	Ω
Impedance	10.009	Ω
Phase angle (positive = current lags)	-2.3768	°
Current	22.980	A
Power factor	0.99914	
Resonant frequency 1 / (2π√(LC))	50.329	Hz
Quality factor (1/R)√(L/C)	3.1623	
Bandwidth f_0 / Q	15.915	Hz

Notes for this case

- Series circuit with ideal components. At resonance X_L = X_C, the impedance falls to R and the voltage across L and C can be Q times the supply.

Formula and method

$$X_L = 2\pi f L, \quad X_C = \frac{1}{2\pi f C}, \quad Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}, \quad Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Variables

f	Supply frequency	1/s
R	Resistance	Ω
L	Inductance	H
C	Capacitance	F

V	Supply voltage (rms)	V
X_L	Inductive reactance 2πfL	Ω
X_C	Capacitive reactance 1 / (2πfC)	Ω
X	Net reactance X_L − X_C	Ω
Z	Impedance	Ω
φ	Phase angle (positive = current lags)	rad
I	Current	A
$\cos\varphi$	Power factor	-
f_0	Resonant frequency 1 / (2π√(LC))	1/s
Q	Quality factor (1/R)√(L/C)	-
BW	Bandwidth f_0 / Q	1/s

Method and standards

Series RLC impedance with phasors.

Assumptions and limits

- Ideal components, series connection.
- R, L and C must all be above zero; a circuit without an inductor has no resonance.

References

- AC circuit theory (phasors)

Report details

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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/circuits/reactance-resonance

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Reopens the calculator with the inputs of this report.