Gapped Inductor Design: Turns and Air Gap

Turns and air gap of a gapped ferrite inductor for an inductance and peak current without exceeding a flux density, from the core area and magnetic path.

Method: Gapped-core inductor design from Faraday's law and the magnetic circuit

Input parameters

Unit system: SI

Parameter	Value	Unit
Inductance wanted	100.00	µH
Peak current	5.0000	A
Effective core area	120.00	mm²
Effective magnetic path length	70.000	mm
Relative permeability of the core material	2,000.0	
Highest flux density allowed	0.30000	T

Calculated results

Parameter	Value	Unit
Turns (before rounding)	13.889	
Turns, rounded up	14.000	
Total air gap for the rounded turns	0.26056	mm
Peak flux density with the rounded turns	0.29762	T
Energy stored at peak current	1.2500	mJ
Inductance factor of the gapped core	510.20	nH

Notes for this case

• Faraday's law fixes the turns: N = L I_pk/(B_max A_e) keeps the peak flux density at B_max. The gap then sets the inductance with those turns: L = μ₀N²A_e/(l_g + l_e/μ_r), so l_g = μ₀N²A_e/L − l_e/μ_r. Almost all the energy is stored in the gap. Fringing near a large gap raises the inductance a few per cent and heats nearby windings; check the window area for the wire and the core loss at the ripple current.

Formula and method

$$N = \frac{L I_{pk}}{B_{max} A_e}, \quad l_g = \frac{\mu_0 N^2 A_e}{L} - \frac{l_e}{\mu_r}, \quad E = \frac{1}{2} L I_{pk}^2$$

Variables

L	Inductance wanted	H
I_{pk}	Peak current	A
A_e	Effective core area	m²
l_e	Effective magnetic path length	m
μ_r	Relative permeability of the core material	-
B_{max}	Highest flux density allowed	T
N	Turns (before rounding)	-
N_{sel}	Turns, rounded up	-
l_g	Total air gap for the rounded turns	m
B_{pk}	Peak flux density with the rounded turns	T

E	Energy stored at peak current	J
A_L	Inductance factor of the gapped core	H

Method and standards

Gapped inductor.

Assumptions and limits

- No fringing; uniform flux; linear core.

References

Gapped-core inductor design from Faraday's law and the magnetic circuit

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/electronics/gapped-inductor-air-gap

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Reopens the calculator with the inputs of this report.