Transformer Magnetising Inrush Peak (Air-Core Saturation Estimate)

Peak magnetising inrush current of a transformer energised at voltage zero with remanence, from turns, winding height and flux densities, and its multiple.

Method: Air-core saturation estimate of inrush

Input parameters

Unit system: SI

Parameter	Value	Unit
Turns of the energised winding	600.00	
Winding height	1,000.0	mm
Rated peak flux density	1.7000	T
Remanent flux density	0.80000	T
Saturation flux density of the core	2.0300	T
Rated rms current of that winding	105.00	A

Calculated results

Parameter	Value	Unit
Peak flux demanded	4.2000	T
Flux beyond saturation	2.1700	T
Peak inrush current	2,878.1	A
Multiple of rated peak current	19.382	

Notes for this case

• Switching at voltage zero drives the flux to 2B_n + B_r; the part above saturation must be supplied by the winding as an air-core coil, i_pk ≈ h_w(2B_n + B_r − B_s)/(μ₀N). Source impedance and winding resistance reduce it, and it decays over cycles to seconds. Typical results are 5–15 times rated peak for large units, more for small ones; energising the outer winding gives less.

Formula and method

$$B_{pk} = 2B_n + B_r, \quad i_{pk} \approx \frac{h_w(2B_n + B_r - B_s)}{\mu_0 N}$$

Variables

N	Turns of the energised winding	-
h_w	Winding height	m
B_n	Rated peak flux density	T
B_r	Remanent flux density	T
B_s	Saturation flux density of the core	T
I_r	Rated rms current of that winding	A
B_{pk}	Peak flux demanded	T
ΔB	Flux beyond saturation	T
i_{pk}	Peak inrush current	A
$i_{pk}/(\sqrt{2}\,I_r)$	Multiple of rated peak current	-

Method and standards

Inrush estimate.

Assumptions and limits

- Single phase, worst-case switching instant; resistance and source impedance neglected.

References

Air-core saturation estimate of inrush

Report details

Report reference	FCC-T6D7-0RQF (the same inputs always give the same reference)
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Release checks	3 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/electrical/transformers/transformer-inrush-current

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.