AC Machine Winding: Turns per Phase from the EMF Equation

Flux per pole and turns per phase of a three-phase AC machine winding from its voltage, frequency, bore, core length, poles and mean gap flux density.

Method: EMF equation E = 4.44 f Φ T k_w and specific magnetic loading

Input parameters

Unit system: SI

Parameter	Value	Unit
Line voltage	415.00	V
Winding connection	Delta	
Frequency	50.000	Hz
Number of poles	4.0000	
Stator bore diameter	200.00	mm
Core length	150.00	mm
Mean flux density in the air gap	0.45000	T
Winding factor	0.95500	
Induced EMF as a share of the phase voltage	0.97000	

Calculated results

Parameter	Value	Unit
Flux per pole	10.603	mWb
Induced EMF per phase	402.55	V
Turns per phase	179.08	
Conductors per phase (2T)	358.15	
Pole pitch	157.08	mm

Notes for this case

• The EMF per phase is E = 4.44 f Φ T k_w, with the flux per pole Φ = B_av × the pole area π D L / p. The phase voltage is the line voltage for delta and line/√3 for star; a motor's induced EMF is a few per cent below it (about 0.95–0.98), a generator's slightly above. Round the turns to a whole number that suits the slots, parallel paths and coil sides, then recalculate the flux density.

Formula and method

$$E_{ph} = 4.44\, f\, \Phi\, T_{ph}\, k_w, \quad \Phi = \frac{B_{av}\, \pi D L}{p}$$

Variables

V_L	Line voltage	V
conn	Winding connection	-
f	Frequency	1/s
p	Number of poles	-
D	Stator bore diameter	m
L	Core length	m
B_{av}	Mean flux density in the air gap	T
k_w	Winding factor	-

E/V	Induced EMF as a share of the phase voltage	-
Φ	Flux per pole	Wb
E_{ph}	Induced EMF per phase	V
T_{ph}	Turns per phase	-
Z_{ph}	Conductors per phase (2T)	-
τ_p	Pole pitch	m

Method and standards

EMF equation.

Assumptions and limits

- Sinusoidal gap flux; the EMF ratio is an estimate.

References

EMF equation E = 4.44 f Φ T k_w and specific magnetic loading

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/motors/ac-winding-turns-per-phase

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.