Induction Motor Equivalent Circuit from No-Load and Locked-Rotor Tests

Stator and rotor resistances, leakage reactances, magnetising reactance and rotational loss of an induction motor from DC, no-load and locked-rotor test readings.

Method: No-load; locked-rotor and DC tests for the per-phase equivalent circuit

Input parameters

Unit system: SI

Parameter	Value	Unit
Stator resistance per phase (from the DC test, star equivalent)	0.25000	Ω
No-load line voltage	415.00	V
No-load current	8.5000	A
No-load input power (three-phase)	900.00	W
Locked-rotor line voltage	85.000	V
Locked-rotor current	28.000	A
Locked-rotor input power (three-phase)	1,900.0	W
Locked-rotor test frequency relative to rated	1.0000	
Design class (split of the leakage reactance)	Class B (X_1 = 0.4 X_LR)	

Calculated results

Parameter	Value	Unit
Stator leakage reactance	0.62216	Ω
Rotor leakage reactance referred	0.93324	Ω
Magnetising reactance	27.566	Ω
Rotor resistance referred	0.59623	Ω
Rotational (friction, windage and core) loss	845.81	W
No-load power factor	0.14730	
Locked-rotor impedance per phase	1.7527	Ω

Notes for this case

- Star-equivalent per-phase values. X_LR is scaled to rated frequency; R_2' includes the correction $((X_2' + X_m)/X_m)^2$ for the magnetising branch. Use the results in the equivalent-circuit torque–slip calculator.

Formula and method

$$|Z_{LR}| = \frac{V_{br}/\sqrt{3}}{I_{br}}, \quad R_{LR} = \frac{P_{br}}{3I_{br}^2}, \quad X_{LR} = \frac{f_{rated}}{f_{test}}\sqrt{|Z_{LR}|^2 - R_{LR}^2}$$

$$X_m = \frac{V_{nl}/\sqrt{3}}{I_{nl}} - X_1, \quad R'_2 = (R_{LR} - R_1)\left(\frac{X'_2 + X_m}{X_m}\right)^2, \quad P_{rot} = P_{nl} - 3I_{nl}^2 R_1$$

Variables

R_1	Stator resistance per phase (from the DC test, star equivalent)	Ω
V_{nl}	No-load line voltage	V
I_{nl}	No-load current	A

P_{nl}	No-load input power (three-phase)	W
V_{br}	Locked-rotor line voltage	V
I_{br}	Locked-rotor current	A
P_{br}	Locked-rotor input power (three-phase)	W
f_{test}/f_{rated}	Locked-rotor test frequency relative to rated	-
class	Design class (split of the leakage reactance)	-
X_1	Stator leakage reactance	Ω
X'_2	Rotor leakage reactance referred	Ω
X_m	Magnetising reactance	Ω
R'_2	Rotor resistance referred	Ω
P_{rot}	Rotational (friction, windage and core) loss	W
$\cos\phi_{nl}$	No-load power factor	-
	Z_{LR}	$

Method and standards

Equivalent-circuit parameters from standard motor tests.

Assumptions and limits

- Balanced three-phase motor, star-equivalent values, linear magnetics.

References

No-load, locked-rotor and DC tests for the per-phase equivalent circuit

Report details

Report reference	FCC-8G23-3PP1 (the same inputs always give the same reference)
Generated	23 November 2026, 18:24 UTC
Calculator	Induction Motor Equivalent Circuit from No-Load and Locked-Rotor Tests
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/motors/induction-motor-test-parameters

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Reopens the calculator with the inputs of this report.