Grid-Connected Induction Generator Output

Slip, power delivered, reactive power drawn and power factor of a grid-connected induction machine driven above synchronous speed, from its equivalent circuit.

Method: Induction machine equivalent circuit at negative slip

Input parameters

Unit system: SI

Parameter	Value	Unit
Line voltage (star)	400.00	V
Frequency	50.000	Hz
Number of poles	4.0000	
Shaft speed	1,530.0	rpm
Stator resistance per phase	0.080000	Ω
Stator leakage reactance	0.35000	Ω
Magnetising reactance	12.000	Ω
Rotor resistance referred	0.090000	Ω
Rotor leakage reactance referred	0.40000	Ω

Calculated results

Parameter	Value	Unit
Slip (negative when generating)	-2.0000	%
Electrical power delivered to the grid	33.051	kW
Reactive power drawn from the grid	18.943	kvar
Power factor	0.86760	
Mechanical input power	34.452	kW
Efficiency	95.933	%

Notes for this case

• Above synchronous speed the slip is negative and R_2'/s becomes a negative resistance: the machine returns real power to the grid while still drawing magnetising reactive power from it. Power is computed from the full equivalent circuit (stator impedance in series with the magnetising branch and rotor branch in parallel). Output rises roughly linearly with negative slip up to the pull-out point; reactive power is usually compensated with capacitors. Efficiency shows 0 if the machine is motoring.

Formula and method

$$s = \frac{n_s - n}{n_s} < 0, \quad Z = R_1 + jX_1 + \frac{jX_M(R_2'/s + jX_2')}{R_2'/s + j(X_2' + X_M)}, \quad S = 3V_\phi I^*$$

Variables

V_L	Line voltage (star)	V
f	Frequency	1/s
p	Number of poles	-
n	Shaft speed	rad/s
R_1	Stator resistance per phase	Ω
X_1	Stator leakage reactance	Ω
X_M	Magnetising reactance	Ω

R_2'	Rotor resistance referred	Ω
X_2'	Rotor leakage reactance referred	Ω
s	Slip (negative when generating)	-
P_e	Electrical power delivered to the grid	W
Q	Reactive power drawn from the grid	var
$\cos\varphi$	Power factor	-
P_m	Mechanical input power	W
η	Efficiency	-

Method and standards

Induction generator.

Assumptions and limits

- Steady state; constant parameters; star connection; core loss neglected.

References

Induction machine equivalent circuit at negative slip

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/induction-generator-grid

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.