Synchronous Machine Power–Angle and Pull-Out Power

Active and reactive power of a round-rotor synchronous machine from internal EMF, bus voltage, synchronous reactance and load angle, with pull-out power.

Method: Chapman; Electric Machinery Fundamentals; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Internal EMF (line value)	13.000	kV
Terminal (bus) line voltage	11.000	kV
Synchronous reactance per phase	12.000	Ω
Load angle	30.000	°

Calculated results

Parameter	Value	Unit
Active power	5.9583	MW
Reactive power to the bus	0.23680	Mvar
Pull-out (steady-state limit) power	11.917	MW
Stability margin	2.0000	

Notes for this case

• Round rotor, resistance neglected, line values (P = EV sin δ/X_s for three phases with line voltages). Salient-pole machines add a reluctance term.

Formula and method

$$P = \frac{EV}{X_s}\sin\delta, \quad Q = \frac{EV\cos\delta - V^2}{X_s}, \quad P_{max} = \frac{EV}{X_s}$$

Variables

E	Internal EMF (line value)	V
V	Terminal (bus) line voltage	V
X_s	Synchronous reactance per phase	Ω
δ	Load angle	rad
P	Active power	W
Q	Reactive power to the bus	var
P_{max}	Pull-out (steady-state limit) power	W
P_{max}/P	Stability margin	-

Method and standards

Round-rotor power–angle relation.

Assumptions and limits

- Round rotor, armature resistance neglected, line values for three phases. At zero load angle P is zero and the margin P_max/P is unbounded, so the page leaves it out.
- Infinite bus; resistance neglected.

References

• Chapman
• Electric Machinery Fundamentals
• 5th ed. (McGraw-Hill, 2012)

- ch. 4 (power and torque in synchronous machines)

Report details

Report reference	FCC-MT5W-4Y8D (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Synchronous Machine Power–Angle and Pull-Out Power
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/synchronous-power-angle

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.