



calculatoratoz.com



unitsconverters.com

Synchronous Motor Circuit Formulas

Calculators!

Examples!

Conversions!

Bookmark calculatoratoz.com, unitsconverters.com

Widest Coverage of Calculators and Growing - **30,000+ Calculators!**
Calculate With a Different Unit for Each Variable - **In built Unit Conversion!**
Widest Collection of Measurements and Units - **250+ Measurements!**

Feel free to SHARE this document with your friends!

[Please leave your feedback here...](#)



List of 31 Synchronous Motor Circuit Formulas

Synchronous Motor Circuit

1) 3 Phase Input Power of Synchronous Motor

$$\text{fx } P_{\text{in}(3\Phi)} = \sqrt{3} \cdot V_L \cdot I_L \cdot \cos(\Phi_s)$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 1584\text{W} = \sqrt{3} \cdot 192\text{V} \cdot 5.5\text{A} \cdot \cos(30^\circ)$$

2) 3 Phase Mechanical Power of Synchronous Motor

$$\text{fx } P_{\text{me}(3\Phi)} = P_{\text{in}(3\Phi)} - 3 \cdot I_a^2 \cdot R_a$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 1056.25\text{W} = 1584\text{W} - 3 \cdot (3.70\text{A})^2 \cdot 12.85\Omega$$

3) Angular Slot Pitch in Synchronous Motor

$$\text{fx } Y = \frac{P \cdot 180}{n_s \cdot 2}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 162.8406^\circ = \frac{3 \cdot 180}{95 \cdot 2}$$



4) Armature Current of Synchronous Motor given 3 Phase Mechanical Power

$$\text{fx } I_a = \sqrt{\frac{P_{\text{in}(3\Phi)} - P_{\text{me}(3\Phi)}}{3 \cdot R_a}}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 3.7\text{A} = \sqrt{\frac{1584\text{W} - 1056.2505\text{W}}{3 \cdot 12.85\Omega}}$$

5) Armature Current of Synchronous Motor given Input Power

$$\text{fx } I_a = \frac{P_{\text{in}}}{\cos(\Phi_s) \cdot V}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 3.699853\text{A} = \frac{769\text{W}}{\cos(30^\circ) \cdot 240\text{V}}$$

6) Armature Current of Synchronous Motor given Mechanical Power

$$\text{fx } I_a = \sqrt{\frac{P_{\text{in}} - P_{\text{m}}}{R_a}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 3.700878\text{A} = \sqrt{\frac{769\text{W} - 593\text{W}}{12.85\Omega}}$$



7) Armature Resistance of Synchronous Motor given 3 Phase Mechanical Power

$$\text{fx } R_a = \frac{P_{\text{in}(3\Phi)} - P_{\text{me}(3\Phi)}}{3 \cdot I_a^2}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 12.85\Omega = \frac{1584\text{W} - 1056.2505\text{W}}{3 \cdot (3.70\text{A})^2}$$

8) Armature Resistance of Synchronous Motor given Input Power

$$\text{fx } R_a = \frac{P_{\text{in}} - P_m}{I_a^2}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 12.8561\Omega = \frac{769\text{W} - 593\text{W}}{(3.70\text{A})^2}$$

9) Armature Winding Constant of Synchronous Motor

$$\text{fx } K_a = \frac{E_b}{\Phi \cdot N_s}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 0.614762 = \frac{180\text{V}}{0.12\text{Wb} \cdot 23300\text{rev}/\text{min}}$$



10) Back EMF of Synchronous Motor using Mechanical Power

$$fx \quad E_b = \frac{P_m}{I_a \cdot \cos(\alpha - \Phi_s)}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 179.8755V = \frac{593W}{3.70A \cdot \cos(57^\circ - 30^\circ)}$$

11) Distribution Factor in Synchronous Motor

$$fx \quad K_d = \frac{\sin\left(\frac{n_s \cdot Y}{2}\right)}{n_s \cdot \sin\left(\frac{Y}{2}\right)}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.001297 = \frac{\sin\left(\frac{95 \cdot 162.8^\circ}{2}\right)}{95 \cdot \sin\left(\frac{162.8^\circ}{2}\right)}$$

12) Input Power of Synchronous Motor

$$fx \quad P_{in} = I_a \cdot V \cdot \cos(\Phi_s)$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 769.0306W = 3.70A \cdot 240V \cdot \cos(30^\circ)$$



13) Load Current of Synchronous Motor given 3 Phase Mechanical Power



$$\text{fx } I_L = \frac{P_{\text{me}(3\Phi)} + 3 \cdot I_a^2 \cdot R_a}{\sqrt{3} \cdot V_L \cdot \cos(\Phi_s)}$$

[Open Calculator](#)

$$\text{ex } 5.5\text{A} = \frac{1056.2505\text{W} + 3 \cdot (3.70\text{A})^2 \cdot 12.85\Omega}{\sqrt{3} \cdot 192\text{V} \cdot \cos(30^\circ)}$$

14) Load Current of Synchronous Motor using 3 Phase Input Power



$$\text{fx } I_L = \frac{P_{\text{in}(3\Phi)}}{\sqrt{3} \cdot V_L \cdot \cos(\Phi_s)}$$

[Open Calculator](#)

$$\text{ex } 5.5\text{A} = \frac{1584\text{W}}{\sqrt{3} \cdot 192\text{V} \cdot \cos(30^\circ)}$$

15) Load Voltage of Synchronous Motor given 3 Phase Mechanical Power



$$\text{fx } V_L = \frac{P_{\text{me}(3\Phi)} + 3 \cdot I_a^2 \cdot R_a}{\sqrt{3} \cdot I_L \cdot \cos(\Phi_s)}$$

[Open Calculator](#)

$$\text{ex } 192\text{V} = \frac{1056.2505\text{W} + 3 \cdot (3.70\text{A})^2 \cdot 12.85\Omega}{\sqrt{3} \cdot 5.5\text{A} \cdot \cos(30^\circ)}$$



16) Load Voltage of Synchronous Motor using 3 Phase Input Power

$$fx \quad V_L = \frac{P_{in(3\Phi)}}{\sqrt{3} \cdot I_L \cdot \cos(\Phi_s)}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 192V = \frac{1584W}{\sqrt{3} \cdot 5.5A \cdot \cos(30^\circ)}$$

17) Magnetic Flux of Synchronous Motor given Back EMF

$$fx \quad \Phi = \frac{E_b}{K_a \cdot N_s}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 0.120937Wb = \frac{180V}{0.61 \cdot 23300rev/min}$$

18) Mechanical Power of Synchronous Motor

$$fx \quad P_m = E_b \cdot I_a \cdot \cos(\alpha - \Phi_s)$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 593.4103W = 180V \cdot 3.70A \cdot \cos(57^\circ - 30^\circ)$$

19) Mechanical Power of Synchronous Motor given Gross Torque

$$fx \quad P_m = \tau_g \cdot N_s$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19_img.jpg\)](#)

$$ex \quad 592.9128W = 0.243N*m \cdot 23300rev/min$$



20) Mechanical Power of Synchronous Motor given Input Power

$$fx \quad P_m = P_{in} - I_a^2 \cdot R_a$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$ex \quad 593.0835W = 769W - (3.70A)^2 \cdot 12.85\Omega$$

21) Number of Poles given Synchronous Speed in Synchronous Motor

$$fx \quad P = \frac{f \cdot 120}{N_s}$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$ex \quad 3 = \frac{61Hz \cdot 120}{23300rev/min}$$

22) Output Power for Synchronous Motor

$$fx \quad P_{out} = I_a^2 \cdot R_a$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$ex \quad 175.9165W = (3.70A)^2 \cdot 12.85\Omega$$

23) Phase Angle between Voltage and Armature Current given Input Power

$$fx \quad \Phi_s = a \cos\left(\frac{P_{in}}{V \cdot I_a}\right)$$

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d_img.jpg\)](#)

$$ex \quad 30.00394^\circ = a \cos\left(\frac{769W}{240V \cdot 3.70A}\right)$$



24) Power Factor of Synchronous Motor given 3 Phase Mechanical Power



$$fx \quad \text{Cos}\Phi = \frac{P_{me(3\Phi)} + 3 \cdot I_a^2 \cdot R_a}{\sqrt{3} \cdot V_L \cdot I_L}$$

Open Calculator

$$ex \quad 0.866025 = \frac{1056.2505W + 3 \cdot (3.70A)^2 \cdot 12.85\Omega}{\sqrt{3} \cdot 192V \cdot 5.5A}$$

25) Power Factor of Synchronous Motor given Input Power

$$fx \quad \text{Cos}\Phi = \frac{P_{in}}{V \cdot I_a}$$

Open Calculator

$$ex \quad 0.865991 = \frac{769W}{240V \cdot 3.70A}$$


26) Power Factor of Synchronous Motor using 3 Phase Input Power

$$fx \quad \text{Cos}\Phi = \frac{P_{in(3\Phi)}}{\sqrt{3} \cdot V_L \cdot I_L}$$

Open Calculator

$$ex \quad 0.866025 = \frac{1584W}{\sqrt{3} \cdot 192V \cdot 5.5A}$$




27) Pull Out Torque in Synchronous Motor 

$$fx \quad \tau = \frac{3 \cdot V_{\Phi} \cdot E_a}{9.55 \cdot N_m \cdot X_s}$$

Open Calculator 


$$ex \quad 0.034575N*m = \frac{3 \cdot 28.75V \cdot 25.55V}{9.55 \cdot 13560rev/min \cdot 4.7\Omega}$$

28) Synchronous Speed of Synchronous Motor 

$$fx \quad N_s = \frac{120 \cdot f}{P}$$

Open Calculator 


$$ex \quad 23300.28rev/min = \frac{120 \cdot 61Hz}{3}$$

29) Synchronous Speed of Synchronous Motor given Mechanical Power 

$$fx \quad N_s = \frac{P_m}{\tau_g}$$

Open Calculator 

$$ex \quad 23303.43rev/min = \frac{593W}{0.243N*m}$$

30) Torque Induced in Synchronous Motor 

$$fx \quad \tau = \frac{3 \cdot V_{\Phi} \cdot E_a \cdot \sin(\delta)}{9.55 \cdot N_m \cdot X_s}$$

Open Calculator 

$$ex \quad 0.033397N*m = \frac{3 \cdot 28.75V \cdot 25.55V \cdot \sin(75^\circ)}{9.55 \cdot 13560rev/min \cdot 4.7\Omega}$$



31) Voltage of Synchronous Motor given Input Power

[Open Calculator !\[\]\(4729e517bc6a7cd81c8025b9646574fb_img.jpg\)](#)

$$\text{fx } V = \frac{P_{\text{in}}}{I_a \cdot \cos(\Phi_s)}$$

$$\text{ex } 239.9905V = \frac{769W}{3.70A \cdot \cos(30^\circ)}$$



Variables Used










- **Cos Φ** Power Factor
- **E_a** Internal Generated Voltage (Volt)
- **E_b** Back EMF (Volt)
- **f** Frequency (Hertz)
- **I_a** Armature Current (Ampere)
- **I_L** Load Current (Ampere)
- **K_a** Armature Winding Constant
- **K_d** Distribution Factor
- **N_m** Motor Speed (Revolution per Minute)
- **n_s** Number of Slots
- **N_s** Synchronous Speed (Revolution per Minute)
- **P** Number of Poles
- **P_{in}** Input Power (Watt)
- **P_{in(3 Φ)}** Three Phase Input Power (Watt)
- **P_m** Mechanical Power (Watt)
- **P_{me(3 Φ)}** Three Phase Mechanical Power (Watt)
- **P_{out}** Output Power (Watt)
- **R_a** Armature Resistance (Ohm)
- **V** Voltage (Volt)
- **V_L** Load Voltage (Volt)
- **V Φ** Terminal Voltage (Volt)



- X_s Synchronous Reactance (Ohm)
- γ Angular Slot Pitch (Degree)
- α Load Angle (Degree)
- δ Torque Angle (Degree)
- T Torque (Newton Meter)
- T_g Gross Torque (Newton Meter)
- Φ Magnetic Flux (Weber)
- Φ_s Phase Difference (Degree)



Constants, Functions, Measurements used

- **Function:** **acos**, $\text{acos}(\text{Number})$
Inverse trigonometric cosine function
- **Function:** **cos**, $\text{cos}(\text{Angle})$
Trigonometric cosine function
- **Function:** **sin**, $\text{sin}(\text{Angle})$
Trigonometric sine function
- **Function:** **sqrt**, $\text{sqrt}(\text{Number})$
Square root function
- **Measurement:** **Electric Current** in Ampere (A)
Electric Current Unit Conversion 
- **Measurement:** **Power** in Watt (W)
Power Unit Conversion 
- **Measurement:** **Angle** in Degree ($^{\circ}$)
Angle Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Magnetic Flux** in Weber (Wb)
Magnetic Flux Unit Conversion 
- **Measurement:** **Electric Resistance** in Ohm (Ω)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Angular Velocity** in Revolution per Minute (rev/min)
Angular Velocity Unit Conversion 
- **Measurement:** **Torque** in Newton Meter ($\text{N}\cdot\text{m}$)
Torque Unit Conversion 



Check other formula lists

- **Synchronous Motor Circuit Formulas** 

Feel free to SHARE this document with your friends!

PDF Available in

[English](#) [Spanish](#) [French](#) [German](#) [Russian](#) [Italian](#) [Portuguese](#) [Polish](#) [Dutch](#)

2/13/2024 | 4:51:22 AM UTC

[Please leave your feedback here...](#)

