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# DC Motor Characteristics Formulas

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# List of 26 DC Motor Characteristics Formulas

## DC Motor Characteristics

### 1) Angular Speed given Electrical Efficiency of DC Motor

$$fx \quad \omega_s = \frac{\eta_e \cdot V_s \cdot I_a}{\tau_a}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$ex \quad 52.1788 \text{rev/s} = \frac{0.8 \cdot 240\text{V} \cdot 0.724\text{A}}{0.424\text{N}\cdot\text{m}}$$

### 2) Armature Current given Electrical Efficiency of DC Motor

$$fx \quad I_a = \frac{\omega_s \cdot \tau_a}{V_s \cdot \eta_e}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$ex \quad 0.723989\text{A} = \frac{52.178 \text{rev/s} \cdot 0.424\text{N}\cdot\text{m}}{240\text{V} \cdot 0.8}$$

### 3) Armature Current of DC Motor

$$fx \quad I_a = \frac{V_a}{K_f \cdot \Phi \cdot \omega_s}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$ex \quad 0.724496\text{A} = \frac{320\text{V}}{1.135 \cdot 1.187\text{Wb} \cdot 52.178 \text{rev/s}}$$



#### 4) Armature Torque given Electrical Efficiency of DC Motor

$$fx \quad \tau_a = \frac{I_a \cdot V_s \cdot \eta_e}{\omega_s}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 0.424006N*m = \frac{0.724A \cdot 240V \cdot 0.8}{52.178rev/s}$$

#### 5) Armature Torque given Mechanical Efficiency of DC Motor

$$fx \quad \tau_a = \eta_m \cdot \tau$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 0.4236N*m = 0.60 \cdot 0.706N*m$$

#### 6) Back EMF Equation of DC Motor

$$fx \quad E_b = \frac{n \cdot \Phi \cdot Z \cdot N}{60 \cdot n_{||}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 24.94334V = \frac{4 \cdot 1.187Wb \cdot 14 \cdot 1290rev/min}{60 \cdot 6}$$

#### 7) Constant Losses given Mechanical Loss

$$fx \quad C_{loss} = P_{core} + L_m$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$ex \quad 15.9W = 6.8W + 9.1W$$




8) Converted Power given Electrical Efficiency of DC Motor 

$$fx \quad P_{\text{conv}} = \eta_e \cdot P_{\text{in}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)


$$ex \quad 62.4W = 0.8 \cdot 78W$$

9) Core Loss given Mechanical Loss of DC Motor 

$$fx \quad P_{\text{core}} = C_{\text{loss}} - L_m$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)


$$ex \quad 6.8W = 15.9W - 9.1W$$

10) DC Motor Frequency given Speed 

$$fx \quad f = \frac{n \cdot N}{120}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 4.502949\text{Hz} = \frac{4 \cdot 1290\text{rev}/\text{min}}{120}$$

11) Electrical Efficiency of DC Motor 

$$fx \quad \eta_e = \frac{\tau_a \cdot \omega_s}{V_s \cdot I_a}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 0.799988 = \frac{0.424\text{N}\cdot\text{m} \cdot 52.178\text{rev}/\text{s}}{240\text{V} \cdot 0.724\text{A}}$$



12) Input Power given Electrical Efficiency of DC Motor 

$$fx \quad P_{in} = \frac{P_{conv}}{\eta_e}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 78W = \frac{62.4W}{0.8}$$

13) Machine Construction Constant of DC Motor 

$$fx \quad K_f = \frac{V_s - I_a \cdot R_a}{\Phi \cdot N}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)


$$ex \quad 1.135516 = \frac{240V - 0.724A \cdot 80\Omega}{1.187Wb \cdot 1290rev/min}$$

14) Magnetic Flux of DC Motor 

$$fx \quad \Phi = \frac{V_s - I_a \cdot R_a}{K_f \cdot N}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 1.187539Wb = \frac{240V - 0.724A \cdot 80\Omega}{1.135 \cdot 1290rev/min}$$


15) Mechanical Efficiency of DC Motor 

$$fx \quad \eta_m = \frac{\tau_a}{\tau}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 0.600567 = \frac{0.424N*m}{0.706N*m}$$




16) Mechanical Power Developed in DC Motor given Input Power 

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

Open Calculator 

$$ex \quad 36.06592W = 78W - ((0.724A)^2 \cdot 80\Omega)$$

17) Motor Speed of DC Motor 

$$fx \quad N = \frac{60 \cdot n_{||} \cdot E_b}{Z \cdot n \cdot \Phi}$$

Open Calculator 

$$ex \quad 1289.983\text{rev}/\text{min} = \frac{60 \cdot 6 \cdot 24.943V}{14 \cdot 4 \cdot 1.187Wb}$$

18) Motor Speed of DC Motor given Flux 

$$fx \quad N = \frac{V_s - I_a \cdot R_a}{K_f \cdot \Phi}$$

Open Calculator 

$$ex \quad 1290.586\text{rev}/\text{min} = \frac{240V - 0.724A \cdot 80\Omega}{1.135 \cdot 1.187Wb}$$

19) Motor Torque given Mechanical Efficiency of DC Motor 

$$fx \quad \tau = \frac{\tau_a}{\eta_m}$$

Open Calculator 

$$ex \quad 0.706667N*m = \frac{0.424N*m}{0.60}$$



## 20) Motor Torque of Series DC Motor given Machine Constant

$$\text{fx } \tau = K_f \cdot \Phi \cdot I_a^2$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$\text{ex } 0.706193\text{N}\cdot\text{m} = 1.135 \cdot 1.187\text{Wb} \cdot (0.724\text{A})^2$$

## 21) Output Power given Overall Efficiency of DC Motor

$$\text{fx } P_{\text{out}} = P_{\text{in}} \cdot \eta_o$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$\text{ex } 36.66\text{W} = 78\text{W} \cdot 0.47$$

## 22) Overall Efficiency of DC Motor

$$\text{fx } \eta_o = \frac{P_m}{P_{\text{in}}}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$\text{ex } 0.461538 = \frac{36\text{W}}{78\text{W}}$$

## 23) Overall Efficiency of DC Motor given Input Power

$$\text{fx } \eta_o = \frac{P_{\text{in}} - (P_{\text{cu(a)}} + P_{\text{cu(f)}} + P_{\text{loss}})}{P_{\text{in}}}$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19\_img.jpg\)](#)

$$\text{ex } 0.417949 = \frac{78\text{W} - (1.25\text{W} + 2.81\text{W} + 41.34\text{W})}{78\text{W}}$$



24) Supply Voltage given Electrical Efficiency of DC Motor [Open Calculator](#) 

$$fx \quad V_s = \frac{\omega_s \cdot \tau_a}{I_a \cdot \eta_e}$$

$$ex \quad 239.9963V = \frac{52.178\text{rev/s} \cdot 0.424\text{N}\cdot\text{m}}{0.724\text{A} \cdot 0.8}$$

25) Supply Voltage given Overall Efficiency of DC Motor [Open Calculator](#) 

$$fx \quad V_s = \frac{(I - I_{sh})^2 \cdot R_a + L_m + P_{core}}{I \cdot (1 - \eta_o)}$$

$$ex \quad 240.5996V = \frac{(0.658\text{A} - 1.58\text{A})^2 \cdot 80\Omega + 9.1\text{W} + 6.8\text{W}}{0.658\text{A} \cdot (1 - 0.47)}$$

26) Total Power Loss given Overall Efficiency of DC Motor [Open Calculator](#) 

$$fx \quad P_{loss} = P_{in} - \eta_o \cdot P_{in}$$

$$ex \quad 41.34\text{W} = 78\text{W} - 0.47 \cdot 78\text{W}$$





## Variables Used








- $C_{\text{loss}}$  Constant Loss (Watt)
- $E_b$  Back EMF (Volt)
- $f$  Frequency (Hertz)
- $I$  Electric Current (Ampere)
- $I_a$  Armature Current (Ampere)
- $I_{\text{sh}}$  Shunt Field Current (Ampere)
- $K_f$  Constant of Machine Construction
- $L_m$  Mechanical Losses (Watt)
- $n$  Number of Poles
- $N$  Motor Speed (Revolution per Minute)
- $n_{||}$  Number of Parallel Paths
- $P_{\text{conv}}$  Converted Power (Watt)
- $P_{\text{core}}$  Core Losses (Watt)
- $P_{\text{cu(a)}}$  Armature Copper Loss (Watt)
- $P_{\text{cu(f)}}$  Field Copper Losses (Watt)
- $P_{\text{in}}$  Input Power (Watt)
- $P_{\text{loss}}$  Power Loss (Watt)
- $P_m$  Mechanical Power (Watt)
- $P_{\text{out}}$  Output Power (Watt)
- $R_a$  Armature Resistance (Ohm)
- $V_a$  Armature Voltage (Volt)



- $V_s$  Supply Voltage (Volt)
- $Z$  Number of Conductors
- $\eta_e$  Electrical Efficiency
- $\eta_m$  Mechanical Efficiency
- $\eta_o$  Overall Efficiency
- $T$  Motor Torque (Newton Meter)
- $T_a$  Armature Torque (Newton Meter)
- $\Phi$  Magnetic Flux (Weber)
- $\omega_s$  Angular Speed (Revolution per Second)



## Constants, Functions, Measurements used

- **Measurement: Electric Current** in Ampere (A)  
*Electric Current Unit Conversion* 
- **Measurement: Power** in Watt (W)  
*Power 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 ( $\Omega$ )  
*Electric Resistance Unit Conversion* 
- **Measurement: Electric Potential** in Volt (V)  
*Electric Potential Unit Conversion* 
- **Measurement: Angular Velocity** in Revolution per Second (rev/s),  
Revolution per Minute (rev/min)  
*Angular Velocity Unit Conversion* 
- **Measurement: Torque** in Newton Meter (N\*m)  
*Torque Unit Conversion* 



## Check other formula lists

- [DC Motor Characteristics Formulas](#) 
- [DC Series Motor Formulas](#) 
- [DC Shunt Motor Formulas](#) 

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