



## **Magnetic Circuit Formulas**

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Examples!

Conversions!

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### **List of 23 Magnetic Circuit Formulas**

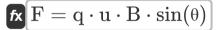
### Magnetic Circuit

### **Electrical Specifications**

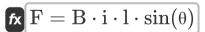
1) Energy Stored in Magnetic Field

$$\mathbf{E} = \frac{\mathbf{B}}{\mu^2}$$

ex  $10.20408 \mathrm{J} = rac{0.2 \mathrm{T}}{\left(0.14 \mathrm{H/m}\right)^2}$ 



 $0.153N = 0.18mC \cdot 4250m/s \cdot 0.2T \cdot sin(90^{\circ})$ 

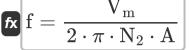


 $\mathbf{ex} \left[ 0.15606 \mathrm{N} = 0.2 \mathrm{T} \cdot 2.89 \mathrm{A} \cdot 270 \mathrm{mm} \cdot \sin(90\degree) \right]$ 

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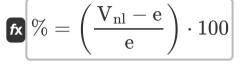
#### 4) Minimum Frequency to Avoid Saturation



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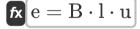
 $extbf{ex} 15.56182 ext{Hz} = rac{440 ext{V}}{2 \cdot \pi \cdot 18 \cdot 0.25 ext{m}^2}$ 

## 5) Percent Voltage Regulation



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## 6) Voltages Induced in Field Cutting Conductors



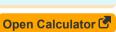
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 $ext{ex} \ 229.5 ext{V} = 0.2 ext{T} \cdot 270 ext{mm} \cdot 4250 ext{m/s}$ 

# Magnetic Specifications &

## 7) Average Hysteresis Power Loss

$$ag{P_{ ext{hystersis}} = K_{ ext{h}} \cdot f \cdot B^{ ext{n}}}$$



 $ext{ex} \left[ 2.523697 ext{W} = 2.13 ext{J/m}^3 \cdot 15.56 ext{Hz} \cdot \left( 0.2 ext{T} 
ight)^{1.6} 
ight]$ 







### 8) Flux Density in Toroidal Core 🗹

 $ext{B} = rac{\mu_{
m r} \cdot N_2 \cdot i_{
m coil}}{\pi \cdot D_{
m in}}$ 

Open Calculator

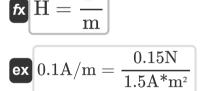
 $0.229183 \mathrm{T} = rac{1.9 \mathrm{H/m} \cdot 18 \cdot 0.012 \mathrm{A}}{\pi \cdot 570 \mathrm{mm}}$ 

## 9) Intensity of Magnetization

 $I_{
m mag}=rac{m}{V}$  o. $810811{
m A/m}=rac{1.5{
m A}^*{
m m}^2}{1.85{
m m}^3}$ 

Open Calculator

## 10) Magnetic Field Strength



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## 11) Magnetic Flux Density

$$0.2 \mathrm{T} = rac{0.05 \mathrm{Wb}}{0.25 \mathrm{m}^2}$$





Open Calculator

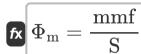
## 12) Magnetic Flux Density using Magnetic Field Intensity 🗗



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 $0.252T = 0.14H/m \cdot 1.8A/m$ 

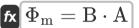
#### 13) Magnetic Flux in Core



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 $0.057377 {
m Wb} = rac{0.035 {
m AT}}{0.61 {
m AT/Wb}}$ 

#### 14) Magnetic Flux using Flux Density



Open Calculator G

 $0.05 \text{Wb} = 0.2 \text{T} \cdot 0.25 \text{m}^2$ 

#### 15) Magnetic Potential

$$\psi = \frac{m}{4 \cdot \pi \cdot [Permeability\text{-}vacuum] \cdot \mu_r \cdot D_{poles}}$$

 $1.5A*m^{2}$ 

fx



#### 16) Magnetic Susceptibility

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Open Calculator

Open Calculator

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 $oxed{ex} 0.45 {
m H/m} = rac{0.81 {
m A/m}}{1.8 {
m A/m}}$ 

## 17) Mutual Inductance

 $M = \frac{[Permeability\text{-}vacuum] \cdot \mu_r \cdot A \cdot Z \cdot N_2}{}$ 

21.6mm

## 18) Permeance

 $\mathbf{f} \mathbf{x} = \frac{1}{S}$ 

= 1.639344H =  $\frac{1}{0.61 \mathrm{AT/Wb}}$ 

### 19) Reluctance

 $\mathbf{S} = rac{\mathrm{L}_{\mathrm{mean}}}{\mathbf{\mu} \cdot \mathbf{A}}$ 

$$ext{ex} 0.617143 ext{AT/Wb} = rac{21.6 ext{mm}}{0.14 ext{H/m} \cdot 0.25 ext{m}^2}$$







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Open Calculator

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## 20) Self Inductance

 $= \frac{1500 \cdot 0.05 \text{Wb}}{0.012 \text{ A}}$ 

## Mechanical Specifications

## 21) Area of Ring

fx  $A = rac{\pi \cdot D_{ ext{in}}^2}{A}$ 

 $\left| \mathbf{ex} \right| 0.255176 \mathrm{m}^{_2} = rac{\pi \cdot \left( 570 \mathrm{mm} 
ight)^2}{4}$ 

22) Mean Diameter

 $ag{D_{ ext{mean}}} = rac{ ext{L}_{ ext{mean}}}{\pi}$ 21.6mm 6.875494mm = -

## 23) Mean Length

fx  $m L_{mean} = \pi \cdot D_{mean}$ 

ex 21.67699mm =  $\pi \cdot 6.9$ mm



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#### Variables Used

- % Percentage Regulation
- A Area of Coil (Square Meter)
- **B** Magnetic Flux Density (*Tesla*)
- Din Coil Inner Diameter (Millimeter)
- D<sub>mean</sub> Mean Diameter (Millimeter)
- Dpoles Pole Distance (Millimeter)
- e Voltage (Volt)
- **E** Energy (Joule)
- **f** Frequency (Hertz)
- F Force (Newton)
- **H** Magnetic Field Strength (Ampere per Meter)
- i Electric Current (Ampere)
- I Magnetic Field Intensity (Ampere per Meter)
- i<sub>coil</sub> Coil Current (Ampere)
- I<sub>maq</sub> Intensity of Magnetization (Ampere per Meter)
- K<sub>h</sub> Hysteresis Constant (Joule per Cubic Meter)
- Length of Conductor (Millimeter)
- L Self Inductance (Henry)
- Lmean Mean Length (Millimeter)
- m Magnetic Moment (Ampere Square Meter)
- M Mutual Inductance (Henry)
- mmf Magnetomotive Force (Ampere-Turn)
- n Steinmetz Coefficient





- N<sub>2</sub> Secondary Turns of Coil
- P Magnetic Permeance (Henry)
- Phystersis Hysteresis Loss (Watt)
- **q** Electric Charge (Millicoulomb)
- **S** Reluctance (Ampere-Turn per Weber)
- **u** Charge Velocity (Meter per Second)
- V Volume (Cubic Meter)
- V<sub>m</sub> Peak Voltage (Volt)
- V<sub>nl</sub> No Load Voltage (Volt)
- X Magnetic Susceptibility (Henry per Meter)
- Z Number of Conductors
- **0** Angle between Vectors (*Degree*)
- µ Magnetic Permeability of a Medium (Henry per Meter)
- µ<sub>r</sub> Relative Permeability (Henry per Meter)
- Φ<sub>m</sub> Magnetic Flux (Weber)
- ψ Magnetic Potential



### Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288
   Archimedes' constant
- Constant: [Permeability-vacuum], 4 \* Pi \* 1E-7 Henry / Meter Permeability of vacuum
- Function: sin, sin(Angle)

  Trigonometric sine function
- Measurement: Length in Millimeter (mm)
   Length Unit Conversion
- Measurement: Electric Current in Ampere (A)
  Electric Current Unit Conversion
- Measurement: Volume in Cubic Meter (m³)

  Volume Unit Conversion
- Measurement: Area in Square Meter (m²)
   Area Unit Conversion
- Measurement: Speed in Meter per Second (m/s)
   Speed Unit Conversion
- Measurement: Energy in Joule (J)
   Energy Unit Conversion
- Measurement: Electric Charge in Millicoulomb (mC)

  Electric Charge Unit Conversion
- Measurement: Power in Watt (W)
   Power Unit Conversion
- Measurement: Force in Newton (N)
  Force Unit Conversion
- Measurement: Angle in Degree (°)
   Angle Unit Conversion





- Measurement: Frequency in Hertz (Hz)
   Frequency Unit Conversion
- Measurement: Magnetic Flux in Weber (Wb)
   Magnetic Flux Unit Conversion
- Measurement: Inductance in Henry (H)
  Inductance Unit Conversion
- Measurement: Magnetic Flux Density in Tesla (T)

  Magnetic Flux Density Unit Conversion
- Measurement: Magnetomotive Force in Ampere-Turn (AT)
   Magnetomotive Force Unit Conversion
- Measurement: Magnetic Field Strength in Ampere per Meter (A/m)
   Magnetic Field Strength Unit Conversion
- Measurement: Electric Potential in Volt (V)
   Electric Potential Unit Conversion
- Measurement: Magnetic Permeability in Henry per Meter (H/m)
   Magnetic Permeability Unit Conversion
- Measurement: Magnetic Moment in Ampere Square Meter (A\*m²)
   Magnetic Moment Unit Conversion
- Measurement: Energy Density in Joule per Cubic Meter (J/m³)
   Energy Density Unit Conversion
- Measurement: Reluctance in Ampere-Turn per Weber (AT/Wb)

  Reluctance Unit Conversion





#### **Check other formula lists**

- AC Circuits Formulas
- DC Circuits Formulas
- Magnetic Circuit Formulas
- Two-Port Network Formulas

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