

Solenoids and Shaped Field Electromagnets

GLOSSARY

These terms are specific to Solenoids. Please also visit our Glossaries for Permanent and Soft Magnetics which are available in the Technology Center section of the Arnold website.

Air Cooled	A means to cool a section of an electromagnet by forcing air to cross its surface to cool.
Air Gap	A non-magnetic discontinuity in a ferro-magnetic circuit. For example, the space between the poles of a magnet, although filled with brass or wood or any other non-magnetic material, is nevertheless called an air gap.
Annulus	The distance from the I.D. of the case material to the O.D. of the conducting section.
Average Winding Temperature	The temperature of the internal windings of a shaped field electromagnet after stabilization has been reached.
Cooling Plate	Usually Copper in design, a means to allow water to flow through the material in effect cooling down the surfaces in contact.
Current	The rate of flow of electricity in a circuit. The practical unit is the ampere, which is one coulomb per second.
Current Density	The ratio of a current to the cross-sectional area of its path in a plane perpendicular to the direction of the current.
Depth of Winding	The distance from the outside diameter of a winding to the inside diameter of a winding.
Henry	The inductance of a circuit in which an emf on one volt is produced when the current in the circuit changes uniformly at the rate of one ampere per second.
Rectifier	Is any device, which presents a different resistance to the flow of an electric current when the direction of the current is reversed.
Resistance	The property of a circuit or element which determines for a given current the rate at which electrical energy is converted to heat in accordance with the formula $W=I^2R$. The practical unit is OHM.
Solenoid	A solenoid is an electrically energized coil, the turns of whose winding are insulated from each other even when the conductor is bare and the turns are spaced in air. Two solenoids mutually attract or repel one another according to their relative polarities.

Space Factor	Space factor of a coil is the ratio of the space occupied by the conductor to the total volume of the coil or winding.
Stacking Core Tube	A non-magnetic cylinder used to stack sections of conducting material onto. This will also act as the I.D. of the entire solenoid assembly.
Turns	Number of turns of conducting material, usually aluminum or copper, that are wrapped around a winding core tube.
Volt	The difference of potential between two points. In a conductor carrying a constant current of one ampere when the power dissipated between the points is one watt, there being no source of emf between the points
Water Cooled	A means to cool a section of an electromagnet by forcing water through cooling plates to cool down the face of a section.
Watt	The power expended when there is an unvarying current of one ampere between two points having a potential difference of one volt.
Winding Core Tube	A non-magnetic cylinder used exclusively to wind the conducting material onto.

Gauss Formula For Center Of Solenoid:

$$B_o = \frac{.4956 * N * I}{O.D. - I.D.} * \ln \left[\frac{O.D. + \sqrt{O.D.^2 + L^2}}{I.D. + \sqrt{I.D.^2 + L^2}} \right]$$

Gauss Formula At Distance x From Center:

$$\frac{.25 * N * I}{R2 - R1} * \frac{L}{2 + x} * \ln \left[\frac{R2 + \sqrt{R2^2 + \left(\frac{L}{2+x}\right)^2}}{R1 + \sqrt{R1^2 + \left(\frac{L}{2+x}\right)^2}} \right] + \frac{L}{2 - x} * \ln \left[\frac{R2 + \sqrt{R2^2 + \frac{L}{2-x}}}{R1 + \sqrt{R1^2 + \frac{L}{2-x}}} \right]$$

- R2 = Outside Radius
- R1 = Inside Radius
- L = Length of Coil
- X = Distance from coil center
- O.D. = Outside diameter
- I.D. = Inside diameter
- N = # of turns of conductor
- I = Current